DETAILED CONTROL ROOM DESIGN REVIEW

PROGRAM PLAN

FOR THE

SHOREHAM NUCLEAR POWER STATION

Prepared for

Long Island Lighting Company

GP-R-221022

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General Physics Corporation

Columbia, Maryland

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SECTION 1. INTRODUCTION

With the Nuclear Regulatory Commission's (NRC) December 17, 1982 distribution of Generic Letter No. 82-33 on "Requirements for Emergency Response Capability" comes the requirement to perform a Detailed Control Room Design Review (DCRDR) at Shoreham. The DCRDR is part of a broad effort within the industry and the NRC to upgrade control rooms, emergency response facilities and procedures. Although the DCRDR is directed toward the existing control room, it is recognized that other areas of concern, such as the Safety Parameter Display System (SPDS), among others, will be coordinated with the DCRDR.

The DCRDR Coordinator will serve as the catalyst for the phased implementation and integration of the emergency response activities at Shoreham. Particularly, the DCRDR will be employed to assure integrated response activities in regards to SPDS and Reg. Guide 1.97 implementation, upgrading of EOPs, and impact to or from the Shoreham training program.

The DCRDR Program Plan describes the manner in which the Long Island Lighting Company (LILCO) intends to conduct a review of the Shoreham Nuclear Power Station. The scope and schedule of the DCRDR are described in Section 1. The plan for managing and staffing the DCRDR is described in Section 2. The anticipated input and output documentation and the procedures for controlling both are contained in Section 3. The methodology for performing the DCRDR is described in Section 4. Finally, a systematic approach for assessing human engineering discrepancies (HEDs) that are identified as a result of the review procedures are described in Section 5.

The Program Plan, by definition, is flexible and subject to revision as the stages of the DCRDR progress. Since the Program Plan serves as input documentation to the review process, the original document and subsequent revisions will be controlled in accordance with the procedures described in Section 3.

1.1 Purpose

The purpose of the Program Plan is to ensure that the DCRDR satisfies government and industry requirements, that the results are understandable and usable, and the benefits of human factors engineering are reflected in the control room design. Since the DCRDR process is rather involved and at times complex, the Program Plan also documents the process, providing traceability of both the process and the results of the DCRDR.

1.2 Scope

The scope of the DCRDR shall consist of:

- Review input documentation, including any applicable operating experience data, plant design information, and applicable standards and regulations.
- Perform an inventory of the control room instrumentation.
- An analysis of any HEDs resulting from the Shoreham Preliminary Design Assessment (PDA) which were relegated to the DCRDR.
- An analysis of all events encompassed in the Shoreham-specific Emergency Operating Procedures (EOPs). The Shoreham EOPs are based on the BWR Owners Group Emergency Procedure Guidelines.
- Determine the requirements of operator tasks in terms of information requirements, decision requirements, and action requirements.
- Verification that Shoreham instrumenation, controls and other equipment meet the specific requirements of the tasks performed by the operators in carrying out the EOPs.
- Validate that the EOPs can be successfully executed.
- Assess HEDs uncovered in any of the review steps.

- Develop a schedule for HED resolution.
- Developed a final engineered operations report addressing the integrated response activities consisting of DCRDR, EOPs, Job Design, SPDS and Training.
- Develop a mechanism for an integrated type of analysis for any HEDs identified throughout the operational life of the Shoreham Nuclear Power Station.

These items are described in greater detail in Sections 4 and 5. A flow chart depicting the interaction between the various review phases is shown in Figure 1.

1.3 Schedule

A schedule depicting the time lines of major tasks in the DCRDR process is shown in Figure 2.

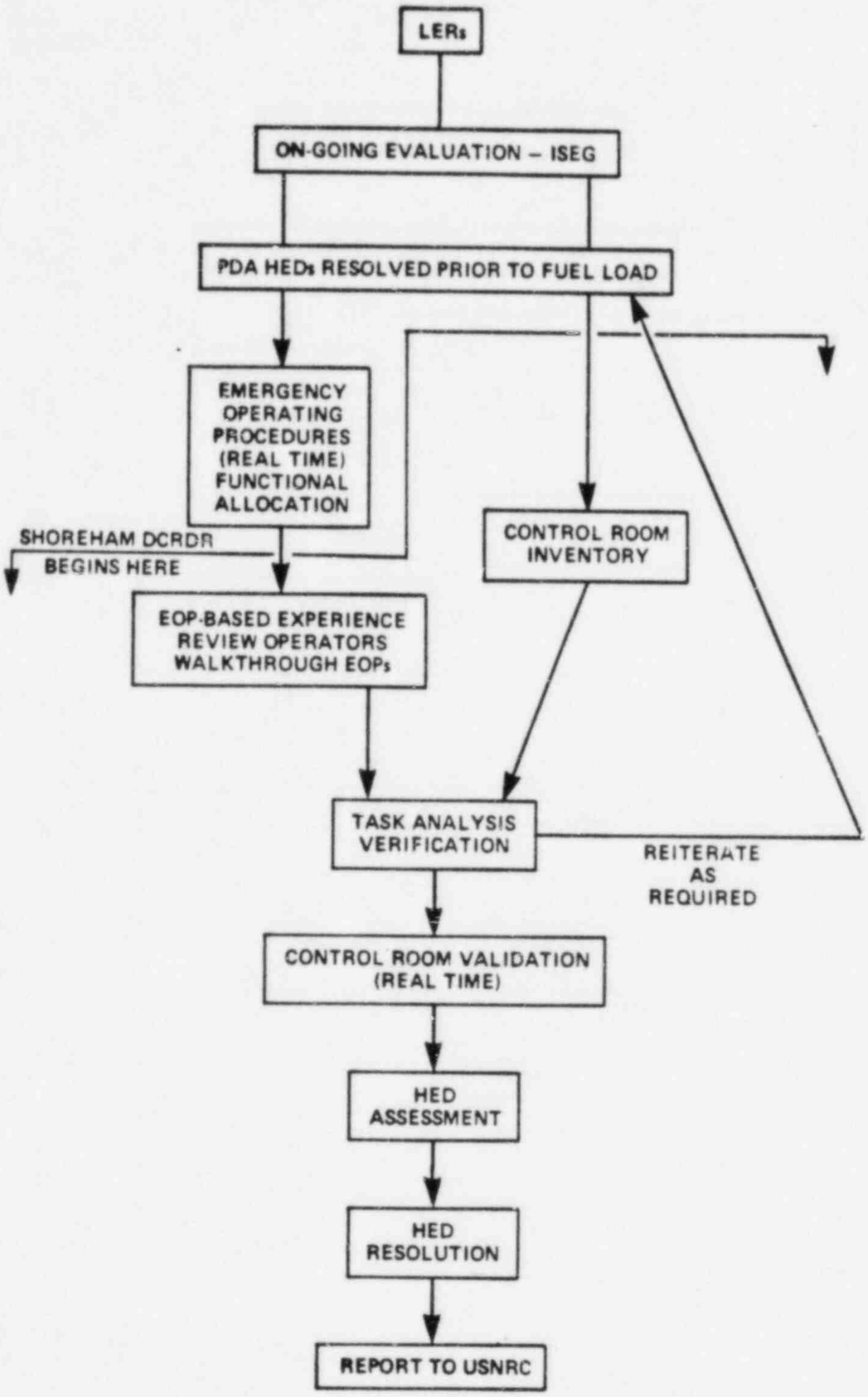

Figure 1. Interaction of DCRDR Activities

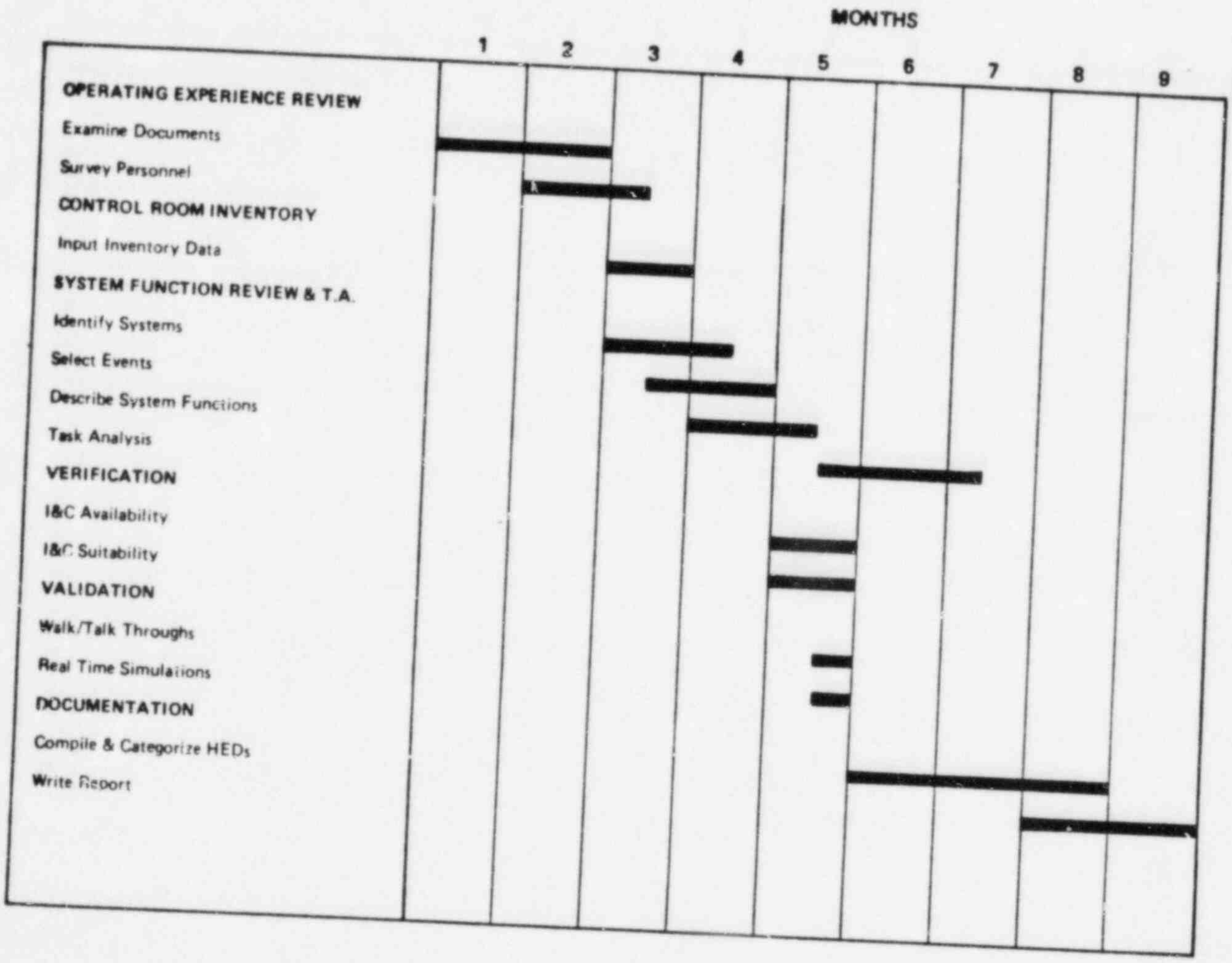

Figure 2. Schedule of DCRDR Activities

SECTION 2. MANAGEMENT AND STAFFING

Chapter 2 of the DCRDR Program Plan addresses the management and staffing aspects of the review. Section 2.1 describes how the review process will be managed. Section 2.2 describes the structure of the review team. Section 2.3 describes the qualifications of the review team. A discussion of how the DCRDR interfaces with and is integrated into the other human factors activities is contained in Section 2.4

2.1 Management of the Review Process

An overview of the sequence of events that comprise the DCRDR is contained in this section. The events described include data gathering, analysis and documentation of results. The overview is presented in a sequential manner, although individual events may at times occur concurrently.

A. Initial Meeting

An initial meeting will be held between LILCO and the human factors consultant. The objectives of this meeting are to:

- Establish review team structure and contacts
- Review and finalize the project schedule
- Obtain existing, applicable documentation

Each of these objectives is discussed below:

(1) Establish review team structure and contacts. During the initial meeting, individuals from both LILCO and the human factors consultant will be identified as members of the DCRDR team. Specific authority and responsibilities for each team member will be identified and agreed upon. In addition, an individual from both organizations will be designated as the primary contact for that organization. Reference Section 2.2 for the proposed structure of the DCRDR team.

(2) Review and finalize the project schedule. During the initial meeting, members from both LILCO and the human factors consultant will review a proposed project schedule (reference Section 1.3). Specific tasks will be scheduled to permit an uninterrupted work flow for the review team, at the same time minimizing interference with control room operations. The end result will be a schedule extending from the beginning of the review through preparation and issuance of the final report.

(3) Obtain existing, applicable documentation. The specific documentation is listed in Section 3.1.

B. Review Documentation

The documentation that was obtained at the initial meeting is to be reviewed to:

- Prepare for the Operating Experience Review
- Obtain information to be used in the Systems Function Review and Task Analysis

C. Conduct Phase I Site-Visits

Site visits will be conducted to:

- Perform the Personnel Survey
- Perform the Validation of Control Room Functions task (Walk-throughs)

At the conclusion of these site visits, a complete listing of Human Engineering Discrepancies (HEDs) identified during the various review processes and a complete listing of inputs to the review from the operating personnel will be obtained. The human factors consultant will also conduct an exit meeting with the LILCO review team at the completion of each site visit.

D. Define System Functions and Analyze Operator Tasks

A functional description of each system utilized in the EOPs will be prepared. Operator tasks per procedural step will be documented on task analysis forms.

E. Conduct Phase II Site-Visits

Site-visits will be conducted to videotape the operating events that were analyzed in the previous step. Operators will walk and talk through these operating events in the control room. The information in the task analysis forms will be reviewed and perhaps revised during these walk-throughs.

F. Analyze the Videotapes to Identify HEDs

After the operating event has been videotaped, operators will be debriefed and the event will be analyzed using the task analysis forms and the videotape. The result may be a second listing of HEDs that were not identified during the control room survey.

G. Assess HEDs

The HEDs that were identified during the various review processes will be assessed for their safety implications. HEDs identified as having safety implications or potential for safety implications will be categorized, and a resolution and implementation schedule will be recommended.

H. Prepare Final Report

The methodology employed in the DCRDR and the findings that resulted from the review will be documented in a draft report prepared by the human factors consultant for LILCO. The draft report will be finalized based on comments provided by LILCO.

I. Participate in NRC Review Meeting

The human factors consultant will support LILCO at any NRC meeting concerning the DCRDR.

J. Project Progress Reports and Memorandum Reports

To ensure that the activities described in these ten steps are performed in a timely and cost-effective manner, the human factors consultant will prepare monthly progress reports throughout the project. The progress report will indicate both funding and scheduling status.

2.2 Structure of the Review Team

The review team will have a core group of specialists in the fields of human factors engineering, plant operations (e.g., licensed operators), and instrumentation and controls engineering; the core group will also include personnel who are cognizant of the SPDS, EOPs and training issues. This core group will be supplemented by other disciplines such as nuclear engineering, mechanical engineering, electrical engineering, industrial engineering, reliability analysis, systems engineering, and operations research, as required.

The ultimate responsibility for the DCRDR will reside with LILCO's executive-level personnel. The day-to-day conduct of the review, however, will be the responsibility of a review team established specifically for the DCRDR. The review team will provide the management oversight to ensure the integration of the project objectives and to meet the regulatory intent of the review. The review team is responsible for the planning, scheduling, coordinating, and integration of DCRDR activities.

The DCRDR project will be staffed by a multidisciplined team of individuals with recognized expertise in various areas. A wide range of

experience and training is necessary to fulfill several kinds of review functions, which are:

- Technical task performance
- Project direction and management
- Administrative support
- Documentation support

Review team selection will result in a team with collective expertise in the following areas:

- Human Factors Engineering
- Reactor Operations
- Instrumentation and Controls
- Design Engineering
- Computer Operations
- Project Management
- Nuclear Licensing
- Data Processing
- SPDS
- EOPs
- Training

Due to the integrative nature of the DCRDR project, the review team will have two distinct factions: those members who are LILCO personnel and those members who are consultant personnel.

2.2.1 LILCO Review Team Faction

The LILCO faction of the review team has the DCRDR Project Coordinator as its key person. This individual provides the administrative and technical direction for the project. Access to information, facilities and those individuals providing useful or necessary input to the team will be coordinated by the Project Coordinator. Because of their detailed knowledge of LILCO systems and methods, this individual will provide the cohesive force for the

different LILCO department individuals and vendor organizations involved with this project.

A LILCO individual will provide the bridge between this project and other human factors activities at the utility. This is an important input to the review team since resolution of Human Engineering Discrepancies (HEDs) identified must be integrated with other possible changes to the control room originating from changed requirements or design.

Nuclear Licensing provides the interface between LILCO and the Nuclear Regulatory Commission. An individual within Nuclear Licensing will be identified as the liaison.

2.2.2 Consultant Review Team Faction

The consultant faction of the review team will consist of the Project Manager, the Project Director, and the Project Staff. The Project Manager will be responsible for all assigned project work and will report directly to the LILCO DCRDR Project Director.

The Project Director will be responsible for ensuring that the Project Manager has the support of the consultant corporate resources, when necessary, to support the project. The Project Director will have the responsibility and authority to assist the Project Manager in staffing the project, coordinating technical support for the project, and providing administrative support for the project.

The project staff members will report to the Project Manager. The staff members will participate in data collection and analysis and report generation. The staff will consist of personnel with expertise in the following areas:

- Human Factors Engineering
- Power Plant Operations

- Systems Analysis
- Computer Applications

A diagram showing the relationship between and among team members is shown in Figure 3.

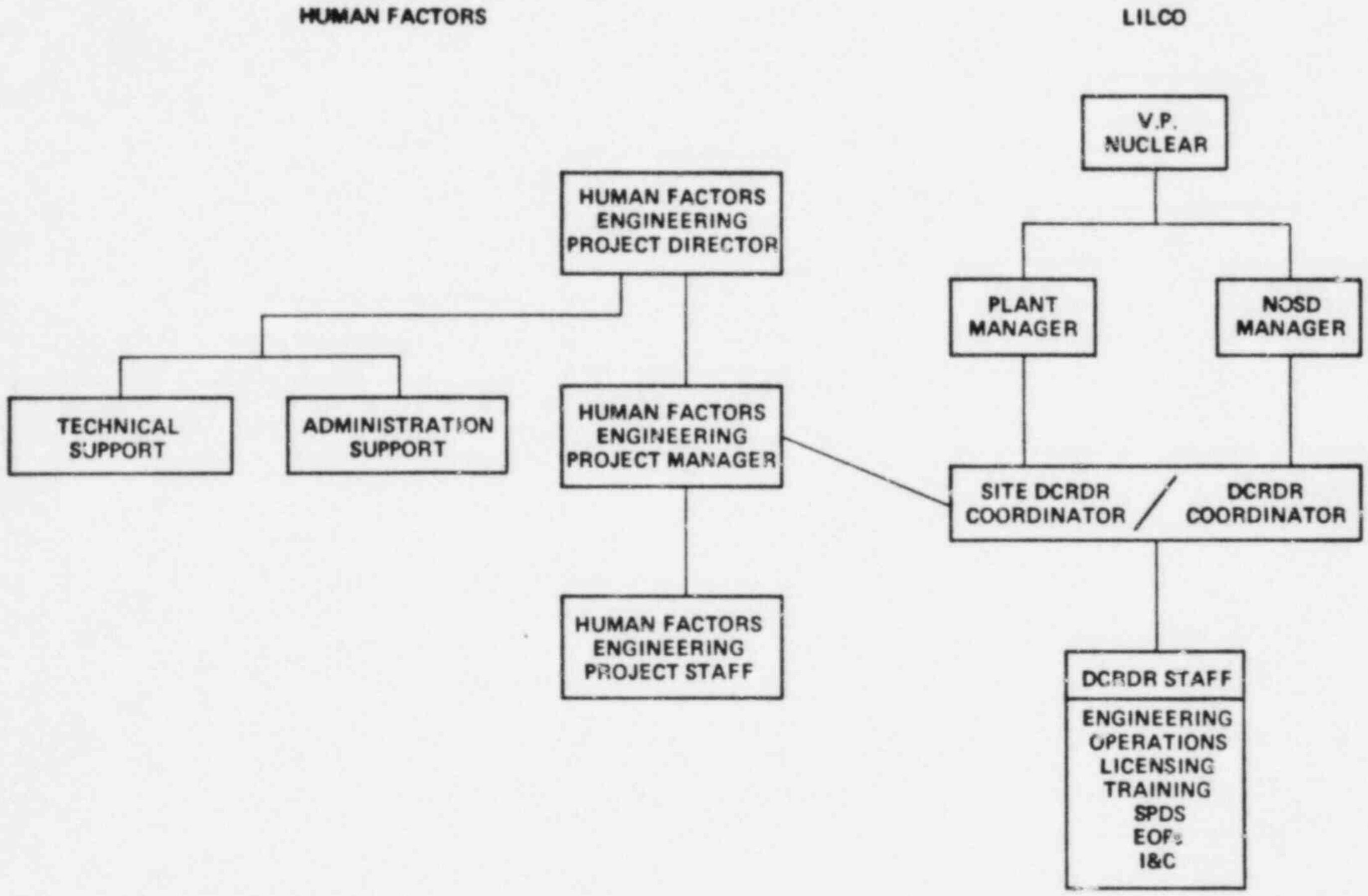

Figure 3. DCRDR Team Organization

2.3 Qualifications of the Review Team

The qualifications of key review team members are as follows:

- Human Factors Specialist: A degree, preferably at the graduate level, in human factors engineering is recommended. The pertinent formal training requirements for human factors specialists should include course work in at least some of the following areas: Human factors engineering, ergonomics, human performance theory, sensory/perceptual processes, experimental design, quantitative methods/statistics, anthropometry, survey design and industrial engineering/design. Preferred specific experience should include the applications of human factors to design and/or evaluation in the following areas: Workspace layout, panel design (control and display layout), environmental mental conditions (e.g., lighting and acoustics), and procedures and training. Experience in systems analysis and task analysis should also be demonstrated within the complement of human factors professionals on the team.

- Reactor Operator: A reactor operator with a minimum of two years experience, preferably in the specific control room being reviewed, will be included on the DCRDR team.

- Instrumentation and Control Engineer: A minimum of five years of applied experience is recommended. Most, if not all, of this experience should have been gained in the nuclear field. The instrumentation and control engineers should be familiar with the regulations, standards and design constraints that have an impact on nuclear power plant control room design.

- Other Disciplines: A bachelor's degree or equivalent in a course of study relevant to the specific discipline is recommended as a minimum. A minimum of three years of applied design or operating technical experience is recommended. Professional licenses or certification and appropriate society memberships provide additional plants or other process control applications is

preferred. Alternatively, experience with other complex commercial, industrial, or military facilities and systems will be considered acceptable.

2.4 Integration of the Control Room Design Review With Other Human Factors Activities

The DCRDR project will interface with and/or reference previous and ongoing human factors efforts at the Shoreham Nuclear Power Station. A description of some of the work is provided below.

During the period from 1970 to 1973, LILCO worked with both the General Electric Company and the Stone and Webster Engineering Corporation to develop the main control room nuclear steam supply system and balance of plant control board layouts. With the idea of enhancing the arrangement of the Shoreham control panels, and to establish a philosophy consistent with those presently in use at other LILCO power stations and also Oyster Creek, Vermont Yankee, Dresden, Pilgrim, Fitzpatrick and the General Electric simulator to review the main control room panels and main control room layouts in an effort to learn those aspects which could be improved. As a result of this investigation, LILCO established criteria which were first developed in a full-scale mock-up of the Shoreham nuclear steam supply and balance of plant control boards and then incorporated into the final design.

A preliminary human factors control room review was performed on the Shoreham control room following the guidance given in NUREG/CR-1580. This review was completed in March 1981. Use of human engineering checklists provided standards for assessment of all properties of the control panels including component arrangement, readability of labels and ambient conditions. These checklists were developed based upon the latest established and recommended human factors engineering criteria. The guidelines contained in NUREG/CR-1580 also supplemented the checklists that were utilized during the preliminary review.

After the preliminary report was issued, work was begun on the correction or resolution of Human Engineering Discrepancies (HEDs) that were uncovered

during the preliminary review. Experimental evaluations of some design aspects will be utilized to assess HED significance and suggest improvements.

With the issuance of Supplement 1 to NUREG-0737, LILCO is responding to the requirements set forth in that document. This Program Plan is the first step in responding to the DCRDR requirements. NUREG-0700 (Guidelines for Control Room Design Review) and NUREG-0801 (Evaluation Criteria for Detailed Control Room Design Reviews) are the primary guidance documents upon which this Program Plan, and the corresponding DCRDR project, will be based.

Given the integrative nature of Generic Letter No. 82-33, the DCRDR process will be coordinated with other post-TMI activities that are addressed in the letter. The results of the DCRDR project can be utilized in specific applications as discussed below:

- EOPs - The Systems Review and Task Analysis portion of the review will use the Shoreham-specific EOPs as its' basis. Thus, this examination of the EOPs will inherently integrate their upgrading with the DCRDR.

- SPDS - As one of the aspects of the DCRDR project is to identify and define operator requirements during conditions of emergency operation, these requirements will define many of the necessary plant inputs to the SPDS and the display formats for the graphic displays.

- Reg Guide 1.97 - The Verification of Task Peformance Capabilities portion of the DCRDR systematically verifies the presence or absence of information required by the operator during emergency operations. The results of this process will give insight into the monitoring instrumentation that is available to the operator and, conversely, if any type of indication is required but missing.

- Emergency Response Facilities - If any portion of the DCRDR project indicates the need for additional information to be added to the control room in (the form of new instrumentation), this information

shall be considered also for inclusion in the design of the Technical Support Center (TSC) and the Emergency Operations Facility (EOF) data acquisition/display system. The Systems Review and Task Analysis portion of the DCRDR will provide useful data with regard to the implementation of this aspect of Generic Letter 82-33.

- Training - The training group will provide input for potential resolution of control room deficiencies and may also be utilized as the mechanism for implementation of the resolutions.

SECTION 3. DOCUMENTATION AND DOCUMENT CONTROL

A large number of documents will be referenced and produced during the DCRDR. Therefore, an efficient and systematic method for controlling these documents is necessary.

Adequate document control provides the following benefits:

- A historic record of the review process itself, and not merely the outcome of the process, is available.
- Proper documentation provides an audit path for the utility.
- Documentation will be traceable for future access to help determine the effects of control room changes proposed in the future.

3.1 Documentation Requirements

The documentation methodology described in this section will be utilized to meet the following requirements:

- Provide a record of all documents used by the review team as references during the various phases of the DCRDR.
- Provide a record of all correspondence generated or received by review team members.
- 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.
- Develop project files in a manner that allows future access to help determine the effects of control room changes proposed in the future.

3.2 Input Documentation

The following documents have been identified as possible reference material to be used during the review process. As the review progresses it is

anticipated that additional material will be identified and referenced. Therefore the following list of documents, if available, is preliminary:

- Licensee Event Reports
- Incident Reports
- Final Safety Analysis Report
- Systems descriptions
- Piping and instrumentation drawings
- Control room floor plan
- Panel layout drawings
- Panel photographs
- Lists of acronyms and abbreviations used in the control room
- Descriptions of coding conventions used in the control room
- Software descriptions, including CRT formats and content
- Emergency Operating Procedures (EOPs)
- Operating training materials
- Guidelines for procedure development
- Instrumentation and controls list
- Annunciator and label engraving lists

3.3 Output Documentation

Throughout the review process documents will be processed to record data, document analyses and record findings. Whenever possible, and appropriate, standard forms will be developed and utilized. All of the documentation produced during the course of the review will be controlled in accordance with the procedures described in Section 3.4. The following list represents a preliminary estimate of the types of documents that will result from the DCRDR project:

- Detailed Control Room Design Review Program Plan
- Project schedule
- Control room inventory
- Operator questionnaire
- List of HEDs assessed according to their safety implications
- Summary DCRDR Report

3.4 Documentation Control Procedures

A review team member will be designated as responsible for documentation control. All documents received from LILCO, used as primary input to the review, or generated during the review will be subject to the following control procedures:

3.4.1 Log-in Procedures

All documentation received and generated during the review will be logged into a Document Receipt/Distribution Log (see Figure 4). The log contains the document identifier, the revision level, the date received, and individual(s) to whom the document is distributed.

3.4.2 Internal Routing

After documents have been logged, they are routed to review team members. If the document is too large to be routed, e.g., an FSAR, a memo giving the document date, title, and revision will be routed. After all team members have signed the routing sheet, the document will be returned to the document control person.

3.4.3 Log-out Procedures

In a manner similar to the log-in procedures, all documents will be controlled through a log-out procedure. Once again, the document identifier, the revision level, the date sent, and to whom it is distributed will be logged. In the case of revisions, the superseded version can be recalled concurrently with issuance of the latter version using the Document Receipt/Distribution Log.

3.4.4 Document Filing

All project documents will be maintained in a project file. The document control person will periodically insure that no material has been removed from the file that has not been properly logged-out.

DOCUMENT RECEIPT/DISTRIBUTION LOG

Document Category: **Project:**

Date Received	Document Identification	Revision	Description/Remarks	Distribution		Recall — Dates	
				To:	Date	Notice	Received

Figure 4. Document Receipt/Distribution Log

3.5 Management of HED Records

All information pertaining to Human Engineering Discrepancies (HEDs) shall be stored in a DCRDR Computer Database System. The DCRDR Computer Database System is operated by the HEDSMAN software package which allows the control and tracking of DCRDR data in accordance with the guidelines in NUREG-0801. This software has proven to be a valuable tool to the human factors engineer who has the responsibility to consolidate the large amounts of HED data into a logical and coherent form.

When an HED has been identified, the engineer records his/her observations on an HED form (see Figure 5). This data is entered into the computer via the HEDSMAN software which assigns this HED a unique number and stores the data for each entry under this unique number. At this point, the software is emulating a text processor in that it can output the data on the HED form. The difference is that the HEDs can be output in a user-defined sorting by any of the data fields in the HED form (e.g., by the guideline number or by the component number or by both). Also, any portion of the HED can be output for the rapid comparison of data. For example, all of the HEDs which apply to a given component can be identified and the HED numbers listed. This information allows the engineer the opportunity to compare all of the discrepancies which apply to a given component. The same is true for any of the other fields.

* HUMAN ENGINEERING DISCREPANCY RECORD * PLANT: PAGE: 34

REVIEWER: DATE: 02/12/82 NO.: 41

PANEL IDENTIFIER | COMPONENT IDENTIFIER

1CC-2 STEAM GENERATOR 11, 12, 13, 14
I, II, III, IV INDICATORS

REVIEW SECTION CODE: 9. C/D INTEGRATION III GUIDELINE NO.: 6.9.2.2d&e

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DESCRIPTION OF DISCREPANCY:
STEAM GENERATOR PRESSURE AND LEVEL INDICATORS ARE NOT CONSISTENTLY ARRANGED FOR CHANNELS I THROUGH IV.

HED CATEGORY CODE: 1___ 2___ 3___ 4___ LEVEL: A___ B___ C___ D___

IMPLEMENTATION SCHEDULE:

RECOMMENDATIONS:
NO CHANGE RECOMMENDED.

COMMENTS/JUSTIFICATION FOR NON-CONFORMANCE:
INDICATORS ARE ARRANGED IN ACCORDANCE WITH PSE&G SEPARATION CRITERIA.

Figure 5. HED Form

SECTION 4. REVIEW PROCEDURES

The review procedures utilized in the DCRDR project will result in data that is used to assess the adequacy of the interfaces between operator and plant processes as found in the control room, including the remote shutdown panel.

The review addresses the following specific objectives:

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

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

The first objective is concerned with the completeness of the control room given control room operator functions and task responsibilities. The second objective is concerned with the suitability of the design in light of human and equipment performance capabilities, individual task responsibilities, and operational dynamics.

Six major processes will be used to establish and apply benchmarks for identifying human engineering discrepancies of both completeness and human engineering suitability:

- Operating Experience Review
- Control Room Inventory
- Resolution of Preliminary Design Assessment (PDA) HEDs
- System Function Review and Task Analysis
- Verification of Task Performance Capabilities
- Validation of Control Room Functions and Integrated Performance Capabilities

The procedures involved in each of the six processes are discussed below.

4.1 Operating Experience Review

4.1.1 Purpose

The purpose of the Operating Experience Review is to identify factors or conditions that could cause and/or have previously caused human performance problems and could be alleviated by improved human engineering. This review will provide information on potential problem areas by studying documented occurrences of human engineering-related problems that have occurred in operating plants that are similar to Shoreham.

4.1.2 Methodology

Two major steps are utilized in the Operating Experience Review. They are the Documentation Review and the Personnel Survey. The methodologies for both are described below.

4.1.2.1 Documentation Review

Industry-wide Licensee Event Reports (LERs) on plants most similar to Shoreham will be obtained and reviewed in an effort to identify incidents (occurrences or near-misses) that have occurred in the past which could impinge on control room operations or reflect control room design deficiencies.

Other LERs will also be examined as part of the Generic Experience Review. The Institute of Nuclear Power Operations (INPO) will be requested to provide LILCO with a printout of LERs sorted by the following characteristics:

LERs from: General Electric BWRs
Designed from: 1965 through 1975

Errors by: Licensed operators

Involving: Human error or procedural deficiency

The documents will be reviewed and the circumstances and events leading to the problem noted in the LER will be summarized. Then, the resulting summarizations will be reviewed to determine if the LER does indeed describe a control room problem. A control room problem is defined as one in which:

- The equipment referenced in the LER is located in the control room or remote shutdown panel, or
- The procedure (or steps therein) referenced is utilized within the control room or remote shutdown panel, or
- The personnel error occurred utilizing control room or remote shutdown panel components.

A list of the sources reviewed along with summaries of instances that were deemed to be control room problems will be prepared and retained for input into other areas of the review project.

4.1.2.2 Personnel Survey

A self-administered questionnaire format will be used as the medium for soliciting and recording operator input. The questionnaire has proven to be a very robust data gathering device in terms of subject response and information gathered. Areas that will be addressed include:

- Workspace Layout and Environment
- Panel Design
- Controls
- Displays
- Annunciator Warning System
- Communication Systems
- Computer Systems

- CRT Displays
- Corrective and Preventive Maintenance
- Procedures
- Staffing and Job Design
- Training

A sample questionnaire is provided in Appendix B.

A range of operations staff, with varying degrees of experience and training, will be asked to complete the questionnaire.

Respondents will be insured anonymity by following the methodology described below:

1. Questionnaires will be provided with two cover pages. The outside cover page will be blank except for the title "Operator Questionnaire" and an area in which to record a code number. The inside cover sheet will briefly describe the content and purpose of the questionnaire, along with a description of the process that will be used to insure the respondents' anonymity. A self-addressed, stamped envelope will be attached that the respondent will use to forward the completed questionnaire.

2. When a questionnaire is received, a code number will be assigned and recorded in the space provided on the outside cover sheet. The same code number will be recorded in the space provided on the inside cover sheet.

3. The inside cover, which includes the respondents' name sheet, will be removed from questionnaire packet and retained on file. The questionnaire will then be available for review with the respondents' anonymity retained.

When all questionnaires have been completed, returned and subjected to the procedures described above, they will be reviewed and responses will be summarized and partitioned into negative and positive responses. Positive responses will be kept on file for reference as possible recommendations or solutions to HEDs. Negative responses will be reviewed and will be investigated further in follow-up interviews.

Follow-up interviews will be conducted with at least 50 percent of the questionnaire respondents; a larger percentage will be interviewed if all negative responses cannot be investigated by interviewing only half the respondents.

Each respondent will be interviewed in a one-on-one, face-to-face situation. The interviews will be structured to the extent that the items of interest in the questionnaire will be addressed; however, the interviews will be open-ended to allow the interviewer and respondent to interact in such a manner that will allow elaboration on the respondents' part with regard to the particular problem item in question. The interview will be tape recorded to save time that would otherwise be used by the interviewer taking notes. The tapes will then be transcribed for input into other phases of the review.

4.2 Control Room Inventory

4.2.1 Purpose

The purpose of the Control Room Inventory is to establish a set of reference data which identifies all instrumentation, controls and equipment in the control room and remote shutdown panel. This inventory will be used for comparison with the requirements identified through the analysis of operator tasks. Additionally, the inventory will include data pertaining to particular component characteristics such as units of measure, parameter range, and scalar markings.

4.2.2 Methodology

The inventory data will be collected in the control room and will be transferred onto the inventory forms shown in Figures 6 and 7. The form for Indicators and Controls (Figure 6) will include the data pertaining to instrument number, description, panel number and type. Based upon type, which will be either an "I" or "C" for Indicator or Control, the appropriate information will be recorded. For type "I", the range, major/minor divisions, factor, scaling, band and color will be recorded. For type "C", the class, division and positions will be recorded. The class and division information will be in accordance with a predetermined coding scheme which will identify the control. For example, a class 1, division 1 control would identify the control as a covered pushbutton. The coding scheme utilized will depend upon the different types of controls in the control room.

The form for Recorders (Figure 7) will include data pertaining to the instrument number, panel number, pen number, description, the major/minor divisions, factor, scaling, band parameters, and color of ink. This form is completed with multiple entries under the same instrument number in the case of multi-pen recorders.

The following is a description of the terms used in the column headings on both Control Room Inventory Documentation Forms.

Columns common to both forms:

Instrument No. - a number which uniquely identifies this control or indicator from all others. May be available from the nameplate or drawing or may be externally imposed (i.e., a unique sequential number).

Panel - the number of the panel on which this instrument or control appears. May be taken from a nameplate or drawing or may be externally imposed.

CONTROL ROOM INVENTORY
DOCUMENTATION FORM
(Indicators and Controls)

Plant ______________________________ Page____ of________

Unit ______________________________ Date____________

Data Collector ______________________________

Instrument No.	Panel	Type	Description	(I) RNG	Maj/Min	Factor	Scaling	Band
				(c) Class	Div.	Position		

Figure 6. Indicators and Controls Inventory Form

CONTROL ROOM INVENTORY
DOCUMENTATION FORM
(Recorders)

Plant____________________________________ Page_____ of____________

Unit ____________________________________ Date________________

Data Collector____

Instrument No.	Panel	Type	Description	Pen	Maj/Min	Factor	Scaling	Band	Color

Figure 7. Recorders Inventory Form

Type - the type of instrument or control. Will be either an I, C, or R for Indicator, Control or Recorder, respectively.

Description: - A description of the instrument or control as it appears on the nameplate (e.g., Main Steam Isolation Valve, or Heat Exchanger IA Temp)

Indicators and Controls Form (for Indicators):

RNG - The Range of indication. For example, 0-100 for zero to one hundred units

MAJ/MIN - the major and minor divisions in the scale. For example, 11/40 for a scale which ranges from 0 to 100 in increments of ten with increments of 2 between major divisions.

Factor - the multiplier, as applicable. If the indication is in tens but the measure is 10,000's, then the factor is 1000.

Scaling - the units of measure. For example, PSIG, PSIA, CFM.

Band - the parameters of a band if it appears on an instrument. For example, if a band appears on a meter from the 10 to 30 unit indication, 10-30 is entered here.

Indicators and Controls Form (for Controls):

Class - the classification of the control according to a predetermined coding scheme.

Division - the division code for the control within a certain classification according to a predetermined coding scheme.

Positions - the number of possible positions in which the control can be configured.

Recorders Form:

Pen - Either a letter or number, depending upon various factors of the instrument number, which will uniquely identify this pen of the recorder from the other pens.

MAJ/MIN - the number of major scale marks and the number of minor scale marks between major scale marks on the meter scale.

Factor - the multiplier, if used, the compute the indication.

Scaling - the units of measure (e.g., PSIA, CFM)

Band - the parameter of a band on the meter, if used.

Color - the color of ink in the pen

The data collected in the Control Room Inventory phase of the DCRDR project will be utilized in the Verification of Task Performance Capabilities phase to assess the availability and suitability of operator-required instrumenation and controls.

4.3 Resolution of Preliminary Design Assessment (PDA) HEDs

4.3.1 Purpose

The purpose of the resolution of PDA HEDs is to correct or resolve those HEDs that were identified during the PDA that were relegated to investigation during the DCRDR.

4.3.2 Methodology

After identification and inspection, the PDA HEDs will be corrected and/or resolved by the methods described in Section 5.2.

4.4 System Function Review and Task Analysis

4.4.1 Purpose

The purpose of the System Function Review and Task Analysis portion of the DCRDR is to identify control room operator tasks and corresponding information and control requirements during emergency operations. This will be accomplished by performing an analysis of all events encompassed in the Shoreham-specific Emergency Operating Procedures (EOPs).

4.4.2 Methodology

As the section title indicates, this portion of the DCRDR entails two major, sequentially-oriented subtasks. Each of the two are discussed separately below.

4.4.2.1 System Function Review

Plant systems and subsystems that are utilized in the EOPs will be identified and listed. Major systems will include the reactor control and instrumentation systems, safety systems, feedwater systems, radwaste systems, power generation systems, and power distribution systems. Subsystem identification will be taken down to the level of major components such as Reactor Vessel and Suppression Pool.

Once the systems and subsystems have been identified and listed, the next step will be to identify and document the functions associated with each system and subsystem. This documentation will take the form of a summary description of the system and its related components, and the functions of the system and related components. This information will be derived from the Shoreham FSAR.

4.4.2.2 Task Analysis

Using the Shoreham-specific EOPs as a basis, the Task Analysis will identify and document the discrete tasks that the operators must perform during emergency operations. Correspondingly, the specific instrumentation, controls and equipment that are required to successfully perform the emergency operations will be identified and documented.

Using the Task Analysis Form shown in Figure 8, the EOPs will be analyzed and documented in the following manner:

1. The identification of discrete steps in the EOPs in order of performance. These steps will be recorded in the "Procedural Step" column of the Task Analysis form.

2. A brief description of the operators' tasks per procedural step will be recorded in the "Operator Tasks" column of the Task Analysis form.

3. The identification and recording of the particular training requirements that are associated with each operator task. For example, an understanding of the thermodynamic properties of plant systems would be required to make an appropriate decision given plant status information via the indicators in the control room.

4. The identification of instrumentation and/or controls that the operator requires per procedural step to either: (1) initiate, maintain or remove a system from service, (2) confirm that an appropriate system response has or has not occurred, or (3) make a decision regarding plant or system status. The required Instrumentation and Controls will be recorded in the "I&C Requirements" column of the Tasks Analysis form.

TASK ANALYSIS FORM

Event ______

Unit ______

Page ____ of ____

Procedural Step	Operator Tasks	Training Requirements	Instrumentation and Controls Required	Availability		Suitability	
				Yes	No	Yes	No

Figure 8. Task Analysis Form

The remaining columns of the Task Analysis Form will be utilized during the Verification of Task Performance Capabilities, which is described in the next section.

4.5 Verification of Task Performance Capabilities

4.5.1 Purpose

The purpose of the Verification of Task Capabilities is to systematically verify that the Instrumentation and Controls that were identified in the Task Analysis as being required by the operator are:

- Present in the Control Room
- Effectively designed to support correct procedure performance

4.5.2 Methodology

The Verification of Task Performance Capabilities will utilize a two-phase approach to achieve the purpose stated above. In the first phase, the presence or absence of the Instrumentation and Controls that were noted in the Task Analysis will be confirmed. This will be done by comparing the requirements in the "I&C Requirements" column of the Task Analysis Form to either the Control Room Inventory or the actual control room.

Regardless of which methodology is utilized, the presence or absence of required Instrumentation and Controls will be noted in the "yes" or "no" areas, respectively, in the "Availability" column of the Task Analysis form. If it is discovered that required Instrumentation and Controls are not available to the operator, any such occurrence will be identified as an HED and documented accordingly.

The second phase will determine the human engineering suitability of the required Instrumentation and Controls. For example, if a meter utilized in a particular procedure step exists in the control room, that particular meter's inventory data will be examined to determine whether

or not the meter has the appropriate range and scaling to support the operator in the corresponding procedural step. If the range and scaling are appropriate, it will be noted by checking the "yes" area in the "I&C suitability" column of the Task Analysis Form. Conversely, if the meter range or scaling is not appropriate for the parameter of interest to the operator, the "no" area in the "I&C Suitability" column of the Task Analysis Form will be checked. This type of occurrence will be defined as an HED and documented accordingly.

4.6 Validation of Control Room Functions

4.6.1 Purpose

The purpose of the Validation of Control Room Functions step in the DCRDR process is to determine whether the functions allocated to the control room operating crew can be accomplished effectively within (1) the structure of the Shoreham-specific EOPs and (2) the design of the control room as it exists.

Additionally, this step provides an opportunity to identify HEDs that may not have become evident in the static processes of the review.

4.6.2 Methodology

Utilizing the completed Task Analysis Forms from the Systems Functions Review and Task Analysis portion of the DCRDR, the events that the forms describe will be talked-through and walked-through in the control room, providing a dynamic simulation of the events. A normal complement of the operating crew will be performing the talk/walk throughs.

4.6.2.1 Talk-Throughs

The operating crew will be provided with copies of the Task Analysis Forms to follow as they are talking through the events.

One event at a time will be talked-through. Operators will be requested to perform the talk-through in slower than real time to provide a relatively slow-paced rehearsal of the event.

During the talk-throughs, the operators will be instructed to speak one at a time and describe their actions. This is done in an attempt to force as much serial action from the operators as possible. Specifically, the operators will verbalize:

- The component or parameter being controlled or monitored
- The purpose of the action
- The expected result of the action in terms of system response

As the operators talk-through the event, they will point to each control or display that they utilize, and indicate which annunciators are involved.

As the talk-throughs proceed, the operators will note any errors, such as improper step sequencing or branching, that may occur on the Task Analysis Forms. These errors will be traced back to the EOPs for investigation by the review team to ascertain whether the error occurred because of a procedural problem.

If a procedural problem is discovered, it will be documented. This documentation will be useful in responding to Item 7 of Supplement 1 to NUREG-0737, which involves the Upgrade of Emergency Operating Procedures. This documentation will also be useful in any type of long-term training program which involves or procedures upgrades.

4.6.2.2 Walk-Throughs

When the talk-throughs of events are complete, the walk-throughs will be performed. In the walk-throughs, the operators will perform the events in real time, as opposed to the slower time

sequences that were utilized in the talk-throughs. The operators will still point to the controls, displays and appropriate annunciators, but will otherwise perform the event in a realistic manner.

The walk-throughs will be videotaped to provide a record for analysis later in the review process, as described below.

After each event is videotaped, the operators who performed the event will review the tapes along with task analysts. The operators will be asked to note any errors or problems that were encountered in the walk-throughs and to expound upon the source of the errors or problems. These errors or problems will be documented for investigation as possible HEDs.

After all events have been videotaped, the tapes will be subjected to further analysis which will result in the addition of more discrete information onto the Task Analysis Form. For each procedural step, the following types of information will be extracted from the videotapes:

- The identification of which member of the operating crew is performing the task. This will be added to the "Operator Tasks" column on the Task Analysis Form.

- A description of the specific behavioral action that is associated with each operator task. This will include communications between and among crew members. This will be added to the "Operator Tasks" column on the Task Analysis Form.

- A description of the system response as a function of the Instrumentation and Controls required in the associated procedural step, for example, an indicating light on a controller energizing to red, or a pointer on a meter deflecting upward. This will be added to the

"Instrumentation and Controls Required" column on the Task Analysis Form.

Once the videotapes of the events have been analyzed to extract the information noted above, Link Analyses, which trace the movement patterns of the operating crew, will be prepared to assess whether control room layout hinders operator movement while performing the events.

The final step in the validation process will be to have a reactor operator who did not walk or talk through the events view the tapes in attempt to uncover any operator task difficulties from an objective viewpoint.

Any dynamic performance problems that were uncovered during this phase of the DCRDR process will be documented for review in the HED Assessment and Resolution phase of the DCRDR.

SECTION 5. HED ASSESSMENT AND RESOLUTION

5.1 HED Assessment

All HEDs that are identified as a result of the DCRDR process will be assessed and categorized. Additionally, recommendations for the correction or resolution of HEDs will be generated, and a schedule for their implementation will be developed.

5.1.1 Purpose

The purpose of the HED Assessment phase of the DCRDR project is to examine the HEDs that have been identified and place them into categories in terms of their potential to increase operator error during operations. This is accomplished by analyzing and evaluating the problems that could arise from the identified HEDs.

5.1.2 Methodology

The DCRDR review team will evaluate all HEDs for their potential to increase operator error during operations. As each HED is assessed, they will be categorized as follows:

1. Category I - HEDs Associated with Documented Errors
   All HEDs which have been previously documented (as determined in the Operating Experience Review) as having contributed to an operating crew error will be assigned to Category I.

2. Category II - HEDs Associated with Potential or Interactive Errors

   HEDs placed in Category II come from two sources:

A. If it is judged that the HED degrades performance and if the effects of the HED are judged to be serious enough to cause or contribute to increasing the potential for operator error, the HED will be assigned to Category II.

B. If it is judged that the HED has any cumulative or interactive effects with other HEDs, it will be assigned to Category II. Cumulative HEDs would be those that are placed in this category by their number of occurrences, such as improper labeling characteristics throughout the entire control room. Interactive HEDs would be those HEDs that excaberate each other such as improper scaling on a meter combined with the absence of a parameter designation.

3. Category III - HEDs Associated with Low Probability Errors of Serious Consequences

All HEDs that are judged by the DCRDR review team to have a low potential for error but could result in serious consequences if the error did occur would be placed in Category III.

4. Category IV - Non-Significant HEDs

All HEDs that are judged by the DCRDR review team to neither increase the potential for causing or contributing to an operating crew error, nor to have adverse safety consequences, nor to have any cumulative or interactive effects will be assigned to Category IV.

5.2 HED Corrections

5.2.1 Purpose

Recommendations for HED resolution or correction will be made for each identified HED. This will be done in an attempt to alleviate the human engineering problems that are associated with the HEDs. Recommendations will be based upon three criteria:

1. The recommended improvement adheres to accepted human factors engineering principles.

2. The recommended improvement is cost-effective and feasible from an implementation perspective.

3. The recommended improvement will be acceptable to both LILCO and the NRC.

5.2.2 Methodology

The following techniques will be among the methods that can be utilized for the corrections of discrepancies:

- Correction by Enhancement: Enhancement techniques include changing control and/or display labels and annunciator title legends, or adding demarcation lines or mimic lines to existing arrays of controls and displays. These techniques will be mocked-up via drawings. The review team will then judge their effectiveness in resolving the HED. If the enhancement correction is judged to be effective, it will be considered to be the appropriate resolution.

- Correction by Design Change: HEDs that cannot be effectively corrected by enhancement will usually require a design effort, either in terms of component reconfiguration or rearrangement. These design changes will be mocked-up and verified by having operations personnel assess their effectiveness in a dynamic manner. This will be acheived by having operators walk through the portion of an EOP that involves the utilization of the component(s) that were reconfigured or rearranged to see if the design correction did in fact provide an enhancement.

- Correction by SPDS, Training, or Procedural Modifications: Some HEDs can be resolved through methods that do not require physical modifications to instrumentation and controls. The lack of a required indication could be resolved by supplying this indication on the SPDS. Training programs could be initiated or supplemented to alert operators to particular control arrangements that are not optimal but cannot be reconfigured due to space constraints or

separation criteria, and Procedures could be modified to compensate for irreconcilable instrument and control layout or location.

5.3 Implementation Schedule

In terms of scheduling of implementation of HED resolution, Category I resolutions will be implemented first when possible and practical. Lower categories of HEDs will have their resolutions implemented in the sequence of Category II next, then Category III, then Category IV. This sequence will be followed whenever possible.

SECTION 6. DCRDR FINAL REPORT AND FUTURE APPLICATIONS

6.1 DCRDR Final Report

At the completion of the DCRDR project, a final report will be generated. This report will document, in summary form, the procedures utilized in the DCRDR. Any departures from the methodologies described in this Program Plan will be noted and justified.

The final report will also describe the results of the review process. The HEDs that were identified during the Operating Experience Review, and the Systems Review and Task Analysis will be included along with the recommendations for correction and/or resolution for each HED. A schedule for the correction of the HEDs, based upon their assessment categorization, will be included.

The final report will also address the utilization of the DCRDR results in an integrative manner with regard to the other areas of Supplement 1 to NUREG-0737. The data gathered can be used to address the upgrading of EOPs, the design, implementation and location of the SPDS, the adequacy of Reg. Guide 1.97 instrumentation and the Emergency Response Facilities.

The results of the DCRDR will be incorporated into Shoreham training programs as applicable. This will ensure that any implemented changes will be brought to operators' attention with regard to physical modifications or procedural alterations.

6.2 Future Applications

To provide a mechanism for an integrated type of analysis for any HEDs identified throughout the operational life of the Shoreham Nuclear Power Station, the following tasks will be undertaken:

- Personnel Survey - an operator questionnaire, similar to the one utilized in the DCRDR, will be distributed periodically. The responses will be perused for human engineering problems in the

same manner as will be performed in the Personnel Survey portion of the DCRDR. Problems identified will be investigated, assessed as HEDs, and recommendations for correction or resolution will be made.

- Design Change Evaluation - any design change, modification (addition or deletion of instrumentation) will be examined prior to implementation and the human factors aspect of the change will be evaluated. The examination will attempt to identify any HEDs that are associated with the purposed design change. The resulting HEDs, if any are discovered, will be assessed, and recommendations for correction or resolution will be made.

Proposed design changes will also be examined with regard to their impact on the SPDS, EOPs, 1.97 instrumentation requirements and other related emergency response capabilities.

APPENDIX A

Review Team Resumes

(APPENDIX A TO BE INCLUDED LATER)

APPENDIX B

Operator Questionnaire

OPERATOR QUESTIONNAIRE

#______________________

Operator Questionnaire

As part of the human factors control room design review, you are asked to complete this questionnaire. The information provided by operations personnel is an important contribution to the design review. Your responses will be given serious consideration. Please answer each question as completely as possible.

To aid us in our record-keeping and analysis, please fill in the following information.

Date: ______________________

Number of years or months (specify which) you have been a licensed operator: __________

Number of years or months (specify which) you have been a trainee: _____

Present job title: ____

Name: ____

We will need your name to follow up on your comments if we need more specific information.

When you are finished, please mail the completed questionnaire to General Physics using the attached self-addressed, stamped envelope. Please complete and return the questionnaire within the next two weeks.

You may be interviewed to elaborate on your responses.

NOTE

To ensure anonymity, the following steps will be taken:

1. Upon receipt of your questionnaire a code number will be assigned to your questionnaire.

2. This sheet, with your name on it, will be removed from the questionnaire packet and placed in a file at General Physics.

3. The cover sheet, which contains only the code number, will become the only cover sheet in the questionnaire package, your name will not appear anywhere in the package. Your name will not be linked to your response when the results are presented.

4. The inside cover sheet containing your name will be used only to identify you if an interview is requested.

Thank you for your time and consideration.

WORKSPACE LAYOUT AND ENVIRONMENT

1. What aspects of the control room workspace, furniture and equipment make your job hard to do?

   What are your suggestions for improving each of these?

2. What problems are there in the control room with color coding or labeling? Please be as specific as you can.

3. What areas of the control room have inadequate lighting?

4. Have you ever seen the use of the emergency lighting? (circle one) Yes No ?
If yes, what aspects of it were inadequate?

5. Is heating/ventilation adequate? Yes No
If no, please explain.

6. What would you change in your work environment to reduce stress, fatigue, or boredom? Be specific if you can:

Which of these recommended changes are significant enough, in your opinion, to reduce the likelihood of operator error?

7. Which (if any) noise levels are particularly high? Is communication between operators made difficult as a result of high noise levels?

8. Are there any special problems in operating panels/systems that make your job difficult (for example, layout, location, etc.)? Please explain and indicate panel or system to which you are referring.

What would you change about this to make your job easier or more effective?

9. What unsolved or repeated problems have you had with the maintenance or repair of panels? Please be specific.

10. On what systems or panels would more practice or training be useful, and why?

Additional Comments and Recommendations:

CONTROLS

11. Which controls do you think are difficult to find or access? Please be very specific.

12. Which controls are poorly designed or built for handling or operating, and why?

13. Which controls are most likely to be operated in error, and why (for example, due to location or label, etc.)?

14. Which controls, not currently in the control room, are needed to respond to normal or emergency situations?

15. Are there any controls on back panels that should be on front panels or vice-versa? Please be specific.

Additional Comments and Recommendations:

DISPLAYS (Excluding CRT Displays, Including Meters, Recorders, Indicator Lights)

16. Which displays are hard to locate or access? Please explain.

17. Which displays are difficult to read, and why?

18. Which important indicators are difficult to see during normal or emergency operation, and why?

19. Which control room displays are unnecessary?

20. What displays, not now in the control room, are needed to respond to normal or emergency situations?

Additional Comments and Recommendations:

ANNUNCIATORS

21. How can the annunciators be improved (e.g. content of legend, hardware, etc.)?

22. On what panel(s) does the placement of individual annunciators not follow a logical pattern?

23. Identify annunciators that are difficult to interprete or do not help diagnose a problem.

24. Identify annunciators that alarm too late to allow operator action.

25. Identify nuisance alarms.

Additional Comments and Recommendations:

COMMUNICATIONS SYSTEM

26. Is more or better communication equipment needed in the control room? Yes No If yes, please explain.

27. Are verbal messages in the control room ever unclear? Yes No If yes, please explain.

COMPUTER SYSTEM

28. Are the computers useful in providing you accurate, timely and easily usable data regarding important system parameters under normal, abnormal, and emergency conditions? Yes No If no, please explain.

29. Are the computers difficult to use in retrieving important system data? Yes No If yest, please explain.

Additional Comments and Recommendations:

CRT DISPLAYS

30. Are there problems with any of the following characteristics of the CRT displays?

a. visibility (glare or location)	yes	no
b. image quality	yes	no
c. coding (for example, color, symbol)	yes	no
d. organization of call-up displays	yes	no
e. format of displays	yes	no
f. response time	yes	no
g. keyboard (or other entry techniques)	yes	no

If you answered "yes" to any of the above, please explain as specifically as possible.

Additional Comments and Recommendations:

CORRECTIVE AND PREVENTIVE MAINTENANCE

31. Is the control room preventive maintenance program effective? Yes No
Are the maintenance procedures effective? Yes No
If no to either of the above, please explain.

Additional Comments and Recommendations:

<u>PROCEDURES</u>

32. Can you find the procedure binder you need when you need it? Yes No
    Can you easily find the specific procedure or procedural step you need? Yes No
    If no to either of the above, please explain.

33. Which specific procedures are so unclear that portions of them should be rewritten, and why?

Additional Comments and Recommendations:

STAFFING AND JOB DESIGN

34. What problems of control room shift staffing interfere with smooth, continuous system operation?

35. Under what circumstances are individual responsibilities and chain-of-command not clearly understood, and how could this be improved?

36. What duties are you required to perform that you consider unreasonable or distracting in your primary responsibility as SRO or RO?

37. What administrative procedures do you think could be implemented more efficiently (e.g. shift change, control room access)?

38. In off-normal situations, describe any workload problems you have encountered:

TRAINING

39. What items of real importance should you have known that you did not when you began working as an operator?

40. What could have been done to make your training more effective?

41. In what areas would refresher training be helpful for more effective operation?

42. In what technical or skill areas would additional training be helpful?

Additional Comments and Recommendations:

GENERAL

43. If you have any additional comments that have not been covered elsewhere, please note them in the space below.