Revision 1
December 2, 1983

PROGRAM PLAN REPORT

for a

DETAILED CONTROL ROOM DESIGN REVIEW

for

Indiana and Michigan Electric Company

Donald C.Cook Units 1 and 2

to

The United States Nuclear Regulatory Commission

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prepared by

American Electric Power Service Corporation

and

Westinghouse Electric Corporation / Canyon Research Group

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SECTION 1
INTRODUCTION

1-1. GENERAL

This Program Plan Report describes the plan to perform a detailed control room design review (DCRDR) of the Donald C. Cook Units 1 and 2 nuclear power generation stations operated by the Indiana and Michigan Electric Company (I&MECo).

The purpose of the Detailed Control Room Design Review Program is to study and evaluate, from a human engineering point of view, the total control room work space, environment, instrumentation, controls, and other equipment for both system demands and operator capabilities and to identify, assess, and recommend control room design modifications/enhancements to correct identified inadequacies in the existing design.

The approach of the DCRDR Program will be to perform a total review on the Unit 1 control room. Then a review of the Unit 2 control room will be done to determine the differences between units. The Unit 2 control room review will be based on the results of the Unit 1 review, with all differences being addressed separately. Therefore, this review technique will ensure that all aspects of the Units 1 and 2 control rooms will be evaluated for human factors.

This program is part of an integrated plan to address the TMI-related actions referenced in TMI-2 Action Plan, NUREG-0660. The plan will include a consideration of the relationship of the DCRDR Program with NUREG 0737, Supplement 1 (figure 1-1), including the following:

- Designing control room modifications which correct conditions adverse to safety (reducing significant contributions to risk) and considering the addition of the instrumentation necessary to implement Regulatory Guide 1.97

- Verifying the safety parameter display system (SPDS), data display, and function

- Using selected plant-specific, symptom-based emergency operating procedures for verifying and validating control room functions

- Communication interface with the Technical Support Center, Emergency Operations Facility, and the Operating Support Center

I&MECo has committed the necessary resources, including knowledgeable management and technical personnel from the plant staff, American Electric Power Service Corporation (AEPSC), technical consultants from Westinghouse Electric Corporation, and human factors specialists from Canyon Research Group to effect the program defined herein.

1-2. BACKGROUND

1-3 Plant Description

The Indiana and Michigan Electric Company is currently operating a two-unit nuclear power plant located along the eastern shore of Lake Michigan in Lake Township, Berrien County, Michigan, approximately 11 miles south-southwest of Benton Harbor.

This facility has been designated the Donald C. Cook Units 1 and 2 which began commercial operation in August of 1975 and July of 1979, respectively. Each unit contains a Westinghouse-supplied four-loop nuclear steam supply system (Unit 1 - 3250MWt, 1030 MWeNet and Unit 2 - 3411 MWt, 1100 MWeNet). The turbine generators for Units 1 and 2 were furnished by General Electric and Brown Boveri, respectively. The architect/engineer for both units is AEPSC.

1-4. Definition of Control Rooms

The Donald C. Cook Units 1 and 2 control rooms are essentially identical. The control room for each unit is defined, for the purposes of the DCRDR Program,

as the panels and other equipment in the main control board area including the SPDS displays and the hot shutdown panels. A general arrangement drawing is illustrated in figure 1-2; functional layout drawings of the control room panels are shown in figures 1-3 and 1-4, and a comprehensive tabulation of this material is shown in figure 1-5.

1-5. Control Room Status

The main control boards are operational and complete except for those areas of activity which are now being performed to address the requirements set forth by NUREG 0737, Supplement 1.

1-6. SCOPE OF THE PROGRAM

The Detailed Control Room Design Review Program covers the human engineering review of the vertical operational and associated hot shutdown panels identified in paragraph 1-4, and the control room workspace and environment. The equipment to be reviewed includes all displays, controls, peripheral consoles, communication equipment, ancillary devices, and other main control board components with which the control room operators interface.

During the review process, the government regulations and guidelines listed below and other related industry standards and guidelines will be used for information or background:

- NUREG 0659 (staff supplement to 1580)
- NUREG 0660 (action plan as a result of TMI-2 accident)
- NUREG 0694 (TMI-related requirement for new operating licensees)
- NUREG 0696 (functional criteria for emergency response facilities)
- NUREG 0700 (control room human engineering guidelines)
- NUREG 0737 (clarification of TMI action plan requirements)

- NUREG 0737, Supplement 1 (requirements for emergency response capability)

- NUREG 0801 (draft evaluation criteria for control room design review)

- NUREG 0814 (methodology for evaluation of emergency response facilities)

- NUREG 0835 (human factors acceptance criteria for SPDS)

- NUREG 0899 (guidelines for the preparation of emergency operating procedures)

- Regulatory Guide 1.47 (bypassed and inoperable status indication)

- Regulatory Guide 1.97, Revision 2 (postaccident monitoring instrumentation)

1-7. OBJECTIVES OF THE PROGRAM

The Detailed Control Room Design Review Program will be conducted to achieve the following objectives:

- Determine whether the existing control room design provides the system status information, control capabilities, feedback, and analytical aids necessary for control room operators to perform their functions effectively

- Identify characteristics of the existing control room instrumentation, controls, other equipment, and physical arrangements which may significantly impair/impede control room operator performance

- Analyze and evaluate the problems which could occur during emergency conditions, and identify means of correcting those discrepancies which could lead to substantial operational or safety concerns

- Verify and validate the proposed means of correction to provide an effective plan of action which applies human factors principles to improve the control room design and enhance operator efficiency and effectiveness

- Integrate the DCRDR Program with other area of human factors identified in the NRC Task Action Plan

- Provide effective coordination of control room enhancements and/or modifications with identifications of NUREG 0696 and Regulatory Guide 1.97 considerations, plant operating/emergency procedures development, and the implementation of training as necessary to ensure that control room operators can function adequately with any control room design changes

- Ensure that the results of this total effort meet the intent of NUREG 0737, Item I.D.1, and NUREG 0700. In addition, perform the DCRDR Program cognizant of these documents as clarified in NUREG 0737, Supplement 1, Item 5.2.a

1-8. DCRDR PROGRAM ACTIVITIES

The design review process will address four major phases of activity (figure 1-6):

- PHASE I -- PLANNING (section 4). The Program Plan Report for the D. C. Cook Units 1 and 2 DCRDR and the preliminary Control Room Human Engineering Criteria (CRHEC) Report will provide the basis for the design review.

- PHASE II -- REVIEW (section 5). During the Review Phase, data will be collected, reduced, and analyzed to observe and document whether the existing control room design provides operators with the capabilities necessary to perform their function and tasks under normal and

emergency operating conditions. Results of Phase II activity will generate task summary reports and a listing of departures from the Control Room Human Engineering Criteria Report.

- PHASE III-A -- ASSESSMENT (section 6). During this phase, an assessment will be made of the significance and impact of the departures from the CRHEC reports identified in Phase II. For those departures assessed as significant, recommended design changes/enhancements will be developed.

- PHASE III-B -- IMPLEMENTATION (section 7). After the assessment has been completed and all corrective actions identified, a schedule will be developed to ensure the integration of the proposed control room changes with other post-TMI programs, refueling outages, and other company modifications.

- PHASE IV -- REPORTING (section 8). A Program Summary Report will be prepared which will document the overall review process, describe and identify all of the human engineering discrepancies and findings, and summarize all DCRDR activities, methodologies, and proposed control room improvements and schedules.

Each phase will be performed by a team of specialists from I&MECo, AEPSC, Westinghouse, and Canyon Research Group. Disciplines represented on the team will include instrumentation and control engineering, nuclear safety and licensing, electrical engineering, human factors, plant operations, quality assurance, project engineering, and training to maximize the efficiency of the effort and to complete the total review identified in this Program Plan Report.

1-9. DEFINITION OF TERMS

A list of abbreviations and acronyms is contained in appendix A to this report. Also, to alleviate ambiguity of terms, the following definitions are provided:

Control Room Enhancement. A change to a piece of equipment, such as a control panel, which can be performed without interfering with the operation of that equipment. Such changes might include the application of labels or demarcation lines.

Control Room Modification. A change to a piece of equipment, such as a control panel, which is likely to interfere with the operation of that equipment on which the change is being performed. Such changes include the removal or relocation of an existing control panel component or the addition of a panel component.

Emergency Operating Procedures. Plant procedures which guide the operator(s) during a transient or emergency condition.

Emergency Response Guidelines. Symptom-based guidelines from which emergency operating procedures are developed.

Human Engineering. The science of optimizing the performance of human beings and the design of equipment for more efficient use by human beings.

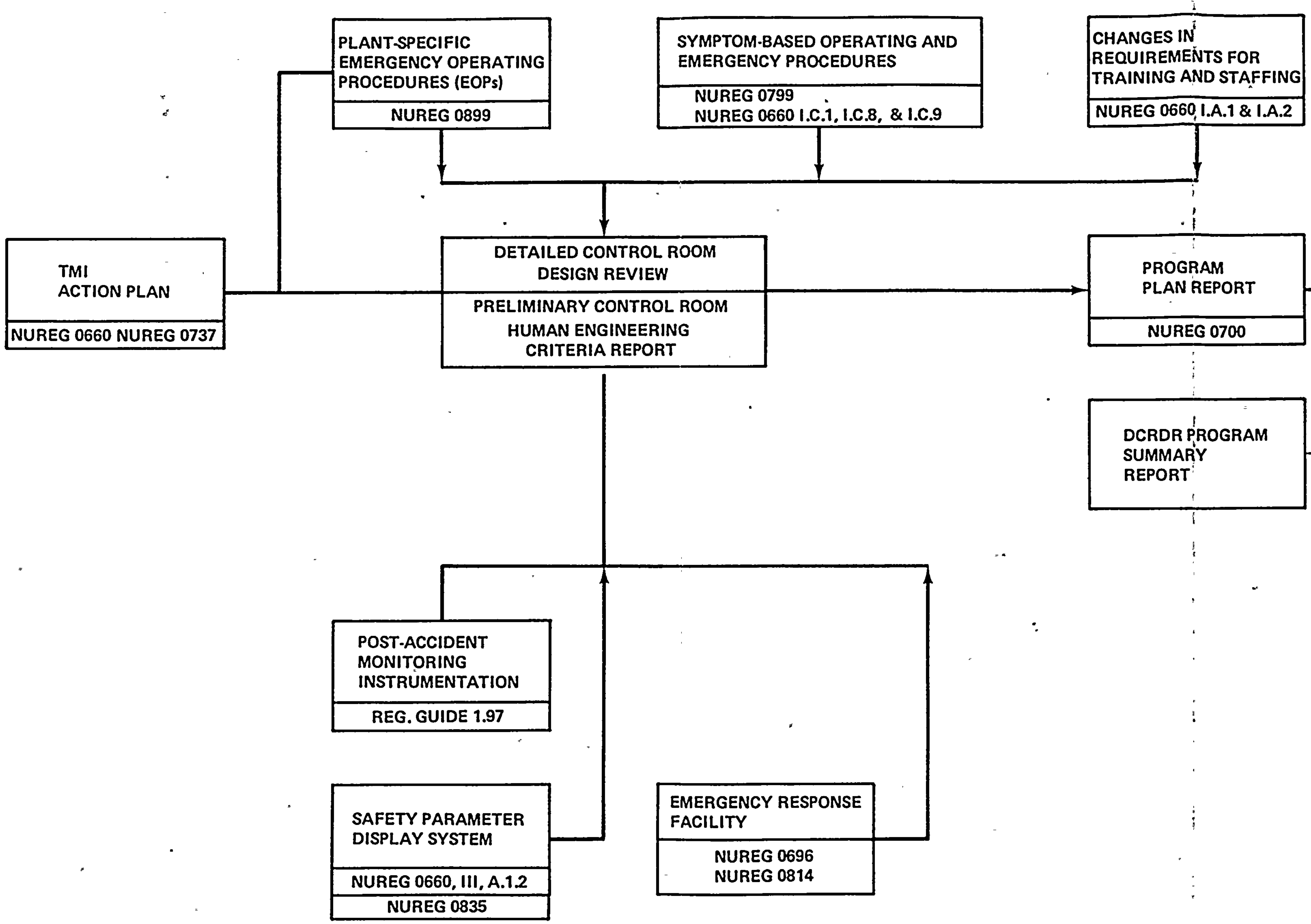
Human Engineering Discrepancy. A departure from the established human factors criteria for the control room design which could impair/impede operator performance.

Photomosaic. A scaled photographic reproduction of the main control room panels.

Safety Parameter Display System. Display system which provides continuous indication of plant parameters to assist control room personnel in evaluating the safety status of the plant.

Validation. The process of determining whether the physical design supports the procedures for operation in an adequate manner to support effective integrated performance of the functions of the control room operating crew.

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



PRC APERTURE CARD

Also Available On Aperture Card

Figure 1-1. Relationship of NUREG 0660 Task Action Items

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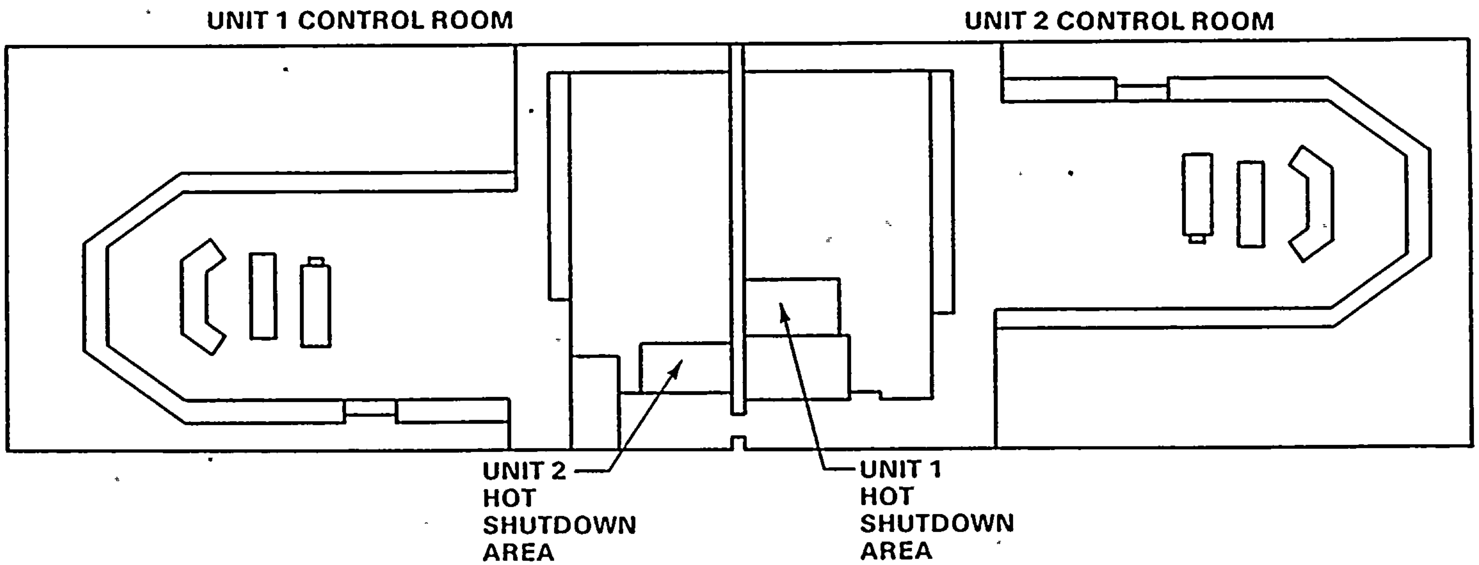

Figure 1-2. General Arrangement Drawing of Donald C. Cook Units 1 and 2 Control Rooms

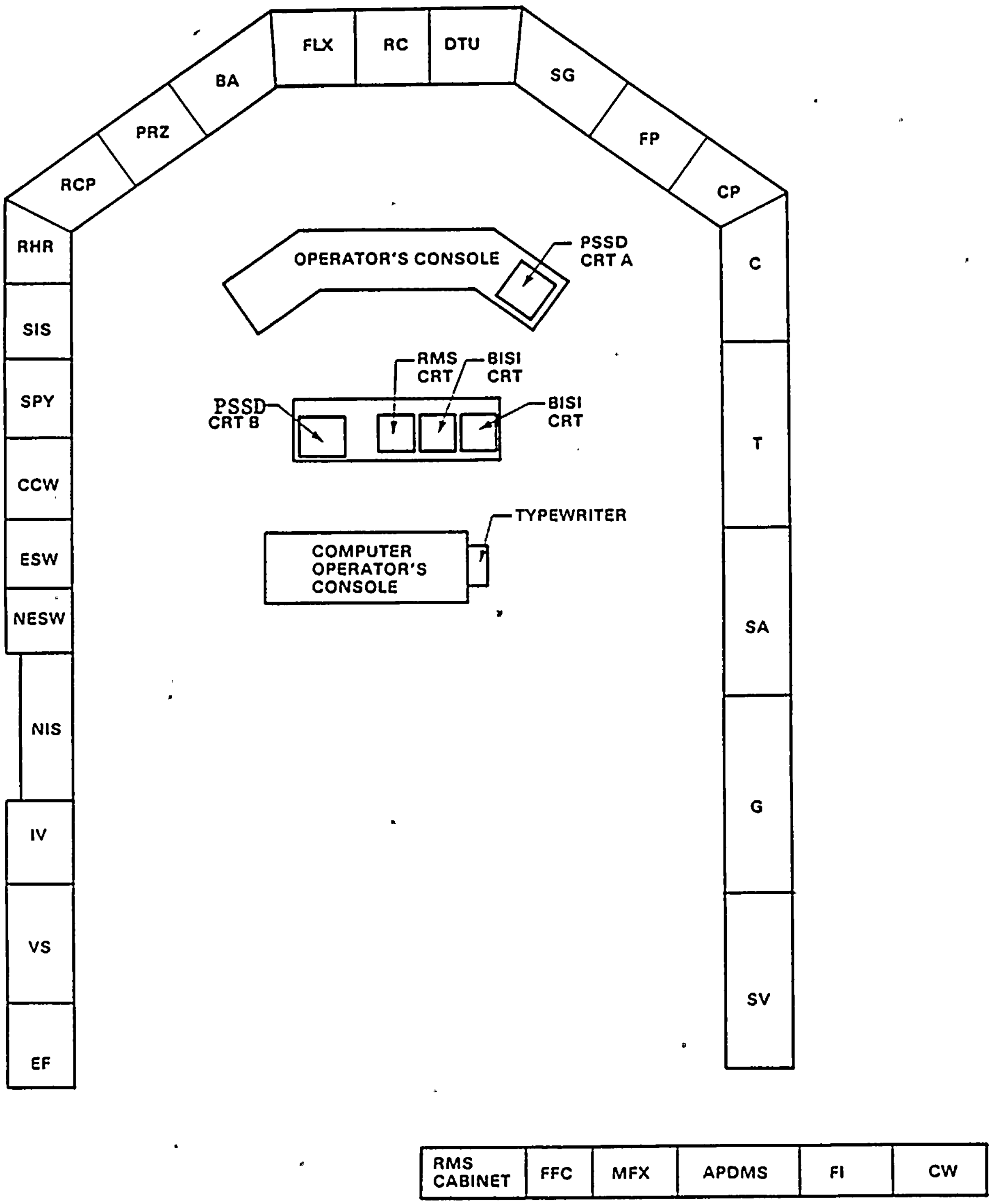

Figure 1-3. Functional Layout Drawing of Donald C. Cook
Unit 1 Control Room Panels

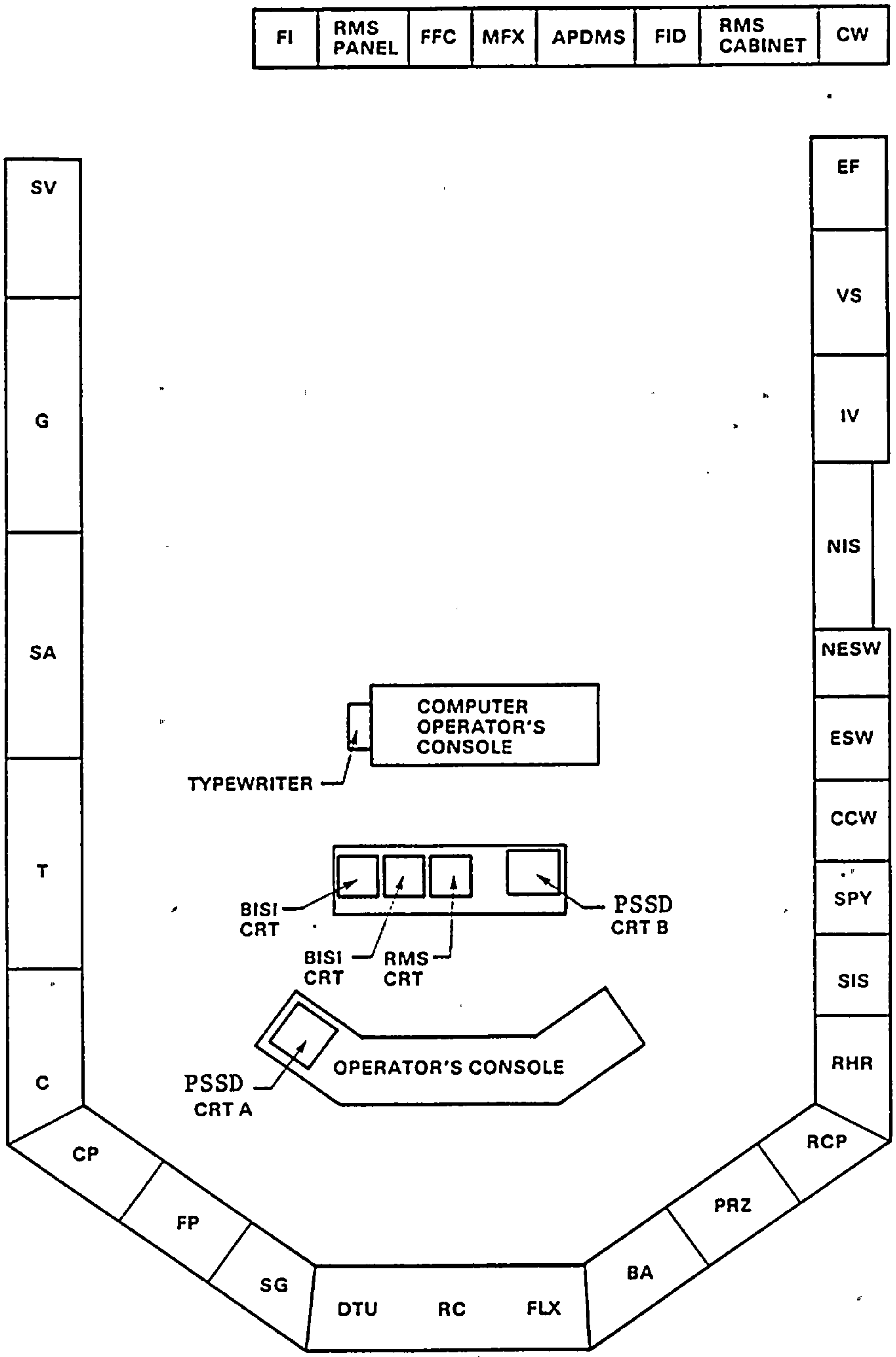

Figure 1-4. Functional Layout Drawing of Donald C. Cook Unit 2 Control Room Panels

FLX	-	Flux Panel
RC	-	Rod Control Panel
DTU	-	Delta T and Unit Panel
SG	-	Steam Generator Panel
FP	-	Feed Pump Panel
CP	-	Condensate Polishing Panel
C	-	Condensate Panel
T	-	Turbine Panel
SA	-	Station Auxiliary Panel
G	-	Generator Panel
BA	-	Boric Acid Panel
PRZ	-	Pressurizer Panel
RCP	-	Reactor Coolant Pump Panel
RHR	-	Residual Heat Removal Panel
SIS	-	Safety Injection System Panel
SPY	-	Containment Spray Panel
CCW	-	Component Cooling Water Panel
ESW	-	Essential Service Water Panel
NESW	-	Nonessential Service Water Panel
IV	-	Isolation Valves Panel
VS	-	Ventilation Panel
EF	-	Emergency Fire Panel
SV	-	Plant Service Panel
NIS	-	Nuclear Instrumentation Cabinets
FI	-	Fixed In-Core Panel
RMS	-	Radiation Monitoring System Panel
FFC	-	Failed Fuel Communications Panel
MFX	-	Movable In-core Cabinet
APMS	-	Axial Power Distribution Monitoring System Cabinet
FID	-	Fixed In-core Cabinet
RMS	-	Radiation Monitoring System Cabinet
CW	-	Circulating Water Panel

Figure 1-5. List of Abbreviations and Function for Control Panels

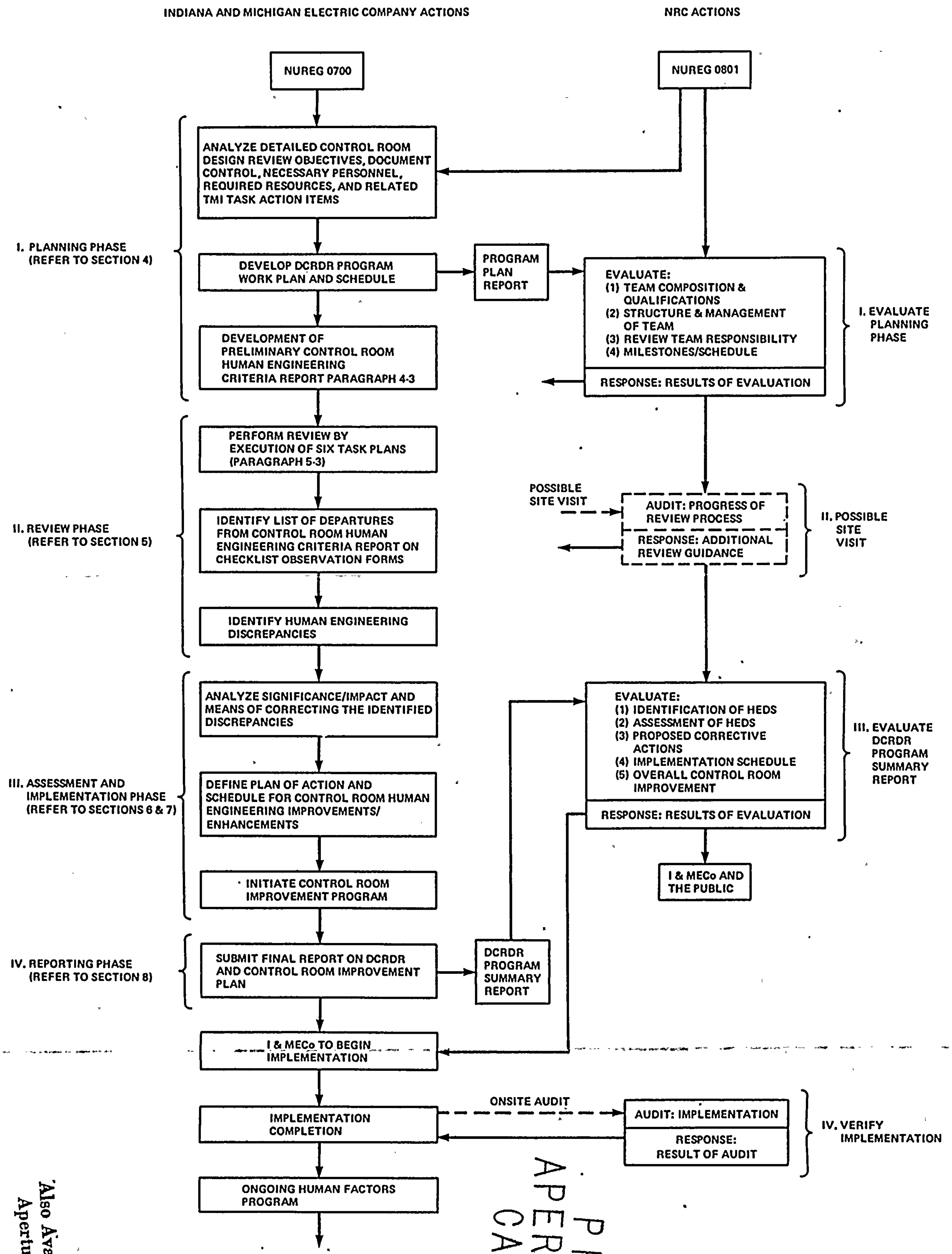

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Figure 1-6 Four Major Phase Activities for the DCRDR Program

SECTION 2
MANAGEMENT AND STAFFING

2-1. PURPOSE

The purpose of this section is to identify the DCRDR Program teams and their areas of responsibility. Figure 2-1 details the organizational structure of personnel involved in the DCRDR Program. Qualifications of key personnel are provided in appendix B. All personnel on the Donald C. Cook DCRDR Program teams will meet or exceed the qualifications provided in NUREG 0801 and related guidance.

2-2. DCRDR TEAM INTERFACE

To effectively perform the DCRDR Program and still be able to be successfully audited, an interface between the various review teams is required. The "DCRDR Program Lead Engineer" will be the primary contact and liasion for the management organization, design review, project review, and assessment teams. Figures 2-2 through 2-6 show these various interfaces.

2-3. MANAGEMENT FUNCTION

The management function for the DCRDR Program will be provided under previously established AEPSC procedural requirements and responsibilities defined in AEPSC General Procedure 25, "Engineering Design Changes," and General Procedure 32, "Preparation of Submittals to the U.S. Nuclear Regulatory Commission."

The function of management is to:

- Approve the Program Plan Report
- Review and approve recommendatons for control room design changes

- Provide the resources necessary for implementation of the DCRDR
- Approve the Program Summary Report
- Provide the mechanism for the preparation and submittal of documents to the U.S. Nuclear Regulatory Commission.

2-4. PROJECT REVIEW TEAM

The Project Review Team will coordinate the DCRDR Program. Typical team functions are to:

- Approve Task Plans prior to performance of associated Review Task
- Ensure that the DCRDR Program is performed in accordance with the AEPSC Quality Assurance Program
- Provide overall support to the DCRDR process
- Monitor the DCRDR progress
- Ensure that the design review objectives and tasks, in relation to other NUREG 0660 efforts, are properly coordinated
- Establish and initiate a control room improvement program

Key personnel for the Project Review Team are identified in figure 2-1.

2-5. DESIGN REVIEW TEAM

The Design Review Team comprises the qualified multidiscipline personnel to perform the various review functions. The areas of expertise include:

- NSSS and balance-of-plant systems
- Instrumentation and control

- Conrol board design
- Human factors
- Plant operations (licensed operators)
- Training
- Licensing/nuclear safety

The function of the Design Review Team is to carry out the entire design review program in accordance with the guidelines detailed in this Program Plan Report. Design Review Team responsibilities include the following:

- Develop the Program Plan Report
- Develop the Licensee Event Report Review Report
- Develop the Control Room Inventory
- Develop forms/checklists
- Develop Task Plans
- Develop Control Room Human Engineering Criteria Report
- Perform Review Tasks
- Develop Task Summary Reports
- Assist Assessment Team as technical support
- Develop Implementation Plans
- Develop the Program Summary Report

Key personnel for the Design Review Team are identified in figure 2-1.

2-6. ASSESSMENT TEAM

The Assessment Team will:

- Evaluate the significance of the observed departures from the CRHEC Report identified in the Phase II review

- Identify the applicable departures as human engineering discrepancies (HED)

- Assign a category and priority to the HEDs for scheduling of corrective action

- Review/approve control room recommendations for HED corrective action prior to origination of a request for change (AEPSC procedure 25).

Key personnel for the Assessment Team are identified in figure 2-1.

PROJECT REVIEW TEAM

* DCRDR Program Administrator: A. S. Grimes
* DCRDR Program Lead Engineer: R. F. Shoemaker
* DCRDR Program Plant Coordinator: T. R. Stephens
* DCRDR Program Project Engineer: F. Van Pelt, Jr.
* DCRDR Program Manager (Westinghouse): J. D. Young
* AEPSC Human Factors Consultant: Dr. T. Sheridan

DESIGN REVIEW TEAM

* DCRDR Program Administrator: A. S. Grimes
* DCRDR Program Lead Engineer/AEPSC I & C Engineer: R. F. Shoemaker
* AEPSC Nuclear Safety & Licensing Engineer: K. J. Toth
* I&MECO Reactor Operators
* DCRDR Program Plant Coordinator: T. R. Stephens
* AEPSC Quality Assurance Engineer: J. B. Brittan
* DCRDR Program Project Engineer: F. Van Pelt, Jr.
* AEPSC Electrical Engineer: L. P. DeMarco
* DCRDR Program Manager (Westinghouse): J. D. Young
* DCRDR Human Factors Consultant (Canyon Research): Dr. G. A. Elliff
* I&MECO & Westinghouse Training Personnel
* Westinghouse Training Personnel: R. J. Wartenberg

ASSESSMENT TEAM

* DCRDR Program Administrator: A. S. Grimes
* DCRDR Program Lead Engineer: R. F. Shoemaker
* AEPSC I&C Section Manager: J. C. Jeffrey
* AEPSC Nuclear Safety and Licensing Section Manager: J. G. Feinstein
* D. C. Cook Plant Management: B. A. Svensson
* AEPSC Human Factors Consultant: Dr. T. Sheridan
* I&MECO Senior Reactor Operator(s)
* AEPSC Manager of Quality Assurance: R. F. Kroeger
* AEPSC Electrical Generation Section Manager: R. C. Carruth

Figure 2 - 1. DCRDR Program Organization Structure

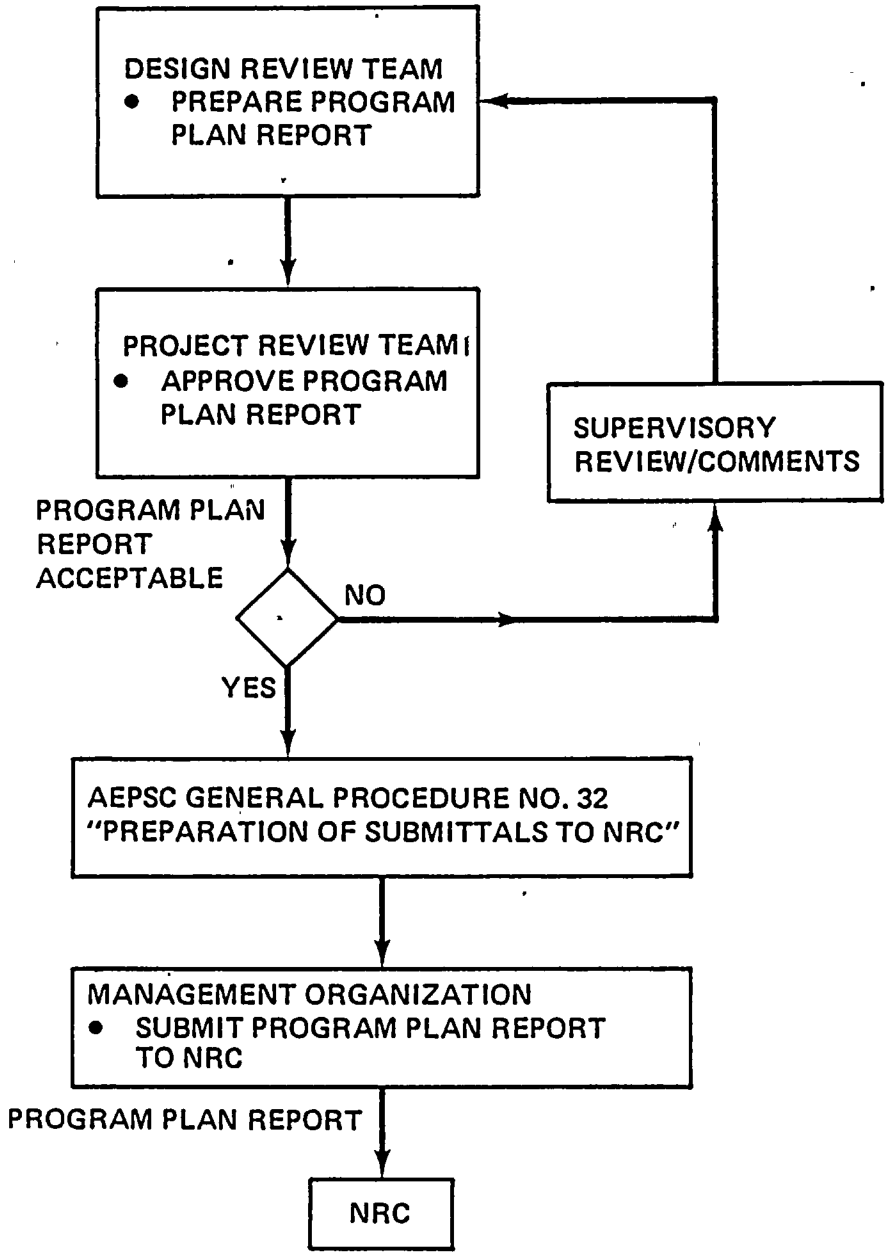


Figure 2-2. Personnel Interface and Information Flow Diagram for Phase I, Planning

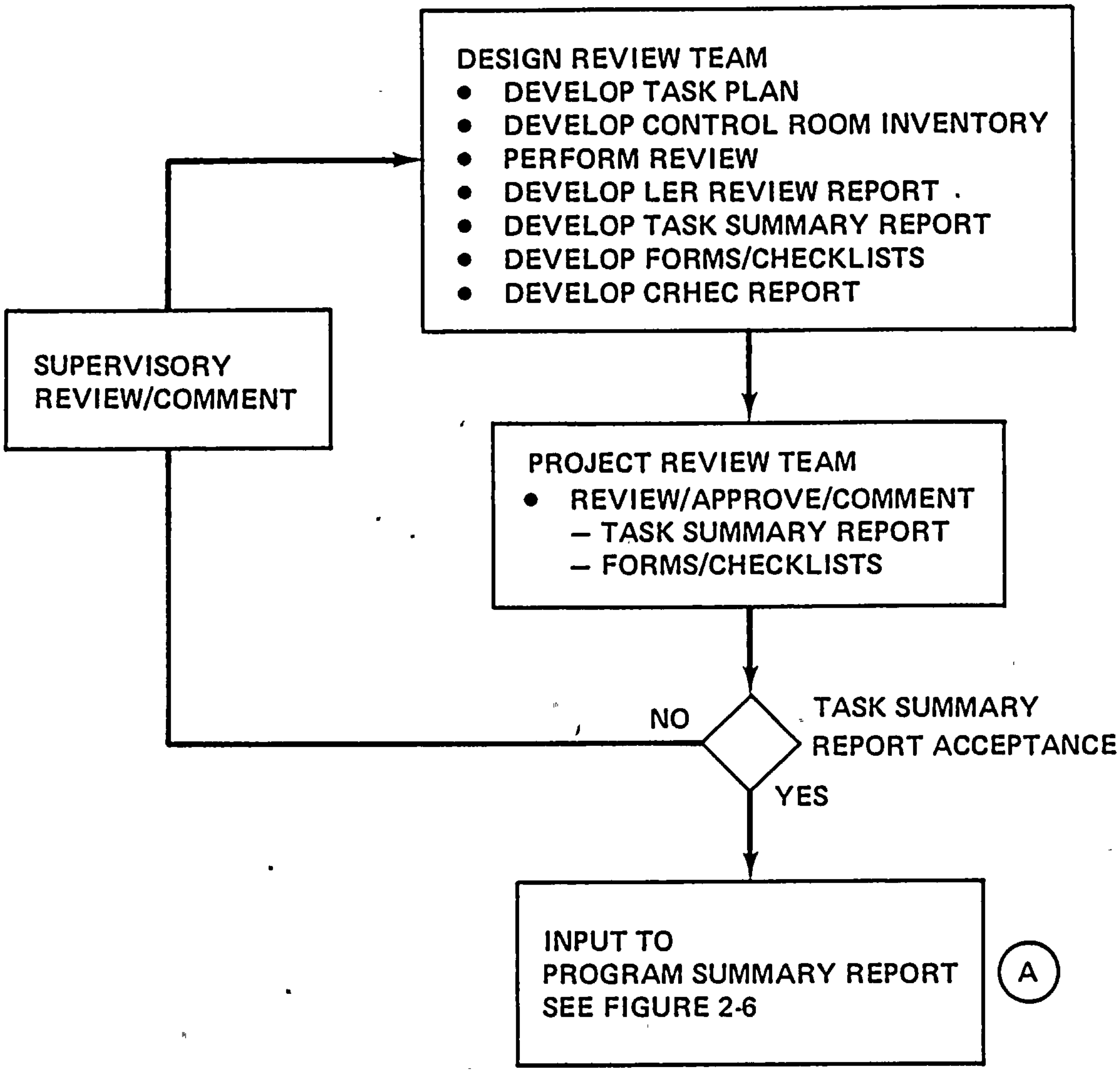


Figure 2-3. Personnel Interface and Information Flow Diagram for Phase II, Review

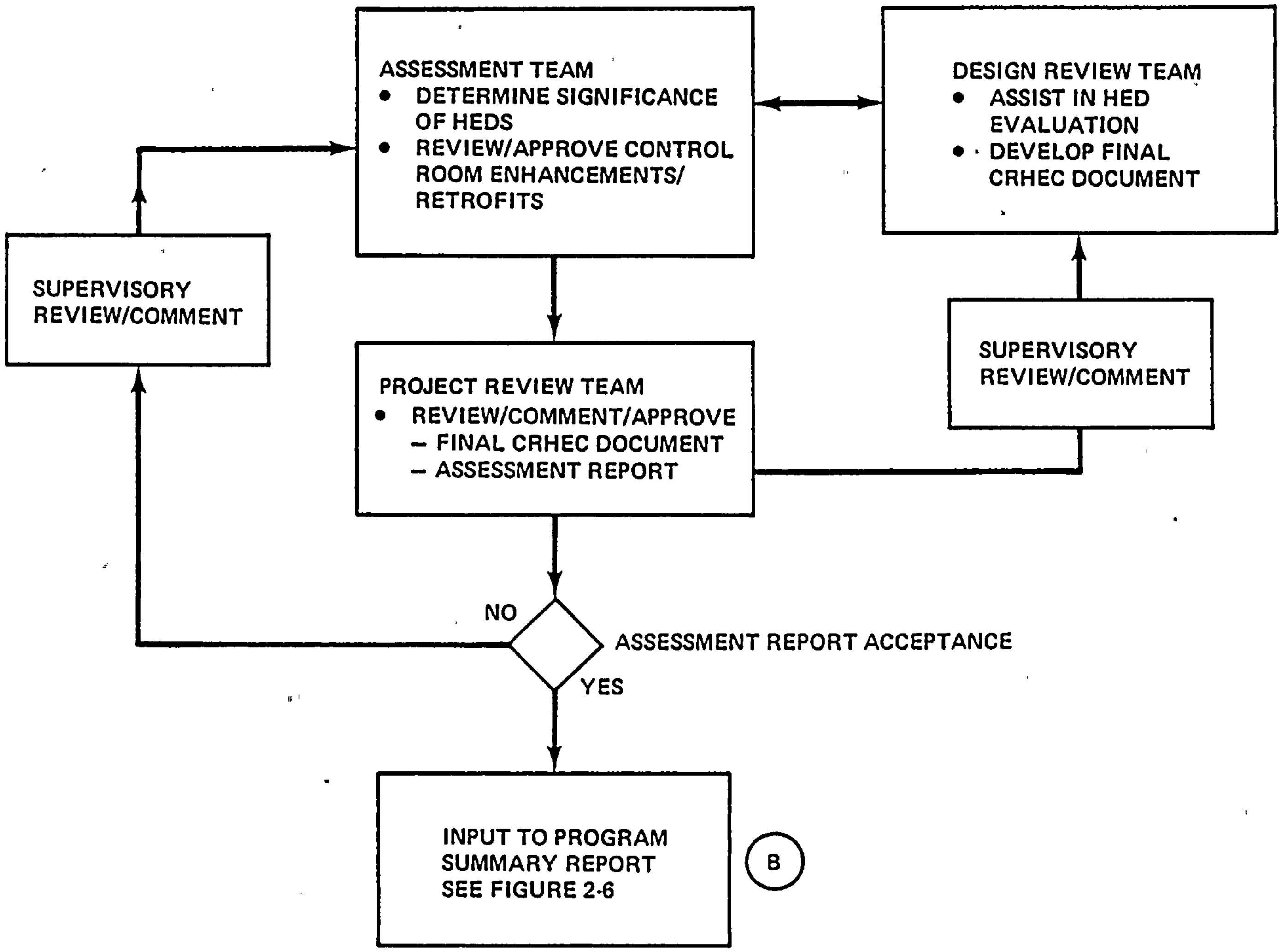


Figure 2-4. Personnel Interface and Information Flow Diagram for Phase III-A, Assessment

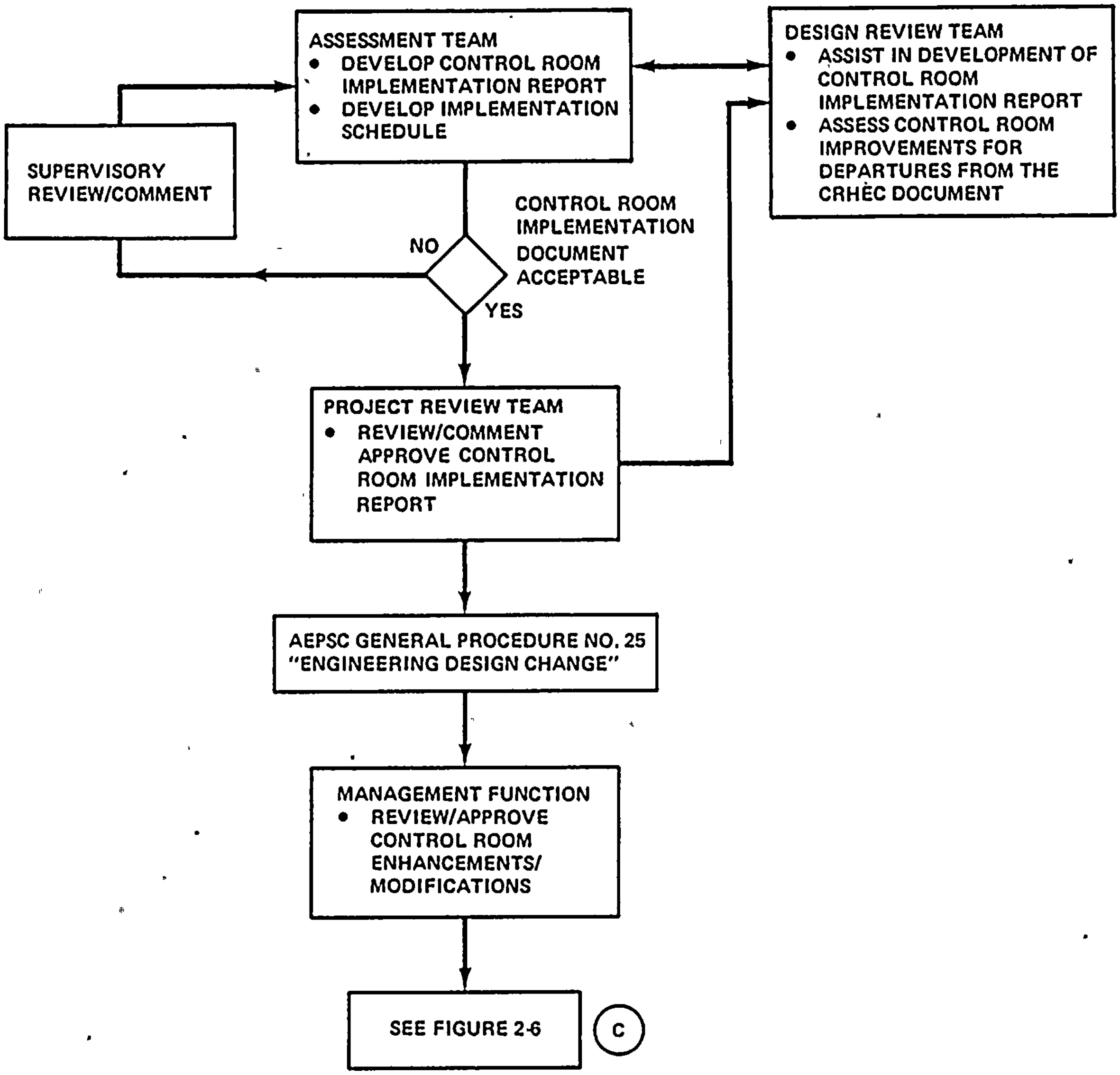


Figure 2-5. Personnel Interface and Information Flow Diagram for Phase III-B, Implementation

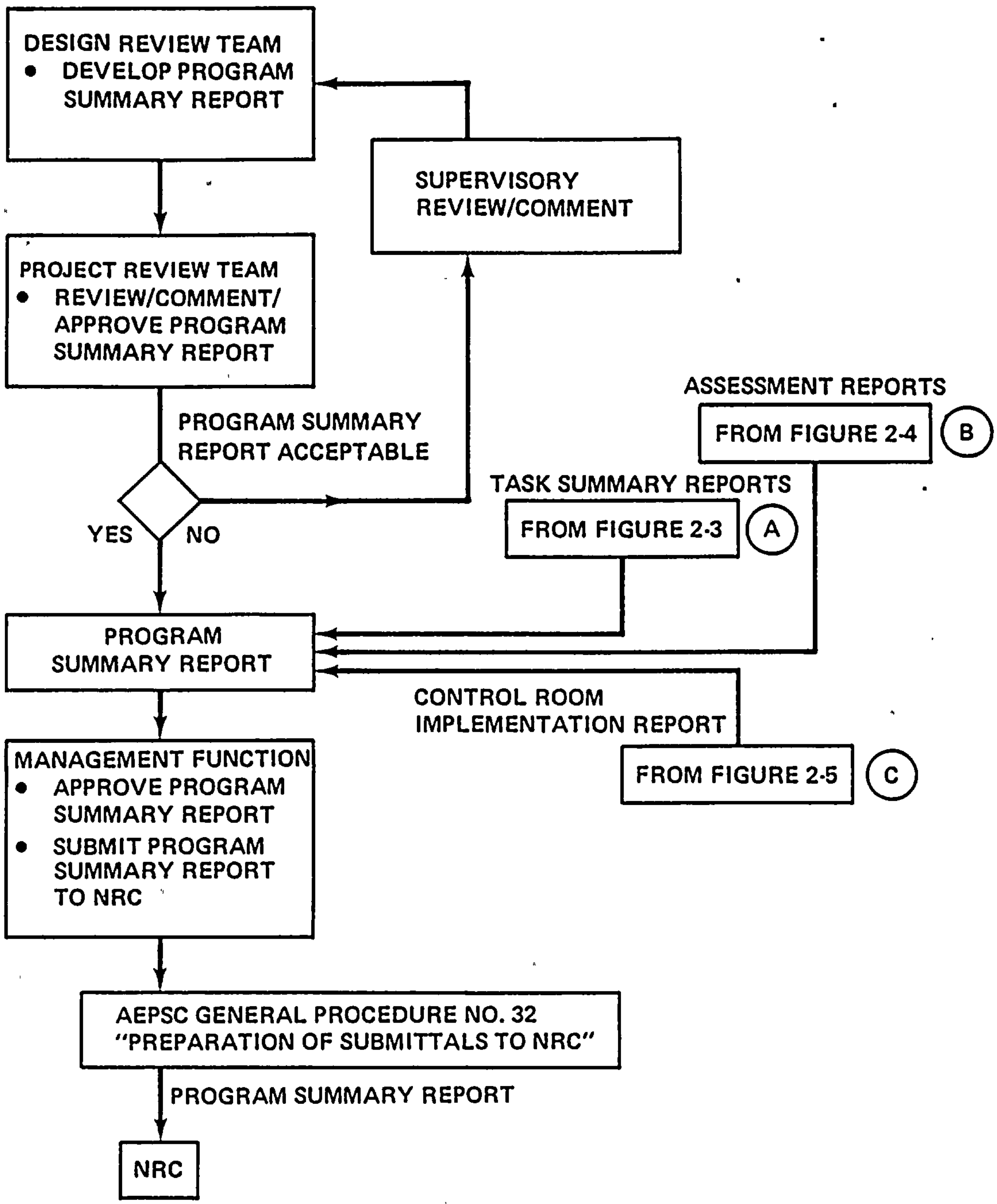


Figure 2-6. Personnel Interface and Information Flow Diagram for Phase IV, Reporting

SECTION 3
DOCUMENTATION AND DOCUMENT CONTROL

3-1. INTRODUCTION

A complete and up-to-date library of reference information is necessary to manage and perform the various phases of the DCRDR Program. This library will provide support during the design review as well as a data base for future control room modifications.

3-2. REFERENCE DOCUMENTATION

The following documentation will be used during the review phase:

- Control room drawings (panel layouts, floor plan, and the like)
- Control board equipment specifications
- Control panel photographs (photomosaic)
- Control room preliminary assessments
- Description of coding conventions
- Original and Updated FSAR for D. C. Cook Units 1 and 2
- Instrumentation and control diagrams
- Operator training material
- Systems function task analysis

- Lists of acronyms and abbreviations

- Piping and instrumentation drawings

- Plant computer software description and sample printout

- Procedures (emergency, normal, and the like)

- System descriptions

- Regulatory guides and NUREGs (paragraph 1-6)

- Control room inventory list

- AEPSC quality assurance procedure

- Licensee event reports

Any additional reference material identified by the design review team during the review phase (Phase II) will be obtained and added to the library.

Because D. C. Cook Units 1 and 2 are operating, access to the control rooms will be limited. Therefore, photomosaics will be used to perform most of the tasks outlined in section 5.

3-3. DCRDR-GENERATED DOCUMENTATION

The documentation generated by the design review process will be subject to those controls identified in paragraph 3-4. The following documentation will be produced by the DCRDR process:

- Program Plan Report (this document)

- Control room operating personnel surveys

- Control room inventory
- Control room human factor surveys
- Task plans, checklists, data collection forms, sketches, photographs, and photomosaics used in the review and assessment/recommendation phases
- Control room human engineering criteria report
- Licensee event report (LER) review
- Program Summary Report

3-4. DOCUMENT CONTROL

A controlled-access file will be established for all hard copy DCRDR Program output documents. In addition, these documents will be entered into a computer-based data system. Access to these files will be controlled by the DCRDR program manager.

SECTION 4
DESCRIPTION OF PHASE I, PLANNING

4-1. INTRODUCTION

The planning phase consists of developing a well-defined work program which outlines specific recommendations for personnel, reference material, and documentation needed to perform the Detailed Control Room Design Review Program (figure 4-1).

I&MECo intends to commence with the DCRDR Program as documented in this Program Plan Report prior to formal acceptance by the NRC. Any deficiencies noted in this Program Plan Report should be brought to the attention of a I&MECo in a timely manner. Final acceptance of this document will end the Planning Phase.

4-2. DCRDR MILESTONES

A schedule for Phases I and II of this Program Plan was developed and is included as figure 4-2. As stated in the I&MECo response to G.L. 82-33 (AEP:NRC:0773) on April 15, 1983, an intermediate milestone response will be sumitted to the NRC with the current status of the DCRDR Program on September 1, 1984. At that time, Phases I and II will be essentially completed, and an estimate for the Phase III-A Assessment will be developed shortly thereafter. The NRC will be provided with more detailed information regarding Phase III-A Assessment schedule (in another intermediate milestone response) when this estimate has been made and the evaluation of it is completed.

4-3. CONTROL ROOM HUMAN ENGINERING CRITERIA REPORT

At the beginning of the review phase, a preliminary Control Room Human Engineering Criteria Report will be developed. This preliminary criteria report will contain, as a baseline, detailed Task Plans which will be executed to complete specific Phase II Review Tasks within the DCRDR Program. The Task

Plans have been proven effective on over 20 human factors control room reviews. The Task Plans will provide a detailed audit trail to the generic guidelines provided in NUREG 0700, yet have been restructured to facilitate the data collection, documentation, and auditing requirements inherent in a NUREG 0700 oriented DCRDR Program.

Based on observations and assessments of the DCRDR Program, the generic guidelines of NUREG 0700 found in the preliminary CRHEC Report will be revised to reflect plant-specific design conventions and plant-specific human factors criteria. A section of the final CRHEC Report will be dedicated to departures from NUREG 0700 with the applicable justification provided therein. The final CRHEC Report is intended to ensure that any future control board modifications reflect previously evaluated human factors practices and do not detract from operability of the control board.

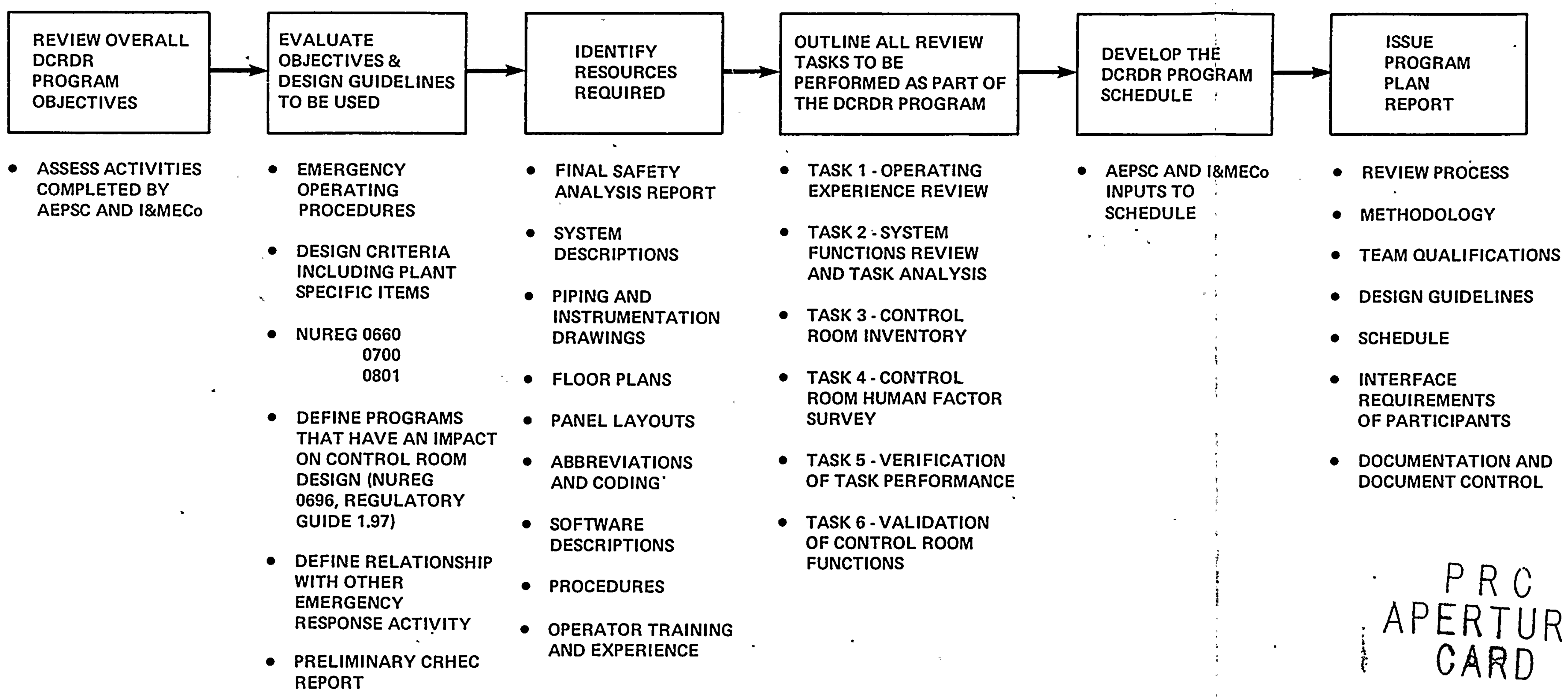


Figure 4-1. Planning Phase Development Outline

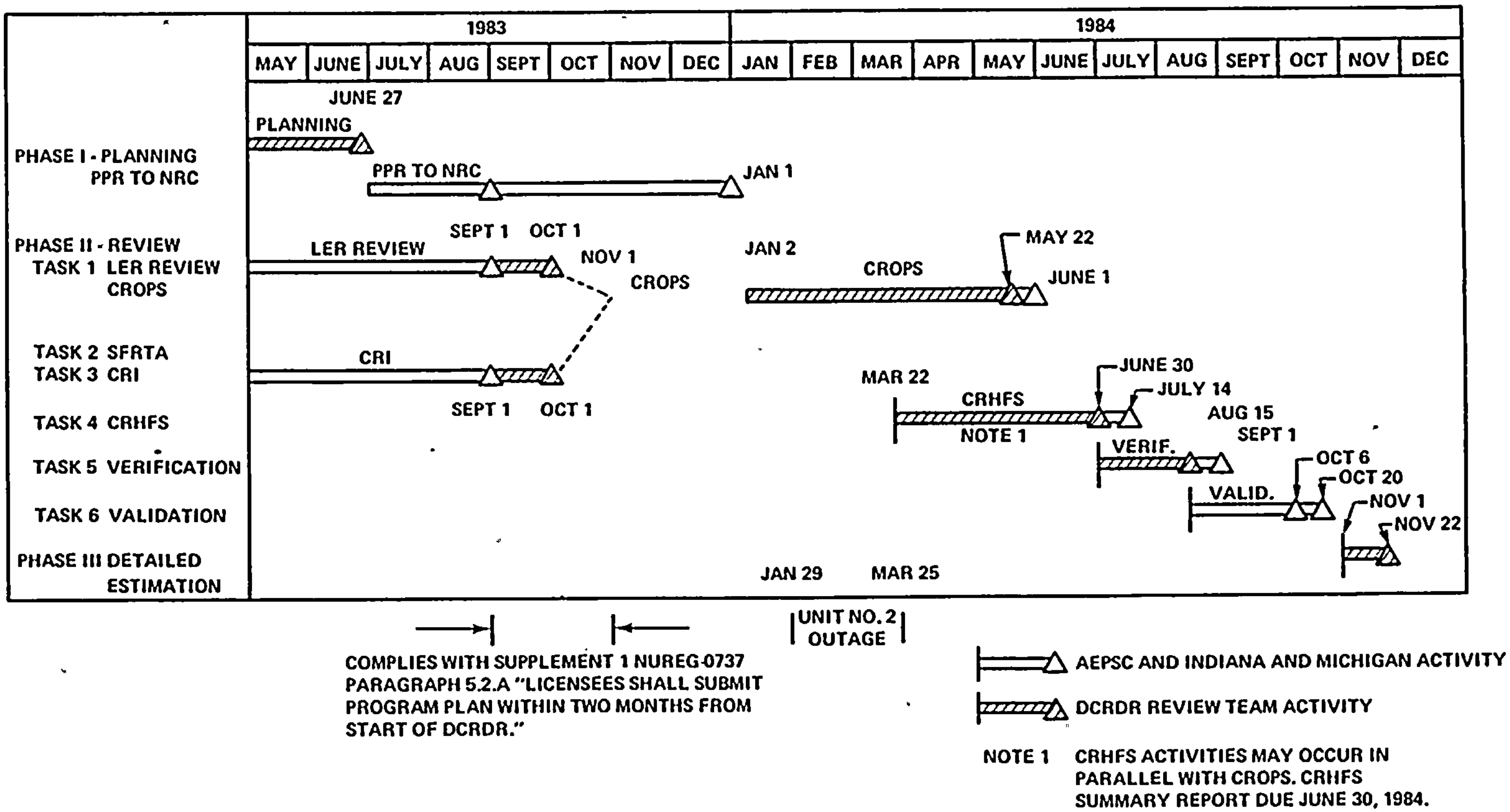


Figure 4-2. DCRDR Program Schedule for Phases I and II

SECTION 5
DESCRIPTION OF PHASE II, REVIEW

5-1. INTRODUCTION

During the Review Phase of the D. C. Cook DCRDR Program, data will be collected and human factors issues will be reviewed. Thus, the objective of the Review Phase is the collection of data identifying attributes of the D. C. Cook Units 1 and 2 control rooms which depart from criteria specified in the D. C. Cook Control Room Human Engineering Criteria Report (paragraph 4-3).

The Review Phase will generate:

- Task Summary Reports for each major review phase task specifying methods used and findings
- Component sheets specifying the findings of each task related to each component in the control room
- Checklist observation forms documenting departures from the human engineering criteria established before and during the review phase

5-2. REVIEW PHASE STAFFING

The Review Phase will be conducted by the Design Review Team. Representatives of I&MECo, AEPSC, Westinghouse, and Canyon Research Group will be included on the team. Appropriate disciplines from these organizations will be included on each task team. Design Review Team members include:

- System designers and analysts
- Human factors consultants
- Control board designers

- Instrumentation and control engineers
- Plant operators
- Licensing engineers
- Data management technicians
- Electrical engineers
- Quality assurance engineers

5-3. METHODOLOGY FOR REVIEW PHASE TASKS

The methodology for the Review Phase tasks will consist of executing Task Plans and completing human engineering surveys as reflected in the D. C. Cook Control Room Human Engineering Criteria Report.

5-4. Task 1 -- Operating Experience Review

The operating experience review consists of two related activities. The first is a review of plant performance records for D. C. Cook Units 1 and 2 (and a review of LERs for other similar plants) to identify areas in which human error has caused problems in the past that may be related to control panel design. The second activity is the Control Room Operating Personnel Survey (CROPS). The Design Review Team will interview a representative sample consisting of at least 50 percent of the licensed control room operators at D. C. Cook Units 1 and 2. The objective of the CROPS is to identify specific attributes of the D. C. Cook Units 1 and 2 control board design which, in the operators' opinions, have caused or could potentially cause operator error. The CROPS will be conducted by administration of questionnaires and by conducting individual and group interviews.

5-5. Task 2 -- System Function and Task Analysis

The System Function and Task Analysis will establish instrumentation requirements and performance criteria for select normal and emergency conditions. This task will be performed by using plant-specific procedures generated from the Westinghouse Owners' Group Emergency Response Guidelines. These plant-specific procedures will be submitted to the Design Review Team. This data will provide input to the Design Review Team for the verification and validation of control room functions (Tasks 5 and 6).

5-6. Task 3 -- Control Room Inventory

The control room inventory will be developed on a computer data base and will include all data required by NUREG 0700 for each component. AEPSC will develop and maintain the D. C. Cook Control Room Inventory data base. Formats and completeness of the data item list have been reviewed by all review team members and comments have been incorporated to ensure that the inventory data base to support relevant D. C. Cook DCRDR Program tasks can be accepted.

5-7. Task 4 -- Control Room Human Factors Survey

The bulk of the detailed data regarding specific departures from the Control Room Human Engineering Criteria Report will be gathered in the Control Room Surveys Task. The Control Room Surveys Task will be conducted by completing 14 human engineering surveys as follows:

- Workspace
- Anthropometrics
- Emergency equipment
- Heating, ventilating, and air conditioning
- Illumination

- Ambient noise
- Maintainability
- Communications
- Annunciator
- Controls
- Displays
- Labels and location aids
- Computer system review
- Conventions

Detailed Task Plans, checklists, special data collection forms, NUREG 0700 criteria references applicable to D. C. Cook, and methodology descriptions for each survey will be included in the CRHEC Report. The Annunciator Survey Task Plan is included in this Program Plan Report in appendix C as an example.

5-8. Workspace Survey -- This survey concentrates on the general layout and arrangement of control room equipment. The workspace survey will also address the adequacy of control room noninstrumentation items such as desks and chairs.

5-9. Anthropometric Survey -- The anthropometric survey will assess and document the vision and reach envelopes for all D. C. Cook control room equipment. This data will be evaluated for general control and display location adequacy based upon the CRHEC Report anthropometric criteria for the 5th percentile female and 95th percentile male. In addition, the anthropometric data will be used to support the verification and validation tasks.

5-10. Emergency Equipment Survey -- Emergency equipment will be evaluated for usability by the control room operators. Included will be an assessment of emergency equipment storage locations; operator accessability; tactile, visual, and auditory adequacy of breathing apparatus and protective clothing; and other critical features of the control room emergency equipment.

5-11. Heating, Ventilating, and Air Conditioning Survey -- The air flow, temperature regulation, and humidity control within the control room will be evaluated in terms of the CRHEC Report. The primary concern is to identify parameters which may be out of tolerance or unstable to the point of adversely affecting the recommended comfort zones for the control room.

5-12. Illumination Survey -- Ambient illumination will be measured using appropriate instruments for lighting levels at various workstations and control board areas. Presence of glare, if any, on instrumentation will be documented. Illumination will be evaluated for compliance with recommended and required light levels for identified tasks.

5-13. Ambient Noise Survey -- Ambient noise will be measured using appropriate sound measurement equipment. A primary concern will be the peak and average decibel(A) levels and the preferred octave band decibel levels for the ambient noise conditions. The data will be reviewed for potential sound problems which may interfere with operator communication requirements or which may mask auditory signals.

5-14. Maintainability Survey -- The maintainability survey will assess human factors suitability of all equipment in the control room. Primary concerns are that the operators can maintain indicator lights, determining if annunciator system bulbs are replaceable, replenishing expendables such as recorder paper and ink, and determining that spare parts and expendables are available and accessable.

5-15. Communications Survey -- The control room communication systems will be reviewed and evaluated to determine if they are adequate to support emergency and normal operations. Systems such as the paging system, intercom

system, telephone system, sound-powered and portable radio communications equipment, and free/air, unaided voice communications will be included in this review. Auditory signals will also be evaluated for applications, meaning, coding techniques, signal transmission/propagation, and signal characteristics.

5-16. Annunciator Systems Review -- The annunciator system, as a special case of legend light displays and auditory signals, will be evaluated in terms of its general human engineering suitability and also as a critical and central control room system used in the identification of transient and emergency conditions. Data collected will be analyzed for discrepant characteristics which may potentially increase the probability of human error. Also, relevant data will be used to support the verification and validation tasks.

5-17. Controls Survey -- All controls will be reviewed for general human engineering suitability without reference to specific task supportive roles. The primary criteria will be that contained in the CRHEC Report based on section 6.4 of NUREG 0700.

5-18. Displays Survey -- As with controls, all displays will be checked for general human engineering suitability independently of the specific tasks in which the displays are used. The primary criteria will be that contained in the CRHEC Report based on Section 6.5 of NUREG 0700.

5-19. Labels and Location Aids -- The control panels and instrumentation will be surveyed for general readability and consistency of terms, abbreviations, and acronyms. Data from this task and the conventions survey will furnish the base line information used to establish a standard dictionary of terms, abbreviations, and acronyms used throughout the control room.

5-20. Computer System Review -- The P-250 process computer system used in the control room will be assessed for its functional integration into the operational requirements of the control room. It will also be evaluated for general human factors suitability and for its supportive role in control room operation. The critiera from the CRHEC Report, based on NUREG 0700, Section 6.7 (process computers), forms the basis for this task plan.

5-21. Conventions Survey -- The purpose of the conventions survey is threefold. Those conventions used at D. C. Cook, whether general stereotypes, industry conventions, or plant-specific conventions, will be identified. Second, the identified conventions will be evaluated for good human factors characteristics, as defined in the criteria from the CRHEC Report based on section 6 of NUREG 0700. Finally, any inconsistencies in the applications of identified conventions will be documented and their impact assessed. Data from this task and the labeling and location aids task will be used to develop and document a standard dictionary of terms, abbreviations, and acronyms for the D. C. Cook plants.

5-22. Task 5 -- Verification of Control Room Function

As one of the two terminal tasks in the review phase, the presence and suitability of control room instrumentation will be verified. The primary concern will be determining that all required information and control capabilities are in the control room. As a corollary, the presence of nonessential information and control instrumentation will be assessed to ensure that it does not detract from adequate operator performance. Data from the Control Room Inventory and the systems function and task analysis are extensively used in these activities.

5-23. Task 6 -- Validation of Control Room Functions

Through a process of walkthroughs and talkthroughs selected emergency and normal operations will be validated for the availability of required skills and knowledge of the trained operators.

5-24. PRODUCTS OF THE REVIEW PHASE

The primary output of the Review Phase is a set of checklist observation (CLO) forms. Each departure from established human factors criteria observed during the Review Phase will be documented. Each CLO form will state the problem, affected components, criteria violated, probable error, and other relevant data required for analysis of the problem.

The CLOs will provide the primary input to the Assessment Phase, where each will be categorized according to safety and/or operational impact. In addition, at the completion of the Review Phase, component sheet files will be complete, and Task Summary Reports for each task will have been prepared.

SECTION 6
DESCRIPTION OF PHASE III-A, ASSESSMENT

6-1. INTRODUCTION

The review process described in section 5 will result in the identification of departures from human engineering criteria defined in the CRHEC Report. Analysis and interpretation of these departures will be required to establish their potential safety implications. Means of correcting or minimizing the effects of the departures will be identified and documented. A plan of action will be applied to improvements affecting operator performance under emergency and selected normal operating conditions.

The Phase III activities of assessment and implementation are covered in this section and section 7, following. The Assessment Phase of the DCRDR Program will achieve the following objectives:

- Analyze and evaluate the observed departures from human engineering criteria identified during the review phase
- Recommend the means of correcting those departures which could affect safety or plant/operator performance.
- Define a plan of action which applies the human factor principles to improve control room design and to enhance operator effectiveness and efficiency
- Apply the assessment process to other projects related to the control room which are concerned with, or may be affected by, the human factors review (Regulatory Guide 1.97, Revision 2, safety parameters display system, procedures, training)

6-2. METHODOLOGY

The assessment process involves the review and evaluation of all CRHEC Report departures identified by the Design Review Team during Phase II to determine which departures can affect the operator's performance such that the potential for operator eror is increased. This process also involves determining the extent of corrections and justifying any recommendations which do not completely correct the discrepancies.

All departures from the CRHEC Report identified during the Review Phase will be processed according to the assessment methodology presented in figure 6-1. These departures will be documented on checklist observation forms and will be provided to the Assessment Team for analysis and assessment. Also, some of the operating personnel will be canvassed using the photomosaic to resolve any factors which could contribute to performance problems.

The Assessment Team will review the CLOs to determine the need for reassessment by the Design Review Team or their acceptance as HEDs. The disposition of each CLO will be justified and/or documented by the Assessment Team. The Assessment Team will evaluate and categorize each HED according to the methodology presented in figure 6-2. This approach accomplishes the assessment objectives of NUREGs 0700 and 0801.

All category I, II, and III HEDs will be analyzed for correction as per figure 6-3. Category IV HEDs, considered optional for correction, will be assessed for their cumulative and interactive effects on all other HEDs. Those category IV HEDs shown to possess the above effects will be recategorized to the appropriate category II level.

The initial step in this process is to identify those HEDs which can be corrected by enhancements, training of operators, and/or procedural revisions. The remaining HEDs will be analyzed to identify and provide design improvement alternatives. A cost/benefit analysis will be performed to determine which corrections are the most feasible and acceptable from a human engineering point of view. As a part of the review, I&MECo/AEPSC will perform a cost/ benefit assessment for implementation of the recommendations.

The control room review process will be reapplied as appropriate to ensure the following:

- That the creation of new HEDs is identified
- That other corrections are not invalidated
- Compliance with human engineering guidelines developed during Phase II

The HEDs and final recommendations for correction provided by the assessment team will be submitted to the Project Review Team for review and disposition. Rejected CLOs and/or recommendations will be returned to the Assessment Team for additional assessment.

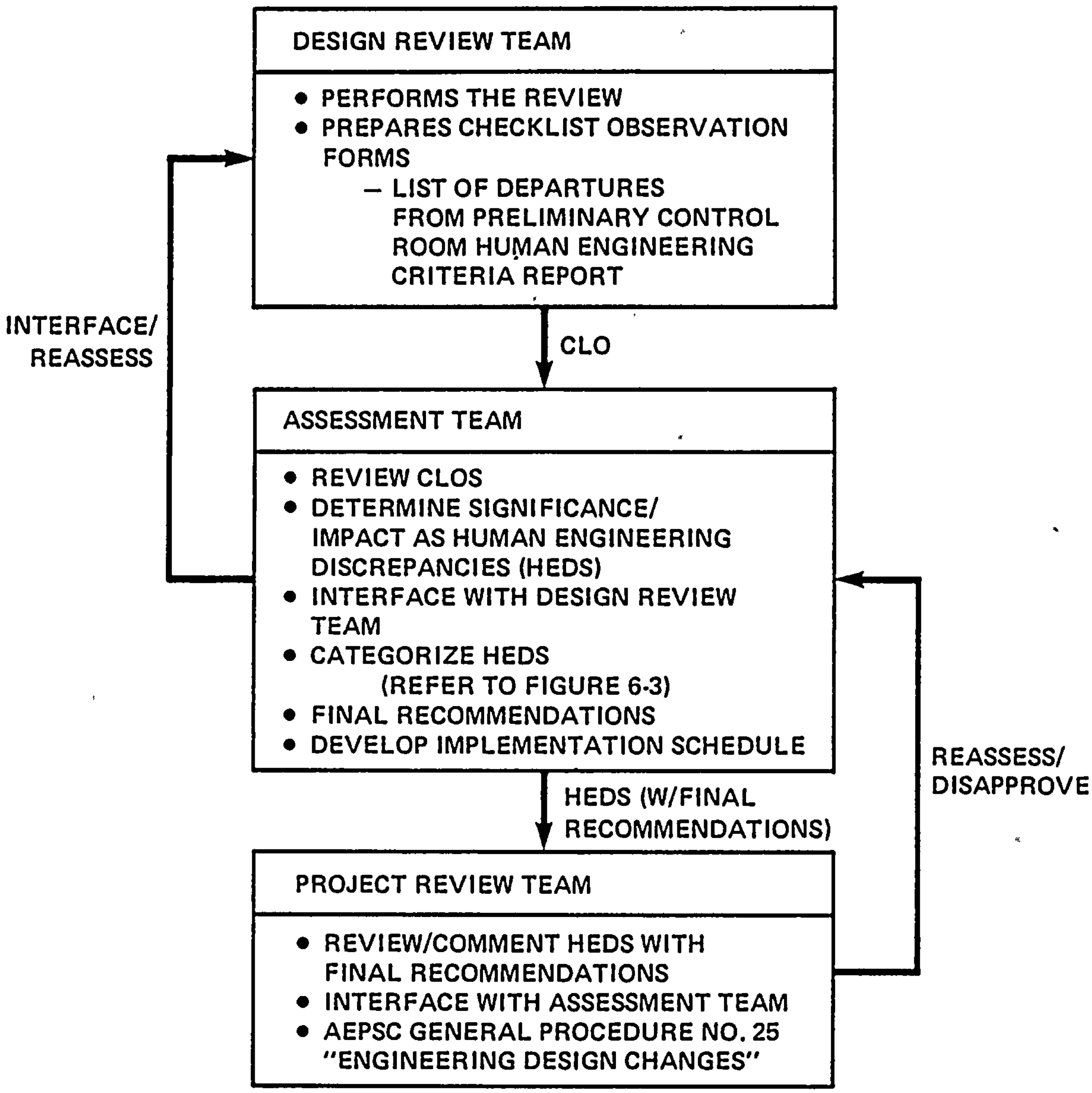


Figure 6-1. Assessment Methodology Chart

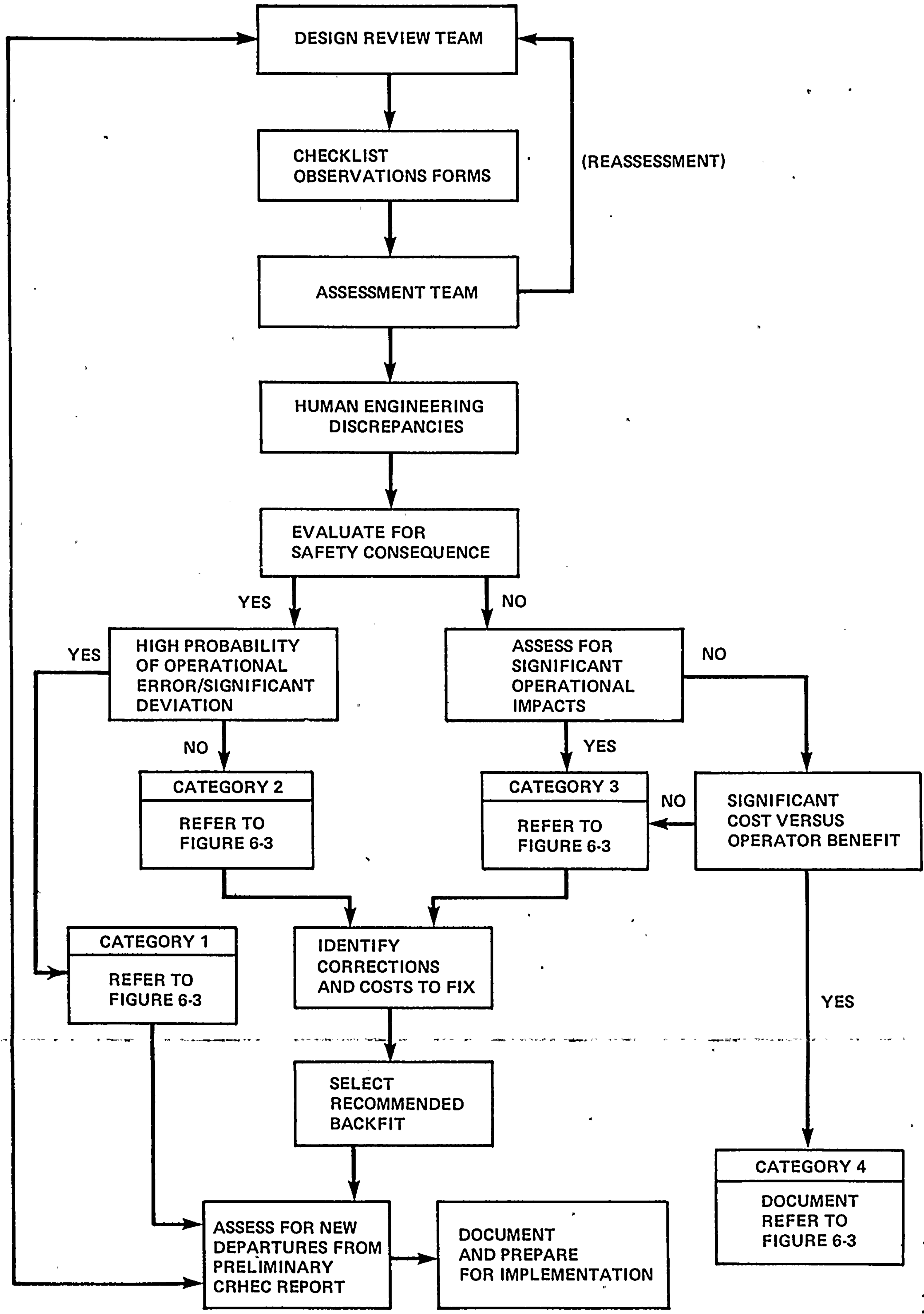
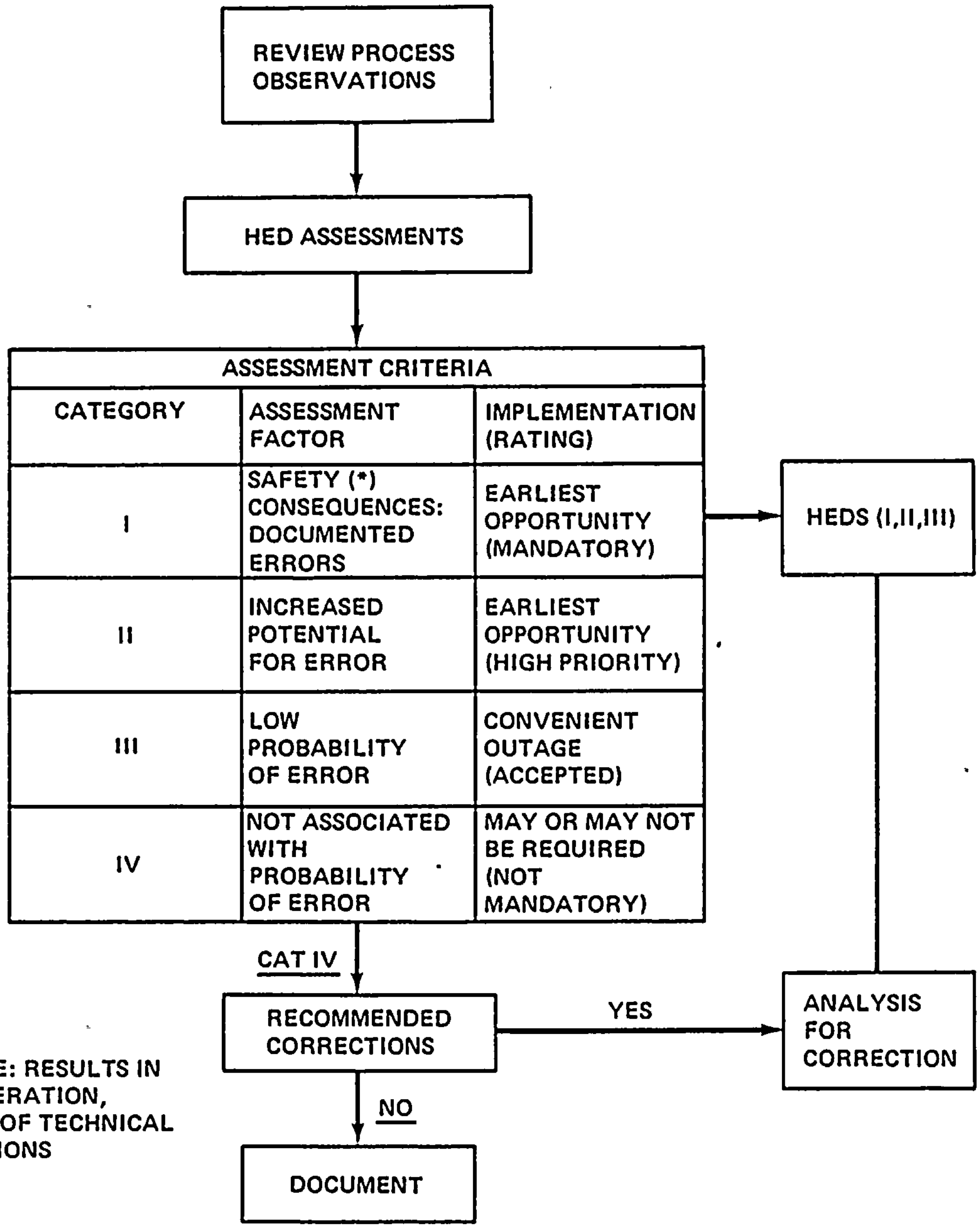


Figure 6-2. Human Engineering Discrepancy Evaluation Flow Chart



(*) EXAMPLE: RESULTS IN UNSAFE OPERATION, VIOLATION OF TECHNICAL SPECIFICATIONS

Figure 6-3. HED Category Guidelines

SECTION 7
DESCRIPTION OF PHASE III-B, IMPLEMENTATION

Approved solutions of HEDs by the Project Review Team will be scheduled for implementation. The category guidelines established in section 6 will be used as a basis for the corrective action schedule. Additional considerations in the development of the implementation schedule will be:

- Safety consequences of operator errors that could be caused by the discrepancy
- Integration with other post-TMI programs
- Plant operation constraints
- Operator training/retraining requirements
- Outage schedules
- Equipment procurement schedules

The following designations, identifed in NUREG 0801, will be adopted for scheduling purposes:

- Prompt action. Correct problems promptly on a schedule approved by the NRC. Make changes at the first refueling after submittal of the report or the first outage after receipt of equipment (expedited).
- Near term. Correct problems on a schedule approved by the NRC. Make changes at the second refueling outage after submittal of the report.
- Long term (optional). Corrections of insignificant discrepancies may be implemented at any time.

SECTION 8
DESCRIPTION OF PHASE IV, REPORTING

A Program Summary Report will be prepared in accordance with NUREGs 0700 and 0801 upon completion of the DCRDR Program. This report will document the overall review process, describe and identify all of the human engineering discrepancies and findings, and summarize all DCRDR activities, methodologies, and proposed control room improvements. This report will also provide an implementation schedule for planned corrective action. The schedule for planned corrective action shall be based on realistic and achievable dates. The use of intermediate milestones in place of end dates may be used if additional relevant information is not available at the time the Program Summary Report is submitted to the NRC. Intermediate milestone dates will be determined based upon the date by which necessary additional information will be known, thus permitting an informed determination of end dates. The Program Summary Report will update the Program Planning Report.

The Program Summary Report will be prepared using the recommended format shown in figure 8-1. In addition to this final report, supporting documentation will be available for completeness in the event of an NRC audit.

CONTROL ROOM DESIGN REVIEW SUMMARY REPORT

1.0 METHODOLOGY

1.1 Detailed Control Room Design Review Program Plan Objectives

1.1.1 Detailed Control Room Design Review methodology

1.1.2 Detailed Control Room Design Review program management

1.1.3 Proposed schedule of the four phases of activity (chart)

1.1.4 Integration of other emergency response activities of NUREG 0737, Supplement 1

1.1.5 Quality assurance program

1.2 Management and Staffing

1.2.1 Qualification of Detailed Control Room Design Review personnel

1.2.2 Organizational structure of DCRDR Review Teams

1.3 Documentation and Document Control.

1.4 Review Phase

1.4.1 Operating experience review

1.4.2 System functions review and task analysis

1.4.3 Control room inventory

1.4.4 Control room human factors survey

1.4.5 Verification of task performance

1.4.6 Validation of control room functions

2.0 REVIEW CONCERNS

2.1 Control Room Human Factor Survey Concerns

2.1.1 Workspace Survey

2.1.2 Anthropometrics Survey

2.1.3 Emergency Equipment Survey

2.1.4 Heating, Ventilation, and Air Condition Survey

2.1.5 Illumination Survey

2.1.6 Ambient Noise Survey

Figure 8-1. Sample of Program Summary Report Format (Sheet 1)

CONTROL ROOM DESIGN REVIEW SUMMARY REPORT (cont)

- 2.1.7 Maintainability Survey
- 2.1.8 Communication Survey
- 2.1.9 Annunciator Systems Review
- 2.1.10 Controls Survey
- 2.1.11 Displays Survey
- 2.1.12 Labels and Location Aids
- 2.1.13 Computer System Review
- 2.1.14 Conventions Survey

2.2 Panel/Work Station Concerns

2.3 System Concerns

2.4 Other Review Concerns

3.0 <u>ASSESSMENT, RECOMMENDATION, AND IMPLEMENTATION PHASE</u>

3.1 HED Assessment

3.2 Proposed Implementation

3.3 Scheduled Implementation

4.0 <u>CONCLUSION</u>

Figure 8-1. Sample of Program Summary Report Format (Sheet 2)

SECTION 9
COORDINATION WITH NUREG 0737, SUPPLEMENT 1, ACTIVITIES

The activities to be coordinated with the DCRDR in accordance with NUREG 0737, Supplement 1, include the following requirements for Emergency Response Capabilities:

- Safety Parameter Display System (SPDS)
- Upgrade of Emergency Operating Prodecures (EOPs)
- Application to Emergency Response Facilities - Regulatory Guide 1.97
- Emergency Response Facilities (ERFs)

I&MECo will address these activities as referenced in I&MECo's response to NRC Generic Letter 82-33 for D. C. Cook Units 1 and 2; letter #AEP-NRC-0773, dated April 15, 1983. A schedule of performance and integration of these other post TMI activities with the DCRDR is shown in Figure 9-1.

6755B:1/062883

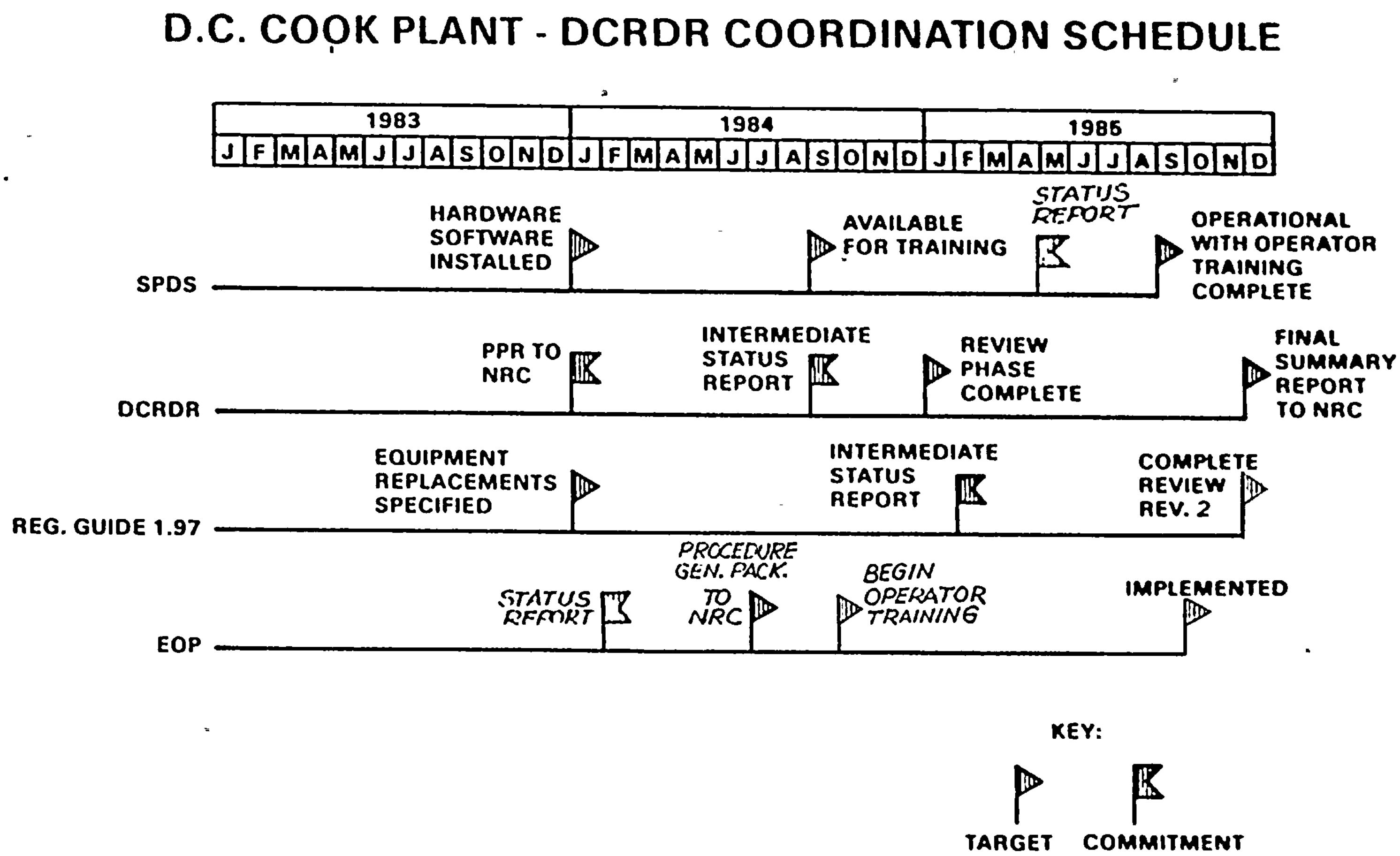


Figure 9-1. Schedule of Performance

SECTION 10
QUALITY ASSURANCE

The DCRDR Program will be performed in accordance with AEPSC Quality Assurance Program for the Donald C. Cook Nuclear Plant, specifically AEPSC General Procedure 2.1 and other applicable general procedures as referenced herein and the applicable portions of Westinghouse WCAP-8370 pertaining to document control and auditability.

SECTION 11
SUMMARY

This Program Plan Report defines the overall process by which the D. C. Cook Units 1 and 2 Detailed Control Room Design Review Program will be performed. It is an effective and thorough design review which will ensure that the results of this effort meet the intent of all applicable government regulations and guidelines.

Indiana and Michigan Electric Company has committed the resources needed to perform the design review as detailed in this document. Therefore, the acceptability of the Detailed Control Room Design Review Program will be based on the approval of this Program Plan Report. The Indiana and Michigan Electric Company Corporation reserves the right, however, to make changes and will notify the NRC prior to the execution of any planned departures.

Final acceptance of this document will end the Planning Phase of this program.

APPENDIX A
LIST OF ABBREVIATIONS

The following abbreviations apply only to this Program Plan Report and do not necessarily apply to efforts associated with plant standard abbreviations.

A/E - Architect/Engineer
AEPSC - American Electric Power Service Corporation
BOP - Balance of Plant
CLO - Checklist Observation (form)
CR - Control Room
CRI - Control Room Inventory
CROPS - Control Room Operating Personnel Survey
CRT - Cathode Ray Tube
DCRDR - Detailed Control Room Design Review
DRT - Design Review Team
EOP - Emergency Operating Procedures
EPRI - Electric Power Research Institute
ERG - Emergency Response Guidelines
FSAR - Final Safety Analysis Report
HE - Human Engineering
HED - Human Engineering Discrepancy
HF - Human Factors
I&C - Instrumentation and Control
I&MECo - Indiana and Michigan Electric Power Company (licensee)
INPO - Institute of Nuclear Power Operators
LE - Lead Engineer
LER - Licensee Event Report
MCB - Main Control Board
MWe - Megawatt (electric)
MWt - Megawatt (thermal)
NRC - Nuclear Regulatory Commission
NSSS - Nuclear Steam Supply System
OSD - Operational Sequences Diagrams
PC - Plant Coordinator
PM - Program Manager
PPR - Preliminary Planning Report

PRT - Project Review Team

PSR - Program Summary Report

PWR - Pressurized Water Reactor

SFTA - Systems Function and Task Analysis

SPDS - Safety Parameter Display System

TMI - Three Mile Island

WOG - Westinghouse Owner's Group

CRHEC - Control Room Human Engineering Criteria

TP - Task Plan

CRG - Canyon Research Group

CRHFS - Control Room Human Factors Survey

APPENDIX B

RESUMES OF KEY PERSONNEL

Robert F. Kroeger

Manager of Quality Assurance

Twenty three years experience in electrical engineering, nuclear fuel, and quality assurance involving major power generating and distribution in the U.S.

EDUCATION: B. S. Electrical Engineering
Purdue University - 1960

Additional Education:
- -Indiana University - Business Management 1960-62
- -General Electric Co. Power Systems Engineering Course 1967-1968
- -AEP Management Program - University of Michigan - 1980

EXPERIENCE: American Electric Power Service Corporation.

1978 to Present — Manager of Quality Assurance - Responsibilities include: formulating and recommending policies and practices with respect to the QA and QC programs for Cook Plant; establishing effective QA and QC programs for the Cook Plant; insuring effective implementation of the established QA and QC programs; providing guidance and assistance to AEPSC and Cook Plant management on QA and QC requirements and then implementation; monitoring of compliance with established QA programs through audits, surveillance and reviews; and reporting to Senior management and QA programs effectiveness. Direct the day-to-day operation of the AEPSC QA Department including recommending the hiring, salary adjustments, promotions, transfers, disciplining, and termination of personnel. Continue as Secretary of the CCB. Elected a member of the AEPSC Nuclear Safety Design Review Committee (Offsite review committee for Cook Plant).

1976 to 1978 — Staff Engineer, Nuclear Engineering Division - Responsibilities included participation in nuclear fuel design reviews, vendor evaluation, and inprocess surveillance and audits of nuclear fuel fabrication. Continued as Secretary of the CCB.

1973 to 1976 — Staff Engineer, Project Management Division - Responsibilities included development of transmission and distribution project management systems and techniques, methods of manpower allocations, and methods for cost control. Was assigned the responsibility as Secretary of the AEPSC Change Control Board (CCB) for the Donald C. Cook Nuclear Plant. Was assigned to a 2 person task action group to develop corporate project management and control procedures for an anticipated, new high temperature gas cooled nuclear reactor project. Received additional special assignments on Cook Plant in the areas of control of modification, and tracking of commitments.

1971 to 1973 — Administrative Assistant to the AEPSC Vice Chairman, Engineering and Construction - Responsibilities were numerous and widely diversified involving all facets of electric utility engineering, design, construction and operation. Assigned responsibilities for coordination of numerous special projects, studies and problem solving task forces. Prepared responses to outside correspondence for all levels of senior management. Developed and implemented an AEPSC engineering manpower monitoring programs to continually monitor changes in engineering manpower and technical level of engineering.

1970 to 1971 — Senior Engineer - Electrical Engineering Division Special Assignment to Nuclear Task Force - D. C. Cook Nuclear Plant (17 months) - Responsibilities included development of; Electrical Engineering Division QA procedures, site electrical construction QA procedures, electrical equipment specifications, original corporate wide seismic qualification specification, and electrical equipment supplier qualification programs. Conducted preaward audits of and inprocess surveillance on suppliers of safety related electrical equipment. Conducted numerous site audits of electrical construction activities.

1965 to 1970 — Engineer (various grades) - Electrical Engineering Division - Distribution Section NY Office - Primary responsibility was for long range planning of the distribution systems for two of the AEP system operating companies, including improvement plans, load forecasts, system optimization, cost analyses, coordination of plans with transmission planning groups and presentation of plans to corporate management for approval. Other responsibilities included: administration (further development of and implementation of the AEP system wide distribution transformers load monitory program (program to predict on a statistical basis the monthly and annual peak loads on over 400,000 distribution transformers); development and implementation of an AEP system side distribution system trouble, damage and interruption reporting program to provide statistical data on circuit and equipment "reliability" for planning and equipment evaluation purposes; participated in a task force to develop distribution system planning guidelines; conducted numerous special studies on distribution system equipment, construction standards and planning calculation techniques.

1963 to 1965 — Associate Engineer - Canton Ohio Engineering Division - Primary responsibilities were basically the same as those shown for 1965 to 1970. This position was established as part of an effort to develop an AEPSC engineering group in Canton, Ohio. After two years, the decision was made to transfer the distribution planning function to the AEPSC New York office.

1960 to 1963 — Indiana & Michigan Electric Company Assistant Engineer - System Engineering Office, Distribution Section - Primary responsibilities were for short range distribution system planning, development of detailed work plans for implementation of distribution system improvements, and special customer related studies.

Additional responsibilities included: evaluation of sheet light equipment, equipment utilization studies and installation standards; continuous evaluation of distribution conductor connects and associated tooling and hardware.

RESUME: Robert C. Carruth

TITLE: Head Electrical Generation Section
American Electric Power Service Corporation

EDUCATION: Bachelor of Engineering 1965
Stevens Institute of Technology

Master of Engineering - Electric Power Systems
Engineering 1967 Rensselaer Polytechnic Institute

PRESENT: Manager Electrical Generation Section
Electrical Engineering Division
American Electric Power Service Corporation

1979-1981 Assistant Manager of Electrical Generation Section
Electrical Engineering Division AEPSC:

Execute a broad range of technical and administrative responsibilities in supervision of an organization of 40 engineers and supporting technical personnel involved in all aspects of Power Plant Electrical Design Engineering, including power equipment specification and application, auxiliary power system design, application of protective relaying and protective interlocking circuits, design of relay and solid state logic control systems, application of fault diagnostic equipment, performance of equipment and system failure analysis and the monitoring and upgrading of installed and operating electrical equipment and systems. Specific technical and administrative responsibilities include:

- Conducting Job Performance Reviews.
- Administrative of the training and orientation program for new technical personnel.
- Manpower planning and manpower allocation.
- Providing independent technical reviews.
- Participating in Nuclear Standards Development.
- Participating in Nuclear Safety Design Review Sub-Committee activities.
- Conducting special studies in Nuclear and Fossil Plant Design, construction and operation related area.
- Research or conduct evaluation of systems or equipment misoperations, reportable occurrences, equipment failures, etc.
- Participate in Nuclear Plant Site Audits.

Previous Nuclear Experience

1972-1979 Senior Engineer, and Project Electrical Engineer for D.C. Cook Nuclear Plant; two 1100 MW Westinghouse PWR's.

Responsible for technical and administrative supervision of an organization of six to ten engineers and engineering support personnel involved in construction, qualification, licensing, pre-operational testing, startup and post operational engineering and design support. Specific technical and administrative responsibilities included:

- Performing or supervising the detail design of Class IE as well as balance of plant electrical systems, circuits and components.
- Preparation of Equipment Qualification test procedures.
- Witness acceptance testing.
- Supervise the preparation of plant site audit plans.
- Write and supervise the preparation and execution of pre-operational test procedures.
- Supervise the development and testing of Class IE components.
- Provide on site startup technical support and supervision.
- Develop an Engineering Procedures Manual.
- Establish procedures for engineering quality control.
- Institute an Engineering Quality Assurance Program.
- Assist in the establishment of a Corporate Design Change Control Process.
- Perform work planning; scheduling manpower and assignments.
- Personnel Performance Reviews.
- Supervise and provide technical liaison to a consultant organization contracted to supplement the permanent staff assigned to the Project Electrical organization.

General Industry Experience

1977-1979 Senior Engineer and Supervisory Engineer for the electrical design of Racine Hydroelectric Project.

Responsible for conceptual as well as detail engineering of the electrical systems, protectives, plant controls, dispatch automation and supervisory and diagnostic systems for remote unattended operation. Specific areas of activity included:

- Generation of Electrical One Lines.
- Specification purchase and application of major electrical systems and hardware including:
  - 600 V and 6.9kV switchgear.
  - 6.9kV Isolated and Non Seg. Phase bus.
  - Programmable controllers for control and dispatch functions.
  - Equipment status and alarm monitoring system.
  - Remote supervisory and data acquisition system.
  - Battery charger, inverter and UPS system.
  - Parameter monitoring and data management system.
- Design of plant controls and protective interlocking circuits and logic.
- Development of dispatch algorithims for economic dispatch of the facility.
- Application of generator and auxiliary power system protective relaying.
- Integration of plant controls and operation with subtransmission system relaying and switching requirements.
- Application of station oscillograph and plant systems status diagnostic computer and annunciator systems.
- Application of on-site emergency diesel generation, and the design of automatic load shedding, restoration, re-transfer and testing circuitry.

1969-1972 Engineer and Sponsor (Project Electrical) Engineer for Mitchell Plant - two 800 MW coal fired super-critical units:

Responsible for electrical control and protection, auxiliary power systems protective relaying, related operator training and related startup and commissioning supervision. Specific responsibilities and activities included:

- Design of electrical control and power circuits.
- Application and setting of protective relays.
- Application of switchgear and other switching and protective devices.
- Design of relay and digital solid state logic for plant coal handling automation.
- Design of relay control logic and interlocking for plant systems.
- Preparation of operator reference system descriptions and operating instructions.
- Prepare and deliver operator training and orientation lectures on key plant systems.
- Write test and commissioning instructions.
- Provide on-site technical support to construction and relay checkout personnel.

1968-1972 Engineer and Project Electrical Engineer for the design and installation of a 345 MVAR synchronous condenser installation as part of a 765kV EHV system expansion. Responsibilities included:

- Design of all controls and protectives.
- Design of auxiliary power system.
- Rating major electrical components.
- Specification and purchase of control components, switchgear, transfer switches, auxiliary power equipment, motor control centers, transformers.
- Review and approval of all vendor supplied systems, including excitation, generator cooling water treatment and demineralizer system equipment, and all starting system equipment including generator starting and running bus switching equipment.

1967-1969 Associate Engineer, Assisting Project Electrical Engineer in various aspects of a strip mine expansion project, automated coal haulage (railroad), overland conveyors, coal processing stations and misc. coal handling systems.

[illegible]

KARL J. TOTH

EDUCATION

University of Southern Califormia, M.A., System Management, 1968
University of Omaha, B.S., Military Science, 1962
Central Michigan College of Education, 1950

REGISTRATION

Professional Engineer, State of California

EXPERIENCE

American Electric Power Service Corporation, 1983 - Present
NUS Corpodation, 1980 - 1983
U.S. Air Force, 1951 - 1980
Michigan School System, 1950 - 1951

AMERICAN ELECTRIC POWER SERVICE CORPORATION - Assigned to the Nuclear Safety and Licensing Section with responsibility for safety implications of all proposed D. C. Cook Nuclear Plant modifications. Reviews all proposed changes for 10CFR50.59 requirements and D. C. Cook licensing commitments to the NRC.

NUS - As a consulting engineer with the Consequence Assessment Department, is responsible for the analysis of probabilities and consequences of industrial and transportation accidents. Conducted aircraft impact hazard analysis for the San Onofre, Skagit/Hanford, and Hope Creek nuclear power plants and wrote Section 3.5.1.6 of the preliminary and final safety analysis reports (PSAR and FSAR) for the Hope Creek plant. Performed analysis of probabilities for accidents injuries, and deaths for the environmental impact statement for away-from-reactor fuel receiving and storage stations at Nuclear Fuel Services, West Valley, New York; General Electric, Morris, Illinois, and Allied General Nuclear Services, Barnwell, South Carolina. Conducted risk analyses, including possible accidents scenarios, on military deployment and use of krypton-85 advanced airfield lighting systems. Performed excavatioon planning and time estimates for the Ginna Nuclear Power Plant. Conducted accident and risk analyses of remotely piloted vehicles for the U.S. Department of Energy. These analyses included possible accident scenarios, failure modes, and probabilities. In addition, performed field surveys, collected data, and managed projects for both offite and onsite hazards analysis for control room habitability for Units 1 and 2 of the Surry, Skagit/Hanford, and Midland Nuclear Power Plants. This work resulted in writing revisions to Section 2.2 of the Midland FSAR, which included an extensive study and report, and writing Section 2.2 of the Skagit/Hanford PSAR and the Hope Creek FSAR. Participated in the IDCOR Atomic Industrial Forum on Nuclear Power Plant Control Room Operator Human Factors Study.

U.S. AIR FORCE - Served as pilot and in progressive management positions in both the operations and safety functions. At termination of Air Force career, was Chief of Safety for Air Force Systems Command, with responsibility for system safety, reliability, maintainability, and overall product assurance for approximately 90 percent of the hardware and software purchased by the U.S. Air Force.

From 1974 through 1977, was responsible for reviewing and approving evacuation plans and control center operations for 20 installations in the eastern United States. Has had extensive experience working with and directing postaccidents radiation-monitoring teams, decontamination teams, and accident investigations.

As Chief of Safety and Disaster Control, from 1962 to 1974, conducted evacuation studies at six nuclear installations; one in Japan, two in Europe, and three in the United States. Studies included time estimates, routes, methods, and procedures for dispersing personnel and critical defense equipment. Responsibilities also included establishing and directing emergency control center procedures and operations at each location. Investigated a catastrophic bomber aircraft crash in Japan which resulted in many unnecessary civilian casualties. These losses were attributed to a lack of knowledge by the local population. As a result, developed, and translated, and distributed emergency procedures checklists for local officials. Also wrote an explanation of the hazards and risks and established simple procedures to be followed in the event of future accidents. These procedures were translated and published in local papers and broadcast periodically on local radio and television. These checklists and news media releases were well received and subsequently translated and successfully used at locations in Europe and in the United States.

MEMBERSHIPS

American Defense Preparedness Association
American Nuclear Society
Certified Hazard Control Manager
International Society of Air Safety Investigators
National Aerospace Education Association
National Society of Professional Engineers
System Safety Society

ARTHUR S. GRIMES

Consulting Mechanical Engineer

Thirty five years experience in mechanical engineering activities involving major power generating facilities in the United States and Israel.

EDUCATION:	Professional degree in Mechanical Engineering University of Cincinnati, 1948
	Additional Education: Business Administration, Adelphi University 1955 Automatic Control, University of Michigan 1954
EXPERIENCE: 1978 to Present	American Electric Power Service Corp. Consulting Mechanical Engineer - Consultant to mechanical engineering and other disciplines in areas of automatic control, plant operation and thermal performance. Perform nuclear plant audits. Consult on research projects.
1972-77	Assistant Division Manager - Mechanical Engineering Responsible for mechanical engineering activities in plant modification and operation of a nuclear power plant.
1955-72	Manager, Results Section - Responsible for design and purchase of instrumentation and control systems, steam cycle analysis, and performance testing of power generating plants. Plants included coal, oil, nuclear and hydro.
1950-55	Engineer - Responsible for design and purchase of instrumentation and control systems for fossil power plants.
1948-49	Appalachian Power Co., Logan, West Virginia Results Engineer responsible for maintenance of instruments and controls and for performance testing in coal fired power plant.
PROFESSIONAL AFFILIATION:	Fellow, American Society of Mechanical Engineers
PUBLICATIONS:	Chapter 8, Pump Handbook-McGraw-Hill 1976
	Operating Experience With The Cardinal Plant Training Simulator - American Nuclear Society 1970
	Service Experience With Analog Computers For Utility Power Plants - American Power Conf. 1962

Measurement of Density and Moisture in a Large Coal Storage Pile - American Power Conf. 1961

Application of an Automatic Digital Data Collecting System To The Philo Supercritical Unit, American Power Conf. 1958

Thermal Performance Of The Philo Supercritical Unit - American Society of Mechanical Engineers, 1958

PATENTS:

4,343,682 Feedwater Heating Means for Nuclear Units During Start-up and Method of Controlling Same.

3,721,898 Apparatus for Detecting Leakage From or Rupture of Pipes and Other Vessels Containing Fluid Under Pressure.

3,211,135 Steam Generator Unit Control System

Summary Resume of THOMAS B. SHERIDAN

Thomas B. Sheridan attended Purdue University (B.S. 1951) and, after two years in military service (Aeromedical Laboratory, Wright Patterson Air Force Base, Ohio) attended the University of California, Los Angeles (M.S. 1954) and M.I.T. (Sc.D. 1959). His doctoral program was interdepartmental between systems engineering and psychology, with one year spent in cross-registration at Harvard University.

For most of his career, Dr. Sheridan has remained at M.I.T., where until recently he was Professor of Mechanical Engineering and is now Professor of Engineering and Applied Psychology. He heads the Man-Machine Systems Laboratory and teaches both graduate and undergraduate subjects in Man-Machine Systems. He is a Faculty Associate of the M.I.T. Science, Technology and Society Program. He helped develop a new interdepartmental graduate degree program in Technology and Policy, and has taught the core seminars for that program. He has also taught control, design and other engineering subjects.

He has served as visiting faculty member at the University of California, Berkeley, Stanford University, and the Technical University of Delft, Netherlands.

Dr. Sheridan's research has been on mathematical models of human operator and socio-economic systems, on man-computer interaction in piloting aircraft and in supervising undersea and industrial robotic systems, and on computer graphic technology for information searching and group deicision-making. He is author, with W. R. Ferrell, of Man-Machine Systems: Information, Control and Decision Models of Human Performance, M.I.T. Press, 1974, 1981 (published in Russian, 1980) and co-editor of a 1976 Plenum Press book, Monitoring Behavior and Supervisory Control.

He is a fellow of the Institute of Electrical and Electronics Engineers, was formerly editor of the IEEE Transactions on Man-Machine Systems, is past president of the IEEE Systems, Man and Cybernetics Society, served as Chairman of the IEEE Committee on Technology Forecasting and Assessment and was chairman of the 1981 IEEE Workshop on Human Factors in Nuclear Safety. He is also a Fellow of the Human Factors Society, and in 1977 received their Paul M. Fitts Award for contributions to education. He is Associate Editor of Automatica and on the Editorial Advisory Board of Computer Aided Design.

Dr. Sheridan has served on the Accident Prevention and Injury Control Study Sections of the National Institutes of Health, the NASA Life Sciences Advisory Committee, the NSF Automation Research Council, the NASA Study group on Robotics, the U.S. Congress OTA Task Force on Appropriate Technology, and the NSF Advisory Committee on Applied Physical, Mathematical and Biological Factors and served on the NRC Ad Hoc Committee on Aircrew-Vehicle Interaction and two advisory panels of the NRC Marine Board.

His industrial consulting activities have included: The General Motors Corp. (auto safety); General Electric Co. (telemanipulators); C.S. Draper Laboratory

(design of astronaut interface for Apollo guidance system, industrial robots); Biodynamics, Inc. (biomedical and human factors); Public Broadcast Service (TV audience feedback); National Bureau of Standards (industrial robots); Group Dialog Systems, Inc. (group meeting and decision technology); Northrop Aircarft (pilot workload); Babcock and Wilcox Co. (industrial instrumentations); Lockheed, General Physics, American Electric Power, Consumer's and Webster, the BWR Owners' Group, Brookhaven National Laboratory, Yankee Atomic, and Electric Power Research Institute (man-machine aspects of nuclear plant safety).

John C. Jeffrey

Manager, Instrumentation and Control Section

Seventeen years experience in instrumentation, control and equipment protection activities involving major power generating and distribution facilities in the United States.

EDUCATION: B. S. Electrical Engineering, Illinois Institute of Technology, 1966

Additional Education:
AEP Management Course - University of Michigan, 1979

REGISTRATION: Professional Engineer - California (1977)

EXPERIENCE:

1977 to Present

American Electric Power Service Corporation
Manager, Instrumentation & Control Section - Responsibilities include supervising the development of the overall plant control philosophy. Review, approve and recommendations of instruments, controls & computer supplied with all major mechanical equipment. Organize the development of software, selection of hardware for power plant process computers. Supervise the arrangement of control rooms, simulators and panels incorporating human factor considerations. Assure documentation of instrumentation, control and computer strategies via the Engineering Control Procedure (ECP) packages. Carry out the interface between Mechanical and Electrical Engineering for Control Design and Engineering. Provide for professional development and training of Section personnel. Recommend hiring, salary adjustments, promotion, transfers and release of personnel. Project work includes Montaineer Unit 1 and Rockport Units 1 & 2 1300 mw fossil fired power plants, Cook Nuclear Plant Units 1 & 2 upgrades, the Pressurized Fluidized Bed Combustion Project Studies, and a new series of Fossil Fired Plant studies in-plant monitoring computers for Stack Environmental Data.

1976 to 1977

Assistant Section Head/Instrumentation & Control Section - Responsibilities included supervision, instrument and control work, training, evaluating personnel performance, review and approval of purchase orders, standards and drawings, supervise the arrangement and design of control panels, supervise and design of control systems, coordinate the preparation of boiler & turbine interlock diagrams and analyzing the power plant cycle and their controls. Project work included a series of 1300 MW Fossil Fired Power Plants, D. C. Cook Nuclear Plant Unit 1 & 2 and a Mechanical Engineering Division Power Plant Cycle Study.

1975 to 1976	Engineer, Instrumentation & Control Section, N.Y. Office - Responsibilities included design of control systems, selection of instruments and control devices, preparation of specifications, review of construction drawings, inspection of new facilities, prepare calibrated and operation instructions and make dynamic response studies. Project work included the Cook Plant Waste Evaporator and Waste Evaporator Bottoms Systems, Request For Change Sheet, Lot and Unit #2 replacement equipment.
1974 to 1975	Engineer, Instrumentation & Control Section at Cook Plant - Responsibilities included supervision of the NERVE organization as outlined below plus assisting the Cook Plant with staff procedures, audits, tests and training.
	<u>Indiana & Michigan Electric Company</u>
1972 to 1974	Supervising Engineer, General Office, Station Department at Cook Plant - Responsibilities included supervision, engineer, design, construction, maintenance and operation of station & plant facilities, supervise installation & maintenance and of station and plant equipment, formulate policies and procedures, supervise special studies and reports, assist in planning and engineering new stations, supervise repairing equipment in connection with failure. Responsible for employment, promotion, transfer, discipline and discharge. Projects included all electrical controls and D. C. Cook Nuclear Plant.
1971 to 1972	Senior Engineer, General Office, Station Department at Cook Plant - Responsibilities included performing and directing others in testing, adjusting station and plant equipment, reviewing construction prints to assure that they are consistent with intended function, inspect & coordinate the work of contractors, make recommendations to correct malfunctions, plan and perform special tests, analyze test results, prepare estimates, reports and studies. Projects included all electrical controls at D. C. Cook Nuclear Plant.
1970 to 1971	Senior Engineer, General Office, Station Department at New York Office - Responsibilities included participating in the design and engineering of D. C. Cook Nuclear Plant. Projects included diesel load analysis, safeguard pump control, essential service water, sewage disposal, auxiliary feed water, control air, black-out sequencing, component cooling water the 345/765 station and the 69/4KV emergency power station.

1969 to 1970	Engineer, General Office, Station Department at Michigan Power Company - Responsibilities included Maintenance and Performance Tests of Station and Hydro equipment such as circuit breakers, transformers, relays and protective equipment. I was responsible for inspection of station construction projects and coordinating contractor's work and training. Projects included two 69KV transmission and distribution station and Constatine and Mottville Hydro electric plants.
1969 to 1969	Engineer, General Office, Station Department at Big Sandy Plant - Responsibilities included performing tests of Plant Equipment such as circuit breakers, heaters, transformers, pumps, valves, relays, protective equipment and training. Projects include circulating water, cooling towers, transformers, pulverizers, generator, unit circuit breakers and the 765 KV station equipment.
1968 to 1969	Engineer, General Office, Station Department at Michigan Power Company - Responsibilities included maintaining and performing tests of station equipment, such as circuit breakers, transformers, relays and protective equipment. I was responsible for inspection of station construction projects and coordinating contractors work, design, economic justification of new station control and training. Projects included inspection, testing, repair and partial redesign of Control at all Michigan Power Transmission Stations. The control design & economic justification, testing, calibration and placing in service of a 69/34KV transmission station School Craft South.
1966 to 1968	Engineer, General Office, Station Department at Indiana and Michigan Electric Co. - Responsibilities included running special equipment test, performing testing of station equipment such as circuit breakers, transformers, relays and protective equipment, carrier current and supervisory control. I was responsible for inspecton of station construction projects and coordinating contractor's work for training and training equipment, for calibration and timing studies, calibration record system and calibration aids. Projects included testing of solid state relays, testing shock preventative devices, design and construction of a training simulator, development of a calibration record, calibration charts, station calculations, timing coordination studies, installation of 345KV circuit breakers at Tanners Creek Plant. Station removal and installation of 345KV circuit breakers at Breek Plant Station.

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Rexford F. Shoemaker

Senior Engineer, Instrumentation & Control Section

Twenty-one years experience in instrumentation, control and protective systems activities in fossil fuel power generation stations.

EDUCATION:	B. S. Mechanical Engineering West Virginia Institute of Technology, 1961
EXPERIENCE:	Appalachian Power Company
1972 to 1983	Plant Performance Superintendent, John E. Amos Plant - Responsibilities included all plant instrumentation, control and protective systems, cycle chemistry and control, environmental controls and thermal performance and testing. Supervise eighty (80) technical and supervisory personnel. Wrote first 1300 MW Integrated Unit Control System line up and calibration procedure. Alternate weekend call-out duties with Operation Department Superintendent, supervise unit start-ups and operation. Wrote first 1300 MW unit normal cold start-up procedure.
1970 to 1972	Performance Supervising Engineer - Responsibilities included supervising technicians and engineers in check-out, calibration and start-up activities of Amos plant instrumentation and controls systems on two 800 MW and one 1300 MW coal fired supercritical pressure units.
1969 to 1970	Performance Engineer Senior, on temporary assignment to American Electric Power Service Corporation, Instrumentation & Control Section in New York City - Responsibilities included helping to assemble calibration books for Amos Units 1 and 2. Revise as required for automatic control Big Sandy Unit 2 Integrated Unit Control System. Develop first 800 MW Integrated Unit Control System calibration and line up drawings. Help with Mitchell Unit One Westinghouse-Hagan factory checkout of Integrated Unit Control System Cabinets.
1968 to 1969	Performance Engineer, Kanawha River Plant - Responsibilities included supervising instrument and control technician crew.

	<u>Bailey Meter Company</u>
1966 to 1967	Systems Engineer, Wickliffe, Ohio - Responsibilities included design, specify, document standard control system logic for central station applications. Trouble shoot large electronic control systems on supercritical units and revise as necessary to help develop company standards. Help design, assemble, check-out and put into service first closed loop analog simulator for factory checkout of large electronic control systems for supercritical units.
1961 to 1966	Field Service Engineer, Cincinnati, Ohio - Responsibilities included service and maintain existing control systems plus checkout and start-up new control systems ranging from small pneumatic on industrial drum boilers and processes to large electronic on central station units.

Frank S. VanPelt, Jr.
Professional Engineer - Michigan

Section Manager - Construction Project Management III
American Electric Power Service Corp.

Bachelor of Science - Mechanical Engineering
Virginia Polytechnic Institute and State University

June, 1982 - Present - American Electric Power Service Corp.

Section Manager for Cook Plant Project Management III Planning and Scheduling RFC work for Cook Plant.

March, 1980 - May, 1982 - American Electric Power Service Corp.

Section Manager - Planning and Scheduling; Project Controls. Coordinated Cook Plant FSAR Update; began development of detail logic networks for Coal Fired Power Plant Construction program. Headed one of three teams during Study program for new coal fired power plant.

July, 1979 - February, 1980 - American Electric Power Service Corp.

Project Control Engineer - Construction Projects. Began the development of computer program for scheduling the engineering, design and construction of a coal fired power plant.

April, 1978 - June, 1979 - American Electric Power Service Corp.

Project Manager assigned to Helium Breeder Associates, San Diego, California.

Assisted in the development of the Management System and program to be used for the Gas Cooled Fast Breeder Reactor Program.

May, 1977 - March, 1978 - I & M Electric Co. - D. C. Cook Plant

Lead Start-up Engineer
Directed six Start-Up Engineers in the completion and start-up of Unit 2 ant Cook Plant. Maintained the Preop schedule and assured timely release of systems for Preop Testing.

August, 1972 - April, 1977 - I & M Electric Co. - D. C. Cook Plant

Start-Up Engineer/Assistant Lead Start-up Engineer Coordinated the completion and start-up of assigned systems for both Unit 1 and 2. Prepared system initial operating procedures, flushing procedures and hydrostatic test procedures.

June, 1970 - July, 1972 - Central Operating Co. - Philip Sporn Plant

Performance Engineer
Planned, set-up equipment, took data, calculated and analyzed the results and made recommendations for equipment performance improvements for my assigned units.

James B. Brittan

Senior Engineer, Quality Assurance

More than twenty years experience in various Quality Assurance and Reliability activities including seven years with nuclear power generation facilities.

EDUCATION:	B. S. in Marine Engineering, NY State Maritime 1954 Graduate Studies in Nuclear Engineering, UCLA MBA, CW Post, Div. LIU.
EXPERIENCE: 1977 to	American Electric Power Service Corporation Responsible for establishment and implementation of complete supplier qualification program for all companies furnishing equipment or services important to nuclear safety to AEP (more than four hundred diverse organizations). Responsible for auditor training and certification program. Responsible for planning, scheduling and implementation of internal Quality Assurance audit program. Project QA representative on spent fuel rack modification and Plant security system projects.
1962-1976	Lundy Electronics & System, Inc. Quality Assurance Manager, responsible for quality planning, reliability, quality planning, quality engineerng, quality control and all testing associated with the company's diverse line of electromechanical products. Directed environmental lab, model shop, electronic lab, and metrology functions. Managed budgets, test program contracts, other planning & scheduling functions. Wrote proposals, test plans and reports.

Louis P. DeMarco

EXPERIENCE:	6/73 - Present	Engineering Assistant Electrical Generation Section Electrical Engineering Division

RESPONSIBILITIES:

4/79 - Present	Responsible for System Engineering functions such as: Evaluating and implementing all phases of design modifications for two 1100MW nuclear units, including Radiation Monitoring System, Reactor Protection System, Hydrogen Mitigation Distributed Ignition System, Fire Protection Systems, various plant systems and their support. Provide plant staff with electrical engineering support. Investigate and prepare responses in connection with Nuclear Regulatory Commission circulars and bulletins. Coordinate Plant Annunciator Response Procedure Review. Task force member for Onsite Low Level Radiation Waste Storage Facility.
3/76 - 4/79	Quality Control Engineer responsible for managing and implementing the quality control system for nuclear plant engineering design modifications, including review of all electrical engineering design modifications for technical and procedural completeness.
6/73 - 3/76	Technical Assistant, assisting both fossil and nuclear engineering staff by: performing engineering calculations, data tabulations, equipment specifications, purchase and expediting.

EDUCATION:	Polytechnic Institute of New York 110 credits completed toward B.S.E.E. Staten Island Community College A.S.S. Degree - 1973 Electro-Mechanical Technology

Thaddeus Russell Stephens

Citizenship

U.S. (Born - Niles, Michigan)

Position Title

Senior Performance Engineer

Present Employer

Indiana and Michigan Electric Company
Donald C. Cook Nuclear Plant

Education

November 1980: Attended Combustion Engineering's two-week Simulator Training Program and completed the reactor startup examination satisfactorily.

April 1980: University of Michigan, Ann Arbor, Michigan. Successfully completed the two-week Reactor Operator Training Program at Ford Nuclear Reactor/Phoenix Memorial Laboratory.

March 1978: A sixteen-hour course on vibration analysis given by the IRD Company.

June - August 1976: American Electric Power's Performance Improvement Program consisted of 240 hours of both classroom lectures on power plant related subjects and performance testing of 1300 megawatt coal fired unit with related equipment and calculations of test data.

March 1975: A forty-hour recorder and controls maintenance course given by the Leeds & Northrup Company.

1974: Graduated, Tri-State College, Angola, Indiana, Bachelor of Science in Mechanical Engineering.

Attended a 40-hour Management Training Course given by the Indiana & Michigan Electric Company.

Work Experience

September 1979 to Present: Senior Performance Engineer assigned to the Operations Department at the Donald C. Cook Nuclear Plant. Duties include the review and revision of the Operations Department Procedures and general technical support for the Department.

August 1976 to September 1979: Senior Performance Engineer at Tanners Creek, having the duties to supervise the Performance Engineers who have unit responsibility, to schedule test work and assign and monitor project work.

November 1974 to August 1976: Worked as a Performance Engineer in a 1050 megawatt generating station which has four coal-fired units. The station is the Tanners Creek Station owned by the Indiana & Michigan Electric Company, a subsidiary of American Electric Power Company. My duties included testing of major unit equipment, assorted project work, and the maintaining of the unit's control systems.

March 1974 to November 1974: Worked as a first line supervisor of a forge line and welding line in the manufacture of single piece axle housings in the Housing Division of Clark Equipment Company. Left to get work more in line with my professional training.

June 1968 to March 1974: Co-op student with Clark Equipment Company in Buchanan, Michigan.

JOHN D. YOUNG - Senior Engineer, Electrical Power Systems/Control Board Design, Westinghouse Electric Corporation

Education:

- B.S. in Electrical Engineering from Tri-State College

Experience:

Mr. Young is with Westinghouse Electric Corporation in the Instrumentation and Control Department, Electrical Power Systems and Control Board Design group. His work experience for the past ten years has been in the area of main control and panel layout design. He is the lead engineer for the Control Board Design group.

Mr. Young was the responsible design engineer for the control boards for the following nuclear power plants:

a) Sequoyah Units 1 and 2
b) Watts Bar Units 1 and 2
c) Krsko Unit 1 (Yugoslavia)
d) Napot Point Unit 1 (Philippines)

He was also the responsible engineer in the design of a modular operation console which can integrate the requirements of Reg. Guide 1.97 and NUREG 0696 into existing control rooms.

Mr. Young also has over three years experience with the reactor protection and safeguards systems panels. He was instrumental in the design of the safeguards on-line testing system.

Mr. Young's experience in the nuclear industry spans fourteen and one-half years with Westinghouse in the Instrumentation and Control field.

WAYNE R. YOUNG - Engineer, Electrical Power Systems and Control Board Design

Education:

- A.S. in Electronics Technology from the Community College of Allegheny County

- Continuing towards a B.S. in Electrical Engineering from the University of Pittsburgh

Experience:

Mr. Young is with the Westinghouse Electric Corporation in the Instrumentation and Control Department, Electrical Power Systems and Control Board Design Group. His work experience has been in the area of main control board/panel layout and design. His total nuclear experience spans nine years of service with Westinghouse in the instrumentation and control field.

He is the cognizant engineer for the human engineering evaluation for the Louisiana Power and Light Waterford 3 nuclear plant, a program which included the following.

a) Assess the layout and adequacy of the main control board (MCB) required to support operating crew activities through the use of plant-specific Emergency Operating Procedures (EOPs).

b) Verify that the EOP sequence of steps and procedural flow are compatible with the MCB layout.

c) Conduct EOP verification walk-throughs in the Waterford 3 control room.

d) Provide recommendations for resolution of Human Engineering Discrepancies (HEDs).

e) Assist in the development of plant specific, symptom-based, event scenarios for use in the EOP verification.

WAYNE R. YOUNG (continued)

f) Assist in the preparation of the event recognition report, MCR display maps, task maps, and link analysis documentation.

Mr. Young is also responsible for the main control board equipment qualification program. Duties for equipment qualified to IEE 323-1974 and 344-1975 include:

a) Participation in the preparation of equipment qualification reports.

b) Generation and maintenance of baseline design documents.

c) Generation and maintenance of computerized specifications.

d) Equipment quotations.

e) Equipment procurement.

f) Maintenance of qualification fils for auditability.

Additionally, Mr. Young is the systems engineer for the Nuclear Steam Supply System (NSSS) on the following power plants:

a) Comanche Peak Units #1 and #2
b) McGuire Units #1 and #2
c) Catawba Units #1 and #2
d) Mannshan Units #1 and #2
e) Korea Unit #2
f) Millstone Unit #2
g) Virgil C. Summer
h) Beaver Valley Unit #2

Activities include review and approval of architect/engineer documentation, design of the rod drop disconnect switch box, equipment procurement, scheduling, and documentation transmittal.

ROBERT J. WARTENBERG - Instruction Coordinator and Instructor, Instrumentation Technology Training Center, Westinghouse Electric Corporation

Education:

- Community College of Allegheny Country, 12 credit hours in Education

- Southern Illinois University, 69 credit hours in Education

- Military schools: Electronic Technician "A" School, Basic Nuclear Power School, and Nuclear Power Prototype

Experience:

Mr. Wartenberg has over 8 years of experience in the naval and commercial nuclear fields, with emphasis on plant operations and training, and supervisory experience in all aspects of course presentation, personnel training, and program administration and development. Mr. Wartenberg assists in human factors evaluations of control room designs and procedure verifications. In October of 1981, he received Senior Reactor Operator certification.

As an instruction coordinator, he is responsible for meeting the overall objectives of all customer simulator courses and the direction of instructional activities of fifteen instructors, with participation directly in student and instructor evaluations and audits.

Previous work experience includes an assignement as an instructor to the reactor controls division, and as a qualified reactor operator and shutdown reactor operator on a naval nuclear prototype. As a training engineer, Mr. Wartenberg also assisted in the startup of the SNUPPS II simulator.

G. ALLEN ELLIFF

EDUCATION:

Ph.D., Industrial Engineering/Operations Research, Texas A&M University, 1973
M.S., Industrial Engineering/Operations Research, Texas A&M University, 1971
B.S., Industrial Engineering, Texas A&M University, 1970

AFFILIATIONS:

American Institute of Industrial Engineers.
Operations Research Society of America
Alpha Pi Mu (Industrial Engineering Honor Society)
Sigma Xi

PROFESSIONAL BRIEF:

Dr. Elliff is a Branch Manager in Essex Corporation's Alexandria office. He is currently responsible for management, technical direction, and review of projects for nuclear industry clients of the Industrial Services Department. Dr. Elliff's utility experience includes direct project management responsibility for several nuclear power plant control room design reviews, as well as management oversight and review of related projects for nuclear industry clients. He has 10 years consulting experience with the military (Navy, Air Force, and Office of the Secretary of Defense); other federal agencies (Department of Energy, Department of Transportation); and private sector clients (utilities, motor carriers, railroads, military hardware vendors). His experience includes applied human factors analysis, maintenance management, logistic support analysis, life cycle cost/design to cost analysis, information system validation, business and financial management, market analysis, transportation operations analysis, mathematical modelling, reliability/maintainability analysis, production engineering, statistical quality control, and training course development and presentation. Prior to joining Essex in 1981, Dr. Elliff was associated with Evaluation Research Corporation; Peat, Marwick, Mitchell, & Co.; Logistics Management Institute; and the Texas A&M University graduate faculty. Dr. Elliff also has three years experience as a full-time graduate faculty member at Texas A&M University teaching industrial engineering and operations research courses and supervising thesis research.

EXPERIENCE:

CANYON RESEARCH GROUP, a Division of Essex Corporation (1981 - Present)

Manager, Operations Analysis Branch, Industrial Services Department - Provide management and technical direction for conduct of Industrial Services Department operations analysis projects. Have primary technical responsibility for all operational task analysis, probabilistic risk assessment, and human reliability analyses for the Industrial Services Department. Serve as senior technical resource for application of industrial engineering and operations research techniques to client situations. Responsible for technical review of client deliverables.

Provide management review of project plan, technical scope, and resource estimates for Industrial Services Department projects. As branch manager, supervise human factors analysts and licensed Senior Reactor Operators (SROs). Assign appropriate personnel to client projects, as needed. Monitor cost and schedule status on all Industrial Services Department projects to ensure completion of products to client satisfaction.

Project manager for detailed control room design review (DCRDR) for Public Service Electric and Gas Company's Hope Creek Generating Station (HCGS). HCGS is a near term operating license boiling water reactor. The control room is one of the more advanced nuclear power plant control rooms in the United States and employs several CRTs. Also serving as project manager for DCRDR of Donald C. Cook Unit 1 and 2 control rooms. D.C. Cook plant is an operating plant with several years of operating experience.

Managed detailed human factors control room design review for Texas Utilities Generating Company's Comanche Peak Steam Electric Station (CPSES) Unit 1. Evaluated control room for compliance with human engineering principles and applicable regulatory guidelines. Directed Essex human factors analysts and SROs in assessment of proposed client rearrangement of CPSES control boards. Assisted client in design and application of mimics, demarcation, and hierarchical labeling of the CPSES Unit 1 control boards.

Developed a model for predicting human reliability in nuclear power plant control room operations. For a foreign nuclear utility, developed estimates of expected improvements in operator reliability for suggested backfits to resolve thirty generic control room design problems.

Provided general management direction for major procedures development and production project for a near term operating license (NTOL) plant. The first phase of the project involved rewriting/reformatting of all emergency, abnormal, and standard operating procedures. As a result of project team performance, Essex was also awarded contract for development and production of approximately 300 nuclear power plant surveillance/test procedures. This phase involved rewrite/reformat, technical review, and editing of procedures; technical direction of all project staff; and coordination of the production of the procedures from initial writing through final word processing. Essex project team was composed of 6 to 8 technical writers, two editors, two nuclear plant operations specialists, and 8 word processors, plus two shift supervisors from client organization.

EVALUATION RESEARCH CORPORATION (1979-1981)
Vienna, Virginia

Principal Engineer and Branch Manager, Systems Engineering and Analysis Group - Provided technical and engineering support to NAVSEA, NAVELEX, NAVAIR, and other Federal government clients. This support included integrated logistics support (ILS) analyses, systems analysis, systems engineering, cost analysis, and application of operations research techniques for ship and system acquisition programs and ILS functional offices.

Participated in development of NAVSEA Reliability and Maintainability Technical Seminar.

Performed a comparative life cycle cost (LCC) analysis of JERED and CHT marine sanitation systems for DD 963 class ships. Results were a prime input to NADEC briefing.

As a member of CAPTOR Production Readiness Review (PRR) Team, assessed the capability of prime contractor and first tier subcontractor to effectively manage full-scale production. As a result of the PRR, the contractors were required to make substantive improvements to production control procedures prior to full production release.

Developed multiple regression model to project Navy ship-building quality assurance (QA) manpower requirements based on workload descriptor parameters.

Developed an analytic approach and plan for trade-off and cost impact analysis of alternative aviation intermediate maintenance support strategies for the Aviation Intermediate Maintenance Improvement Project Office. Objective of this task was identification of the complement of intermediate-level maintenance equipment, spare parts, and personnel skills that would most improve mission effectiveness of the deckload of a given aircraft carrier. Analytic approach integrated existing Navy data files and models to the greatest extent practical.

Managed project to assess performance and effectiveness of defense contractor in providing supply and depot repair support on AN/SLQ-32(V). Evaluated timeliness, quality, and cost of depot repair and supply support provided by contractor. Integrated and cross-validated transaction data from numerous contractor internal data sources, including ADP reports, manual log books, and source documents. Assessed operational availability based on analysis of CASREPTS and 4790-2K forms and data.

Determined system stock and maintenance repair parts requirements to support AN/SLQ-32(V). Assisted in conducting FY 1981 provisioning conference. Prepared contract orders to implement results of provisioning conference. Attended program reviews in support of program office.

Provided technical review of Logistic Support Analysis (LSA) Program Plan for Army Stand-off Target Acquisition System (SOTAS) under contract to Motorola.

<u>Senior Analyst and Project Manager, Planning and Sciences Group</u> - Managed and directed numerous projects for U.S. Department of Energy clients. Senior technical analyst for quantitative analysis tasks for the Planning and Sciences Group. Directed independent validations of various DOE and industry information systems and models.

Managed a project to validate the DOE Crude Oil Transfer Pricing System (ERA-51). Project included assessment of user requirements, respondent reporting and measurement practices, and DOE data processing procedures. Qualitative and quantitative analyses for data consistency and validity were performed, both within ERA-51 and between ERA-51 and related DOE reporting systems.

Provided technical and management direction for quantitative data analyses for four data systems providing information on major industrial combustors to support enforcement of the Power Plant and Industrial Fuel Use Act. Systems analyzed included the DOE Boiler Manufacturer's Report (ERA-97), DOE 1975 Major Fuel Burning Installation Coal Conversion Report (FEA-C-602-S-0), DOE 1980 Manufacturing Industries Energy Consumption Study and Survey of Large Combustors (EIA-463), and EPA National Emissions Data System (NEDS).

Developed scenarios for assessment of refinery industry capability to respond to various supply and demand scenarios. Analysis required familiarity with two refinery models: Bonner and Moore Refinery and Petrochemical Modeling System (RPMS) and Turner, Mason, Solomon (TMS) refinery model. RPMS and TMS models were linked to account for refinery processing capabilities, transportation network, and petroleum inventory management considerations.

Developed product prices and cost, quality, and quantity characteristics of crude slates for several refineries using DOE data in quick-reaction support for the Office of Special Counsel (OSC). Data was input to RPMS, which was used in support of OSC audit and compliance analysis.

PEAT, MARWICK, MITCHELL & CO. (1975 - 1979)
Washington, D.C.

Senior Consultant and Project Manager - Managed the development and implementation of a life cycle cost/budgetary projection model for the HARPOON Project Office. Determined and documented logistics resources for support of a given procurement schedule; developed and validated predictive cost estimating relationships; identified appropriation and budget sponsors for each end item and logistic resource category; and developed time-phased funding requirements by appropriation to support a particular acquisition scenario.

As a member of a management audit team, evaluated the analytic capability of the F-16 System Project Office organization. Areas evaluated included life cycle cost/design to cost (LCC/DTC) estimation and tracking capability, configuration management, ILS planning and coordination, and assessment of the extent to which a common data base of cost and performance parameters was maintained for use in performing the various analytic tasks.

Defined and developed an integrated project task management information system (MIS) for the Shipboard Intermediate Range Combat System Project Office. Surveyed information requirements; conducted an inventory and assessment of information sources; defined information flows; investigated information processing and display alternatives; and developed an MIS to provide key project personnel with current and projected cost/schedule status, variance analyses, financial flexibility analyses, and assessment of the probable impact of potential management decisions.

Developed and presented seminars for commercial clients on life cycle cost/design to cost, Department of Defense (DOD) acquisition policies, and DOD marketing. Served as corporate representative to the Weapon System Life Support (WSLS) group under NSIA Logistics Management Committee (LOMAC).

Managed a project for the Federal Railroad Administration to perform systems engineering for intermodal freight systems. Identified, described, and analyzed the full range of improved and innovative components, subsystems, and systems. Assessed proposed innovations and improved technologies for potential to improve profitability and return on investment for rail-based intermodal freight systems.

Principal Investigator for a project to develop an improved passenger car maintenance and utilization program for the National Railroad Passenger Corporation (AMTRAK). Specific responsibilities included assessment of the effectiveness of the current AMTRAK passenger car maintenance process, identification of trade-offs between passenger car maintenance and passenger car utilization, and development of recommendations for improving both the quality of AMTRAK maintenance and utilization of its passenger car fleet.

Managed a study for the Federal Railroad Administration to assess alternative organizational structures for yards and terminals for the United States rail industry. Analyzed management control systems, measures of effectiveness, and the effect of organizational alternatives for yards and terminals on the infrastructure of the rail industry.

Managed projects for private railroads involving market, operations, and traffic analysis, and development of business strategies. For a major motor carrier, performed an analysis of terminal and line-haul operations to improve carrier profitability and operational efficiency.

LOGISTICS MANAGEMENT INSTITUTE (1974 - 1975)
Washington, D.C.

Senior Research Associate - For PMS 306, under joint sponsorship with the Assistant Secretary of Defense (Installations and Logistics), analyzed and evaluated the ability of the Navy's intermediate-level maintenance activities to support the surface Fleet in the mid-1980's. Responsibility included assessment of the adequacy of the Navy's maintenance data collection system (MDCS) in documenting maintenance delivered to the Fleet, trade-off analyses to determine the most effective utilization of Navy resources in supporting the surface Fleet, and development of specific recommendations for improvement.

Developed a management information system and the associated data base to assist planners in the Office of the Assistant Secretary of Defense (Installations and Logistics) in making policy decisions regarding avionics standardization. The system was capable of producing annual projections of the demand for avionics systems in terms of functional requirement and/or associated hardware by TMS of aircraft, at the equipment level, for aircraft scheduled for major modification or acquisition during the 1975-1985 timeframe.

The data base could be readily updated on an annual basis, thereby enabling the system to continue providing 10 year projections.

Developed a cost element structure (CES) for life cycle cost (LCC) analysis of tracked vehicles as input to an LMI task addressing the feasibility of a standardized LCC CES for various types of DOD systems.

TEXAS A&M UNIVERSITY (1972 - 1974)
College Station, Texas

Assistant Professor of Industrial Engineering - Taught graduate courses and supervised thesis research in operations research, production engineering, manufacturing processes, production management, engineering cost estimating, production and inventory control, and quality assurance to graduate students in reliability and maintainability engineering programs sponsored by the Army Material Command (now DARCOM). Dissertation topic addressed economic design of a continuous sampling quality assurance plan, which has resulted in a publication and presentations.

PUBLICATIONS AND TECHNICAL PRESENTATIONS

Franco, J., Elliff, G. A., and Tulis, E. A. Memorandum Report - Development of Product Prices for RPMS Static Refinery Model, June 2, 1981. Prepared for Office of Technology and Computer Sciences, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A., and Franco, J. Applicability of DOE Models in Short-Term Contingency Planning, March 27, 1981. Prepared for Office of Technology and Computer Science, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A. Memorandum Report - Assignment of Costs to Crude Oil Feedstocks for Establishing Static Refinery Base Cases, March 19, 1981. Prepared for Office of Technology and Computer Science, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A., and Tulis, E. A. Memorandum Report - Analysis of the "Average Day" Concept for Establishing Crude and Product Slates for Sohio Base Cases, February 9, 1981. Prepared for Office of Technology and Computer Science, Office of Special Counsel, Economic Regulatory Administration, U.S. Department of Energy.

Elliff, G. A., and Tulis, E. A. Preliminary Analysis of the DOE Transfer Pricing System, February 1, 1981. Prepared for the Office of Energy Information Validation, Energy Information Administration, U.S. Department of Energy.

Leilich, R. H., Elliff, G. A., et al. Systems Engineering for Intermodal Freight Systems (3 volumes). Prepared for the Federal Railroad Administration, U.S. Department of Transportation, March 1978.

Yager, R., Elliff, G. A., and Bauer, R. Study to Develop an Intercity Passenger Car Maintenance and Utilization Program, April 1977. Prepared for the Federal Railroad Administration, U.S. DOT, and National Railroad Passenger Corporation (AMTRAK).

Fisher, W., Elliff, G. A., and White, J. M. DOD Demand for Selected Avionic Assemblies - Phase I. Interim Report on LMI Task 75-9, November 1975.

Shepherd, F., Elliff, G. A., and Wroblewski, P. Surface Ship Maintenance, LMI Report 74-21, AD A008233, January 1975.

Elliff, G. A., and Foster, J. W. "A Note of Calculation of the Average Fraction Inspected for a Continuous Sampling Plan." International Journal of Production Research, 1975.

Elliff, G. A., and Foster, J. W. "Least Cost Continuous Sampling Plans." Presented at ORSA/TIMS Joint National Meeting, Las Vegas, Nevada, November 1975.

Elliff, G. A., and Foster, J. W. "Economic Design of a Multilevel Continuous Sampling Plan." Presented at AOA Symposium on Logistics, Fort Lee, Virginia, February 1974.

Elliff, G. A. "An Economic Basis with Inspector Accuracy Considerations for Design of a Multi-level Continuous Sampling Plan," unpublished doctoral dissertation, Texas A&M University, 1973.

Elliff, G. A. "Cost Optimization of a Trickling Filtration Sewage Treatment Facility Using Pattern Search with Summation of Gradients," unpublished masters' thesis, Texas A&M University, 1971.

SECURITY CLEARANCE:

SECRET, granted by DISCO (1974).

JOHN E. FARBRY, JR.

EDUCATION: Bachelor of Architecture, Washington University, 1965.
M.A. Experimental Psychology, University of Missouri-Columbia, 1973
Ph.D. Experimental Psychology, University of Missouri-Columbia, 1978; Major Area: Human Memory and Cognition

AFFILIATIONS: American Psychological Association (Member)
Division 21: Society of Engineering Psychologists
Human Factors Society (Member)
Technical Interest Group: Computer Systems
Potomac Chapter of the Human Factors Society (Member)

PROFESSIONAL BRIEF:

Dr. Farbry's activity in psychology has been concerned with basic research in human performance, teaching, and the application of psychological knowledge to complex systems in industrial settings. His research activity involves the investigation of stress effects interacting with individual differences and the analysis of human memory and learning. In the first area, stress effects were examined with regard to coping responses in a VA hospital environment. Also, the effects of stress on problem-solving behavior were studied in a laboratory setting. The second area includes the study of qualitative changes in memory over an extended period of time and the observation of error behavior in rote learning. The undergraduate courses taught include experimental method, physiological psychology, introductory psychology and the psychology of language. During his three years at Essex, his work has been primarily concerned with the analysis and evaluation of the operator-machine interface in nuclear power plant control rooms. This work has been directed primarily to the evaluation of conventional PWR and BWR main control rooms in the U.S. and a BWR radwaste control room in Japan. He has conducted design studies of control panel component arrangement in both cases. The two most recent projects have focused on the evaluation of CRT display systems in advanced control rooms for BWR and PWR facilities in Japan.

EXPERIENCE:

ESSEX CORPORATION (1980 - Present)

Project Manager. Directed evaluation of CRT display system for advanced control room of Chubu Electric Power Company. This work included the updating and reorganization of CRT specifications; analysis of population stereotype data from client operations personnel and application of the results to CRT evaluation. Conducted review of functional allocation between control room operator vs. CRT system and an information availability analysis. Evaluation of CRT display system including features of CRT format organization, color/symbol schemes, alarm system, CRT information access and labeling.

Research Scientist. Developed general guidelines and criteria to support design of main control room in a nuclear power plant. The guidelines were directed to the

arrangement and grouping of components and component systems on the main control panel, the determination of the profile and floor plan configuration of the control panel and the planning of the control room facility.

Research Scientist. Developed population stereotype questionnaire for control panel elements with results applied to stereotype specification for an advanced control room (ACR) of a pressurized water reactor unit for Mitsubishi Heavy Industries. Also evaluated CRT pages for ACR and studied operator movement among CRTs. Developed voice-computer communication guidelines to support interactive computer systems.

Project Engineer. Evaluation of proposed and existing control panels for radwaste control room of boiling water reactor plant for Japan Atomic Power Company. Short- and long-term recommendations were made regarding the arrangement of panel components, proposed component types and annunciator system. The recommendations included a design proposal for the component arrangement of two radwaste control subpanels.

Research Associate. Performed human factors evaluation and a design study for main control panel arrangement of new pressurized water reactor power plant for Carolina Power and Light. Also participated in on-site evaluation of individual components and panel arrangement for main control panel of existing boiling water reactor plant and prepared label backfit supplement.

HELLMUTH, OBATA, AND KASSABAUM, INC. (1978 - 1980)
Saint Louis, Missouri

Architectural Draftsman/Research. Commercial structures: preparation of construction documents, statistical research on firms distribution of manpower across different building types. Client contact, coordination with structural and mechanical engineers, building code analysis.

CHINN AND ASSOCIATES (1977 - 1978)
Columbia, Missouri

Architectural Draftsman. Commercial and residential structures. Coordination with structural and mechanical engineers, preparation of construction documents such as site plans, floor plans, elevations, construction details and perspectives.

STEPHENS COLLEGE (1976 - 1977)
Columbia, Missouri

Instructor. Department of Psychology. Full responsibility for six courses in Basic Psychology and courses in Psychobiology and the Psychology of Language. Also, student advising and staff seminar participation.

MID-MISSOURI MENTAL HEALTH CENTER (1974 - 1976)
Columbia, Missouri

Research Assistant - Coordinated medical, research, and technical staff for psychological research on stress in hospital patients receiving a difficult examination (endoscopy). Also recording of polygraph data before and during examination, pre- and post-patient interviews, data reduction/preliminary analysis, library research, and assistance with the preparation of a variety of journal articles.

CHINN, DARROUGH, AND COMPANY (1973 - 1974)
Columbia, Missouri

Architectural Draftsman. Commercial and residential structures: preparation of construction documents, coordination with structural and mechanical engineers.

UNIVERSITY OF MISSOURI (1973)
Columbia, Missouri

Teaching Assistant. Department of Home Economics. Architectural Design II: Taught design process, planning, and development of drafting skills. Delineation course: Emphasis on color media applied to interior perspective drawing.

UNIVERSITY OF MISSOURI (1969 - 1973)
Columbia, Missouri

Teaching Assistant. Department of Psychology. General Experimental Psychology (Laboratory Instructor); General Psychology (Course Coordinator, Discussion Leader); and Research Methods, The Senses, Applied Psychology (Assistant).

UNIVERSITY OF MISSOURI (1969 - 1971)
Columbia, Missouri

Research Assistant. Department of Psychology. Design of graphic stimuli (face components) for automated display in a human learning study, data collection, and assistance with the writing of journal articles.

HELLMUTH, OBATA, AND KASSABAUM, INC. (1966 - 1968)
Saint Louis, Missouri

Architectural Draftsman. Commercial structures: preparation of construction documents.

A.L. AYDELOTT AND ASSOCIATES (1965)
Memphis, Tennessee

Architectural Draftsman. Commercial structures: preparation of construction documents.

TECHNICAL REPORTS:

Summary Report: A Human Engineering Review of an Advanced Control Room CRT Display System for the Chubu Electric Power Company. Technical Report for Chubu Electric Power Company, Inc. in Nagoya, Japan, in press. (with D. Eike)

Human Engineering Specifications for an Advanced Control Room CRT Display System for the Chubu Electric Power Company. Technical Report for Chubu Electric Power Company, Inc. in Nagoya, Japan, in press. (with R. Kane, S. Fleger, and T. O'Donoghue)

A Functional Allocation Review of an Advanced Control Room CRT Display System for the Chubu Electric Power Company. Technical Report for Chubu Electric Power Company, Inc. in Nagoya, Japan, in press, (with T. Harding).

A Human Engineering Evaluation of an Advanced Control Room CRT Display System for the Chubu Electric Power Company. Technical Report for Chubu Electric Power Company, Inc. in Nagoya, Japan, in press. (with S. Fleger, R. Kane, T. Harding, and D. Pilsitz).

Response Sterotypes of Japanese Control Room Operators to Elements of CRT Display Systems. Technical Report for Chubu Electric Power Company, Inc. in Nagoya, Japan, October, 1982.

A Human Engineering Evaluation of CRT Formats, CRTs, and Keyboards for the Mitsubishi Heavy Industries Advanced Control Room. Technical Report for Mitsubisi Heavy Industries, Japan, July 1982. (with R. Kane, S. Fleger, T. Harding and F. Piccione)

Extracontractual Studies on: Stress, Method for Design Criteria Evaluation, and PCC Configuration Study. Technical Report for Mitsubishi Heavy Industries, Japan, July, 1982. (with R. Kane, D. Metcalf, R. Benel, S. Fleger)

Response stereotypes of Japanese nuclear power plant control room operators. Study for Mitsubishi Heavy Industries, December 1981. (with R. Kane and S. Fleger)

System-Specific Specifications, Basic Console Evaluation, and Human Engineering Library Bibliography for Advanced Control Room. Technical Report for Mitsubishi Heavy Industries, Japan, July 1982. (with R. Kane, H. Manning, S. Fleger, T. O'Donoghue, N. Tulloh, and L. Grealis)

Human factors evaluation report on the Tsuruga Number One New Radwaste Control Room. Final report prepared for the Japan Atomic Power Company, September 1981. (with A. Strong)

Label backfit supplement BSEP 1 and BSEP 2. Prepared for Carolina Power and Light, September 1981.

Human factors evaluation report for the Brunswick Unit 1 and Unit 2 Control Room. Final Report prepared for Carolina Power and Light, September 1981. (with W. Talley, D. Beith, E. Talley, and T. Justice)

Human factors design evaluation report for the Shearon Harris Unit 1 control room. Final report prepared for Carolina Power and Light, September 1981. (with W. Talley, J. Haher, T. Amerson, D. Beith, and T. Justice)

JOURNAL ARTICLES:

Control-display integration on large, multi-system control panels. Proceedings of the Human Factors Society 25th Annual Meeting. Rochester, New York 1981. (with T. Harding and K. Mallory)

Evaluative persistence: Salt from the evaporative forgetting process. Dissertation Abstracts International, 1979, 39 (No. 8), 4068 B.

Greater repetition of errors under performance compared to observation in multiple-choice human learning. Perceptual and Motor Skills, 1973, 37, 949-950. (with M.H. Marx and D. Witter)

Psychological preparation for endoscopy. Gastrointestinal Endoscopy, 1977, 24, 9-13. (with R.H. Shipley, J.H. Butt, and B. Horwitz)

Preparation for a stressful medical procedure: Effect of amount of stimulus preexposure and coping style. Journal of Consulting and Clinical Psychology, 1978, 46, 499-507. (with R.H. Shipley, J.H. Butt, and B. Horwitz)

Long-term persistence of response-repetition tendencies based on performance or observation. Bulletin of the Psychonomic Society, 1978, 8, 65-67. (with D.W. Witter and M.H. Marx)

PRESENTATIONS:

Evaluative persistence: A long term memory for first impressions. Paper presented at the convention of the American Psychological Association, Montreal, September 1980.

Videotape preparation for a stressful medical procedure: Effects of number of exposures. Paper presented at the meeting of the Association for Advancement of Behavior Therapy, New York City, December 1976. (with R.H. Shipley, J.H. Butt, and B. Horwitz)

JAMES G. FEINSTEIN

EDUCATION

University of Hartford, B.S., Mechanical Engineering, 1965
Union College, graduate courses 1966-1969
Northeastern University, graduate courses 1969-1970
General Electric Advanced Course in Engineering

EXPERIENCE

American Electric Power Service Corporation, 1983-Present
NUS CORPORATION, 1978-1983
American Electric Power Service Corporation, 1971-1978
Stone & Webster Engineering Company, 1969-1971
Knolls Atomic Power Laboratory, 1965-1969

American Electric Power Service Corporation - Manager, Nuclear Safety and Licensing. Management and direction of section personnel in carrying out assigned responsibilities and activities which includes maintenance of NRC related documentation, review coordination, and resolution of all matters pertaining to nuclear safety affecting AEPSC. Provide knowledge, expertise, and analytical capability in nuclear safety related matters necessary to support plant operations and licensing efforts. I also serve as Secretary, NSDRC, and as Corporate Cognizant Engineer for Nuclear Safety.

NUS - Have been responsible for a variety of safety analysis and licensing activities in support of domestic and foreign utilities. Typical activities have included: Service for eight months as a member of the On-Site Safety Review Group, Salem Generating Station; technical specification coordinator for a large domestic utility; project manager for NUS support activities on the FSAR update of the Donald C. Cook Nuclear Plant; project manager for the Big Rock Point Plant Spent Fuel rack Addition Consolidated Environmental Impact Evaluation and Safety Analysis Report; and technical advisor to the Japanese Survey Group on new siting concepts.

Until October 1982 was Manager, Nuclear Waste Management Department. Duties included project management and technical contribution to fulfill NUS contractual responsibilities to the Basalt Waste Isolation Program and the Office of Nuclear Waste Isolation. Various safety and licensing activities performed under these contracts included development of licensing coordination plans, performance of operational and long term radiological safety and risk analyses for nuclear waste repositories, development of a preliminary safety analysis report for a nuclear waste repository in a domed salt formation, development of guidelines for a quality assurance program, and performance of cost benefit analyses. Also served as a member of an ONWI-sponsored task force on geotechnical and anthropomorphic problems associated with siting a nuclear waste repository in a domed salt formation.

American Electric Power Service Corporation - Lead Engineer Safety Analysis and subsequently Manager, Nuclear Safety and Licensing. Duties included support of licensing, design, construction, and operation of the Donald C. Cook Nuclear Plant, the first Westinghouse PWR with an ice condenser containment to be licensed for operation. Principal responsibility was to assure that all safety systems were designed and analyzed in a manner acceptable to the United States Nuclear Regulatory Commission. Involved in many first-of-a-kind analyses, systems design, and technical specification development in the areas of heat transfer, fluid dynamics, thermal hydraulics, post-LOCA hydrogen generation, ice sublimation, radiological dose analyses, etc. Responsible for technical and administrative coordination of major projects such as plant modifications required to meet NRC concerns on high energy line breaks outside containment,

ECCS systems design, and environmental qualification of safety related equipment. Had lead technical responsibility for American Electric Power for meetings with the NRC and for presentations to the Advisory Committee on Reactor Safeguards.

Was responsible for the technical input and coordination of safety reviews of design changes, the Final Safety Analysis Report and amendments, and oral and written correspondence with the NRC. Supervisory responsibility for development of commitment lists, Westinghouse owners group activities, fire protection program, N-lists, technical specifications, security plan, emergency plan, internal QA procedures, plant health physics support, nuclear safety and licensing aspects of fuel reloads, probabilistic risk assessment studies, etc. Was Secretary of Nuclear Safety Design Review Committee, member of Edison Electric Institute ad-hoc committee to comment on WASH-1400; company representative to joint utility - AEC - vendor task force on water reactor safety research (later taken over by EPRI), member of joint TVA-DUKE-AEP ice condenser task force, and Chairman of Helium Breeder Associates Committee to review safety and licensing problems with gas cooled fast reactors.

Stone & Webster - Was responsible for developing analysis methods for containment design and post-LOCA hydrogen generation analysis. Many assumptions from this work were subsequently adapted by the NRC in their published Regulatory Guide 1.7. Also performed preliminary evaluations to determine whether probabilistic techniques could be used for nuclear power plant design.

Knolls Atomic Power Lab - Performed thermal hydraulic analysis of nuclear reactors, designed tests and experiments, and delivered training lectures to Naval personnel.

EDUCATIONAL HONORS

University of Hartford Regent's Award for being top student in Mechanical Engineering, 1964 and 1965
American Society of Mechanical Engineers Greater Hartford Chapter Annual Award 1965
Kappa Mu - Honorary Engineering Fraternity

PUBLICATIONS

Technical Society

"Post DBA Containment Hydrogen Methods for Calculating and Controlling Hydrogen Accumulation" (co-author); presented at ANS Topical Meeting on Power Reactor System and Components, Williamsburg, Virginia, 1970.

"Survey Methods for Assessment of Radiological Release from Geological Repositories" (lead author); presented at ANS Annual Meeting Atlanta, Georgia, June 1979.

"Procedures, Barriers, State Variables, and Processes Important to Near Field Analysis" (lead author); presented at ANS Annual Meeting, Las Vegas, Nevada, June 1980.

Safety Analysis

"Evaluation of Consequences to Risk of Time Fan Cooling Units are Out of Service at Salem Generating Station," prepared for PSE&G, November 1981.

"Evaluation of Analytical Problems Associated with Changeover to Hot Leg Recirculation Following a Hypothetical Loss of Coolant Accident at Salem Generating Station," prepared for PSE&G, October 1981.

"Evaluation of Safety Concerns Associated with Loss of Coolant Accident Without Automatic Actuation of Containment Sprays," prepared for PSE&G, September 1981.

"Evaluation of Effect of Design Basis Accidents on Proposed Changes to Auxiliary Feedwater System at Salem Nuclear Power Generating Station," prepared for PSE&G, October 1981.

"Evaluation of Heat Balance Code Used at Salem Generating Station," prepared for PSE&G, December 1981.

"Evaluation of Inadvertent Human Intrusion into a Salt Dome Repository by Solution Mining" (co-author) draft report prepared for Office of Nuclear Waste Isolation, September 1980.

"Criticality Analysis for a Brine Filled Cavity in a Spent Fuel Nuclear Waste Repository Located in a Domed Salt Formation" (co-author), NUS-TM-326, January 1980.

"Questionnaire for Performing Safety Evaluations for Changes to Structures, Systems, and Components at the Salem Nuclear Plant," prepared for PSE&G, July 1981.

"Donald C. Cook Nuclear Plant, Unit No. 1, Results of the December 1974 Initial Weighing Program" prepared for American Electric Power, March 1975.

"Long Term Evaluation of the Ice Condenser System: Results of the January 1976 and April 1976 Ice Weighing Programs" (lead author) July 1976.

"Long Term Evaluation of the Ice Condenser System: Results of the January 1977 Ice Weighing Program" (lead author), May 1977.

Licensing

"Survey of New Types of Siting Research for Nuclear Power Plants" (lead author) NUS-4068, April 1982.

"Big Rock Point Plant: Spent Fuel Rack Addition Consolidated Environmental Impact Evaluation and Safety Analysis," (co-author), April 1982.

"Suggested Quality Assurance Requirements for a Mined Geologic Repository" (co-author), NUS-TM-338, May 1981.

"Safety Analysis Report Annotated Outline for a Nuclear Waste Repository in a Deep Geologic Formation," (co-author) NUS-TM-360, April 1981.

"Preliminary Information Report for a Conceptual Reference Repository in a Deep Geological Formation," (co-author) draft report prepared for office of Nuclear Waste Isolation, January 1980.

"Method for Developing the Q-list for a Geologic Repository" (co-author), NUS-TM-343, April 1981.

"A Preliminary Assessment of the PNL Strontium Heat Source Development Program to Determine its Adequacy for Licensing Purposes in FY 1981," (co-author) draft report prepared for Battelle Northwest, August 1979.

"Annotated Bibliography for a Cost Benefit Study of Several Aspects of a Nuclear Waste Repository" NUS-3528, July 1980.

"Cost Benefit Study of Several Aspects of a Geologic Nuclear Waste Repository" prepared for Basalt Waste Isolation Program, NUS-3569, April 1980.

"Quality Assurance Classification Requirements for Structures, Systems, Components, and Activities Related to a Mined Geologic Repository for Permanent Disposal of High Level Nuclear Waste" (co-author) prepared as a draft for Office of Nuclear Waste Isolation, March 1980.

"Applicable Requirements, Supporting Sequences, and Preliminary Strategy for the Office of Nuclear Waste Isolation Licensing Coordination Plan (co-author), NUS-3267, October 1980.

"NWTS Licensing Plan for High Level Waste Repositories in Geologic Formations" (co-author), prepared as a draft for Office of Nuclear Waste Isolation, September 1978.

"Donald C. Cook Nuclear Plant, Units 1 and 2, Final Safety Analysis Report - Update" (project manager and lead contributor), June 1982.

"Donald C. Cook Nuclear Plant, Units 1 and 2, Final Safety Analysis Report and Amendments" (co-author).

APPENDIX C
ANNUNCIATOR SURVEY TASK PLAN

D.C. COOK NUCLEAR PLANT
DCRDR PROGRAM

HUMAN FACTORS TASK PLAN
FOR THE
ANNUNCIATOR SYSTEM REVIEW

Canyon Research Group
The Essex Building
333 North Fairfax Street
Alexandria, Virginia 22314
(703) 548-4500

PREPARED BY: ______________________ ________
(Signature) (Date)
DCRDR Design Review Team
Human Factors Consultant

APPROVED BY: ______________________ ________
(Signature) (Date)
DCRDR Project Review Team

PERFORMED BY: ______________________ ________
(Signature) (Date)
DCRDR Design Review Team
Human Factors Consultant

RECORD OF REVISIONS

Rev. No.	Rev. Date	Description

TABLE OF CONTENTS

APPENDICES

1.0 OBJECTIVES

a. To assess to what degree the annunciator system conforms to the generic criteria in NUREG-0700.

b. To identify and document any features in the annunciator system design that do not conform to the criteria in NUREG-0700.

c. To identify and document any plant-specific design conventions and other plant-specific human factors criteria not defined in NUREG-0700.

2.0 REVIEW TEAM SELECTION AND RESPONSIBILITIES

a. A human factors specialist to conduct the data collection and analysis and to prepare the task report.

b. A client nuclear operations specialist to supply plant systems information concerning alarm parameters and alarm response procedures.

c. A client plant I&C engineer to assist in identifying relevant plant systems information.

3.0 CRITERIA

The criteria are from NUREG-0700; paragraphs 6.3.1.1; 6.3.1.2a through d(2); 6.3.1.3a through d; 6.3.1.4a and b; 6.3.1.5a through b(3); 6.3.2.1a through f; 6.3.3.1a through b(2); 6.3.2.2a and b; 6.3.3.1a through c(3); 6.3.3.2a through f(2); 6.3.3.3a through f; 6.3.3.4a through d; 6.3.3.5a through d(6); 6.3.4.1a through d(2); 6.3.4.2a through c; 6.3.4.3a and b; 6.5.1.6a through c(2) and e(1) through 3(3);and 6.6.6.2a, b, and c (see Appendix A).

4.0 PROCEDURES

4.1 <u>General Instructions</u>

4.1.1 Preparation and Conduct of Procedures

a. Prior to conduct of this task, ensure that all required data forms, plant documentation, engineering drawings, equipment, and materials are available. Ensure that permission has been obtained for all required access to the control room or other plant areas.

b. Record all exceptions, deviations, or changes to these procedures in Section 9.0 of this Task Plan. Number each entry sequentially, starting with 1. Include an explanation (technical justification) as to why the exception, deviation, or change was made.

4.1.2 Task Plan Critique

Upon completion of this task, fill out the Task Plan Critique contained in Appendix D. Submit the completed critique to your supervisor or project manager.

4.2 Data Collection

a. Data are collected using various methods and procedures consisting of measurements, observations, interviews and questionnaires, and document reviews. Appendix C illustrates the distribution of the criteria for the various methods.

b. Measurements and observations should be made for all items contained on the Measurements data forms and Observations checklists contained in Appendix B.

c. The operator questionnaire (Appendix B) should be administered to at least 50 percent of the licensed reactor operators for the plant. Administration may be conducted singly or in a group, but should be proctored or monitored.

d. The results of the System Function and Task Analysis tasks should be reviewed for annunciator-relevant data in reference to 6.3.3.1; 6.3.1.4a; 6.3.3b and d(2); 6.3.3.4a and c; 6.3.4.3a; and 6.6.6.2a(1), (2), and (3).

e. In addition to the review results from d, above, plant documentation should be reviewed to verify the items listed in the Document Review Checklist in Appendix B. The required plant documents include:

1. Annunciator Response Procedures
2. Administrative Procedures relevant to annunciators.

4.3 Analysis

a. All deviations from the criteria shall be recorded on Human Engineering Discrepancy (HED) reports (Appendix B). Recorded information shall include the instrument or instruments involved (e.g., auditory alarm horns, specific light tiles, etc.), a description of the problem including the 0700 paragraph number of the criteria, and a recommended solution.

b. Data collection method(s) shall also be recorded on the HED form (see Appendix B). Where data from two or more sources are contradictory, resolution of the conflict through data review and client interview shall be made.

c. Use the analysis aids from Appendix B for all data reduction and analysis. Upon completion of all analyses, ensure that the criteria in Appendix A are properly annotated (as specified in the analysis aids).

d. Submit the completed task plan to your immediate supervisor for review. Upon project management approval, initiate Task Report 3.1.

5.0 EQUIPMENT AND FACILITY REQUIREMENTS

a. Access to the control room.

b. Sound level meter.

c. Protractor and tape measure.

d. Flash comparator.

6.0 INPUTS AND DATA FORMS

a. Annunciator Response Procedures

b. Annunciator Administrative Procedures

c. Completed Task Reports for:

1. System Function and Task Analysis
2. Labels and Location Aids
3. Maintainability

d. Criteria List (Appendix A)

e. The following from Appendix B:

1. Measurements Data Forms
2. Questionnaire
3. Observations Checklist
4. Documentation Review Checklist
5. Analysis Aids
6. HED Report Forms

f. Criteria Matrix (Appendix C)

g. Task Plan Critique Form (Appendix D)

7.0 OUTPUTS AND RESULTS

a. Completed HEDs

b. Completed Task Report.

8.0 FIGURES AND TABLES

None.

9.0 PROCEDURE EXCEPTIONS

The following exceptions, deviations, and changes were made to these procedures during conduct of the task (include a statement of justification on each item):

APPENDIX A

CRITERIA

	N/A	YES	NO	COMMENTS
6.3.1.1 GENERAL SYSTEM DESIGN Annunciator warning systems are the primary control room interface to immediately alert the operator to out-of-tolerance changes in plant condition. Annunciator warning systems consist of three major subsystems: (a) an auditory alert subsystem, (b) a visual alarm subsystem, and (c) an operator response subsystem (see Exhibit 6.3-1). Together, these three subsystems should be designed to provide a preferred operational sequence for annunciator warnings as indicated in Exhibit 6.3-2.				
6.3.1.2 ALARM PARAMETER SELECTION a. SET POINTS—The limits or set points for initiating the annunciator warning system should be established to meet the following goals: (1) Alarms should not occur so frequently as to be considered a nuisance by the operators.				
(2) However, set points should be established to give operators adequate time to respond to the warning condition before a serious problem develops.				
b. GENERAL ALARMS (1) Alarms that require the control room operator to direct an auxiliary operator to a given plant location for specific information should be avoided.				
(2) If general alarms must be used, they should only be used for conditions that allow adequate time for auxiliary operator action and subsequent control room operator action.				
c. MULTICHANNEL OR SHARED ALARMS (1) Annunciators with inputs from more than one plant parameter set point should be avoided. Multi-input alarms that summarize single-input annunciators elsewhere in the control room are an exception.				
(2) Where multi-input annunciators must be used, an alarm printout capability should be provided. The specifics of the alarm should be printed on an alarm typer with sufficient speed and buffer storage to capture all alarm data.				

	N/A	YES	NO	COMMENTS
6.3.1.2 ALARM PARAMETER SELECTION (Cont'd) c. MULTICHANNEL OR SHARED ALARMS (Cont'd) (3) A reflash capability should be provided to allow subsequent alarms to activate the auditory alert mechanism and reflash the visual tile even though the first alarm may not have been cleared.				
d. MULTI-UNIT ALARMS– (1) Alarms for any shared plant systems should be duplicated in all control rooms.				
(2) When an item of shared equipment is being operated from one control room, a status display or signal should be provided in all other control rooms which could potentially control this equipment.				
6.3.1.3 FIRST OUT ANNUNCIATORS a. REACTOR SYSTEM (1) A separate first out panel should be provided for the reactor system.				
(2) The first out panel should consist of separate annunciator tiles for each of the automatic reactor trip functions.				
(3) In the event of a reactor trip, the tile associated with the event should illuminate, and no other.				
b. TURBINE-GENERATOR SYSTEM–A separate first out panel, similar in function to the reactor system panel, is recommended.				
c. POSITION–First out panels should be located directly above the main control work station for the system.				
d. APPLICATION–First out annunciators should conform to the general auditory, visual, and operator response guidelines of this section.				

	N/A	YES	NO	COMMENTS
6.3.1.4 PRIORITIZATION a. LEVELS OF PRIORITY (1) Prioritization should be accomplished using a relatively small (2-4) number of priority levels.				
(2) Prioritization should be based on a continuum of importance, severity, or need for operator action in one or more dimensions, e.g., likelihood of reactor trip, release of radiation. Exhibit 6.3-3 provides an example of prioritization based on three levels of prioritization.				
b. PRIORITY CODING (1) Some method for coding the visual signals for the various priority levels should be employed. Acceptable methods for priority coding include color, position, shape, or symbolic coding.				
(2) Auditory signal coding for priority level is also appropriate. See Guideline 6.2.2.3 for recommended coding techniques.				
6.3.1.5 CLEARED ALARMS a. AUDITORY SIGNAL—Cleared alarms should have a dedicated, distinctive audible signal which should be of finite duration				
b. VISUAL SIGNAL—The individual tile should have one of the following: (1) A special flash rate (twice or one-half the normal flash rate is preferred, to allow discrimination), or				
(2) Reduced brightness, or				
(3) A special color, consistent with the overall control room color coding scheme, produced by a diffe·ently colored bulb behind the tile.				

Item	N/A	YES	NO	COMMENTS
6.3.2.1 SIGNAL DETECTION a. INTENSITY—The signal should be such that operators can reliably discern the signal above the ambient control room noise. A nominal value of 10 dB(A) above average ambient noise is generally adequate.				
b. CONTROL—Signal intensity, if adjustable, should be controlled by administrative procedure.				
c. LIMITS—The signal should capture the operator's attention but should not cause irritation or a startled reaction.				
d. DETECTION—Each auditory signal should be adjusted to result in approximately equal detection levels at normal operator work stations in the primary operating area.				
e. RESET—The annunciator auditory alert mechanism should automatically reset when it has been silenced.				
f. IDENTIFICATION—The operator should be able to identify the work station or the system where the auditory alert signal originated. Separate auditory signals at each work station within the primary operating area are recommended.				
6.3.2.2 AUDITORY CODING a. LOCALIZATION (1) Auditory coding techniques should be used when the operator work station associated with the alarm is not in the primary operating area.				
(2) Coded signals from a single audio source should not be used to identify individual work stations within the primary operating area.				
b. PRIORITIZATION—Coding may be used to indicate alarm priority. (See Guideline 6.3.1.4.)				

	N/A	YES	NO	COMMENTS
6.3.3.1 VISUAL ANNUNCIATOR PANELS a. LOCATION—Visual alarm panels should be located above the related controls and displays which are required for corrective or diagnostic action in response to the alarm. (See Exhibit 6.3-4.)				
b. LABELING. (1) Each panel should be identified by a label above the panel.				
(2) Panel identification label height should be consistent with a subtended visual angle of at least 15 minutes when viewed from a central position within the primary operating area.				
6.3.3.2 VISUAL ALARM RECOG AND IDENT a. FLASHING – The specific tile(s) on an annunciator panel should use flashing illumination to indicate an alarm condition.				
b. FLASH RATE – Flash rates should be from three to five flashes per second with approximately equal on and off times.				
c. FLASHER FAILURE – In case of flasher failure of an alarmed tile, the tile light should illuminate and burn steadily.				
d. CONTRAST DETECTABILITY—There should be high enough contrast between alarming and steady-on tiles, and between illuminated and non-illuminated tiles, so that operators in a normally illuminated control room have no problem discriminating alarming, steady-on, and steady-off visual tiles.				
e. "DARK" ANNUNCIATOR PANELS – A "dark" annunciator panel concept should be used. This means that under normal operating conditions no annunciators would be illuminated; all of the visual tiles of the annunciator panels would be "dark."				
f. EXTENDED DURATION ILLUMINATION— If an annunciator tile must be "ON" for an extended period during normal operations (e.g., during equipment repair or replacement), it should be:				
(1) Distinctively coded for positive recognition during this period, and				
(2) Controlled by administrative procedures.				

Item	N/A	YES	NO	COMMENTS
6.3.3.3 ARRANGEMENT OF VISUAL ALARM TILES				
a. MATRIX ORGANIZATION – Visual alarms should be organized as a matrix of visual alarm tiles within each annunciator panel.				
b. FUNCTIONAL GROUPING–Visual alarm tiles should be grouped by function or system within each annunciator panel. For example, area radiation alarms should be grouped on one panel, not spread throughout the control room.				
c. LABELING OF AXES (1) The vertical and horizontal axes of annunciator panels should be labeled with alphanumerics for ready coordinate designation of a particular visual tile.				
(2) Coordinate designation is preferred on the left and top sides of the annunciator panel.				
(3) Letter height for coordinate designation should be consistent with a subtended visual angle of at least 15 minutes as viewed from a central position within the primary operating area.				
d. PATTERN RECOGNITION – (1) The number of alarm tiles and the matrix density should be kept low (a maximum of 50 tiles per matrix is suggested).				
(2) Tiles within an annunciator panel matrix should be grouped by subsystem, function, or other logical organization.				
e. OUT-OF-SERVICE ALARMS–Cues for prompt recognition of an out-of-service annunciator should be designed into the system.				
f. BLANK TILES–Blank or unused annunciator tiles should not be illuminated (except during annunciator testing).				
6.3.3.4 VISUAL TILE LEGENDS a. UNAMBIGUOUS – Annunciator visual tile legends should be specific and unambiguous. Wording should be in concise, short messages.				
b. SINGULARITY – Alarms which refer the operator to another, more detailed annunciator panel located outside the primary operating area should be minimized.				

	N/A	YES	NO	COMMENTS
6.3.3.4 VISUAL TILE LEGENDS (Cont'd) c. SPECIFICITY – Tile legends should address specific conditions; for example, do not use one alarm for HIGH-LOW, TEMPERATURE-PRESSURE.				
d. ABBREVIATIONS – Abbreviations and acronyms should be consistent with those used elsewhere in the control room.				
6.3.3.5 VISUAL TILE READABILITY a. DISTANCE – The operator should be able to read all the annunciator tiles from the position at the work station where the annunciator acknowledge control is located.				
(1) Letter height should subtend a minimum visual angle of 15 minutes, or .004 x viewing distance. The preferred visual angle is 20 minutes, or .006 x viewing distance.				
(2) Letter height should be identical for all tiles, based on the maximum viewing distance. Separate calculations should be made for stand-up and sit-down work stations.				
b. TYPE STYLE – The size and style of lettering should meet the following: (1) Type styles should be simple.				
(2) Type styles should be consistent on all visual tiles.				
(3) Only upper-case type should be used on visual tiles.				
c. LEGEND CONTRAST – Legends should provide high contrast with the tile background. (1) Legends should be engraved.				
(2) Legends should be dark lettering on a light background.				
d. LETTER DIMENSIONS AND SPACING – (1) Stroke-width-to-character-height ratio should be between 1:6 and 1:8.				
(2) Letter width-to-height ratio should be between 1:1 and 3:5.				
(3) Numeral width-to-height ratio should be 3:5.				

Item	N/A	YES	NO	COMMENTS
6.3.3.5 VISUAL TILE READABILITY (Cont'd) d. LETTER DIMENSIONS AND SPACING – (Cont'd) (4) Minimum space between characters should be one stroke width.				
(5) Minimum space between words should be the width of one character.				
(6) Minimum space between lines should be one-half the character height.				
6.3.4.1 CONTROLS (See Exhibit 6.3-5.) a. SILENCE (1) Each set of operator response controls should include a silence control.				
(2) It should be possible to silence an auditory alert signal from any set of annunciator response controls in the primary operating area.				
b. ACKNOWLEDGE (1) A control should be provided to terminate the flashing of a visual tile and have it continue at steady illumination until the alarm is cleared.				
(2) Acknowledgement should be possible only at the work station where the alarm originated.				
c. RESET (1) If an automatic cleared alarm feature is not provided, a control should be provided to reset the system after an alarm has cleared.				
(2) The reset control should silence any audible signal indicating clearance and should extinguish tile illumination.				
(3) The reset control should be effective only at the work station for the annunciator panel where the alarm initiated.				
d. TEST (1) A control to test the auditory signal and flashing illumination of all tiles in a panel should be provided.				
(2) Periodic testing of annunciators should be required and controlled by administrative procedure.				

N/A	YES	NO	COMMENTS

6.3.4.2 CONTROL SET DESIGN

a. POSITIONING OF REPETITIVE GROUPS—Repetitive groups of annunciator controls should have the same arrangement and relative location at different work stations. This is to facilitate "blind" reaching.

b. CONTROL CODING—Annunciator response controls should be coded for easy recognition using techniques such as:

(1) Color coding;

(2) color shading the group of annunciator controls;

(3) demarcating the group of annunciator controls; or

(4) shape coding, particularly the silence control. (See Exhibit 6.3-5, Example 2.)

c. NONDEFEATABLE CONTROLS—Annunciator control designs should not allow the operator to defeat the control. For example, some pushbuttons used for annunciator silencing and acknowledgement can be held down by inserting a coin in the ring around the pushbutton. This undesirable design feature should be eliminated.

6.3.4.3 ANNUNCIATOR RESPONSE PROCEDURES

a. AVAILABILITY—Annunciator response procedures should be available in the control room.

b. INDEXING—Annunciator response procedures should be indexed by panel identification and annunciator tile coordinates.

6.5.1.6 COLOR CODING

a. REDUNDANCY—In all applications of color coding, color should provide redundant information. That is, the pertinent information should be available from some other cue in addition to color.

b. NUMBER OF COLORS

(1) The number of colors used for coding should be kept to the minimum needed for providng sufficient information.

(2) The number of colors used for coding should not exceed 11.

Item	N/A	YES	NO	COMMENTS
6.5.1.6 COLOR CODING (Cont'd) c. MEANING OF COLORS (1) The meaning attached to a particular color should be narrowly defined.				
(2) Red, green, and amber (yellow) should be reserved for the following uses: Red: unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance. Green: safe, no operator action required, or an indication that a parameter is within tolerance. Amber (yellow): hazard (potentially unsafe), caution, attention required, or an indication that a marginal value or parameter exists.				
d. CONSISTENCY OF MEANING (1) The meaning assigned to particular colors should be consistent across all applications within the control room.				
(2) The meaning of a particular color should remain the same whether applied to panel surfaces or projected in signal lights or on CRTs.				
6.6.6.2 DEMARCATION a. USE—Lines of demarcation can be used to: (1) Enclose functionally related displays.				
(2) Enclose functionally related controls.				
(3) Group related controls and displays.				
b. CONTRAST—Lines of demarcation should be visually distinctive from the panel background.				
c. PERMANENCE—Lines of demarcation should be permanently attached.				

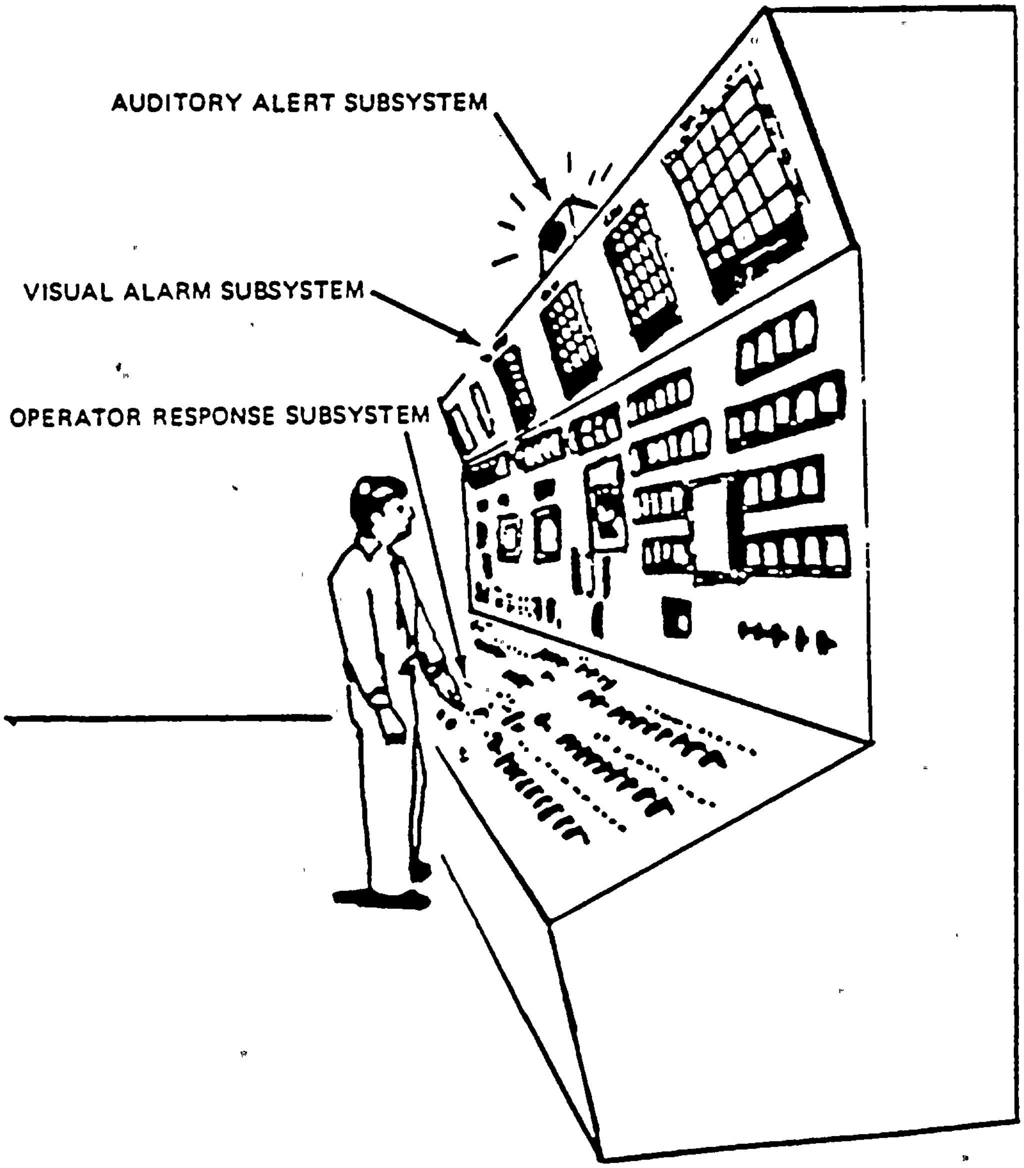


Exhibit 6.3-1. Annunciator warning system.

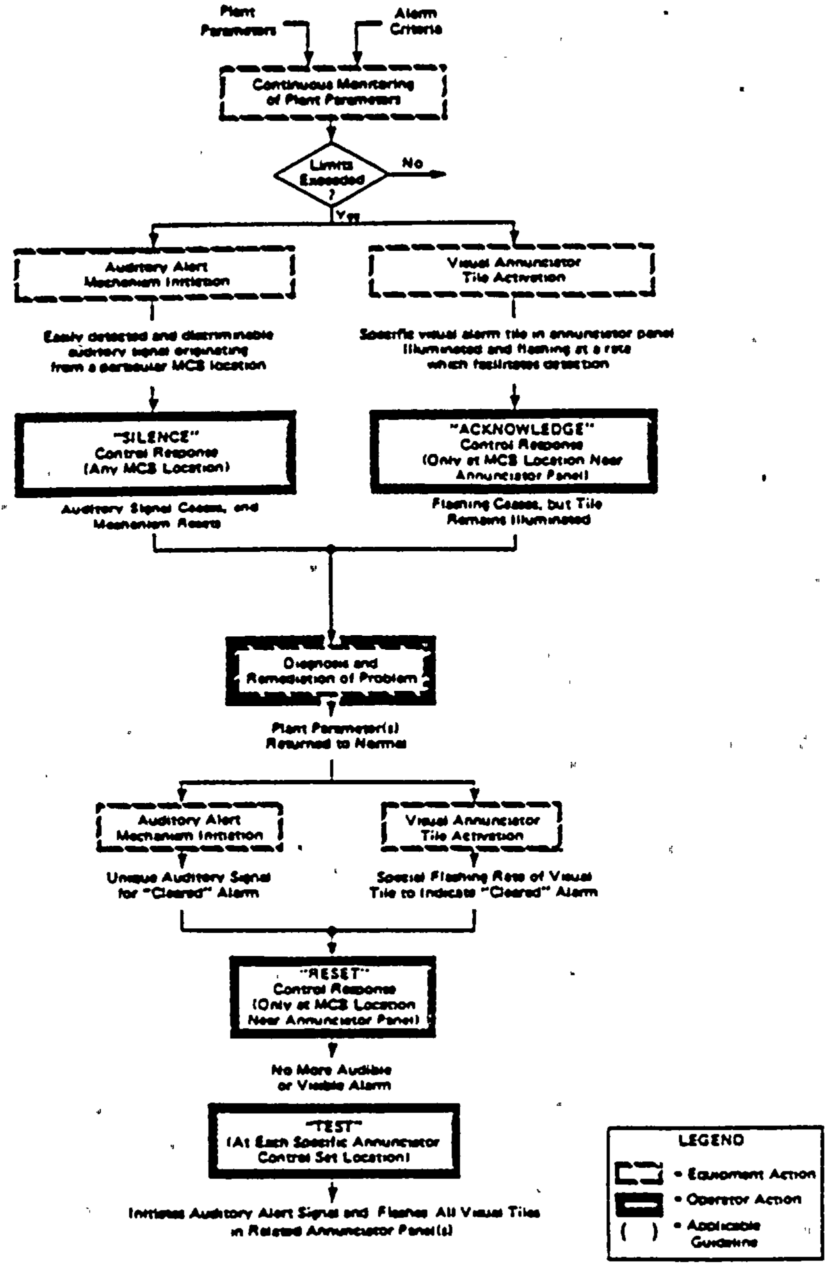


Exhibit 6.3-2. Annunciator system preferred operational sequence.

FIRST PRIORITY ALARMS

- Plant shut down (reactor trip, turbine trip)
- Radiation release
- Plant conditions which, if not corrected immediately, will result in automatic plant shutdown or radiation release, or will require manual plant shutdown.

SECOND PRIORITY ALARMS

- Technical specification violations which if not corrected will require plant shutdown
- Plant conditions which, if not corrected, may lead to plant shut down or radiation releases

THIRD PRIORITY ALARMS

- Plant conditions representing problems (e.g., system degradation) which affect plant operability but which should not lead to plant shutdown, radiation release, or violation of technical specifications

Exhibit 6.3-3. Three-level annunciator prioritization example.

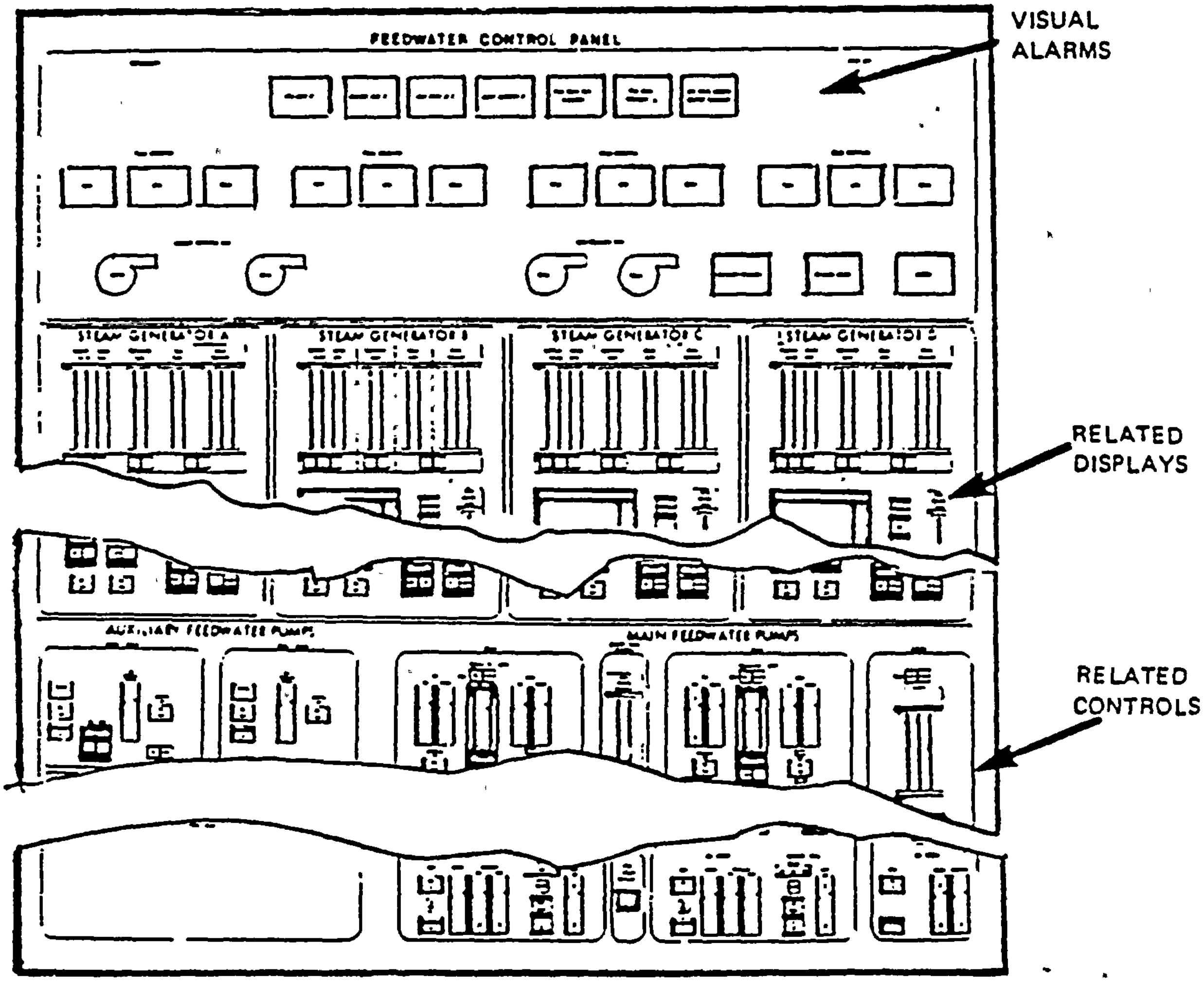
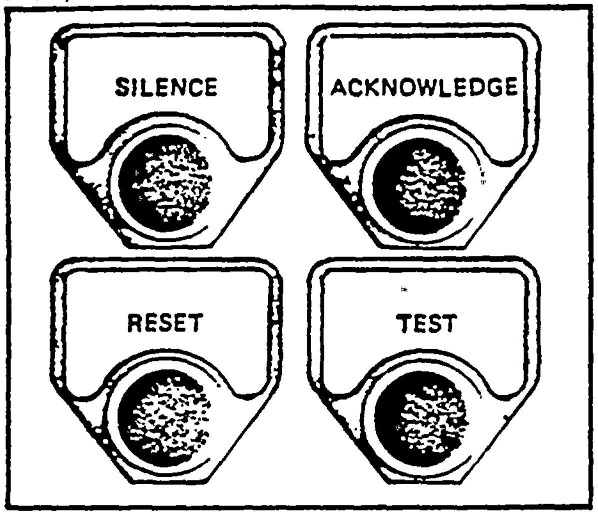


Exhibit 6.3-4. Visual alarms located above the related controls and displays. (From Seminara et al., 1979).

Example 1



Example 2

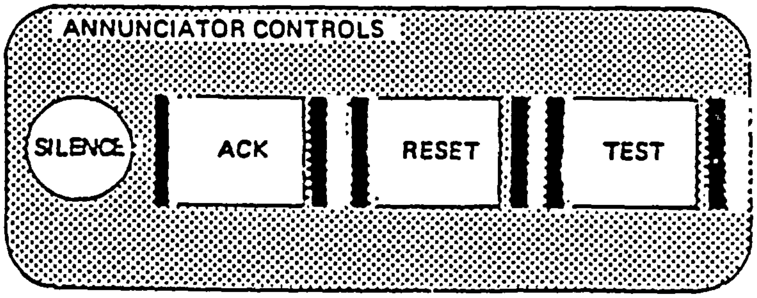


Exhibit 6.3-5. Annunciator response controls.

Color Serial or selection number	General color name	ISCC-NBS centroid number	ISCC-NBS color-name (abbreviation)	Munsell renotation of ISCC-NBS Centroid Color
1	white	263	white	2.5PB 9.5/0.2
2	black	267	black	N 0.8/
3	yellow	82	v.Y	3.3Y 8.0/14.3
4	purple	218	s.P	6.5P 4.3/9.2
5	orange	48	v.O	4.1YR 6.5/15 0
6	light blue	180	v.l.B	2.7PB 7.9/6.0
7	red	11	v.R	5.0R 3.9/15 4
8	buff	90	gy.Y	4.4Y 7.2/3.8
9	gray	265	med Gy	3.3GY 5.4/0 1
10	green	139	v.G	3.2G 4.9/11.1
11	purplish pink	247	s.pPk	5.6RP 6.8/9.0
12	blue	178	s.B	2.9PB 4.1/10 4
13	yellowish pink	26	s.yPk	8.4R 7.0/9.5
14	violet	207	s.V	0.2P 3.7/10.1
15	orange yellow	66	v.OY	8.6YR 7.3/15.2
16	purplish red	255	s.pR	7.3RP 4.4/11.4
17	greenish yellow	97	v.gY	9.1Y 8.2/12.0
18	reddish brown	40	s.rBr	0.3YR 3.1/9.9
19	yellow green	115	v.YG	5.4GY 6.8/11.2
20	yellowish brown	75	deep yBr	8.8YR 3.1/5.0
21	reddish orange	34	v.rO	9.8R 5.4/14.5
22	olive green	126	d.OlG	8.0GY 2.2/3.6

Exhibit 6.5-7. Twenty-two colors of maximum contrast (from Kelly, 1965).

APPENDIX B

DATA FORMS

ANNUNCIATOR SYSTEM

APPENDIX B
DATA FORMS

TABLE OF CONTENTS

APPENDIX B1.1
MEASUREMENTS DATA

1. LINEAR MEASUREMENTS (LABELING)

1.1 Annunciator Light Box (ALB) Summary Labels - 6.3.3.1b(2).

a. If there are no summary labels, check here: ________

b. If there are summary labels, measure and record in Table 1.1b the following information:

ITEM NO.	ITEM DESCRIPTION
1)	Character height
2)	Character width and/or numeral width
3)	Character strokewidth
4)	Character spacing
5)	Word spacing
6)	Line spacing

TABLE 1.1b

ITEM	ALB-____	ALB-____	ALB-____	ALB-____	ALB-____	ALB-____	ALB-____
1.	____	____	____	____	____	____	____
2.	____	____	____	____	____	____	____
3.	____	____	____	____	____	____	____
4.	____	____	____	____	____	____	____
5.	____	____	____	____	____	____	____
6.	____	____	____	____	____	____	____

1.2 Tile Labeling - 6.3.3.5a(1) and a(2), and 6.3.5.5d(1) through d(6).

a. Measure and record in Table 1.2a the character height(s) used in the tiles. If more than one size character is used, record the height for all of the represented heights. Also measure and record the farthest left and farthest right tile from its associated acknowledge station for each of the represented character heights (start at the left most acknowledge station and number the stations going clockwise around the MCB).

APPENDIX B1.1
MEASUREMENTS DATA

1.2 (Cont.)

TABLE 1.2a

CHAR HT	STA 1 LEFT	STA 1 RIGHT	STA 2 LEFT	STA 2 RIGHT	STA 3 LEFT	STA 3 RIGHT	STA 4 LEFT	STA 4 RIGHT	STA 5 LEFT	STA 5 RIGHT

b. For each acknowledge station in the table above, measure and record in Table 1.2b the height from the floor for the farthest left and farthest right tile from this same table.

TABLE 1.2b

CHAR HT	TILE HEIGHT FROM FLOOR STA 1	STA 2	STA 3	STA 4	STA 5

APPENDIX B1.1
MEASUREMENTS DATA

c. Measure and record the following for each of the different character heights from a, above:

TABLE 1.2c

	HT (ref)	CHAR/NUM WIDTH	STROKE WIDTH	CHAR SPACING	WORD SPACING	LINE SPACING
1.						
2.						
3.						
4.						
5.						
6.						

1.3 Data Reduction and Analysis.

For data reduction and analysis, obtain the appropriate analysis aids from Appendix B5 (ref. B5.1).

ANNUNCIATOR SYSTEM

APPENDIX B1.2
MEASUREMENTS DATA

2. SOUND MEASUREMENTS (AUDIBLE SIGNALS)

2.1 Annunciator Audible Alarms - 6.3.2.1a.

Measure the sound level in dB(A) for each annunciator audible alarm at each of the following operator positions:

TABLE 2

		MCB						
		SAFETY SYSTEMS						
	ALARM LOCATION	POS 1	POS 2	REAC CONT	TURB GEN	ELEC DIST	RAD MON CONSOLE	OP'S DESK
1.								
2.								
3.								
4.								
5.								

2.2 Data Reduction and Analysis.

For data reduction and analysis, obtain the appropriate analysis aids from Appendix B5 (ref. B5.2).

APPENDIX B1.3
MEASUREMENTS DATA

3. LIGHT MEASUREMENTS (TILE FLASH CHARACTERISTICS) - 6.3.5b(1) and 6.3.3.2b

3.1 Using the Flash Comparator, measure the flash rate of tiles in alarm and in clear. Record the rates.

Alarm Flash Rate: ____________________

Cleared Flash Rate: ____________________

3.2 Using the Flash Comparator, measure the on-off ratio for the alarm flash rate and cleared flash rate.

On-Off Ratio (Alarm): ________________

On-Off Ratio (Cleared): ________________

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

INSTRUCTIONS

1. The following are questions concerning the general layout, functional organization, and operational considerations in your control room. Most of the questions will require a YES or NO answer, with some additional information.
2. When you have comments or suggestions, use the space provided below each question. If you need additional room, use the backs of the sheets.
3. If you do not understand a question, please ask the monitor for clarification.
4. Please answer all of the questions as completely as possible.
5. Take as much time as you need to complete the questionnaire.
6. All of your answers, and your biographical information, will be kept in the strictest confidence and will be used to aid in the performance of the detailed control room design review.

PLEASE BEGIN

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

BIOGRAPHICAL DATA:

Name: ______________________________ Age: __________

Sex: ___________ Height: ___________ Weight: _______

Current Position/Title: ______________________________

1. Do you have a current reactor operator's license? YES ___ NO ___
2. Amount of licensed experience at this plant: ______________
3. Total amount licensed experience: ______________________
4. Related experience and amount (example: operator-trainee, Hodge NPP Unit 1, 1 yr.):

5. Education:
   a. Highest level attained: ______________________
   b. Specialized Schools or courses (list):

6. Military experience:

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

1. Do you have a first out annunciator panel where only the tile associated with the reactor trip event illuminates and all subsequent alarms on that panel are "locked out"? YES NO

2. Do you know of any automatic reactor trip functions that do not have a separate annunciator tile on the first out panel (either missing or shared with other functions)? YES NO

3. Are the annunciator panels in the control room identified by a label above each panel? YES NO

4. From your primary operating area, can you read all annunciator panel labels with a minimum of effort? YES NO

5. Is the annunciator system priority coded by color, position, shape, or symbolic coding of the tiles? YES NO

6. Does your annunciator system use color coding? YES NO

7. Are there more than eleven colors used for coding the panels? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

8. Is there a standard meaning attached to the colors used for coding the panels? YES NO

9. Is the color red ever used for a condition other than unsafe, danger, immediate operator action required, or as an indication that a critical parameter is out of tolerance? YES NO

10. Is the color green ever used for a condition other than safe, no operator action required, or as an indication that a parameter is within tolerance? YES NO

11. Is the color amber (yellow) ever used for a condition other than hazard (potentially unsafe), caution, attention required, or as an indication that a marginal value or parameter exists? YES NO

12. Do you know of any unnecessary color coding on the annunciator panels? YES NO

13. Do you know of any colors that are not used consistently across all applications within the control room, from panel-to-panel or in signal lights and on CRTs? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

14. Are auditory signals priority coded by pulse, frequency change (warbling), intensity, or different frequencies for different signals? YES NO

15. If you have separate alarm horns, can you easily identify the work station or system where the auditory signal originated? YES NO

16. Do you have different alarm horns for work areas not at the main control board? YES NO

17. If the auditory alarm signal has only one source, is the sound coded to direct you to different work areas? YES NO

18. Do any of the alarm horns startle or irritate you? YES NO

19. If you have different alarm horns, do any of them sound too loud or too soft in comparison to the others at your normal work station? YES NO

20. Do you have a silence control with each set of response controls in your primary operating area? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

21. Is a control provided which terminates a flashing visual tile, but allows a steady illumination until the alarm is cleared? YES NO

22. Can you acknowledge an alarm from more than one response control area? YES NO

23. If cleared alarms do not reset automatically, do you have a control to reset them yourself? YES NO

24. Does the reset control silence the auditory signal as well as extinguish the illumination? YES NO

25. Does the reset control operate from more than one response control area? YES NO

26. Can you defeat any of the annunciator controls, such as locking out the audible alarm or locking down the acknowledge control? YES NO

27. Can you test the auditory and flashing illumination signals of all tils for each panel? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

28. Is there an administrative procedure that controls the periodic testing of all annunciators? YES NO

29. Are all tiles dark on annunciator panels when no alarm is indicated? YES NO

30. Can you easily tell if a tile is normally on for an extended duration during normal operating conditions? YES NO

31. Are you immediately aware if an annunciator tile is out of service? YES NO

32. Can you immediately determine when the flasher of an alarm tile fails? YES NO

33. Do you know of any alarms that occur so frequently that you consider them a nuisance? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

34. Do you know of any alarms that do not give you ample time to respond to a warning condition? YES NO

35. When responding to an alarm tile, can you readily locate the controls and displays required for corrective or diagnostic action? YES NO

36. Do you have access to annunciator response procedures in the control room? YES NO

37. Do you know of any alarms which require you to obtain additional information from a source outside of the control room area? YES NO

38. Are there too many alarms which require additional information from panels outside your operating area? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

39. If alarms are used that require information outside the control room, do they allow you ample time to respond? YES NO

40. Are alarms provided for shared equipment in all control rooms? YES NO

41. Is there a status display or signal provided for shared equipment in all control rooms which indicates that the equipment is currently being operated? YES NO

42. Do you have any tiles with dual messages such as HIGH-LOW? YES NO

43. Does the multi-input alarm have a reflash capability that reflashes the visual tile after an auditory alert even if the first alarm has not been cleared? YES NO

APPENDIX B2
OPERATOR INTERVIEW/QUESTIONNAIRE

44. Do multi-input annunciators provide you with an alarm printout? YES NO

45. Does the multi-input alarm typer have sufficient speed to print the alarm data fast enough for your needs? YES NO

46. Does the alarm typer ever skip or loose information, or garble (mix up) the printing? YES NO

APPENDIX B3
OBSERVATIONS CHECKLIST

INSTRUCTIONS

1. Using the attached checklist, make all the noted observations.
2. Record all necessary information in the comments column to justify an N/A check and to detail a NO check.
3. Insure that all comments for NO checks include component, instrument, panel, equipment, etc. identification and location information.
4. Initiate HED reports on all NO checks per the directions contained in the checklist analysis aids.

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
1. A separate first out panel should be provided for the reactor system - 6.3.1.3a(1).				
2. A separate first out panel is recommended for the turbine-generator system that is functionally similar to the reactor system panel - 6.3.1.3b.				
3. First out panels should be located above their main work stations - 6.3.1.3c.				
4. All first out panels should conform to the general auditory and visual items in the rest of this checklist - 6.3.1.3d.				
5. A small number (2-4) of levels of priority coding are used - 6.3.1.4a(1).				
6. Priority coding of color, position, shape, or symbol is used for visual signals - 6.3.1.4b(1).				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
7. Auditory signal priority coding may be used - 6.3.1.4b(2).				
8. If more than one, each auditory signal should sound at approximately equal loudness at normal work stations in the primary operating area - 6.3.2.1d.				
9. An auditory signal should capture the operator's attention but should not irritate or cause a startled reaction - 6.3.2.1c.				
10. Separate auditory signals at each work station within the primary operating area are recommended - 6.3.2.1f.				
11. The operator should be able to identify the work station or area where the auditory alert originated - 6.3.2.1f.				
12. The auditory signal should automatically reset when silenced - 6.3.2.1e.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
13. When an alarm clears (or is cleared) there should be a dedicated, distinct audible signal with a finite duration - 6.3.1.5a.				
14. Auditory alert signal(s), if adjustable, should be controlled by administrative procedure - 6.3.2.1b.				
15. The specific title(s) in an ALB should visually flash to indicate an alarm condition - 6.3.3.2a.				
16. In case of flasher failure, an alarming tile should illuminate and burn steadily - 6.3.3.2c.				
17. Contrast between tiles should present no problem discriminating between alarming, steady-on, and steady-off conditions - 6.3.3.2d.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
18. Under normal (nonalarmed) conditions no annunciator tiles should be illuminated - 6.3.3.2e.				
19. If a tile must be on for an extended period during normal operations it should be distinctively coded for positive recognition during this period (see also 6.3.3.2f(2), item 2c on the Document Review Checklist) - 6.3.3.2f(1).				
20. Cleared tiles should have either a special flash rate, a reduced brightness, or a special color - 6.3.1.5b(1) through b(3).				
21. All tiles associated with a given acknowledge control should be readable when operating that control - 6.3.3.5a.				
22. Character style on all tiles should be simple - 6.3.3.5b(1).				
23. Character style should be consistent on all tiles - 6.3.3.5b(2).				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
24. Character style should be uppercase on all tiles - 6.3.3.5b(3).				
25. Tile legends should have high contrast with the tile background - 6.3.3.5c.				
26. Tile legends should be engraved - 6.3.3.5c(1).				
27. Tile legends should be dark and opaque on a light and translucent background - 6.3.3.5c(2).				
28. Tile legends should be specific, unambiguous, concise, and short - 6.3.3.4a.				
29. Tile legends should address specific conditions, HIGH TEMP, or LOW PRESS, not HIGH-LOW TEMP-PRESS - 6.3.3.4c.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
30. Abbreviations and acronyms in legends should be consistent with those in other labeling in the control room - 6.3.3.4d.				
31. Tiles should be organized as a matrix within each ALB - 6.3.3.3a.				
32. The vertical and horizontal axes of the ALBs should be alphanumerically labeled for tile designation coordinates - 6.3.3.3c(1).				
33. Coordinate designators are preferred at the left and top sides of the ALBs - 6.3.3.3c(2).				
34. Character height for the coordinate labels should be the same height as those used in tile legends - 6.3.3.3c(3).				
35. The number of tiles in an ALB should be kept low, with a maximum of 50 tiles per ALB suggested - 6.3.3.3d(1).				

APPENDIX B3.
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
36. Cues for prompt recognition of an out-of-service annunciator should be designed into the system - 6.3.3.3e.				
37. Blank or unused tiles should not be illuminated except during annunciator testing - 6.3.3.3f.				
38. Demarcation lines may be used to enclose functionally related titles - 6.6.6.2a(1).				
39. Demarcation lines may be used to group tiles with their related controls and/or displays - 6.6.6.2a(1) through a(3).				
40. If used, demarcation lines should be visually distinctive from the panel background - 6.6.6.2b.				
41. If used, demarcation lines should be permanently attached - 6.6.6.2c.				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
42. ALBs should be located above the controls and displays required for corrective or diagnostic action when they alarm - 6.3.3.1a.				
43. Each ALB should be identified by a label directly above it - 6.3.3.1b(1).				
44. Each set of annunciator controls should include a silence control - 6.3.4.1a(1).				
45. An acknowledge control should be provided that terminates the flashing and causes the tile to continuously illuminate until it has cleared - 6.3.4.1b(1).				
46. If an automatic cleared alarm feature is not provided, a control should be provided to reset the system after an alarm has cleared - 6.3.4.1c(1).				

APPENDIX B3
OBSERVATIONS CHECKLIST

	N/A	YES	NO	COMMENTS
47. A control to test the auditory alarm and the flashing illumination of all tiles in a panel (i.e., in one or more ALBs) should be provided - 6.3.4.1d(1).				
48. Repetitive groups of annunciator controls should have the same arrangement and relative location at different work stations - 6.3.4.2a.				
49. Annunciator controls should be coded differently than other panel controls either by color, demarcation, or shape - 6.3.4.2b(1) through b(4).				
50. Shape coding is preferred for the silence control - 6.3.4.2b(4).				
51. Annunciator control designs should not allow the operator to defeat the control operation such as inserting a coin into a control guard ring - 6.3.4.2c.				
52. Annunciator response procedures should be available in the control room - 6.3.4.3a.				

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

INSTRUCTIONS

Collect the following documents and review them for the information contained in the attached checklist:

1. Administrative Procedures concerning annunciators
2. Annunciator Response Procedures
3. Results from the following task reports:
   a. Convention Survey
   b. System Function Task Analysis
   c. Labeling Survey
4. Insure that all comments for NO checks include component, instrument, panel, equipment, etc. identification and location information.
5. Initiate HED reports on all NO checks per the directions contained in the checklist analysis aids.

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

	N/A	YES	NO	COMMENTS
1. ANNUNCIATOR RESPONSE PROCEDURES a. Response procedures should be indexed by panel I.D. and tile coordinates - 6.3.4.3b				
b. There should be no alarms that require the operator to direct an auxiliary operator outside the control room to obtain more specific information - 6.3.1.2b(1).				
c. Annunciators with inputs from more than one plant parameter set point should be avoided (multi-input alarms that summarize single-input alarms elsewhere in the control room are an exception) - 6.3.1.2c(1)				
2. PLANT ADMINISTRATIVE PROCEDURES a. Periodic testing of annunciators should be required and controlled by administrative procedures - 6.3.4.1d(2).				
b. If audible alarm intensity is operator-adjustable, it should be controlled by administrative procedures - 6.3.2.1b.				

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

	N/A	YES	NO	COMMENTS
PLANT ADMIN PROCESS (cont) c. When annunciator tiles must be on for an extended period during normal operations, it should be controlled by administrative procedures (see also 6.3.3.2f(1), item 19 on the Observations Checklist) - 6.3.3.2f(2).				
3. CONVENTIONS TASK REPORT a. Color meanings should not be the only means for identifying pertinent information, that is, all color coding used should be redundant information - 6.5.1.6a.				
b. The number of colors used for coding should be kept to the minimum needed to provide sufficient information and should not exceed 11 - 6.5.1.6b(1) and b(2).				
c. Color meanings should be narrowly defined - 6.5.1.6c(1).				
d. Red should mean unsafe, danger, immediate operator action required, or an indication that a critical parameter is out of tolerance - 6.5.1.6c(2). It is important to note that in one sense, a strict interpretation of				

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

	N/A	YES	NO	COMMENTS
CONVENTIONS TR (Cont) this statement would mean that a standard, and broadly applied convention in the nuclear industry was incorrect. However, keep in mind that flowing electricity (closed breakers), flowing water or steam (running pumps and open valves), and an active reactor can be considered inherently less safe than a shut off or shut down condition.				
e. Green should mean safe, shut off, shut down, no operator action required, or an indication that a parameter is within tolerance - 6.5.1.6c(2).				
f. Amber or yellow should mean a hazard, potentially unsafe, caution, attention required, or an indication that a marginal value or parameter exists - 6.5.1.6c(2).				
g. Meanings assigned to a particular color should be consistent across all control room applications regardless of whether it is on a panel surface, in indicator lights or in CRTs - 6.5.1.6d(1) and (2).				
h. Abbreviations and acronyms should be consistent across control room applications - 6.3.3.4d.				

APPENDIX B4
DOCUMENTATION REVIEW CHECKLIST

	N/A	YES	NO	COMMENTS
4. SFTA TASK REPORT a. The annunciator warning system should be designed as the primary alerting interface with the operator for out-of-tolerance conditions. It should consist of three major subsystems: auditory alert, visual alarm, and operator response. These three subsystems should function to provide a prefered operational sequence for annunciator warnings - 6.3.1.1.				
b. Visual alarm tiles should be grouped by function, system, subsystem, or other logical organization within ALBs - 6.3.3.3b and d(2).				
c. Prioritization of annunciators should be based on a continum of importance, severity, or need for operator action in one or more dimensions such as, the likelihood of a reactor trip or the likelihood of a release of radiation - 6.3.1.4a(2).				
d. Tile legends should address specific conditions rather than a range of conditions and/or parameters. As an example, separate tiles should be used to indicate temperature-low, temperature-high, pressure-low, and pressure-high, rather than a single tile with the legend HIGH-LOW TEMP-PRESS - 6.3.3.4c.				

APPENDIX B5.1
MEASUREMENTS ANALYSIS

1. LINEAR MEASUREMENTS (LABELING)

1.1 ALB Summary Labels - 6.3.3.1.b(2)

a. If there are no summary labels, check N/A for criterion 6.3.3.1.b(2) in Appendix A.

b. If there are summary labels, calculate the visual angels for each label for the operator positions listed in Table 1.1b

Table 1.1b

		MCB							
		SAFETY SYSTEMS							
	ALB IDENT	POS 1	POS 2	REAC CONT	TURB GEN	ELEC DIST	RAD MON CONSOLE	OP'S DESK
1.								
2.								
3.								
4.								
5.								
6.								
7.								

Calculations (use extra sheets, as needed):

c. If all visual angles in Table 1.1b are 15 minutes of arc or greater, check YES for criterion 6.3.3.1b(2) in Appendix A.

d. If there are visual angles in Table 1.1b less than 15 minues of arc, record on an HED report form the position(s) and label(s) where this is so. Include the code number TP-3.1B5.1.1 in data collection description. For criterion 6.3.3.1b(2) in Appendix A, check the NO column and record the HED report number and the code number, TP-3.1B5.1.1 in the COMMENTS column

1.2 Tile Labels - 6.3.3.5a(1) and d(1) through d(6).

a. Calculate the visual angles for each character height at its farthest left and farthest right location for each workstation in Table 1.2a, below.

TABLE 1.2a

ALB NO/	STA 1		STA 2		STA 3		STA 4		STA 5	
CHAR HT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT	RIGHT

Calculations (use extra sheets, as required):

APPENDIX B5.1
MEASUREMENTS ANALYSIS

b. If all visual angles in Table 1.2a are 15 minutes of arc or greater, check YES for criterion 6.3.3.5a(1) in Appendix A.

c. If any visual angles in Table 1.2a are less than 15 minutes of arc, record on an HED report form the position(s) and tile legend(s) where this is so. Include the code number TP-3.1B5,1.2 in the data collection description. For criterion 6.3.3.5a(1) in Appendix A, check the NO column and record the HED report number and the code number, TP-3.1B5.1.2, in the COMMENTS column.

d. Compare the character dimensions and legend measurements for each character height recorded with criteria 6.3.3.5d(1) through d(6).

e. If all character heights and legends meet the criteria, check the YES column for these criteria in Appendix A.

f. If any character dimensions or legend measurements fail to meet the criteria, record on an HED report form the tile coordinates, character height implicated, and a description of the failure. Include the code number TP-3.1B5.1.2 in the data collection description. For criteria 6.3.3.5d(1) through d(6) in Appendix A, check the NO column and record the HED report number and the code number TP-3.1B5.1.2, in the COMMENTS column.

APPENDIX B5.2
MEASUREMENTS ANALYSIS

2. SOUND MEASUREMENTS (AUDIBLE SIGNALS)

2.1 Annunciator Audible Alarms - 6.3.2.1a.

a. Obtain the average.ambient noise level in db(A) from the Ambient Noise Survey Task Report (TR-1.6) and record below:

Average noise level: ___________ db(A)

b. Based upon the below adjustment factors, reduce each measured annunciator alarm level and record in Table 2.1b.

ABSOLUTE DIFFERENCE BETWEEN MEASURED LEVEL (Lm) AND AVERAGE NOISE LEVEL (Ln)	SUBTRACT THIS AMOUNT FROM MEASURED LEVEL (Lm) AND AND RECORD IN TABLE 2.1b
4	2.2
5	1.7
6	1.3
7	1.0
8	.8
9	.6
10	.4
11	.3
12	.3
13	.2
14	.2
15	.1

TABLE 2.1b

		MCB						
		SAFETY SYSTEMS						
	ALARM LOCATION	POS 1	POS 2	REAC CONT	TURB GEN	ELEC DIST	RAD MON CONSOLE	OP'S DESK
1.								
2.								
3.								
4.								
5.								

APPENDIX B5.2
MEASUREMENT ANALYSIS

c. Compare all adjusted dB(A) levels in Table 2.1b to the average noise level.

d. If all adjusted audible alarm levels are at least 10 dB(A) above the average noise level check the YES column for criterion 6.3.2.1a in Appendix A.

e. If any adjusted alarm levels are less than 10 dB(A) above the average noise level, record each occurance on an HED report form. Include the code number TP3.1B5.2.1 in the data collection description. For criterion 6.3.2.1a in Appendix A, check the NO column and record the HED report number and the code number, TP3.1B5.2.1 in the COMMENTS column.

APPENDIX B5.3
MEASUREMENT ANALYSIS

3. LIGHT MEASUREMENTS (TILE FLASH CHARACTERISTICS)

3.1 Alarmed Flash Characteristics - 6.3.3.2b.

a. From the recorded data, determine if the alarmed flash rate is between 3 to 5 flashes per second and that the on-off ratio is approximately 1:1.

b. If both parameters meet the criteria, check the YES column for criterion 6.3.3.2b in Appendix A.

c. If either parameter fails to meet the criteria, record the discrepancy on an HED report form. Include the code number TP-3.1B5.3.1 in the data collection description. For criterion 6.3.3.2b in Appendix A check the NO column and record the HED number and the code number, TP-3.1B5.3.1, in the COMMENTS column.

3.2 Cleared Flash Rate - 6.3.1.5b(1).

a. From the recorded data, determine if the cleared flash rate is approximately double or ½ the alarmed flash rate.

b. If the cleared flash rate passes the criterion, check the YES column for criteria 6.3.1.5b(1) in Appendix A.

c. If the cleared flash rate fails to meet the criterion, record the discrepancy on an HED report form. Include the code number TP-3.1B5.3.2 in the data collection discription. For criterion 6.3.1.5b(1) in Appendix A, check the NO column and record the HED number and the code number, TP-3.1B5.3.2, in the COMMENTS column.

APPENDIX B6
OPERATOR INTERVIEW/QUESTIONNAIRE ANALYSIS

1. GENERAL

   a. Review all questionnaires for completeness of biographical information and question responses.

   b. Delete incomplete and unusable questionnaires from the data base. If required by contract, re-schedule these questionnaires for correction/completeness.

   c. When the data base assembly is complete perform the anaylsis, below.

2. BIOGRAPHICAL DATA

   a. Assemble biographical data and determine ranges and distributions for all relevant dimensions.

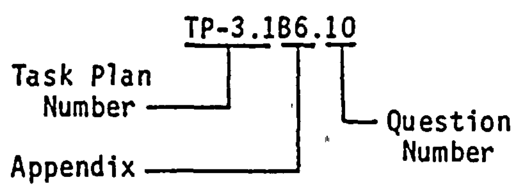
   b. Using appropriate statistics, determine the distribution (or its approximation) for this data.

3. RESPONSE DATA

   a. Summarize all responses and determine percent frequency response for each negative answer.

   b. For each negative answer, initiate Preliminary HEDs (PHEDs) for discrepancy review. Record frequency data, response question number and data collection code number on each PHED. Code numbers are developed as follows: (See List 3b for criteria)

Example:



   c. Submit all PHEDs to your immediate supervisor.

   d. Subsequent verification, validation and disposition of all PHEDs will be conducted per TP-10.1 (HED Review Procedure).

APPENDIX B6
OPERATOR INTERVIEW/QUESTIONNAIRE
ANALYSIS

LIST 3b

1. 6.3.1.3a(3)
2. 6.3.1.3a(2)
3. 6.3.3.1b(1)
4. 6.3.3.1b(2)
5. 6.3.1.4b(1)
6. 6.5.1.6b(1)
7. 6.5.1.6b(2)
8. 6.5.1.6c(1)
9. 6.5.1.6c(2)
10. 6.5.1.6c(2)
11. 6.5.1.6c(2)
12. 6.5.1.6b(1)
13. 6.5.1.6d(1)&(2)
14. 6.3.1.4b(2)& 6.3.2.2b
15. 6.3.2.1f
16. 6.3.2.2a(1)
17. 6.3.2.2a(2)
18. 6.3.2.1c
19. 6.3.2.1d
20. 6.3.4.1a(1)&(2)
21. 6.3.4.1b(1)
22. 6.3.4.1b(2)
23. 6.3.4.1c(1)
24. 6.3.4.1c(2)
25. 6.3.4.1c(3)
26. 6.3.4.2c
27. 6.3.4.1d(1)
28. 6.3.4.1d(2)
29. 6.3.3.2e
30. 6.3.3.2f
31. 6.3.3.3e
32. 6.3.3.2c
33. 6.3.1.2a(1)
34. 6.3.1.2a(2)
35. 6.3.3.1a
36. 6.3.4.3a
37. 6.3.1.2b(1)
38. 6.3.3.4b
39. 6.3.1.2b(2)
40. 6.3.1.2d(1)
41. 6.3.1.2d(2)
42. 6.3.3.4c
43. 6.3.1.2c(3)
44. 6.3.1.2c(2)
45. 6.3.1.2c(2)
46. 6.3.1.2c(2)

APPENDIX B7
OBSERVATION CHECKLIST
ANALYSIS

1. For each checklist item checked NO, initiate an HED report. Enter the HED report number in the COMMENTS column of the checklist for that item. Include all necessary information on the HED report concerning identification of the discrepancy and the criteria (checklist item) not met.

2. Enter the following code number in the data collection description:

   TP-3.1B3.<u>n</u>

   n — Checklist Item Number

3. Find the appropriate criterion or criteria in Appendix A from the reference number in the checklist item. Check the NO column and enter the HED number and the data collection code number in the COMMENTS column for that criterion or criteria.

APPENDIX B8
DOCUMENTATION REVIEW CHECKLIST
ANALYSIS

1. For each checklist item checked NO, initiate an HED report. Enter the HED report number in the COMMENTS column of the checklist for that item. Include all necessary information on the HED report concerning identification of the discrepancy and the criteria (checklist item) not met.

2. Enter the following code number in the data collection description:

TP-3.1B4.n
└── Checklist Item Number

3. Find the appropriate criterion or criteria in Appendix A from the reference number in the checklist item. Check the NO column and enter the HED number and the data collection code number in the COMMENTS column for that criterion or criteria.

APPENDIX B9

HUMAN ENGINEERING DISCREPANCY (HED) REPORT

____
PLANT/UNIT

ORIGINATOR: ______________________ HED NO.: ______________

VALIDATED BY: ______________________ DATE: ______________

a) HED TITLE: ____

____

b) ITEMS INVOLVED:
c) PROBLEM DESCRIPTION:
d) DATA COLLECTION DESCRIPTION CODE NUMBER:
e) SPECIFIC HUMAN ERROR(S):

HED REPORT (CONTINUED)

_________________________ HED NO.: _______________
PLANT/UNIT

f) SUGGESTED BACKFIT:
g) REVIEW AND DISPOSITION:

APPENDIX C

CRITERIA MATRIX

CRITERIA MATRIX

Criteria Distributed Across Data Collection Methods.

Notes:

1. The following codes apply to the matrix columns:

   M - Measurement (instruments and/or measuring devices required)

   O - Observations (observation notes taken)

   I - Interview/Questionnaire (generally a structured interview unless otherwise specified)

   D - Document Review (documentation review to include engineering drawings, CWDs, etc.)

   A - Auditory Criteria

   V - Visual Criteria

   C - Controls Criteria (physical characteristics)

   P - Physical Arrangement/Location Criteria

   F - Functional Criteria (usually requires some operational data for verification)

2. Data sources listed are suggested. Alternatives should be used when those listed are not available or are not adequate.

CRITERIA MATRIX

CRITERIA NUREG--0700 para number	Crit type	DATA COLLECTION METHODS M	O	I	D	SUGGESTED DATA SOURCES	REMARKS
6.3.1.1	F				X	SFTA Rpt	also in TP-9.1 (SFTA)
6.3.1.2a(1)	F			X		Ops	
a(2)	F			X		Ops	
b(1)	F			X	X	Ops, Ann Resp Procs	
b(2)	F			X		Ops	
c(1)	F				X	Ann Resp Procs	
c(2)	F			X		Ops	
c(3)	F			X		Ops	
d(1)	F			X		Ops	
d(2)	F			X		Ops	
6.3.1.3a(1)	PF		X			Pnl	
a(2)	PF			X		Ops	
a(3)	PF			X		Ops	
b	PF		X			Pnl	
c	PF		X			Pnl	
d	PF		N/A			All	see text para. 4.2a
6.3.1.4a(1)	PF		X			Pnl	
a(2)	PF				X	Pnl, SFTA Rpt	also in TP-9.1 (SFTA)
b(1)	F		X	X		Pnl	
b(2)	F		X	X		Pnl	
6.3.1.5a	F		X			Pnl	
b(1)	F	X	X			Pnl	
b(2)	F		X			Pnl	
b(3)	F		X			Pnl	
6.3.2.1a	F	X				CR	
b	F		X		X	CR, Admin Procs	
c	F		X	X		CR, Ops	
d	F		X	X		CR, Ops	
e	F		X			CR	
f	F		X	X		CR, Ops	
6.3.2.2a(1)	PF			X		Ops	
a(2)	F			X		Ops	
b	F			X		Ops	
6.3.3.1a	P		X			Pnl	
b(1)	P		X			Pnl	
b(2)	P	X				CR	
c(1)	P		N/A				in TP-1.8 (Maint)
c(2)	P		N/A				in TP-1.8 (Maint)
c(3)	P		N/A				in TP-1.8 (Maint)

CRITERIA MATRIX

CRITERIA NUREG--0700 para number	Crit type	DATA COLLECTION METHODS M	O	I	D	SUGGESTED DATA SOURCES	REMARKS
6.3.3.2a	F		X			Pnl	
b	F	X				Pnl, Comp Spec	
c	F		X	X		Pnl, Ops	
d	P		X			Pnl	
e	PF		X	X		Pnl, Ops	
f(1)	PF		X	X		Pnl, Ops	
f(2)	PF				X	Admin Procs	
6.3.3.3a	P		X			Pnl	
b	PF				X	SFTA Rpt	also in TP-9.1 (SFTA)
c(1)	P		X			Pnl	
c(2)	P		X			Pnl	
c(3)	P		X			Pnl	also in TP-6.1 (Labels)
d(1)	P		X			Pnl	
d(2)	PF				X	SFTA Rpt	also in TP-9.1 (SFTA)
e	F			X		Ops	
f	F		X			Pnl	
6.3.3.4a	P		X		X	Pnl, SFTA	also in TP-9.1 (SFTA)
b	PF			X		Ops	
c	PF		X	X	X	Pnl, Ops, SFTA Rpt	also in TP-9.1 (SFTA)
d	P		X		X	Pnl, Conv Rpt	also in TP-8.1 (Conv)
6.3.3.5a	P		X			Pnl	
a(1)	P	X				Pnl	
a(2)	P	X				Pnl	
b(1)	P		X			Pnl	
b(2)	P		X			Pnl	
b(3)	P		X			Pnl	
c	P		X			Pnl	
c(1)	P		X			Pnl	
c(2)	P		X			Pnl	
d(1)	P	X				Pnl	
d(2)	P	X				Pnl	
d(3)	P	X				Pnl	
d(4)	P	X				Pnl	
d(5)	P	X				Pnl	
d(6)	P	X				Pnl	
6.3.4.1a(1)	P		X	X		Pnl, Ops	
a(2)	PF			X		Ops	
b(1)	F		X	X		Pnl, Ops	
b(2)	F			X		Ops	
c(1)	F		X	X		Pnl, Ops	
c(2)	F			X		Ops	
c(3)	F			X		Ops	

CRITERIA MATRIX

CRITERIA NUREG--0700 para number	CRITERIA Crit type	DATA COLLECTION METHODS M	O	I	D	SUGGESTED DATA SOURCES	REMARKS
6.3.4.1d(1)	F		X	X		Pnl, Ops	
d(2)	F			X	X	Ops, Admin Procs	
6.3.4.2a	P		X			Pnl	
b(1)	P		X			Pnl, Conv Rpt	also in TP-8.1 (Conv)
b(2)	P		X			Pnl, Conv Rpt	also in TP-8.1 (Conv)
b(3)	P		X			Pnl, Conv Rpt	also in TP-8.1 (Conv)
b(4)	P		X			Pnl, Conv Rpt	also in TP-8.1 (Conv)
c	P		X	X		Pnl, Ops	
6.3.4.3a	P		X	X	X	CR, Ops, SFTA Rpt	also in TP-9.1 (SFTA)
b	F				X	Ann Resp Procs	
6.5.1.6a	P				X	Conv Rpt	
b(1)	P			X	X	Ops, Conv Rpt	also in TP-8.1 (Conv)
b(2)	P			X	X	Ops, Conv Rpt	also in TP-8.1 (Conv)
c(1)	P			X	X	Ops, Conv Rpt	also in TP-8.1 (Conv)
c(2)	P			X	X	Ops, Conv Rpt	also in TP-8.1 (Conv)
d(1)	P			X	X	Ops, Conv Rpt	also in TP-8.1 (Conv)
d(2)	P			X	X	Ops, Conv Rpt	also in TP-8.1 (Conv)
6.6.6.2a	F		X			Pnl, Ops, SFTA Rpt	also in TP-9.1 (SFTA)
b	VC		X			Pnl	also in TP-6.1 (Labels)
c	P		X			Pnl	also in TP-6.1 (Labels)

APPENDIX D

TASK PLAN CRITIQUE

APPENDIX D
TASK PLAN CRITIQUE

INSTRUCTIONS

1. Attach a copy of Section 4.0.
2. Fill in the required information and answer all questions.
3. Explain all NO answers in detail.
4. When complete, turn in to your immediate supervisor.

1. Name of Respondent: ______________________________

2. Name of Plant: ______________________________

3. Date of Survey: ______________________________

4. Were all of the criteria correct and appropriate for this task (do not explain criteria that were N/A because System/CR did not have that design feature)? YES___ NO___

5. Did the task plan instructions present the easiest and best methodology for performing the assessment? YES___ NO___

6. Were the data collection forms adequate? YES___ NO___