PROGRAM PLAN FOR IMPLEMENTATION
OF
CONTROL ROOM DESIGN REVIEW
PACIFIC GAS AND ELECTRIC COMPANY
DIABLO CANYON POWER PLANT
UNITS 1 AND 2

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1 INTRODUCTION

The control room design review (CRDR) is part of a broad effort within the industry and the Nuclear Regulatory Commission (NRC) to upgrade control rooms, emergency response facilities, and procedures. The CRDR is directed toward the existing control room with the provision that future changes will receive a human factors review prior to implementation.

Guidance for the CRDR and related activities has been provided by the NRC in the form of various NUREGs and Regulatory Guides. In addition to these guides, industry in cooperation with Institute of Nuclear Power Operation (INPO), Electric Power Research Institute (EPRI), and others has developed methodologies for performing a CRDR. Pacific Gas and Electric (PGandE), with the assistance of a human factors consultant, will select those guides which provide the best approach.

The purpose of this implementation plan is to describe the manner in which PGandE intends to conduct a review of the Diablo Canyon Power Plant (DCPP) Unit 1 and Unit 2 control rooms. PGandE is commencing this review without waiting for approval from the NRC as directed by guidance provided in Supplement 1 to NUREG 0737. However, PGandE expects that any major deficiencies in the plan noted by the NRC staff will be brought to PGandE's attention in a timely manner.

A second function of this implementation plan is to provide a basis for judging the adequacy of PGandE's CRDR. It is hoped that any audit of PGandE's CRDR by NRC personnel or contractors will use this implementation plan as the reference document and that the criteria for completeness and adequacy will be taken from this document and supporting DCPP CRDR procedures.

A flow chart is included to show the relative placement of selected activities within the CRDR process. An overall schedule for the CRDR, SPDS installation, and new emergency operating procedure implementation has been submitted as required by Supplement 1 to NUREG-0737.

2 OVERVIEW

2.1 PURPOSE

The purpose of the PGandE CRDR is to evaluate the DCPP control room design against accepted human factors engineering (HFE) criteria and to ensure that the DCPP control rooms will support operation during emergency conditions.

2.2 OBJECTIVES

To ensure that the CRDR fulfills its stated purpose, several objectives will be met during the review. The following specific objectives are defined for the CRDR:

- To perform a control room survey that compares the existing control room design with accepted human engineering criteria
- To identify human engineering discrepancies (HEDs)
- To review relevant plant operational experience using appropriate documentation and structured operator interviews
- To determine the input and output requirements of control room operator tasks during emergency conditions
- To evaluate the extent and importance of any identified discrepancies
- To formulate and implement resolutions for significant discrepancies (as judged above)
- To ensure that the proposed resolutions do, in fact, eliminate or mitigate the discrepancies for which they are formulated without creating new discrepancies

2.3 DESCRIPTION OF CRDR ACTIVITIES

To achieve the stated objectives of the CRDR, several activities will be completed during the review. A flow chart of these activities is presented in Figure 1. This flow chart shows the interrelationships of the information needed and obtained by each activity. The CRDR is divided into six nominal phases: planning, execution, assessment, correction, effectiveness, and documentation. A brief synopsis of these activities follow.

2.3.0 Planning Phase

The planning phase of the CRDR will scope the activities, establish the review team members, obtain the requisite consultants and consultant interface points and develop a program schedule for review activities. This implementation plan represents a product of these activities; however, planning will continue throughout the review.

2.3.1 Execution Phase

The execution phase will constitute the investigative, data gathering portion of the CRDR. During this phase, a control room survey will compare the characteristics of the existing control room with appropriate human engineering design guidelines. An examination of operating experience, both generic and plant-specific, will be conducted by a review of historical operational documents, such as control room operator logs and Significant Event Reports, and through structured interviews with control room operators. During the task analysis, the new symptom-oriented EOPs and the plant systems called for in the EOPs will be analyzed to determine the tasks required of operators during emergencies. The instrumentation and control requirements for those tasks will be established, and the adequacy and completeness of existing instrumentation and controls will be determined.

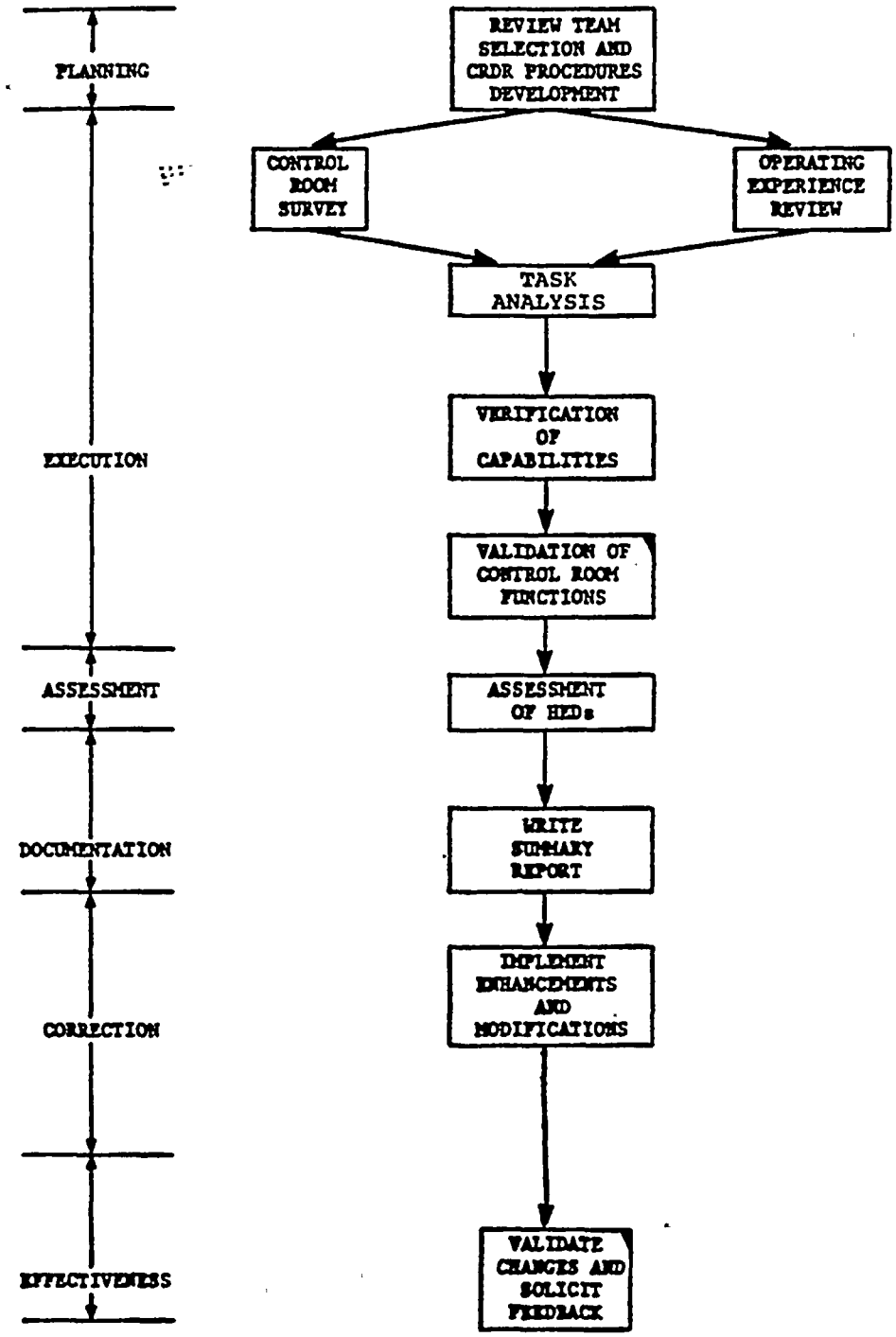

Figure 1. Schematic of Control Room Design Review Activities

The execution phase will specifically address both units' control rooms. This activity will assure that differences are recognized and documented. The control rooms will not be considered identical.

2.3.2 Assessment Phase

During the assessment phase, all discrepancies identified in the execution phase will be analyzed, and the potential impact of each discrepancy on plant operation will be evaluated. Discrepancies will be classified according to their potential impact on plant operation. Significant discrepancies will be resolved through enhancement, modification, or other means, such as changes in procedures, staffing, and training. Any actions proposed to resolve significant discrepancies will be analyzed for their effect on operation.

2.3.3 Documentation Phase

A summary report will be submitted to the NRC at the conclusion of the CRDR. It will:

- Summarize the overall review process,
- Summarize the identified human engineering discrepancies,
- Describe the disposition of discrepancies for which no changes were made,
- Describe control room design improvements implemented during the course of the review, and
- Identify proposed design improvements that were not implemented during the review and
- Identify their schedules for implementation, if available.

2.3.4 Correction Phase

A plant-specific plan will be developed that ensures the integration of proposed control room changes with other

post-TMI programs, as well as plant operating status. A schedule will be developed for the orderly introduction of proposed changes. The schedule will take into account the required training of operators on pending changes. Administrative follow-up will be instituted to ensure the successful completion and integration of all control room changes.

2.3.5 Effectiveness Phase

The changes which may result from the CRDR activities will be evaluated for their effectiveness prior to implementation. Future changes will be reviewed for compliance with human factors principles using a methodology similar to that of this review.

2.4 DEFINITION OF TERMS

Control Room Design Review (CRDR) - A post-TMI task listed in NUREG-0660, "Task Action Plan Developed as a Result of the TMI-2 Accident," and NUREG-0737, the staff supplement to NUREG-660, as Task I.D.1.

Control Room Survey - One of the activities that constitutes a CRDR. The control room survey is a static verification of the control room performed by comparing the existing control room instrumentation and layout with selected human engineering design criteria, i.e., checking the control room match to the physical capabilities and limitations of the human operator.

Emergency Operating 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 Response Guidelines (ERGs) - Guidelines that provide sound technical bases for plant-specific EOPs.

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 design review.

Human Engineering Suitability - An attribute of a system, component, or procedure that determines its compliance with the human engineering requirements of its users and the job in which it is used.

Nuclear Utility Task Action Committee (NUTAC) for CRDR - Representatives from various nuclear utilities and INPO organized to define areas of CRDR implementation for which an overall effort can provide assistance to individual utilities in completing Task I.D.1, NUREG-0737.

Operational Experience Review - One of the activities that constitutes a CRDR. The operating experience review screens plant operating documents and operator experience to discover human engineering shortcomings that have caused, or could have caused, actual operating problems in the past.

Safety Parameter Display Systems (SPDS) - An aid to the control room operating crew for use in monitoring the status of critical plant parameters.

Subject Matter Expert (SME) - An individual who, by virtue of training and experience, possesses in-depth knowledge in a specific subject area.

Task Analysis - The systematic process of identifying and examining operating tasks in order to identify conditions, instrumentation, skills, and knowledge associated with the performance of a task.

Validation - The process of determining whether the control room operating crew can perform their functions effectively given the control room instrumentation, procedures, and training.

Verification - In the CRDR, verification consists of two independent activities. The first is the process of determining whether instrumentation, controls, and other equipment exist to meet the specific requirements of the emergency tasks performed by operators. The second activity, the control room survey, is also a verification process, checking the control room match to the human operator. In the CRDR context, verification implies a static check of instrumentation against human engineering criteria.

3 PLANNING PHASE

3.1 CRDR MANAGEMENT TEAM

The ultimate responsibility for the DCPP CRDR will reside with the PGandE Vice President of Nuclear Power Generation. The day-to-day conduct of the review, however, will be the responsibility of a review team established specifically for this CRDR. The management team will provide the management oversight to ensure the integration of the project objectives and to fulfill the intent of the review. The management team is responsible for approving the planning, scheduling, and coordinating the total integrated CRDR. The management team will consist of members from PGandE line organizations.

3.2 REVIEW TEAM

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

- Review team leader
- Human factors specialist
- Reactor operator
- Instrumentation and controls engineer
- Design engineer

The core team will be supplemented, as required, by other disciplines such as mechanical, and electrical, engineering; training; computer operations; procedures; licensing; health physics; and

emergency preparedness. During the course of the review, any additional specialists (e.g., lighting, acoustics) required for specific tasks will be made available to the review team, as needed.

3.2.1 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. This individual provides a cohesive force for the various PGandE department personnel and vendor organizations involved with this project. Plant operations personnel provide input to the review team through contact with the review team leader.

It will be the responsibility of the review team leader to resolve opinions on methodology, technique, review findings, assessment and HED corrective actions. The minimum qualifications for the review team leader will include the following:

- Bachelor's level degree (or equivalent) in an engineering discipline, <u>or</u>
- SRO-certification and
- Five years' experience in nuclear plant operations or engineering

3.2.2 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 activities requiring human factors expertise and provide guidance to assure task performance quality is maintained at a level necessary for a valid and comprehensive review.

Minimum qualifications for human factors specialists include the following:

- o M.A. or M.S. in human engineering or related discipline or
- o Five years' experience in human factors, one of which is in nuclear control room review or a closely related systems area

3.2.3 Instrument and Controls (I&C) Engineer

The I&C Engineer will assist in the identification of plant system design features and will serve as the review team expert on the capabilities and limitations of controls and instruments. The I&C Engineer will also provide input to the team during the assessment phase of the review, especially when the review team considers proposals for mitigating HEDs.

The minimum qualifications for the I&C Engineer will include the following:

- o B.S. degree (or equivalent) in engineering or applied science field
- o Five years of I&C engineering experience, at least two of which are in the nuclear design area

3.2.4 Reactor Operator (RO)

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

The minimum qualifications for the RO include the following:

- o A reactor operator's license at DCPP
- o At least two years' experience as a licensed nuclear reactor operator

3.2.5 Design Engineer

The design engineer will assist in the identification of plant design and will serve as the review team expert on the factors affecting the design decisions at the plant. The design 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 minimum qualifications for the design engineer will include the following:

- o B.S. degree in an engineering or applied science field
- o Five years of design experience, at least two of which are in the nuclear design area

3.3 REVIEW TEAM ACTIVITIES

Review team activities will include developing the methodologies for the review and assessment of discrepancies, establishing the overall plan and schedule for the CRDR, acting as a resource for the line

organizations, and integrating all action items. The review team will develop, or has developed, all reports relating to the CRDR and will ensure that appropriate reports are submitted to PGandE management for review and approval.

3.4 REVIEW TEAM ORGANIZATIONAL INTERFACES

3.4.1 Line Organization Interface

In order to perform the CRDR expeditiously while utilizing and broadening the experience in our existing organizations, control room review tasks will be performed by the review team with line organization assistance as needed. Specific tasks in the CRDR may be delegated to line organization, supplemented, as necessary, with technical specialists. The relationship between the review team and line organizations will be established as follows:

- Based upon the objectives defined by the review team, a mutually agreed upon schedule will be developed. The review team will ensure that the line activities are coordinated with and support the overall effort. This schedule will address the major activities required to perform the assigned task.

- The review team leader will have the authority to contact the appropriate manager of each line area to establish a cooperative working relationship with the line organization.

3.4.2 Corporate Interface

The review team will exist as an independent entity in the PGandE corporate structure. The review team leader will report to the PGandE Vice President of Nuclear Power Generation. The work of the review team will not be arbitrarily restricted in any area without written justification.

It is essential that the CRDR be coordinated with other ongoing activities that involve potential physical changes to the plant, such as the construction and manning of emergency response facilities (ERFs). To ensure that such coordination takes place, the review team leader will assure CRDR activities are provided to the DCPP coordination committee that oversees ongoing work for the ERFs and the control room.

3.5 REVIEW TEAM ORIENTATION

Each member of the review team will bring specific, in-depth knowledge to the team. It is important, however, that the review team be able to conduct the CRDR from a common basis of understanding. The entire review team will undergo an orientation program designed to provide certain basic knowledge requirements.

The orientation program will consist of the following minimum instructional areas:

- Human factors - Orientation will familiarize the review team with principles of human factors and their application to the control room review. Included in this area will be a brief synopsis of the history of the CRDR requirement and its ultimate goals. In addition, the review team members will receive instruction, both hands-on and tutorial, in structured interviews, human factors surveys, verification and validation methods, and assessment methods.

- Miscellaneous - During the course of the review, other areas may be identified and orientation will be provided to meet these needs.

3.6 USE OF CONSULTANTS

Human factors consultants will be an integral part of the review team during the CRDR. Some of the skills required during certain review activities are not represented within PGandE and will be contracted. For example, PGandE and the human factors expert will perform the control room operator interviews.

It is envisioned that the human factors specialist will be used part-time during the development of the CRDR methodology and procedures. After this activity is complete, he will assist the review team, as indicated, in the remainder of this plan.

4 EXECUTION PHASE

The objective of the PGandE CRDR is to determine the extent to which the DCPP control room provides the operators with sufficient information to complete their required functions and task responsibilities efficiently under emergency conditions. The review will also determine the human engineering suitability of the designs of the instrumentation and equipment in the DCPP control room. This section of the implementation plan describes the process that will be used to accomplish those overall objectives.

4.1 OPERATING EXPERIENCE REVIEW

The Diablo Canyon Nuclear Plant is a two-unit Westinghouse pressurized water reactor (PWR) designed in the late 1960's. The units are a 4-loop, high-head design with a net electrical output of 1,100 MW each. As there is a lack of any long operating history, the experience of operational personnel and data from plant operation documents is not expected to be a major source of information for the CRDR.

The review of operating experience should provide information on potential problem areas in the control room by studying actual occurrences in other plants. Two separate steps are involved in reviewing operating experience. The first is to review available and applicable historical documentation pertaining to plant-specific and generic occurrences. The second step is to survey operating personnel. Operating personnel surveys should identify specific problem areas in the DCPP control room and, in particular, should point out problems that occur during normal operations.

4.1.1 Historical Documentation Review

Since PGandE is most concerned with events that have occurred at DCPP, the major portion of the documentation review will involve plant-specific documents. Plant documents that will

be examined are the control operators log (COL) and Operations Department monthly report. They will be examined for instances of incorrect control room operation that may have led to a plant trip or turbine trip.

It is recognized that documentation originating elsewhere in the industry should be reviewed to ascertain whether generic problems have been found that might relate to DCPP. A mechanism exists for reviewing all Significant Operating Experience Reports (SOERs) and Significant Event Reports (SERs) distributed by the Institute of Nuclear Power Operations (INPO). These reports are routinely screened for applicability to DCPP systems.

The final generic documentation to be reviewed will be Licensee Event Reports (LERs) from DCPP.

The CRDR team will review the appropriate SOER and SER reports from a representative period and the LER Summary. Copies of those involving control room operator, procedural, and/or control board equipment failure and/or design arrangement errors will be obtained. These reports will be screened with the assistance of an operations subject matter expert (SME) to determine if the report describes and documents a control room problem. A control room problem is defined as one that meets one or more of the following criteria:

- Equipment referenced (valve/pump controls, displays, indicators, etc.) must be in the physical confines of the control room or remote shutdown panel.

- Procedure steps referenced should be accomplished within the physical confines of the control room or remote shutdown panel.

- Personnel error referenced must have occurred in the control room on equipment in the control room or remote shutdown panel or entailed a deviation from procedures that were to be accomplished in the control room or remote shutdown panel.

Reports that pass the above selection criteria will be retained for further analysis.

4.1.2 Operating Personnel Survey

Probably the most valuable source of data on operational problems is the person who has operated the plant. The intent of the operating personnel survey is to gain as much firsthand information as possible on actual and potential operational errors. The survey will consist of structured interviews.

4.1.2.1 Structured interviews

There are several suitable methods to obtain detailed operator comments. PGandE will use one such method--structured interviews. As the name suggests, structured interviews are conducted according to a predesigned outline. The outline may have specific questions be asked during the interview. A structured interview helps to reduce the variability of interview results caused by asking different questions of each interviewee or by allowing the interview topics to appear more or less randomly during the interview. Structured interviews will be developed to obtain detailed information in areas of control room design. The interview outline will also allow detailed follow-up in areas of general interest to the review team.

This particular activity will be performed by PGandE review team and the human factors consultant.

It is essential that the interview team has experience in a control room environment. Unless such experience is present, the importance of certain responses might be missed by the interviewer. Also, responses might lead an experienced individual to probe deeper in specific areas, seemingly unrelated to the response. Therefore, an SME with control room experience will be provided to assist the interviewers.

Interviews will be conducted using a structured technique that helps ensure all important areas will be addressed. The structure will be flexible enough to allow added emphasis on certain topics, if necessary. The operating personnel to be interviewed will be selected on a random basis from each shift. A representative sample of all licensed operators at DCPP will be interviewed.

The structured interviews will cover eight content topics. Specifically, the areas covered will be as follows:

- Work-space layout and environment
- Panel design
- Annunciator warning system
- Communications
- Process computers

- Procedures
- Training
- Other areas for operator comment

As much as possible, the interview questions will be formulated to meet the following criteria:

Simplicity - Questions will be direct, employ common everyday language, and be as brief as possible.

Clarity - Questions will be unambiguous so that the response received will be unbiased and accurate.

Objectivity - Questions will be free of emotionally charged words such as good/bad, strong/weak, etc.

Error Free - Surveys are susceptible to social desirability, leniency, central tendency, and halo-type errors. Retained items will be those that have the minimum tendency towards these types.

When conducting the structured interview, the interviewee will be provided the following information:

- The purpose of the interviews will be explained
- Describe the areas that will be covered
- Ensure respondent confidentiality
- Convey what will be done with the results
- Request biographical information

A preliminary draft of the interview questions is included in Appendix A.

It is anticipated that both positive and negative control room features will be identified by the respondents. Further investigation will therefore be carried out for each response to determine whether there is sound human factors basis. Negative responses will be addressed in other phases of the CRDR.

4.1.3 Personnel Assignments

The personnel requirements for the operating experience review are noted in the description of each activity. The requirements will be summarized here for clarity.

For the historical documentation review, the CRDR team leader and a subject matter specialist from the review team will be responsible for the initial document screening. They may use additional people if, in their opinion, they require expertise in any area beyond their own specialties.

The structured interviews will be conducted by both human factors personnel and review team members who will then summarize the interview responses for later analysis.

4.2 CONTROL ROOM SURVEY

A survey of the existing DCPP control room will be conducted during the CRDR. The purpose of the survey will be to compare the design features of the existing control room with applicable human engineering design guidelines. The survey will be conducted by the review team. The review team will use checklists, surveys, and operator information to compile data regarding the as-built characteristics of the control room.

4.2.1 Checklists and Surveys

There are numerous checklist and surveys available that address human engineering design considerations. These lists include those developed in NUREG 0700, EPRI, and the NUTAC on CRDR. PGandE will review these documents and, in cooperation with the human factors expert develop a set of checklists and surveys. A general description, as presently conceived, is provided below.

4.2.1.1 Checklists

Source candidates for checklists are included in the NUTAC survey documents. These are an overview checklist; operator-assisted checklist; a labeling, mimics, and demarcation checklist; a general panel checklist; and a process computer checklist. Each checklist is designed to allow one or two people to walk around the control room and determine whether individual checklist items are satisfied by the existing control room design.

The checklists consist of simple declarative sentences describing an acceptable design characteristic. For example, item two in the overview checklist states: "Sanitary Facilities and Drinking Water are Easily Accessible." If the individual(s) using the checklist make(s) the judgement that the statement is true or correct for the control room under review, then that item is checked off, and no further action is necessary concerning the characteristic. However, if the review team member makes the judgement that the control room is not designed to be acceptable for a particular checklist item, an HED is written for that particular facet of the design.

Some degree of judgement is involved in various checklist items. However, the nature of these judgements is such that a common sense approach should result in a consensus among individuals on the review team concerning questionable items. If situations arise where two or more judgements cannot be reconciled, an HED will be written, and the dispute will be resolved by the review team during the assessment phase.

The checklist evaluation will not require extensive operator involvement. The amount of operator time required will depend on the checklist being used and the evaluator. Most of the required operator input will concern the location and existence of certain procedures or equipment and the meaning of label markings.

4.2.1.2 Surveys

Several surveys will be completed during the CRDR Survey Activity. The preliminary survey items include the following:

- General Design Convention Survey
- Lighting Survey
- Noise Survey
- Anthropometric Survey
- Communication Survey

- Abbreviation and Acronym Survey

- Color-Coding Survey

These surveys will be done independently. They function as a framework within which various measurements can be recorded. Some of the surveys consist of simply noting control room conventions such as color usage and instrument arrangement. The information obtained in these surveys will be used in other CRDR activities to determine where particular instruments or systems depart from the overall convention. For these surveys, in particular, operator input will be required to describe how certain controls function and the meaning assigned to particular colors.

Other surveys direct review team members to measure certain physical quantities, such as illumination and sound level, and to compare these measurements to acceptable upper and lower limits for such quantities. HEDs will be written for characteristics that fall outside the acceptable band. The individuals conducting these surveys must be able to operate the appropriate measuring instruments and interpret the output properly. PGandE <u>may</u> elect to retain outside specialists to operate the measuring equipment. If not, selected review team members will be trained to use such equipment. Regardless of who makes the measurements, review team members will be responsible for writing any resulting HEDs.

4.2.2 Personnel Assignments

The actual survey, with its documentation requirements, will be conducted by members of the review team supplemented, as necessary, from the PGandE line organizations. Personnel selected to conduct the survey will be designated as members of the survey team and trained to use the survey checklists and surveys properly.

The leader of the survey team will be a human factors specialist. Other members will be drawn from Design, Maintenance, and Operations.

4.3 TASK ANALYSIS

The operating experience review and the control room survey will identify as HEDs control room characteristics that have caused, or nearly caused, problems during normal operation or HEDs that do not conform to certain human engineering design criteria. The final activity in the CRDR execution phase, the task analysis, will identify the tasks operators must perform during emergency operation, determine whether the instrumentation, controls, and equipment is available to perform those tasks, and will validate that the emergency tasks identified can be performed under simulated emergency conditions in the DCPP control room.

The task analysis will use as its basis the Emergency Response Guidelines (ERGs) developed by the Westinghouse Owners Group (WOG). These ERGs have been designed to generate plant-specific emergency operating procedures (EOPs) for Westinghouse nuclear plants. The CRDR Task Analysis will be coordinated with the DCPP emergency operating procedures development. This will assure procedures which provide validated human factors principles.

4.3.1 Task Identification

The methodology to be used in the DCPP task analysis is as follows: Starting with specific Westinghouse ERGs, all tasks within the ERGs will be identified and analyzed to determine the instrumentation required to make those decisions. Specifically, PGandE will analyze Westinghouse optimal recovery guidelines E0, E1, E2, E3, and the function restoration guidelines.

Beyond the tasks to be analyzed, certain plant systems are referenced in the EOPs as resources to be used during emergency operation. As part of the task analysis, the tasks necessary to use the plant systems, as they are required to be used in the EOPs, will be delineated. Any instrumentation and controls necessary to complete these tasks will be determined.

After the required tasks are delineated and the necessary instrumentation and controls identified, a two-step process will be undertaken that will (1) verify that the required instrumentation and controls are present in the control room and are of the appropriate range with the appropriate scales and labels and (2) validate, with dynamic walk-through-talk-throughs, that all ERG and system-specific steps can be completed in the DCPP control room by the normal complement of operating personnel.

4.3.2 Verification of Instrumentation

The process of verifying that the control room contains appropriate instrumentation and controls will be completed in two overlapping steps. First, a determination will be made as to whether the instrumentation and controls necessary to make the decisions and implement the tasks identified previously are, in fact, present in the control room. If not, any such instance will be defined as an HED and documented accordingly.

The second step of the verification process consists of an examination of the instrumentation and controls located in the first step, above, to determine its human engineering suitability for the task or decision it is supposed to support. Although the control room survey examined all control room instrumentation for conformance with human engineering design criteria, this verification step is required to determine if a meter, for example, has the appropriate range and scale graduations to support a EOP decision or system-specific task step.

4.3.3 Validations of Control Room Tasks

The final step in the task analysis is to evaluate the tasks delineated earlier and assure that those tasks can be completed in the DCPP control room by the normal operating crew. This evaluation will be accomplished as follows: First, the DCPP control room will be used to determine if the instrumentation called for in the EOPs is located so it can be used with the number of individuals normally on shift. Next, specific transients will be selected that will require operators to use the EOPs. These transients will be analyzed using the DCPP control room and a licensed operating crew. The crew will walk through the actions that are required by the EOPs. These activities are described more fully below.

PGandE may use a mock-up for the walk-throughs if access to the control room is not available.

4.3.3.1 Walk-through using control room

For each EOP, the walk-through procedure will be the same. A complete operating crew will be assembled and the crew members will take their normal positions relative to the control boards. An observation team will be assigned to lead the crew through the

specific instructions in the EOP and to record crew comments and movements in response to those instructions. The crew will be encouraged to move about just as they would normally move about the control room and to verbalize what they are doing, why they are doing it, and which instruments and controls they are using for each activity.

The transients to be analyzed will be chosen from the list of scenarios used by the Westinghouse Owners Group to validate their ERGs on the Callaway Nuclear Power Plant Training Simulator (Summary Report - Emergency Response Guidelines Validation Program, Westinghouse, WCAP-10204, September, 1982). The specific transients to be analyzed during the walk-throughs are yet to be determined.

4.3.4 Data Recording and Analysis

Various data will be recorded by the members of the observation team (see 4.3.5) during the walk-throughs. Observers will trace the path of the crew through the appropriate EOPs and plant systems. Notations will be made of significant communication links used during each transient and any instances of crew member conflict (either physical access problems or communication problems) will be noted.

During the walk-throughs, the observation team will question the operating crew concerning the instrumentation they are using at any point in time and their strategy for dealing with the particular transient. This information will be cross-checked and any obvious discrepancies noted.

The review team will use the output from the control room walk-throughs to determine if HEDs occurred because of the layout of the control room and the dynamic interaction of the operating crew during emergency operation.

4.3.5 Personnel Assignments

The task analysis described in Subsection 4.3.1 is characterized by extensive analysis of ERGs, EOPs, and emergency resource systems <u>before</u> any walk-through validation is done. With representatives from design, operations, procedures, and human factors, the review team will have all the expertise required to perform such an analysis of operator tasks.

After the analysis is complete, the control room walk-throughs will require the intermittent participation of certain review team members. The CRDR team leader will be responsible for coordinating the scheduling of crews to run through the selected EOPs in the control room.

5 ASSESSMENT PHASE

5.1 OBJECTIVES

The objectives of this phase of the CRDR are as follows:

- To evaluate the significance of the HEDs defined in the previous phases of the CRDR

- To describe the technical and operational basis for HEDs of minor significance

- To formulate changes to the control room, procedures, operator training, or any combination thereof to mitigate HEDs found to be of potentially major significance.

Of these objectives, the most conceptually difficult is to evaluate HED significance. A straightforward set of criteria for HED evaluation is described in the Section 5.2.

5.2 EVALUATION CRITERIA

Human engineering discrepancies found during the control room survey, the operating experience review, and the systems review will be evaluated by the review team for their potential to affect operation adversely. A categorization scheme will be used that requires each HED to be assessed by the review team and prioritized for resolution. The following three categories are designed so a consensus by the review team can be obtained to determine in which category each HED should be assigned.

Category 1 (highest priority) - HEDs that are judged likely to adversely affect the management of emergency conditions by control room operators. Most of the HEDs in this category may be found during the task analysis and may be supported by the results of the survey and operating experience review.

Category 2 - HEDs that have caused or could cause problems during normal operation. The HEDs in this category will emerge during operator interviews and reviews of incident reports. Some support may come from the control room survey.

Category 3 - HEDs that can be "fixed" with simple and inexpensive enhancements, so-called "paint, tape, and label" (PTL) fixes. This may seem to be an implementation rather than an assessment category. However, this category for HEDs that the review team feels are easy to fix, but difficult to assess as to effect on emergency operation.

The precise method to be used to put HEDs into these categories has not been delineated. It is envisioned that comparing HEDs to higher level principles, such as those listed in the CRDR NUTAC document "Human Factors Principles for Control Room Design Review", will help determine which HEDs are likely to result in actual performance problems. Those HEDs that are likely to affect performance will be further categorized as described above. The priority rating of HEDs will be by review team consensus.

5.3 RESOLUTION OF HUMAN ENGINEERING DISCREPANCIES (HEDs)

One of the final responsibilities of the review team will be to propose solutions to the HEDs that have been identified and categorized. There are, in general, many ways to solve specific human engineering problems. In some cases, a change in training or procedures may suffice, although this solution is sometimes overused and inadequate to address the root causes of a particular problem.

If it is determined that the correction must involve movement, modification, addition, or deletion of instrumentation, then these corrections will be evaluated with respect to their impact on the existing control room, including operator performance, training, and procedures. Before any large-scale changes are approved, the

proposed modifications will be mocked-up and evaluated to determine their effectiveness, and a review by operations personnel will be obtained.

Criteria related to several characteristics will be used by the review team when evaluating candidate proposals for HED correction. The following characteristics of each proposal will be considered:

- Impact on operating effectiveness
- System safety
- Cost
- Impact on plant availability
- Consistency with existing features
- Compliance with regulatory design requirements
- Impact on control room staffing
- Impact on operator training programs

6 DOCUMENTATION PHASE

The importance of data management before, during, and after the CRDR cannot be overemphasized. Adequate documentation and document control creates a traceable and systematic translation of information from one phase of the CRDR to the next. It is mandatory that the CRDR team have immediate access to a complete, up-to-date library of documents to:

- Provide a support base to manage and execute the various steps and phases of the control room reviews

- Provide a design data base from which future control room modifications may draw

Therefore, a data base library will be established to ensure the success of the CRDR process.

This section describes the functional requirements that will be fulfilled by the documentation system PGandE will use to support its control room design review.

6.1 GENERAL DOCUMENTATION REQUIREMENTS

Many documents will be referenced and produced during the CRDR project.

The documentation system will meet the following requirements:

- Provide a record of all documents used by the Review Team as references during various phases of the CRDR

- Provide a record of all correspondence generated or received by the review team during the review

- Provide a record of all documents produced by the review team as project output

- Allow an audit path to be generated through the project documentation

- Retain project files in a manner that allows future access to help determine the effects of control room changes proposed in the future

6.2 REFERENCES

The following documents have been identified as possible reference material to be used during the review project. As the review progresses, it is anticipated that additional material and references will be identified.

- Diablo Canyon Power Plant Final Safety Analysis Report

- Westinghouse Emergency Response Guidelines (ERGs)

- Regulatory Guides (e.g., RG 1.97 and RG 1.47)

- NRC guidance documents (e.g., NUREG-0700)

- PGandE training documents

- Control room drawings (floor plan, panel layout, etc.)

- Control room photographs (panel photographs, etc.)

- Human factors design information
  - Van Cott & Kinkade
  - McCormick
  - MIL-STD-1472C

- Existing system descriptions

- Piping and instrumentation diagrams (P&IDs)

- Operating training materials
- Results of preliminary control room review activities
- Instrument tabulations
- Annunciator and label engraving lists
- CRDR NUTAC documents
- Westinghouse Emergency Response Guidelines Task Analysis
- EPRI reports, NP 1118, NP 2360

6.3 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:

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

In order to facilitate systematizing and recording control room design review activities, PGandE has developed several standard forms. These forms appear as samples in Appendix B. Appendix page numbers appear in parentheses.

- Operational Experience Review Problem Analysis Report (B-2)

- Human Engineering Discrepancy Record (B-3)

- Interview Item Summary (B-4)

Any or all of these forms may be revised based on the experience gained during the CRDR. Documentation for the review will be input to the companies' Record Management System (RMS).

6.4 SUMMARY REPORT

Upon completion of the CRDR, a summary of the results will be prepared and submitted to the NRC for review. The summary report will describe the results of the CRDR and will be submitted after completion of the review. This report will summarize the review process, provide descriptions of the identified human engineering discrepancies (HEDs), detail proposed corrective actions and present implementation schedules for each action. Details of the CRDR, along with complete documentation, will be available for NRC evaluation and review.

The final report will specify the personnel who participated in the Control Room Design Review and delineate their qualifications. It will also indicate any modifications or revisions made to the implementation plan submitted to the NRC. These may become necessary periodically throughout the CRDR and will be described by the review team in the report.

A summary of the Operating Experience Review processes and results will be contained in the final report. The types of historical reports reviewed and the period of time they covered will be provided. The experience levels of the surveyed operators as well as the procedures used to conduct the survey will be summarized.

The final report for the CRDR will provide a summary of processes involved in the system function review and task analysis and will contain the following:

- Charts or list of major systems and subsystems, and their major components

- Task descriptors, organized by system

Samples of forms used in the control room survey will be provided. Procedures used for verification of task performance capabilities and validation of control room functions will be summarized.

Findings of the CRDR will be organized according to significance. Each will describe identified discrepancies and will identify the proposed corrective action. Details of the assessment procedure used in this process will be summarized and supporting documentation provided. Changes that do not provide a full and complete correction of an identified HED, or decisions to allow a discrepancy (which was assessed to be corrected) to remain, will be justified, and information pertinent to such decisions will be provided. Identified design improvements, whether safety-related or not, will be described. An implementation schedule will also be provided.

The summary report will address findings of the structured interviews. A copy of the Operations personnel interview questions used to collect the personnel data, as well as copies of other pertinent forms, will be contained in the appendices.

7 CORRECTION PHASE

The actions required to resolve significant HEDs will vary, as will the time required to complete proposed changes. It is essential, however, to set some end point for completing the proposed changes for each HED category.

7.1 SCHEDULING

The following schedule will become goals for PGandE when planning the activities appropriate to resolve significant HEDs.

Category	Completion
1	As soon as practical after a specific solution has been approved. No later than 1 year or first refueling outage after the review.
2	As scheduling permits no later than the second refueling outage after the review.
3	No specific completion date.

It should be recognized that these completion dates are goals and that some changes may still be pending after these dates. PGandE will make all reasonable efforts to meet these goals.

7.2 IMPLEMENTATION

Modifications required to resolve significant HEDs will be implemented through the existing design change process. The design change process is described by the Administrative Policy Manual for DCPP and by the Engineering Manual in the Engineering Department.

The use of existing design change procedures ensures that plant operators will be made aware of impending changes and trained to use the modified control panels and systems.

This approach to the implementation of changes will help ensure the success of the modifications and will give the line organization a tool for developing their techniques for long-term support of the control room.

8 EFFECTIVENESS PHASE

During the correction phase of the CRDR, proposed modifications and enhancements are evaluated for their effectiveness in solving the deficiencies that prompted them. Recognizing the need for operational feedback on the usability of control room changes resulting from CRDR, PGandE will obtain operational feedback prior to implementing any change at DCPP.

8.1 VALIDATION OF CHANGES

The validation of control room changes will be accomplished using validation process described in Section 4.3.3.

During the process, the review team consider the following items:

- The change reflects the intent of the recommendation and appears to mitigate the associated HED(s).
- The change reflects the intent of the recommendation, but the problem associated with the HED(s) appears to still be present.
- The change does not reflect the intent of the recommendation.
- The change has created an HED other than the HED that prompted the change.

Any HED still present after the changes or created by the changes will be treated as a problem requiring resolution, and it will be evaluated by the plant engineering staff.

8.2 FUTURE CONTROL ROOM CHANGES

In order to ensure adequate human factors considerations for control room changes that are considered after the CRDR is completed, a procedure will be established within the company to integrate all such changes. To evaluate the human factors acceptability of all proposed control room modifications, the procedure will provide guidances similar to those used during the CRDR. Any proposed control room change will be examined using a methodology similar to that of this review prior to implementing any changes.

9 COORDINATION WITH OTHER ACTIVITIES

The CRDR process described in this implementation plan will be coordinated with other post-TMI activities in several ways. These activities include the following:

- o Upgrading emergency operating procedures
- o Installation of an SPDS
- o Installation of post-accident monitoring instrumentation (R.G. 1.97) within the control room

The task analysis portion of the CRDR will use the new Westinghouse ERGs as its starting point. Thus, the task of upgrading emergency procedures is inherently integrated into the CRDR.

The SPDS will undergo a review similar to any other system within the control room. PGandE will use any information available which will assist in this review.

The instrumentation identified by Reg. Guide 1.97 and located in the control room will receive a human factors review under this program.

APPENDIX A

PRELIMINARY OPERATIONS EXPERIENCE REVIEW QUESTIONS AND PERFORMANCE GUIDE

OPERATING EXPERIENCE STRUCTURED INTERVIEW

The purpose of this questionnaire is to help PGandE determine which characteristics of the DCPP control room you find helpful in your job and which characteristics, if any, have caused you problems. Your input is essential if we are to find and correct aspects of the control room that have caused actual operating problems. These questions, as well as the other control room review activities, are not in any way meant to judge your ability to do your job. Your name will not appear anywhere.

We are asking for some biographical and physical information about you. This information will be used only in the aggregate to characterize the group of individuals interviewed. The information will be coded so there will be no chance of anyone associating an individual to a particular response. Your supervisor will not see individual responses, only summaries of responses to each item.

Thank you in advance for your input and for your patience during the control room review process.

BIOGRAPHICAL AND PHYSICAL DATA

JOB TITLE: DATE:

EDUCATION: (Include High School and Technical Schools)

PRIOR POSITIONS HELD: (Include Positions Held With Other Utilities)

ESTIMATED TOTAL YEARS OF EXPERIENCE: _____

AGE: _____ HEIGHT: _____

DO YOU WEAR CORRECTIVE LENSES? _____
IF "YES," MOST OF THE TIME OR JUST FOR READING? (Please Circle)

INSTRUCTIONS

The following questions are grouped into eight content areas. Specifically, the areas to be covered are the following:

- o Workspace Layout and Environment
- o Panel Design
- o Annuciator System
- o Communications
- o Process Computers
- o Procedures
- o Training
- o Other

The main idea in this interview is to get you to tell us a few things about each topic. First, and most important, we want to know if the particular characteristic of the DCPP control room has ever caused or almost caused an operation problem. Specifically, has the design led or allowed you to do something that you didn't intend to do? If so, we want you to describe one or two such incidents. We are particularly interested in incidents that caused plant transients or challenged a safety system. If equipment was misoperated, but the error was discovered quickly and corrected, we want to know that, too. Remember, we do not want names--just enough detail to identify the specific equipment and the circumstances of operation.

The second thing we would like to know is any aspect of the systems covered in a topic area that have helped you during plant operation. These might be characteristics of particular systems that let you operate more quickly or efficiently. Perhaps there are features that let you know when a transient is imminent. If you personally do not know of any such features, have you seen someone else benefit from specific design features?

One thing to keep in mind during this interview is that this is an operating experience review. If you do not have first-hand knowledge of occurrences in an area, just state that fact. We understand that this is a fairly tedious task, but we want to assure you that we will do something about control room features that have caused or nearly caused operational problems at DCPP. Thank you in advance for helping us make DCPP a better place to work.

NOTE: The following questions are listed in a format designed to minimize space requirements.

WORKSPACE LAYOUT AND ENVIRONMENT

1. Has the layout of the control panels in the control room ever caused you, or someone you have seen, to either misoperate or be unable to operate any plant system? If so, please describe. This question refers only to the placement of the panels themselves, not to the arrangement of controls and displays on the panels.

2. Is there some aspect of the panel layout that helps you operate particular systems or the plant in general? Please describe.

3. Has the layout of control room equipment other than panels (e.g., computer console) ever caused you or someone you have seen either to misoperate or be unable to operate any plant system? If so, please describe.

4. Does the layout of control room equipment help you operate particular plant systems or the plant in general? Please describe.

5. Has the arrangement of furniture in the control room ever hindered your access to the operating area or obstructed your view of important displays? If so, please describe.

6. Does the furniture arrangement provide easy access to the operating area and allow you to see the plant instrumentation? Please describe any features that are particularly helpful.

7. Has the lighting in the control room, either normal or emergency, ever caused you or someone you have seen to either misoperate or be unable to operate any plant system? If so, please describe. This question refers to both the level of control room lighting and to other characteristics such as glare, color, etc.

8. Is there some feature of the control room lighting that helps you operate particular systems or the plant in general? Please describe.

9. Has the noise level in the control room ever caused missed verbal communication or misinterpretation of instructions between you and other members of the operating staff? If so, please describe. This question refers both to the ambient (plant) noise and to the noise caused by alarms, phones, etc.

10. Has the temperature and/or humidity in the control room ever reached a level, either high or low, at which you were very uncomfortable? Please describe.

11. Has the temperature/humidity ever reached the level, either high or low, that control room instrumentation or equipment malfunctioned? Please describe.

PANEL DESIGN

1. Does the layout of controls and displays on any panel(s) help you operate particular systems or the plant in general? Please describe.

2. Have you ever activated a piece of plant equipment by accidently bumping a control that is placed in a precarious location? Is so, please describe.

3. Have you ever had to leave the main operating area to activate a control or read a display during an emergency or time-critical situation? If so, please describe. This question refers mainly to back panel controls and indicators.

4. Have you ever had to put temporary labels, Dymo tape, grease pencil markings, or other clarification on a control room panel to make systems easier to operate and understand? If so, please describe.

ANNUCIATORS

1. Has the layout or operation of the annunciator system ever mislead you as to what is happening in the plant? If so, please describe.

2. Are there any features of the annunciator system that you find helpful for plant operation or for diagnosing off-normal occurrences? Please describe.

3. In general, have you used the information supplied by the annunciator system more for normal, abnormal, or emergency operation?

4. Are there any annunciators that you consider essential for operating during emergency or post-trip conditions? If so, please list them.

5. Are there any annunciators that you consider to be non-essential or nuisance alarms for operating during any condition? If so, please list them.

COMMUNICATIONS

1. Is there any feature of the communication system that helps you operate a particular system or the plant in general? Please describe.

2. Has the use of the communication system ever caused control room instrumentation to operate improperly (e.g., nuclear instrumentation picking up walkie-talkie signals)? If so, please describe.

3. Is there any general problem with the plant communication system that degrades its usefulness during plant operation (for example, absence of a protocol requiring walkie-talkie users to identify themselves)? If so, please describe.

PLANT COMPUTER SYSTEM

1. Has the plant computer system ever mislead you as to what is happening in the plant? Please describe. This question refers to computer output that is misleading because of inaccuracies, incorrect status indications, time delays, etc.

2. Is there any feature(s) of the plant computer system that you have found particularly useful during plant operation? Please describe.

3. In general, have you used the plant computer system more for normal, abnormal, or emergency operation?

4. Do you believe that you understand how the plant computer system works well enough to use the system to its potential? Please explain.

5. Although it is not absolutely required, do you think the plant computer system is necessary for normal operation?

PROCEDURES

1. Are there particular procedures that you tend to use more than others? Please list them.

2. Are the emergency procedures usable as they are now written? Please explain.

3. Has a procedure, normal or emergency, ever left you in doubt as to what your next action should be? If so, which procedure(s)?

4. Are there procedures that are particularly easy to use during normal or emergency operation? Which ones and why?

TRAINING

1. Has the training you received been applicable to the operating situations you have encountered? If not, please describe the deficiencies.

2. Is there some feature of the PGandE training program that has been especially helpful to you during plant operation? Please describe.

3. Has your training placed too much or too little emphasis on emergency operation? Please suggest a balance between normal and emergency emphasis during training (e.g., 60/40, etc.).

4. Have there been instances when the transients you see during requalification actually occur at the plant please cite an example.

5. Do you feel that more practice handling transients would be beneficial for operating during such transients? Can you give an example where such practice was or would have been helpful?

6. Has an unclear procedure ever caused you or someone else to misoperate any plant system? If so, please describe.

APPENDIX B

PRELIMINARY CRDR DATA COLLECTION FORMS

APPENDIX B

CRDR DATA COLLECTION FORMS

OPERATING EXPERIENCE REVIEW
PROBLEM ANALYSIS REPORT

Name(s) of Investigator: _____

Station: _____ DATE: _____

Unit: _____ Index Number: _____

Report Type and Number: _____

Date of Incident: _____

Unit Operating Status: _____

Documented Problem: _____

_____

Sequence of Events: _____

_____

_____

_____

Effect on Unit: Unit Derated _____ hrs. Unit Shutdown _____

Unit Trip (Scram) _____ hrs.

Corrective Actions Taken or Proposed: _____

_____

_____

_____

Subsequent Action Taken of a "Corrective" Nature: _____

_____

_____

_____

Problem Identified and Corrected: Yes ____ No ____

Control Room Human Engineering Discrepancy Index/Log Number: _____

HUMAN ENGINEERING DISCREPANCY

No: _____ Plant Unit: _____ Date: _____

Reviewer Name: _____

a) HED title: _____

_____

_____

b) Items Involved:

Item Type	Nomenclature	Location	Photo No.

_____

c) Problem descriptions (guidelines violated):

d) Specific operator error(s) that could result from HED:

e) List the procedures or operations that use the listed items in a manner to induce the operator error:

f) List the consequences of operator error during all modes of operation:

g) Suggestions for potential backfits:

	Name	Date
Reviewer	_____	_____
Data Coll. Mgr.	_____	_____
HED Proc. Mgr.	_____	_____
Eval. Dir.	_____	_____

PRELIMINARY STRUCTURED INTERVIEW ITEM SUMMARY FORM

1. HF Analyst: _____
2. Content Area: _____
3. Question #: _____
4. Question:

FREQUENCY/%	TYPE OF RESPONSE/SPECIFIC EQUIP. REF.	INVESTIGATION

APPENDIX C

REFERENCES

REFERENCES

1. NUREG-0737, Supplement 1, Emergency Response Capability

2. NUREG-0700, Guideline for Control Room Designs

3. EPRI NP-1118, Human Factors Methods for Control Room Design

4. ERC NUTAC, Component Verification and System Validation Guideline (draft)

5. CRDR NUTAC, Human Engineering Review Principles (draft)

6. CRDR NUTAC, Control Room Design Review Survey Development Guideline (draft)

7. CRDR NUTAC, Control Room Design Review Task Analysis

8. EPRI NP-2360, Human Factors Methods for Assessing and Enhancing Power Plant Maintainability