SAN ONOFRE NUCLEAR GENERATING STATION - UNIT 1

CONTROL ROOM DESIGN REVIEW

PROGRAM PLAN

Prepared for:

U.S. Nuclear Regulatory Commission

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SCE M38953

Southern California Edison Company
2131 Walnut Grove Avenue
Rosemead, California

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EXECUTIVE SUMMARY

E.1 CONTROL ROOM DESIGN REVIEW (CRDR) METHODOLOGY

E.1.1 General Comments

The background, purpose, requirements, and scope of the CRDR are discussed in the Program Plan. This Executive Summary outlines the methodology that Southern California Edison (SCE) will use to perform the CRDR.

E.1.2 CRDR Phases

SCE will use a methodology that divides the CRDR into component phases similar to those recommended in NUREG-0700 and NUREG-0800s Each phase is described briefly below and is detailed in Program Plan Sections 2 through 6.

E.2 PLANNING PHASE

E.2.1 Planning Phase Objectives

The Planning Phase will define the organization and direction of the San Onofre Nuclear Generating Station - Unit 1 (SONGS-1) CRDR. The Program Plan is the principal record of this phase and will be used as the guiding document for all SONGS-1 CRDR activities. Program Plan deviations will be documented by SCE in periodic Program Plan revisions if needed, and/or recorded in the Final Summary Report.

E.2.2 Summary of Planning Phase Components

The principal components of the Planning Phase are listed below and detailed in Program Plan Section 2:

- CRDR Management and Staffing
- Data Management
- Equipment
- Scheduling
- Planning Phase Documentation

E.3 REVIEW PHASE

E.3.1 Review Phase Objectives

The Review Phase is the investigative portion of the CRDR. There are two objectives for this phase:

a. Determine whether the Control Room provides the system status information, control capabilities, feedback, and performance aids necessary for Control Room operators to accomplish their emergency response functions and tasks effectively.

b. Identify characteristics of the existing Control Room instrumentation and controls (I&C), other equipment, and physical arrangements that may detract from operator emergency response performance.

E.3.2 Summary of Review Phase Processes

The six processes of the Review Phase are listed below and are detailed in Program Plan Section 3:

- Operating Experience Review
- Control Room Inventory
- Control Room Survey
- System Function Review and Task Analysis
- Verification of Task Performance Capabilities
- Validation of Control Room Functions

E.4 ASSESSMENT AND IMPLEMENTATION PHASE

E.4.1 Assessment and Implementation Phase Objectives

The objectives for this CRDR phase are listed below:

a. Analyze and evaluate the problems that could arise from identified human engineering discrepancies (HEDs).

b. Analyze means of correcting those discrepancies that could lead to substantial problems.

c. Interface the assessment process with those other Control Room related projects that are concerned with or may affect human factors.

d. Integrate the implementation process with the goals and implementation processes of these related human factors projects and other SONGS-1 activities.

Although the emphasis is on improvements affecting operator performance under emergency conditions, all improvements affecting operator performance will be considered.

E.4.2 Summary of Assessment Activities

During Assessment, all HEDs will be analyzed and the importance of each to plant safety and operation will be determined. The HEDs will be prioritized according to importance; significant discrepancies will be selected for resolution through modifications, additional training, etc. The proposed resolutions will be analyzed for impact and effect on plant safety and operation, cost/benefit relationship, and possible alternatives. As a final assessment step, an evaluation of the extent of correction for each HED selected for resolution will be made in order to document and justify all HEDs not fully corrected. The assessment process is detailed in Program Plan Section 4.

E.4.3 Summary of Implementation Activities

During Implementation, approved modifications will be integrated with other enhancement programs. These changes will be scheduled consistent with SCE's integrated living schedule, with consideration given to the possible HED safety consequence, plant operating status, procurement time, etc. The implementation process is detailed in Program Plan Section 4.

E.5 REPORTING PHASE

E.5.1 Reporting Phase Objectives

The Final Summary Report will be submitted to the Nuclear Regulatory Commission (NRC) to document the SONGS-1 CRDR. The report will accomplish the following objectives:

- Summarize the overall review process.
- Document all identified HEDs.

- Identify Control Room design improvements implemented before and during the CRDR..
- Identify proposed and finalized design improvements.

Although the CRDR is to be reported in summary form, the details of the entire review will be documented and maintained in readily retrievable format for future SCE use and possible NRC audit.

E.5.2 Summary of Reporting Phase Activities

The Reporting Phase will consist of Interim Reports, Final Summary Report and the filing and storage of CRDR documentation as the program concludes. The Reporting Phase is detailed in Program Plan Section 5.

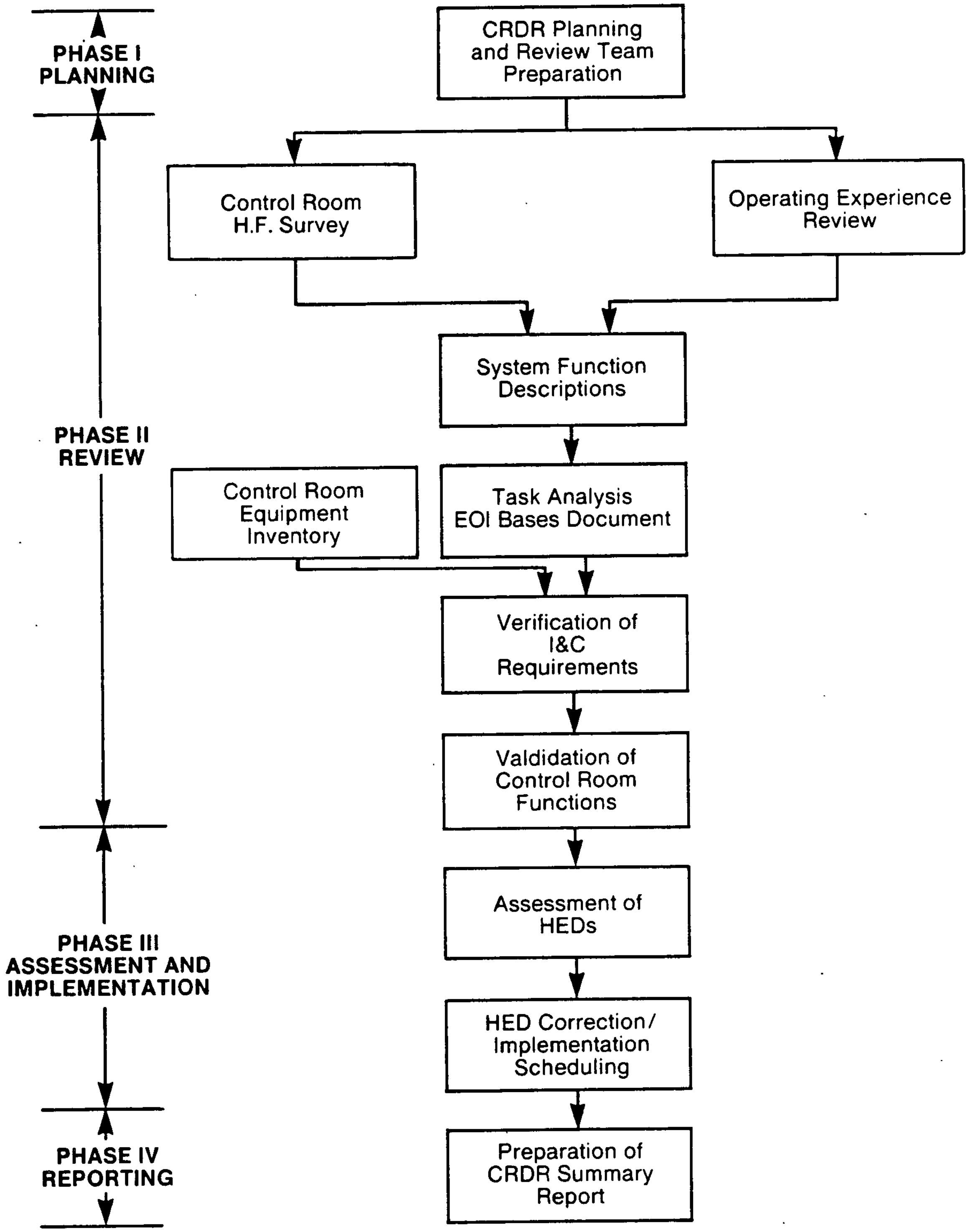
E.6 PROGRAM INTEGRATION

E.6.1 General Comments

The importance of integrating CRDR information and activities into SONGS-1 design procedures and other NUREG-0737 Supplement 1 programs, and vice versa, is such that SCE considers Program Integration to be one of the five main components of the SONGS-1 CRDR (see Program Plan Sections 2 through 6). However, due to the nature of this component, there will be few activities accomplished specifically under Program Integration. Each of the CRDR phases, processes, and activities will incorporate the applicable requirements and objectives of Program Integration, as discussed below and detailed in Program Plan Section 6.

E.6.2 Program Integration Objective

The objective of Program Integration is the coordination of the CRDR with the various NUREG-0737 Supplement 1 programs, the Safety Parameter Display System (SPDS), Reg. Guide 1.97, Emergency Operating Instructions (EOIs), and Emergency Response Facilities (ERFs) so that all programs are properly accomplished to provide an integrated Control Room.



Flowchart of CRDR Activities

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SAN ONOFRE NUCLEAR GENERATING STATION - UNIT 1

CONTROL ROOM DESIGN REVIEW PROGRAM PLAN

1. INTRODUCTION

1.1 General Comments

1.1.1 Program Plan Purpose

This Program Plan describes the program which Southern California Edison (SCE) will use to perform a Control Room Design Review (CRDR) of the San Onofre Nuclear Generating Station - Unit 1 (SONGS-1) in accordance with the requirements of NUREG-0737 Supplement 1.

1.1.2 The Need for a CRDR

The need for CRDRs has been well documented by the Nuclear Regulatory Commission (NRC) as a result of the investigations of the Three Mile Island accident (see Appendix A, Bibliography). The significant areas of concern identified included noncompliance of Control Room facilities with human factors principles, deficiencies in information presented to the operator, and inadequate operating procedures.

1.1.3 Other SCE Improvement Efforts in the Control Room

The CRDR is part of a larger effort within SCE to improve the overall Emergency Response Capability (ERC). The scope of this Program Plan is directed toward a human factors review of the design adequacy and operability of the existing Control Room. However, SCE recognizes and intends that other areas of concern related to the Control Room and ERC will be coordinated with the CRDR to ensure that an integrated Control Room will result. These other areas include Emergency Operating Instructions (EOIs), a Safety Parameter Display System (SPDS), post-accident monitoring (PAM) instrumentation per Regulatory Guide 1.97, and Emergency Response Facilities (ERFs).

1.2 CRDR Purpose and Requirements

1.2.1 Purpose

The purpose of the CRDR is to:

(1) Review and evaluate instrumentation, controls and other equipment in the control room workspace from a human factors engineering viewpoint, taking into account both system demands and operator capabilities and information requirements.

(2) Identify, assess and implement control room design enhancements and modifications to correct items which have safety-significance or otherwise substantially adversely impact the potential for operator error in preventing or coping with emergency situations.

1.2.2 Regulatory Requirements and Guidance

To accomplish the above purpose, SCE has designed the CRDR to fulfill the requirements of NUREG-0737 Supplement 1 in accordance with the guidance of the applicable portions of NUREG-0700 and NUREG-0800. These requirements for the SONGS-1 CRDR are listed below:

a. The establishment of a qualified multidisciplinary review team and a review program incorporating accepted human engineering principles.

b. The use of system function review and task analysis to identify Control Room operator tasks and information and control requirements during emergency operations.

c. A comparison of the display and control requirements with a Control Room inventory to identify missing and inadequate displays and controls.

d. A Control Room survey to identify deviations from accepted human factors principles. This survey will include, among other things, an assessment of the Control Room layout, the usefulness of audible and visual alarm systems, the information recording and recall capability, and the Control Room environment.

e. An assessment of human engineering discrepancies (HEDs) that are significant and should be corrected; the selection of design improvements that will correct these discrepancies.

f. A verification that each selected design improvement will provide the necessary correction, and can be introduced in the Control Room without creating unacceptable HEDs because of significant contribution to increased risk, unreviewed safety questions, or situations in which a temporary reduction in safety could occur. Improvements that are introduced will be coordinated with changes resulting from other improvement programs such as SPDS, upgraded EOIs, and Regulatory Guide 1.97.

1.3 Plant Description

1.3.1 Plant Site and Description

The site for SONGS 1 is on the west coast of Southern California, in San Diego County, about 62 miles southeast of Los Angeles and 51 miles northwest of San Diego. See Figure 1.

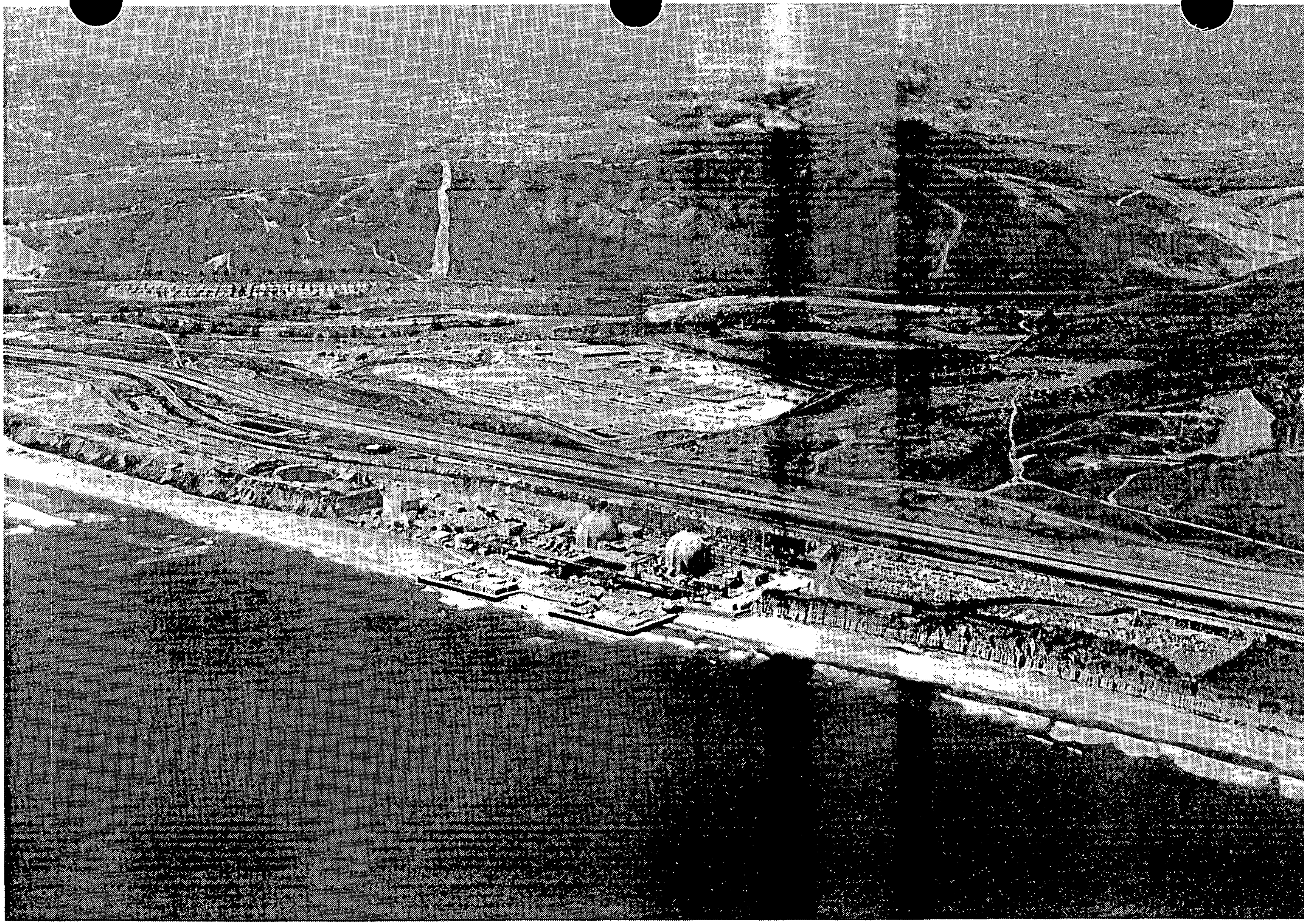

Figure 1. Plant Site

SONGS 1 is a Westinghouse designed, pressurized water reactor which began commercial operation in January 1968. The unit characteristics are as follows:

SONGS 1 Unit Characteristics

Type	PWR
Capacity:	450 MWe (gross)
Reactor Designer:	Westinghouse
Generator Mfr:	Westinghouse
Engineer:	Bechtel
Commercial Operation:	January 1968

1.4 Plant Features Covered by the CRDR

1.4.1 Main Control Room

The central focus of the CRDR will be the main control room illustrated in Figure 2.

1.4.2 Remote Shutdown Panel

Also included in the CRDR will be the displays and controls required to bring the plant to cold shutdown should the main control room become uninhabitable.

1.5 Glossary of Terms and Acronyms

1.5.1 General Remarks

Within this Program Plan, a number of terms and acronyms are used that apply to the CRDR. Since there are differences in the usage of these terms (even among practitioners in the nuclear industry), the definitions shown below will apply to all SONGS-1 CRDR activities. Applicable acronyms are also listed.

1.5.2 Terms

a. Control Room - The term "Control Room" refers to all plant features covered by the CRDR as outlined in Section 1.4.

b. Control Room Enhancements - Surface modifications that do not involve major physical changes, for example, demarcation, labeling changes, and painting.

c. Control Room Design Review (CRDR) - The Control Room Design Review described in this Program Plan, as required by NUREG-0737 and NUREG-0737 Supplement 1.

d. Emergency Operating Instructions (EOIs) - Plant emergency operation instructions (EOIs) directing operator actions necessary to mitigate the consequences of accidents.

e. Final Summary Report - Report of the results of the CRDR as described by NUREG-0737 Supplement 1. The SONGS-1 Final Summary Report is described in Section 5.1 of this Program Plan.

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

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

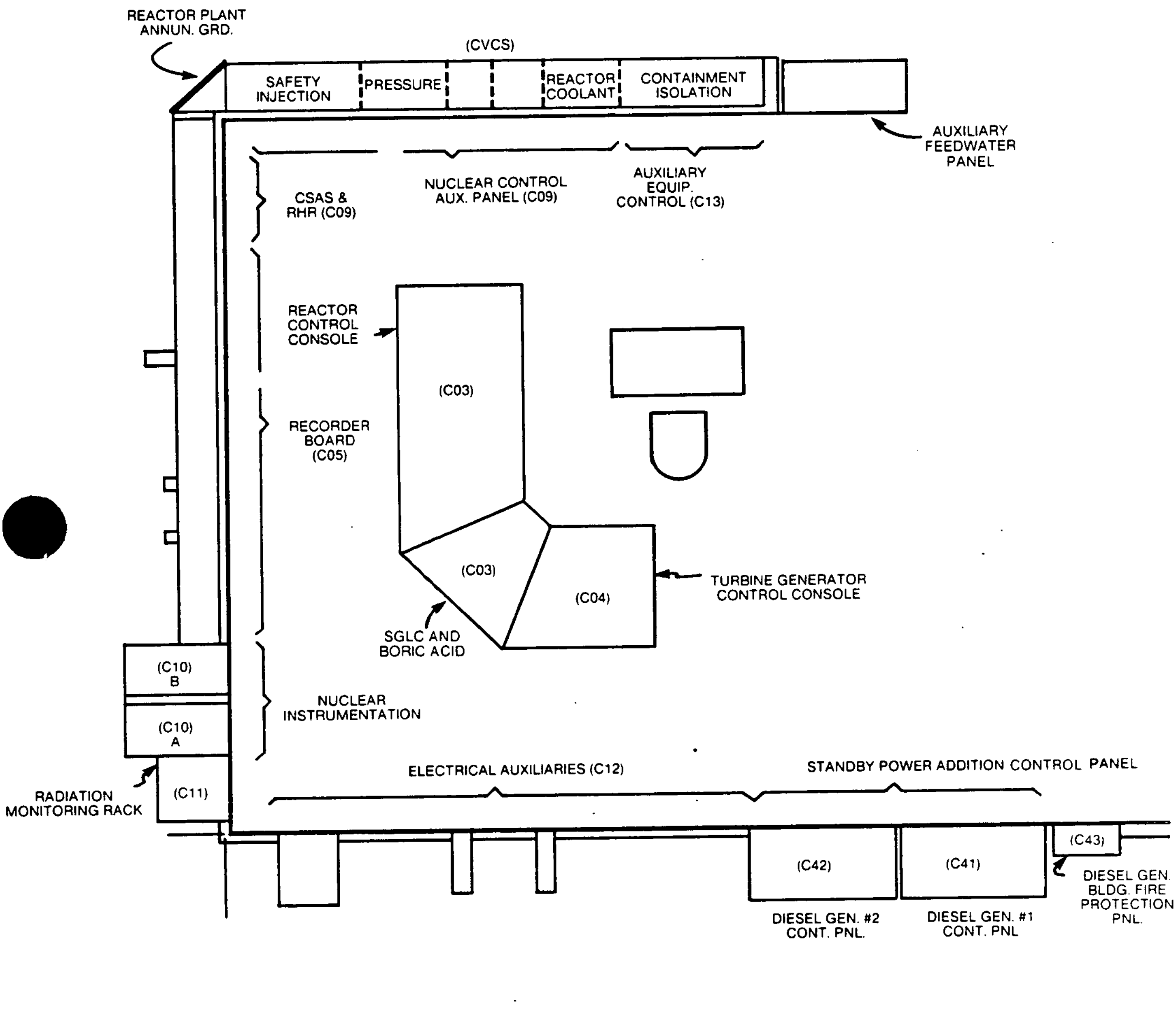

Figure 2. Main Control Room Layout

h. Function/Functional Analysis - The examination of system goals to determine the functions the system requires. Also, examination of the required functions with respect to available manpower, technology, and other resources, to determine how the functions may be allocated and executed. In the CRDR, primarily the identification of established functions and examination of how they are allocated and executed.

i. Guidance - A given condition that is subject to modification or change when adequate, documented justification is provided.

j. Human Engineering - The science of optimizing the performance of human beings, especially in industry. Also, more narrowly, the science of the design of equipment for efficient use by human beings. In SONGS-1 CRDR activities, the broader definition is used.

k. Human Engineering Discrepancy (HED) - A departure from some benchmark of system design suitability for the roles and capabilities of the human operator.

l. Operator - Any NRC-licensed individual in a nuclear power facility who manipulates a control or directs another to manipulate a control.

m. Requirement - A given condition that is not subject to modification or change.

n. System (Subsystem) - A whole that functions as a whole by virtue of the interdependence of its parts. Also, especially of human systems, an organization of interdependent constituents that work together in a patterned manner to accomplish some purpose.

o. System(s) Analysis - Examination of a complex organization and its constituents to define their relationships and the means by which their actions and interactions are regulated to achieve goal states.

p. Task (Subtask) - A specific action, performed by a single system constituent, person or equipment, that contributes to the accomplishment of a function. In the CRDR, only tasks allocated to people, in particular to Control Room operators, are addressed in detail.

q. Validation - The process of determining whether the physical and organizational design for operations is adequate to support effective integrated performance of the functions of the Control Room operating crew.

r. Verification - The process of determining whether instrumentation, controls, and other equipment meet the specific requirements of the task performed by operators.

1.5.3 Acronyms

a. AMI - Accident Monitoring Instrumentation

b. ATWS - Anticipated Transient Without Scram

c. CR - Control Room

d. CRT - Cathode Ray Tube (Display)

e. DBMS - Database Management System

f. CRDR - Control Room Design Review

g. EOF - Emergency Operations Facility

h. EOI - Emergency Operating Instruction

i. ERGs - Emergency Response Guidelines

j. ERC - Emergency Response Capability

k. ERF - Emergency Response Facility

l. FSA - Final Safety Analysis

m. GDGs - Graphic Display Guidelines

n. HED - Human Engineering Discrepancy

o. <u>HF</u> - Human Factors

p. <u>HFC</u> - Human Factors Consultant

q. <u>I&C</u> - Instrumentation and Controls

r. <u>LER</u> - Licensee Event Report

s. <u>NCR</u> - Non Conformance Report

t. <u>NPE</u> - SCE Nuclear Plant Engineering

u. <u>NRC</u> - U.S. Nuclear Regulatory Commission

v. <u>PAM</u> - Post-Accident Monitoring

w. <u>PDA</u> - Preliminary Design Assessment

x. <u>PGP</u> - Procedures Generation Package

y. <u>PWR</u> - Pressurized Water Reactor

z. <u>RG</u> - Regulatory Guide

aa. <u>RO</u> - Reactor Operator

bb. <u>SCE</u> - Southern California Edison

cc. <u>SIR</u> - Station Incident Report

dd. <u>SPR</u> - Station Problem Report

ee. <u>SME</u> - Subject Matter Expert

ff. <u>SONGS-1</u> - San Onofre Nuclear Generating Station - Unit 1

gg. <u>SPDS</u> - Safety Parameter Display System

hh. <u>SRO</u> - Senior Reactor Operator

ii. <u>TAW</u> - Task Analysis Worksheet

jj. <u>TSC</u> - Technical Support Center

kk. <u>V&V</u> - Verification and Validation

2. PLANNING PHASE

2.1 Planning Phase Objectives

The main objectives of the Planning Phase are to completely identify activities and schedule of events to be performed by the responsible organization and to develop a Program Plan, which describes the activities and schedule, for submittal to the NRC. In addition, the Planning Phase will be used to develop the CRDR Task Plans, plan and schedule activities in a CRDR Project Plan, orient CRDR Team members, and document Human Factors Criteria for CRDR use.

2.2 CRDR Management and Staffing

2.2.1 CRDR Team Structure

SCE management personnel will have the ultimate responsibility for the Control Room Design Review. The day-to-day conduct of the review, however, will be the responsibility of a review team established specifically for the CRDR. 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 CRDR activities.

a. CRDR Team Leader

SCE management recognizes the importance of the CRDR and the other NUREG-0737 Supplement 1 programs. SCE is dedicated to providing the management involvement necessary to provide a complete, multidisciplined Control Room review. However, the day-to-day conduct of the review (including the use of additional support for the CRDR Team as needed) will be the responsibility of the CRDR Team Leader. The CRDR Team Leader will provide the program management oversight to ensure the accomplishment of the project objectives and to meet the regulatory requirements of the review. The GP Project Manager is responsible for planning, scheduling, coordinating, and integrating all CRDR activities.

b. CRDR Team Members

The CRDR Team consists of a core group of specialists in human factors engineering, plant operations, and nuclear and electrical/instrumentation & controls (I&C) engineering. This core group includes personnel who are also knowledgeable in licensing, training, program management, and other NUREG-0737 Supplement 1 programs such as SPDS and upgrade of EOIs. The relationships among team members are shown in Figure 3.

2.2.2 CRDR Team Member Qualifications and Duties

The qualifications of the CRDR Team members meet the NUREG-0800 criteria. The team members' resumes are provided in Appendix B. Briefly, the team members include:

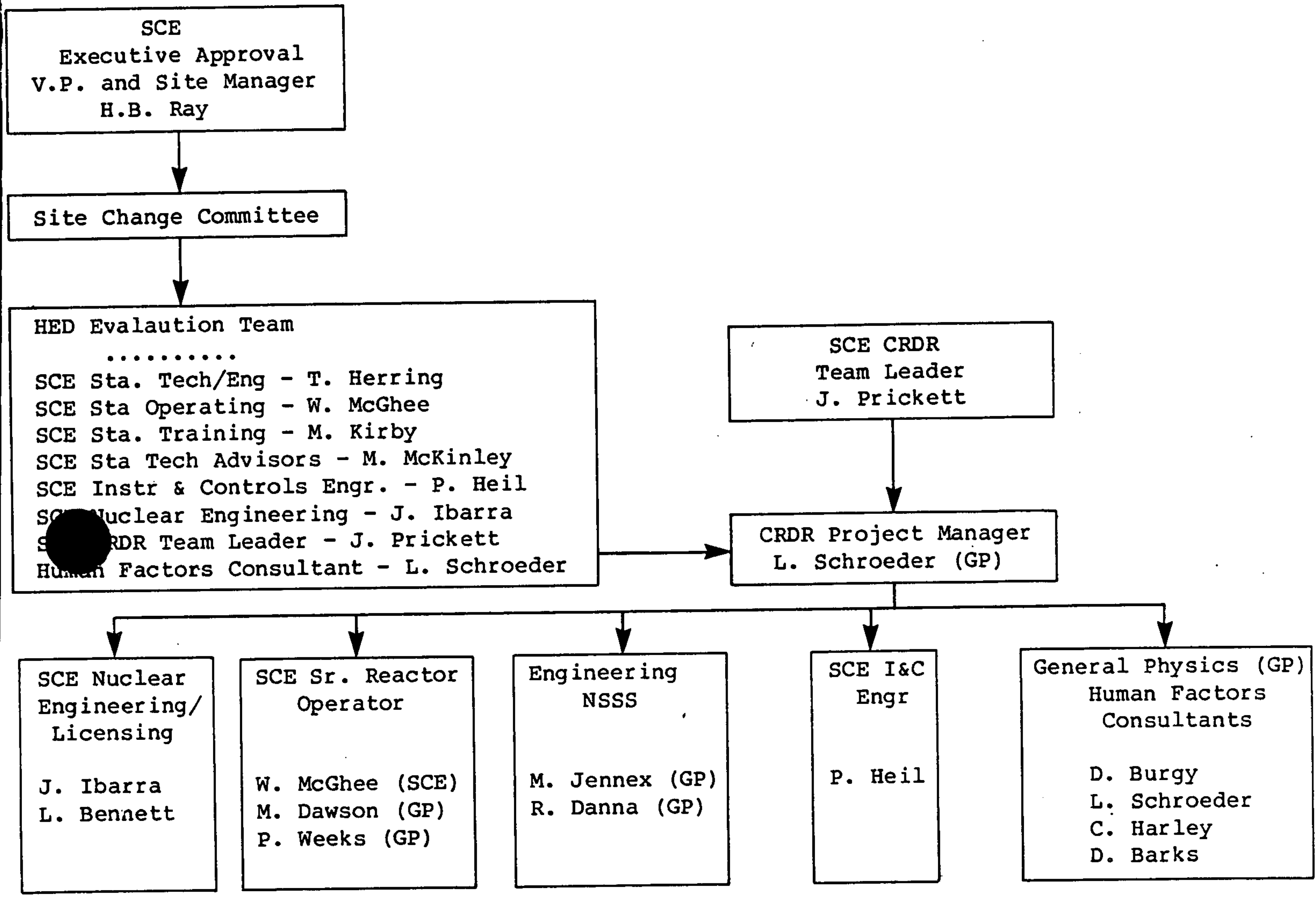

Figure 3. Functional CRDR Team Organization

a.	J. L. Prickett	CRDR Team Leader The CRDR Team Leader will be responsible for incorporating planned future control room changes, resulting from other NRC requirements and SCE capital improvement projects into the CRDR.
b.	W. McGhee	CRDR Team Member for Operations
c.	M. L. Kirby	CRDR Team Member for Training
d.	L. A. Bennett	CRDR Team Member for Licensing
e.	J. G. Ibarra	CRDR Team Member for SCE Nuclear Engineering.
f.	M. B. McKinley	CRDR Team Member for Station Technical Advisors
g.	T. Herring	CRDR Team Member for Station Engineering
h.	Mr. D. C. Burgy	CRDR Team Member for Human Engineering Assigned as Human Factors Consultant (HFC) Project Director for the SONGS-1 CRDR by General Physics Corporation, Mr. Burgy holds a master's degree in applied-experimental psychology and has more than 8 years' experience in the human factors field.

i. Dr. L. R. Schroeder — CRDR Team Member for Human Engineering Assigned as Human Factors Consultant (HFC) Project Manager for the SONGS-1 CRDR by General Physics Corporation, Dr. Schroeder holds a Phd in experimental-applied psychology and has over 11 years' experience in the human factors field. He will provide human factors engineering input to the CRDR team, and is responsible for conducting the CRDR.

2.2.3 CRDR Team and Support

a. Proposed Project Team

General Physics Corporation (GP) will provide experienced personnel to support the multi-disciplinary project team. GP team members have extensive experience in Control Room Design Reviews and have worked together as a team in prior CRDRs. The personnel selected from General Physics are fully capable and experienced in the required areas of specialization.

The Project Director for the SONGS 1 CRDR team will be Mr. Donald Burgy, Director, Human Factors Engineering. The project director serves as the primary point of contact between the project manager and the senior members of the corporate staff. Mr. Burgy is responsible for obtaining required expertise and resources from throughout the General Physics Corporation to complete project objectives.

The GP project manager for the SONGS 1 CRDR team will be Dr. Lothar Schroeder. The project manager directs the technical work of the project staff and serves as the primary client contact and is responsible for the preparation of project reports, and he is responsible for control of schedule and budget and attainment of technical objectives. Dr. Schroeder has extensive experience with control room review projects performed by General Physics for nuclear utility companies. During these efforts, the coordination of human factors operations and engineering expertise has been a key factor in successful project performance.

The following sections contain vitae for all key personnel proposed on the project. These vitae have been developed to highlight expertise pertinent to this project. Complete resumes are contained in Appendix B.

b. Human Factors Engineers

The qualifications and experience of the human factors engineers on the team are based on a total of 16 control room reviews. Each person has participated in at least two major control room review projects. The combined human factors experience of the proposed team is over 50 years, 12 years in the nuclear industry alone.

- Donald C. Burgy, Ph.D. Candidate - Project Director

Mr. Burgy directs all human factors engineering and man-machine systems design and evaluation work for General Physics. His human factors expertise includes system analysis, information processing, human-computer interactions and performance evaluation. Representative projects include:

Control Room Design Review

Participated in human factors control room design reviews at several utilities including Pennsylvania Power and Light Company's Susquehanna Steam Electric Station and Cincinnati Gas and Electric Company's William H. Zimmer Nuclear Power Station.

Emergency Response Facility Design, Cincinnati Gas and Electric Company

Participated in design and review of Technical Support Center, Emergency Operations Facility, Safety Parameter Display System and related software at William H. Zimmer Nuclear Power Station.

Operability Review and Crew Task Analysis

Participated in a human factors operability review of prototype large breeder reactors as part of an Electric Power Research Institute review; assisted in developing a methodology for a task analysis of plant operating crews for the Nuclear Regulatory Commission.

- David Barks - Human Factors Engineer

Mr. Barks' responsibilities include project management, writing program plans, developing experimental design, and marketing corporate capabilities in human factors engineering. Representative projects include:

Human Factors Design Reviews

Mr. Barks participated in human factors control room design reviews at several nuclear plants including Omaha Public Power District's Fort Calhoun Station, Gulf States Utilities' River Bend Station, and Georgia Powers' Vogtle Plant. He also participated in human factors design review of letter sorting machines for the United States Postal Workers Union.

Task Analysis of Operator Action

Served as project manager for the task analysis of nuclear power plant operator actions; developed a methodology to demonstrate what information could be derived from task analysis; investigated various data sources to demonstrate the applicability to the nuclear power plant environment; task analysis used to develop performance criteria for Oak Ridge National using errors of commission and compliance.

- Craig Harley - Human Factors Specialist

Mr. Harley is a member of the Human Factors Engineering Department where he supports human factors evaluations of control rooms and emergency operating procedures upgrade projects, participating in on-site data collection of human factors data and conducting data analysis, and writing training materials for utility clients. Representative projects include:

Control Room Design Review

Participated in human factors control room design reviews at several nuclear power plants including Mississippi Power and Light Company, Grand Gulf Unit 1; New York Power Authority, Indian Point Unit 3; Wisconsin Electric Power Company, Point Beach Nuclear Plant. Responsibilities included conducting operating experience reviews, operator interviews, control room survey, and task analysis based on Emergency Operating Procedures (EOPs).

Emergency Operating Procedures Preparation

Conducted reviews of symptom-based Emergency Operating Procedures for New York Power Authority, Indian Point Unit 3 verification efforts; also contributed to system review and task analysis efforts as part of a procedures upgrade program using WOG ERGs.

c. Reactor Operator with PWR Experience

- Paul Weeks - PWR Reactor Operator

Mr. Weeks supervises and provides pressurized water reactor (PWR) services to nuclear utility clients. Representative projects include:

Operator Hot License Course Development, Public Service Company of Indiana

Acted as Project Supervisor of a training materials preparation project for Marble Hill Nuclear Power Station's reactor operator and senior reactor operator hot licensing program; supervised writing editing, and production of all training materials.

System Training Manual Development, Commonwealth Edison Company

Acted as Project Supervisor of this project for Byron and Braidwood Stations; supervised the writing and editing of the Systems Training Manual, which detailed the purpose, description, operation, and design bases of the systems associated with a PWR power station.

On-site Instruction

Acts as instructor for on-site training programs; has conducted training programs for various utilities including both licensed operator training and shift technical advisor (STA) training. Has also prepared training materials including lesson plans, transparencies, student handouts, text materials, and audit examinations.

Operating Procedures Review

Has performed operating procedures reviews for Westinghouse PWRs including all facets of station operation.

- Michael W. Dawson - PWR Reactor Operator

Mr. Dawson provides technical and operational support services to the nuclear industry in the areas of procedures development, quality assurance/control, training program development and implementation, and radiation protection/health physics. He is certified as a Senior Reactor Operator in Vogtle Plant, a PWR of similar vintage to SONGS Unit 1. Mr. Dawson is currently assigned to GP's San Diego office where he is responsible for operations and training services provided from this office. Recent assignments include:

- Station startup services for the Diablo Canyon Power Plant including preparation of systems operations procedures, annunciator response procedures, and surveillance test procedures.

- Training Program Development including preparation of systems lesson plans for Licensed Operator training. Also taught Nuclear Power Plant Fundamentals courses to prospective operators.

d. Nuclear Systems Engineers

- Robert Danna, P.E. - Project Engineer

Mr. Danna serves as Director of the Engineering Services Department for General Physics and is located out of our local office in San Diego. In this position, he is responsible for an engineering staff located in our regional office in San Diego, in addition to several site locations including San Onofre. His engineering expertise includes the analysis of safety and non-safety related systems, development of operating and engineering procedures, configuration management, and utility engineer training. Representative projects include:

Configuration Management

Mr. Danna supervised, as Project Manager, the review and evaluation of all SONGS Unit 2 Design Change Packages (DCPs) and Proposed Facility Changes (PFCs) to determine their impact on the simulator trainer baseline configuration. Coordinated with SCE, Singer Link, and Taurio Corporation (currently a GP subsidiary) to provide information adaptable to SCE's automated Configuration Management system.

Site Engineering Support

Mr. Danna is responsible for on-site personnel currently located in SONGS engineering, compliance, and procurement organizations. These individuals provide on-site support for all three units and include modifications evaluations, license event report evaluation and development, support for leak rate testing, Unit 1 Return to Service support, and component procurement engineering.

Shift Technical Advisor and Specialized Training

Mr. Danna has provided STA training at numerous nuclear utilities including SONGS. During both 1982 and recently in 1985 Mr. Danna presented a course in material Science for Shift Technical Advisors at SONGS. In addition, in June 1985, he presented a 3-day seminar in San Diego to 13 members of the SONGS technical staff entitled "Codes, Standards, and Regulatory Requirements."

- Murray Jennex - Engineering On-Site

Mr. Jennex has been assigned as a GP site engineer to San Onofre since 1981. He initially assisted the training department with the development of training materials for SONGS Units 2 and 3. During the past two years Mr. Jennex has been assigned to the engineering department where he has supported systems modifications on all three units and has supported the local and integrated leak rate testing of Unit 1, along with Units 2 and 3. Mr. Jennex is currently committed to SCE in contract through the end of 1985. He is expected to be available to support this project as of January 1, 1986. His Unit 1 Return to Service experience would be used to assist in on-site data and documentation collection and component conformation.

2.2.4 CRDR Team Orientation

a. SONGS-1 Orientation for Human Factors Consultant

The HFC will undergo a brief orientation period at SONGS-1. During this orientation period, the HFC will establish a working knowledge of the SONGS-1 CRDR by participating in an organizational meeting to establish project control guidelines and policy. In addition, this period will be a time for the HFC to become familiar with the general plant and Control Room layout and SCE ERC efforts.

2.3 Data Management

A large number of documents will be referenced and produced during the CRDR. Therefore, an efficient and systematic method for controlling these documents is necessary. The CRDR Project Manager is responsible for documentation control. All documents used as primary input to the CRDR or generated during the CRDR will be subject to document control procedures. All documentation received or generated during the CRDR will be logged. The log will contain the document name and the date received. Written procedures will be prepared for the control of CRDR documentation.

A comprehensive documentation file will be maintained for use by the CRDR Team. At the end of the project, any SONGS-1 documentation retained by the HFC will be turned over to SCE to maintain for future use and reference.

2.3.1 Documentation Requirements

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

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

b. Provide a record of all documents produced by the CRDR Team as project output.

c. Allow an audit path to be generated through the project documentation.

d. Develop project files in a manner that allows future access to help determine the effects of Control Room changes proposed in the future.

2.3.2 Input Data

The following documents have been identified as reference and input 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 is preliminary:

- Licensee Event Reports (LERs)
- Station Incident Reports
- System Descriptions
- Piping and Instrumentation Drawings
- I&C Index
- Control Room Floor Plan
- Panel Layout Drawings

- Panel Photographs
- SONGS-1 EOIs
- SONGS-1 EOI, Bases Documents
- Abnormal Operating Instructions
- Westinghouse Generic Systems Review and Task Analysis (SRTA)
- Westinghouse Generic Emergency Response Guidelines (ERGs)
- Functional Specification of the Technical Data Display and Transmit System (Fox 3)
- Regulatory Guide 1.97
- Environmental Qualification Master List
- Final Safety Analysis
- Technical Specifications

2.3.3 Output Data

Throughout the CRDR, documents will be processed to record data, document analyses, and record findings. Whenever possible and appropriate, standard forms will be developed and used. The following list represents a preliminary estimate of the types of documents that will result from the CRDR:

- Program Plan
- Project Plan (including schedule)
- Operator Questionnaire
- LER Review Results forms
- Control Room Inventory Worksheets
- Panel Checklists (from the Control Room Survey)
- Task Analysis Worksheets
- Videotapes of Validation
- All HEDs
- Interim Report
- Final Summary Report

2.3.4 Database Management System

The focus of the computerized database management system (DBMS) is an IBM XT computer. The DBMS software is based on the dBASE III system by Ashton-Tate, as modified by General Physics Corporation for CRDR projects. The DBMS will allow for selective sorts and lists of data collected throughout the CRDR. The following data will be input into the DBMS files:

- All HED Records
- Task Analysis Data
- Equipment Characteristics Data
- System Function Description List

Each of the input data files will allow for rapid, convenient management and tracking of the review findings and results. The HED file will provide a look-alike output form that will be used in the Final Summary Report and other documentation.

2.4 Equipment

The HFC will provide all the equipment required to conduct the Control Room Survey and videotaping of Validation walk-throughs.

2.5 Scheduling

SCE has prepared a schedule for all CRDR activities. This schedule is shown in Figure 4.

2.6 Planning Phase Documentation

2.6.1 NRC Program Plan

In accordance with NUREG-0737 Supplement 1 this Program Plan was prepared for submittal to the NRC and is the controlling document for the SONGS-1 CRDR.

The Program Plan, by definition, is flexible and subject to revision as the stages of the CRDR 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.

2.6.2 Human Factors Criteria

Human factors specialists will develop and document the human engineering criteria and conventions specifically applicable to the SONGS-1 Control Room. All applicable requirements, whether NRC (NUREG-0700) or other, and the source criteria will be identified in a manner that permits easy reference for convenient project use. Also, the human factors specialists will provide documentation indicating why specific NRC criteria are not applicable in a particular case. These criteria and documentation will be submitted to the CRDR Team for review and approval. After the CRDR, the Human Factors Criteria will be adapted for ongoing reviews and documentation of future changes to the SONGS-1 Control Room.

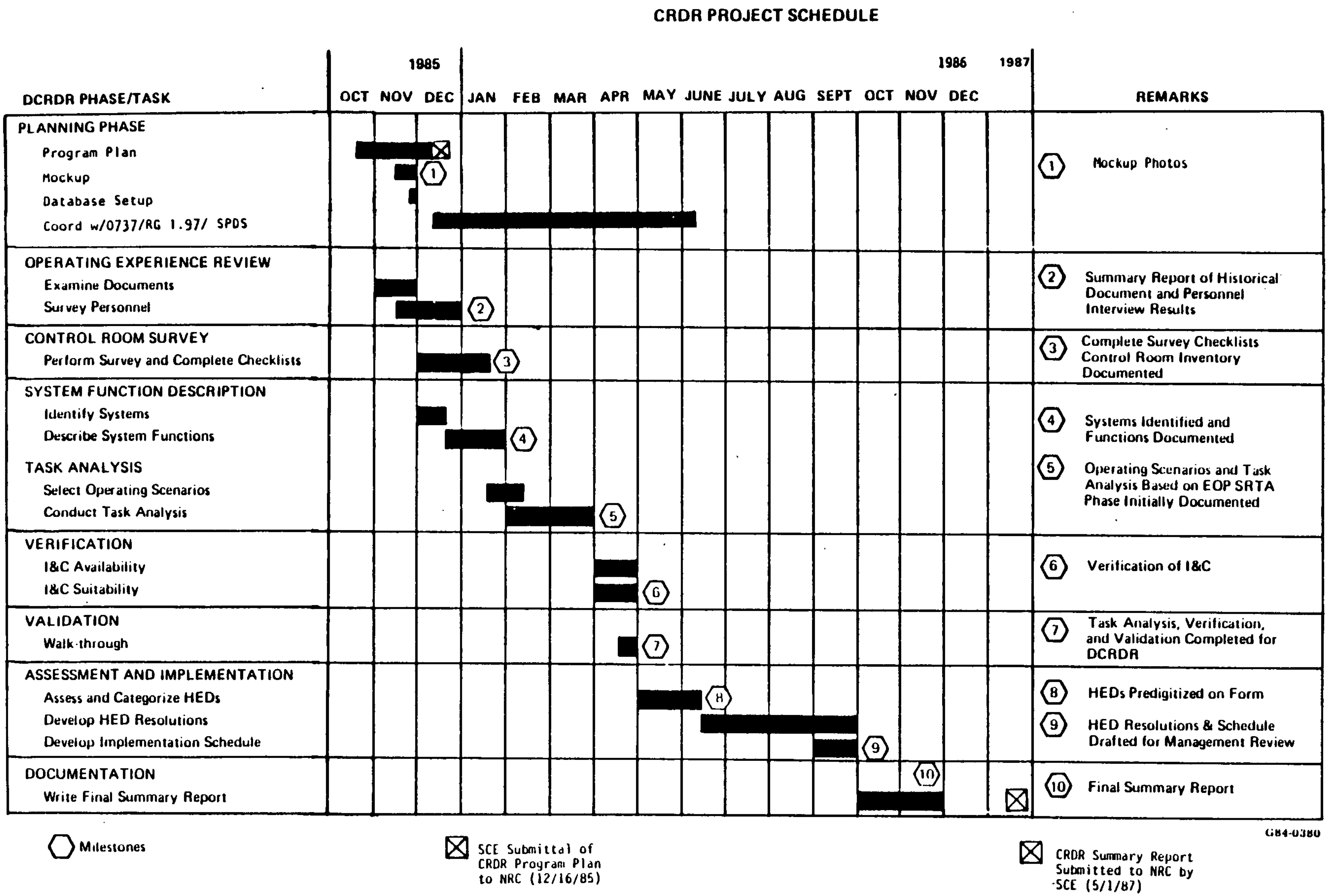

Figure 4. CRDR Project Schedule

3. REVIEW PHASE

3.1 Review Phase Processes

Six major processes discussed in NUREG-0700 will be used to establish and apply benchmarks for identifying HEDs of both Control Room completeness and its human engineering suitability:

- Operating Experience Review
- Control Room Inventory
- Control Room Survey
- System Function Review and Task Analysis
- Verification of Task Performance Capabilities
- Validation of Control Room Functions

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

3.2 Operating Experience Review

3.2.1 Purpose

The Operating Experience Review will 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 at SONGS-1 and at similar plants.

3.2.2 Methodology

There are two major steps in the Operating Experience Review: a Historical Documentation Review and Operator Interviews. The methodologies for both tasks are described below.

a. Historical Documentation Review

LERs, SIRs, SPRs, and NCRs for SONGS-1 will be reviewed to identify deficiencies known to have previously contributed to operator errors. This review will consist of the following steps:

1) Obtain documentation.

2) Examine LER, SIR, SPR, and NCR documentation and summarize the circumstances and events that are associated with the Control Room problem noted in the documentation. An Historical Documentation Review Summary form, similar to Figure 5, will be used to summarize and document Control Room human factors problems identified in historical reports. The form will provide information concerning the event itself, an indication of what actions have been taken to resolve the problem, and additional human factors recommendations. A Control Room problem is defined as one in which:

   a) The equipment referenced in the LER, SIR, SPR, or NCR is located in the main control room or remote shutdown panels.

   b) The procedure referenced is used within the main control room or remote shutdown panels.

   c) The personnel error occurred using main control room or remote shutdown panel components.

3) The CRDR Team will review the completed Historical Review Results forms to determine applicability to SONGS-1. All applicable Control Room problems from the Historical Documentation Review will be documented as HEDs.

SONGS-1 CRDR
HISTORICAL DOCUMENT REVIEW
LER HED REVIEW SUMMARY

LER __________ Other (Specify) __________

Report Number: Report Date: Occurrence Date:

Error Categorization: Work Station:

Instruments Involved: Procedures Involved:

Major System Involved:

Identification of Occurrence:

Summarize Events Preceding Occurrence:

Summarize Events During Occurrence:

Identification of Probable Cause:

Corrective Action Taken/Proposed:

Additional Recommendations:

Figure 5. Historical Documentation Review Summary

b. Operator Interviews

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

The steps for conducting operator interviews are:

1) Distribute confidential questionnaires to at least 50% of licensed operations staff. The HFC will distribute and evaluate the questionnaires to ensure uninhibited responses.

2) Assimilate questionnaire responses and develop interview format based on responses.

3) Conduct follow-up interviews with approximately half of the questionnaire respondents. If possible, conduct interviews in the Control Room (or mock-up) so that interviewees can refer to the control boards to explain in detail the types of concerns or problems they have encountered. Again, the HFC will take the lead in this activity to prevent peer and/or management pressure from influencing responses.

4) The CRDR Team will review data to ascertain whether the concerns encountered are HEDs.

5) Document HEDs on an HED form.

3.3 Control Room Inventory

3.3.1 Purpose

The purpose of a Control Room Inventory is to provide a current listing of all instruments, controls, and equipment in the control room that the operators interface with during the course of their assigned activities. The information and control requirements developed from the task analysis is compared with the control room inventory to determine whether the I&C needed to support SONGS-1 emergency operations are available in the Control Room.

3.3.2 Methodology

Utilizing a full-size photographic mock-up, an inventory of all the equipment on the control panels will be performed. The inventory will consist of data, in the form of equipment characteristics, that will be entered on an Equipment Characteristics form (see Figure 6). This form will comprise the inventory control documentation.

The following types of inventory data will be transfered onto the equipment characteristics form; the numbers in the list correspond to the numbers of the data input areas on the form:

1. Panel I.D. - the specific panel identification code. It can be a letter code or number code.

2. Reviewer and Date - the name of the person filling out the equipment characteristics form and the date it was performed.

3. I&C Description - this is the noun name description of the instrument or control as it appears on the panel. The parameter measured should be included as the last part of the I&C Description where applicable.

4. I&C Tag Number - this is the alpha-numeric identification code given to an instrument or control.

5. Instrument Type - this is either a switch, meter, recorder, controller, potentiometer, pushbutton, indicator light, etc.

6. Range - this is the meter range from minimum to maximum on the scale.

7. Units - the standard of measurement such as GPM, AMPS, INCHES, RPM, etc.

8. Divisions and Scale - the divisions are listed as major and minor graduations. The scale is either log or linear.

9. Control and Lights - for a control, list all of the switch positions (i.e., open-normal-close). For lights, list the color and its meaning when illuminated.

3.4 Control Room Survey

3.4.1 Purpose

The purpose of the Control Room Survey is to identify characteristics of I&C, equipment, physical layout, and environmental conditions that do not conform to precepts of good human engineering practice, regardless of the particular system or specific task requirements. This survey is accomplished by conducting a systematic comparison of existing Control Room design features with documented human engineering guidelines. The ultimate objective is to identify potential enhancements and modifications of the operator-Control Room interface that will reduce the potential for human error.

3.4.2 Full Scale Photographic Mock-up for Control Room Survey Task

The first task in the control room survey is to construct a full-size mock-up of the SONGS-1 control room operator control panels and consoles.

EQUIPMENT CHARACTERISTICS

Panel ID: ____________

Reviewer: ____________

Date: ____________

I & C Description and Parameter	I & C Number	Inst. Type: SW/Meter/ Recorder/Controller	Range	Units	Divisions: Major/Minor Scale: Log/Linear	Control: SW Positions Lights: Color/Meaning

Figure 6. Equipment Characteristics Form

3.4.3 Methodology

The Control Room Survey will be performed using the guidelines contained in NUREG-0700 "Guidelines for Control Room Design Review".

Some checklist items will be addressed on a control room-wide basis such as items that fall into the categories of communications, process computer, control room layout, and environmental factors. Other items will be approached on a control room-wide basis first, and then panel-by-panel, such as the annunciator system and panel layout. Still other items will be evaluated component-by-component, and then for overall control room consistency, such as controls, displays, labels and location aids.

Finally, control and display functional grouping and integration are examined panel-by-panel. Control room operators or supervisors will be helpful at this stage given their detailed knowledge of the panels and their operations experience.

The major environmental items on the checklist, lighting and sound, will require specialized equipment and methodologies beyond the checklist itself. These items will be conducted in the actual control room.

The performance of the light survey consists of measuring the lighting characteristics of the SONGS-1 control room. These measures fall into two major categories: illuminance measurements, which measure the amount of light falling upon a surface or object, and luminance measurements, which measure the amount of light reflected from a surface or emitted from a source. Measurements will be taken per NUREG-0700 guidelines using calibrated instrumentation.

The performance of the sound survey consists of taking measurements of the noise characteristics of the control room. Integrated "A" weighted dB(A) measurements will be taken, and 1/3-octave measurements will also be noted including center frequencies from 250 Hz to 4000 Hz. Sound measurements will include ambient noise levels (where ambient noise is defined as background control room noise without the contribution of alarms, printers, or communications equipment), and annunciator alarm (or other warning device) levels. Other aspects of the control room environment, temperature, humidity, and wind velocity will also be measured using specialized instrumentation.

A team composed of human factors engineers and operations personnel will perform the control room survey in the SONGS-1 control room or in the mock-up for those guidelines that are applicable. The checklists are designed to include principles or explanatory statements followed by specific categorical or numerical statements that require a "yes" or "no" response. The procedure is to observe or measure, as required, and check compliance with each categorical or numerical statement. If compliance with a guideline is observed, it will be noted by checking the "yes" column of the guideline. An item that receives a "yes" response indicates that control room-wide compliance has been observed. If there is any instance of non-compliance, full or partial, the "no" box is checked, and a reference notation will be made as to where non-compliance occurred. A specific reason or reasons for non-compliance will be described in an adjacent space. The HED form (see Figure 7) is used to record non-compliances identified during the review phase.

The HED information will then be inputed into the CRDR Computer Database System. The system is used to store HEDs in a manner that will allow for efficient HED data retrieval, sorting, and manipulation.

The results of the control room survey will be data in the form of HEDs. These HEDs will be examined during the assessment and implementation phases of the CRDR project.

HUMAN ENGINEERING DISCREPANCY RECORD
SAN ONOFRE NUCLEAR GENERATING STATION--1

TE: HED NO.: 0

VIEWER: TRACKING STATUS: REVIEW PHASE

TA SOURCE: NONE

ECKLIST NO.:

NEL/WORKSTATION NO.

SCRIPTION OF DISCREPANCY:

COMMENDATIONS:

TION:

DCR# ISSUE DATE / /

TEGORY RATING:
PLEMENTATION SCHEDULE:

Figure 7. HED Form

3.5 System Function Review and Task Analysis

3.5.1 Purpose

The purpose of the system function review and task analysis portion of the Control Room Design Review is to determine the input and output requirements of the control room crew for emergency operation and to ensure that required systems can be efficiently and reliably operated under the conditions of emergency operation by available personnel. Westinghouse Owner's Group (WOG) System Review and Task Analysis documentation that has been used as a basis for developing the Emergency Response Guidelines (ERGs) will serve as one of the inputs to the plant-specific CRDR along with the ERGs themselves. The ERG guidelines have been developed to verify automatic actuations following a reactor trip or safety injection condition (Guideline E-0), to diagnose the plant condition with respect to event sequence (Guideline E-0), to diagnose the plant safety state (Guideline F-0), to recover the plant from an event sequence (remaining E Series Guidelines), and to restore the plant safety state (remaining F Series Guidelines).

3.5.2 Methodology

The activities which comprise the system function review and task analysis for the CRDR are shown in Figure 8. For clarity, the procedure for determining these input and output requirements is divided into the following two areas:

- Identification of systems and systems functions
- Identification and analysis of operator tasks

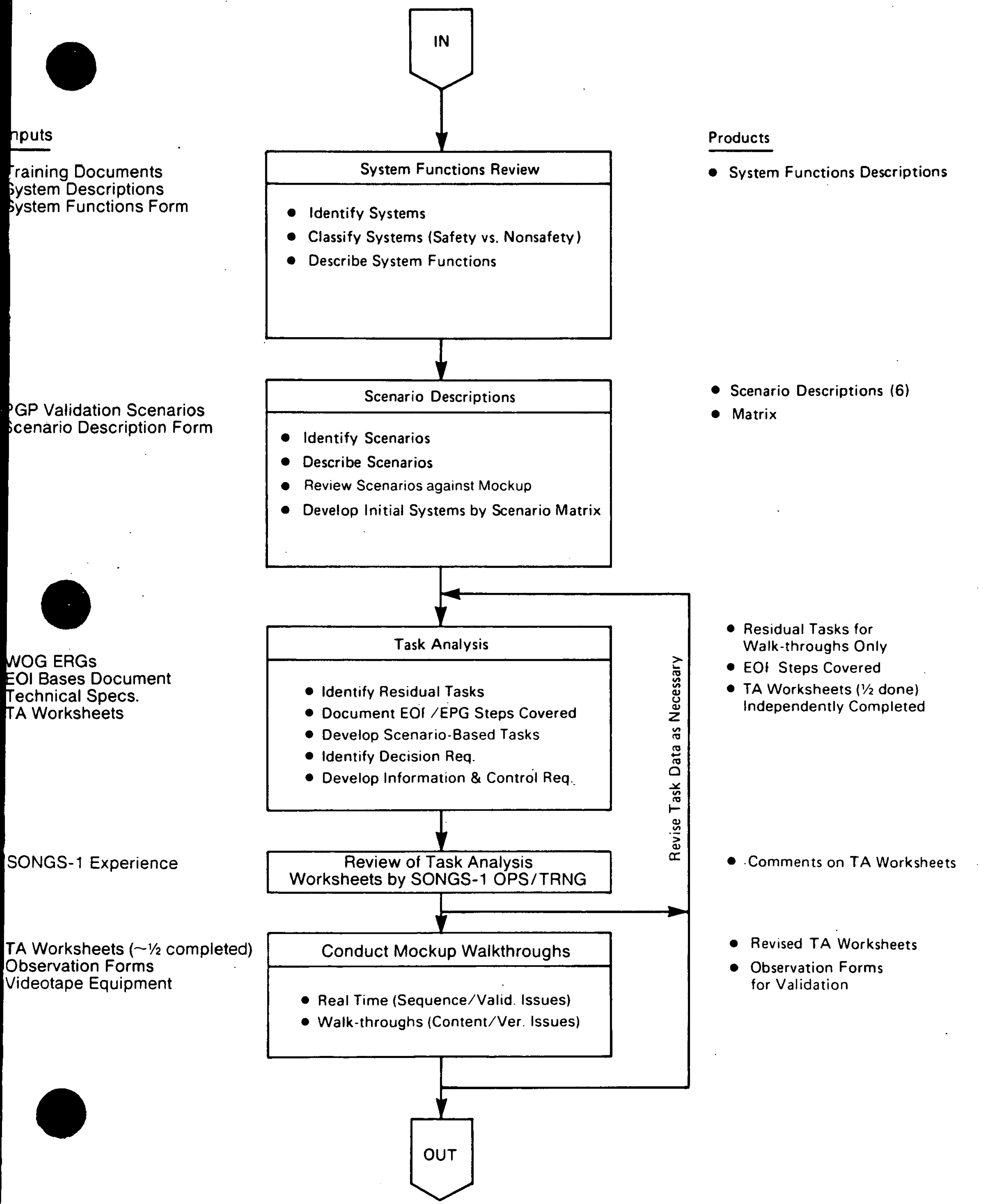

Figure 8. Systems Function Review and Task Analysis

G85-0935

3.5.3 Identification of System and System Functions

Plant systems and subsystems in the SONGS-1 control room that the operator must access and utilize during emergency operations will be identified. This set will be comparable to the safety and safety-related systems found in the WOG Emergency Response Guidelines. Existing plant documentation (e.g., SONGS-1 EOI Bases Documents and System Descriptions) relating to safety systems will serve as a prime information source. Descriptions of the functions for each of the systems identified above will be prepared. These system descriptions (see Figure 9) include:

- The function(s) of the system
- Under what conditions the system is used

The description of systems functions, in this manner, serves as a reference base for subsequent task analysis. In addition, the systems functions listing will be used to assist in the selection of operating scenarios.

3.5.4 Identification and Analysis of Operator Tasks

There are several steps to this phase of the Task Analysis effort. These steps are outlined in Figure 8 beginning with the step of defining representative scenarios for analysis. The steps are discussed briefly below. Each step below will be appropriately documented during the actual conduct of the CRDR.

a. Define Representative Scenarios The SONGS-1 safety and safety-related systems and function descriptions will be used to define a set of scenarios which adequately samples various emergency conditions and the plant systems and functions used in those conditions. The related SONGS-1 plant-specific EOIs will be identified as well in this step. A check will be performed to ensure that the desired systems and system functions

PLANT SYSTEM FUNCTION DESCRIPTION
SONGS-1

Plant System Name:

System Abbreviation:

System Number: System Status:

System Procedure References:

System Function(s):

Conditions for System Use:

Reviewer: Date:

Figure 9. Plant System Function Description

are exercised in the scenarios chosen. A brief narrative description of each scenario will be prepared that establishes the limits and conditions of the events to be analyzed. The descriptions will include:

- Procedures Used
- Initial Conditions
- Scenario Sequence
- Expected Response
- Termination Criteria

Residual operator tasks (unique tasks) from the plant-specific EOIs not covered in the scenarios will be analyzed independently for information and control requirements. The analysis of residual tasks will be done to ensure that all operator interfaces have been examined even if those interfaces are not exercised in the sample of emergency scenarios selected for validation. Verification of equipment availability and suitability will be performed for these residual tasks as well as for tasks embedded in the emergency scenarios.

b. Develop Task Analysis Worksheet A Task Analysis Worksheet will be developed and used to collect task performance data and other information needed for the CRDR. The worksheet will (see Figures 10, 11, and 12) indicate the operational steps required in each scenario, along with the appropriate information and control requirements, means of operation, and I&C present on the control boards. The operator tasks will be analyzed using the selected plant-specific EOIs as a starting basis and documented in the following manner.

1. The discrete steps in the plant-specific EOIs in order of performance will be recorded in the "Procedure Number and Step Number" column of the Task Analysis Worksheet and branching points noted, depending on the plant transient being analyzed, in the "Scenario Response" column.

2. A brief description of the operator's tasks (in order of procedural steps) will be recorded in the "Tasks/Subtasks" column of the Task Analysis Form. All tasks, both explicit and implicit, will be documented using operations, engineering, and human factors personnel.

3. The operator decisions and actions that are linked to task performance are then recorded in the "Task Decision Requirements" and "Task Action Requirements" column, respectively. System functional response is described when appropriate in these columns. This set of data also includes branching points in the EOIs that determine the outcome of the operating sequence.

4. Input and Output requirements for successful task performance are recorded in the "Information and Control Requirements" columns. These would typically be system component and parameter, relevant characteristics, and procedural information that is necessary for operators to adequately assess plant conditions or system status (e.g., hot leg temperature, reactor coolant system flow, pressurizer pressure, etc.). Specific values for parameter readings or control characteristics (i.e., closes-open, off-auto-on) will be recorded based on EOIs, EOI Bases documents, and Technical Specifications.

It is important to note that Steps 1 through 4 are completed on the Task Analysis Worksheet using <u>independent</u> sources of data other than the actual I&C present in the control room.

Page ____ of ____

Scenario ____________

TASK ANALYSIS WORKSHEET

Procedure Number and Step No.	Task/Subtask	Scen Resp	Crew Memb	Loc	Task Decision Requirements	Task Action Requirements

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Figure 10. **Task Analysis Worksheet**

Procedure Number and Step No.	Information and Control Requirements		I&C Identification			Verification		Fox 3		Comments/Candidate HEDs
	System Components/Parameter	Relevant Characteristics	Means	No	Panel	Avail.	Suit	Y	N	

Figure 11. Task Analysis Worksheet (continued)

G85-0935

1. **SCENARIO** - operating scenario name and identifier (ID).

2. **PROCEDURE NO. AND STEP NO.** - procedure step number for SONGS-1 EOIs (Emergency Operating Instructions).

3. **TASK/SUBTASK** - a description of the crew member task/subtask in the operating sequence

4. **SCEN.RESP.** - a notation designating decision points or branching information needed for correct task execution for the operating scenario (as defined in the operating scenario description).

5. **CREW MEMBER** - the crew member who performs the task.

6. **LOC** - the location where the task is performed.

7. **TASK DECISION REQUIREMENTS** - operator decisions that are linked to task performance.

8. **TASK ACTION REQUIREMENTS** - operator action requirements for task performance.

9. **INFORMATION AND CONTROL REQ.** - the information and control requirements for successful task performance (derived independently of the actual I&C in the control room). (1) System Component/Parameter (2) Relevant Characteristics (type of component, range, units, positions).

10. **MEANS** - the actual means (e.g. switch, meter, etc.) used by operators to perform the task in the control room.

11. **I&C NO.** - the actual Instrumentation and Controls (I&C) number identified from the control room inventory.

12. **PANEL NO.** - the panel on which the control or instrument is located

13. **VERIFICATION (AVAIL/SUIT.)** - columns that indicate the availability and suitability of the Instrumentation and Controls (I&C) needed for task performance. These columns would contain a "yes" or "no" answer.

14. **FOX** 3 - the presence or absence of the I&C and associated characteristics on the FOX 3 Computer is noted in the "Y" and "N" columns.

15. **COMMENTS** - any comments related to scenario execution, task performance, or the accompanying task requirement columns (the balance of the task analysis worksheet).

Figure 12. Task Analysis Worksheet Fields (Columns) Definitions

The remaining columns of the Task Analysis Form will be utilized during the Verification and Validation (V&V) phases which are described below:

5. Once the Tasks, Decision Requirements, and Information and Control requirements have been specified, the existing Instrumentation and Controls (I&C) that the operator uses or can use for each procedural step will be documented based on the control room inventory. All I&C needed or available to either (1) initiate, maintain or remove a system from service, (2) confirm that an appropriate system response has or has not occurred, i.e., feedback, or (3) make a decision regarding plant or system status, will be listed in the "Means", "I&C No." and "Panel" columns. The "Means" column refers to how the information and control requirements are presented on the existing control boards (e.g., switch, meter, etc.). The "I&C No." column provides the specific identification number of the control or instrument. The "Panel" column provides the specific panel number the control or instrument is located on.

6. Verification column (used during V&V phase)

   - "Availability" of the necessary I&C required for successful operator task performance is noted by a **"Yes"** or **"No"** in this column.

   - "Suitability" of the existing I&C to meet the postulated information and control requirements for operator tasks is noted by a "Yes" or "No" in this column.

7. FOX 3 (used during V&V phase)

   San Onofre Unit 1 currently has a technical data display and transmit system (FOX 3 Computer) that allows persons in the TSC and EOF to receive plant status information during an emergency condition. Although this system does not have a control room display, it will be reviewed during this phase of the CRDR to support a future analysis of its adequacy in fulfilling the SPDS function. During V&V, presence or absence of information and control requirements will be noted by "X-ing" either the "yes" or "no" columns.

8. Comments and Candidate HEDs

   Comments or candidate HEDs can be noted in this column during any step of the Task Analysis or V&V phases. Data for HEDs will be entered on a HED form and into the computerized database.

9. During the validation phase, the identification of which member of the operating crew is performing each task will be recorded in the "Crew Member" column.

10. During the validation phase, the Location of the crew member when performing the task will be recorded in the "Location" column.

The Task Analysis Worksheet thus serves as the complete record of operator tasks, decisions, information and control requirements, and I&C availability and suitability during the selected emergency operating sequences. This record is developed through the series of steps described above. All task data will be entered into the CRDR computerized database.

c. Conduct Walkthrough of Scenarios Using the appropriate Task Analysis Worksheets, human factors engineers will perform a walk-through of each scenario with SONGS-1 control room operators. During this walk-through the tasks required will be analyzed in terms of the presence of necessary instruments and controls or other equipment or job aids (the Verification of Task Performance Capabilities specified in NUREG-0700) and the suitability of equipment, job aids and control room design for reliable execution of the required tasks (the Validation of Control Room Functions specified in NUREG-0700).

Walkthroughs will be videotaped to fully document the tasks involved for all crew members and the candidate human engineering discrepancies which may arise. A complete description of the walk-through method is described in the validation process in Section 3.7. The task data is subsequently examined in both the verification and validation process described in the sections that follow.

An important element in the successful and accurate completion of the task analysis is the involvement of all disciplines (engineering, operations and human factors) in each of the steps above.

3.6 Verification of Task Performance Capabilities

3.6.1 Purpose

The purpose of the Verification of Task Performance 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 task performance

3.6.2 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 Worksheets will be confirmed. This will be done by comparing the postulated requirements in the "Information and Control Requirements" column of the Task Analysis Form to the actual control room I&C listed in the "I&C Identification" columns.

a. I&C Availability

The presence or absence of the required Instrumentation and Controls will be noted by a "Yes" or "No" 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 on an HED form.

A result of the verification of I&C availability will be a control room inventory listed in the task analysis worksheet columns, labeled "I&C Identification." The parameter, range, scaling units, and related information will be compiled on a separate inventory listing. A separate review of the I&C identified above will be done to verify that direct (rather than indirect) indications of parameters are provided.

b. I&C Suitability

The second phase will determine the human engineering suitability of the required Instrumentation and Controls by comparing them against the criteria shown on Figure 13. For example, if a meter utilized in a particular procedure step exists in the control room, that particular meter will be examined to determine whether or not it has the appropriate range and scaling to support the operator in the corresponding procedural step. If the range and scaling were appropriate, it will be noted by placing "Yes", in the "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, "No" will be written in the "Suitability" column of the Task Analysis Form. This type of occurrence will be defined as an HED and documented accordingly on an HED form. The suitability review of I&C will be performed by an operations expert and I&C engineer.

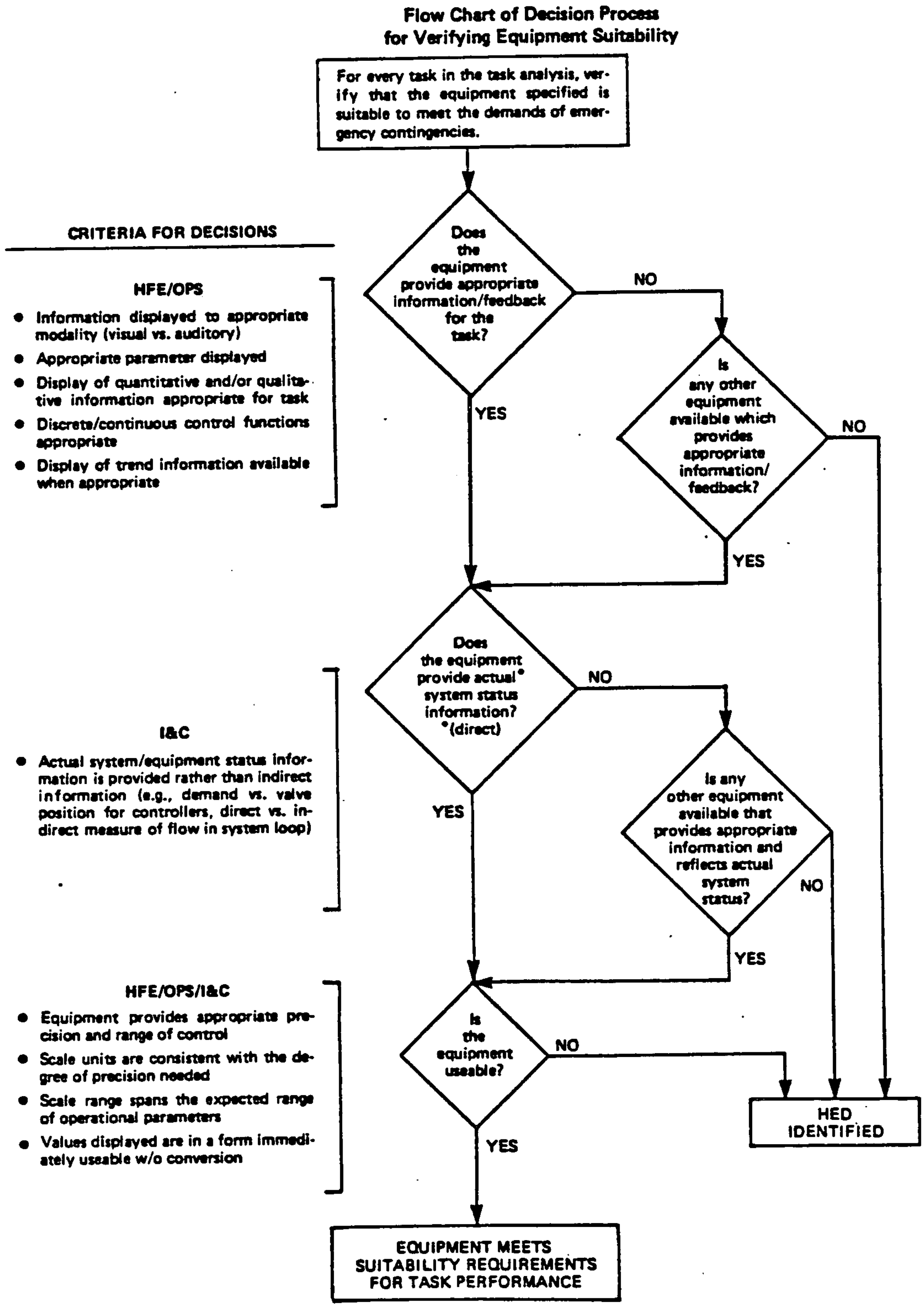

Figure 13. Flow Chart of Decision Process for Verifying Equipment Suitability.

3.7 Validation of Control Room Functions

3.7.1 Purpose

The purpose of the Validation of Control Room Functions step in the CRDR process is to determine whether the functions allocated to the control room operating crew can be accomplished effectively within (1) the structure of the SONGS-1 specific EOIs, 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 CRDR, for example in the control room survey.

3.7.2 Methodology

Utilizing the completed Task Analysis Worksheets, walk-throughs will be performed using a full scale photographic mock-up of the control room based on the symptom-oriented EOIs developed from the WOG ERGs. A normal complement of the SONGS-1 operating crew will be performing the walk-throughs.

The purpose of the walk-through is to evaluate the operational aspects of control room design in terms of control and display relationships, display grouping, control feedback, visual and communication links, manning levels and traffic patterns.

The operating crew will be provided with copies of the EOIs to follow as they are walking through the events. CRDR team members will use the partially completed Task Analysis Worksheets to record observations and potential HEDs.

One event at a time will be walked-through. Operators will perform the walk-through in slower than real-time to provide a relatively slow-paced rehearsal of the event. During the walk-throughs, the operators will be instructed to speak one at a time and describe their actions. Since this will force serial action, the operations will not be performed simultaneously.

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

The operators who performed the event will review the Task Analysis Worksheets along with human factor specialists. The operators will be asked to note any errors or problems that were encountered in the walkthroughs and to expound upon the source of the errors or problems. These errors or problems will be documented for investigation as possible HEDs. For each task, the following types of information will be recorded:

- An indication that the scenario response was accomplished will be noted in the "Scen. Resp." column.

- The identification of which member of the operating crew is performing the task. This was noted in the "Crew Member" column on the Task Analysis Worksheet.

- The location of the crew member when performing the task in the "Loc." column.

- A verification of the specific decisions and contingent actions that are associated with each operator task. This will include communications between and among crew members.
- A verification 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 "I&C Ident." column on the Task Analysis Worksheet.
- Comments related to verification or validation and potential HEDs.

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

Any dynamic performance problems that were uncovered during this phase of the CRDR process will be documented for review in the HED assessment phase of the CRDR.

3.8 Review Phase Documentation

All findings from the Review Phase will be documented on HED forms. The forms will contain a description of the findings as well as the source, panel, and instruments found discrepant from Human Factors Criteria. The HED forms will be maintained in the computerized DBMS for retrieval and update during the Assessment and Implementation Phase.

4. ASSESSMENT AND IMPLEMENTATION PHASE

4.1 Assessment Team

The Assessment Team is made up of members with the following specialties, backgrounds, experience, and responsibilities (see Figure 14):

- SCE CRDR Team Leader
- SCE Nuclear Engineering
- SCE Instrumentation and Control Engineering
- General Physics Human Factors Consultant
- A Senior Reactor Operator
- An NSSS Engineer

4.1.1 Assessment Methodology

The Human Engineering Discrepancies (HEDs) that are identified during the previous phase of the CRDR will be assessed by the assessment team through the following steps:

a. Utilizing the HED Assessment Criteria, Table 1, review the description on the HED form to verify that it is in fact an HED.

b. If the HED is deemed not to be an HED, Delete will be written across the top of the HED form and the rationale will be documented on the HED form in the Recommendations section. The form will then be filed in a Deleted HED file.

c. For HEDs not deleted, the procedure described in Table 2 will be used to perform the prioritization assessment of the HED. This categorization considers probability of error, safety significance, and Technical Specification conformance.

d. Formulate and describe alternative conceptual design improvements for correcting the HED.

e. Select the preferred conceptual design alternative.

f. The Assessment Team leader or his designee signs the HED form in the appropriate space, and transmits the HED form to the Evaluation Team for their review and action.

g. Meeting minutes are to be kept for all Assessment Team meetings.

Table 1 HED Assessment Criteria (Sheet 1 of 2)

1. Could the HED cause a unit trip or loss of equipment availability?

2. Could the HED result in personnel injuries?

3. Could the HED cause confusion, create difficulty for the operator, or cause him a problem?

4. Could the HED increase the operator's mental workload or distract him from his duties?

5. Could the HED hamper the operator's ability to see or read accurately or to hear clearly?

6. Could the HED cause a delay or degrade signal or information feedback to the operator?

7. Could the HED contribute to or make stressful situations worse?

8. Could the HED lead to the inadvertent activation or deactivation of controls?

9. Does the HED seem likely to cause a specific type of error?

10. Could the HED detract from the operator's ability to correctly or effectively manipulate the controls?

11. Will the HED contribute to operator discomfort or fatigue?

Table 1 HED Assessment Criteria (Sheet 2 of 2)

12. Could the HED degrade control personnel performance?

13. Can the HED actually be considered a defect?

14. Is the HED one of a larger group of similar HEDs that could have an adverse cumulative effect?

15. Does the HED violate conventions or practices followed in control rooms or by the nuclear industry?

Table 2 Categorizing and Establishing Priorities for Correction of HEDs
(Sheet 1 of 3)

A method of evaluating the importance or significance of individual HEDs and, based upon this, assigning a priority for their correction has been developed. This method is an approved, published means for normalizing random but rated variables, and is adapted from D. Meister's Human Factors Theory and Practice dated 1971.

Three factors were considered for relative importance and corresponding numeric value weightings were assigned using the following comparison matrix:

1.	Potential for Error	1
2.	Degree of Safety Importance	1
3.	Potential for Unsafe Condition or Technical Specification Violation	3

		First Pass Relative Weight	Readjusted Relative Weight
1.	Potential for Error	2/3 = 0.667	0.555
2.	Degree of Safety	0/3 = 0.000	0.167
3.	Potential for Unsafe Condition or Technical Specification Violation	1/3 = 0.333	0.278
		1.000	1.000

A scale to assign a relative magnitude to each individual factor was established as follows:

0	1	2	3	4	5
None	Very Low	Low	Moderate	High	Very High or Documented

Table 2 (Sheet 2 of 3)

The relative importance of each HED was then determined by employing the following formula:

Relative Weight of Factor 1 = W_1 = 0.555
Relative Weight of Factor 2 = W_2 = 0.167
Relative Weight of Factor 3 = W_3 = 0.278
Scale Magnitude of Factor 1 = M_1 = Variable *
Scale Magnitude of Factor 2 = M_2 = Variable *
Scale Magnitude of Factor 3 = M_3 = Variable *
$(W_1)(M_1) + (W_2)(M_2) + (W_3)(M_3)$ = HED Point Value

Where the higher the point value of the HED, the more critical is the need for correction.

* Each member of the Assessment Team will independently assess each HED using the scale above (0 = none to 5 = very high or documented) to determine the Scale Magnitudes of Factor 1, 2 & 3 (M_1, M_2, and M_3). Tables 3 and 4 will serve as guidance in this process. Then the members will meet as the Assessment Team to determine the consensus Scale Magnitude of Factors 1, 2, and 3 for each HED. Each member has an equal vote and simple majority rule prevails.

Example:

An HED that has resulted in a documented error of low safety importance, and having resulted in a documented Technical Specification violation would have the following calculated point value:

$M_1 = 5$
$M_2 = 2$
$M_3 = 5$
$(0.555)(5) + (0.167)(2) + (0.278)(5) = 4.499$

Table 2 (Sheet 3 of 3)

(By reference to the following table of HED point value ranges, this HED is placed in Priority Level 2 requiring prompt correction. This is the equivalent of the NUREG-0801 Category IB, which is also a Priority 2 prompt correction HED).

Based upon the HED point value totals, nine priority levels for correction were established in an approximate correspondence to the NRC's total number of categories as follows:

Priority Level for Correction	NRC Equivalent Category	HED Point Value Range	Category for Modification
1	IA	4.667 to 5.0	Prompt
2	IB	4.334 to 4.666	Prompt
3	IC	4.0 to 4.333	Prompt
4	IIA	3.5 to 3.999	Near-Term
5	III	3.0 to 3.499	Near-Term
6	IIB	2.5 to 2.999	Near-Term
7	ID	2.0 to 2.499	Near-Term
8	IIC	1.0 to 1.999	Long-Term (Mandatory)
9	IV	0 to 0.999	Long-Term (Optional)

CRDR Team Member

Identifies HED
Prepares HED Form

↓

HED Assessment Team (4 of 7)

CRDR Team Leader - J. Prickett (Chair)
SCE Nucl Licensing Engr - L. Bennett, J. Ibarra
SCE Instr & Controls Engr - P. Heil
Human Factors Consultant - L. Schroeder
Senior Reactor Operator - W. McGhee
NSSS Engr - R. Danna

Performs Review
Determines if HED should be HED
Establishes Correction Priority
Formulates Alternative Corrections
Recommends Corrective Action

↓

HED Evaluation Team (5 of 9)

SCE Sta/Tech - T. Herring (Chair)
SCE Sta/Operations - W. McGhee
SCE Sta/Training - M. Kirby
SCE Sta/Station Tech Advisor - M. McKinley
CRDR Team Leader - J. Prickett
SCE Instr & Controls Engr - P. H. Heil
SCE Nucl. Engr. - J. Ibarra
Human Factors Consultant - L. Schroeder

Reviews Assessment Findings
Confirms/Rejects Assessment Recommendation
Endorses Recommendation/Resolves
Differences/Overrides Recommendation

↓

Site Change Committee

Station Manager - H. E. Morgan
Manager of Nuclear Gen. Services - D. E. Nunn
Deputy Station Manager - M. A. Wharton
Operations Manager - R. W. Kreiger
Project Manager Unit 1 - M. P. Short
Manager Common Facilities - M. H. Sollberger
Station Technical Manager - J. Reilly
Maintenance Manager - D. E. Shull

Approves/Rejects Recommendations
Authorizes/Rejects Corrective Action
Considers Cost/Schedule Factors

↓

SCE Executive Approval

V.P. and Site Manager
H. B. Ray

Overall Budget/Cost Trend Approval

Notes:

1. A HED may be processed with a majority of team members present.
2. Each team member has one equal vote.
3. Delegated replacements may participate instead of team members.

Figure 14. Organization Chart for HED Processing

Table 3 HED Potential for Error Assessment Criteria
(Modified from NUREG-0800)

To what extent do you agree with the following?

1. This discrepancy will cause undue operator fatigue.
2. This discrepancy will cause operator confusion.
3. This discrepancy will cause operator discomfort.
4. This discrepancy presents a risk of injury to control room personnel.
5. This discrepancy will increase the operator's mental workload (for example, by requiring interpolation of values, remembering inconsistent or unconventional control positions, etc.).
6. This discrepancy will distract control room personnel from their duties.
7. This discrepancy will affect the operator's ability to see or read accurately.
8. This discrepancy will affect the operator's ability to hear correctly.
9. This discrepancy will degrade the operator's ability to communicate with others (either inside or outside the control room).
10. This discrepancy will degrade the operator's ability to manipulate controls correctly.
11. This discrepancy will cause a delay of necessary feedback to the operator.

Table 3 HED Potential for Error Assessment Criteria (continued)

12. Because of this discrepancy the operator will not be provided with positive feedback about control tasks(s).

13. This discrepancy violates control room conventions or practices.

14. This discrepancy violates nuclear industry conventions.

15. This discrepancy violates societal stereotypes.

16. Operators have attempted to correct this discrepancy themselves (by self-training, temporary labels, "cheaters," "helper" controls, compensatory body movements, etc.).

17. Tasks in which this discrepancy is involved will be highly stressful (i.e., highly time constrained, of serious consequence, etc.).

18. This discrepancy will lead to inadvertent activation or deactivation of controls.

19. If this discrepancy causes a specific error, it is probable that another error of equal or more serious consequences will be committed.

20. This discrepancy is involved in a task which is usually performed concurrently with another task (e.g., watching water level while manipulating a throttle valve control).

Table 4. HED Plant Impact Assessment Criteria

To what extent do you agree with the following:

1. This discrepancy involves controls or displays that are used by operators while executing emergency procedures.

2. It is likely that the error caused by this HED would result in:

   a. A violation of a technical specification, safety limit, or a limiting condition for operation

   b. The unavailability of a safety-related system needed to mitigate transients or system needed to safely shut down the plant.

3. This discrepancy involves controls or displays that are part of an engineered safety function or are associated with a reactor trip function.

4. This discrepancy involves control or display problems that would not be readily identified or corrected by alarms, interlocks, or other instruments.

4.2 Evaluation Team

The Evalaution Team is made up of representatives from the following: (see Figure 14)

- SCE Station Engineering/Technical
- SCE Station Operations
- SCE Station Training
- SCE Station Shift Technical Advisor
- SCE CRDR Team Leader
- SCE Instrumentation and Controls Engineer
- SCE Nuclear Engineer
- General Physics Human Factors Engineer

All participants have an equal vole and simple majority rule prevails.

4.2.1 Evaluation Methodology

The second phase in the processing of an HED is the responsibility of the Evaluation Team that processes it through the following steps:

a. Review the HED documentation for validity and prioritization

b. Review the recommended conceptual design improvement and consider the practical acceptability of the recommended correction including the degree of difficulty and schedule aspects of the recommended solution.

c. Endorse the recommendations of the Assessment Team or discuss and resolve disagreements. If agreement cannot be reached, the Evaluation Team has the prerogative to document the disagreement and make its own recommendation on the HED form.

d. The Evaluation Team chairman or his designee signs the HED form.

e. The evaluated HEDs that include the recommended conceptual design changes are transmitted via Station Technical to the Site Change Committee for Management approval (see Figure 14) and authorization of corrective action.

4.3 Site Change Committee Methodology

The third phase in the processing of an HED is the responsibility of the Site Change Committee (SCC). The Evaluation Team initiates recommendations for actions to correct HEDs based upon the conceptual designs by the use of Work Requests (WR). The work request is processed through the Station Technical Department that reviews and approves it for technical evaluations, studies, designs, or engineering related matters. The SCC evaluates work requests utilizing criteria relating to safety, compliance, technical specifications, cost benefit analysis, operation and ALARA. They also have the overall responsibility and authority to review and accept or reject the scope, priority, budget category, and schedule of plant work requests. If the SCC rejects the CRDR recommendation, the Evaluation Team will determine if an acceptable, alternate, remedial measure can be recommended. If this is possible, the revised recommendation will be presented to the SCC. If the SCC disapproves of all proposed recommended corrective actions for an HED, the reasons will be documented by the Evaluation Team on that HED form and the HED will be considered closed.

Before a corrected HED can be closed, a review is conducted by the HED Evaluation Team to validate that the corrective action did not create a new HED.

4.4 Assessment of Cumulative Effect of HEDs

Individual Priority 9 HEDs (equivalent to NUREG-0801 Category IV) will be reviewed by the CRDR team. The potential cumulative or interactive effects of these HEDs will be examined by sorting them on the basis of panel/system using the computerized database management system. The HEDs will then be reviewed on a panel/system basis to determine (1) how many Priority 9 HEDs exist and (2) the extent to which they cumulatively increase the potential for error on that panel/system.

In those instances where there are more than three (3) Priority 9 HEDs per panel, the similarity of those HEDs will be assessed. If the HEDs are similar in either operation of the system, checklist area, or in human performance modality (e.g., all visual and auditory modality), the HEDs will be considered to have a potential interactive effect. The CRDR Team Leader will then have the HEDs reevaluated using the methodology in Table 3.

4.5 Implementation Schedule

The development of a schedule to correct HEDs is based on category assigned, complexity of modification, additional engineering study requirements, resource requirements, engineering and equipment lead time requirements, plant scheduling constraints, and the Integrated Living Schedule (ILS) covered in Section 6.

The Summary Report submitted to the NRC upon completion of the CRDR will outline proposed control room changes with estimated schedules for implementation as required by NUREG-0737, Supplement 1.

5. REPORTING PHASE

5.1 Reports

At the end of the project, the actual methods used in each phase will be fully documented. Reports will be prepared for:

1. Operating Experience Review
2. Control Room Survey
3. Task Analysis
4. HED Assessment

These reports will be contained in the SONGS-1 Project Files.

5.2 NRC Final Summary Report

At the completion of the CRDR, a final report will be prepared for submittal to the NRC in accordance with NUREG-0737 Supplement 1. This report will document in summary form the processes and activities utilized in the CRDR. Any departures from the methodologies described in this Program Plan will be noted and justified.

The final report will summarize the results of the CRDR review process. The HEDs that were identified during the Operating Experience Review, the Control Room Survey and the Task Analysis will be included along with the recommendations for correction and/or resolution for each HED. A proposed schedule for completion of the modifications to correct HEDs will be included.

5.3 Documentation Storage

The CRDR Team Leader will be responsible for storing and/or distributing all CRDR documentation so that it is:

- Readily auditable by the NRC
- Readily accessible for future reference and use by SCE

6. PROGRAM INTEGRATION

6.1 General Comments

The CRDR process is one part of an overall program to provide Control Room improvement and Control Room operator ERC. Effective Control Room emergency operations are dependent on a complete analysis of all Control Room functions and operator needs during an accident.

6.2 CRDR Integration with Other ERC Programs

SCE's letter to the NRC of April 23, 1985, provided the integrated plan to respond to the NUREG-0737, Supplement 1 initiatives at San Onofre Unit 1. Due to the current status of SCE's compliance with the Supplement 1 initiatives, the actions necessary to complete our response to Supplement 1 focus on the control room enhancement oriented initiatives (i.e. CRDR, R.G. 1.97, and SPDS). The CRDR will be the focal project, and as stated in the April 23, 1985, the remaining initiatives will feed into and extract from the CRDR as appropriate. The final report that is scheduled for submittal to the NRC on May 1, 1987 will include the final modification plans to resolve the CRDR related issues, the SPDS, and the R.G. 1.97 related issues. Any modifications necessary to resolve these issues will be incorporated into the Integrated Living Schedule (ILS) for backfits. The organization/division of these projects that are incorporated into the ILS will depend upon the nature of the backfits presented in the final report.

A discussion of our plans for the SPDS and R.G. 1.97 are presented below.

Safety Parameter Display System (SPDS)

By letter dated October 17, 1979 SCE responded to NUREG-0578, Item 2.2.2.b, Onsite Technical Support Center, in which it was stated that a Technical Data Display and Transmit System would be installed in the Technical Support

Center (TSC). By letter dated July 1, 1981, the NRC was provided with the design description of the above mentioned system and indicated that it also contains the capability to transmit the data, via modems, to the offsite Emergency Operations Facility (EOF). This data display and transmission system, currently installed, is not intended to comply with the requirements for an SPDS.

As stated above in the description of the SPDS current status at San Onofre Unit 1, SCE currently has a technical data transmission system that allows the persons in the TSC and EOF to receive plant status information during an emergency condition. However, the current system has not been evaluated to determine its adequacy in fulfilling the SPDS function and, due to space constraints, it does not currently have a control room display. Since the technical data transmission capability is available, the SPDS criteria development will be delayed until the role of the SPDS in resolving control room HED's, is established as part of the CRDR. Therefore, the completion date of SPDS design criteria development cannot be completed until the HED resolution phase of the CRDR.

The SPDS design criteria when developed will utilize the SONGS 1 upgraded EOI's to establish the Critical Safety Functions (CSF's) for the SPDS. The design criteria will specify the role of the SPDS, the intended users of the SPDS, the selection of location for the SPDS and specify the availability of the hardware.

Regulatory Guide 1.97

Regulatory Guide 1.97 (Rev. 2) was issued in December, 1980 and has been implemented at SONGS 1 only where appropriate as a design criteria for instrumentation backfits required to respond to NUREG-0737 requirements. The balance of the accident monitoring capabilities described in Regulatory Guide 1.97 (Rev. 2) have not been committed for SONGS 1.

A plant-specific response has been developed which specifies the scope of instrumentation necessary to provide information to allow the operators to (1) take the necessary preplanned actions to accomplish safe shutdown of the plant, (2) ensure accomplishment of critical plant safety functions, and (3) monitor the release of radioactive materials and implement the radiological dose assessment actions of the offsite Emergency Plan. The existing plant instrumentation will be evaluated against the above discussed plant-specific list utilizing the design criteria of Reg. Guide 1.97. Deviations from Reg. Guide 1.97 design criteria will be justified or resolved with the modification plan that will be provided in the May 1, 1987 final report.

APPENDIX A

BIBLIOGRAPHY

BIBLIOGRAPHY

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NUREG-0899, "Guidelines for the Preparation of Emergency Operating Procedures," August 1982.

NUREG-1000, "Generic Implications of ATWS Events at the Salem Nuclear Power Plant," April 1983.

NUREG/CR-1250, "Three Mile Island: A Report to the Commission and to the Public," January 1980.

Regulatory Guide 1.97, Revision 2, "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions during and following an Accident," December 1980.

NUREG-0800, Section 18.1, Appendix A, "Evaluation Criteria for Detailed Control Room Design Reviews, U.S. N.R.C. Standard Review Plan, Sept. 1984.

APPENDIX B

CRDR TEAM MEMBER RESUMES

LAWRENCE A. BENNETT

EDUCATION:	University of Nebraska - Lincoln Bachelor of Science in Chemical Engineering Degree Received 1980
EXPERIENCE: **1981-Present**	Southern California Edison Company - Rosemead, California Nuclear Engineering, Safety and Licensing Department. Licensing Engineer - San Onofre Unit 1. Duties include the preparation of license amendments and NRC submittals pertaining to the continued safe operation of San Onofre Unit 1. Responsible for interface and direction to other SCE groups, procurement of and direction of A/E and consulting services to SCE, and provide budget coordination of all assigned tasks. Assigned as lead engineer on significant issues such as SCE's responses to Post-TMI Requirements, Control of Heavy Loads at Nuclear Power Plants, Supplement 1 to NUREG-0737 - Requirements for Emergency Response Capability, various SEP Topics, and recently, Steam Generator related licensing.
Sept. 1980 **to** **Sept. 1981**	Omaha Public Power District - Omaha, Nebraska Generating Station Engineering Division Engineer - Nuclear Department. Duties encompassed engineering design and design review for modifications to fossil and nuclear power stations. Responsible for preparation of work orders, purchase specifications, contract documents, startup procedures, system descriptions, and safety analysis. Review design work being performed by A/E firms. Provided economic analyses, evaluation, justification, and budget coordination of all assigned tasks.

PAUL H. HEIL, P.E.

EDUCATION:	BSEE, Iowa State College, Ames, Iowa, 1951	
Summary:	Present:	SONGS 2 and 3 Control Room Design Review (CRDR) - SEC Engineering and DCRDR HED Evaluation Team member
	17 years:	Electric Utility Industry experience in power and I&C systems design.
	10 years:	Nuclear Power Plant design, test and start-up.
	17 years:	Design, construction and operation of I&C systems for large rocket engines, spacecraft and jet engine development-test facilities.
	10 years:	Supervising Engineer for control system design group on SONGS 1, 2 and 3.

EXPERIENCE:

Southern California Edison - Supervisory responsibility for Instrumentation and Controls design group for SONGS 1, 2, and 3. Directed group of design engineers on the SONGS 1 Standby Power Additions (SPA) and Sphere Enclosure major modification projects. Design coordination for SONGS 2 and 3 with extensive involvement in TMI related backfits such as R.G. 1.97, CRDR, Emergency Feedwater systems, Emergency Procedures, SPDS, etc.

ITT Barton - Senior I&C Engineer responsible for seismic and environmental qualification of controls and instrumentation (proprietary products) for nuclear power plant application.

Aerojet General - Aetron Division - Design, layout, installation and start-up for large test facilities. Required adherence to military specification for vibration, environmentnal and human factors (CR 1580) aspects. As a subcontractor with Litton Industries, participated in design of centralized engine room controls for the LHA (Landing Helicopter Assault) ships. Responsible for conceptual layout and control system aspects for reliability analysis on the Navy destroyer (DD 963) program. Adherence to miliary specifications for shock, vibration, human factors considerations and environmental were required.

North American - Rocketdyne - Responsible for facility design, construction, checkout and operations of large space program engines. Lead responsibility for static operational firing and data gathering. Filled in as operator and trainer during development phases.

EXPERIENCE: (Continued)

Allis Chalmers - Responsible for start-up and field service for a wide variety of equipment manufactured for the electric utility industry. Equipment included, steam turbines, generators, large motors, switchgear, transformers and related controls.

PROFESSIONAL AFFILIATIONS:

Member, Institute of Electrical and Electronic Engineers (IEEE)

Member, IEEE Nuclear Power Engineering Committee (NPEC) SC-6 subcommittee responsible for IEEE standards writing related to Nuclear Safety Systems.

Registered Professional Engineer (Electrical), California

PUBLICATIONS:

P. Heil, principal author, "Automatic Termination of a Protective Action" (Subcommittee 6 of NPEC Technical Paper on the Application of IEEE 603 - 1980). IEEE Publication No. 85 SM 440-3.

JOSE G. IBARRA

EDUCATION:

BS Electrical Engineering, New Mexico State University, 1975
18 Semester Credits toward MBA, University of Nevada/Las Vegas
Nuclear Reactor Safety, Summer Course, Massachusetts Institute of Technology, 1979
Man-Machine Interface, Summer Course, Massachusetts Institute of Technology, 1980

SUMMARY:

Present: Nuclear Systems Engineer - Supported the CRDR effort for Units 2 and 3 in the Safety Function Task Analysis and the integration of NUREG-0737 Requirements. Member of the CRDR Project team for Unit 1 providing interface between human factor consultant and SCE.

3 Years: I&C Engineer in the Nuclear Engineering Organization providing, conceptual design, Nuclear Engineering support to plant modifications, and technical lead on several TMI Licensing issues.

1 Year: Startup Engineer at SONGS Unit 1, starting up several TMI Radiation Monitoring System Retrofits.

7 Years: Electronic Engineer doing system design for nuclear weapons testing at the Nevada Test Site.

4 Years: Consultant to the NRC on several Electrical and I&C Systems. Heave involvement with the TMI Short-Term Lessons Learned and TMI Implementation Plan.

3 Years: Satellite Tracking Operator and Instructor. Responsible for operations and maintenance of remote satellite tracking systems for worldwide coverage. Responsible for teaching station procedures and station maintenance.

EXPERIENCE:

Mr. Ibarra has over 14 years of experience in the design and application of instrumentation to the application of nuclear weapons research and the nuclear power industry. The last 8 years have been in TMI related issues first working with the NRC Staff and the last 3 years working as a Nuclear Engineer for Southern California Edison.

His present job of Nuclear Engineer with Southern California Edison involves doing conceptual designs and providing Nuclear Engineering input to plant modifications. He has provided the technical lead for Southern California Edison on the SPDS Safety Analysis and Regulatory Guide 1.97 compliance.

EXPERIENCE (continued)

Before the nuclear power industry, he was involved in nuclear weapons testing with the design of systems to record the prompt diagnostics in nuclear detonations. As an Electronic Engineer for Lawrence Livermore National Laboratory he designed state-of-the-art systems for nano-second resolution. Responsibilities included fielding the systems, and data analysis.

His nuclear power involvement was begun as a consultant to the NRC for the Electrical and I&C Systems branches. Tasks involved doing technical evalaution and the writing of the TER's. He was on loan to the NRC for a period of one year in Bethesda. During this time, he was the electrical representative on site inspection teams for the TMI Short-Term Lessons Learned Implementation. While on loaan, he also worked with the I&C Systems Branch in reviews of near-term licensees on the TMI Implementation Plan.

He did system startups at San Onofre Nuclear Generating Station Unit 1. He put into operations several of the TMI radiation monitoring systems. He interfaced extensively with the vendor and the project engineers in resolving the systems problems. Southern California Edison was the first utility to install several of the TMI radiation monitoring systems.

He was involved 3 years in worldwide satellite tracking operations both as an operaor and as an instructor. As an operator he was responsible for station operations and maintenance of the tracking systems. As an instructor he taught operation and maintenance procedures.

His satellite tracking operator experience has encouraged him to pursue the human factors interface interests. He has attended the MIT Human Factors Engineering summer course. He has attended human factors lecturers at the NRC Headquarters and in his pursuit of his MBA has concentrated on Organization Behavior courses. Since early in this year, he has been a member of the human factors task force preparing the 1985 control room design criteria. He provided support in the Accident Monitoring System, EOI Task Analysis and the Human Factors Control Room Survey for the Units 2 and 3 CRDR. Presently he is a project team member for the Unit 1 CRDR.

PROFESSIONAL AFFLIATION Instrument Society of America, Member

MICHAEL J. KIRBY

EDUCATION:	Orange Coast College - Costa Mesa Associate of Arts degree
EXPERIENCE:	
1975 - Present	Southern California Edison Company
1982 - Present	Nuclear Training Administrator - In charge of all aspects of operator training for SONGS Unit 1 (Non-Licensed, Licensed, STA, and Requal.)
1980 - 1982	Nuclear Training Instructor - Responsible for conducting classroom training for SONGS 1 operators (RO, SRO, and Requal.)
1975 - 1980	Operator SONGS 1 - Progressed from non-licensed operator to RO (11-76) to SRO (1-79) to Operating Foreman
1965 - 1973	U. S. Navy - Navy Nuclear Program, Mechanical Operator, Qualified EWS, and Prototype Instructor.

WILLARD MCGHEE, JR.

EDUCATION:	U.S. Navy Nuclear Power Training Program Reactor Operator License Training Program, San Onofre Nuclear Generating Station - Unit 1 Senior Reactor Operator License Training Program, San Onofre Nuclear Generating Station - Unit 1
LICENSES AND CERTIFICATIONS:	Reactor Operator License, San Onofre Nuclear Generating Station - Unit 1 Senior Reactor Operator License - San Onofre Nuclear Generating Station - Unit 1 U.S. Navy Nuclear Power Program - Reactor Plant Mechanical Operator - Engineering Laboratory Technician Southern California Edison Company San Onofre Nuclear Generating Station - Unit 1 - Nuclear Plant Equipment Operator - Nuclear Assistant Control Operator - Nuclear Control Operator
EXPERIENCE:	Member of the Control Room Design Review (CRDR) Project Team for Unit 1 Primary operations reviewer for various documents developed in response to (1) NUREG-0737, Supplement 1 issues, (2) Selected NUREG-0737 topic areas, and (3) 10CFR50, Appendix R, related issues. Member of the Westinghouse Owners Group Procedures Subcommittee.
July 1983 to October 1984	Project Manager for the San Onofre Units 2 and 3 emergency operating instruction upgrade utilizing the Emergency Response Guidelines developed by the Combustion Engineering Owners Group (CEOG). Developed the associated Procedures Generation Package (PGP). Member of the Combustion Engineering Owners Group (CEOG) Procedures Subcommittee.

April 1982 to June 1983	Participated as an author, reviewer, and Project Manager in the Unit 1 emergency operating instruction upgrade utilizing the Westinghouse Owners Group (WOG) Emergency Procedure Guidelines. Developed the associated Procedures Generation Package (PGP).
	Member of the Westinghouse Owners Group (WOG) Procedures Subcommittee.
June 1981 to March 1982	Supervised the development and implementation of the Unit 1 Operations Procedures Group which is responsible for the initiation and maintenance of all Unit 1 operating instructions.
December 1980 to May 1981	Nuclear Training Administrator - responsible for all aspects of operator training for Units 1, 2 and 3.
October 1977 to November 1980	Operating Foreman/Nuclear Training Administrator - responsible for all aspects of operator training for Units 2 and 3. Developed assigned procedural and system description documents.
April 1976 to September 1977	Completed Senior Reactor Operator training program, passed NRC examination, and received SRO license. Performed Nuclear Assistant Control Operator and Nuclear Control Operator duties.
June 1972 to March 1976	Completed Reactor Operator training program, passed NRC examination, and received RO license. Performed Nuclear Plant Equipment Operator and Nuclear Assistant Control Operator job duties. Qualified to perform Nuclear Control Operator job duties.
1965 - 1972	U.S. Navy -
	Completed Machinist Mate "A" School, Nuclear Power Program Basic and Prototype training, and Engineering Laboratory Technician (ELT) training.
	Performed Reactor Plant Mechanical Operator duties on the USS LONG BEACH CCN-9.
	Performed Engineering Laboratory Technician duties on the USS SAMUEL COMPERS AD-37.

JERRY L. PRICKETT

EDUCATION: B.S., Electrical Engineering, Tri-State University, 1956

Graduate courses taken:
Principles of Management, Organization/Human Behavior, Psychology, Computer Design, Data Processing

Other courses/training:
SCE - Supervisory sessions, Assertive Management, Conflict Management, Motivation and Leadership, Telemetry/Supervisory Control Systems, Combustion Engineering - Nuclear Reactor and Steam Supply System Course, Human Factors Engineering and Design Reliability.

DOD/U.S. Navy - Joint Chiefs of Staff/Armed Forces Staff College, Sr. Program Managers School for Systems Procurement and Logistics Control, Aircraft Instruments and Controls, Celestrial Navigation, Avionics Weapons, Surveillance Satellites and Data Acquisition Systems, Leadership and Command.

Summary:

Present:	DCRDR coordinator for SCE San Onofre Nuclear Generating Station, Units 2 and 3
5 years:	Special Projects Coordinator/Team Leader for numerous task groups, IEC systems at SONGS 2 and 3.
14 years:	Extensive supervisory and lead engineer positions in control systems and console design, installation and testing for several agencies like NASA, AEC, USAF, public utility and commercial projects, including the LM/FBR program at Hanford, Washington, and the George C. Marshall Space Flight Center at Huntsville, Alabama (NASA).
4 years:	Supervisory positions in operations/test for complex, heavily instrumented and computerized facilities (Aerojet - General and TRW Systems)
5years:	Commander/USNR - Program Manager of Avionics Weapons Systems Task Force efforts for Naval Air Systems Command Headquarters, Washington, D.C.

EXPERIENCE: Mr. Prickett is currently the Group Coordinator for the SONGS 2 and 3 Detailed Control Room Design (DCRDR) being completed at Bechtel Power Corporation in Norwalk.

JERRY L. PRICKETT
(Page Two)

EXPERIENCE: (Continued)

Prior to this, he has been the Special Project Leader for numerous task groups formed and directed by him for installation and testing at SONGS 2 and 3, including radiation monitoring, all computer systems such as plant computer, critical functions monitor, core protection computer, plant security, health physics, etc.

Previously, he was the Assistant Group Leader for the Kaiparowitz Project which included in-house design.

Before joining SCE, Mr. Prickett worked for Aerojet-General Corporation (AGC) and TRW Systems for 13 years as follows:

1971 - 1974: Supervisor, Electrical, Controls and Instrumentation Design Dept. for the FFTF (Fast Breeder) Project at Hanford, Washington. He was responsible for the formation and direction of engineering design department (12 Sr. Engineers and Designers) in the development of special power instruments, controls, video and communication systems design for numerous large test complexes like the AED, USAF, and NASA.

He was also involved in the development of design criteria, projected work plans, procurement specifications, and estimates, establishment of all drawing format and standards, control consoles, design and cabling distribution systems for remote handling of core components and fuel pin assemblies in a high radiation environment.

His related duties included customer and management presentations, design review meetings, mechanical design interface, and updating of detailed work plans.

Also, as Plant Electrical Engineer for a commercial firm in Detroit during a 4-year modernization program, he designed the power distribution system and numerous automatic processing systems.

1969 - 1971: Supervisor/Test Conductor for USAF Satellite Testing Facility (AGC, Azusa). He supervised all testing and maintenance for a multiple systems infrared satellite text complex consisting of a digital data acquisition and control system, a large hi-vacuum test chamber, and associated pumping systems, internal dual phase heating and cooling shrouds, and large optical alignment fixtures. His duties required an intimate knowledge of analog and digital

EXPERIENCE: (Continued)

data compression and transmission technique, computer software and peripheral equipment, hi-vacuum pumping systems and controls, infrared and optical systems and cryogenics.

In his capacity as Senior Engineering Specialist at ACC in El Monte, California, he assisted in proposal efforts for a liquified natural natural gas (LNG) facility by developing required instrumentation from a P&ID and generating a detailed process control instrumentation list consisting of full proportioning controllers, converters, transmitters, indicators and control panels and consoles. Also designed a fire detection system and an area lighting system for a large fuel storage facility.

1968 - 1969: Lead Instrumentation Engineer, TRW Capistrano Test Site, LEMDE Program. He was responsible for supervision and technical direction of the instrumentation and data acquisition systems for the LEMDE Static Fire Test Area. His coordinate duties included design of special instrumentation and control system requirements, transducer applications, proposal efforts, volatile gas flow measurement studies, and specification and bid evaluation.

1967 - 1968: Project Controls Engineer for the design of USAF satellite test facility. He designed all vacuum chamber I&C systems for testing complex satellite systems from $-280^{\circ}F$ to $+150^{\circ}F$ while under vacuum of 1×10^{-9} TORR.

1966 - 1967: Lead Control Systems Engineer/Consultant to CE Leam Siegler Facility (NASA), SI-C and SII stages for I&C system. He served as Technical Consultant to General Electric for redesign, installation and checkout of hydrogen gas and fire detection systems and proportional control systems for oxidizer and propellant loading, transfer, and storage systems for Saturn SI-C and SII Test Complex at the NASA Mississippi Test Facility, Bay St. Louis, Miss.

1963 - 1965: Resident Field Engineer, NASA/Saturn V Test Complex; Redstrone Arsenal, Huntsville, Alabama. He completed this job as Resident Manager. He responsible for the installation and checkout of I&C systems at NASA Test Facilities.

EXPERIENCE: (Continued)

1961 - 1963: Systems Design Engineer, NASA/Saturn V projects. He designed numerous automatic control and power distribution systems for the NASA Saturn V Test Complex at Marshall Space Flight Center. Complete design drawing packages included schematics, console and equipment fabrication drawings, control console and panel layout, and conduit and cable tray installations in conformance with NEC Code and NEMA Standards.

Prior position held was Project Engineer, Plant Engineering Department, Wolverine Tube Division, Calumet and Hecla, Detroit, Michigan. Mr. Prickett was responsible for all electrical projects in the plant during a 5-million dollar modernization program. He redesigned the primary power distribution system (eight - 1500 kVA Unit Substations, 4800/480V), automated several new processes, developed material handling systems, established preventive maintenance and nondestructive testing programs, and supervised subcontractor installation work and checkout.

Military: U.S. Naval Air Reserve/Active. He is presently assigned as Commander/Program Manager to Pacific Missile Test Center, Pt. Mugu, California, responsible for P3 Avionics Weapon System Projects. CMDR. Prickett directs efforts of three Project Managers and eight Project Officers on high visibility projects for the regular Navy.

He has held prior positions as Project Officer, Operations Officer, Flight Officer, Training Officer, Personnel Officer, Electronic Division Officer, and Navigation/Tactics Officer. He was formerly a Chief Petty Officer, Division Chief, and Instructor

PROFESSIONAL AFFILIATIONS: Rgistered Control Systems Engineer, California No. 808, June 1976 Member, Instrument Society of America (ISA) Member, Pacific Coast Electrical Association (PCEA) Member, Institute of Electrical and Electronic Engineers (IEEE) Sponsor, Instrumentation and Control (I&C) Group (1978-79)

GP

DONALD C. BURGY
Director, Human Factors Engineering

EDUCATION	Ph.D. Candidate, Applied-Experimental Psychology, Catholic University of America
	M.A., Applied-Experimental Psychology, Catholic University of America
	B.A., Psychology, Swarthmore College

EXPERIENCE
1979 - Present

General Physics Corporation

Special qualifications include human factors engineering, man-machine systems design and evaluation, information processing, display technology, man-computer interfaces, performance evaluation, training system development, and speech/non-speech. Applied research background includes an emphasis in auditory and visual perception methods, multivariate statistical analysis, mini/micro computer applications and software psychology.

Managed a major 18-month Nuclear Regulatory Commission (NRC) research program on nuclear power plant control room crew task analysis. A data collection approach and methodology used to conduct a task analysis of nuclear power plant control room crews was developed in this program. The task analysis methodology used in this project was discussed and compared to traditional task analysis and job analysis methods in a Program Plan report. The data collection was conducted at eight power plant sites by teams comprised of human factors and operations personnel. Plants were sampled according to NSSS vendor, vintage, simulator availability, architect-engineer, and control room configuration. The results of the data collection effort were compiled in a computerized task data base.

Additional task analytic experience has been for the Navy SUBACS (Submarine Advanced Combat Systems) program. The human factors aspects of the SUBACS project involved the development of task analysis formats and collection methodology for the Fire Control and Acoustic Subsystems in the early Concept

Development Phase. Team performance improvement and training enhancement were primary goals of the systems development effort.

Research and development experience has included two Electric Power Research Institute studies entitled (1) Survey and Analysis of Communication Problems in Nuclear Power Plants, and (2) Operability Design Review of Prototype Large Breeder Reactors. Methodology for collection and analysis of real-time field data in power plant control rooms was developed as part of the communications study. Function/Task analyses and operational sequence diagrams were generated as part of the operational design review that involved the evaluation of six breeder reactor designs in their early design phase.

Industrial experience in nuclear power plant control room reviews has included on-site field evaluations at River Bend, Indian Point 3, Hatch, North Anna, Surry, Zion, LaSalle, Susquehanna (Advanced Control Room Design), Zimmer, Shoreham Salem, and Trojan Stations. Evaluations have included the application of current NRC Human Factors Engineering guidelines and existing military standards (MIL-STD-1472C) to control room designs as well as field and laboratory experimentation to validate criteria used in design trade-off analyses.

1978 - 1979 <u>Consultant</u>
Private consulting in statistical design and analysis, computer programming and applications, microcomputer systems and software psychology.

1976 - 1978 <u>Catholic University, Human Performance Laboratory</u>
Research Assistant

Applied and basic research experiments conducted on auditory signal classification of complex underwater sounds. Research sponsored by the Human Factors Engineering branch of the Office of Naval Research. Additional research and related areas included auditory and visual pattern recognition, performance measurement and evaluation, multidimensional scaling, and computer-based systems for acoustic and experimental data analysis. Computer experience involved programming experimental events and subsequent data analysis on Digital Equipment Corporation PDP-8/e, PDP-11/34 and DECSystem-10 Computers.

1975 - 1976	**Eagleville Hospital and Rehabilitation Center** Research Assistant and Interviewer Interviewed study participants and assisted in data processing for an Alcohol Abuse Research Grant and coordinated all programming and clerical needs for a sub-study on Life Stress Events. Skills in programming included JCL, SPSS, PL/1, and FORTRAN on IBM 370/168 system.

PROFESSIONAL ORGANIZATIONS

Acoustical Society of America
American Psychology Association
Human Factors Society
National Conference on the Use of On-Line Computers in Psychology
Psychometric Society
Psychonomic Society
Software Psychology Society
Sigma XI

AWARDS

Grant-in-Aid of Research, National Sigma XI (1978)

Grant-in-Aid of Research, The Catholic University of America Chapter of Sigma XI (1978)

PUBLICATIONS

Burgy, D., Lempges, C., Miller, A., Schroeder, L., Van Cott, H., Paramore, B. Task Analysis of Nuclear Power Plant Control Room Crews: Project Approach and Methodology (NUREG/CR-3371, Vol. 1). Washington, D.C.: U.S. Nuclear Regulatory Commission, September 1983.

Burgy, D., Lempges, C., Miller, A., Schroeder, L., Van Cott, H., Paramore, B. Task Analysis of Nuclear Power Plant Control Room Crews: Data Results (NUREG/CR-3371 Vol. II). Washington, D.C.: U.S. Nuclear Regulatory Commission, September 1983.

Burgy, D., Lempges, C., Miller, A., Schroeder, L., Van Cott, H., Paramore, B. Task Analysis of Nuclear Power Plan Control Room Crews: Task Data Forms (NUREG/CR-3371, Vol. 3). Washington, D.C.: U.S. Nuclear Regulatory Commission, December 1984.

Burgy, D., Lempges, C., Miller, A., Schroeder, L., Van Cott, H., Paramore, B. Task Analysis of Nuclear Power Plan Control Room Crews: Task Data Forms. (NUREG/CR-3371, Vol. 3). Washington, D.C.: U.S. Nuclear Regulatory Commission, December 1984.

Burgy, D., and Schroeder, L. Nuclear Power Plan Control Room Crew Task Analysis Database: SEEK System. (NUREG/CR-3606) Washington, D.C.: U.S. Nuclear Regulatory Commission, May 1984.

Topmiller, D. A., Burgy, D. C., Roth, D. R., Doyle, P. A., and Espey, J. J. Survey and Analysis of Communications Problems in Nuclear Power Plants (EPRI RP 501-5). Electric Power Research Institute; Palo Alto, CA, September 1981.

Burgy, D. C., Doyle, P. A., Barsam, H. F., and Liddle, R. J. Applied Human Factors in Power Plant Design and Operation. Columbia, MD; General Physics Corporation, 1980.

Howard, J. H., Jr., and Burgy, D. C. "Structure Preserving Transformations in the Comparison of Complex Steady-State Sounds" (Technical Report ONR-78-6). Washington, D.C., The Catholic University of America Human Performance Laboratory, December 1978.

Howard, J. H., Jr., Ballas, J. A., and Burgy, D. C. "Feature Extraction and Decision Processes in the Classification of Amplitude Modulated Noise Patterns" (Technical Report ONR-78-4). Washington, D.C., The Catholic University of American Human Performance Laboratory, July 1978.

Howard, J. H., Jr., Burgy, D. C., and Ballas, J. A. "A Deglitching Circuit for the AA50 D/A Converter." Behavior Research Methods and Instrumentation, 1978, 10, (6), 858-860.

Burgy, D. C. "Hemispheric Asymmetries in the Perception of Non-Speech Sound Characteristics." Unpublished master's thesis, The Catholic University of America, May 1978.

Howard, J. H., Jr., and Burgy, D. C. "Selective and Non-Selective Preparation Enhancement Effects of an Accessory Visual Stimulus on Auditory Reaction Time." Unpublished manuscript, The Catholic University of America, 1977.

"River Bend Station Detailed Control Room Design Review Summary Report: Methodology and Results" (Gulf States Utilities Company). Columbia, MD, General Physics Corporation, September 1984.

"Human Factors Maintenance Plan" (Gulf States Utilities Company). Columbia, MD, General Physics Corporation, November 1984.

"Human Factors Criteria" (Mississippi Power & Light Company). Columbia, MD, General Physics Corporation, March 1985.

"Task Analysis of Emergency Diesel Generator Loading" (Long Island Lighting Company). Columbia, MD, General Physics Corporation, April 1985.

REPORTS

"Preliminary Human Factors Engineering Recommendations for Near-Term Improvements of the Surry Nuclear Station Control Room" (Virginia Electric & Power Company, GP-R-705). Columbia, MD, General Physics Corporation, June 1980.

"Preliminary Human Factors Engineering Recommendations for Near-Term Improvements of the Zion Power Station Control Room" (Commonwealth Edison Company, GP-R-708). Columbia, MD, General Physics Corporation, June 1980.

"Human Factors Engineering Recommendations for Near-Term Improvements of the Zimmer Nuclear Power Station Control Room:" (Cincinnati Gas and Electric Company), GP-R-13002). Columbia, MD, General Physics Corporation, August 1980.

"Summary of the LaSalle County Nuclear Generating Station Noise Report" Commonwealth Edison Company, GP-R-13010). Columbia, MD, General Physics Corporation, August 1980.

"Summary of the LaSalle County Nuclear Generation Station Lighting Survey" (Commonwealth Edison Company, GP-R-13011). Columbia, MD, General Physics Corporation, August 1980.

Human Factors Engineering "Considerations for Implementing a 'Green Board' at Zion Nuclear Generating Station" (Commonwealth Edison Company, GP-R-13008). Columbia, MD, General Physics Corporation, August 1980.

"Human Factors Engineering Meter Banding Study" (Commonwealth Edison Company, GP-R-13016). Columbia, MD, General Physics Corporation, September 1980.

SECURITY CLEARANCE SECRET

LOTHAR R. SCHROEDER
Principal Scientist

EDUCATION	Ph.D., Experimental/applied Psychology, Lehigh University
	M.S., Engineering Psychology, Lehigh University
	B.S., General Engineering, University of Illinois
	B. A., Psychology, University of Illinois

EXPERIENCE
1982 - Present

General Physics Corporation

Dr. Schroeder's areas of expertise include task and error analysis, procedures validation, equipment design studies, operations research, and organizational design and management. He is currently managing all human factors integration services for Georgia Power Company in meeting their emergency response capability requirements at Plant Hatch.

Dr. Schroeder has supported an NRC research project, applying control crew task analysis data in areas of human engineering design and staffing. He was also responsible for implementing a data management system for this project. He is currently managing a follow-on research project for the NRC which will use the existing task analysis database to identify training needs and to evaluate emergency procedures.

Other representative projects include: evaluating computer displays and work areas, assessing human factors aspects of flowcharts and reviewing equipment tagging procedures. Dr. Schroeder has also developed and given numerous supervisory skills workshops for operations and technical staff.

1981 - 1982

U.N.C. Nuclear Industries

Dr. Schroeder worked as a human factors specialist, interfacing with engineers and other staff in identifying and solving problems relating to equipment design, the use of procedures, and training efforts at Hanford's N-Reactor. He also performed a human factors review of the 105-N control room in support of an on-going control room upgrade program.

1974 - 1980	**Department of Psychology, Moravian College** Dr. Schroeder's responsibilities as Assistant Professor and Department Chairperson included planning and coordinating a day and evening program in psychology involving over 100 majors, serving on several college committees, supervising individual field study, independent study, and honors projects, and serving as academic advisor to day and evening session students having an interest in applied psychology.
1973	**Wigdahl Electric Company** Dr. Schroeder worked as a consultant, identifying potential organization problems and conducting problem solving sessions.
1972	**Jewish Employment and Vocational Services** As an industrial psychologist, Dr. Schroeder consulted with several industries and governmental agencies in order to develop, validate and administer "job-related" personnel selection tests under a Department of Labor contract.
PROFESSIONAL AFFILIATIONS	Member, Human Factors Society Member, American Nuclear Society
PUBLICATIONS	"A Human Factors Guided Survey for Systems Development," American Nuclear Society Winter Meeting, December 1981, coauthor with D. R. Fowler. "Control Room Human Factors in Context," American Nuclear Society Winter Meeting, November, 1982, coauthor with D. R. Fowler & D. E. Friar. "Learning Style Data Applied to Nuclear Power Plant Training Programs." American Nuclear Society Annual Meeting, June 1983. "Task Analysis of Nuclear Power Plant Control Room Crews, Vol.", NUREG/CR-3371, U. S. Nuclear Regulatory Commission, June 1983. Authored with D. Burgy, C. Lempges, A. Miller, H. Van Cott, and B. Paramore. "Crew Task Analysis Database: SEEK System Users Manual NUREG/CR-3606, U. S. Nuclear Regulatory Commission, Authored with D. Burgy, March 1984.

(9/85)

CRAIG R. HARLEY
Senior Engineer
Human Factors Specialist

EDUCATION

B.S., Mechanical Engineering, Purdue University
A.A., General Studies, St. Petersburg Junior College
U.S. Naval Nuclear Power Training Program

EXPERIENCE

1984 - Present

General Physics Corporation
Mr. Harley is a member of the Human Factors Engineering Department where he supports human factors evaluations of control rooms and emergency operating procedures upgrade projects, participating in on-site data collection of human factors data and conducting data analysis, and writing training materials for utility clients. Representative projects include:

- Detailed Control Room Design Review
  Participated in human factors detailed control room design reviews at several nuclear power plants including Mississippi Power and Light Company, Grand Gulf Unit 1; New York Power Authority, Indian Point Unit 3; Wisconsin Electric Power Company, Point Beach Nuclear Plant. Responsibilities included conducting operating experience reviews, operator interviews, control room survey, and task analysis based on Emergency Operating Procedures (EOPs).

- Emergency Operating Procedures Preparation
  Conducted reviews of symptom-based Emergency Operating Procedures for New York Power Authority, Indian Point Unit 3 verification efforts; also contributed to system review and task analysis efforts as part of a procedures upgrade program using WOG ERGs.

- Instructional Technologist for the industry-wide Shift Supervisor/Senior Control Room Operator task analysis project for the Institute of Nuclear Power Operations (INPO).
  Performed job and task analysis at many of the nuclear sites in the United States. Duties included conducting interviews with utility Subject

Matter Experts (SME's) to obtain task analysis data. Completed the General Physics INPO Instructional Technologist training course.

- <u>Control Room Mockup Construction</u>
  Designed and built full size control room photographic mockup of New York Power Authority, Indian Point Unit 3s control room.

- <u>Training Materials</u>
  Acted as a Subject Matter Expert (SME) in the development of a Nuclear Power Training Program course curriculum for Nuclear Engineering Personnel (i.e., Assistant Nuclear Engineers, Nuclear Engineers, and Senior Nuclear Engineers) and Headquarters Staff Engineers (i.e., Civil, Nuclear, Electrical, and Mechanical Engineers) for Taiwan Power Company.
  Assisted in writing the Review Committee Training Program for Toledo Edison Company, Davis Besse Nuclear Power Station.

1978 – 1984

- <u>United States Navy</u>
  Mr. Harley served as Assistant Engineer Officer aboard USS RAY (SSN 653) where he was responsible for the safe and proper operation of the nuclear power plant and its auxiliaries. Additionally, he was responsible for the management of personnel and material resources associated with the engineering department. Mr. Harley's duties encompassed organization, administration, managing day-to-day activities through the supervision and control of 1st and 2nd line supervisors, being actively involved in intermediate and long range planning, and the training qualifications and requalification of the 51 members of the engineering department. Concurrently, he served as ship's representative to the non-nuclear Joint Test Group for Charleston Naval Shipyard, which reviewed and approved all non-nuclear test procedures for submarine overhaul. Mr. Harley also held a variety of Division Officer jobs while aboard USS RAY, including the following: Damage Control Officer, Subsafe Certification/Quality Assurance Officer, Ships Diving Officer, Sonar Officer, Reactor Controls Officer and Assistant Weapons Officer.

PROFESSIONAL AFFILIATIONS

Member, American Society of Mechanical Engineers

(6/85)

MICHAEL W. DAWSON
Manager, Program Development

EDUCATION

M.S. Candidate, Nuclear Engineering/Health Physics, University of Cincinnati

B.B.A., Business Management, National University

U.S. Navy Nuclear Power Training Program

LICENSES AND CERTIFICATIONS

Certified PWR Senior Reactor Operator

Certified Level III Quality Assurance in accordance with ANSI N45.2.6 for Administration, Documentation and Training; Level II Quality Assurance for Operations Inspections

Electrical Operator: U.S. Navy Nuclear Power Program

Engineering Laboratory Technician: U.S. Navy Nuclear Power Program

EXPERIENCE
1981 - Present

General Physics Corporation
Mr. Dawson provides engineering, training, and management consulting services to industry and government clients. As Manager of Program Development for the Engineering Services Department, he is directly responsible for the coordination of projects in the western U.S. from GP's San Diego Regional office. Representative projects include:

- Station/Facility Services
  Prepared system operating procedures, annunciator response procedures, test and surveillance test procedures. Developed and prepared a surveillance test program to implement Environmental Technical Specifications. Participated in the procedures validation of the Emergency Operating Procedures for a PWR power plant.

- Quality Assurance/Program Development Services
  Prepared site organization and QA Administration procedures, and participated in the rewrite of the site QA Manual. Developed and wrote the program instructions for a computerized nonconformance reporting system. Developed the design control

program for a utility assuming these responsibilities from an A/E. Participated in the review of administrative and implementing procedures, and the QA Manuals of contractors and vendors for QA Program compliance. Performed the Quality Engineering review and disposition of nonconformances and procurement documents. Performed inspections and surveillances of operations department activities, and participated in the development of the department Quality Control Manual at the Diablo Canyon Power Plant. Participated in audits and management reviews of programs and procedures in subjects including nonconformance reporting and dispositions, document control, training, clearance and jumper control, document and system turnover from construction to operations, and design modification control.

- Training Program Development
  Prepared lesson plans for Licensed Operator systems training. Developed the Basic Radiation Protection training course, including lesson plans, and all training aids and demonstrations at the William H. Zimmer Nuclear Power Station.

- Training Services
  Administered and taught Radiation Protection course, the GP Nuclear Power Plant Fundamentals courses, and the academic fundamentals portion of Licensed Operator training on-site for a client. Has taught portions of the academic fundamentals to operator and STA candidates on-site, and portions of the GP Codes and Standards course for Technical Staff Engineers.

- Human Factors Engineering
  Participated in Detailed Control Room Design Review as the SRO Subject Matter Expert at both a PWR and a BWR. These projects included Emergency Operating Procedure validation, control room walk-throughs, and the independent assessment of control room I&C.

1979 - 1981 General Atomic Company

Mr. Dawson served as the Health Physics Representative on a total of seven projects with General Atomic. He was responsible for independently carrying out the Health Physics Programs on these projects, which included HTGR fuel fabrication, TRIGA facilities, hot cell facilities, and radwaste.

1978 - 1979 **Franzen & Associates**

Mr. Dawson investigated and marketed personal savings and investment programs. He researched and designed business plans for small businesses including structuring and maintaining accounting systems. He prepared tax returns and tax planning programs.

1969 - 1978 **U.S. Navy**

Engineering Laboratory Technician

Mr. Dawson served in progressive assignments as Electrical Operator and Engineering Laboratory Technician. He was responsible for operation and maintenance of electrical distribution systems and radiac and sampling equipment. He prepared and delivered shipboard training programs in radiation protection. He served as Prototype Instructor for plant systems, radiation protection, and chemistry.

PROFESSIONAL AFFILIATIONS

Plenary Member, Health Physics Society

Member, American Society for Quality Control

Secretary of the Modifications (Design) Subcommittee of the Committee for QA of Operating Power Plants
- Standards Committee of ASQC

(11/85)

PAUL L. WEEKS
Director, PWR Training Projects

EDUCATION

B.S. Candidate, Electrical Engineering, The Johns Hopkins University

A.S., The University of the State of New York

U.S. Navy Nuclear Power Training Program

LICENSES AND CERTIFICATIONS

Certified Nuclear Power Plant Senior Reactor Operator Instructor, Pressurized Water Reactor

EXPERIENCE
1980 - Present

General Physics Corporation
Mr. Weeks manages the PWR Training Projects department, which provides services to pressurized water reactor (PWR) nuclear utility clients. Representative projects include:

- Emergency Procedures Upgrade Support
  Acted as Project Manager for two EOP upgrade projects at operating PWRs using the WOG ERG format. Responsible for all phases of EOP upgrade including procedures writing, documentation, and verification and validation.

- Operating Procedures Review
  Has performed operating procedure, Technical Specifications, and surveillance procedure reviews for Westinghouse PWRs including all facets of station operation.

- Human Engineering Control Room Design Review
  Has provided technical expertise for all phases of Control Room design reviews.

- Operator Hot License Course Development, Public Service Electric and Gas Company
  Acted as Project Manager of a training materials preparation project for the Salem Nuclear Generating Station's reactor operator and senior reactor operator hot licensing program; supervised writing, editing, and production of all training materials.

- <u>Operator Hot License Course Development, Carolina Power and Light Company</u>
  Acted as Project Supervisor of a training materials preparation project for the H.B. Robinson Plant's reactor operator and senior reactor operator hot licensing program; supervised writing, editing, and production of all training materials.

- <u>System Training Manual Development, Commonwealth Edison Company</u>
  Acted as Project Supervisor of this project for Zion Nuclear Generating Station; supervised the writing and editing of the Systems Training Manual, which detailed the purpose, description, operation, and design bases of the systems associated with a PWR power station.

- <u>On-Site Instruction</u>
  Acts as instructor for on-site training programs at both PWRs and boiling water reactors (BWRs); has conducted training programs for PWR and BWR utilities including both licensed operator training and shift technical advisor (STA) training. Has also prepared training materials including lesson plans, transparencies, student handouts, text materials, and audit examinations.

1972 - 1980

<u>United States Navy</u>
Mr. Weeks served onboard an operating submarine as Reactor Controls Division Leading Petty Officer, where he was responsible for supervising the operation and maintenance of the electronic equipment associated with the submarine's nuclear unit. Mr. Weeks served at the Nuclear Power Training Unit at Idaho Falls, Idaho, where he was a staff instructor. He was also the Reactor Controls member of the Staff Training Group responsible for training staff instructors in plant operation and instructional techniques.

PROFESSIONAL AFFILIATIONS

Member, American Nuclear Society

(11/84)

ROBERT DANNA
Director, Engineering Services

EDUCATION

M.S., Environmental Engineering, University of Central Florida

M.A., Physics, Hunter College of the City University of New York

B.A., Physics, Hunter College of the City University of New York

LICENSES AND CERTIFICATIONS

Registered Professional Mechanical Engineer: Maryland

EXPERIENCE
1980 - Present

General Physics Corporation

Mr. Danna directs engineering consulting services for government and utility clients. He has been responsible for projects from $5,000 to $1.8 million. All projects were completed on schedule and within budget. Representative projects include:

- An Evaluation of the Benefits, Risks, and Costs of Establishing Regulatory Cut-off (De Minimis) Levels for Radioactivity in Certain Waste Streams from Nuclear Power Plants, Atomic Industrial Forum, Inc.
  Serves as project engineer for the National Environmental Studies project to examine the sources, concentrations, and quantities of very low level radioactive wastes (VLLW) generated at light water nuclear power plants. The final report will be usable as technical support for an industry petition for rulemaking to NRC, under 10CFR20 and 10CFR61, to establish a regulatory cut-off for VLLW.

- Pressure Vessels/Systems Certification Support, NASA Kennedy Space Center (KSC)
  Serves as Project Manager for a program designed to certify all pressure systems at KSC; responsibilities include the coordination of on- and off-site engineering staff, the evaluation of current automated data processing of certification documentation, and the monitoring of the Lockheed, EG&G, and McDonnell Douglas certification effort.

- Safety Review Committee Program Development, Gulf States Utility Company, Sacramento Municipal Utility District, Toledo Edison Company.
  Directed the development of Plant Review Committee and Management Safety Review Committee training programs. The programs provide for the training and qualifications of key plant and corporate management personnel responsible for assessing the safety of plant operations or configuration changes.

- Technical Staff Training Program Development, New York Power Authority, Texas Utilities, Baltimore Gas & Electric, Commonwealth Edison, Niagara Mohawk, and Houston Lighting & Power
  Serves as project director for the development of engineer training programs which include Codes and Standards, Nuclear Licensing, Equipment Qualification, Material Science, and Plant Chemistry.

- Startup Test Procedure Review, Pennsylvania Power and Light Company
  As Project Director, supervised the detailed technical review of all the Susquehanna Steam Electric Station Unit 2 startup test procedures. The test procedures were reviewed against the design criteria established in the FSAR and GE design documents to insure that they demonstrated compliance with these criteria.

- Multilayered Vessel Recertification Analysis, National Aeronantics and Space Administration
  As Project Director, provided technical direction to the analysis of pressure vessels at White Sands Test Facility to meet ASME Section VIII Divisions 1 and 2.

- San Onofre Nuclear Generating Station Unit 2 Simulator Trainer Configuration Management Program, Southern California Edison Company
  Supervised, as Project Manager, the review and evaluation of all SONGS Unit 2 Design Change Packages (DCPs) and Proposed Facility Changes (PFCs) to determine their impact on the simulator trainer baseline configuration. Developed project procedures and overall program guidelines for use in utility management of CM program.

- Energy in Municipal Wastewater Treatment: An Energy Audit Procedure and Supporting Data Base, U.S. Environmental Protection Agency
  Supervised, as Project Manager, the development of a data base which compiles all reported literature on energy use in municipal wastewater treatment plants; developed a generic methodology to assess the total energy required for construction and operation of wastewater treatment plants.

- <u>Shift Technical Advisor and Senior Reactor Operator Training Programs</u>
  Managed or instructed courses in Reactor Physics, Thermal-Hydraulic Analysis, Accident Assessment, and Nuclear Plant Materials to utility engineers seeking qualification as Shift Technical Advisor and Senior Reactor Operator at twelve power plants.

1976 - 1980 **<u>United States Navy</u>**
Mr. Danna was the Director of the Physics Division at the Naval Nuclear Power School. He developed and taught the curriculum, revised the text, and trained new instructors. He also taught reactor dynamics, core characteristics, and reactor principles.

1973 - 1976 **<u>Hunter College of the City University of New York</u>**
Mr. Danna was a Lecturer and Research Assistant in the Physics Department. He taught a two-semester course in physics to science majors. In addition, he developed computer simulations for the study of chemical structures by resonance spectroscopy.

PROFESSIONAL AFFILIATIONS:
Member, American Society of Mechanical Engineers
Member, American Society for Metals

PUBLICATIONS AND PRESENTATIONS:

J. P. Davis, R. Danna, "De Minimis Concentrations of Radionuclides in Various Waste Media, Status Report," Transactions of the American Nuclear Society, <u>47</u>, p 101 (1984).

D. E. Sharp, R. Danna, J. E. Stoneking, T. G. Carley, "Failure Prevention Program Implementation: A Case Study of High Pressure Gas Storage Vessels," American Society of Mechanical Engineers, 84-PVP-66, pp 1-6 (1984).

E. G. Landauer, R. Danna, "The Need for Technical Staff Training," Transactions of the American Nuclear Society, <u>46</u>, pp 44-46 (1984).

K. J. Rebeck, R. Danna, G. S. Miller, R. T. Hollingsworth, "Recertification Analysis and Inspection Planning for Environmental Test Facilities," Proceedings of the Institute of Environmental Sciences, pp 328-335 (1984), also published in the Journal of Environmental Sciences, <u>27</u>, pp 33-39 (1984).

C. S. Trent, R. Danna, "Development of a Configuration Management Program for Nuclear Power Plant Simulators," <u>All About Simulators, 1984</u>, Society for Computer Simulation, <u>14</u>, pp 18-24 (1984).

R. Danna, C. S. Trent, "Implementation of a Configuration Management Program for Nuclear Plant Simulators," Transactions of the American Nuclear Society, <u>45</u>, pp 558-559 (1983).

R. Danna, "Overview of Configuration Management Program Development and Implementation for Ground Based Pressure Vessels and Systems," NASA Pressure Systems Seminar, White Sands Test Facility, September (1983).

R. Danna, K. J. Rebeck, "Failure Prevention Program Development: An Application of Pressure Vessel and System Recertification and Inspection Planning," <u>Failure Prevention and Reliability - 1983</u>, American Society of Mechanical Engineers, pp 109-117 (1983).

R. Danna, "Critical Exposure Pathways: An Analysis of the Environmental Impact of Gaseous Effluents from Light-Water-Cooled Reactors," Research Paper, University of Central Florida (1979).

DAVID B. BARKS
Senior Engineer

EDUCATION B.S., Psychology, University of Tennessee, Chattanooga

EXPERIENCE
1980 - Present

General Physics Corporation

Responsibilities include project management, the writing of program plans, experimental designs, and the marketing of corporate capabilities in response to NUREG issuances in the area of control room review. Representative projects include:

- Human Factors Design Review
  Participated in human factors control room design reviews at several nuclear plants including Wisconsin Electric Power Company, Point Beach States, Mississippi Power & Light, Grand Gulf Nuclear Station. Omaha Public Power District's Fort Calhoun Station Gulf States Utility's River Bend Station and Georgia Powers' Plant Vogtle Preliminary Design review Participated in human factors design review of letter sorting machines for the United States Postal Workers Union.

- Data Base Development

  Developed and coded data base management systems for Wisconsin Electric Power Company, Mississippi Power and Light company Long Island Lighting Company Nuclear Regulatory Commission, Omaha Public Power District Gulf States Utilities.

- Syncrude Canada Ltd.
  Assisted in the writing of system's training manual for a cogeneration power plant.

- BWR 1983-84 Research Study, Oak Ridge National Laboratory
  As Chief Task Analysis, the analysis of actions to develop performance criteria was the prime importance of this project.

- <u>Safety Related Operators Actions Wrap Up, Oak Ridge National Laboratory</u>
  The developing and implementing of a computer actuated model of nuclear power plant operator performance to augment the ANSI N660 standard was the result of this project.

- <u>BWR Task Analysis Pilot Study, Oak Ridge National Laboratory</u>
  As project manager for development and testing mathematically predictable model of operator performance.

- <u>PWR Task Analysis Pilot Study, Oak Ridge National Laboratory</u>
  Investigated and authorized this pilot study (NUREG-CR-2498) to demonstrate what information task analysis can provide for various applications.

- <u>Shift Technical Advisor (STA) Training, Georgia Power Plant, Plant Hatch</u>
  Taught a 16-week program on behavioral science and management.

- <u>Preliminary Control Room Review, Georgia Power Company, Plant Vogtle</u>
  As principal investigator reviewed human factors considerations of a nuclear power plant control room in accordance with Nuclear Regulatory Commission guidelines; participated in project design and data evaluation.

1978 - 1980 <u>Henry J. Kaiser Company</u>

Mr. Barks' duties included the performance and evaluation of construction testing for the Cincinnati Gas and Electric Company. As Principal Generation Construction Turnover Engineer he was responsible for seeing that all items turned over to the client were accurate and that appropriate documentation was on file. As part of the documentation aspect of his work, Mr. Barks worked on and assisted development of a computerized system index test matrix to keep track of all testing and documentation for system turnover.

His other duties included work for the client in a quality assurance function. As Principal Quality Assurance Turnover Group Engineer, he reviewed all turnover documentation against all applicable documentation prior to turnover. Mr. Barks also assisted operations in the performance of preoperational startup tests.

1977 - 1978	**The Baylor School** Mr. Barks oversaw the renovation of two buildings including design and construction of an outdoor recreation facility.
PUBLICATIONS	Safety Related Operator Actions Wrap Up; Criteria of Operator Performance NUREG-CR-XXX (IN PRESS). Coauthor with E. J. Kozinsky, A. M. Beare, F. Gomer, and L. H. Gray
	"Nuclear Power Plant Control Room Task Analysis: Pilot Study for Pressurized Water Reactors," NUREG-CR-2598, May 1982, Coauthor with E. J. Kozinsky, and S. Echols. "Criteria for Safety-Related Nuclear Power Plant Operator Actions: Initial Boiling Water Reactor (BWR) Simulator Exercises," (DRAFT) NUREG/CR-2534 (ORNL/NUREG/TM-8195), September 1981, Coauthor with E. J. Kozinsky, A. N. Beare, P. M. Haas.
	"Nuclear Power Plant Control Room Task Analysis: Pilot Study for Boiling Water Reactor Study". Coauthor with F. Gomer, G. Moody.
	"Task Analysis Methodologies for Safety Related Operator Actions", American Nuclear Society Winter Meeting 1981.

MURRAY EUGENE JENNEX
Project Manager

EDUCATION

Professional Certification, Micro-Computer Engineering, University of California at San Diego Extension

Master of Business Administration with emphasis in Computer Information Systems, National University

U. S. Navy Surface Warfare Officers School

U. S. Navy Nuclear Prototype

U. S. Navy Officer Candidate School

Bachelor of Arts in Chemistry and Physics, William Jewell College

EXPERIENCE
1981 - Present

GENERAL PHYSICS CORPORATION

Mr. Jennex served as a member of the Integrated Leak Rate Test (ILRT) Team in Station Technical Power Generation Group at the San Onofre Site. This involved serving as a computer operator during the Unit 1 ILRT, with performance of several local leak rate tests (LLRT) on Units 1, 2 and 3 Containment Isolation Vales and airlocks, as well as planning for the Unit 2 ILRT, as a computer operator for the Unit 2 ILRT, and assisting in development of the Unit 2 and 3 ILRT and LLRT Procedures and being the primary author of the Computer Program to be used in performing all future San Onofre Site ILRT's. Additional engineering duties included dispositioning Nonconformance Reports and Site Problem Reports for Units 1, 2 and 3, and designing an Airlock Interlock Failure Alarm for the Unit 1 control room. Mr. Jennex also has served as the General Physics On-site Project Manager during this time. His duties for this have included supervising five (5) on-site Engineers and serving as the on-site representative for General Physics.

Mr. Jennex served as the Technical Programatic Administrative Support Group Lead for Station Technical Plant Betterment Group at the San Onofre Site. His duties during this time included the supervision of the Proposed Facility Change/Design Change Package (PFC/DCP) Clerical Staff, PFC/DCP planning for the current outages, Unit 1 Return to Service and for all uupcoming outages including the Unit 2 refueling outage, and review of all outage PFC/DCPs for potential Technical Specification Restraint Impact. Mr. Jennex also continued to improve and develop the PFC Tracking and Logging Program resulting in an improved system being implemented that tracks all PFCs and Turnovers for Units 1, 2 and 3.

Mr. Jennex served as a Plant Betterment Engineer for the Nuclear Steam Supply System (NSSS) support group at the San Onofre Nuclear Generating Station (SONGS) Units 1, 2 and 3. He was responsible for designing and implementing a proposed facility change tracking and logging program using the IBM PC and dBASE III relational database. The effort included program generation, troubleshooting, clerical staff training, and user's manual development. His other duties included reviewing and approving proposed facility changes, system turnovers, temporary modifications to the plant, test procedures and results, and procedure changes. His primary responsibility was ensuring the safety of the plant by doing the safety reviews for these items. Auxiliary duties included assisting in training and planning for the NSSS support group. During this time, Mr. Jennex was involved in several planned and unplanned plant outages, gaining experience in outage planning and scheduling and in ensuring work was performed and accepted on time. Mr. Jennex also gained expertise in developing proposed facility change and system turnover procedures and in the developing of a temporary modification program.

Mr. Jennex served as the Senior Technical Writer and on-site Editor for the San Onofre Nuclear Generating Station (SONGS) Units 2 and 3 System Description Project. His duties included writing specific system descriptions and editing of all descriptions for technical accuracy. Mr. Jennex also served as the project liaison between General Physics and the client. Mr. Jennex's auxiliary duties included researching data voids for the SONGS 2 and 3 simulator project. During this time, Mr. Jennex has achieved a high degree of technical expertise on the British built GEC Turbine-Generator and the main feedwater pump, incore and excore detector, control element drive mechanism, and reactor protection systems. Prior to this assignment, Mr. Jennex completed an Emergency Operating Facility (EOF) shield evaluation for the Saint Francisville Nuclear Power Station owned by Gulf States Utility. This evaluation included calculating shield design thickness for the various radiation hazards following a design base accident.

As a Staff Specialist for General Physics, Mr. Jennex served as a PWR Simulator Instructor, specializing in Chemistry and Radiation Protection. He has completed an eleven (11) week in-house Instructor Training Course including eight (8) weeks of classroom academics and three (3) weeks of training and classroom work on the Sequoyah Nuclear Power Plant Simulator. His auxiliary duties included technical writing for the Vogtle Nuclear Power Plant simulator training manual and the development of training materials for the various Simulator Training Centers managed by General Physics.

1978 - 1981 **U.S. NAVAL NUCLEAR POWER PROGRAM**

As an Engineering Officer of the Watch, Mr. Jennex has two (2) years experience in the Naval Nuclear Program. He served as a qualified watchstander at AIW Prototype in Idaho, and has experience in plant operations and major shutdowns for overhaul. As an officer onboard the USS BAINBRIDGE, Mr. Jennex gained further experience in plant operations, supply problems, training and personnel management.

1975 - 1978 **CHEMISTRY DEPARTMENT, WILLIAM JEWELL COLLEGE**

As a Laboratory Assistant, Mr. Jennex spent three (3) academic years operating and supervising the freshman laboratory. He was also responsible for instruction and safety in the Laboratory. He assumed the job of Lead Lab Assistant in his senior year, which also included the duties of sample and stock solution preparations and storeroom supervision and management.