DETAILED CONTROL ROOM DESIGN REVIEW (DCRDR) PROGRAM PLAN FOR DAVIS BESSE NUCLEAR POWER PLANT

Prepared For:

Nuclear Regulatory Commission

Prepared By:

Toledo Edison Company

June 15, 1983

Revision 0

DETAILED CONTROL ROOM DESIGN REVIEW (DCRDR)
PROGRAM PLAN FOR DAVIS BESSE NUCLEAR POWER PLANT

TABLE OF CONTENTS

DETAILED CONTROL ROOM DESIGN REVIEW (DCRDR)
PROGRAM PLAN FOR DAVIS BESSE NUCLEAR POWER PLANT

LIST OF FIGURES

LIST OF TABLES

DETAILED CONTROL ROOM DESIGN REVIEW (DCRDR)
PROGRAM PLAN FOR DAVIS BESSE NUCLEAR POWER PLANT

1.0 REVIEW PLAN

1.1 Introduction

This Program Plan Report has been prepared in response to NUREG-0737 para. I.D.1. and describes the program for a Detailed Control Room Design Review (DCRDR) to be conducted for the Davis Besse Nuclear Power Plant owned and operated by the Toledo Edison Company. The format of this report follows that recommended by NUREG-0700 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 Implementation
6. DCRDR Schedule

This program plan addresses the acceptance guidelines stated in Section 2 of the October 81 Draft of NUREG-0801 and the guidelines provided in Section 2 "Planning Phase" of NUREG-0700.

1.2 Task Phasing

The review is to be conducted in four phases, as follows:

Phase 1- Project Planning

Final acceptance of this document culminates the planning phase.

Phase 2- CR Review

This represents the period in which data collection, reduction and analysis is conducted, resulting in human engineering discrepancy (HED) reports and draft reports.

Phase 3 - Enhancement and Design Solutions

Discrepancies are collated, alternate enhancements and design solutions are generated and the results are considered in trade-offs.

Phase 4 - Reporting

DCRDR results are provided to the NRC in a Summary Report outlining proposed control room changes, including their proposed schedules for implementation. These schedules will be prepared in accordance with the criteria set forth in TED's Integrated Living Schedule Program.

Figure 1 shows, in general, the phases and task flow for conducting the DCRDR. A brief discussion of the activities conducted in each phase of the review is provided below. More detailed descriptions of the objectives, approach, data reduction and results of specific evaluations will be provided in detailed task plans. Refer to Section 4.0 Technical Approach of this review plan for a description of the scope and content of these task plans.

NUREG 0700 shall be used to provide guidelines in the performance of the DCRDR and every effort will be made to comply with the guidance provided therein. Approaches, methods or reporting procedures different from the guidance provided in NUREG 0700 shall be structured to ensure adequate human factors engineering considerations which shall be appropriately documented.

1.2.1 Phase 1 - Project Planning

Acceptance of this document essentially concludes project planning. The guidelines provided in NUREG-0700 and NUREG-0801 form the basis of this document.

1.2.2 Phase 2 - CR Review

The CR review phase is subdivided into seven tasks as follows:

1. Review of Operating Experience
2. Assemble CR Documentation
3. Review of System Functions and Task Analysis (SFTA)
4. CR Surveys
5. Verify Task Performance Capability
6. Validate CR Functions
7. Assess Discrepancies

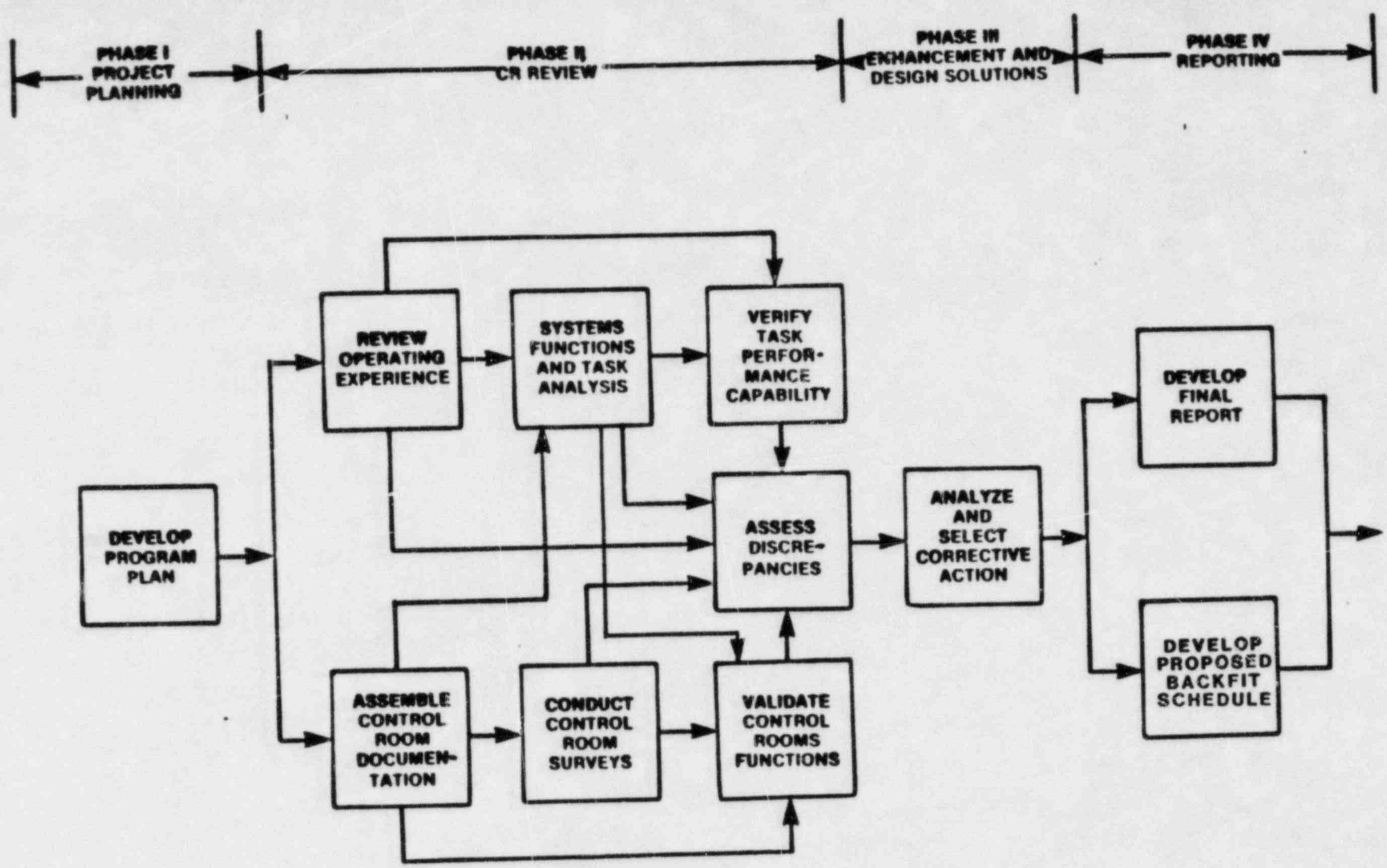


FIGURE 1 The four phases and the task flow/relationships of the CR review.

1.2.2.1 Review of Operating Experience

This task is composed of two subtasks:

1) Conduct of operator interviews

2) Review of plant operational experience through LERs, TAP Reports, etc.

1.2.2.2 Assemble CR Documentation

In this task, a CR data base is established to support the subsequent evaluation. A library is established with CR related documentation (tech specs, drawings, etc.), CR components are photo-documented, and full scale photo-mosaic is constructed. The library and photo-documentation are centrally located to support the effort. In addition to the library and photographic documentations, a CR inventory of components is developed, identifying for each component, its location, system relationships, functions, and characteristics. Inventory data is filed for subsequent use.

1.2.2.3 Conduct CR Surveys

Much of the detailed assessment of the control room is conducted via surveys. A total of 13 surveys will be conducted. Surveys require the collection of data using preconstructed checklists, interview forms, and direct measurements of CR parameters such as noise levels, light levels etc. The guidance for the survey criteria is found in NUREG-0700. For each survey, a draft report (summarizing HEDs) is prepared for subsequent inclusion into a final report. The surveys to be conducted are:

- Noise - direct measurements of noise levels are taken and compared to individual checklists items

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

- CR Environment - assessments are made by direct measurement of the parameters listed below and comparison of the data to the 0700 guidelines

  - Temperature
  - Humidity
  - Ventilation
  - Workspace Arrangement
  - Document Organization, Use and Storage
  - CR Access

- Design Conventions - evaluated by survey for the conventions listed below. Data subsequently compared to 0700 guidelines

  - Coding methods (color, shape, pattern, etc.)
  - Standardization of abbreviations and acronyms
  - Consistency of Control Use
  - Consistency of Display Measurement or Indication

- Controls - checklist evaluation of controls

- Displays - checklist evaluation of displays

- Computers - checklist evaluation of computer systems

- Labeling - checklist evaluation of labels

- Annunciators - checklist evaluation of annunciator systems

- Anthropometrics - analysis of reach and visual access to CR components given physical configuration of boards, panels, layout, etc. Data subsequently compared to checklist item requirements

- Force/Torque - where indicated by operator observation, force/torque information for control types are collected for comparison to checklist items

- Communications - checklist evaluation of communications systems. Speech intelligibility analysis of communications modes

- Maintainability - checklist and questionnaire data concerning operator-maintained components (trend recorders, bulbs, etc.)

1.2.2.4 Review of System Functions and Task Analysis (SFTA)

System functions and tasks are identified and evaluated in this task. A four step procedure is employed:

- Identification of systems and subsystems by review of plant documentation

- Identification of event sequences to undergo task analysis. The scope of this analysis will include those sequences set forth in the Davis Besse Abnormal Transient Operating Guidelines.

  These events include:

  - Small Break LOCA
  - Small Steam Line Break
  - Excess Feedwater
  - Loss of Normal Feedwater
  - Loss of Offsite AC Power
  - Steam Generator Tube Rupture

- Identification of system/subsystem functions through document review and operator interviews

- Identification and analysis of CR operational tasks

Task analysis data is an input for the verification of task performance capability and the validation of CR functions (see paragraphs 1.2.2.5 and 1.2.2.6). The results/products of this task are:

1. Response Selection Diagrams

2. Task Analysis of Functional Sequences

3. Task Analysis of Event Sequences

4. Spatial-Operational Sequence Diagrams of Task Sequences

5. Traffic Pattern Diagrams

1.2.2.5 Verify Task Performance Capability

This evaluation task involves two subtasks: verification of instrument/control availability, and verification of HE suitability. The first, verification of availability, is conducted using the task analysis and CR inventory. In general, tasks associated with CR functions are examined in terms of appropriate instrumentation in the CR (i.e., task equipment demands vs. actual equipment presence in the CR). Also, task sequences required in selected event sequences are estimated as to frequency of occurrence in the event sequences. Comparing both frequency and requirements data to the inventory, identification is made of:

1. The absence (in the CR) of task required information or control.

2. The estimated frequency with which the information or control is required.

3. The conditions (events, procedures, etc.) under which the information or control is required. Based on the above, HEDs are identified and documented.

The second, verification of suitability, involves using Spatial-Operational Sequence Diagrams (S-OSDs), traffic pattern diagrams, identified functional groups, and checklists to evaluate HE suitability in terms of sequence of component use, control/ display proximity and so forth. The NUREG-0700 guidelines serve as the source document for evaluation criteria.

1.2.2.6 Validate CR Functions

This involves analysis of workload and distribution of workload for operators for specific task and event sequences. Also analyzed is overall CR traffic. The means of the analysis are:

1. Task Timelines
2. Traffic Analysis, and
3. Walk- and talk-through simulation of task sequences.

Checklists will be used to aid in the validation of CR functions.

1.2.2.7 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:

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

1.2.3 Phase 3 - Enhancement and Design Solutions

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

1. Analysis of Correction by Enhancement

2. Analysis of Correction by Design Alternatives

3. Assess Extent of Correction

1.2.3.1 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.

1.2.3.2 Analysis of Correction by Design Alternative

Identification of design alternatives will be achieved by the examination of the HED, reference to task analysis data, and identification of potential constraints (e.g., availability of equipment, Reg. Guide 1.75, etc.). The acceptability of design alternatives will be verified by further evaluation using the following:

- o Functional Analysis
- o Task Analysis
- o Reapplication of 0700 Guidelines

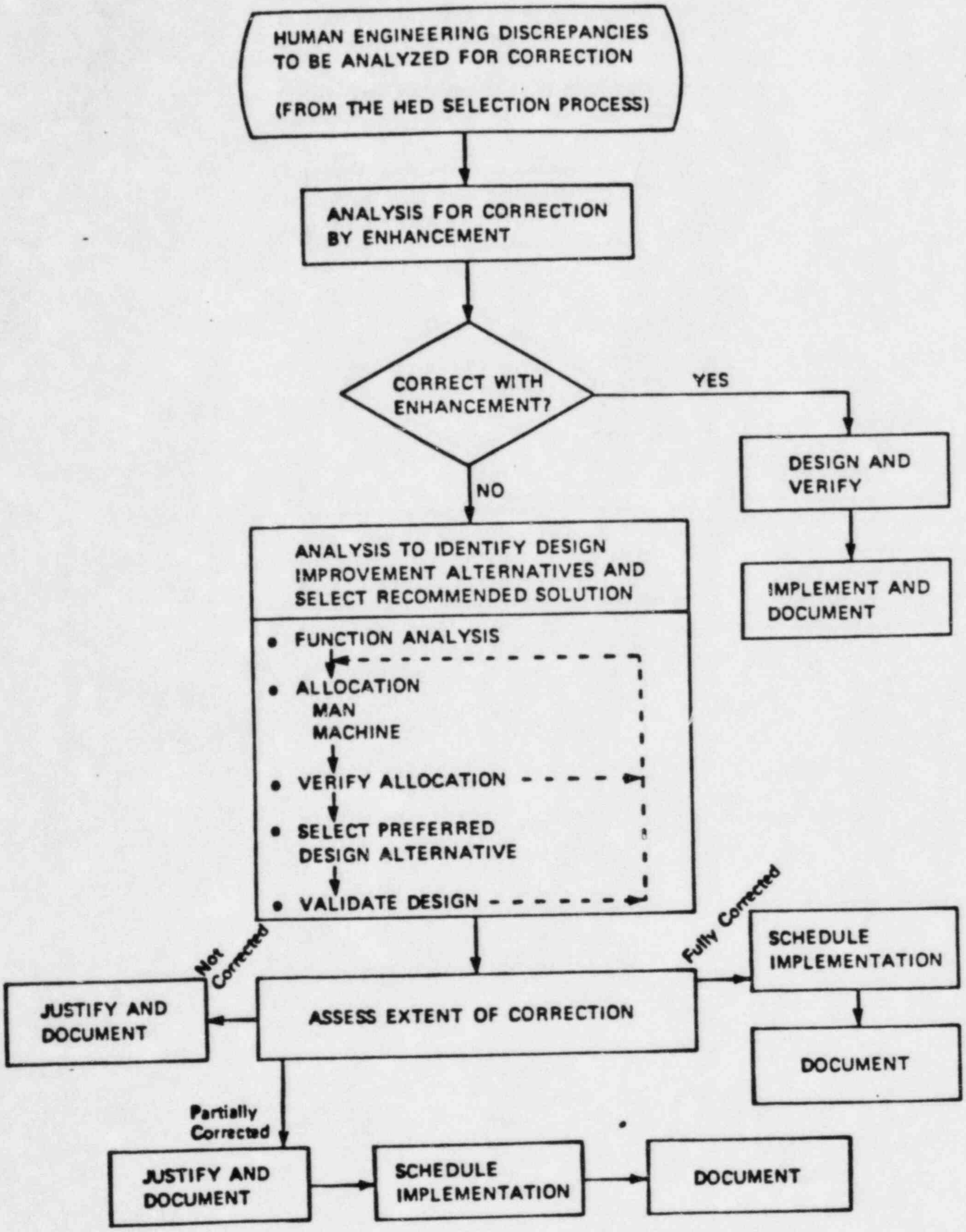


FIGURE 2
ASSESSMENT: SELECTION OF DESIGN IMPROVEMENTS
(FROM NUREG 0700)

1.2.3.3 Assess Extent of Correction

For all HEDs selected for correction, extent of correction (by enhancement or redesign) will undergo evaluation. The means to achieve the assessment is simply reapplication of NUREG-0700 guidelines and verification of HE suitability.

1.2.4 Phase 4 - Reporting

Two requirements of this phase are:

1. Preparation of proposed schedules for implementation of selected backfits, utilizing the criteria set forth in the Integrated Living Schedule Program.

2. Preparation and submittal of the final summary report.

1.2.4.1 Develop Backfit Schedules

Backfit schedules will be prepared as HEDs are identified, documented, and assessed. Scheduling of HED backfits will be a function of:

- o The Integrated Living Schedule Program Committments
- o HED category and priority
- o Engineering and procurring lead time requirements and constraints
- o Overall plant outage schedules

Schedules will be reviewed and updated as part of the implementation program.

1.2.4.2 Develop Final Summary Report

The DCRDR report will closely follow the outline recommended in Section 5.2 of NUREG-0700. Specifically, the final report will address:

- The DCRDR phases
- The technical activities
  - Review of Operating Experience
  - Assembly of CR Documentation
  - System/Function/Task Analysis
  - Conduct of CR Surveys
  - Verification of Task Performance Capability
  - Validation of CR Functions
- Method of Assessment of Discrepancies
- Method of Identification and Selection of Enhancement and Design Solutions
- Review results of HEDs, HED Assessment, and the selected enhancement and design solutions will be organized into the following groups:
  - Survey findings (annunciator, communications, etc.)
  - Task analysis findings (panel/workspace)
  - HE suitability and validation of functions findings (CR traffic, workload distribution, man/machine functional allocations)
- Improvements to be made
  - Enhancements/justification/extent of correction
  - Design alternative/justification/ extent of correction
- Proposed schedule for implementation

2.0 MANAGEMENT AND STAFFING

2.1 Introduction

The quality of the review effort and the results of the DCRDR depend upon the composition, balance and management of the review team. This section provides a description of the structure and management of the Davis Besse DCRDR team including the names of team members, their responsibilities, their estimated participation and a brief statment of their qualifications.

The DCRDR is being performed as part of an Integrated Emergency Response Review Program in response to Supplement 1 to NUREG-0737. Therefore the DCRDR is being coordinated and integrated with the other initiatives involving human factors which are part of that program such as the Safety Parameter Display System (SPDS), Upgrade of Emergency Operating Procedures, Regulatory Guide 1.97 review and Emergency Response Facilities.

2.2 Structure and Management of DCRDR Team

The DCRDR team consists of a combination of Toledo Edison (TED) personnel and outside consultants, who provide the necessary interdisciplinary expertise to conduct the review. Figure 3 shows the review team organization. Individual review tasks or processes will be performed primarily by EDS Nuclear, Inc. and ESSEX Corporation personnel with the necessary expertise. TED personnel will provide the required support for the performance of all tasks and will review all plans, procedures and reports associated with each task. The technical advisory team, consisting of senior technical specialists from TED, EDS and ESSEX will perform an independent check and review function on the project. They will assist in establishing the direction of the project and will actively participate in resolving the problems that arise. The primary function of the advisory team however will be in the area of HED assessment.

The following is a brief description of the responsibilities and qualifications of the key review team members.

2.2.1 The Project Administrator is the Toledo Edison Company's representative who has the overall responsibility for the DCRDR. His responsibilities include but are not limited to:

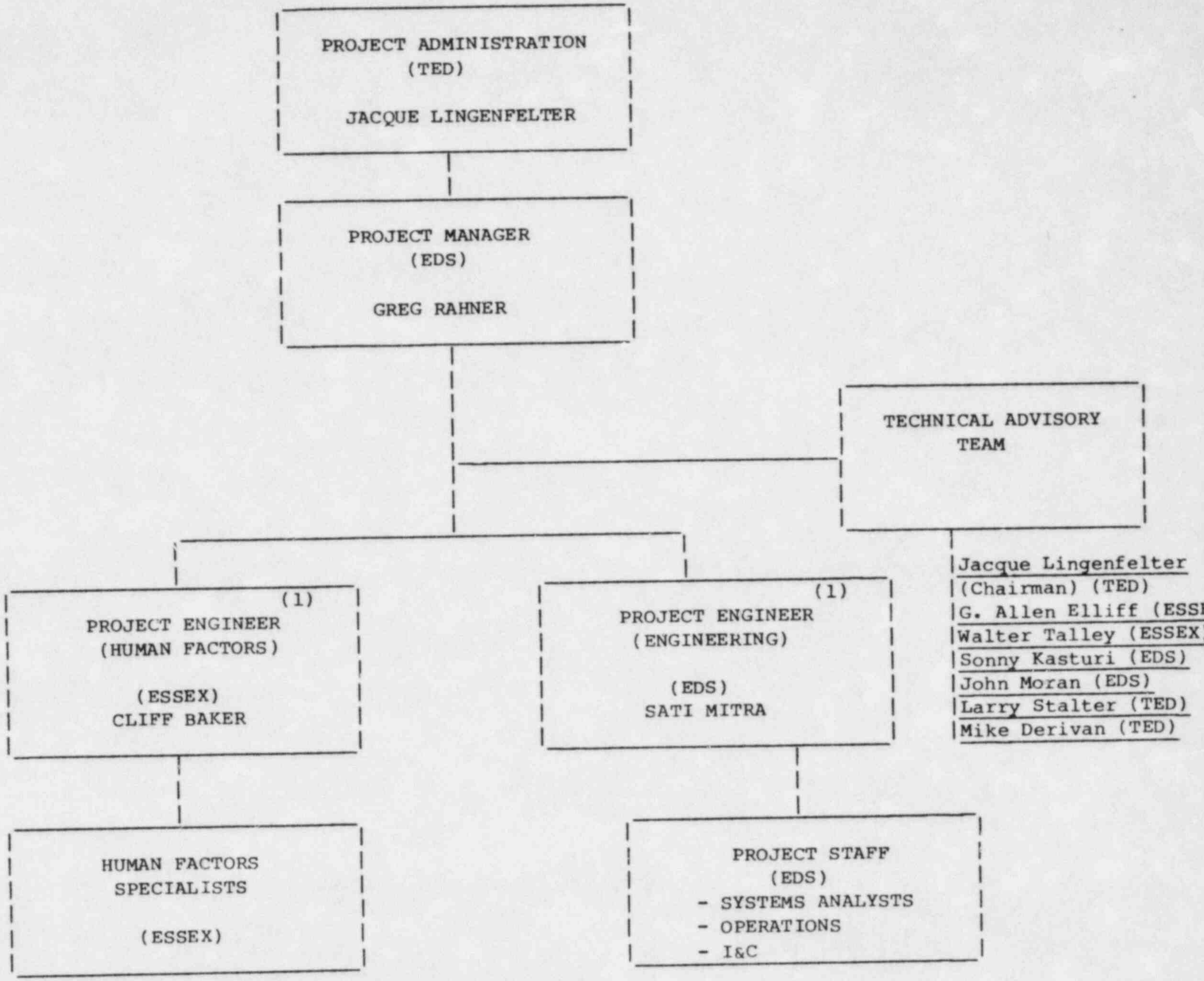
A) The overall administration of the Detailed Control Room Design Review (DCRDR).

B) Administering vendor contracts associated with the performance of the DCRDR.

FIGURE 3

DAVIS BESSE DCRDR PROGRAM ORGANIZATION

TED - Toledo Edison Company
EDS - EDS Nuclear, Inc.
ESSEX - ESSEX Corporation



(1) The position of Project Engineer corresponds to that of Technical Review Leader discussed in Section 2.1.1 of Draft NUREG-0801.

C) Integrating and coordinating other Human Factors Programs as described in other NRC publications.

D) Coordinating and developing the necessary administrative controls to support the organization controls of an implementation program.

E) Interfacing with other department/divisions within Toledo Edison to provide the necessary support of review team activities.

F) Serving as technical advisory team chairman (see paragraph 2.2.5 below)

The Project Administrator will be Mr. Jacque Lingenfelter.

Mr. Lingenfelter has over 11 years experience in the Davis-Besse nuclear power program at Toledo Edison. As a part of the on-site technical support staff, his involvement in the preoperational, startup, and operational phases of the Davis-Besse Nuclear Power Station have given him exposure to a broad range of activities. These activities included responsibility for all phases of reactor operations, the development of administrative systems for activities such as licemsee event reporting, surveillance test scheduling, and all phases of plant startup testing. He obtained a Senior Reactor Operators license on the unit and was, consequently, involved in the development of plant operations, testing, and emergency procedures, and in the analysis of station trips and transients. He became one of the primary interfaces between the Station and the NRC, and was involved in the initial development of plant Technical Specifications.

Mr. Lingenfelter is currently the Technical Engineer at Toledo Edison, managing the on-site Technical Services Section. This group is responsible for the development of the Safety Parameter Display System and the implementation of the Upgraded Emergency Operating Procedures, in addition to the conduct of the Detailed Control Room Design Review and the integration of all activities identified in Supplement 1 to NUREG 0737.

2.2.2 The Project Manager (PM) reports directly to the Project Administrator. The PM is responsible for directing and coordinating the necessary personnel, task teams and review groups required to support the DCRDR effort. This arrangement of administrative responsibility allows the DCRDR management team to quickly evaluate project priorities, and assign specialized key personnel based on the overall project schedule. The assessment and disposition of HED's will be addressed under the technical advisory team (paragraph 2.2.5).

The Project Manager will be Mr. Gregory T. Rahner. Mr Rahner has eleven years experience in various aspects of power plant safety and licensing. Mr. Rahner has had extensive experience in the area of PWR and BWR safety system analysis. Mr. Rahner and his staff have evaluated the response of various plant systems to selected events. The results of these analyses are used to review the plant's mechanical, electrical, heating and ventilating and instrumentation equipment to ensure proper functional response. The analysis is also used to develop plant operating/emergency procedures, train operators, etc.

2.2.3 The Project Engineer (Engineering) (PE-E) reports directly to the Project Manager. The PE-E will coordinate and schedule all project efforts under his responsibility. He will be responsible for the timely performance of all engineering tasks and will supervise project personnel on a day-to-day basis. He will have reporting to him a project staff of specialists consisting of a reactor operator, a nuclear systems engineer, and an instrumentation and control engineer.

The Project Engineer (Engineering) will be Dr. Sati Mitra. Dr. Mitra has had extensive experience in the area of Reliability and Risk Assessment. Dr. Mitra served as Project Engineer on several risk assessment projects including a Level 1 PRA on the first British PWR.

Dr. Mitra has done work in development of stochastic models and use of reliability techniques in assessing nuclear safety. He has worked in the following areas: risk assessment of class 3-8 accidents, fault/event tree methodology, accident analysis, source term and consequence modelling, radiolytic production of hydrogen at TMI, common cause failure models, human errors, failure data evaluation (Bayesian and classical methods). Dr. Mitra had been working on a study of the implications of applying quantitative risk criteria in the licensing of nuclear power plants.

2.2.4 The Project Engineer (Human Factors) (PE-HF) reports directly to the Project Manager. The PE-HF will coordinate and schedule all project efforts under his responsibilty. He will be responsible for the timely performance of all human factors tasks and will supervise project personnel on a day-to-day basis. He will have reporting to him a staff of human factors specialists in the area of data collecton, task analysis and operations. The PE-HF will be involved in all phases of the project and will share in the technical leadership of the entire project.

The Project Engineer (Human Factors) will be Mr. Clifford Baker.

Mr. Baker has over six years experience in the application of Human Factors Engineering data and methods to a variety of human-machine interfaces. With experience related to military, industrial and transportation systems he is well versed in the science of Human Factors Engineering. He has participated in highway traffic safety studies concerning rear end lighting configurations and related collisions. He has participated in the design, development, test and evaluation of a variety of military systems. He has developed procedures for integrating HFE data, principles, and methods with the Navy weapon system acquisition process. His most recent work has been in the conduct of human-machine interfaces evaluations for over ten nuclear power generating stations. Mr. Baker is currently Manager of ESSEX's Human Factor Analysis Branch of the Industrial Services Division.

2.2.5 The Technical Advisory Team shall be comprised of a minimum of seven members. The function of the adisory team was discussed in paragraph 2.2. The advisory team shall be headed by a chairman.

The Technical Advisory Team (TAT) Chairman is responsible for coordinating the TAT's effort. The chairman interfaces with the designated site operations representatives to arrange for Access to: plant information (records, documents, plans, procedures, drawings, etc.) required facilities (control room computers, word processing, cameras/VTR, etc.) and personnel with useful or necessary information (reactor operators, equipment designers or planners, or utility management).

The TAT Chairman presides over the HED Review meetings and coordinates the necessary personnel and resources required to support the assessment, disposition and recommended backfits for HED's submitted to the team for review by the DCRDR Team. The TAT Chairman is responsible for signing the disposition block and signifying TAT concurrence or dissenting opinion. The HED's are then reviewed for engineering scope, material requirements and implementation schedule. The implementation schedule will be determined utilizing the criteria set forth in the Integated Living Schedule Program and will then be incorporated into the DCRDR findings section of the final report for submittal to the NRC for review and approval.

The TAT Chairman is Mr. Jacque Lingenfelter.

The following is a brief description of the qualifications of the other advisory team members:

G. Allen Elliff (ESSEX)

Dr. Elliff is a Branch Manager in ESSEX Corporation's Alexandria office. He is currently responsible for management and technical direction and review of projects for clients of the Industrial Services Department. Prior to joining ESSEX in 1981, Dr. Elliff was associated with Evaluation Research Corporation; Peat, Marwick, Mitchell & Company; Logistics Managment Inc., and was Texas A & M graduate faculty member.

He has 9 years consulting experience with the military (Navy, Air Force and Office of the Secretary of Defense) other federal agencies (Department of Energy, Department of Transporation) and private sector clients, utilities, motor carriers, railroads, and military hardware vendors. His experience includes human factor analysis, maintenance management, logistic support analysis, mathematical modeling, reliability/maintainability analysis, production engineering, statistics, quality control and training course development and presentation. Dr. Elliff has three years experience as a full-time graduate facility member at Texas A&M University teaching industrial engineering and operations research courses and supervising thesis research.

Walter Talley (ESSEX)

Mr. Talley has been actively involved in human factors test and evaluation projects for commercial utilities and for the military since July 1978. From 1974 to 1978 as a member of the Technical Staff at Bell Telephone Laboratories he was responsible for the analysis, developemnt, design and implementation of the user-interfaces for large computer-based data management systems. Mr. Talley also has extensive civilian and military technical background which dates back to 1954. This engineering-related experience includes electronics research and development for the U.S. Air Force and for the Douglas Aircraft Missile and Space Division; electro-mechanical design work at the project engineering level for large diesel and gas turbine powered mobile and emergency generator sets; and electo-mechanical design work for cryogenic storage facilities and materials testing facilities.

Sonny Kasturi (EDS)

Mr. Kasturi has over fifteen years experience in the nuclear industry. Among many other assignments, Mr. Kasturi has served as Manager of a multi-discipline project department involved in the engineering and design of the instrumentation and control systems for a twin unit 2,500 MW nuclear power project. He directed the development, engineering, detailed design, procurement and installation of all instrumentation, control and protection systems including several computer based systems such as plant computer systems, radiation monitoring systems, security systems, and fire protection and alarm systems for these plant.

Mr. Kasturi has considerable experience in all facets of equipment qualification (EQ) as it has impacted upon the nuclear power industry in the United States. He has recently served as Manager of an (EQ) Group where has was Project Manager for two PWRs and one BWR operated by the Yankee Atomic Electric Company. He also served in this capacity for the Virginia Electric Power Company's Surrey, 1 and 2 plants. Further, Mr. Kasturi was instrumental in formulation of the United State's nuclear power industry's EQ position on aging and operating time for equipment and for the qualification of laboratories to perform testing of equipment.

John Moran (EDS)

Mr. Moran has been associated with the commercial and naval nuclear industry for over ten years. He has extensive experience in nuclear power plant design, licensing and safety analysis.

Mr. Moran held the position of Nuclear Project Engineer at a large utility, assigned to both BWR and PWR projects. In this capacity, Mr. Moran was responsible for the technical and administrative management of major design and licensing related projects. His specific responsibilities include identification of the work scope for major projects, selection of an Engineering Firm to perform the work, preparation of necessary licensing documentation and directing and controlling the project to conclusion.

Mr. Moran held various positions of increasing responsibily at a major PWR nuclear steam system supplier firm. His last position was as Supervisor of Special Technical Projects where he directed a staff of engineers responsible for formulating and implementing solutions to nuclear power plant design and licensing problems.

Larry Stalter (TED)

Mr. Stalter has been associated with the Power Industry for seventeen years. Thirteen of those were directly in the Nuclear Industry. Eight years were on the Davis-Besse Nuclear Power Station staff where he participated in the initial senior reactor operator's training program, was responsible for the planning and conduct of the start-up test program for Davis Besse Unit 1, and supervised the Technical Engineering and Instrumentation and Controls Section.

Mr. Stalter has five years experience in Nuclear Facility Engineering where he designed electronics control systems, supervised the Instumentation and Controls Systems Section, and currently Supervises the Electrical and Control Systems Section. He is responsible for the Environmental Qualification Program for Davis-Besse, is a member of the EPRI Equipment Qualification Advisory Group. He has completed training in Human Factors Engineering at the University of Michigan.

Mike Derivan (TED)

Mr. Derivan has over 17 years of experience in the naval and commercial nuclear industry with extensive experince in plant operations and training. Presently holds and maintains a Senior Reactor Operator License on Toledo Edison's Davis-Besse Unit One. Previous assignments have included positions as Operator Instructor at U.S. naval nuclear training facility, Shift Foreman, Operations Supervisor, Licensed Operator Requalification Instructor, and Nuclear Operations Training Supervisor. Present position of Operations Technical Coordinator includes responsibility for writing the upgraded emergency operating procedures from the B&W Abnormal Transient Operating Guidelines (ATOG). Presently and previously associated with the B&W Owners Group Operator Support Committee, INPO Emergency Operating Procedures Implementation Assistance (EOPIA) Review Group, and Florida Power Corporation Nuclear Safety Task Force for Crystal River Unit Three.

2.2.6 The DCRDR Review Team will be composed of a core group of specialists in the fields of human factors engineering, plant operations, instrumentation and controls, and nuclear systems. The following is a list of the key people who will be performing the task work on this project and a brief description of their qualifications:

Ms. Danna Beith - Data Collection (ESSEX)

Ms. Beith has been involved with human factors research, design and evaluation since 1976. Since 1980 she has been a member of the technial staff in the Industrial Service Department at ESSEX working for commercial utilities. Before joining ESSEX Ms. Beith worked for Xerox Corporation in the Human Factors Department where she worked on product design and behaviorial testing. She also worked for Bio-technology as a field researcher collecting large truck accident data.

Ms. Candace Weiss - Task Analyst (ESSEX)

Ms. Weiss is a Research Associate in ESSEX Corporation Alexandria office. She is a member of the technical staff in the Process Control System Department. Ms. Weiss holds a B.A. degree from the George Washington University and has taken post-graduate courses at George Washington University and George Mason University. Ms. Weiss has assisted in control room evaluations at eight nuclear power plants and one fossil fuel plant. Various tasks performed have included designing and implementing a demarcation and hierarchial labeling scheme; designing coding device and evaluating color coding uses; conducting anthropometric, light, and noise surveys; performing task analysis; report writing; developing task plan procedures and developing design specifications.

Mr. Dale Pilsitz - Operations Specialist (ESSEX)

Dale Pilsitz is a senior Operations Specialist in ESSEX Corporation's Alexandria office who provides nuclear power plant operations expertise to support ESSEX Human Engineering services to the Nuclear Power Industry. He has directed system function and task analysis of several detailed Control Room Design Reviews; developed formats and texts of emergency and operating procedures and provided support for the revisions to previously written procedures. He has also operationally reviewed human engineering deficiences and performed detailed control panel design and analysis for several nuclear power plants. He participated in the development of the Human Engineering Design Handbook for Nuclear Power Plants prepared for the Electric Power Research Institute. He is presently performing a human engineering analysis of a CRT system for an advanced control room. Prior to joining ESSEX in 1981, he spent 12 years in nuclear power plant operations. He has participated in initial plant startups and several refueling outages. He is licensed by the NRC as a Senior Reactor Operator and served for over 5 years in the capacity. He has received extensive training including time spent at the B&W Reactor Simulator in Lynchburg, Virginia and Penn State University Reactor Facility State College, Pennsylvania.

Mr. Steven Moss - Reactor Operations/I&C (EDS)

Mr. Moss has eight years experience in power and research reactor systems, instrumentation and controls, research reactor operations, and equipment maintenance.

Mr. George MacDonald - I&C/Nuclear Systems (EDS)

Mr. MacDonald has seven years experience in the engineering, operations and maintenance of commercial and naval nuclear power generating stations.

This core group shall be supplemented by other disciplines such as nuclear engineering, mechanical engineering, electrical engineering, industrial engineering, reliability analysis, system engineering, and operation research as required. Table 1 contains a matrix of the qualifications of each team member.

The different phases of the DCRDR will require varying degrees of emphasis of the primary disciplines to bring the desired perspective to the review. Table 2 reproduced from Exhibit 2-1 of NUREG-0801 provides a list of the major identifiable portions of the review and the disciplines which shall be emphasized to provide appropriate technical direction to those efforts. Specification of a discipline which shall be emphasized for the various review processes does not imply that these functions will be performed solely by the team members with that expertise. All of the disciplines and types of experience represented on the DCRDR team will be necessary for most efforts in the review.

The DCRDR is being performed under the applicable QA programs of each participating organization. As EDS Nuclear's subcontractor ESSEX is performing their tasks under the EDS Nuclear QA Program. One of the requirements of these programs, is that each participant on the project receive proper project orientation and training. This includes a project kick-off meeting at which the objectives, methods, schedules, etc. associated with the project are explained. At this meeting, reading assignments are given which includes project procedures, NUREG documents (i.e., 0700, 0801, and 0799), and plant design and operations data. Upon completion of the reading assignment a QA form is completed and signed for documentation purposes.

TABLE 1

PERSONNEL QUALIFICATION MATRIX

DCRDR TEAM PERSONNEL	Human Factors	Reactor Operations	Instrumentation & Control	Nuclear Systems Engineering	Mechanical Engineering	Electrical Engineering	Industrial Engineering	Reliability Analysis	Operations Research
TED									
Jacque Lingenfelter		X		X					
Mike Derivan		X		X					
Larry Stalter			X	X		X			
Jan Stotz					X				
Stan Batch		X		X	X				
EDS									
Greg Rahner				X	X				
Sati Mitra				X		X		X	X
Steve Moss		X	X	X					
George MacDonald		X		X	X				
Sonny Kasturi			X			X			
John Moran				X	X				
ESSEX									
Cliff Baker	X								
Danna Beith	X								
Candance Weiss	X								
Dale Pilsitz		X							
Dave Eike	X								
Walter Talley	X								
G. Allen Elliff							X	X	X

TABLE 2

MAJOR DCRDR PROCESSES AND DISCIPLINE EMPHASIS

Review Process	Discipline Emphasis
1. Operating Experience Review	
o Examination of Available Documents	Nuclear Systems Engineering/ Operations
o Control Room Operations Personnel Survey	Human Factors/Reactor Operations
2. Review of Systems Functions and Analysis of Operator Tasks	
o Identification of Event Sequences	Nuclear Systems Engineering
o Function Identification	Nuclear Systems Engineering
o Function Analysis	Human Factors/Systems Analysis
o Operator Task Identification	Nuclear Systems Engineering/ Reactor Operations
o Task Analysis	Human Factors/Systems Analysis
3. Control Room Inventory	Instrumentation and Control/ Reactor Operations
4. Control Room Survey	Human Factors/Subject Specialists
5. Verification of Task Performance Capabilities	
o Verification of Availability	Instrumentation and Control/ Reactor Operations
o Verification of Human Engineering Suitability	Human Factors
6. Validation of Control Room Functions	Instrumentation and Control/ Reactor Operations/Human Factors/ Systems Analysis

The DCRDR will have the authority to carry out its mission. The Project Administrator (who also serves as the Technical Advisory Team Chairman) shall arrange for:

- Access to information (records, documents, plans, procedures, drawings, etc.)
- Access to required facilities (control room, computer, word processing, cameras/VTR, etc.)
- Access to people with useful or necessary information (reactor operators, equipment designers or planners, or utility management)

3.0 DOCUMENTATION AND DOCUMENT CONTROL

3.1 Introduction

Three types of documentation will be addressed; 1) reference documentation, 2) process and HED documentation, and 3) DCRDR output findings and reports.

3.2 Reference Documentation

A program library has been established with reference documents to support the DCRDR tasks. When complete this will contain:

- Liscensee Event Reports
- Outage Analysis Reports
- FSAR
- Tech specs and system descriptions
- P&IDs
- Floor plans
- Panel drawings and photographs
- Software descriptions
- Procedures
- Samples of computer printouts
- Various NRC and industry documents bearing on CR design (0700, 0660, IEEE spec and standards, HF texts, etc.)
- Abnormal Transient Operating Guidelines

As needed, these will be referenced to support specific tasks within the CR evaluations.

3.3 Process and HED Documentation

3.3.1 Process

The means by which data collection and reduction takes place will be documented for reporting purposes. The general flow of information management is presented in Figure 4. The individual task plans discussed in Section 4.0 Technical Approach, will serve as the basic process documentation. Where deviations from the guidance in these tasks plans occur in the conduct of evaluations, task plans will be modified to reflect accurate data collection procedure.

3.3.2 Guideline HED

Data files for each task will be generated. For each task requiring a report, file space will be reserved for that report. HED information will be stored in a computer file which will contain the following information:

- o Guideline number which also serves as the HED number
- o HED description
- o HED assessment
- o HED locations (components which are discrepant from the 0700 guidelines)
- o Action to be taken on the HED.

The Human Engineering Descrepancy Report to be used is presented in Figure 5.

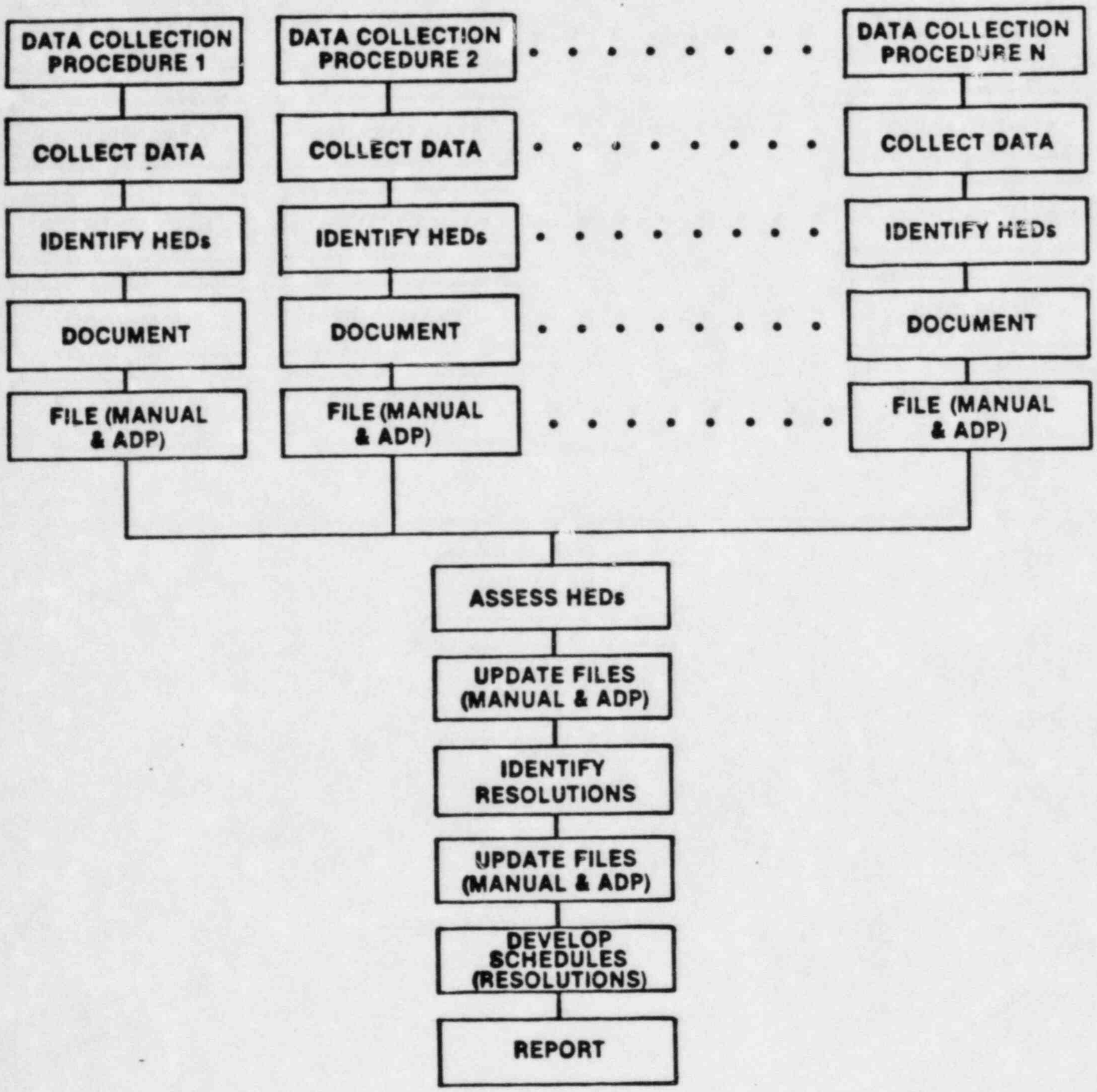
3.3.3 Component HED Reports

A file will be established which documents, for each component, all HEDs cited for that component. In addition, the header for each component HED contains the following CR inventory information:

- o Panel/Workstation
- o Unique Location Code
- o System relationship
- o Component function and use
- o Component type and characteristics

FIGURE 4

INFORMATION MANAGEMENT



PLANT-UNIT: ____________ HED No: ________

FIGURE 5

DATE: ________

HUMAN ENGINEERING DISCREPANCY REPORT

REVIEWER NAME: ______________________________

a) HED TITLE: ______________________________

b) ITEMS INVOLVED:

ITEM TYPE	NOMENCLATURE	LOCATION	PHOTO NO.

c) PROBLEM DESCRIPTION (GUIDELINES VIOLATED):

d) SPECIFIC OPERATOR ERROR(S) THAT COULD RESULT FROM HED:

FIGURE 5 (continued)

e) SUGGESTIONS FOR POTENTIAL BACKFITS

f) ESSEX REVIEW

DATA COLLECTOR ______________________ DATE ______________

DATA COLLECTION MGR ______________________ DATE ______________

PROGRAM MGR ______________________ DATE ______________

g) DISPOSITION

- ☐ FURTHER REVIEW BY ______________________ DATE ______________
- ☐ TO BE CORRECTED BY ______________________ DATE ______________
- ☐ REFER TO OPERATIONS
- ☐ NO ACTION
- ☐ OTHER ____

____

____

____

EVALUATION COMPLETED

TED PROJECT ADMINISTRATOR ______________________ DATE ______________

The HEDs noted against a component where appropriate, are listed on the bottom of the form, by HED # (which corresponds to 0700 guideline #). A sample Component Level form which could be used is presented in Figure 6.

3.3.4 Task Reports

For each plan in Section 4.0, a separate report section will be generated, detailing:

- o Objectives of the task plan
- o The actual data collection and analysis methods employed
- o The criteria (guidelines) implemented
- o Summary of findings

In short, the process followed for each survey or evaluation from inception to writing of HEDs, will be reported.

3.4 DCRDR Summary Report

This report is prepared at the conclusion of the DCRDR, and consists primarily of the Process and HED reports previously prepared. The following will be used:

1.0 Methodology

1.1 Overview - Review Plan

1.2 Management and Staffing

1.3 Documentation

1.4 Review Procedures Employed

a) Operating experience review and results summary

b) Systems, functions, and task analysis (SFTA)

c) Surveys of CR equipment

- o Controls
- o Displays

FIGURE 6
COMPONENT REPORT
HUMAN ENGINEERING DISCREPANCY REPORT

COMPONENT(S) LABEL	ASSOCIATED EQUIPMENT	DESIGNATION #
NE 1 ______	______	PANEL ______
NE 2 ______	______	LOC CODE / TYPE
NE 3 ______	______	

SUBSYSTEM: ______ CONTROL MODES/DISPLAY RANGE: ______

USE: ______

HED NUMBER	CAT

HED NUMBER	CAT

- o Verification of Task Performance Capability
- o Validation of CR Functions
- o etc.

1.5 Assessment procedures

2.0 Findings

2.1 Survey findings

2.2 SFTA findings

3.0 Implementation

3.1 Completed Improvements

3.2 Proposed Improvements

4.0 TECHNICAL APPROACH

4.1 Introduction

The technical approach to be employed is discussed briefly in Section 1.0. Detailed task plans are being developed which describe the activities for the following tasks:

- o Review of operating experience
- o Assembly of CR documentation
- o Review of system functions and task analysis
- o Surveys (one task plan for each)
  - noise
  - lighting
  - CR environment
  - design conventions
  - controls
  - displays
  - computers
  - labeling
  - annunciators
  - anthropometrics
  - force/torque
  - communications
  - maintainability
- o Verification of task performance capability
- o Validation of CR functions
- o Assessment of discrepancies

These task plans are being developed using the guidance provided in Section 3 of NUREG-0700 and the overall methodology conforms to Exhibit 2-2 of NUREG-0801.

4.2 Task Plan Content

Each task plan addresses:

Task Objectives - The type of data to be collected or human performance variables under analysis.

Review Team - The personnel required to conduct the task.

Criteria - Generally the NUREG-0700 guidelines appropriate to the task at hand.

Task Definition - Steps or procedures to be followed to conduct the task.

Equipment Requirements - List of any equipment required to conduct the task.

Input and Data Forms - Task results. Often these are HEDs, but may be data which is drawn upon by subsequent tasks (e.g., task analysis).

5.0 ASSESSMENT AND IMPLEMENTATION

Once a HED has been identified, its disposition must be determined. This section of the Program Plan report 1) provides a means whereby HEDs are assessed for error inducing potential and system consequences of induced errors and 2) details the means by which HEDs will be disposed (redesign, additional job performance aids, etc.). The assessment portion, in essence, determines the scheduling of backfits as a function of the potential consequences of the HED. The disposition portion determines the means by which an HED will be ameliorated. Assessment is initially divorced from disposition in terms of selection of backfits, however, HED disposition may drive, in some instances, scheduling of backfits, due to availability of materials, extent of engineering redesign, and so forth. Also, candidate backfits undergo assessment to ensure that HEDs have been adequately addressed. In all instances scheduling of backfits shall be done in accordance with the Integrated Living Schedule Program.

5.1 Assessment

The basic assessment process is divided into four steps as follows:

- o Assess extent of deviation from 0700 guidelines
- o Assess HED impact on error occurrence
- o Assess potential consequences of occurrence
- o Assign of HED scheduling priority.

A diagram and a form for assessment is presented in Figure 7.

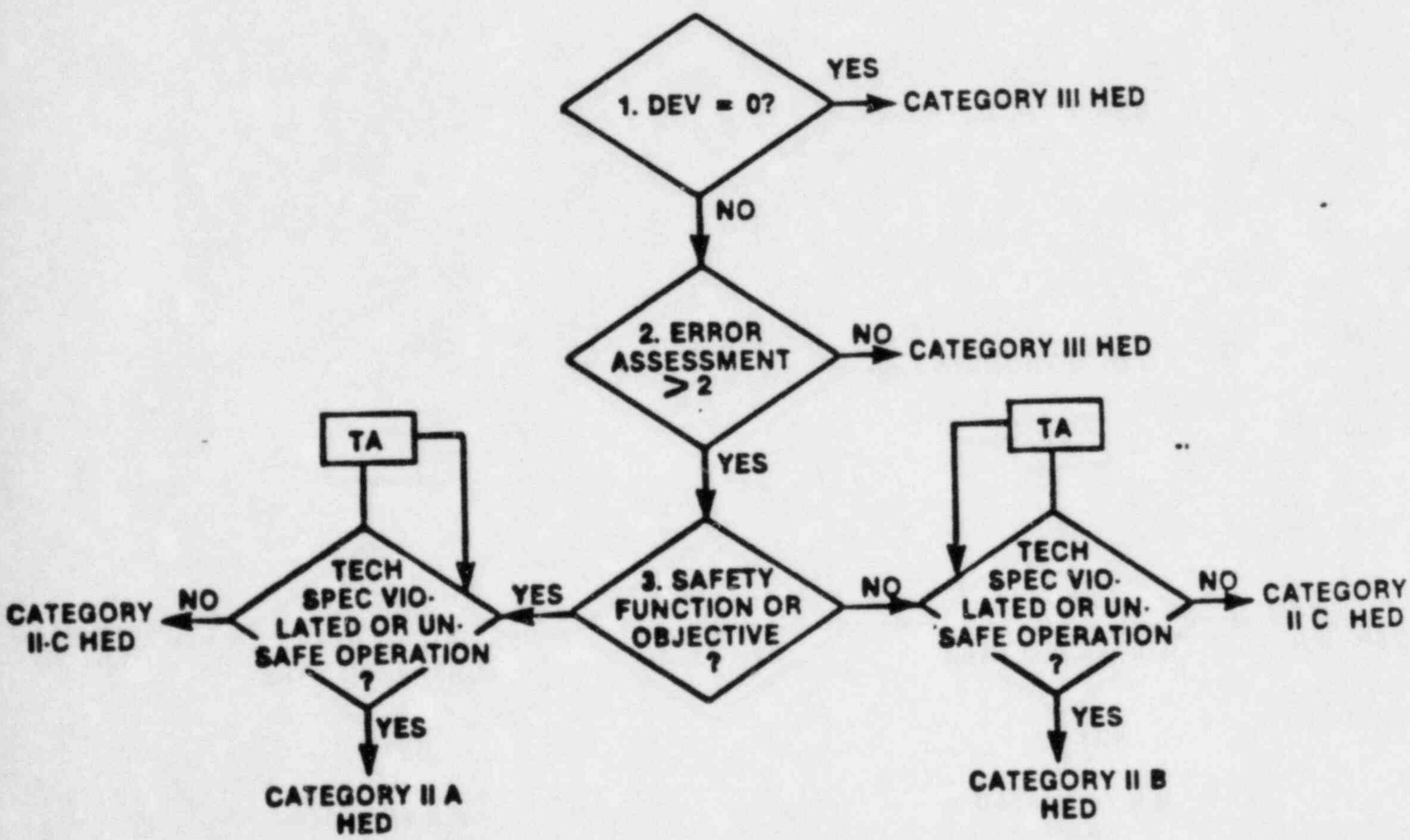
5.1.1 Assess Extent of Deviation from 0700 Guidelines

The step requires that a subjective assessment of the extent of discrepancy from 0700 guidelines be made with regard to the CR. For example, symbol/background contrast might be 40% rather than 50%, or, only small amounts of parallax may exist in a display. A judgement is made based on the content of the guidelines being applied and the CR component under assessment. Extent of deviation is then subjectively scaled from 1 (some deviation) to 5 (complete deviation). There is also a category N/A (not applicable) for HEDs which are not a part of NUREG-0700 (discrepancies from other documents such as military standards, HFE Texts, etc.) Extent of deviation judgements are not directly used to assess priority or scheduling of backfits, but relate to assessment of increase operational error potentials.

FIGURE 7
HED PRIORITY

HED#	

1. EXTENT OF DEVIATION FROM 0700 GUIDELINES	N/A	SOME 1	2	3	4	COMPLETE 5
2. ERROR ASSESSMENT		LOW 1	2	3	4	HIGH 5
3. SAFETY FUNCTION ?	YES					NO
4. NON SAFETY RELATED, REQUIRED TO MITIGATE CONSEQUENCES OF AN ACCIDENT	YES					NO
5. CONSEQUENCES OF ERROR OCCURENCE						
A. UNSAFE OPERATION	YES					NO
B. VIOLATION OF TECH. SPECS.	YES					NO



It is possible to have little deviation from the guidelines and high error assessments, and vise versa, but the two will probably be positively correlated. Extent of deviation will not be used to assess errors induced by HEDs.

5.1.2 Assess HED Impact on Error Occurrence

Given that no control system can be designed to be operationally error-free, assessment here is to estimate HED impact on hypothetical (unknown) baseline error rates of CR components; e.g., will additional errors be induced by discrepancies from the guidelines? Estimates of HED impact on error occurrence are qualitatively arrived at by consideration of the following:

Body physiology
- Fatigue/physical stress
- Discomfort
- Injury
- Anthropometry

Sensory/perceptual performance
- Vision
- Audition
- Propioception
- Touch

Information processing
- Overload
- Confusion
- Recall
- Pattern matching/recognition
- Data manipulation (comparing, extrapolating, etc.)

Learning
- Inhibition
- Habituation
- Response predominance
- Transfer
- Response competition
- Response latency

Task Demands
- Frequency
- Duration
- Competition
- Sequence
- Speed
- Communication
- Presision
- Information

5.1.3 Assess Potential Consequences of Error Occurrence

Review Team technical staff and operacions representatives evaluate system consequences of hypothesized operational errors. Four determinations are required:

1. Does the HED relate to plant safety functions?

2. Does the HED relate to plant functions required to mitigate the consequences of an accident?

3. Could an error lead to unsafe operations or plant conditions?

4. Could an error lead to violations of technical specifications?

Each of these require a yes/no type response. The logic diagram on Figure 7 (HED Priority) shows how these data are integrated to assign categories and priorities to HEDs.

Category 1 HEDs are those which have been noted from documented operational errors. All Category 1 HEDs are deemed to increase error potential, but consequences must still be assigned to determine ultimate scheduling priority.

Assessment of error occurrence is estimated for the following:

1. Overall operator performance is/is not degraded by HED impact on body physiology?

2. HED does/does not degrade sensory performance?

3. Information processing capability is/is not exceeded via the HED?

4. The HED does/does not induce direct error due to principles of learning?

5. Task difficulty and reliability is/is not affected by the HED?

Based on the above, a subjective error assessment is generated on a 5-point scale, a one meaning a low probability of induced errors is expected as a result of the HED, a five indicating a high probability level of additional errors being induced.

5.1.4 Assign HED Priority Scheduling

Priority for scheduling of backfit purposes is per the following:

Priority A - Prompt - Recommended to be completed by first outage, given availability of materials and engineering lead time.

Priority B - Near Term - Recommended to be completed by second refueling outage given availability of parts and engineering lead time.

Priority C - Long Term - Can be completed at any time.

5.2 Implementation

Implementation is discussed in three parts, as follows:

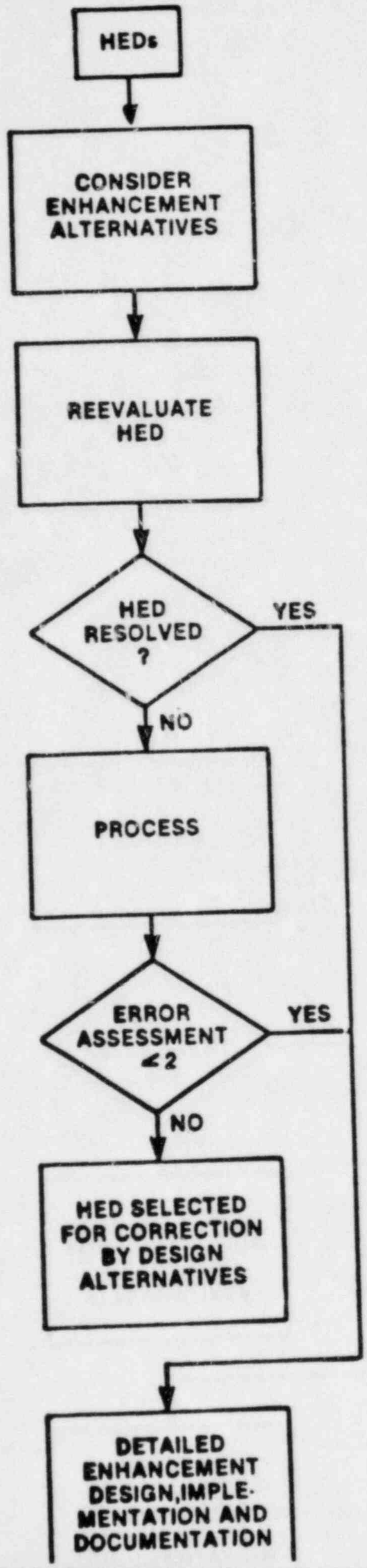
- Analysis of the correction by Enhancement/assess correction
- Analysis of Design Alternatives/assess correction
- Scheduling and implementation

Each of these is discussed, in turn, below.

5.2.1 Analysis for Correction by Enhancement

In this task each HED is considered for correction by enhancement. Many, e.g., labeling HEDs, are easily corrected. For other HEDs, enhancement solutions may only partially ameliorate the discrepancy. Figure 8, shows the process for identifying HEDs to be corrected by enhancement (color coding, labeling, demarcation, etc.)

FIGURE 8 FLOW FOR CORRECTION OF HEDs BY ENHANCEMENT



NOTES:

Using photomosaic

Using 0700 guidelines

using NUREG 0801 and 0700

Detailed design proceeds, using 0700 guidelines where appropriate, as design requirements

5.2.1 Analysis of Design Alternatives

This task requires that each HED selected for analysis of design alternatives undergo Task and Functions analysis review. The basic procedure employed is shown in Figure 9. Note that where design alternatives do not exist, HEDs are again considered for correction by enhancement, since some mitigation of the error inducement may be achievable.

5.2.3 Scheduling and Implementation

HEDs recommended for correction by enhancement will undergo implementation scheduling. Longer term corrections will be scheduled and the schedule reported to the NRC for review and approval. Scheduling of all design improvements will be done in accordance with the criteria set forth in the Integrated Living Schedule Program.

Figure 10 shows the form to be used which documents the results of the HED Backfit Assessment Enhancement/Design alternatives, and subsequent backfit decisions.

FIGURE 9

PROCESS FOR ANALYZING HED DESIGN ALTERNATIVES

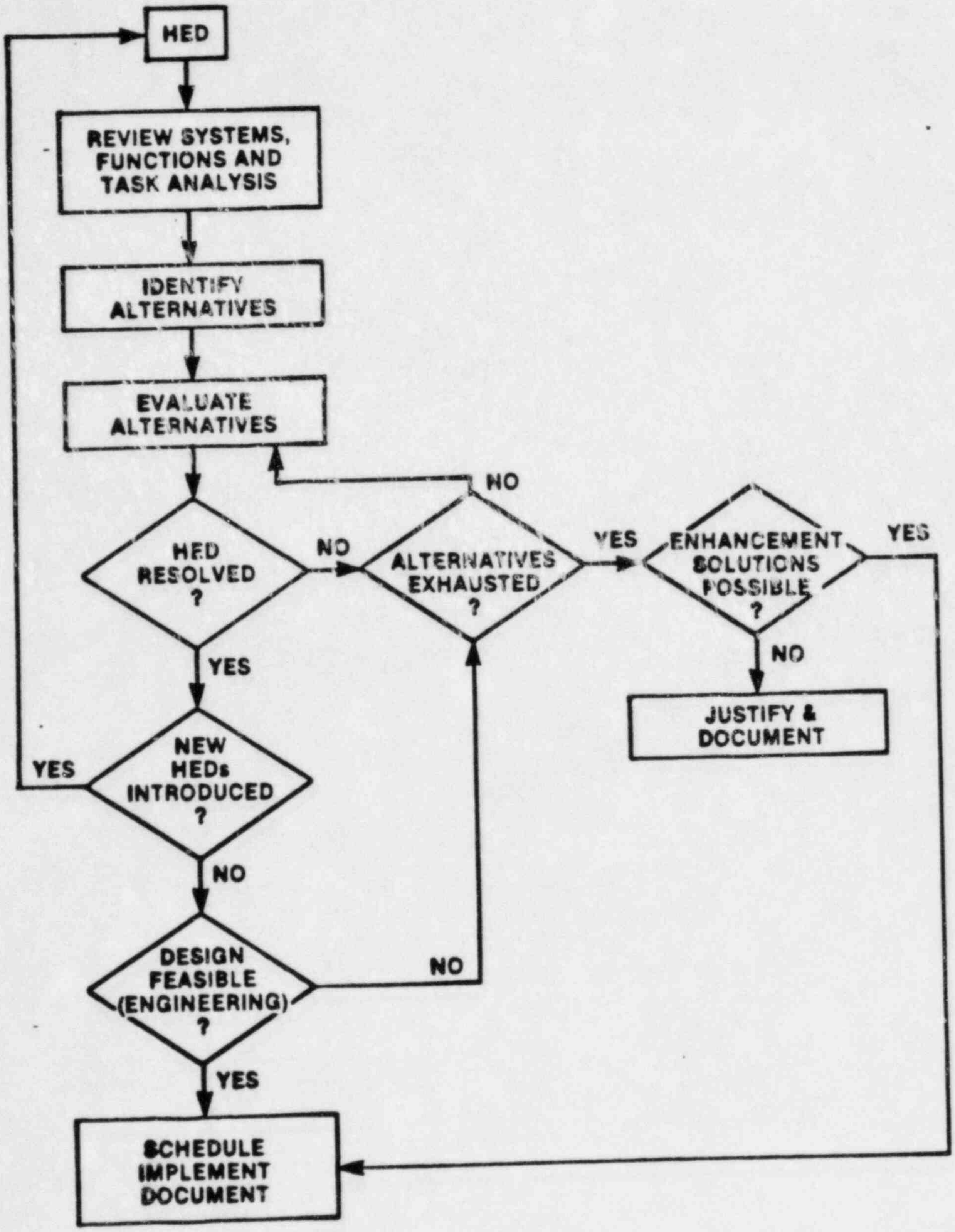


FIGURE 10

HED NO. ______________________ **HED BACKFIT ASSESSMENT**

		PROPOSED BACKFIT	IMPLEMENTED BACKFIT
I ENHANCEMENT			
a) LABELING	a)		
b) DEMARCATION	b)		
c) CODING	c)		
d) PROCEDURES	d)		
e) TRAINING	e)		
II DESIGN ALTERNATIVES			
a) RELOCATION	a)		
b) REPLACEMENT	b)		
c) CONFORMANCE TO PROCESS CONVENTION	c)		
d) RELOCTION OF FUNCTION	d)		

REASSESSMENT OF PROBABLE ERROR AND DEVIATION

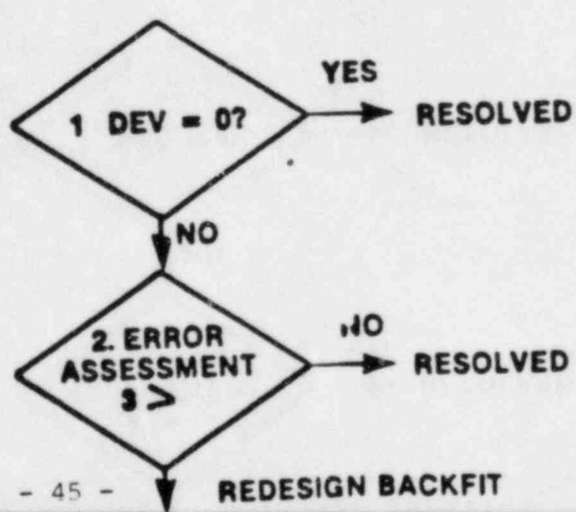
	N/A	SOME				COMPLETE
1. EXTENT OF DEVIATION FROM 0700 GUIDELINES		1	2	3	4	5

	LOW				HIGH
2. ERROR ASSESSMENT	1	2	3	4	5

SIGNOFF: HEPM

____

DATE: ______________________



6.0 DCRDR SCHEDULE

Figure 11 shows a milestone chart showing the schedule of phases and tasks and an identification of the estimated team skills required for each task.

Phase	Task	Corresponding NUREG Reference		Time (Months)												Manhours		
				1	2	3	4	5	6	7	8	9	10	11	12	Human Factors	Systems Engineering	Operations
I Planning	Analyze Objectives and Integrate	2.1	(0700)	///												50	50	50
	Review Team Selection	2.3	(0700)	///												50	50	50
	Organize Methodology	2.4-2.6	(0700)	///	///											150	150	50
	Prepare and Submit Program Plan	2.0	(0801)		///											150	150	50
II Review	Operating Experience Review	3.3	(0700)			///	///	///								300	250	300
	System Function and Task Analysis	3.4	(0700)		///	///	///	///	///							400	600	200
	Control Room Inventory	3.5	(0700)			///	///									0	150	20
	Control Room Survey	3.6	(0700)			///	///	///	///	///						750	0	100
	Verify Task Perform. Capabilities	3.7	(0700)						///	///						100	300	50
	Validate Control Room Functions	3.8	(0700)							///	///					200	200	200
	Compile Discrepancy Findings	3.9	(0700)									///				100	100	20
III Assessment and Implementation	Determine Significance	4.2	(0801)										///	///		200	200	200
	and Categorize HEDs	4.2	(0700)															
	Select/Design Corrective	4.2.2	(0700)										///	///		200	200	200
	Actions	4.3	(0801)															
	Prioritize and Schedule	4.4	(0801)											///		100	100	100
	Begin Implementation	4.3	(0700)													(later)		
IV Report and Implement	Develop Ongoing CR Program															(later)		
		4.6	(0801)															
	Final Report	5.0	(0700)											///	///	200	200	200
	Interaction with NRC																	
	Finalize and Verify Implement.	5.0	(0801)													(later)		
															Totals	2,950	2,700	1,790

FIGURE 11

DCRDR MILESTONE CHART