PALISADES NUCLEAR PLANT
CONTROL ROOM HUMAN FACTORS REVIEW
SUMMARY REPORT

AUGUST 15, 1986

PALISADES NUCLEAR PLANT
CONTROL ROOM HUMAN FACTORS REVIEW SUMMARY REPORT
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I. INTRODUCTION

The Palisades Nuclear Plant is a Combustion Engineering designed, pressurized water reactor located on Lake Michigan near Covert, Michigan. It was designed and built in the late 1960's and was placed in operation in 1971. Its early operating availability record was not particularly good, largely because of equipment failures rather than operator errors. However, subsequently the availability has improved and there is little evidence of serious human factors problems. Because Palisades is a relatively old plant, many members of the control room operating staff have a great deal of operating experience.

Consumers Power initiated a detailed control room review effort in late 1980. A full scale mockup was constructed and the review effort, including the initial walkthroughs of procedures, were begun in 1981. After the requirements for a program plan were issued by the NRC, a program plan (Reference 1) was prepared and forwarded to the NRC in early 1982. In late 1983 and early 1984 the main console and back panels in the control room were relabeled. In 1986 the majority of the other panels were relabeled.

The NRC staff reviewed the Program Plan for the control room review in late 1983 and a meeting was held with the NRC staff in February 1984 to review CPCo response to the NRC comments. At that meeting the large amount of completed review work, the completed portions of the relabeling and demaration, and other completed and planned corrective action were reviewed with the NRC. As a result of this meeting no major changes in the review program were made except that CPCo agreed to perform an additional, formal function and task analysis to supplement the numerous walkthroughs of procedures which had aleady been completed. The results of this function and task analysis are reported separately as Appendix F.

This report summarizes the results of the detailed control room design review and describes the organization and approach used (Section II). The report summary (Section III) outlines the major findings of the review. Following the summary, the report discusses the individual findings in detail in Sections IV and V. The assessment of each finding is presented in Section VI. Where appropriate, the schedule

for completion of modifications to correct human factors deficiencies is also presented in Section VI or in the various appendices.

The findings are presented in terms of comparison to the guidelines which are given in Appendix A. These findings are divided into:

(1) operational review findings (Section IV), e.g., comparison to operational guidelines, review of operator's responsibilities, and the results of procedure walk-throughs, and

(2) human engineering findings (Section V), e.g., detailed reviews of panels, alarms, and environment.

The report includes appendices for detailed information. In addition to the guidelines, the appendices include results of operator interviews and the results of environmental and emergency lighting surveys. The human factors review of the Remote Shutdown Panel (C-33), which is not in the control room, and Panel C11A, which was added to the control room, are covered by self-contained appendices.

The detailed function and task analysis of the emergency procedure guidelines is described and the major results summarized as a self-contained appendix.

II. APPROACH

A. Management And Staffing

The performance of the human factors review was the responsibility of a team made up of personnel from Consumers Power (both engineering and operations), MPR Associates, and an independent outside consultant, Dr. T. B. Sheridan of the Massachusetts Institute of Technology (MIT). The responsibility and functions of the members of the team are described below; resumes are included in Appendix E of this report.

MPR Associates, Inc.

MPR was responsible to provide the major portion of the detail management and review effort. This included providing the full scale mock-up and control room drawings, conducting the procedure walk-throughs, interviewing operators, comparing the control room to the detail guidelines, coordinating the identification and assessment of the human engineering discrepancies, and establishing potential modifications. For this purpose MPR assembled a working group consisting of Messrs. H. Estrada, D. H. Harrison, J. Hibbard, C. Schlaseman and A. Zarechnak, with supporting services such as drafting. It was augmented by other MPR staff personnel where special skills or experience were required.

Consumers Power Company

Plant operations was initially represented on the review team by Mr. W. S. Skibitsky, Operations Superintendent and holder of a senior reactor operators license at the Palisades Plant until late 1982. He participated in planning, reviewing results, and ensured that plant operators' input was provided. Beginning in early 1983 Mr. C. Kozup replaced Mr. Skibitsky as Operations Superintendent and member of the review team. Mr. Kozup also participated in assessing the findings and identifying potential modifications. Individual licensed operators participated in several aspects of the review including for example the procedure walk-throughs, environmental survey, and review of operating experience.

Engineering was represented on the review team by four individuals: Mr. R. L. Muzzi from the plant engineering staff and Messrs. R. R. Biggs, and K. A. Toner from the general office engineering staff. In early 1985 Mr. Muzzi left the plant staff and was replaced by Mr. R. M. Hamm. Messrs. Muzzi, Skibitsky, Biggs and Toner participated in the planning, reviewing results, assessing findings, and identifying potential solutions. They also assured that engineering input from various sources was incorporated. This included other ongoing plant modifications and obtaining necessary information from the architect-engineer and other contractors to Consumers Power. Messrs Muzzi, Biggs, Toner, and Hamm participated in the Consumer's Power Human Factors Training Seminar in January, 1982.

The detailed function and task analysis based on the emergency procedure guidelines was prepared by Consumers Power engineering and operations staff. MPR personnel reviewed this analysis and then reviewed the evaluation and the suitability from a human factors viewpoint of the control room equipment to carry out the defined tasks. The staff, methodology, and results of the task analysis are described in Appendix F.

Outside Consultant

Dr. T. B. Sheridan, professor of engineering and applied psychology at MIT provided the review team with assistance and participation in the human factors aspects of the review: methodology, interpretation of guidelines, review of environmental survey, review of control room and control panels, interviews with control room operators, assessment of human engineering discrepancies, and evaluation of potential improvements.

B. Information Sources

The Palisades Nuclear Plant has been operating since 1971. Consequently its operating procedures were considered to be a relatively accurate representation of how the plant was operated. These operating procedures were, therefore, the primary source of information for control room operator activities.

In addition to these procedures, other sources of information which were used in the control room review included:

- plant piping and instrumentation drawings and electrical diagrams,
- operator training manuals and other training material,
- the Final Safety Analysis Report and the plant technical specifications,
- drawings of the control room and the control panels,
- licensee event reports and internal plant reports on reactor trips and other events, and
- plant logs.

In addition, the review team had access to the plant operators through interviews and participation in the walk-throughs. Access was also provided to other members of the plant staff - operations, maintenance, and engineering. The review team was provided access to the actual control room as appropriate for photographs of control panels, surveys, special observations, and specific questions subject to the normal constraints on control room access exercised by the Shift Supervisor.

C. Review Processes

The objectives of the Palisades control room review were the same as those stated in NUREG-0700 (Reference 3):

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

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

The review processes used in the review of the Palisades control room are described below. The methodology differs somewhat in its organization from the methodology described in NUREG-0700; but each element of a thorough human factors review is covered. Figure II-1 shows how the review processes described in NUREG-0700 were covered by the Palisades review processes described below. It should be noted that the separate items described below were not in a time sequence and portions of the various processes took place in parallel.

1. <u>Review of Operating Experience</u>

   The objective of the review of operating experience was to make sure that problems actually encountered in operation of the Palisades plant were identified and factored into the review of the control room.

   A most useful source of information on operating experience was the detailed comments, solicited as well as unsolicited, from the operating staff in the course of the walk-throughs and talk-throughs on the control-room mock-up.

   A formal survey of control room operators was also conducted. The objective of this survey is to identify problems and strengths of the control room that have been noted by the control room operators in the course of operations. Questions were based on a written questionnaire and interview protocol prepared beforehand and agreed to by the Review Team. The recommendations for protocol and interview questions listed in Appendix C to NUREG-0700 served as one of the inputs to this questionnaire. Additional walk-throughs were identified to investigate further any significant problems which were identified during these interviews.

   Operations staff with a range of experience was involved. The interviews were conducted by personnel on the review team who are not members of Consumers Power Company: Dr. T. Sheridan, Dr. D. Harrison and A. Zarechnak. The personnel conducting the operator interviews had previously participated in other aspects of the Palisades control room review and in that process had already established cooperative professional

relationships with the control room operators. In the course of the interviews the control room operators answered freely and volunteered detailed technical examples of specific operator concerns. Results of the operator survey are documented in Appendix B.

The review of experience also included a review of the Licensee Event Reports, the Nuclear Power Experience summaries, operator's logs, and discussions with plant maintenance personnel.

2. Inventory of Control Room Instrumentation and Equipment

The objective of the control room inventory was to identify all instrumentation, controls and equipment within the control room. All components with which the operators interface were included in the inventory.

In the Palisades control room review, the construction of a full-scale mock-up of all main control room panels (including annunciator alarms) used by the operators was part of the inventory process. The displays and controls for the mock-up panels were reproduced by a combination of photographic and Xerox reproductions of a grid work of high quality photographs.

The actual inventory was contained in a complete set of reproducible drawings of the control panels based on the same photographs used for the mock-up. The drawings and the mock-up allowed identification and review of the panel components without disruption of control room activities. In the course of the review some modifications were made to the control room. The drawings and the full-scale mock-up were revised to incorporate these changes.

On the basis of the drawings and mock-up, special tabular listings of controls and displays were generated and used in the process of making comparisons of specific detailed human factors guidelines. These special listings were used, for example, for verification of the adequacy of the scale ranges of meters.

3. <u>Detailed Review of Control Room Components and Environmental Survey</u>

The objective of the control room component review was to identify any characteristics of instruments, equipment, layout and ambient conditions that did not conform to good human engineering practice. The review was performed in three stages: the detailed control panel review, the alarm review, and the environmental survey, as described below:

a. <u>Panel review</u>

This included review of the following:

- controls,
- displays,
- process computers,
- panel layout including anthropometric considerations, and
- control/display relations.

b. <u>Alarm system review</u>

This included review of the following:

- selection of alarms and
- presentation (human factors) of alarms.

c. <u>Environmental survey</u>

This included review of the following:

- overall ambient conditions, including temperature, humidity, and ventilation;
- lighting levels;
- sound levels;
- control room workspace;
- communications;

- emergency equipment and clothing; and
- administrative practices such as transfer of information during operator shift changes, control of key-lock switches, etc.

The control panel, alarm system and environmental conditions surveyed were compared to detailed human engineering guidelines prepared for the Palisades control room. These guidelines were developed before the guidelines of NUREG-0700 were available and are presented in Appendix A. After corrective actions have been defined, the control room as it will be with those improvements was compared to the detailed human factors guidelines in Section 6 of NUREG-0700. This provided a cross check that all important factors had been addressed and that no significant human factors problems had been overlooked.

4. <u>Review Based on Operator Responsibilities</u>

The responsibilities of the control room operators at Palisades, divorced from any specific event, were identified. These responsibilities are listed in the review guidelines (Appendix A, Part II.A.) It should be noted that each operator responsibility involves a number of tasks and each task in turn may require the operator to take a number of specific actions.

The detailed manner, i.e., the specific actions by which each of these operator responsibilities is discharged in the Palisades control room, was reviewed. This process established the display and control requirements for each general operator responsibility (e.g. control of secondary water inventory) which may not be obvious from analysis of particular operating events or from existing plant procedures. These requirements were compared to the existing instrumentation.

This effort was in addition to the separate function and task analysis of emergency procedures described in Section II.C.6, below, and in Appendix F.

5. Review Based on Existing Plant Procedures and Walkthrough of Expected Operational Evolutions and Postulated Off Normal Events

A set of operational evolutions was selected for analysis of operator actions. These included:

Normal Operational Evolutions

- heatup and startup,
- shutdown and cooldown,
- operation at power (including automatic and manual operations of reactor, steam generator and main turbine),
- refueling,

Transient and Emergency

- reactor and turbine trips from a variety of mechanistic causes,
- primary coolant leaks small enough so that the charging system can maintain coolant inventory,
- primary coolant leaks too large for normal charging system makeup (including transients leading to core conditions with inadequate core cooling or core degradation),
- various size secondary system leaks within the makeup capability and exceeding the make-up capability,
- loss of feedwater flow,
- various losses of off-site and on-site power (including losses of instrumentation power sources),
- loss of instrumentation air, and
- postulated failures of systems and components (such as the main steam isolation valves, steam generator tube ruptures, safety valves, etc).

For each of the normal evolutions qualified Palisades operating personnel performed the simulated operations on the mock-up using the appropriate plant operating procedures with the evaluations being performed by the review team. A talk-through technique was generally used in these procedure walk-throughs. On the basis of the information obtained from the walk-throughs, operator tasks were identified for each of the evolutions considered. These walk-throughs also served to familiarize the review team members with the Palisades Plant.

A similar approach was followed at the mock-up for the emergency and abnormal events with the following exceptions: The analysis of these events was initiated by postulating a set of symptoms consistent with a possible plant condition, including system or component malfunctions. The symptoms were in the nature of specific meter readings, alarms, noises, etc. and were presented (described) to the operators. For example, one walk-through postulated a sequential loss of primary coolant pump seals resulting in a small loss-of-coolant accident (LOCA). Initial symptoms included an intermediate seal pressure oscillating with an amplitude of 700 psi, and a seal high temperature alarm. Subsequently, the leakage flow increased beyond the capability of the charging pumps, the primary pressure dropped, and the radwaste panel alarm came on. Responding to the stated symptoms, the operator then made a determination of what specific event was in progress, and which (if any) plant procedures were applicable to the perceived event. The operator, if he wished, asked for information on the readings of other meters and the status of other indicators. In the postulated small LOCA discussed above, if the operator asked, he was told that the level in the reactor coolant drain tank was rising. For some events, additional symptoms were presented to the operator, consistent with the postulated event. In this way, information was elicited regarding the actual operator tasks including the displays which the operator used to diagnose a problem, initiate a course of action and confirm the results of his action.

Toward the latter part of the human factor control room review a complete full-size active simulator of the Palisades control room was completed for the purpose of training control room operators. This simulator was used in lieu of the original (passive) mock-up to conduct the latter walk-throughs including electrical upsets and instrument air malfunctions. During these walk-throughs special attention was paid to the ability of the operator to diagnose complex malfunctions in "real time" and respond properly.

The plant normal and emergency procedures define a set of control and display requirements. These control and display requirements were compared to existing instrumentation and any discrepancies were documented, utilizing appropriate criteria. These criteria include consideration of questions such as:

- Is required input information available?
- Is required equipment, e.g., controls, tools, charts, lists, communication links, etc. available?
- Is this task physically and mentally practical to perform? For example, is control too high to reach easily or does operator need to have memorized too much information?
- Is required system response indication available?
- Is required component response indication available?
- Does this task conflict with other control room operations in progress?
- Are there potential errors in this task which have serious consequences?
- Would a simultaneous fire or medical emergency have a serious impact on this task?

- Do controls and displays used in this task meet appropriate human factors guidelines, e.g., control/display relationships, display units, label/procedure nomenclature consistency?

- Is manning level consistent with the assignment of responsibilities for this task?

As a result of the walk-throughs, those tasks which were difficult to perform were identified. The review team then determined the course of action for further more detailed evaluation of the particular task involved.

An additional function of the walk-throughs was to compare the nomenclature of control console and panel labeling with that of plant procedures and appropriate piping and instrumentation schematic diagrams. Where discrepancies were found, appropriate changes to console labeling, diagrams, or procedures were recommended.

6. Function and Task Analysis of Emergency Procedure Guidelines

A detailed function and task analysis of the generic Emergency Procedure Guidelines (Reference 2) was conducted by Consumers Power Engineering and Operations staff. The results were independently reviewed by MPR. MPR also performed a detailed evaluation of the human factors of the control room equipment used to perform the defined tasks. This function and task analysis and its interrelation with the detailed control room design review is described in Appendix F.

In addition, new emergency operating procedures are being developed by CPCo operations personnel which use the results of the function and task analysis as a reference. This effort is not part of the detailed control room design review; however, personnel from the human factors review team observed the operators in the Palisades simulator when the revised emergency procedures were validated.

7. Documentation of Review Data

During each phase of the control room review, data were recorded in the form most convenient to the particular task to minimize the fraction of the review effort which was devoted to assembling, programming, recording, and storing data on deficiencies. Emphasis was placed on using existing documents, for example, copies of the guidelines or procedures, marked up to record problems as they were observed. Special forms were used, however, in some instances to record data. These initial notes and raw data were further consolidated so that generic problems were identified.

For example, the control room survey was performed in a systematic panel-by-panel sequence. Individual copies of the human factors guidelines were made for each panel. Each specific guideline was applied to each individual display and control on the panel being reviewed; each guideline was marked as being met or not met for the panel being reviewed. If practical, guideline discrepancies were documented next to the specific guideline being applied; when necessry detailed lists were generated which documented all instances of deviations from the specific guidelines. In this manner defficiences which were generic to the control room, i.e. appeared for many components, were easily compiled and resolution of such discrepancies could often be addressed in a systematic manner on a control room-wide basis. The results of this compilation of deviations from a specific guideline are included in the tables in Section VI of this report.

All discrepancies are documented and discussed in this control room review report. Detailed tables in Section VI of this report or in the appendices identify each discrepancy and document its resolution.

Examples of specific types of documentation which were used are as follows:

- Copies of the detailed human factors guidelines were used to record compliance with specific guidelines and to identify instances where guidelines are not met.

- Tables were prepared for findings that are generic, i.e. for multiple, similar departures from a single guideline.

- Tabular listings of controls or displays were used to evaluate certain attributes such as units and ranges on displays and position indications for valve switches.

- Drawings of the control room panels were produced from detailed photographs of the existing control room and are used as part of the record of the control room inventory.

- Copies of procedures were marked up to keep notes on walk-through observations. These are augmented by collected notes after a walk-through session. These data are further reviewed and evaluated to identify particular problems.

- Forms for recording control room light measurements and sound measurements were prepared to plan the data taking, minimize the disruption of the control room, and used to document these measurements.

- Control room operator survey forms were prepared and used in conducting interviews with the control room operating staff.

PALISADES REVIEW PROCESSES	NUREG-0700 REVIEW PROCESSES 1. REVIEW OF OPERATING EXPERIENCE	2. REVIEW OF SYSTEM FUNCTIONS & OPERATOR TASKS	3. CONTROL ROOM INVENTORY	4. CONTROL ROOM SURVEY	5. VERIFICATION OF TASK PERFORMANCE	6. VALIDATION OF CONTROL ROOM FUNCTIONS
1. REVIEW OF OPERATING EXPRIENCE	X					
2. CONTROL ROOM INVENTORY (MOCKUP & DRAWINGS)			X			
3. DETAIL REVIEW (PANEL, ALARMS, & ENVIRONMENT)				X		
4. REVIEW BASED ON OPERATOR RESPONSIBILITIES		X			X	
5. REVIEW BASED ON PLANT PROCEDURES AND WALK-THROUGHS		X			X	X
6. FUNCTION AND TASK ANALYSIS		X			X	X
7. DOCUMENTATION OF REVIEW DATA	X	X	X	X	X	X

FIGURE II-1

COMPARISON OF PALISADES REVIEW PROCESSES
TO NUREG-0700 REVIEW PROCESSES

III. SUMMARY OF MAJOR FINDINGS

This section summarizes the major findings of the detailed control room review. This summary groups the findings generically wherever practical; more detailed discussions of specific shortcomings are found in Sections IV, V and Appendices B and C. The purpose of this section is to give an overview of the results of the review and the major approaches which are available for the correction of its human factors shortcomings. All these findings and the recommended specific corrective actions are summarized in tabular form in Section VI of this report except those in Appendices D, F, G, and H.

A. Strengths of the Present Control Room

This section describes those features of the Palisades control room which appear to contribute strongly to good human factors in the plant's operation. They are not absolute in the sense there are instances where the strong feature is not carried through in some details. However, they represent overall features and approaches where the basic Palisades control room design is particularly sound, and should be preserved.

1. Locations of Major Groups of Controls and Displays

The control room separates the major groups of related controls and displays into areas which allow effective operation. For example, reactivity control, primary system inventory, safety injection, steam system, turbine-generator, service systems, and electrical distribution are alloted more-or-less separate areas. The normal manning (two control room operators) and the division of responsibility between these two operators appear to match satisfactorily with the locations of these groups of controls.

2. Overall Room Layout

The Palisades control room is relatively compact, quiet, and adequately lighted. There are no large amounts of extraneous equipment or traffic. The shift supervisor has direct access to the control room operators. He can see and hear the activity in the control room; visitors to the shift supervisor do not have to enter the control room.

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3. Main Alarm System

The main alarm system, for the most part, is well located with respect to the related controls and displays and the alarms for individual systems are presented in orderly groups. It has a manageable number of alarms, has some prioritization by color, and, is designed to be "dark" at power. The main audio alarm (a chime) is effective and the acknowledgement scheme does not have a large potential for missing a new alarm or inadvertent acknowledgement.

4. Indication of "Normal" Status

The Palisades control room includes a system to identify for the control operator the component status which is defined as "normal" for power operation. This is accomplished by distinctive black dots (about a quarter inch in diameter) which are applied to the console adjacent to indicator lights or switch positions. The operator can see at a glance by scanning the console whether his status is "normal". This system is particularly valuable in shift turnover.

5. Control Types

In almost all instances the type of control used to operate a valve is different from a control used to operate an electrical breaker, e.g., turn on a pump. The operator, therefore, has significantly less potential to confuse controls. In at least two instances the plant staff has taken steps to further avoid confusion among important controls or displays: the primary coolant pump switch handles have been painted yellow and the bezels of the electrical meters for the vital power (bus 1C and 1D) on panel C04 have been painted red.

6. Active Full Size Simulator

A full size high fidelity active simulator of the Palisades control room has been built and is being used for operator training, evaluating operator and plant response to off-normal conditions and for evaluating human engineering discrepancies and improvements.

B. Generic Shortcomings of the Present Control Room

This section of the review report describes those shortcomings of the control room which can be grouped generically, either because they are an overall control room problem or because they occur often on the console and panels. Obviously many of these "generic" problems are actually individual problems, each of which has various degrees of importance when judged against the consequences of the error which could result. These problems are grouped generically, when possible, to make it simpler to define a consistent approach to improvements or corrective action.

1. Local Arrangement

Although, as discussed above, the major related groups of controls and displays are located sensibly, within those major groups there are many instances where the local arrangement is difficult for the operator to work with. In some cases it appears that modifications or additions to the console and panels have resulted in separation of related controls and displays. Electrical separation has also contributed to some of the fragmented subgroups. Examples and tabulations of these local arrangement problems are discussed in Sections V.B.1 and V.C.1.

Corrective action has included using relabeling and demarcation to assist the operators to identify related controls and displays. A limited color code for demarcation lines of specific functional groups has been instituted: specifically orange for high pressure safety injection, black for auxiliary feed water, blue for service water, green for component cooling water and red for emergency functions such as fire and trips. Also, some moves of components have been made and others are planned.

2. Backpanel Displays

The main control console at Palisades (C01, C02, and C03) is separated from its associated backpanels (C11, C12, and C13) by an aisle which is about 30 inches wide. This aisle allows access to the controls on the backpanel and access to the back of the main console. As a result of the aisle arrangement the operator in front of the

main console is approximately 7 feet from the backpanel. Leaning over the console can reduce this distance but not without some risk of inadvertent actuation of controls on the main console.

This distance is too great to read reliably the labels on most of the controls and displays on the backpanel. For certain operations, the operator needs to get panel information from the backpanel while he is in front of the console, e.g., trends on a recorder, approximate meter position, relation of a meter pointer to an alarm marker, and indicator light status. It appears that the operator can make these observations; however, to do them from the front of the console the operator must memorize the position of a display since its identifying label is not legible. In some cases this poses no particular problem because the display is unique or easily identified, e.g., steam generator level recorders; however, in many others, particularly groups of similar displays, the operator may be forced to lean far over the console or leave his normal station and go behind the console if he has doubts as to whether he is consulting the proper display.

Corrective action has included relabeling and providing locating aids for the operators, such as outlines, larger labels and group labels, etc., so the identification of the displays on the backpanel can be made reliably by an operator standing in front of the main console.

3. Labeling and Demarcation

The control room consoles typically use black labels with white letters for individual controls and displays. Demarcation for functional groupings is not used. Specific weaknesses of the existing labeling are listed in Tables VI-8 through VI-14 and are discussed in Section V of this report. These weaknesses include inconsistent nomenclature and abbreviations, unclear labels, missing or temporary labels and labels with missing identifying numbers.

A systematic relabeling and demarcation of the control room panels has corrected essentially all of these weaknesses.

4. Color Coding in Lights and Labels

The Palisades control room consistently uses red and green lights in the same manner as conventional power station practice: red indicates "on" or electric current or fluid flowing, green indicates "off" or electric current or fluid stopped. This is consistent with the original Consumer Power Company Plant Design Guide (Reference 4 which has more recently been recalled). Beyond this, however, colors of indication and status lights may have several different meanings, i.e., the meaning of white, yellow, blue lights are inconsistent. There are also some uses of red and green lights which do not have the usual meaning.

A code for color of lights has been established which is consistent with the Consumers Power Plant Design Guide (Reference 4). The control room lights' colors will be modified where practical to comply with the color code. Where lights cannot be changed, labeling has been added to assure the meaning is unambiguous.

The Palisades Control Room uses predominately black labels with white engraved letters. The white letters tend to become filled with dirt and, therefore, become illegible. In addition, the original labeling makes differentiation difficult between those plates which name the control and display and those which provide secondary information such as a instrument or switch designation or general information. The current labels also do not help the operators identify the small number of emergency or critical controls or displays. Both yellow and red warning label are used.

This deficiency has been corrected by using a consistent label color code to distinguish among the various label types. The following is the color code for label plates:

- Identification labels are white labels with black letters.

- Identification labels for a small number of critical controls such as safety injection and trip buttons are white labels with red letters.

- Caution labels are yellow with black letters.

- Information of a reference nature is provided on black labels with white letters.

- Labels used for identifying hand switch numbers for controls and instrument numbers for displays are small labels of a distinctive, but unobtrusive color, i.e. light brown with dark brown letters.

5. <u>Meter Scales</u>

Although most of the meter scales in the Palisades control room are easy to use, a number of specific weaknesses appear and are listed in Tables VI-17 through VI-20 and VI-22 and are discussed in Section V. These include instance of undesirable scale divisions, unidentified units and setpoints and inadequate scale ranges.

Each of these instances has been evaluated on a case basis and corrective action identified in Section VI of this report.

6. <u>Alarm Legend Readability</u>

The basic sizes of the legends on the main alarm windows (0.20 to 0.25 inch) are barely adequate to permit reliable reading by an operator of normal eyesight when standing at the front edge of the main console directly in front of the particular panel which is alarming. If the operator does not "remember" the alarm position, he is forced to go to that area of the console when the alarm comes in. Although this is quite often close to where he needs to be to take action, it does not permit him to make any judgement as to what is happening without leaving his current position if he has not memorized the position of the alarming window.

It should be noted that quite often in a serious upset of the plant, the regular control room operators will be heavily occupied by the regular controls and displays on the console and

backpanels. Consequently, the shift supervisor, who will probably have entered the control room, is the one most likely to have the time and the necessary experience to assess the meaning of the main alarm panel. In particular, he would be likely to spot the unusual alarm which could be the signal that the event was not routine, if he could reliably read the alarm tiles as he enters the control room.

Palisades is planning to conduct and to complete by December 1987 a review of the entire alarm system using the methods similar to those described in Reference EPRI-NP-3448. The alarm tile readability will be improved as part of that overall alarm review process.

7. <u>Non-Functioning Alarms</u>

When an alarm is not functioning the alarm window is tagged with a small yellow adhesive tag. However, in some cases the non-functioning window is lighted and in a few cases the non-functioning window flashes. These lighted windows confuse the operator and tend to mask the actual alarm situation. Furthermore the operator may mistake a real alarm for one of the tagged, but lighted alarms, and consequently ignore it.

C. <u>Specific Operational Shortcomings of the Present Control Room</u>

1. <u>Wide Range Measurement of Hot Leg Temperature</u>

Average primary coolant temperature is displayed on a digital indicator and recorders on panel C02. Individual hot leg and cold leg temperatures are displayed on meters on backpanel C12. These instruments also provide the input to the digital subcooling margin meter located on backpanel C12.

These instruments are narrow range; they do not read temperatures below about 515°F. As a consequence, none of these displays can be used to control reactor coolant temperature during cooldowns (normal or emergency).

Wide range cold leg temperature is displayed on a recorder on panel C12. No display of wide range hot leg temperature is available in the control

room; however, it may be needed during natural circulation. The only means available to the operator for determining hot leg temperatures below 515°F is to query the individual exit core thermocouples from the Primary Data Logger (PIP).

This deficiency will be corrected by providing wide range hot leg temperature indications to the operator and to the subcooled margin monitor.

2. <u>Steam Generator Control</u>

Control of steam generator water level is effected by the operators with main feed and auxiliary feed controls on panel C01. Water level meters are provided on C01 while the water level recorder is on backpanel C12.

Control of steam generator level at low power is the only task reported to be demanding by the operators. Specifically, transition from auxiliary feed flow to main feed flow can result in a rapidly rising water level unless the turbine demand is increased simultaneously. The primary cause of difficulty in maintaining water level at low power with main feed appears to be poor mechanical isolation of the feedwater regulating valves (CV-0701 and CV-0703) and the operational practice to keep the isolation valves (CV-0742 and CV-0744) open.

In addition, manual control of steam generator water level involves repetitive near-far seeing tasks; the operator uses the recorder on the backpanel for rate feedback to stabilize his response. Operators open the recorder door to obtain the necessary visibility and must leave their station at C01 and walk to the recorder to change recorder speeds or observe the level trends more closely.

The operators now get training of steam generator water level control at low power on the Palisades simulator.

3. <u>Control of Primary Coolant Inventory</u>

The operator can follow the inventory of the primary coolant under normal and accident conditions by knowing the levels (volumes) in

several vessels, tanks, and sumps (See Section IV.A.3) and the letdown and make-up flows. Although the levels for most of these vessels, tanks, and sumps are displayed in the control room, most are calibrated in percent and the operator has no means to integrate this level information to determine quickly whether there may be a small primary coolant leak.

4. Control of Liquid Inventory in the Steam Plant

The liquid inventory in the steam plant resides primarily in the steam generator, the feedwater heaters and drain tanks, the condenser hot well and the condensate storge tank. The levels for most of these are provided in the control room. However, these levels are usually in percent and do not allow the operator to easily track shifts in liquid inventory in order to identify small to moderate leaks in the steam plant.

5. Isolating Steam Dumps and Opening the Main Steam Isolation Valves

Very few plant evolutions require the control room operator to leave the control room. The following two exceptions are noted:

- opening the individual main steam isolation valves and

- isolating a stuck-open atmospheric steam dump.

It is Operation's policy to assign these tasks to an auxiliary operator.

6. Electrical Power Distribution

The C04 panel, which includes the majority of the inplant electrical distribution controls and displays as well as those for diesel generators, presents special difficulties for the control room operators. This panel appears to have a number of human factors problems; for example,

° The left side of the panel is not visible from the main console.

- The handles for some breakers are potentially subject to inadvertent actuation because of their location on a vertical panel in a narrow passageway.

- The operators have to perform a "flag matching" operation which has a high potential for error - see Section IV.A.5.a(5) for a detailed discussion.

- The meters are installed in a array which makes their relationships difficult to recognize quickly.

Based on walkthroughs of various electrical distribution upsets conducted at the Paliades' simulator the following difficulties were noted:

- Various losses of DC buses challenge the ability of the operators to control the plant; current procedural guidance and diagnostic assistance provided to the operators under loss of DC buses does not appear to be adequate.

- Several postulated losses of AC buses are difficult to diagnose quickly, partly because of multiple simultaneous alarm indications.

- Identification of powered/not powered status of various equipment is difficult under various losses of power; status indicating lights are sometimes powered by a different source than associated equipment.

D. Specific Human Factors Shortcomings of the Present Control Room

1. Visibility of Green and Blue Indicator Lamps

Both qualitative and quantitative evaluations have shown that many of the green and blue indicator lamps (GE square type R103C) are only marginally distinguishable as being illuminated. By leaning over and looking at a thin area in the front side of the molded plastic cap, the operator can tell if a light is on.

2. Failure Position of Sigma Meters

Some recently added edgewise panel meters (Sigma Instruments), although specially designed for the nuclear power industry (seismically qualified), operate in a different manner from the older visually similar Sigma meters. The "new" meters are stepping motor, servo-powered units which fail "as-is" when power to them is lost. The meter is provided with a green neon light which is illuminated when the power is on. The older and virtually identical appearing Sigma meters have more conventional movements and fail down-scale when power is lost.

In the long term a modified meter design could become available which would operate in a more conventional manner. For the short term, corrective action has been taken which insures that each of the new Sigma meters has an unpainted (aluminum) bezel so that the operators can tell at-a-glance whether it should have a power-on light.

3. Heating, Ventilation and Air Conditioning of the Control Room

A number of significant problems with the heating, ventilation and air conditioning (HVAC) in the control room were identified by the environmental survey (Appendix C). Specifically,

- Temperature control is not always reliable.
- The humidity control evidently does not function leading to excessively dry air in the winter and some problems with static electricity.
- Diesel fumes can be drawn into the control room.

Since the initial survey, the HVAC system has been extensively modified to increase reliablity and to help meet its design requirements for temperature and humidity. The operators can now select an alternate air intake location when diesel fumes contaminate the normal air intake.

IV. OPERATIONAL FINDINGS AND OBSERVATIONS

This section of the report presents the operational findings and observations made by the review team in the course of the human factors review. The operational findings are largely based on the results of procedure walk-throughs at the full scale control room mockup and at the Palisades simulator and a review of the control room design against the operators' responsibilities. It will be presented in the same order as the related parts of the guidelines (Appendix A, Section II). A general layout of the control room showing the locations of the major equipment and giving the alphanumeric panel designations will be found at the end of the next section as Figure V-1. Some of the findings and observations in this section are also noted in Section V, under the discussion of specific human factors considerations.

The specific findings of this section are summarized in Table VI-1. These findings are based on the configuration or conditions when the review was conducted. Corrective action has been taken on many of the items. The action taken or planned is summarized in Table VI-1. It will not generally be described in the body of the chapter to avoid unnecessary repetition.

A. Functions Performed in Control Room

A.1.* Core Neutron Production Control

Guideline II. A. 1. "Maintain control of the reactivity of the reactor core and monitor the shape of the neutron flux profile in the core."

The controls and displays required for the short term and long term control of reactivity are clustered effectively on the right hand section of the center console (C02). A few additional displays are located, less visibly, on the back panel (C12) behind the C02 panel.

* In this section and in Section V, the identification of subsections will be expanded to facilitate reference from the tables in Section VI.

Control of reactivity at Palisades can be in either of two modes depending on plant operating conditions.

- During an approach to criticality, and during operations at relatively low power levels, reactivity is controlled by changing the position of control rods.

- During operations at high power, operating policy at Palisades results in all control rod groups fully withdrawn and reactivity control effected by controlling the concentration of boric acid in the reactor core. In the latter mode, short term reactivity changes brought about, for example, by the build up or decay of fission product poisons, or by changes in coolant temperature, or by changes in reactor power, are compensated by adjusting boric acid concentration.

A.1.a. Rod control

When reactivity is being controlled by the rods, the reactor operator receives immediate visual feedback of the results of a control action (i.e., the withdrawal or insertion of the controlling group of rods) from a rod position indicator. Seven position indicators are arrayed above and to the left of the master raise-and-lower control switch, the switch used for positioning all rod groups. The control-display relationship between the raise-lower switch and the group position indicators is generally satisfactory. As will be discussed below, however, the labeling of the position indicators and the switches which select the rods whose positions are displayed have shortcomings.

Discussions of Shortcomings

(1) Displays indicating individual rod positions are used as indicators of the position of an entire rod group. The selection of the rod whose position is to be used as representative of the group is made by a switch below each position indicator. The position indi-

cators and the corresponding selector switches are not tied together with either sufficiently large labels or demarcation to make their relationship obvious. (An experienced operator is not likely to err as a result of these labeling deficiences, but an inexperienced one could be confused).

(2) Immediately above each position indicator is a small 4 element matrix of indicating lights. The two right-hand side lights are labeled with arrows, one pointing up, the other down. The two left-hand side lights are labeled "SEL" and "DEV". The upward pointing arrow indicates that the rods are being raised; the downward pointing arrow indicates that the rods are being lowered. The "SEL" light indicates which of the seven groups has been selected for control by the rod drive group selector switch. The "DEV" light is lit if the position of any rod in the group to which the light pertains deviates from the average for that group by more than a pre-selected amount. The deviation indication is the fundamental indication that there is adequate control of the flux shape when the rods are being used to control reactivity. The labels for this 4-element matrix of lights are abbreviated and do not clearly indicate the meaning of each light. In addition, the lights themselves are very small, unbefitting their importance.

(3) Four of the control rods (designated "power shaping group") are designed to be used for power shaping; neutron absorbing poison is provided only over the lower 1/4 of these rods. Though this feature is not used, the rods remain operable and are withdrawn with other groups. Unlike other position indicator selector switches, the position indicator selector switch for the power shaping group has a "group" position, as well as switch positions for displaying

the position of each of the four control rods, 42, 43, 44, and 45. The rod position displayed when this switch is in the "group position" is actually the rod position for rod number 42.

(4) The positions of the rod drive control group selector switch are labeled A, B, 1, 2, 3, 4, P, and OFF. These positions signify shutdown groups A and B, regulating groups 1, 2, 3, 4, and the power shaping group.

(5) The positions of the rod drive control mode selector switch are labeled: "MI" for Manual Individual, "MG" for Manual Group, "MS" for Manual Sequential (in this mode, the rod groups are withdrawn and inserted in accordance with a pre-defined program), "BAL" for balance (used in transferring from the "Manual Sequential" to the "automatic mode", - in BAL the system functions exactly as in "MS" mode) "A" for "automatic" (no longer used, but originally used to obtain the preselected program sequence when reactor power and temperature were controlled automatically), and "EM OFF" standing for Emergency Off which cuts off control power to the rod drive control system.

A.1.b. <u>Intermediate Visual Feedback for Reactivity Control: Nuclear Instrumentation</u>

When controlling the reactivity using the control rods, longer term feedback -- showing the results of a change in rod position -- is provided to the operator visually via the neutron flux detectors. In the power range this information is displayed on six similar vertical meters, each showing the output of six power range nuclear instruments, and located immediately above the rod position indicators on the backboard section of C02. Logarithmic startup (source) range meters and wide (intermediate) range meters are immediately above the power range meters.

The source and intermediate range instruments are used during plant startup, in the approach to power. Immediately adjacent to each source and intermediate range meter is a meter displaying the rate of change of the log of the flux level (expressed in decades per minute). These displays are particularly useful since the rate of change of flux rather than the flux itself is the essential feedback variable during startup.

Two start-up channel meters, two log power meters and four linear power meters are also displayed on side panel C06. Additional startup and log power recorders are located on panel C12. Finally, reactor power is also indicated on four digital displays on side panel C07.

Discussions of Shortcomings

(1) To the right of the array of source and intermediate range instruments on C02 is a reactivity meter. This instrument is used during core physics testing by the reactor engineer. It is not used by the operators.

(2) The human factors of the meters displaying the outputs of the nuclear instrumentation are generally satisfactory. The meters themselves are of good design. Labeling is deficient in terms of readability.

(3) Power range information of the nuclear instrumentation system is obtained from ionization chambers which are arrayed radially around the exterior of the reactor vessel. Each radial location houses two uncompensated ion chambers, one atop the other. Flux tilt information is derived by comparing the output of the chamber in a specific radial location to the average of the four locations used in the reactor protective system. Two levels of flux tilt information are alarmed; i.e., indications corresponding to 5% (level 1) and 10% (level 2) core flux tilt. Indicating lights on the linear power channel drawers on C06 identify the

level of deviation (1 or 2) and the associated channel.

There are six unlabeled indicator lights immediately below each of the six power range meters as well as below the power range flux recorder on C12. These lights indicate the scale range selected for each of the six channels; i.e., the times one or the times 10.

(4) The four linear power channel drawers on side panel C06 have a green "power on" light. This violates the red-energized, green-not-energized convention for indicating lights.

(5) Readability of digital power indicators on side panel C07 is marginal from operator station at C02 (approximately 0.4 inch tall neon-type digits). Previous indicators were bigger, easier to read.

A.1.c. <u>Long term Visual Feedback for Reactivity Control</u>

The operator obtains long term feedback of the results of a change in the reactivity balance from the average primary coolant temperature displays.

If a change in reactivity causes reactor power to exceed the power consumed by the steam plant, average temperature will rise at a rate dependent on the difference. On the other hand, if reactor power is less than the power consumed by the steam plant, average temperature will fall, again at a rate dependent on the difference. Average temperature is displayed digitally on a display immediately to the left of the nuclear instrumentation displays and also on recorders above and below the digital display. The recorders are useful in determining rate of temperature change -- hence the amount of the power mismatch. These displays are also fundamental to the control of the energy flow from the reactor to the steam generators.

The location of the T_{ave} displays relative to the rod controls, and also relative to the controls for the soluble poison (boric acid), also used for reactivity control, is satisfactory. However, the displays have a number of deficiencies as discussed below.

Discussion of Shortcomings

(1) The digital T_{ave} indicator is unlabeled.

(2) The T_{ave} indicator has a limited valid range 515°F to 615°F). If the average temperature is above or below these values, the T_{ave} indicator will indicate "615" or "515"; there is nothing to indicate to the operator that the instrument is at the end of its useful range.

(3) The selector switch used to select the average temperature displayed on the digital indicator is correctly but confusingly labeled. It has two positions -- "Unit 1" and "Unit 2" -- which denote the names given to the two (redundant) automatic temperature controllers from which the (computed) T_{ave} signal is derived. [Although the automatic rod control is no longer used, portions of the circuitry associated with this control still are]. In the Unit 1 position, the average temperature of Loop 1 (containing steam generator A) is displayed. The Unit 2 position selects the Loop 2 average temperature. The reactor regulating system selector switch also determines whether Loop 1 or Loop 2 T_{ave} is used for the steam dump and bypass system.

(4) The T_{ave} recorders are equipped with 2-speed drives: Speed is selected by an internal selector switch. The speed at which a recorder is operating cannot be determined without opening the recorder. The two recorders which display T_{ave} each include two pens. On the upper recorder a red pen displays the average temperature of Loop No. 1. On

the lower recorder, the red pen displays the average temperature for Loop 2. The blue pen on each of the recorders displays the demanded average temperature, computed by the control system. Redundant automatic controls are provided; hence two demanded T_{ave} values are displayed. Even though the automatic control does not position the rods, the T_{ave} demand computed by it is used by the operators for long-term reactivity control decision-making. However, the labeling of the recorders is small and not readable except at close range. This is a deficiency of most recorders in the control room. Also, the use of color coding to distinguish between the demanded and average temperatures, with no other visual cue, would put an unnecessary burden on colorblind operators. It is noted that currently there are no colorblind control room operators at Palisades; tests for colorblindness are administered periodically for operator relicensing.

(5) Immediately adjacent to the two T_{ave} recorders is an illuminated arrow display. The arrows, unlabeled, represent the direction of rod motion that the automatic control would call for if it were in operation. For example, if average temperature or reactor power is low, the arrow pointing up (rods out) would be illuminated. If average temperature is high, or power is excessive, the down (rods in) arrow would be illuminated. If average temperature and power are within limits, neither arrow is illuminated; in this case a circular indicator light between the two arrows would be lit. The circular light is also unlabeled. The operators use the arrows to assist them in manual control of the rods and in planning boric acid additions or dilutions.

A.1.d. <u>Control of Reactivity by Means of Boric Acid</u>

When the reactor is operating at high power, all control rod groups are fully withdrawn and compensation of reactivity changes are accomplished by changing the concentration of the boric acid, a neutron absorbing poison, in the reactor coolant. An increase in concentration is effected by injecting a concentrated solution of boric acid through the makeup system. A reduction in concentration is effected by injecting pure water through the makeup system.

The operator controls reactivity with boric acid changes as follows:

Most reactivity perturbations are brought about by a requirement to change the plant operating power. Suppose the load dispatcher requests an increase in generator output of, say, 40 megawatts. This increase is brought about by the following process:

- The operator commences reducing boric acid concentration by diluting the reactor coolant with pure water through the makeup system. Because the coolant volume is large and because the injection flow is small, the rate of change in concentration is very slow.

- As the concentration of boron in the reactor coolant slowly diminishes, reactor power increases.

- The small and slow increase in reactor power upsets the balance between the power produced by the reactor and the power delivered to the steam plant by the steam generator. As a consequence, the average coolant temperature rises.

- As the operator observes the average coolant temperature rising, he slowly opens turbine control valves. He does so until he reverses the climb in aver-

age temperature. He then allows average temperature to fall slowly toward the bottom of its control band.

- But as the dilution continues, average temperature will again commence rising, again reaching the top of its control band, where the process described above will be repeated. In this stepwise fashion, the control valve position on the turbine generator is gradually increased and as a consequence, the electrical power generated by the unit is increased.

- The concentration change needed to bring about a specified increase in generated power will be calculated before initiating the power change. For the example under discussion, when sufficient pure water to effect the power change has been injected, the injection will be terminated. But because of the very long mixing time constant, the changing reactivity will persist, perhaps for several hours after the injection is terminated. Likewise, the desired power level may not be reached for several hours after the start of the change (exactly how long depends on the time in the fuel cycle; if the fuel is new and concentration is high, the time required is short. If the fuel is old and concentration is low, a small power change can require more than a day). Finally, changes in power also result in Xenon transients; boron concentration must also be adjusted to take these into account.

Controls associated with the boric acid feed valves and the makeup control mode selection for makeup controls are clustered below the batch controllers and logs. Controls and displays for the boric acid feed pumps are approximately four feet to the left, together with the letdown and charging controls. All controls are located conveniently with respect to the T_{ave} displays used in connection with the above described evolution. Controls for the turbine control

valves are more remote -- on console C01. A second operator typically will man the turbine controls and coordinate his activities with the reactor operator orally.

Discussion of Shortcomings

(1) The Palisades plant designers intended that the operator obtain short-term feedback of the effects of a change in boric acid concentration from a display of the concentration of boric acid in the reactor coolant system. This measurement was to be accomplished by a boronometer, the recorded output of which is displayed on console C02 backboard, about two feet to the left of the average temperature recorders. While the idea is a good one, the boronometer has proven unreliable and inaccurate. The operators often can not use it. As a consequence, the operators rely on the effects of a change of boric acid concentration (in terms of changes in reactor power and temperature) to confirm reductions or increases in boric acid concentration, as appropriate. In this regard, the operation at Palisades is like many other PWRs.

(2) The total amount of makeup injected is kept track of by two flow integrators: one for the concentrated boric acid solution, the other for the pure water. These integrators are located centrally in console C02. In order to know how much water or poison has been injected, the operator maintains a running written log of how much water or concentrate have been added. There are also batch controllers for boric acid and water. These indicators are said to be out of calibration, but they are also used as a check in the process.

A.2. Control of Energy Production and Transfer

Guideline: II.A.2. "Maintain control of the energy production and transfer", including:

- production of energy in the reactor core,
- transfer of energy to the reactor coolant system,
- transfer of energy through the steam generators to the steam system,
- conversion of some energy to electricity in the turbine generator, and
- rejection of the remaimder through the condenser and circulating water system."

A.2.a. Reactor Power/Steam Generator Power

The displays and controls involved in the control of reactor power and the reactor power-steam generator power match have been discussed in the preceding section. The reactor power is the direct result of the specifics of the reactivity balance; a mismatch in reactor power and steam generator power manifests itself in an increasing or decreasing average reactor coolant temperature.

Discussion of Shortcomings

(1) The difficulty in controlling coolant temperature and its rate of change during cooldown is discussed in a later section. In part, the difficulty derives from the poor location for the wide range cold leg temperature recorders; they are below the field of vision of an operator of median height.

(2) A second difficulty involved in this control is that the cooldown rate is set by manually positioning the turbine bypass valve using the manual control mode for this valve. The operator is not given any guidance as to the valve position required for a specified rate, and the correct position is apparently found on a trial and error basis during the first 15-20 minutes of cooldown. Operating procedure requires that the operator manually plot the cooldown rate

(temperature versus time). During this period, the operator must shuttle back and forth between the valve controller centrally located on panel C01, and the wide range temperature recorder on backpanel C12.

A.2.b. Turbine Generator Power

The control of the energy delivered by the steam generator to the turbine is effected during power operations by controlling the position of the turbine control valves. These valves are controlled by an electrical/hydraulic control system provided by the turbine vendor. The principal governor controls are located in a packaged assembly on console C02. Deficiencies in the displays and controls of this package are as discussed below.

Discussion of Shortcomings

(1) The visibility of backlighted push-buttons and indicators on the turbine control panel is poor, due to a lack of contrast between the light emanating from the pushbuttons and the surroundings (the surroundings pick up reflected light from the overhead lighting in the room).

(2) The "reference" and "setter" digital indicators on the turbine control panel read in percent power when the plant is in the load control mode (that is, synchronized), and in revolutions per minute when the unit is in the speed control mode (before synchronization). Indicating lights to the left and right of the reference and setter digital indicators identify which mode the plant is in (speed or load). However, there is no indication of this change in units for the reference and setter digital displays (rpm or percent power) when the control mode changes.

(3) The "setter" indicator shows the percentage power which the turbine is

ultimately programmed to reach (subject to rate of change and other limitations imposed by the automatic control). The "reference" indicator displays the present value of the demand signal to the governor valve control system. If the unit is in the "impulse pressure in" mode, this amounts to a demand for percent of rated full power impulse chamber pressure. If the unit is in the "impulse pressure out" mode, this amounts to a demand for a specific linearized control valve position. Backlighted pushbuttons indicate which mode is selected, but there is no specific indication of the changed nature of the reference signals.

(4) The actual impulse chamber pressure is read on a circular scale meter on the turbine control section of the panel. The calibration of the transmitter or the amplifying circuit feeding the meter is in error. The meter reads 93% of rating, when the actual pressure is 98.5% of rating.

(5) A thumb wheel is used to select a loading rate for the turbine. The thumb wheel calibration requires multiplication by a factor of 0.1. A piece of Dymo tape affixed to the control panel is used to indicate this.

(6) The control of the electrical energy transferred from the generator to the grid is set by control valve position when the unit is synchronized. Reactive power is controlled by controlling the amount of excitation supplied to the generator. Exciter and voltage regulator controls for the generator are on the right end of panel C01 adjoining the turbine controls. The design of these controls and displays appears generally satisfactory. One deficiency should be noted. A label plate in the vicinity of the main output bus voltmeter indicates that voltage is to be maintained on this bus at 357 KV.

The implication is that the voltage is to be maintained within meter accuracy; no tolerance is given. This requirement is inconsistent with a second requirement (not stated on a label plate) to keep the amount of reactive power generated by the unit within 200 megavars of 0. In fact, the megavar requirement overrides and the operators indicate that they will occasionally deviate from the specified voltage with the permission of the load dispatcher.

A.2.c. Steam Generator Mass Balance

To ensure that the steam generators deliver the steam power demanded by the turbine, a dynamic mass balance around the steam generator must be maintained. This is accomplished, in the power range, by a conventional three element steam generator water level control. The control matches water fed to the steam generator to steam flow, in the short term, and "trims" water flow so that water level (hence, in effect, steam generator liquid inventory) is maintained at a preset value in the long term. The necessary feedwater regulating valve position controls are at the left end of console C01. Operation of these controls (one per steam generator) is normally automatic. Manual control is necessary at very low power, or if the automatic system malfunctions. The instrument displays which the operator needs to monitor operation of the automatic control (and to control manually) are as follows:

- Steam generator level is displayed both on recorders and vertical meters. Specifics on these displays are described below under Section A.4, "Liquid Inventory in the Steam Plant"

- Feedwater and steam flows for each steam generator are displayed on recorders located on backpanel C12. Although they are in the general vicinity of related controls, the indications of the recorders are not readable with precision from the control station at the console.

- The feedwater flow measurement indicates promptly the result of a change in the feedwater regulating valve position. At low power, however, water flow indication is imprecise, and valve position can be useful as a feedback signal for manual control. Valve position is displayed on indicators adjacent to the controllers. In addition, the position demanded of the valve(s) by the controllers is displayed on the controllers themselves.

Discussion of Shortcomings

(1) The position indicator on the controllers is demanded rather than actual valve position.

(2) Under certain conditions, feed to the steam generators is supplied by an auxiliary feedwater system. The controls and displays for the pumps and valves associated with this system are located near the main feed controls on console C01. The response of steam generator water level to auxiliary feed changes can lead to instability if the operators are inexperienced.

(3) On the controllers for the auxiliary feedwater the manual "close" button is on the right and the "open" button is on the left side of the controller, different from other nearby controllers.The position indication is "closed" at 100% on the right, and "open" at 0% on the left. Position indicators for nearby controllers are closed at 0% on the left and open at 100% on the right.

(4) The manual control of steam generator water level involves repetitive, near-far seeing tasks which are difficult for some operators. The steam generator water level recorder is located on the back panel, operator controls are on the front panel. The recorder is used for the rate feedback the operator needs to stabilize his response. Operators open the recorder door to obtain necessary visibility. In addition, they must leave their station and walk to the recorder to change recorder speed. Fast speed is used for spotting trends.

(5) The operators received no effective training on control of steam generator water level at low power on the generic CE simulator. The new Palisades simulator provides the capability to perform this training. The Foxboro auxiliary feedwater controller on that simulator was different from the Bailey controller recently installed at Palisades, however, it has been replaced so that the plant and simulator are the same.

(6) Control of steam generator water level at low power can be demanding. Specifically, the transition from auxiliary feed flow to main feed flow can result in a rapidly rising water level unless the turbine demand is increased simultaneously. The primary cause of difficulty in maintaining water level at low power with main feed may be poor mechanical isolation of the feedwater regulating valves (CV-0701 and CV-0703) and the operational practice to keep the isolation valves (CV-0742 and CV-0744) open.

A.2.d. <u>Control of Power Rejected to the Surroundings.</u>

Controls and displays for maintaining condenser vacuum are divided between the control room and local control stations.

Vacuum itself, and two variables related to the maintenance of this vacuum -- gland seal pressure and gland seal condenser vacuum -- are displayed satisfactorily on vertical meters on console C01.

Discussion of Shortcomings

(1) Operating status of the two (motor driven) gland seal condenser exhausters is displayed on backpanel C11. Labels for these displays are not readable from the normal control station in front of the console.

(2) Condenser vacuum is trended on a recorder on the back panel. This display, potentially useful in detecting and diagnosing vacuum system upsets, loses some of that usefulness by its location. It is not readable from a normal operator station in front of the console.

(3) Controls for the gland seal system and for the air ejection systems are not in the control room. Since the operation of these controls is generally a deliberate and planned operation, the local location is considered satisfactory. However, the absence of certain of the displays normally associated with these controls deprives the operator of early warning of vacuum degradation. Specifically, there is no indication in the control room of air ejector exhaust gas flow. Loss of this flow is indicative of an inoperative air ejector which will generally lead to a loss of vacuum. A major increase in this flow is indicative of a large air leak, which will lead to oxygenation of the condensate, loss of vacuum, and, in the long term, damage to the condenser, or possibly, the steam generator tubes.

(4) Controls and displays for the circulating water (cooling tower) system whereby heat rejected through the condenser is transported to the atmosphere

are on panels C126 and C106. These are located on the right side of the control room (when facing the main console). The panels are not in the normal line of sight of the operator and are partially obscured by the recently installed C11A panel. Interpretation of any indication requires the operator to leave his normal station and approach the panel.

(5) Excepting labeling and demarcation deficiencies common to most of the controls and displays, the human factors associated with displays and controls of the valves and pumps of the water circuit are satisfactory. A particular problem is clearly dividing the 'A' and 'B' parts of this circuit from one another.

(6) The pushbuttons controls for the cooling tower fans, and the displays of fan status are arrayed on panel C106. Labeling of the multiple status pushbuttons is potentially confusing. Also, the selection of fans to run is based on equalizing load distribution among the electric power feeders which supply them. The electrical information is also displayed on C106, but the relationships between a specific electrical feeder and a specific fan group is not clear.

A.3. Control of Reactor Coolant Inventory and Thermodynamic State

GUIDELINE II.A.3. "Maintain an adequate inventory of chemically suitable water at the proper pressure and temperature in the primary (reactor coolant) system."

A.3.a. Pressurizer and Volume Control Tank Levels

Under normal conditions, the volumetric inventory of reactor coolant liquid is inferred by the operator from measurements of pressurizer level and volume control tank level. Pressurizer level is displayed in the

center section of central control console C02 on redundant recorders. Supplementing the recorder displays are controller displays. The controller displays are immediately adjacent to each of the level recorders. Four additional (redundant) level displays are provided by four vertical meters located on backpanel C12, to the rear and left of the benchboard displays.

Volume control tank level is also displayed on console C02, about two feet away from the level recorders.

Discussion of Shortcomings

(1) The units of pressurizer level as displayed both on the recorders and the level meters are percent of full scale in the pressurizer. There is nothing to tie this indication to a meaningful volumetric unit such as gallons.

(2) The human factors of the volume control tank level display are satisfactory, except for the units. Again the meter is calibrated in percent; there is nothing to tie a change in this level to a change in pressurizer level or a specific deficiency in makeup, etc.

A.3.b. Charging and Letdown Flow

Influx and efflux of liquid from the reactor coolant system is measured by charging and letdown flow measurements. Results are displayed on side-by-side meters located on the left center of panel C02. Human factors of these displays are generally satisfactory. Units are in GPM; a discrepancy of a few GPM, -- indicative of a small leak -- can be detected. The meters are appropriately located near the charging pump and letdown controls.

A.3.c. Subcooling Margin Monitor

In certain off-normal situations steam voids may form in the top of the reactor vessel or in the upper portion of the U-bends in the

steam generator. In such situations, the pressurizer level and volume control tank levels together do not constitute an accurate measurement of the volumetric inventory of reactor coolant liquid. The operator should be alerted to this loss by the approach of reactor outlet temperature to saturation for the then-prevailing pressure. Two subcooling margin monitor are intended to fulfill this function. The outputs of these monitors are displayed in digital format on Back Panel C12. Either monitor can display margin in degrees Fahrenheit or in psi.

<u>Discussion of Shortcomings</u>

(1) It is not obvious from a station at the main console which of the monitors reads temperature margin and which reads pressure margin: the back lighted pushbutton which displays this information cannot be read from the normal control station.

(2) The meaning of a positive or a negative sign with respect to the subcooling margin is not obvious.

(3) The temperature instruments which feed the subcooled margin monitor are of limited range. As a consequence, if reactor coolant temperature drops below about 515°F, the output of the monitor is meaningless, although the operator knows that the temperature is below 515°F because the digital display flashes. Furthermore, there are not-improbable situations wherein temperature is below 515°F and a knowledge of subcooled margin is important to the safety of the unit.

(4) The current setpoint for subcooling margin alarm is 50°F which is near normal subcooling at full power. The alarm clear setpoint is 55°F. Consequently once actuated, this alarm will not normally clear itself unless reactor power is reduced substantially. Manual clearing of alarm

at subcooling monitor is possible but operators do not appear to be trained in this operation.

A.3.d. Safety Injection Tank Levels

In the event of a loss of coolant sufficiently large to cause reactor coolant pressure to drop below about 250 psi, liquid may be injected into the reactor coolant system itself from any or all of four safety injection tanks. Knowledge of the levels in these tanks is necessary to account for all the liquid which has been put into the reactor coolant system under such circumstances. The levels of the four safety injection tanks are displayed on four meters located on backpanel C13.

Discussion of Shortcomings

(1) The units are in percent. There is nothing to tie a specific increment in tank level as measured on the meter to a change in, say, pressurizer level.

(2) The back panel location of the meters makes them unreadable with precision from a normal station in front of the console.

A.3.e. Makeup Tank Levels and Flows

A total accounting of reactor coolant inventory requires a knowledge not only of the free surfaces in the reactor coolant system and the volume control system; it also requires a knowledge of the levels of liquid in the tanks from which makeup is drawn, and also the levels in the tanks, sumps, and other receptacles to which letdown may be directed or to which leaks or other abnormal liquid discharge make their way. This requirement derives from:

° the large (approximately 30%) volumetric change of reactor coolant associated with heating and cooldown,

- the large turnover of reactor coolant necessary to effect the boric acid concentration changes associated with chemical control of reactivity, and

- the desire to detect reactor coolant system leaks as soon as possible. (A small reactor coolant system leak -- and most leaks start small -- would increase the makeup to the reactor coolant system).

In addition to the makeup tanks discussed below (which contain pure water), makeup is drawn from the concentrated boric acid tanks; the liquid from these tanks is blended with that from the primary system makeup storage tanks to obtain a desired concentration of boric acid in the makeup to the Reactor Coolant System. The levels of the boric acid tanks are displayed in the control room; like the pure water from the makeup tank, flow from these tanks is displayed on a recorder and on a vertical meter on the concentrated boric acid flow controller. These instruments adjoin those for pure water flow. Except for labels which are difficult to read, they are satisfactory from a human factors standpoint.

<u>Discussion of Shortcomings</u>

(1) Makeup typically originates in the primary system makeup storage tank T90 or in a similarly named tank, T81, in which case its path is through T90. Such makeup is injected into the reactor coolant system via the charging pumps. The levels of the two makeup water storage tanks are not displayed in the control room (though levels are readable by auxiliary operators). Offsetting this deficiency, flow from the tanks is measured and displayed in the control room. A recorder plus a vertical meter on the makeup flow controller are provided. These are located centrally on console C02, and bear a generally satisfactory relationship to related controls.

A.3.f. Emergency Makeup

Discussion of Shortcomings

(1) Under certain accident conditions, a large amount of makeup to the reactor coolant system can be drawn from the "SIRW" tank (Safety Injection and Refueling Water) (T58) and/or the containment sump. Levels for the SIRW tank and the containment sump are displayed on vertical meters located on backpanel C13. The location, though sensible from a fluid systems viewpoint, is remote from the other displays related to reactor coolant inventory. The meters cannot be read with precision from the normal operating station in front of the control console.

(2) If high or low pressure coolant injection systems are called upon to operate, the high and low pressure injection coolant flows are measured. Four high pressure and four low pressure flow measurements are made, corresponding to the four separate branches of each system. The indications are displayed on vertical meters on backpanel C13. The meters cannot be read with precision from a normal position at the console. Although there may be a functional requirement for the four measurements, asking the operator to sum the four measurements in his head is unreasonable. What the operator really wants to know in the event of a serious leak is:

- whether or not the total flow into the reactor system accords with his expectations -- this tells him that the HPSI (or LPSI) system is operating as intended and combined with other information may give him an indication of the leak rate, and

- the integral of the <u>total</u> flow -- ultimately, all the water injected must reside either in the coolant

system itself or in one of the repositories to which it can escape. (The integral information is needed to reconcile information from other displays as to the current in-system coolant inventory and leakage pathways.)

The controls and displays do not assist the operator in keeping track of how much water he has put into the reactor coolant system under these conditions.

A.3.g. Effluent Repositories

Reactor coolant exiting the reactor coolant system can reside in a limited number of repositories. The displays associated with these repositories and their shortcomings are discussed below.

Discussion of Shortcomings

(1) The primary system drain tank (T74) is the collecting place for uncontrolled pump seal leakage flow and miscellaneous in-containment drains. The level for this drain tank is not displayed in the control room. The most likely path by which coolant would make its way to this tank is via a leaking pump seal. Controlled seal leakoff flow to the volume control tank for each pump is displayed on recorders on backpanel C11. These flows are normally small, hence the flow recorders are ranged such that if there is a substantial leak in one of the seals, the recorder is likely to be offscale, up. Nonetheless the recorders are useful for detecting an incipient seal failure.

The primary pump seal leakoff recorders are not visible from a normal operating station in front of the console; however, operators indicated that the recorders are inspected at least several times a shift.

(2) The reactor coolant quench tank, T73, also located in the containment, is a repository for liquid and vapor exiting the reactor coolant system via pressurizer relief and safety valves, as well as other miscellaneous sources. Its level is displayed prominently on center console C02 adjacent to the reactor coolant pressure controller and near the pressurizer level displays. Human factors of this display are satisfactory.

Should pressurizer safety valves lift and fail to seat, a flow path between the reactor coolant system and the quench tank is established. The presence of this flow -- but not the amount -- is detected and the operator alerted to it by means of an acoustic flow detection system. The outputs of this system are not displayed within the reactor operator's field of view (they are located on the back of panel C11A in the rear of the control room). However, an audible alarm alerts the operator to the presence of an unusual noise level, hence flow, in this circuit.

(3) The containment sump, which can receive leakage from a variety of sources as well as overflow from the quench tank and from the primary system drain tank, has level indicators on backpanel C13. The level is not easily read with precision from the usual operating station in front of the console, nor is the level expressed in units which allow it to be readily correlated with other displays.

(4) There are several auxiliary building sumps and drain tanks. Leakage in the area of the emergency safeguards equipment in the auxiliary building is collected in sumps, the levels for which are measured and displayed on C03. The engineered safeguards rooms sump pumps discharge to the equipment drain tank (T80). The level for this tank is not

displayed in the main control room. Reactor coolant leakage in other parts of the auxiliary building can make its way to two other sumps, the levels for which are not displayed in the control room.

(5) The component cooling system surge tank, (T3), would collect coolant leaking through the shutdown cooling heat exchangers, the reactor coolant pump cooling coils, or the letdown heat exchanger. An increase in the component cooling surge tank level can be evidence of a reactor coolant system leak. The component cooling surge tank level is displayed in an array of related meters on console C03. The level is expressed in percent of range; there is no tie between the units of this meter and other meters related to reactor coolant volumetric inventory.

(6) Leaks in steam generator tubes can result in the transfer of reactor coolant to the steam plant. If the leak is small, it will result in a reduction in the amount of makeup required by the steam plant. If the leak is a bit larger, there will arise a need to dump surplus condensate to the condensate water storage tank.

Discussions of the ability to monitor secondary plant inventory are covered in Section A.4, below. A unique, additional symptom of a steam generator tube leak is the presence of radioactive material in the condenser air ejector stack. Concentration of radioactive material in the air ejector exhaust is measured, but is not displayed in the operator's field of view. Radiation monitors are on the back of panel C11). A generalized radiation monitoring alarm on the main annunciator panel is intended to alert the operator to a problem of this kind. Since many diverse monitors annunciate this alarm, it is of limited effectiveness.

(7) The clean waste receiver tanks (T64A, B, C, D) are not likely repositories for leaking coolant, but are the tanks to which the surplus liquid generated by the volumetric expansion of reactor coolant during startup is directed. The tank levels are not displayed in the control room.

(8) The volume control tank is discussed in Section A.3.a, above.

A.3.h. Controls for Reactor Coolant System Inventory.

Normally used controls for reactor coolant inventory are grouped on the left end of the bench board section of center console C02. The controls bear a generally satisfactory relationship with respect to the location to the displays associated with them.

Discussion of Shortcomings

(1) The relationships of the controls to one another and to the fluid systems to which they are related are not reflected in their arrangement on the control panel. For example, the three control switches for the three coolant charging pumps form an inverted "L". On the horizonal leg are controls for Pumps C and B in that order. Below the controls for Pump B is the control for Pump A. The controls for valves associated with directing liquid to suctions of the charging pump are likewise confusingly arranged. As a result, following a high pressure coolant injection and in restoring valves and pumps to normal line-up, there appears to be a risk of isolating the charging pump suction. The controls also have significant labeling deficiencies.

(2) Makeup following substantial coolant leaks is effected by operation of the high and low pressure coolant injection pumps. Controls for these systems are located on the right hand end of console

C03. Again, the controls are located in the same general area as related displays (though in this case many of the displays are on backpanel C13 and are marginally readable). Specifics of the arrangement are confusing. It is difficult to determine from the labeling or the arrangement the precise functions of each control and display. In addition, controls for certain of the safety injection valves utilize a modified rotary switch. The operating handle for the switch apparently is easily broken. After it has been broken, the control is difficult to operate and does not comply with human factors torque guidelines.

A.3.i. Coolant Thermodynamic State

Thermodynamic state of the reactor coolant is monitored by a large number of pressure and temperature instruments.

Discussion of Shortcomings

(1) Narrow range temperatures. The two reactor outlet (hot leg) temperatures and the four reactor inlet (cold leg) temperatures are displayed on a series of vertical meters located on backpanel C12. The meters are incorporated in a mimic of the reactor coolant system at this location. Eight hot leg temperature measurements -- two sets of four redundant measurements each -- are displayed. Eight cold leg temperature measurements -- four sets of two redundant measurements each -- are displayed. The human factors of the vertical meters themselves are generally acceptable. However, none of the displays is readable with precision from the normal operating station in front of the main console. The existing displays are, on this account, only marginally useful. Additionally, all of the indicators incorporated in the mimic are narrow-ranged -- they do not read temperatures below about 515°F. As a

consequence, none of these displays can be used to control reactor coolant temperature during cooldown.

(2) Wide range hot leg temperatures - Wide range hot leg temperatures can be determined from the individual exit core thermocouple readings which can be obtained from the PIP computer. The sequence of commands for obtaining this information is somewhat involved and not easily remembered by all operators.

(3) Wide range cold leg temperatures - Recorded displays of two wide range cold leg temperatures measurements are also located on backpanel C12. These recorders are essential to the control of reactor coolant temperature during cooldown. Because they are below the line of sight for most operators at their normal control station, operators must shuttle back and forth between the console and the backpanel during a cooldown to monitor the cooldown rate.

(4) Average reactor coolant temperature - The displays of average reactor coolant temperature have been discussed previously in Section A.1.c, above.

(5) Subcooling Margin - Deficiencies of the displays of subcooling margin have been discussed previously in Section A.3.c.

(6) Reactor Coolant Pressure - Reactor coolant pressure is monitored by instruments connected to the pressurizer. The output of these instruments is displayed on two narrow range pressure recorders, and one wide range vertical meter centrally located on Panel C02. Human factors of these displays are generally satisfactory (except for generic labeling deficiencies). In addition, there is a digital display of reactor coolant pressure in the center of the console. The digital display has both the wide range and a narrow range. The selection of range is made by a small

toggle switch immediately below the digital display. In the wide range position, the display reads pressures from 0 to approximately 2500 psi. In the narrow range position, the display reads pressure only in the range 1500 to 2500 psi. In the latter case, there is no indication on the display itself that the display is at the end of its range. That is, if coolant pressure is below 1500 psi and the switch is in the narrow range position, the display will read 1500 psi and the operator will be misinformed.

Finally, wide range pressure is recorded on backpanel C12 together with wide range cold leg temperature. The human factors of this recorder is discussed in paragraph A.3i(3), above.

A.3.j. <u>Control of the Thermodynamic State of Reactor Coolant</u>

Control of the energy content of the reactor coolant, essentially measured by its temperature, is described above in Section A.1.c. The control of reactor coolant pressure is effected at console C02. Redundant pressure controllers are provided which control both the power delivered to the pressurizer heaters (which increase pressure), and the coolant pressurizer spray flow (which decreases pressure). Controls and displays associated with coolant pressure control are satisfactory.

A.4. <u>Liquid Inventory in the Steam Plant</u>

<u>Guideline II.A.4</u> "Maintain an adequate inventory of chemically suitable water at the proper pressure and temperature in the secondary (steam) system."

A.4.a. <u>Liquid Inventory Repositories</u>

(1) <u>Steam generators</u>

The water level in each steam generator is used at Palisades, as elsewhere, as a

qualitative indication of steam generator liquid inventory (the actual volume of liquid present depends on operating pressure and power as well as level). Steam generator level is displayed in percent on two sets of five redundant vertical meters each on backpanel C12. Level indicators for each steam generator are also provided on the water level controllers at the left end of panel C01. These level indications display the level being fed to the automatic water level control. They are readily viewable from the main console.

Discussion of Shortcomings

(a) The steam generator level displays on C12 are not readily visible from the station at which steam generator water level is controlled (the left end of panel C01). It should be noted however that these displays are rarely used for steam generator control and are redundant to the level recorders on C12 and the level indicator on C01.

(b) The trend in time of steam generator water level is important in establishing the existance of a small mismatch in the inflow and outflow. Trend is particularly important in control of water level at low power. Two water level recorders, one for each steam generator, are provided, from which trends can be inferred. These are also located on backpanel C12. Visibility of these recorders is marginal from the normal control station; the operators often open the doors of the recorders to allow better viewing from that station.

(c) All the steam generator level indications are calibrated in percent of full range. There is no obvious relationship, in terms of liquid

mass or volumetric units, between these displays and other related displays in the feed system, condensate system and condensate make-up systems.

(2) Feedwater heaters

Not-negligible water inventory resides normally in each of the feedwater heaters. Levels for these heaters are displayed, for the low pressure heaters (Stages 1 through 4), on a level recorder located on backpanel C11.

Discussion of Shortcomings

(a) Currently this recorder is not used. Furthermore, indications of the heater levels are not readable from the operator's normal station at the main console. Even in the aisle in front of the back panel, reading the recorder is difficult. In addition, the recorder is calibrated in percent; there is no direct relationship between the indicated heater levels and the units of other inventory and flow displays for the secondary plant.

(b) The fifth stage heaters have a rather large drain tank (Moisture Separator Drain Tank, T5) which houses a sizable fraction of the total secondary plant inventory. The level for this drain tank is displayed on a vertical meter readily visible to the operator on Console C01. Again, the units of display are in percent making it difficult to correlate the indication on this meter with other secondary plant inventory displays.

(c) The levels in the sixth stage heaters are not displayed.

(d) High level alarms are provided for all heaters, including the sixth stage at a location on the backpanel C11. These consist of 12 pair of indicating lights: red for high level and white for normal level. The labels on these high alarms are not readable from an operator's normal station at a main console.

(3) <u>Hotwell</u>

Significant secondary plant inventory -- three to five minutes of full condensate flow -- resides in the condenser hot well.

<u>Discussion of Shortcomings</u>

(a) Hot well level is displayed on a vertical level meter on console C01. The units are in percent and not correlatable with other level and flow displays.

(4) <u>Condensate Storage Tank (T2)</u>

Surplus condensate, generated by the volumetric expansion of secondary plant fluid during plant heatup and escalation to full power, is dumped to the condensate water storage tank. Makeup for leaks and compensation for the volumetric contraction during plant cooldown is drawn from this tank, usually by vacuum dragging liquid from the tank to the condenser hot well.

<u>Discussions of Shortcomings</u>

(a) The level for the condensate water storage tank is displayed on two meters among an array of miscellaneous meters on backpanel C13. This location is not functional. (The location was likely chosen because the condensate water storage tank is a source of water for the auxiliary feed water pumps and

is therefore used in emergency situations. Emergency-related displays are collected on panel C13). The indication of the condensate water storage tank level meter is not readable, and the meter itself is not identifiable from the normal secondary plant control station near console C01. Again, the meter units are in percent, with no direct correlation between these units and others.

(5) Miscellaneous Tanks and Turbine Building Sump

Secondary side inventory may also reside in the reheater drain tanks (T-4A, B) and the feedwater drain tanks (T-26A,B), the moisture separator reheaters (E-9A, B, C, D) and the drain coolers (E-7A, B), and the turbine building sump.

Discussion of Shortcomings

(a) The levels for these tanks and sump are not displayed in the main control room. It is noted, however, that the amount of secondary coolant resident in these tanks is small and the drain coolers are normally full.

A.4.b. Secondary Makeup Flow Rate

The flows among the repositories of secondary plant inventory can be significant in detecting leaks. Steam and feed flow measurements discussed elsewhere are useful only in detecting extremely large (and improbable) leaks.

Discussion of Shortcomings

(1) For the operator in the control room, the only feasible means to detect a moderate to small leak is to note an increase in makeup flow from the condensate water storage tank to the con-

denser hot well (the hot well level control will act to maintain hot well level and in so doing will increase the amount of this flow). But the makeup flow is not measured. The position of the makeup control valves could be used to infer a change in makeup requirements, but as is discussed in the next paragraph, is not readily discerned.

A.4.c. Secondary Plant Inventory Control

As indicated above, surplus inventory generated during heatup, is rejected from the steam plant to the condensate water storage tank through a valve which is automatically controlled. Makeup to the condenser hot well is also automatically controlled. There are two separate valves for this purpose; one for normal makeup, and one for fast makeup when operating the steam dump. A third makeup valve, manually controlled, is also provided.

Discussion of Shortcomings

(1) The control for the manual makeup valve is centrally located on console C01 near the condenser hot well display. Actual position of this third valve is not displayed; however, demanded position as generated by the controller is. As has been stated elsewhere, a knowledge of the position of the three automatically controlled valves could be used for early detection of steam plant leaks (alternatively, knowledge of makeup or rejection flow rates would be useful). The position of none of these valves is directly displayed to the operator. The positions of the automatic valves are recorded on the event recorder on the side of panel C13; however, the usefulness of their information for daily monitoring of inventory is questionable.

A.4.d. Indication and Control of Steam System Thermodynamic State

Except in extremely unusual circumstances, the steam generated by the Palisades steam

generator is saturated; a knowledge of pressure is all that is necessary to establish the thermodynamic state of the steam delivered to the turbine.

Discussion of Shortcomings

(1) The pressure of the steam generators is displayed on redundant steam generator pressure indicators located on backpanel C12. These displays are not readable with precision by the operator at his normal control station.

(2) The pressure delivered to the steam turbines is displayed directly on panel C01. In this case, the steam pressure is displayed in a horizonal array of similar appearing vertical meters. The indications of the other meters are not directly related to steam pressure, hence the display tends to be lost. Scale range selection for this particular indicator is inconsistent with the steam generator pressure meters on C12.

(3) Steam pressure is not normally controlled. The pressure inherent in a given power level of operation with a given reactor coolant average temperature is accepted. Under certain conditions, particularly at low power, however, control of steam pressure is necessary. This control is effected by dumping steam through turbine bypass valves or, when the condenser does not have a vacuum, to the atmosphere through steam dumps. Steam dump and turbine bypass controls are satisfactorily located on panel C01 near the related steam pressure display. The automatic setpoint selector on the turbine bypass controller is confusingly labeled. 100% setpoint results in a steam pressure setpoint of 1000 psi, and a 0% setpoint results in a steam pressure reference of 800 psi.

A.5. Distribution of Electric Power and Other Services

Guideline II.A.5."Distribute electrical power and other necessary services (such as air and cooling water) to the plant auxiliaries and control the production and the distribution of emergency electric power."

A.5.a. Electric Power Distribution

Distribution of electric power to plant auxiliaries is controlled from Panel C04, in the south west (front right) corner of the control room. Control room layout is depicted in Figure V-1.

Discussion of Shortcomings

(1) The displays and status lights on the C04 panel are not readily visible from the normal console control station; this requires the operator to leave this station when control action on the electrical distribution system is required.

(2) The mimic provided on C04 is extremely difficult to follow.

(3) Before tripping the unit, the house load must be shifted from the main generator bus to the offsite feeders. As a precautionary measure, the diesel generator is started prior to the shiftover. The transfer of house load is actually made by closing in the feeder breaker for each of the individual house load buses to the offsite source. After a 3 cycle delay, the feeder breaker from the station generator is automatically tripped. The tripping action is apparently triggered by a contact on the breaker position switch; the operators indicate that on some occasions the offsite feeder breaker has failed to close, but the generator feeder breaker has tripped. The consequences of this is to leave an important segment of the house load without power, at least until the diesel can be closed in. For the

4160V buses (which provide the coolant pumps and other important large loads) and for 2400V bus 1E, the diesels do not provide backup and the consequence of the malfunction described above is to leave the buses without power until a reclosure to the generator source can be effected. There is no reasonable or practical way of pre-testing the effectiveness of the transfer before the transfer is attempted.

(4) The breaker control switches are not provided with a separate tripped (i.e., unmatched flag) indicator light. After the transfer discussed in the preceding paragraph has been effected, the five feeder breakers which feed the five house buses from the generator output will be in a tripped state, i.e., a green light indicating an open breaker will be lit, but the red flag indicating that the last demanded position of the breaker was "closed" will be displayed on the switch escutcheon. Following the transfer to offsite power, the operator is instructed to "match flags". What this means is that he should go to each of the five generator feeder breakers and bring up a green flag by manually turning each of the five control switches to the trip or open position. The operators indicated that they can get a mindset wherein they bring up a green flag on all bus feeder breakers. They indicated that operators have made this mistake -- causing loss of power to one house bus -- at least once. In one case, loss of both vital 2400V busses occurred before the operator could stop himself.

(5) Various losses of DC buses challenge the ability of the operators to control the plant, based on walkthroughs conducted at the plant simulator. Guidance and diagnostic assistance provided to the operators under losses of DC buses does not appear to be adequate.

(6) Several postulated losses of AC buses are difficult to diagnose quickly, partly because of multiple simultaneous alarm indications. Once diagnosed proper operator action appears to be adequately defined and executable. Based on walkthroughs conducted at the simulator a loss of instrument bus Y-01 is particularly difficult to diagnose quickly. Even more challenging for both diagnosis and corrective action is a loss of offsite power while diesel 1-1 is unavailable (down for maintenance) since (based on the Palisades simulator) this combination also appears to result in loss of instrument bus Y-01 and loss of instrument air.

(7) Identification of powered/not powered status of various equipment is difficult under various losses of power.

(8) During the loss of all AC incident in January, 1984, operators did not know the diesel was failing from alarms/indications in control room; smoke was noticed by auxiliary operator.

A.5.b. <u>Service Water and Component Cooling Systems</u>

Waste heat generated by plant machinery is, generally speaking, rejected via the service water system. For some systems -- most notably coolant pumps, charging pumps, coolant letdown, and shutdown cooling -- an intermediate closed system is provided: the component cooling system.

<u>Discussion of Shortcomings</u>

(1) Controls and displays for both of these systems are located at the left end of console C03. The controls for both systems are intermingled with each other, and with those for the containment cooling and other miscellaneous systems. They are also confusingly labeled. Based on conversations with

control room operators, this has led to confusion in operating controls on this panel.

A.5.c. Control and Instrument Air Systems

Instrument air alarms are at the extreme left end of the annunciator panel above C13, near the corresponding air system controls available to the operator on panel C13. Based on walkthroughs of various losses of instrument air at the simulator, the operators appeared to have no trouble reacting to malfunctions in this system. It is noted that these walkthroughs were conducted following the relabeling and demarcation effort; prior to this the controls for the air system were located in a confusing array of pumps and fans.

A.6. Control of Radioactive Material

Guideline II.A.6. **"Maintain control of radioactive material which may be contained in any of the systems which are the control room operators' responsibility. This includes the responsibility to maintain the leaktight integrity and pressure of the reactor containment. Monitor radioactivity of all streams with potential release to the environment. (Also included is monitoring and isolation, if necessary, of the waste gas and liquid discharge.)"**

Radiation monitors are located on the back of panels C11 and on panels C115 and C207. If a high radiation level is detected, an annunciator alarm will flash and there will be an audible alarm. To determine the location of high activity the operator must walk to the monitor at the back of the panel. The "alert" level (as opposed to a "high" level) on the monitors does not give an alarm. An "alert" level would be noticed at the beginning of a shift when an operator logs in monitor readings.

Operators may call on a radio-chemist to perform a radiochemical analysis to determine the presence or absence of radioactive material. On weekends the chemists work two shifts and are "on call" during the third shift.

Discussion of Shortcomings

(1) Keeping containment pressure below 0.9 psig during startup is reported to be difficult at times now that containment purge valves have been removed. This may slow down bringing the plant to power. This potential difficulty arises from regulatory and engineering requirements and is not considered a human factors deficiency.

(2) Very early in the Palisades plant operating history (1974) the AEC fined CPCo for violations of AEC requirements regarding control of radioactive releases and reporting of effluent discharge activity levels. In 1979, NRC fined CPCo for not maintaining containment integrity during power operation by leaving open two manual containment isolation valves. The principal cause of these early deficiencies was concluded to be procedural inadequacies rather than discrepancies of a human factors nature. Extensive corrective actions of a procedural and administrative nature were undertaken by CPCo in both of these instances. Review of more recent plant records indicates no further problems with control of radioactive releases or with effluent discharge.

The operators also reported no further difficulties in control of radioactive material.

(3) Individual radiation monitors are located on the back side of the vertical panels in the control room, out of the operator's field of view. Knowledge of the readings, particularly of the process monitors, would be useful in diagnosis of some events such as steam generator tube leaks.

A.7. Control of the Inventory and Location of Fissionable Material During Refueling

Guideline II.A.7 - "Maintain control of the inventory and location of fissionable material."

During refueling the operators control the refueling equipment as well as perform normal

activities. They go to twelve-on, twelve-off shifts. During a shift, 4 hours are spent on normal control room duties, 4 hours monitoring the refueling in the control room, and 4 hours on the refueling machine.

Normally the No. 1 operator runs the refueling machine in the containment while the No. 2 operator is responsible for the service platform in the fuel handling building. The licensed operators also uncouple and couple control rods. Each movement is individually authorized by the operator in the control room.

Discussion of Shortcomings

(1) The use of licensed control room operators to physically "drive" the refueling machine and service platform puts a significant manning burden on the operators. It effectively requires at least four licensed operators per shift -- twice the normal number. The heavy overtime required to man refueling comes at the end of a plant shutdown evolution and at a time of significant administrative burdens on the operators associated with the outage.

    The actual machine operations and their human factors were not considered to be within the scope of the control room review. However, there have been numerous instances of operator errors causing machine or equipment damage, e.g. breakage of TV cameras by running into obstructions and bending a control rod. It is also of concern that the machine operation is a direct hands-on operation, repetitive and tedious, quite different from what the operator does in the control room. The actual machine operation (particularly the refueling machine in the containment) is under hot, noisy, uncomfortable conditions requiring protective clothing. The control rod uncoupling operations are done on the reactor vessel head. This is also a disagreeable job and quite different from the normal control room work.

(2) There has been at least one instance where the wrong fuel assembly was picked up by the service platform operator, sent through the

transfer system, and installed in the core. It then had to be removed and the correct fuel assembly installed. Discussion with the operators indicated that the service platform operator cannot communicate with the control room from his seat on the machine and consequently the double checking of coordinate positions is difficult. He can only talk to the control room by going to an intercom on the wall of the fuel building. In contrast, there is direct communication from the refueling machine in the containment to the control room and the operator can call off his position to the operator in the control room as a double check that he is at the correct location.

A.8. Control of Operators' Logs, Procedures, and Checklists

Guideline II.A.8 - "Maintain control of and complete entries in the operators' logs, procedures, and checklists."

The evaluation of this guideline was based primarily on the interviews of the operators and their comments during walkthroughs. As would be expected, the operators found the burden of paperwork unpleasant and sometime distracting; however, no serious problem was identified.

Consumers Power has been upgrading the existing P&ID's to improve their readability and incorporate computer aided drafting to make it easier to keep them accurate when plant changes are made.

Operator logs were examined in the course of the review of experience of Palisades and were found to be a useful source of information regarding varius off-normal events and malfunctions. Comparison of operator logs with other documentation such as Event Reports indicated that the operator logs were used consistently and reliably to document unusual plant iterations.

It appears that the existing responsibilities for logs can be carried out and that there is adequate control of other documents used by the operators.

A.9. Administrative Control of Maintenance, Repair, and Testing

Guideline II.A.9 - "Maintain administrative control of the maintenance, repair, testing, calibration, etc. in those systems under the control of the operators in the main control room."

Administrative control of maintenance of control room equipment and plant systems at Palisades is not judged to provide an excessive burden on the operators. Tagging of equipment out of service is controlled systematically with appropriately sized tags and forms.

Discussion of Shortcomings

(1) Determining the effect of removing particular equipment, especially power supplies, on availability of other equipment, power trains, etc. can be difficult especially with multiple maintenance in progress.

A.10. Control of Fire Fighting

Guideline II.A.10 - "Initiate those fire fighting actions which are controlled from the control room, e.g., activating deluge valves, starting pumps, obtaining help in fire fighting. In addition, the operators are responsible to initiate those actions in the systems under their control which may be needed to compensate for fire damage."

The responsibilities of control room personnel during plant fires are defined in the Fire Protection Implementing Procedures. Responsibilities include determining the location of the fire (from alarms or telephone reports), communicating information to plant personnel and fire brigade members and performing a plant shutdown if the fire threatens safety related equipment. Equipment necessary for fighting fire (e.g. fire pumps) are automatic and controlled remote from the control room, thus the control room has no functions other than to monitor and communicate status.

Discussion of Shortcomings

Panel C47 is an annunciator panel for smoke detectors in various parts of the plant. This panel is mounted on the south control room wall at the south west corner of the control room. Panel C47 has an audible alarm which is louder than any of the other alarms in the control room. An alarm at C47 also results in an alarm on the main annunciator panel. Silencing the alarm requires the operator to go to the panel and leave the main control area. This panel does not have reflash capability; consequently if a second alarm comes in after the first one has been acknowledged but not cleared, the second alarm may not be annunciated, either audibly or at the main alarm panel although a light will flash at the local C47 panel. As a result, operators are currently instructed to survey this panel once every hour. This is discussed further in Section V.F.2.f.

A.11. Control of Site Emergency

Guidelines II.A.11. - "Recognize symptoms requiring activation of the site emergency plan, declare the appropriate action level and initiate approprite corrective actions and communications."

The responsibilities of control room personnel in activating the Site Emergency Plan are defined in the Emergency Plan Implementing Procedures. Responsibilities incude identifying symptoms for each emergency classification, notifying appropriate plant personnel and state and federal agencies, and taking the necessary actions to maintain or restore the plant to stable conditions. Implementation of the Emergency Plan requires an integrated knowledge of the status of plant and equipment conditions. There are no specific control and display requirements associated with control of the Site Emergencies Plan, however, improvements in human factors in general makes the assessment of plant conditions easier thus improving the capability to perform the control room assessment function.

A.12. Control of Plant Effluent

Guideline II.A.12 - "Monitor effluent temperature and chemistry and initiate dilution as required."

Monitoring of plant effluents to assure compliance with the National Pollutant Discharge Elimination System (NPDES) permit is performed by the Plant Chemistry Department. The only control room manipulations associated with operating within the NPDES permit is to realign the circulating water system blowdown and dilution valves as requested by the Chemistry Department. Appropriate displays and controls for performing this valve realignment are located on the C-126 panel in the rear of the control room.

A.13. Communications With Power Controller

Guidelime II.A.13 - "Maintain communications with power controller concerning changes in power and switchyard operations."

The operators communications with the power controller are very limited and the operators indicated it posed no burden or problem. Switchyard communication is also limited and no problems were reported.

B. Controls and Displays Required in the Control Room

The principal objective of this evaluation (see Guidelines II.B.) is to identify those displays and controls which are absent from the control room which operational requirements indicate should be located there.

The following displays currently not provided in the control room, are considered to be needed:

B.1. Wide range hot leg (T_h) temperature.

This indication would be used with a wide range T_c indication during cooldown under natural circulation conditions. Natural circulation cooldown is required by procedure for any evolution in which high pressure coolant injection is initiated.

B.2. Wide range subcooling.

This indication would be used during overcooling accidents, small leaks and other evolutions involving plant cooldown. It is important for the

operator to have an indication of subcooling throughout the cooldown. The current indication is invalid at temperatures below 515°F.

B.3. Air ejector exhaust flow.

As discussed in Section A.2d, above, an absence of this flow is a precursor to the loss of condenser vacuum. An increase in the amount of flow is indicative of an air leak. Such leaks must be corrected to maintain condensate water chemistry.

B.4. Individual radiation monitor indications.

Individual radiation monitors are located on the back side of the vertical panels in the control room, out of the operator's field of view. Knowledge of the readings, particularly of the process monitors, would be useful in diagnosis of some events such as steam generator tube leaks.

B.5. Secondary plant makeup flow.

Although the position of certain of the condensate makeup and dump valves are recorded on the event recorder, the use of this recorder to determine a significant change in makeup rate (as would be indicative of a condensate feed or steam system leak) is not possible. A direct indication of makeup (or reject) flow would be useful.

B.6. No. 6 feedwater heater level.

Although levels for all other feedwater heaters are indicated, the No. 6 level is not. A high level in this heater can result in water ingestion in the turbine and if the non-return valve fails to close, overspeed during a turbine trip. A high level alarm is provided for this variable.

C. Availability of Personnel

During normal operations at power, two licensed operators are normally present in the Palisades Control Room: the No. 1 operator (the more senior of the two operators), has overall operational responsibility. He typically is responsible for operation of the steam plant controls and supervises the No. 2 operator in operating the reactor controls. The No. 1 operator is

also responsible for switching and tagging -- that is, supervision of maintenance activity from a personnel and plant safety viewpoint.

C.1. The No. 2 operator, also licensed, but less senior, is responsible for reactor controls as indicated above. During normal operations at power, the burden does not seem excessive. During startups, however, it is not clear that two operators can effectively perform all switching and tagging and logging operations plus startup operations, plus manually control steam generator water level (a more or less continuing responsibility throughout a startup).

C.2. During off-normal evolutions, and particularly fast-paced ones, two operators again appear able to handle the hands-on control and display-reading activity. However, it is questionable whether the evaluation and diagnostic activity necessary in such a situation and the consultation of procedures, also necessary in such situations, can effectively be carried out by either the No. 1 or the No. 2 operator. Such diagnostic and supervisory responsibilities normally reside in the shift supervisor. Operators indicated that a shift supervisor will often be present in the Control Room during off-normal evolutions, and would effectively discharge these duties.

C.3. Procedural walkthroughs indicated that the need to operate certain controls not currently located in the control room place a burden on the current control room manning levels. Specifically:

- Opening individual main steam isolation valves is not possible from within the control room.
- Isolating a stuck-open atmospheric steam dump (or turbine bypass) requires the operator to leave the control room.

Further comments regarding difficulty of operator tasks are discussed in Section V.A. The personnel requirements during fuel handling were discussed previously in Section IV.A.7.

D. Prioritization of Control and Display Locations

With regard to priority of arrangements, of control panels as well as of functional groups of controls and displays the key is that the operators be able to execute their responsibilities in off-normal situations without leaving their normal stations in front of the console. As has been indicated in the previous discussion, there are a number of controls and displays for which this requirement is not met. Specifically:

D.1. The readability of recorders and indicators on backpanels is not satisfactory, and the location of certain critical displays on the backpanel requires that the operators circle around behind the console to read such indicators during off-normal events. Examples of critical indicators located on backpanels include:

- wide range coolant temperature indication,
- individual narrow ranged hot and cold leg temperature indications,
- steam generator water level recorders,
- feed and steam flow recorders,
- containment sump level indicator,
- "SIRW" tank level indicator, and
- condensate water storage tank level indicator.

D.2. The location of the electric panel C04 beyond and beside console C11 may require that one of the operators leave his station in front of the console following a reactor trip or power distribution system upset.

D.3. High pressure and low pressure emergency coolant injection are manually initiated by pushbuttons on backpanel C13.

E. Key Process Variables

This guideline states that preferably the operators should be provided with diverse means for confirming

the reasonableness of the information they are presented on certain key process variables. Examples of key process variables include:

- reactivity
- reactor coolant conditions
- steam system conditions
- reactor thermal power
- off gas radiation levels and concentrations, and
- availability of electric power

The plant computer and the Critical Function Monitor provide extensive plant information which can effectively assist the operator in confirming trending and diagnosing plant state based on key "critical function" as well as detailed specific plant parameters. Thus, the operator is considered to have adequate and diverse presentation of key process variables.

V. HUMAN ENGINEERING FINDINGS AND OBSERVATIONS

This section of the report presents the human engineering findings and observations made by the review team in the course of the human factors review. These findings are largely based on comparison of the control room to detailed human engineering guidelines (Appendix A, Section III). They also draw on the procedure walk-throughs at the full scale control room mock-up and Palisades simulator and thus some of these findings and observations may also be discussed in Section IV, above. A general layout of the control room showing the locations of the major equipment and giving the alphanumeric panel designations used in this section is found at the end of this section as Figure V-1.

A. General Guidelines

A.1. Location

The majority of controls and related displays have compatible relationships in that they are located within the same area of the control panel. The primary exceptions are several displays located on the backpanels (C11, C12 and C13) which are used by an operator stationed at the main panels (C01, C02, and C03). Examples of such related controls/displays include:

- the steam generator flows and water level on the back panel with the related flow controls on the front panel,
- the primary coolant cold leg temperatures on the back panel with primary temperature controls on the front panel, and
- safety injection flows and levels on the back panel with the flow controls on the front panel.

A.2. Operational Status

The operational status of controls such as valves, pumps, breakers, etc. is usually indicated by status lights above the controls. These status lights generally follow a consistent color code supplemented by a positional stereotype. Green

status lights mean off, de-energized, not flowing, and red lights mean on, energized, flowing. The green light (off, etc.) is to the left of the red light (on, etc.). This color code is in common use by utilities and is strongly ingrained, and no change is recommended. However, red and green are also used on occasion to indicate status information other than the above conditions. Instances of this are included in Table VI-2. The use of color codes is discussed further below.

The status lights for valves in almost all cases provide an indication of actual valve position, and not just the demanded position. Based on a review of the P&IDs, however, there appear to be a few valves for which the actual valve position is not indicated. These are summarized in Table VI-3.

Finally there are a few controls for which no indicating lights are provided, that is, the feedback provided to the operator comes from changes in plant parameters and other displays but no direct evidence of control actuation is provided. These controls listed are in Table VI-25.

A.3. <u>Normal, Off-Normal Codes</u>

The normal (at power) positions for many controls in the control room are indicated by black dots. These dots are located on the panels next to the indicating lights normally lit or next to the normal switch position label. These dots can be used effectively by the operators as a quick check to verify proper control line-up under normal power conditions. This aid in determining the normal status quickly may be even more effective if used for a more limited, critical set of controls. There is no formal system for controlling the application and removal of the dots.

There is no uniform color code convention (such as a yellow light) to indicate off-normal status. The meanings currently attributed to various colors are summarized in Table VI-2.

A.4. Detection of Non-Functional Instruments and Controls

Most meter scales in the Palisades control room fail down-scale. This often allows a failed or non-functional meter to be distinguished from a normally operating meter. There is no separate "power lost" position or indication on the meters.

The Sigma meters added during the 1981 refueling outage remain "as-is" upon loss of power. These meters include small green power-on lights to show when power is lost. This is opposite to the usual meaning of green on the panel. Also, there are many other green lights on the panel so that the power-on light tends to be lost. There is also no way to tell easily from a distance whether a Sigma meter is "new" or "old" (The old meters fail down scale and have no green lights).

Each of the main alarm annunciator panels have a specially marked (green) window which indicates when power has been lost to the panel.

Loss of power to the controls and instruments on the panels, however, is not annunciated. Thus, at least for some controls and instruments there is no unambiguous means to distinguish between functioning and non-functioning controls and instruments. The position indicating lights for some valves, for example, are powered by a different electrical source than the valves themselves.

A.5. Control Room Communications

An evaluation of control room communications was performed as part of the environmental review and operator interviews. Results are included in Appendix C.

A.6. Tag-out of Controls and Displays

Temporary yellow caution tags or stickers are attached to controls or displays which are non-functional. These tags are small enough that they do not obscure adjacent controls and displays nor the identification label of the tagged control or display. No change to the tag-out system is required.

A.7. Maintainability of Replacement Hardware

Any specific hardware changes that are made to this control room as a result of this review have been checked for maintainability according to the guidelines in Appendix A.

A.8. Difficulty of Operator Tasks

No control operations were identified which overtaxed the physical capabilities of the operators. However, see Section V.B.2, where the broken switch handles on the injection valves can make operation difficult.

The difficulties in controlling the steam generator (water level and feedwater flow) at low power are discussed in Section IV. No other tasks were identified in the procedural walk-throughs which require continuous concentration and operation using the feedback generated by previous control actions.

Several plant evolutions currently may require the operator to leave the control room. These include:

- isolation of individual steam dump valves

- opening of individual main steam isolation valves (MSIV)

Some areas of the control panels present challenges to the memory and concentration of the operator in that controls for different systems may be interspersed within the same area of the control panel. This is especially true on panel C03 where controls and displays for component cooling, shield cooling, fuel pool cooling, containment air and service water are intermixed.

Availability of operating personnel has been discussed in Section IV.C of this report.

A.9. Distinction Between Revised Control Arrangement and Existing Arrangement

Changes to be made to the control room as a result of this control room review were checked to assure that the changes were sufficiently distinctive

that previous operator training and habits will not cause error. Relabeling and demarcation of the simulator was done at the same time as the control room so that training is being performed on an accurate duplicate of the control room.

A.10. Functional Labeling of Control Panel Sections

Although many of the control panels are distinguishable by functional groups (e.g. steam generator controls are on the left hand side of panel C01), labels identifying such functional grouping are not currently used.

An additional benefit of implementing the relabeling and demarcation on the simulator is that the simulator will systematically exercise unusual scenarios and transients and thus will identify potential problems with the relabeling and demarcation under these conditions.

B. Controls

B.1. Location

The main control area is at control panels C01, C02, and C03, directly in front of the operators' desks. The most often used controls are accessible on the main control panels, C01, C02 and C03. As indicated in Figure V-1, these panels include the controls for the turbine generator, control rods, steam generator, pressurizer, the chemical and volume control system, the primary coolant pumps, service water and component cooling water systems.

The reactor trip buttons on panels C02 and C06 and the unit emergency trip button on C01 are prominent and easily accessible. The controls for the safety injection system are split between main panel C03 and backpanel C13, directly behind C03. The electrical distribution and emergency power panel, C04, is readily accessible although not fully visible from the main control panels.

For some groups of controls, the location of individual controls within that group does not follow the expected alphabetic or numeric progression of left-to-right or top-to-bottom. For example the "B" boric acid pump is to the left

of the "A" boric acid pump rather than the expected progression of A-B. Table VI-4 identifies those controls which do not follow the expected alphabetic or numeric progression.

Mirror image groups of controls, usually considered undesirable, are used on a few panels, as described in Table VI-5. Many of those groups are mirrored partly and inconsistently.

B.2. Operation

Controls are easily operated except as noted below:

- Several control handles have been broken off. This is the case for the Safety Injection Loop 2B Low Pressure and High Pressure valves (MO-3014 and MO-3042) on panel C03.

- The spring loaded rotary switches MOV-5311 (labeled DIL PP P40A to MIX BASIN), MOV-5312, MOV-5313 and MOV-5314 on the cooling tower panel have to be held against a spring force for approximately 45 seconds before valves are fully open. A similar, but less bothersome condition was noted by one operator with the "Matrix Relay Hold" switch on C06.

- One operator indicated the push-button lighted indicators on the cooling tower panel and the test push buttons on the radiation monitors on the back of panel C11 were relatively easy to break.

- The Linear Power Channel Test circular switch on C06 was considered too sensitive and "flakey" by one operator.

- On the new controllers for auxiliary feed, push buttons are used as a variable rate device. A light push results in a small valve motion, a heavy push (past a detent) results in a larger motion. One operator found this different type of control unusual and somewhat difficult to operate smoothly (he tended to get too much valve motion).

The direction of operation of rotary valves usually follows a consistent set of conventions, i.e., controls rotate counterclockwise to close a valve, trip a pump or turn something off. The open position is normally to the right of the close position. The only noted exceptions to these conventions are listed below:

°	Panel C01	-	Moist Sep Drn Tank/Htrs E5A&B Diff Press Cont CV 0610
		-	Base Adjuster (raise-counter-clockwise, lower - clockwise)
°	Panel C02	-	The controllers for the shutdown cooling heat exchanger by-pass valve, CV-3006
			The low pressure letdown temperature control valve, CV-0909
°	Panel C04	-	Diesel governor setpoint controls (raise-counter-clockwise, lower - clockwise)
°	Panel C13	-	Switches for containment lights and containment emergency lights

On flow controllers the "auto" position is not consistently positioned with respect to the "manual" position. That is, "auto" is sometimes to the right and sometimes to the left of "manual", depending on the make of flow controller being used. This does not appear to present a problem to the operators and no corrective action is considered necessary.

On three-position rotary controllers, there is no consistent positioning of "off", "auto" and

"manual". The desirable order is usually "off" "auto" and "man". It is recognized, however, that for some rotary controllers, a different order may be desirable, for example, to avoid passing through "auto" when turning a pump off. The following are instances of non-standard position order:

°	Panel C02	-	Pressurizer Heater Controls PCP Oil Lift Pumps
°	Panel C11	-	Domestic Water Storage Tank fill valve CV2001 Primary System Storage Tank fill valve CV2008 Cond Storage Tank fill valve CV2010
°	Panel C13	-	Air Compressors

The position indicating lights for controls are usually consistently placed with respect to the position of the control, e.g., the "open" light is above the "open" position of the control. Instances where this is not the case are described in Table VI-6.

There are a relatively large number of key operated controls. Although the guideline conventions of having the key slots vertical with the key removed is not generally followed, this does not seem to be a serious detriment and no action is recommended. Similarly, there are a few violations of the guideline convention to have the detents oriented upward (e.g. CV-0741 and CV-0742 on C01). Since operation of each key-lock switch is a slow, deliberate action, this is not considered a significant detriment and no action is recommended. The walk-throughs have not identified any case where the key locked control has to be operated quickly; however, specific evaluation of each key lock control was not performed to determine whether the inherent delay in its operation (to get the key) is a problem.

Control position is easily identifiable in that there are usually both a position light and orientation of switch handle to indicate the control position.

B.3. Type

Control types are generally consistent and easily identifiable. Valve controls are usually finger-grip rotary controls while motor controls and breakers are pistol-grip controls. Safety injection inlet valves use long handled rotary switches. Push buttons are used for the cooling tower fan controls. There are a few exceptions to these conventions as noted in Table VI-7.

B.4. Protection

Generally, the controls are adequately separated and protected to avoid inadvertent actuation. MIL-STD-1472C (Reference 6) guidelines specify minimum separation between adjacent controls. The only exception to these guidelines noted for the Palisades controls are the primary coolant pump oil lift pumps. The separation between these adjacent controls is 7/8" rather than 1" as given in the MIL-STD. The operators reported no problems with these controls and no corrective action is warranted.

Several controls are specifically protected and/or identified to prevent inadvertent actuation. Specifically,

- protective collars are provided for trip buttons for turbine trip, reactor trip, and safety injection system manual initiation.
- handles are painted yellow for the primary coolant pumps, condensate pumps, and the volume control tank vent valve switch.

The electrical controls on panel C04 for station power, offsite power, and emergency power are somewhat liable to inadvertent actuation because of their location in a narrow passageway. The operators reported that instances of inadvertent actuation by maintenance personnel have occurred

at these panels. Operators also noted that all visitors to the control room are warned to use extreme caution in this passageway.

Finally, at the time of the control room review there was some potential for the cooling tower pump controls on C126 to be inadvertently tripped because they are located in a narrow passageway which was being used by security personnel in performing a firewatch.

B.5. Identification

Most controls are adequately identified with both a descriptive name and a particular component number. Controls which are missing an identifying label or position indication are listed in Table VI-8, together with displays whose identification is similarly inadequate. Those controls and displays which are identified with a descriptive name but not with a component number are listed in Table VI-9. Although not always essential, component numbers can assist in positive identification of controls and displays, especially in consultation of the P&IDs. Furthermore, some valve controls are labeled with the valve identifier number as well as with the corresponding hand-switch identifier number; sometimes only the valve number is used; sometimes only the hand-switch number is used. Usually, but not always, the hand-switch number is the same as the valve number.

Many of the labels could be improved to provide more complete and more accurate information. Examples of labels which appear to lack specific information or are unclear are listed in Table VI-10.

Several instances of inconsistent nomenclature are identified and summarized in Table VI-11. The most prominent of these are the labels associated with the primary coolant pumps and the labeling of the safety injection system channels.

Abbreviations are used widely and several are not obvious or consistent. Some abbreviations are followed by periods, others are not. On several indicator lights there are undefined abbreviations

engraved on the light caps. Table VI-12 lists those abbreviations which appear on the light caps which need to be made consistent and defined.

The legend plates are easily identified with their respective controls. In general, the legend plates are located above their controls, although some exceptions to this convention can be found on the main consoles (C01, C02 and C03). Letter size on all panels is adequate for viewing directly in front of the panel, with the exception of the small "2"s on the N_2H_4 labels which are 1/16" high. However, for several plant evolutions, displays and labels on the back panels (C11, C12 and C13) are used by an operator stationed at the front panel. At this distance the labels on the back panels are too small. For adequate readability at this distance of approximately 8 feet, the letter height would have to be approximately doubled to 0.25 inches (based on guidelines in Reference 5).

Several special labels giving information on precautions are used on various control room panels. In some instances it is not clear which controls these labels refer to and in some cases the statement of information or precaution is unclear. These cases are listed in Table VI-13.

Temporary labels (typewritten, pressure tape, labeling tape) are used on several panels. These are listed in Table VI-14. All temporary labels need to be replaced with standard, permanent labels, unless the information being displayed often changes. In the latter case, provision is needed for clear, durable labels that can also be changed easily.

The color coding used for labels and legend plates appears to be that identification legend plates are black with white letters but precautions and information labels can be various color combinations. The existing color coding is summarized in Table VI-2.

In some cases the meaning of the "manual" position for rotary controls is unclear; that is, it may actually mean "on" or "running".

B.6. Maintenance

Maintenance of light bulbs is discussed as part of the environmental review in Appendix C.

C. Displays

C.1. Location

As discussed in section A, above, displays are generally located in the same area as the related controls. However, within that general area, there is often no consistent relationship between the display location and the related control. Examples of displays whose locations do not correspond to their controls are noted in Table VI-15.

Some of the displays on the back panels are located too high for the operators to read accurately without using a stool. The tops of the displays on panels C11, C12 and C13 are from 80 inches to 90 inches off the floor. These are listed in Table VI-24. Some of these displays apparently rarely require close observation, (such as the primary coolant pump vibration monitor).

As with controls, the orientation of multiple displays should follow the expected left-to-right or top-to-bottom alphabetic or numeric progression. Displays which violate this convention are listed in Table VI-16.

Operations of controls in the Palisades control room generally do not obscure their related displays. The only potential exception are the pump controls on the backboard on panel C03 with some related displays on the benchboard, below the controls. Specifically, currents for component cooling water pumps P52C and P52B are located directly below the handles for their respective controls. This is not considered a problem serious enough to warrant moving the controls or displays.

Groups of displays which appear in mirrored sequences have been listed previously in Table VI-5.

C.2. Scales

The graduations on the scales used with the displays are adequate for viewing in front of the panel. For display scales on the back panel viewed from the front panel, the graduations are not distinguishable but the operator can reliably determine the relative position of the display pointer with respect to the set points (if any) indicated on the display.

The ranges indicated on the scales are adequate for both normal and off-normal conditions with a few apparent exceptions, listed in Table VI-17.

Most displays employ a usual numerical progression for the major scale divisions such as 0, 50, 100 or 0, 20, 40, 60, 80, 100, etc. When a multiplier is used it is usually a factor of 10. Those scales which violate these conventions are listed in Table VI-18.

The units on some of the displays are not specified. These are listed in Table VI-19. In addition a large number of scales are displayed in percent rather than engineering units. Although this may be appropriate in many cases, the equivalence between the scale reading and the actual engineering unit may not be readily available to the operator. Table VI-20 lists those scales calibrated in percent and gives the approximate equivalent of the 100% reading in engineering units.

Multiple displays of the same parameter use consistent scales with the exception of the containment building pressure. On panel C03 the units are psia and the range is 0-100 psia while on panel C13 the units are psig and the scale range is 0-5 psig. The scales on these units should be consistent.

C.3. Identification

The guidelines for identification of displays are similar to those for controls, as discussed previously. Although most displays are identified properly, some are unlabeled (see Table VI-8 and some do not have identifying numbers (see Table VI-9). Those display labels that appear to

lack information or are unclear are listed in Table VI-10. Problems specific to indicating lights are identified in Table VI-21.

Legend plates are located unambiguously, i.e. it is clear to which display they apply. Typically, legend plates are located above their respective displays and below their respective indicating lights.

The set point markers on meters are easy to see and to compare to the pointer. A few displays for which set point indications apparently would be appropriate do not have permanent setpoint markers. These are listed in Table VI-22. Temporary and handwritten set points should be made permanent (except for any which may change frequently).

Legend plates for displays are similar to those used for controls, and the previous comments for controls apply to displays as well. Specifically, the letter size on the legends is adequate except for those displays on the back panel which are used by an operator at the front panel. All legend plates are black with white letters except for the typewritten labels (white paper with black letters) or handwritten information directly on the panel. The temporary labels and the typewritten labels listed in Table VI-14.

The color convention for the indicating lights is that red means a component is on or open and green that the component is off or closed. However, red and green are occasionally used to signify other conditions as well. Table VI-2 lists all of the colors used together with their meaning.

Several engraved plates listed below are filling in with dirt or wearing off.

° Several light cap engravings on panels C01, C02, C03, C04, C106 and C126;

° Numbers on the steam generator mimic on C12;

° "2"s for N_2 and H_2 on C126, (should be N_2 H_4); and

° NI REC-1 and NI REC-2 on C12.

Finally, special precaution labels are not always positioned in a logical and obvious relationship to the related displays. These are listed in Table VI-13.

C.4. Type

The display types, e.g., analog or digital, are appropriate for the displays used in the control room, and consistent types of displays are used for similar functions.

For some measurements displayed on the backpanel and used by an operator at the main panel, a larger or an additional display on the main panel would be appropriate. For example, steam generator level is indicated on a meter and recorder on the backpanel which cannot be read accurately from the front panel. These are discussed in Section III.B.2, above.

C.5. Maintenance

No significant maintenance concerns were noted in the review of the displays in the Palisades control room.

C.6. Recorders

Several problems with strip-chart recorders used in the control room were noted in the course of this review. Instances of inadequate labeling for recorders are included in Table VI-8. Other specific problems with recorders, including mechanical problems, are listed in Table VI-23.

C.7. CRT Displays

The Control Function Monitor System (CFMS) a CRT display for presentation of information. Review of the CFM is summarized below.

D. Process Computer and Critical Function Monitor

The control room computers include a primary computer (PIP) as well as a backup secondary computer, a data logger and a Critical Function Monitor. The primary computer is used largely by the operators to obtain periodic printouts of data. In addition it is used occasionally to obtain sensor information but available

on control board displays such as core exit thermocouples. It provides the operator wide range hot leg reactor coolant temperature information.

The data logger is used largely for recording long term data and for post-trip data analysis.

The Critical Function Monitoring System (CFMS) is a computer based system incorporated into the plant design to meet requirements for a Safety Parameter Display System (SPDS). The CFMS is a multicolor CRT based system providing multiple fixed format graphic displays. These displays are arranged in a hierarchy for efficient operator access. The top level display consists of status indicators providing an overall status of plant safety functions. Lower level display pages consist of mimics of various plant systems.

The capability to trend input parameters to the CFM/SPDS is provided. Two display pages of trend information can be accessed by the operator. Each trend page can display the time history of up to four parameters simultaneously. The parameters to be trended on a page and the time base to be utilized on that display page are selectable by the operator.

The CFM provide the capability for historical data storage and retrieval. All inputs to the CFM data base are included in the data storage. Data is stored at two resolutions. High resolution data is stored at two second intervals for the previous 16 hours while low resolution data is stored at one minute intervals for the previous two weeks. Capability is provided to dump the data to magnetic tape or the line printer for long term storage, or to view the data in graphic form on a system CRT.

Discussion of Shortcomings

- The top level alarm display of the CFMS was designed to alert the operator to the fact that one of the plant critical functions is in jeopardy. The alarms on this page are not consistent with the safety function status check utilized by the Emergency Procedure Guidelines.

- Only two trend display pages are available for use by all users of the CFMS (total of 4 CRT's). If one user is viewing a trend page it cannot be modified by any other user. During emergencies

all stations may simultaneously want to observe trends of different parameters resulting in confusion as several users try to trend display pages to suit their needs.

- Some text is displayed on the CFMS utilizing dark blue characters on a black background. The readability of this text is marginal.

E. Control Room Environment

The results of the review of the control room environment are summarized in Appendices C and H.

F. Alarms

This section presents the results of a general review of the Palisades Control Room alarms against the human factors guidelines of Appendix A Section III.F. The guidelines are divided into two major sections: one relating to the selection of alarms and the other related to their presentation. This discussion of the review will be similarly divided.

F.1. Selection

The guidelines for selection of alarms are intended to be applied on a detailed alarm-by-alarm basis. This review has not yet been conducted on that basis; however, a number of preliminary findings on the general aspects of alarm selection have been developed. These result from walk-through observations, operator interviews, comparisons of the alarms to the controls and displays on the console and panels, and comparison against the Palisades alarm response procedures.

F.1.a. Alarms Included

The selection of alarms appears to be generally workable in that no outstanding lack of alarms is present and the overall number is not overwhelming. The main group of alarm panels (above C-11, C-12, C-13 and C-06) involves a total of 494 windows. A few (approximately 10) were unused at the time the control room inventory was taken.

The operator's perception of the alarm systems selection of alarms as indicated by operator interviews was that the selection was largely satisfactory. However, a few were viewed by the operators as not being useful, for example, panel C-11 (K-05):

"ELEVATOR TROUBLE"

F.1.b. Dark at Power

It is apparent that the alarms have been selected to be dark when the plant is operating at full power with all systems operating normally. It appears from observations and comments of the operators that this is reasonably approximated in practice.

A major reason for alarm lights being on at power appears to be related to maintenance of the alarm system. It was found by observation and confirmed by operator comments that alarms may be out of service but the tile may be lighted and in a few cases even flashing. There is the possibility that this may have contributed to an incident where an operator ignored an alarm.

F.2. Presentation

The guidelines for presentation of alarms should be applied as part of the alarm-by-alarm reviews as for the guidelines for selection. There are, however, a number of general observations which have been developed as for the previous section on selection of alarms.

F.2.a. Combination of Alarms and "Reflash"

Combination of alarms and whether there is adequate "reflash" logic for those alarms which are combined can only be based on a detailed alarm-by-alarm review. The lack of reflash capability for the fire panel C47 is discussed in Section IV.A.10.

F.2.b. Grouping

The majority of the alarms are grouped by plant system or function. The detailed alarm-by-alarm review is needed to systematically identify those alarms that are improperly grouped.

A few individual alarms appear to be out of place in their current location. For example the K11 panel at the far left of the alarm panels (above C13) includes the "Diesel Generator Control Circuit Problem" alarm whereas all other alarms related to the diesel generator are properly located above the C-11 panel near the diesel generator controls. Similarly the "Low Subcooling Margin" alarm is on the K-11 panel whereas other related alarms are located properly above the C-12 panel.

In the main alarm panel some limited prioritization by color has been used. Particularly critical alarms are lighted red. These are:

Panel C-13 (K-11)	CIS INITIATED
Panel C-13 (K-11)	CRITICAL SERV. WATER HEADER "B" LO PRESSURE
Panel C-13 (K-11)	CRITICAL SERV. WATER HEADER "A" LO PRESSURE
Panel C-13 (K-11)	NON-CRITICAL SERV. WATER LO PRESSURE
Panel C-13 (K-13)	SAFETY INJ. INITIATED
Panel C-13 (K-13)	CONTAINMENT HI PRESS.
Panel C-13 (K-13)	CONTAINMENT HI PRESS.
Panel C-13 (K-13)	CONTAINMENT HI RADIATION
Panel C-13 (K-13)	SV AND/OR PORV OPEN
Panel C-12 (K-07)	NO PCS PROTECTION
Panel C-12 (K-09)	DROPPED ROD
Panel C-12 (K-09)	REACTOR TRIP
Panel C-11 (K-01)	TURBINE TRIP
Panel C-11 (K-03)	GENERATOR TRIP
Panel C-11 (K-05)	BATTERY CHARGERS POWER OFF
Panel C-11 (K-05)	125 VDC BUS GROUND
Panel C-11 (K-05)	125 VDC BUS UNDER VOLTAGE
Panel C-11 (K-05)	DIESEL GEN. NO. 1-1 FAIL TO START
Panel C-11 (K-05)	DIESEL GEN. NO. 1-2 FAIL TO START
Panel C-06 (A)	HIGH POWER LEVEL CHANNEL TRIP
Panel C-06 (A)	HIGH POWER RATE CHANNEL TRIP

Panel C-06 (A)	LOW FLOW CHANNEL TRIP
Panel C-06 (A)	LOW LEVEL SG1 CHANNEL TRIP
Panel C-06 (B)	LOW LEVEL SG2 CHANNEL TRIP
Panel C-06 (B)	LO PRESS SG1 CHANNEL TRIP
Panel C-06 (B)	LO PRESS SG2 CHANNEL TRIP
Panel C-06 (B)	HI PRESSURE PRESSURIZER CHANNEL TRIP
Panel C-06 (C)	TM/LO PRESSURE CHANNEL TRIP
Panel C-06 (C)	LOSS OF LOAD CHANNEL TRIP
Panel C-06 (C)	CONTAINMENT HI-PRESSURE TRIP
Panel C-06 (C)	DROPPED ROD
Panel C-06 (C)	LO NEUTRON DETECTOR VOLTAGE (CH 3-8)
Panel C-06 (D)	CHANNEL DEVIATION LEVEL 5%
Panel C-06 (D)	CHANNEL DEVIATION LEVEL 10%

All the alarms which indicate the failure of the 0.5 amp fuse on the particular alarm panel are color coded by lighting "green". There is no consistent location for the green light, however. There are also two other windows on the main panel which are lighted in green:

Panel C-06 (D)	ON THE LINE
Panel C-13 (K-13)	RADIATION MONITOR SAMPLERS FLOW FAILURE

There are also two main alarm windows which are yellow or at least appear to be a different hue from nearby red windows:

Panel C-13 (K-13)	PCS PRESS 325 PSIA
Panel C-11 (K-01)	CONDENSER PRIME REQUIRED

Although the prioritization by color is useful, it is not clear that it is consistently applied. Particularly troublesome is whether the "yellow" appearing windows are actually intended to be red and the use of green windows.

F.2.c. Proximity of Alarms to Related Controls and Displays

The majority of the alarms are localized relatively close to the controls and displays which the operator would have to consult in case the alarms were to activate. A detailed

alarm-by-alarm review is needed to identify those specific alarms which do not follow this general approach.

F.2.d. Annunciator Windows

Nomenclature and Abbreviations

There is consistency of much of the nomenclature and abbreviations. For example, the convention of first stating component or system and then the condition is almost universally followed, e.g.,

"SPENT FUEL
POOL
LO LEVEL"

Although review of the nomenclature, abbreviations, etc., should be done as part of the detailed alarm-by-alarm review, a preliminary review of some panels indicates there are a significant number of detail inconsistencies. As an example of these problems, reference should be made to Figure V-2 which shows the face of alarm panel K-13 on back panel C-13.

- Containment is abbreviated as both "CONT" and "CONTMT."
- The abbreviation "CONT." means both control and containment on the same window.
- Some abbreviations have periods, others do not.
- The abbreviation for circuit appears as both "CKT." and "CTK."

In addition, annunciator tile legends for two containment high pressure alarms are identical although they alarm at different pressure levels.

Finally, nomenclature used for preferred AC buses is bus 1 or bus Y-10; bus 2 or bus Y-20, etc; and the relation of these buses to reactor protection channels A, B, C, D is not clearly identified.

Lettering Size and Style

The lettering size and style used on the alarm windows is not uniform. The majority of the windows use a relatively compressed lettering of height 0.20 inch with a width of 0.10 inch. There are, however, many windows with larger letters (0.25 inch high by 0.18 inch wide). The quality of the larger lettering appears to be variable and less sharp than the smaller letters. It may be that the smaller letters are associated with the original alarms; however, added alarms have used the larger letters.

Using the recommendations of Reference 5 (Page 494) as a reasonable limit of visibility, the alarm panel should be readable at about six feet for the small letters and about eight feet for the larger letters. When the operator stands in front of the console his eyes are about seven feet from the alarm panel. This distance can be reduced to about six feet by leaning forward slightly. The alarm windows would not be expected to be readable unless the operator is standing almost directly in front of the alarming panel. Observations in the control room confirm this conclusion. The alarm legends are essentially unreadable from the operator's desks in the center of the control room. However, because the alarms are relatively well grouped, the operator often can tell at least the general subject of the alarm.

It would be desirable to increase the legibility of the alarm windows so that:

- The operators could read the windows from their desks;

- An operator, other than the one actually standing in front of the panel, could tell what is alarming, if he also wished; and

- The Shift Supervisor could confirm the alarm situation as soon as he enters the control room.

Identification

Each annunciator panel is uniquely identified; however, these letters are essentially the same size as the lettering on the windows and, consequently, are no more readable. Furthermore, the numbers from left to right are not in a normal order, i.e., they are K11, K13, K07, K09, K01, K03 and K05. The back panels, on the other hand, are numbered C13, C12, and C11 from left to right.

Within the array of windows on the alarm panel for the purpose of reference in the alarm response procedures the windows are identified by numbers which start with one (1) in the upper left corner, go down the column to six (6), then starting with the next column to the right they continue from seven (7) to twelve (12), etc. To find a particular alarm window, the operator must count the columns, multiply by six, and add the position in the column. There is no labeling on the panels to assist the operator in this regard.

F.2.e. Acknowledgement - Visibility

The overhead annunciators are acknowledged and silenced at the console segment directly in front of the alarm panel. Other panels in the room (except those on C06, see below) are acknowledged at the panel on which they are mounted.

The alarms on the protection system panels (C06) are acknowledged from the station at the center of the main console. They are not readable from that location; however, there are only a limited number of them and they are in relatively easily remembered groups. It appears that the operator gets the necessary information without actually reading the tile. Consequently, this does not appear to be a serious shortcoming.

F.2.f. Acknowledgement - Proximity to Controls and Displays

The fire alarm (Panel C-47) is a very distinctive and very loud alarm. The first action by an operator in case of that alarm would be to go to Panel C-47 which is in the far back corner of the room to establish the source of the alarm so that he can direct the action. The fire alarm not only alarms on the local panel, there is also an alarm window on the main annunciator panel (C-13, K-11, No. 48). This alarm must be silenced and acknowledged on the left segment of the main console. The fire panel (C-47) is reached by going around the right end of the main console. Since the fire alarm is loud and distinctive, the additional alert from the main annunciator appears unnecessary and could delay the operator finding the fire location since he would have to acknowledge the main annunciator before going to the fire panel.

It should be noted that the fire alarm bell can apparently be silenced by a single switch. If that is the case, and the alarm can easily be turned off, that feature would have to be deleted before eliminating the window on the main annunicators. This panel is also discussed in Section IV.A.10 of this report.

F.2.g. Audible Tones

Specific information on the level and characteristics of the audible tones is provided in the environmental review (Appendix C). The main alarm audible tone is a chime which is very distinctive. The main annunciator audible tone is complemented by blue lights which key the operator as to which of the main annunciator panels is alarming. This appears to be an effective system and the operators expressed a high level of satisfaction with it.

Subsidiary alarm panels in the control rooms cannot be mistaken for the main alarm audible tone; however, there is no particular effort

to make them individually distinctive. Although they are different, they are generally in the same direction so that directionality provides little help to the operator. Because of the general lack of a critical nature to these alarms, this does not appear to be a serious shortcoming. However, based both on measurements and subjective evaluation, the sound level for alarm Panel C106 is too low.

F.2.h. <u>Flash Rates</u>

Flash rates are clearly distinguishable. Faster flashes being used for a new alarm and slow flashes for a cleared alarm.

F.2.i. <u>Annunciator Lights</u>

Specific measurements of the brightness of annunciator lights were taken in the environmental review (Appendix C). Examination of the actual control room indicates there are no problems with establishing which alarms are lit, nor are they annoyingly bright.

F.2.j. <u>Sequence of Multiple Alarms</u>

The Palisades control room has limited ability to reconstruct a sequence of alarms because the feedwater purity data logger used for this purpose does not appear to be reliable.

There are currently two additonal sources of information which can be used to reconstruct a sequence of events: the reactor protection panel, and an event recorder. These provide only limited capability in this regard.

F.2.k. <u>Annunciator Ringback</u>

It is believed that most alarms "ringback". "Ringback" in an annunciator sequence provides a second visual and auditory indication that an alarm which was previously received and acknowledged has now cleared -- gone back to normal. A separate "reset"

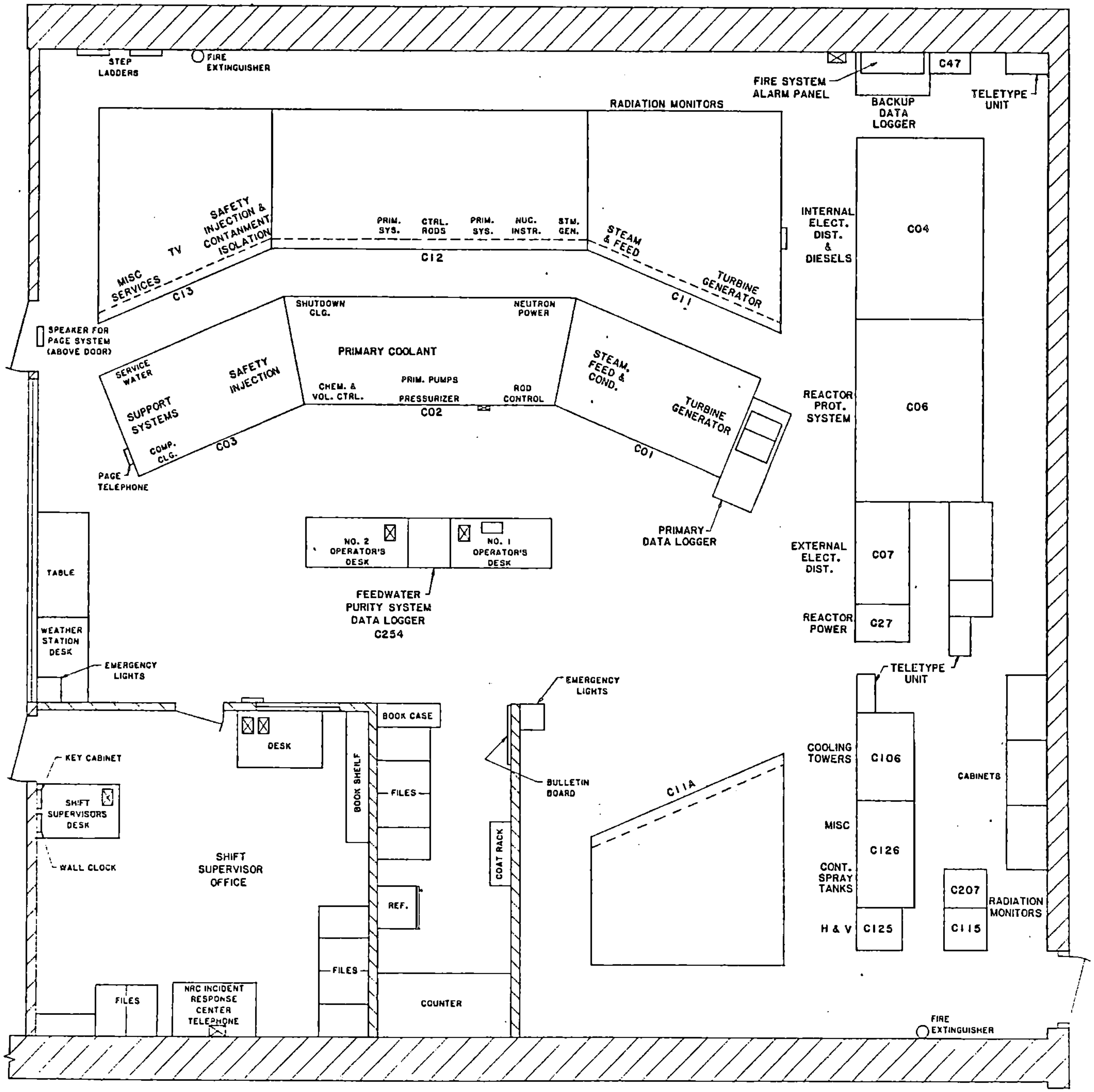
control is typically provided. The alarm response procedures do not indicate whether an alarm has a "ringback" feature.

F.2.l. Silencing

Alarms are silenced at the same individual stations by the acknowledge control. The audio acknowledge control is not separate from the visual acknowledge control.

F.2.m. Tagout

Malfunctioning annunciators are indicated by distinctive yellow tags which are placed on the face (edge or corner usually so as not to obscure the legend) of the window. In some cases, the tagged window is lighted, in other cases it is dark, and in at least one observed case it was flashing. This can confuse the operators' recognition of real, working alarms (see also previous item F.1.b.).



PALISADES CONTROL ROOM
OVERALL ARRANGEMENT

FIGURE V-1

VI. ASSESSMENT OF HUMAN ENGINEERING DISCREPANCIES AND DEFINITION OF CORRECTIVE ACTION

The purpose of this section is to list each of the Human Engineering Discrepancies (HED) identified in the course of this review and to define corrective action as appropriate.

The summary tables at the end of this section include the following:

- a summary description of each HED;
- a reference to the appropriate section of this report which discusses the HED;
- the corrective action to be taken, if appropriate;
- the justification for not taking corrective action, if none is required;
- a priority assignment for each corrective action;
- a reference to additional documentation, if appropriate; for example, the Action Item Record (AIR) number assigned by CPCo to implement and follow the recommended corrective action; and
- the scheduled completion date for the recommended corrective action.

These items are discussed in more detail below.

A. Assignment of Corrective Action

Each HED has been considered by the Review Team. First, the finding was reviewed to determine whether it is factually correct and whether it constitutes a violation of human factors guidelines. Then either appropriate corrective action was defined or if no corrective action is required, the reasons for this were documented.

For those human factors findings for which the consensus of the review team is that some action is needed, a corrective action has been identified. The action to resolve a particular human factors problem

may or may not involve physical changes to the existing configuration. Some hardware changes may be desirable and practical; however, in some instances the most practical way to meet the concern that a human factors guideline addresses is through the use of modified procedures and training which is specifically directed at compensating for the existing configuration.

In selecting a corrective action the review team considered a number of factors. The most important of these were:

- the relative effectiveness of the action in correcting the problem;
- the relative practicality and ability to implement the action promptly;
- the potential for the action to introduce other human factors problems;
- the impact of the action on the operator's training, practices, and habits; and
- the compatibility of the action with other requirements, e.g., fire protection and separation.

A large number of HEDs have already been corrected. An extensive relabeling and demarcation effort was implemented during the 1983 refueling outage and following the 1985 refueling outage.

Examples of problems which have been addressed include:

- labels which were wordy, used small letters and did not use functional groupings;
- identification of displays on the back panels such that an operator can use them from his operating station at the front panels;
- ordering of controls and displays; and
- intermixing of unrelated items.

All HEDs which have already been corrected are so designated in the summary tables. That is, for corrected HEDs a D ("Done") is specified in the "CATEGORY" and "DUE DATE" columns.

For each HED which still requires corrective action, the method for tracking the corrective action is identified in the REFERENCE column. Usually this is with an Action Item Record, (AIR) which describes the deficiency and assigns responsiblity. Resolution of each AIR is then documented as part of the normal CPCo AIR System.

B. Assignment of Priority

All HEDs which require corrective action and which have not yet been corrected are assigned a priority category based on the degree of importance of the deficiency and on the degree of difficulty in implementing the corrective action. These categories are then used in establishing a schedule for the corrective action. The following priority categories are used:

Degree of Importance of Deficiency

A May have adverse impact on plant or personnel safety or significant impact on plant availability.

example: Inadequate ability to reconstruct cause of plant trip

B Does not have a direct impact on plant or personnel safety, but may add to the overall difficulty of operations.

example: inadequate and confusing labeling

C Is not likely to cause operator error or the consequences of the potential error are insignificant and can be easily corrected.

example: temporary labels

Degree of Difficulty of Corrective Action

1 - Can be implemented without significant hardware modification or engineering analysis.

example: relabeling and demaraction

2 - Involves some hardware changes and/or engineering analysis.

example: changing meter scales

3 - Involves major hardware change or engineering analyses.

example: performing detailed alarm review

4 - Requires development effort to define adequate corrective action or requires hardware which is not available.

example: replacing current recorders with more reliable recorders.

In addition, if the HED is evaluated elsewhere, for example as part of a later generic table of HEDs, the category is identified as EE. Finally, as indicated earlier, if the HED had already been corrected at the time it was assessed, the category indicated is "D", and no further prioritization was done

C. Justification For Not Requiring Corrective Action

For some HEDs the Review Team concluded that corrective action is not required. This decision is the result of a detailed assessment of the HED which addressed the following primary issues:

- degree of departure from the guidelines
- potential effect on operator performance; i.e., the type of error which may result
- likely consequences of the error, including:
  - safety significance
  - violation of a technical specification or a limiting conditon of operation

- loss of availability (component and/or plant)
- damage to equipment.

The assessment criteria listed in NUREG-0801 were also considered.

For those HEDs which require no corrective action, the justification is documented in the ACTION column of the HED tables.

D. Tables of Findings and Corrective Actions

The following tables list all the findings and associated corrective actions. Table VI-1 provides a summary and overview whereas Tables VI-2 through VI-25 provide the individual findings and specific corrective actions, grouped generically. These Tables cover the following generic subjects:

TABLE	TITLE
VI-1	SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS
VI-2	EXISTING COLOR MEANINGS
VI-3	VALVE CONTROLS ON MAIN PANELS WHICH HAVE NO DIRECT INDICATION OF ACTUAL VALUE POSITION
VI-4	CONTROLS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL PROGRESSION
VI-5	MIRRORED IMAGE GROUPS OF CONTROLS AND DISPLAYS
VI-6	CONTROLS WITH A DIRECTION OF MOTION DIFFERENT THAN THAT OF CORRESPONDING LIGHTS
VI-7	EXCEPTIONS TO CONTROL-TYPE CONVENTIONS
VI-8	CONTROLS AND DISPLAYS WITH MISSING LABELS OR POSITION INDICATIONS
VI-9	CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS BUT MISSING IDENTIFICATION NUMBERS
VI-10	EXAMPLES OF CONTROL AND DISPLAY LABELS WHICH ARE UNCLEAR OR DO NOT PROVIDE ADEQUATE INFORMATION
VI-11	INSTANCES OF INCONSISTENT NOMENCLATURE

VI-12 UNIDENTIFIED OR INCONSISTENT ABBREVIATIONS

VI-13 SPECIAL PRECAUTION OR INFORMATION LABELS THAT MAY NOT BE CLEAR

VI-14 TEMPORARY LABELS

VI-15 DISPLAY LOCATIONS WHICH DO NOT CORRESPOND TO THEIR RELATED CONTROLS

VI-16 DISPLAYS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL ORDER

VI-17 SCALES WITH INADEQUATE RANGE

VI-18 UNUSUAL OR UNDESIRABLE SCALE DIVISIONS

VI-19 MISSING UNITS

VI-20 SCALE UNITS GIVEN AS PERCENT

VI-21 PROBLEMS WITH INDICATING LIGHTS

VI-22 SETPOINTS NOT ADEQUATELY INDICATED ON DISPLAYS

VI-23 PROBLEMS SPECIFIC TO STRIP-CHART RECORDERS

VI-24 DISPLAYS LOCATED TOO HIGH ON PANELS

VI-25 CONTROLS WHICH HAVE NO CORRESPONDING INDICATION OF ACTUATION

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Generic Shortcomings of the Present Control Room					
Local Arrangement					
Within the major groups of controls and displays there are many instances where the local arrangement is confusing.	III.B.1	Relabeled and demarcated, color coding added to some controls and displays. Colored demarcation lines used as follows: orange for high pressure safety injection, dark blue for auxiliary feed water, light blue for service water, green for component cooling water and red for emergency functions such as fire and trips.	D	NA	D
		For individual cases see V.B.1 and V.C.1, below.	EE	NA	NA
Backpanel Displays					
The distance from a station at the main control panel to the back panel is too great to identify and read reliably the labels of most controls and displays and meter scales.	III.B.2	Relabeled and demarcated.	D	NA	D
		For individual cases See IV.D.1.	EE	NA	NA
Labeling and Demarcation					
There are a number of weaknesses in the existing labeling and demarcation scheme. Specifics include: inconsistent nomenclature and abbreviations, unclear labels, missing or temporary labels and labels with missing identifying numbers.	III.B.3	Relabeled and demarcated.	D	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Color Coding in Lights and Labels					
The meanings of indication and status light colors (white, yellow, blue, etc.) are inconsistent. There are some uses of red and green lights which do not follow the conventional power station meanings.	III.B.4	A consistent color code for indicating lights will be established and implemented using Consumers Power Design Guide as basis. See Table VI-2 for details.	B1	AIR A-NPP 84-05	1988 outage
		A consistent color code for labels has been established and implemented. Specifically: - identification labels are white with black letters, - identification labels for a small number of critical controls such as safety injection and trip buttons are white with red letters, - caution labels are yellow with black letters, - information of a reference nature are black labels with white letters, - labels used for identifying hand switch numbers for controls and transducer numbers for displays are small light brown labels with dark brown letters.	B1	AIR A-NPP 84-05	D
Meter Scales					
Some meter scales have undesirable scale divisions, unidentified units and setpoints, and inadequate scale ranges.	III.B.5	See Sections V.C.2 and V.C.3 and tables VI-16, VI-17 and VI-18 for details.	EE	NA	NA

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Alarm Legend Readability					
Alarm window legends are difficult to read for an operator standing at the main console.	III.B.6	A detailed alarm review will be performed which will consider increasing legend size by using groupings and headings.	B2	AIR A-NPP 84-07	12/87
Non-Functioning Alarms					
Alarms tagged out-of-service may have the window still lit or even flashing.	III.B.7	CPCo has an on-going effort to make alarm panel dark at power by fixing non-functioning alarms and removing "status" alarms that may be lit with the plant in a normal condition. As part of overall alarm review consideration will be given to allow the operators to make non-functioning alarms dark when tagged.	B2	AIR A-NPP 84-07	12/87
Specific Operational Shortcomings of Present Control Room					
Wide Range Measurement of Hot Leg and Cold Leg Temperatures					
No display of wide range hot leg temperature is provided in the control room. Existing displays do not read temperatures above about 615°F or below about 515°F. As a consequence, these cannot be used to control coolant temperature during cooldown under natural circulation conditions, or during cooldown. Existing wide range cold leg recorder is below operator's line of sight and does not provide indication above 615°F.	III.C.1	Wide range temperature measurements with readable indications at the operator's station will be added. Related findings are in following sections: IV.A.1.c(2) IV.A.2.a(1) IV.A.3.c(3) IV.A.3.i(1) i(2) i(3) IV.B.1 .2 IV.D.1	A3	AIR A-NPP 84-08	1987 outage

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Steam Generator Control					
Manual control of steam generator water level at low power is reported to be demanding by the operators. Operators must open the water level recorder door to obtain the necessary visibility and leave their station to change recorder speed or to observe level trends more closely.	III.C.2	Simulator training is provided; steam generator level trending information is also provided on the CFMS. (See also IV.A.2.c(2), c(4), c(6) and IV.A.4.a(1)b. It is noted that this concern is related to normal evolutions only and is not a safety issue.	B2	AIR A-NPP 84-49	D
Control of Primary Coolant Inventory					
Most of the vessels, tanks and sumps associated with the coolant inventory have level indicators that are calibrated in percent. The operator currently uses a manual procedure to determine whether there may be a small primary coolant leak. The information required to identify the location of a small leak is not readily available in the control room.	III.C.3	During the validation walkthroughs of emergency procedures operators were consistently able to diagnose relatively small reactor coolant system leaks using their available indications of pressurizer level; containment sump level; charging pump status (or, in effect volume control tank level); and containment radiation level, pressure, and temperature. The function and task analysis included consideration of control of reactor coolant inventory and no major lack of information was established. Even if some further instrumentation were added to the control room to provide information to localize a leak, it is not apparent that it would reduce the need for work to localize a leak by operators outside the control room or significantly affect the operators' short term emergency actions. No change to control room instrumentation is considered necessary. See also IV.A.1.d(2) and IV.A.3.a(2).	NAR& EE	NA	NA

TABLE VI-1

SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Control of Liquid Inventory in the Steam Plant					
Most of the repositories for steam system inventory have level indicators calibrated in percent. Also, there is no indication of makeup flow. A manual procedure is used daily to calculate liquid inventory and to identify a small to moderate leak. The results of this daily inventory are provided to the operations supervisor.	III.C.4	Makeup valve position is recorded on the event recorder and data logger. Operations staff considers that daily inventory determination provides adequate capability to satisfy the concern. It is noted that this is not a safety concern.	NAR	NA	NA
Isolating Steam Dumps and Opening the Main Steam Isolation Valves					
For the following two plant evolutions it is normal plant practice for the operator to leave the control room: - opening the individual main steam isolation valves - isolating a stuck-open atmospheric steam dump	III.C.5	Engineering evaluation to determine feasibility of providing remote opening of individual main steam isolation valve from control room was performed and determined not to be feasible. Labeling at steam dump location has been improved to allow unambiguous identification of manual valve controls.	B3	AIR A-NPP 84-10	D
Electrical Power Distribution					
Electrical/diesel panel C04 has a number of human factor problems; for example,	III.C.6				

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
- The left side of the panel is not visible from the main console.	III.C.6 (Cont'd)	- Electric upsets are alarmed at main panel; operator can walk to C04 quickly to confirm information and activate controls; based on observations at simulator the location of C04 does not place undue burden on operator: no action required.	NAR	NA	NA
- The handles for some breakers are subject to inadvertent actuation because they are located on vertical panels in a passageway.		- Operations has evaluated the need for protective covers. Since there have been no instances of accidental actuation, and since covers could interfere with the operators actions to diagnose and correct power losses, protective covers will not be added.	NAR	NA	NA
- The operators have to perform a flag matching operation which has a high potential for error.		- The major changes to the panel labeling have included special provisions to help the operator to distinguish the breakers from each other. This should reduce the potential for operator error. Although the error would cause some confusion, it does not appear that plant safety would be compromised or equipment damaged. As in the item above, protective covers would tend to clutter the panel and obstruct operator actions. Protective covers will not be added.	A1	NA	D
- The relationship among arrayed meters is difficult to determine.		- Demarcation, relabeling, color coding some meters and buses has been completed.	B1	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Several electrical upsets of both DC and AC power supplies are difficult to diagnose and respond to:	III.C.6 (Cont'd)				
- Losses of DC buses challenge the ability of the operator to control the plant; little guidance is provided to the operators under loss of DC buses.		- An engineering evaluation of the loss of DC power has been performed. This evaluation did not indicate the need for additional control room indications of DC power status. Labeling has been added to Panel C04 to specifically identify the DC power sources associated with existing control power lights. See also IV.A.5.a(3).	D	AIR A-NPP 84-22	D
- Loss of AC instrument bus Y-01 and other AC power sources are difficult to diagnose quickly.		- Engineering evaluation has been completed and no equipment changes have been identified. The Palisades simulator is being used to assure that operators are familiar with the symptoms of the loss of AC power and their proper response.	D	AIR A-NPP 84-23	D
- Identification of powered/not-powered status of various equipment is difficult under various losses of power.		- Procedures have been reviewed and modified to improve the operators' ability to diagnose power losses (see preceding item) and checklists of affected equipment have been provided. These events are also covered by simulator training. See IV.A.5.a(7).	D	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Specific Human Factors Shortcomings of Present Control Room					
Visibility of Green and Blue Indicator Lamps					
In many cases, it is difficult to determine if the green and blue indicator lamps are illuminated.	III.D.1 (Appendix C)	The dark green and blue caps will be replaced with thinner caps or other equivalent solution will be provided.	B1	AIR A-NPP 84-43	1988 outage
Failure Position of Sigma Meters					
The recently installed Sigma meters fail "as-is" when power is lost. These meters have a green power-on light. This is inconsistent with the conventional meaning assigned green.	III.D.2	Replacement meters have been identified which fail off-scale low. These will be used for replacement as required.	A4	AIR A-NPP 84-11	D
		In the interim, identification of these meters is provided with unique bezel color.	A1	NA	D
Heating, Ventilation and Air Conditioning of the Control Room					
There are a number of problems with the heating, ventilation and air conditioning (HVAC) system.	III.D.3 (Appendix C)				
- Sometimes the temperature cannot be controlled adequately.		- HVAC system has been upgraded.	D	NA	D
- Excessively dry air in the winter has led to static electricity problems.		- Operators report no problems with static electricity following upgrade of HVAC.	B1	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
- Diesel fumes can be drawn into the control room.	III.D.3 (Appendix C) (Cont'd)	- Operating practices have been modified to allow operation in recirculation mode if diesel fumes are a problem.	B3	AIR A-NPP 84-11	D
Operational Findings and Observations - Functions Performed in Control Room					
Core Neutron Production Control					
Labeling of control rod position indicator and corresponding selector switches does not tie these together effectively.	IV.A.1.a(1)	Relabeled and demarcated.	D	NA	D
Lights above position indicator are labeled "SEL" next to an upward printing arrow and "DEV" next to a downward printing arrow. This may be confusing.	IV.A.1.a(2)	Information label added.	D	NA	D
The labels for lights above the position indicator are abbreviated and hard to read.	IV.A.1.a(2)	Relabeled.	D	NA	D
The position indicator selector switch for the power shaping group of rods has a "group position" which actually is the rod position for rod number 42.	IV.A.1.a(3)	No action required - CRDM controls are well covered during training; operators understand meaning.	NAR	NA	NA
Labeling at the rod drive control group selector switch is abbreviated and does not clearly identify the meaning of each switch position.	IV.A.1.a(4)	No action required - labels are adequate; CRDM controls are well covered during training; operators understand meaning of abbreviations.	NAR	NA	NA

TABLE VI-1

SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Labeling of the rod drive control mode selector switch does is abbreviated and not clearly identify the meaning of each switch position.	IV.A.1.a(5)	No action required - labels are adequate; CRDM controls are well covered during training; operators understand meaning of abbreviations.	NAR	NA	NA
Reactivity meter is labeled only by the scale on the side of the meter.	IV.A.1.b(1)	Not used by operator; used by reactor engineer for testing (not operational while plant is at power) existing identification is adequate for use - no action required.	NAR	NA	NA
Nuclear instrumentation labeling is deficient.	IV.A.1.b(2)	Relabeled.	D	NA	D
Indicator lights below six of the power range meters are unlabeled.	IV.A.1.b(3)	Labels added.	D	NA	D
The "power on" light for the linear power channels on C06 violates the red-energized, green-not-energized convention.	IV.A.1.b(4)	Lamp color will be changed.	C2	AIR A-NPP 85-13	1987 outage
Readability of digital power indicators on C07 is marginal from operator station at C02.	IV.A.1.b(5)	In-service experience and opinion of operators indicate that current size is adequate. No action is required. See Table VI-15.	NAR	AIR A-NPP 84-34	NA
Digital average temperature display for primary coolant is unlabeled.	IV.A.1.c(1)	Label added.	D	NA	D
Digital average temperature display gives no indication of sensing an off-scale temperature.	IV.A.1.c(2)	Warning label added. Addition of wide range input was evaluated and considered undesirable because it would add inaccuracy to temperature display.	D	AIR A-NPP 84-08	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The selector switch for the average temperature display has a label that is ambiguous.	IV.A.1.c(3)	Relabeled.	D	NA	D
The average temperature recorders have labels that are small and hard to read; Color coding is the only way to distinguish between the actual and demanded temperatures recorded.	IV.A.1.c(4)	Relabeled.	D	NA	D
Illuminated arrows and circular light next to the average temperature recorders are unlabeled.	IV.A.1.c(5)	Label added.	D	NA	D
Boronometer is reported to be unreliable and inaccurate.	IV.A.1.d(1)	Boronometer has been repaired to improve reliability; it is used by operators for trend information only; chemistry sample is used to confirm; no further action is required.	D	NA	D
Batch controllers on C01 benchboard for water and boric acid concentrate which are used as a check on how much is injected, are said to be out of calibration.	IV.A.1.d(2)	Controllers have been calibrated and found adequate.	B2	AIR A-NPP 84-14	D
Control of Energy Production and Transfer					
The wide range cold leg temperature recorders are obscured by front panels.	IV.A.2.a(1)	Wide range cold leg temperature recorders will be installed at a location visible from front panel.	A2	AIR A-NPP 84-08	1987 outage

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The turbine bypass valve position required for a given cooldown rate is not known. The valve control is not near the wide range temperature recorders; this requires the operator to shuttle between the two during cooldown.	IV.A.2.a(2)	Operators indicate that this is not a problem; cooldown rate is plotted on figure from procedure; sufficient time is available to both operate valve control and observe recorder trace; no action required.	NAR	NA	NA
Turbine control panel pushbuttons and indicators have poor visibility.	IV.A.2.b(1)	Training is being provided on simulator.	B1	NA	D
Digitial indicators on the turbine control panel give no indication that the units for the "reference" and "setter" digital displays are either percent power or revolutions per minute, depending on whether the plant is in load or speed control mode.	IV.A.2.b(2)	Adjacent labels on turbine panel and operator training make the units clear. Further action is not required. See also Table VI-19.	NAR	NA	NA
There is no indication of the change in nature of the reference signal when the control mode is shifted from "impulse chamber pressure in" to "impulse chamber control out" other than the backlit pushbuttons.	IV.A.2.b(3)	Control modes are adequately covered in system training by operators; no further action is required.	NAR	NA	NA
The basis for impulse chamber pressure meter is unclear.	IV.A.2.b(4)	Operators indicate they do not use this information for control; engineering evaluation and calibration is complete.	C1	AIR A-NPP 84-15	D
Turbine loading rate thumb wheel requires a 0.1 multiplication factor, as indicated by a temporary label.	IV.A.2.b(5)	Replaced with permanent label.	D	NA	D

TABLE VI-1

SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
A label plate near the main output bus voltmeter indicates that voltage is to be maintained at 357KV. This is inconsistent with an overriding requirement that reactive power remain within 200 megavars of 0.	IV.A.2.b(6)	Relabeled.	D	NA	D
Valve position indicators, such as the feedwater regulating valve controller and valve position indicating lights do not identify whether the valve position is demanded or actual position.	IV.A.2.c(1)	See Table IV-3 and Section V.A.2.	EE	AIR A-NPP 84-17	NA
The response of steam generator water level to auxiliary feed changes can lead to instability if the operators are inexperienced.	IV.A.2.c(2)	New controllers have been installed at plant and at simulator; training with new controller is being conducted at simulator.	B2	AIR A-NPP 84-49	D
The open position on the auxiliary feed-water controllers is on left of the meter at a reading of "0"; the closed position is on the right at a reading of "100". This is inconsistent with the convention of "0" meaning closed, "100" open, on adjacent controllers.	IV.A.2.c(3)	Making positions of indicator and control consistent with adjacent controllers and of reversing the meter scale to indicate "100" when the valve is open has been evaluated as not being feasible; labeling will be added to clarify operation of controller. Training is being provided at simulator.	B2	AIR A-NPP 84-29	1987 outage
The steam generator water level recorder is on back panel; the feedwater controllers are on front panel. The operator must leave his station and go behind console to read the recorder with precision or to change chart speed.	IV.A.2.c(4)	Operators state that readability is adequate. Confirmed during validation of emergency procedures. No modification of control room equipment is necessary.	B3	AIR A-NPP 84-09	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
There is inadequate operator training on steam generator water level control at low power. Auxiliary feed water controller on the simulator is not the same as in the control room.	IV.A.2.c(6)	Simulator has been made similar to control room.	B2	AIR A-NPP 84-49	D
Labels for the gland seal condenser exhausters are not visible from the operator's station.	IV.A.2.d(1)	Relabeled.	D	NA	D
Recorded condenser vacuum trend cannot be identified and read from the operator's station.	IV.A.2.d(2)	Relabeled and demarcated to allow identification from front panel.	D	NA	D
Air ejector flow is not displayed in the control room.	IV.A.2.d(3)	Off-gas flow is determined manually once each shift and entered in AO log. The plant considers this adequate and that no further action is required; this is not a safety concern.	NAR	NA	NA
Cooling tower controls and displays are located such that the operator cannot see front of this panel from normal operating station.	IV.A.2.d(4)	Pump trip is annunciated on main alarm panel; local alarms including basin level have unique audible annuniciations; no action is required. This is not a safety concern.	NAR	NA	NA
The A and B parts of the circulating water system are not distinguished.	IV.A.2.d(5)	Relabeled and demarcated.	C1	NA	D
Labeling of the cooling tower fan controls and displays is confusing. The relationship between electrical feeders and fan groups is not clear.	IV.A.2.d(6)	Relabeled and demarcated.	C1	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Control of Reactor Coolant Inventory and Thermodynamic State					
Pressurizer level is displayed as percent of full scale. The conversion to a volumetric unit is not given.	IV.A.3.a(2)	See Table VI-20.	EE	AIR A-NPP 84-13	NA
Volume control tank level is displayed as percent of full scale. The conversion to a volumetric unit is not given.	IV.A.3.a(3)	See Section V.C.2 and Table VI-20.	EE	AIR A-NPP 84-13	NA
The back-lighted pushbuttons that indicate whether the subcooling margin monitor is indicating pressure or temperature cannot be read from the normal control station.	IV.A.3.c(1)	Relabeled.	D	NA	D
The meaning of a positive or negative sign with respect to subcooling margin is not obvious.	IV.A.3.c(2)	A positive sign on the subcooling margin (for both pressure and temperature) indicates positive subcooling; i.e., that the pressure is greater than saturation pressure. Operator training is adequate and no action is required.	NAR	NA	NA
The instruments which feed the subcooled margin monitor are of limited range, i.e. the output is not meaningful at temperatures below 515°F.	IV.A.3.c(3)	When wide range temperature indication is provided, subcooling margin will use wide range input. (See III.C.1 and IV.B.2)	A3	AIR A-NPP 84-46	1987 outage

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Subcooling alarm normally does not clear automatically if plant is at full power; manual clearing by operators is not well understood.	IV.A.3.c(4)	Subcooling setpoint has been lowered to 25 F; automatic clearing is now adequate.	A2	AIR A-NPP 84-18	D
Safety injection tank level is displayed as percent full. The conversion to a change in reactor coolant inventory is not given.	IV.A.3.d(1)	See Table VI-20, panel C-13.	EE	AIR A-NPP 84-13	NA
Safety injection tank level meters cannot be identified and read from the operator's station.	IV.A.3.d(2)	Relabeled and demarcated.	D	NA	D
Primary makeup tank level T90, is not displayed in the control room.	IV.A.3.e(1)	Level is displayed locally; transfers from this tank are deliberate; transfer pumps P90A, B trip on low level in T-90; no action required.	NAR	NA	NA
SIRW tank and containment sump level displays are remote from other reactor coolant inventory displays; they cannot be read from the operator's station.	IV.A.3.f(1)	Indicators are appropriately located on C13 with other SIS components. CFM provides indication of SIRW and containment sump level near front panel. Relabeled indicators on back panel are easier to find.	NAR	NA	NA
The high and low pressure injection loop flow displays cannot be identified or read precisely from the operator's stations. Total flow into the reactor system is not displayed.	IV.A.3.f(2)	Relabeled and demarcated to allow identification; precise reading is not required from front of panel.	D	NA	D
		Total injection flow to be provided on CFM.	B2	NA	1987 outage

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The primary system drain tank level is not displayed in the control room. This tank collects uncontrolled pump seal leakoff flow and miscellaneous in-containment drains. Thus its level would provide a back-up indication of pump seal leakage.	IV.A.3.g(1)	No specific need for primary drain tank level was identified as part of the Function and Task Analysis; primary pump seal leakage is displayed on recorders in control room.	NAR	NA	NA
Primary pump seal leak-off flow and pressure recorders are not visible from the operator's station.	IV.A.3.g(1)	Flow and pressure alarms are annunciated; leak-off flow and pressure recorders are easily accessible for viewing if required; no action required.	NAR	NA	NA
Displays indicating which pressurizer safety valves have lifted are not within the operator's field of view.	IV.A.3.g(2)	No action is required: alarm indicating that pressurizer safety valves have lifted is presented to operator at main panel; short term operator response does not depend on which safety valves have lifted.	NAR	NA	NA
The containment sump level indicators on C13 cannot be identified or read precisely from the operator's station.	IV.A.3.g(3)	Relabeled to allow identification; precise reading is not required from front of panel.	D	NA	D
The conversion from the containment sump level displayed to other display units is not given.		See Table VI-20.	EE	NA	NA
Equipment drain tank (T80) level and several auxiliary building sump levels are not displayed in the control room.	IV.A.3.g(4)	No specific need for secondary drain tank and auxiliary building sump level was identified as part of the Function and Task analysis; no action required.	NAR	NA	NA
The component cooling system surge tank level (T3) is expressed in percent of range. The conversion to a volumetric unit is not given.	IV.A.3.g(5)	High and low levels are alarmed; conversion is not required by operations; see Section V.C.2 and Table VI-20, C03.	EE	AIR A-NPP 84-13	NA

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The concentration of radioactive material in the air ejector exhaust is displayed on the back of panel C11, outside the operators' field of view.	IV.A.3.g(6)	High radiation alarm is annunciated on main panel together with other gaseous monitors. The addition of an individual alarm window for air ejector exhaust will be considered as part of alarm review.	B2	AIR A-NPP 84-07	12/87
Clean waste receiver tank (T64A, B, C, D) levels are not displayed in control room; these tanks may receive reactor coolant during startup.	IV.A.3.g(7)	No specific need for this level information in the control room has been identified; plant startup is a controlled, deliberate process; no action is required.	NAR	NA	NA
The specific location of individual controls within a given fluid system often does not bear a consistent relation to other controls within that system and controls from different fluid systems are sometimes interspersed.	IV.A.3.h(1)	Relabeled and demarcated; color code added to some controls and displays. See Section III.B.1. See Tables IV-4, IV-5, IV-15, IV-16, and IV-24.	D EE	NA NA	D NA
Detailed arrangement of high and low pressure injection controls and displays may be confusing and the labeling for these controls and displays is not clear.	IV.A.3.h(2)	Relabeled and demarcated.	D	NA	NA
Certain valves utilize a rotary switch handle that has been broken.		Broken handles were replaced. The handles were evaluated and it was concluded that the handles should be adequate. No further handle breakage has occurred. No action to change handle type is considered necessary.	NAR	AIR A-NPP 84-20	NA
Hot and cold leg temperature displays on the backpanel cannot be read from the operator's station. The displays are narrow ranged and cannot be used during reactor cooldown.	IV.A.3.i(1)	See III.C.1, above.	EE	AIR A-NPP 84-8	NA

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The sequence of PIP computer commands required to obtain individual core exit thermocouple measurements are somewhat involved and not easily remembered by operators.	IV.A.3.i(2)	Operator aid was added to panel. Procedure is available at console.	B1	AIR A-NPP 84-47	D
Wide range cold leg temperature displays are below the line of sight of the operator.	IV.A.3.i(3)	See IV.A.2.a(1).	EE	NA	NA
There are several deficiencies with the displays of the average primary coolant temperature. See IV.A.1.c above.	IV.A.3.i(4)	See IV.A.1.c(1) through IV.A.1.c(5).	EE	NA	NA
There are several deficiencies with the subcooling margin monitor. See IV.A.3.c, above.	IV.A.3.i(5)	See IV.A.3.c(1) through IV.A.1.c(3).	EE	NA	NA
When the reactor coolant pressure display is in the narrow range mode, there is no indication of an off-scale reading when pressure is above 600 psi.	IV.A.3.i(6)	Warning label will be added.	B1	NA	1987 outage
Liquid Inventory in the Steam Plant					
Steam generator level meters on backpanel C12 are not readily visible from operator's station at C01.	IV.A.4a(1)a	These displays are not usually used for steam generator control and are redundant to the level recorder on C12 and the level indicator on C01. No action is required.	NAR	NA	NA
Steam generator level recorders are difficult to identify and are marginally readable from the operator's station.	IV.A.4a(1)b	See IV.A.2.c(4).	EE	AIR A-NPP 84-09	NA

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
All steam generator level displays read percent of full scale. The conversion to a volumetric or mass unit is not given.	IV.A.4a(1)d	Procedures instruct operators in per cent; See also V.C.2 and Table VI-20, C12.	EE	AIR A-NPP 84-13	NA
Feedwater heater level recorder displays are difficult to identify and cannot be read from the operator's station; they are difficult to read even close-up.	IV.A.4a(2)a	Relabeled. Lights indicating normal and high levels in the feedwater heaters are visible to operator.	D	NA	D
Recorder was inoperable.		Recorder has been repaired.	C2	AIR A-NPP 84-21	D
The level displays are in percent; the conversation to volumetric units is not given		See Table VI-20.	EE	NA	NA
Moisture separator drain tank level is displayed in percent. The conversion to volumetric units is not given.	IV.A.4a(2)b	Operators do not use volumetric information for operational evolutions. See also V.C.2 and Table VI-20, C01.	EE	AIR A-NPP 84-13	NA
Sixth stage heater level is not displayed on recorder.	IV.A.4a(2)c	No action is required: Volume is small compared to other repositories of secondary side fluid; lights indicating normal and high levels are presented to operator.	NAR	NA	NA
Feedwater high level alarm labels cannot be read from the operator's station.	IV.A.4a(2)d	Relabel and demarcate.	D	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Condenser hot well level is displayed in percent. The conversion to volumetric units is not given.	IV.A.4a(3)a	Operators do not use volumetric information; see Table VI-20, panel C01.	EE	AIR A-NPP 84-13	NA
The condensate storage tank level is displayed among an array of other meters and cannot be identified from the operator's station.	IV.A.4a(4)a	Relabeled. Tank level changes slowly and is alarmed; current location is adequate.	D	NA	D
The display is calibrated in percent without a conversion to volumetric units.		See Table VI-20, panel C13.	EE	NA	NA
The levels for the turbine building sump and several miscellaneous tanks are not displayed in the control room.	IV.A.4a(5)a	Turbine sump is alarmed; other tanks are small; no action required. This is not a safety concern.	NAR	NA	NA
Makeup flow to the condenser hot well is not displayed in the control room. Valve positions for the two automatically controlled makeup valves are not displayed in the control room.	IV.A.4.b(1) IV.A.4.c(1)	Valve positions are on data logger and event recorder; need for flow information to hotwell was not identified during Function and Task Analysis. Refill of condensate storage tank is manual operation; no action required.	NAR	NA	NA
Redundant steam generator pressure displays on backpanel C12 cannot be read from the operator's station.	IV.A.4.d(1)	No action necessary - steam pressure indication is available at C01, near operator controls.	NAR	NA	NA
Steam generator pressure displays on C01 cannot be distinguished easily from other unrelated meters nearby. The range is not consistent with other steam pressure indicators on C12.	IV.A.4.d(2)	Relabeled. Both ranges are needed for the operator: 0-1000 psia for accurate input to reactor protection; 0-1500 psia for safety relief valve setting. Meters are not required to be read simultaneously.	D	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The automatic setpoint selector on the turbine bypass controller is confusingly labeled.	IV.A.4.d(3)	Proper operation is taught by training; adjacent information label has been clarified.	D	NA	D
Distribution of Electric Power and Other Services					
The operator must leave his normal station to use the electrical distribution system controls and displays.	IV.A.5.a(1)	No adverse consequences were identified during postulated loss-of-power walk-throughs, including reactor trips; no action required.	NAR	NA	NA
The electrical distribution system mimic is difficult to follow.	IV.A.5.a(2)	Relabeled and more color coding provided See also III.C.6.	D	NA	D
There is no way of pretesting the transfer of house electrical load from the main generator to offsite feeders before the transfer is attempted.	IV.A.5.a(3)	Engineering feasibility of pretesting this transfer was evaluated and judged impractical; maintenance corrective action has been taken to assure adequate transfer.	D	AIR A-NPP 84-45	D
The breaker control switches in general are not provided with a separate tripped indicator light; the operators must perform a "flag-matching" operation which has a high potential for error.	IV.A.5.a(4)	See III.C.6.	EE	NA	NA
Losses of DC buses challenge the ability of the operator to control the plant; little guidance is provided to the operators under loss of DC buses.	IV.A.5.a(5)	See III.C.6	EE	NA	NA
Loss of preferred AC buses and loss of AC instrument bus Y-01 are difficult to diagnose quickly. Loss of offsite power with diesel 1-1 unavailable challenged operators' ability to diagnose and control plant condition at simulator.	IV.A.5.a(6)	See III.C.6.	EE	NA	NA

TABLE VI-1
SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Identification of powered/not-powered status of various equipment is difficult under various losses of power.	IV.A.5.a(7)	See III.C.6.	EE	NA	D
Operators did not know diesel was failing from alarms/indications in control room during loss of AC in January, 1984.	IV.A.5.a(8)	Diesel alarms will be reviewed as part of overall alarm review.	A2	AIR A-NPP 84-07	12/87
Controls and displays for the service water and component cooling systems are not functionally separate and are further intermingled with other miscellaneous system controls.	IV.A.5.b(1)	See III.B.1.	D	NA	D
Control of Radioactive Materials					
Individual radiation monitors are located on the back side of the vertical panels in the control room, out of the operator's field of view. Knowledge of the readings, particularly of the process monitors, would be useful in diagnosis of some events such as steam generator tube leaks.	IV.A.6.(3)	See IV.B.4.	EE	NA	NA
Control of the Inventory and Location of Fissionable Material					
The major manning burden for the operators results from the use of licensed control room operators to physically man the refueling and service platform. This effectively doubles the number of licensed operators required to be on a shift.	IV.A.7.(1)	Population of licensed operators has increased; adequate number of operators are now available; no further action is required.	NAR	NA	NA
There is no direct voice communication between the operator's station on the service platform and the control room.	IV.A.7.(2)	Communications have been added to service platform.	B2	AIR A-NPP 84-24	D

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Administrative Control of Maintenance, Repair and Testing					
Determining the effect of removing particular equipment, especially power supplies on availability of other equipment, power trains, etc. can be difficult, especially with multiple maintenance in progress.	IV.A.9	Operations has developed an LCO status board, diesel generator status board and shift turnover status sheets which indicate plant status and LCO status. The Palisades Plant now has a designated group in Operations to monitor maintenance and its effect on the plant systems.	A2	NA	D
Control of Fire Fighting					
The C47 panel is out of sight of the operator at his normal work station, and although annunciated at the main alarm panel, it does not have reflash capability.	IV.A.10	Reflash capability will be added. See V.F.1b and V.F.2f.	A2	AIR A-NPP 84-19	1987 outage
Controls and Displays Required in the Control Room					
The following displays currently not provided in the control room are needed:					
° Wide range hot leg temperature	IV.B.1	See III.C.1.	EE	NA	NA
° Wide range subcooling indication	IV.B.2	Wide range subcooling indication will be added See also III.C.1 and IV.A.3c(3).	A3	AIR A-NPP 84-46	1987 outage
° Air ejector exhaust flows	IV.B.3	See IV.A.2.d(3).	EE	NA	NA

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
° Individual radiation monitor indications	IV.B.4	Evaluation during EOP validation walkthroughs indicates that the location of the radiation monitors places some burden on the operators; however, not one which appeared to adversely affect his performance. Radiation monitor information will be presented on the Critical Function Monitor System which will be available to the operators in the control room.See also IV.A.3.g(6).	B2	NA	D
° Secondary plant makeup flow	IV.B.6	See IV.A.4.b.	EE	NA	NA
° No. 6 feedwater heater level	IV.B.7	See IV.A.4.a.(2)c.	NAR	NA	NA
Availability of Personnel					
During plant startup and manual control of steam generator water level the minimum manning requirements of two control room operators do not appear to be adequate for the operators to keep up with some other operator duties such as logging, switching and tagging.	IV.C.1	A third control room operator is often available in the control room and can help with logging, switching and tagging. If necessary, administrative actions such as logging are postponed for a short time until the active plant control burden on the operator is reduced. No further action is considered required.	NAR	NA	NA
Opening individual MSIVs and isolating a stuck-open steam dump or turbine bypass requires the operator to leave the control room.	IV.C.3	See III.C.5.	EE	AIR A-NPP 84-10	NA
Arrangement Priority					
Certain critical indicators located on backpanels cannot be read from the operator's station. Specifically:	IV.D.1				

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
° wide range cold leg coolant temperature indication,	IV.D.1 (Cont'd)	See IV.A.2.a(1).	EE	NA	NA
° individual hot and cold leg narrow range loop temperature indications,		See III.C.1.	EE	NA	NA
° steam generator water level recorders,		See III.C.2.	EE	NA	NA
° feed and steam flow recorders,		No need for these indicators to be located at the front panels was identified as part of Function & Task Analysis; no action required.	NAR	NA	NA
° containment sump level indicator,		See IV.A.3.g(3).	EE	NA	NA
° SIRW tank level indicator, and		See IV.A.3.f(1).	EE	NA	NA
° condensate water storage tank level indicator.		See IV.A.4a(4)a.	NAR	NA	NA
Electrical panel C04 is poorly located. Operator may have to leave his station during a reactor trip or power distribution system upset.	IV.D.2	See III.C.6.	EE	NA	NA
Controls for manual initiation of safety injection are located on back panel C13.	IV.D.3	Manual initiation is deliberate. The potential consequences were evaluated during validation walkthroughs of emergency procedures and no problems were identified with the control location. No relocation of these controls is considered to be required.	B2	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Human Engineering Findings and Observations - General Guidelines					
Some controls and related displays are not located within the same area of the control panel. Displays are on backpanels, controls on front panels. Examples include: ° Steam generator levels and flows, ° Primary coolant cold leg temperature, and ° Safety injection flows and levels.	V.A.1	See IV.D.1, IV.D.2, and IV.D.3.	EE	NA	NA
Red and green lights are used on occasion to indicate status information other than the meaning in common use. There is no color code convention to indicate off normal status.	V.A.2, V.A.3	See III.B.4.	EE	NA	NA
For a few valves, demanded position rather than actual position is displayed by indicating lights on the control console.	V.A.2	Evaluated on a case basis. See Table VI-3.	EE	AIR A-NPP 84-17	NA
For a few controls, no direct indication of control actuation is provided to the operator.		Evaluated on a case basis. See Table VI-25.	EE	NA	NA
Black dots are used to indicate normal (at power) position for both critical and non-critical controls. No formal system is in place for determining which controls have dots.	V.A.3	A formal system for controlling the application and removal of these dots has been implemented.	B1	AIR A-NPP 84-16	D

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Unlike most meters in use, the Sigma meters added during the 1981 refueling outage remain "as-is" upon loss of power. For these meters, the green power-on light is inconsistent with the usual meaning of green on the panel.	V.A.4	See III.D.2.	EE	NA	NA
For some controls and instruments there is no unambiguous means to distinguish between functioning (powered) and non-functioning controls and instruments.	V.A.4	Procedures have been modified to improve diagnosis capability and include checklists of associated equipment. See III.C.6 and IV.A.5.a(7).	EE	NA	NA
Telephones on the operator's desks have cords that are too short. The operator's ability to monitor the console is limited while using the telephone.	V.A.5	Longer telephone cords will be provided.	C1	AIR A-NPP 84-25	1987 outage
Two plant evolutions currently may require the operator to leave the control room: ° isolation of individual steam dump valves ° opening of individual main steam isolation valves (MSIV)	V.A.8	See section III.C.5.	EE	NA	NA
Some areas of the control panels present challenges to the memory and concentration of the operator in that controls for different systems may be interspersed within the same area of the control panel.	V.A.8	See III.B.1.	D	NA	NA

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Labels identifying functional groups on the control panels are not currently used.	V.A.10	Group labels added.	D	NA	D
Controls					
Some individual controls within a group of controls do not follow the expected alphabetic or numeric progression. A list of these controls is provided in Table VI-4 of the report.	V.B.1	Evaluated on a case basis as part of relabeling effort. See Table VI-4.	EE	AIR A-NPP 84-26	NA
Mirror image groups of controls, usually considered undesirable, are used on a few panels, as described in Table VI-5. Many of those groups are mirrored partly and inconsistently.	V.B.1	Evaluated on a case basis. See Table VI-5.	EE	NA	NA
Controls not easily operated are noted below.	V.B.2	Evaluated on a case basis.			
° Safety injection loop 2B high and low pressure valves handles on C03 have been broken.		- See IV.A.3.h(2).	EE	AIR A-NPP 84-20	NA
° Spring loaded rotary switches on the cooling tower panel are difficult to operate.		- Handle type will be changed to one which is easier to hold in position. Jogging capability is required so that it is not practical to use a seal-in circuit.	C2	AIR A-NPP 84-27	1987 outage
° The push-button lighted indicators on the cooling tower panel are relatively easy to break.		- No practical replacement is available; no action is considered necessary. This is not a safety concern.	NAR	NA	NA

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
° The test push-button on the radiation monitor is relatively easy to break.	V.B.2 (Cont'd)	– No practical replacement is available; no action is considered necessary. This is not a safety concern.	NAR	NA	NA
° The Linear Power Channel Test circular switches are too sensitive.		– Evaluation has been performed and current switch was found to be adequate; not a safety concern.	NAR	AIR A-NPP 84-28	NA
° The auxiliary feed controller utilizes a push button that is difficult to operate smoothly.		– See IV.A.2.c(2).	EE	AIR A-NPP 84-49	NA
Some controls do not operate with a direction of motion that is consistent with the standard directional stereotype. These are noted below:					
° Panel C01 – Moist Sep Drn Tank/Htrs E5A&B Diff Press Cont CV-0610 (Open position is at left at "0" meter setting)		– Modifying controller to place open position at right at "100" meter setting was evaluated and found impractical. Labels clearly show actual positions. This is not a safety concern.	NAR	AIR A-NPP 84-29	NA
– Base adjuster: raise-counter-clockwise, lower-clockwise		– Training is adequate; labels are clear; no action is required. This is not a safety concern.	NAR	NA	NA
° Panel C02 – The controllers for the shutdown cooling heat exchanger bypass valve CV-3006		– Modifying controller to place open position at right at "100" meter setting was evaluated and found impractical. Labels clearly show actual positions. This is not a safety concern.	NAR	AIR A-NPP 84-29	NA

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY			SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
		The low pressure letdown temperature control valve CV-0909	V.B.2 (Cont'd)	- Modifying controller to place open position at right at "100" meter setting was evaluated and found impractical. Labels clearly show actual positions. This is not a safety concern.	NAR	AIR A-NPP 84-29	NA
°	Panel C04 -	Diesel generator governor controls: raise- counter-clockwise, lower - clockwise		- Training is adequate, labels are clear; no action is required.	NAR	NA	NA
°	Panel C13 -	Switches for containment lights and containment emergency lights		- Switch on-off positions will be reversed.	C1	AIR A-NPP 84-30	1987 outage
On flow controllers the "auto" position is not consistently positioned with respect to the "manual" position.				Transfers between the auto and manual positions are infrequent, deliberate actions. Thus, this does not present a problem to the operators and no action is required.	NAR	NA	NA
On three-position rotary controls there is no consistent positioning of the "off", "auto" and "manual" positions. The following do not follow the predominant sequence of "off" - "auto" - "manual":				The operators reported no problems operating these controls; these operations are slow, deliberate actions; no action is considered necessary.	NAR	NA	NA
°	Panel C02 -	Pressurizer Heater Controls, Primary Coolant Pump Oil Lift Pumps					

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
° Panel C11 - Domestic water storage tank fill valve CV2001 Primary storage tank fill valve CV2008 Cond Storage Tank fill valve CV2010 ° Panel C13 - Air Compressors	V.B.2 (Cont'd)				
For some controls, the position indicating lights are not placed in a consistent positional order. These instances are listed in Table VI-6 of the report.		Evaluated on a case basis. See Table VI-6.	EE	AIR A-NPP 84-35	NA
Key operated switches do not usually have their slots vertical with the key removed and detents are not always oriented upwards.		This is not considered a significant deficiency and no action is recommended. The position of the key slots is not a safety concern.	NAR	NA	NA
A few controls do not follow convention as to type (e.g. finger grip, pistol grip, pushbutton ect.).	V.B.3	See Table VI-7.	EE	AIR A-NPP 84-31	NA
The separation between primary coolant pump oil lift pump controls is 7/8" rather than 1".	V.B.4	Operators reported no problem with these controls; no action is recommended. This is not a safety concern.	NAR	NA	NA
The electrical controls on C04 may be inadvertently activated because they are located in a narrow passage.		See III.C.6.	EE	NA	NA

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Some of the cooling tower pump controls on C126 may be inadvertently tripped because they are located in a narrow passageway used by security personnel in performing a firewatch.	V.B.4 (Cont'd)	Firewatch rounds conducted by security personnel was a short-term isolated situation while C11A panel was being constructed. This is no longer a problem and is not expected to occur again. Therefore no correction action is considered required.	NAR	NA	NA
Some controls and displays are missing an identifying label or position indicator (Table VI-8). Others are identified with a descriptive name but not with a component number (Table VI-9). Many labels are unclear or lack specific information (Table VI-10). Inconsistent nomenclature and color coding, abbreviations and temporary labels are other problems with the identification system, listed in Tables VI-2 and Tables VI-10 through VI-14 of the report.	V.B.5	Relabeled, and labels added. See Tables VI-8 through VI-14.	EE	AIR A-NPP 84-32 84-33 84-34 84-38	NA
The meaning of "manual" is not always clear for 3-position rotary controls.		Clarified, as part of relabeling effort.	D	NA	D

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Pulling the cap on the reheater control system "power on" switch to change the light bulb causes some valve positions to change.	V.B.6 (Appendix C)	Caution label will be added.	B1	NA	1987 outage
Displays					
Some display locations are not consistent with the location of their corresponding controls (Table VI-15).	V.C.1	Evaluated on a case basis. See Table VI-15.	EE	NA	NA
A few displays on the backpanels are located too high for the operators to read easily (Table VI-24).		Evaluated on a case basis. See Table VI-24.	EE	NA	NA
The orientation of multiple displays does not always follow the expected alphabetic or numeric progression (Table VI-16).		Evaluated on a case basis - See Table VI-16.	EE	NA	NA
Operation of some pump controllers on the C03 backboard panel may obscure related displays on the benchboard.		This is not considered a significant problem since no continuous "feedback" operations are performed with these controls; no action is necessary.	NAR	NA	NA
Some groups of displays are mirrored (Table VI-5).		Evaluated on a case basis. See Table VI-5.	EE	NA	NA
Some display scale ranges are not adequate for both normal and off-normal conditions (Table VI-17).	V.C.2	Evaluated on a case basis. See Table VI-17.	EE	AIR A-NPP 84-08	NA

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Some displays do not employ a usual numerical progression for the major scale divisions (Table VI-18).	V.C.2 (Cont'd)	See Table VI-18. See also III.B.5.	EE	AIR A-NPP 84-06	NA
The units on some of the displays are not specified (Table VI-19).		See Table VI-19.	EE	AIR A-NPP 84-39	NA
Many display scales are in percent rather than engineering units (Table VI-20).		See Table VI-20. See also III.B.5.	EE	AIR A-NPP 84-13	NA
Multiple displays of the containment building pressure do not have scales with consistent units.		Psia will be changed to psig to be consistent.	B2	AIR A-NPP 84-06	1987 outage
Some displays are unlabeled, do not have identifying numbers or appear to lack information. Specifics are found in Tables VI-8, VI-9, and VI-10 respectively. Some indicating lights are not adequately identified (Table VI-21).	V.C.3	See Tables VI-8, VI-9, VI-10, and VI-21.	EE	NA	NA
The set points on some displays are temporary and handwritten (Table VI-22).		See Table VI-22.	EE	NA	NA
Legend plates for backpanel displays used by the operator at the front panel have a letter size that is too small.		See III.B.2.	D	NA	D
Some displays have temporary identification labels (Table VI-14).		See Table VI-14.	EE	NA	NA

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The color code for display indicating lights is not followed consistently (Table VI-2).	V.C.3 (Cont'd)	See III.B.4.	EE	AIR A-NPP 84-05	NA
Several engraved label plates are filling in with dirt or wearing off.		Labels replaced.	D	NA	D
Special precaution labels are not always positioned with an obvious relationship to the corresponding display (Table VI-13).		See Table VI-13.	EE	NA	NA
Backpanel displays used by operators at the front panel are not easily identified and read.	V.C.4	See III.B.2.	EE	NA	NA
There are several problems with strip chart recorders such as inadequate labeling and mechanical difficulties (Table VI-23).	V.C.6	See Table VI-23.	EE	NA	NA
<u>Process Computer and Critical Function Monitor</u>					
Alarms in critical function monitor (CFM) are not consistent with the safety function status check utilized by the Emergency Procedure Guidelines.	V.D.	The display will be redesigned to reflect the same condition identified in the emergency procedures.	A2	NA	12/86
Only two trend displays are available and the trending capability for multiple users is limited.		The system will be modified so that each station has its own trend capbility which is independent of other users.	B2	NA	1988 outage

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Some text is displayed with dark blue characters on a black background which is only marginally readable.	V.D. (Cont'd)	The display will be modified to improve its readability.	B2	NA	1988 outage
Alarms					
A few alarms were viewed by the operators as not being useful.	V.F.1.a	Detailed alarm review will evaluate deletion of alarms.	B3	AIR A-NPP 84-07	12/87
Alarms tagged out-of-service may be lighted or even flashing.	V.F.1.b	See III.B.7.	EE	AIR A-NPP 84-07	NA
Fire panel C-47 does not have reflash capability.		See IV.A.10 and V.F.2.f.	EE	NA	NA
Some alarms are not grouped by plant function or system.	V.F.2.b	Regrouping will be evaluated in detailed alarm review.	B3	AIR A-NPP 84-07	12/87
There is no consistent location for the green light indicating failure of the alarm panel fuse.		Alarm review will evaluate replacing with separate "power failure" light, or use consistent location for alarm panel fuse failure.	B3	AIR A-NPP 84-07	12/87
It is not clear that alarm prioritization by color is consistently applied.		Detailed alarm review will review color prioritization.	B3	AIR A-NPP 84-07	12/87
Some alarms are not located near their related controls and displays.	V.F.2.c	Will be evaluated as part of detailed alarm review.	B3	AIR A-NPP 84-07	12/87

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
There are a significant number of detail inconsistencies in nomenclature and abbreviations. Examples include:	V.F.2.d	Alarm tiles will be relabeled and procedures revised as part of alarm review.	B1	AIR A-NPP 84-07	12/87
- Containment is abbreviated as both CONT and CONTMT.					
- The abbreviation CONT means both control and containment on the same window.					
- Some abbreviations have periods, others do not.					
- The abbreviation for circuit appears as both CKT. and CTK.					
- Annunciator tile legends for two containment high pressure alarms are identical although they alarm at different pressure levels.					
- Preferred AC buses are labeled both bus 1 and bus Y-10, bus 2 and bus Y-20, etc.					
- The alarm response procedure for T-81 high-low refers incorrectly to tank T-90.		Procedure has been modified to reflect correct tank number.	B1	NA	D
The lettering size and style used on the alarm windows are not uniform.	V.F.2.d	Will be relabeled, following alarm review.	B1	AIR A-NPP 84-07	12/87
In most cases the alarm window can only be read if the operator is standing directly in front of the alarming panel.		Will be relabeled following alarm review.	B1	AIR A-NPP 84-07	12/87

TABLE VI-1
SUMMARY OF FINDINGS AND RECOMMENDATIONS (Continued)

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Alarm panel identification lettering is too small.	V.F.2.d (Cont'd)	Relabeled.	D	NA	D
The numbering of alarm windows is not in a normal order.		Revising numbering scheme will be considered in alarm review.	B1	AIR A-NPP 84-07	12/87
Within a panel, there is no labeling to assist the operator in finding a particular alarm window number.		Alarm review will evaluate new numbering scheme, or adding existing alarm window numbers to windows.	B1	AIR A-NPP 84-07	12/87
In the event of a fire, alarms are annunciated at both the fire alarm (Panel C-47), and the main annunciator panel.	V.F.2.f	See IV.A.10.	EE	NA	NA
Fire panel alarms are out of view of operators at control stations.		See IV.A.10.	EE	NA	NA
PORV alarms are annunciated on both the main annunciator panel and on the C11A panel; acknowledgement is required separately on both panels.	Appendix C	Will be evaluated as part of detailed alarm review.	B3	AIR A-NPP 84-07	12/87
Alarm panel C106 is not sufficiently audible at operator's desk.	V.F.2.g	Sound level of alarm has been increased to be clearly audible at operator's desk.	B1	AIR A-NPP 84-39	D
The Palisades control room has limited capability in reconstructing a sequence of events; the data logger is often limited because of maintenance of system.	V.F.2.j	Reliability of feedwater purity data logger has been upgraded.	A2	AIR A-NPP 84-41	D
In some cases malfunctioning alarms (although tagged-out) can still be lit or even flashing.	V.F.2.m	See III.B.7.	EE	AIR A-NPP 84-07	NA
C125 alarm panel test capability is not operational.		Test capability has been repaired.	B1	AIR A-NPP 84-50	D

TABLE VI-2

EXISTING COLOR MEANINGS

INDICATING LIGHTS

COLOR	MEANING	COMMENTS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Red	On/Open Normal Refuel High Level		Red will be used for on/open.	C1	AIR A-NPP 84-05	1988 outage
Green	Off/Closed Normal Refuel Auto		Green will be used for off/closed.	C1	AIR A-NPP 84-05	1988 outage
Amber	Auto Non Auto Filter-Run-Out Stand By Manual Defeat Auto Non Auto Hold Enable Closed Start-auto Manual	"A" engraved on light cap "Non Auto" engraved on cap "F" engraved on light cap "C" engraved on light cap "M" engraved on light cap	Amber will be used for caution or off-normal.	C1	AIR A-NPP 84-05	1988 outage
White	Power Available Power Available Power Failure Cranking Control Power Auto Auto Normal Level Oil Permissive Manual Charging Motor	 "P" engraved on light cap "CP" engraved on light cap "A" engraved on light cap "OP" engraved on light cap "CM" engraved on light cap	White will be used with engraving on cap whenever red, green, amber, or blue are not appropriate.	C1	AIR A-NPP 84-05	1988 outage

TABLE VI-2 (Continued)

EXISTING COLOR MEANINGS

INDICATING LIGHTS

COLOR	MEANING	COMMENTS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Blue	Overload Torque Raise/Lower Off Auto	"T" engraved on light cap	Blue will be used for overload torque.	Cl	AIR A-NPP 84-05	1988 outage
Gray	Test Auto Start		Gray will not be used.	Cl	AIR A-NPP 89-05	1988 outage

ALARM WINDOWS

COLOR	MEANING	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Red	Critical Alarm	Evaluate as part of alarm review.	Bl	AIR A-NPP 84-07	12/87
Green	Fuse blown in Panel (and two others)				
White	All others				

LABELS

COLOR OF PLATE	COLOR OF LETTERS	PURPOSE	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Black	White	Identification	Black plate with white letters will be information.	D	NA	D
Yellow Yellow Yellow	White White Black	Information Precaution Precaution	Yellow plate with black letters will be caution.	D	NA	D

TABLE VI-2 (Continued)

EXISTING COLOR MEANINGS

LABELS (continued)

COLOR	MEANING	COMMENTS	ACTION	CATEGORY	REF.	DUE DATE
Red Red	White White	Precaution Identification (temporary)	Red plates will not be used.	D	NA	D
White	Black	Information	White plates with black letters will be for identification; white plates with red letters will be for trips; tan plates with brown letters will be for ID numbers.	D	NA	D
Blue	Black	T51 label (identification)	These plates must be replaceable to allow identification of proper tank; the current practice of using a blue plate for this "moveable" label will be continued.	NAR	NA	NA
Blue	White	reheater label on C01	Replace with black label with white letters.	Cl	NA	1987 outage

TABLE VI-3

VALVE CONTROLS ON MAIN PANELS WHICH HAVE NO DIRECT INDICATION OF ACTUAL VALVE POSITION

PANEL	CONTROLS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Moisture Separator Drain Tank Pressure Control: CV-0610 (DPIC-0609), P&ID M-206	This control is kept in automatic and is not used by the operators. No need for the addition of valve position indication or indication of tank pressure has been identified.	B2	AIR A-NPP 84-17	NA
	Condenser Make-up: CV-0729 (HIC-0729), P&ID M-207.	Actual valve position is not an important feedback. Operators position valve and determine effect of its motion by considering condenser hot well level which is indicated on C01. No need for the addition of a direct valve position indicator has been identified.	B2	AIR A-NPP 84-17	NA
C02	Pressurizer Power Relief Blocks: MO-1042A and MO-1043A, P&ID M-201.	The P&ID is apparently incorrect and will be modified.	C1	AIR A-NPP 84-17	1987 outage
	Pressurizer Power Relief: CV-1042B and CV-1043B, P&ID M-201.	The P&ID is apparently incorrect and will be modified.	C1	AIR A-NPP 84-17	1987 outage
	Shutdown Cooling Heat Exchanger Discharge; CV-3025 (HIC-3025), P&ID M-204	Actual valve position is not an important feedback. Operators position valve and determine effect of its motion by observing shutdown cooling heat exchanger outlet temperature which is indicated on C02. No need for the addition of a direct valve position indicator has been identified.	B2	AIR A-NPP 84-17	NA

TABLE VI-3 (Continued)

VALVE CONTROLS ON MAIN PANELS WHICH HAVE NO DIRECT INDICATION OF ACTUAL VALVE POSITION

PANEL	CONTROLS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C02 (Cont'd)	Shutdown Cooling Heat Exchanger Bypass: CV-3006 (FIC-0306), P&ID M-204	Actual valve position is not an important feedback. Operators position valve and determine effect of its motion by observing shutdown cooling flow which is indicated on the controller. No need for the addition of a direct valve position indicator has been identified.	B2	AIR A-NPP 84-17	NA
	Manual Control Letdown Orifice Bypass: CV-2202 (HIC-2202), P&ID M-202	Actual valve position is not an important feedback. Operators position valve and determine effect of its motion by observing letdown flow which is indicated on C02. No need for the addition of a direct valve position indicator has been identified.	B2	AIR A-NPP 84-17	NA
	Temperature Control for Intermediate Pressure Letdown CCW from Letdown Heat Exchanger: CV-0909 (TIC-0203), P&ID M-209	Actual valve position indication is not an important feedback. Operators position the valve by observing letdown temperature which is available on the controller. No need for the addition of a direct valve position indicator has been identified.	B2	AIR A-NPP 84-17	NA
	Pressure Control for Intermediate Pressure Letdown: CV-2012 or CV-2122 (PIC-0202), P&ID M-202	Actual valve position is not an important feedback. Operators position the valve by oberving the pressure which is on the controller. No need for the addition of a direct valve position indicator has been identified.	NAR	NA	NA
	Boric Acid Pump Discharge Pressure Control: CV-2130 (PIC-0208) and CV-2136 (PIC-0206), P&ID M-202	Actual valve position indication is not an important feedback. Operators position the valve by observing boric acid pump discharge pressure on the controller. No need for the addition has been identified.	B2	AIR A-NPP 84-17	NA

TABLE VI-3 (Continued)

VALVE CONTROLS ON MAIN PANELS WHICH HAVE NO DIRECT INDICATION OF ACTUAL VALVE POSITION

PANEL	CONTROLS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03	Safety Injection Tank Fill and Drain: CV-3039 (HIC-3039), CV-3043 (HIC-3043), CV-3004 (HIC-3004), and CV-3003 (HIC-3003), P&ID M-203	Actual valve position is not an important feedback. Operators position these valves by observing the fill and drain flow which is indicated on C13 as well as the level in the particular tank which is also indicated on C13. No need for the indicator has been identified.	B2	AIR A-NPP 84-17	NA
C13	Charging Pumps Discharge to HPSI Train 2: MO3072, P&ID M-204	The P&ID is apparently incorrect and will be modified.	C1	AIR A-NPP 84-17	1987 outage

TABLE VI-4

CONTROLS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL PROGRESSION

PANEL	CONTROLS	CURRENT PROGRESSION OF CONTROLS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Feedwater Heater Drain Pumps P-10	B-A	Move controls as part of aux feed modifications.	D	NA	D
	Feedwater Reg Block Valves	B-A	Move controls to comply with positional stereotype	A2	NA	1987 outage
	Atmospheric Steam Dump Valves	B-A	Relabel to clearly indicate progression.	D	NA	D
	Bleeder Trip Valves for Feedwater Heaters	6A-6B-4A 4B-3A-3B	Relabel to clearly indicate progression.	D	NA	D
	Aux Feed Pump P-8 Section (lower left corner of C01)	B-B-B-B B-A	Move controls as part of aux feed modifications.	D	NA	D
	Feedwater Heater Dump Valves	4-3-2-1 4-3-2-1	No action required; location is consistent with flow left to right from turbine to condenser.	NAR	NA	NA
	MSIV Bypass Valves	B-A	Move controls to comply with positional stereotype	B1	NA	D
C02	Boric Acid Pumps P-56	B-A	Relabel to indicate clearly actual progression (results from electrical separation requirement).	D	NA	D
	Turbine Run Back Relay	V2-V1	Relabel	D	NA	D
	Charging Pumps P-55	C-B A	Relabel and demarcate to clearly indicate actual progression.	D	NA	D

TABLE VI-4 (Continued)

CONTROLS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL PROGRESSION

PANEL	CONTROLS	CURRENT PROGRESSION OF CONTROLS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03	Service Water Pumps P-7	B-A-C	Relabel to clearly indicate actual progression (results from electrical separation requirement).	D	NA	D
	Component Clg Pumps P-52	A-C-B	Relabel to clearly indicate actual progression (results from electrical separation requirement).	D	NA	D
	Containment Cooling Recirc Fans	4-1-2-3	Relabel to clearly indicate actual progression (results from electrical separation requirement).	D	NA	D
	Shield Cooling Pump P-77	B-A	Relabel to clearly indicate actual progression; use of these controls is deliberate, slow action.	D	NA	D
	HPSI Pumps P-66	B-C-A	P-66C is removed as part of aux feed modification; relabel to clearly indicate actual progression.	D	NA	D
	LPSI Pumps P-67 and SIRW tank low level trip	B-A	Relabel to clearly indicate actual progression; keep consistent with HPSI pumps, electrical separation.	D	NA	D
	Safety Injection Loops Redundt VV (upper right corner)	2A-1B 2B-1A	Relabel to clearly indicate actual progression.	D	NA	D
	West Engrd Safegrd Room Sump Pump P-73	B-A	Relabel to clearly indicate actual progression.	D	NA	D
	East Engrd Safegrd Room Sump Pump P-72	B-A	Relabel to clearly indicate actual progression.	D	NA	D

TABLE VI-4 (Continued)

CONTROLS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL PROGRESSION

PANEL	CONTROLS	CURRENT PROGRESSION OF CONTROLS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03 (Cont'd)	Containment Spray Pumps P-54	B-C-A	Relabel to indicate clearly actual progression (results from electrical separation requirement).	D	NA	D
	Safety Injection Loops 2A and 2B HI Press Valves	B A	Relabel to indicate clearly actual progression (results from layout of electrical separation).	D	NA	D
	Component Clg HX E-54 Inlet Valves	B-A	Relabel to indicate clearly actual progression (results from layout of electrical separation).	D	NA	D
	Component Clg HX E-54 Serv Wtr Outlet Valves	B-A	Relabel to indicate clearly actual progression (results from layout of electrical separation).	D	NA	D
	Emerg Diesel Gen HX E-22 Serv Wtr Inlet	B-A	Relabeling eliminates need for B-A reference.	D	NA	D
	Critical Serv Wtr Header Shutoff Valves	B-A	Add mimic and relabel to clearly indicate actual progression.	D	NA	D
	Containment Air Clr VHX Serv Wtr Inlet	4-1-2-3	Relabel to clearly indicate actual progression; results from electrical separation.	D	NA	D
	Containment Air Clr VHX Serv Wtr Outlet	4-1-2-3	Relabel to clearly indicate actual progression; results from electrical separation.	D	NA	D
	Reactor Shield Clg Coil Inlet	B-A	Relabel to clearly indicate actual progression; use of these controls is deliberate, slow action.	D	NA	D
C04	Bus	A-B C-E-D	This sequence is inherent in the plant design; relabel to clearly indicate actual progression.	D	NA	D
	Feeder Breakers	1-7-2-8	This sequence is inherent in the plant design; relabel to clearly indicate actual progression.	D	NA	D

TABLE VI-4 (Continued)

CONTROLS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL PROGRESSION

PANEL	CONTROLS	CURRENT PROGRESSION OF CONTROLS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12	Charging Pump P-55 Auto/Man Selector	C-B	Relabel to clearly indicate actual progression and to keep consistent with progression on CO2.	D	NA	D
C13	Safeguard Room Cooler Fans V-27	A-C-D-B	Relabel. Evaluated as part of emergency procedure validation walk-throughs. No problems with arrangement were identified. Relocation of controls is not required.	B3	AIR A-NPP 84-26	D
	Displays and Range Selector Switches for Safety Injection Tanks	B-C A-D	Relabel to clearly indicate actual progression; consistent with loops and mimic on C12.	D	NA	D

TABLE VI-5

MIRRORED IMAGE GROUPS OF CONTROLS AND DISPLAYS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C04	The groups of meters and controls in the upper portion of this panel appear to be generally mirrored about the synchroscope in the middle of the panel. However, within individual groups the controls/displays are duplicated left-to-right, not mirrored.	Relabel and demarcate to clearly indicate groupings of meters and controls.	D	NA	D
C12	Loops 1 & 2 hot leg temperatures are mirrored. Loops 1B, 1A and 2A, 2B cold leg temperatures are mirrored. The 6 recorders along the bottom row are mirrored. (It is noted that these displays are adjacent to the mimic of the primary coolant loops on panel C12. The mimic itself forms a type of mirror-display.)	Relabel to clearly indicate actual progression; this mirroring is inherent in plant layout; layout of displays consistent with mimic is appropriate.	D	NA	D
C13	The indications of safety injection tank levels and pressures, and LPSI and HPSI flows are mirrored; loop 1 injection is on the left of the mirror point, loop 2 injection is on the right.	Relabel to clearly indicate actual progression; similar mirror is used on mimic of reactor coolant loops on C12.	D	NA	D
	The controls for the right and left channel containment isolation valves are a combination of mirroring and duplicating.	Switch containment isolation on high pressure control with containment isolation on high radiation to make mirrors consistent.	A2	AIR A-NPP 84-26	1987 outage
	The controls for the right and left safety injection channels at the bottom of panel C13 are partially mirrored.	The validation walkthroughs of emergency procedures at the simulator did not indicate any serious problems with these controls and displays. However, these controls will be relocated to make them a consistent mirror to match the related controls and displays immediately above them on the panel.	A2	NA	1987 outage

TABLE VI-5 (Continued)

MIRRORED IMAGE GROUPS OF CONTROLS AND DISPLAYS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C106	The cooling tower fan push-button controls and cooling tower bypass valve controls are mirrored: cooling tower "A" on left side of mirror, "B" on right side.	Use of these controls is slow, deliberate process; relabel to clearly indicate actual progression.	D	NA	D
	Some of the electrical meters near the top of the panel are also mirrored.	Use of these controls is slow, deliberate process; relabel to clearly indicate actual progression.	D	NA	D

TABLE VI-6

CONTROLS WITH A DIRECTION OF MOTION DIFFERENT THAN THAT OF CORRESPONDING LIGHTS

PANEL	CONTROL	SWITCH	LIGHT ORDER	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Steam Generator Main Steam Isolation Valves CV 0501 & CV 0510	close-open	CP-close-open	CP indicator is clearly labeled; no confusion is likely and no corrective action is required	NAR	AIR A-NPP 84-35	NA
C02	Oil Lift Pumps	hand-off-auto	off-auto-on	No action required; use of these controls is slow deliberate action.	NAR	NA	NA
	Pressurizer heaters	auto-off-man	off-on	No action required; use of these controls is slow deliberate action.	NAR	NA	NA
C13	CV 2001, Demin Wtr Stor Tk fill Valve	hand-off-auto	closed-open	Relabel to indicate open-closed auto; action is slow, deliberate.	D	NA	D
	CV 2008, Prim Sys Stor Tk fill Valve	hand-off-auto	closed-open	Relabel to indicate open-closed auto; action is slow, deliberate.	D	NA	D
	CV 2010, Cond Stor Tk Fill Valve	hand-off-auto	closed-open	Relabel to indicate open-closed auto; action is slow, deliberate	D	NA	D
	Air Compressors C2	hand-off-auto	off-auto-on	No action required; use of these controls is usually a slow, deliberate action; on loss of power, the compressors must be restarted. Based on walkthroughs at the simulator, operators appear to have no problem operating these controls.	NAR	NA	NA
	Containment Lighting	on-off	off-on	Reverse control.	C2	AIR A-NPP 84-35	1987 outage
	Emerg. Cont. Lights	on-off	off-on	Reverse control.	C2	AIR A-NPP 84-35	1987 outage

TABLE VI-6 (Continued)

CONTROLS WITH A DIRECTION OF MOTION DIFFERENT THAN THAT OF CORRESPONDING LIGHTS

PANEL	CONTROL	SWITCH	LIGHT ORDER	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C125	Fuel Handling Ventilation Dampers, D1 and D2	Normal-Refuel	Refuel-Normal Normal-Refuel	Light order is consistent with open/closed stereotype; relabel and demarcate to establish relation between single control, two sets of lights.	D	NA	D
C126	Cooling Tower System P39A	Stop-Start	off-on-P	P indicator is clearly labeled, no confusion is likely. Engraving will be changed to CP to be consistent with other power available indicator lights.	C2	AIR A-NPP 84-35	1988 outage
	Cooling Tower System P39B	Stop-Start	off-on-P	P indicator is clearly labeled, no confusion is likely. Engraving will be changed to CP to be consistent with other power available indicator lights.	C2	AIR A-NPP 84-35	1988 outage

TABLE VI-7

EXCEPTIONS TO CONTROL-TYPE CONVENTIONS

PANEL	CONTROL	CURRENT CONTROL TYPE	EXPECTED CONTROL TYPE	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Control valve CV-0521, alternate steam supply for auxiliary feed pump P-8B	Pistol Grip	Finger grip	Replace control as part of aux feed modification.	D	NA	NA
	Control valve CV-0522B turbine driven auxiliary feed pump auto start	Pistol Grip	Finger grip	Replace control as part of aux feed modification.	D	NA	NA
C03	East and West safe-guards rooms sump pumps, P72A, P72B P73A, P73B	Finger grip	Pistol grip	This is a selector switch not a pump control. Consequently, the finger grip control type is appropriate and no corrective is required.	NAR	AIR A-NPP 84-31	NA
C13	Demin water transfer pump P-936	Finger grip	Pistol grip	Differing from the control handle type convention is not considered a significant deviation from the guide-lines: in this case the control is near the bottom of a vertical panel and at this location the existing finger-grip control is less prone to inadvertent actuation. No action required.	NAR	AIR A-NPP 84-31	NA
C126	Heater controls for N_2H_4 T102 and NaOH T103	Finger grip	Pistol grip	This is a selector switch not a pump control. Consequently, the finger grip control type is appropriate and no corrective is required.	NAR	AIR A-NPP 84-31	NA

TABLE VI-8

CONTROLS AND DISPLAYS WITH MISSING LABELS OR POSITION INDICATIONS

PANEL	LOCATION ON PANEL	DESCRIPTION OF COMPONENT	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Backboard, Right	Red alarm light on reheater control system panel is unlabeled.	Add label.	B1	NA	1987 outage
C02	Benchboard, Left	Unlabeled switch below charging pump P55A switch.	Remove switch.	C2	AIR A-NPP 84-32	1987 outage
	Benchboard Left	Unlabeled switch to the left of Boric Acid pump P56B.	Remove switch.	C2	AIR A-NPP 84-32	D
	Benchboard, Middle	Unlabeled button is no longer functional.	Remove button.	C2	AIR A-NPP 84-32	1987 outage
	Backboard, Right	Digital display of Tave is not labeled.	Add label.	D	NA	D
	Backboard, Right	Reactivity meter is labeled only by the scale by the side of the meter.	See IV.A1.b(1); existing label is adequate - no action is required.	NAR	NA.	NA
	Backboard, Left	Pressure indicator above CV2136 should be labeled "Boric Acid Pump Discharg Pressure, psig, PIC0206".	Add label.	D	NA	D
C03	Benchboard, Middle	Key lock switches above hand switches for CV 3027 and CV 3056 are not identified.	Add label.	D	NA	D
	Benchboard, Left	Switch above shield cooling Pump P77B is unlabeled.	Remove switch.	C2	AIR A-NPP 84-32	1987 outage
	Benchboard, Right	Selector switch for HPSI Pumps P66C, P66A is unlabeled.	Switch is removed.	D	NA	NA
	Benchboard, Middle	Lights showing pump rotation are not labeled.	Add label	C1	NA	1987 outage

TABLE VI-8 (Continued)

CONTROLS AND DISPLAYS WITH MISSING LABELS OR POSITION INDICATIONS

PANEL	LOCATION ON PANEL	DESCRIPTION OF COMPONENT	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C07	Upper Middle	Selector switch for phase to phase voltage is not labeled. It is not clear whether Bus F or Bus R voltmeter is affected.	Add label.	D	NA	D
	Bottom	Frequency Recorders HzR-0001 and HzR-0002 are unlabeled.	Add label to clarify which frequency is displayed.	D	NA	D
C11	Right	3 temperature scales (0-300°F) are unlabeled.	These meters are not functional and will be removed.	C2	AIR A-NPP 84-32	1987 outage
	Middle	Recorders REC/VXCD and TR 0505 are unlabeled.	Add label.	D	NA	D
C12	Lower Left	Position indication, "close/open", for HIC 2122 (Intermediate Letdown Pressure Control Valve Bypass Valve Control) appears to be missing.	Add label.	D	NA	D
C13	Middle	Containment lighting switch does not have position indication ("on/off") label. (Switch orientation appears to be backwards from related indicating lights).	Add label.	D	NA	D
C13-BACK	Middle	Pressurizer pressure and level displays PIC0101A, PIC0101B; LIC0101AL, LIC0101BL are not labeled.	Add labels.	D	NA	D
C13-SIDE		Position indications "off/on", for event recorders on Channels A and C are missing.	Add labels.	D	NA	D
C126	Upper Left	Small rotary controls are unlabeled above water box inlet valve position meters and cooling tower pump discharge valve position meters.	These controls adjust the span on the adjacent valve position indication; an information label has been added.	D	NA	D

TABLE VI-8 (Continued)

CONTROLS AND DISPLAYS WITH MISSING LABELS OR POSITION INDICATIONS

PANEL	LOCATION ON PANEL	DESCRIPTION OF COMPONENT	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C126 (Cont'd)	Middle	Temperature scales on each cooling tower pump and motor multipoint alarms do not identify which temperature (pump bearing or motor winding) is being displayed.	Temporary labels are used currently; permanent labels will be provided.	C1	NA	1987 outage
	Bottom	Switch below Basin "B" Blowdown Line Valve M05326B and adjacent spare next to it are not labeled.	Remove switches.	C1	AIR A-NPP 84-32	1987 outage
	Left	The current meter for pump P-39A is not labeled.	Add label.	D	NA	D

TABLE VI-9

CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS BUT MISSING IDENTIFICATION NUMBERS

PANEL	LOCATION ON PANEL	MISSING LABEL NAME	NUMBER	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Backboard	Steam Gen Feed Pumps Suction Press	PIA 0786	Add label.	D	NA	D
		Stm Gen Feed Pump P-1A Disch Pres.	PI 0701	Add label.	D	NA	D
		Steam Gen Feed Pump P-IB Disch Press	PI 0703	Add label.	D	NA	D
		Aux Feed Pump P-8B Steam Supply Press	PI 0521A	Add label.	D	NA	D
		Aux Feed Pumps Disch Press	PI 0789	Add label.	D	NA	D
		Moisture Sep Drain Tk T-5 Level	LI 0609	Add label.	D	NA	D
		Condenser Hotwell Level	LI 0729	Add label.	D	NA	D
		Cond. Demin System Vessel A, B, C or D Diff Press Selector	DPI 8733	Add label.	D	NA	D
		Condenser Vacuum	PI 0763	Add label.	D	NA	D
		Main Steam Pressure	PI 0580	Add label.	D	NA	D
		Gland Seal Steam Supply Pressure	PI 0581	Add label.	D	NA	D
		Gland Seal Condenser Vacuum	PI 0582	Add label.	D	NA	D
		Turb-Gen Brg Oil Hdr Press	PI 1403	Add label.	D	NA	D

TABLE VI-9 (Continued)

CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS BUT MISSING IDENTIFICATION NUMBERS

PANEL	LOCATION ON PANEL	MISSING LABEL NAME	NUMBER*	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01 (Cont'd)	Backboard	Turb-Gen Mn Oil Pump Disch Press	PI 1412	Add label.	D	NA	D
		Turb-Gen Mn Oil Pump Suct Press	PI 1410	Add label.	D	NA	D
		LP1	LPA,TI 0533	Add label.	C1	NA	1987 outage
		LP2	LPB,TI 0530	Add label.	C1	NA	1987 outage
	Benchboard, Left	Steam Gen Feed Pump Turb Driver K-7A Speed	SPI 0563A	Add label.	D	NA	D
		Steam Gen Feed Pump Turb Driver	SPI 0565A	Add label.	D	NA	D
	Benchboard, Middle	Steam Gen Feed Pump Turb Driver K-7A Low Press Stop VV	157FW(POS0562)	No action required; P&ID identification is not used.	NAR	NA	NA
		Steam Gen Feed Pump Turb Driver K-7A Hi Press Stop VV	155FW(POS0563)	No action required; P&ID identification is not used.	NAR	NA	NA
		Steam Gen Feed Pump Turb Driver K-7B Low Press Stop VV	158FW(POS0565)	No action required; P&ID identification is not used.	NAR	NA	NA
		Steam Gen Feed Pump Turb Driver K-7B Hi Press Stop VV	156FW(POS0566)	No action required; P&ID identification is not used.	NAR	NA	NA
C02	Backboard, Middle	Primary Makeup Water Flow	FQI 0210A	Add label.	D	NA	D
	Backboard, Left	Low Press Letdown Pressure Control	PIC 0202	Add label.	D	NA	D
C03	Benchboard Left	Component Clg Wtr HX E-54B Outlet Temp	TIA 0916	Add label.	D	NA	D
		Shutdown Clg HX E-60B Outlet Temp	TI 0913	Add label.	D	NA	D

TABLE VI-9 (Continued)

CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS
BUT MISSING IDENTIFICATION NUMBERS

PANEL	LOCATION ON PANEL	MISSING LABEL NAME	NUMBER*	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03 (Cont'd)	Benchboard Left	Reactor Shield Clg Coil B Outlet Temp	TIA 0933	Add label.	D	NA	D
		Shield Clg Surge Tk T-62 Level	LIA 0927	Add label.	D	NA	D
		Component Clg Wtr HX E-54A Outlet Temp	TIA 0914	Add label.	D	NA	D
		Shutdown Clg HX E-60A Outlet Temp	TI 0912	Add label.	D	NA	D
		Component Clg Surge Tk T-3 Level	LIA 0917	Add label.	D	NA	D
		Component Clg Pumps Disch Pressure	PIA 0918	Add label.	D	NA	D
		Reactor Shield Clg Coil A Outlet Temp	TIA 0931	Add label.	D	NA	D
	Backboard Left	Component Clg HX E-54B Serv Wtr Temp Out	TI 0824	Add label.	D	NA	D
		Crit Serv Wtr Hdr B Press	PI 1319	Add label.	D	NA	D
		Emer Dies Gen HXS E22A&B Serv Wtr Temp Out	TI 0832	Add label.	D	NA	D
		Component Clg HXE-54A Serv Wtr Temp Out	TI 0823	Add label.	D	NA	D
		Crit Serv Wtr Hdr A Press	PI 1318	Add label.	D	NA	D
	Backboard Middle	Safety Injection TK T-82A Press Cont Valve CV 3042	PIC 0342	Add label.	D	NA	D
		Safety Injection Tk T-82B Press Cont Valve CV 3046	PIC 0346	Add label.	D	NA	D
		West Engrd Safegrds Room Sump PP Press	PI 1106	Add label.	D	NA	D

TABLE VI-9 (Continued)

CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS BUT MISSING IDENTIFICATION NUMBERS

PANEL	LOCATION ON PANEL	MISSING LABEL NAME	NUMBER*	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03 (Cont'd)	Backboard Right	Safety Injection Tk T-82C Press Cont Valve CV 3047	PIC 0347	Add label.	D	NA	D
		Safety Injection Tk T-82D Press Cont Valve CV 3038	PIC 0338	Add label.	D	NA	D
	Backboard Right	East Engrd Safegrds Room Sump PP Press	PI 1108	Add label.	D	NA	D
		Shutdown Cooling Heat Exchangers Inlet Temperature	TI 0303	Add label.	D	NA	D
C11	Upper	Fast Makeup Valve for Main Steam	CV 0733	Add number to label.	C1	NA	1987 outage
		HP Steam Flow Turb Driver K-7A	FI 0526	Add label.	D	NA	D
		HP Steam Flow Turb Driver K-7B	FI 0529	Add label.	D	NA	D
		Aux Fw Flow Stm Gen E-50A	FI 0737	Add label.	D	NA	D
		Aux Fw Flow Stm Gen E-50B	FI 0736	Add label.	D	NA	D
	Upper Right	Generator #8 Bearing Oil Drain	TIA 0532	Add label.	D	NA	D
		Excitor Bearing Oil Drain	TIA 0529	Add label.	D	NA	D
		Turbine Thr Brg-F Oil Drain	TIA 0560	Add label.	D	NA	D
		Turbine Thr Brg-R Oil Drain	TIA 0561	Add label.	D	NA	D
		HP Turbine #1 Bearing Oil Drain	TIA 0506	Add label.	D	NA	D
		HP Turbine #2 Bearing Oil Drain	TIA 0508	Add label.	D	NA	D
		LP Turbine #3 Bearing Oil Drain	TIA 0510	Add label.	D	NA	D
		LP Turbine #4 Bearing Oil Drain	TIA 0512	Add label.	D	NA	D
		LP Turbine #5 Bearing Oil Drain	TIA 0514	Add label.	D	NA	D
		LP Turbine #6 Bearing Oil Drain	TIA 0518	Add label.	D	NA	D

TABLE VI-9 (Continued)

CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS BUT MISSING IDENTIFICATION NUMBERS

PANEL	LOCATION ON PANEL	MISSING LABEL NAME	NUMBER*	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C11 (Cont'd)	Upper Right	Generator #7 Bearing Oil Drain	TIA 0520	Add label.	D	NA	D
		FW Pump P-1A Thrust Brg Active Face.	TIA 1434	Add label.	D	NA	D
		FW Pump P-1A Thurst Brg Inactive Face	TIA 1435	Add label.	D	NA	D
		FW Pump P-1A Journal Thr Brg End	TIA 1436	Add label.	D	NA	D
		FW Pump P-1A Journal Coupling End	TIA 1437	Add label.	D	NA	D
		Turb Driver K-7A Journal Exhaust End	TIA 1438	Add label.	D	NA	D
		Turb Driver K-7A Thrust Brg Active Face	TIA 1439	Add label.	D	NA	D
		Turb Driver K-7A Thrust Brg Inactive	TIA 1440	Add label.	D	NA	D
		FW Pump P-1B Thrust Brg Active Face	TIA 1441	Add label.	D	NA	D
		FW Pump P-1B Thrust Brg Inactive Face	TIA 1442	Add label.	D	NA	D
		FW Pump P-1B Journal Thr Brg End	TIA 1443	Add label.	D	NA	D
		FW Pump P-1B Journal Coupling End	TIA 1444	Add label.	D	NA	D
		Turb Driver K-7B Journal Exhaust End	TIA 1445	Add label.	D	NA	D
		Turb Driver K-7B Thrust Brg Active Face	TIA 1446	Add label.	D	NA	D

TABLE VI-9 (Continued)

CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS
BUT MISSING IDENTIFICATION NUMBERS

PANEL	LOCATION ON PANEL	MISSING LABEL NAME	NUMBER*	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C11 (Cont'd)	Upper Right	Turb Driver K-7B Thurst Brg Inactive Face	TIA 1447	Add label.	D	NA	D
		Cond Pump P-2A Motor Winding	TIA 0711	Add label.	D	NA	D
		Cond Pump P-2A Motor Thurst Brg	TIA 0713	Add label.	D	NA	D
		Cond Pump P-2B Motor Winding	TIA 0715	Add label.	D	NA	D
		Cond Pump P-2B Motor Thrust Brg	TIA 0717	Add label.	D	NA	D
	Upper Middle	Generator Hydrogen Purity	PuI 1424	Add label.	D	NA	D
		Generator Hydrogen Pressure	PI 1419	Add label.	D	NA	D
C12	Lower Left	Intermediate Letdown Pressure Control Valve Bypass Valve Control	HIC 2122	Add label.	D	NA	D
C13	Upper Left	East Engrd Safeguards Room Temp	TI 0869	Add label.	D	NA	D
		West Engrd Safeguards Room Temp	TI 0870	Add label.	D	NA	D
	Upper Right	Safety Inj Tk T-82A Level	LIA 0365	Add label.	D	NA	D
		Safety Inj Tk T-82A Pressure	PIA 0363	Add label.	D	NA	D
		Safety Inj Tk T-82B Level	LIA 0368	Add label.	D	NA	D
		Safety Inj Tk T-82B Pressure	PIA 0367	Add label.	D	NA	D
		Safety Inj Tk T-82C Level	LIA 0372	Add label.	D	NA	D
		Safety Inj Tk T-82C Pressure	PIA 0371	Add label.	C1	NA	1987 outage
		Safety Inj Tk T-82D Level	LIA 0374	Add label.	D	NA	D
		Safety Inj Tk T-82D Pressure	PIA 0369	Add label.	D	NA	D

TABLE VI-9 (Continued)

CONTROLS AND DISPLAYS WITH DESCRIPTIVE LABELS BUT MISSING IDENTIFICATION NUMBERS

PANEL	LOCATION ON PANEL	MISSING LABEL NAME	NUMBER*	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C126	Lower Right	N_2H_4 Tk T102 Heater A Control SW	HS 0437C	Relabel.	D	NA	D
		NAOH Tk T103 Heater A Control SW	HS 0438C	Relabel.	D	NA	D
		N_2H_4 Tk T102 Heater B Control SW	HS 0437D	Relabel.	D	NA	D
		NAOH Tk T103 Heater B Control SW	HS 0438D	Relabel.	D	NA	D
		Pump & Motor P39A Temp	TIA 5303	Add label.	D	NA	D
		Pump & Motor P39B Temp	TIA 5304	Add label.	D	NA	D
	Upper Left	Water Box A Inlet Vlv Position	PoI 5301	Add label.	D	NA	D
		Water Box B Inlet Vlv Position	PoI 5302	Add label.	D	NA	D
	Upper Left	Clg Twr PP P-39A Disc Valve Pos	PoI 5305	Add label.	D	NA	D
		Clg Twr PP P-39B Disc Valve Pos	PoI 5306	Add label.	D	NA	D
		Clg Twr PP P-39A Basin Level	LIA 5307	Add label.	D	NA	D
		Clg Twr PP P-39B Basin Level	LIA 5308	Add label.	D	NA	D
		Water Box A Inlet Temperature	TIA 1317	Add label.	D	NA	D
		Water Box B Inlet Temperature	TIA 1316	Add label.	D	NA	D
		Water Box A Outlet Temperature	TIA 1332	Add label.	D	NA	D
		Water Box B Outlet Temperature	TIA 1328	Add label.	D	NA	D
		Basin A Blowdown Line Flow	FI 5327A	Add label.	D	NA	D
		Basin B Blowdown Line Flow	FI 5327B	Add label.	D	NA	D

TABLE VI-10

EXAMPLES OF CONTROL AND DISPLAY LABELS WHICH ARE UNCLEAR OR DO NOT PROVIDE ADEQUATE INFORMATION

PANEL	LOCATION	DESCRIPTION OF LABEL	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Benchboard	HS 0734 and HS 0735 each have a 2 position indication light centered above the switch. It is not clear what this light indicates.	Relabel.	D	NA	D
	Backboard, Right	Reheater Control displays labeled only "LP1" and "LP2" are indications of inlet temperatures for LP turbines A and B, respectively. Operators use either designation interchangeably, i.e. LP1 or LPA, etc.	Add label.	D	NA	D
C02	Benchboard, Left	One control switch (with indicating lights) is labeled "PRESS - LETDOWN ORIFICE BYPASS STOP VALVE CV-2002A". Switch below this (without indicating lights) is labeled "FLOW-LETDOWN ORIFICE BYPASS STOP VALVE CV-2002B". More accurate labeling would be as follows: The indicating lights would be labeled: LETDOWN ORIFICE BYPASS STOP VALVE CV-2002; the top switch would be labeled: SV-2002A CLOSES ON HIGH LETDOWN PRESSURE AT PIC-0222 OR PIC-0220; the bottom switch would be labeled: SV-2002B CLOSES EITHER ON HIGH LETDOWN FLOW AT FIC-0202 OR HIGH LETDOWN PRESSURE AT PIC-0221.	Relabel.	D	NA	D
	Backboard, Left	The label for PIC-0202 (letdown pressure control) does not indicate which valve(s) are being controlled.	Relabel.	D	NA	D

TABLE VI-10 (Continued)

EXAMPLES OF CONTROL AND DISPLAY LABELS WHICH ARE UNCLEAR OR DO NOT PROVIDE ADEQUATE INFORMATION

PANEL	LOCATION	DESCRIPTION OF LABEL	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03	Benchboard	Two displays on the left of the panel are labeled "SHUTDOWN CLG HX E-60A OUTLET TEMPERATURE" and "SHUTDOWN CLG HX E-60B OUTLET TEMPERATURE" while a display on the right side is labeled "SHUTDOWN COOLING HEAT EXCHANGER INLET TEMPERATURE". It is not clear from the labels that the first two displays refer to the cooling water side of the heat exchanger and the last display refers to the primary water side of the exchanger.	Relabel.	D	NA	D
	Benchboard, Middle	Two switches labeled "LPSI PUMP P-67A(B) SIRW TANK LOW LEVEL TRIP". The switch positions are labeled "OFF" and "ON". It appears the position should be labeled "DISABLE" and "ENABLE".	Relabel.	D	NA	D
		Two key lock switches are located above the control switches for the SIRW tank recirculation valves. The switch positions are labeled "OPEN" and "CLOSE". The "close" position actually enables the recirc valves to be closed by the adjoining control switches.	Add clarifying label.	D	NA	D
C06		The four cabinets of panel C06 are labeled A, B, C, D, corresponding to the four safety channels. Additional labels identifying these with preferred AC buses Y-10, Y-20, Y-30 and Y-40, respectively, would assist the operators in diagnosing AC power failures.	Add labels.	B1	NA	D
C07	Top	Kiloamp scales for Argenta and Cook lines have "X1000" handwritten beside them. This is a reminder to the operators that the Argenta and Cook line currents are in kiloamps whereas the adjacent Vergennes and Tallmadge lines are in amps.	Handwritten note has been removed. Scale faces are clearly marked with correct units.	NAR	NA	NA

TABLE VI-10 (Continued)

EXAMPLES OF CONTROL AND DISPLAY LABELS WHICH ARE UNCLEAR OR DO NOT PROVIDE ADEQUATE INFORMATION

PANEL	LOCATION	DESCRIPTION OF LABEL		ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12	Middle	Primary coolant loop flow displays are labeled FI 0102 A, B, C, D. These flows are averaged and not associated with individual loops, but the "A, B, C & D" can get confused with PCPs A, B, C & D.		Relabel.	D	NA	D
	Lower Left	The label for HIC-2122 "Intermediate Letdown Pressure Control Valve Bypass Valve Control" does not indicate which valves are being controlled.		Add label.	D	NA	D
C13	Left	Two displays are labeled "EAST(WEST) ENGRD SAFEGUARDS RM TEMP". The temperatures being displayed would more accurately be labeled the air temperatures exiting the engineered safeguards room chillers.		Relabel.	D	NA	D
	Upper Right	The relationship of the SI tank level display and the wide/narrow range control is unclear.		Relabeled to identify the function of the range control switch. The setpoint indicators are based on tech spec limits. Level indicator is operated in narrow range except when filling or draining.	C1	NA	D
	Upper Right	Confusing numbering system:					
		Flow through: MO F012 MO 3011 MO 3010 MO 3009 MO 3008 MO 3007	Flow indicator: FI 0311 FI 0312 FI 0309 FI 0310 FI 0307 FI 0308	Confusion is inherent in component numbering system; relabeling emaphasizes function of each flow rate.	D	NA	D
C126	Several locations	The words "control valve" and "control SW" appear to be redundant on several labels on this panel and can be removed. The abbreviation SW can be confused with service water.		Relabel.	D	NA	D

TABLE VI-11

INSTANCES OF INCONSISTENT NOMENCLATURE

- PRIMARY COOLANT PUMPS*

LOCATION		NOMENCLATURE				ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
CONSOLE	C02	1A	B	C	D	Relabel to use consistent nomenclature: P-50A, P-50B, P-50C, P-50D;	D	NA	D
BACK PANEL	C11	PCP A	PCP B	PCP C	PCP D				
BACK PANEL	C11	1A	1B	2A	2B				
BACK PANEL	C12	P-50A	P-50B	P-50C	P-50D				
BACK PANEL	C12	A pump	B pump	C pump	D pump				
MIMIC	C12	PCP "A"	PCP "B"	PCP "C"	PCP "D"				
P&ID	M-201	P-50A	P-50B	P-50C	P-50D				
P&ID	M-201	1A	1B	2A	2B				
TRAIN MAN	Ch4, p16	P-50A	P-50B	P-50C	P-50D				
TRAIN MAN	Fig 3-1	1A	1B	2A	2B				
PROCEDURES	SOP 1	P-50A	P-50B	P-50C	P-50D				

* Main feedwater pumps are also labeled P-1A, P-1B

- PRIMARY COOLANT PUMP DOWNWARD THRUST BEARING TEMPERATURE

LOCATION		NOMENCLATURE				ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Train Man	Table 4-1	0133A	0133B	0143A	0143B	Panel is labeled correctly; training manual is incorrect. Discrepancy has been forwarded to Training Department; no further action required	NAR	NA	NA
Back Panel	C11	0139A	0139B	0149A	0149B				
P&ID	M-209	0139A	0139B	0149A	0149B				

- REACTOR VESSEL

	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
PDT 104 on C12 should be PDT 0104, consistent with P&ID M-201.	Revision of label is not considered necessary since confusion is unlikely.	NAR	NA	NA

TABLE VI-11 (Continued)

INSTANCES OF INCONSISTENT NOMENCLATURE

- STEAM GENERATORS

LOCATION	NOMENCLATURE	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
The back of C12 calls E-50A Feedwater Regulating System "Unit 1" and E-50B Feedwater Regulating System "Unit 2".		Relabeled as SG A Feed Reg System and SG B Feed Reg System	C1	NA	D
Steam Generator Feed Pump Turb Driver K-7A Speed Control on C01 is labeled HIC 0526 and on P&ID M205 Sheet 2 (E-4) is labeled HIC 0576.		P&ID has been corrected.	D	NA	D
FIC 0736 (0737) apparently should have a dotted line drawn on P&ID M207 8-E (8-D) to CV 0736A (0737A) to indicate that flow can control this valve. On this P&ID, FI should read FIC. The Training Manual Chapter 21, pg. 32, doesn't mention that these valves can be controlled automatically by flow.		Major modification to aux feed system makes original observation invalid. Revision of P&ID and Training Manual accomplished as part of modification procedure. No further action required.	NAR	NA	NA

- COOLING TOWER BASIN WATER LEVEL

LOCATION		NOMENCLATURE		ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Panel	C106	30A	30B	Relabel with consistent nomenclature 30A, 30B.	D	NA	D
Panel	C106	A	B				
Train Man	Ch.23 p5	1	2				
Procedures	SOP14	A	B				
P&ID	M653	E-30A	E-30B				

- WATER BOXES

LOCATION		NOMENCLATURE			ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Panel	C126	A	B	(display)	Relabel with consistent nomenclature.	D	NA	D
Panel	C126	West	East	(controls)				
P&ID	M653	West	East					

TABLE VI-11 (Continued)

INSTANCES OF INCONSISTENT NOMENCLATURE

- PLANT POWER

LOCATION	NOMENCLATURE			ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
Train Man Panel	Ch32, Fig. 32-2C C07	Twin Branch Cook No. 1	Olive Cook No. 2	Panel labels are correct; discrepancy with training manual has been forwarded to Training Department; no further action required.	NAR	NA	NA
Train Man Train Man Panel	Ch 32, p10 Ch 32, Fig. 32-2C C07	Remote Ch/Test/Master Ch Emd Ch/Test/Status Ch Cmd Ch/Test/Status Ch		Panel labels are correct; discrepancy with training manual has been forwarded to Training Department.	C1	NA	D

- ELECTRIC GENERATORS

The three symbols for generators on C04 should be labeled "Main Gen", "DG 1-1 and "DG 1-2" as in System Lesson Notes Fig 33-1.	Relabel.	D	NA	D

TABLE VI-12

UNIDENTIFIED OR INCONSISTENT ABBREVIATIONS

PANEL	LOCATION	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Light cap Light cap Light cap Light cap	A (white) C (orange) CP (white) M (orange)	Engrave light caps as part of relabeling effort.	C1	AIR A-NPP 84-33	1988 outage
	Special Label	C.W.P. on Motor Starting Duty Instruction	C.W.P. stands for Circulation Water Pumps; no revision is required.	NAR	NA	NA
C02	Light cap Light cap	A (white) OP (white)	Engrave light caps as part of relabeling effort.	C1	AIR A-NPP 84-33	1988 outage
	Control	MI, MG, ... on Rod Drive Control Mode Selector	Control modes are extensively covered during system training program; operators understand terminology well; no action required.	NAR	NA	NA
C03	Light cap	Engraving on CV 0915	Engrave light caps as part of relabeling.	C1	AIR A-NPP 84-33	1988 outage
	Caution label	RIAS undefined	Relabel.	D	NA	D
C04	Control	Start-up sometimes abbreviated SU	Relabel.	D	NA	D
	Controls and Displays	Transformer sometimes abbrevited XFMR, sometimes Trans, sometimes Transf.	Relabel.	D	NA	D
	Controls and Displays	Station Power sometimes abbreviated Sta. Pwr., sometimes Station Pwr.	Relabel.	D	NA	D
	Control	Undervoltage abbreviated U.V.	Relabel	D	NA	D

TABLE VI-12 (Continued)

UNIDENTIFIED OR INCONSISTENT ABBREVIATIONS

PANEL	LOCATION	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C06	Trip Indicating Lights	Level and Load are both abbreviated by "L"	Meaning of labels are clear from context. Abbreviations are required because of limited space.	NAR	NA	NA
C12	Display	NI 010,009, trip lights need explanation	Relabel.	C1	NA	D
C12-BACK	Display	Pounds per hour abbreviated lb/hr, #/hr, PPH	Relabel.	D	NA	D
C106	Light cap	CP (white)	Engrave as part of relabeling.	C1	AIR A-NPP 84-33	1988 outage
C126	Light cap	P (white)	Engrave as part of relabeling.	C1	AIR A-NPP 84-33	1988 outage
	Controls & Displays	Discharge sometimes Disch, sometimes Disc	Relabel.	D	NA	D
	Control	Control SW used for Control Switch (SW may be confused with Service Water)	Relabel.	D	NA	D

TABLE VI-13

SPECIAL PRECAUTION OR INFORMATION LABELS THAT MAY NOT BE CLEAR

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Current label reads: "CONDENSATE PP DISC VV OPEN 25 TR TO START FIRST PUMP". This label means: "Before starting first condensate pump, open discharge valve 25 turns".	Relabel.	D	NA	D
C02	The "MOTOR STARTING DUTY..." label for the primary coolant pumps is located next to the PCP oil lift pumps controls and may be more properly located next to the primary coolant pump controls.	Current location is adequate. No action required.	NAR	NA	NA
	The caution tag next to the primary coolant pump controls currently states "CHECK FLOW SWITCH BEFORE TRIPPING PUMPS". This should be changed to indicate that the "flow switch" is on the reactor protection panel (C-06).	Relabel.	D	NA	D
C11	The current label "ROTOR POSITION OPR. LIMTIS 25-95 MILS' should read: " ... LIMITS ..."	Relabel.	D	NA	D
	The label next to the vibration recorder for the feedwater pump turbine drivers, K-7A and K-7B identifies alarm and trip levels. Each recorder includes two plots of vibration and one of axial movement. The label should be modified to make clear that the specified limits apply only to the axial movement, an additional label should be provided to specify the vibration limits and the units on both the label and the recorder should be identified.	Current label removed to make room for FOGG valves; evaluate need for new label. (See also Table VI-19.)	C1	AIR A-NPP 84-37	D

TABLE VI-13 (Continued)

SPECIAL PRECAUTION OR INFORMATION LABELS THAT MAY NOT BE CLEAR

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12	Current label near Boric Acid Tank Level Indicators reads "Levels Governed by T. S. 3.2.2 and 3.2.3". This refers to the plant Technical Specifications 3.2.2 and 3.2.3 which specify that the two boric acid tanks together shall contain at least 118 inches of boric acid (6.25% - 10% solution by weight). It is recom mended that this label be changed to identify the 118 inch limit and to relate this limit to the 0-100% scale for the tank level indicators.	Relabeled (See also Table VI-20.)	C1	NA	D
C13	The "SIAS RESET" label should be moved closer to each of the two reset buttons.	Move label and add demarcation.	D	NA	D
C125	The label above TR5370 gives cryptic temperature limits based on tech spec 3.9.9.	Tech spec requirement has been eliminated. This label removed as part of relabeling.	D	NA	D
C126	The following label is unclear: " - DBA - REMOVE HANDJACKS FROM CV 0438A/B. OPEN 3365/3366ESS".	Clarify as part of relabeling effort.	D	NA	D
	The label above the P-39A multipoint alarm states: "CAUTION WHENEVER STOP LOG OVERFLOW EXCEEDS 3.5 " (BOTH) OR EXCEEDS 7" (ONE) WATCH BASIN DISCH. TEMP. CLOSELY - DO NOT EXCEED 5° TEMP. RISE".	The tech spec requirement has been eliminated; this label removed.	D	NA	D

TABLE VI-14

TEMPORARY LABELS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Turbine Bypass Control CV 0511 has two temporary labels indicating setpoint information.	Add permanent label.	D	NA	D
	Sound powered phone channel selector switch (lower right) uses temporary position labels.	Add permanent label.	D	NA	D
	"Main" or "S.O. Unit" temporary labels are above 7 pump switches.	Add permanent label.	D	NA	D
	Handle positions are handwritten on panel around condensate demineralizer system vessel selector.	Add permanent label.	D	NA	D
	There is a temporary x.1 label for Turbine Generator Loading Rate indicator.	Add permanent label.	D	NA	D
	There are typewritten labels on each of the two steam generator level controllers.	Add permanent label.	D	NA	D
C02	Letdown Orifice Bypass Stop Valves CV2002 have temporary "A", "B", "Press" and "Flow" labels.	Add permanent label.	D	NA	D
	Primary coolant pumps have temporary "B", "C" and "D" labels.	Add permanent label.	D	NA	D
	There are three typewritten sheets with volume control tank and pressurizer information.	Add permanent operator aid or label.	C1	AIR A-NPP 84-38	D
	Typewritten information labels are included in or on the following controllers: HIC 3025, FIC 0306, HIC 2202, TIC 0203, PIC 0208, PIC 0206, PIC 0202, PRC 0101A, PRC 0101B, LRC 0101A, LRC 0101B, FRC 0210AB.	Add permanent labels.	D	NA	D
	Typewritten information labels are included in or on the following recorders: TR 0351, AR 0203, NR 0100, dTR 0111/0121, TR 0111, TR 0121.	Add permanent labels.	D	NA	D

TABLE VI-14 (Continued)

TEMPORARY LABELS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03	The list of symbols engraved on light caps is on a typewritten sheet.	Sheet has been removed; abbreviations will be engraved on light caps.	C1	AIR A-NPP 84-33	1988 outage
C04	"Main transformer Backfeed" label is temporary.	Add permanent label.	D	NA	D
C06	Temporary labels ("700", "900", "710"and "910") are used beside each of the 8 chamber voltage readings.	These labels identify the desired chamber voltage which changes periodically; a temporary label is appropriate.	NAR	NA	NA
	On Channel A, there are temporary "7.3" and "10.6" labels on the Linear Power Channel Panel.	These labels are used by I&C, not control room operators. The numbers indicate out-of-core chamber deviation for 15% and 20% core flux tilt, respectively. Current labels are adequate.	NAR	NA	NA
C07	There are temporary labels in the mimic (e.g., "Spare Comp" and "Not in Service").	Add permanent label for "Spare comp" as part of relabeling effort; "Not in Service" must be moveable.	D	NA	D
	There are 6 temporary handwritten labels near the bottom of the panel.	Add permanent labels.	D	NA	D
C12	Temporary numbers (700) are written beside each of 2 Chamber Voltage indicators on Linear Power Channel panels.	These labels identify the desired chamber voltage which changes periodically; a temporary label is appropriate.	NAR	NA	NA
	Temporary labels below Concentrated Boric Acid tank level displays.	Add permanent "concentration" label with provision for changing hand written entries.	D	NA	D
	Recorder labels on PR 0130A, PR0130B, PR0140A, PR0140B, LR0701, LR0703, PTR0115, and PTR0125, FR 0701/0702, and FR0703/0704 are temporary.	Add permanent labels.	D	NA	D

TABLE VI-14 (Continued)

TEMPORARY LABELS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12 (Cont'd)	"Control" and "S" are handwritten above SG level displays.	These labels are not needed and have been deleted as part of relabeling effort; no further action required.	NAR	NA	NA
C12 BACK	There are several typewritten labels on the steam flow-feedwater flow indicators.	Replace as part of relabeling effort.	D	NA	D
C13	Multiplication factor of x25 beside PI 0375 is temporary.	Meter scale should be changed to make it similar to PI-0318. See also Table VI-18.	EE	AIR A-NPP 84-06	1987 outage
	"North" is handwritten above V14A, "South" above V14B.	Add permanent label.	D	NA	D
	"Inner" is handwritten above CV 0767 and CV 0768.	Add permanent label.	D	NA	D
C13 BACK	"Alarm" is handwritten on CRDM Leak Off Temp Recorder, and a number of handwritten information notes are written above the pressurizer pressure and level indicators	Relabeled.	D	NA	D
C13 SIDE	Four typewritten legends are used for the recorders.	These sheets are behind the glass of the recorder door and thus are adequately protected; no action is required.	NAR	NA	NA
C27	Temporary typewritten labels below each of 4 voltage meters.	Relabeled	D	NA	D
C106	3 temporary identification numbers (LR 5320, LI 5320B, LI 5321B) are used for the cooling tower basin level recorder and indicators.	Add permanent label.	D	NA	D
C125	Temporary "Normal" and "Refuel" labels below control for fuel handling area ventilation damper HS-1894.	Add permanent label.	D	NA	D
	Temporary note on recorder TR 5370.	Add permanent label.	C1	NA	D

TABLE VI-14 (Continued)

TEMPORARY LABELS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C126	Temporary "psig" label above PIA 0437 (T-102 Pressure). Scale is incorrectly labeled psia.	Relabel.	D	NA	D
	"South" and "North" above cooling towers basin level displays are temporary.	Add permanent label.	D	NA	D

TABLE VI-15

DISPLAY LOCATIONS WHICH DO NOT CORRESPOND TO THEIR RELATED CONTROLS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Main Steam Pressure display is on right side of C01; steam generator controls are on left side of C01.	Main steam press display located appropriately next to turbine controls, and near steam generator controls; relabel to enable identification of steam pressure display by operator manning steam generator controls.	D	NA	D
C04	The current, frequency and wattage meters are arranged in an array with little apparent relation to their corresponding bus breakers.	Use color coding, relabeling and demarcation to make relationships clear between displays and controls.	D	NA	D
C02	Charging pump P-55A speed switch and display should be closer to pump P55A control.	Add demarcation to tie display and control.	D	NA	D
C11	Feedwater heater level indicating lights are on C11; feedwater heater dump valves are on C01.	Relabel to enable identification of heater level lights by operator manning heater controls.	D	NA	D
	Recorder for turbine generator speed and governor valve position are on C11; controls are on C01.	Actual speed/load and valve indication is available at C01; relabel to enable identification of recorder by operator manning controls.	D	NA	D
	Recorders for primary coolant pump seal leakage are on C11; pump controls are on C02.	Note 1 (see below).	NAR	NA	NA
	Recorders for feedwater pump turbine drivers are on C11; controls for pumps are on C01.	Relabel to enable identification of displays by operator manning controls.	D	NA	D
C12	Boric Acid pump controls are on C02, level displays are on C12.	Relabel to enable identification of displays by operator manning controls.	D	NA	D

TABLE VI-15 (Continued)

DISPLAY LOCATIONS WHICH DO NOT CORRESPOND TO THEIR RELATED CONTROLS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12 (Con'd)	HIC 2122 and HS 0202 are on C12; related controls and displays on C02.	Controls on C12 include a selector switch and a control for redundant letdown pressure control valve. The selector switch is used to equalize wear on the valves; backup valve is used during heatup when extra letdown is required due to volume expansion. Thus use of these controls is deliberate and no corrective action is required.	NAR	NA	NA
	Charging pump auto/manual selectors are related controls and displays are on C02.	Relabel and add information labels at C12 and C02.	D	NA	D
	Steam Generator level, flow, and pressure indicators and recorders are on C12; controls are on C01.	See Table VI-1, item IV.A.2.c(4)	EE	AIR A-NPP 84-09	NA
	LPSI & HPSI Loop flow and safety injection tank displays appear on C13; pump controls and safety injection inlet valve controls are on C03.	Evaluated during walkthroughs of emergency procedures at simulator. No difficulties were evident with the arrangement which affected the operators' performance. No relocation of controls or displays is required. See also Table IV-1, item IV.D.3.	A2	NA	D
	Indicators for Containment Spray Injection Flow are on C13; control valves are on C03.	Evaluated during walkthroughs of emergency procedures at simulator. No difficulties were evident with the arrangement which affected the operators' performance. No relocation of controls or displays is required. See also Table IV-1, item IV.D.3.	A2	NA	D
	Shutdown Cooling HX Inlet Press display is on C13; related controls and displays are on C03.	Evaluated during walkthroughs of emergency procedures at simulator. No difficulties were evident with the arrangement which affected the operators' performance. No relocation of controls or displays is required. See Table IV-1, item IV.D.3.	B2	NA	D

TABLE VI-15 (Continued)

DISPLAY LOCATIONS WHICH DO NOT CORRESPOND TO THEIR RELATED CONTROLS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12 (Cont'd)	Condensate Storage Tank Level is on C13 (so are inlet valve and Condenser Transfer Pump controls) but Condensate Pump and Aux Feed Pump controls are on C01.	The condensate storage tank is a large volume tank and there is sufficient time to observe level on C13 even when controlling the plant from C01. When plant is on auxiliary feed, operators do not have to continuously man the auxiliary feed controls. No action to relocate displays is required.	NAR	NA	NA
C27	Most useful indication of reactor power is with neon-type digital display on C07. Readability for operator at C02 is marginal (about 0.4 inch digits). Previous indicators were bigger easier to read.	See Table VI-1, item IV.A.1.b(5)	NAR	AIR A-NPP 84-34	NA

NOTES

1. The primary pump seal leakage recorder together with the seal pressure recorder provide an indication of proper pump seal behavior. Excessive seal leakage is alarmed. Since the recorders are not used in a continuous "feedback loop" with the pump controls (the pumps are either "on" or "off") close proximity of this display to its related control is not required.

TABLE VI-16

DISPLAYS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL ORDER

PANEL	DISPLAYS	ORDER	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	SG feed pump P1 Recirc valve indicating lights	B-A	Move indicating lights to comply with positional stereotype	C1	NA	1987 outage
C03	Component Clg Wtr HX E54 Outlet T Shutdown Clg HX E60 Outlet T Reactor Shield Clg Coil Outlet T Component Clg Pump P52 Amperes	B-A B-A B-A C-A-B	Relabel to clearly indicate actual progression; progressions of displays are consistent with progressions of controls.	D	NA	D
C04	2400 V Bus Voltmeter	1C-1E-1D	Relabel to clearly indicate actual progression; progression of displays is consistent with progressions of controls.	D	NA	D
C06	Clutch power supply	1-4 2-3	Progression is correctly labeled but inconsistent with training manual, Chap. 14, p. 36. Information has been passed to Training Department. No further action required.	NAR	NA	D
	RPS power supply	AD1 BD1 CD1 CD2 AC1 BC1 BC2 BD2 AB1 AB2 AC2 AD2	Current arrangement in cabinets A, B, C, D is consistent with power supplies A, B, C, D and should not be changed; no action required.	NAR	NA	NA
C07	Argenta Line Meters	2 1	Relabel to indicate clearly actual progression; meters are used deliberately.	D	NA	D
C11	Gland Steam Exhausters and Oil vapor Extractors	C1A-C1B C5A-C7 C5B	Move oil vapor extractors to form consistent progression.	B2	AIR A-NPP 84-36	1987 outage

TABLE VI-16 (Continued)

DISPLAYS NOT ARRANGED IN EXPECTED NUMERICAL OR ALPHABETICAL ORDER

PANEL	DISPLAYS	ORDER	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12	PCP Diff Pressures and Temperatures	1B-2A 1A-2B	Relabel to clearly indicate actual progression which is part of mimic.	D	NA	D
	PCP Seal Pressure Recorders	B-A-C-D	Relabel to clearly indicate actual progression.	D	NA	D
	PCP Amperes.	B-C	Relabel to clearly indicate actual	D	NA	D
C13	Safety Injection Tanks LPSI & HPSI Loop Flow	B-C A-D 1B-2A 1A-2B	Relabel to clearly indicate actual progression; relationship of SI tanks to primary coolant loop is same as for pumps as indicated in mimic on C12.	D	NA	D

TABLE VI-17

SCALES WITH INADEQUATE RANGE

PANEL	DISPLAY	ACTUAL RANGE	REQUIRED RANGE	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C03	S.I. Pumps Recirculation FI 0404	0-400 gpm	Note 1	Range is exceeded in recirculation mode only, not needed then - range is adequate for other normal mode of emergency injection. No charge of display is required.	NAR	NA	NA
C12	Loop 1 and 2 Hot Leg Temperature Indications	515 F-615 F	212 F-615 F	Provide wide range temperature indications.	A3	AIR A-NPP 84-08	1987 outage

Note 1: Recirculation line flow is offscale when the SIRW Tank is in recirculation mode.

TABLE VI-18

UNUSUAL OR UNDESIRABLE SCALE DIVISIONS

PANEL	COMPONENT	EXISTING SCALE DIVISIONS	DESIRABLE DIVISIONS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Aux Feed Pump P-8B Steam Press	0,125,250...,750	0, 100, 200, ..., 800	No requirement for precision reading of the pressure can be identified. Change of scale divisions is not required.	NAR	NA	NA
	Cond Demin Syst Effluent Flow FI 8777A	0,300,600,..., 1700	0,200,400..., 1000	Precise reading of this meter is not required; no action required.	NAR	NA	NA
C02	Boron Concentration Recorder AR 0203	0,50,100,..., 550	(See Note 1 below)	No action required; boronometer reading is slow, deliberate process, confirmed by chemistry sample.	NAR	NA	NA
	Shutdown Cooling Return	Uneven scale div. FIC 0306	-	No action required; scale is exaggerated in the normal and emergency range of operation: 4000-8000 gpm, and is adequate for normal shutdown flow of approximately 3000 gpm.	NAR	NA	NA
	Pressurizer Recorders PRC 0101A and PRC 0101B	150-250X10	1500-2500	No action required: factor of 10 is consistent for recorders, controllers and meters and allows use of larger more visible digits.	NAR	NA	NA
	Pressurizer Pressure PI 0103A	0-300(X10)	0-3000	No action required: factor of 10 is consistent for recorders, controllers and meters and allows use of larger, more visible digits.	NAR	NA	NA

Note 1: This recorder combines three scales in one: when the red light is lit, 500 should be added to the existing 0-550 scale; when the blue light is lit, 1000 should be added; when the green light is lit, 1500 should be added.

TABLE VI-18 (Continued)

UNUSUAL OR UNDESIRABLE SCALE DIVISIONS

PANEL	COMPONENT	EXISTING SCALE DIVISIONS	DESIRABLE DIVISIONS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C06	Contactor Coil Suppression Network (4 displays)	0,30,60,90,...	0,20,40, 60,...	This is a status indicator; precise reading of scale is not required; no action required.	NAR	NA	NA
C07	345KV Bus F and 345 KV Bus R	300,330,360,...	300,320,340,..	Scales do not need to be read quickly; voltage expected to be steady at 345; no action needed.	NAR	NA	NA
	Argenta & Cook Lines Megawatts & Megavars Scales	12,6,0,6,12(x100)	1500, 1000, 500,0,500, 1000,1500	Scales do not need to be read quickly; no action needed.	NAR	NA	NA
C11	REC/VXCD Vibration Scale	0, 3, 6,...	0, 2, 4,..	No action required; vibration measurements are recorded, reading is deliberate, slow process.	NAR	NA	NA
	Cond Pump P-2A Motor Winding Temp TIA 0711	0-350	0-300 (like others)	Scales do not need to be read quickly; they are used to record temperatures for long term trend information and to determine whether the indicated setpoint has been exceeded. No action required.	NAR	AIR A-NPP 84-06	NA
C12	All hot leg and cold leg temperatures	515,535,555,...	500,520,540,..	No action required; interpretation of scale provides no undue burden on operators; digital readout is provided on main console.	NAR	NA	NA
	PDT 104 Reactor Vessel DP	1.25 psi per division	1 psi/div	Meter scale will be replaced.	C2	AIR A-NPP 84-06	1987 outage

TABLE VI-18 (Continued)

UNUSUAL OR UNDESIRABLE SCALE DIVISIONS

PANEL	COMPONENT	EXISTING SCALE DIVISIONS	DESIRABLE DIVISIONS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C13	East and West Engrd Safegrds Rm Temp Scales TI 0869 & TI 0870	50,70,90,...	40,60, 80,...	No action required; interpretation of scale provides no significant burden on operators.	NAR	NA	NA
	High Pressure Injection Pump Train 2 Discharge Pressure Indication, PI 0375	0, 20,..., 100 (x25)	Same as for PI-0318: 0, 500,1000,1500	Replace meter scale to make consistent with PI-0318.	C2	AIR A-NPP 84-06	1987 outage
C126	Clg Tower PP P-39A and P-39B Disc Press Ind PI 5305 and PI 5306	15,30,45,...,85	10,20, 30,...,90	No action required; interpretation of existing scale is easy.	NAR	NA	NA

TABLE VI-19

MISSING UNITS

PANEL	COMPONENT	ENGINEERING UNITS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Steam Generator Feed Pump Turb Driver K-7A Speed	rpm	Replace current label "SPEED" with "SPEED (rpm)".	D	AIR A-NPP 84-37	D
	Steam Generator Feed Pump Turb Driver K-7B Speed	rpm	Replace current label "SPEED" with "SPEED (rpm)".	D	AIR A-NPP 84-37	D
	Steam Generator E-50A FW Controller FIC 0701	10^6lb/hr	Replace label "FIC-0701" above scale with indication of units.	D	AIR A-NPP 84-37	D
	Steam Generator E-50B FW Controller FIC 0703	10^6lb/hr	Replace label "FIC-0703" above scale with indication of units.	D	AIR A-NPP 84-37	D
	Stm Gen E-50A Aux FW Control FIC 0737A	gpm	Add indication of units.	D	NA	D
	Stm Gen E-50B Aux FW Control FIC 0736B	gpm	Add indication of units.	D	NA	D
	Turbine Speed	rpm	Adjacent labels on turbine panel and training make actual units obvious; no action required.	NAR	NA	NA
	Turbine Load	%	Adjacent labels on turbine panel and training make actual units obvious; no action required.	NAR	NA	NA
	Bypass Feed Level Controllers LIC-0735 and LIC-0734	%	Replace paper labels above scales with "Level Setpoint - % "	D	AIR A-NPP 84-37	D

TABLE VI-19 (continued)

MISSING UNITS

PANEL	COMPONENT	ENGINEERING UNITS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C02	Tave	°F	Add indication of units.	D	NA	D
	LP Letdown Temp Control TIC 0203	°F	Replace paper label above scale with indication of units.	D	AIR A-NPP 84-37	D
	LP Letdown Pressure Control PIC 0202	psi	Replace paper label above scale with indication of units.	D	AIR A-NPP 84-37	D
	Boron Concentration	ppm boron	Add indication of units to paper label inside recorder.	D	AIR A-NPP 84-37	D
	dTR 0111/0121 recorder	°F	Replace paper label above scale with indication of units.	D	AIR A-NPP 84-37	D
C11	Seal Leakage recorder FR 0133 A/B	gpm	Add indication of units to scales inside recorder or to paper label inside recorder.	D	AIR A-NPP 84-37	D
	Seal Leakage recorder FR 0143 A/B	gpm	Add indication of units to scales inside recorder or to paper label inside recorder.	D	AIR A-NPP 84-37	D
	Temperature recorder TR 0505	°C	Add indication of units, similar to other adjacent recorders.	D	AIR A-NPP 84-37	D
	Turbine First Stage Pressure Recorder PR 0517	psig	Add units to scale inside recorder or to paper label inside recorder.	D	AIR A-NPP 84-37	D
	Condenser Vacuum Recorder PR-0763	in, Hg	Add units to paper label inside recorder.	D	AIR A-NPP 84-37	D
	Feedwater Pump Turbine Driver K-7A VR 0563	mils	Add units to top of indicator scale or to paper label inside recorder.	D	AIR A-NPP 84-37	D

TABLE VI-19 (continued)

MISSING UNITS

PANEL	COMPONENT	ENGINEERING UNITS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C11 (Cont'd)	Feedwater Pump Turbine Driver K-7B VR 0565	mils	Add units to top of indicator scale or to paper label inside recorder.	D	AIR A-NPP 84-37	D
	Precaution Label for VR 0563 and 0565	mils	Label has been removed to make room for FOGG valves; consider adding new label.	D	AIR A-NPP 84-37	D
	Feedwater Temp Recorder TR 0706	°F	Add units to top of indicator scale or to paper label inside recorder.	D	AIR A-NPP 84-37	D
	Reheat Steam Flow Turbine Drivers K-7A and K-7B FR 0524	lb/hr	Add units to top of indicator recorder.	D	AIR A-NPP 84-37	D
C12	Primary Coolant Loop Flow FI 0102A, 0102B, 0102C and 0102D	?	Displayed values are indicative of total core flow. Full power flow apparently corresponds to a value of approximately 72 on this scale. Operators indicate current information is adequate. No need for flow indication in engineering units was identified as part of function and task analysis.	NAR	NA	NA
	T cold and Pri Pressure recorder TR 0115	°F, psi	Add units to paper label inside recorder.	D	AIR A-NPP 84-37	D
	T cold and Pri Pressure recorder TR 0125	°F, psi	Add units to paper label inside recorder.	D	AIR A-NPP 84-37	D
	Subcooled Margin monitors	°F, psi	Add units.	D	NA	D

TABLE VI-19 (continued)

MISSING UNITS

PANEL	COMPONENT	ENGINEERING UNITS	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12 (Cont'd)	Start up & Wide Range Log Channels NI REC-1	Note 1	Actual units are identified on C02 and are known from training; these recorders are used for trending; no action required.	NAR	NA	NA
	Power Range Safety Channels NI REC-2	% Power	Actual units are identified on C02 and are known from training; these recorders are used for trending; no action required.	NAR	NA	NA
	Seal Pressure recorder PR 0130A, PR 0130B, PR 0140A and PR 0140B	psig	Add units to paper label inside recorder.	D	AIR A-NPP 84-37	D
C106	Basins A & B level Recorder	(ft)x10	Add units to paper label inside recorder.	C1	AIR A-NPP 84-37	D

Note 1: Counts per second for channels 1 and 2; percent power for channels 3 & 4

TABLE VI-20

SCALE UNITS GIVEN AS PERCENT

PANEL	COMPONENT	100% EQUIV.	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Condenser Hotwell Level LI 0729	About 60000 gal 51.75 inches	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Moisture Separator Drain Tank T-5 Level LI 0609	18,000 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Steam Generator E-50A Level Controller LIC 0701	about 1200 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Steam Generator E-50B Level Controller LIC 0703	about 1200 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Turbine Bypass Control PIC 0511	1000 psia, 100%=800 psia	Conversion label has been added.	D	NA	D
C02	Pressurizer Level LRC 0101A, LRC 0101B, and LI 0101A	1500 ft^3	Tech Spec 3.1.1.h specifies a maximum liquid volume of 700 ft^3 in the pressurizer as one of the criteria for starting a primary coolant pump if the primary coolant temperature is below 250 F. A conversion will be added to procedure.	B1	AIR A-NPP 84-13	1987 outage

Note 1: No requirement for conversion from percent to engineering units has been identified.

TABLE VI-20 (continued)

SCALE UNITS GIVEN AS PERCENT

PANEL	COMPONENT	100% EQUIV.	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C02 (Cont'd)	VCT Level LIA 0205	3608 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Quench Tank Level LIA 0118	1147 ft^3	See Note 1.	NAR	AIR A-NPP 84-13	NA
C03	East Engrd Safegrds Rm Level LI 1110	240 in. (elev. 584'0")	See Note 1.	NAR	AIR A-NPP 84-13	NA
	West Engrd Safegrds Rm Level LI 1107	240 in. (elev. 584'0")	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Component Clg Surge Tank T-3 Lev LIA 0917	1230 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Shield Clg Surge Tank T-62 Level LIA 0927	1700 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
C11	Prim Coolant Pump Lower Oil Res LIA0137A, 0137B, 0147A, 0147B	18 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Prim Coolant Pump Upper Oil Res LIA0136A, 0136B, 0146A, 0146B	62 gal	See Note 1	NAR	AIR A-NPP 84-13	NA
	Feedwater Heater Level recorder LR 0612	varies with heater	See Note 1.	NAR	AIR A-NPP 84-13	NA
C12	Steam Generator E-50A Levels LIA 0702A, LIA 0751A, LIA 0751B, LIA 0751C, LIA 0751D, LR 0701	estimated 1200 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA

TABLE VI-20 (continued)

SCALE UNITS GIVEN AS PERCENT

PANEL	COMPONENT	100% EQUIV.	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C12 (Contd)	Steam Generator E-50B Levels LIA 0704A, LIA 0752A, LIA 0752B, LIA 0752C, LIA 0752D, LR 0703	estimated 1200 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Concentrated Boric Acid Tank T-53A LIA 0208B, and Tank T-53B LIA 0206B	125 in.	Tech Spec 3.2.2 requires a combined A and B tank level of 118 inches. Because the cross-connect valves between Tanks A and B are normally closed, power failure may result in only one tank being available. Thus, currently the plant requires 118 in. in each tank A and B. Add permanent marking on meter face (See Table VI-13)	C1	AIR A-NPP 84-13	1987 outage
	Reactor Level Ind LI 0105	Centerline Hot Leg plus 149 in.	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Pressurizer Levels LI 0102A, 0101B, 0102C, 0102D	1500 ft^3	See comment on pressurizer level above.	B1	AIR A-NPP 84-13	1987 outage
C13	Primary System Makeup TK Level LIA 2020	75,000 gal	Tech Spec 3.5.1 requires a combined volume of 100,000 gal for the condensate storage tank and primary coolant system makeup tanks. Low level alarm indicates violation of Tech Spec - daily calculation shows tech spec is met. Conversion is available. No further action is required.	NAR	AIR A-NPP 84-13	NA
	Diesel Oil Stor TK T-10 Level LIA 1400	16000 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA

TABLE VI-20 (continued)

SCALE UNITS GIVEN AS PERCENT

PANEL	COMPONENT	100% EQUIV.	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C13 (Contd)	Diesel Gen Day Tank T-25A Level LIA 1416	180 in.	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Diesel Gen Day Tank T-25B Level LIA 1417	180 in.	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Condensate Storage Tank Level LIA 2021	125,000 gal	Tech Spec 3.5.1 requires a combined volume of 100,000 gal for the condensate storage tank and primary coolant system makeup tanks. See above for LIA 2020.	NAR	AIR A-NPP 84-13	NA
	Domestic Water Storage Tank Level LIA 2009	14 ft (Note 2)	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Demin Water Storage Tank Level LIA 8946	300,000 gal	See Note 1.	NAR	AIR A-NPP 84-13	NA
	Fuel Oil Tank T926 Level LIS 8314	130 in.	See Note 1.	NAR	AIR A-NPP 84-13	NA
	SI Tanks 82A, 82B, 82C, 82D Levels LIA 0365, LIA 0368, LIA 0392, LIA 0374	1067 ft^3 (Note 3)	Tech Spec 3.3.1 requires the levels in the SI tanks to be between 186" (55.5%.) and 198" (59%); SOP 3 says normal level is 196" or 50%; Alarm response procedure says high level is at 200" at 58% with low level at 192" at 42%. These inconsistencies have be corrected; Alarm set points are consistent with Tech Spec; no further action required.	C1	AIR A-NPP 84-13	D

TABLE VI-20 (continued)

SCALE UNITS GIVEN AS PERCENT

PANEL	COMPONENT	100% EQUIV.	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C13 (Cont'd)	Containment Sump Level LIA 0358, and LIA 0359	10 ft (Note 4)	See Note 1.	NAR	AIR A-NPP 84-13	NA
	SIRW Tank Level LIA 0331, and LIA 0332	285,000 gal	Tech Spec 3.3.1 requires minimum of 250,00 gal. Alarm set points are consistent with Tech Spec; no further action required.	NAR	AIR A-NPP 84-13	NA
C106	Cooling Tower Basin Level Recorder LR 5320	6 ft range (approx. elev) A-612' B-611')	Level recorder is used for trending; actual levels are displayed on adjacent meters in feet; no action required.	NAR	AIR A-NPP 84-13	NA
C126	Iodine Removal Hydrazine Tank T-102 LIA 0437A and LIA 0437B	about 11 ft.	Tech Spec 3.19.1 requires 270±17 gallons. Alarm set points are consistent with Tech Spec; no further action required.	NAR	AIR A-NPP 84-13	NA
	Iodine Removal Makeup Sodium Hydroxide Tank Tank T103, LI0438 A&B	7 ft 6 in.	Tech Spec 3.19.1 requires a minimum of 4200 ± 300 gallons. Alarm set points are consistent with Tech Spec; no further action required.	NAR	AIR A-NPP 84-13	NA

Note 2: 96% = 162 inches and 68% = 120 inches thus 100% = 168 inches = 14 ft

Note 3: Training notes, Chapter 10

Note 4: 12 inches = 10% (assume 0 inches = 0%) thus 100% = 120 inches = 10ft

TABLE VI-21

PROBLEMS WITH INDICATING LIGHTS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	Set of lights below Aux Feed Pump P8A is not labeled (apparently disconnected).	Lights have been removed as part of aux feed modification.	D	NA	D
	There are single orange lights above HS-0735 and HS-0734, the interlock bypass switches for the steam generator feed bypass valves. The meaning of these lights is not clear.	Relabel.	D	NA	D
	Similarly, there are single white indicating lights above the steam generator feed pump trip buttons labeled "steam generator feed pump driver K-7A (K-7B) trip control pwr failure". The meaning of these lights is not clear.	Relabel.	D	NA	D
C02	Lights under Power Range Safety Channels are not labeled.	Relabel.	D	NA	D
	Lights and arrows above and below Reactor Regulating System Unit Selector Switch are not labeled.	Relabel.	D	NA	D
C03	Key lock switches for CV 3027 and CV 3056 (SIRW tank recirc valve) each have a single indicating light. The meaning of the light is not indicated.	Engrave lens cap with "enabled".	C1	AIR A-NPP 84-33	1988 outage
	CV 3027 and CV 3056 (SIRW tank recirc valves) have double sets of indicating lights. The meaning of the second set is not clear.	Add label.	D	NA	D
	The meaning of the yellow light above the switches for the shield cooling pumps P-77A and P-77B is not clear.	Engrave "AUTO" on lens cap.	C1	AIR A-NPP 84-33	1988 outage

TABLE VI-21 (Continued)

PROBLEMS WITH INDICATING LIGHTS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C06	There are 12 lights without labels for each safety channel.	Add labels; lights are illuminated when trip-inhibit switches are in the bypass position, i.e. when the trip is bypassed.	D	NA	D
	Log Power Channel C lights need labels like those on "D".	Labels added.	D	NA	D
	All trip lights should have "1", "2", and "3" on them.	Numbers not considered necessary position of lights is consistent; no action required.	NAR	NA	NA
C12	Trip lights at bottom of Power Range Control Channel NI 010 are not labeled like similar trip lights on NI 009.	Trip lights are not applicable to NI009 and NI010. Labeling has been removed from NI010.	C1	NA	D
	Four sets of lights above Power Range Control Channel NI 010 are unlabeled.	Add label.	D	NA	D
C13	Safety injection channels indicating lights are not identified.	Add label.	D	NA	D
C106	The pushbutton light for cooling tower fan VCT 30A-13 is installed backwards.	Replace with correct light cap.	D	NA	D
	The pushbutton light for cooling tower fan VCT 30A-14 has a misspelled engraving: "RED" should be "REV"	Replace with correct light cap.	D	NA	D

TABLE VI-22

SETPOINTS NOT ADEQUATELY INDICATED ON DISPLAYS

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C01	A label next to the turbine speed indicator warns the operator to avoid continuous operation at 1024 rpm, 1200 rpm and 1730 rpm. These critical speeds are not marked, however, on the turbine speed indicator itself.	Warning label is considered adequate; no action required.	NAR	NA	NA
	Emergency operating procedures impose a limit of 150 gpm for the auxiliary feedwater flow. No such setpoint is indicated on the flow controllers.	Auxiliary feed system is modified; 150 gpm limit is no longer applicable; no action required.	NAR	NA	NA
	Meter PI 0521A for steam supply pressure to the auxiliary feed pump has no setpoints or indication of normal range. Normal reading is 250 psi, relief valve setting is 300 psi, low pressure limit is 200 psi.	This pressure is remotely controlled; since operators have no control over this pressure, they do not require setpoint indication.	NAR	NA	NA
C04	There is no warning label or "red-line" reminder not to exceed allowed loading limits on the diesel generators.	Maximum loading is taught adequately by training; Operations states that warning label is not required.	NAR	NA	NA
C12	Steam generator pressure indicators (PIC 0751A, B, C, D and PIC 0752 A, B, C, B) and pressurizer pressure indicators (PIA 0102ALL, BLL, CLL and DCL) each have two setpoints indicated. Although the setpoint markers are low pressure/ high pressure markers it appears that both are actuated on low pressure.	No action required. Both sepoints are actuated on low pressure. The first is a block permissive, the second is a trip. Operators are trained in meanings of both.	NAR	NA	NA
	The steam generator water level setpoints are handwritten at the side of the level recorders, LR 0701 and LR 0703.	Evaluated by Operations and considered not required. Handwritten setpoints have been removed.	NAR	AIR A-NPP 84-42	D

TABLE VI-23

PROBLEMS SPECIFIC TO STRIP-CHART RECORDERS

PANEL	RECORDER	PARAMETER BEING RECORDED	PROBLEM	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C11	PR-0517	turbine first stage pressure	Inoperative or run out of paper at time of control room review photographs	Recorder has been repaired.	D	NA	D
	FR-0524	reheat steam flow/turbine driver	Same as above.	Recorder has been repaired.	D	NA	D
C12	PR-0139A PR-0139B PR-0140A PR-0140B	primary coolant pump seal stage pressures	Pointer scale has range of 0-20 (with no scale factor); (paper trace has correct range of 0-2000) bottom portion of traces (0-100 psi) obscured by label.	Add scale factor; move label.	D	AIR A-NPP 84-40	D
	FR-0703/ 0704	steam generator feedwater flow	Pointer on one of scales is bent.	Repaired.	D	NA	D
	TR-0125	Primary system pressure, loop #2	Label inconsistent with display.	Clarify label.	D	NA	D
	NI REC-1 NI REC-2	Start-up and wide range log channels and power range safety channels	The new TRACOR Westronics recorders (startup and wide range log channels - NI-REC1 and power range channels - NI-REC2) are small and more difficult to see from the operator's station than the previously used recorders.	Operators state that visibility of new recorders is adequate. Recorders are used for trend information only and are visible from console; no action required.	NAR	NA	NA
C13 back	TRA-0150	control rod drive mechanism temperature	Correspondence between the recorded data points and the individual mechanisms does not seem to be identified.	Add identification label.	D	NA	D

TABLE VI-24

DISPLAYS LOCATED TOO HIGH ON PANELS

PANEL	DISPLAY	PARAMETER BEING DISPLAYED	ACTION	CATEGORY	REF.	DUE DATE
C04		Top two rows of electrical displays for station power transformers 1-1, 1-2, 11, 12, 13, 14, 90 and 91; start-up power transformers 1-1, 1-2, 1-3; diesel generators 1-1 and 1-2; 4160 volt buses and 2400 V buses and synchroscope and scynchronizing volts. (Total of 36 meters).	Meters can be read with sufficient accuracy in current location; no action required.	NAR	NA	NA
C07		Vergennes, Argenta No. 2 and Cook No. 1 amps, watts, vars and volts (total of 12 meters).	Meters can be read with sufficient accuracy in current location, no action required	NAR	NA	NA
C11	CV-0717 CV-0716	Heater Drain Pumps Subcooling valves position	Indicating lights can be seen adequately; no action required.	NAR	NA	NA
	C-1A C-1B	Gland steam exhausters	Indicating lights can be seen adequately; no action required	NAR	NA	NA
	C-5A C-5B	Turbine Oil Vapor Extractor	Indicating lights can be seen adequately; no action required.	NAR	NA	NA
	C-7	Generator Loop Seal Tank Vapor Extractor	Indicating lights can be seen adequately; no action required.	NAR	NA	NA
	--	Fast MU Valve for MS Dump	Indicating lights can be seen adequately; no action required.	NAR	NA	NA
	CR-8612	Condensate Demineralizer Conductivity Recorder	Recorder repaired.	D	AIR A-NPP 84-21	D
	LR-0612	Feedwater Heater Level	Recorder repaired.	D	AIR A-NPP 84-21	D
	FI-0529 FI-0526	HP steam flow to Main Feed Pump Turbines	Steam flow does not need to be read with precision; no action required.	NAR	NA	NA

TABLE VI-24 (Continued)

DISPLAYS LOCATED TOO HIGH ON PANELS

PANEL	DISPLAY	PARAMETER BEING DISPLAYED	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C11 (Cont'd)	FI-0749A FI-0737 FI-0727A FI-0736	Auxiliary feed flow to steam generators A and B	Aux flow is also available on C01; no action required.	NAR	NA	NA
	PVI-1424 PI-1419	Generator Hydrogen purity and pressure	Reading these meters is slow and deliberate; these meters are used as status indicators rather than for precise measurements; no action required.	NAR	NA	NA
	TIA-05xx (11 displays)	Main Turbine Generator Oil Drain Temperatures	Reading these meters is slow and deliberate; high temperature is alarmed on main panel; no action required.	NAR	NA	NA
C12		Primary Coolant Pumps Vibration Monitors	Reading these meters is slow and deliberate; alarm indicated by local light; no action required.	NAR	NA	NA
C13	LI-1336 LI-1337	North and South Bay Levels	Reading these meters is slow and deliberate; no action required.	NAR	NA	NA
	LIA-1400 LIA-1416 LIA-1417	Diesel Tank Levels	Reading these meters is slow and deliberate; tank level is alarmed no action required.	NAR	NA	NA
	LIA-2020	Primary System Makeup T-81 Level	Makeup to VCT from T-81 is manual deliberate operation; tank level will decrease slowly, is alarmed.	NAR	NA	NA

TABLE VI-24 (Continued)

DISPLAYS LOCATED TOO HIGH ON PANELS

PANEL	DISPLAY	PARAMETER BEING DISPLAYED	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C13 (Cont'd)	LIA-2021	Condensate Storage T-2 Level	Tank is alarmed at administrative limit with large margin to tech spec limit; quick, accurate reading of meter is not necessary and thus no action is required.	NAR	NA	NA
	LIA-2009	Domestic Water T-7 Level	Reading this meter is slow and deliberate; level is alarmed no action required.	NAR	NA	NA
	PIA-1210	Instrument Air Pressure	Approximate reading of this instrument is adequate during unusual events; annunciator panel provides additional well-ordered information; no action required.	NAR	NA	NA
	LI-8946	Demin Water T-939 Level	Reading this meter is slow and deliberate; no action required.	NAR	NA	NA
	LIS-8314	Fuel Oil T-926 Level	Reading this meter is slow and deliberate; no action required.	NAR	NA	NA
	LPIR-0383	Containment Building Pressure and Level Recorders	See note.	B2	NA	D
	LIA-0368 LIA-0372	Levels in SI Tanks T-82B and T-82C	See note.	B2	NA	D
	PIA-0367 PIA-0374	Pressures in SI Tanks T-82B and T-82C	See note.	B2	NA	D

TABLE VI-24 (Continued)

DISPLAYS LOCATED TOO HIGH ON PANELS

PANEL	DISPLAY	PARAMETER BEING DISPLAYED	ACTION OR ASSESSMENT	CATEGORY	REF.	DUE DATE
C13 (Cont'd)	FI-0309 FI-0311	LPSI Flows in Loops 1B and 2B	See note.	B2	NA	D
	FI-0310 FI-0312	HPSI FLows in Loops 1B and 2A	See note.	B2	NA	D
	FI-0317A FI-0316A	Loop 1 Hot Leg HPSI TR1 and TR2 Flows	See note.	B2	NA	D

Note: Evaluated during walkthroughs of emergency procedures at simulator. The operators experienced no difficulty with the location and there were no apparent effects on their performance. No relocation of these displays is considered to be required.

TABLE VI-25

CONTROLS WHICH HAVE NO CORRESPONDING INDICATION OF ACTUATION

PANEL	DESCRIPTION	ACTION OR ASSESSMENT	CATEGORY	REF	DUE DATE
C02	Volume control tank vent valve, CV-2080 has no indicating lights	Position of switch indicates whether vent valve is open or closed.	NAR	NA	NA
C03	The switches for P67A and P67B "pumps trip on SIRW tank low level" have no indicating lights	Position of switch indicates whether trip logic is enabled or defeated; no action required.	NAR	NA	NA
C04	Main transformer backfeed switch has no indicating lights	Position of switch indicates whether switch is in normal or transfer cutout; no action required.	NAR	NA	NA

VII. REFERENCES*

1. "Palisades Nuclear Plant Human Factors Review Program Plan", forwarded by CPCo letter dated March 16, 1982 to USNRC, Nuclear Reactor Regulation, Dennis M. Crutchfield, Chief of Operating Reactors Branch No. 5.

2. Combustion Engineering Generic Emergency Procedure Guidelines, CEN-152, Revision 2.

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

4. Consumers Power Company Plant Design Guide.

5. W. E. Woodson, Human Factors Design Handbook, 1981, McGraw Hill, Inc.

6. "Human Engineering Design Criteria for Military Systems, Equipment and Facilities" MIL-STD-1472C.

7. "Human Engineering Design Criteria for Military Systems, Equipment and Facilities" MIL-STD-1472B.

* Appendix A to this report includes listing of other references which are specifically related to the guidelines in that appendix.

VIII. APPENDICES

A. HUMAN FACTORS GUIDELINES

B. RESULTS OF OPERATOR INTERVIEWS

C. RESULTS OF ENVIRONMENTAL SURVEYS

D. HUMAN FACTORS REVIEW OF REMOTE SHUTDOWN PANEL

E. RESUMES OF HUMAN FACTORS REVIEW TEAM

F. FUNCTION AND TASK ANALYSIS OF EMERGENCY PROCEDURE GUIDELINES

G. REVIEW OF PANEL C11A AGAINST DETAILED HUMAN ENGINEERING GUIDELINES

H. EVALUATION OF EMERGENCY LIGHTING FOR THE PALISADES CONTROL ROOM

APPENDIX A

HUMAN FACTORS GUIDELINES

I. PURPOSE

The purpose of these guidelines is to provide a basis upon which to evaluate the Palisades Control Room. They are intended to assist in the identification of those aspects of the current control room which may need improvement from a human factors viewpoint and to provide guidance for any modifications.

II. OPERATIONAL GUIDELINES

A. Functions Performed in Control Room

The control room operators who man the main control room should be provided with appropriate controls and displays to perform a set of defined functions. Controls and displays, including annunciators, which are not needed to perform those defined functions tend to divert the control room operators' attention and should not normally be provided to them. It should be an objective to move out or keep out of the control room itself those personnel, controls, and displays which are not related directly to the defined functions. In any case, those other functions which may be done in the control room should be arranged so that they can be done by personnel other than those manning the main console and panels without causing interference or distractions.

The functions of the control room operators manning the main console are defined to be the following:

1. Maintain control of the reactivity of the reactor core and monitor the shape of the neutron flux profile in the core.

2. Maintain control of the energy production and transfer, including:

   ° production of energy in the reactor core,

   ° transfer of energy to the reactor coolant system,

   ° transfer of energy through the steam generators to the steam system,

   ° conversion of some energy to electricity in the turbine generator, and

   ° rejection of the remainder through the condenser and circulating water system

3. Maintain an adequate inventory of chemically suitable water at the proper pressure and temperature in the primary (reactor coolant) system.

4. Maintain an adequate inventory of chemically suitable water at the proper pressure and temperature in the secondary (steam) system.

5. Distribute electrical power and other necessary services (such as air and cooling water) to the plant auxiliaries and control the production and the distribution of emergency electric power.

6. Maintain control of radioactive material which may be contained in any of the systems which are the control room operators' responsibility. This includes the responsibility to maintain the leaktight integrity and pressure of the reactor containment. Monitor radioactivity of all streams with potential release to the environment. (Also included is monitoring and isolation, if necessary, of the off-gas and liquid discharge.)

7. Maintain control of the inventory and location of fissionable material.

8. Maintain control of and complete entries in the operators' logs, procedures, and checklists.

9. Maintain administrative control of the maintenance, repair, testing, calibration, etc. in those systems under the control of the operators in the main control room.

10. Initiate those fire fighting actions which are controlled from the control room, e.g., starting pumps and obtaining help in fire fighting. In addition, the operators are responsible to initiate those actions in the systems under their control which may be needed to compensate for fire damage.

11. Recognize symptoms requiring activation of the site emergency plan, declare the appropriate action level and initiate appropriate corrective actions and communications.

12. Monitor effluent temperature and chemistry and initiate dilution as required.

13. Maintain communication with power controller concerning changes in power and switchyard operations.

The following are examples of items which should not be the responsibility of the control room operators manning the main console or panels:

- ° security or access control, except access which may affect the leaktight integrity of the reactor containment;
- ° communications not directly related to their responsibilities, e.g. routine plant telephone calls;
- ° routine operation of the liquid waste disposal system; and
- ° routine chemical control in support systems.

B. Controls and Displays Provided in the Control Room

The controls and displays presented directly to the control room operators manning the main control room, i.e. those controls and displays directly visible to them when they are at their normal stations, should be limited to those for which a clearly defined need can be established. Additional guidelines which may be applicable to the location of controls and displays in the control room are:

1. A control or display may be located in the control room if its location elsewhere would not permit its use in a timely manner.

2. A control may have to be located in the control room if the only location for the displays needed to operate the control is also in the control room.

3. A control or display used only for test purposes or only for certain planned plant evolutions may be located in the control room if it involves the use of other controls or displays which are located only in the control room.

Note that these guidelines do not necessarily require controls and displays to be directly visible to the operators stationed at the console.

C. Availability of Personnel

The control room arrangement should be such that any anticipated off-normal operational evolution can be effectively carried out in the short term with the personnel complement present for the normal evolution then underway. Specifically, the response to off-normal conditions may not assume that any more personnel are available in the short term than would normally be present in the control room when the initiating event occurs. Other on-site personnel can be assumed to be available in a time period consistent with the travel time from their normal location if they have no other duties in the event. Off-site personnel who are on call can be assumed to be available, as defined in the Palisades emergency plan.

D. Arrangement Priority

The control room and panel arrangements should provide, in convenient locations, those controls and displays which are needed for normal planned plant evolutions and steady state operation (plant startup and planned shutdown, power generation, hot standby, and refueling); however, higher priority for arrangement should be given to the controls and displays which are involved with the operators carrying out their assigned responsibilities under those off-normal conditions which are both likely and which require timely action. Such off-normal conditions include:

° reactor and turbine trip,

° partial or complete loss of feedwater,

° loss of coolant accidents (particularly those from valve openings or major seal failures),

° loss of various sources of control or instrumentation power or air,

° overcooling accidents (particularly those from steam system valves stuck open or excessive feed),

° control rod motion accidents,

° electrical power upsets, (including those in the site AC system or in the site DC system).

The operators desk should give the operator a clear unobstructed view of the main control boards. Operator movement and communication should be unobstructed.

E. Key Process Variables

It should be an objective to provide the operators with the means necessary qualitatively to confirm the reasonableness of the information they are presented on certain key process variables. Preferably these means should be diverse from the normally used displays.

These key process variables fall into the following categories:

1. Reactivity

- When critical, the operators should have the process variables necessary to assess whether the reactivity contributions of the following are in the expected relationship: rod position, boron concentration, power level, power (flux) shapes, coolant temperature, and prior operating history.

- When subcritical, the operators should have the process variables necessary to assess the shutdown margin of the reactor and whether the following are in the expected relationship: rod position, boron concentration, coolant temperature, prior operating history, and neutron level.

2. Reactor Coolant Conditions

- Inventory of reactor coolant (pressurizer level)

- Thermodynamic state of coolant (temperature and pressure)

- Coolant flow rate

- Radioactivity in coolant

3. <u>Steam System Conditions</u>

- Inventory of secondary coolant (hotwell, steam generator, heater shell, and drain tank levels)
- Steam pressure
- Feedwater flow and temperature
- Radioactivity in steam

4. <u>Reactor Thermal Power</u>

5. <u>Off-gas Radiation Levels and Concentrations</u>

6. <u>Availability of Electric Power</u>

III. HUMAN ENGINEERING GUIDELINES

The guidelines for the human engineering review of the Palisades Control Room are based on those in MIL-STD-1472B, Human Engineering Design Criteria for Military Systems, Equipment and Facilities. Since the military standard is directed toward military applications and covers types of equipment which are not in the control room, some parts of it are inappropriate. The guidelines listed below are those which are particularly important to the control room review, amplified and clarified for direct application to the control room. It is recognized that in the course of the review, situations may be encountered which are not adequately addressed by MIL-STD-1472B and the guidelines included below. In such cases other human engineering references may be consulted, for example:

- Van Cott, H.P. and Kinkade, R.G., Human Engineering Guide to Equipment Design, (reference 3).
- Woodson, W. E., and Conover, D. W., Human Engineering Guide for Equipment Designers, (reference 4).

A. General Guidelines

1. The controls and displays should have compatible locations, that is:

   - Where timely operator action may be needed, the sources of information from which the operator concludes that he needs to take action, and that action is permissible, should be located close to where the control action is taken.
   - When a control action is taken, the operator who takes the action should have immediate feedback that the controlled element has responded and, if practical, that the plant or system itself has responded. This usually involves the location of the related displays close to where the control action is taken.
   - Functionally related controls and displays should have an apparent and consistent relationship. Preferably, functionally related controls and displays should be

located in close proximity, yet far enough apart that operation of the control does not interfere with observation of the display.

- ° Location of recurring functional groups should be similar from panel to panel.

- ° Related controls and displays should be easily distinguishable by the operator. The following relationships should be immediately apparent to the operator:

  - the display(s) associated with each control,

  - the anticipated direction of movement of the control and display, and

  - the functional results of activating the control.

2. Consistent and unambiguous methods should be provided to inform the operators of the operational status, e.g., open or closed valve position, and of the conditions, e.g., temperatures or flows, in those systems under their control. Likewise, status and conditions in other systems in the plant which could affect the action the operators may take should be provided in a consistent and unambiguous manner.

3. Where a control or display is intended to provide information to the operators as to whether conditions are "off-normal," this should be done in a consistent and unambiguous manner. This should include consideration of what conditions are to be defined as "normal" in a particular system as well as avoiding confusion between indicating status (see item A.2, above) and indicating "normal" or "off-normal." In general, the extinguishing of a light should not be used to convey important normal or off normal information feedback to the operator. (Under certain circumstances, for example, "power off" conditions, an extinguished light, in combination with other, active indications may be used effectively to convey information).

4. There should be some means for the operator to know that a control or display is not functioning

properly. It is particularly important to know when a display or control has lost power. The most desirable situation would be to have the malfunction evident to the operators without any action on their part, e.g., by having a unique "power lost position" for a meter. This may be impractical. If so, other ways to make the operator aware of failures may have to be used, such as:

- providing means for periodic testing of a control or display (including status lights),
- providing the operator with immediate feedback (see A.1. above), or
- providing redundant or diverse displays which allow cross checking.

For some critical items it may be appropriate to utilize several ways to make the operators aware of malfunctions and to provide them with special training and guidance in the procedures.

5. Communication of a control room operator with an auxiliary operator either within or outside the control room shall be considered the same as operating a control or reading a display. These communications should not require the use of communication links which may involve interference or may be unavailable because of other activities. The communications should consider the potential for unusual environmental conditions: noise, respirators, etc. Voice communications should provide for repetition and confirmation of each transmission, when required to assure accuracy.

6. Tag-out of a control or display should:

   - be unambiguous as to which control or display is tagged,
   - not obscure the identification of the control or display which is tagged, and
   - not obscure any other controls or displays or interfere with operations.

7. For any changes to the console and panels, replacement and servicing should be considered. In that case guidelines on maintainability such as the following should be applied:

   - Replacement and servicing should not require the removal of other items on the panel.

   - Replacement or servicing of an item should not involve operations which preclude proper operator response to a plausible off-normal event. This includes putting an excessive number of other items out of service in order to perform the maintenance.

   - Replacement should involve a minimum risk of improper reconnection.

   - Replacement or servicing should involve a minimum risk to personnel.

   - Replacement or servicing should involve a minimum risk of inadvertent actuation of other controls.

   - Displays (lights, etc.) used only for maintenance and servicing should not be visible, e.g., they should be covered during normal operations.

   If some specific problems with maintenance have been experienced in the Palisades control room, these should be considered in the control room review.

8. The capabilities required of the operators to perform the assigned functions should be reasonable in terms of work load, span of mental concentration, physical endurance, amount of memorization, and time and space available to perform a function. The assigned functions should be consistent with the physical capabilities required of the operators.

9. Changes to existing arrangements should be sufficiently distinct that when an operator uses the new control or display it is unlikely that previous training and habits will cause errors.

Consideration should be given to using completely different types of controls in such applications, for example, using pushbuttons in place of a rotary switch rather than changing the direction of rotation of the rotary switch.

10. Control panel sections containing functionally related controls and/or displays should be prominently labeled.

B. Guidelines for Controls

1. Location

a. The most often used controls should be given priority in location, except where this would conflict with the use of controls or displays for off-normal conditions. Control placement should comply with the anthropometric standards (5 - 95th percentile male and female stature and arm reach) given in Van Cott and Kinkade, reference 3.

b. Controls for off-normal conditions should be placed in a readily accessible location but clearly distinguished from controls used for normal conditions.

c. The progression of controls, numerically or alphabetically, should be consistent throughout the panel. It is preferred that they progress left-to-right and top-to-bottom.

d. All controls for multiple elements should have the same arrangement, that is, either horizontal or vertical.

e. If controls are operated in sequence, they should be located in a consistent left-to-right or top-to-bottom progression.

f. Where multiple controls affect the same element, e.g., valve control pushbuttons, their relationship should be consistent and readily apparent to the operator without detail comparison of the legends.

g. Mirror image groups of controls should not be used.

2. Operation

a. The control should be capable of operation without special aids for the operator, e.g., a stool, screw driver, or special tools, except where required to prevent inadvertent actuation.

b. The forces and motions required to actuate the control must be within the capabilities of all the plant operators. This applies under normal operating conditions and when emergency clothing is being worn.

c. The direction of operation should follow a consistent set of conventions, for example:

° Pushbutton valve operators should have the "open" button on top, if vertically arranged; if horizontally arranged, the "open" button should be on the right.

° Rotary controls for circuit breakers and electrical motors should rotate clockwise to turn the item "on" i.e., close a breaker or start a motor.

° The "Auto" position of a rotary control should be in a consistent direction of rotation.

° "On" or "start" pushbuttons should be above "off" or "stop" pushbuttons.

° Rotary controllers should rotate clockwise to increase the controlled quantity.

d. The direction of motion of the controller should be consistent with the direction of motion of the display which responds to the control.

e. Key operated controls should follow a standard set of conventions, e.g., detents oriented upward.

f. Control position should be easily identifiable.

3. Type

a. Each control type should be easily identifiable. Control coding, e.g. size, shape and color should be consistent throughout.

b. Consistent types of controls should be used for similar functions.

4. Protection

a. Adequate distance between controls and between groups of controls to allow the operator easily to recognize the controls and to avoid inadvertent actuation should be provided. MIL-STD-1472B (reference 1) guidelines for separation distance should be utilized.

b. Controls which may be confused and which have serious consequences if actuated should be protected or special steps taken to highlight or distinguish them. This may include such means as color coding, covers, separate handles, the use of two hands to operate, or key operated controls.

c. Controls which would otherwise be subject to inadvertent actuation by clothing, cleaning operations, etc., should be relocated or protected. Protective measures should not interfere with control operation.

5. Identification

a. Each control should be positively identified with both a descriptive name and a particular identifying number for the controlled element.

b. Nomenclature should be consistent with that used in the procedures and system diagrams

and that on related displays and controls. The use of abbreviations should be minimized.

c. Legend plates should be located over the control to which they apply. If this cannot be done, some special visual clue of the unusual relation should be provided to the operator. In no case should a location convention be the only means of telling to which control a label applies. Legend plates should be readily visible from the station at which they must be read.

d. Where special precautions apply to the operation of a control, this should be clearly stated and it should be clear to which control(s) they apply.

e. Legend plates on controls should meet consistent standards of letter size (Van Cott and Kinkade, reference 3).

f. Legend plates on controls should meet consistent standards of durability. Temporary label plates should not be used.

g. The color of legend plates should conform to a consistent code, for example:

 ° Identification labels should be black letters on a white background.

 ° Information of a reference nature for the assistance of the operator should be white letters on a black background.

 ° Precaution labels should be red with white letters.

h. Identification techniques in addition to label plates, e.g. size, shape, location, color, texture, should be used for similar controls, where necessary to avoid improper actuation.

6. <u>Maintenance</u>

All light bulbs should be commonly stocked types and should be replaceable from the front of the panel without special tools and without risk of inadvertent actuation or damage of the control.

C. Guidelines for Displays

1. <u>Location</u>

   a. The display should be located properly with respect to its related controls. (See Criterion II.A.1.). Display placement should comply with appropriate visibility standards of Woodson and Conover, reference 4.

   b. The orientation of multiple displays should be consistent with normal conventions for progression of numerical or alphabetical quantities, i.e., top-to-bottom or left-to-right.

   c. The orientation (horizontal or vertical) of an array of displays should be consistent with the orientation of related controls.

   d. The operation of the control related to a display should not obscure the display.

   e. Mirror image groups of displays should not be used.

2. <u>Scales</u>

   a. The graduations on a scale should be consistent with the resolution required by the operator. Woodson and Conover, reference 4, guidelines should be followed.

   b. The scale range should be adequate for all normal and off-normal conditions under which the display is required.

   c. The major scale divisions should be a usual numerical progression. Scale multipliers should be avoided, but where used should be in a consistent location and easily read. Only multiples of 10 should be used.

d. The units for all scales should be identified and located in such a manner that it is clear to which display the units apply.

e. The units of the scales should be consistent between rate and integral displays for related items. For example, all the flows into or out of a tank should be provided in consistent units of volume and time and the tank contents should be displayed in units which are consistent with the units of the flows.

f. Where multiple displays are provided of the same parameter, e.g., wide and narrow ranges, these instruments should have consistent scale units and consistent zero points. For example, steam generator start-up, operating and wide-range level instruments could all be referenced from the top of the lower tube sheet as "zero".

g. The arrangement and scale design of multiple displays should involve a minimum risk of confusing the readings, e.g., erroneously matching the pointer on one instrument with the scale on another.

3. Identification

a. Each display should be identified with both a descriptive name and, where applicable, an identifying number which relates the indication unambiguously to a particular instrument or sensor.

b. The nomenclature should be consistent with that used in the procedures and system diagrams and that on related controls and displays. The use of abbreviations should be minimized.

c. Legend plates should normally be located over the display to which they apply. If this cannot be done, some special visual clue of the unusual relation should be provided to the operator. In no case should a location convention be the only means of telling to which display the label applies.

d. If the limits or set points of the displayed variable are needed by the operator when the display is used, then they should be presented in a clear and unambiguous manner. It is particularly important that memorization of numbers by the operators be minimized. The method of identifying set points and limits should be consistent among the displays.

e. Legend plates on displays should meet consistent standards (Van Cott and Kinkade, reference 3) of letter size. Legend plates should be readable from the station at which they must be read.

f. Temporary label plates should not be used.

g. The color of the legend plates used on displays should follow the same general rules as for controls (see B.5.g.).

h. Where colors are used as an integral part of the information displayed, a consistent coding should be used. Color codes may include:

- red to show that a component, usually a motor, or breaker is "on" or energized;
- green to show that a component, usually a motor or breaker, is "off" or de-energized;
- a yellow display to indicate that a system is in a transitional condition or that a "bypassed" condition exists;
- a white display to indicate a status condition.

i. If special information labels are used it should be clear to which display(s) they apply.

j. Redundant identification techniques, e.g. size, shape, location, should be used for similar displays where necessary to avoid improper actuation.

4. Type

   a. Display type, e.g. quantitative, qualititative, analog or digital, should be suitable for its intended application. For example, digital displays minimize time and error in reading an exact numerical value, but provide limited rate information.

   b. Consistent types of displays should be used for similar functions.

5. Maintenance

   a. Replacement of bulbs should take place from the front of the panels and all light bulbs should be commonly stocked types. Special tools should not be required.

   b. The risk that a display will be reassembled in such a manner that it gives erroneous information, for example, by switching lighted legend lens caps, should be minimized.

6. Recorders

   a. A recorder should meet the same requirements for visibility, scales, units, etc., as any other display.

   b. Where multipoint or multi-pen recorders are used, the recorded data should be unambiguous.

   c. When different inputs can be selected for the same recorder, switching transients should not be such that they can be mistaken for signal changes.

   d. When different inputs can be selected for presentation there should be some positive way to determine what specific input the trace represents.

   e. The amount of the recorded trace which is visible should be adequately long to cover the time span of interest to the operators. Reference to portions of the trace which are

not visible should not involve blocking other critical displays or controls or risking inadvertent actuation of controls.

f. The recorder should provide for a tolerance on the timing for changing paper or ink of at least two hours. That is, chart paper and ink should be replenished when there is at least two hours of recording left. This is to insure that if an emergency evolution takes place there will be at least a two hour capability to follow it without servicing the recorder.

g. It is preferable for charts to have time as the horizontal coordinate increasing to the right.

h. Changing chart paper or ink should require a minimum of time and should not block other critical controls or displays. There should be little possibility of the inadvertent actuation or damage of nearby controls.

7. CRT Displays

a. The loss of any CRT display or other single failure in the associated hardware (power supplies, computer, keyboards, etc.) should not preclude the performance of an emergency procedure.

b. Information orientation and zones, titles, label locations and parameter locations should be standardized. Standard sets of characters, symbols, and abbreviations should be used.

c. Color assignments should be consistent from display-to-display and should be consistent with color conventions used on the console and panels.

d. Mimic displays should be oriented from left-to-right or top-to-bottom unless this conflicts with existing panel mimics, P&IDs or the arrangements of items on the panels. Procedures steps or decision "trees" should be oriented from top-to-bottom. Time should be displayed from left-to-right.

e. Each display should have a descriptive title. This title should be in a consistent location and have a consistent color and format.

f. Display characters should be selected from a standard set (such as ASCII). The letter size should meet consistent standards (Van Cott and Kinkade, reference 3) for the distance at which they are used. Capital letters should be used.

g. The refresh rate of the displays should be 60 Hz or more.

D. <u>Process Computer Guidelines</u>

1. Only authorized personnel should be able to alter the computer data base.

2. Data base changes should require a positive command action by the operator. The operator should be automatically provided with information describing the implications of the data base change before he makes the change. The system should then require him to acknowledge this information before the data base change is executed. The system should provide confirmatory feedback when the data base change has been accomplished.

3. The process computer command language should be logical and consistent. Language words and abbreviations should be consistent with operating procedures and system diagram terminology.

4. Command entries should require a minimum number of keystrokes. Single keystroke function keys should be used for important control inputs.

5. The process computer operating system should aid the operator by providing prompting and assistance in recovering from an error.

6. Command entry keyboards should be standardized and readily usable under all operating conditions. The operator should receive positive feedback of each keyed entry.

7. Computer output devices, e.g., line printers and typewriters should present information in a readily usable and readable format. Output devices used to list alarm messages should have adequate output speed to list alarm messages in real time with no significant backlog or loss of information.

E. Overall Control Room Environment

1. Temperature and humidity should be controlled to provide operator comfort and to allow proper functioning of control room equipment. One means of demonstrating that the temperature and humidity levels are adequate is to show that they meet the following recommendations:

   a. An effective temperature (ET) range of 65 F to 85 F is recommended in MIL-STD-1472B.

   The effective temperature can be determined from Figure 32 of MIL-STD-1472B or from the following approximate formula:

   $$ET = xWB + (1-x)DB$$

   where

   WB = wet bulb temperature (F),
   DB = dry bulb temperature (F), and
   $x = (DB-45)/(64+DB-WB)$.

   b. A relative humidity of approximately 45% at 70 F is recommended in MIL-STD-1472B.

   Control of relative humidity may also be required to reduce problems with static electricity, especially for computer components. A minimum value of 45% is recommended in reference 8.

2. Adequate ventilation must be provided in the control room.

   a. The control room air should be free of excessive dirt, noxious fumes and odors.

   b. Air should be introduced at a minimum rate of 30 cubic feet per man per minute.

c. Air velocity in the control room should be low enough to avoid distracting the operators, e.g. by blowing paper off operator's desk.

3. Adequate illumination should be provided to allow all required operator seeing tasks to be performed comfortably, and without likelihood of error. Examples of required seeing tasks are: reading labels on panel faces and annunciator windows, reading gauge divisions on meter faces, reading type-written material such as operating procedures at the operator's desk and writing entries into the operator's logs.

   a. Normal illumination levels are considered adequate if they meet the minimum illumination levels given in MIL-STD-1472B: 30 footcandles at console and panel surfaces and 50 footcandles for general office work including reading of small type or data recording. If illumination levels are lower in particular locations, the nature of the seeing tasks at these locations should be evaluated to determine whether the identified seeing tasks can be accomplished without difficulty or likelihood of error.

   b. Emergency Lighting

      The control room illumination when powered by the diesel generators should meet all the requirements of the normal illumination.

      When neither the normal nor emergency diesel generator power is available, battery-powered illumination must be provided at the locations to be used under these conditions, e.g. the diesel generator panels, the associated power distribution sections, areas for reading procedures, etc. The illumination levels at these locations should be evaluated to determine their adequacy to accomplish the required tasks. A minimum illumination level of 3 footcandles is recommended for emergency lighting in MIL-STD-1472B.

c. Glare should not interfere with the readability of displays, labels or indications and should not produce operator discomfort.

d. The luminance of surfaces in the control room should be sufficiently uniform to allow the operator to perform all seeing tasks comfortably.

e. Shadows which distract the operator should be avoided under normal illumination.

4. The ambient noise level in the control room should be sufficiently low to allow easy direct voice communication in the control room as well as communication by telephone or radio to personnel outside the control room.

   A maximum ambient noise level of 65 db(A) (A-weighted scale) is recommended for areas similar to control rooms in MIL-STD-1472B.

5. There should be adequate provision for the control of traffic in the control room and accommodating visitors or observers without adversely affecting operations.

6. There should be adequate provision for the storage of personal items and emergency equipment.

7. There should be adequate workspace for the operators to use reference material and to support any on-the job training.

8. There should be adequate provisions for storage and use of the following without blocking access to any controls or displays:

   a. procedures,
   b. manuals,
   c. diagrams and drawings,
   d. logs,
   e. personnel rosters,
   f. other files.

9. There should be direct and defined access to the supervisor's office. Good visual and voice contact should exist with the control room.

10. There should be adequate rest room and kitchen facilities.

11. There should be adequate and defined access for maintenance of the control room equipment including availability of technicians, tools, and spares. Such maintenance should not interfere with normal operation.

12. There should be adequate access from the control room to the remainder of the plant.

13. The control room and its associated spaces should contain adequate provisions for communications. This includes particular consideration of the following:

    a. means for paging in the rest rooms, kitchen and any other associated spaces, and

    b. communication facilities for the shift supervisor, shift foreman, and other personnel in the control room so that they do not interfere with or confuse the communication links used by the operators on the main console and panels.

14. The control room should be free of personnel hazards such as items which could trip the operators, sources of electric shocks, etc.

15. There should be adequate safeguards on the systems which control temperature and ventilation so that, in case of failures in these systems, proper working conditions can be re-established before they deteriorate excessively.

16. Emergency equipment including operator protective equipment, fire extinguishers suitable for electric fires, radiation equipment and rescue equipment as required should be readily available.

17. Access openings normally used by the control room operator should be clearly and consistently labeled. Labels should contain prominent warnings if access possesses a danger, e.g., high voltage.

F. Guidelines for Alarms

1. Selection

The following guidelines and criteria should be used in evaluating alarm selection.

a. Candidate alarm conditions include: (1) conditions within a system which cause, or may cause, the system or its components to malfunction, or to function in a manner different from that intended for the existing mode of plant operation, and (2) conditions which cause, or may cause damage to plant equipment. Candidate alarm conditions should be chosen based on knowledge of the operation and intended function of the system or component. In determining what is "normal" or "intended" operation for a given system, Guideline b., below, should be applied.

With respect to the different types of systems in the plant, the following guidelines should be applied on a system-by-system basis in order to identify candidate alarm conditions:

(1) Candidate alarm conditions for fluid systems are values of the thermodynamic parameters in the mass, momentum and energy equations which indicate the system is not functioning as intended. In particular, inventory, flow rate, temperature and pressure usually are candidate alarm conditions.

(2) Candidate alarm conditions for electrical distribution systems are breaker trips, improper paralleling of generators, batteries or inverters, and inverter failure or malfunction. Candidate alarm conditions for transformers are high temperature, high gas pressure, presence of combustible gas, and other conditions for their support systems which are determined by application of the appropriate system-specific guidelines (e.g., the guidelines above for fluid systems). Candidate alarm conditions for batteries and diesel generators should be

determined by reference to the guidelines below for protection systems and large machines.

(3) Candidate alarm conditions for control systems are loss of power, automatic transfer to manual control, automatically initiated changes in automatic control mode and symptoms of control loop malfunctions.

(4) Candidate alarm conditions for protection systems are a lack of readiness, actuation of the system, problems in actuation and problems in operation. Candidate alarm conditions for problems in operation should be chosen by application of the appropriate system-specific guidelines (e.g., the guidelines above for a fluid system).

(5) Candidate alarm conditions for large machines are trips, and trip causes that may alter the operator's response to a trip. Alarms for supporting subsystems should be chosen by application of appropriate system-specific guidelines.

b. Candidate alarm conditions should be chosen so that the process annunciator panels are dark when the plant is operating normally at power. "Normal" means full power operation with all systems operating as intended in their most typical lineup for this condition.

c. In order to warrant an alarm in the control room, each candidate alarm condition must satisfy the following criteria:

(1) The condition requires operator action as defined below, <u>and</u>

(2) The operator's normal surveillance activities cannot be relied on to alert him to the condition, <u>and</u>

(3) It is considered plausible that the condition could occur during the life of the plant.

For the purpose of this guideline, operator action may take any of the following forms:

- direct manual action,
- backup of an automatic action, and
- other modification of surveillance activities.

Any condition not meeting these criteria should be eliminated from the list of candidate alarms.

d. After a set of alarms has been defined, these alarms should be reviewed to ensure that each alarm requires unique operator action, in order to minimize the number of annunciators in the control room. Alarms which require identical operator action may be candidates for combination.

2. Presentation

a. In order to minimize the number of annunciators within the control room, several types of alarms should be considered for combination into a single annunciator, whenever doing so would not interfere with timely operator response to the alarm. If alarms are combined, a reflash* capability should be provided. The following types of alarms should be considered for combination (subject to the restrictions listed in the next paragraph):

- alarms for the same parameter on the same component, e.g., tank level high/low;

- alarms for the same condition on redundant components, or logic trains, when each has a separate indicator and the indicators are placed in closed proximity on the console, e.g., pump A/B

*"Reflash" is the capability to cause an annunciator combining a number of alarm conditions to recommence flashing and sound a tone on the existence of a second alarm condition occurring after a first has been received and acknowledged (but has not cleared).

trip, safeguards actuation A/B;

- alarms for several conditions relating to one component or several redundant components, which require the operator to obtain further diagnostic information either by sending an auxiliary operator out to the component(s) or checking the computer (if applicable), e.g., pump A/B trouble.

Candidates for combination should <u>not</u> be combined if:

(1) different actions are to be taken depending on which constituent is alarming <u>and</u> information is not available to the operator to identify which constituent is alarming;

(2) the required response time is so short that taking time to consult the control panel or the computer (if applicable) to determine which constituent is alarming would risk an inadequate operator response;

(3) information or protection for the other alarm constituents after any one has activated the combined annunciator is not available to the operator;

(4) operator understanding is improved by annunciating the conditions separately because of similarity to the layout of the associated controls; or

(5) the constituents and/or significance are not of a similar nature and are not of the same order of importance.

b. Alarms should be grouped according to plant system or function. Within each group, the alarms should be arranged to maximize the operator's ability to assimilate multiple

alarm occurrences. Alarms should be organized to indicate relationships among alarms within the same system.

c. Alarm groups should be placed in close proximity to the corresponding controls.

d. Annunciator windows should be designed and lettered according to the following guidelines:

   (1) Nomenclature and abbreviations should be consistent with those used for the corresponding controls and indicators.

   (2) If no precedent has been set on the controls and indicators or by other commonly accepted usage, abbreviations should be in accordance with MIL-STD-12C.

   (3) Lettering size, type font and viewing angle must be such that the alarm legends are readable by the operators when standing at their primary control stations. In addition, it is highly desirable that the legends be readable by the operator who is acting in a supervisory capacity (e.g., shift supervisor). The standard in Van Cott and Kinkade, reference 3, should be used in making these evaluations.

   (4) Annunciator panels should be positively identified. Label plates used for panel identification should meet standards for letter size that are consistent with those used for similar labels on the control panels (Van Cott and Kinkade, reference 3).

e. An operator should be able to acknowledge only those alarms within his field of vision.

f. An operator should be able to acknowledge an alarm only from a station near the controls which are operated in response to the alarm.

g. Audible tones signifying an alarm should satisfy the following requirements:

(1) The combination of tone volume, frequency and construction (e.g., warble or other variation) must be chosen such that the operator is alerted to the alarm under the most adverse anticipated conditions of background noise.

(2) The tone must not be so loud that the operator is startled or disoriented, or is unable to effectively communicate with others in the control room.

(3) The audible tones used for the various annunciator panels should be chosen and directed such that the operator can distinguish which annunciator panel or panels require his attention.

h. Flash rates used for annunciator lights should be within the range of 1 to 5 flashes per second. Equal amounts of on and off time should be used. Flash rates which must be distinguished one from another should differ in rate by at least a factor of two.

i. Annunciator lights should be bright enough to stand out clearly against the panel on which they appear under all expected lighting conditions, but they should not be so bright as to be annoying or distracting.

j. The capability to reconstruct the sequence of events in a multiple alarm situation should be provided. In particular, the operator should have a means of identifying the first alarm that occurred.

k. Annunciator ringback* should be provided whenever the operator requires information on

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*"Ringback" in an annunciator sequence provides a second visual and auditory indication that an alarm which was previously received and acknowledged has now cleared--gone back to normal. A separate "reset" control is typically provided.

clearing of an alarm, particularly if he must take action (or stop the action he took in response to the alarm) when the condition returns to normal. Ringback should not be used if the operator does not require the information (and takes no action) and therefore the ringback becomes a distraction. Where ringback is used, a separate control should be provided to "reset" the annunciator -- acknowledging the ringback.

l. The annunciator system should be designed to minimize the nuisance associated with leaving an audible signal sounding continuously until alarms can be assimilated and acknowledged in a multiple alarm situation. One means of addressing this is the provision of a silence control for the audible signal, separate from the acknowledge control for the visual tiles. Other means may also be acceptable.

m. Annunciators should meet the requirements of paragraphs III.A.4 and III.A.6 for indicating malfunction or tag-out of annunciators.

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APPENDIX B

RESULTS OF OPERATOR INTERVIEWS

I. INTRODUCTION

This appendix is an edited version of the responses obtained during the Palisades control room operator interviews conducted during February and March of 1982. The purpose of these interviews was to identify weaknesses and strengths of the control room that have been noted by the operators in the course of plant operation.

The question which was posed as the basis for the discussion is presented first and then the responses are tabulated. In accordance with the plans for the interviews, the responses are kept anonymous in this tabulation.

II. RESPONSES

A. OVERALL ENVIRONMENT

1. Have there been instances where the heating, ventilation, and air conditioning in the control room interfered with operations? Do you consider the control room is often too hot, too cold, too dry, or stuffy?

   Diesel fumes have been a problem for most of the operators and one operator mentioned that auxiliary boiler fumes have occasionally been evident in the control room.

   One operator indicated he felt the ventilation has been improved with the repair of one fan (it had been working backwards). Cigarette smoke, however, is still bothersome to one operator - the use of a large portable floor fan had been tried, but had proved unacceptable because papers were blown off the tables.

   A number of operators indicated that temperature in the room appears to have a large swing, sometimes too cool and sometimes too hot. Instances of air conditioning being out-of-service in the summer were mentioned. In some cases this has evidently led to high temperatures in the equipment cabinets.

   Several operators indicated that static electricity has been a problem at times; however, it is not evident that there have been any equipment malfunctions as a result. Some operators also indicated that they found the room "dry".

2. Do you consider the lighting in the control room satisfactory? Are there places where the glare is a particular problem?

   Lighting was generally judged to be satisfactory; however, the operators pointed out that this was only after a number of the fluorescent bulbs had been removed. Some of the operators indicated that although they considered the lighting

adequate, it was brighter than necessary. One operator uses photo-grey glasses to counteract the brightness.

A few instances of glare were pointed out, particularly when the operator was seated; however, overall the operators did not appear to consider glare a problem. Some concern about glare on recorder glass "doors" and digital power meter faces on C-27 was expressed.

3. Do you consider the noise level in the control room satisfactory? Have there been instances of inadequate communication or inability to hear alarms in the room because of noise levels?

Noise level is judged good by the operators and much improved with addition of carpet and replacement of "PIP" computer printer. One operator indicated that the cooling tower teletypewriter is still somewhat noisy. No instances of inadequate communication because of noise levels were noted.

4. What communication equipment in the control room do you use most often? What communication equipment do you consider the most effective? Have there been instances where communications were particularly ineffective, e.g., busy phones, interference of radios with other electronic equipment, or Auxiliary Operators who could not be reached? Do "nuisance" calls on the telephone or page system occur often?

The telephones and the page system are used most often by the operators for communication. The radios are also used and are judged quite effective; although, there are some areas which cannot be reached. Dead spots for the page system were cooling tower and "dog-house" area. It was also noted that the secondary plant Auxiliary Operator is sometimes hard to reach because of high noise level in the plant.

There have been some instances where telephones have not worked properly; in those instances more radios were issued and used.

The control operators have an emergency page phone system which they can use; however, it is at the

far left end of the main console so that it requires an operator to leave the main operating area to use it.

Nuisance calls were not considered a problem.

5. <u>Are the desks, chairs and other furniture in the control room satisfactory in terms of location, orientation, knee room and surface space?</u>

The operators described no general problems with the furniture; however, several operators mentioned the need to have a table for the large P&ID's. These large diagrams are not regularly used, the operators preferring the reduced versions; however, the small sets are not "red lined" with changes. Consequently, when dealing with a changed system the operator needs to consult the larger prints to be sure things have not been changed or to confirm what the changes are. There is currently a regular folding table in front of panel C-11A which is being used for the large prints. One operator found this table uncomfortably low.

6. <u>Is the written material, e.g., procedures, drawings, etc., used in the control room easily accessible? Is the format convenient? Does it require substantial memorization or consulting of other reference material to use?</u>

Most operators consider the written material including P&IDs and operating procedures generally satisfactory.

One operator commented that the control room set of P&IDs tends to wear out rapidly and should be replaced on a regular basis.

Concern was expressed that the small but convenient set of P&IDs would be replaced with a larger set that could not easily be read at the operator's desk (see also 5. above).

Alarm response procedures were singled out by several operators as being out of date. As an example, the operator pointed out that many of the annunciator windows on the cooling tower panel are not yet identified in the alarm response procedures.

Several concerns with keeping the procedures up-to-date were expressed. From the standpoint of the operator, temporary changes, particularly if extensive, are difficult to work with. It requires constant rereading of the temporary change to insert them when the step is reached in the main procedure to which they apply. Another factor is that temporary changes are often handwritten and marginally legible.

The operators keep a "breaker-book" which lists all the electrical breakers, what they control, and where they are located. This book apparently has no official status, but is kept up by the operators from other information. The book, judging from its condition, is used a great deal as it is evidently more convenient than other sources of the information.

B. PANELS

1. Controls

a. Are there controls which are particulary difficult to operate, e.g.

- out of reach,
- operate in an unusual way,
- are in an unexpected or inconvenient location or don't correspond in location to the associated displays and controls,
- require too much or too little force, or
- require very precise positioning?

The spring loaded rotary switches MOV-5311 (labeled DIL PP P40A to MIX BASIN), MOV-5312, MOV-5313 and MOV-5314 on cooling tower panel have to be held against a spring force for approximately 45 seconds before valves are fully open. A similar, but less bothersome condition was noted with the "Matrix Relay Hold" switch on C06. The safety injection MOVs on C03 are finger-grip switches which require holding for about 15 seconds against a spring-return. These handles are also easily broken. One operator indicated the

the push button lighted indicators on the cooling tower panel and the test push buttons on the radiation monitors on the back of panel C11 were relatively easy to break.

The Linear Power Channel Test circular switch on C06 was considered too sensitive and "flakey" by one operator.

On the new controllers for auxiliary feed, push buttons are used as a variable rate device. A light push results in a small valve motion, a heavy push (past a detent) results in a larger motion. One operator found this different type of control unusual and somewhat difficult to operate smoothly (he tended to get too much valve motion).

Several operators (even those who were very experienced) indicated that variation in "A" "B" positioning was a problem. They were particularly concerned about the new Main Steam Bypass Valve controls (MO-0501 and MO-0510) which are backwards from the expected order, i.e., the valve for the B steam generator is at the left of the valve for the A steam generator.

b. <u>Are there controls which are never used?</u>

Several operators indicated that they found the presence of spare or inactive controls confusing and expressed the preference to have them removed and the holes plugged.

An operator indicated that the "TURBINE RUN BACK RELAY test-reset" button on C02 is never used; there is a permanent "caution" tag attached.

An operator indicated that well pump P-6A control on C13 is never used since this pump has been removed. A "caution" tag dated 3-12-78 has been put on this control.

One operator cited the automatic MSR DP control which is not used.

c. <u>Are there controls which are needed, but are not in control room?</u>

None were identified.

d. <u>Are there controls which are often out of service for repair?</u>

The charging pumps were noted by one operator as being frequently out-of-service.

Several operators noted that problems sometimes occurred with the batch controllers in the chemical and volume control system and that gears have been replaced in the units several times.

e. <u>Are there controls which are labeled in a confusing manner, e.g.</u>

- <u>nomenclature inadequate or ambiguous,</u>
- <u>letter size too small, or</u>
- <u>label location inappropriate?</u>

One operator pointed out the labeling of the Tcold reactor regulator as incomplete.

Several operators commented that the labeling of the SI valves gives no hint what SI bottle is involved. These controls are often used in conjunction with bottle filling. Small pencil letters on the panel can be seen to identify the SI bottle. The operators noted that the arrangement differs between the two parts of panel C03.

One operator pointed out the labeling on the controls on the left end of the console (largely service and component cooling water) as being difficult to use because of the long similar legends (except for one key word) on many of the controls.

2. <u>Panel Displays</u>

a. <u>Are there displays which are difficult to use, e.g.,</u>

- <u>hard to see or interpret,</u>
- <u>out of sight or inconveniently located,</u>
- <u>unusual color, shape or configuration,</u>
- <u>inappropriate units,</u>

- awkward scale divisions,
- obscured by glare or dimly lit,
- require very precise reading, or
- don't correspond in location to associated controls and displays?

Concerns expressed about displays included:

- Upon loss of power the "new" Sigma meters remain "as-is". These meters include green power-on lights to show when power is lost. This is opposite to the usual meaning of green on the panel. Also, there are many other green lights on the panel so that the power-on light tends to be lost. There is also no way to tell easily from a distance whether a Sigma meter is "new" or "old" (The old meters fail down scale and have no green lights).

- Several operators expressed concern that old large recorders have been replaced with smaller, harder to read recorders such as the startup recorders on C12. One operator considered the condensed log scale on this recorder hard to understand. Another operator indicated that he found the combination of start-up rate and wide range on one unit to be confusing.
- Feedwater heater level recorder and generator gas level (C11) are considered too high by one of the shorter operators.

- Steam generator level recorders and primary coolant pump seal recorders on back panels are hard to read from in front of the console; similarly the safety injection tank levels and pressures on C13 are hard to read from in front of the console.

- The divisions for pDT-104 Reactor Vessel DP are awkward; similarly, some of the temperature and pressure gauges on C126 have awkward divisions.

- The scale on FI-0404 is difficult to use for both high flow into SIRW tank and low flow from HPSI pump recirculation.

- The scales for tanks T102 and T103 are side-by-side but are different, apparently without reason.

- One operator indicated that he believed some valve lights operate differently than expected, i.e., that both the red and green lights are <u>not</u> on when the valve is between open and closed.

- All the Sigma meters have red lights which are activated by the meter set points. In some cases the lights go with the related alarm; however, in some cases the meter has the red light on normally.

b. <u>Are there displays which are never used?</u>

One operator indicated that the rod mimic lights on the back panel C-12 have very limited utility. They are useful almost exclusively for confirming that most of the rods have bottomed in a trip. (See also boronometer 2.d., below)

c. <u>Are there displays which are needed but are not in control room?</u>

One operator indicated that upper and lower bearing temperatures for the condensate pump would be useful in the control room.

One operator indicated that alarms on the radiation monitoring panels can sometimes be a problem because an operator must leave the main operating area to determine what monitor is alarming.

One operator indicated that SI pumps have no ammeters so that the only confirmation that they are running comes from the red breaker light and the system flow.

One operator indicated that they have no indication of the status of the pressure

protection at low temperature. This protection is provided automatically but the operator has no indication when it takes place or when it is removed.

One operator indicated that the system mimic on the back panel C-12 would be more useful if it showed the pressurizer spray and surge lines. In particular, this would make it easier to remember which coolant pumps must be running to have the pressurizer spray function.

d. <u>Are there displays which are often out of service for repair?</u>

Several operators singled out the alarm annunciators as often being out of service (See B.4 below). One operator also indicated that the event recorders were often out of service.

Several operators pointed out that the boronometer has never functioned satisfactorily; it occupies prime space at the center of the main console it is evidently left on to provide a display and a strip chart record but it is not used.

e. <u>Are there displays which are labelled in a confusing manner, e.g.,</u>

- <u>nomenclature ambiguous or unusual</u>,
- <u>letter size too small, or</u>
- <u>location inappropriate</u>?

One operator pointed out that two meters on C13 now have temporary labels because it was found that they read chiller outlet temperature <u>not</u> room temperature as indicated by the existing labels.

One operator pointed out the pressurizer heater channel selector label as confusing.

3. <u>Panel Arrangement</u>

a. <u>Are there panels which you consider particularly easy or difficult with respect to:</u>

° normal operation or
° off-normal or emergency operation?

In general, the operators indicated the panels were relatively easy to operate. One experienced operator indicated that he had found the shutdown cooling and safety injection systems at C03 and C02 to be difficult for new operators. Another operator stated that he had found the service water system on C03 difficult.

b. Are there panels or operations which you consider particularly easy or difficult with respect to

° initial learning or
° requalification?

The turbine control panel pushbuttons at C01 were judged confusing by one operator; in particular he commented that the training material for these controls "reads like an insurance policy".

One operator indicated that it was difficult to get adequate training and information on changes.

Several operators commented that the addition of the C11A panel obscures the operator's view of the side panels.

4. Panel Alarms

1. Are there alarms which you consider:

° are a nuisance (constantly activating),
° are incorrectly or ambiguously labeled,
° are unnecessary,
° are not provided,or
° needed, but are located inconveniently or illogically?

Many of the operators expressed concern about the number of alarms which are out of service. In some cases a tagged-out alarm window is dark, in other cases it is lighted, and in a few cases it is flashing.

Examples of chronically out of service alarms include "Condenser Prime Required" on C12, "Condensate Transfer Pump Low Pressure", "P-11 low press", and "VCT level hi/low".

The C47 fire panel, C42 turbine sample panel, and concentrated Boric Acid alarm, Diesel Fire Pump P-41 Engine Trouble, are examples of alarms that are often "in" (not cleared). One operator noted that multiple purpose alarms such as P50D PCP HI TEMP LEAKAGE HI FLOW require operator to perform additional trouble shooting. One operator noted that multiple alarms on C47 fire panel do not reflash in control room.

The operators indicated that the level limits on the SIRW are so tight that it often alarms.

Several operators pointed out that the thermal margin alarms are in unexpected locations.

"Elevator trouble" was pointed out by an operator as an example of an alarm of limited value.

b. Do you consider the alarm sound levels satisfactory?

The operators found the overall alarm sound levels satisfactory. However, one operator mentioned that the fire panel (C-47) alarm was very loud; however, he considered it important and felt it was probably justified.

Several operators pointed out that they had some trouble in distinguishing the alarms on C-106, C-125, and C-126 from each other because of the similarity of their sound and location.

c. Do you know of instances where alarms were missed or acknowledged inadvertently?

The following is a recent instance of an alarm which was missed: The condensate storage tank, T2, was being filled. A high

level alarm apparently was missed and the tank overflowed into the condensate pump room. The room pump level alarm either didn't work or was also missed. Finally the turbine hall pump hi-level alarm was noted. By this time there was about four feet of water in the condensate pump room and one foot of water in the adjacent auxiliary feed pump room (the check valve in the sump drains between the two rooms did not work properly). One operator attributed the missing of the alarm in part to the confusion caused by an adjacent malfunctioning alarm "P-11 low pressure".

C. OPERATIONS

1. Do you know of incidents where an operator either did or came close to doing any of the following:

- operating the wrong control,
- not operating a control in a timely manner,
- reading the wrong display, or
- misinterpreting a display?

Several operators described the incident where a primary coolant pump was tripped instead of boric acid pump. This incident led to the primary coolant pump control handles being painted yellow.

One operator described an incident where Breaker 25F7 on C01 was tripped instead of the generator base being adjusted.

One operator reported operating the rod mode selector improperly.

One operator indicated that incidents where the wrong value was read and logged are fairly common; however, incidents of actually misreading a display and taking improper action as a result are very limited in his experience.

One operator indicated some errors or near errors have occurred in manipulating safeguards valves, particularly with respect to filling and draining of high pressure injection tanks.

2. <u>Do you know any incidents of inadvertent operation of a control?</u>

During the recent 1981 outage the D bus breaker on C04 was inadvertently tripped by maintenance personnel working on panel C04.

Several operators expressed concern about the controls on C-106; however, only the one incident described above could be recalled.

3. <u>Do you know of any incidents where a display was not functioning and the operators were unaware of it?</u>

An operator described an incident where the cooling tower pump P39A discharge valve position indication improperly showed fully closed.

4. <u>What operations in the control room would you consider:</u>

- <u>the most difficult to perform,</u>
- <u>the most difficult to learn, and</u>
- <u>the most demanding of time and attention?</u>

The following operations were noted as presenting some difficulty:

- feedwater control during start up.
- safeguards initiation,
- synchronization of generator and
- keeping pressure from exceeding 500 psi in shutdown cooling system during cooldown with bubble still in pressurizer.

Several operators indicated that startup and shutdown was difficult, particularly since it usually involves dealing with much paperwork (switching and tagging orders, maintenance orders, and Tech Spec testing). Another operator indicated it was sometimes difficult to keep within all the specified limits with all the startup and shutdown activity, e.g., keeping temperature and pressure in bounds.

One operator indicated that anytime the plant state is changed operations become much more difficult.

5. What operations in the control room do you consider are most helped by simulator training? Which ones are most confused by the simulator differences? For which ones is the similator inadequate?

The operators indicated the following are not helped by simulator training since the simulator being used differs substantially from Palisades:

- turbine generator operation,
- electrical distribution, and
- feedwater control.

One very experienced operator expressed concern about the impact of the simulator's differences on his performance and that it might have a negative effect. However, he felt it was good for a new operator as long as little emphasis was placed on details.

6. Under what conditions do you consider the control room staff is most heavily loaded with work?

Starting up and shutting down tend to result in a heavy work load particularly when related to an outage. This is because Tech Spec testing and various maintenance activities have to be provided for. (See also in 4. above)

When there is some kind of a "crisis" the control room often becomes too crowded.

Several operators commented that the day shift ("B" shift) is a particularly busy time.

7. Have you found the shift turnover procedures effective?

The operators generally considered the shift turnover procedure to be adequate.

8. <u>Are there tasks which you are required to perform which you feel distract from your primary responsibilities?</u>

Several operators pointed to the large amounts of paperwork as a distraction. (See also below)

One operator mentioned duties imposed by the shift supervisor at inappropriate times as sometimes being a distraction.

D. <u>OTHER</u>

<u>What other strengths or weaknesses do you perceive in the control room operations and equipment?</u>

One operator felt there was excessive regulation and paperwork for self-protection which made it difficult to run the plant.

One operator pointed out that the feedwater purity data logger often doesn't work.

One operator commented that recorder supplies are often low. He indicated that he was not aware that anyone is responsible to keep up the current inventory. This sometimes requires a control room operator to go to the storeroom to get supplies rather than getting them from the storage cabinets in the room.

One experienced operator commented that for him training tends to become "do-it-yourself" exercise with the operator knowing more than the instructor.

Several operators mentioned concern about the amount of out-of-service equipment and outstanding maintenance, and the lack of direct feedback on the maintenance orders they initiate.

APPENDIX C

RESULTS OF ENVIRONMENTAL SURVEYS

I. INTRODUCTION AND PURPOSE

The purpose of this review was to assess the adequacy of the Palisades control room environment for the activities which must take place there. The review was structured around the following primary elements:

- Quantitative measurements of environmental parameters, including light, noise, temperature, and humidity. These measurements were compared to military standards (Reference 7).

- Interviews with control room operators, including interviews with both an experienced operator and an operator who had reently obtained his license.

- Qualitative observations in the control room by the reviewers to assess the strengths and weaknesses of the existing control room environment.

In Section II in this appendix, there is a summary of the results from the review. Section III gives a detailed discussion for each of the areas investigated. The format used in Section III is to introduce each topic with a statement of the concern which the review was intended to address, followed by discussion of the observations and conclusions. The findings of these reviews along with the results of this assessment and the action for those which require action are included in the tables in Section VI of the main report.

II. SUMMARY OF RESULTS

The review of the Palisades control room indicated that the control room environment is generally satisfactory. The review results are summarized below for each of the areas investigated. These results identify those environmental conditions which have the potential to adversely affect operator performance or the overall quality of the control room environment.

A. Air Condition

At the time of the survey, the control room air condition, including temperature, humidity, and ventilation, was found to meet applicable standards. Likewise, the operators interviewed indicated that the control room atmosphere was generally good. There are, however, three specific problem areas where additional improvements would be beneficial. These problem areas -- air conditioning system reliability, static electricity, and the occasional presence of diesel fumes in the control room -- are discussed below. In addition, at the time of the survey CPCo was in the process of correcting a past problem. Water had on occasion leaked through the roof into the control room. When necessary, operators controlled the leakage by temporarily attaching translucent plastic sheets to the ceiling. Since the review, CPCo has corrected the problem and has stopped the leakage.

1. Air Conditioning System Reliability

Operators reported that during the summer, the air conditioning system was sometimes not adequate. If the control room temperature rose above 80°F, the operators would take special precautions to avoid electrical equipment problems. Independent of the human factors review, CPCo conducted a review and upgrade of the heating, ventilating, and air conditioning (HVAC) systems for the control room and auxiliary building at Palisades.

2. Static Electricity and Humidity

The operators reported some problems due to static electricity buildup. Humidity control is one potential means for minimizing static electricity buildup. At the time of the survey, the measured humidity was approximately 35%. If the relative humidity could be maintained at about 50%, it is expected that static electricity would not be a problem. The upgraded HVAC system includes a system for controlling humidity.

3. Air Quality

The operators said that the air quality was good, with the exception that when the diesels are run, diesel exhaust fumes could sometimes be pulled into the control room. The HVAC upgrade included installation of an additional control room air intake 100 meters from the plant for use during certain emergency situations. This remote intake

can also be used if required to eliminate diesel fumes in the control room.

B. Lighting

The quality of the lighting in the control room was evaluated, including control room illumination, panel and instrument glare, and luminance of lighted indicators. The illumination was judged to be satisfactory, and the review team found no significant panel or instrument glare. Luminance for lighted indicators is discussed below.

GE square indicating lights are used to give the status of various breakers, motors, valves, and other components. The luminance of most of the indicators is bright enough to clearly show whether the indicator is lit or not. However, based on both luminance measurements and observations in the control room, the status (i.e., lit or unlit) of some of the blue and green indicators is difficult to determine.

C. Sound Levels

The general background sound level in the control room is about 62 dBA which is within the recommended sound level of 65 dBA for an operational area.

The sound levels of various alarms in the control room were measured and evaluated. The use of chimes for the main annunciators on the backpanel

was considered particularly effective in getting operator attention without being annoying. The sound level for other alarms was acceptable.

D. Communication Equipment

The primary means used by the operators to communicate with personnel outside the control room are the telephones, the page system, and radio sets. Telephones for emergency use, such as the direct line to the NRC, are in the shift supervisor's office, immediately adjacent to the control room. The operators reported that the communication equipment was generally satisfactory.

It was noted, however, that the telephones, particularly those on the operators' desks, have such short cords that they limit the ability of the operator to monitor the console while using the telephone.

E. Control Room Workplace

Other aspects of the control room workplace environment were investigated, including the number of personnel present in the control room, access between the control room and the shift supervisor's office, access of the operators to required documents and supplies, and adequacy of eating facilities and restroom facilities. Each of these areas was found to be satisfactory.

III. SURVEY RESULTS

A. Air Condition

The air in the control room should be conditioned and controlled so that operators are not uncomfortable or distracted, and also so that control room equipment is not adversely affected. Parameters of concern are temperature, humidity, static electricity, cleanliness, ventilation, and air quality.

1. Temperature

Wet bulb and dry bulb temperature measurements were made in the control room on March 3, 1981, i.e., at a time of year when the heating system was in use. The measurements are shown on Figure C-1. Using these wet and dry bulb measurements, an "effective temperature" of 65°F is calculated with the nomograph on Figure C-2 (the nomograph is from Reference 7). An effective temperature of 64°F is the minimum value recommended by the referenced standard. Thus, on this particular day, the effective temperature was greater than the recommended minimum by 1°F.

Winter temperatures in the control room are comfortable, according to the operators interviewed. The temperature is controlled by a thermostat located on the wall behind the operator's desk. The thermostat setting is determined and is set by the operators.

During the summer operators use a thermostat setting of about 75°F. If the air temperature exceeds 80°F, an operator reported that the computer in panel C106 can cause spurious alarms at the primary data logger. On occasions when the air conditioning system is not functioning, the operators take special measures to avoid equipment problems from high temperatures. The primary data logger power supply cabinet (back of C106) is opened and air is blown into the cabinet with a floor fan. To keep the control room cool, the control room air lock doors are opened and air from the auxiliary building hall is circulated through with fans.

2. Humidity and Static Electricity

The measured relative humidity in the control room was about 35%. This is less than the recommended value of 45% given in Reference 7.

Those operators who were interviewed said that the humidity in the control room was acceptable from a comfort point of view. However, the operators said that static electricity could be troublesome. A feather duster is used to clean the main console, and the feather duster can build up a static electric charge. This can affect the pointer position on certain meters. The operators interviewed said they are careful not to cause large meter deflections, especially on meters with set points. A shift supervisor was aware of an incident that occurred about five to ten years

ago, when feather dusting caused a meter deflection past a set point. A plant transient resulted from this, although the plant did not trip.

Another problem involving static electricity buildup is in using the backup data logger. To make a programming change, it is necessary to take a key from the primary data logger to the backup data logger. Before inserting this key, operators discharge any static electricity buildup. Inserting the key without this precaution has caused spurious readings on the backup data logger.

3. Cleanliness

The main console is occasionally cleaned with a feather duster. Besides the static electricity buildup when using the feather duster, the operators interviewed indicated there were no problems associated with cleanliness in the control room.

4. Ventilation

According to Reference 7, adequate ventilation should provide a minimum of 30 cubic feet per minute (cfm) per occupant. Palisades Plant Drawing M-132, "Heating and Ventilating Equipment List," shows that the total capacity of the two identical fans for the control room (V-17 and V-34) is 8,000 cfm. This is an adequate volume of air for the number of people who would be in the control room.

The operators interviewed said that the control room ventilation was good, i.e., the room did not become stuffy. They also said that there were no spots which were uncomfortable because of blowing air.

5. Air Quality

The operators interviewed said that the air quality is generally good. The exception is that when the diesels are run and if the wind direction is unfavorable, diesel exhaust fumes can be pulled into the control room. One operator reported that the diesel exhaust had caused him headaches. Palisades plant drawings show that the intake for control room air is about 70 feet south from the diesel exhaust and about 20 feet higher in elevation. The HVAC upgrade included installation of an additional control room air intake 100 meters from the plant for use during certain emergency situations. This remote intake can also be used if required to avoid diesel fumes in the control room.

6. Water Leakage Through the Control Room Ceiling

Water has on occasion leaked into the control room through the control room ceiling. The dripping water has occurred in the vicinity of the main console panel C03 and backpanel C13. When required, large translucent sheets of plastic have been attached to the ceiling to control this leakage. CPCo has since corrected this problem and eliminated water leakage into the control room.

B. Lighting

1. Illumination

The level of lighting in the control room should allow the operators to perform necessary visual tasks accurately without eye fatigue or strain.

Illumination measurements were taken in the control room under normal conditions with most illumination provided by the overhead fluorescent lights. (An evaluation of emergency lighting is provided in Appendix H.) The measurements for near horizontal surfaces are given on Figure C-3. Illumination averaged about 49 fc (foot candles) on the main console benchboard and about 29 fc on the main console backboard. For the vertical panels, measurements were taken at two elevations, one at about eye level and a second at the lowest level of instruments, switches, or indicators on the panel. These illumination measurements are given on Figure C-4. Illumination averaged about 19 fc at eye level on the backpanel, and 2 feet above the floor in the backpanel it was about 13 fc.

Reference 7 recommends 50 fc (30 fc minimum) for console surfaces, meter readings, and ordinary seeing tasks. For general office work, 70 fc is recommended (50 fc minimum). The operators' desks had a measured illumination of about 66 fc which meets the requirements for general office space

lighting. For the main console, most of the illumination measurements are above the 30 fc recommended minimum. However, most of the vertical panels have an illumination level between 10 and 30 fc, i.e., they fall below the recommended minimum.

The operators interviewed said that they had reduced the lighting level at the main console by removing bulbs from the overhead fluorescent fixtures. The objective was to reduce glare from instrument faces on the main console. Thus, the present control room lighting levels represent a trial and error approach by the operators to reduce glare by reducing illumination. In interviews, the operators stated that the present control room lighting levels were satisfactory. Also, to the reviewers, it appeared that the illumination levels were adequate for performing operator tasks.

2. Panel and Instrument Glare

Glare from instrument faces is undesirable because it impairs instrument readings. In addition, glare from panel faces can be annoying to the operators.

Operators stated that there were no problems with glare in the control room. However, glare had been a problem in the past and had been eliminated by selective removal of overhead fluorescent bulbs. (See Section III.B.1 above).

The review team did not find sources of significant glare in the control room. In summary, it is concluded that glare is not a problem in the control room.

3. Luminance of Lighted Indicators

The operator must be able to easily discern the status of lighted indicators, i.e., whether they are lit or unlit.

Luminance measurements (photometric brightness) were taken for some of the different types of lighted indicators on the panels in the control room. These measurements are given in Table 1. Reference 7 recommends that the luminance of lighted indicators be at least 10% greater than the background luminance. In Table 1, the indicators not meeting this criteria are some GE indicating lights with green or blue covers, a GE indicator with a red cap, and a blue rod position light.

The review team's subjective evaluation of the indicating lights was as follows:

- it is difficult to determine the status of some GE indicators with blue or green caps;

- the status of the GE indicators with yellow, white, or red caps is easily determined (including the red-capped indicator referred to above with a luminance less than 110% of background); and

- the status of the blue rod position lights is easily determined.

4. Bulb Inspection and Replacement

The operators depend on lighted indicators to give information on the status of the plant, and thus it is important that the number of burned out bulbs be kept to a minimum. Also, it should be easy for an operator to replace a burned out bulb, without dismantling equipment or affecting plant operation.

The operators are required to perform an inspection for burned out bulbs for the annunciator alarms and for the normally lit valve position indicator lights at the beginning of every shift. Also, burned out bulbs are replaced if they are spotted during the course of the shift. On the average, the operators estimated that about one bulb is replaced during a shift.

The operators identified only one bulb which is typically not changed when it burns out. This is the bulb in the "power on" switch for the reheater control system. Pulling this switch cap to change the bulb causes some valve positions to change.

C. Noise

General background noise levels in the control room should not distract or annoy the operators or impair

necessary communication. In addition, the sound level for the annunciator alarms should be clearly audible to the operator above background noise, without being excessively loud.

Measurements of the sound level were taken at various locations in the control room and for significant sound sources, e.g., alarms. These measurements are shown on Figure C-5. The sound level is given in decibels using the "A" weighted scale, which approximates the response of the human ear to sounds at different frequencies.

The general background sound level in the control room was about 62 dBA. This conforms to the recommendation of Reference 7, that the sound level in an operational area be less than 65 dBA. An operational area is defined as a space requiring frequent telephone use or frequent direct communication at distances up to 5 feet. Examples are operation centers, combat information centers, and computer rooms.

The operators interviewed indicated that there were no difficulties in telephone or personal communication in the control room.

An octave band analysis was performed for the annunciator alarms, and results are shown in Figure C-6. An octave band analysis consists of unweighted sound level measurements at frequency bands through the range of human hearing. In Figure C-6 the data are plotted at the center frequency of each band. The octave band analysis was done at the main console for background noise, the backpanel chimes, and the annunciator alarms

on panels C06, C07, C106, C126, and C51 (the alarm on panel C125 was not functioning). For the control room alarms the sound level above background is given in the table below.

ALARM	dB ABOVE BACKGROUND IN OCTAVE BAND	FREQUENCY BAND (Hz)
Backpanel Chimes	16	1000
Supervisory Control Panel -- C07	20	4000
Cooling Tower Panel -- C106	13	4000
Dilution Control Panel -- C126	9	4000
PORV Panel -- C51	19	4000

The recommendation for audible alarms in Reference 7 is that the sound level be at least 20 dB above background in at least one octave and between 200 and 5000 Hz. However, the review team conclusion from subjective evaluation in the control room is that this criteria is too high and that lower sound levels are completely audible. Consequently, in this review alarm acceptability was determined by the subjective evaluation of the reviewers.

The subjective evaluation of the review team was that all of the alarm sound levels were satisfactory. Also,

the use of chimes for the main annunciators on the backpanel was considered particularly effective. The chimes are distinctive and perform the function of getting operator attenton, but are not annoying.

It appeared that some of the alarms, namely the PORV (C51) and fire, alarmed on both the local panel and the main annunciator panel (C12). The need for this redundancy should be evaluated further in the alarm reviews.

D. Personnel in the Control Room

The number of people in the control room and the activities they engage in should not impair the operators' control of the plant.

During normal power operation there are two CROs (control room operators) in the control room. In addition, the operators interviewed said that during the day shift several Instrument and Controls personnel are typically in the control room performing calibration and repair work. There might also be one or two auxiliary operators there to make logbook entries. The operators had no objections to the number of people in the control room during normal operation.

E. Documents

Documents required by the operators should be readily accessible and there should be space for their use.

There is a book cart in the control room behind the No. 1 operator's desk for documents the operators use

(see Figure C-7). Other documents are kept in the file drawer of the No. 1 operator's desk. One operator interviewed said that use of books in the file drawer was inconvenient and that another book cart would be the best location for the documents in the desk drawer.

On the same wall by the book cart are the data sheets which are used by the operators and auxiliary operators. The data sheets are kept on clipboards which are hung from hooks on the wall.

F. General Storage and Supplies

The supplies necessary to support the control room activities should be available when needed and obtaining these should not interfere with plant operations.

Extra bulbs for the control panel indicating lights are stored in the operator's desk. If this supply is exhausted, there is also a stock of bulbs kept in a filing cabient in the control room. If supplies are required, these are, in general, obtained from the Document Control Room. Xerox copies are obtained using the machine at the maintenance office. Each of the operators has a file cabinet drawer for storage of personal papers and items. The operators interviewed indicated there were no problems with availability or access to supplies for the control room.

G. Access To and From the Supervisor's Office

The operators should be able to gain access easily to the shift supervisor's office when required, and also,

the shift supervisor should have easy access to the control room.

The location of the shift supervisor's office is shown on Figure C-7. A door, which is typically left open, connects the supervisor's office to the control room. The supervisor's desk is positioned such that by looking up and through a door and a window, he can see part of the main console and some of the annunciators on the backpanels.

Operators require access to the supervisor's office to get keys for key switches. Each key switch (there are about 54 on the main console) has a unique key which is stored in a key cabinet by the supervisor's desk. (Operators interviewed said that keyed switches were not used during power operation or emergency conditions). The key for the key cabinet is kept in the supervisor's desk drawer. The operators have access to the supervisor's desk. The operators indicated that there were no problems with this arrangement.

H. Eating Facilities

The operators should be able to eat meals without interferring with the control of the plant.

Control room operators typically bring a lunch and eat it at their desks. Next to the shift supervisor's office is a small kitchen with a refrigerator and microwave oven (see Figure C-7). Food and beverages can be purchased from vending machines at the plant cafeteria. Bottled water is available in the control

room. There is a drinking fountain outside the control room in the viewing gallery. To go to the plant cafeteria or to the drinking fountain an operator must ask the shift supervisor to stand in for him in the control room. The operators indicated there were no problems with the eating facilities.

I. Restroom Facilities

The operators should be able to use the restroom without affecting operation of the plant.

There is a restroom located off of the viewing gallery. To use it, an operator must get the shift supervisor to stand in for him. This could require a wait if the shift supervisor is not immediately available or if he is at another part of the plant. The operators said that there were no problems with this arrangement.

J. Communication Equipment

Effective communication equipment is required in the control room to allow operators to communicate with personnel inside and outside the plant without disrupting the control operations.

The communication equipment used by the operators includes telephones, the page system, radio sets, and a voice powered phone. The telephones are used for in-plant and out-of-plant communications. The radio sets are used for in-plant communication, primarily with auxiliary operators. The master radio set is located

on the No. 1 operator's desk (see Figure C-7). Outside the control room, the auxiliary operators use handheld radio sets. The storage area for the handheld sets is in the control room. Operators said that the voice powered phones do not work well and are infrequently used.

The location of telephones is shown on Figure C-8. There is a multiple extension phone on each of the operator's desks, a single extension phone on the main console panel C02, and a single extension phone on the wall near the back corner of backpanel C11. Phones for emergency use, such as the direct line to the NRC, are in the shift supervisor's office.

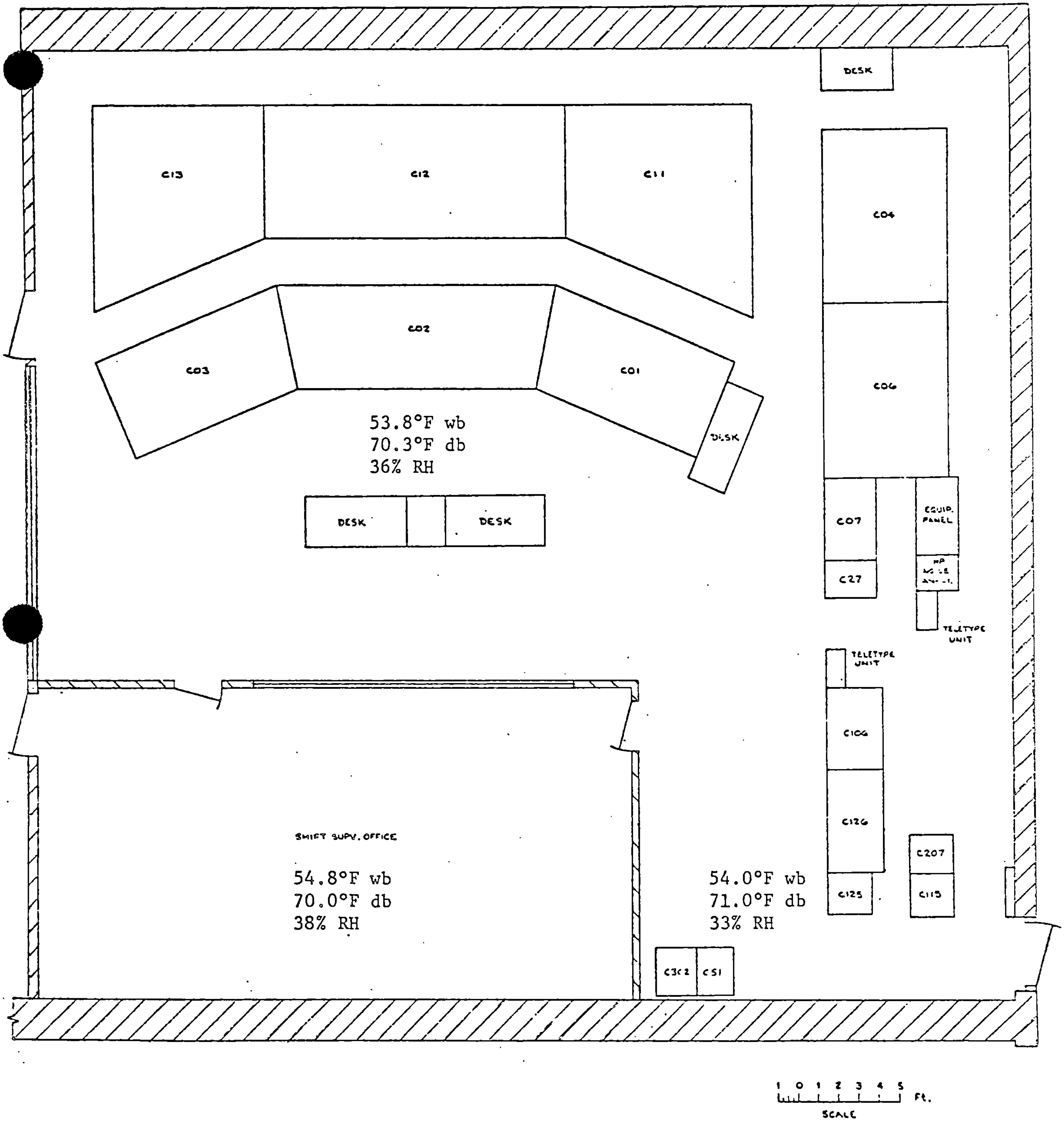
Cord length was measured for the phones in the control room, and Figure C-8 depicts the areas which can be reached while talking on the phone. The phones on the operator's desk cannot be used when reading instruments or operating controls on the main console. The main console phone reaches about 65% of the main console. The back of panel C11 and the front of C04 can be reached with the phone on the back wall.

TABLE C-1

LUMINANCE OF LIGHT INDICATORS

PANEL	IDENTIFICATION	STATUS	COLOR	LUMINANCE (Foot-Lamberts) INDICATOR	BACKGROUND
C03-BACK	CV-1319	ON	RED	24.	15.
C03-BACK	CV-0826	ON	GREEN	17.	14.
C03-BACK	CV-0877	OFF	GREEN	4.9	
C03-BACK	CV-0826	OFF	RED	3.1	
C03-BACK	P-52C	OFF	YELLOW	8.4	15.
C03-BACK	P-52A	ON	YELLOW	50.	
C03-BACK	P-7A	ON	YELLOW	480.	
C03-FRONT	P-77B	ON	YELLOW	67.	24.
C03-FRONT	P-77A	OFF	YELLOW	27.	
C03-FRONT	CV-0951	ON	GREEN	23.	24.
C03-FRONT	CV-0946	OFF	GREEN	18.	
C03-FRONT	CV-0951	OFF	RED	10.	
C03-FRONT	CV-0948	ON	RED	18.	
C02-BACK	MO-3045	OFF	BLUE	1.3	12.
C02-BACK	P-1A (INCANDESCENT IN CLEAR CAP)	ON	ORANGE	20-26	20.
C02-BACK	P-80A	ON	WHITE	79.	20.
C02-BACK	P-1A	OFF	WHITE	24.	
C02-BACK	LEVEL CONTROLLER "DOT"	ON	RED	13.	.90*
C02-FRONT	ROD POSITION LIGHT, REG GRP1	ON	YELLOW	4.3	.96*
C02-FRONT	TR-0121 (DOT)	ON	GREEN	23.	11.
C02-FRONT	TR-0121 (ARROW)	OFF	GREEN	2.9	
C02-FRONT	POWER RANGE MULTIPLIER	ON	GREEN	13.	9.1
C02-FRONT	POWER RANGE MULTIPLIER	OFF	GREEN	2.1	
C02-FRONT	POWER RANGE MULTIPLIER	OFF	YELLOW	4.9	
C02-FRONT	MO-2170 (AT AN ANGLE)	ON	GREEN	12.	18.
C02-FRONT	MO-2170 (STRAIGHT DOWN)	ON	GREEN	11.	14.
C01-FRONT	-0670	ON	GREEN	20.	11.
C03-BACK	MO-3052: RED CAP REPLACED W/ BLUE	ON	BLUE	15.	9.3
C03-BACK	MO-3010: GRN CAP REPLACED W/ BLUE	ON	BLUE	5.9	11.
C04	DIESEL GEN 1-1 2400 VBUS 1C	ON	GREEN	9.9	4.3
C12	ROD POSITION LIGHTS	ON	YELLOW	15.	9.2
C12	ROD POSITION LIGHTS	OFF	YELLOW	6	
C12	ROD POSITION LIGHTS	OFF	RED	3.7	
C12	ROD POSITION LIGHTS	ON	RED	19.	
C12	ROD POSITION LIGHTS	OFF	BLUE	1.6	
C12	ROD POSITION LIGHTS	ON	BLUE	9.7	
C12	ROD POSITION LIGHTS	ON	BLUE	4.6	
C12	ROD POSITION LIGHTS	OFF	GREEN	3.9	
C11	ANNUNCIATOR-PRESS HTR TRANSFER	ON	WHITE	20.	6.6
C11	ANNUNCIATOR	OFF	WHITE	6.6	
C12	ANNUNCIATOR-STM + FEED P TEMP	ON	WHITE	75.	
C12	ANNUNCIATOR-PCP P50A SEAL PRESS	ON	WHITE	30.	
C12	ANNUNCIATOR	ON	GREEN	17.	
C12	ANNUNCIATOR	ON	RED	17.	
C12	ANNUNCIATOR	OFF	GREEN	4.9	
C12	ANNUNCIATOR	OFF	RED	5.4	
C125	DAMPER D2	ON	GREEN	6.9	5.8
C125	DAMPER D2	OFF	GREEN	4.0	
C-11 BACK	RADIATION RECORDER GLASS, GLARE	--	--	110.	
C-11 BACK	RADIATION RECORDER GLASS, NO GLARE	--	--	31.	

*Background was colored black.



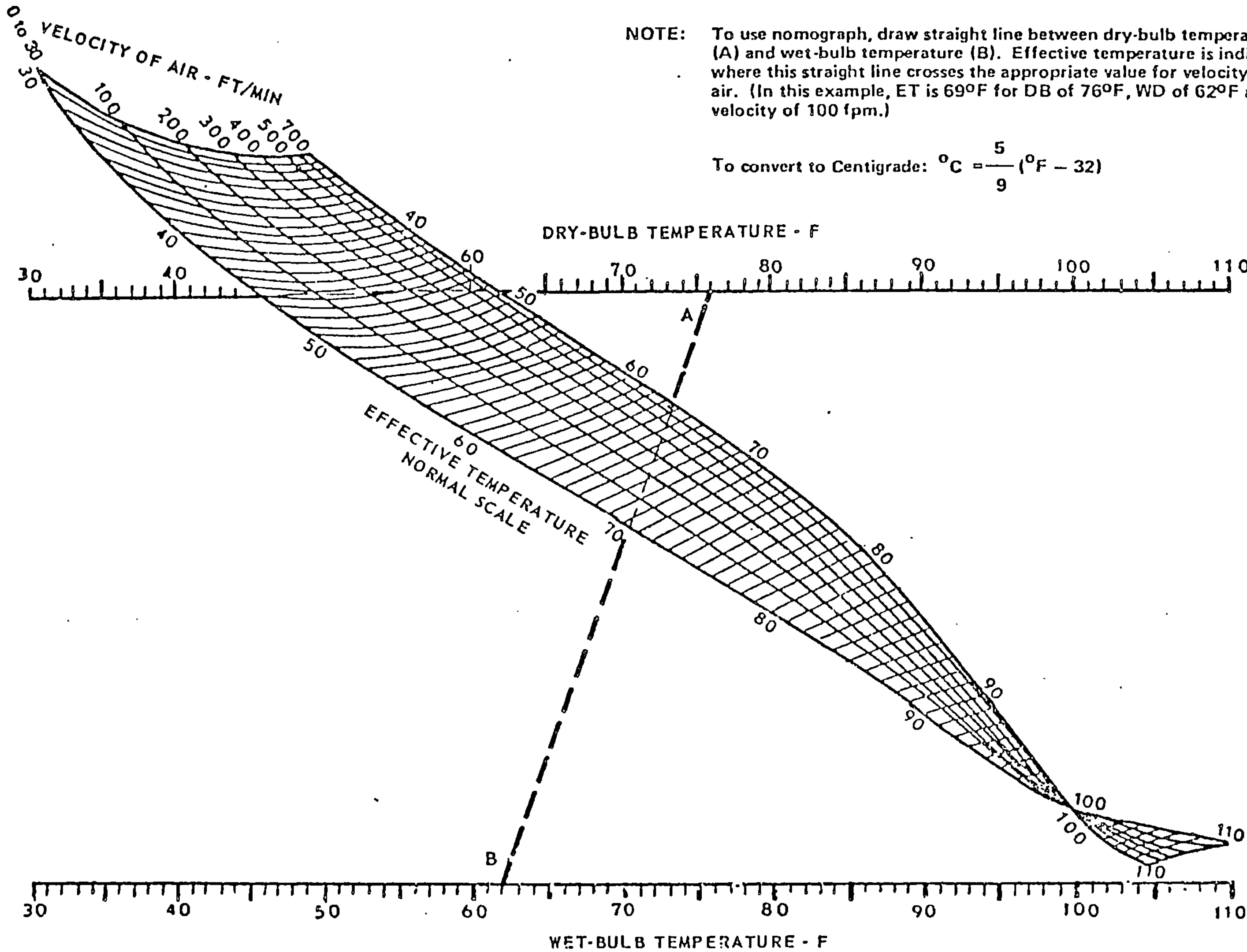
TEMPERATURE AND HUMIDITY MEASUREMENTS
ON MARCH 3, 1981

FIGURE C-1

NOTE: wb - wet bulb; db - dry bulb; RH - Relative Humidity

NOTE: To use nomograph, draw straight line between dry-bulb temperature (A) and wet-bulb temperature (B). Effective temperature is indicated where this straight line crosses the appropriate value for velocity of air. (In this example, ET is 69°F for DB of 76°F, WD of 62°F and air velocity of 100 fpm.)

To convert to Centigrade: $^{o}C = \frac{5}{9}(^{o}F - 32)$

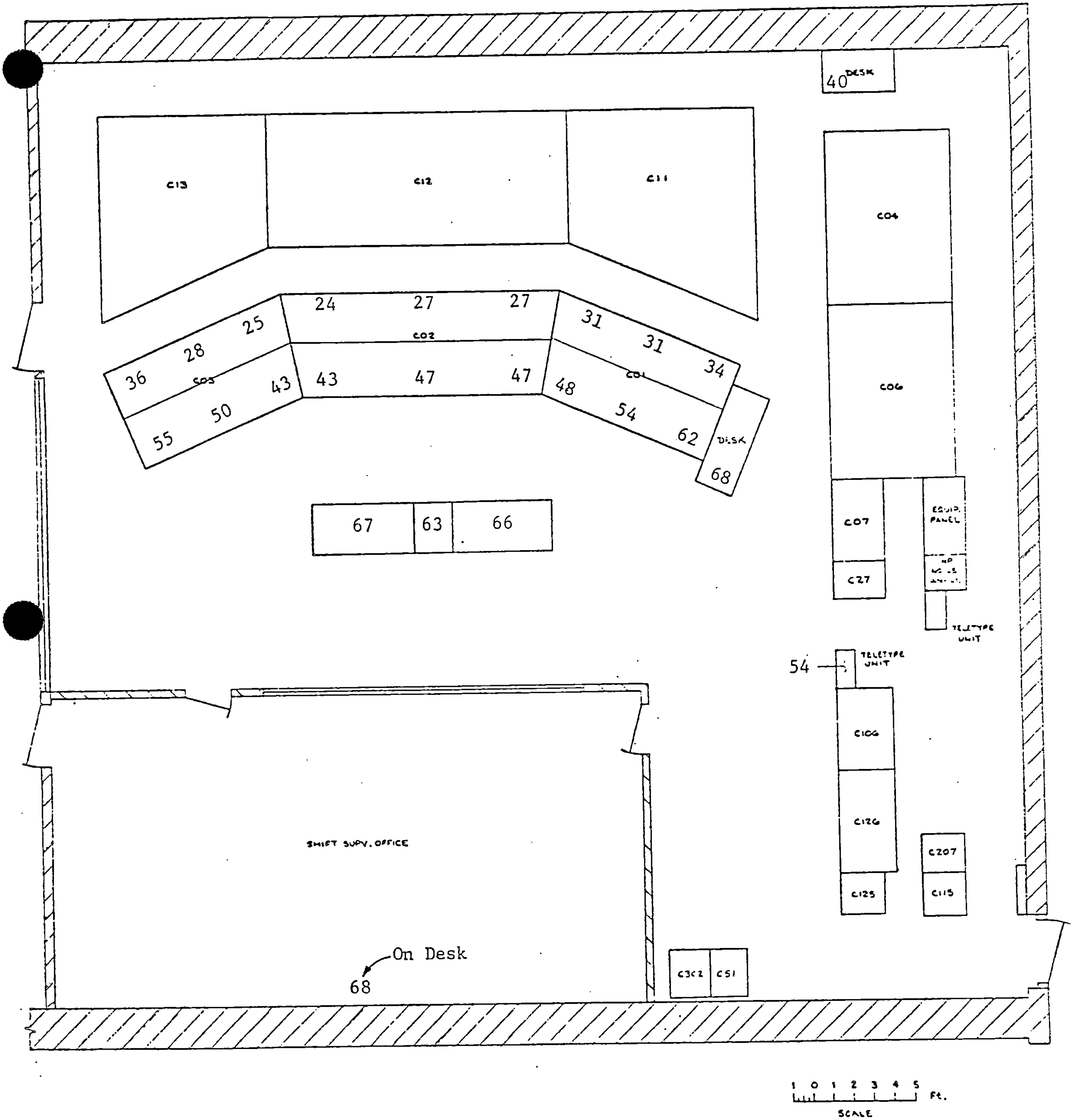


Clothing: Customary indoor clothing. Activity: *Sedentary or light muscular work.* Heating Methods: *Convection type, i.e., warm air, direct steam or hot water radiators, plenum systems.*

EFFECTIVE TEMPERATURE *

FIGURE C-2

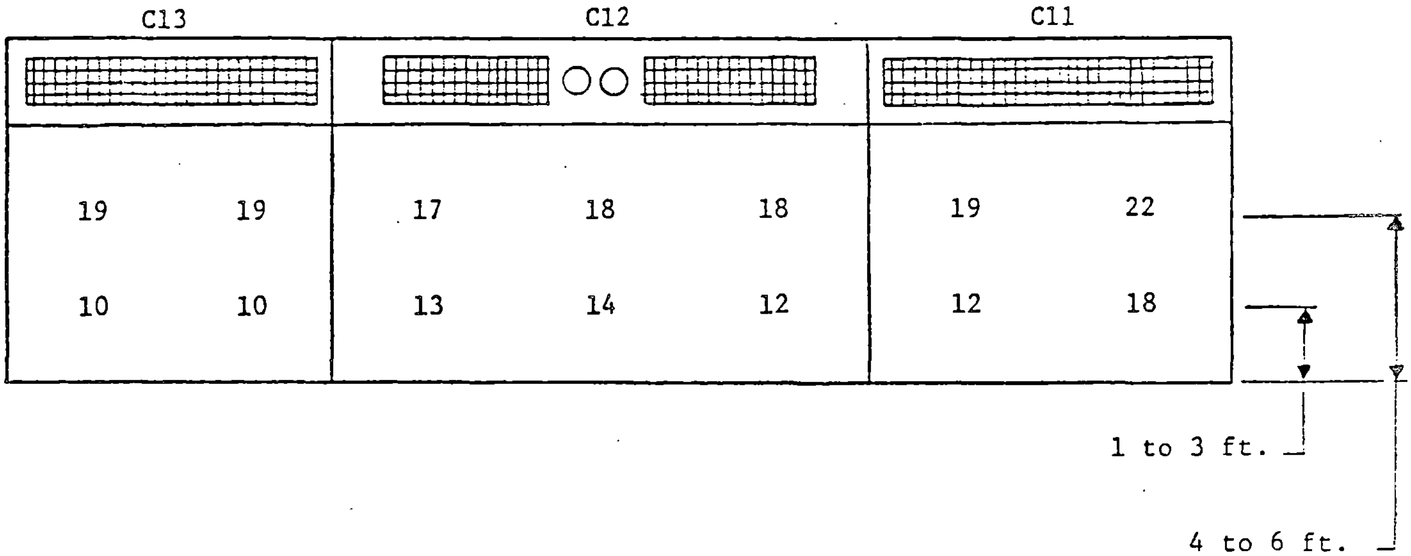
* Reproduced from Reference 7.



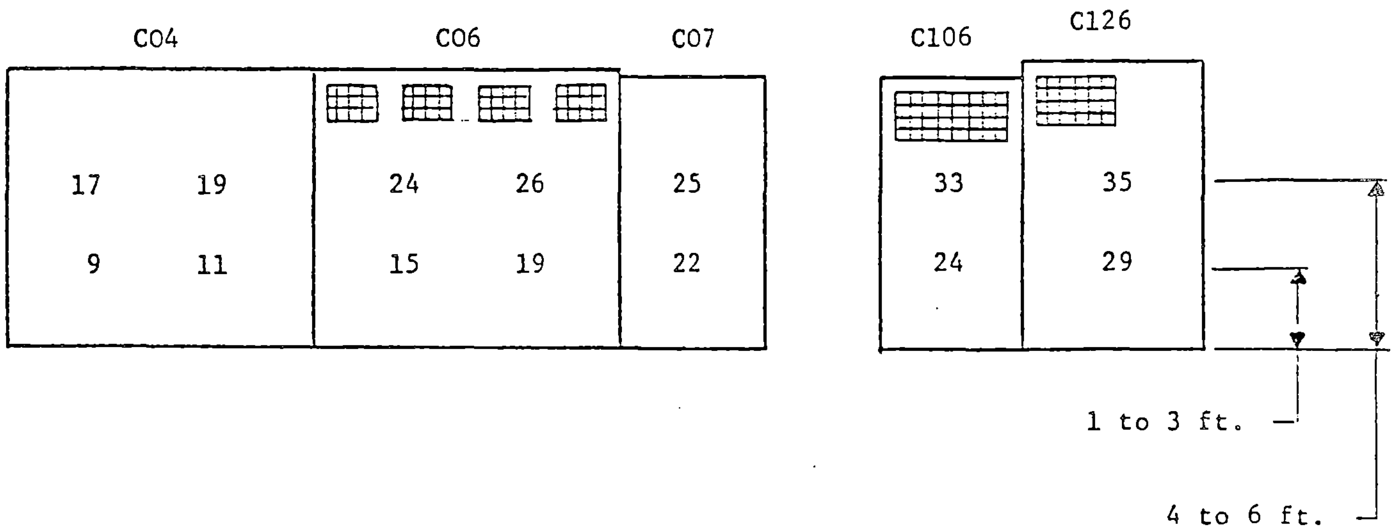
ILLUMINATION LEVELS (FOOTCANDLES) ON NEAR HORIZONTAL SURFACES

FIGURE C-3

FRONT OF BACKPANEL

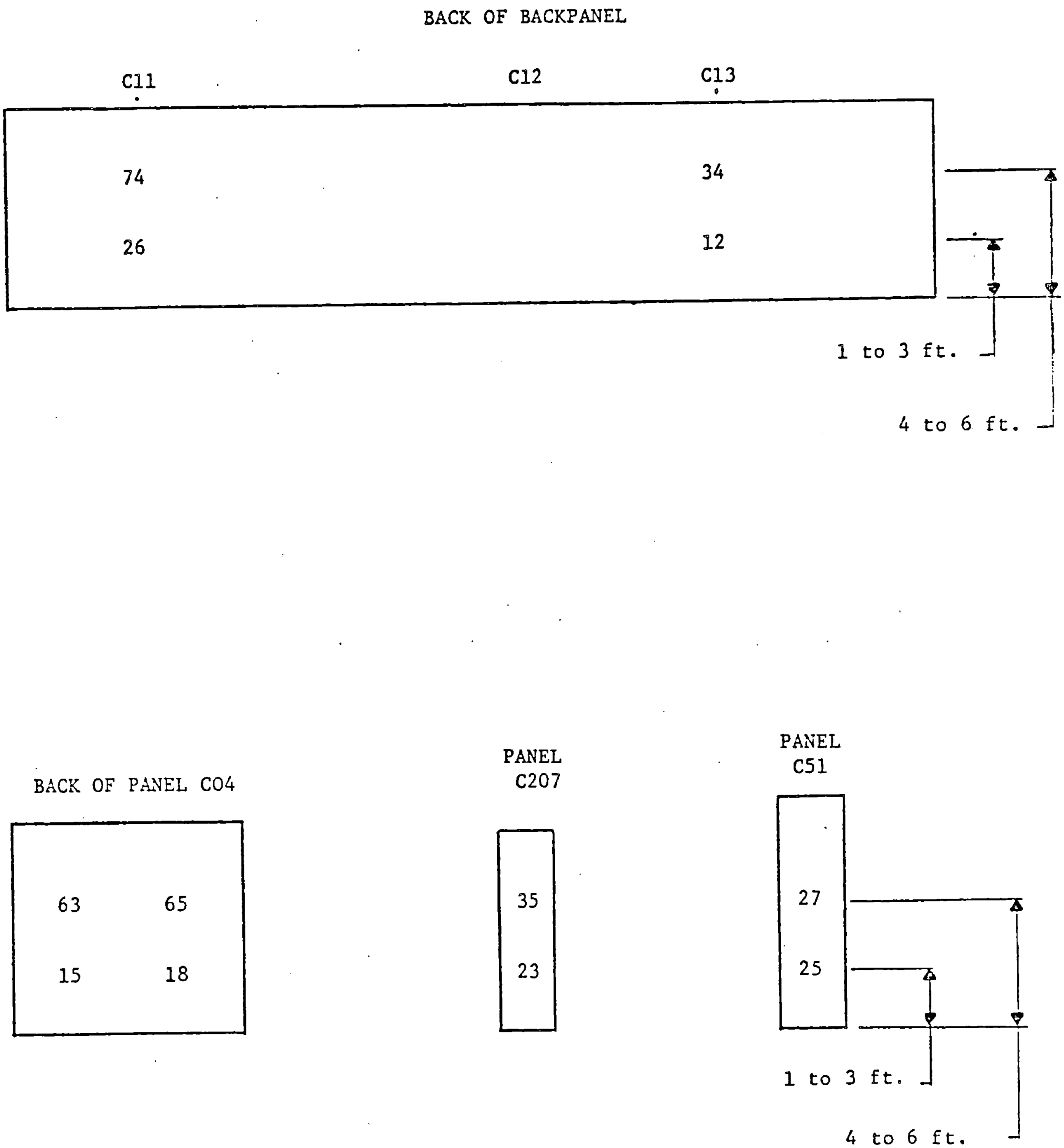


FRONT OF SIDE PANELS



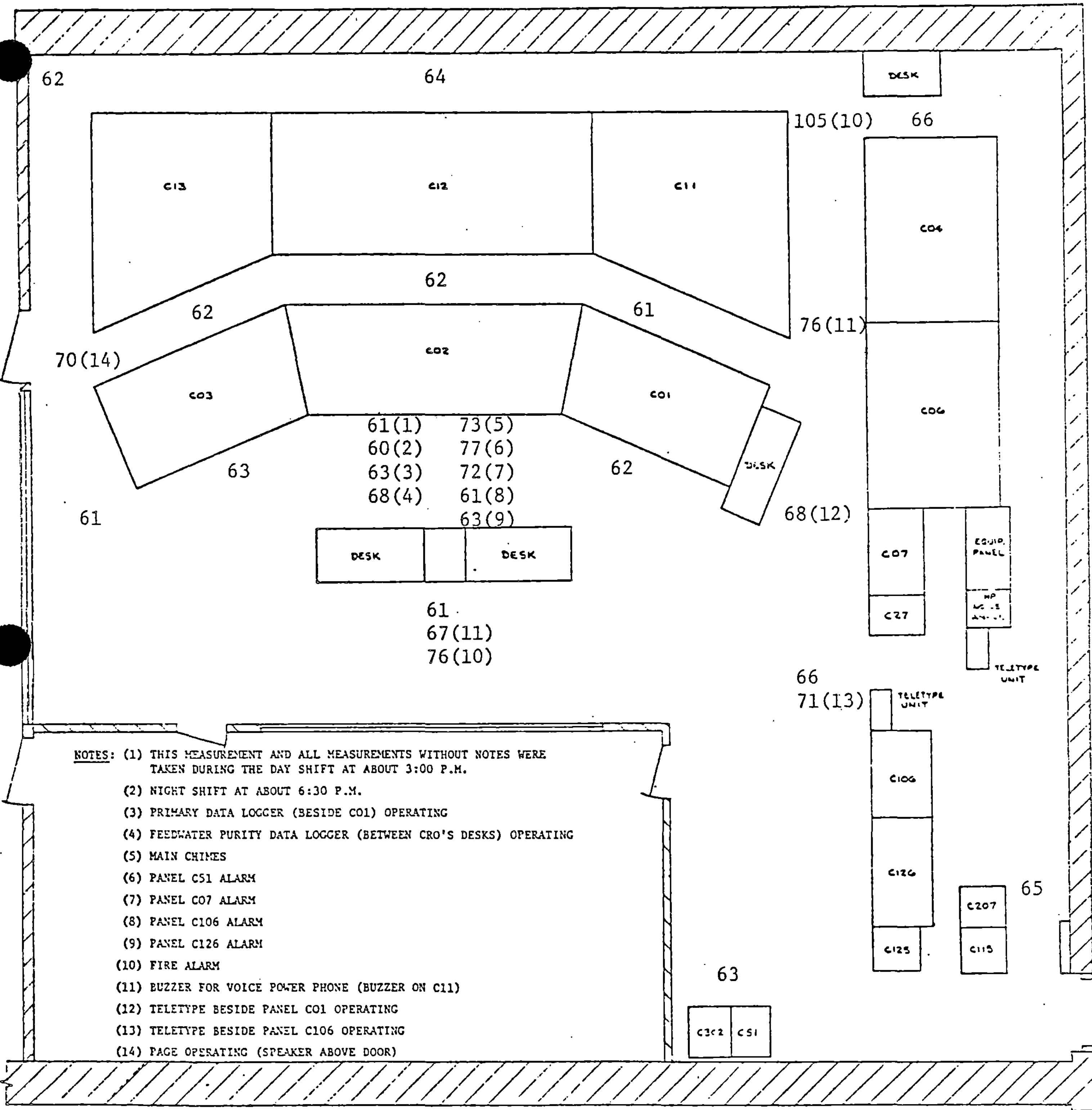
ILLUMINATION LEVELS (FOOTCANDLES) ON VERTICAL SURFACES

FIGURE C-4



ILLUMINATION LEVELS (FOOTCANDLES) ON VERTICAL SURFACES

FIGURE C-4



NOTES: (1) THIS MEASUREMENT AND ALL MEASUREMENTS WITHOUT NOTES WERE TAKEN DURING THE DAY SHIFT AT ABOUT 3:00 P.M.

(2) NIGHT SHIFT AT ABOUT 6:30 P.M.

(3) PRIMARY DATA LOGGER (BESIDE C01) OPERATING

(4) FEEDWATER PURITY DATA LOGGER (BETWEEN CRO'S DESKS) OPERATING

(5) MAIN CHIMES

(6) PANEL C51 ALARM

(7) PANEL C07 ALARM

(8) PANEL C106 ALARM

(9) PANEL C126 ALARM

(10) FIRE ALARM

(11) BUZZER FOR VOICE POWER PHONE (BUZZER ON C11)

(12) TELETYPE BESIDE PANEL C01 OPERATING

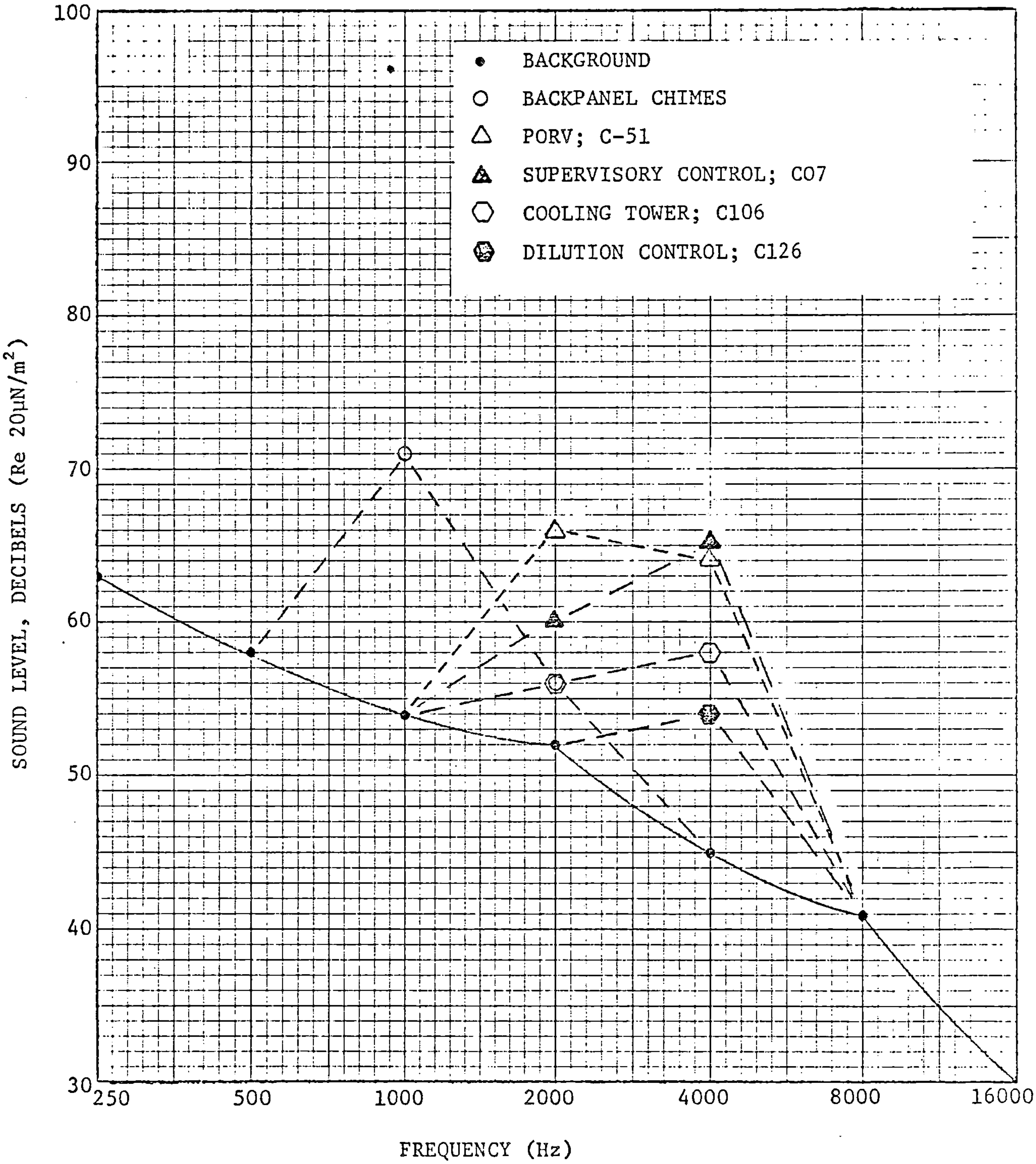
(13) TELETYPE BESIDE PANEL C106 OPERATING

(14) PAGE OPERATING (SPEAKER ABOVE DOOR)

1 0 1 2 3 4 5 Ft.
SCALE

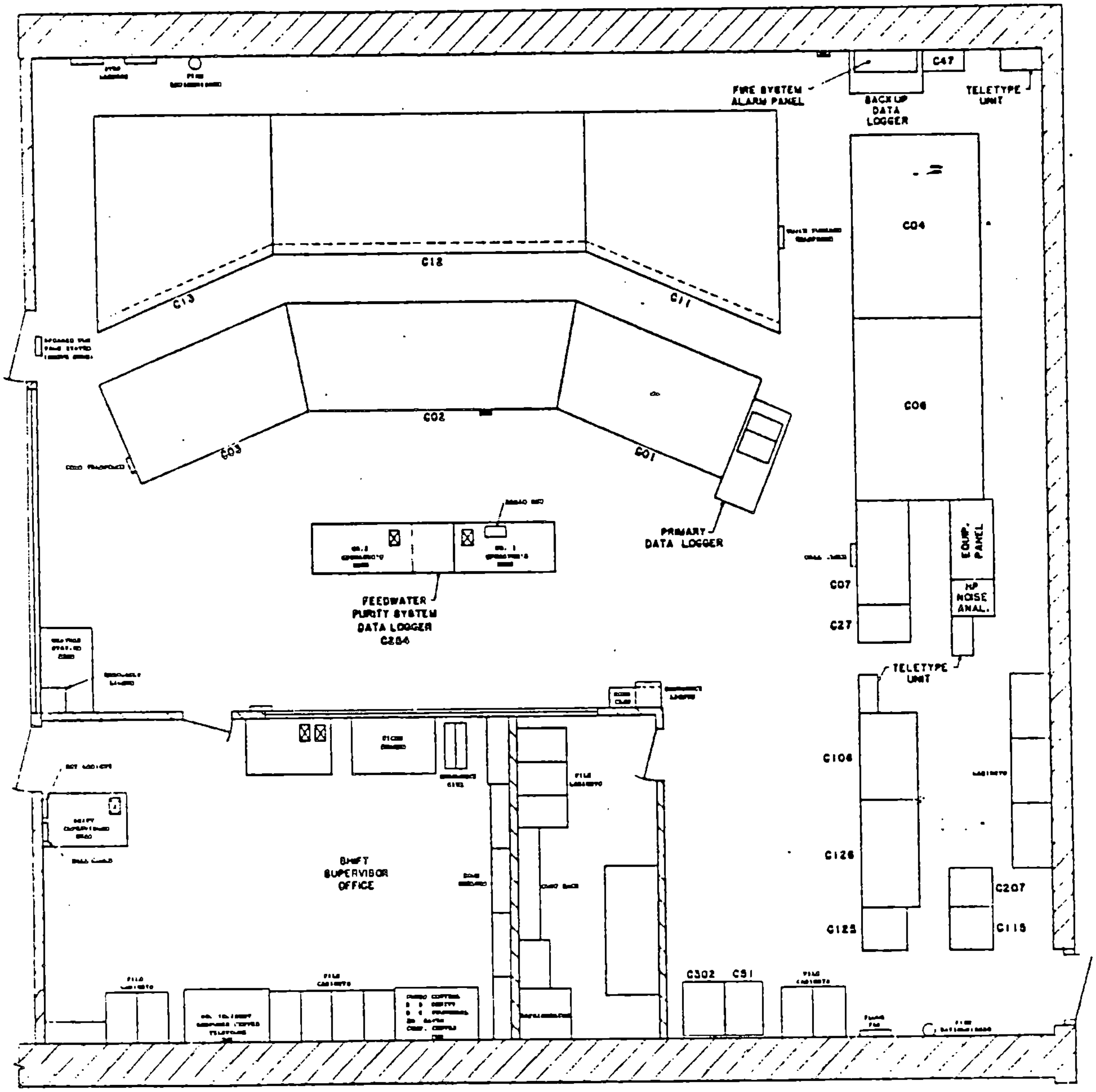
SOUND LEVEL MEASUREMENTS
A-WEIGHTED (dBA)

FIGURE C-5



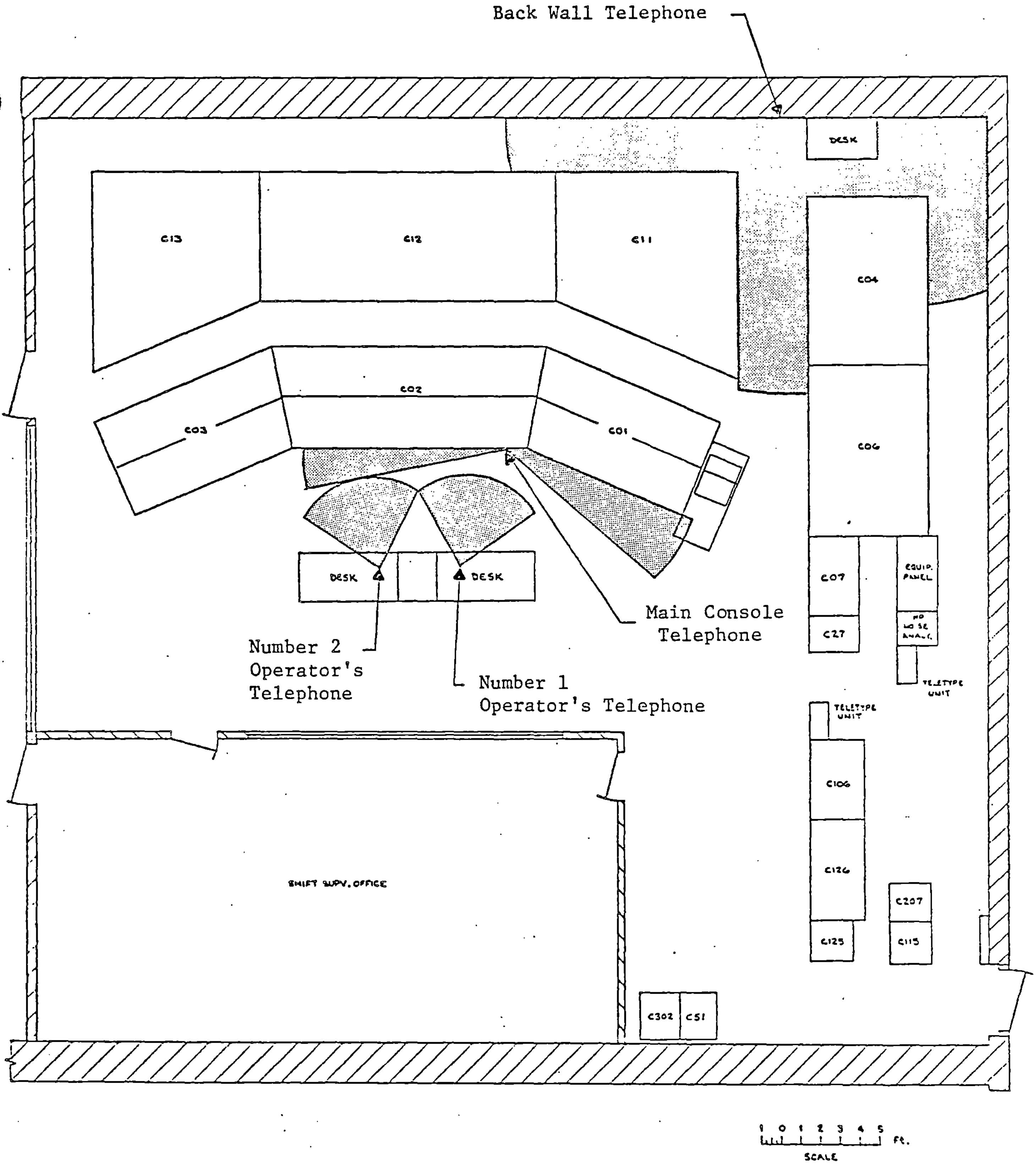
OCTAVE BAND ANALYSIS FOR ANNUNCIATOR ALARMS

FIGURE C-6



PALISADES CONTROL ROOM

FIGURE C-7



EXTENSION OF TELEPHONE CORDS IN PALISADES CONTROL ROOM

FIGURE C-8

APPENDIX D

REVIEW OF REMOTE SHUTDOWN PANEL

I. INTRODUCTION

As stated in the Palisades FSAR, it is intended that the operators have the capability to bring the plant from operating at power to cold shutdown even if the control room is inaccessible. To this end the plant incorporates a special, remote shutdown panel (C-33). The panel is located inside the controlled access area in conjunction with panels which are part of the radwaste system (C-40).

This remote shutdown panel was reviewed as part of the detailed control room review. The results are presented in this appendix. Two different reviews were performed:

- The governing procedure for use of the panel (EDP-10) was used to walk-through with a control room operator the actions involved in using the C-13 panel. The results of this review are reported in Section II of this appendix.

- The panel was reviewed against the human factors guidelines used to review the control room, i.e., Appendix A. The results of this review are reported in Section III of this appendix.

In addition to the C-33 panel, which was reviewed as part of the detailed control room design review, Palisades has recently installed another panel (C-150) to meet the 10CFR50 Appendix R requirements for an Alternate Shutdown Panel. With incorporation of the C-150 panel into the plant design, the C-33 panel is relegated to lesser status and will no longer be the primary control station for performing shutdown evolutions in the event the control room has to be

evacuated. Due to the recent incorporation of the C-150 panel into the plant, the control room design review team was not able to perform a human factors review of this panel in time to support submittal of this report. A review of the C-150 panel against the human factors guidelines of Appendix A will be performed. This review will be completed by the end of 1986. Modifications to the C-150 panel to correct noted human factors deficiencies evaluated as requiring correction will be performed on a schedule consistent with other human factors modifications as identified in this report.

II. REVIEW BASED ON PROCEDURE WALK-THROUGH

The method used in this walk-through was to follow the operator as he explained how he would perform the various steps in the governing procedure (EOP-10) either at Panel C-33 or at other locations within the plant, as appropriate. No particular assumption as to the reason for the evacuation of the control room was made. It was assumed that the operator was unable to do anything before leaving the control room. This is unlikely, but should provide an upper bound to the number of operations which would have to be performed at Panel C-33 or elsewhere in the plant.

The remote shutdown operation tends to divide naturally into two phases: first, the reactor must be tripped and the plant put in a stable (but still hot) condition, and second, the plant must be brought to a cold shutdown condition. It appears that the first phase deserves much greater emphasis than the second; primarily because the potential to actually perform this operation is significantly higher and because the operator has less freedom to control the pace of the operation. It is unlikely that the control room would be unaccessible for so long that it would be necessary to bring the plant to cold shutdown without re-entry to the control room.

The findings discussed below are also presented in Table D-1. This table summarizes the results of assessing these findings and the action taken or planned to correct those findings requiring action. The format of this table is similar to that used in the main report Section VI.

A. General Findings

1. No significant operations required by the governing procedure were found to be impossible.

2. The governing procedure does not provide any guidance for responding to the possible initiation of safety injection in the course of the shutdown. Many controls and displays related to safety injection are provided; however, no procedure covers their use concurrent with the use of the remote shutdown panel. The operator participating in the walk-through indicated that at Palisades the inadvertent actuation of safety injection during a trip is not unexpected and has occurred on occasion.

B. Specific Findings

The following are specific findings developed in the course of the walk-through.

1. In order to prevent inadvertent or unauthorized actuation of controls on C-33, the panel is covered by a locked, clear-plastic cover. It appears to be adequate for this purpose. The key to this cover is in the Shift Supervisors' office; in addition, each Shift Supervisor has a master key which would fit the lock. The cover is constructed in two halves which overlap and slide sideways. There is clear access to only one side of the panel at a time. The cover is not particularly sturdy and it appears that the operators

probably could forcibly remove it to get access to the entire face of the panel.

2. The C-33 area includes a single telephone at a nearby desk, which is used normally by auxiliary operators. The page system is clearly audible at the C-33 panel. The single telephone on the operators' desk and any radios the operators may have brought with them from the control room would be the only sources of communication. There is a sound powered telephone jack; however, the operator pointed out that this does not go to areas which are particularly useful. There was also no head phone set for the sound powered phone in the area. The telephone number of the telephone on the desk did not appear in the plant telephone list. It would not be practical for the operator to use the telephone and to monitor the displays on the C-33 panel at the same time -- the desk is too far away.

   Since the use of the remote shutdown panel requires communication throughout various areas of the plant, a single telephone appears to be inadequate, particularly since its use requires the operator to leave his station in front of the C-33 panel.

3. The auxiliary operators' desk at C-33 was supplied with a current set of operating procedures, P&IDs and major electrical single-line diagrams. These apparently were not an officially controlled set. No copy of the technical specifications was

provided nor were there copies of other reference material normally available in the control room. There were some P&IDs posted (in plastic covers) on the passage wall opposite the C-33 panel. The operator indicated that these may be out of date and would not normally be used.

4. The C-33 panel is located in a relatively narrow passageway. The narrowness of the passage makes it difficult to accommodate more than one or two persons in front of the panel at one time. There is also a door which opens into the area and which can disrupt operations if opened suddenly or if held open, particularly if the operator in front of the panel were trying to communicate with another operator at the auxiliary operators' desk, since the door blocks their line-of-sight when it is open. Although the area is awkward, it appears that the required operations can be performed.

5. The control switches on the C-33 panel are not equivalent to those in the control room. Each control switch on C-33 has a designated position (marked with a piece of red "Dymo" tape). When the switch on C-33 is in that position the switch in the control room has control. For example, if the designated "red" position of a valve control switch on C-33 is "close", when the switch on C-33 is in that position, the control switch in the control room can both open and close the valve. Irrespective of the position of the control room switch the valve can be opened by moving the switch on C-33 to "open" (the "non-red" position).

Note that the switch on C-33 may not be able to both open and close a particular valve. It depends on the position of the control switch in the control room. Consider the example previously given. If the control room switch were left in the "open" position, it would not be possible to close the valve from C-33. Placing the C-33 switch to "close" actually only transfers control to the control room switch which is in the "open" position and, therefore, the valve cannot be closed.

No specific cases were identified where this control scheme would result in problems; however, as discussed previously, control of safety injection and recovery from inadvertent actuation were not covered by the plant procedure and were not included in the walk-through.

Finally, the newly installed and relabeled flow controllers (four on each side of the panel) have no "Dymo" tape or other indication of which position is required for control to be available in the main control room.

6. Because the panel is very seldom manned, it appears there is considerable likelihood of burned out indicating lights going unnoticed and uncorrected. As discussed in Item 5, because the switch position and the lights may not match and because the operator may or may not be able to

cycle a valve, the functioning of the indicating lights on C-33 is especially important.

7. There are several key-lock switches on the C-33 panel. The keys were in these switches. Since the panel is covered and locked when not in use, it is not clear why key-locked switches are necessary. If not needed, the key-locked feature should be eliminated, since it introduces a potential way for a control to be inoperable.

8. The emergency lighting in the area of C-33 was not reviewed. There appeared to be an emergency incandescent light in the area of the auxiliary operators desk; however, it is unlikely that it will provide any significant illumination to the front of C-33. There are no battery powered emergency light units (battle lanterns). There was also no working flashlight in the desk.

9. The C-33 panel has only a wide range cold leg temperature. There is no indication of hot leg temperature nor is there any alternate source of this information, e.g., the core outlet thermocouples which are available in the control room. The operator needs hot leg temperature to confirm proper natural circulation temperature differences and to assure an adequate saturation margin.

10. Only narrow range steam generator level is indicated on the C-33 panel. During the evacuation of the control room and plant shutdown using the C-33 panel, the steam generator level could fall below

the normal range. Although this may be acceptable, if the operator had no wide range indication he would have to assume the worst as to the steam generator level, i.e., that the steam generator was dry. That is, the operator might be forced to assume he has a problem when, in fact he does not, thereby diverting his attention from his possible real problems.

11. The new auxiliary feedwater controllers apparently indicate demanded valve position. The display has 0% meaning "open," on the left and 100% meaning "closed," on the right. On the other hand, the manual pushbutton "open" is on the right and "closed" is on the left. Therefore, pushing the right "open" button results in the indicator moving to the left and vice versa.

12. In the course of the walk-through a fairly frequent source of confusion or hesitation on the part of the operator was his need to decide where a control function was to be performed. The procedure seldom gave the operator guidance as to where the control was to be accomplished, e.g., at C-33, in the cable spreading room, locally at a breaker, or locally at the component.

13. The panel includes meters and switches which are both very high and very low on the panel. In conjunction with the limited space at the panel this makes some operations awkward and some meters difficult to read accurately. However, no operations were identified which were clearly not capable of being performed.

III. REVIEW BASED ON COMPARISON TO DETAILED HUMAN FACTORS GUIDELINES (APPENDIX A)

This section reports the results of a comparison of the controls and displays on C-33 to the human factors guidelines which were used for the main control room (Appendix A). The results are summarized in tabular form in Tables D-1 through D-4. These tables summarize the results of assessing these findings and the action taken or planned to correct those findings requiring action. The format of these tables is similar to that used in the main report Section VI.

A. General Guidelines

1. Location

Controls on the remote shutdown panel do not have an apparent or consistent relationship to their related displays. The displays are in a horizontal row across the top of the panel, split into two halves apparently for electrical separation. The only way to associate controls and displays is by reading the label plates.

2. Operational Status

In general, when a valve is actuated, the operator receives feedback on the actual position of the valve. There are, however, several exceptions where the feedback given is apparently demanded position and not actual position. The controls

that do not have actual position feedback are identified on Table D-2.

3. Normal -- Off-Normal Codes

Normal and off-normal positions for controls on the C-33 panel are discussed in Section II.B.5, above.

4. Detection of Non-Functional Controls and Displays

The two Sigma meters added during the 1983 refueling outage remain "as-is" upon loss of power. These meters include small green power-on lights to show when power is lost. This is opposite to the usual meaning of green on the panel. There is also no way to tell easily from a distance whether a Sigma meter is "new" or "old" (the old meters fail down scale and have no green lights).

More generally, use of this C-33 remote shutdown panel is intended when the main control room has been evacuated because of an emergency. Depending on the nature of the emergency (e.g., a fire in the cable spreading room below the main control room), one or more power sources may be inoperative. Knowledge of which power sources are available and which groups of instruments and components are powered may be crucial for the operator to decide whether control from C-33 is possible. The existing individual indicating lights may not provide adequate information

because some are often burned out, as discussed in Section II.B.6 above, and because the position indicating lights for some valves may be powered by a different electrical source than the valves themselves.

5. Communications

An evaluation of communications was performed as part of the procedure walk-through. Results are discussed in Section II.B.2, above.

6. Difficulty of Operator Tasks

The difficulty of operator tasks was evaluated during the remote shutdown panel walk-throughs. The results are presented in Sections II.A.1, II.A.2, II.B.12, II.B.13, above.

7. Functional Labeling of Control Panel Sections

There is some grouping of controls on the remote shutdown panel; however, there is no labeling to distinguish the related groups of controls.

B. Controls

1. Location

The alphabetic progression of some controls is right-to-left, which is not consistent with the progression of the majority of groups of controls and with the preferred stereotype. The controls

which do not have the typical progression are identified on Table D-3.

Most controls on the left half on C-33 have corresponding controls in the same relative position on the right half of C-33. For example, the left uppermost control on the left half is the flow controller for AUX FW FLOW P-8A/B the left uppermost control on the right half is AUX FW FLOW P-8C. In some cases, however, the "paired" control on the right half of the panel is not located in its expected place. In addition, certain progressions of controls within each half of the panel are not as expected. These instances are also tabulated in Table D-3.

Finally, some controls are awkward to operate because they are located low on the panel, as discussed in Section II.B.13, above.

2. Operation

The controls are the same types as used in the main control room and, therefore, no operational difficulties would be expected.

The handle is broken off of the control for safety injection valve MO-3011. There are 14 other controls which have the same design handle, but which are not broken.

3. Type

Only valve controls are located on C-33 (no pumps or breakers). The types of controls used are consistent with the valve controls in the main control room.

4. Protection

The controls are adequately separated and protected to prevent inadvertent actuation. During day-to-day operations, the controls are protected by a plastic cover. Nine of the controls on the panel are key operated. However, the keys are left in the controls at all times. Use of the key-operated control presents a risk that a key will not be in the control when needed. Since the controls are adequately protected by the plastic cover, it is not evident why key-locked controls are needed. For further discussion of the item, see Section II.B.7, above.

5. Identification

The C-33 panel labels are typically black labels with white letters, similar to those which were used on the main control room panels prior to relabeling. Because functional group labels are not used, each individual label tends to be wordy and hard to read. In general, the wording on the labels on C-33 are not identical with the control room labels for the corresponding controls on the main panels.

The following specific label deficiences are also noted:

- The label for one of the two steam dump controllers reads "HIC 0781B, Operates CV-0779 & CV-0781." The other steam dump controller has a similar label. There is no indication of the function of these controllers.

- "Dymo" tape is used to identify the control position necessary to control the element from the control room. "Dymo" tape is generally not considered to be a "permanent" labeling method. See II.B.5.

6. Maintenance

The controls on C-33 are the same type as in the main control room. Operators report no problems with maintenance of these controls, either in the main control room or on C-33.

C. Displays

1. Location

There are 22 displays in a horizontal row at the top of the panel, 11 above each half of the control panel. In general, there is no relation between the display and the associated control.

The numerical and alphabetic progression of

displays is satisfactory with one exception. The displays above the left half of the panel include the East Engineered Safeguards Room radiation indication and the West Safety Injection Sump Room Level indication while the right half of the panels includes the West Engineered Safeguards Room radiation indication and the East Safety Injection Sump Room Level indication. Normal (map-like) conventions would put both East displays on the right and both West displays on the left.

Finally, the displays are located high on the panel, as discussed in Section II.B.13, above.

2. Scales

Meter scales were acceptable except that:

° On displays integral with some controllers, there is no label or indicated units on the scale for demanded position from the controller. The controllers are as follows:

(1) Shutdown cooling heat exchanger bypass valves CV-3025 and CV-3006 (two controllers),

(2) HIC for CV-0779 and CV-0781 (one controller), and

(3) HIC for CV-0780 and CV-0782 (one controller).

- The scales for steam generator level are in percent; however, the scales for auxiliary feed are in flow rate (gpm). These are not consistent units.

3. Identification

Displays are identified with the same type of labels as the controls and have similar deficiencies, as discussed above. A number of specific labeling inaccuracies on the displays are noted in Table D-4.

In addition, legend plates are located under the displays, which are located across the top part of the panel. This is not the normal convention for displays in the main control room. The label plate positions are such that the plates are clearly readable.

4. Type

Consistent types of displays are used, and the type of displays are appropriate for their intended use.

5. Maintenance

Operators report no problems with maintenance of the displays, and since the displays are the same type as in the main control room, none is expected.

TABLE D-1

REVIEW OF REMOTE SHUTDOWN PANEL C-33 -- SUMMARY OF FINDINGS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
Human factors review of the C-150 alternate shutdown panel was not performed.	I	Complete a review of the C-150 panel against the Appendix A human factors guidelines.	A2	12/86
The governing procedure does not provide any guidance for responding to the possible initiation of safety injection in the course of the shutdown. Many controls and displays related to safety injection are provided; however, no procedure covers their use concurrent with the use of the remote shutdown panel. The operator participating in the walkthrough indicated that at Palisades the inadvertent actuation of safety injection during a trip is not unexpected and has occurred on occasion.	II.A.2	The procedure for "control room evacuation" (EOP-10) will be modified to cover the possible actuation of safety injection in the course of the reactor trip. The procedure will include bypassing SI while cooling down, and overriding SI when initiated. Both of these actions can be accomplished by opening breakers at the Y-20 and Y-30 buses, in the cable spreading room.	A2	1987 outage
In order to prevent inadvertent or unauthorized actuation of controls on C-33, the panel is covered by a locked clear plastic cover. The cover is constructed in two halves which overlap and slide sideways. There is clear access to only one side of the panel at a time.	II.B.1	The cover design will be modified so that it can be completely removed and the operators can have access to the entire panel.	A2	1988 outage
The C-33 area includes a single telephone at a nearby desk, which is used normally by auxiliary operators. It would not be practical for the operator to use the telephone and to monitor the displays on the C-33 panel at the same time because the desk is too far away. Since the use of the remote shutdown panel requires communication throughout various areas of the plant, a single telephone appears to be inadequate, particularly since its use requires the operator to leave his station in front of the C-33 panel.	II.B.2	A longer telephone cord has been installed which allows an operator at the panel to use the desk phone. Remote, two-way radios ("walkie-talkies") are expected to be the primary means of communication between remote panel C-33 and other plant locations; consequently, additional telephones for the area are not essential.	D	D

TABLE D-1

REVIEW OF REMOTE SHUTDOWN PANEL C-33 -- SUMMARY OF FINDINGS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
The telephone number of the telephone on the desk did not appear in the plant telephone list.	II.B.2	The telephone number for the phone will be added to the plant telephone listing.	A1	12/86
The auxiliary operators' desk at C-33 was supplied with a current set of operating procedures, P&ID's and major electrical single-line diagrams. These apparently were not an officially controlled set.	II.B.3	Controlled copies of the operating procedures, P&ID's, and electrical single-line diagrams are now available at the C-33 panel.	D	D
There were some P&ID's posted (in plastic covers) on the passage wall opposite the C-33 panel. The operator indicated that these may be out of date and would not normally be used.	II.B.3	Posted P&ID's are now controlled copies.	D	D
The C-33 panel is located in a relatively narrow passageway. Required actions can be performed, but movement of more than one or two persons in front of the panel at one time is awkward. There is a door which opens into the area and which can disrupt operations if it is opened suddenly or if held open, particularly if the operator in front of the panel was trying to communicate with another operator at the auxiliary operators' desk, since the door blocks their line-of-sight when it is open.	II.B.4	Use of the C-33 panel has been integrated with the other remote shutdown panel, C-150. The Station Shift Supervisor and most operators would be at C-150 if the control room were evacuated; consequently, overcrowding at C-33 should not be a problem. Changing the direction of swing of the door to open into the hallway was considered and rejected since the design of the HVAC system results in a higher ambient air pressure at the C-33 panel than in the adjacent hallway; changing the door to open into the hallway would pose a personnel safety hazard.	B2	D

TABLE D-1

REVIEW OF REMOTE SHUTDOWN PANEL C-33 -- SUMMARY OF FINDINGS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
The control switches on the C-33 panel are not equivalent to those in the control room. The control switch positions and lights may be mismatched and the ability to position valves depends, in part, on the switch position in the control room.	II.B.5	As part of the relabeling of the panel, a caution label will be added to remind the operator of the switch characteristics. Training on this characteristic is being performed on the Palisades simulator.	A1	1987 outage
With the exceptions noted below, each control switch on C-33 has a designated position (marked with a piece of red "Dymo" tape). When the switch on C-33 is in that position the switch in the control room has control.	II.B.5	The current temporary Dymo tape strips which indicate the position for control room control will be replaced by black dots similar to those in the control room.	A1	1988 outage
The newly installed and relabeled auxiliary feedwater flow controllers (4 on each side of the panel) have no "Dymo" tape or other indication of which position is required for control to be available in the main control room.	II.B.5	Black dots will be added to the new flow controllers to indicate which position is required for control to be available in the main control room.	A1	1988 outage
Because the panel is seldom manned, there is a considerable likelihood of burned out indicating lights going unnoticed and uncorrected.	II.B.6	Auxiliary operators are trained to replace burned out bulbs at the C-33 panel and perform this task frequently. Operations considers this practice to be acceptable; therefore, no other action is required.	NAR	NA
There are several key-lock switches on the C-33 panel. The keys were in these switches. Since the panel is covered and locked when not in use, it is not clear why key-locked switches are necessary.	II.B.7	There is no reason for anyone to borrow these keys because they do not fit anywhere else. Also, the keys are located behind locked doors. The likelihood of the keys not being available, therefore, is very remote. Eliminating the key-locked controls is not considered essential.	NAR	NA

TABLE D-1

REVIEW OF REMOTE SHUTDOWN PANEL C-33 -- SUMMARY OF FINDINGS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
The C-33 panel has only a wide range cold leg temperature indicator. There is no indication of hot leg temperature nor is there any alternate source of this information, e.g., the core outlet thermocouples which are available in the control room. The operator needs hot leg temperature to confirm proper natural circulation temperature differences and to assure an adequate subcooling margin.	II.B.8	Use of the C-33 panel has been integrated with the other remote shutdown panel, C-150. Decisions based on information obtained from a wide range T_h indicator will not be made at C-33, and wide range T_h is available at the C-150 panel. Consequently, there is no need for a wide range T_h indicator at C-33.	NAR	NA
Only narrow range steam generator level is indicated on the C-33 panel. During the evacuation of the control room and plant shutdown using the C-33 panel, the steam generator level could fall below the normal range.	II.B.9	Use of the C-33 panel has been integrated with the other remote shutdown panel, C-150. Decisions based on information obtained from a wide range steam generator level indicator will not be made from C-33, and wide range steam generator level is available at the C-150 panel. Consequently, there is no need for a wide range steam generator level indicator at C-33.	NAR	NA
The new auxiliary feedwater controllers apparently have demanded valve position indication with 0% meaning "open," on the left and 100% meaning "closed," on the right. On the other hand, the manual pushbutton "open" is on the right and "closed" is on the left. Therefore, pushing the right "open" button results on the indicator moving to the left and vice versa.	II.B.11	Clarify with relabeling similar to the controllers on panel C-01.	A1	1987 outage
The "control room evacuation" procedure (EOP-10) seldom gave the operator guidance as to where the control was to be accomplished, e.g., at C-33, in the cable spreading room, locally at a breaker, or locally at the component.	II.B.12	Because of the unusual nature of this procedure, the operating procedure for the panel has been revised to specifically indicate where an action is to be accomplished.	D	D

TABLE D-1

REVIEW OF REMOTE SHUTDOWN PANEL C-33 -- SUMMARY OF FINDINGS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
The C-33 panel includes meters and switches which are both very high and very low on the panel.	II.B.13	The walkthroughs verified that all required operations could be performed. Moving the controls and displays to the ends of C-33 would make them more difficult to view without operator movement and would further complicate the construction of the protective cover. Relocation of controls and displays on C-33 is not considered necessary.	NAR	NA
Controls on the remote shutdown panel do not have an apparent or consistent relationship with their corresponding displays. The displays are in a horizontal row across the top of the panel, split into two halves apparently for fire and electrical separation. The only way to associate controls and displays is by reading the label plates.	III.A.1	Labels and demarcation will be added to improve the association of controls and displays.	B1	1988 outage
The two Sigma meters added during the 1983 refueling outage remain "as-is" upon loss of power. These meters include small green power-on lights to show when power is lost. This is opposite to the usual meaning of green on the panel. There is also no way to tell easily from a distance whether a Sigma meter is "new" or "old" (the old meters fail down scale and have no green lights).	III.A.4	Same as deficiency cited in main report Table VI-1, Section III.D.2.	EE	NA

TABLE D-1

REVIEW OF REMOTE SHUTDOWN PANEL C-33 -- SUMMARY OF FINDINGS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
Knowledge of which power sources are available and which groups of instruments and components are powered may be crucial for the operator to decide whether control from C-33 is possible. The existing individual indicating lights may not provide adequate information because some are often burned out, as discussed in Section I.C.6 above, and because the position indicating lights for some valves, for example, may be powered by a different electrical source than the valves themselves.	III.A.4	Use of the C-33 panel has been integrated with the other remote shutdown panel, C-150. Power supply considerations at C-33 are significantly reduced because C-150 is powered independently of the control room and C-33. Because of this additional power supply, indicators are not necessary at C-33.	NAR	NA
There is some grouping of controls on the remote shutdown panel; however, there is no labeling to distinguish the related group of controls.	III.A.7	Labels and demarcation to identify existing functional groups will be added.	B1	1988 outage
The handle is broken off the control for safety injection valve MO-3011.	III.B.2	The broken handle has been replaced. The breaking of the handle does not appear to be a generic problem; therefore, a different type of handle is not required.	D	D
The C-33 panel labels are typically black labels with white letters, similar to those used on the main control room panels prior to relabeling. Because the functional group labels are not used, each individual label tends to be wordy and hard to read. In general, the labels on C-33 are not identical with the labels for the corresponding controls on the main control room panels.	III.B.5	Relabeling and demarcation of panel C-33 will use labels which are more readable and which will be consistent with those in the main control room.	C1	1988 outage

TABLE D-1

REVIEW OF REMOTE SHUTDOWN PANEL C-33 -- SUMMARY OF FINDINGS

DEFICIENCY	SECTION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
The label for one of the two steam dump controllers reads "HIC 0781B, Operates CV-0779 & CV-0781." The other steam dump controller also has a similar label. There is no indication of the function of these controllers.	III.B.5	The labels will be revised.	A1	12/86
On displays integral with some controllers, there is no label or indicated units on the scale for demanded position from the controller. The controllers are as follows: 1. Shutdown cooling heat exchanger bypass valves CV-3025 and CV-3006 (two controllers). 2. HIC for CV-0779 and CV-0781 (one controller). 3. HIC for CV-0780 and CV-0782.	III.C.2	Existing scales are adequate and consistent with the practice in the main control room. The scale of 0 to 100 is in percent of valve position as on other controllers. These controllers should not be different from other controllers and, therefore, no changes are required.	NAR	NA
The scales for steam generator level (in percent) and for auxiliary feedwater (gpm) are not in consistent units.	III.C.2	The percent scales for the steam generators, as well as the gpm scales for feed flow are consistent with operator training and procedures. Therefore, the scales should not be changed and no action is required.	NAR	NA
Legend plates are located under the displays which is not the normal convention for displays in the main control room.	III.C.3	The labels are more readable in their existing locations because of the height of the meters. There is no potential for an error in reading the meters. It is concluded that labeling under the meters is preferred and, therefore, no change in label location should be made during panel relabeling.	NAR	NA

TABLE D-2

CONTROLS WHICH DO NOT HAVE ACTUAL VALVE POSITION INDICATED

	CONTROLS WITHOUT ACTUAL POSITION INDICATION	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
1.	Steam Generator Atmospheric Dump Valves CV-0779, CV-0780, CV-0781, and CV-0782	Operators rely on other parameters, e.g., PCS temperature and cooldown rate, to determine changes in ADV position; therefore, no action is required.	NAR	NA
2.	Shutdown Cooling HXS E-60A and B bypass CV-3008 and outlet CV-3025	Valve position indication is not available in either the control room, or on C-33. In both locations, the primary cooldown rate would indicate whether these valves are open or closed. No action is, therefore, required.	NAR	NA
3.	Auxiliary Feedwater Flow to SG E-50A and B (HIC-0749, HIC-0737A, HIC-0727, HIC-0736A), CV-0749, CV-0737A, CV-0727, and CV-0736A	Flow indication is available, so direct indication of valve position is not required.	NAR	NA

TABLE D-3

CONTROLS NOT LOCATED IN EXPECTED LOCATION OR NOT ARRANGED IN EXPECTED ORDER

	DEFICIENCY	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
1.	The controls for the 16 high and low pressure injection valves are duplicates of the controls located in the main control room. Some are located in an identical array to the control room controls; others are in different locations. Specifically, the following controls are not in the same location as in the main control room: MO-3011, MO-3013, MO-3081, MO-3083, MO-3066, MO-3068, MO-3080, and MO-3082.	Rearrange and relabel to match control room.	B2	1988 outage
2.	The C33 panel is divided into two halves. The expected left-to-right progression of controls is not followed in some cases, specifically: a. The handswitches for the HP Safety Injection Pumps Cold Water Inlet Valves (CV-3070 and CV-3071) -- The order from left-to-right is pumps B and C and then pump A. b. HP Safety Injection Pumps Discharge Isolation Valves (CV-3059 and CV-3037) -- The order from left-to-right is pumps B and C and then Pump A. c. Handswitches for the Component Cooling Heat Exchanger Service Water Outlet Valves (CV-0826 and CV-0823) -- The order from left-to-right is heat exchanger B then A. d. Handswitches for the Component Cooling Heat Exchanger Component Cooling Water Inlet Valves (CV-0946 and CV-0945) -- The order from left-to-right is heat exchanger B then A. e. Handswitches for the Containment Air Coolers Service Water Inlet and Outlet Valves -- Cooler 4 is to the left of coolers 1, 2, or 3.	These control locations are a direct consequence of the separation of the right and left channels and the components assigned to a particular channel. The arrangement matches the control room. No errors from this order would be expected.	NAR	NA

TABLE D-3

CONTROLS NOT LOCATED IN EXPECTED LOCATION OR NOT ARRANGED IN EXPECTED ORDER

	DEFICIENCY	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
3.	The Handswitches for Boric Acid Tanks Drain Valves (MO-2170 and MO-2169) -- The valve for tank B is to the left of the valve for tank A.	Exchange controls so A is on the left.	B2	1988 outage
4.	The Handswitches for the Containment Air Coolers Service Water Outlet Valves (CV-0873, CV-0864, and CV-0861) -- The order of the heat exchangers from left-to-right is 3-2-1. Immediately above these controls the inlet valves are arranged left-to-right 1-2-3.	Exchange controls for 1 and 3 so that the order is 1-2-3 from left. Order of controls in the main control room in 1-2-3 from left-to-right.	B2	1988 outage
5.	The controllers for Auxiliary Feedwater Flow (HIC-0727 and HIC-0749 for P-8A&B, and HIC-0736A and HIC-0737A for P-8C) -- The controllers are located so that the controller for steam generator B is above the controller for steam generator A.	Relabel to emphasize A and B. Location of controllers will remain as is to correspond to location of associated displays.	B1	1988 outage
6.	The Handswitches for the Engineered Safeguards Room Isolation Dampers (CV-1810 and CV-1817 for the East Room and CV-1811 and CV-1813 for the West Room -- The East room control is on the left; the normal (map-like) order would put the West room on the left.	Control locations are a direct consequence of the separation of right and left channels and components assigned to a particular channel. The arrangement matches the main control room. No errors from the order would be expected.	NAR	NA
7.	The Handswitch for the Shutdown Cooling Return Valves (MO-3015 and MO-3016) -- Valve MO-3016 is located at the extreme left of a row; MO-3015 is not.	Rearrange, relabel, and demarcate. See items 3 and 8.	B2	1988 outage
8.	On the right half of C33, the service water outlet valves for the containment air coolers are located directly under the inlet valves. On the left half, the outlet for cooler 4 is not located under the inlet.	Rearrange, relabel, and demarcate to connect the inlet and outlet. See items 3 and 7.	B2	1988 outage

TABLE D-4

INACCURATE LABELS ON DISPLAYS

CONTROL LABEL	PROBLEM/COMMENT	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
HPSI Loop 1A FI-0308B Flow Thru MO-3007	Flow Indicator FI-0308B actually measures combined flow through MO-3007 and MO-3068.	Relabel.	B1	1988 outage
HPSI Loop 1B FI-0310B Flow Thru MO-3009	Flow Indicator FI-0310B actually measures combined flow through MO-3009 and MO-3066.	Relabel.	B1	1988 outage
HPSI Loop 2A FI-0312B Flow Thru MO-3011	Flow Indicator FI-0312B actually measures combined flow through MO-3011 and MO-3064.	Relabel.	B1	1988 outage
HPSI Loop 2B FI-0313B Flow Thru MO-3013	Flow Indicator FI-0313B actually measures combined flow through MO-3013 and MO-3062.	Relabel.	B1	1988 outage

APPENDIX E

RESUMES OF

HUMAN FACTORS REVIEW TEAM

The resumes for the following individuals were included as Appendix B to the Palisades Control Room Review Program Plan (Reference 1) and they will not be repeated in this report:

R. R. Biggs
K. A. Toner
R. L. Muzzi
W. S. Skibitsky
T. B. Sheridan
H. Estrada
D. H. Harrison
J. L. Hibbard
A. Zarechnak

The resumes for the following individuals are included in this Appendix:

R. M. Hamm
C. S. Kozup
C. S. Schlaseman

ROBERT M. HAMM

Business Address:	Consumers Power Company Palisades Nuclear Plant Rt 2, Box 154 Covert, Michigan 49043
Education and Training:	Basic Electronics School, United States Marine Corps, San Diego, CA - 3 Months (1964) Teletype Repair Course, United States Marine Corps, San Diego, CA - 3 Months (1964) Crypto Repair Course, United States Marine Corps, Vallejo, CA - 1 Month (1964) Bachelor of Science in Electrical Engineering, University of Illinois (Chicago Circle) (1972) Reactor Physics and Reactor Dynamics, Bettis Reactor Engineering School, West Mifflin, PA - 80 Hours (1973) Nuclear Power Engineering School, Naval Reactor Idaho Falls, ID - 6 Months (1974) Sensor Response Time Testing in Nuclear Power Plants, University of Tennessee, Knoxville, TN - 1 Week (1977) Fundamentals of a Seismic Qualification Program, NATLSCO Corp - 1 Week (1978) EPRI Seminar, "Human Factors in the Control Room", Palo Alto, CA - 3 Days (1980) Babcock & Wilcox Nuclear Power Plant Simulator, Lynchburg, VA - 1 Week (1980)

INPO Workshop, "Control Room Evaluations," Atlanta, GA - 3 Days (1980)

Engineering Economics, Consumers Power Company, Jackson, MI - 1 Week (1981)

Biotechnology Inc. Seminar, "Practical Human Factors for Nuclear Power Plant Evaluation and Improvement," Jackson, MI - 3 days (1982)

Palisades Operations Familiarization (Simulator) Midland, MI - 1 Week (1984)

Experience: Electronics Technician, United States Marine Corps (1963-1967).

Nuclear Safety Engineer: Bettis Atomic Power Laboratory. Evaluated transient response of pressurized water reactors for accident and normal operating conditions utilizing both digital and analog computational methods. Developed an analog computer model of a Light Water Breeder Reactor for use in analyzing plant response to routine load changes and as a training aid for plant operations personnel. (1972-1974)

Reactor Plant Test Engineering: Bettis Atomic Power Laboratory. Provided on-site technical assistance as the reactor plant contractor's field representative during shipyard refueling and overhaul of nuclear submarines. Determined system test requirements following maintenance on reactor plant components. Reviewed and approved reactor plant test procedures prior to performance. Closely followed the status of testing in progress, and reviewed and approved completed test procedure data. Acted as liaison between the shipyard and the reactor plant contractor in the resolution of

problems experienced during maintenance, testing and operation of the reactor plant. (1975-1976)

Reactor Plant Plant Operations Engineer: Consumers Power Company. Responsible for developing test abstracts and descriptions of the startup test program for incorporation into the Midland Final Safety Analysis Report. Reviewed engineering documentation related to the Instrumentation and Controls design of a PWR and made recommendations concerning the acceptability of the design. Reviewed operating procedures against design information to ensure technical accuracy. (1977-1978)

Midland Plant Project Engineering: Consumers Power Company. Responsible for design, modifications and licensing of PWR Instrumentation and Control Systems. Provided functional specifications for replacement of plant computer system to meet new licensing requirements. Developed and implemented a Safety Parameter Display System on the plant computer system. Managed the Control Room Design Review. Responsible for interfacing with the Nuclear Regulatory Commission on matters related to instrumentation and controls and human factors engineering. (1979-1984)

Palisades Project Engineering: Consumers Power Company. Responsible for coordination of NUREG 0737 Supplement 1 Items including regulatory guide 1.97, Control Room Design Review and Safety Parameter Display System.

CHARLES S. KOZUP

Business Address: Consumers Power Company
Palisades Nuclear Plant
Rt 2, Box 154
Covert, Michigan 49043

Education: BS Metallurgical Engineering, Cleveland State University - 1971

MS Metallurgical Engineering, University of Pittsburgh - 1980

Experience: Consumers Power Company - 1981 to Present

Operations Superintendent-Palisades - 1982
Directed activities of Operations Department which included the control room operators.

Shift Technical Advisor - Palisades - 1981
Provided Technical support of the operators in the control room.

Senior Plant Engineer - Westinghouse Electric Corporation
Idaho Falls - 1977-1981
Supervised operation, maintenance and training activities at reactor facilities.

Senior Engineer, Westinghouse Electric Corporation
Bettis Atomic Power Lab - 1973-1977
Provided technical follow of naval reactor core production.

Product Research Supervisor - Premier Industrial Corporation, Cleveland, Ohio - 1971-1973
Provided technical support in all product areas.

CAROLINE S. SCHLASEMAN

Business Address: MPR Associates, Inc.
1050 Connecticut Avenue, N.W.
Washington, D.C. 20036

Education: BS in Civil Engineering
Duke University - May 1981
(Magna Cum Laude)

Experience: 1981 - present -- MPR Associates, Inc. Analysis and problem solving of a variety of tasks related to nuclear and fossil-fueled electric generating stations. This work has included:

- Inspections and evaluation of material condition of auxiliary equipment in coal-fired generating stations as part of material condition/life extension study.

- Turbine water induction prevention study for coal-fired generating station. Researched reliability and maintainability of water induction related equipment through personnel interviews, inspections, and discussions with equipment vendors.

- Evaluation of proposed structural modifications to a large fossil-fueled boiler, to allow conversion from forced draft firing to balanced draft operation. Reviewed boiler vendor drawings and calculations, performed check calculations, discussed proposed modifications with vendor, and walked-down boiler.

- Development of structural inspection procedure for counterflow natural draft cooling towers.

- Finite element analysis of piping systems and components. Recommended hardware modifications as required by ASME Code criteria. Leak-before-break failure analysis for selected piping systems in a nuclear station.

- Participation in function and task analysis and detailed design review of a nuclear power plant control room.

- Evaluation of current design requirements for seismic flooding, tornado and other extreme external events, and the effect of these requirements on older, operating nuclear units.

1980 Summer -- Hayes, Seay, Mattern and Mattern - Reinforced concrete design of rectangular tanks, floor slabs and beams; prestressed concrete girder bridge design work.

<u>Honor Societies:</u> Chi Epsilon - National Civil Engineering

<u>Awards:</u> Graduated with Departmental Distinction - 1981 American Society of Civil Engineer's Prize - 1981

<u>Other:</u> North Carolina Engineer-in-Training Certification
Professional Engineering Registration - State of Virginia

APPENDIX F

FUNCTION AND TASK ANALYSIS OF EMERGENCY PROCEDURE GUIDELINES

I. PURPOSE

Section IV of the main report presented the operational findings and observations largely based on the results of procedure walk-throughs at the full scale control room mockup and at the Palisades simulator and a review of the control room design against the operators' responsibilities. In addition to this review, which is a type of function and task analysis, a detailed, more formal function and task analysis of emergency procedures was performed. This appendix reports the results of this detailed function and task analysis based on emergency procedure guidelines.

II. BACKGROUND AND INTRODUCTION

Consumers Power is revising the emergency operating procedures (EOPs). That effort is based on the generic emergency procedure guidelines (EPGs) developed by the Combustion Engineering Owner's Group, CEN-152 (Reference 2). These generic guidelines were used by Consumers Power to prepare a Palisades-specific set of EPGs and thereby provide reference for the upgraded EOPs. These Palisades-specific EPGs also provide the definition of functions which was used in a detailed function and task analysis of the emergency procedure guidelines.

This appendix first describes the methods used in the function and task analyses. This includes:

- A description of the basic function analysis.
- A description of the how the function analysis was used to define the individual tasks.
- A description of how the individual tasks were compared to the control room equipment and configuration.
- A description of how demonstrations on the Palisades simulator were used to confirm the ability to perform the tasks.

The appendix then summarizes major findings of the review, i.e., where the control room does not appear to support the operators in performing the tasks. These findings are presented in both discussion form and in the same tabular

format as other findings in the report, including the results of assessments and corrective actions.

The portion of the function and task analysis which established and defined the functions and the individual tasks was performed by an interdisciplinary team of Consumers Power individuals. The Reactor Engineering Department had the lead responsibility for the project to assure consideration of available transient analysis and transient data generated in the development of the generic emergency procedure guidelines. Plant personnel from the Operations and Engineering Departments were also involved in the function and task analysis.

The logic charts and information on individual tasks were independently reviewed by MPR Associates as a prerequisite to the review by the DCRDR team of the specific tasks against the control room equipment. The MPR personnel included those involved in the DCRDR (See resumes in Appendix E) as well as other MPR personnel as needed on particular technical subjects.

The assessment of the findings and determination of corrective action was handled by the DCRDR Team, the Palisades Plant Staff, and Consumers Power Engineering in the same manner as other findings of the Control Room Review.

III. FUNCTION ANALYSIS

A. General

The generic safety functions contained in CEN-152 (Reference 2) provided the basis for the function analysis. The resource trees found in CEN-152 were modified to be specific to the Palisades Plant.

The function analysis consisted of three parts:

- The safety functions (SF) were identified and defined.
- The modes of control (or "success paths" per CEN-152 terminology) were identified for each SF based on the transient status of key parameters, plant equipment availability and plant response characteristics. Flow charts (logic diagrams) were prepared for each success path of each SF.
- The success criteria of the success paths for each SF were identified.

B. Classification of Safety Functions

Seven Safety Functions (SFs) must be fulfilled. All are directed at mitigating an event or controlling radioactivity releases. These SFs can be grouped into three major classes as follows:

- Anti-core melt SFs,
- Containment integrity SFs, and
- Maintenance of vital auxiliaries needed to support other SFs.

C. Definitions of Safety Functions

1. Definitions of the anti-core melt class of SFs are:

   a. Reactivity Control (RC)

      The purpose of reactivity control is to achieve and maintain a shutdown condition in the reactor.

   b. Primary Coolant System (PCS) Inventory Control (IC)

      The purpose of maintaining PCS inventory control is to provide a medium for the removal of decay heat.

   c. PCS Pressure Control (PC)

      The purpose of PCS pressure control is to maintain the PCS subcooled and prevent the loss of inventory through the pressurizer power operated relief valves (PORVs) or safety valves, thereby preventing release of radioactive liquid to the containment and possibly the atmosphere. The control of the maximum PCS pressure within Technical Specification limits is important to minimize the potential for pressurized thermal shock.

d. PCS Temperature Control (TC)

The purpose of the PCS temperature control function is to remove decay heat and cool the PCS to a stable heat removal condition.

2. Definitions of the containment integrity class of SFs are:

a. Containment Isolation (CI)

The purpose of the containment isolation function is to maintain closure or blockage of those flow paths required to isolate the containment following an event characterized by an increase in containment pressure or radioactivity levels or by an increased risk of release of activity through a steam generator with leaking tubes.

b. Containment Atmosphere Control (CA)

The purpose of the containment atmosphere control function is to maintain the containment temperature, pressure, and combustible gas concentration within their design limits. This will protect the final barrier to fission product release and prevent damage to vital equipment.

3. Definitions of the remaining SF is:

   a. Maintenance of Vital Auxiliaries (MVA)

      The purpose of maintaining vital auxiliaries is to assure that support systems used to accomplish SFs described above are kept in service.

Some SFs have precedence over others with respect to their sequence of implementation during an event. The following order is utilized at Palisades:

- Reactivity Control
- Maintenance of Vital Auxiliaries
- PCS Inventory Control
- PCS Pressure Control
- PCS Temperature Control
- Containment Isolation
- Containment Atmosphere Control

IV. TASK ANALYSIS

A. General

The task analysis effort was a detailed extension of the function analysis effort which determined the actual tasks to be performed and the instrumentation and control needs of the operator to perform those specific tasks. It was assumed for the function and task analysis that the operator was fully trained and experienced in the details of component operation.

CEN-152 (Reference 2) includes guidelines for general, symptom oriented actions under emergency conditions in the form of Functional Recovery Guidelines (FRGs). In addition it includes so-called Optimal Recovery Guidelines (ORGs), which are to be used when the specific initiating event, e.g., steam generator tube rupture, has been diagnosed. The function and task analysis was based on FRGs. However, because the ORGs involve tasks which are identical to those in the more general FRGs, the operator actions, decisions, equipment used, etc., of the ORGs are adequately evaluated.

B. Logic Diagrams

Logic diagrams (flow charts) were prepared for each success path of each safety function as the first step in the task analysis. The steps to perform the functions or operator actions in the logic diagram created in the function analysis were then established. These tasks were identified by analyzing the system or equipment involved in a particular operation. System

drawings, including electrical drawings, were used to determine steps required to perform actions of the logic diagrams. During this analysis, existing instrumentation was disregarded. The process concentrated on system components and their functions in listing tasks to be performed.

When the task listings were completed for the FRGs, each was compared for consistency. (Since the same systems are utilized to satisfy success criteria in several safety functions, this review verified that tasks were consistent in operation of the same equipment).

The tasks were listed on a form which also provided a list of information and control capability data. Tasks and subtasks were listed for the success path of a safety function. The desired action was entered for each task or subtask and the characteristics of the information or control capability required entered on the form. These forms were then used to independently verify by comparison to the actual control room equipment that the information and control capability requirements were met by the control room equipment. This included consideration of whether the equipment exhibited the proper characteristics as well as whether it met appropriate human engineering guidelines.

One of the logic diagrams is included as an example in this report as Figure F-1. An example of an information and control capability form which lists the individual tasks and the results of their evaluation is included as Figure F-2.

As part of the overall program of validation of the upgraded emergency operating procedures, the Palisades simulator was used to demonstrate the emergency procedures in an active, real-time environment. Since these procedures included, in effect, the tasks identified in the function and task analysis, these validation demonstrations provided a means to assess the significance of any discrepancies between the identified needs for controls and displays and those actually provided at Palisades. In addition, the demonstrations provided further confirmation that the tasks could be practically performed.

Members of the DCRDR review team observed these demonstrations of the functional recovery guidelines. This provided further confirmation of the review team's evaluation of the compatibility of the control room equipment with the operators' tasks.

V. RESULTS OF FUNCTION AND TASK ANALYSIS

Twenty-five human engineering deficiencies (HEDs) were identified in the function and task analysis evaluation. These results are presented in Table F-1, in a format similar to that used in the main body of the report. The table includes a brief statement of the deficiency, recommended action or assessment, category (as defined in Section VI of the main report), and action due date.

Each HED identified in the function and task analysis is described below.

1. Indication of Flow to Charging Pumps (F&T Section RC-2.2.4): During the reactivity control safety function (SF) success path using boration through the chemical volume control system, the operator must start the boric acid (BA) pumps and simultaneously confirm that they have started. The three feedback parameters listed in the subtask to confirm that the BA pumps have started are: (1) pump breaker position, (2) pump discharge pressure indication, and (3) indication of flow from the BA pumps to the charging pump suction. The third feedback parameter, indication of flow from the BA pumps to the charging pumps, is not available. The other two feedback parameters, however, are assessed to be sufficient to confirm whether or not the BA pumps have started. In addition, lack of flow to the charging pumps would be indicated by the lack of charging flow to the system, which is available to the operator. No action is therefore required.

2. Position Indication for CV3006 and CV3025 (F&T Sections RC-3.4.6 and 3.4.7): In the reactivity control SF success path using boration through the safety injection system, the operator must be able to switch from using the HPSI pumps to the containment spray pumps. As part of this realignment, the shutdown cooling heat exchanger bypass valve, CV3006, must be closed and the heat exchanger outlet valve, CV3025, must be opened. Position indication lights are not available for either of these valves. This deficiency was also noted in Table VI-3 of the main report.

3. Subcooling Margin Meter (SCMM) (F&T Section IC-1H.1): For the inventory control SF (and later the temperature control SF), the operator must verify that the primary coolant subcooling margin is at least 15°F or greater. One of the indication parameters for this verification is the SCMM. The SCMM, however, does not function below 515°F. This deficiency is related to the lack of a wide range hot leg temperature (T_h) indicator (see item 4 below).

4. Wide Range Hot Leg Temperature (T_h) Indication (F&T Section IC-1H.1): Another parameter required to verify subcooling margin is T_h. The current T_h indication covers only the narrow range between 515°F and 615°F. The required off-normal condition range for T_h is 70°F-600°F. This deficiency was also noted in Table VI-1, Item III.C.1 of the main report.

5. Primary Coolant System (PCS) Pressure Meter (F&T Section IC-1H.1): Another parameter required to verify subcooling margin is the PCS pressure. The accuracy of

the current pressure meter is ±60 psi, which includes ±25 psi readability based on an instrument error analysis. The ±60 psi accuracy corresponds to an uncertainty in subcooling of 25°F. The original work on the Palisades F&T Analysis required a subcooling margin of 15°F. The development of new emergency procedures, however, resulted in a requirement of 25°F subcooling margin. Since this requirement is consistent with the available accuracy, no further action is required.

6. <u>Reactor Vessel Level Indication (F&T Section IC-2.7)</u>: During the inventory control SF success path which uses the safety injection system (SIS) to correct low inventory (and all other success paths that use the SIS), the operator must determine whether the initiating emergency event is a LOCA or not. (He is required to trip all four primary coolant pumps if the event is a LOCA.) One of the parameters listed in the subtask to diagnose a LOCA or non-LOCA is the Reactor Vessel Level Monitoring System (RVLMS). This system is not currently installed; however, it is scheduled to be installed during the 1987 outage.

7. <u>Manual Initiation of the Recirculation Actuation System (RAS) (F&T Section IC-2.12)</u>: For the success paths using the SIS, the operator is required to verify that the RAS automatically switches SIS suction from the SIRW tank to the containment sump, when the level in the SIRW tank drops below 2%. If automatic initiation of the RAS does not occur, the operator could attempt to manually actuate the RAS. The necessary switches, however, are spring loaded so that it would be neces-

sary for the operator to hold the switches in position. As a result, manual actuation of RAS by the panel normal/test switches is not practical. The operator can, however, manually perform the operations performed automatically by the RAS. That is, the two pumps and six valves can be operated by their console hand switches. The ability of the operator to perform these operations manually was confirmed during operator walkthroughs of emergency procedures.

Note that in any case, the operator's response to failure of the RAS automatic actuation would most likely be to manually line up the system components--not to attempt to actuate an automatic system which has already demonstrated that it does not work.

8. HPSI Flow Indication (F&T Section IC-2.13): During a success path which uses the SIS, the operator must ensure that if the HPSI pumps are running, each pump is receiving flow at least equal to the minimum required rate of 30 gpm. The current HPSI flow indicators do not give accurate flow readings near 30 gpm because the scale is too coarse at low flow rates. The HPSI flow meter will be modified to allow readings of low flow conditions to within 5 gpm.

9. Pressurizer Spray Valve Flow Indication (F&T Section PC-1H.5): During the pressure control SF success path which uses manual control of the pressurizer sprays to control high PCS pressure, the task analysis indicates that the operator must verify that the pressurizer spray valves are open after he has opened them. Three feedback parameters are listed for

the subtask to verify that the spray valves are open: (1) valve position indication, (2) pressurizer pressure indication, and (3) spray flow indication. Spray flow indication is not currently available. The two other parameters, particularly the pressurizer pressure indication, are judged sufficient to determine whether the spray valves are open and operating effectively. Note that the operator will base his subsequent actions, not on the spray valve position or the spray flow, but on the pressurizer pressure. Therefore, the lack of a spray flow indication is not a serious deficiency and no action is required.

10. <u>Trending Low Water Level in Steam Generators (F&T Section PC-4.2)</u>: In the forced circulation success path of the PCS pressure control SF, the operator needs to determine if each steam generator level is normal or restoring so he can use the steam generators for reducing PCS pressure. Trending was not available for S/G levels below the normal condition zero point level. Trending is now available through the critical function monitoring system (CFMS), so no further action is required.

11. <u>Circulating Water Flow Indication (F&T Section PC-4.5)</u>: As part of the forced circulation success path of the pressure control SF, the operator must verify that he can dump steam to the main condenser. Four parameters are listed in the subtask to verify that the condenser is available: (1) condensate pump breaker position, (2) condensate pump current, (3) condenser vacuum (pressure) indication, and (4) circulating water flow indication. The fourth

parameter, circulating water flow indication is not available. The three other parameters, especially condenser vacuum, are sufficient to allow the operator to know if he can make use of the condenser for cooling. That is, the circulating water flow is, at best, a secondary indication; the condenser vacuum would be adequate to show that the condenser is available. No action to provide circulating water flow indication is required.

12. <u>PCS Cooldown Rate (F&T Section PC-4.6.2)</u>: In the forced circulation success path of the pressure control SF, the operator needs to know the PCS cooldown rate. There is currently no instrument that directly indicates cooldown rate for the operators; operators plot cooldown rate manually. A trend recorder is also provided for cold leg temperature from which the operator can determine a cooldown rate. Operations personnel say that this arrangement is used routinely for cooldown and has proved to be adequate; therefore, no action is required.

13. <u>Turbine Bypass Valve (TBV) Position Indication (F&T Section PC-4.6.2)</u>: During the pressure control SF forced circulation success path, the operator may need to control the position of the TBV to control the cooldown rate. The subtask for TBV operation requires position indication for the full range of valve positions (0-100%); current TBV position indication is open/closed. The operator would, however, rely on other parameters, e.g., PCS temperature and cooldown rate, to determine each required change in TBV position. That is, the operator will not base his decision

for further action on the valve position, but on the PCS temperature and pressure. Consequently, valve position itself is not a particularly important parameter to the operator except as an immediate feedback of moving the valve. This feedback, though delayed, is currently obtained through the PCS temperature and pressure, which are the parameters of major interest and the ones he is attempting to control. It is concluded that the operator's task can be adequately performed without TBV position indication.

14. Atmospheric Dump Valve (ADV) Position Indication (F&T Section PC-4.7): During the forced circulation success path, the operator may also need to control the position of the ADV to control the cooldown rate. The subtask for ADV operation requires full range of valve positions (0-100%); current ADV position indication is open/closed. As described above for the TBV, the PCS temperature and pressure are the parameters of interest and operators would base their decisions to change the ADV positions on these parameters, not on the exact position of the valves. ADV position indication, therefore, is not considered necessary for the operator's task to be adequately performed.

15. Secondary Relief Valve Position Indication (F&T Section PC-4.8): During the pressure control SF forced circulation success path, the operators are required to know if the secondary relief valves are open (thereby cooling and depressurizing the PCS). These valves do not have position indication (open/closed) in the control room. Operators state, and the experience of review team members confirms, that lifting of these

valves is clearly audible from inside the control room. Also, main steam flow indication would confirm whether the valves are open or closed. Accordingly, it appears that the operators can confirm the opening of the valves and no action to provide position indication is required.

16. Trending of T_h (PC-5.8.c): One of the subtasks of the natural circulation success path for the pressure control SF requires the operator to verify that natural circulation has been established. One of the criteria needed to verify natural circulation is decreasing or constant T_h. Trending of T_h was not available; however, it is now available on the CFMS. Further, trending of wide range T_h will be available with pen recorders to be added during the 1987 outage.

17. Power Operated Relief Valve (PORV) Isolation Valves (PC-6.1): The last success path for the pressure control SF is to use the PORVs to reduce pressure in the PCS. For the PORVs to operate, the PORV isolation valves must be open. To open these valves, an auxiliary operator must be sent from the control room to close the 480V breakers 52-195, 52-196, 52-223, and 52-224. The adequacy of this arrangement was confirmed during operator walk-throughs of emergency procedures.

18. Manually Cycling PORVs (F&T Section PC-6.2): For the pressure control SF success path which uses PORVs to reduce pressure in the PCS, the operator must be able to manually open and close the PORVs. Currently, this can be accomplished only by pulling and replacing bistables in control panel C06. Operator walk-throughs

of emergency procedures using a simulator were used to confirm the adequacy of this arrangement.

19. Neutron Detectors for Void Monitoring (F&T Section TC-2.9.g): During the temperature control SF success path which uses natural circulation cooling through the steam generators, voiding in the PCS is of concern. Several parameters are listed in the subtask to diagnose voiding, including neutron monitoring for erratic behavior. Although loss of water between the neutron detectors and the core due to voiding would clearly cause erratic readings of the nuclear instruments, the character of this erratic behavior cannot be predicted and, therefore, the capability of the instrumentation to display the behavior cannot be evaluated quantitatively. Since there are many other indications of voiding for the operator which are more effective and require less voiding for them to be detected, it is concluded that operators would not rely heavily on the nuclear instruments to detect voiding. Consequently, the lack of a quantitative evaluation of the nuclear instruments for this task is not a problem. It appears that the operators can adequately perform the basic task of void detection and no action is required.

20. Core Exit Thermocouple (CET) Trending (F&T Section TC-3.4): As part of the temperature control SF success path which uses both the steam generators as a heat sink and the SIS, the effectiveness of the cooldown must be determined by trending of the CETs. No trend recorders for the CETs are currently provided in the

control room. Trend recorders are scheduled to be added to the control room and to the CFMS during the 1987 outage.

21. Indication of Flow From Service Water (SW) Headers to Air Coolers (F&T Section CA-1.8): One of the success paths for the containment atmosphere SF uses air coolers to reduce the temperature in the containment. One of the subtasks in this path requires the operator to verify that the air coolers are receiving water flow from the SW headers. The operators can confirm that the service water header is pressurized; however, there is no direct indication of flow to the air coolers. Indication of flow from SW headers to air coolers is scheduled to be provided on the CFMS in 1987.

22. Containment Temperature Trending (F&T Section CA-2.16.2): The containment spray system is also used in a success path for the containment atmosphere SF. In this success path, the operator is required to verify that the containment temperature is constant or decreasing. Trending of containment temperature is required to accomplish this function. Containment temperature trending was not available; however, it has since been added to the CFMS.

23. Diesel Generator Frequency Indication (F&T Section MVAE-1.3): The diesel generators have no speed indication in the control room: frequency, therefore, is the only available indication that the diesel generator is running, independent of the indicator lights on the control switch. The generator frequency meter range is limited (58-62 Hz). If the diesel generator is operating outside of this range, it is not operating normally, and

an operator would not be able to use it. Instead, the operator would have to go to the diesel generator locally to troubleshoot. No action to change the range of the diesel generator frequency meter is required.

24. <u>Direct Indication of Instrument AC (Y01) Power (F&T Section MVAE-C.5.2</u>: There is no direct indication in the control room, neither meters nor alarms, that instrument AC power (YOl bus) is energized. There are, however, a number of unique indications which are caused by this failure. An off-normal procedure exists to cover this situation. In addition, operators are trained to recognize the unique symptoms of a loss of Y01 on the Palisades simulator. No special direct indication of Y01 status is considered necessary.

25. <u>Flow Indication for Component Cooling Water Heat Exchangers (F&T Section MVAW-1.4)</u>: The operator is required to establish that the component cooling water heat exchanger is in operation. The operator has temperatures of the outlet component cooling water; however, these would not be a valid indication that the heat exchanger was working unless there is flow through the unit. There is no direct flow indication; however, the discharge pressure and the pump current are indicated. In addition, the inlet valve positions are indicated. Although flow indication would be desirable, it is considered that the operator has enough other information to establish that the heat exchangers are operating normally.

TABLE F-1

SUMMARY OF FUNCTION AND TASK ANALYSIS FINDINGS AND CORRECTIVE ACTION

	DEFICIENCY	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
1.	Indication for flow from the boric acid pumps to the charging pumps is not available.	Flow to charging pumps can be determined by other means, e.g., discharge pressure of the boric acid pumps, so actual flow rate measurements are not necessary.	NAR	NA
2.	Position indications for CV3006 and CV3025 are not available.	Evaluated in Table VI-3 of main report.	EE	NA
3.	The SCMM does not work below 515°F.	SCMM indication for temperatures below 515°F will be available when the wide range T_h is installed (see below).	EE	NA
4.	Wide range T_h is not available.	Evaluated in Table VI-1, item III.C.1 of main report.	EE	NA
5.	Accuracy of pressure meter corresponds to 25°F subcooling instead of 15°F, as required by function and task analysis.	Development of new emergency procedures resulted in a requirement of a 25°F subcooling margin, which is consistent with available accuracy.	D	D
6.	Reactor vessel level indication is not available.	Reactor vessel level monitoring will be installed.	A3	1987 Outage
7.	Manual initiation of the recirculation actuation system (RAS) as a single operation is not practical because the initiating switch is spring-loaded to normal; manual manipulation of the control for each component will be required.	Initiation of RAS is required only after the level in the SIRW tank has fallen below the low level setpoint and automatic initiation has failed. The ability of the operators to manually align the necessary pumps (2) and valves (6) to duplicate the action of the RAS was confirmed during operator walkthroughs of emergency procedures; therefore, no action is required.	NAR	NA

TABLE F-1

SUMMARY OF FUNCTION AND TASK ANALYSIS FINDINGS AND CORRECTIVE ACTION

DEFICIENCY	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
8. Accuracy of HPSI flow indication for flow rates near the pump minimum flow condition (30 gpm) is not adequate.	HPSI flow indication will be modified to allow readings of low flow (approx. 30 gpm) conditions to within 5 gpm.	B2	1988 outage
9. Pressurizer spray valve flow indication is not available.	Flow from spray valves can be determined by other means, e.g., pressure and level indications and trends, so actual flow rate measurements are not necessary.	NAR	NA
10. Trending is not available for very low water level in steam generator.	Trending of S/G water level is now available on the CFMS.	D	D
11. Circulating water flow indication is not available.	Condenser vacuum is the primary indication of whether the condenser is available; therefore, circulating water flow indication is not required.	NAR	NA
12. PCS cooldown rate is not available.	Operators manually plot cooldown rate. Additionally, a trend recorder, PTR-0115, is provided for T_c from which operators can determine cooldown rate. Operations personnel say this arrangement is used routinely for cooldown and is adequate.	NAR	NA
13. TBV position indication is not available except in open or closed position.	Operators rely on other parameters, e.g., PCS temperature and cooldown rate, to determine each required change in TBV position; therefore, no action is required.	NAR	NA
14. ADV position is not available except in open or closed position.	Operators rely on other parameters, e.g., PCS temperature and cooldown rate, to determine each required change in ADV position; therefore, no action is required.	NAR	NA

TABLE F-1

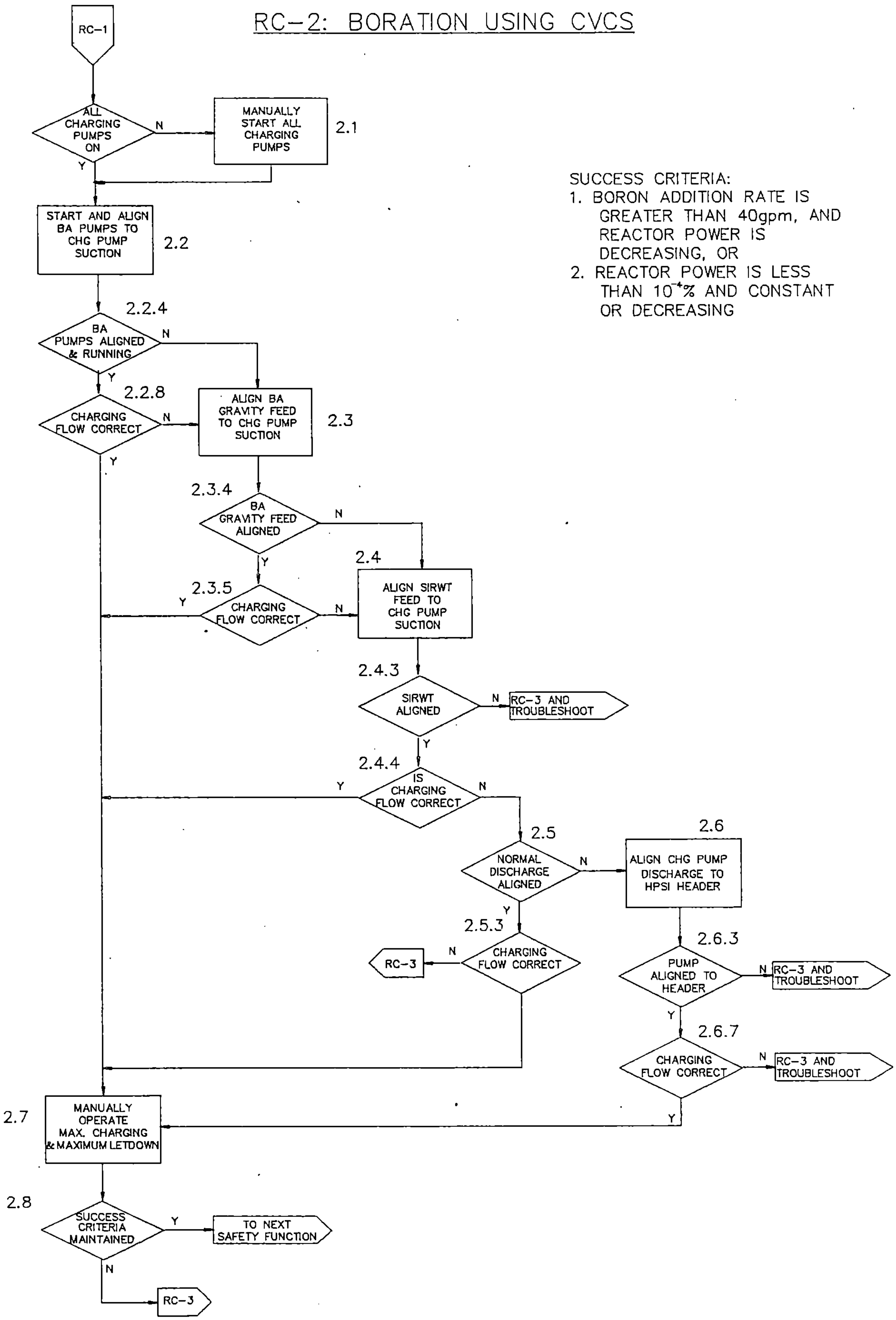
SUMMARY OF FUNCTION AND TASK ANALYSIS FINDINGS AND CORRECTIVE ACTION

DEFICIENCY	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
15. Secondary relief valves do not have control room position indication.	Lifting of valves is audible from inside the control room. Also, main steam flow indication would confirm whether the valves are open or closed. Therefore, no action is required.	NAR	NA
16. No trending is now available for T_h.	Trending of T_h is now available on the CFMS. Trending recorders will be provided in the control room.	A2	1987 outage
17. PORV isolation valves cannot be opened without closing 480V breakers 52-195, 52-196, 52-223, and 52-224. This action must be performed by an auxiliary operator outside the control room.	The adequacy of this arrangement was confirmed during operator walkthroughs of emergency procedures.	NAR	NA
18. PORVs cannot be manually cycled without pulling bistables in C06 cabinet.	The adequacy of this arrangement was confirmed during operator walkthroughs of emergency procedures.	NAR	NA
19. Requirements for using neutron detectors for monitoring voids are not established.	Void detection is accomplished more effectively with other instrumentation; no action required.	NAR	NA
20. CET trending is not available.	Trending recorders will be installed in the control room and trending capability will be added to the CFMS.	B2	1987 Outage
21. Indication of flow from SW headers to air coolers is not available.	Indication of flow from SW headers to air coolers will be provided on the CFMS.	B2	1987 Outage

TABLE F-1

SUMMARY OF FUNCTION AND TASK ANALYSIS FINDINGS AND CORRECTIVE ACTION

DEFICIENCY	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
22. Containment temperature trending is not available.	The capability to trend containment temperature is now provided on the CFMS.	D	D
23. Diesel generator frequency range is limited to 58-62 Hz.	The diesel generator would not be operated outside the range of the existing meter; therefore, no action is required.	NAR	NA
24. No direct indication of whether instrument AC power (Y01) is available.	See Table IV.A.5.a(6)	EE	NA
25. No flow indication available for component cooling water heat exchangers.	Pump discharge pressure and current provide adequate verification of flow. Also, outlet temperatures provide confirmation of CCW heat exchanger flow.	NAR	NA



EXAMPLE LOGIC DIAGRAM OF SAFETY FUNCTIONS

Figure F-1

COMPARISON OF REQUIRED INFORMATION AND CONTROL CAPABILITY TO AVAILABLE DISPLAYS AND CONTROLS

FUNCTION: REACTIVITY CONTROL
PATH NO: RC-2: CVCS

TASK/SUBTASK		REQUIRED INFORMATION AND CONTROL CAPABILITY			AVAILABLE DISPLAYS AND CONTROLS		RANGE OR ACTION		RESOLUTION ACCURACY		SPEED OF RESPONSE		COMMENTS/CONCLUSIONS
		DESIRED ACTION	CODE	TYPE ACTION OR PARAMETER	ID	LOCATION	REQUIRED	AVAILABLE	REQUIRED	AVAILABLE	REQUIRED	AVAILABLE	
RC	2.1	Start all available charging pumps	A	Discrete	P55A,B,C	C02	On	Trip/Closed	O/C	O/C	NA	NA	OK
			F	Bkr pos	P55A,B,C	C02	On	Trip/Closed	O/C	O/C	NA	NA	OK
			F	Charging flow	FIA-0212	C02	0-150 gpm	0-140 gpm	±5 gpm	±2 gpm	NA	NA	Acceptable - maximum pump pump flow is 133 gpm
	2.2	Align conc. BA pumps to charging pump suction											
	2.2.1	Open BA pumps feed valve	A	Discrete	MO-2140	C02	Open	Open/Closed	NA	NA	NA	NA	OK
			F	Valve pos	MO-2140-lights	C02	Open	Open/Closed	NA	NA	NA	NA	OK
			F	BAT levels	LIA-0206B,0208B	C12	0-100%	0-100%	±5%	±5%	NA	NA	OK
	2.2.2	Verify closed BA blender feed valve	I	Valve pos	CV2153	C02	Closed	0-100%	O/C	±2%	NA	NA	OK
			I	Flow	FRC-0210B	C02	Zero	0-25 gpm	O/C	<1 gpm	NA	NA	OK
	2.2.3	Check BAP recirc valves 100% open	I	Valve pos.	CV-2130,2136	C02	Open	0-100%	O/C	±2%	NA	NA	OK
	2.2.4	Start BA Pumps	A	Discrete	P-56A,B	C02	On	Trip/Closed	O/C	O/C	NA	NA	OK
			F	Bkr pos	P-56A,B	C02	On	Trip/Closed	O/C	O/C	NA	NA	OK
			F	Disch. press	PIC-0206,0208	C02	0-150 psi	0-120 psi	±15 psi	±5 psi	NA	NA	Acceptable - discharge pressure used only to indicate pump on
			F	Flow to charging pumps	None		0-150 gpm	none	±15 gpm	none	NA	NA	HED
	2.2.5	Close VCT outlet valve	A	Discrete	MO-2087	C02	Closed	Open/Closed	O/C	O/C	NA	NA	OK
			F	Valve pos	MO-2087	C02	Closed	Open/Closed	O/C	O/C	NA	NA	OK
	2.2.6	Verify letdown switches to rad-waste on high VCT level	I	Valve pos	CV-2056	C02	O/C	O/C	NA	NA	NA	NA	OK
			I	VCT level	LIC-0205	C02	>83 inches	0-100% (88" = 100%)	±2 inches	±2%	NA	NA	OK

EXAMPLE OF INFORMATION AND CONTROL CAPABILITY FORM

Figure F-2

COMPARISON OF REQUIRED INFORMATION AND CONTROL CAPABILITY TO AVAILABLE DISPLAYS AND CONTROLS

FUNCTION: REACTIVITY CONTROL
PATH NO: RC-2: CVCS

TASK/SUBTASK	REQUIRED INFORMATION AND CONTROL CAPABILITY			AVAILABLE DISPLAYS AND CONTROLS		RANGE OR ACTION		RESOLUTION ACCURACY		SPEED OF RESPONSE		COMMENTS/CONCLUSIONS
	DESIRED ACTION	CODE	TYPE ACTION OR PARAMETER	ID	LOCATION	REQUIRED	AVAILABLE	REQUIRED	AVAILABLE	REQUIRED	AVAILABLE	
RC 2.2.7	Manually direct letdown to rad-waste	A	Discrete	CV-2056	C02	O/C	O/C	NA	NA	NA	NA	OK
		F	Valve pos	CV-2056.								See RC-2.2.9
		F	VCT level	LIC-0205								See RC-2.2.9
		F	Letdown flow	FIC-0202								See RC-2.2.6
2.2.8	Verify correct charging flow	I	Charging flow	FIA-0212	C02							See RC-2.1
2.3	Align BAT to gravity feed if necessary											
2.3.1	Open BAT gravity feed valves	A	Discrete	MO-2169,2170	C02	Open	0-100%	O/C	±2%	NA	NA	OK
		F	Valve pos	MO-2169,2170	C02	Open	0-100%	O/C	±2%	NA	NA	OK
2.3.2	Close VCT outlet valve	A	Discrete	MO-2087	C02	Closed	Open/Closed	NA	NA	NA	NA	OK
		F	Valve pos	MO-2087	C02	Closed	Open/Closed	NA	NA	NA	NA	OK
2.3.3	Close BAP recirc valves	A	Discrete	CV-2130, 2136								See RC-2.2.1
		F	Valve pos	CV-2130, 2136								See RC-2.2.1
2.3.4	Verify BA gravity feed aligned	I	Valve pos.	MO-2169,2170	C02							See RC-2.3.1
2.3.5	Verify correct charging flow	I	Charging flow	FIA-0212	C02							See RC-2.1.
2.4	Align SIRWT to gravity feed if necessary											
2.4.1	Open SIRWT to charging pump suction valve	A	Discrete	MO-2160	C02	Open	Open/Closed	NA	NA	NA	NA	OK
		F	Valve pos	MO-2160	C02	Open	Open/Closed	NA	NA	NA	NA	OK
		F	SIRWT level	LIA-0331	C13	0-100%	0-100%	±2%	±2%	NA	NA	OK

Figure F-2 (Continued)

COMPARISON OF REQUIRED INFORMATION AND CONTROL CAPABILITY TO AVAILABLE DISPLAYS AND CONTROLS

FUNCTION: REACTIVITY CONTROL
PATH NO: RC-2: CVCS

TASK/SUBTASK		Required Information and Control Capability: DESIRED ACTION	CODE	TYPE ACTION OR PARAMETER	Available Displays and Controls: ID	LOCATION	Range or Action: REQUIRED	AVAILABLE	Resolution Accuracy: REQUIRED	AVAILABLE	Speed of Response: REQUIRED	AVAILABLE	COMMENTS/CONCLUSIONS
RC	2.4.2	Close VCT outlet valve	A F	Discrete Valve pos	MO-2087 MO-2087	C02 C02							See RC-2.2.5 See RC-2.2.5
	2.4.3	Verify SIRWT aligned	I	Valve pos.	MO-2160 MO-2087	C02 C02							See RC-2.4.1 See RC-2.4.2
	2.4.4	Verify correct charging flow	I	Charging flow	FIA-0212	C02							See RC-2.1
	2.5	Verify normal charging pumps discharge to PCS											
	2.5.1	Verify open CV2111	A F	Discrete Valve pos.	CV2111	C02	Open	Open/Closed	NA	NA	Deliberate	NA	OK
	2.5.2	Verify open CV2113,2115	A F	Discrete Valve pos.	CV2113,2115	C02	Open	Open/Closed	NA	NA	Deliberate	NA	OK
	2.5.3	Verify charging flow correct	I	Charging flow	FIA-0212	C02							See RC-2.1
	2.6	Align charging pumps discharge to HPSI train 2											
	2.6.1	Stop chg. pumps	A F	Discrete Bkr. pos.	P55A,B,C	C02	Off	On/Off	NA	NA	Deliberate	NA	OK
	2.6.2	Open MOV's 3062, 3064, 3066, or 3068	A F	Discrete Valve pos.	MOV-3062,3064, 3066,3068	C03	Open	Open/Closed	NA	NA	Deliberate	NA	OK
	2.6.3	Open MO-3072 to HPSI system	A F	Discrete Valve pos.	MO-3072	C03	Open	Open/Closed	NA	NA	Deliberate	NA	OK
	2.6.4	Verify closed CV3018 and 3036	A F	Discrete Valve pos.	CV3018,3036	C03	Closed	Open/Closed	NA	NA	Deliberate	NA	OK

Figure F-2 (Continued)

COMPARISON OF REQUIRED INFORMATION AND CONTROL CAPABILITY TO AVAILABLE DISPLAYS AND CONTROLS

FUNCTION: REACTIVITY CONTROL
PATH NO: RC-2: CVCS

TASK/SUBTASK	REQUIRED INFORMATION AND CONTROL CAPABILITY: DESIRED ACTION	CODE	TYPE ACTION OR PARAMETER	AVAILABLE DISPLAYS AND CONTROLS: ID	LOCATION	RANGE OR ACTION: REQUIRED	AVAILABLE	RESOLUTION ACCURACY: REQUIRED	AVAILABLE	SPEED OF RESPONSE: REQUIRED	AVAILABLE	COMMENTS/CONCLUSIONS
RC 2.6.5	Close CV2111	A	Discrete									
		F	Valve pos.	CV2111	C02							See RC-2.5.1
2.6.6	Start charging pumps as needed	A	Discrete	P55A,B,C	C02							See RC-2.1
2.6.7	Verify correct flow to PCS	I	HPSI flow	FI-0308,0310 0312,0313	C13	0-150 gpm	0-250 gpm	±40 gpm	±25 gpm (at low end of scale)	NA	NA	OK
2.7	Manually operate charging and letdown											
2.7.1	Start as many chg. pumps as needed	A	Discrete									
		F	Bkr. pos.	P55A,B,C	C02							See RC-2.1
		I	Chg. flow	FIA-0212	C02							See RC-2.1
2.7.2	Open CV 2009 (letdown stop)	A	Discrete	CV2009	C02	Open	O/C	NA	NA	NA	NA	OK
		F	Valve pos	CV2009	C02	Open	O/C	NA	NA	NA	NA	OK
		F	Letdown flow	FIC-0202								See RC-2.2.6
		I	Pzr level	LRC-0101A,B								See RC-2.2.6
2.8	Check success criteria											
2.8.1	Boron addition rate is >40 gpm	F	Charging or HPSI flow	FIA-0212 or FI-0308,0310, 0312,0313	C02, C13							See RC-2.2.5, RC-2.6.7
		F	PCS boron	AR-0203	C02	0-1500 ppm	0-2050 ppm	±10 ppm	±10 ppm	NA	NA	Trending is required and provided; accurate sample provided by chemistry dept.
2.8.2	Reactor power <10^{-4}% and constant or decreasing	I	Reactor power	RM-5,RM-7	C02	10^{-8}% to 100%	10^{-8}% to 100%	±5% of decade	±5% of decade	NA	NA	OK
		I	SUR	RM-2,RM-4	C02	-1 to 7 DPM	-1 to 7 DPM	±.1 DPM	±.1 DPM	NA	NA	OK

Figure F-2 (Continued)

APPENDIX G

REVIEW OF PANEL C11A AGAINST DETAILED HUMAN ENGINEERING GUIDELINES

I. INTRODUCTION

The C11A panel was added to the Palisades control room subsequent to the walk-throughs reported in Section IV of the main report. Because of the limited number of controls and displays, formal walk-throughs of these panels were not warranted.

II. RESULTS

The controls and displays on the front and back of panel C11A were compared to the detailed human engineering guidelines in Appendix A. The results are summarized in Table G-1 in the same format as the tables in Section VI of the main report. The assessment and categorization of these differences followed the same approach as that outlined in Section VI of the main report. Table G-1 indicates the results of the assessment and the corrective action.

TABLE G-1

PANEL C11A - SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS

DEFICIENCY	APPLICABLE GUIDELINES	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
FRONT OF C11A:				
1. The following controls and displays are located lower on the panel than recommended in the guidelines, i.e., less than 34 inches from the floor for controls and 41 inches from the floor for displays: ° Controls for purge fan V-94 ° Display lights for dampers D15, D16, D17, and D18 ° Display lights for condensing units VC-10 and VC-11 The following controls and displays are located higher than recommended in the guidelines, i.e., greater than 70 inches from the floor: ° Controls and display lights for dampers D7 and D14 ° Display lights for dampers D5, D6, D12, D13, D20, and D21 ° Display lights for VHX-26A and VHX-26B	B.1.a and C.1.a	During off-normal conditions these controls automatically align their associated equipment. The operators do not need to operate these controls or read the displays under any significant time constraints, nor on a frequent basis. Although outside the guideline limits, the locations are workable and the potential for error is small. Relocation of the controls and displays is not considered necessary.	NAR	NA
2. The following controls and displays do not follow the normal left-to-right numerical progression: Left / Right Displays: D18 / D17 Controls: VC-11 / VC-10 The following displays do not follow the normal top-to-bottom numerical progression: Top: D5 D12 D6 D13 D20 D21 Bottom: D7 D14	B.1.c and C.1.b	The controls and displays are arranged so that the equivalent controls and displays for the two channels (right and left) are paired functionally. The numerical order is not important. Relabeling will be used to improve number identification and to define functional groups, but the components need not be rearranged to correct the numerical sequence.	CI	1988 outage

TABLE G-1

PANEL C11A - SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS

DEFICIENCY	APPLICABLE GUIDELINES	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
3. The various characteristics of the label plates are not consistent with those on the relabeled main control panels.	B.5.e, B.5.g, C.3.e, and C.3.g	Relabel.	B1	1988 outage
4. Control panel sections containing functionally-related controls and displays are not prominently labeled.	A.10	Relabel.	B1	1988 outage
BACK OF C11A:				
1. Normal and off-normal conditions are not clearly distinguished. Limits and set points are not identified. Color is not used consistently to indicate off-normal status for the following: ° The "fail reset" indicating lights on RIA-2323, -2324, and -2327 are green; and ° The light indicating the range of H_2 is red.	A.3 and C.3.d	Colors will be standardized as part of relabeling effort. Necessary limits and set points will be added during relabeling.	C1	1988 outage
2. Functionally-related controls and displays are not prominantly labeled.	A.10	Relabel.	B1	1988 outage
3. The following controls and displays are located lower on the panel than recommended in the guidelines, i.e., less than 34 inches from the floor for controls and 41 inches from the floor for displays: ° HS-2415A, HS-2415B, HS-2413A, HS-2413B, HS-2417, HS-2419 ° DPIC-1659, RM-2321A ° AIR-2401, FR-2318, RM-1818 ° RIA-2327 ° HS-2414A, HS-2414B, HS-2412A, HS-2412B, HS-2416, HS-2418 ° DPIC-1660, RM-2322A	B.1.a and C.1.a	These controls and displays are used infrequently and in a deliberate manner. Their location does not appear to introduce the potential for significant operational error. Consequently, relocation is not considered essential.	NAR	NA

TABLE G-1

PANEL C11A - SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS

DEFICIENCY	APPLICABLE GUIDELINES	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
3. (Continued) The following controls and displays are located higher on panel than 70 inches: ° Pressurizer vent valves PRV-1069, and PRV-1070 ° Containment gamma and Main Steam gamma radiation monitors RM-2321, RIA-2321, RIA-2323, RIA-2324, RM-2322, and RIA-2322				
4. The following controls do not follow the normal top-to-bottom progression: PRV - 1069 - 1071 - 1067 PRV - 1070 - 1072 - 1068	B.1.c	The layout of these controls is consistent with the mimic, and the numerical sequence of the controls is not important. Relocation would eliminate the mimic and would degrade the human factors; therefore, relocation will not be done.	NAR	NA
5. The following displays do not follow the normal left-to-right progression: E-50B, E-50A (gamma radiation monitors).	C.1.b	These displays are clearly labeled and the information is provided on the CFMS. It is considered unlikely that the operator will confuse the radiation monitors. Accordingly, rearrangement is not essential.	NAR	NA
6. Detents for key-operated controls are not always oriented upward.	B.2.e	This is not considered a significant deficiency and no action is recommended. There are no significant consequences if the operator is delayed by having to turn the key over.	NAR	NA
7. The following controls and displays are not identified with a descriptive name: DPIC - 1659 DPIC - 1660 RIA - 2327 RM - 1818	B.5.a and C.3.a	Relabel.	B1	1988 outage

TABLE G-1

PANEL C11A - SUMMARY OF FINDINGS AND CORRECTIVE ACTIONS

DEFICIENCY	APPLICABLE GUIDELINES	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
8. Characteristics of labels for controls and displays are not consistent with the relabeled main control panels.	B.5.e, B.5.g, C.3.e, C.3.g, and C.3.h	Relabel.	C1	1988 outage
9. The following legend plates are not located above the displays: ° Containment gamma monitors ° H_2 monitor	C.3.c	Relabel.	C1	1988 outage
10. For the recorders, the charts do not have time as the horizontal coordinate.	C.6.g	This deficiency is not considered significant. The use of these recorders is deliberate and the operators do not use them for control purposes. Although the time coordinate is vertical, the recorders are suitable for the needs of the operators. Changing them to a different recorder with a horizontal time line is not necessary.	NAR	NA

APPENDIX H

EVALUATION OF EMERGENCY LIGHTING
FOR THE PALISADES CONTROL ROOM

I. PURPOSE

The purpose of this appendix is to report the results of an evaluation of the Palisades control room emergency lighting. The intent of the evaluation was to determine if the light levels were sufficient for the operators to perform their required tasks.

II. SUMMARY OF RESULTS

There are two different emergency lighting conditions that can occur after loss of station power. The control room may be lit by the emergency fluorescent lights or by the emergency incandescent lights and battle lanterns. The lighting case will depend on whether diesel No. 1 has started and loaded.

Information for evaluation of the emergency lighting was obtained from the following three sources:

- a questionnaire completed by personnel who participated in a surveillance test during which the control room was lit with emergency lighting,
- measurements of the illumination in the control room, and
- a subjective evaluation by members of the review team.

Results from these evaluations are summarized below.

- Light levels are satisfactory throughout most of the control room under both sets of emergency lighting conditions. This includes the main console, the operators' desks, the back panels, and side panels C06, C07, and C207.
- Light levels are marginal at panels C04, C106, and C126 (panels C106 and C126 are adjacent to each

other), when the control room is lit with the emergency incandescent lights. Operator tasks such as reading label plates and displays could be easily performed, however, the lighting was marginal for reading procedures.

- For both cases of emergency lighting, the light levels behind panels C04, C12, and C13 were judged to be insufficient for rapid passage of personnel. Other areas of the control room appeared adequately illuminated for personnel passage. It is noted, however, that this judgement is based on subjective evaluation by the reviewers, and no specific quantitative criteria were developed or measurements obtained to evaluate this task.

III. DESCRIPTION AND RESULTS OF EMERGENCY LIGHTING EVALUATION

A. Location and Description of the Emergency Lights

The location of emergency lights in the Palisades control room is shown in Figure H-1. Three types of emergency lights are used, as follows:

- emergency battle lanterns,
- emergency incandescent, and
- emergency fluorescent.

There are two lighting situations which may occur after a loss of station power incident. If diesel generator No. 1 starts and loads, the emergency fluorescent lights will be on, and the incandescent and battle lanterns will be off. If diesel generator No. 1 does not start, the emergency incandescent and battle lanterns will be on, and the emergency fluorescent lights will be off. These two lighting conditions are described below.

The emergency incandescent lights are suspended from the control room ceiling and consist of a bulb in a cylindrical housing which is open at the ends. The lights are powered from battery D02.

The two battle lantern emergency lights are wall mounted near the ceiling. Each of these has two incandescent bulbs which can be pivoted to point where light is needed. The battle lantern lights have a

built in battery power supply which is kept charged by normal station power.

Approximately 12% of the fluorescent fixtures in the control room are powered from safety bus 1C, which in turn is energized by diesel generator No. 1. These are the emergency fluorescent lights. The location of all the emergency lights is shown on Figure H-1.

B. Engineered Safeguards System Test With Simulation of Loss of AC Power: Identification of Operator Tasks and Evaluation of Emergency Lighting

Technical Specification Surveillance Test R-08, "Engineering Safeguards System" was performed at Palisades in late December, 1981. Loss of AC power is simulated in the test with the result that the control room is lit with emergency lighting. The emergency fluorescent lights were on during this test (diesel generator No. 1 running). Normal lighting is re-established about 10 to 15 minutes into the test. After the test one of the control room operators and the shift technical advisor completed a questionnaire pertaining to their observations of the effectiveness of the emergency fluorescent lighting during the surveillance test. The results are presented below.

In the course of the test the operator went to the following panels while the emergency lights were on (see Figure H-1 for location of panels):

- main console panels C02 and C03,
- back panels C12 and C13, and

- sidepanels C04 and C07.

The operator stated that typical tasks included verifying pumps running, checking valve positions, and operating breakers. The use of panel C04 was limited to verifying that the diesel generator started and loaded. This was accomplished by observing lighted indicators on C04 from the operator's work station at C01. The operator stated that in all areas where he had to go, the lighting was sufficient to complete his duties.

C. Results of Emergency Light Measurements

Illumination measurements were taken in the control room for the two cases of emergency lighting. The measurements for horizontal surfaces are given on Figure H-2 and for vertical panels on Figure H-3.

1. Emergency Incandescent and Battle Lanterns

Illumination averaged about 12 foot-candles (fc) on the main console. For the vertical panels, measurements were taken at two elevations, one at eye level and a second at the lowest level of instruments on the panel. On the backpanels, illumination averaged 2.5 fc at the high measuring point and 1.2 fc at the low point. Panels C06, C07, and C207 had similar illumination levels at about 1.5 fc. Panels C04, C106, and C126 had illuminations significantly lower than the panels mentioned above because they are not located near an emergency light. Measurements on these panels were in the range 0.12 to 0.44 fc.

2. Emergency Fluorescent

In general, with the emergency fluorescent lights on, the illumination was better on the back panels and side panels, but worse on the main console. At the main console and at the back panels the illumination averaged about 4 fc. For the front of the side panels the illumination ranged between 0.9 and 5.2 fc.

An evaluation of the above illumination levels is given in the following section.

D. Emergency Lighting Criteria

Tests were performed at MPR to determine illumination levels needed to easily perform control room tasks (such as identify label plate colors and content, read procedures, and read meter scales). The conclusion of these tests is that with lighting levels of 3 fc and above it is easy to read procedures and with lighting levels of 1 fc and above it is easy to read meters and label plates, and to identify colors.

From these test results, the following conclusions are drawn regarding the light measurements presented in the previous section:

- light levels are satisfactory at the main console, the operators desks, the back panels, and side panels C06, C07 and C207,

- light levels are marginal at panels C04, C106, and C126 with emergency incandescent lighting; reading label plates and meter scales is relatively easy;

however, reading procedures is possible but relatively difficult, and

- light levels at the back of panels C11, C11A, C12, C13, and C04 for both lighting cases are not sufficient for performing normal operator tasks; however, based on the Engineered Safeguards System Test described in Section B above, the operator does not need to utilize these panels during an emergency lighting situation.

E. <u>Subjective Evaluation by Review Team Members</u>

Two members of the review team performed the illumination measurements which are presented in Section C of this report. In the course of taking the measurements, the following observations were made for the two cases of emergency lighting conditions:

- In the main control room workplace the lighting was good for tasks of reading displays and label plates. This included the control room operators' desks, the main console, the back panels, and side panels C06, C07, and C207.

- Reading displays and label plates at panels C04, C106, and C126 was difficult, but possible.

- The walkways behind panels C04, C12, and C13 were very dark. Although no specific operator tasks at these locations have been identified during an emergency lighting situation, rapid passage through these areas, if required, would be difficult.

These observations are consistent with the measurements discussed in Section C, above.

F. Assessment and Corrective Action

The deficiencies, the results of assessment, and corrective action related to the emergency lighting are summarized in Table H-1.

TABLE H-1

CONTROL ROOM EMERGENCY LIGHTING - SUMMARY OF REVIEW RESULTS

	DEFICIENCY	ACTION OR ASSESSMENT	CATEGORY	DUE DATE
1.	When the control room is lit with the emergency incandescent lights, light levels at panels C04, C106, and C126 (panels C106 and C126 are adjacent to each other) are marginal so that, although the reading of label plates and meter scales would be relatively easy, reading of procedures would be difficult.	No specific errors were identified which would be expected to result from the low illumination levels. However, the C-04 panel involves the electrical distribution system so there is some potential for activity at that location during a period of extended power loss. Emergency incandescent lights will be added near the front of panel C04. Also, a new emergency incandescent light will be installed near the front of panel C126, or the existing incandescent light will be moved from above C115 to the front of C126.	B2	1987 outage
2.	For both cases of emergency lighting, the light levels behind panels C04, C12, and C13 were judged to be insufficient for rapid passage of personnel.	No specific operator tasks at these locations during an emergency lighting situation nor need for rapid passage have been identified. One battle lantern with two pivotal bulbs will be installed in the southwest corner of the control room to illuminate the passageways behind panels C04, C12, and C13. A second battle lantern with two pivotal bulbs will be installed in the northwest corner of the control room to illuminate the areas behind panels C11A, C115, and C207. These battle lanterns will come on for both cases of emergency lighting.	B2	1987 outage

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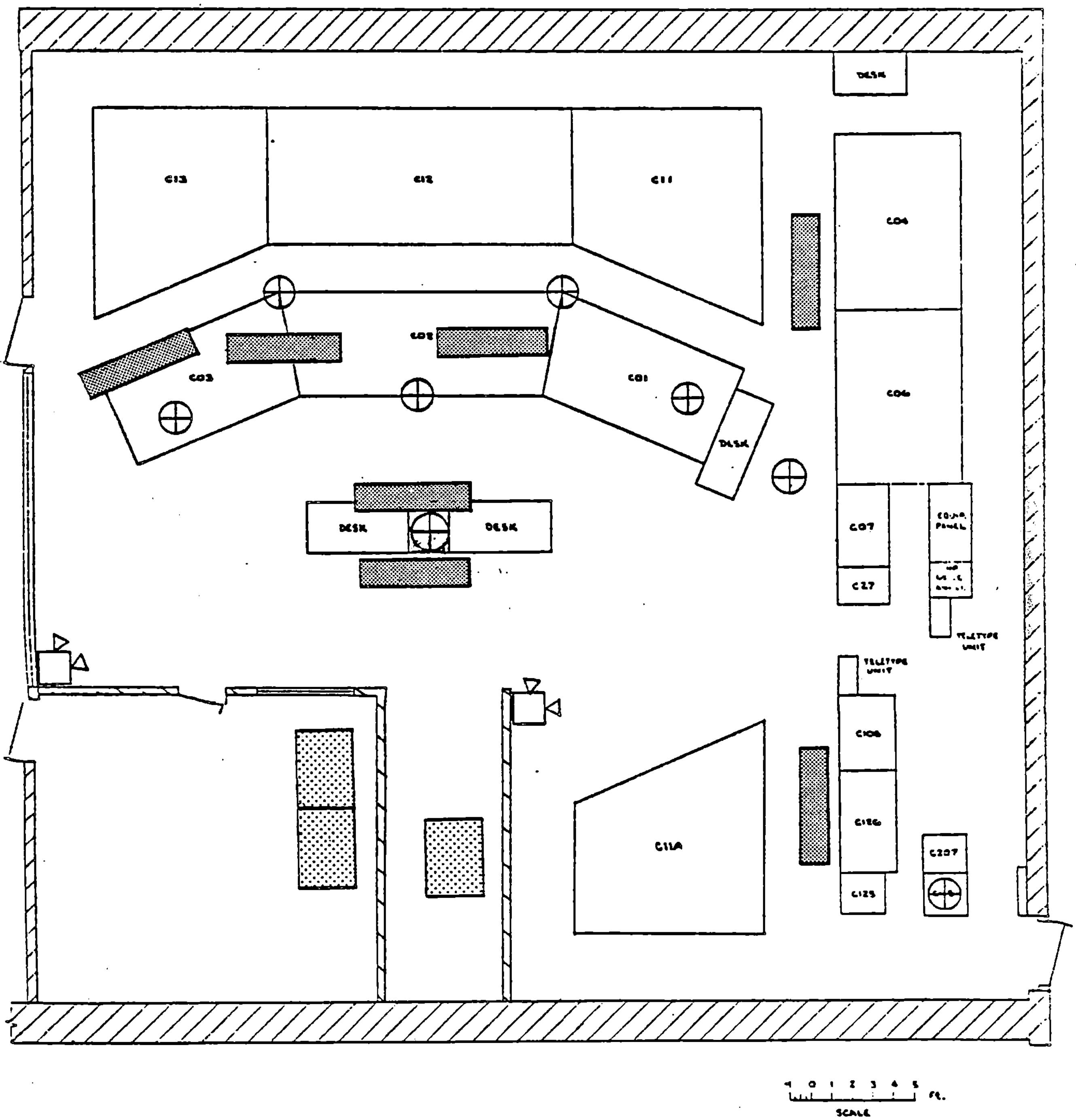
F-98-72-2
8/10/84

Battle Lantern Emergency Light

Single Bulb Emergency Fluorescent Light

Four Bulb Emergency Fluorescent Light

Overhead Incandescent Emergency Light



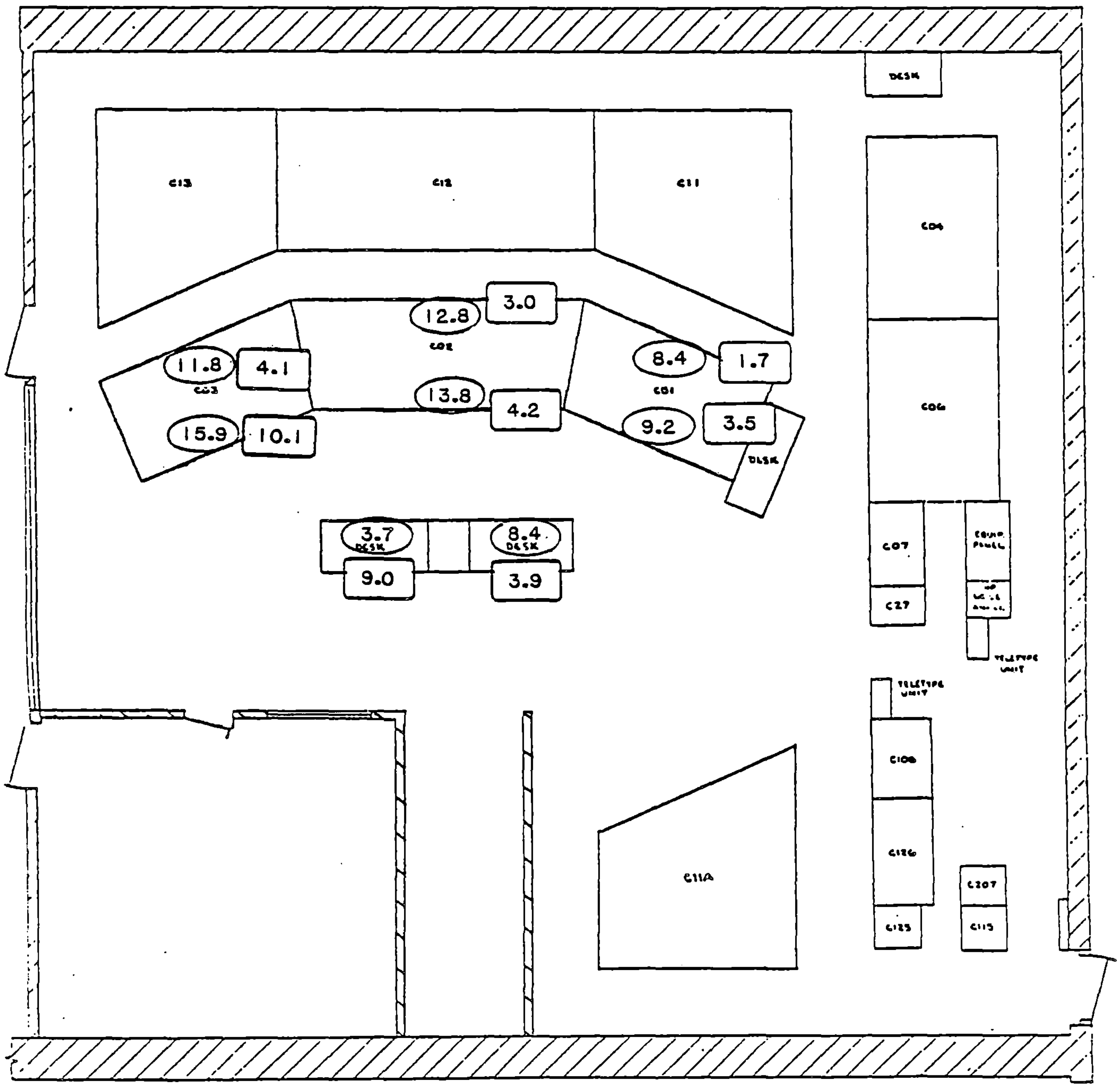
LOCATION OF EMERGENCY LIGHTS
IN PALISADES CONTROL ROOM

FIGURE H-1

MPR ASSOCIATES
F-98-72-3
8/10/84

Emergency Incandescent And Battle Lanterns

Emergency Flourescent

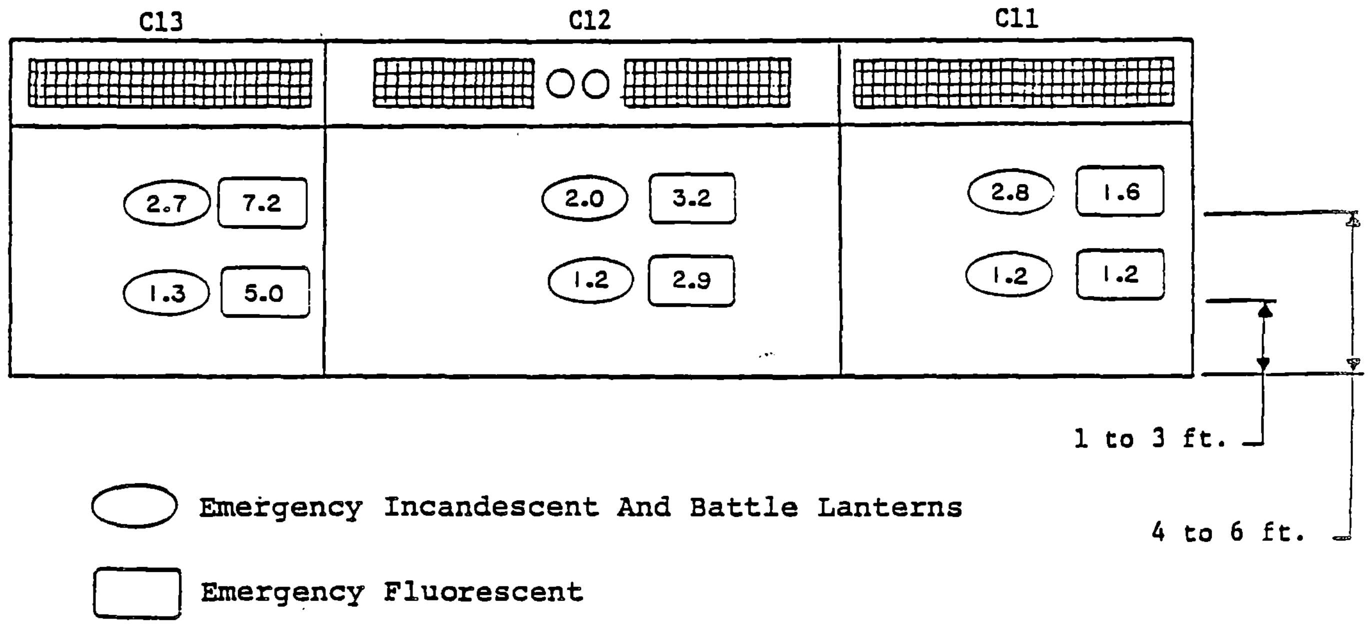


EMERGENCY LIGHTING
ILLUMINATION LEVELS (FOOTCANDLES)
ON HORIZONTAL SURFACES

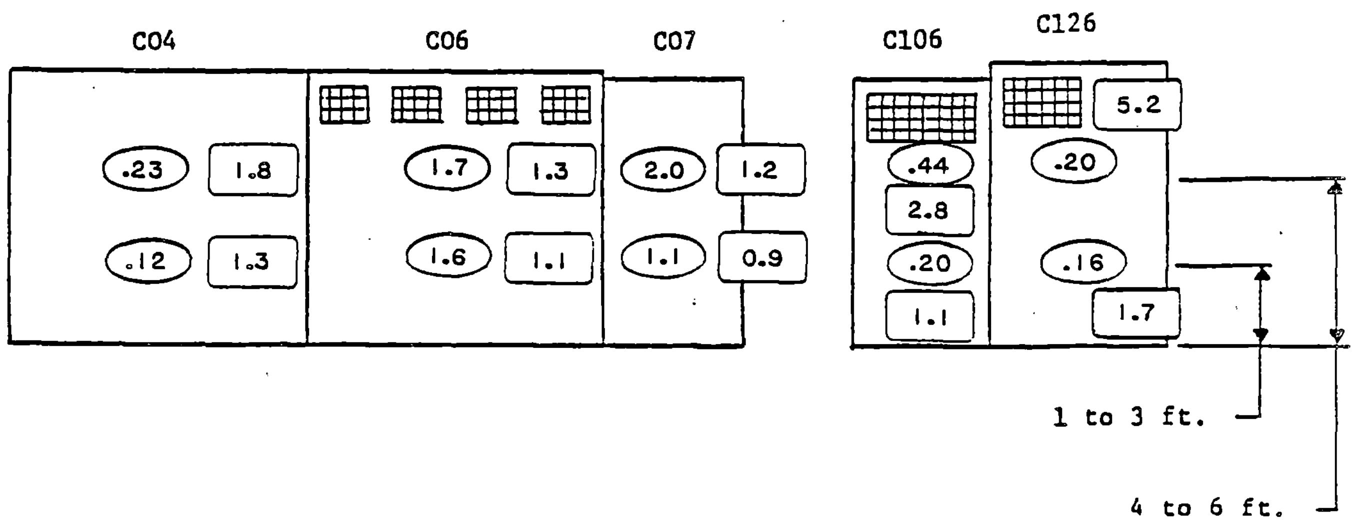
FIGURE H-2

MPR ASSOCIATES
F-98-72-5
8/10/84

FRONT OF BACKPANEL



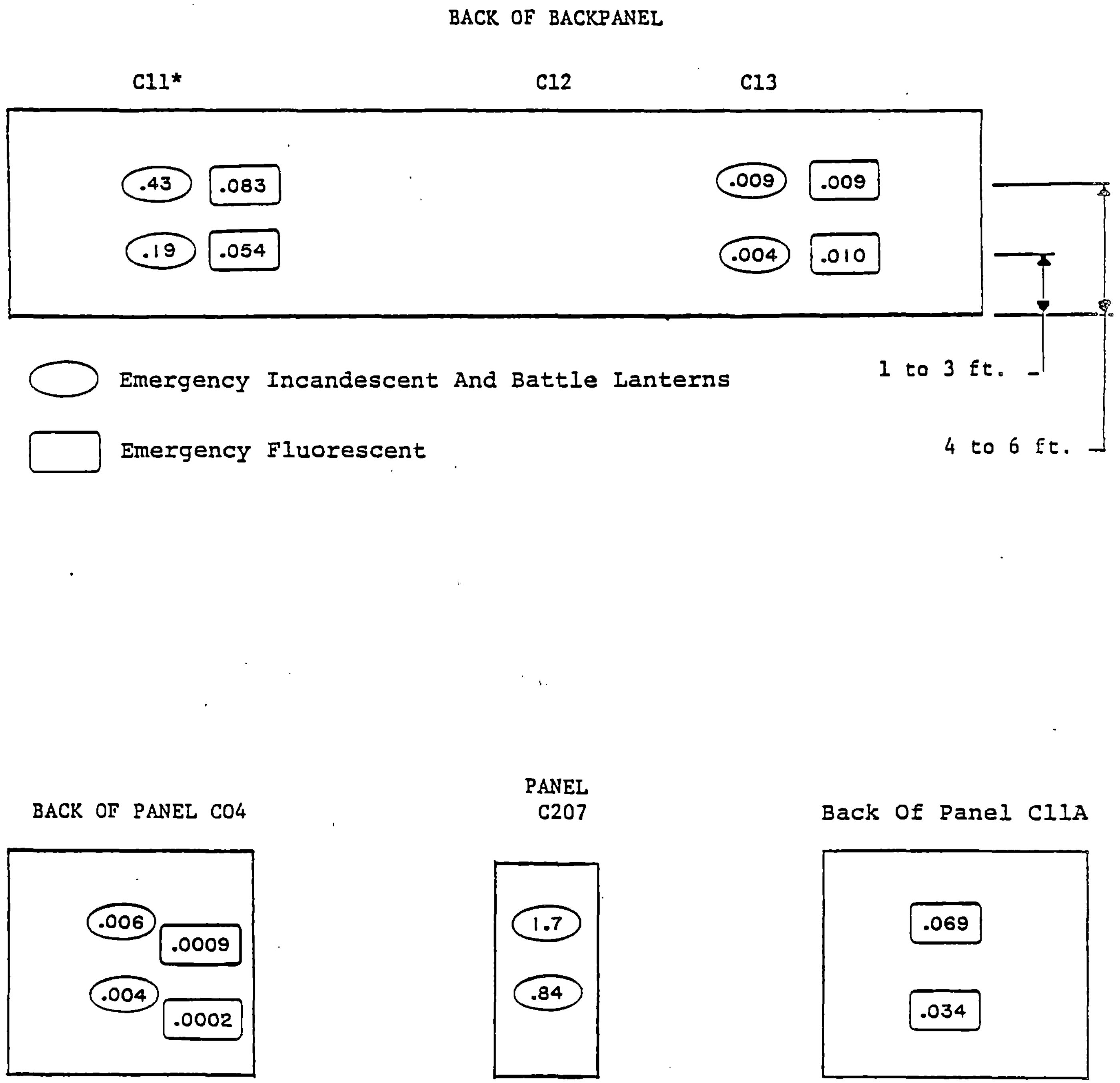
FRONT OF SIDE PANELS



EMERGENCY LIGHTING
ILLUMINATION LEVELS (FOOTCANDLES)
ON VERTICAL SURFACES

FIGURE H-3

MPR ASSOCIATES
F-98-72-4
8/10/84



* Most of Illumination Provided By Self Lighted Recorders.

EMERGENCY LIGHTING
ILLUMINATION LEVELS (FOOTCANDLES)
ON VERTICAL SURFACES

FIGURE H-3