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Control Room Design Review

Operating Experience Review Report

The South Texas Project

HOUSTON LIGHTING & POWER COMPANY

OPERATING EXPERIENCE REVIEW REPORT

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

ARO	Auxiliary Reactor Operator
ASSOC	Associated
ASST	Assistant
AUX	Auxiliary
CAT	Category
CLO	Checklist Observation
CONT	Control
CR	Control Room
CRDR	Control Room Design Review
CRT	Cathode Ray Tube
CVCS	Chemical Volume Control System
EES	Emergency Event Sequences
EOF	Emergency Operating Facility
EPRI	Electric Power Research Institute
ESF	Engineered Safety Feature(s)
EST	Estimate(d)
EXPER	Experience
FW	Feedwater
HE	Human Engineering
HED	Human Engineering Discrepancy
HHSI	High Head Safety Injection
HL&P	Houston Lighting and Power Company
HPSI	High Pressure Safety Injection
I&C	Instruments and Controls
INPO	Institute of Nuclear Power Operators
INSTR	Instrument
LDR	Leader
LHSI	Low Head Safety Injection
LOCA	Loss of Coolant Accident
LOSP	Loss of Offsite (AC) Power
LPSI	Low Pressure Safety Injection

ACRONYMS AND ABBREVIATIONS (Cont.)

LR01	Licensed Reactor Operator #1
LR02	Licensed Reactor Operator #2
M/M	Man/Machine
MCP	Main Control Panel
MON	Monitor
MSR	Moisture Separator Reheater
MT	Management Team
MW(e)	Megawatts (electric)
NOS	Numbers
NRC	Nuclear Regulatory Commission
OERT	Operating Experience Review Task Group
OSC	Operational Support Center
PORV	Power Operated Relief Valve
PRT	Project Review Team
PSAR	Preliminary Safety Analysis Report
RAS	Recirculation Actuation Signal
PZR	Pressurizer
RCB	Reactor Containment Building
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RECIRC	Recirculating
REQ'D	Required
RG	Regulatory Guide
RHR	Residual Heat Removal
RO	Reactor Operator
RWST	Refueling Water Storage Tank
RX	Reactor
SBCS	Standby Cooling System
SFTA	System Function and Task Analysis
SG	Steam Generator
SIS	Safety Injection System

ACRONYMS AND ABBREVIATIONS (Cont.)

SOE	Selected Operational Event(s)
SPDS	Safety Parameter Display System
SRO	Senior Reactor Operator
SS	Subsystem
STAT	Systems Task Analysis Team
SUPVR	Supervisor
SW	Switch
SYS	System
TMI	Three-Mile Island
TSC	Technical Support Center

PREFACE

The control room design review (CRDR) of the South Texas Project (STP) Nuclear Generating Station was started in September 1982. This review is being performed by Torrey Pines Technology for Houston Lighting & Power Company (HL&P) with Bechtel Energy Corporation (Bechtel) acting as agent.

Prior to completion of the CRDR, a decision was made by HL&P to redesign six of the ten main control panels. This redesign effort is required to accommodate design changes resulting from plant design evolution and Reg. Guide 1.97 requirements. Human engineering discrepancies determined in the CRDR for the six panels will be corrected in the redesign effort.

The CRDR is described in the Program Plan document. It contains a detailed description of the tasks to be performed and the reports documenting the overall results. Due to the control room redesign effort, a modified approach is required to complete and document the CRDR program. The following changes have been made in the CRDR:

A. The documentation program described in the Program Plan was changed to allow reporting of results on the individual CRDR tasks.

B. An Implementation Plan Report was written to describe the background and reasons for the redesign effort. It outlines the approach to be used for implementing panel layout changes.

C. The tasks described in the Program Plan will be completed for the original design. The SFTA and the control room survey will be updated to validate any design revisions.

This report is one of several documents (See Figure 1) that describe the CRDR and the associated redesign effort on the STP control panels. The following is a description of these documents:

A. Program Plan - Defines the plan for performing the CRDR.

B. Criteria Report - Provides the basis for the CRDR and describes the interface between the control room and plant systems.

C. Operating Experience Review Report - Describes the review process results, conclusions and recommendations of the operating experience review (OER) task defined in the Program Plan.

D. System Function and Task Analysis Report - Describes the methodology, results, conclusions and recommendations for the SFTA effort defined in the Program Plan.

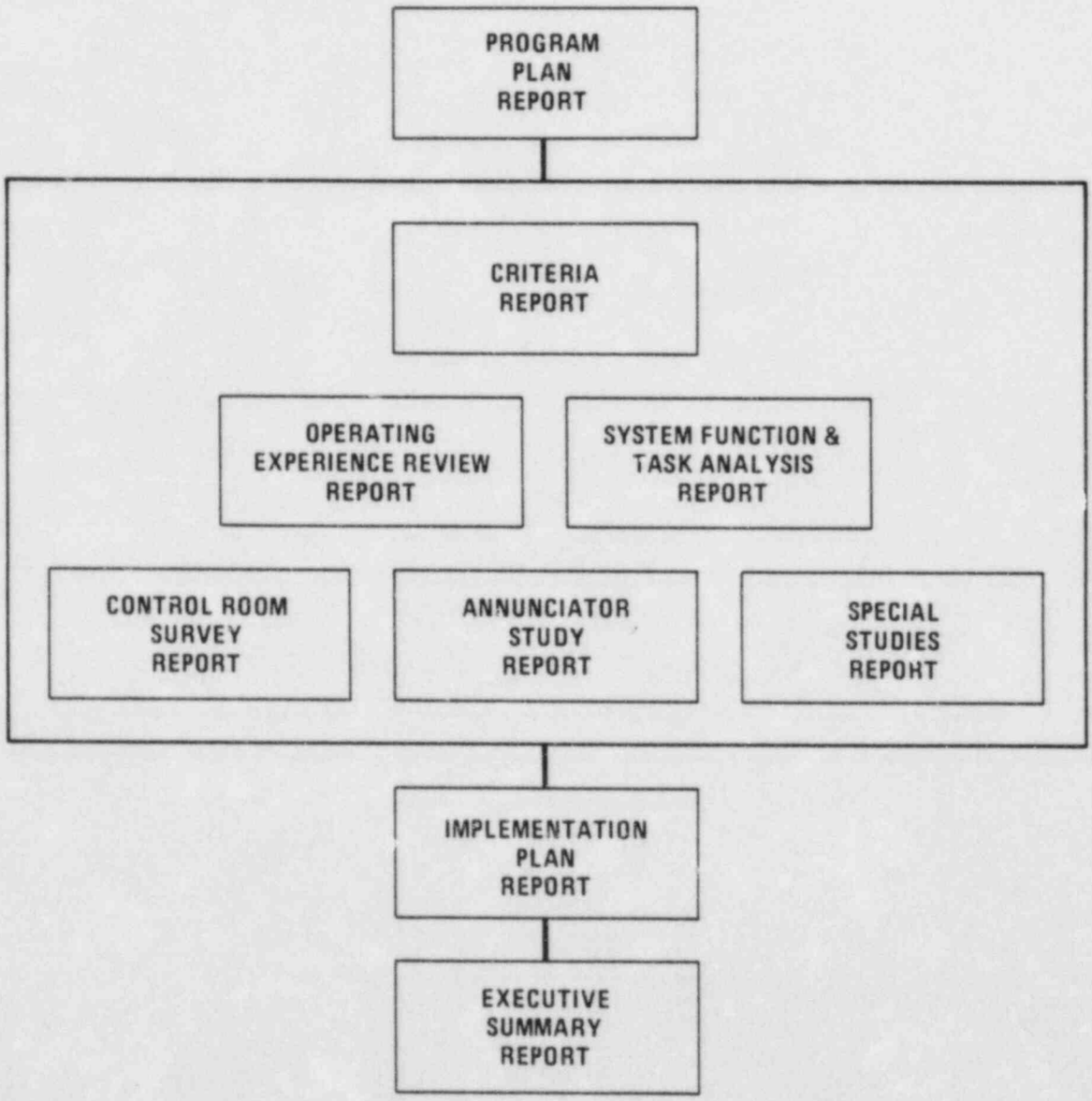
E. Control Room Survey Report - Describes the review process, results, conclusions and recommendations of the control room survey task defined in the Program Plan. This report also includes the final results and dispositions for the human factor observations obtained from the OER and the SFTA.

F. Annunciator Report - Describes the review process, results, conclusions and recommendation of the annunciator review task defined in the Program Plan.

G. Special Studies Report - Describes details of any miscellaneous studies performed as part of the CRDR. This will include the anthropometric study, the hierarchial labeling study and the demarcation study.

H. Implementation Plan Report - Summarizes the CRDR, the control room design changes, and the proposed methods of implementing the design changes.

I. Executive Summary - Summarizes the CRDR, results, conclusions and recommendations. Technical details are in the Operating Experience Review Report, the System Function and Task Analysis Report, the Control Room Survey Report, and the Annunciator Report.



STP – MAJOR REPORTS

Figure 1

SUMMARY

The control room design review process, detailed in the program plan, includes as a very important generic task the operating experience review (OER). This report documents the work performed under the OER task of the CRDR. Included are sections covering the OER methods and procedures, and the comments resulting from the operator questionnaires and interviews. These comments are tabulated in Section 3.1 and 3.3 respectively, and have not been evaluated as to severity, desirability, or internal disagreement. The OER is consistent with the program plan.

The System Task Analysis Team will prepare, on checklist observation (CLO) forms, evaluations of the observations, with recommended resolutions, for presentation to the Project Review Team. In this report, no screening has been performed to eliminate duplication, either between interviewed personnel, or with other checklisted items. It is to be expected that not all operator concerns can result in control room revisions due to other constraints such as schedule, cost, etc.

Many of the operator's comments were confirmed by the other operator interviews, and for statistical purposes, this duplication is retained in the sections dealing with results of the various interviews. However, when preparing checklist forms for presentation to the PRT for resolution, an attempt was made to eliminate duplications between operator comments. Some comments were broad in scope, and generally were not transcribed onto the checklist forms, because these aspects are examined during the Human Factors Review. For example, "some controls are above (rather than below) their corresponding displays." In the absence of any more specific information, each display in the control room would have to be checked to identify those to which the operator referred. However, one of the human factors checklists verifies just this criteria for each display. In the interest of reducing effort, no OER checklist item would be prepared for the above example.

Disposition of the operator comments that have been transcribed will be carried out according to the methodology described in the Program Plan, Section 4.

1.0 PURPOSE

The operating experience review (OER) was designed to assess all safety- and efficiency-related factors of the projected STP control room as identified by supervisors and operators. Its major objective was to identify aspects of the control room that were considered problematic relative to operator performance, as well as potential solutions to those problems. Additionally, operational inputs were sought regarding outstanding features of the projected control room complex from the users' standpoint. The use of critical incident techniques was considered, but rejected, due to their limitations for collecting accident/incident data. Such limitations are stated in Chapanis, 1960, and in Flanagan, 1954.

Review activities conducted to achieve these OER objectives included the following:

A. Initial and followup interviews with operations and shift superviors

B. Visit and tour of the plant site

C. Orientation/indoctrination meetings on plant systems and procedures

D. Review of plant-specific training materials

E. Preparation, distribution, and completion of questionnaires

F. Supervisor/operator control board orientation

G. Conduction of structured interviews based on questionnaire responses

2.0 METHODS AND PROCEDURES

2.1 INITIAL INTERVIEW WITH SUPERVISORS

The principal purposes of this interview were to familiarize the members of the operating experience and task analysis teams with plant-specific systems and procedures; to discuss criteria for selecting normal and emergency events to be used for task analysis purposes; and to indentify other information requirements. Information derived from the Westinghouse Emergency Response Guidelines (ERGs) and the Final Safety Analysis Report (FSAR) was used to structure interview questions. Other topics discussed included staff responsibility in carrying out normal and emergency procedures; the logistics involved in generating and reviewing the procedures; operator training conducted at the simulator and at the plant site; probabilistic operator decision/response data used in the selection of emergency transients; identification of cues used to diagnose emergency conditions; factors used for determining whether ERGs are written for a given emergency condition; and annunciator response procedures.

In addition to the ERGs and FSAR, other information sources to be acquired or considered for inclusion in the operating experience review were identified, including:

A. Westinghouse Plant Information Package (PIP)

B. Precautions, Limitations, and Setpoints

C. STP System Descriptions

D. Equipment Technical Manuals

E. Licensee Event Reports (LERs) from related plants

F. Significant Operating Event Reports (SOERs) produced by the Institute of Nuclear Power Operations (INPO)

G. Nuclear Power Experience Reports of the Petroleum Information Corporation

H. Electric Power Research Institute (EPRI) reports dealing with task analysis and/or operating experience reviews.

The STF supervisors were briefed on the planned approach for providing operators with orientation on the mock-up, for distributing questionnaires to the operators, and for conducting the follow-up interviews based on operators' questionnaire responses. They also were informed of the general nature of information sought from supervisors and operators. Job descriptions were requested and obtained on all operational personnel, and staffing requirements were discussed.

2.2 VISIT OF PLANT SITE

Following the initial interview with supervisors, five members of the operating review and task analysis teams traveled to the plant site. During the visit, a guided tour was conducted of STP Unit One by a shift supervisor. Further information was acquired and discussed pertaining to selected plant operating events. Inputs were obtained from the STP management staff concerning content areas to be addressed by the questionnaires and interviews, as well as the logistics for administering them.

2.3 REVIEW OF TRAINING MATERIAL

STP training materials were obtained from, and discussed with, the Operator Training Supervisor. These materials concerned the following topics:

A. Conduction of formal classroom and on-the-job training for operator and senior operator candidates

B. Training objectives and lesson plans

C. Content and duration of each phase of training

D. Coordination and scheduling of simulator training

E. Preparation, administration, and grading of examinations

F. Evaluation of each candidate's readiness for NRC license examination

G. Procedures for maintenance of training records

H. Examination of document forms and audiovisual aids

2.4 PREPARATION OF QUESTIONNAIRES

A questionnaire (Appendix A) containing 66 items was prepared covering the content areas included in NUREG-0700. All applicable guidelines contained in NUREG-0700 were used to structure the questionnaire. Questions were posed such that acceptable aspects of the control room or panels were indicated by "YES" responses and undesirable or negative aspects by "NO" responses. This was done to facilitate response analyses. For "NO" answers, respondents were asked to indicate the specific problem or deficiency and, if applicable, the specific components or equipment in question. Recommendations concerning actions that could be taken to correct or improve the deficiencies also were sought. Confidentiality was assured and maintained for all respondents.

2.5 OPERATIONAL PERSONNEL AND CONTROL ROOM ORIENTATION

Eleven operational personnel participated in the OER. Prior to completing the questionnaire, five supervisors (three of whom are designated Senior Reactor Operators) and six who are designated Reactor Operators (two of whom are training instructors)

underwent a standard orientation on the mockup of the STP control panels located at the Bechtel-Houston facilities. Background data on the supervisors and operators are shown in Table 2.5-1.

Mean total experience of these personnel is 15.7 years while their mean experience with HL&P is 4.6 years. Ten of the eleven personnel are former Naval Reactor Operators. The orientation consisted of the execution of a normal steam bubble startup procedure in its entirety using the HL&P/STP plant procedures manual. The procedure required approximately three hours to complete, commencing with the establishment of nitrogen pressure and terminating with main steam reheat temperature verification at 35% power. Supervisors and operators worked in teams of three or four in conducting the procedure. The startup procedure was selected to provide the supervisors and operators with representative structured exposure to board components and overall layout prior to completing the questionnaire. This exposure was considered to be especially critical since no STP operating experience could be used to guide responses to the questions.

2.6 COMPLETING THE QUESTIONNARIE

Having undergone board orientation, respondents completed the questionnaire at the plant site. They were permitted up to five days to complete the questionnaire. The mean actual amount of time required to complete the questionnaire, as estimated by the respondents, was 3.8 hours. Questionnaires were submitted to the Operating General Supervisor who checked them for completeness before returning them for analysis to the OER team. Prior to scheduling the follow-up interviews, questionnaire responses were carefully reviewed and assessed on a preliminary basis. This review and assessment enabled the OER team to focus the follow-up interview on questionnaire content areas that were identified by respondents as potential problem sources. Thus, optimum use could be made of follow-up interview time.

Table 2.5-1
SUPERVISOR AND OPERATOR BACKGROUND DATA

POSITION OTHER	TOTAL EXPER. (YRS.)	HI&P EXPER. (YRS.)	QUALIF. LEVEL	EX-NAVAL RO	COLLEGE EDUCATION	USN NUCLEAR POWER SCHOOL	NSSS DESIGN REVIEW	SIMULATOR TRAINING	MEMPHIS STATE	EPRI/ INPO SEMINARS	
REACTOR OPERATIONS SUPERINTENDENT	19	1.0	SRO	YES	4 YEARS	YES	YES	YES	YES	YES	11 YEARS RO/TNG SUPERVISOR AT WISC. ELECT. POWER; 2 YEARS SHIFT SUPERVISOR AT ARIZ. PUBLIC SERV.
SHIFT SUPERVISOR	17.0	4.5	SRO	YES	? YEARS	YES	YES	YES	YES	–	BWR RO LICENSE
SHIFT SUPERVISOR	17.0	5.5	SRO	YES	–	YES	–	YES	YES	YES	USN ELECTRICIANS MATE
UNIT SUPERVISOR	14.0	3.0	RO	YES	–	YES	–	–	YES	–	USN ELECTRONICS TECHNICIAN
UNIT SUPERVISOR	19.5	4.5	RO	YES	–	YES	YES	YES	YES	YES	USN MACHINIST MATE; UNIV. OF WISCONSIN HUMAN PERF. WORKSHOP
HEAD OPERATOR	8.5	8.5	RO	–	2 YEARS	–	–	YES	YES	–	WESTINGHOUSE NUCLEAR POWER SCHOOL; SEQUOYAH CONTROL ROOM OBSERVATION
HEAD OPERATOR	20.0	5.5	RO	YES	–	YES	–	YES	YES	–	USN ENGINEMAN
OPERATOR	10.0	4.0	RO	YES	2 YEARS	YES	–	YES	YES	–	WESTINGHOUSE NUCLEAR POWER SCHOOL
OPERATOR	21.0	4.0	RO	YES	–	YES	–	YES	YES	–	SEQUOYAH CONTROL ROOM OBSERVATION
OPERATOR TRAINING INSTRUCTOR	15.0	5.5	RO	YES	2 YEARS	YES	–	YES	–	YES	USN ELECTRICIANS MATE; WESTINGHOUSE NUCLEAR POWER
OPERATOR TRAINING INSTRUCTOR	12.0	5.0	SRO	YES	4 YEARS BS–ACCTG.	YES	–	YES	–	YES	USN ELECTRICIANS "A" SCHOOL; WESTINGHOUSE NUCLEAR POWER SCHOOL
SUMMARY	MEAN – 15.7 YEARS	MEAN – 4.6 YEARS	5 SRO's 6 RO's	10 OF 11							

2.7 CONDUCTING THE FOLLOW-UP INTERVIEW

Follow-up group interviews (Appendix B) were conducted at the Bechtel-Houston facilities 5-10 days following board orientation and 3-5 days after questionnaires had been returned to the OER team. Interview sessions required approximately three hours to conduct.

Three of the interviews included two respondents and one interview was comprised of four respondents. The Operating General Supervisor was interviewed alone. Since interview questions were compatible with those contained in the questionnaire, respondents were encouraged to provide more detailed comments on problem areas they had noted on the questionnaires. To facilitate this process, each respondent was provided with his questionnaire which was used to structure his interview responses. Additionally all respondents were interviewed within the STP mockup area. This permitted them to point out equipment-specific problems on the panels as they responded to each question. This procedure proved highly effective in eliciting all pertinent operational inputs. Emphasis was placed on interview questions that had produced "NO" responses and problem notations on the questionnaire. "YES" responses on the questionnaire were addressed by interview questions only if the response contained commentary on exemplary or desirable human engineering concepts. As noted earlier, this optimized the use of interview time. Interview data were evaluated immediately following the completion of each interview. This was done to assure that the information will not be misinterpreted by the OER Team at the time of final data analysis.

3.0 QUESTIONNAIRE/INTERVIEW RESULTS

General problem areas relating to the STP panel design were identified by tabulating questionnaire responses and summarizing those responses by NUREG-0700 content area. The purpose of this approach was to provide summary data that could easily be compared with data produced by the human factors survey and checklist evaluations. More detailed data on problem areas were derived from the follow-up interviews.

3.1 PROBLEM AREAS IDENTIFIED FROM QUESTIONNAIRE RESPONSES

Three major content problem areas were identified from questionnaire responses as shown in Table 3.1-1: annunciators, controls, and overall panel layout/integration. These content areas produced an average of 66.0, 50.4, and 49.3% "NO" responses, respectively. As noted earlier, "NO" responses indicated perceived problem areas in all cases. To determine those questions (over all content areas) that produced the highest percentage of "NO" responses, an item analysis was conducted. Thirteen questions were identified as those which were answered "NO" by nine (82%) or more of the 11 respondents. Each question includes the percentage (and number) of respondents answering "NO" as well as some of the reasons or comments accompanying the response.

A. Workspace (Question No. 5 Appendix A)

Do you feel that all visual displays are located in a viewing area that provides for efficient and comfortable monitoring?

82% (nine) of the respondents answered "NO".

TABLE 3.1-1

PERCENTAGE OF "YES" AND "NO" QUESTIONNAIRE RESPONSES

NUREG-0700 Content Area	No. of Questions	Mean % "YES"	Mean % "NO"	Mean % "UNCERTAIN"
Workspace	6	68.2	30.3	1.5
Controls	13	49.6	50.4	0
Displays	11	56.3	37.1	6.6
Annunciators	12	29.5	66.0	4.5
Labels/Location Aids	15	63.6	34.0	2.4
Process Computers	2	82.0	9.0	9.0
Panel Layout/Integration	7	49.5	49.3	1.2

Reasons given included:

1. Indicators (pressure, temperature, flow) too high on panels
2. Annunciators hard to read
3. Permissive panel hard to read from RO panel
4. Recorders too high on panel
5. Synch. scope on 010 too high
6. Bistable status lights hard to read
7. Auxiliary feed flow indicators hard to read

B. Controls (Question No. 7, Appendix A)

Do you feel that controls are arranged to facilitate operator responses?

91% (ten) of the respondents answered "NO".

Reasons given included:

1. Turbine controls and generator voltage and breaker controls are too far apart
2. Auxiliary feedwater controls are scattered
3. Controls are not mimiced and hard to identify
4. VCT controls are poorly arranged
5. Main feedwater system controls not grouped properly
6. ESF controls inconsistent across 001, 002, and 003
7. Steam dump control switches are too far away from steam dump controllers
8. One set of manual SI switches should be on ESF panels
9. HVAC spread all over panels
10. Controls require excessive operator movement
11. Controls are not standardized by control function

C. Controls (Question No. 9, Appendix A)

Do you feel that all controls will be easy to reach and manipulate by both small and large operators?

82% (nine) of the respondents answered "NO".

Reasons given included:

1. Boards are too tall
2. Small operators will have problems reaching certain controls on vertical panels
3. Some controls and all recorders are hard to reach, even for tall persons
4. DRPI controls on 005 impossible to reach
5. BTRS controls on 004 hard to reach
6. Case-by-case evaluations should be done on operator reach

D. Controls (Question No. 10, Appendix A)

Do you feel that controls are well arranged with respect to plant systems?

82% (nine) of the respondents answered "NO".

Reasons given included:

1. 004 illogically arranged
2. Turbine drain switches are scattered
3. Generator controls should be nearer turbine controls
4. Controls for same system are on different panels or spread too much on one panel
5. Reset switches on ESF boards poorly arranged
6. CVCS system controls not integrated
7. Auxiliary feedwater system illogical
8. Feedpump master controller should be nearer the middle of 006
9. Controls are too scattered about the panels

E. Annunciators (Question No. 20, Appendix A)

Do you like the design and overall layout of the annunciators?

91% (ten) of the respondents answered "NO".

Reasons given included:

1. Annunciators should be arranged by degree of importance (need prioritization)
2. Layout is inconsistent with Westinghouse design for permissives and is not labeled for clear understanding
3. Permissives should be on separate panel with permissive number
4. Permissives need auditory tone when actuated and when reset
5. Need first-out indications
6. Annunciators are hard to read
7. Common systems are not grouped together
8. Many alarms on 007 (e.g. RCB and loose parts monitoring) should be on 005
9. Layout is illogical with respect to systems
10. Should be able to silence an alarm from any panel and acknowledge from system panel
11. Recommend color coded annunciator system
12. Panels contain too many miscellaneous alarms
13. Controls for a given system are on different panel from their corresponding annunciator windows

F. Annunciators (Question No. 22, Appendix A)

Will each annunciator be dedicated to only one plant parameter set point?

100% (all eleven) of the respondents answered "NO".

Reasons given included:

1. Too many high/low inputs (need indication of status nearby if multiple input alarms are to be used)
2. Common alarm annunciators should be carefully reviewed
3. There are several general catagory alarms

G. Annunicators (Question No. 23, Appendix A)

Do you feel that it will be possible to rapidly identify the initiating event (first-out) for automatic plant shutdown?

100% (all eleven) of the respondents answered "NO".

Comments given included:

1. There are no first-outs (they are needed badly)
2. Highly recommend that first-out feature be incorporated into design
3. In the event of computer outage, operator has no way to diagnose what caused a plant trip
4. No first-outs, prioritization poor

H. Annunciators (Question No. 25, Appendix A)

Are you satisfied with the prioritization of alarm levels?

91% (ten) of the responders answered "NO".

Comments given included:

1. What prioritization?
2. No prioritization exists
3. No priorities have been established
4. Annunciators need to be color-coded by priority

I. Annunciators (Question No. 27, Appendix A)

Do you feel that the annunciator tiles are properly and consistently labeled and easy to read?

100% (all eleven) of the respondents answered "NO".

Reasons given included:

1. Tiles are too small and too cluttered
2. Too many letters in small area
3. Difficult to distinguish among tiles
4. Poor labeling
5. Inconsistent abbreviations
6. Hard to read and identify
7. Labels are inconsistent within panels and across panels

J. Labels and Location Aids (Question No. 41, Appendix A)

Are controls, displays, and other equipment clearly and accurately labeled?

82% (nine) of the respondents answered "NO".

Reasons given included:

1. Labeling needs to be reviewed for accuracy and consistency with FSARs and Westinghouse tech manuals
2. Recorders (e.g. Steam Generator Level, Steam Flow) are poorly labeled
3. Need major system labels (especially on ESFs)
4. Labels on controllers need to include the system or function being controlled
5. Recorder labels do not indicate what is recorded (RCP and SG, e.g.)

K. Labels and Location Aids (Question No. 56, Appendix A)

Do you feel that demarcation is adequate?

91% (ten) of the respondents answered "NO".

Reasons given included:

1. 004, 005 and 006, need demarcation
2. Very little demarcation is used
3. Demarcation is used only on ESF panels and it is not labeled
4. Demarcation is needed on 004, 005, 007, 008 and 009

L. Panel Layout/Integration (Question No. 60, Appendix A)

Do you feel that the panels are effectively designed with respect to the overall layout of controls, displays, and other equipment?

82% (nine) of the respondents answered "NO".

Reasons given included:

1. Need more logical and functional groupings
2. Need better demarcation and better labeling
3. 004, 005, 006 and 007 are especially poorly laid out
4. Many of peripheral panels that are outside of the primary operating area need to be included in main panel layout
5. Electrical controls are much too far from turbine controls
6. Feed pump master controller should be located between individual controls
7. Panels need extensive rearrangement

M. Panel Layout/Integration (Question No. 61, Appendix A)

Are controls and displays that are used together grouped together or otherwise logically arranged?

82% (nine) of the respondents answered "NO".

Comments given included:

1. The following systems are illogically grouped:
   - o RHR and CVCS
   - o Turbine to Generator
   - o Main Feedwater
   - o Auxiliary Feedwater
   - o EHC controls
2. Steam generator controls and displays are split
3. Rod position indication and controls could be better integrated

3.2 CORRELATES OF PROBLEM IDENTIFICATION ON QUESTIONNAIRES

No significant relationships were found between questionnaire responses ("YES" vs. "NO") and variables related to respondents' background and experience. For example, "NO" responses were no more prevalent among those with more (> 15 years) experience than those with less (< 15 years) experience. Similarly, while some response differentiation occurred between supervisors and operators and between SROs and ROs, these differences were not statistically reliable.

3.3 INTERVIEW DATA

As previously noted, the primary objective of the interview was to obtain detailed comments on the general problem areas identified in the questionnaire. Another objective was to obtain safety and efficiency ratings of the STP control panel design with respect to each NUREG-0700 content area.

Table 3.4-1 shows a list of interview results by content area. Some of the findings relate to commendable aspects of panel design and others to the respondents' preferences and recommendations concerning the final STP control room design. In generating the following list, no attempt was made to evaluate the criticality of a given problem or recommendation in terms of its overall effect on plant operating conditions. Respondents were asked to consider both number and criticality of problems for a given content area in rating its overall safety and efficiency.

A. CONTROL ROOM WORKSPACE

1. Access to CR
   a. Security door (keycard) required
   b. Door behind panels potential problem (excess traffic)
   c. Limited access needed

2. Space, Comfort, Convenience
   a. Spacious
      - o Need two ROs to cover panels
      - o Need storage space behind panels
      - o Need writing space, especially 005 and 006 area; recommend two portable podiums and one fixed; arrangement should permit RO to face panel while writing; fixed podium could be mounted above panels or extendable
      - o Space between 007 and 010 is too great; generator breaker switches on 010 should be integrated with turbine-generator controls on 007
      - o Supervisors office is adequately located but could be nearer and better aligned with primary operating area. Supervisors' view of the entire control room will be limited given the present location.

b. Lighting, Acoustics, Temperature
   - o To be determined
   - o Lighting placement, adjustability is critical
   - o Recommend diffused, non-glare, egg-crate lighting
   - o Recommend carpeted floors with heavily padded runner in front of panels (will reduce fatigue and decrease noise)
   - o Printers may be noisy unless covered
   - o Control rooms are generally too cold (equipment purposes)

c. Anthropometry
   - o Panels are too tall (9 ft.) and too deep (31 in.)
   - o Will have to administratively control operator size (this is not considered problematic)
   - o Panels contain many controls/displays that could be relocated (backpanel) or removed (e.g., too many SG drains on 008; too many chart recorders)
   - o Annunciators are hard to read
   - o Some vertical meters will be hard to read (parallax)

3. Control Room Furniture and Equipment
   a. Furniture to be determined; chairs should be as shown in Exhibit 6.1-19 of NUREG 0700 except without arm rest
   b. Additional desk or table is recommended (to be located away from 004, 005, 006)
   c. Need ladder that enables ROs to change bulbs and paper without standing on panels
   d. Need portable cart for transporting procedures and writing materials
   e. Protective and emergency equipment should be easily accessible within CR complex
   f. Printers may need to be closer to primary operating area for convenience

g. Relocated Equipment
   - o CP 016 (Auxiliary Boiler Panel) could be out of control room
   - o CP 011 (Nuclear Instrumentation) should be in primary operating area
   - o BA batch tank controls (004) should be moved to Chemical Operations panel
   - o CP 018 may need to be in primary operating area (depending on information it contains)

h. Kitchen and Restroom
   - o Restroom and kitchen should be slightly closer to (or in) control room envelope and should be designated for use by operational personnel only. Need coffee pot in control room; otherwise one RO will have to handle all panels while other RO leaves control room.

4. Plant Shutdown
   a. Given present control room equipment, safe plant shutdown can be accomplished but could be facilitated with more efficient panel layout
   b. Plant-critical decisions (except fire- and seismic-related) can be made within primary operating area
   c. In some cases, status information cannot be determined (e.g. pressurizer spray valves on 005)
   d. Phone with outside line should be outside the control room unless access to control room is limited to ROs only
   e. Plant alarm system needs to be in control room (locations and characteristics to be determined)

B. Annunciators

1. Arrangement is illogical
   a. No first-outs are provided (need separate first-out panel)
   b. No prioritization is provided (need coding by row or by color)

c. Initiating events are hard to identify
d. Some multiple input alarms (e.g. CVCS) exist
e. Annunciators have to be silenced on the same panel as alarm. RO should be required to go to that panel to acknowledge, but not to silence, alarms
f. Common alarms should have reflash and repeat capability
g. Some controls are on different panel from corresponding windows
h. Some alarms cannot be controlled from the control room (e.g. sump alarms on 005); these should be removed from the control room annunciator system
i. Annunciators should have one window for each alarm (not two alarms per window). Light diffusion is potential problem (need dividers in status indicator windows)

2. Tile abbreviations are inconsistent and wordy
   a. Need description of specific nature of problem
   b. 006 tile engravings should be alphanumeric

3. Too many tiles
   a. Many sump and batch tank alarms could go on computer
   b. Many alarms should be moved to bistable status system with controls integrated into the displays
   c. Too many tiles lit during normal operations (prefer black board)

4. Tiles are too high on panels (hard to read)

5. Plastic tiles and hinges break easily and often

6. Annunciator Controls
   a. Need demarcation
   b. Pushbuttons could be replaced by joysticks (better touch differentiation)

7. Need more alarm CRTs

8. Interaction with PAMS is poor

9. Need more functional layout on 005 and 006

10. Location of tiles for given alarm is inconsistent from one panel to another

11. Need permissives on 006

12. Recommend auditory differentiation for each area alarm (but not per panel)

C. Controls

1. Most panels contain too many controls (e.g. supply cooler fans, drain controls on 007, and BA batch tank control on 004); one set of CS/CIB/CVI controls on 005 could be moved to ESF; one SI switch & one CIA/CVI switch on 005 could be moved to ESF; one Rx trip switch on 005 could be moved to 007

2. Control types are not standard for valves and pumps (pumps, fans, and breakers should be pistol grips; valves should be 2940s)

3. Some controls are hard to reach by smaller operators (e.g. BTRS controls on 004 and bus selector switches on 010); critical controls should be in easily reachable locations

4. Layout for some controls is illogical (e.g. SGFW on 006 and HTR layout on 005); control arrangement is inconsistent on ESF panels (e.g. CRDM vent fans); flow orientation on 004 is illogical; need more breaker controls on 010 from 13.8 busses, otherwise have to rely on AO to provide information to return to normal conditions.

5. Rod control switch will break easily (poorly designed)

6. Control positions (e.g. auto) should be standard from one panel to another and within panels (e.g. Auto-Open vs. Close-Open 2940s)

7. Some controls should be moved (e.g. one Rx trip and SI actuation control on 005; controllers on 007 should be on 006). Feedpump master switch on 006 should be centrally located. FW reset switches on 001 should be on 006 (same for turbine-generator).

8. Need color or shape coding for switches for easy differentiation (e.g. 006 and 007); this is especially true for critical controls (e.g. Rx trips).

9. Some controls used in conjunction with each other are separated by too great a distance (e.g. generator controls on 007 and 010); auxiliary feed pump controls, steam dump switches, and steam dump controller on 007.

10. Sequencing of control operation within a system is poor; process flow should be standardized and mimiced.

11. Control arrays on 007 are confusing. If they are to remain on panel, drain switches need demarcation; MSIV and bypasses should be reoriented, MSIVs above bypasses.

12. Steam dump switches on 007 should be directly beneath their indicators

13. Rx trip switches on 005 should be closer to their indicators; also mid-position should be "Normal", not "Actuate"

14. Systems/subsystems relationships are unclear

15. Charge flow controls on 004 are above (rather than below) their indicators

16. Accidental actuation of some critical controls is possible (e.g. rod control, turbine trip, steam line isolation, and steam dump); these need covers or recessed pushbuttons

17. Some switches are hard to operate (e.g. rod control switch)

18. Controllers need status indications, otherwise easy to operate. Controllers on 007 should be higher on panel (drain valves could be moved); dual indications on controllers hard to interpret; buttons could be larger.

19. CR 2940 switches are easy to use except 3-position (RO has to hold in "open" position)

20. RPI system is good except controls should be lower

21. Recorder pen selector controls should be standardized (preferrably knurled knobs for both controls)

22. The operation of TAVG and ΔT defeat switches (005) may cause defeat of other than intended loop

23. Need position indication of condensate polisher bypass somewhere on panels (e.g. on 008)

24. RO has to go through "Man" from "Off" to "Auto" in operating the main turbine turning gear control on 007

25. Need bearing lift pump control

26. Need precise status of valves open on 007; demand information is given but need status

27. Pressurizer control on 004 needs indication of "Auto" values prior to switching from "Man" to "Auto"

28. Control actuations should be consistent across panels

Displays

1. Some displays are illogically arranged (e.g. shutdown counters, bypass status, synch. meter on 010 should be directly above breakers or on swivel at each end of panel, chart recorders on 004 and 005).

2. Meters should have hi/lo limits.

3. Some meters are located too high on boards (e.g. those on 010).

4. Some meters have inconsistent units of measurement (e.g. SG blowdown meters).

5. Some meters and controller set points require mental conversion (ΔT meters).

6. Some displays that are used in conjunction with each other are not grouped functionally (e.g. 005).

7. Some displays do not (but should) indicate status of system or subsystem.

8. Some chart recorders will produce information of very limited use (e.g. 007 and 009); 005-NR 45 recorder actually has three scales, when door is closed, RO cannot see; scales are confusing, so ROs use meters; multiple stamp recorders are hard to read, superimposed numbers, excess ink and blur; multiple pen recorders produce superimposed lines, hard to read.

9. Some displays are too far removed from their associated control.

10. More alarm CRTs are needed.

11. Need bearing lift pumps indication.

12. Operating range on turbine shaft speed indicators is unrealistically large (should be 0-2400 RPM). (For generator electrical load, should be 0-1500 MW.)

13. Remote digital displays (rear projection) may be hard to read.

14. LP Inlet Steam Temp Meters on 008 actually will have three 2-pen meters rather than of six single-pen meters (this is better for matching values).

15. Colors on vertical meter pointers need to be standardized.

16. Switch indicator lights on 004 should not both be red (one should be another color).

17. Feed pump displays on 006 give no indication of the status of lube oil, turning gear, and vibration eccentricity.

18. HCV 218 gives no feedback indication of valve status.

19. Need indication of Loop Delta T, Steam Flow, Feed Flow relative to reactor power.

20. Digital clock on 009 should be on 004, 005, or 006.

21. The nine vertical meters on the top right side of 006 (Segment B) are not needed; the four meters to the left of those nine should be on 005.

22. Failed two-needle meters are hard to identify.

23. Recommend circular meter for wind direction.

24. Permissive status lamps (006) are cluttered and hard to interpret; not logically arranged by rows and columns.

E. Labels and Location Aids

1. Major systems are not labeled.

2. Labels are not above some indicator lights.

3. Some functional groups are not labeled (e.g. Rx coolant flow on 004).

4. No hierarchical labeling is provided.

5. Some labels are inconsistent with FSARs and technical manuals.

6. Chart recorder labels should show what parameters are being recorded.

7. Trend recorders are not labeled.

8. Labels should indicate the controlled device rather than (or in addition to) the controller number.

9. Labels are inconsistent with respect to wording, nomenclature, and abbreviations.

10. Labels are not consistently located above controls/displays.

11. Labels should be color coded by system or function.

12. Panels need more (and better) demarcation and mimics (especially 004, 005, and 006).

13. Many labels do not include functions (e.g. vent fans and RHR HX; on 001 main FW on 006).

14. Many labels do not (but should) provide measurement units.

15. Controllers for specific valves should indicate what is being controlled.

16. "Manual" vs. "Auto" control not differentaited on some 2940s.

17. Cross connect valves (001) mislabeled; needs clarification concerning origin vs. destination.

18. Rx coolant pump recorders (004) need more specific and complete labeling (same for SG1A recorder).

19. Need row/column designator matrix format for annunciator labels.

20. Switch on chart pen recorder (005) will cover some labels in any given position.

21. "T Error" vertical meter on 005-ambiguous.

22. Turbine Control Panel (006) "Loss" should be "Low".

23. Reactor Coolant Pump Recorders (004) should have "Seal Leakoff" on labels.

24. Need clearer demarcation between panels (wider lines).

25. Panel numbers should be top-center.

26. Mimics on 010 wrong color-emergency transformers should be red; generator/auxiliary should be blue; standby transformers should be amber.

27. Labels on PRT Vent Control Isolation Valves need indication of "inside" or "outside" containment.

F. Panel Layout

1. Illogical and inefficient arrangements (e.g. CVCS; 004, 005, and 006) in general; shutdown counters should be arranged bottom to top since rods are withdrawn that way; not functionally grouped.

2. Some controls used in conjunction with each other are separated by too great a distance (e.g. generator controls on 007 and 010).

3. More and better demarcation and mimics are needed.

4. More color coding is needed.

5. Some controls are above (rather than below) their corresponding displays (e.g. charging flow on 004).

6. Need more alarm CRTs.

7. Some controls are separated from their corresponding displays by too great a distance (e.g. some selector switches on 005 give indications on 006 and on ESF panels); meters are too far away from controls within 006; PZR level (005) control and display are on separate panels; steam header pressure and feedwater header pressure are split.

8. Sequencing of control operation is not optimized within a panel in some cases; need arrangement by logical flow.

9. Control arrays on 007 are confusing.

10. System/subsystem relationships are unclear.

11. ESF panels need standardized arrangement (002 different).

12. 007 and 010 should be closer, or need additional controls on 010 to match frequencies.

13. For the PZR heaters on 005, the backups should be grouped together with the main control isolated from that group.

14. Condensate pumps optimally located.

15. Most critical equipment is located as it should be on 004, 005, and 006.

16. All auxiliary feedwater pump flow meters on ESF should be on 006.

17. SG levels on ESF should be on 006.

18. Need indication of control position in close proximity to the corresponding control; e.g. level PZR record selector on 005 contains three positions on controls, but only one of these is indicated on adjacent meters. On 006, SG1A level selector has two positions but only one is indicated on adjacent display.

G. Control - Display Integration

1. Separation of controls and displays is too great in many cases (both within panels and among panels); e.g. turbine-generator controls-displays are split.

2. Systems/subsystems relationships are unclear (e.g. SG, CVCS, and Rx).

3. Some controls are above (rather than below) their corresponding displays.

4. ESF boards are inconsistently arranged and poorly integrated.

5. Some controls are above or to the side of corresponding displays. BA tank controls-displays are split; steam dumps on 007, controls-displays are split laterally; auxiliary feedwater pump to SG1D controls-displays are split (control on 006, display on 001); BTRS system (004) controls are above displays.

6. Generator controls on 007; synch scope used in conjunction with generator controls is on 010.

7. SG vertical meters need to be integrated with controller on 007.

8. Steam pressure indications on 006 and 007 should be together.

9. Rod control switch is too far away from vertical meter on 005.

3.4 EFFICIENCY AND SAFETY RATINGS BY RESPONDENTS

At the completion of each interview session, respondents were asked to subjectively rate the overall efficiency and safety of the STP control room with respect to each NUREG-0700 content area. Three general categories were used to generate the ratings: unsatisfactory, questionable, and satisfactory. Table 3.4-1 presents these efficiency and safety ratings by category for the eleven respondents. Table values represent the frequency of ratings (number of respondents) contained in each category separately by content area. All of the content areas except two were rated inefficient by the majority of the respondents, and the exceptions (workspace and control-display integration) were rated of questionable efficiency. The overall safety ratings of the control room are less clear. In general, the respondents reserved judgment on safety aspects of the control room until the plant becomes operational. This is reflected in the preponderance of "Questionable" ratings as applied to most of the content areas. However, it is interesting to note that six of the eleven respondents rated the panel layout unsafe as designed relative to overall plant operations. The conclusion to be drawn from the efficiency and safety ratings is that from an operational standpoint, substantial improvements need to be made to the design and arrangement of the control panels.

3.5 OTHER INTERVIEW INFORMATION

In the group interviews, information also was sought concerning control room procedures and policies, job requirements, shift rotation schedules, training, and management policies. It was determined that STP control room procedures are currently under development and are being generated by the operational management staff. Preliminary versions of some procedures (e.g. those for plant startup) have already been written and are undergoing revision. The startup procedures were used (and modified as required) for the control panel orientations described in Section 2.5. Respondents were asked for suggestions concerning procedures or policies that could be used to improve overall plant

EFFICIENCY AND SAFETY RATINGS
(NUMBER REPRESENT FREQUENCY OF RATINGS)
Table 3.4-1

	UNSATISFACTORY		QUESTIONABLE		SATISFACTORY		COMMENTS
	Eff.	Safety	Eff.	Safety	Eff.	Safety	
WORKSPACE	1	0	9	1	1	10	RO adaptation required; Door behind panels creates potential traffic problem
ANNUNCIATORS	11	1	0	7	0	3	Need first-outs, prioritization; ambiguous, scattered; hard to read
CONTROLS	8	0	3	7	0	4	Some control arrangements are unsatisfactory
DISPLAYS	6	1	5	4	0	6	Need spent fuel indication; failed displays are hard to identify
LABELS/ LOCATION AIDS	10	2	1	8	0	1	Insufficient demarcation and mimics
PANEL LAYOUT	9	1	2	4	0	6	Illogical arrangement
CONTROL-DISPLAY INTEGRATION	4	0	7	7	0	4	Hard to obtain control indications in some cases

control (relative to operating plants with which they were familiar). Following is a list of such suggestions:

A. Access to the control room should be restricted and stringently enforced. Policy concerning personnel access should be established as soon as feasible.

B. Entrance to the control room should be by keycard only.

C. The post accident monitoring systems (PAMS) and part of the ESF status monitoring system should be integrated into the safety parameter display system (SPDS).

D. Communications equipment and facilities should be optimized from the standpoint of information needed and transmitted by ROs and supervisors. (It was felt that some plants have too many phones in the control room - very confusing.)

E. An additional person (administrative assistant) may be needed to assist in scheduling, surveillance, preparing, handling reports, etc.

F. To reduce attrition among the operational staff, job requirements and shift rotation schedules should be realistic. A six week rotation was considered acceptable. Training and other activities that are required during that time period may result in rotation becoming too work-intensive.

Operational personnel expressed some concerns for the training program. These were not analyzed in depth in view of the very early stages of the STP training program formation. TPT will make recommendations for a follow-up review of training to be administered after the total training program has been in use at least four months. These recommendations will be included in the final report.

Operational views toward STP management policies were largely positive. Their concerns were that a substantial number of policy changes already have been made concerning control room design. They felt that a best case decision concerning panel design would consist of incorporating operational inputs (enhancements) into the overall layout of panels and equipment. A worst case management decision was viewed as one that would utilize the present panel design. This design was considered workable, but not optimal from a human factors point of view. Given the present design, delays were expected in RO board familiarization.

4.0 INTEGRATION AND INTERPRETATION OF OER RESULTS

In general, the implication of the OER results is that while the present configuration contains all of the equipment necessary to operate the plant safely, the overall design contains human factor inadequacies that, unless modified, can be expected to decrease user orientation. These inadequacies range in severity from very minor, in some cases, to potentially severe in others (e.g. annunciators and overall panel layout). Arrangement of components will create inconvenient sequences of RO movement about the control room and across control panels to perform normal and abnormal procedures (Section 3.4).

Inconsistent control-display arrangements will create the potential for misinterpreting information. Such misinterpretation can lead to decisions being made on the basis of inaccurate or incomplete data.

Control sequences, even for normal conditions, are in some instances inconsistent with expected human factors conventions. This includes a lack of logical and/or functional arrangement in terms of direction and proximity. Because of the extensive experience of the STP operational personnel in other (operating) plants, substantial training and adaptation is likely to be necessary to overcome the negative transfer created by the above problems.

It should be emphasized that the human factors problems identified by operational personnel closely corresponded with observations contained in the human factors checklists. These checklists were being completed by another (independent) CRDR team at the time of the OER questionnaires and interviews.

Trade-offs and constraints are involved in considering the human factors aspects of the control room design. For instance, locating displays in close proximity to their corresponding controls minimizes operator confusion by providing an easily accessible and usable indication of control inputs. However, since they must be within easy reach of operators, controls are generally located on the lower panels. When displays are located on the lower panels next to the controls valuable panel space is consumed, thereby

extending the control panels horizontally and increasing the physical space required to accommodate the panels. This increase in size may create as many human factors problems as it solves. Thus, human factors design trade-offs and constraints must be considered in the evaluation of all previously-cited OER results.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Data obtained from the OER study indicates that modifications are necessary to the present control panel design if the final arrangement is to be optimized from the standpoint of operator use. The extent of such modifications cannot be determined entirely on the basis of the OER results. However, based on the number and potential severity of the human factors problems identified by operational personnel, extensive modifications in panel layout (or a complete redesign of the panels) would seem to be warranted.

APPENDIX A

SUPERVISOR/OPERATOR

QUESTIONNAIRE

STP CONTROL ROOM DESIGN REVIEW

SUPERVISOR/OPERATOR QUESTIONNAIRE

Date:

Your Job Title:

Operating Experience:

Purpose

This questionnaire is intended to gather information from STP plant supervisors and operators. This information will be used in conjunction with data from other sources in the STP Control Room Design Review. The interest is in obtaining your opinion about both desirable and undesirable aspect of the control room. Please be sure that you have obtained appropriate experience on the mockup located at the Bechtel-Houston facilities before completing the questionnaire. A review of this questionnaire is recommended prior to your mockup orientation. While your experience with other (operating) plants will probably influence some of your responses, please confine your responses to the STP Control Room.

Completing this Questionnaire

Each question should be answered with either a "Yes" or "No" response.

1. Questions are posed such that acceptable aspects of the control room or panels are indicated by "YES" responses and undesirable aspects are signified by "NO" responses. For "NO" responses, please indicate the nature of problems or deficiencies, and, if applicable, the components or equipment below the response. An example of such a response is provided on the first page of the questionnaire. If you know of actions that could be taken to correct deficiencies, please include a brief description of them. Feel free to comment on "YES" responses also, if you wish. If additional space is needed, use supplemental sheets of paper. Include the question number on each supplemental sheet. Questions are posed for the content areas contained in NUREG-0700. Please consider the content area shown at the top of each page before responding to a given question.

2. To minimize writing and avoid redundancy, it is recommended that you read over all the questions for a given content area before responding to any of them. This questionnaire contains only content area questions that can be answered given the present state of STP construction. For example, communications and process computer content areas cannot be fully addressed until the plant becomes operational.

3. It is preferable to include brief descriptions of multiple problems rather than detailed descriptions of a single problem. It will be possible to go into more detail for a given problem during the upcoming interview.

4. Your job title is needed so your responses on this questionnaire can be used to structure your interview. All information obtained from questionnaires and interviews will remain confidential. No information will be linked to specific individuals for future licensing or performance evaluation purposes. Information will not be released for HL&P review. All questions are designed to assess the control room only. Your complete and candid inputs via this questionnaire and the interview will hopefully result in an operator-oriented control room. Thank you for your cooperation.

Do you feel that the data entry keyboards are well-designed and will they be easy to use?

YES (Keyboards Well-Designed And Easy To Use) ☐

NO (Keyboards Poorly Designed Or Hard To Use) ☑

1. EFIS keys too small and too close together
   - potential for data entry errors, especially for those with large fingers under turbulent conditions

2. Characters on keys hard to read
   - keyboard too far from pilot
   - poor contrast between light gray keys and white characters

EXAMPLE

STP Workspace Considerations

1. Does the projected control room contain all the instrumentation and equipment needed to detect and arrest abnormal plant conditions?

YES (Instrumentation/Equipment Is Sufficient) ☐

NO (Insufficient Instrumentation/Equipment) ☐

STP Workspace Considerations

2. Do you think it will be possible to bring the plant to a safe and undelayed shutdown given the projected instrumentation and equipment?

YES (Shutdown Safe And Undelayed) ☐

NO (Potential Unsafe Or Delayed Shutdown) ☐

STP Workspace Considerations

3. Will it be possible to make all plant-critical decisions and responses within the projected primary operating area?

YES (Decisions/Responses Can Be Made) ☐

NO (Some Decisions/Responses May Have To Be Made Outside Primary Operating Area) ☐

STP Workspace Considerations

4. Is the shift supervisor's office conveniently located to the primary operating area?

YES (Conveniently Located) ☐

NO (Inconveniently Located) ☐

STP Workspace Considerations

5. Do you feel that all visual displays are located in a viewing area that provides for efficient and comfortable monitoring?

YES (Displays Are Easy To Monitor) ☐

NO (Some Displays Difficult To Monitor) ☐

STP Workspace Considerations

6. Given the present control room design, is there adequate writing space?

YES (Adequate Writing Space) ☐

NO (Writing Space Inadequate) ☐

STP Controls

7. Do you feel that controls are arranged to facilitate operator responses?

YES (Good Arrangement) ☐

NO (Undesirable Arrangement) ☐

STP Controls

8. Are controls easy to identify?

YES (Easily Identified) ☐

NO (Hard To Identify) ☐

STP Workspace Considerations

9. Do you feel that all controls will be easy to reach and manipulate by both small and large operators?

YES (All Controls Reachable And Easy To Manipulate) ☐

NO (Some Controls Difficult To Reach Or Manipulate) ☐

STP Controls

10. Do you feel that controls are well-arranged with respect to plant systems?

YES (Optimal Arrangement For Systems) ☐

NO (Undesirable Systems Arrangement) ☐

STP Controls

11. Within a given system (steam generator, e.g.), do you feel that controls are well-arranged for subsystems (feedwater turbine pump, e.g.)?

YES (Optimal System Arrangement) ☐

NO (Undesirable Subsystem Arrangement) ☐

STP Controls

12. To make the operator's job easier, there should not be too many or two few controls. In your opinion, do the STP boards contain an optimum number of controls to accomplish all required functions?

YES (Number Of Controls Is Optimum) ☐

NO (Too Many Or Too Few Controls) ☐

STP Controls

13. Does the arrangement of controls make accidental activation unlikely?

YES (Accidental Activation Is Unlikely) ☐

NO (Some Controls May Be Accidentally Activated) ☐

STP Controls

14. Is the arrangement of controls consistent across boards and across systems?

YES (Consistent Arrangement) ☐

NO (Inconsistent Arrangement) ☐

STP Controls

15. Are the physical characteristics of controls (shape, size, type) consistent across boards and across systems?

YES (Characteristics Are Consistent) ☐

NO (Inconsistent Characteristics) ☐

STP Controls

16. Do you like the design and arrangement of pushbuttons?

YES (Good Design And Arrangement) ☐

NO (Undesirable Design Or Arrangement) ☐

STP Controls

17. Do you like the design and arrangement of the J-handles?

YES (Good Design And Arrangement) ☐

NO (Undesirable Design Or Arrangement) ☐

STP Controls

18. Do you like the design and arrangement of continuous adjustment rotary controls?

YES (Good Design And Arrangement) ☐

NO (Undesirable Design Or Arrangement) ☐

STP Controls

19. Do you like the design and arrangement of rotary selection controls?

YES (Good Design And Arrangement) ☐

NO (Undesirable Design Or Arrangement) ☐

STP Annunciator Warning Systems

20. Do you like the design and overall layout of the annunciators?

YES (Good Design And Layout) ☐

NO (Undesirable Design Or Layout) ☐

STP Annunciator Warning Systems

21. Based on your knowledge of the STP annunicators, do you feel that the number of false or insignificant alarms will be minimal?

YES (Acceptable Number Of False Or Insignificant Alarms) ☐

NO (Too Many False Or Insignificant Alarms) ☐

STP Annunciator Warning Systems

22. Will each annunciator be dedicated to only one plant parameter set point?

YES (Only One Set Point Per Annunciator) ☐

NO (More Than One Set Point Per Annunciator) ☐

STP Annunciator Warning Systems

23. Do you feel that it will be possible to rapidly identify the initiating event (first-out) for automatic plant shutdowns?

YES (Rapid Identification Of First-Out Is Possible) ☐

NO (First-out Hard To Identify) ☐

STP Annunciator Warning Systems

24. Given the project design, do you feel that it will be easy to differentiate more critical alarms from less critical ones?

YES (Easy To Distinguish Critical Alarms) ☐

NO (Difficult To Distinguish Critical Alarms) ☐

STP Annunciator Warning Systems

25. Are you satisfied with the prioritization of alarm levels?

YES (Alarm Priorities Are Good) ☐

NO (Undesirable Alarm Priorities) ☐

STP Annunciator Warning Systems

26. Do you consider it easy to identify alarms that have been cleared?

YES (Cleared Alarms Easy To Identify) ☐

NO (Cleared Alarms Difficult To Justify) ☐

STP Annunciator Warning Systems

27. Do you feel that the annunciator tiles are properly and consistently labeled and easy to read?

YES (Good Labeling And Easy To Read) ☐

NO (Undesirable Labeling Or Difficult To Read) ☐

STP Annunciator Warning Systems

28. Under normal operating conditions, will all tiles be unlit?

YES (All Unlit During Normal Conditions) ☐

NO (Some Lit During Normal Conditions) ☐

STP Annunciator Warning Systems

29. Do you feel that controls to silence, acknowledge, reset, and test annunciators are satisfactory?

YES (All Controls Are Satisfactory) ☐

NO (Some Controls Are Unsatisfactory) ☐

STP Annunciator Warning Systems

30. Do you feel that the annunciator controls will be easy to use?

YES (Controls Will Be Easy To Use) ☐

NO (Some Controls Difficult To Use) ☐

STP Annunciator Warning Systems

31. Are the annunciator controls properly arranged and coded by color or shape?

YES (Controls Well-Arranged And Coded) ☐

NO (Controls Poorly Arranged Or Coded) ☐

STP Visual Displays

32. Do you feel that control room displays will present complete and accurate information concerning plant status?

YES (Complete And Accurate Information Displayed) ☐

NO (Incomplete Or Inaccurate Information) ☐

STP Visual Displays

33. Do you feel that it will be possible to easily differentiate between displayed demand and status information?

YES (Demand And Status Information Easily Differentiated) ☐

NO (Hard To Differentiate Demand From Status Information) ☐

STP Visual Displays

34. Will it be possible to easily identify failed displays?

YES (Failed Displays Easily Identified) ☐

NO (Difficult To Identify Failed Displays) ☐

STP Visual Displays

35. Do you feel that display scale graduations and numbers will permit operators to make readings of the precision required?

YES (Scale Graduations And Numbers Permit Sufficiently Precise Readings) ☐

NO (Scale Graduations Or Numbers Do Not Permit Sufficiently Precise Readings) ☐

STP Visual Displays

36. Will display values be immediately usable by the operator without requiring mental conversion?

YES (Values Are Immediately Usable) ☐

NO (Mental Conversion Required) ☐

STP Visual Displays

37. Do you feel that the STP displays will be easy to read and interpret?

YES (Easy To Read And Interpret) ☐

NO (Difficult To Read Or Interpret) ☐

Visual Displays

38. Do you feel that the chart recorders will produce information that is easy to interpret and use?

YES (Information Easy To Interpret And Use) ☐

NO (Information Difficult To Interpret Or Use) ☐

STP Visual Displays

39. Does the overall design of the chart recorders (paper, pens, scales, etc.) make them easy to read and use?

YES (Recorders Easy To Read And Use) ☐

NO (Recorders Difficult To Read Or Use) ☐

STP Visual Displays

40. Do you feel that the drum counters are well-designed, and easy to read and interpret?

YES (Drum Counters Well-Designed, Easy To Read And Interpret) ☐

NO (Drum Counters Poorly Designed, Hard To Read Or Interpret) ☐

STP Labels and Location Aids

41. Are controls, displays, and other equipment clearly and accurately labeled?

YES (Labeling Is Clear And Accurate) ☐

NO (Labeling Is Unclear Or Inaccurate) ☐

STP Labels and Location Aids

42. Are labels for major systems and components clearly distinguished from all other labels?

YES (Major Labels Are Distinctive) ☐

NO (Major Labels Are Not Distinctive) ☐

STP Labels and Location Aids

43. Are subordinate labels used to identify subsystems?

YES (Subordinate Labels Used) ☐

NO (Subordinate Labels Not Used) ☐

STP Labels and Locations Aids

44. Are all letters and numbers used in the labels distinct, clearly visible, and easy to read?

YES (Label Characters Are Clear And Easy To Read) ☐

NO (Label Characters Are Hard To Read) ☐

STP Labels and Location Aids

45. NUREG 0700 recommends that labels be located above the panel elements they represent. Is this practice followed for the STP panels?

YES (Labels Are Consistently Located Above Panel Elements) ☐

NO (Labels Are Inconsistently Located) ☐

STP Labels and Location Aids

46. Are all labels placed close to the panel elements they represent?

YES (Label-Panel Element Relations ips Easily Seen) ☐

NO (Some Label-Panel Element Relationships Unclear) ☐

STP Labels and Location Aids

47. Are control labels located such that they will not be covered up when the control is operated?

YES (Labels Will Be Visible) ☐

NO (Some Labels Will Be Covered Up) ☐

STP Labels and Location Aids

48. Are labels separated such that they are not read as one continuous label?

YES (Label Separation Is Good) ☐

NO (Some Labels Not Sufficiently Separated) ☐

STP Labels and Location Aids

49. Are all labels oriented horizontally?

YES (Labels Are Horizontally Oriented) ☐

NO (Some Labels Are Vertically Oriented) ☐

STP Labels and Location Aids

50. Do all labels describe the functions of the equipment items they represent?

YES (Labels Depict Functions) ☐

NO (Some Labels Do Not Depict Functions) ☐

STP Labels and Location Aids

51. Are all label instructions clear, precise, easily understood, and consistent across equipment?

YES (Label Instructions Are Clear And Consistent) ☐

NO (Some Label Instructions Are Unclear Or Inconsistent) ☐

STP Labels and Location Aids

52. Are functionally grouped displays or controls properly labeled?

YES (Functional Groupings Properly Labeled) ☐

NO (Functional Groupings Unlabeled Or Poorly Labeled) ☐

STP Labels and Location Aids

53. Are all functional control positions identified?

YES (All Control Positions Are Identified) ☐

NO (Some Control Positions Are Not Identified) ☐

STP Labels and Location Aids

54. Will the use of temporary labels be administratively controlled?

YES (Temporary Labels Administratively Controlled) ☐

NO (Temporary Labels Not Administratively Controlled) ☐

STP Labels and Location Aids

55. Will the use of temporary labels be subject to review procedures?

YES (Temporary Labels Subject To Review Procedures) ☐

NO (Temporary Labels Not Subject To Review Procedures) ☐

STP Labels and Location Aids

56. Do you feel that demarcation is adequate?

YES (Demarcation Is Good) ☐

NO (Demarcation Undesirable) ☐

STP Labels and Location Aids

57. Are the mimics properly laid out and color coded?

YES (Mimics Well Laid Out And Color Coded) ☐

NO (Mimics Poorly Laid Out Or Color Coded) ☐

STP Process Computers

58. Do you feel that the data entry keyboards are well-designed and will they be easy to use?

YES (Keyboards Well-Designed And Easy To Use) ☐

NO (Keyboards Poorly Designed Or Hard To Use) ☐

STP Process Computers

59. Do you feel that the CRTs are located in comfortable and convenient viewing locations on the panels?

YES (CRTs Are Well Located) ☐

NO (CRTs Are Not Well Located) ☐

STP Panel Layout and Integration

60. Do you feel that the panels are effectively designed with respect to the overall layout of controls, displays and other equipment?

YES (Overall Panel Layout Is Effective) ☐

NO (Overall Panel Layout Could Be Improved) ☐

STP Panel Layout and Integration

61. Are controls and displays that are used together grouped together or otherwise logically arranged?

YES (Logical Grouping Or Arrangement) ☐

NO (Illogical Grouping Or Arrangement) ☐

STP Panel Layout and Integration

62. Are frequently used controls (and displays) located such that they are easy to operate and monitor?

YES (Optimal Locations For Frequently Used Controls And Displays) ☐

NO (Some Frequently Used Controls Or Displays Poorly Located) ☐

STP Panel Layout and Integration

63. Are functional groups of panel components arranged consistently from one panel to another?

YES (Consistent Arrangement Of Functional Groups) ☐

NO (Inconsistent Arrangement Of Functional Groups) ☐

STP Panel Layout and Integration

64. Is the physical spacing among controls sufficient to permit access to any one of them without accidentally operating another?

YES (Physical Spacing Is Adequate) ☐

NO (In Some Cases, Physical Spacing Is Inadequate) ☐

STP Panel Layout and Integration

65. Are controls located below their corresponding displays?

YES (All Controls Are Below Corresponding Displays) ☐

NO (Some Controls Are Above Corresponding Displays) ☐

STP Panel Layout and Integration

66. Does the overall panel layout clearly show relationships among systems and subsystems?

YES (Systems-Subsystems Relationships Clearly Shown) ☐

NO (Systems-Subsystems Relationships Unclear) ☐

APPENDIX B

FOLLOWUP SUPERVISOR/OPERATOR

INTERVIEW

INTERVIEW

OPERATING GENERAL SUPERVISOR

SHIFT AND UNIT SUPERVISORS

1. Based on your experience with related plants, what are the strengths and problems with the following STP control room characteristics:

Workspace

a. Strengths

Workspace

b. Problems

Annunciators

a. Strengths

Annunciators

b. Problems

Controls

a. Strengths

Controls

b. Problems

Displays

a. Strengths

Displays

b. Problems

Labels and Location Aids

a. Strengths

Labels and Location Aids

b. Problems

Panel Layout

a. Strengths

Panel Layout

b. Problems

Control-Display Integration

a. Strengths

Control-Display Integration

b. Problems

2. How safe and efficient are the following control room characteristics?

Workspace

Annunciators

Controls

Displays

Labels and Location Aids

Panel Layout

Control-Display Integration

3. What do you like and dislike about the physical characteristics of the control room?

Likes

Dislikes

4. What do you like and dislike about the procedures to be used in the control room?

Likes

Dislikes

5. Describe the overall projected control room complex in terms of comfort and convenience.

6. What techniques or procedures could be used to improve overall plant control?

7. What are the responsibilities of the following operations personnel during an emergency condition (e.g. LOCA)?

a. Operating General Supervisor

b. Unit Supervisor

c. Senior Reactor Operator

d. Reactor Operators

e. Auxiliary Operators

8. Are overall job requirements of the various operations personnel realistic? If not, explain.

9. What do you think of STP's projected management and administrative policies?

10. What do you like and dislike about STP training programs? How can training be improved?

11. Describe the projected relationship among operational personnel, maintenance personnel, and other workers. What are the potential strengths and problems relative to plant safety and efficiency?

12. How convenient will it be to replace chart recorder paper and indicator bulbs?

13. What do you think of the annunciator warning system?

14. What characteristics should the Safety Parameter Display System (SPDS) have to aid in rapid recovery from emergency conditions?

15. Describe a well-designed remote shutdown panel. What factors should be considered in its design? How should panel components be arranged? Where should the panel be located?

INTERVIEW

SENIOR REACTOR OPERATORS

REACTOR OPERATORS

1. Based on your experience with related plants, what are the strengths and problems with the following STP control room characteristics:

Workspace

a. Strengths

Workspace

b. Problems

Annunciators

a. Strengths

Annunciators

b. Problems

Controls

a. Strengths

Controls

b. Problems

Displays

a. Strengths

Displays

b. Problems

Labels and Location Aids

a. Strengths

Labels and Location Aids

b. Problems

Panel Layout

a. Strengths

Panel Layout

b. Problems

Control-Display Integration

a. Strengths

Control-Display Integration

b. Problems

2. How safe and efficient are the following control room characteristics?

Workspace

Annunciators

Controls

Displays

Labels and Location Aids

Panel Layout

Control-Display Integration

3. What do you like and dislike about the physical characteristics of the control room?

Likes

Control Room Characteristics

Dislikes

4. What do you like and dislike about the procedures to be used in the control room?

Likes

Procedures

Dislikes

5. Describe the overall projected control room complex in terms of comfort and convenience.

6. What techniques or procedures could be used to improve overall plant control?

7. Are your job requirements realistic? How could they be improved?

8. What do you think of STP's training programs?

9. Do you anticipate any problems in handling emergencies given the projected control room design? What are they?

10. What is your role during an emergency (e.g. LOCA)?

11. How is your time divided in the control room in terms of sitting, standing, monitoring, operating controls, making decisions, etc?

12. What do you think of the overall layout and design of the STP panels?

13. How easy will it be to replace chart recorder paper and indication bulbs?

14. What do you think of the annunciator warning system?

15. What characteristics should the Safety Parameter Display System (SPDS) have? Where should it be located and how should it be arranged?

16. What characteristics should the remote panel shutdown have? What factors should be considered in its design? How should panel components be arranged? Where should the panel be located?

Control Room Design Review

Criteria Report

The South Texas Project

HOUSTON LIGHTING & POWER COMPANY