10-29-81
24cyp
PNTIS

① 38028

UCTD- 19103

MASTER

HUMAN FACTORS ENGINEERING CONTROL ROOM
DESIGN REVIEW TECHNICAL EVALUATION REPORT
CALLAWAY PLANT UNIT 1

Jan Preston

September 9, 1981

Lawrence
Livermore
Laboratory

This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the Laboratory.

This work was supported by the United States Nuclear Regulatory Commission under a Memorandum of Understanding with the United States Department of Energy.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

HUMAN FACTORS ENGINEERING BRANCH

CONTROL ROOM DESIGN REVIEW

SAFETY EVALUATION REPORT

CALLAWAY PLANT UNIT 1

POSITION

As part of the NRC task actions following the TMI-2 accident (Item I.D.1, NUREG-0660, May 1980, and NUREG-0737, November 1980), we require all licensees and applicants for operating licenses to conduct a Detailed Control Room Design Review (DCRDR) to identify and correct human engineering discrepancies (HEDs). These DCRDRs will be initiated after issuance of NUREG-0700, "Guidelines for Control Room Design Reviews".

Those applicants for operating licenses who are unable to complete this review prior to issuance of a license shall make a preliminary design assessment (PDA) of their control rooms to identify HEDs and establish a schedule, approved by us, for correcting deficiencies. These applicants shall be required to complete the more detailed control room design review as are licensees with operating plants.

DISCUSSION

As a result of these requirements, Union Electric Company, through the Standard Nuclear Unit Power Plant System (SNUPPS) organization, performed a PDA of the SNUPPS control room design. Data for the PDA report were collected from two sources - the SNUPPS simulator at Zion, Illinois and the control room at the Callaway Plant. The findings of the PDA were submitted to the NRC in a report dated July 26, 1981. Some of the items identified as discrepancies in the SNUPPS PDA were specific to the simulator at Zion and did not appear in the Callaway Plant control room.

A Human Factors Engineering Branch (HFEB) team reviewed the SNUPPS PDA report. After reviewing the PDA, the HFEB team, assisted by consultants from Lawrence Livermore National Laboratory and BioTechnology, Inc., conducted an abbreviated onsite Control Room Design Review/Audit (CRDR/A) from July 29 to July 31, 1981. Because of construction status of the control room at the time of the visit, the team was unable to complete its review and may return to finish the evaluation at a later date. Most of the human engineering discrepancies identified and reported by SNUPPS in its PDA were reviewed during the HFEB design review to evaluate the suitability of proposed corrective actions. Some discrepancies identified on the simulator and reported in the PDA could not be evaluated because the systems or items were not yet available in the Callaway Plant control room.

The CRDR/A conducted by the HFEB included an evaluation of the control room layout, the adequacy of the information provided, the arrangement and identification of important controls and displays, the usefulness of the audio and visual alarm systems, the information recording and recall capability, lighting, and other considerations of human factors that have an effect on operator performance. The review was performed by means of an inspection of the control panels and interviews with the operators.

Although our review identified human engineering discrepancies, we found that overall the systems that were available for our review in the control room were designed to permit effective and efficient operator actions. The Callaway control room is the standard SNUPPS design. This standardization will aid in the transfer of operator training among the various SNUPPS units, and will make available a larger operating experience data base for this design. All the controls and displays needed during operations are on the inner and outer rings of the main control panels, rather than being partially located on the back panels. The inner consoles have a center break that permits operator movement from within the inner ring to the outer ring panels. The annunciator system includes reactor trip and turbine trip first-out information to aid the operator in diagnosing the causes of trips. The mimic designs generally seem to be helpful to the operator.

The HFEB review team identified a number of additional HEDs which will be documented in our Control Room Design Review/Audit (CRDR/A) report to be transmitted to the applicant. The report will present the prioritization of the HEDs according to their importance. Observed HEDs have been given a priority rating of one, two, or three (high, moderate, low), based on the increased potential for operator error and the possible severity of the consequences of that error.

We require the applicant to implement corrective measures for all Priority 1 and 2 deficiencies prior to issuance of an operating license because we believe that the correction of these items will significantly reduce the potential for operator error. We also require that those Priority 3 deficiencies whose resolution involves simple corrective actions relative to the potential for improving operator performance be corrected prior to issuance of an operating license. Finally, we require the applicant to report on all other Priority 3 discrepancies as part of its DCRR to be conducted in accordance with NUREG-0737, and to propose corrective actions that are acceptable to the HFEB. However, no immediate actions are specified for resolution of the Priority 3 discrepancies not scheduled for correction with the Priority 1 and 2 items because we believe that they will not significantly affect the safe operation of the plant.

During our site visit, a number of systems and items were not available for our review. These are listed in Part A of the appendix to this report. All of these items must be evaluated by the applicant when installation is complete, and any identified deficiencies must be resolved.

A letter, dated August 12, 1981, was submitted to the NRC by SNUPPS which proposed disposition of each of the human engineering findings identified in the PDA report. Some corrective actions proposed in this letter are acceptable to the HFEB. These deficiencies and their acceptable resolutions are listed in Part B of the appendix to this report. Many of the proposed resolutions in the SNUPPS letter are not acceptable to the HFEB and some findings were listed by SNUPPS as still being unresolved. All of the discrepancies identified during the PDA or during the HFEB site visit will be included in the CRDR/A report.

CONCLUSIONS

The applicant's proposed resolutions of the HEDs which are documented in Part B of the appendix to this report are acceptable to the HFEB staff.

The applicant shall submit proposed resolutions to all Priority 1 and 2 HEDs contained in the forthcoming CRDR/A report and shall implement acceptable corrective measures for all deficiencies prior to issuance of an operating license. Certain Priority 3 deficiencies that will be identified in the CRDR/A report, whose resolution involves simple corrective actions relative to the potential for improving operator performance, will also require resolution and correction prior to issuance of an operating license. In addition, the applicant shall report on all other Priority 3 discrepancies as part of its OCRDR which will be conducted in accordance with NUREG-0737.

Because of the large number of systems and items not available for evaluation during the HFEB site visit (see appendix, Part A), a second visit will be required by the HFEB review team after construction and installation are closer to completion. We require that the applicant perform an evaluation of all items not reviewed and that they submit their findings, proposed corrective actions, and schedule for implementing the actions. The report of these items shall be submitted for our review and approval 120 days before issuance of the operating license. Our final evaluation of the Callaway Plant Unit 1 control room will be reported on in a later supplement to the Safety Evaluation Report.

REFERENCES

1. NUREG-0660, Volume 1, May 1980; NRC Action Plan Developed as a Result of the TMI-2 Accident.
2. NUREG-0737, November 1980; Clarification of TMI Action Plan Requirements.
3. NUREG-0700, Guidelines for Control Room Design Reviews (To be published in the fall of 1981).
4. Human Factors Engineering Evaluation of the Standard Nuclear Unit Power Plant System (SNUPPS), July 26, 1981, SNUPPS
5. Letter: From N. A. Petrick, SNUPPS, to H. R. Denton; Response to the NRC's Human Factors Engineering Evaluation of the SNUPPS Control Room, Callaway Plant Unit 1, received August 12, 1981.
8. UCID-19103, Human Factors Engineering Control Room Design Review Technical Evaluation Report, Callaway Plant, September 9, 1981, Lawrence Livermore National Laboratory.

APPENDIX

HFEB SAFETY EVALUATION REPORT ON CALLAWAY PLANT UNIT 1

SYSTEMS AND ITEMS NOT AVAILABLE FOR HFEB REVIEW

This section contains a description of those systems and items which were not available for review during the HFEB site visit of July 29-July 31, 1981. These systems and items must be reviewed and evaluated, and any deficiencies that are identified must be corrected prior to issuance of an operating license. The term in parenthesis following some of the unevaluated items (e.g., PDA Summary #046) refers to the summary identification number assigned to each discrepancy in the PDA report submitted by SNUPPS.

1.0 CONTROL ROOM WORKSPACE

- A. Furnishings layout
- B. Procedures storage and accessibility
- C. Spare parts and tools storage and accessibility (PDA Summary #022)
- D. Operator access to work stations
- E. Emergency equipment storage and accessibility
- F. Environment
  - 1. Temperature and humidity
  - 2. Ventilation
  - 3. Illumination (including emergency system)
  - 4. Auditory environment

2.0 COMMUNICATIONS

- A. Voice communications (including communications during emergencies and while using emergency breathing apparatus)
- B. Auditory signal systems

3.0 ANNUNCIATOR WARNING SYSTEM

- A. Auditory alert signals
- B. Lamp replacement

4.0 CONTROLS

- A. SYNC CHECK RELAY BYPASS MA HS-7 (PDA Summary #150) - handle not available
- B. Missing process controllers

5.0 DISPLAYS

- A. Missing trend recorders, process controllers, vertical indicators (PDA Summary #089, #102, #123, #145, #059)
- B. All displays - not energized
- C. Indicator light intensity - not energized, final illumination system incomplete
- D. Effect of final illumination installation on display readability (PDA Summary #017, #151)

6.0 LABELS AND LOCATION AIDS

- A. Panels RLO17 and RLO18 mimics - in the process of being redesigned
- B. Maintenance tag-out system unavailable

7.0 PROCESS COMPUTER

- A. Display formats not yet prepared
- B. No alarm printer in control room for evaluation
- C. CRT displays on Panel RLO20 non-operational
- D. Effect of final illumination installation on CRT display readability

8.0-9.0 PANEL LAYOUT and CONTROL-DISPLAY INTEGRATION

- A. Remote Shutdown panel - construction and installation incomplete
- B. Panels RLO17, RLO18, and RLO22 - in the process of being redesigned (PDA Summary #115, #118, #124, #129, #132, #135, #136)
- C. Panels RLO13 and RLO14 - plant specific to Callaway (non-standard SNUPPS) and in the process of being modified

DEFICIENCIES WITH PROPOSED RESOLUTIONS THAT ARE ACCEPTABLE TO THE HFEB

This section contains a description of those deficiencies identified in the PDA report with resolutions proposed by the applicant that are acceptable to the HFEB. These items must be corrected prior to issuance of an operating license. The items are organized by NUREG-0700, Section 6 topic headings. The term in parenthesis following each HED description (e.g., PDA Summary #046) refers to the summary identification number assigned to each discrepancy in the PDA report submitted by SNUPPS.

4.0 CONTROLS

<u>PRIORITY RATING</u>	<u>FINDING</u>
2	1 There is no way to visually distinguish controls that require continuous pressure to operate from momentary contact switches. (PDA Summary #042) All pushbuttons that require the operator to depress the button until the valve or damper has completely changed state or is used to jog the valve to a mid position will be changed to a different color button with contrasting lettering. This change will be implemented for all applicable motor-operated and air-operated valves and dampers.
1	2 The REACTOR COOLANT M/U WATER control has a STOP position, a RUN position, and a PULL TO LOCK position. There is a stop provided at the RUN position that would indicate to the operator that this function had been activated. However, there is no such stop for the STOP function. There are no other indications associated with this control that would indicate that the STOP function had been activated. (PDA Summary #065) A line will be engraved on the switch face of BG-HS-26 adjacent to STOP to indicate the stop position. Since this switch provides an input to the Westinghouse reactor makeup system and controls the action of more than one device, addition of indicator lights on the switch will not be made.
1	3 Both of the SOURCE RANGE BLOCK and RESET pushbutton switches are located very close to the edge of the panel and are subject to inadvertent activation. If the reset pushbutton was accidentally activated, it would clear the system for start-up, tripping the unit off line if the reactor power level was less than 10%. (PDA Summary #073) Shrouds will be added to pushbuttons SE-HS-5 and SE-HS-10.

4.0 CONTROLS

<u>PRIORITY RATING</u>	<u>FINDING</u>
1	4 It is difficult to distinguish the legend pushbuttons from the legend lights on the MAIN TURBINE EHC panel. (PDA Summary #084) Modifications will be made to either the legend lights or the pushbuttons on the MAIN TURBINE EHC panel so that there is a clear distinction between the two.
3 ¹	5 The RCIC DRAIN TANK HX DISCHARGE pushbutton does not use the abbreviation for "normal" used elsewhere in the control room. Instead of the standard NORM, this pushbutton reads: NOR MAL. (PDA Summary #134) The pushbutton for HB-HIS-7176 will be revised to read NORM in order to provide consistency with other pushbutton labeling.

5.0 DISPLAYS

<u>PRIORITY RATING</u>	<u>FINDING</u>
1	1 The displays do not have tolerance zones or set points indicated. (PDA Summary #019) Tolerance zones will be marked on all meters for which tolerances exist. The markings will be applied so that they are in the plane of the meter face to avoid parallax error. As this involves partial disassembly of the meter, plant I&C personnel will be involved. Actual application of marking will follow system turnover to operations.
1	2 The glass potentiometers covers on some of the Hagen process controllers are missing. (PDA Summary #059) This problem is unique to construction. This type of problem will be corrected during system turnover to operations.
2	3 The REACTOR TRIP BREAKER A and B indicator lights violate the plant color-coding convention for the use of red and green. These breaker indicators use red = open and green = closed. The convention is red = closed and green = open. (PDA Summary #075) The REACTOR TRIP BREAKER A and B indicator lights will be revised to indicate red when closed and green when open.

5.0 DISPLAYS

<u>PRIORITY RATING</u>	<u>FINDING</u>
2	4 The scale on a VARMETER on RL006 is inappropriate to measure vars. The zero mark is currently located at the bottom of the scale. The zero should be at the middle of the scale so that the operator could monitor lead/lag by the location of the pointer above zero or below. (PDA Summary #092) The meter MA-J: 4 will be revised to a zero-centered scale to provide indication of VARS "in" or "out".

6.0 LABELS AND LOCATION AIDS

<u>PRIORITY RATING</u>	<u>FINDING</u>
3 ¹	1 A label on RL002 which refers to the emergency boration system imprecisely reads IMMEDIATE BORATE FLOW. (PDA Summary #063) This label will be revised to read EMERGENCY BORATE FLOW.
1	2 Three labels on RL004 are missing the delta symbol that indicates temperature change. The labels incorrectly read RCLP 2T, RCLP 3T, and RCLP 4T. (PDA Summary #074) The labels of indicators BB-TI-421A, 431A, and 441A will be revised to include the delta symbol.
3 ¹	3 The label leading to the 4.16 KV BUS NB01 BREAKER and the 4.16 KV BUS NB02 BREAKER J-handle controls on the breaker mimic on RL015 is not clear in its specification of the origin of the mimic. The label reads OFFSITE POWER, while it should more appropriately read FROM ESF XFMR XNB01. (PDA Summary #109) The mimic label on RL015 will be revised to read FROM ESF XFMR XNB01.
1	4 The J-handle label XMRO1 TO XNB01 BREAKER 252PA0201 on RL016 is wrong. This label should read XMRO1 TO XNB02 BREAKER 252PA0201. (PDA Summary #111) The label for NB-HIS-1 will be revised to read XMRO1 TO XNB02 BREAKER 252PA0201.

6.0 LABELS AND LOCATION AIDS

<u>PRIORITY</u> <u>RATING</u>	<u>FINDING</u>
1	5 Several of the line origination and termination labels for the mimics on RLO17 and RLO18 provide the operator with inaccurate information. Some of the origination labels indicate where the line should be going (TO) as a termination label should, while some of the termination labels indicate the origination of the line (FROM) as an origination label should. (PDA Summary #116) This HEF is being resolved by pending changes to RLO17 and RLO18. The proposed redesign as illustrated by the revision mockup has been reviewed by the HFEB and is acceptable.
1	6 The accumulator mimics have lines that terminate without labels to indicate their destinations. (PDA Summary #120) These panels are undergoing changes and review as a result of this finding. The proposed redesign as illustrated by the revision mockup has been reviewed by the HFEB and is acceptable.
1	7 The label for the CONTAINMENT ISOLATION PHASE B SB-HS-47 J-handle control is incorrect and should read PHASE A. (PDA Summary #121) The label for switch SB-HS-47 will be revised to read CONTAINMENT ISOLATION PHASE A.
1	8 The label for the N₂ SUPPLY CTMT ATMOS ISO VLV EP-HC-93 is incorrect. This process controller is for a vent valve, not an isolation valve. (PDA Summary #126) The label for process controller EP-HC-93 will be changed to ACCUM N₂ SUPPLY LINE VENT.
1	9 The N₂ SUPPLY CTMT ATMOS ISO VLV EP-HC-93 process controller relates to two separate mimic loops but visual connection is poor. This is due to the lack of a mimic line termination label. (PDA Summary #127) A termination label will be added to the mimic that reads TO ACCUMULATOR TANKS A & C.

6.0 LABELS AND LOCATION AIDS

<u>PRIORITY RATING</u>	<u>FINDING</u>

3 ¹	10 The AUTO position label for several control switches on RL025 is a decal and therefore subject to easy removal. (PDA Summary #144)

Control switches CB-HIS-4, 5, 6, 7, 8, 9, and 10 will have their switch plates replaced. The new plates will have the AUTO label engraved.

8.0 PANEL LAYOUT

<u>PRIORITY RATING</u>	<u>FINDING</u>

2	1 The BORIC ACID TOTALIZER is located over the COMBINED REACTOR M/U & BA COUNTER. The COMBINED M/U & BA FLOW TOTALIZER is located over the BORIC ACID COUNTER. The counters are not related and the totalizer locations should be reversed. (PDA Summary #067)

The locations of the BORIC ACID TOTALIZER and the COMBINED M/U & BA FLOW TOTALIZER will be reversed.

2	2 The NIS RECORDER SELECT SW SE HS-1 and the NIS RECORDER SELECT SW SE HS-2 are arranged in an unconventional numerical sequence. The NIS RECORDER SELECT SW SE HS-2 is located to the left of the NIS RECORDER SELECT SW SE HS-1. (PDA Summary #070)

The positions of the NIS RECORDER SELECT SW SE HS-1 and 2 controls will be reversed.

9.0 CONTROL-DISPLAY INTEGRATION

<u>PRIORITY RATING</u>	<u>FINDING</u>

2	1 Several pairs of indicator lights on RL017 and RL018 are located to the right of their associated controls rather than above them. In addition, the associated identification labels are located below rather than above these lights. (PDA Summary #119)

A mock-up of RL017 and RL018 has been prepared for utility input and review. The correction as shown on this mockup is acceptable to the HFEB.

9.0 CONTROL-DISPLAY INTEGRATION

<u>PRIORITY RATING</u>	<u>FINDING</u>
1	2 There is inconsistent labeling between some trend recorders on RL018 and their associated controls on RL017. The numbers "1" and "2" are used for component identification within trains on the trend recorders, while the letters "A" and "B" are used for component identification within trains on the controls. (PDA Summary #124) The labels on the recorders will be changed to read "A" and "B" instead of "1" and "2".
2	3 The AIR COMPRESSOR C indicator lights are located over the AIR COMPRESSOR A RESET CONTROL. In addition, the AIR COMPRESSOR A and B indicator lights are located in an unconventional alphabetical sequence. The AIR COMPRESSOR A indicator lights are located to the right of the AIR COMPRESSOR B lights. (PDA Summary #139) The position of the AIR COMPRESSOR A indicator lights will be reversed with position of the AIR COMPRESSOR C indicator lights.
2	4 The displays for the MFW PUMP TURB A and MFW PUMP TURB B are arranged in the following horizontal sequence: TURB A TURB BRG OIL PRESS, TURB B TURB BRG OIL PRESS, TURB A PUMP BRG OIL PRESS, TURB B PUMP BRG OIL PRESS. The associated controls for TURB B are below the PUMP BRG OIL PRESS (right-hand pair of meters). The associated controls for PUMP A are in a vertical column below the TURB BRG OIL PRESS meters (left-hand pair of meters). This is poor functional grouping of the TURB A and TURB B displays with their associated controls. (PDA Summary #148) The locations of the MFW PUMP TURB B TURB BRG OIL PRESS meter and the MFW PUMP TURB A PUMP BRG OIL PRESS meter will be interchanged.