SUPPLEMENT NO. 1

HUMAN FACTORS CONTROL ROOM DESIGN REVIEW

OF

COMANCHE PEAK STEAM ELECTRIC STATION

MARCH 1984

ABSTRACT

Supplement 1 to the Human Factors Control Room Design Review of Comanche Peak Steam Electric Station (CPSES) provides resolution to those issues open when the original report was issued in December 1982 and to the issues/HED's identified during the Human Factors Engineering Branch audit of CPSES of April 4 to 8, 1983, as documented in B. J. Youngblood's letter to R. J. Gary dated July 8, 1983.

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1.0 INTRODUCTION

1.3 SCOPE OF THE CRDR

a. The initial scope of the CRDR was to perform an evaluation using the NUREG/CR-1580 (Draft) guidelines. After the issuance of NUREG-0700, the CRDR was restructured to follow NUREG-0700 guidelines.

b. All areas of the CPSES detailed CRDR have been addressed. In addition, CPSES has agreed to perform noise, lighting and environmental surveys at the Hot Shutdown Panel. The results of these surveys will be addressed later.

1.5 EXCEPTIONS TO NUREG-0700 GUIDELINES

CPSES CRDR does not take exception to the guidelines of NUREG-0700. Alternate methods of complying with two aspects of these guidelines, the Program Plan and the System Function/Task Analysis, are described below.

1.5.1 Program Plan

At the time of issuance of NUREG-0700, the CPSES CRDR had already been started. At that time, CPSES chose not to submit a Program Plan. In lieu of this Program Plan, CPSES is submitting a historical account of the detailed methodology used in the CRDR. The following cross-reference is provided to assist in correlating the applicable NUREG-0700 Program Plan requirements to the appropriate sections of this report.

The cross-reference also addresses the program plan information requested by Generic Letter 82-33, Supplement 1 to NUREG-0737, as tabulated in the CPSES In-Progress Audit Results (see Youngblood to Gary letter of July 8, 1983).

NUREG 0700	In-Progress Audit of Results	CPSES CRDR Report
2.1	--	1.2
2.2	9.	2.0
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1.5.2 System Function/Task Analysis

When NUREG-0700 was issued, the CPSES control room was being design reviewed against the guidelines in NUREG/CR-1580. An engineering evaluation was underway to group functionally related controls/displays on the CPSES control boards to facilitate mimicking and demarcation. This evaluation took into consideration system functions and operator tasks. The control board rearrangements that resulted were based on a balance of accepted human engineering practices, improved operability, and cost effectiveness. Although none of the thought processes used in the evaluation were documented, the resulting control board arrangement was a considerable improvement over the original design and CPSES was confident that a SFTA would not result in any violations that would require further control board modifications. At that point, the decision was made to begin implementing the proposed control board design so as not to impact the fuel load schedule.

By the time Westinghouse had issued their generic guidelines, all of the proposed control board modifications had been completed. These Westinghouse generic guidelines were converted into CPSES plant specific Emergency Response Guidelines (ERGs). These ERGs were then verified using the modified control board arrangement to satisfy NUREG-0899. To perform this verification CPSES contracted the services of licensed Senior Reactor Operators with previous experience in the operation of a Westinghouse four-loop PWR. The verification process, consisting of flow chart review, table top review, and control room walk-throughs, was structured to verify that each task defined in the procedures could be accomplished with the minimum shift complement and that all the controls/displays required to complete each step in the procedure were available at the main control board. Documentation of the results is on file with each emergency procedure generation package.

3.0 METHODOLOGY AND SCOPE

3.2 SCOPE

The overall scope of the CRDR was as follows:

a. Review the Unit 1 control boards to assess compliance with NUREG/CR-1580 guidelines.

b. Reassess control boards for compliance with NUREG-0700 guidelines.

c. Evaluate applicable SERs and LERs.

d. Develop corrections for all Unit 1 discrepancies.

e. Compare Unit 2 to Unit 1 to assess design differences.

f. Develop and implement design change packages such that Unit 2 will be identical to the corrected Unit 1.

The review was limited to those primary control panels with which the operator normally interfaces. In addition, the review was extended to cover the Hot Shutdown Panel. The noise, lighting and environmental surveys were performed in the Control Room. CPSES has also agreed to perform these surveys at the Hot Shutdown Panel.

3.4 SURVEYS

3.4.1 Control Room Workspace

3.4.1.3 Scope

3.4.1.3.4 Noise, Lighting and Environmental

A final noise, lighting and environmental surveys have been performed. The methodology used is contained in Appendix H. The noise, lighting and environmental surveys at the Hot Shutdown Panel will be addressed after they are completed.

6.0 INCOMPLETE TASKS

6.1 INTRODUCTION

All portions of the CPSES detailed CRDR have been completed.

6.2 NOISE, LIGHTING AND ENVIRONMENTAL SURVEYS

All required surveys have been completed. The agreed upon noise, lighting and environmental surveys at the Hot Shutdown Panel have been scheduled for the near future.

6.3 SYSTEM ANALYSIS

The systems analysis is complete as discussed in Section 1.5.2.

APPENDIX A

HED ORGANIZATION
AND
CROSS REFERENCES

APPENDIX A HED ORGANIZATION AND CROSS REFERENCES

HED CONTROL NO.	APPENDIX B SECTION								
	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
25								25	
335	335								
336	336								
337	337								
338					338				
339							339		
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APPENDIX B

HED SUMMARIES

2.0 WORKSPACE HEDS

A. HED DESCRIPTION

MLB lamp tests are not accessible to 50th percentile operators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.b.(1).

C. LOCATION

CB-01, CB-02, and CB-11

D. POTENTIAL SAFETY CONSEQUENCES

Inability to detect MLB failures.

E. ASSESSMENT PROCESS

1. Feasibility of relocating lamp tests was examined.
2. Alternative locations were evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

CPSES realizes the need to be able to test the MLB lamps from a location accessible to the fifth percentile operator, however, in view of the possibility to compromise plant safety with such an extensive change, we do not feel it is justified. Furthermore, since the control room will be manned with a minimum of 5 operators at any given time, it is highly unlikely that at least one of those operators will not be able to test the MLB lamps from their present test location.

A. HED DESCRIPTION

The control room has several traffic obstructions (the PRODAC and drawing layout table) which obstruct traffic flow between portions of the control boards.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.1.3.c.1.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The drawing layout table is temporary and will be replaced with permanent furniture. The PRODAC is essential to the operator for information retrieval and as such is located with similar readout devices. Location of the PRODAC does not significantly impede operator mobility.

A. HED DESCRIPTION

Temporary control room ventilation presents white noise, which could degrade communications as well as mask alarms and communications signals.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.5.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to respond to alarm condition.
2. Failure to acknowledge communications.

E. ASSESSMENT PROCESS

Control room noise survey

F. BACKFIT

Ambient noise levels were found to be below 65 dBA as prescribed in the guidelines. Carpeting will be installed in the control room to further reduce "white noise".

A. HED DESCRIPTION

Conclusive NRC sound level surveys were not performed.

B. GUIDELINE REFERENCE

None

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

NA

E. ASSESSMENT PROCESS

None.

F. BACKFIT

A sound level survey has been performed as detailed in Appendix H.

A. HED DESCRIPTION

Recorder glass causes glare, thereby hampering readability of scale indicators

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.1

C. LOCATION

All panels except CB-11 and CB-12

D. POTENTIAL SAFETY CONSEQUENCES

Delayed in or incorrect data interpretation.

E. ASSESSMENT PROCESS

Source of glare was pinpointed during lighting survey.

F. BACKFIT

The source of the glare on recorder glass was determined to be reflected light from the control room floor. The control room floor is being replaced with carpeting to reduce noise levels. We anticipate using a darker color to reduce reflected light which should correct the glare problem on recorder glass. This will be re-evaluated after installation of the carpet in the control room.

A. HED DESCRIPTION

Toggle switches located below recommended 34-inch minimum height.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.a.(1).

C. LOCATION

In-core instrumentation panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Situations requiring operator interface with these switches were reviewed.

F. BACKFIT

These toggle switches were used to select an In-Core thermocouple for monitoring on the P2500 computer. With the new Core Cooling Monitoring (CCM) design, these toggle switches are bypassed and will be removed.

A. HED DESCRIPTION

Infrequently operated controls located above 70-inches maximum height from floor.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.a.(1).

C. LOCATION

In-core instrumentation panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Situations involving requiring interface with these switches were reviewed.

F. BACKFIT

None.

1. JUSTIFICATION

The In-Core Instrumentation Panel is not used by the operator for plant operations. It is used by the plant reactor engineer to periodically run flux maps on the reactor core to determine fuel burn-out. The operator may be called upon to assist the reactor engineer, however, this will not occur frequently enough to warrant rearrangement of the controls on this panel.

A. HED DESCRIPTION

Controls are too high (above 74 inches) and too low (24 inches) for easy access. Recorders are too low (below 41 inches) for easy visibility.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5.a.(1) and b.(1).

C. LOCATION

Radiation Monitoring Panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The Radiation Monitoring Panel has been redesigned to improve control and display location problems. Due to the density of controls/displays located on this panel, there are still some controls located below 24 inches. However, in view of the operator's infrequent use of this panel during normal operations, this poses no threat to plant safety.

A. HED DESCRIPTION

Glare hampers readability of PRODAC.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.f.

C. LOCATION

Printer console.

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect or delayed data interpretation.

E. ASSESSMENT PROCESS

1. Determined source
2. Evaluated impact on readability of printed information.

F. BACKFIT

None

1. JUSTIFICATION

Glare on PRODAC does not impede the readability of the printed information.

A. HED DESCRIPTION

Controls violate anthropometric maximum and minimum requirements of distance from the control board edge.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.d.(1) and (2).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Inadvertent control actuation.

E. ASSESSMENT PROCESS

Potential backfits were investigated.

F. BACKFIT

None.

1. JUSTIFICATION

An anthropometric study was conducted to evaluate the accessibility of controls. Controls located on the transition and vertical sections of the control boards were found to be out of the extended reach of the 5th. percentile female operator. Where feasible, controls were moved to where they are within reach. Where movement was not feasible, control functions were examined individually to determine the safety-related consequences of misoperation, if any, due to its inaccessibilty. The only controls that were found to have the potential for safety-related consequences due to misoperation were the Auxiliary Feedwater Flow controllers and the Turbine Driven Auxiliary Feedwater Pump speed controller located on the transition section of CB-09. These controls will be used in conjunction with the process indications located directly above them. Any misoperation which may occur due to these controls being difficult to reach will be immediately apparent to the operator through the feedback provided by these indications.

A. HED DESCRIPTION

The oblique angle from the operator's line of sight to the plane of the outboard annunciators is less than 45° from several control stations. This contributes to poor readability, especially on panels CB-09, CB-11, and CV-01. In the case of CV-01, many annunciators cannot be read at all from the control station.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.2.e.(2)

C. LOCATION

CB-09,11,CV-01

D. POTENTIAL SAFETY CONSEQUENCES

1. Failure to respond to alarm
2. Possible equipment damage due to delayed response time.

E. ASSESSMENT PROCESS

1. Evaluated readability of far left/right annunciator tiles from annunciator control station.
2. Evaluated feasibility of relocating control stations to increase viewing angle.
3. Evaluated feasibility of adding control stations in an area such that viewing angle would be 45°.
4. Evaluated feasibility of moving annunciator tiles to a more readily viewable position.

F. BACKFIT

JUSTIFICATION

1. CPSES realizes that the viewing angles are acute and that it affects the operators ability to read the legends on the outboard columns of the annunciator matrices of the annunciators on CB-09, CB-11, and CV-01 from their respecitve annunciator control stations.

The viewing angles on CB-09 and CB-11 were re-evaluated and, in particular, operators were consulted. It is our conclusion that the problem does not affect the operator's ability to respond to those alarms in a timely manner.

2. For CV-01, the annunciator control station will be moved from the end of the panel closest to the operator to a more central location. The relocation of this control station will generally cause the operator to pass in front of the annunciators prior to reaching the control station. This backfit represents the most reasonable modification for ensuring that the operator knows which annunciators are affected by actions at the control station.

A. HED DESCRIPTION

There is no scheme for rapid, positive identification of Unit 1 and Unit 2 procedures.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.3.1.d.

C. LOCATION

Control Room

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect operator response

E. ASSESSMENT PROCESS

None required

F. BACKFIT

Procedures manuals for Unit 1 and Unit 2 will be uniquely identified.

A. HED DESCRIPTION

According to plant conventions for shared panels, Unit 1 controls and displays are located toward the Unit 1 control room and Unit 2 controls and displays are located toward the Unit 2 control room. This convention is violated on the Radiation Monitoring Panel.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.3.1.e(4)

C. LOCATION

CV-13

D. POTENTIAL SAFETY CONSEQUENCES

Misinterpretation of displays

E. ASSESSMENT PROCESS

Evaluated feasibility of rearranging displays

F. BACKFIT

Displays for Unit 1 and Unit 2 Containment Radiation will be interchanged.

A. HED DESCRIPTION

Human factors improvements have not been made to the NIS Panel, the Meteorological Panel, the In-Core Instrumentation Panel, or the Recorder Panel.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.2.5

C. LOCATION

NIS Panel, Meteorological Panel, In-Core Instrumentation Panel, Recorder Panel.

D. POTENTIAL SAFETY CONSEQUENCES

1. Inability to operate controls
2. Failure to read displays.

E. ASSESSMENT PROCESS

Determine operator interface requirements at these panels.

F. BACKFIT

None.

1. JUSTIFICATION

Each of these panels was design reviewed for compliance with NUREG-0700 guidelines. Several HEDs were identified on each panel. The HEDs written against the Meteorological Panel and against the Recorder Panel are covered in this report and will be dispositioned as described herein. The HEDs written against the NIS Panel and against the In-Core Instrumentation Panel were not addressed since the operator very rarely interfaces with these panels.

A. HED DESCRIPTION

Ambient noise levels make verbal communications difficult at distances of over 16 feet.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.5.a.

C. LOCATION

Control Room

D. POTENTIAL SAFETY CONSEQUENCES

Failure to communicate

E. ASSESSMENT PROCESS

None required

F. BACKFIT

Carpeting is being installed in the control room to reduce ambient noise.

A. HED DESCRIPTION

Illumination levels are excessive.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.a

C. LOCATION

CB-04, 12

D. POTENTIAL SAFETY CONSEQUENCES

None

E. ASSESSMENT PROCESS

Illumination survey.

F. BACKFIT

Translucent diffusing panels will be installed to temper the illumination levels in these areas.

A. HED DESCRIPTION

Illumination levels are inadequate

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.a

C. LOCATION

SRO desk

D. POTENTIAL SAFETY CONSEQUENCES

None

E. ASSESSMENT PROCESS

Illumination survey

F. BACKFIT

SRO desk will be provided with a desk lamp to improve workplace illumination.

A. HED DESCRIPTION

Reflectance of upper walls is excessive

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.g

C. LOCATION

Control room

D. POTENTIAL SAFETY CONSEQUENCES

None

E. ASSESSMENT PROCESS

Reflectance calculations from illumination/luminance data.

F. BACKFIT

None.

1. JUSTIFICATION

The high reflectance of the upper walls in the control room does not degrade the overall lighting levels in the control room.

A. HED DESCRIPTION

Reflectance of consoles/panel surfaces is excessive.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.g

C. LOCATION

Control room

D. POTENTIAL SAFETY CONSEQUENCES

None

E. ASSESSMENT PROCESS

Reflectance calculations from illumination/luminance data.

F. BACKFIT

None.

1. JUSTIFICATION

The high reflectance of the consoles/panel surfaces does not degrade the overall lighting levels in the control room.

A. HED DESCRIPTION

Illumination levels under Train A emergency lighting are insufficient.

B. GUIDELINE REFERENCE

NUREG-0700: 6.1.5.3.c

C. LOCATION

CV-01, 03

D. POTENTIAL SAFETY CONSEQUENCES

Inability to read

E. ASSESSMENT PROCESS

Emergency lighting Survey

F. BACKFIT

Perform a review of lighting system and evaluate the feasibility of adding Train B lighting at CV-01 and CV-03.

A. HED DESCRIPTION

Control Room temperature was not maintained within comfort range.

B. GUIDELINE REFERENCE

NUREG-0700: 0700: 6.1.5.1.a

C. LOCATION

Control Room

D. POTENTIAL SAFETY CONSEQUENCES

NONE

E. ASSESSMENT PROCESS

Environmental Survey

F. BACKFIT

Control Room HVAC system is currently being modified. The survey will be repeated when the implementation is complete.

3.0 COMMUNICATIONS HEDS

A. HED DESCRIPTION

Inadequate provisions for communication between HVAC panel and the main control room and between the In-Core Instrumentation panel and the main control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.8.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in or incorrect HVAC operation.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A page phone has been installed at the HVAC panels. Communications between the In-Core Instrumentation panel and the main control room are not required.

A. HED DESCRIPTION

Presently, there is only one outside phone in the control room. There is no dedicated phone for NRC hotline, state or local authorities, or NRC operations center.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.8.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A

E. ASSESSMENT PROCESS

Requirements for communications in the control room were assessed.

F. BACKFIT

All required communication links to the control room will be provided. These communication links include the following:

1. Dedicated link to NRC Incident Response Center over the Emergency Notification System.
2. Dedicated telephone links to the Technical Support Center (TSC), Emergency Operations Facility(EOF), Operations Support Center (OSC), Dept. of Public Safety, Hood County EOC, Somervell County EOC, and the System dispatcher.
3. Two-way radio communication to the TSC, EOF, and OSC.
4. Normal telephone communications to all of the above.
5. Sound-powered telephone communications to various In-Plant areas.

A. HED DESCRIPTION

No communication link between control room and Technical Support Center.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.7.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

The following communication links will be provided between the control room and the Technical Support Center:

1. Dedicated telephone
2. Two-way radio
3. Normal telephone

A. HED DESCRIPTION

Sound-powered jack communications are incomplete.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.3.b.(6)

C. LOCATION

Control room and HSP

D. POTENTIAL SAFETY CONSEQUENCES

N/A

E. ASSESSMENT PROCESS

The sound-powered jack communications were re-evaluated.

F. BACKFIT

Sound-powered jack communications have been completed. Headsets will be provided in the control room and at the Hot Shutdown Panel.

A. HED DESCRIPTION

Page speaker volume prevents detection of some auditory alarms.

B. GUIDELINE REFERENCE

NUREG-0700: 6.2.1.6.3(1)

C. LOCATION

Control room

D. POTENTIAL SAFETY CONSEQUENCES

Failure to respond to alarm

E. ASSESSMENT PROCESS

None required

F. BACKFIT

Page speaker volume will be adjusted to ensure that speaker communications do not mask auditory alarms.

4.0 ANNUNCIATOR HEDS

A. HED DESCRIPTION

Audible alarms are not discernible over ambient control room noise.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.1.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to respond to alarm condition.

E. ASSESSMENT PROCESS

Control room noise survey.

F. BACKFIT

Audible alarm levels will be adjusted such that they are at least 10 dBA over ambient noise levels as measured from any station where auditory recognition is required.

A. HED DESCRIPTION

The ability of an alarm to capture the operator's attention could not be evaluated.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.1.c.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to respond to alarm condition.

E. ASSESSMENT PROCESS

Control room noise survey.

F. BACKFIT

Audible alarm levels will be adjusted such that they are at least 10 dBA above ambient noise levels as measured from any station where auditory recognition is required.

A. HED DESCRIPTION

Alarm detection levels could not be evaluated.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.2.1.d.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to respond to alarm condition

E. ASSESSMENT PROCESS

Control room noise survey.

F. BACKFIT

Audible alarm levels will be adjusted such that they are at least 10 dBA above ambient noise levels as measured from any station where auditory recognition is required.

A. HED DESCRIPTION

When the lamp drive transistor fails on the cards, the lamp box fails OFF. If there is a failure in the control card (which controls the flash rate for individual alarms), it will also fail OFF.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.2.c.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to identify problems.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

A full functional annunciator test will be performed per shift and repairs made as required.

A. HED DESCRIPTION

Annunciator tile legends are not specific.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.3.4.a.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to understand or correct problem.

E. ASSESSMENT PROCESS

A readability survey was performed.

F. BACKFIT

The legends have been reviewed and will be rewritten, as necessary, to make the message clear and understandable. An informal design change procedure has been instituted to assure that new annunciators are human factored in accordance with Appendix C before installation.

A. HED DESCRIPTION

Lack of strong administrative procedures governing testing of annunciators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.3.4.1.d.(2) and 6.3.4.2.c.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to detect alarm failure.

E. ASSESSMENT PROCESS

1. The need to test annunciators was assessed.
2. The methods by which annunciators could be tested were assessed.

F. BACKFIT

Administrative procedures will be implemented for the testing of annunciators and replacement of defective bulbs, as required.

5.0 CONTROLS HEDS

A. HED DESCRIPTION

Control switches violate direction of movement convention (e.g., AUTO is counter-clockwise and CLOSE is clockwise) and control positions are inconsistent across controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.1.

C. LOCATION

CB-03 and CB-10.

D. POTENTIAL SAFETY CONSEQUENCES

1. Improper control operation.
2. Loss of sampling capacity.
3. Loss of main steam relief heating steam.

E. ASSESSMENT PROCESS

Feasibility of modifying switch positions was assessed.

F. BACKFIT

Control switch positions will be changed to meet established human engineering stereotypes.

A. HED DESCRIPTION

Different switch types are used for valve controls - different plant equipment (i.e., pumps, valves) operated by J-handles.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.d.

C. LOCATION

CB-08 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect system operation.
2. Loss of feedwater could result in possible plant shutdown.

E. ASSESSMENT PROCESS

1. Reviewed feasibility of shape coding.
2. Reviewed feasibility of symbol coding.

F. BACKFIT

J-handles valve controls will be coded with a valve symbol on the handle to differentiate them from J-handle pump controls.

A. HED DESCRIPTION

Continuous adjustment rotary control knobs are uncomfortable and fatiguing if held in the contact position for a long time.

B. GUIDELINE REFERENCE

NUREG/CR-1580: CON-37

C. LOCATION

CB-03

D. POTENTIAL SAFETY CONSEQUENCES

Failure to open containment hydrogen purge dampers.

E. ASSESSMENT PROCESS

1. Function of switches were reviewed.
2. Electrical schematic drawings were reviewed to verify circuits.

F. BACKFIT

Continuous adjustment rotary controls will be provided with extended handles to make them less fatiguing to operate.

A. HED DESCRIPTION

CMC switches stop between detented positions.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.4.5.b.2.

C. LOCATION

CB-02 and CB-04.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect SI valve alignment.
2. Loss of SI flow.

E. ASSESSMENT PROCESS

Incorrect positioning of these switches was investigated.

F. BACKFIT

None.

1. JUSTIFICATION

These CMC switches can only be stopped between positions with a concentrated effort to do so. If they are inadvertently stopped between positions, feedback is provided through the valve position lights located on the switch module. Furthermore, these valve controls are used very infrequently under strong administrative controls making misoperation very unlikely.

A. HED DESCRIPTION

There is no coding or visual enhancement for controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

1. Incorrect control/display association.
2. Improper control actuation.

E. ASSESSMENT PROCESS

The applicability of various types of visual enhancements were examined.

F. BACKFIT

Controls will be coded and visually enhanced as outlined in Appendix G:

A. HED DESCRIPTION

The color coding of pushbuttons on the miniature turbine control panel and on the process controllers is indiscriminant.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.f.

C. LOCATION

CB-04, CB-05, CB-06, CB-08, CB-09, CB-10, CV-01, and CV-03.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Color coding of process controller pushbuttons will be changed as follows:

Amber - manual
White - auto
Red - increase output
Green - decrease output

The pushbutton color coding on the miniature turbine control panel is clear and unambiguous.

A. HED DESCRIPTION

A rotary control with clockwise-counter clockwise movement is used to control a "lower" and "raise" function.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1.a. or 6.4.2.1.

C. LOCATION

CB-11

D. POTENTIAL SAFETY CONSEQUENCES

Diesel Generator shutdown from incorrect voltage control.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

Switch configurations will be changed to have "RAISE" in the clockwise position and "LOWER" in the counterclockwise position.

A. HED DESCRIPTION

The association between controls and related display is not immediately apparent, i.e., the meaning of coding of selector switch and pointer on trend recorder is not obvious.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.f.(2).

C. LOCATION

CB-07

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of color coding was reviewed.

F. BACKFIT

Color coding will be added to key each selector switch to the appropriate recorder pen.

A. HED DESCRIPTION

Westinghouse controllers are used in the control room for the Steam Generator PORV's. Leeds and Northrup controllers are used for the same function on the Hot Shutdown Panel.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.1.1 (2)

C. LOCATION

HSP

D. POTENTIAL SAFETY CONSEQUENCES

Misoperation of controllers

E. ASSESSMENT PROCESS

Determine what, if any, operational differences exist between these two controller types.

F. BACKFIT

None.

1. JUSTIFICATION

The Westinghouse controllers used for Steam Generator PORV control from the control room are setpoint controllers and operate automatically to maintain main steam line pressure at the setpoint valve. The Leeds and Northrup controllers on the HSP are strictly manual loaders used to manually position the Steam Generator PORV's to regulate main steam line pressure. These operational differences dictated the use of the two different controller types.

6.0 VISUAL DISPLAY HEDS

A. HED DESCRIPTION

If rod control lever is held down, the step counters will continue to advance beyond 228 steps after the control rods are entirely out.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.e.

C. LOCATION

CB-07.

D. POTENTIAL SAFETY CONSEQUENCES

Only applicable in bank control with no safety consequences.

E. ASSESSMENT PROCESS

CPSES reviewed with Westinghouse, the supplier of this equipment, the criteria for control board interface as it relates to reactor operation and control rod manipulation.

F. BACKFIT

The Westinghouse design for control rod control requires that these step counters continue to count past 228 steps if the operator inadvertently advances the control rods after they are entirely out. A recovery procedure will be provided for the operator in the event that this misoperation occurs.

A. HED DESCRIPTION

Reactor Coolant Pump vibration levels are not displayed in startup area.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.

C. LOCATION

CV-07

D. POTENTIAL SAFETY CONSEQUENCES

Possible Reactor Coolant Pump damage.

E. ASSESSMENT PROCESS

The operational requirements to successful performance in situations involving this indication were reviewed.

F. BACKFIT

None.

1. JUSTIFICATION

Section 7.5 of the CPSES FSAR details the "Information Systems Important to Safety". The analyses and evaluations performed in conjunction with the development of this section did not identify RCP vibration as a parameter required to permit the operator to take action to mitigate design basis accident event scenarios.

A. HED DESCRIPTION

Reactor coolant drain tank level indication is not displayed in the control room.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.

C. LOCATION

Control room

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Section 7.5 of the CPSES FSAR details the "Information Systems Important to Safety". The analyses and evaluations performed in conjunction with the development of this section did not identify RCDT level as a parameter required to permit the operator to take action to mitigate design basis accident event scenarios.

A. HED DESCRIPTION

Inconsistent pointer positi8on in de-energized circular meters.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.

C. LOCATION

CB-11

D. POTENTIAL SAFETY CONSEQUENCES

Incorrect display interpretation.

E. ASSESSMENT PROCESS

Each meter was examined to determine its proper pointer position when de-energized.

F. BACKFIT

None.

1. JUSTIFICATION

Redundant information exists to determine whether a meter has failed or whether it is reading zero. For voltmeters, the redundant information is the position of the feeder breaker(s) for that bus. If one of the feeder breakers is closed, then there should be voltage on the bus. Ammeter readings can be verified through the associated voltmeters. During normal operation, if there is voltage on a bus, then there should be current flow from the bus (as measured at the feeder breaker). Ammeter readings can be verified locally. This is done twice per shift as part of the operators daily routine. Frequency meters should always read 60 Hz when energized. Wattmeters should read positive whenever there is voltage and current.

A. HED DESCRIPTION

There is no test function for some LED displays.

B. GUIDELINE REFERENCE

NUREG/CR-1580: VD-91.

C. LOCATION

CB-08, CB-09, CB-10, CB-12.

D. POTENTIAL SAFETY CONSEQUENCES

None

E. ASSESSMENT PROCESS

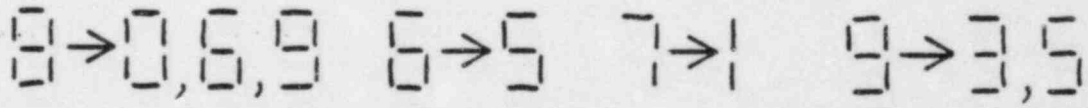
Assessed life span of LEDs.

F. BACKFIT

None.

1. JUSTIFICATION

LEDs are highly reliable and typically long-lived displays. Should a segment on one of the digits fail, our evaluation identified six undetectable failures. These failures are illustrated below:



Each of these failures was evaluated as it affected each digit of each digital display. The only significant failure was determined to be in the "hundreds" digit of the AFWPT SPEED display since this failure could go undetected for some time. Such a failure, however, would not affect system operation. Redundant AFW flow indications are provided to assure that the AFWPT is performing its safety function.

Furthermore, periodic surveillance tests will be performed to assure that each digital display is operating properly.

A. HED DESCRIPTION

Brightness of indicator lights is variable, due to the use of different light covers.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Extent/magnitude of the variability was evaluated.

F. BACKFIT

The existence of different intensities of red and green indicator lights caused by the use of different indicator light types does not, in CPSES's opinion, affect discrimination between priorities or the operator's color sensitivity. The different intensities of red and green indicator lights that exists in the Master Specialties Series 90K and 800K lights is caused by the fact that some have translucent diffusers and some do not. For Master Specialties Series 90K and 800K lights, all translucent diffusers will be removed.

A. HED DESCRIPTION

Scales on trend recorders obscure pen traces and other scales.

B. GUIDELINE REFERENCE

NUREG/CR 1580: VD-10 and VD-78.

C. LOCATION

CB-05 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

1. Delayed or incorrect reading.
2. Reactor trip.
3. Loss of seal flow.

E. ASSESSMENT PROCESS

Alternative solutions were generated and evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

These recorders are used to trend selected parameters. They are not used for indication. As such the visibility of the pen traces and scales from the normal operating position is not critical. Indications of the parameters required for normal operation are provided on vertical meters located in close proximity to these recorders.

A. HED DESCRIPTION

J-handle "target" colors are difficult to differentiate from each other.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.3.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in control operation.

E. ASSESSMENT PROCESS

Cause of poor differentiation between colored flag indicators was determined.

F. BACKFIT

The "target" colors are difficult to differentiate between because the targets are dirty as a result of construction activity. The targets will be cleaned to make colors easy to differentiate.

A. HED DESCRIPTION

There is no lamp test provided to test indicator lights associated with control switches.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.a.2.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in response to component failure.

E. ASSESSMENT PROCESS

Functional modes of indicator lights were investigated.

F. BACKFIT

Sufficient feedback exists for the operator to determine a lamp failure without the use of a lamp test feature. Administrative procedures will be written to require the operator to perform a check for and replace failed lamps at each shift turnover.

A. HED DESCRIPTION

No control coding is currently being used for:

a. Mechanical valves, pumps, breakers, motors, etc.

b. Throttle valves.

c. Emergency or critical controls.

B. GUIDELINE REFERENCE

NUREG-0700: 6.4.2.2.

C. LOCATION

CB-08 and CB-09.

D. POTENTIAL SAFETY CONSEQUENCES

Improper control actuation.

E. ASSESSMENT PROCESS

1. Reviewed various forms of coding, including shape, size, and symbology coding.
2. Estimated effectiveness of using labeling to contain information, differentiating types of components.
3. Assessed symbology coding as the most effective and feasible means of denoting various types of components.

F. BACKFIT

Control switches will be coded as specified in Appendix G.

A. HED DESCRIPTION

Incomplete color coding of indicators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.

C. LOCATION

Control room.

D. POTENTIAL SAFETY CONSEQUENCES

N/A

E. ASSESSMENT PROCESS

Effort to complete indicator color coding was assessed.

F. BACKFIT

RG 1.97, Rev. 2 Category 1 indications will be color-coded as specified in Appendix G.

A. HED DESCRIPTION

Overlapping pens on trend recorders cause other pens to be obscured.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.2.b.

C. LOCATION

CB-09, CB-05

D. POTENTIAL SAFETY CONSEQUENCES

1. Possible incorrect FW operation
2. Delay in operation of control.
3. Reactor trip.

E. ASSESSMENT PROCESS

Alternative solutions were generated and evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

These recorders are used to trend selected parameters. They are not used for indication. As such, the visibility of the pen traces and scales from the normal operating position is not critical. Indications of the parameters required for normal operation are provided on vertical meters located in close proximity to these recorders.

A. HED DESCRIPTION

There is no direct indication of percent flow bypassed. It must be determined by comparing letdown flow to CVCS return flow. These two indicators have different scales and are not adjacent to each other.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.1.b.8.

C. LOCATION

CB-06

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Feasibility of equipment modification was evaluated.

F. BACKFIT

None.

1. JUSTIFICATION

Indication of % BTRS bypass flow is not required. It is independent of charging and letdown flow. Indication is provided for BTRS demineralizer flow in gallon-per-minute.

A. HED DESCRIPTION

Indicator light lenses are subject to accidental interchange.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.c.(2).

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Delay or improper equipment operation.

E. ASSESSMENT PROCESS

Examine all potential problem areas.

F. BACKFIT

All potential problem areas were examined and it was determined that the only indicator light lenses that are subject to interchange are the indicator light lenses on the Safety System Inoperable Indicators (SSII). These SSII boxes have been redesigned. New indicator lights are designed such that lenses need not be removed to change bulbs; thus, inadvertent interchange is not a problem.

A. HED DESCRIPTION

Trend recorders use frosted glass.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.k.

C. LOCATION

CB-10

D. POTENTIAL SAFETY CONSEQUENCES

Possible turbine shutdown or damage.

E. ASSESSMENT PROCESS

1. Trend recorder glass was examined to determine effect on readability.
2. Replacement glass was examined.
3. Recorder operation was examined.

F. BACKFIT

None.

1. JUSTIFICATION

Recorders with frosted glass are equipped with display lighting mounted inside recorder doors. When the recorders are energized this display lighting should improve the readability of recorded data to acceptable levels.

A. HED DESCRIPTION

Trend recorder doors in the control room could swing down when unlatched and stride and obscure components located below them.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.4.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Inadvertent control actuation.

E. ASSESSMENT PROCESS

1. Effect on operations was evaluated.
2. Potential consequences of plant safety were examined.

F. BACKFIT

Recorder doors that swing down and obscure components below them are missing rubber restraints on the door hinges. These restraints will be replaced.

A. HED DESCRIPTION

Indicator lights are used to indicate unfavorable status.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.3.1.d.

C. LOCATION

CB-08, CB-09, CB-10, and CV-01.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to detect problem.

E. ASSESSMENT PROCESS

Examined enhancements to improve operator awareness.

F. BACKFIT

These red lights will be changed to white lights to indicate which parameter in a multiple input annunciator window is out of limits as per the color coding detailed in Appendix G. Specific alarm response procedures will be written to define the operator interface with these indicator lights.

A. HED DESCRIPTION

Some indicating lights do not follow the existing indicating light color code convention.

B. GUIDELINE REFERENCE

NUREG-0700: 6.5.1.6.d.(1)

C. LOCATION

CV-03, HSP

D. POTENTIAL SAFETY CONSEQUENCES

Misinterpretation of display

E. ASSESSMENT PROCESS

1. Determine intended meaning of indicating light.
2. Examine feasibility of changing color to conform to established color code.

F. BACKFIT

Indicating light colors will be changed to conform to the color code outlined in Appendix G.

7.0 LABELING & LOCATION AIDS HEDS

A. HED DESCRIPTION

Train A and Train B color coding is not applied consistently and/or correctly.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.1.1.

C. LOCATION

All panels.

D. POTENTIAL SAFETY CONSEQUENCES

Improper control actuation.

E. ASSESSMENT PROCESS

1. Usefulness of color coding train designation was assessed.
2. Examined conspicuous train label inconsistencies.

F. BACKFIT

None.

1. JUSTIFICATION

Conspicuous train color coding inconsistencies were examined and no errors were found. All apparent errors in train designation were found to be correct as is.

A. HED DESCRIPTION

Control switch indicating lights, for controls with three indicating lights, are not labeled.

B. GUIDELINE REFERENCE

NUREG 0700: 6.6.1.1.

C. LOCATION

CB-01

D. POTENTIAL SAFETY CONSEQUENCES

1. Loss of instrument air.
2. Unit shutdown.

E. ASSESSMENT PROCESS

The functional meaning of indicator lights were determined.

F. BACKFIT

None.

1. JUSTIFICATION

Control switch indicating lights, for controls with three indicating lights, conform to the color coding standard given in Appendix G.

A. HED DESCRIPTION

Remote/Local positions on HSP and STP transfer switches are confusing. It is not clear whether the "Remote" position means remote from the control room or remote from the HSP.

B. GUIDELINE REFERENCE

NUREG-0700: 6.6.3.2.d and 6.6.3.3.b

C. LOCATION

HSP, STP

D. POTENTIAL SAFETY CONSEQUENCES

Misoperation of control switches

E. ASSESSMENT PROCESS

1. Determine proper meaning of "Remote".
2. Examine alternate labels that are clearer.

F. BACKFIT

Remote/Local positions on HSP and STP transfer switches will be changed to CR/HSP, respectively.

8.0 PROCESS COMPUTER HEDS

A. HED DESCRIPTION

There is no readily available index listing information contained in the process computer groups. Thus, the operator must search for desired information or memorize the information contained in each group.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.8.b.(2).

C. LOCATION

CB-07

D. POTENTIAL SAFETY CONSEQUENCES

Delay in finding information.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

Process computer groups are programmable by the operator to fit operating situations. Point number indeces would provide no assistance since they are subject to frequent damage.

A. HED DESCRIPTION

There are no operating procedures for operator actions if total loss of the process computer system should occur.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.8.a. 5 (b)

C. LOCATION

Process computer system.

D. POTENTIAL SAFETY CONSEQUENCES

Delay in receiving and assessing information.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

An operating procedure has been provided for use during total loss of the process computer system.

A. HED DESCRIPTION

There is no color coding on the process computer CRT.

B. GUIDELINE REFFRENCE

NUREG/CR-1580: VD-52

C. LOCATION

CB-07

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

No assessment necessary.

F. BACKFIT

None.

1. JUSTIFICATION

The process computer CRT is only used for alarm summary and therefore color coding provides no advantage. Color coding will be provided on the SPDS CRT as outlined in Appendix G.

A. HED DESCRIPTION

Alarm legends on P2500 process computer do not match alarm legends on control board annunciators.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.3.2.f.(1)

C. LOCATION

Control Room

D. POTENTIAL SAFETY CONSEQUENCES

Failure to relate printed alarm message to illuminated annunciator tile.

E. ASSESSMENT PROCESS

Examine feasibility of changing process computer alarm legends.

F. BACKFIT

P2500 process computer alarm legends will be changed to match the alarm legends on control board annunciator tiles.

A. HED DESCRIPTION

Abbreviations in computer displays do not conform to those in the Comanche Peak Steam Electric Station "Dictionary of Acronyms and Abbreviations".

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.1.2.c

C. LOCATION

Process computer

D. POTENTIAL SAFETY CONSEQUENCES

Misinterpretation of display

E. ASSESSMENT PROCESS

None required

F. BACKFIT

Abbreviations on computer displays will be changed to conform to those listed in the CPSES Dictionary of Acronyms and Abbreviations.

9.0 PANEL LAYOUT HEDS

A. HED DESCRIPTION

If operator fails to acknowledge a process computer alarm at printer console, subsequent process computer audio alarms will be inhibited when the main CRT flashes an alarm.

B. GUIDELINE REFERENCE

NUREG-0700: 6.7.3.2.

C. LOCATION

Printer console.

D. POTENTIAL SAFETY CONSEQUENCES

Failure to receive CRT alarm message.

E. ASSESSMENT PROCESS

Feasibility of reprogramming computer was evaluated.

F. BACKFIT

None

1. JUSTIFICATION

This is a desireable feature from the standpoint that it requires the operator to acknowledge each alarm individually as it is printed at the printer console.

A. HED DESCRIPTION

The controls and displays on the Radiation Monitoring Panel are arranged by train and are mirror imaged.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.3.3.

C. LOCATION

Radiation Monitoring Panel.

D. POTENTIAL SAFETY CONSEQUENCES

None.

E. ASSESSMENT PROCESS

Operational situations were reviewed.

F. BACKFIT

The Radiation Monitoring Panel has been redesigned to correct mirror imaging.

A. HED DESCRIPTION

Layout of electrical distribution system controls/indicators is mirror-imaged.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.3

C. LOCATION

CB-11

D. POTENTIAL SAFETY CONSEQUENCES

Misoperation of Diesel Generator controls

E. ASSESSMENT PROCESS

1. Reviewed feasibility of rearranging components.
2. Reviewed operability of panel in its present layout.

F. BACKFIT

The electrical distribution system controls are best mimicked in a "mirror-image" layout. Demarcation and hierarchical labeling was added to the electrical distribution system indicators to enhance their layout and improve control/display integration.

Diesel Generator controls will be demarcated out of the mimic and rearranged such that the layout of the Diesel Generator 1 controls match the layout of the Diesel Generator 2 controls.

A. HED DESCRIPTION

Bottom-to-top orientation of Generator Ammeter Select Switches does not match left- to-right orientation of the corresponding displays.

B. GUIDELINE REFERENCE

NUREG-0700: 6.8.2.2.

C. LOCATION

CB-11

D. POTENTIAL SAFETY CONSEQUENCES

Misinterpretation of display

E. ASSESSMENT PROCESS

1. Examine feasibility of rearranging select switches.
2. Examine feasibility of rearranging displays.

F. BACKFIT

The selector switches will be interchanged to match the left-to-right orientation of the corresponding displays.

10.0 CONTROL DISPLAY INTEGRATION HEDS

A. HED DESCRIPTION

Bistable (Reactor trip status) lights [illegible]-04 are remote from related Reactor control on CB-07.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.1.2.a.

C. LOCATION

CB-04

D. POTENTIAL SAFETY CONSEQUENCES

Delay in responding to Reactor protection problems or failures.

E. ASSESSMENT PROCESS

1. Reviewed the feasibility of moving the permissive indicators to CB-07.
2. Analyzed the operator interface with these trip status lights.

F. BACKFIT

None.

1. JUSTIFICATION

Reactor trip status lights are not required for Reactor control. They are used primarily to give the operator information on the status of reactor trip bistables during normal operation. Reactor control permissives/interlocks have been provided to the operator through the installation of a Permissive and Control Interlock Panel (PCIP) located directly above the reactor controls.

A. HED DESCRIPTION

On CB-04, the left-to-right arrangement of two pairs of valve controllers (controllers 1-HIC-606 and 1-FK-618 and controllers 1-HIC-607 and 1-FK-619) and the representation of those pairs of valves in a mimic are reversed.

B. GUIDELINE REFERENCE

NUREG-0700: 6.9.2.2.c(1)

C. LOCATION

CB-04

D. POTENTIAL SAFETY CONSEQUENCES

Misoperation of controllers

E. ASSESSMENT PROCESS

None required

F. BACKFIT

Mimic has been reversed to match controller layout.

APPENDIX C - ANNUNCIATOR SYSTEM HUMAN ENGINEERING GUIDELINES

4.0 GUIDELINES

4.3 DETAILED GUIDELINES

The detailed human engineering guidelines as provided in the original report are modified to read as noted below:

C. LOCALIZATION OF ANNUNCIATOR ALARM SIGNALS AND CONTROL STATIONS - LOCALIZED

2. Annunciator Control Stations

c. Annunciator Control Stations should be coded to distinguish them from nearby associated controls as specified in Appendix G.

E. PRIORITIZATION OF ANNUNCIATOR ALARMS

3. If color is used to prioritize alarms, the color code should conform to the guidelines set forth in Appendix G.

APPENDIX D - VERTICAL INDICATOR HUMAN ENGINEERING GUIDELINES

5.0 GUIDELINES

The design requirements for the coding of vertical indicators has been expanded as noted below:

5.3 DESIGN REQUIREMENTS

G. Coding - Both single and dual indicators may be coded for normal operating range and setpoints. Coding schemes should conform to the guidelines set forth in Appendix G.

APPENDIX E - DEMARCATION, LABELING, AND MIMC HUMAN ENGINEERING GUIDELINES

5.0 GUIDELINES

The guidelines for train indication on labels and the color coding of mimic have been modified as noted below:

E. Label Design Requirements

4. Label Qualities

f. Train Indication - Train should be indicated on labels for train specific controls and displays. Train color coding should conform to the guidelines set forth in Appendix G. The design should be selected for ease of recognition at the anticipated viewing distance at which train identification is required.

H. Mimics

9. Color Coding - Mimic line color should conform to the color coding scheme set forth in Appendix G.

APPENDIX G

CODING

HUMAN ENGINEERING GUIDELINES

HUMAN ENGINEERING GUIDELINES

1.0 PLANT: Comanche Peak Steam Electric Station

3.0 REV. NO. 0
REV. DATE _____

2.0 TITLE: CODING STANDARDS

4.0 GUIDELINES

4.1 INTRODUCTION

In the large interactive systems of a nuclear power plant, hundreds of controls and displays must be operated and monitored. Locating and operating the appropriate control or display can be crucial to safe operation of the plant, especially in transient or emergency situations. Operator aids can be useful to support efficient, safe, and expedient operations. One such operator aid that has been proven effective in the identification and processing of information is the use of coding schemes. The following sections set forth the guidelines which should be followed when implementing coding schemes in the Comanche Peak Steam Electric Station (CPSES) control room.

4.2 BACKGROUND

These guidelines have been prepared for the CPSES control room. Specific design requirements and criteria have been selected based on NUREG-0700 guidelines, generally accepted and applied human engineering criteria, and conventions currently employed in the existing CPSES control board design. These guidelines were developed as part of the detailed control room design review. In several instances the constraints of the existing design preclude backfits which would be optimal in accordance with human engineering guidelines.

4.3 PURPOSE

The purpose of these guidelines is to provide specific human engineering guidance and criteria for developing uniform, standardized, coding schemes in the CPSES control room. Application of these guidelines to the development of coding schemes should result in the following:

A. Reduced misinterpretation of displays
B. Reduced visual search time for controls/displays
C. Reduced probability of control usage errors
D. Ease in identifying functional relationships

4.4 GENERAL GUIDELINES

Coding schemes selected for use in the CPSES control room should conform to the following general guidelines:

A. The meaning assigned to a particular code or coding scheme should be consistent throughout all control room applications.
B. The code or coding scheme should provide redundant information to more pertinent information contained in some other form (e.g. labels, scales, etc).
C. The meaning assigned to a particular code or coding scheme should be narrowly defined.
D. Use of codes and coding schemes should not be excessive so as to become confusing or distracting.

SUPPLEMENT 1

4.5 DETAILED GUIDELINES

A. Color Coding

1. Number of colors - The number of colors used for color coding should be kept to a minimum and should not exceed eleven (11).
2. Meaning of colors - The meaning of a particular color should remain the same whether applied to control board mounted devices or to CRTs.
3. Contrast of colors - Different colors used in color coding should be easily distinguishable from one another.
4. Specific color codes

   a. Indicating lights - Color coding used for simple indicating lights should conform to the following standards:

      1. Red - pump/fan/breaker operating, valve/damper open, process controller output at maximum.
      2. Green - pump/fan/breaker not operating, valve/damper closed, process controller output at minimum.
      3. Amber - pump/fan/breaker control switch mismatch, process controller in manual.
      4. White - [1] pump/fan/breaker auto trip, process condition exists, process controller in auto.
      5. Blue - permissive satisfied.

   b. Mimic - Color coding used for mimic lines should conform to the following standards:

      1. Blue - fluid lines
      2. Grey - air lines
      3. Green - Train B electrical bus
      4. Orange - Train A electrical bus
      5. Silver - Train C (non-train) electrical bus
      6. White w/diagonal black stripes - 138kV electrical distribution
      7. White w/lateral brown stripes - 22kV electrical distribution
      8. White w/diagonal brown stripes - 345kV electrical distribution

[1] White indicating lights should be used whenever it is necessary to supplement a multiple input alarm with redundant indications. For instance, consider a design where it is desired to alert the operator to a low priority condition such as a high level in one of several auxiliary steam line drain pots. If each drain pot level were annunciated individually, it would use up valuable annunciator space. An alternate solution is to have a single multiple input annunciator that corresponds with several individual white indicating lights to pinpoint which drain pot level is out of limits.

c. Annunciator Prioritization - Color coding used for annunciator prioritization should conform to the following standards (refer to Appendix C for definition of priorities):

1. Red - first priority
2. Amber - second priority
3. White - third priority

d. Component labels - Color coding used for component labels should conform to the following standards:

1. White (black text) - component identification
2. Black (white text) - component identification for Reg. Guide 1.97, Category 1 indications.

e. Train ID labels - Color coding used for train ID labels should conform to the following standards:

1. Orange (white text) - Train A
2. Green (white text) - Train B
3. White (black text) - Train C (non-train)

f. Scale bands - Color coding used in conjunction with operating range and setpoint banding of indicator scales should conform to the following standards:

1. Red - reactor trip point
2. Amber - caution/marginal zone
3. Green - normal operating range

g. Control switches - Color coding applied to control switches should be as follows:

1. Red - emergency/critical controls
2. Yellow - annunciator controls

h. CRT displays - Color coding used in conjunction with CRT displays should conform to the following standards:

1. Bar graphs

   i. red - parameter in alarm state
   ii. green - parameter within limits
   iii. yellow - input invalid/unavailable
   iv. beige - static (borders, legends, etc)

2. P & IDs

i. red - (pump/fan/breaker) operating, (valve/damper) open.
ii. green - (pump/fan/breaker) not operating, (valve/damper) closed.
iii. white - input valid
iv. yellow - input invalid/unavailable
v. beige - static (piping, tanks, etc)

B. Size/Shape Coding

1. Size - No more than three different sizes of controls should be used for discrimination of absolute size.

2. Shape - Control shapes should be visually and tactually identifiable.

3. Consistency - Whenever practical; controls used for the same function on different items of equipment should be the same shape and size. When not practical, another coding method may be used to supplement the size/shape code.

4. Specific control switch size/shape codes - Size/shape coding of control switches should conform to the following standards:

a. J-handle controls - as a general rule, J-handle control switches should be used for all pump, fan, breaker, and emergency systems actuation controls and all other similar applications.

b. T-handle controls - T-handle control switches should be used for selector functions.

c. Star-handle controls - Star-handle control switches should be used for all synchroscope switches.

d. Thumb rotary controls - Thumb-rotary control switches should be used for valve and damper controls and all other similar applications.

In cases where application of the conventional size/ shape code is precluded due to engineering constraints, unconventional applications should be supplemented by some other type of coding (e.g. symbol coding).

C. Location Coding - Controls should be located so as to be easily related to functions and functional groupings.

1. Consistency - Controls with similar functions should be in the same location from panel to panel or within panels.
2. Repeated functions - The layout of identical control or display sets should be consistent at all locations.
3. Mirror imaging - Layouts of repeated functions should not be mirror imaged.
4. Specific Location Codes

   a. Control switch layout - Control switches for process systems should be laid out with the suction side of the system at the bottom of the control board and the discharge side of the system at the top of the control board as depicted in Figure 1.

   b. Vertical indicator layout - As a general rule, control board process indications should be laid out as depected in Figure 2.

D. Symbol Coding

1. Meaning - abstract symbols should be used only if they have a commonly accepted meaning for all intended users.
2. Distinguishability - Symbols should be unique and distinguishable from one another.
3. Standard - A commonly accepted standard configuration should be used.
4. Specific symbol codes

   a. Valve control operation - Thumb-rotary controls used for valve/damper control are generally either 2-position maintained or 3-position spring-returned to center. These two types of switches are easily differentiated from one another by the "at rest" orientation of the respective handles of each. The "at rest" orientation of the 2-position maintained control switch handle is either at 10 o'clock or at 2 o'clock. The "at rest" orientation of the 3-position spring-returned to center control switch handle is at 12 o'clock. Any deviations from these two types of control switch operations should have each discrete position coded using the following code (See illustration in Figure 3):

   → - Spring return from counterclockwise position
   ← - Spring return from clockwise position
   ⊗ - maintained position
   □ - Throttling control.

b. J-handle valve controls - Whenever it is necessary to use a J-handle control switch for valve control, a valve symbol (⋈) should be engraved on the control switch handle to differentiate J-handle valve controls from the conventional J-handle pump/fan/breaker controls.

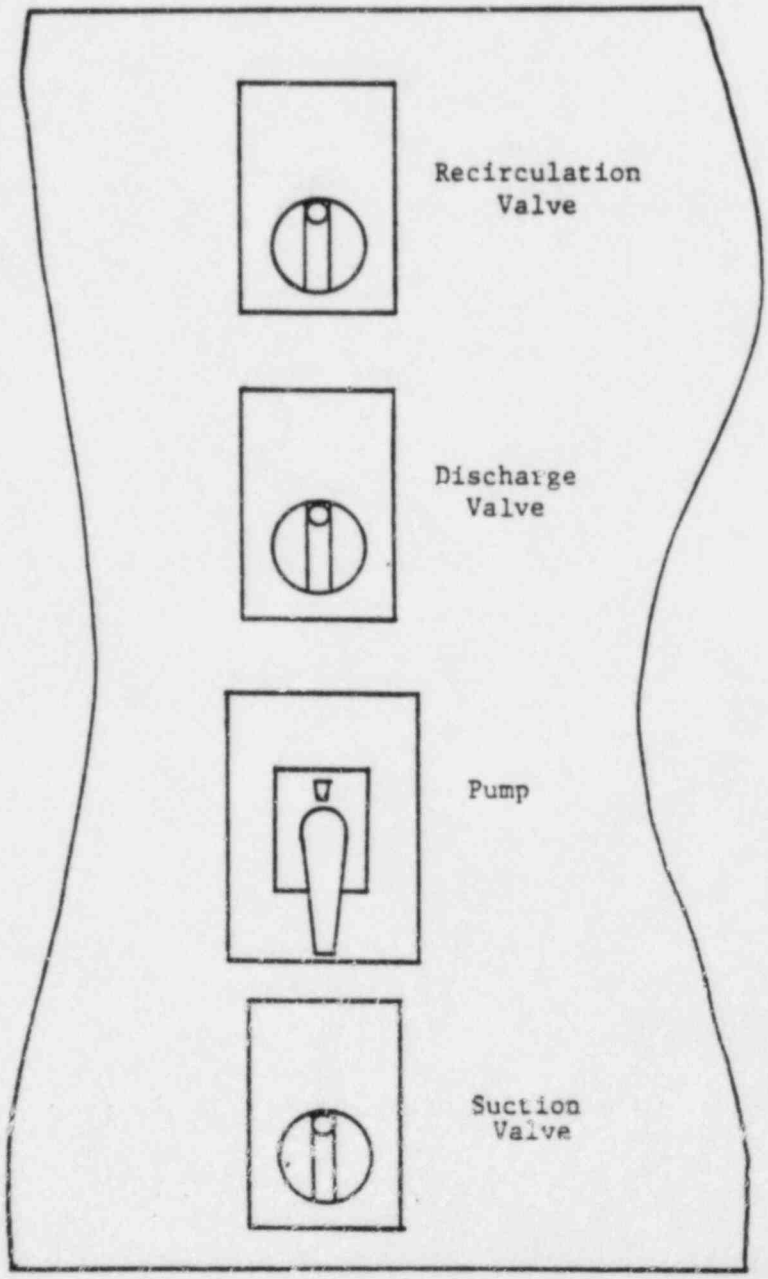


FIGURE 1

Typical Bottom-to-Top Control Switch Layout
Depicting Flow Path of Process

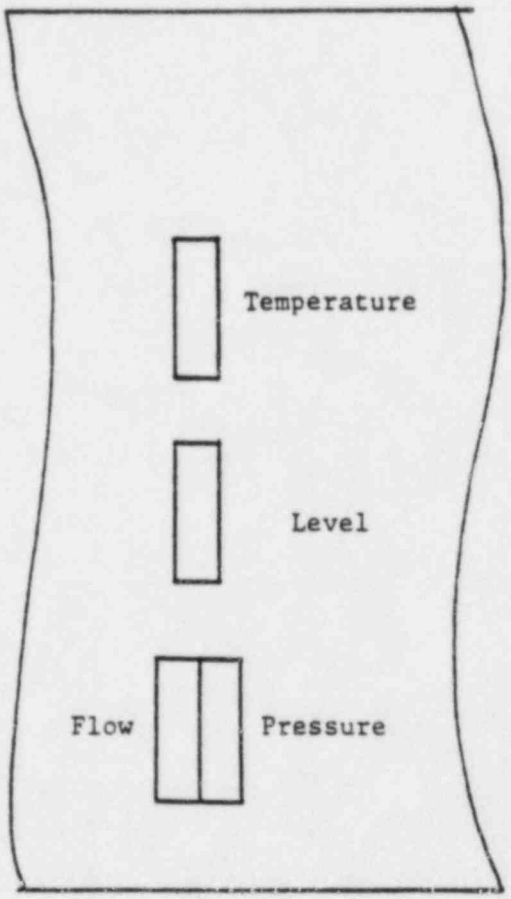


FIGURE 2

Typical Vertical Indicator Layout

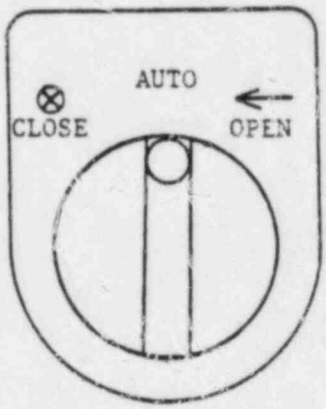


FIGURE 3

Typical Configuration of
Valve Control Operation Symbol Cooling

APPENDIX H

NOISE, LIGHTING AND ENVIRONMENTAL SURVEYS METHODOLOGY

NOISE, LIGHTING AND ENVIRONMENTAL SURVEYS

1.0 NOISE

1.1 Objective - The objective of this survey was to measure the ambient noise levels in the control room from various operator positions and assess its impact on the operators ability to verbally communicate and/or discriminate audible signals.

1.2 Instrumentation - The performance of this study required the use of an appropriate sound level meter, selected to conform to the requirements established.

1.3 Methodology - The performance of this evaluation required the consideration of not just normal control room noise but any factors that could add to the overall noise level. Included in this were the occasional noises of very short duration that caused high peak levels.

A. Noise Conditions - The noise survey started with a basal noise level; that is, the ambient noise without alarms, typers, or communications equipment contributing. Once this measurement had been taken, a measurement was taken with each potential source of added noise active. Once all potential noise sources had been measured, a measurement was taken with all these sources active simultaneously. The following are potential noise sources:

1. Audible alarms
2. Typers and printers
3. Communications equipment (ringing telephones, PAs, radios)
4. Emergency or atypical environmental control systems (air conditioning, exhaust fans).
5. Loud conversation
6. Adjacent control room alarms
7. Open doors leading out of the control room.

B Survey Conduct - Noise measurements were taken at each operator position that requires verbal communication and/or auditory discrimination of a signal. This included the Reactor Operator's console, the Senior Reactor Operator's desk, a point near the center of each panel/board, and any position at back panels requiring communications (e.g. HVAC). Three measurements were taken at each position, one with the microphone directed towards the major noise source, one with the microphone directed towards the panel surface and one with the microphone directed towards the farthest operator's position that would require communications. Measurements were taken in decibels (dBA). Any instances of extreme peak values were noted and the source located.

1.4 Data Evaluation - The collected data was compared to the appropriate guidelines contained in NUREG-0700. Values that exceeded the established limits were documented on Human Engineering Discrepancy Summary Sheets contained in Appendix B.

2.0 LIGHTING

2.1 Objectives - The objective of this survey was threefold. First, to measure the ambient illumination in the control room and assess its impact on the operator's ability to read and interpret displays, controls, labeling, and printed matter such as drawings and procedures. Second to measure the luminance of displays and calculate the luminance ratio values to determine the adequacy of display lighting. Third, to measure and calculatethe reflectance of surfaces to determine the level of reflected light in the control room.

2.2 Instrumentation - The ambient illumination was measured using a photometer and an illuminance probe. The luminance measurements were taken with a photometer and a luminance probe. Reflectance was measured using a photometer in conjunction with illumination and luminance probes. All instruments conformed to the established requirements.

2.3 Methodology - The ambient illumination was performed under normal and emergency lighting. The luminance and reflectance surveys were performed under normal lighting.

A. Ambient Illumination - Measurements were taken at all operator positions. These included:

1. Reactor operator's console
2. Senior reactor operator's work desk
3. Each control panel, including back panel areas
4. Each point where reading of printed material might be required

At each operator position a light meter was held at eye height and pointed first at the panel/desk; a second reading was taken with the meter pointed at the ceiling. If reading of printed material was required, it was in place when the measurement was taken.

B. Luminance - Measurements were taken for the display types listed below:

1. Indicator lights
2. CRT (video) characters
3. LED light emitting diode characters
4. Labels
5. Status/Monitor lights
6. Annunciator alarms

The luminance probe was focused on the reflected or emitted light source and a reading was taken. The probe was then focused on the surface adjacent to the display and another reading was taken. Measurements were taken from a wide selection of displays on the boards to provide an adequate sampling of the brightness of displays and ensure uniformity of illumination. All measurements were recorded on data sheets.

C. Reflectance - Measurements were taken for the surfaces listed below:

1. Ceiling
2. Upper wall
3. Floor
4. Operator's console
5. Senior Reactor operator's work desk
6. Control panel surface
7. Visual displays

Two measurements were taken for reflectance. First, surface luminance was measured as outlined in paragraph B. Second, surface illumination was measured as outlined in paragraph A. All measurements were recorded on data sheets.

2.4 Data Evaluation - The collected data was compared to the appropriate guidelines of NUREG-0700. The data from the luminance survey was substituted in the following formula to calculate luminance ratio (LR).

$LR = L_1/L_2$ where L_1 = Bright area and L_2 = Dark area

The data from the reflectance survey was substituted into the following formula to calculate reflectance values (R):

$R = (L/I) \times 100\%$ where L = Luminance and I = Illumination.

The values were compared to the appropriate guidelines in NUREG-0700. Any deviations from the guidelines were reported on Human Engineering Discrepancy Summary Sheets contained in Appendix B.

3.0 ENVIRONMENTAL

3.1 Objective - The objective of this survey was twofold. First, to measure the temperature and humidity in the control room. Second, to measure the temperature differential at floor level and at head level.

3.2 Instrumentation - The temperature and relative humidity were measured and recorded by two-pen temperature and humidity recorders.

3.3 Methodology - The temperature and relative humidity were recorded for a 24 hour period at two locations in the control room. One recorder was placed at an elevation of approximately six feet. The second recorder was at floor level.

3.4 Data Evaluation - The collected data was compared to the appropriate guidelines contained in NUREG-0700. Any deviations from the guidelines were reported on Human Engineering Discrepancy Summary Sheets contained in Appendix B.

TABLE 1
NOISE DATA

PLANT:	DATE:	TIME:
TEST CONDUCTED BY:		
SOUND LEVEL METER MODEL: SERIAL NUMBER:	MICROPHONE MODEL: SERIAL NUMBER:	CALIBRATION DATE:
OPERATOR POSITION:		

NOISE CONDITION/SOURCE/DIRECTION OF MEASUREMENT	dB(A)	REMARKS

TABLE 2
LIGHTING DATA

PLANT:	DATE:	TIME:
TEST CONDUCTED BY:		
PHOTOMETER MODEL: SERIAL NUMBER:	CALIBRATION DATE:	

OPERATOR/MEASUREMENT POSITION	LIGHTING CONDITIONS		REMARKS
	NORMAL	EMERGENCY	

HUMIDITY/TEMPERATURE RECORD

Plant: _____ Date: _____ Time: _____

Measurements made by: _____ Sheet # ____ of ____

Equipment/Instrument used: _____

Serial #: _____ Calibration date: _____

Time	Height	Temperature	Humidity	Remarks
	Floor			
	6 ft.			
	Floor			
	6 ft.			
	Floor			
	6 ft.			
	Floor			
	6 ft.			
	Floor			
	6 ft.			
	Floor			
	6 ft.			
	Floor			
	6 ft.			

APPENDIX I: RESPONSE TO IN-PROGRESS AUDIT OF COMANCHE PEAK STEAM ELECTRIC STATION CONTROL ROOM DESIGN REVIEW

RESPONSE TO IN-PROGRESS AUDIT OF
COMANCHE PEAK STEAM ELECTRIC STATION
CONTROL ROOM DESIGN REVIEW

1.0 DISCUSSION

On April 4 through April 8, 1983, the Human Factors Engineering Branch conducted an on-site review of the CPSES detailed CRDR. This review was documented in a July 8, 1983, letter from B. J. Youngblood, Chief, Licensing Branch No. 1, Division of Licensing to Mr. R. J. Gary, Executive Vice President and General Manager, Texas Utilities Generating Company and entitled, "Results of In-Progress Audit of Comanche Peak Steam Electric Station Control Room Design Review". This Appendix to supplement 1 responds to the conditions noted in that report which must be satisifed prior to licensing and to the concerns relating to the detailed CRDR.

2.0 CONDITIONS WHICH MUST BE SATISFIED PRIOR TO LICENSING

The audit report noted four conditions that must be satisfied prior to licensing CPSES Unit 1. The response to these four items is noted below:

1. Implementation of the identified HEDs continues. The identified corrective action for all HEDs will be completed prior to fuel load.

2. Revised HEDs are included in this supplement (supplement 1) for all HEDs specified in Appendix B of the audit report as requiring clarification.

3. HEDs are provided in this supplement (supplement 1) for the Human Engineering Discrepancies identified in Appendix C to the audit report (see HEDs 335 through 345). The HEDs describe the corrective actions and all corrective actions will be completed prior to fuel load.

4. Final noise, lighting and environmental surveys have been completed. All HED's identified as a result of these surveys are addressed in this supplement. The guidance for the noise and lighting surveys are included in Appendix H to this supplement.

   CPSES has also agreed to perform noise, lighting and environmental surveys at the Hot Shutdown Panel.

3.0 CONCERNS RELATING TO THE DETAILED CRDR

The audit report noted two concerns that related to the detailed CRDR. The first concern, pertaining a program plan, is addressed in Section 1.5.1 of this supplement. The second concern, which relates to a system function and task analysis, is addressed in Section 1.5.2 of this supplement.