Enclosure 1

TECHNICAL EVALUATION REPORT
OF THE
DETAILED CONTROL ROOM DESIGN REVIEW
FOR
HOUSTON LIGHTING AND POWER COMPANY'S
SOUTH TEXAS PROJECT
NUCLEAR POWER GENERATION STATION

July 19, 1984

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Nuclear Regulatory Commission

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1. BACKGROUND

Licensees and applicants for operating licenses shall conduct a Detailed Control Room Design Review (DCRDR). The objective is to "improve the ability of nuclear power plant control room operators to prevent accidents or cope with accidents if they occur by improving the information provided to them" (NUREG-0660, Item I.D). Supplement 1 to NUREG-0737 requires each applicant or licensee to conduct a DCRDR on a schedule negotiated with the Nuclear Regulatory Commission (NRC).

NUREG-0700 describes four phases of the DCRDR and provides applicants and licensees with guidelines for its conduct.

The phases are:

1. Planning
2. Review
3. Assessment and Implementation
4. Reporting.

Criteria for evaluating each phase are contained in draft NUREG-0801.

A Program Plan is to be submitted within two months of the start of the DCRDR. Consistent with the requirements of Supplement 1 to NUREG-0737, the Program Plan shall describe how the following elements of the DCRDR will be accomplished:

1. Establishment of a qualified multidisciplinary review team

2. Function and task analyses to identify control room operator tasks and information and control requirements during emergency operations

3. A comparison of display and control requirements with a control room inventory

4. A control room survey to identify deviations from accepted human factors principles

5. Assessment of human engineering discrepancies (HEDs) to determine which HEDs are significant and should be corrected

6. Selection of design improvements

7. Verification that selected design improvements will provide the necessary correction

8. Verification that improvements will not introduce new HEDs

9. Coordination of control room improvements with changes from other programs such as SPDS, operator training, Reg. Guide 1.97 instrumentation, and upgraded emergency operating procedures.

A Summary Report is to be submitted at the end of the DCRDR. As a minimum it shall:

1. Outline proposed control room changes

2. Outline proposed schedules for implementation

3. Provide summary justification for HEDs with safety significance to be left uncorrected or partially corrected.

The NRC will evaluate the organization, process, and results of the DCRDR. Evaluation will include review of required documentation (Program Plan and Summary Report) and may also include reviews of additional documentation, briefings, discussions, and on-site audits. In-progress audits may be conducted after submission of the Program Plan but prior to submission of the Summary Report. Preimplementation audits may be conducted after submission of the Summary Report. Evaluation will be in accordance with the requirements of Supplement 1 to NUREG-0737. Additional guidance for the evaluation is provided by NUREG-0700 and draft NUREG-0801. Results of the NRC evaluation of a DCRDR will be documented in a Safety Evaluation Report (SER) or SER Supplement.

Significant HEDs should be corrected. Improvements which can be accomplished with an enhancement program should be done promptly.

2. DISCUSSION

Houston Lighting and Power Company's (HL&P's) South Texas Project (STP) is under construction. Licensing of Unit 1 is scheduled for December 1986. The STP DCRDR was initiated in September, 1982. HL&P briefed the NRC staff on its DCRDR Program Plan on October 5, 1982, and formally submitted that Program Plan on October 20, 1982. Exceptions to the originally planned organization and process of the DCRDR were documented in a March 31, 1983 revision to the Program Plan. The Program Plan included review of the auxiliary shutdown panel within the scope of the DCRDR.

In a letter from J. H. Goldberg to T. M. Novak, dated April 7, 1983, HL&P requested an in-progress audit of the STP DCRDR. The primary purpose of the request was to obtain NRC review of the STP main control board layout. The requested audit was conducted from May 2 through 6, 1983, at the Bechtel Energy Corporation (STP architect-engineer) office in Houston. The NRC was assisted in the audit by its consultants from Lawrence Livermore National Laboratory.

Available at the audit site were:

1. A full-size control room mock-up.

2. A half-size color photo mosaic of the control room simulator.

3. A scale model showing control room layout.

4. Example controls and displays.

5. Examples of the labels and location aids being developed to assist control room operators.

HL&P provided a number of documents by mail and at the audit site to support the in-progress audit. HL&P, Bechtel Energy Corporation, and Torrey Pines Technology (human factors consultant) personnel involved in the DCRDR were available on a daily basis during the audit.

The in-progress audit of May 2 through 6, 1983, consisted of walk-throughs, document reviews, briefings, and discussions. Major emphasis was on evaluation of the organization and process of the DCRDR. DCRDR results, particularly in areas which could affect main control board layout, were also evaluated. Evaluation of DCRDR results was limited because the DCRDR was incomplete at the time of the in-progress audit. An in-progress audit report, transmitted to HL&P on October 31, 1983, summarized staff findings, provided

recommendations, and indicated information needed to complete evaluation of the DCRDR.

HL&P addressed DCRDR progress in a briefing on December 16, 1983. The briefing identified:

1. DCRDR activities completed since the in-progress audit
2. DCRDR activities remaining to be completed as of December 1983.

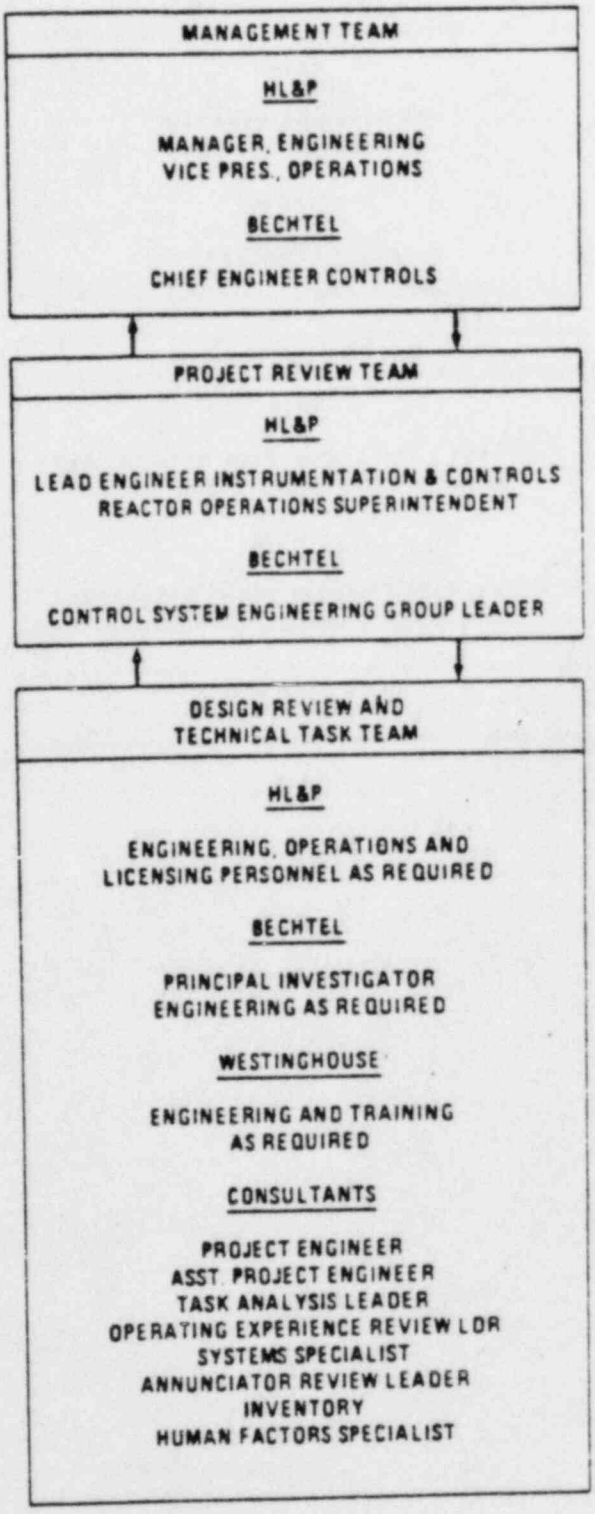
The fabrication status of control room panels CP-001 through CP-010 was also provided.

The Summary Report for the STP DCRDR was submitted April 12, 1984, by letter from J. H. Goldberg to T. M. Novak. That report consisted of 15 documents. Titles are provided in the Reference section of this report. Information in the Summary Report, along with information obtained earlier, was used to evaluate the organization, process, and results of the DCRDR. The NRC was assisted in the evaluation by its consultants from Lawrence Livermore National Laboratory. Results of the evaluation are summarized below.

3. REVIEW TEAM SELECTION

Supplement 1 to NUREG-0737 requires the establishment of a qualified multidisciplinary review team. Guidelines in team selection are found in NUREG-0700 and NUREG-0801.

Houston Lighting and Power (HL&P) established a hierarchy of three teams, as illustrated in Fig. 2-2 of the Executive Summary Report, to manage and conduct the South Texas Plant (STP) DCRDR. The Design Review and Technical Task Team is responsible for the technical aspects of the DCRDR. That team includes HL&P, Bechtel, and Torrey Pines Technology personnel. Westinghouse personnel (nuclear steam supply system vendor) are available as required. Team members represent a number of disciplines, including all those recommended in the NRC



OVERVIEW OF CONTROL ROOM
DESIGN REVIEW ORGANIZATION
Figure 2-2

guidelines. NUREG-0801 evaluation criteria for personnel qualifications and assignments by discipline have not always been fully met. However, DCRDR performance to date does not appear to have suffered on this basis. The ability to supplement the team with needed expertise when required has been demonstrated.

The qualifications of the six Management Team members are described in Appendix A of the CRDR Program plan, and include the HL&P Vice President of Nuclear Plant Operations, the Principal Nuclear Engineer, the STP Engineering Manager, and Assistant Plant Superintendent. Bechtel Corporation members are the STP Systems Project Engineer and the Chief Controls Engineer.

The qualifications of the 20 Project Review Team and Design Review and Technical Task Team members are described in Appendix B of the HL&P CRDR Program plan. The team members are affiliated as follows:

Torrey Pines Technology	9
Canyon Research Group	1
Seville Research Corporation	1
Westinghouse	1
Bechtel Corporation	4
HL&P	4
	20

The team membership includes expertise in Human Factors; Instrumentation and Control; Licensing Plant Operations; Training; Systems Engineering; Psychology; Nuclear, Electrical, and Mechanical Engineering; and Plant Process Systems. Special assignments were made to lead the annunciator and process computer studies.

We conclude that the requirement in Supplement 1 to NUREG-0737 to establish a qualified multidisciplinary review team has been met.

4. MANAGEMENT RESPONSIBILITY

Membership of the Project Review and Management Teams include both HL&P and Bechtel personnel. NRC guidelines recommend that overall management responsibility for the DCRDR be invested in the applicant/licensee. Although it differed from the guidelines, the shared management arrangement was consistent with the plant's design and construction status. Shared management did not appear to cause any functional problems in conduct of the DCRDR.

5. REVIEW OF OPERATING EXPERIENCE

HL&P conducted a very complete and well organized Operating Experience Review (OER). The Operating Experience Review Task Team (OERT) reviewed pertinent operating experience documents (OER Report, Section 2.1) and conducted a survey of control room operations personnel. In addition to typical human factors operator concerns, the OERT emphasized systems operability. It received valuable input for use by the other task groups, particularly the Systems Task Analysis Team (STAT). Specific attention was placed on those normal plant procedures that experienced operators identified as having the greatest potential for human factors engineering enhancements. This information was used in the selection process for those events that were analyzed by the STAT. The methodology used in the preparation of operating procedures was reviewed and comments submitted to the operations department.

The stated purpose of the operating experience review (OER) was to assess all safety-related and efficiency-related factors of the projected STP control room as identified by supervisors and operators. Its major objective was to identify problems relative to operator performance, as well as potential solutions to those problems.

The OER determined that the CR contained all of the equipment necessary to operate the plant safety, but contained significant human factor inadequacies. These inadequacies ranged in severity from very minor to

potentially severe, and the arrangement of components could create inconvenient sequences of RO movement about the control room and the potential for misinterpreting information.

It is stated that the human factors problems identified by operational personnel closely corresponded with observations contained in the human factors checklists. The OER Reports recommended that CR modifications were necessary to optimize the final CR arrangement for operator use.

The work is summarized in the Executive Summary Report, Section 2.3.2, with complete details of the original OER contained in the OER Report. Problem areas identified by operators in the original questionnaire (Appendix A of the OER Report) were used to guide control board modifications, and to develop an OER validation questionnaire (Appendix A of the OER Validation Report). Analysis of the results from the OER validation questionnaire indicated that no new observations were introduced as a result of the redesign of the control boards. Four previous problems that did not receive operator consensus regarding validation of correction have been corrected.

6. FUNCTION AND TASK ANALYSIS

Supplement 1 to NUREG-0737 requires the licensee to perform systems function and task analyses to identify control room operator tasks and information and control requirements during emergency operations. Furthermore, Supplement 1 to NUREG-0737 recommends the use of function and task analyses that had been used as the basis for developing emergency operating procedures technical guidelines and plant-specific emergency operating procedures to define these requirements.

The NRC memorandum of April 5, 1984, from H. Brent Clayton to Dennis L. Ziemann, "Meeting Summary--Task Analysis Requirements of Supplement 1 to NUREG-0737, March 29, 1984 meeting with Westinghouse Owner's Group (WOG) Procedures Subcommittee and Other Interested Persons", states that it appears

that Revision 1 of the WOG Emergency Response Guidelines (ERG) and background documents do provide an adequate basis for gererically identifying information and control needs.

The NRC memorandum of April 5, 1984, states in Item (2) that licensees and applicants must describe and report in the Procedure Generation Package (PGP) or DCRDR Program plan the process for using the generic guidelines and background documentation or other sources to identify the plant-specific characteristics of needed instrumentation and controls.

Item (3) of the memorandum states that safety-signficant, plant-specific deviations from the ERG instrumentation and controls must be reported and justified in the plant-specific technical guideline portion of the PGP, along with other technical deviations.

Item (4) of the memorandum states that for each instrument and control used to implement the EOPs there should be an auditable record of how the needed characteristics were determined from the background documentation of Revision 1 of the ERG, or from plant-specific information.

The STP systems function and task analysis (SFTA) was performed through document reviews, briefings, and walk-throughs of the mock-up. SFTA results identified main control board layout problems which could affect operator performance. Major revisions to main control board layout are currently reflected in the full-scale mock-up. An update of the SFTA using the revised mock-up is reported in the SFTA Validation Report. One NRC concern is that the SFTA was not based on finalized emergency operating procedures (per requirement in Supplement 1 to NUREG-0737). Final emergency operating procedures (EOPs) are not typically available at early stages of design and construction, but should be available prior to licensing. We recommend th. HL&P confirm, after EOPs are finalized, that information (parameter type, dynamic range, accuracy, frequency, feedback, etc.) and control functions (discrete/analog, precision, duration, criticality, etc.) needs have been

adequately identified and are satisfied by available instrumentation and controls.

The applicant should describe specifically how it intends to accomplish Items 2, 3, and 4 of the April 5, 1984 memorandum.

The HL&P SFTA was performed and reported in two steps. The SFTA, performed on the previous CR design, is reported in the SFTA report of March 25, 1983, and resulted in significant design modifications and improvements which were incorporated into the CR mock-up. The revised mock-up was used to perform a validation of the original SFTA for the redesigned control panels. This is reported in the SFTA Validation Report of March 19, 1984, which supplements the earlier report.

Both SFTAs were performed for the following six operational events (SOEs):

A. Small break loss of coolant accident
B. Steam line break
C. Steam generator tube rupture
D. Loss of offsite power
E. Turbine load rejection
F. Plant startup

The selection of these events was based on criteria chosen by HL&P to provide a good cross section of operator actions for the expected normal and emergency plant operating events. Those activities described in the earlier report which were not affected by the redesign were not repeated.

The SFTA program as discussed in the original Program Plan included the following activities by Systems Task Analysis Team members.

A. Review of pertinent plant documents such as: configuration drawings, FSAR, systems descriptions, operating procedures, and the Emergency Response Guidelines (ERG).

B. Attendance at a series of plant design and plant systems lectures conducted by Bechtel.

C. Identification of systems or subsystems and preparation of functional diagrams for these systems.

D. Preparation of a tabulation of emergency event sequences and background system information.

E. Preparation of event selection criteria and the selection of events to be analyzed by the Systems Task Analysis Team (STAT). These events are defined as selected operational events (SOEs).

F. Review of the results of operating experience to help identify events as candidates for review.

G. Performance of SFTA for each SOE considering the following:

1. Preparation of basic elements diagram.

2. Preparation of functional (decision-action) flow diagrams using the ERGs for reference.

3. Complete functional sequence tabulations.

4. Complete a hierarchial review process by identifying tasks associated with each function including equipment required.

5. List details about input and action/decisions using task-oriented decision-action diagrams as required.

H. Preparation of panel interface equipment tabulation including data requirements suitable for use in verification process, as required.

I. Preparation of operational sequence diagrams and traffic link diagrams.

J. Evaluation of data and summary of observations.

The SFTA effort involved the preparation and recording of a large amount of information for each SOE. The following forms and diagrams were used as was appropriate for each SOE, and form a major part of the bulk of the SFTA report:

A. Control Panel Flow Diagrams, which show the major components and systems with the associated flow paths.

B. System Breakdown Form (Form A), which breaks each major system into its subsystems and components, and lists system designators and control panels.

C. Emergency Event Sequences (Form B), which shows the systems and subsystems involved with each emergency event.

D. Background System Information Form, which records the system functions, safety related manual controls needed, credible failures which may cause system failures, and other information useful to the analyses.

E. Basic Elements Diagrams, which show the operator involvement with the SOEs.

F. Functional Flow Diagram, which shows a visual representation of each SOE with decision-action points identified.

G. Systems status at onset of event (Form C).

H. Functional sequence per SOE (Form D), which shows a list of the major functions for each SOE, systems/subsystems involved, who performs/monitors the function, identifies the principal control used for the function, and means of communication between operators.

I. Operator Task Identification and Analysis (Form E), which defines the tasks and task steps for each event.

J. Instrument Details (Form F), which identifies for each task/step sequence number, the instrument parameters being read or monitored, the device number, panel number, the estimated instrument range, and estimated initial value of the parameter.

K. Function Details (Form G), which describes detailed information about the actions and equipment required to perform the task.

L. Operational Sequence Diagram, which shows the operator actions and steps for an individual control panel.

M. Traffic Link Diagram, which shows to approximate scale the relationships of the ten control panels, and the traffic flow between panels.

The original SFTA resulted in the significant relocation of many of the panel devices, which altered the original reference database. The following activities, which are reported in the SFTA Validation Report, were required to validate the original SFTA in terms of the design modifications incorporated into the CR and placed on the CR mock-up:

A. Performance of the SFTA for each SOE.

1. Revise the panel and the panel face locations as required for the task steps on the Operator Task Identification and Analysis forms (Form E).

2. Reidentify or confirm the designated operator performing or monitoring the task steps on Form E.

B. Revise the traffic flow analysis to correspond to the latest panel layouts including revised operational sequence diagrams.

C. Revise the operational sequence analysis to correspond to the latest panel layouts including revised operational sequence diagrams.

D. Evaluate the analyses and summarize observations and recommendations.

E. Perform a walk-through/talk-through validation of two of the SOE studied in the SFTA.

F. Summarize and document the results and observations obtained from the SFTA validation.

The walk-through/talk-through validation effort of Plant Start-up and Steam Generator Tube Rupture showed that the control room crew could accomplish the allocated control room functions as defined in the normal and emergency operating procedures with one exception.

The exception is that one case was found which did not satisfy the task grouping criteria. This involved task 9.10 of the LOCA event where the RCS is depressurized using SI pump controls on panel 001 and pressurizer spray controls on panel 004. The devices for this task are not grouped to minimize

operator movement. The layout of these systems with regard to all the events must be considered before identifying this observation as an HED. The NRC should be advised of the resolution of this situation.

No additional observations of potential HEDs were identified during the walk-through/talk-through.

From our evaluation of the Function and Task Analyses effort, we conclude that the part of the requirements of Supplement 1 to NUREG-0737 to identify CR operator tasks has been satisfied.

However, satisfaction of the part of the requirements concerning identification of information and control needs is not as clear-cut.

We understand the current mock-up design is the result of an evolutionary process which began with a CRDR conducted on an earlier CR design, and that the current mock-up panels were derived from the mock-up which existed when the original SFTA was performed. A significant number of design changes were made to the original mock-up as a result of the original SFTA.

The present design is understood to have developed at as follows:

o Earlier Design	1982 Mock-up (1)	CRDR	HEDs
o Design Changes	Mock-up (2)	SFTA	HEDs
o Design Changes	Mock-up (3)	SFTA	HEDs
o SFTA 1984 Validation			

Part of the evolution included the redesign of the CR panels as described in the Implementation Plan Report. This description states in several places that Relayout Alternative 4 was planned to retain the existing or use the same

type control/display devices that were used on the then existing panels (e.g., Implementation Plan Report, Sections 5.0, 5.1.1, and 5.4).

Equipment, control, and instrument/display needs are tabulated in several places in the report (e.g., Forms D, E, F, G, C-12, D-18, H-67, G-21) and each need is identified with certain specific mock-up panels.

The report also states that Westinghouse generic ERGs and the Westinghouse PIP were included in the documents reviewed and used as references for the SFTA.

The specification of characteristics for information and control requirements for emergency operations should be derived from an SFTA which is completely independent of existing designs or equipment (e.g., actual CRs or mock-ups).

An objective, independent determination of the operator information and control needs for each operator task should be done before instrument and control specifications are developed. Review of the sample forms provided in the report does not indicate that an objective indentification of operator information and control needs was accomplished or adequately documented.

The NRC staff has determined that the current Revision 1 of WOG ERG and background documents provides an adequate basis for generically identifying information and control needs required for emergency operations. (See pg. 4 this report which quotes NRC Memorandum of April 5, 1984.) However, the CR design (mock-up) changes over the two year time span of the HP&L CRDR and SFTAs just described coincide with changes in the WOG ERGs during the same time span. It is not clear whether the existing mock-up information and control equipment requirements were truly determined independently or whether they were substantially influenced by a previous CR design for which the role of prior WOG ERGs is not explained. It is not clear what process was used to identify the operator information and control needs that are associated with each task.

We conclude that more information will be required before it can be determined that this part of Requirement 1 to NUREG-0737 to identify CR operator information and control needs has been acceptably satisfied.

7. CONTROL ROOM INVENTORY

Supplement 1 to NUREG-0737 requires the applicant to make a control room inventory and to compare the operator information and control needs determined from the task analyses with the control room inventory to determine missing controls and displays.

The control room inventory was not evaluated in detail, but descriptions of the inventory in HL&P's Program Plan and Implementation Plan and Executive Summary Reports were reviewed. Those descriptions indicated that the control room inventory involved an automated system which is consistent with NRC guidelines. The inventory will be updated as the STP control room design evolves.

The inventory of controls, displays, and other CR equipment was performed using the CR equipment list at the time of construction of the CR mock-up. The equipment list was prepared on a panel-by-panel basis, categorized by equipment type, and is maintained as a database for ease of updating, revising, and sorting.

The inventory database was updated to reflect the additions and deletions of equipment, relocations between panels as work progressed in the SFTA, the revision of panel layouts, and verification. Devices identified by the control room survey as not complying with the control room criteria, such as wrong switch types, were also entered in the database. The listing contains a unique component identification code, the panel number where installed, the nameplate engraving, and certain characteristics appropriate for the component. The results served as a reference database to verify that all the devices were properly represented on the control room mock-up. In addition,

the inventory provided a means to verify that all of the devices required by the SFTA (for those emergency events analyzed) were available in the control room.

We conclude that the final updated HL&P inventory will be complete and adequate for use as a comparison reference to determine missing controls and displays.

However, we conclude that the applicant has not yet described that an objective comparison of independently determined display and control requirements, as determined by function and task analyses, has been made with the control room inventory to identify missing controls and displays. Therefore, the requirement of Supplement 1 to NUREG-0737 for comparison of operator information and control needs with the control room inventory has not been fully satisfied.

8. CONTROL ROOM SURVEY

Supplement 1 to NUREG-0737 requires that a control room survey be conducted to identify deviations from accepted human factors principles. The objective of the control room survey is to identify for assessment and possible correction, the characteristics of displays, controls, equipment, panel layout, annunciators and alarms, control room layout, and control room ambient conditions that do not conform to good human engineering practices.

The control room survey was evaluated through document reviews, briefings, audits of HL&P identified HEDs, and an independent control room survey by the NRC. A key element of the STP control room survey is the Criterion Report. That document contains control room design criteria from several sources. The criteria have been tailored to the STP application, and all survey areas of NUREG-0700 are addressed. Observed deviations from the criteria (HEDs) are logged in a computerized database. The Control Room Survey report is a product of the computerized database. That report allows tracking of HEDs, their assigned priority, and proposed resolution. It also allows tracking of

Design Review, Technical Task, Project Review, and Management Team decisions about HED resolutions. Information provided in review of the Criteria Report and Control Room Survey report indicated that, in general, the control room survey was conducted in a manner consistent with NRC guidelines for objectives, approach, information sources, staffing, and results. A limited NRC audit of specific HEDs identified during the control room survey was made possible through access to the mock-up, half-scale mosaic of the simulator, and examples of selected types of controls and displays. A limited independent control room survey of the CR mock-up by the NRC was also performed during the NRC audit of May 2 through 6, 1983.

The Criteria Report is very complete and well organized. It contains guidelines for the following major areas:

- o Control Room Layout and Facilities
- o Main Control Panels
- o Auxiliary Shutdown Panel
- o Human Factors
- o Communications
- o Annunciators
- o Post Accident Monitoring
- o By-Passed and Inoperable Status
- o SPDS
- o Plant Computers

Each major area is subdivided into more detailed subsections. The report is replete with tables, appendices, and figures to supplement the text, and includes a list of acronyms, abbreviations, and terms. Display equipment guidelines include descriptions to guide the selection of indicators, recorders, and annunciators. Computer systems will complement and/or duplicate panel-mounted hardwired displays. Uniform control switch selection is guided by Table 4.3-1 of the criteria, "Main Control Room Control Switch Types".

In addition to addressing all areas of NUREG-0700, several supplementary special DCRDR studies were made and used by the Review Team. These were:

- o Anthropometry Report
- o Labeling Study Report
- o Demarcation Study Report
- o Meter Scales
- o Recorder Survey
- o Knurled Knob Position Indicator
- o Distinguishing Legend Pushbuttons from Legend Lights
- o Annunciator Review Guide
- o Evaluation of Specified Parameters
- o Annunciator Report

In each of these reports, HL&P addressed and resolved questions raised during the CRDR.

- o Anthropometry Report - This report addresses the CR standing control panels. The sit-down design was incomplete and not addressed by this review. The NRC should be apprised of the present status of the sit-down design. The most pertinent variables were identified as:

  - o Standing height
  - o Eye height
  - o Shoulder height
  - o Functional reach
  - o Extended functional reach

  The report states that the stand-up panels satisfy the general visual field guidelines in Section 6.1.2:2 of NUREG-0700, but smaller operators may experience difficulty in reading and interpreting annunciator tiles. It is stated that a more detailed

assessment involving smaller operators will be made later. This supplementary assessment and conclusions should be reported to the NRC for review.

The design adequacy is stated to be more questionable for functional operator reach. Using extended functional reach criteria, which HL&P considers to be more operationally relevant, the panels will accommodate the 20th percentile female through 95th percentile male operators. The report suggests that further assessment be made using lower percentile subjects. The results and conclusions of this assessment should be reported to the NRC for review.

o Labeling Study Report - The report states that the labeling study resulted in the correction of the control room survey discrepancies. Each panel received several levels of heirarchial labels that simplified the individual component labels. The study included significant operator participation.

The study produced a labeling guide that will become a permanent part of the criteria report to guide future labeling. Over 1900 labels were formulated. They were formulated, with the objectives of consistency, conformance to human factors recommendations for color contrast (change to light background and dark letters) and use of standard abbreviations consistent with quick recognition of the label content.

o Demarcation Study Report - The demarcation study describes criteria and a technique for easy identification and differentiation of front panel surface mounted devices that are associated with a particular system, subsystem, or functional activity. The study was made to correct discrepancies noted in the CRDR. Three full scale front panel sections were used in the study.

Specific recommendations are made for brand and color of paints. These recommendations have been applied to the twelve CR panels that will be used for plant operations.

- Meter Scale Study - This report presents the results of the CRDR study to determine uniform meter parameters and provides examples for use as guidance in applying meter markings. The study was initiated as a result of the HEDs concerning meter parameters. The study will assure that the HED resolutions are incorporated into the control room design, and that future meter additions conform to established and uniform parameter guidelines.

  The report includes criteria and recommendations in the following areas:

  - Zone marking using color alone (e.g., red, amber, green)
  - Scale graduations per Section 6.5.1.5 of NUREG-0700
  - Scale type style (Helvetica)

- Recorder Function Study - This case-by-case study of nineteen main CR recorders was made as a result of NRC audit comments of May 2, 1983, concerning the suitability of using single speed recorders for real-time indications.

  Each recorder was reviewed for function by two operators. None required that the operator have the capability to run out the recent records to see the parameter values. Therefore, no revisions to the recorders were recommended.

- Knurled Knob Position Indicator - This study was made as a result of NRC audit comments of May 2, 1983. The study concluded that all 71 multiple detent position knurled knob handle controls would be replaced with lever/bar type handles. This will solve the human factors:

- Consistency
- Rotary detent action
- Obscuring the pointer position indication

- Distinguishing Legend Pushbuttons from Legend Lights - Eighteen operators and design engineers were asked to state a preference among five different legend pushbutton shape patterns. The Closed Corner Octogon (CCO) pattern was clearly preferred, and is the recommended shape to be used for distinguishing all legend pushbuttons.

- Annunciator Review Guide - The Control Room Design Review Annunciator Review Guide establishes the basis criteria and methodology for completion of the review of the annunciator system, including the Bypassed and Inoperable Status Lights, and the writing of the final Annunciator Study Report.

  The criteria and methodology set out in this guide will be used to determine the physical parameters, alarm message, and location of each alarmed point. The alarm printout and computer I/O will be revised to reflect changes made by this study.

  The annunciator study was based on criteria developed by:

  - STP CRDR Criteria Report Rev. 1
  - STP CRDR Labeling Guide
  - The contents of the Annunciator Review Guide, considering:

    The list of points to be alarmed, including any new alarm points to be added. Combining alarm inputs to reduce the total number of alarms in the control room to reduce operator confusion. Where multiple inputs to a window are present, the computer is used to identify the source.

The Annunciator list will be reviewed for conformance with the list of acceptable abbreviations in the Criteria Report, Appendix L. This review will assure that wording is consistent, and that the chosen wording can be fitted onto the tiles.

Priorities shall be assigned within the three categories identified in the Criteria Report, Section 8. Physical locations will be determined based upon priority, and the review team's recommendations as to the relative importance of a particular alarm, with the more important alarms being located higher in the tile array.

o Evaluation of Specified Parameters - Historically, the panel layouts for the Pressurizer, Reactor Coolant, and Steam Generator Systems included a wide variety and number of parameter indications. The choice of variables to be displayed has sometimes resulted in a conflict between human factors requirements and the need for redundancy.

The recent availability of the Qualified Display Processing System (QDPS) permits the coordination of the panel layout with the SPDS and the removal of extraneous meter indications to enhance operator effectiveness.

The evaluation encompassed 112 meters associated with the control and protection channels of 53 parameters. The evaluation process determined that 61 meters should be deleted and 10 meters should be added.

Each case is described in detail in the recommendations in the report. The rationale for the deletions is explained, as are the requirements for the additional meters. Where meters were deleted,

the signal was sent to the QDPS for cross channel checking and on-demand display.

The control panel mock-up was laid out based on the results of this evaluation. A walk-through of the startup procedures, from shutdown to power, was performed to verify that only the instrumentation required to operate the plant was there and that the additional recommended instrumentation was needed. It was determined that the operator will be able to operate better, and respond quicker with fewer errors with the new control panel design.

o Annunciator Study Report - This very complete and detailed report documents the results of the review of the plant annunciator systems, the plant computer alarm functions, and the ESF bypassed and inoperable status monitoring systems. The review was performed in two phases on the full scale CR mock-up. The preliminary review was suspended because of the large number of changes projected for the controls. The review resumed when the control board revisions were completed, considering each window for appropriateness, desirability, message, priority, and location.

The objectives of the review were to determine the human factors deviations in the STP control room annunciator system, to provide recommended resolutions, and to accomplish a functional integration of all systems that provide annunciation. The review also supplied recommendations that provided human factors engineering guidance in the Bechtel engineering upgrading program.

The tasks included a review of design documents, NRC/EPRI studies, the development of criteria and the preparation of checklists. Each window was examined for adequacy. Revisions were made to the tile size, character size and spacing, and message content. Tiles were relocated to be near the appropriate controls, and grouped by

function. Each window was assigned the proper priority from a choice of three levels.

The existing design was reduced from 1055 active alarms to approximately 700 by combining alarms, moving alarms to the computer or to other locations, etc. The original 8 by 12 and 8 by 8 window boxes were changed to 6 by 8 alphanumeric identified arrays. There are two first-out window boxes containing the highest priority alarms. Five auditory alert sound sources will be used.

The major Control Room Survey Report is very detailed and very voluminous, but it is not always easily possible to uncover the answers to NRC reviewer questions because the report is not formatted to match the requirements of Supplement 1 to NUREG-0737.

It does, however, identify and summarize deviations from the human factors guidelines referenced in the criteria and the special studies reports.

The CR Survey Report is divided into four volumes.

Vol I states that the purpose of the control room survey was to identify items that do not conform to NUREG-0700 guidelines and/or criteria in the Criteria Report. It was the objective of the Design Review Team to:

A. Identify characteristics of the control room instrumentation and physical arrangements that may impact operator performance.

B. Determine whether the control room provides the system status information, control capabilities, feedback, and analytical aids necessary for effective plant operation.

C. Provide recommendations for correcting observations based on good human factors principles.

The tasks of the control room survey included:

A. Prepare checklists consisting of all criteria and applicable appendices from the Criteria Report.

B. Setup computer program for sorting and reporting checklist observations (CLO).

C. Perform control room survey on mock-up.

D. Visit STP simulator for control panel hardware evaluation.

E. Visit Westinghouse for plant computer evaluation.

F. Put checklist observations (CLO) into computer system.

G. Present CLO to Project Review Team (PRT).

H. Update CLO to Human Engineering Discrepancy (HED) or re-evaluate CLO.

I. Present HEDs to Management Team (MT).

The nine checklists are identified and titled to match the nine sections of Chapter 6 of NUREG-0700. Each checklist criterion is contained in a single checklist form, illustrated by Figs. 2-1 and 2-2 of the CR Survey Report. The filled-out forms were used as CLO data input sheets for computer program entry. Checklists were evaluated on a panel-by-panel, system level, whole control room, or computer basis, as was appropriate. The communication checklist must await evaluation in the completed CR and will be reported later.

CHECKLIST NO. 5

SIGNATURE OF EVALUATOR ______ DATE ______ CHECKED BY ______ DATE ______

PROJECT SOUTH TEXAS PROJECT ______ JOB NO 14926-001

SUBJECT HUMAN ENGINEERING CHECKLIST ______ SHEET ______ OF ______ SHEETS

CHECKLIST TITLE	REF NUREG0700	REF STP	PANEL NO	PANEL NAME	CRITERION NO	CRITERION
Visual Displays Pointers	6.5.2.2	6.2.3			45	Pointers contrast with meter face and are large enough to permit rapid recognition of pointer position

REMARKS

CRITERION: MEETS ☐ DOES NOT MEET ☐

CATEGORY NO.

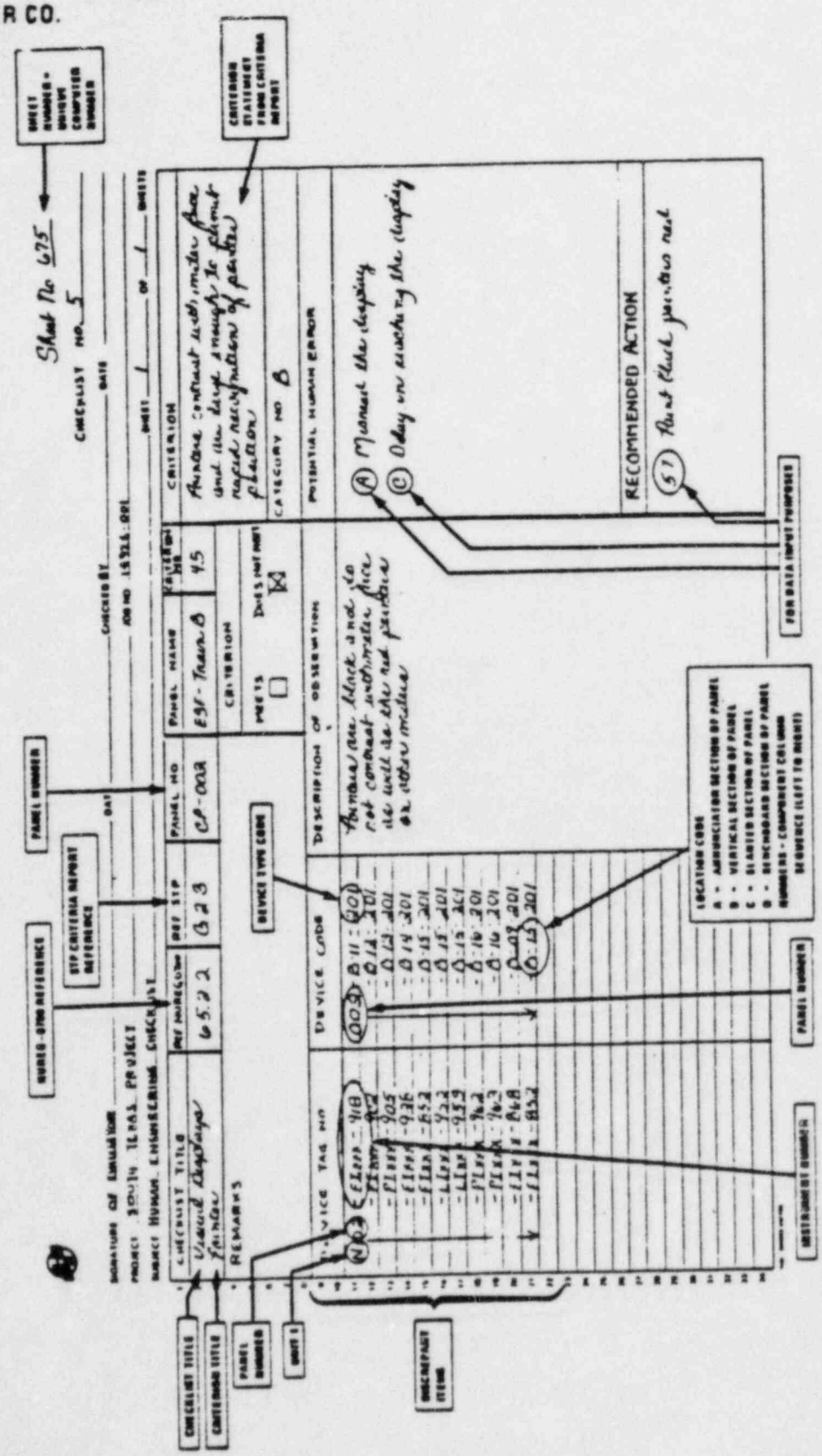
POTENTIAL HUMAN ERROR

DEVICE TAG NO	DEVICE CODE	DESCRIPTION OF OBSERVATION

RECOMMENDED ACTION

CHECKLIST FORM

Figure 2-1



CHECKLIST OBSERVATION
Figure 2-2

The CR survey generated 816 "criteria" (potential HEDs) which resulted in 431 HEDs after screening and evaluation by the Project Review Team and Design Review and Technical Task Team. Checklist observations and HEDs which were converted to computer printout sheets are included in Vols. II, III, and IV of the CR Survey Report as Appendi: B through Q. Vol. II also includes, in Appendix A, eight sample HEDs of various categories with illustrative figures.

For analysis purposes, the computer program is capable of sorting by:

- o Sheet number
- o Checklist number
- o Panel number
- o Criterion number
- o NUREG-0700 reference
- o Category number
- o Priority
- o Accept yes-no (the Observation and Design Review Team recommended action)

Summarized results from the HL&P CR survey are tabulated below.

Checklist	Total Potential HEDs	Total HEDs
1 - Workspace	109	5
2 - Communications	68	0
3 - Annunciators	104	31
4 - Controls	62	24
5 - Visual Displays	112	158
6 - Labels	63	119
7 - Plant Computer	237	5
8 - Panel Layout	24	49
9 - Control/Display Integration	37	40
	816	431

Those CLOs which became HEDs were processed and assessed by the Review Teams for assignment of CLO significance and for outlining a basic corrective action implementation requirement. These will be discussed later in this report under Assessment and Selection of Design Improvements. The CR Survey Report, Vol. I, also includes a summary of HEDs and dispositions by NUREG-0700 section category.

We conclude that, when completed, the applicant will satisfy the requirement of Supplement 1 to NUREG-0737 to conduct a Control Room Survey to identify deviations from accepted human factors principles.

9. ASSESSMENT OF HEDs

Supplement 1 to NUREG-0737 requires that HEDs be assessed to determine which HEDs are significant and should be corrected.

HL&P's Program Plan indicated that their process for selecting HEDs to be analyzed for correction was simplified from that outlined in the NRC

guidelines. HEDs with safety consequences are to be assigned to a single Category (A). Other HEDs will be assigned to categories linked to (B) availability improvements, (C) reliability improvements, and (D) minor improvements. All Category A, B, and C HEDs will be selected to be analyzed for correction. The described process for selecting HEDs to be analyzed for correction appears adequate to satisfy assessment and implementation phase objectives.

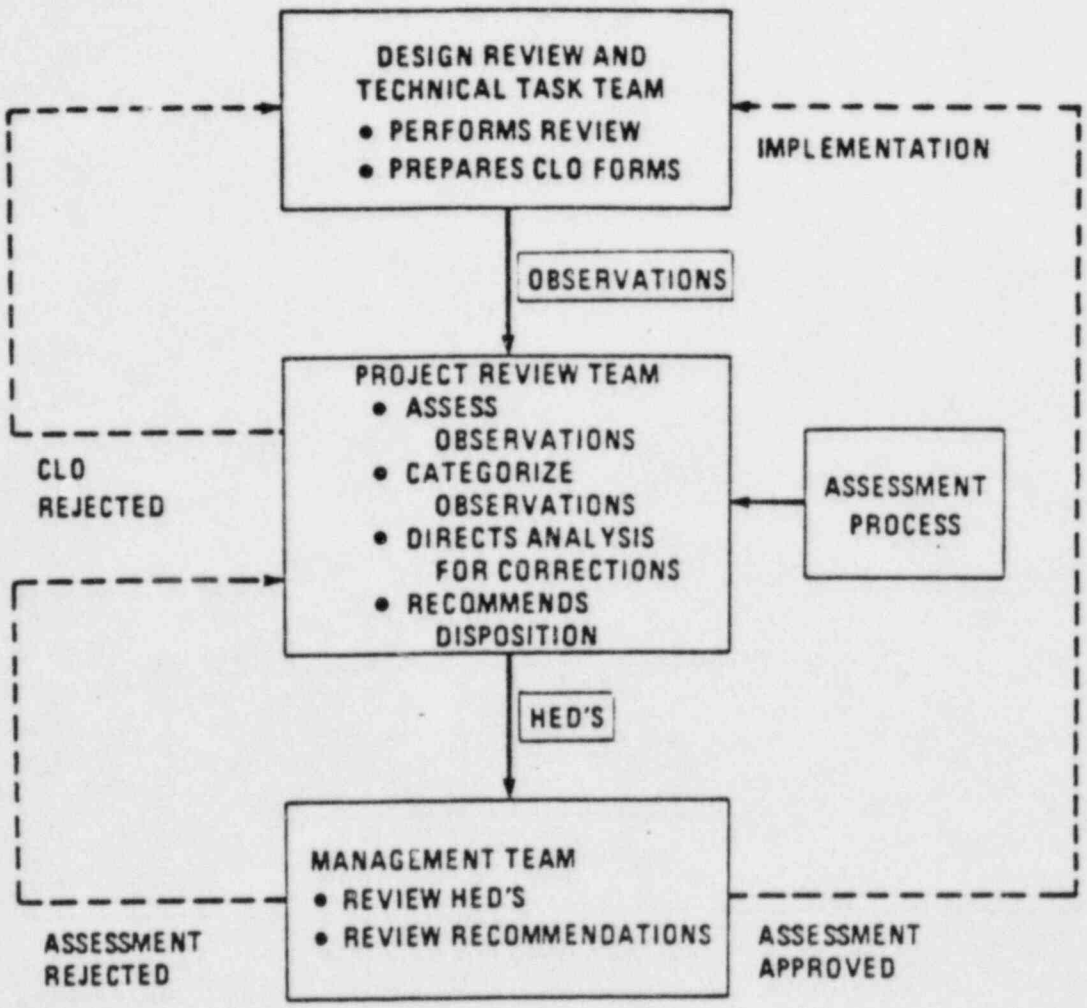
Two other categories used are (D) minor, which are nonmandatory and may or may not be corrected and (E) those which cannot be assessed using the mock-up or simulator, and must be assessed later on the actual CR. The results of assessing the Category (E) HEDs should be reported to the NRC for evaluation.

All observations (potential HEDs) identified by the Review Team were processed according to the methodology presented in Executive Summary Report, Figs. 3-1 and 3-2. These figures show that the observations and recommendations documented by the Review Team on the preprinted Checklist Observation forms (CLOs) were assessed by the Project Review Team (PRT), and either accepted or rejected (Fig. 3-1).

The accepted CLOs were assessed and classified into Categories A, B, C, D, or E (Fig. 3-2). HEDs in Categories A, B, C, and certain Ds were referred to the Design Review and Technical Task Team for analysis for correction.

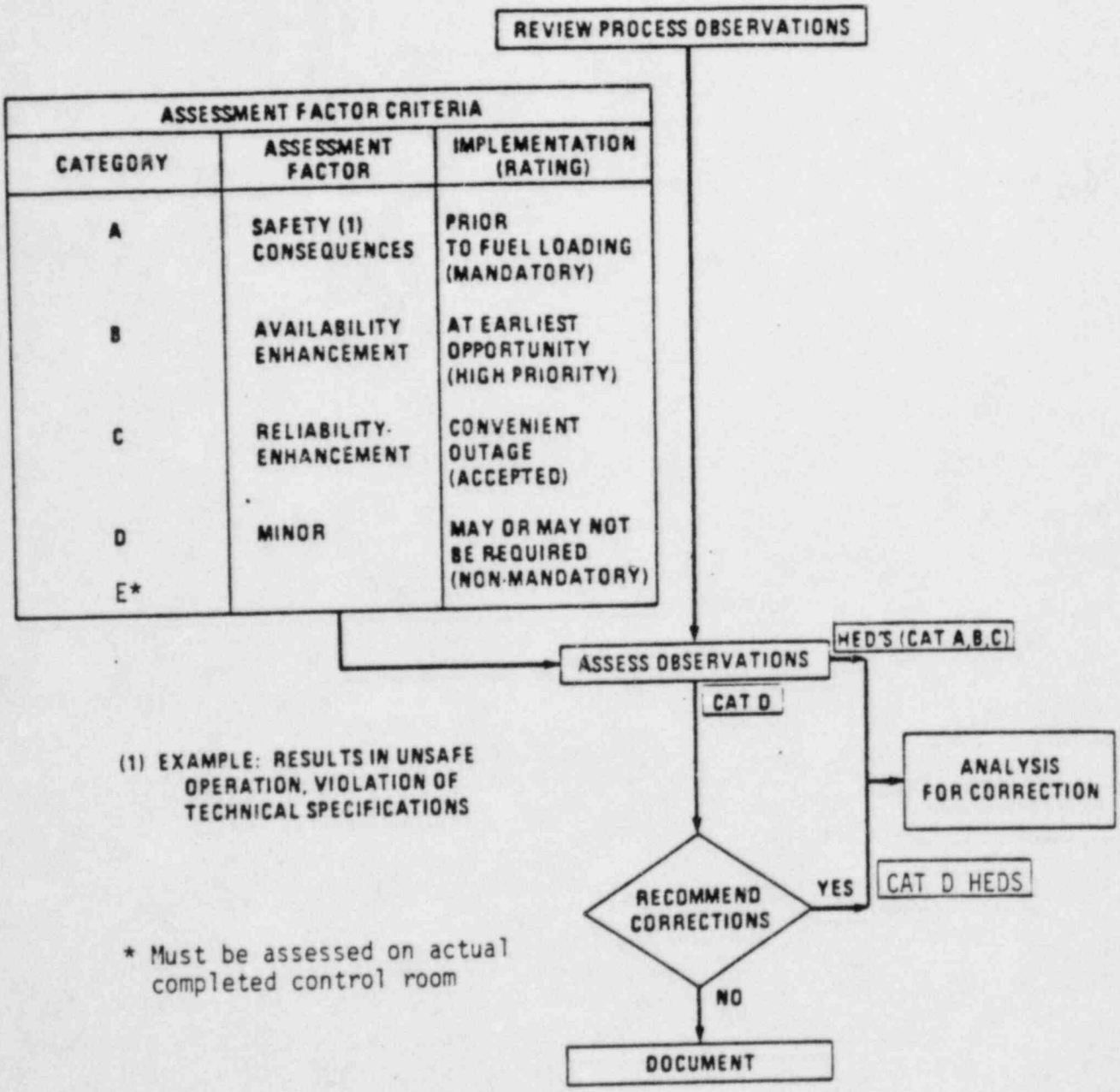
Correction of Category E HEDs was deferred for assessment until the actual control room is available for review. The assessment process is stated by HL&P to accomplish the objectives of NUREG-0700 and NUREG-0801.

We conclude that, when completed, the described process will satisfy the requirement of Supplement 1 to NUREG-0737 to assess HEDs to determine which are significant and should be corrected.



LEGEND:
CLO – CHECKLIST OBSERVATIONS
HED – HUMAN ENGINEERING DISCREPANCY

ASSESSMENT AND
IMPLEMENTATION METHODOLOGY
Figure 3-1



NOTE: CATEGORY E REFERS TO CRITERIA DEFERRED FOR EVALUATION IN THE ACTUAL CONTROL ROOM.

SELECTION OF HED'S TO BE ANALYZED FOR CORRECTION

Figure 3-2

10. SELECTION OF DESIGN IMPROVEMENTS

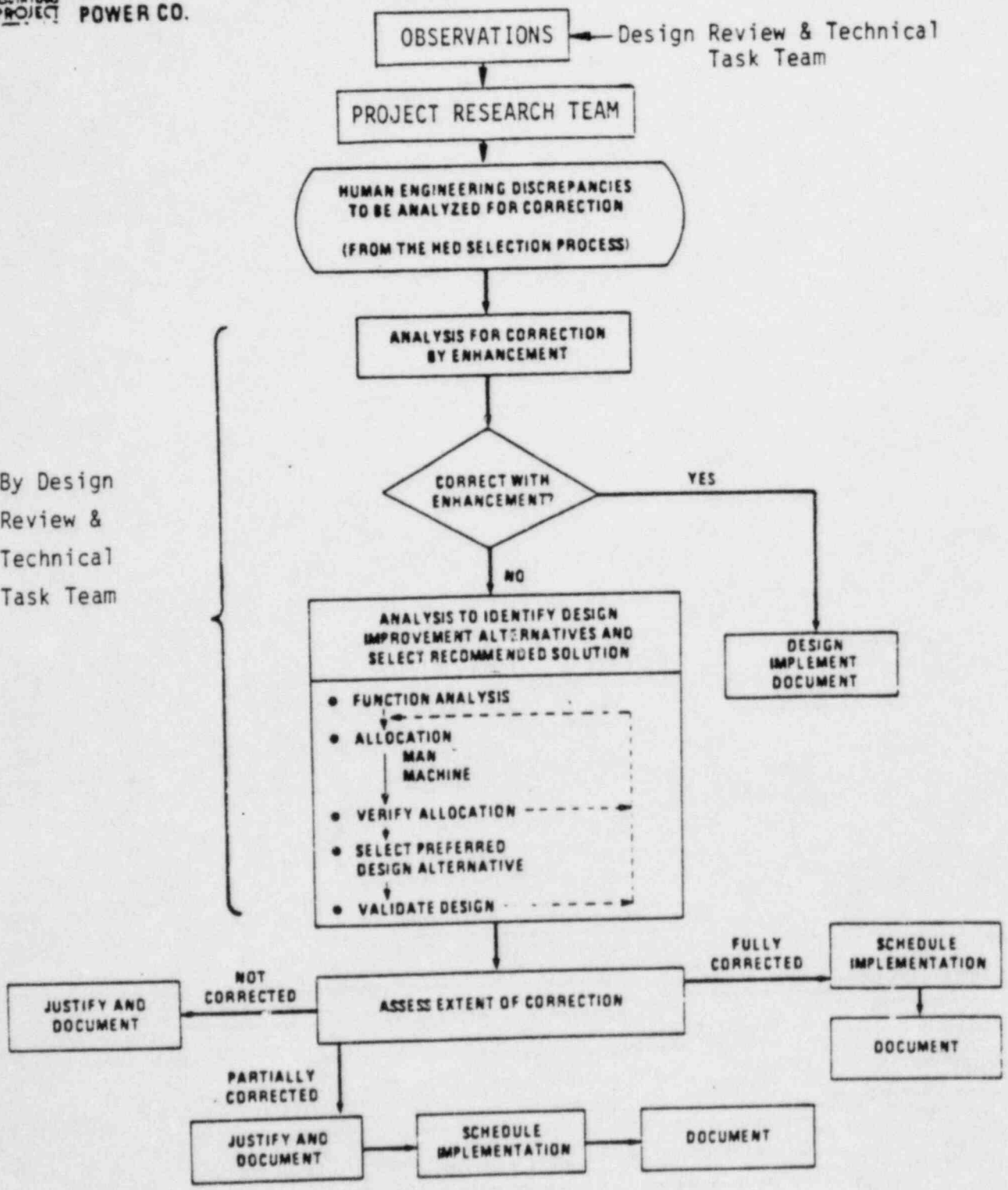
Supplement 1 to NUREG-0737 requires selection of control room design improvements that will correct significant HEDs. It also states that improvements that can be accomplished with an enhancement program should be done promptly. In the STP report, the term "implementation" encompasses the selection of CR design improvements.

The basic scheme for selection of design improvements described in the Program Plan was consistent with NRC guidelines. The selection of design improvements appears in the results of the several special studies included in the STP DCRDR Report. The described process for selection of design improvements appears adequate to satisfy assessment and implementation phase objectives.

The Program Plan states that all observations assigned Categories A, B or C and some Category D observations are planned to be identified as Human Engineering Discrepancies (HEDs) and will be analyzed for correction, (Fig. 4-3 of the Program Plan). The first step in this process is to identify those HEDs which can be corrected by enhancement. The remaining HEDs will be analyzed to identify design improvement alternatives and to select solutions. In addition, some HEDs may be corrected through training. An integral part of this step will be a reapplication of the control room review process as appropriate to ensure that:

- Other guidelines are not violated
- Other corrections are not invalidated
- Any resulting increase in significance of other findings is identified and accommodated

Solutions which do not bring the discrepancies into full compliance with the guidelines will be identified and justified accordingly.



SELECTION OF DESIGN IMPROVEMENTS
Figure 3-3

The Project Review Team will submit the processed CLOs and their recommended solutions to the management team for approval. Rejected CLOs and/or solutions will be returned to the Project Review Team for additional assessment. Approved solutions will be returned to the Design Review and Technical Task Team for implementation planning.

The results of the control room survey, the operating experience review, the SFTA, the annunciator study, and other special studies have been detailed in separate reports. The discrepancies identified in those reports were resolved by the methodology described in the Program Plan and the resulting changes were or will be incorporated into the control board during the redesign and implementation efforts.

The 816 observations (potential HEDs) and their resolutions and/or recommendations are described in several places in the HL&P Summary Report, which are summarized below.

1. Control Room Survey Report - Vol. I, Section 3.0
   Vol. II, Appendix A
   Vol. III
   Vol. IV

2. Control Room Survey Validation Report - Section 3.0, Appendix A, Appendix B

3. Annunciator Study Report - Section 4.0, Appendix C

4. Executive Summary Report - Sections 3.1, 3.2, 4.0 (NRC In-Progress Audit), Appendix A, Appendix B, Appendix C, Appendix D

The following reports also discuss observations and recommendations/ resolutions in narrative format, but do not formally identify them by HED number.

- o Special Studies Reports (see this report, pp. 21 through 27)
- o Implementation Plan Report, Section 3.9
- o SFTA Report, Summary, Section 6.0
- o Operating Experience Review (OER) - Section 3.0
- o OER Validation Report

This report does not include a detailed evaluation of results of the HL&P selections of design improvements. A summary of the results of an examination of selected HED related contents of the above HL&P reports is given below.

HL&P assessed and categorized four hundred and thirty-one HEDs as follows:

TOTAL HEDs PER CATEGORY

Category A -	45	
Category B -	318	
Category C -	20	
Category D -	48	
	431	
Category E -	218	(Not evaluated)

The HL&P report includes a description of all Category A HEDs (45 items) identified during the DCRDR.

The paper trail of descriptive materials for a specific example HED (e.g. Sheet 875) flows through seven locations in several volumes of the report. The multiplicity of documents described below was difficult to unscramble.

(1) Executive Summary Report, Section 3.1

3.1 Assessment Results

The following summarizes the status of the forty-five (45) Category "A" HEDs identified in this program. Appendix A contains the detailed disposition of the Category "A" HEDs:

1. Relayout of panels for functional grouping of associated system or subsystem devices, or relocation on an appropriate panel to minimize operator movement or to facilitate task sequence, or to accommodate frequency of usage.

   Sheet Numbers - 511, 526, 530, 568, 569, 570, 572, 573, 574, 575, 576, 577, 578, 593, 594, 598, 599, 600, 603, 604, 605, 875

(2) Executive Summary Report, Appendix A

HF Area - Workspace HED Category A

Sheet Number / Reference Paragraph	Observation or Criteria Title	Disposition
S-875 / P-6.1.1.1	1. Need AFW Flow Indication related to flow controller	1. AFW flow controller was relocated on panel 006 near indicator
	2. Need ECW pump disch. flow indication	2. ECW Flow Data was included in database for display on QDPS plasma display

(3) Executive Summary Report, Appendix D

Appendix D - List of CLO/HEDs vs. CRS Report

Sheet No.	Volume	Page No.	Sheet No.	Volume	Page No.
822	IV	P9	872	II	E67
823	III	G7	873	II	E69
824	IV	P10	874	II	E48
825	IV	P11	875	II	B1
826	IV	P12	876	III	I66
827	IV	P13	877	II	E62
828	IV	P14	878	II	E43
829	IV	P15	879	II	E44

(4) Control Room Survey Report, Vol. I, pg. 3-6, Section 3.3.1.2

3.3.1.2 Workspace HEDs

The following is a summary of HEDs from the Workspace Checklist:

a. Observation: STP operators identified the need for auxiliary feedwater flow indication to relate to the flow controller and a need for ECW pump discharge flow indication (sheet number 875 - Appendix B, page 2).

Disposition: Relocate auxiliary feedwater flow indicator to panel CP-006 and provide ECW flow. (Category A)

(5) CR Survey Report, Vol. II, page B-1

(See page 42)

SOUTH TEXAS NUCLEAR PROJECT (14926-001)

CONTROL ROOM DESIGN REVIEW REPORT 3 TOTAL DATA BASE

SHT NO.	CK. NO.	CHECKLIST TITLE	PN NO.	CRT NO.	RV NO	STP REFERENCE	NUREG 0700 REF
0875	01	WORK SPACE	00	001		6.1.1.1	6.1.1.1

CRITERION NO. : 001

*CRITERION TITLE CONTROL ROOM WORKSPACE-ACCESSIBILITY

INSTRUMENTATION WITHIN THE CONTROL ROOM INCLUDES CONTROLS & DISPLAYS THAT ARE ESSENTIAL TO DETECT ABNORMAL CONDITIONS & BRING THE PLANT TO A SAFE SHUTDOWN.

CATEGORY NO. : A

*HUMAN ERROR

FAILURE TO DETECT EQUIPMENT FAILURE
FAILURE TO DETECT EQUIPMENT MALFUNCTION
DELAY IN OBTAINING NEEDED INFORMATION

*DESCRIPTION OF OBSERVATION

1. NEED AUX FEED WATER FLOW INDICATION TO RELATE TO FLOW CONTROLLER.
2. NEED ECW PUMP DISCHARGE FLOW INDICATION.

PRIORITY: 1

*DESIGN REVIEW TEAM - RECOMMENDED ACTION

0053: PROVIDE EQUIPMENT

ACCEPT? YES

*PROJECT REVIEW TEAM - DISPOSITION

0164: RELOCATE AFW FLOW INDICATION TO PANEL CP006 PER R.G.1.97, REV. 2.
0165: PROVIDE ECW FLOW PER R.G. 1.97 REV. 2 VIA ODPS.

*REMARKS

ACCEPT? YES

*MANAGEMENT REVIEW TEAM - DISPOSITION

*REMARKS

(6) CR Survey Validation Report, Section 3.0

3.0 Conclusions

3.1 Category "A" HEDs

The following Category "A" HEDs were resolved by the revised panel layouts as detailed in Main Control Panels - Equipment Layout Drawings 5-Z34-1-Z44501 through 9-Z34-1-Z44508. Appendix A contains the data for the resolution of Category "A" HEDs.

Workspace - HED-875

(7) CR Survey Validation Report, Appendix A

This Appendix A is a duplicate of Appendix A in the Executive Summary Report. (See (2) above.)

This kind of paper trail is typical of all HEDs.

Three Category A HEDs remain to be resolved. These are: sheet number 367, which addresses the color green Rototellite indicator lights which cannot be distinguished when lit; sheet number 726, which identifies the bypass and inoperable status light legends as being unreadable due to narrow stroke width and inadequate character separation and line spacing; and sheet number 727, which states that legend messages contain more than three lines of text.

Resolutions of these unresolved Category A HEDs should be reported to the NRC for review and evaluation.

The Summary Report includes a similar descriptive paper trail for a representative sampling (about 11 percent) of the total number of Category B HEDs.

The following Category B HEDs were stated to remain unresolved:

> Sheet number 376 concerning the scaling on the paper for recorder XR 6008 has not been resolved. Sheet number 6 concerning the lack of meter zone markings will be resolved through a technique that will be applied on a case-by-case basis in the field.

Since the above comments apply only to a sampling of Category B HEDs, it is assumed that other similar unresolved open items exist. When resolved, these unresolved HEDs should be reported to the NRC for review and evaluation.

Category C HEDs are mentioned in Fig. 3.2 of the Executive Summary and described as "Reliability Enhancement" items with corrections to be implemented at a convenient outage.

Category C HEDs and dispositions are described in the CR Survey Report, Vol. I, Section 3.3, but are intermingled with and not separated from other HEDs.

In some cases, the dispositions are not specific (e.g., develop a color coding scheme). The CR Survey Report is not dated, and an implementation schedule for corrective actions is not stated. The applicant should describe and schedule specific corrective actions for all HEDs for NRC review and evaluation.

Category D HEDs are described in the CR Summary Report, Vol. I, Section 3.3, but are intermingled with and not separated from other HEDs.

Most of the dispositions reported are nonspecific (e.g., "provide enhancements within the existing computer system capability" or "upgrade within system capability if practical" or "Westinghouse will make changes within updated software") and are not listed for implementation on a stated time schedule.

The applicant should describe and schedule specific corrective actions for all HEDs for NRC review and evaluation.

Category E Criteria (observations/potential HEDs) occur in areas that must be addressed when the CR is constructed and the panels are installed. These potential HEDs are distributed as follows:

Checklist	Total Checklist Criteria	Category E Criteria	Described in CR Review Report Appendix
1 - Workspace	109	76	J
2 - Communications	68	48	K
3 - Annunciators	104	14	L
4 - Controls	62	1	M
5 - Visual Displays	112	33	N
6 - Labels	63	3	O
7 - Plant Computer	237	37	P
8 - Panel Layout	24	0	None
9 - Control/Display Integration	37	6	Q
	816	218	
SPDS Computer		237	None

The observations are described in the HL&P CR Review Report Appendices listed in the table above. There is no appendix listed for the SPDS computer. A narrative description of 18 Category E criteria that will be checked for compliance with the guidelines is listed in item 16 of Section 3.2 of the Executive Summary Report. The areas of concern, including the SPDS computer, are listed in the CR Review Report, Vol. I, Section 3.3, but the HEDs and dispositions are not described in detail. When the work is completed, the applicant should submit for NRC review and evaluation a description of the HEDs, dispositions, and the implementation schedule for corrective actions.

There is a discrepancy between the 218 Category E items above and the 55 mentioned in the Executive Summary Report, pg. xiii, which should be explained to the NRC.

The Executive Summary Report, Appendix C describes and justifies three deviations from the Criteria Report guidelines. One of these concerns the need for inoperative panel instruments to be apparent to the operators. The justification in Appendix C for use of non-off-scale indication type instruments is that (a) the QDPS system performs cross-checking and can provide the operator with a quality tag for each output, or (b) that the operator can cross channel check with redundant meters. However, in the CR Summary Report, Vol. I, Section 3.3.5.2e, a statement is made that failed meters will be made apparent by setting the indicating needle off-scale. The two differing statements should be reconciled and explained for the NRC for their review and evaluation.

The CRDR NRC In-Progress Audit Review is discussed in the Executive Summary in Section 4.0.

HL&P requested an NRC in-progress audit of the STP CRDR in order to receive NRC review comments of the redesigned main panel layouts prior to issuing a release to manufacture panels 001 through 010. The audit was conducted from May 2 through May 6, 1983 at the mock-up facility in Bechtel's Houston engineering facilities and consisted of walk-throughs, document reviews, briefings, and discussions. The results of this audit are reported in a letter from Knighton to Goldberg dated October 31, 1983 (Docket Nos. 50-498 and 50-499).

In Section 4 of the Executive Summary, HL&P has acceptably addressed and responded in detail to the concerns expressed by the NRC during the in-progress audit and to HEDs generated by the limited independent CR survey conducted by the NRC.

These responses are related to and coordinated with HL&P DCRDR HEDs and dispositions reported in other parts of the HL&P Summary Report, and commented on elsewhere in this report.

A summary of 15 other items of remaining work which cannot be completed until the CR and/or simulator is operational is described in narrative form in Section 3.2 of the Executive Summary Report. It is stated that seven of these items will be sample-checked to verify compliance with the guidelines and/or recommendations. The applicant should report the rationale and justification for sample vs. 100 percent checks for NRC review and evaluation.

The HL&P Schedule for completion of all planned CRDR work is stated in general terms in Section 5 of the Executive Summary Report. There is no schedule specifically identified with the implementation of HED corrective actions. The schedule is stated in terms of four major plant milestones as follows:

> "All items will be completed prior to fuel loading. HL&P will submit a supplementary executive summary report to conclude the CRDR reporting within a period of three months following the completion of fuel loading.

5.1 COLD HYDRO

- Random label checkout (including readability from normal control room positions).
- Check of vertical meter pointer painted red.
- Check if demarcation painting complies with the recommendations of the Demarcation Study.
- Verify the implementation of the use and control of temporary labels.
- Validate the correct usage of lamp replacement legend maps.
- Check of labels to correct identifying meaning of some status lights when lit (Sheet No. 0792).

5.2 ENERGIZATION

- o Check of annunciator tiles for compliance with the annunciator study results.
- o Check of switch handles vs. readability of switch position.
- o Check for compliance of meter scale markings.
- o Random check of legend light engraving and "closed corner" markings.

5.3 HOT FUNCTIONAL

- o Resolve and validate correction of Rototellite color problem, and sample check of their engraving.
- o Resolve and validate correction of poor readability of the BYPASS/INOPERABLE status lights.
- o Checkout the QDPS plasma displays.
- o Checkout the effectiveness of annunciator horns.
- o Resolve and validate correction of the problem for some meters to fail off-scale.
- o Complete the review of the Human Engineering suitability and arrangement of panel devices.
- o Resolve and validate correction for the problem for those switches that are difficult to turn.
- o Check of the inadvertant actuation and accessibility of controls to operators.
- o Check of recorder paper and accessibility of supplies.

5.4 FUEL LOAD

- o Review and assessment of all Category E criteria (see Item 16 of Section 3.2).
- o Complete validation of EOPs.

- o Control Room Survey check of control room desk type stations used during plant operations."

We question the adequacy of the random check of some items above. The applicant should report the rationale and justification of such checks to the NRC for review and evaluation.

We conclude that HL&P intends to meet the requirement of Supplement 1 to NUREG-0737 to select design improvements that will correct significant HEDs. However, the applicant should supply the additional information as described earlier in this section so that the NRC can determine that this requirement has been met.

11. VERIFICATION THAT DESIGN IMPROVEMENTS PROVIDE NECESSARY CORRECTION AND DO NOT INTRODUCE NEW HEDs

Supplement 1 to NUREG-0737 requires verification that selected design improvements will provide the necessary corrections of HEDs and will not introduce new HEDs into the CR. Information from the control room inventory and SFTA are needed for the verification process. Those activities, as planned and conducted, were capable of providing the needed information.

The Executive Summary (Section 2.3.3.2) states that after the redesign of the main control board layout was completed, the SFTA was reviewed to verify that the observations (HEDs) had been corrected and no new ones introduced. The operator task identification sheets for the six selected (operational) events were revised to show the new locations of devices, both within panels, and between panels. In some cases, devices had been removed or added, requiring the revision of the instrument detail section of these forms. The traffic link diagrams were then revised to reflect the movement of instruments from panel-to-panel. The spatial operational sequence diagrams were revised to reflect the relocation of subsystems and of instruments within a subsystem. The six sets of diagrams were then evaluated for efficiency of operator motion.

The new layout resulted in significant improvement in the functional arrangement of the control boards. Operator travel between boards was reduced. The summary of this review in the SFTA Validation Report states that the walk-through/talk-through validation effort showed that the control room crew could accomplish the allocated control room functions as defined in the normal and emergency operating procedures. No additional observations of potential HEDs were identified during the walk-through/talk-through.

We conclude that, for corrected and implemented HEDs covered in the present report, HL&P has partially satisfied the requirement of Supplement 1 to NUREG-0737 to verify that selected design improvements will provide the necessary correction and will not introduce new HEDs. Open HEDs requiring further evaluation and implementation should be reported to the NRC in the same manner so that it can be determined if this requirement is fully satisfied.

12. COORDINATION OF CONTROL ROOM IMPROVEMENTS WITH OTHER PROGRAMS

Supplement 1 to NUREG-0737 requires that control room improvements be coordinated with changes from other programs; e.g., safety parameter display system (SPDS), operator training, Regulatory Guide 1.97 (RG-1.97), and emergency operating procedures (EOPs).

The Executive Summary Report states (pg. x, xi) that the CRDR Program was based on an overall HL&P plan to integrate (coordinate) the following pertinent TMI action plan (NUREG-0660) and NUREG-0737 Supplement 1 related activities.

1. Implementation of a safety parameter display system (SPDS)

2. Implementation of Regulatory Guide 1.97 instrumentation for minimizing risk to plant safety

3. Implementation of instrumentation to monitor critical parameters following an accident (post-accident monitors)

4. Training to enhance coping with emergencies

5. Development of symptom-based emergency operating procedures (EOPs), and

6. Design of emergency response facilities.

The Criteria Report specifically addressed post-accident monitoring (Section 9), bypassed and inoperable status (Section 10), safety parameter display system (SPDS) (Section 11), and plant computer features (Section 12) in the control room. In addition, the relayout of main control panels described in the Implementation Plan Report indicated specific examples of DCRDR coordination with the post-accident monitoring and SPDS activities. The decision to proceed with the DCRDR prior to completion of operating procedures and training was noted in the Program Plan and provisions were made to assure proper consideration of the effects of DCRDR CR changes on future operating procedures and training.

The Executive Summary Report (Sections 4.2.3 and 4.2.4) states that HL&P is committed to continuing to apply the benefits of the CRDR Program as appropriate and that finalized EOPs will be validated in accordance with NUREG-0737, using a staff that will provide continuity with the CRDR Design Review Team. The Criteria Report, Appendix T, describes a methodology to assure that good human factors principles will be applied to all future changes.

The Implementation Plan Report, Appendix A, presents the parameter requirements related to Reg. Guide 1.97 which includes parameter, range, category, and other detailed information on the displays and controls that must be added or are already on the panels. There were about 100 of these

changes, primarily for safety related systems. These are described in Section 4.0 of the Implementation Plan Report.

Based on our review, we conclude that when the coordination effort is complete, HL&P will meet the requirement of Supplement 1 to NUREG-0737 to coordinate control room improvements with changes from other programs.

13. CONCLUSIONS

The multi-volume South Texas Project summary report submitted by Houston Lighting and Power Company is complete, voluminous, and of high quality. It is obvious that HL&P intends to meet the requirement of Supplement 1 to NUREG-0737. The report consists of the CRDR final reports identified in the References.

Our review of the STP Summary Report was oriented toward determining if the requirements of Supplement 1 to NUREG-0737 will be met. We conclude that HL&P should be able to meet these requirements following the clarification by HL&P of exceptions which are noted below and the submittal of presently incomplete information.

Areas needing clarification or additional information are listed below.

This Report Section	Page	Comment
6	11	Confirm that information and control needs were adequately identified and satisfied by available instruments and controls.
6	11	Describe how it is intended to accomplish Items 2, 3, 4 of the NRC April 5, 1984 Memorandum.
6	16	Advise resolution of the single HF exception found during walk-/talk-through validation.
6	18	Provide information which will substantiate that information and control needs were determined by an independent, objective analysis.

This Report Section	Page	Comment
8	21	Provide information concerning present status of the sit-down control station design.
8	22	Provide information and conclusions about supplementary assessment of use of smaller operators.
8	22	Provide results and conclusions of supplementary assessment of use of extended functional reach criteria for narrower percentile subjects.
8	29	Provide results and resolutions of the evaluation and assessment of the computer checklist.
9	33	Provide results and resolutions of the assessment of the Category E HEDs.
10	43	Provide results of the resolutions of the three Category A HEDs.
10	44	Provide results of the resolutions of all unresolved Category B HEDs.
10	44	Provide descriptions of specific corrective actions and implementation schedules for Category C HEDs.
10	45	Provide descriptions of specific corrective actions and implementation schedules for Category D HEDs.
10	45	Provide descriptions of the HEDs, dispositions, and implementation schedule for Category E HEDs.
10	46	Reconcile the discrepancy between the stated number of Category E items.
10	46	Reconcile the discrepancy between the two stated resolutions of the problem of alerting operators to the existence of inoperative panel instruments.
10	47,49	Provide explanation of the rationale and justification for random/sample vs. 100 percent checking of items.
10	47	Provide more specific HED implementation schedule information.

REFERENCES

1. NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," May 1980; Revision 1, August 1980.

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

3. NUREG-0737, "Clarification of TMI Action Plan Requirements," November 1980; Supplement 1, December 1982.

4. NUREG-0801, "Evaluation Criteria for Detailed Control Room Design Reviews," October 1981, draft report for comment.

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

6. Generic Letter 83-28, "Required Actions Based on Generic Implications of Salem ATWS Events," July 8, 1983.

7. Memorandum from H. Brent Clayton, Section Leader, Procedures and Systems Review Branch, Division of Human Factors Safety, Office of Nuclear Reactor Regulation, United States Nuclear Regulatory Commission to Dennis L. Ziemann, Chief, Procedures and Systems Review Branch. Subject "Meeting Summary--Task Analysis Requirements of Supplement 1 to NUREG-0737--March 29, 1984 Meeting with Westinghouse Owners Group Procedures Subcommittee and Other Interested Persons," April 5, 1984.

8. Letter to T. M. Novak, Assistant Director for Licensing, Division of Licensing, NRR, USNRC from J. H. Goldberg, Vice President--Nuclear Engineering and Construction, HL&P. Subject, "Control Room Design Review Program Plan," for STP Units 1 and 2, dated October 20, 1982.

9. Letter to D. G. Eisenhut, Director, DOL, NRR, USNRC from J. H. Goldberg, HL&P. Subject, "Response to Supplement 1 to NUREG-0737 Requirements for Emergency Response Capability," for STP Units 1 and 2, dated April 14, 1983.

10. Meeting Summary by A. Vietti, Project Manager, Licensing Branch No. 3, DOL, NRR, USNRC. Subject, "Summary of Meeting - TMI Action Plan Requirements," dated February 13, 1984.

11. Letter to T. M. Novak, Assistant Director for Licensing, DOL, NRR, USNRC from J. H. Goldberg, HL&P. Subject, "Submittal of Control Room Design Review Final Reports," for STP Units 1 and 2, dated April 12, 1984.

References Provided as Control Room Design Review Final Reports

1. Program Plan, Revision 1, March 31, 1983.

2. Criteria Report, Revision 2, March 27, 1984.

3. Operating Experience Review Report, Revision 0, March 25, 1983.

4. System Function and Task Analysis Report, Revision 0, March 25, 1983.

5. Control Room Survey Report - Volume I, undated.

6. Control Room Survey Report - Volume II, Revision 0, March 30, 1984.

7. Control Room Survey Report - Volume III, Revision 0, March 30, 1984.

8. Control Room Survey Report - Volume IV, undated.

9. Annunciator Study Report, Revision 0, March 29, 1984.

10. Special Studies Report, Revision 0, March 30, 1984.

11. Implementation Plan Report, Revision 0, March 28, 1983.

12. System Function and Task Analysis Validation Report, Revision 0, March 19, 1984.

13. Operating Experience Review Validation Report, Revision 0, March 7, 1984.

14. Control Room Survey Validation Report, Revision 0, March 19, 1984.

15. Executive Summary, Revision 0, February 27, 1984.