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Docket No.: STN 50-482

NOV 3 0 1981

Mr. Glenn L. Koester
Vice President - Nuclear
Kansas Gas and Electric Company
201 North Market Street
Wichita, Kansas 67201

Dear Mr. Koester:

Subject: Request for Additional Information for the Review of the Wolf Creek Plant, Unit 1 Regarding Human Factors Engineering

As a result of our review of the Standard Nuclear Unit Power Plant System (SNUPPS) Preliminary Design Assessment (PDA) and our human factors engineering design review/audit performed at the Callaway site, we find that we need additional information to complete our evaluation. The specific information required is in the area of human factors engineering and is presented in the Enclosure.

Note that the first section of the Enclosure contains systems and items that were not available for review at Callaway. These must be reviewed at Wolf Creek by the NRC staff along with those non-standard panels specific to Wolf Creek Unit 1.

To maintain our licensing review schedule for the Wolf Creek Plant FSAR, we will need responses to the enclosed request by January 20, 1982. If you cannot meet this date, please inform us within seven days after receipt of this letter of the date you plan to submit your responses so that we may review our schedule for any necessary changes.

Please contact Dr. G. E. Edison, Wolf Creek Licensing Project Manager, if you desire any discussion or clarification of the enclosed request.

"The reporting and/or recordkeeping requirements contained in this letter affect fewer than ten respondents; therefore, OMB clearance is not required under P.L. 96-511."

Sincerely,

Original signed by:
B. J. Youngblood

B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing

Enclosure:
As stated

cc w/encl.: See next page

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HUMAN FACTORS ENGINEERING
CONTROL ROOM DESIGN REVIEW/AUDIT REPORT

CALLAWAY PLANT UNIT 1
UNION ELECTRIC COMPANY

A human factors engineering preliminary design review of the Callaway Plant Unit 1 control room was performed at the site on July 29 through July 31, 1981. This design review was carried out by a team from the Human Factors Engineering Branch, Division of Human Factors Safety. This report was prepared on the basis of the HFEB's review of the applicant's Preliminary Design Assessment (PDA) and the human factors engineering design review/audit performed at the site. The review team was assisted by consultants from BioTechnology, Inc., Falls Church, Virginia, and from Lawrence Livermore National Laboratory (University of California), Livermore, California.

Observed human factor design discrepancies were given a priority rating of one to three (high, moderate, low), based on the increased potential for operator error and the possible consequences of that error. Priority rating 1 and 2 discrepancies must be corrected prior to issuance of an operating license. Priority rating 3 discrepancies must be evaluated and proposed actions reported as part of the long term design review (due approximately one year from the issue date of NUREG-0700). Note that some priority ratings include a superscript one (e.g., 3^1). Since the resolutions of these discrepancies involve simple corrective actions relative to the potential for improving operator performance, these discrepancies should be corrected prior to issuance of an operating license.

A list of those items that could not be evaluated is presented in the first section of this report. The condition of construction or installation of these items at the time of the site visit was not sufficiently finalized to permit review.

The following sections are numbered to conform to the guidelines of the draft version of NUREG-0700 and summarize the team's observations of the control room design and layout and of the control room operators' interface with the control room environment.

Throughout the report, the use of a single asterisk (*) following the finding number indicates a discrepancy that was also noted in the SNUPPS PDA report, submitted July 26, 1981. The use of a double asterisk (**) indicates that an acceptable corrective action for the discrepancy identified in the SNUPPS PDA has been proposed by Union Electric, and that the resolution of this item has been documented in the HFEB Callaway Safety Evaluation Report input, dated September 14, 1981.

HUMAN FACTORS ENGINEERING
CONTROL ROOM DESIGN REVIEW/AUDIT REPORT

CALLAWAY PLANT UNIT 1
UNION ELECTRIC COMPANY

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, #069)
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 RL017 and RL018 mimics - in the process of being redesigned
B. Maintenance tag-out system unvailable

7.0 PROCESS COMPUTER

A. Display formats not yet prepared
B. No alarm printer in control room for evaluation
C. CRT displays on Panel RL020 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 RL017, RL018, and RL022 - in the process of being redesigned (PDA Summary #115, #118, #124, #129, #132, #135, #136)
C. Panels RL013 and RL014 - plant specific to Callaway (non-standard SNUPPS) and in the process of being modified

HUMAN FACTORS ENGINEERING
CONTROL ROOM DESIGN REVIEW/AUDIT REPORT

CALLAWAY PLANT UNIT 1
UNION ELECTRIC COMPANY

HFEB TEAM REVIEW FINDINGS

1.0 CONTROL ROOM WORKSPACE

PRIORITY RATING	FINDING	
1	1*	Some controls are located too high to be accessible to a 5th percentile operator. One J-handle switch is located 73" above the floor. Some emergency controls for the BORON INJ RECIRC PUMP are located 66" above the floor. The maximum recommended height for controls is 56".
3	2	Controls on the test and maintenance operations panels have not been placed in the vertical area between 34" and 70" above the floor. Controls on these back panels are located significantly above and below the recommended range.
1	3*	There are several J-handle control switches that are located closer to the front edge of the panels than the recommended 3". These switches can be inadvertently actuated. These switches are located on RL001, RL013, RL015, RL019, RL021, RL023, and RL025.
1	4*	Both of the SOURCE RANGE BLOCK and RESET pushbutton switches are located very close to the edge of the panel and are subject to inadvertant 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%.
1	5*	The critical TD AUX FW PUMP TRIP/RESET control is located in a position where it can be inadvertently actuated.
1	6	The annunciator response controls are located on the fronts of the benchboards and can be easily activated by leaning against the panels.

1.0 CONTROL ROOM WORKSPACE

PRIORITY RATING	FINDING	
3	7	Some controls are located further in from the front edge on the inner ring consoles than the recommended 24". These controls will not be accessible to a 5th percentile operator.
1	8*	Some vertical and horizontal meters are located higher than the recommended 70" above the floor. These displays will not be readable or accessible to a 5th percentile operator. Most of these meters are located between 75" and 84" from the floor. Some meters are located as high as 92", and the top rows of the annunciator panels are all located 117" above the floor. This problem exists on all of the main control room outer ring panels and on the Remote Shutdown panel.
3	9	The annunciators are mounted out of the visual field of the 5th percentile operator (recommended maximum = 75° above the horizontal line of sight). The viewing angle was measured to be approximately 80°.
3	10	The annunciator tiles are mounted with less than the recommended minimum 45° viewing angle from the tile plane to the 5th percentile operator's line of sight at the acknowledge controls. The viewing angle was measured to be approximately 33°.

2.0 COMMUNICATIONS

Could not be evaluated.

3.0 ANNUNCIATORS

PRIORITY RATING	FINDING	
1	1	A reflash capability is not provided that allows subsequent alarms to activate the auditory alert mechanism and reflash the visual tile even though the first alarm may not have been cleared.
3	2	The "first out" alarms that are provided for the reactor system and the turbine-generator system are not located on physically separate panels from the remainder of the annunciators. The proposed prioritization scheme for the annunciators will further interfere with easy recognition of the first out alarms.
3	3*	There is no prioritization of annunciator alarms by location, color, or other coding scheme.
1	4	The annunciator indicating BREAKER TRIP is on RL014, while the associated breaker control on is on RL006.
1	5	The tile coordinate labels and panel identification labels for the annunciators have not yet been engraved or otherwise permanently attached. Also, annunciator response procedures are not indexed by panel identification and tile coordinates.
3	6*	Annunciator windows are not keyed or coded to prevent inadvertant inter-change.
2	7	The flash rates of the annunciators are not the recommended three to five flashes per second with approximately equal on and off times. The rates are approximately one flash per second, or slightly less.
3	8	There is no distinctive coding to indicate annunciator tiles that are illuminated for extended periods of time.
3	9	The annunciator panel matrix density is too high on some panels. For example, RL026 is a 23x6 matrix with 138 tiles. The recommended maximum is 50 tiles per matrix.
1	10	Some annunciator tiles do not adequately specify the alarm condition (e.g., "RHR PUMP TROUBLE" and "ACCUM TANK - LEVEL HI/LO").

3.0 ANNUNCIATORS

PRIORITY RATING	FINDING	
3[1]	11*	The annunciator legend character height-to-width ratio was measured to be approximately 7:3. It should be no more than 5:3.
1	12*	The annunciator legends are difficult to read from the inner ring of control consoles, due to inadequate character size, stroke width, and spacing; but they can be acknowledged from that location. For viewing the annunciators from the 12' distance within the inner ring of control consoles, the character stroke width should be at least .058 inch and the height-to-stroke width ratio should be 6:1.
1	13	The annunciator response controls do not include all of the following: silence, acknowledge, reset, and test controls. There is no separate silence control. The acknowledge control will silence the alarm before 10 seconds have elapsed from the time of alarm initiation. The auto silence function will silence the alarm after 10 seconds from initiation. Only the first out alarm panels have reset capability. The remainder of the annunciator alarms are automatically reset.
1	14*	The location order of the annunciator controls is inconsistent from one panel to another (e.g.,Test, Acknowledge on RL015; Acknowledge, Test on RL019 & RL023; Acknowledge, Reset, Test on RL019; Acknowledge, Test, Reset on RL025; First Out Acknowledge, First Out Reset and Annunciator Acknowledge on RL005`

4.0 CONTROLS

PRIORITY RATING	FINDING	
3	1	Some of the Cutler-Hammer pushbuttons will be difficult to operate while wearing protective equipment gloves.
1	2*	The guarding mechanism for several controls on RL018 consists of a red plastic cover with a sliding plastic plate that is removed to operate. Some of the red covers are not permanently attached and will be easily lost. The sliding plates will also be easy to misplace.
2	3*	The intentional or accidental tripping of the two unguarded 480V BREAKER J-handle switches on RL016 (Rod Drive Power Supplies) would result in a reactor trip if both are tripped at same time. Some guarding mechanism is needed for these controls.
1	4	The OPEN and CLOSE pushbuttons on some Cutler-Hammer switch arrays can be actuated and latched simultaneously.
2	5*	Some of the Cutler-Hammer pushbutton arrays are arranged so that they violate plant convention and population sterotypes for the position of the OPEN and CLOSE functions. Some arrays are arranged OPEN/CLOSE rather than the conventional CLOSE/OPEN. Some arrays are arranged with CLOSE on the top row of the array, rather than the conventional OPEN=top and CLOSE=bottom.
2	6*	The SYNC CHECK RELAY BYPASS J-handle control violates direction-of-movement sterotypes. The ON function is at the center, upright position, and the OFF function is at the right-hand position.
1	7*	The BTRS CONTROL SW has an unconventional arrangement of functions. The DILUTE function is located on the left, the BORATE function is located in the center, and the OFF position is located on the right. This implies that the control, when leaving the OFF position, must actuate the BORATE function before it can actuate the DILUTE function.
2	8*	The TURBINE TRIP and OVERSPEED controls are placed adjacent to each other. The controls are extremely similar in appearance and could be easily confused.

4.0 CONTROLS

PRIORITY RATING	FINDING	
2	9*	The two 4.16KV BUS NM02 BREAKER 152 J-handle controls on RL015 are alternate breakers that are not differentiated from the adjacent normal breakers. These controls could be easily confused and incorrectly activated.
2	10**	There is no way to visually distinguish controls that require continuous pressure to operate from momentary contact switches.
1	11**	It is difficult to distinguish the legend pushbuttons from the legend lights on the MAIN TURBINE EHC PANEL.
1	12**	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.
1	13*	Some J-handle controls have excessive spring tension for their return to center function. When an operator releases the handle from a function activation position, the handle can spring back with such force that the activation of the opposite function occurs. In less extreme cases when the opposite function is not activated, an mechanical indicator flag incorporated into the control is sometimes thrown to the opposite function indication, creating a position/indication mismatch.
3	14	On some of the J-handle switches it is possible to mistake the handle of the switch for the position indicator, since there are no other position pointers used.
3	15*	The pointer for the AUDIBLE COUNT RATE CONTROL-AUDIO MULTIPLIER partially obscures the position labels associated with the control. In addition, the pointer is not always visible from the normal position of the operator.
3	16*	The handle on the MAIN GEN VOLTMETER PHASE SELECT switch obstructs both the position labels associated with the control and the switch pointer.

5.0 DISPLAYS

PRIORITY RATING	FINDING	
3	1*	There is no indication of PRESSURIZER PRESSURE in the range between 700-1700 psig on RL002.
2	2*	When displays fail or become inoperative, the failure is not always apparent to the operator.
31	3*	The scales for the COOLING TOWERS BASIN LEVEL meters are indexed in feet above sea level rather than actual basin level.
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.
3	5*	The measurement variable labeling on the scale face of the displays is oriented vertically, from top-to-bottom, rather than horizontally, from left-to-right. The vertical label on the face of the TRANSFER VOLTMETER on RL006 is especially difficult to read because of the length of the legend.
31	6*	The process controller scales (0-100) are not labeled to indicate which is full open and which is full closed.
3	7*	Several display scales begin with an unnumbered major graduation mark.
2	8*	The lengths of the graduation marks on some of the display scales are not large enough to be read from the required distances.
2	9*	The size and contrast of the scale markings and numerals on many of the outer ring displays are inadequate to be read from the inner ring consoles.
1	10*	Some vertical displays use scales which contain both positive and negative numbers. However, no positive (+) or negative (-) markings appear on the scale face.
3	11	The indicator lights for the ROD DIRECTION and the ROD DIRECT DEMAND violate the plant color-coding convention. The IN indicator lights are green and the OUT indicator lights are red.

5.0 DISPLAYS

PRIORITY RATING	FINDING	
2	12**	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 plant convention is red = closed and green = open.
2	13*	The movement of the scale pointers on the Hagan process controllers violates the left-to-right increase convention. The magnitude of the scale reading increases as the pointer moves from right-to-left. The CLOSE/OPEN position convention is also violated. The OPEN position is to the left of the center, and the CLOSE position is to the right.
31	14*	The pointers obscure the shortest graduation marks on the scales some of the trend recorders on RL018. The pointers on some of the recorders on RL022 totally obscures all graduation marks along with the numerals.
3	15*	The numerals on the MFW PUMP TURBINE SPEED circular meters on RL006 are placed on the same side of the meter graduations as the pointer. This causes the pointer to obscure the indicated value.
3	16*	The long hand of the potentiometer dial on the Hagen "Full Station" process controllers obscures the dial numerals.
1	17**	Displays do not have normal operating ranges or set points indicated.
1	18*	Single filament incandescent lamps are used without the means of test for bulb or circuit failure.
2	19*	The legend lights for STEAM DUMP VALVE POSITION violate the OPEN=top and CLOSE=bottom convention. The CLOSED (green) indicators are located above the OPEN (red) indicators.
3	20*	The legend plates for the DEMINERALIZER TRAIN A and B legend lights are not keyed or coded to prevent inadvertant interchange during bulb replacement.

5.0 DISPLAYS

PRIORITY RATING	FINDING	
2	21*	The redundant ESF SYSTEM STATUS INDICATION legend lights lack of identical layout between the matrices. They also make inconsistent use of abbreviations. In addition, inconsistent logic is used in the NSSS monitoring system that interfaces with these two display matrices.
31	22*	The bottom scale on each of the RCP A,B,C, and D SEAL LEAKOFF trend recorders obscures the top of the recorder paper. In addition, the pointer for the bottom scale of each recorder is located behind the scale, prohibiting the reading of current information.
1	23*	The top of the NIS RECORDER window obscures the exponential values at the top of the recorder scale when the scale is viewed from a normal standing position.
2	24*	Many of the two- and three-pen recorders have one pen that is mounted below and/or behind the scale. This location creates parallax which will make the reading of trend information difficult.
2	25*	The recorded data on the MAIN TURBINE VIBRATION AC and MAIN TURBINE TEMP & EXPAN impact recorders is printed on top of other data, making the information totally illegible. The graph lines on these recorders are a light blue color which provides poor legibility and contrast. In addition, the scaling on the graph paper does not correspond to the horizontal scale on the impact recorders. The data is recorded in the form of a number (1-16 or 1-20) of very small size that is difficult to read.
31	26*	There are no units of measurement provided for the counters on RL002.
1	27*	The red covers installed over the counter numbers obscures the numbers from view. To read the counter accurately, the cover must be raised.
1	28**	The glass potentiometers covers on some of the Hagen process controllers are missing.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
1	1*	There are several horizontal meters on RL013 that are missing their associated component labels.
1	2*	Two CIRCUIT/LAMP TEST pushbutton arrays on RL017 are not labeled. This makes it impossible to determine which of the buttons serves each function (circuit test or lamp test).
2	3	There is no label with the REACTOR TRIP BREAKER A and B indicator lights to indicate that the red and green mean closed and open, respectively.
3[1]	4	There are no permanent panel number identification labels. Temporary labels made of dark gray duct tape that are very hard to read have been put on some of the higher numbered panels.
3[1]	5	The SAFEGUARD SYSTEM switches on RL003, which illuminate to acknowledge/clear status indicators on RL018, have no labeling to indicate their function.
1	6	The label on RL002 that reads BORIC ACID TO VCT INLET is incorrect. Boric acid is not sent to the VCT because of possible fouling of the VCT spray system.
1	7	There is an incorrect label for the TRAIN A RETURN VALVE. This label should indicate that this is a SUPPLY/RETURN VALVE.
1	8**	The J-handle label XMR01 TO XNB01 BREAKER 252PA0201 on RL016 is wrong. This label should read XMR01 TO XNB02 BREAKER 252PA0201.
1	9**	The label for the CONTAINMENT ISOLATION PHASE B SB-HS-47 J-handle control is incorrect and should read PHASE A.
1	10**	The label for the N_2 SUPPLY CTMT ATMOS ISO VLV EP-HC-93 is incorrect. This process controller is for a vent valve, not an isolation valve.
3[1]	11*	There are no functional or system summary labels.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
3[1]	12*	The hierarchical labels for the PZR RELIEF TANK indications and the REACTOR COOLANT LOOP FLOW indications do not clearly fulfil their purpose. The system portion of each label is engraved with the same size type face as the indication identifier portions of the label. Since the system portion of each label is engraved over the center indication identifier, it appears only to apply to that indication identifier rather than to the whole group.
3[1]	13	The EXCESS LETDOWN OUTLET TEMPERATURE and PRESSURE display labels on RL002 do not follow the recommended guidelines for hierarchical labeling. The group label for the pair of meters does not include the word OUTLET, which is therefore engraved before PRESSURE and before TEMPERATURE. Labels on displays directly adjacent to this group do follow the hierarchical labeling guidelines.
3[1]	14*	The [illegible] of the lettering on the component labels for [illegible]ls is not 25% larger than the lettering on [illegible]ontrol position labels, as recommended. The position label lettering for all of the J-handle controls is the same size or larger than the associated component label lettering.
2	15*	The labels for some indicator lights on RL013, RL014, and RL018 are located below the lights. Labels are conventionally placed above their associated components elsewhere in the control room.
3[1]	16*	The label for the T REF/T AVG AUCTIONEERED trend recorder is located at the bottom of the recorder, rather than above as is the plant convention.
1	17	The labels for the displays that are located at high positions on the outer ring panels are not readable by an operator at the front edge of the panel. These labels are obscured from this position by their associated displays.
3[1]	18	The central annunciator response control labels are not visible from a standing position at the benchboard edge.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
3[1]	19*	The STM GEN A through D DUMP CTRL AT SHUTDOWN PNL labels are placed such that they can be associated with indicator lights that they do not apply to. These labels apply only to the white light in each group of one red, one green, and one white indicator light. The red and green lights in each group are associated with the STM GEN A through D STM DUMP TO ATMOS VLV POS labels.
2	20*	The ESF XFMR XNB01 UNIT 2 and the XFMR SPB 218 AND MISCELLANEOUS TRANFORMERS labels are located side by side in association with an indicator light. It is not clear from this label arrangement what the associated indicator light refers to.
3[1]	21	The DG NE01 REGULATOR NULL INDICATION label ON RL015 is not attached to the panel. The screw holes in the label are drilled in the wrong places to fit the holes drilled in the panel.
3[1]	22	Some labels in the control room have come loose. Most of the loose labels were glued to the painted panel surface rather than screwed on.
1	23*	The label relating pen color to displayed parameter on some recorders is located in the recorder window. This label location obscures part of the chart paper when the recorder door is closed, and the information provided by the label is not available when the door is open.
2	24*	In addition to the standard component labels, there are one or two labels incorporated into the top and/or bottom edges of some of the Hagan process controllers. These labels generally provide either redundant or confusing information. In some cases, the incorporated labels, which use small print, contain the information that is necessary to differentiate between adjacent controllers.
3	25*	Several J-handle controls on RL015 are designed with the numeral "1" occupying the central position between OFF and ON. The numeral "1" is used as a procedure step to enable synchronization of offsite power sources with the diesel generators, but as presently labeled does not convey any meaningful information to the operators.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
31	26	The J-handles on RL006 that are labeled STEAM FLOW SELECT SW, FW FLOW SELECT SW, and STEAM GENERATOR LEVEL SELECT SW do not select flow or level, as the labels indicate. They select the channel from a flow or level sensor that will be used as an input to the Reactor Protection System.
31	27	Five valve control switches in a group of eight on RL024 do not have component labels that indicate that they actuate valves. This problem also occurs other places in the control room.
1	28*	The TD AUX FW PUMP TRIP/RESET pushbutton has an integral label that reads TRIP. This integral label makes it unclear whether the button can also perform a reseting function, as the component label implies.
31	29**	A label on RL002 which refers to the emergency boration system imprecisely reads IMMEDIATE BORATE FLOW.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
31	30	A label on RL002 which refers to the emergency boration system imprecisely reads IMMEDIATE BORATE TO CHARGING PUMP SUCTION.
2	31*	The labels for the MAIN TURBINE LIFT PUMPS J-handles and indicator lights do not clearly imply the association between the components.
31	32	The labels do not consistently use terminology or abbreviations, even in directly adjacent applications. There is no consistent application of abbreviations in place of complete words. This is a widespread problem throughout the control room. For example, adjacent display groups on RL001 use VCT and VOLUME CONTROL TANK. There is no space constraint that would require the use of the abbreviation VCT on the one label.
31	33*	There is no standard abbreviations list for the control room. Abbreviations are used inconsistently throughout the control room.
31	34**	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.
1	35**	Three labels on RL004 are missing the delta symbol that indicates temperature change. The labels incorrectly read RCLP 2T, RCLP 3T, and RCLP 4T.
1	36	The label on RL004 for RCLP 1 has an "A" instead of a delta symbol.
31	37	The engraved lettering on the small red pushbuttons on the Cutler-Hammer switch arrays is too small to be easily read. The letters are filled with white paint that has become dirty, which has further degraded their legibility.
3	38	All of the labels in the control room appear crowded. The inclusion of the engineering number on the component labels in the same size lettering as the primary identification information contributes to this crowded appearance.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
31	39*	The character height of the position labels on J-handle controls is under the recommended minimum size for the normal viewing distance of 28 inches.
31	40	The contrast of a majority of the colored labels is poor. Some of the combinations of background/lettering colors are: black/white, white/black, red/yellow, yellow/black, etc. Only the white/black are optimally legible. The red/yellow labels are especially hard to read.
31	41	The engraved legends on the keys of the process computer keyboard are hard to read. The magenta function key legends have especially poor contrast, and some of the other keys have inadequate engraving depth.
31	42*	The label script on the TEST INTERLOCK LOSS OF PWR PRESS SIGNAL and STEAM DUMP VALVES POSITION engraved indicator lights on RL006 is barely readable due to inadequate engraving depth and lack of script filler pigment of contrasting color.
31	43*	The engraved surfaces of the labels have no clear filler to prevent the buildup of dirt. This will result in eventual reduction of legibility.
31	44*	The label engraving style makes it impossible to differentiate the letter "I" from the numeral "1". Both letter and numeral are represented by a vertical slash.
31	45**	The AUTO position label for several control switches on RL025 is a decal and therefore subject to easy removal.
31	46	Several J-handle selector switches on RL005 and RL006 have position labels that are decals that can be easily removed.
31	47*	Demarcation is not adequately used to visually isolate separate system components or to enhance existing relationships between components contained within the same system.
31	48*	The label color-code used to differentiate between electrical trains is not consistent with the other uses of color in the control room.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
31	49	The mimic on RL001 incorrectly implies that the CHARGING HDR FLOW control only controls the rate of flow in the flow path, since a single mimic line goes to the control and a single line leaves the control. The mimic does have a second outlet line to indicate the portion of the inlet flow that is used for reactor coolant pump seal injection.
2	50	The mimic on RL001 does not show flow from the CENTRIFUGAL CHARGING PUMPS through the CHARGING PUMP FLOW VALVES.
31	51	The mimic lines have warped and come loose from the panel surface in several places. Several mimics are missing portions of mimic because the lines have broken completely off.
1	52*	There is a missing section of gray mimic line between the 480V XPG20-LCPG20 BREAKER 52PG2001 J-handle control and the 480V LC PG19-PG20 TIE BKR 52PG1415 J-handle control. There is also a missing section of mimic line between the 13.8KV PA02-XPB04 BREAKER 252PA0208 J-handle control and the 13.8KV BUS TO XFMR XPB04 AMPS vertical meter.
1	53*	The transformer symbol label in the mimic for the 480V XPG25-LC PG25 BREAKER 52 PG2501 J-handle breaker control is upside down. The gray portion of the label which symbolizes the 480V side should be on the bottom, and the black portion of the label which symbolized the 13.8KV side should be on the top.
31	54*	There is no consistent color-coding of mimic lines. For example, nine different colors are used for electricity.
31	55*	The mimic lines are not graduated in size to differentiate primary flow paths from secondary flow paths.
1	56*	Some mimic line flow arrows indicate the wrong direction of flow.
31	57*	Several labels within mimics on RL019 are intersected by mimic lines when no actual connection exists between the components indicated by the labels and the flow paths represented by the mimic.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
3[1]	58**	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.
1	59**	Several of the line origination and termination labels for the mimics on RL017 and RL018 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.
1	60**	The accumulator mimics on RL018 have lines that terminate without labels to indicate their destinations.
1	61	The arrangement of valves in the mimic that depicts the flow of boric acid and make-up water to the volume control tank indicates that boric acid can be sent to the volume control tank spray. An operator reported that the valves can even be arranged to accomplish this. If a check valve exists that prevents flow in the indicated direction, an arrow or check valve symbol is needed on the mimic. If there is no such flow restriction in the system, a label is needed to caution the operator not to arrange the valves in this way.
1	62**	The N_2 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.

7.0 PROCESS COMPUTERS

PRIORITY RATING	FINDING	
31	1	The computer system does not include a file of operator entries. The sequence of events log will include operator entries, but these will not be isolated, grouped or coded in any way.
2	2*	The CRT displays can be affected by each of the keyboards. This means that an operator at one location can disrupt and lose data on a CRT that another operator is using. In addition, there are no signal on the displays or elsewhere to indicate which keyboard is being used to effect a particular display.
2	3*	The red, green, and white colored keys on the process computer keyboard are not grouped together and are not in any functional sequence.
2	4*	The dark blue characters on the CRT displays are difficult to read due to poor contrast with the screen background. This color should only be used for non-critical information.
3	5*	The two CRT displays on RL020 are located between 76-91 inches above the standing surface. This location exceeds the recommended height for CRT displays.
3	6	The colors red and yellow are not used on the CRT displays according to the recommended guidelines applications of danger and caution, respectively. On the alarm list display, red is used to indicate digital points in the alarm and yellow is used to indicate analog alarms.
2	7*	The color-coding of information used on the CRT displays is not consistently applied. One color may be used to convey different types of information. Conversely, the same information type may be presented in different colors on different display pages.
3	8	Location references are not provided in the viewable portion of the frame when the operator is required to scroll or pan on the point summaries, system index, and other summary type displays. The system displays are referenced acceptably.
1	9*	There is no printer located in the control room for hard copy information, including alarm printouts. This deprives the operator of useful information.

7.0 PROCESS COMPUTERS

PRIORITY RATING	FINDING	
3[1]	10	Although computer feedback messages are generally provided to the operator, there is no message to indicate that a request for a remote printout has been received and confirmed or denied.
1	11	Several functions available on the control room process computer keyboard are for the use of the computer programers, not the reactor operators. For example, operators have the ability to insert values into the system status displays. No indication appears to identify these as inserted values rather than actual values.
2	12	There are no procedures available to the operator which cover the necessary actions to take in the event the process computer fails.

8.0 PANEL LAYOUT

PRIORITY RATING	FINDING	
1	1*	During emergency procedures, the operator is required to compare the REACTOR COOLANT PRESSURE meter on RL002 and the STEAM GENERATOR PRESSURE meter on RL026. These displays are separated by about 25 feet.
3	2	The SAFEGUARD SYSTEMS STATUS SELECT switches on RL003 are placed between the CRT and the keyboard, but they are not related to the process computer.
3[1]	3*	The two MN STM/FW VLV ACCUM CHARGE TEST and the two MN STM/FW ISO VLV EXERCISE ACTUATE controls are functionally and sequentially related but are not grouped together.
3[1]	4*	The STM GEN A through D LVL SEL SW controls are not located directly below their associated trend recorders. These switches may be inadvertently associated with the AUX FEEDWATER display that they are located directly beneath.
3[1]	5*	The ACCUMULATOR TANK FILL LINE ISO VALVE pushbutton on RL018 is located where it is only clearly associated with the B and D accumumlator tanks although it is actually associated with all of the trains.
3[1]	6	The two RC DRAIN TANK HX DISCHARGE ISO VALVE controls and the two RC DRAIN TANK VENT CONTAINMENT ISO VALVE controls on RL022 are not sufficiently separated or demarcated from the unassociated RELIEF TANK valves to their left.
2	7**	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.
3	8*	The STEAM DUMP SELECT SW AB US-500Z on RL005 selects the mode for the STEAM HEADER PRESSURE CONTROL, but the select switch and process controller are not located adjacent to one another.

8.0 PANEL LAYOUT

PRIORITY RATING	FINDING	
2	9	It is not clear from the panel layout of the BTRS DEMINERALIZER INLET TEMP controllers and the associated BTRS TEMPERATURE display at what point in the flow path the displayed temperature is sensed. The B controller is located below the display and to the left of the A controller. The actual flow path is through the B heat exchanger then through the A heat exchanger. The temperature sensor for the display is located at the outlet of the A heat exchanger.
3	10*	The STEAM GENERATOR A & B and C & D WIDE RANGE LEVEL and the STEAM GENERATOR A & B and C & D PRESSURE trend recorders are not grouped according to the different steam generators. For example, the STEAM GENERATOR A trend information is not grouped with the other STEAM GENERATOR A information.
2	11	The two BTRS DEMINERALIZER INLET TEMP controllers on RL002 appear to be located in an unconventional alphabetical sequence. The B controller is located to the left of the A controller. However, the plant drawings indicate that the associated equipment is also arranged with the B heat exchanger before the A heat exchanger in the flow path.
1	12	The pushbutton orientations of two switches on the RL001 mimic do not match their positions in the mimic. Switch BG-HIS-112A has HUT on the top pushbutton of the switch, with VCT on the bottom. These pushbutton locations should be reversed. Switch BG-HIS-129 has DEMIN on the top pushbutton of the switch, with VCT on the bottom. These locations should also be reversed.
2	13	The RCP A SEAL LEAKOFF & INJ FLOW chart recorders on RL022 are arranged in an unconventional numerical sequence - 2, 4, 1, and 3.
2	14**	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.

8.0 PANEL LAYOUT

PRIORITY RATING	FINDING	
2	15*	The BLOWDOWN VALVE #1 CONDUCTIVITY RATIO/AUTO-MAN CONTROLLER and the BLOWDOWN VALVE #2 CONDUCTIVITY RATIO/AUTO-MAN CONTROLLER are located in an unconventional left to right numerical sequence. The #2 controller is located to the left of the #1 controller.
2	16*	The RHR PUMP ROOM SUMP PUMP A through D controls are arranged in an unconventional alphabetical sequence. The controls are arranged in two rows with B in the top left location, A in the top right location, D in the bottom left location, and C in the bottom right location. The CENTRIFUGAL CHARGING PUMP A and B controls on RL001 and the DEMINERALIZER TRAIN A and B AUTO-MAN FLOW controls on RL014 are also located in an unconventional B = left, A = right arrangement.
1	17	The indicator lights for the INTAKE PUMP C DISCHARGE VALVE control are located in an unconventional red = left and green = right arrangement. The related A and B indicator lights are arranged conventionally with green = left and red = right.
3	18	The CONTROL BANK and SHUTDOWN BANK STEP counters are grouped together. Since these counters are identical, an operator could easily read a count from the wrong group, especially since the same numbering system is used on the labels of each (e.g., A-1, A-2, etc.).
2	19*	Several component groups on RL005, RL006, RL014, RL015, RL017, RL018, and RL019 are mirror imaged. In some of these groups the mirror imaging is not exact. The ESF CONTROL PANEL (RL017 and RL018), in particular, exhibits significant problems in mirror imaging and mixed mirror imaging. These arrangements will create transference of training problems for the operator.

9.0 CONTROL-DISPLAY INTEGRATION

PRIORITY RATING	FINDING	
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.
3	2*	Related controls, displays, and indicator lights throughout the control room are often located on both the inner and outer rings of panels. These rings are separated by approximately 8 feet. This arrangement prevents close visual association between the associated displays and controls. For example, the SEAL WATER OUTLET ISOLATION VALVE controls are located on RL001, while the associated LEAKAGE FLOW indicators are located on RL021.
1	3**	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.
2	4	The ROD INSERTION LIMIT and NEUTRON FLUX DETECTOR recorders on RL022 that will be monitored during control manipulation on RL003 are not located sufficiently close that an operator can read them clearly and without parallax from a normal operating position.
3	5**	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.
2	6*	The MAIN STM RHTR vertical displays are offset to the left of their associated controls by about 6" to 12". The MAIN STM RHTR indicator lights are offset to the left in a 2x2 matrix rather than being located under their associated vertical displays.

9.0 CONTROL-DISPLAY INTEGRATION

PRIORITY RATING	FINDING	
2	7	The FUEL POOL COOLING PUMPS B and A controls are located in an inconsistent order with their associated DISCHARGE displays. The displays are correctly ordered A - B, while the controls are ordered B - A. The ROD DIRECT DEMAND and ROD DIRECTION indicator lights on RL003 are also located in inconsistent order with their associated controls.
2	8	The OVER PWR/OVER TEMP T RECORDER SELECT switch is located beneath its associated trend recorder, but an unrelated trend recorder is located between the associated components.
2	9	The association between the PLANT BYPASS VALVE MAN controller and the PLANT BYPASS display is not clear. The display is below and to the left of the controller and two unrelated controllers are between the associated components.
3	10	Related controls and displays are not always easily identified as being associated. For example, the reactor operations controls and displays on RL003 and RL004 are not well arranged by specific functions (e.g., startup).
2	11*	The arrangement of indicator lights and their associated controls is not consistent from application to application. For example, the CCW PUMP A through D RESET indicator lights are placed to the right or left of their associated control rather than above, as is the convention.
2	12**	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.

9.0 CONTROL-DISPLAY INTEGRATION

PRIORITY RATING	FINDING	
2	13	The control groups in the CVCS mimic are in reversed orientation from their associated displays. The LETDOWN HX OUTLET control is located on the left half of RL001. The LETDOWN HX OUTLET display is located on the right half of RL002. The BORIC ACID TO VCT controls are located on the right half of RL001. The BORIC ACID TO VCT display is located on the left half of RL002.
2	14	Three PRESSURIZER HEATER controls and three PRESSURIZER PRESSURE and LEVEL controls are reversed with respect to their associated displays.