Enclosure
EF2-72747

CONTROL ROOM DESIGN REVIEW

PROGRAM PLAN

FOR

FERMI 2

TABLE OF CONTENTS

TABLE OF CONTENTS
(cont'd)

APPENDICES

1.0 INTRODUCTION

NUREG-0660 and 0737, Supplement 1 provide NRC recommendations for Control Room Design Reviews (CRDR) of nuclear power plants. The CRDR program is one of many modifications requested as an aftermath of Three Mile Island and is intended to identify human engineering deficiencies.

Detroit Edison has an established history of applying human factors engineering principles to the design of control rooms. Design and review activities that have been undertaken for the Fermi 2 Control Room include:

- Application of human factors in original design with review of control panel layout by a multidiscipline Control Room Task Force.
- Construction of a full scale control room mockup.
- Participation in BWR Owner's Group (BWROG) CRDR Program and completion of a control room survey by the BWROG (Jan. 1981).
- NRC Human Factors Engineering Branch review (May, 1981) of Fermi 2 control room with subsequent Detroit Edison assessment and implementation of improvements.
- Installation of a full scale simulator at the Fermi 2 site.

This report constitutes the Control Room Design Review Program Plan as specified in item 5.2.A of NUREG-0737, Supplement 1, for updating/completion of the Fermi 2 CRDR.

2.0 OVERVIEW

2.1 Purpose

The purpose of the CRDR is to:

1) Review and evaluate the control room workspace and remote shutdown panel, instrumentation, controls and other equipment from a human factors engineering viewpoint, taking into account both systems demands and operator capabilities.

2) To identify, assess and implement control room design enhancements and modifications to correct items which are determined safety related or otherwise substantially impact the potential for operator error, particularly in preventing or coping with emergency situations.

2.2 Objectives

The objectives of the CRDR are:

1) To identify improvements in the control room/operator interface which have the potential to reduce the probability of error, particularly with regard to preventing or coping with accident situations.

2) To evaluate any identified problems, establish relative priorities and corrective actions plans according to specific evaluation criteria.

3) To verify that each selected design improvement will provide the necessary correction and can be introduced in the control room without creating any unacceptable human engineering discrepancies because of significant contribution to increased risk, unreviewed safety questions or situations in which a temporary reduction in safety could occur.

4) To coordinate improvements with changes resulting from other human factors/emergency response improvements.

2.3 Description of CRDR Activities

To achieve the objectives of the CRDR, a number of activities have been and will be completed. A flowchart showing the interrelationships of the CRDR activities is presented in Figure 1.

The CRDR has been split into five phases:

- Planning
- Review

- o Assessment
- o Reporting
- o Implementation

A brief synopsis of these activities follows:

2.3.1 Planning Phase

The planning phase commenced with the establishment of the BWROG Control Room Improvements Committee in January 1980. The planning phase was described in detail in Reference 1.

2.3.2 Review Phase

The review phase consists of a control room survey conducted by a multidisciplinary team to compare the characteristics of the control room with appropriate human engineering design guidelines, an operating experience review (including documentation and operator interviews) and function/task analysis for emergency operating procedures. The review phase and the CRDR for Fermi 2 are being performed in accordance with the BWROG methodology. The original survey described above was performed in January 1981.

The remaining activities in this review phase consist of updating the 1981 survey for significant changes since that survey, completing the BWROG checklist supplement, updating the operating experience review and performing function and task analysis for the emergency operating procedures. The results of the task analysis will be compared with the in-place inventory of controls and displays in the control room to assure that the control room supports the Emergency Operating Procedures (EOP's) or identify missing displays or controls.

2.3.3 Assessment Phase

During the assessment phase, identified discrepancies will be evaluated with regard to their probability for causing operator error and the potential impact of the error on safe plant operation. A categorization according to priority category will be performed. Corrective action plans will be established for all significant discrepancies. Consideration will be given to correction by enhancement, design modifications, procedure and training improvements and the capabilities of other emergency response improvement, e.g., Safety Parameter Display System (SPDS).

The resulting corrective action plans will be integrated and correlated with the other NUREG-0737, Supplement 1 emergency response improvement actions. During this assessment phase, major design improvements will be evaluated to assure that the corre tive action plans can be accomplished without creating other problems and that the functions allocated to the control room operators can be effectively accomplished.

2.3.4 Reporting Phase

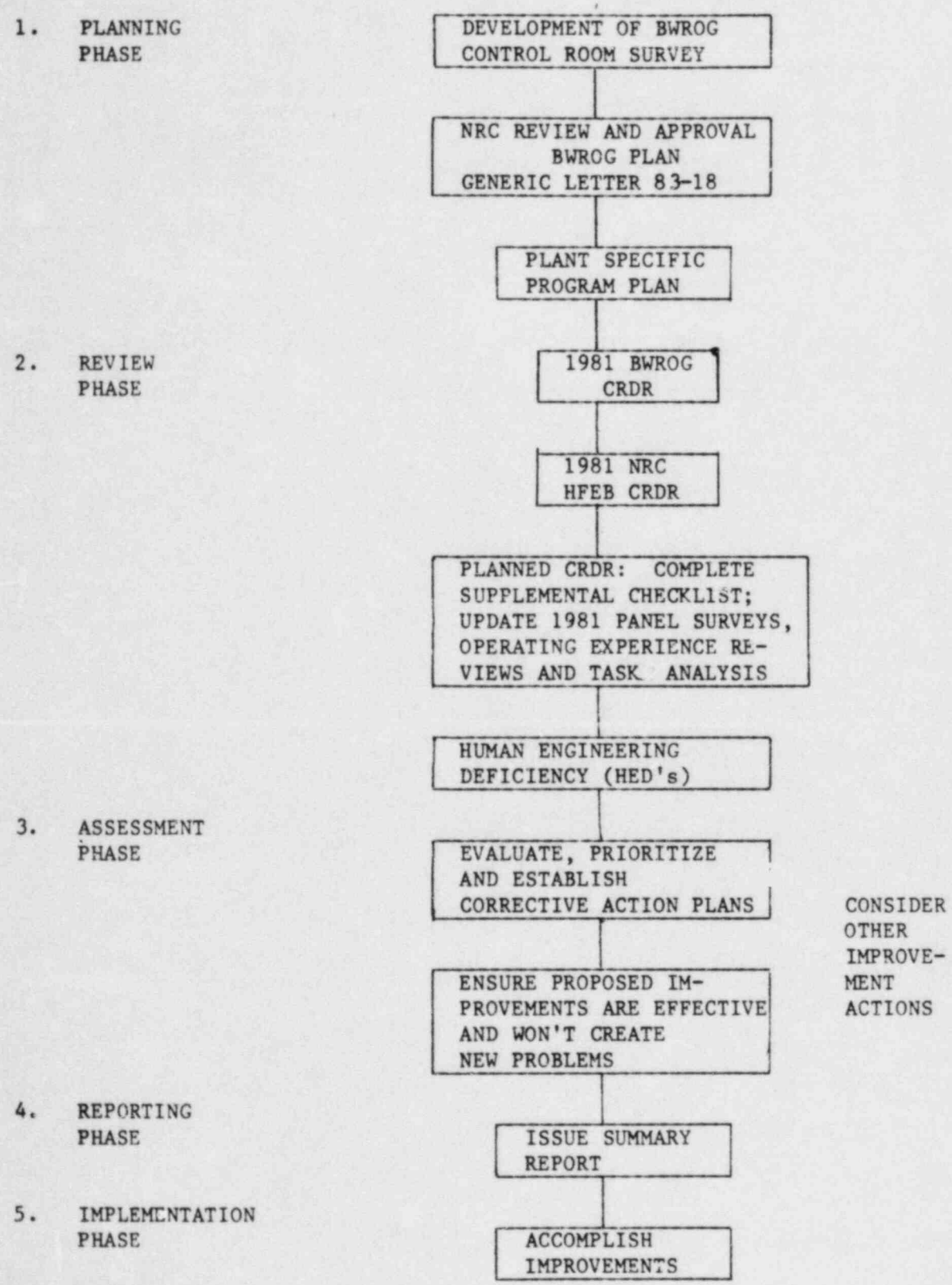
After completing the review and assessment phases, a summary report of the CRDR will be prepared and submitted to the NRC. The summary report will include a discussion of any changes made in the program execution, if any, from the program plan, summarize the human engineering discrepancies identified, outline proposed control room changes and present the schedule for implementation. The report will also provide a summary justification for human engineering discrepancies with safety significance if left uncorrected or partially corrected.

2.3.5 Implementation Phase

The implementation phase will be the actual accomplishment of the control room improvements with continuing attention given to human factors engineer, procedures or instrumentation modifications.

FIGURE 1

CRDR ACTIVITIES



3.0 DEFINITIONS

Emergency Operation Procedures (EOPs) - Plant procedures directing the operator actions necessary to mitigate the consequences of transients and accidents that cause plant parameters to exceed reactor protection setpoints, engineered safety feature setpoints, or other appropriate technical limits.

Emergency Procedures Guidelines (EPGs) - Guidelines developed from system analysis of transients and accidents that provide sound technical bases for plant-specific EOP's.

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

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

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

Human Factors Engineering (HFE) - The science of optimizing the performance of human beings, especially in industry. More narrowly, the science of design of equipment for efficient use by human beings (also known as bioengineering, biotechnology, engineering psychology, ergonomics, and human factors engineering).

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

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

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

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

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

Task Analysis - The systematic process of identifying and examining operator tasks in order to identify conditions, information, instrumentation and control requirements associated with the performance of a task. In the CRDR context, task analysis is used to verify and validate the match of information available in the control room to the information requirements of the emergency operating tasks.

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

Verification - The process of determining whether instrumentation, controls, and other equipment are available to meet the specific requirements of the emergency tasks performed by operators. The control room survey and task analysis are verification activities, checking the control room match to the human operator.

4.0 PROGRAM MANAGEMENT AND STAFFING

The ultimate responsibility for the Fermi 2 CRDR will reside with the Manager, Nuclear Operations. The day-to-day conduct of the review will be the responsibility of the CRDR review team. The original control room survey was conducted by the BWROG Control Room survey team. Remaining CRDR activities will be managed by the review team leader. The review team leader will report progress on the CRDR to the Manager, Nuclear Operations. This will provide the necessary management attention to ensure that the CRDR objectives are met and that the efforts are integrated with overall emergency response improvements. The CRDR team will require interaction with other organizations within Detroit Edison. The review team leader will have the authority to assure freedom of the CRDR team operation. Areas which will be included are:

- Access to information (records, documents, plans, procedures, drawings, etc.).
- Access to all required facilities.
- Access to any personnel with useful or necessary information.
- Access to support services.
- Freedom to document dissenting opinions.

4.1 Review Team Structure

The review team is a multidisciplined team of individuals with the wide range of skills necessary to perform the design review and will include the following personnel:

- Review Team Leader
- Human Factors Specialist
- Senior Reactor Operator
- System Engineer
- Operations Engineer

4.1.1 Review Team Leader

The review team has the review team leader as its key person. This individual provides the administrative and technical direction for the project and has responsibility for the project. Access to information, facilities and individuals providing useful or necessary input to the team is coordinated by the review team leader. Because of the detailed knowledge of Fermi 2 systems and CRDR methods, this

individual provides a cohesive force for the various Detroit Edison personnel and vendor organizations involved with this project. Plant operations personnel provide input to the review team through daily contact with the review team leader.

It will be the responsibility of the review team leader to resolve differences in human factors opinions on methodology, technique, review findings, assessment, and HED corrective actions that dissent with the majority opinion of the CRDR Review Team. The review team leader will be assisted in the performance of his function by the other team members and supporting personnel.

4.1.2 Human Factors Specialist (HFS)

The human factors specialist will work closely with the review team throughout each phase of the control room review and share with the team the human factors technical leadership of the entire CRDR project. The human factors specialist will coordinate all activities from a human factors perspective and verify that task performance quality is maintained at a level necessary for a valid and comprehensive review.

4.1.3 Senior Reactor Operator (SRO)

At least one SRO from Fermi 2 will serve as a member of the core review team. The SRO will assist in identifying operator tasks and will serve as the review team expert on the operational constraints for manipulations of plant systems.

4.1.4 System Engineer

The system engineer will assist in the identification of plant system design goals and functions and will serve as the review team expert on the factors affecting the design decisions at the plant. The system engineer will provide input to the review team during the analysis of functions and tasks for any plant systems and during the assessment, implementation, and effectiveness phases of the CRDR. The system engineer also will assist in completing the checklist supplement and performing the task analysis of emergency operating procedures.

4.1.5 Operations Engineer

The Operations Engineer will serve as a member of the review team providing assistance to the Review Team Leader in coordinating activities with Fermi 2 operations personnel, procedures and facilities. He also will provide input based upon his own operational experience.

4.1.6 Supporting Personnel

In addition to the personnel described in articles 4.1.1.-4.1.5, the support of additional personnel shall be utilized as necessary. The support will include the following personnel.

1. Administration and Documentation Coordinator

   This coordinator provides documentation and administrative support to the team leader. He provides administrative direction to the engineers, operators, and Human Factors personnel assigned to the task and coordinates the assignment of other resources as required.

2. Systems Integration Engineer

   The systems integration engineer will review the CRDR findings and provide advice to the team on systems engineering issues and the resolution of HEDs from the standpoint of integration with other emergency response improvements.

3. Instrumentation and Controls Engineer

   The I&C engineer will provide advice to the team on I&C issues during the assessment of HEDs and the development of design improvement plans.

4. Licensing Engineer

   The licensing engineer will provide advice to the team on safety/licensing issues throughout the process. This includes review and concurrence with the Program Plan and Summary.

4.2 Review Team Activities

The initial development of methodology for the review was performed under the BWR Owners Group as discussed in Reference 1. The review team participated with Fermi 2 management in establishing the overall plan and schedule for the CRDR. The review team will perform the outstanding activities and integrate all action items as detailed in Section 5.1 of this report. The review team will be responsible for the preparation of all reports related to the CRDR and ensure that appropriate reports are submitted to Fermi 2 management for review and approval.

4.3 Review Team Orientation

The initial BWROG review team received their orientation by attending a BWR Owners Group Control Room Survey Workshop on October 8-15, 1980. Topics covered included control room design review objectives, human factor principles, BWROG checklist, operating experience review, task analysis and simulator survey performance exercises. A familiarization with the control room panels was performed when the survey commenced. A second BWR Owners Group Control Room Survey Workshop was held on October 18-20, 1983. Topics covered included human factors principles, NUREG 0737-Supplement 1, NRC Generic Letter 83-18, BWROG Control Room Survey development and methodology, checklist supplement, operating procedures and simulator performance exercises on the checklist supplement and task analysis.

Detroit Edison personnel and members of the review team attended both of these workshops. A brief orientation with the plant will be held when the performance of this checklist supplement commences. The close coordination between the Fermi 2 and consultant personnel on the team will allow any additional orientation needs, which may arise, to be met on an as-needed basis.

5.0 CRDR METHODOLOGY AND DOCUMENT CONTROL

5.1 CRDR Methodology

The methodology which is being used for the Fermi 2 CRDR is primarily based on the BWROG control room design review program, submitted to the NRC by Reference 1, and approved by the NRC in Reference 2. The BWROG Survey Program addresses only the planning and review phases, while this report describes the outstanding activities, assessment, implementation and reporting phases that are planned for the Fermi 2 CRDR.

The Fermi 2 CRDR program addresses specifically the following objectives:

1. To determine the control room inventory in terms of plant system information, system controls and feedback necessary to aid plant operators in accomplishing their tasks effectively.

2. To identify the performance capabilities and limitations of the existing control room inventory that could impact operator effectiveness, and to survey this equipment for compatability with human factor standards.

Three major processes are used to accomplish the above objectives and to identify the human engineering discrepancies.

1. Operator Interviews and Historical Events Report Review
2. Control Room Survey
3. System Function and Task Analysis

Details of the methods to be used in each of the three processes are given below.

5.1.1 Operator Interviews and Historical Events Report Review

1. Operator Interviews

   The purpose of the operator interview is to obtain direct operator input to aid in identifying potential or actual deficiencies in the control room layout or design or in operating procedures that result in confusion (mental activities), difficulty (manual activities) or distraction (the environment).

   Using the questionnaire in Appendix B, operators will be asked to respond in writing based on their operational experience and knowledge of the control room. Copies of the written responses

will be sent to the survey team for a preliminary review. Interviewees will retain their copies and review them with a survey team member during a later oral interview. If additional space is needed, the attached Comment Form is to be used. A representative group of approximately 12 operators, covering a range of experience, education, ability and physical size will be interviewed.

The interviews will be conducted by members of the CRDR team with background or experience in operations and engineering or design within a setting conducive to a free flow of information. It is expected that the oral interview will take one to two hours for each operator.

Following the interviews, the survey team will consolidate the information obtained and analyze it to help identify specific areas of concern for detailed analysis during the CRDR assessment phase.

2. Historical Events Report Review

Review of LERs and scram reports of operating plants has resulted in identifying possible human factor design considerations that may have contributed to operator errors. The BWROG CRDR survey program recommends review of LERs during the last two years of plant operation, for use as a source in identifying the human engineering discrepancies.

Because Fermi 2 is a near term operating licensee without plant specific LERs, a procedure will be followed to extract the necessary information from plants that are similar in design and in control room arrangement to Fermi 2. The identified HEDs for the plants will be checked against the Fermi 2 control room inventory, and later analyzed in the CRDR assessment phase.

5.1.2 Control Room Survey

The purpose of the Control Room Survey is to identify the characteristics of important controls and displays, the usefulness of audio and visual alarm systems, plant status information provided, the control room layout

and environment, and other areas of human factor engineering that potentially impacts operator effectiveness. This is accomplished by conducting a systematic comparison of existing control room inventory against human engineering guidelines. The ultimate objective is to identify potential modifications of the operator/control room interface which will reduce the potential for human error.

1. The BWROG 1981 Survey

The procedures used in conducting the Fermi 2 CRDR survey followed the BWROG control room guidelines of Reference 1. The survey was conducted by the review team using checklists developed by the BWROG. A supplemental checklist was provided in the latest BWROG workshop to give additional guidance to the review team members in completing survey items recommended in NUREG 0700 but not incorporated in the original BWROG checklist.

The 1981 CRDR Survey for Fermi 2 covered the following areas included in the BWROG checklist,

- Panel Layout and Design
- Instrumentation and Hardware
- Annunciators
- Computers
- Procedures
- Control Room Environment
- Maintenance and Surveillance Procedures
- Training and Manning (Received only limited review during the 1981 survey)

Each of these control room survey areas and the general recommendations for enhancement are listed in the Fermi 2 Control Room Survey Summary Report, Reference 4. This report was submitted to the NRC-HFEB prior to their completing an onsite review of the Fermi 2 Control Room. The NRC reviewed the BWROG finding, identified additional HEDs and evaluated the suitability of proposed corrective actions.

The NRC's review of the control room, Reference 10, is reported in the Fermi 2 SER and includes HEDs identified as priority rating 1 and 2 which were required to be completed prior to fuel load.

The implementation status of these priority 1 and 2 items is contained in a recent letter to the NRC, Reference 11. This letter documented an NRC confirmatory audit of the control room completed in November, 1983. [Review and resolution of the priority 3 items will be included in the assesment and implementation phase described in Section 6.0.]

2. The BWROG 1983 Survey Supplement

This supplement is intended to augment Revision 1 of the BWR Owners Group Control Room Survey (CRS) Program dated 1/1/81. It is to be included as part of the Control Room Review Checklists to further document proposed control room enhancements. The additional items listed in the supplement have been drawn from human engineering guidelines recommended in NUREG-0700 (Reference 5) and verified through considerable experience of Owners Group Survey teams.

Major sections of the supplement checklists are identified by letters corresponding to section designations used in the original checklists. In order to differentiate between the two numbering systems, an "S" prefix has been assigned to each supplement item. The supplement checklist sections are:

SA - Panel Layout and Design
SB - Instrumentation and Hardware
SC - Annunciators
SD - Computers
SE - Procedures
SF - Control Room Environment
SG - Maintenance and Surveillance

This checklist supplement will be performed during the planned CRDR activities. The results of 1983 Supplement Survey will be compiled on HED forms described in Section 5.2, Document Control.

5.1.3 System Function and Task Analysis

The purpose of the systems function and task analysis portion of the CRDR is to identify control room operator tasks and corresponding instrumentation and control requirements during emergency operations. Task analysis is used to verify the match of the information available for the control room to the information requirements of the Fermi 2 specific Emergency Operating Procedures.

1. Systems Function Description

Plant systems and subsystems in the control room are specified in the Fermi 2 FSAR. Major systems include reactor controls and instrumentation, feedwater and recirculation systems, safety systems, power generation and power distribution systems. The functions of these systems are identified in the FSAR. Systems identified as safety related are used to control and mitigate abnormal events during plant emergencies.

In the context of CRDR task analysis, systems identification and system functions used during emergencies are provided in the Fermi 2 EOPs. These systems serve to control the reactor primary and secondary containments, and the offsite radiation release (Reference 6).

2. Task Analysis

Using the Fermi 2-specific EOPs as a basis, the task analysis will identify and document the discrete tasks that the operators must perform during emergency operations. The specific instrumentation, controls and equipment that are required to alert the operator to emergency conditions, and to successfully perform the emergency operations will be identified and documented. The characteristic of the controls and information requirements in terms of range, accuracy, setpoints and function allocation will also be included in the task analysis form (see Appendix B).

The controls and information systems available to the operator for each of the specific tasks of the EOPs will be identified and documented on the task analysis form. The human engineering suitability of available inventory against the control and information needs/characteristics will be examined, and the results of this examination will be noted in the task analysis form. In case the available controls and information do not meet the requirements, the suitability column in the task analysis form will be checked "No". This type of occurrence will be defined as an HED and documented accordingly on an HED form.

5.2 Document Control

5.2.1 Review Documentation

Throughout the review process, documents will be processed to record data, analyses and findings. Whenever practical and appropriate, standard forms will be developed and used. The bulk of the documentation generated by the review process will be necessary to do the following:

- o Document the criteria used for each review activity
- o Record the results of the survey, operating experience review and systems review
- o Compile HEDs and associated data for review and assessment

In order to facilitate systematizing and recording control room design review activities, several standard forms have been developed. These forms, which appear as samples in Appendix B, are:

- o Operator Interview Form
- o Human Engineering Discrepancy
- o Task Analysis Data Sheet
- o Memo of Consultation

Any or all of these forms may be revised based on the experience gained during the CRDR.

5.2.2 Reference Documentation

The following documents have been identified as possible reference material. As the review progresses, additional references may be identified.

- o Fermi 2 Final Safety Analysis Report
- o BWR Owners Group Control Room Survey Program
- o BWR Owners Group Emergency Procedure Guidelines
- o Fermi 2 Emergency Operating Procedures (EOPs)
- o NRC Regulatory Guides (e.g., 1.97 and 1.47)
- o NRC Guidance Documents (e.g., NUREG 0700)
- o Fermi 2 Training Documents
- o Control Room Drawings
- o Plant System Design and Operation Descriptions
- o Piping and Instrumentation Diagrams
- o Annunciator Arrangement Drawings and Annunciator Procedures
- o BWROG Control Room Survey Summary Report
- o Human Factors Design Information
- o BWR Owners Group Control Room Design Review Program Summary Report

- Operator Training Manuals
- Fermi 2 Administrative Procedures
- Fermi 2 System Operating Procedures

6.0 ASSESSMENT AND IMPLEMENTATION PHASES

During the asessment phase, all the identified HEDs, including priority 3 HEDs from Reference 10, will be analyzed as to their effects on operator performance and safe plant operation. Discrepancies will be prioritized according to the combined criteria of the likelihood of operator error and the resulting safety consequences. Some HEDs will be selected for correction by enhancement, without undergoing prioritization relative to their safety consequences. For all the HEDs recommended for modification, design corrections will be recommended, and schedules of implementation will be developed based on the priorities and integration with other NUREG 0737 Supplement 1 emergency response improvement actions. Figure 2 shows the assessment process for the HEDs.

6.1 Enhancements

Many identified HEDs resulted from minor deviations from human engineering principles and require simple corrections. Examples of such corrections include panel labeling and swapping of like components, and component improvements to the panel controls and indicators. More specifically, enhancements involve a number of techniques that involve surface improvements such as demarcation lines, shading and mimics. Guidelines in selecting these HEDs for correction by enhancement will be derived from the review team's own experience, Fermi 2 control room standards, and information listed in References 5 and 7. Placing the HEDs in the category of "Enhancements" implies that corrective actions and implementaton will be prompt.

Those HEDs selected for enhancement do not require prioritization relative to safety consequences. However, these enhancements will be considered in the overall program of HED assessment, verification and schedule of implementation, and their effect on other control room corrections will be evaluated.

6.2 Prioritization of HEDs

All the HEDs identified for modification (all those not in the enhancement category) will be analyzed and ranked as to the degree of impact on plant safety and the likelihood of occurrence of such impact. The following factors constitute the basis for the prioritization of the HEDs:

- Impact on safe plant operation resulting from the degradation of operator performance due to the HED
- Function and classification according to safety of the HED-related component/system
- The potential for human error as influenced by the HED

6.2.1 Prioritization Criteria

Considering the above factors, NUREG 0801 (Reference 8), and the CRDR evaluation methods developed by the BWROG (Reference 9), two critieria have been formulated to envelop the HEDs safety consequences and the likelihood of human error. The criteria are:

A. Safety Classification

This criteria is a measure of the safety consequences of the HED. The impact of the HED on safe plant operation as influenced by operator-related actions during emergencies, is taken as the primary measure. Any HED which affects safe plant operation will be classified Safety Related as determined by the judgment of the review team. For those HEDs where the impact on plant safety cannot be established, a secondary measure dealing with the examination of the HED-related system classification will be used. An HED associated with a component belonging to a BWR safety-related system such as ECCS, etc. will be ranked as Safety Related, independent of the analysis for the HED effect on safe plant operation.

B. Error Potential

The likelihood for human error is classified as documented or having potential for occurrence. Operator interviews will be used for input of error potential as well as review team judgement. In addition, the survey results of other BWR control room design reviews (Reference 9) will be reviewed to determine if documented HEDs are applicable to Fermi 2.

6.2.2 Priority Ranking

Based on the above criteria, each HED will undergo a prioritization test according to the flow chart of Figure 3. The resulting priority matrix is given in Figure 4, and a summary of the HEDs prioritization is given below.

Priority I
- Safety Related
- Documented and/or High Potential Error

Priority II
- Safety Related
- Low Potential Error

Priority III - Not Safety Related
- Documented and/or High Potential Error

Priority IV - Not Safety Related
- Low Potential Error

The HEDs will be further examined for their cumulative or interactive effects. If such effects are found, they will be upgraded accordingly.

6.3 Corrective Actions and Schedule for Implementation

Corrective actions will be developed to bring the HEDs into agreement with acceptable human factors guidelines or to limit their effects. The specific corrective actions chosen may be enhancements, design modifications, improved training, revised procedures, or any combination of the above. The review team will develop the corrective actions. References to be used will include NUREG 0700 (Reference 5), EPRI NP-2411 (Reference 7), and other Human Engineering guidelines. The following factors will be used in the assignment of the corrective actions.

- o Priority rating
- o Cost effectiveness
- o Extent of correction: Enhancement vs. modification
- o Operator performance/retraining
- o Potential for creating new errors
- o Integration with other control room improvement programs: SPDS, R.G. 1.97, EOPs, etc.

Sufficient detail regarding the corrective action will be developed by the CRDR team to provide adequate guidelines for its subsequent implementation action.

6.3.1 Schedule for Implementation

An implementation schedule shall be assigned to each HED corrective action according to the classification of the HEDs into enhancements or modifications and according to the prioritization of the modifications noted in Section 6.2. The corrective action assignments to be used are as follows:

HED'S	Assignment	Schedule for Implementation
Enhancements & Priority I	A	Prompt, 1st Refueling
Priority II	B	Near-term, 2nd Refueling

Priority III	C	Medium-term, 2nd Refueling
Priority IV	D	Optional, Left to Utility

Any practical constraints on scheduling of modifications will be considered separately from the determination of the HEDs significance and priority. If such constraints as equipment availability or design lead time conflict with the assignment designation, that designation may be changed to the next appropriate one. Conversely, if the magnitude of the modification of a low level priority HED is relatively small such as the addition of demarcation lines or labels, the assignment of that HED may be upgraded. In all such cases where a change in assignment is made, the change and the reason for doing it and the evaluation of the impact will be documented on the HED report form.

Following the submittal of the CRDR summary report, any change in schedule of implementation and the reasons for the change will be documented. The NRC will be provided periodic updates of HED corrective action by a letter of supplement to the Summary Report.

6.4 Evaluation of Design Improvements

The modified control room instrumentation and control design will be evaluated to assure that the selected design improvements, both individually and collectively, adequately correct their respective discrepancies and do not create other safety problems. The evaluations will be accomplished by performing the following:

1. Comparison of the modified control room design with the control room human factors design conventions document.

2. Comparison of the modified control room design with the instrumentation and controls requirements identified during the control room survey and task analysis.

3. Comparison of the modified control room design with approved project design criteria (e.g., electrical separation criteria).

Figure 3

Prioritization of HED's

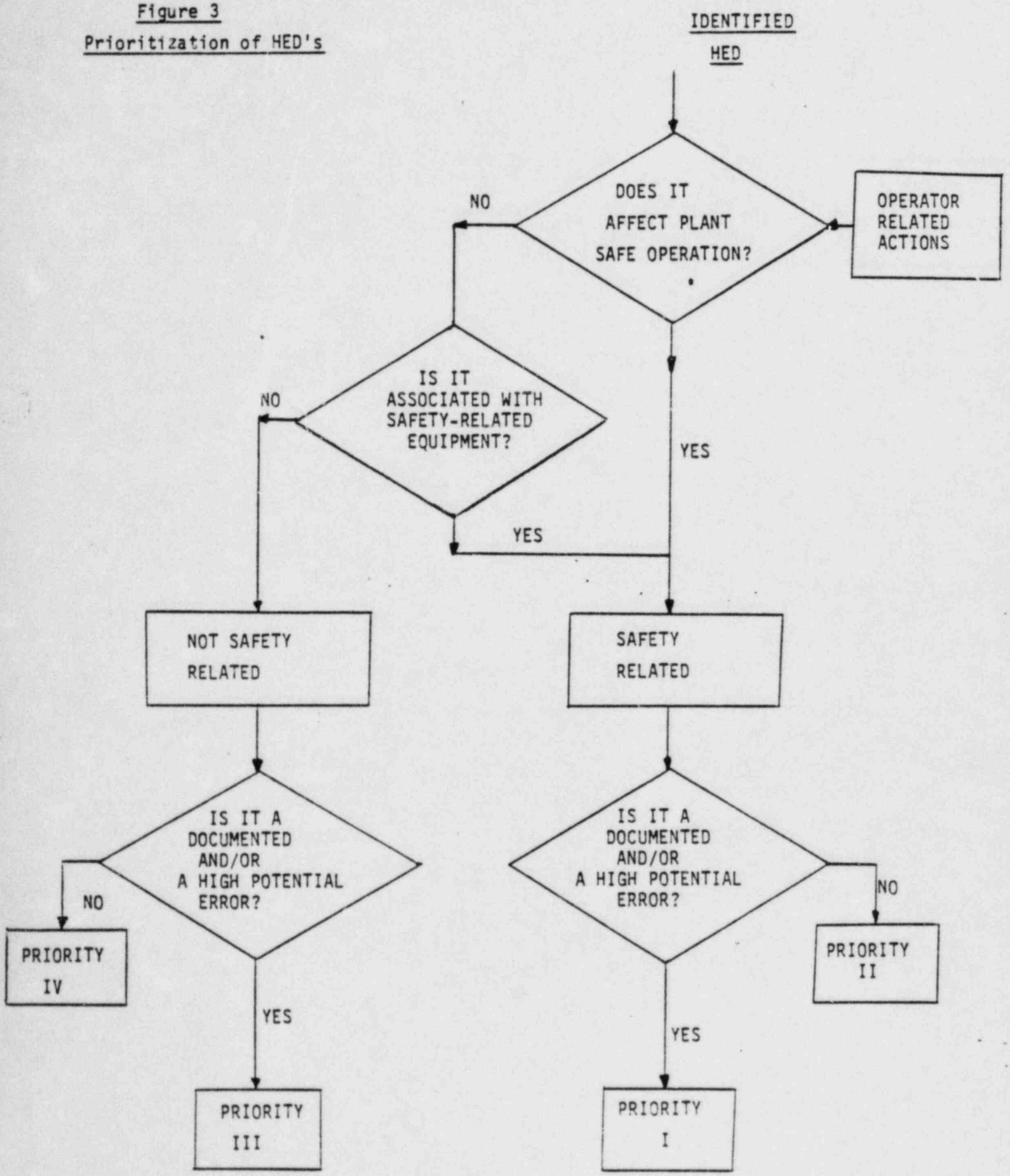


Figure 4

o HED PRIORITIZATION MATRIX

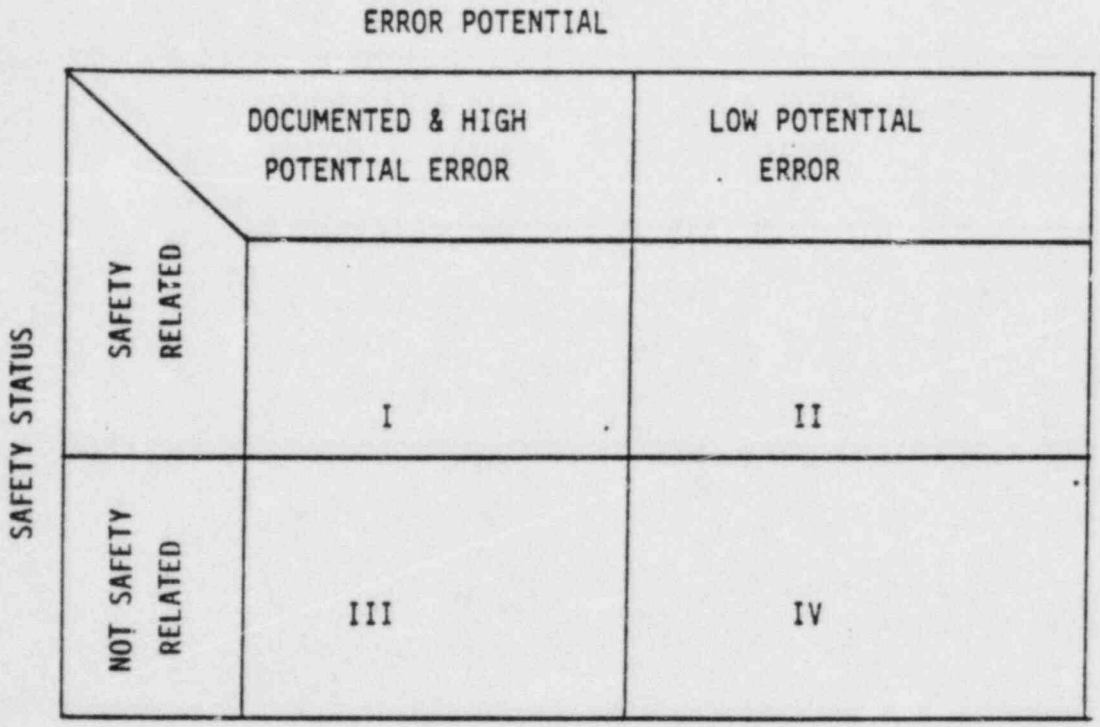
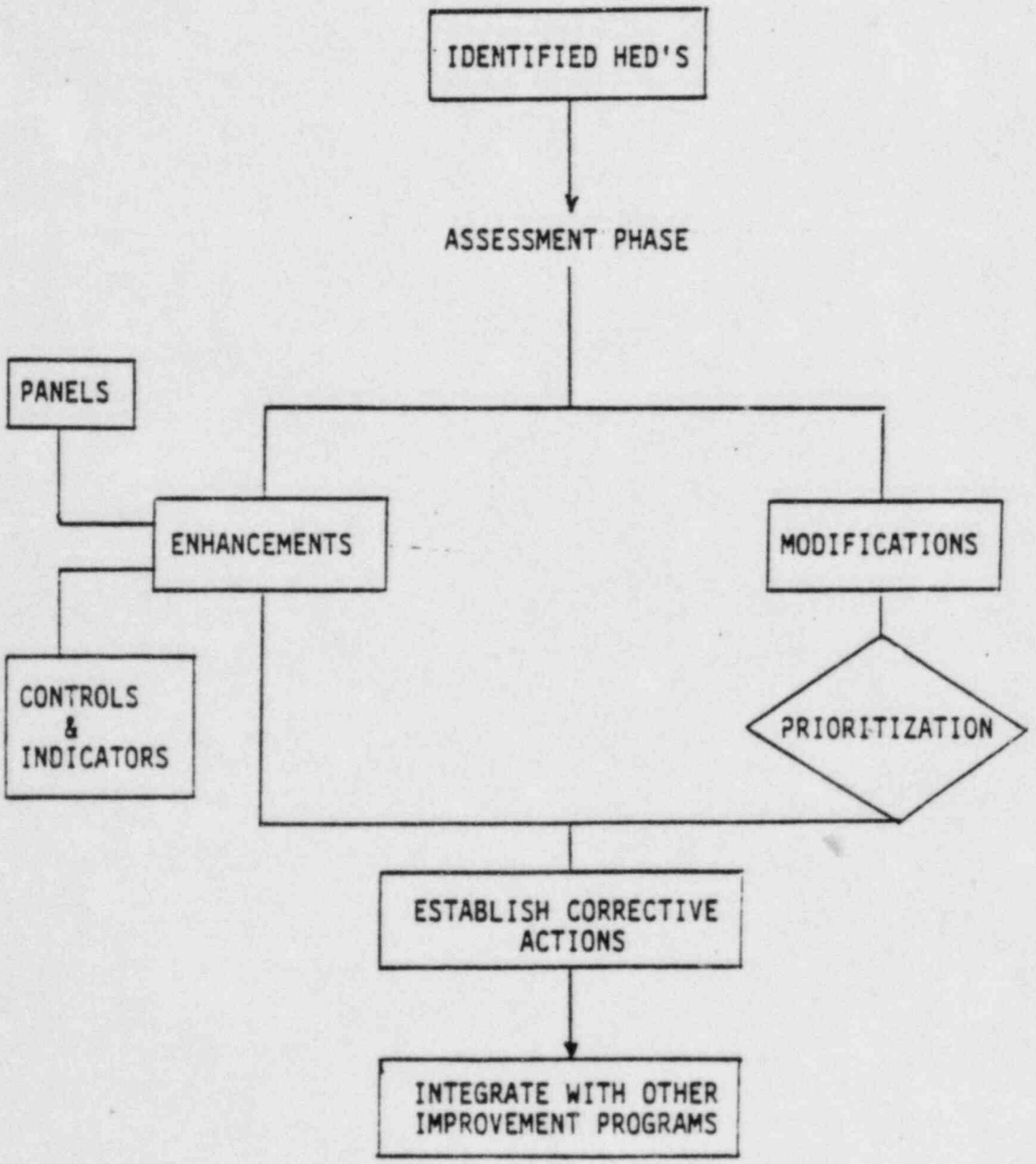


Figure 2

HED'S ASSESSMENT



7.0 SUMMARY REPORT

Following completion of the Review and Assessment Phase, a summary report of the results of the CRDR will be prepared and submitted to the NRC. The report will summarize the review process, referencing this program plan and provide material which updates or revises the plan.

7.1 Review Process

With regard to the actual accomplishment of the plan, the summary report will include the following topics:

- o Operating Experience Review
  - Types and time periods of records reviewed
  - Operator survey procedures
  - Summarize experience of operators interviewed
  - Sample interview questionnaire
- o Control Room Survey
  - Summarize survey procedures
  - Provide sample survey forms
  - Assessment
- o System Function Review and Task Analysis
  - Reference the approved Emergency Procedure Guidelines which are the basis for the Emergency Operating Procedures used in the task analysis
  - Chart or list of major systems and subsystems referenced in the EOPs and used in task analysis.
  - Identification of any instrumentation or controls shown needed to support operator functions in the Emergency Operating Procedures which are not located in the control room.

7.2 Review Findings

This section will be organized by the chapter heading in the BWROG checklist:

- o Panel Layout and Design
- o Instrumentation and Hardware
- o Annunciators
- o Computers
- o Procedures
- o Control Room Environment
- o Maintenance and Surveillance
- o Training and Manning

The above subject areas directly address the BWROG Supplemental Checklist. Additionally, special attention will be given to the findings from the task analysis and operating experience reviews.

Each report section will include a description of all identified HEDs and the proposed (or implemented) corrective action. The assessment process used to identify and select design solutions will be summarized. Where necessary for interpretation of the report, appropriate sketches or photographs will be provided. For HEDs which are found to be important to safety, solutions which only partially correct the problem or decisions not to correct the HEDs will be justified including the assessments providing the basis for such decisions.

7.3 Implementation

This section will summarize the schedule for implementing the design solutions which were described in the "Review Findings" section of the summary report. As noted in 7.2, where corrective actions have already been completed, that will be noted under "Findings" and those solutions will not be repeated in this section. If there are areas which are not fully documented with regard to outstanding actions, it is possible that an addendum to the summary report may be issued.

8.0 SCHEDULE

The schedule for completing the CRDR Summary Report for Fermi 2 is September 1985 as was provided in a previous transmittal to the NRC (Reference 12). The status of implementation for HEDs from the 1981 survey was provided in Reference 11.

9.0 REFERENCES

1. BWR Owners' Group Letter BWROG 83-51 from W. J. Armstrong to V. A. Moore, dated August 25, 1981.

2. NRC Generic Letter 83-18, NRC Staff Review of the BWR Owners' Group Control Room Survey Program, dated April 19, 1983.

3. NRC Generic Letter No. 82-33, Supplement 1 to NUREG 0737, Requirements for Emergency Response Capability, December 17, 1982.

4. "Human Factors Design Review of Enrico Fermi 2 Control Room", Summary Report, March 1981.

5. "Guidelines for Control Room Design Reviews", NUREG 0700, September 1981.

6. "Task Analysis Requirements of Supplement 1 to NUREG-0737 - May 4, 1984 Meeting with BWR Owners' Group Emergency Procedures Guidelines and Control Room Design Review Committees" NRC Letter from S. H. Weiss to W. A. Moore, May 14, 1984.

7. "Human Engineering Guide for Enhancing Nuclear Control Rooms", EPRI Report No. NP-2411, May 1982.

8. "Evaluation Criteria for Detailed Control Room Design Review", NUREG 0801, Draft Report, October 1981.

9. "BWR Owners Group Control Room Design Review Program, Summary Report", General Electric Report No. NEDC-30285, October 1983.

10. "Safety Evaluation Report on Control Room Design by the Human Factors Engineering Branch - Office of Nuclear Reactor Regulation", Appendix D of NUREG 0798, July 1981.

11. Letter from W. Jens to B. J. Youngblood, "Control Room Design Review Open Item Status", EF2-69137, dated July 25, 1984.

12. Letter from W. Jens to B. J. Youngblood, "Response to Supplement 1 of NUREG-0737", EF2-62262, dated April 15, 1983.

Appendix A

Resumes of original BWROG CRS Team:

J. Gebert, Iowa Electric Light and Power Co. (Team Leader)

J. Tolson, Public Service Co. of Oklahoma

K. Ross, General Electric Co.

P. Nicholson, Human Factors Consultant, MIT Group

R. Flinn, General Electric Co.

D. Lanning, Massachusetts Institute of Technology

Resume of

John H. Gebert

PERSONAL INFORMATION

Born: September 27, 1929
Boone, Iowa

EDUCATION

Associate of Science Degree — Boone Junior College
Electricial Engineering — International Correspondent School

EMPLOYMENT HISTORY

3/49 - 1/57	Estimator and Construction Superintendent, Lippert Brothers Construction Company
1/57 - 8/63	Power Plant Employee, Iowa Electric Light and Power Company
8/63 - 5/69	Production and Substation Superintendent, Iowa Electric and Power Company
5/69 - 5/71	Engineering Department Iowa Electric Light and Power Company
5/71 - 3/74	Electrical and Mechanical Maintenance Supervisor DAEC
3/74 - 9/80	Maintenance Superintendent DAEC
9/80 - Present	Senior Electrical Engineer Iowa Electric Light and Power Company

CONTROL ROOM DESIGN REVIEW

* BWR Owners Group Control Room Survey Workshop, Morris, IL
* Team Leader for BWR Owners Group Control Room Survey at the Duane Arnold Energy Center Nuclear Plant
* Team Leader for BWR Owners Group Control Room Survey at the FERMI-2 Nuclear Power Plant

CONTROL ROOM DESIGN REVIEW (cont.)

* Team Leader for BWR Owners Group Control Room Survey at the Cooper Nuclear Power Plant

* Team Member for BWR Owners Group Control Room Survey at the Hatch Nuclear Power Plant

* Team Member for BWR Owners Group Control Room Survey at the Moticello Nuclear Power Plant

* Committee Member of INPO NUTAC Control Room Design Review Committee

BRIEF RESUME OF JAMES TOLSON

SUPERVISOR, ELECTRONIC SYSTEMS

TRANSOK, INC.

Education

BSEE, Le Tourneau College, Longview, Texas, 1976.

Courses taken since graduation include:

Human Factors Engineering in Power Plant Design, BWR Operation, BWR Plant Design and Fundamentals, and various instrumentation and computer courses.

U.S. Navy - Electronics and Nuclear Power Schools.

Experience

U.S. Navy (Six Years)

Title: Electronics Technician (ETI (SS))

Qualified Reactor Operator on nuclear submarine power plants. Performed various levels of operation, supervision, and maintenance during submarine operation and overhaul. Installed field changes to reactor panels to improve operator interface.

Public Service Company of Oklahoma (Five One-Half Years)

Title: Instrument and Control Engineer, Black Fox Project

Responsibilities included specification review and design surveillance for several plant control and protection systems including the main control room (NUCLENET 1000).

Participated in control room reviews at Fermi II and Cooper Power Stations and the Black Fox Simulator to insure an acceptable man machine interface was provided.

Assisted in writing and reviewing NRC licensing submittals for several post TMI issues and participated in conceptual design of an Emergency Response Information System.

Transok, Inc.

Title: Senior Engineer (One One-Half Years)

Worked as Design Engineer on a SCADA system used to control and collect data on a 2,500 mile natural gas transmission gathering system including installation of remote terminals and metering modifications. Also designed lighting systems, valve controls, compressor trip schemes and control panels.

Title: Supervisor, Electronic Systems (Present Job - Six Months)

Supervise hardware, software, and field maintenance on the above referenced SCADA system from the flow transmitters in the field to the master computers. Revision of the CRT formats for improved operator interface is in progress.

Also responsible for an 800 MHZ radio system used to communicate between the dispatch center and 130 field personnel.

Professional Organizations: IEEE, ISA, ENTELEC

RESUME

Name: Kenneth C. Ross

Position: Program Manager

Company: General Electric

Experience includes nine years in the nuclear industry--four years as an instructor in the U.S. Navy nuclear power program, two years as an instructor for General Electric Company, and three years as a program manager for General Electric Company. SRO License. Certified by NRC to teach all phases of BWR operation.

General Electric program manager for BWROG Control Room Survey Program. Provided program management support for eighteen BWR control room design reviews. Principle author of nine control room design review summary reports, co-author of additional seven. Developed, organized, and presented BWROG Control Room Survey Program Workshop. Attended MIT summer seminar on human factors engineering and INPO workshop on control room evaluations. Co-author of training appendices to BWROG EPG's.

Short Resume

Paul J. Nicholson
Box 74
MIT Branch P.O.
Cambridge, Ma 02139
(617)253-3885

P. J. Nicholson is currently an independent consultant serving the nuclear power industry in the areas of instrumentation and control and related topics. Twenty three years of professional experience include 12 years in the aerospace electronic industry and the remainder in nuclear research and advanced reactor instrumentation and dynamics. For the past four years, while principal scientist at the C.S. Draper Lab, he has been guest lecturer in the MIT Nuclear Engineering Department, associate lead investigator for the MIT Advanced Reactor Control Project, and supervisor for a number of nuclear engineering graduate thesis projects. He has been nominated for the position of Visiting Scientist at MIT for the 1980-81 academic year.

From 1958-65 he held positions of increasing responsibility at Raytheon Company, managing advanced aerospace electric projects in air defense, radar and signal processing. Granted academic leave during 1965-69 he joined an experimental high energy physics research group at the Rutherford Laboratory at Harwell, U.K., accepting responsiblity for all electric instrumentation for the Π7 experiment, one of the first successful large scale computer controlled experiments. He was also responsible for control room design displays, data storage and retrieval aspects. While in the U.K. he completed studies for a Ph.D. degree at the Imperial College in London and was appointed undergraduate physics tutor.

Returning to Raytheon he was named manager for Advanced Development, Aerospace Systems with responsibility for the USAF fault tolerant computer program and airborne multiplexing systems. He was a member of the SAE-2K multiplexing committee. Later at GTE Sylvania he was responsible for Air Force Satellite communications, the joint services computer controlled small switch board and DCA worldwide digital voice modem development.

From 1974-1980 at C.S. Draper Lab, he was senior project scientist and principal investigator for advanced reactor instrumentation and control and reactor modeling studies for the DOE fusion program and the EPRI Fusion-Fission Hybrid Kinetics Study. He also collaborated with Combustion Engineering

in the Disturbance Analysis System (DAS) Study and interacted with the nuclear utilities, and industry and the NRC in areas of LWR power plant I&C. Recently he was invited to lecture in the MIT Summer Course on Man-Machine Interfacing in Nuclear Power.

He is a member of the AIAA Terrestrial Energy Technical Committee, served on the IEEE/NRC Smart Instrumentation panel, and is a consultant to the Stone and Webster Engineering Corporation. He is author of several publications in the reactor I&C field.

Prior to his post graduate studies in the U.K., Mr. Nicholson obtained a B.S. in Mechanical Engineering from MIT and an M.A. in physics from Boston University.

Resume

Name: Robert Flinn
Title: Principal Engineer
Component: Control Systems Engineering

Nuclear Related Experience:

Naval S5W reactor operator and electronics technician 1960 to 1965. BSEE, Colorado State University, 1968. Joined GE 1968 as Field Engineer, Marine Service. Transferred to Nuclear Energy Division, San Jose in 1970 as C&I Cost Estimator. Joined Nuclear Services Division in 1976 as Site Operations Engineer at Hatch Nuclear Plant. BWR Station Nuclear Engineering course completed in 1976, SRO Certification 1977. Member of Southern Services Task Force on Reactor Safety as BWR Consultant 1978. Member of Hatch Staff Committee for Capacity Factor Improvement 1979-80. Three years site experience in operations, outage planning, maintenance, core performance and radiation safety. Returned to San Jose as Principal Engineer in Nuclear Services Engineering. Attended Control Room Survey Workshop and participated in Control Room Survey at Fermi. Presently involved in Environmental Qualification of Control and Instrument components.

Brief Resume

David D. Lanning (Ph.D. 1963, M.I.T.)

Professor Lanning's fields of interest are the areas of Applied Reactor Nuclear Engineering, Reactor Operation and Safety. He worked at the MIT Reactor in the areas of teaching, research, and reactor operation from 1957 to 1965, and returned to MIT in 1969. At present, he is the Graduate Admissions Officer for the Nuclear Engineering Department as well as continuing his teaching and research. He was in charge of the, now completed, core modification design and installation for the MIT Reactor. He also worked at the research laboratories in Richland, Washington from 1951 to 1957 and from 1965 to 1969. In the latter period, he worked for Battelle-Northwest as a manager of the Reactor Neutronics Section which included the utilization and operation of the High Temperature Lattice Testing Reactor (HTLTR) and the utilization of the Physical Constants Testing Reactor (PCTR). He currently teaches a course in "Reactor Operations" and a course in "Nuclear Power Reactors." His most recent sponsored research and consulting activities have been in the area of power reactor and research reactor core design, transient analysis, control system studies and safety assessments.

Recent Specific Consulting

1. Member of the Safety Audit Committee for the Northern States Power Company Monticello Nuclear Generating Plant (BWR).

2. Member of certain Design Review Boards for the Stone & Webster Engineering Corporation.

3. Consultant for Argonne National Laboratory working on utiliation of low enriched uranium for research and test reactor fuels.

4. Review of Reactor Safety Related Information for the Boston Edison Company.

5. Member of the General Public Utilities Ad Hoc Committee to review the Man-Machine Interface and Operator Training. (TMI-2 Review)

Appendix B

Documentation forms:

- Operator Interview Form
- Human Engineering Discrepancy
- Task Analysis Data Sheet
- Memo of Consultation

I.OPERATOR INTERVIEW
INTRODUCTION TO QUESTIONAIRE

Job Position_____

Years of Experience_____ Commericial Nuclear_____ Fossil
_____ Navy Nuclear
Date of First License_____ RO _____ SRO

Education/Degrees_____

Age_____ Sex_____ Height _____ Weight_____

In response to a post-TMI NRC requirement, your utility, along with other BWR owners, is conducting an updated control room review to identify and correct design deficiencies in the operator-control room interface to minimize the potential for human error. This review is performed by a survey team composed of utility representatives, human factor specialists, and General Electric engineers using checklists prepared by the Control Room Improvements Subgroup of the BWR Owners Group.

You are asked to complete the attached questionaire basing your responses on your operational experience and knowledge of your control room and interfacing systems. You may complete this questionaire in the control room if you desire but please do so without discussing your detailed responses with other operators completing this survey. If additional space is needed, the attached Comment Form is to be used.

Following completion, a survey team representative will review your responses with you. Upon completion of all interviews, the survey team will consolidate the information obtained and apply it in their evaluation of your control room for compliance with human factor engineering principles.

The biographical information requested above will be used in compiling statistics on operating personnel physical characteristics. Current recommendations for panel design are based largely on data obtained from measurements of military personnel; there are few statistics presently available on, for example, the average height and weight of operators.

This survey provides you with a valuable opportunity for applying your knowledge and experience toward improving operating conditions in both your control room and future control room designs. Your honest and forthright opinions are not only welcomed, but needed.

I. OPERATOR INTERVIEW

QUESTIONAIRE

A. Would you recommend any changes in the following area:

A1 training

A2 color coding

A3 control room access

A4 control panel layout or access

A5 communication systems

A6 heating or ventilation

A7 lighting or noise levels

A8 data recording and log entries

A9 information flow

A10 furniture, equipment or workspace

A11 computers

A12 other?

I. OPERATOR INTERVIEW

QUESTIONAIRE

B Are any controls difficult to operate?

C Are any controls designed, positioned or labeled in a manner that causes risk of inadvertent operation?

D Are any recorders or indicators difficult or confusing to read?

E Are any important indicators located such taht they are difficult to see during normal or emergency operation?

F Do you feel any control room displays are unnecessary, provide unimportant information or needlessly clutter the control panels?

G Based on your operational experience, does you control room lack any controls or displays needed in your response to normal or emergency situations?

H Do you consider the annunciator system to be effective in conveying important information to you?

I. OPERATOR INTERVIEW

QUESTIONAIRE

I Do you have any problems locating or using procedures or operational instructions?

J Have you experienced any problems using or understanding your procedures?

K Is there a partricular panel which you consider more difficult or confusing to operate than the others?

L General Comments:

I OPERATOR INTERVIEW

COMMENT FORM

This form is for use by the operator or interviewer for expanded responses to the Operator Interview questions. When used, each response will be identified by item number on this form and also so noted in the space following the applicable question to assure proper cross-referencing.

Item	Response
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TASK ANALYSIS DATA SHEET

Procedure Title _____ Review Date _____

Rev. No. _____ Date _____ Team _____

Procedure Step	Entry Conditions/Operator Actions per EOP's	Controls and Information Needs/Characteristics	Availability		Suitability	Notes
			Device/Location	Associated Devices/ Location		

HED Report Sheet 2

VERIFICATION OF CORRECTIVE ACTION:

1. Addresses HED?

2. Meets human factors requirements?

3. Safety considerations (question not addressed in HED temporary reduction in safety, increased risk of failure/misoperation):

4. Compounding effects (new HEDs, Adverse Combination with other resolutions):

5. Negative retraining?

IMPLEMENTATION FOR VALIDATION:

1. METHOD USED

2. SCHEDULE

VALIDATION:

1. Method used (Walk/Talk through, checklist, etc.)

2. Validation checklist:

   a. Resolves HED?

   b. Meets human factors requirements?

   c. Safety considerations?

   d. Compounding effects?

   e. Negative retraining?

IMPLEMENTATION IN CONTROL ROOM:

1. Plan

2. Schedule

HUMAN ENGINEERING DISCREPANCY

HED Report Sheet 1

Date: _____

Page ___ of ___

- o Licensee: _____ Plant: _____ Reviewer: _____
- o Plant System: (Reactor Coolant, Reactivity Control, Environment, etc.) _____
- o Plant SubSystem: (Pumps, Valves, HVAC Controls, etc.) _____
- o Equipment Item or Topic - Control Board Section (name/number) _____
  - Control Board Panel (panel identifier) _____
  - Component or Topic Item (e.g., C/D layout, lighting, maintenance procedures, etc.) _____
- o Human Performance Modality (vision, hearing, decision making, etc.) _____
- o BWROG CRS ID (Applicable Section & Subsection) _____

HED DESCRIPTION:

HED SERIAL NUMBER: (If used)

PHOTO ID NUMBER:

1. Description of HED:

2. This HED Relates to:

   a. Event:

   b. Function/Task:

3. Safety Consequences/Pricrity Rating:

4. Interaction of HED with other HEDs, systems, events, functions/tasks, etc.

ACTION PROPOSED TO CORRECT HED:

CORRECTION SCHEDULE

COMMENTS: (This section contains other pertinent explanatory or supplementary information including, identification of HED with applicable steps or substeps of system review)

MEMO OF CONSULTATION

SUBJECT OF CONSULTATION: _____

RELATED HEDs: _____

NAME OF CONSULTANT: _____

DATE: _____

DESCRIPTION:

CONCLUSION:

INITIATED BY:

_____
Signature Date

VERIFIED BY:

_____
Signature Date