AUDIT REPORT

Human Factors Engineering
Control Room Design Review/Audit

Saint Lucie Nuclear Power Plant
Unit No. 2
Florida Power & Light Company

A human factors engineering preliminary design review of the Saint Lucie Unit 2 control room was performed at the site on August 3 through August 7, 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 and the human factors engineering design review/audit performed at the site. The review team included human factors consultants from BioTechnology, Inc., Falls Church, Virginia, and from Lawrence Livermore National Laboratory (University of California), Livermore, California.

Observed human factors 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 should be corrected prior to issuance of an operating license. Priority rating 3 discrepancies should be evaluated and proposed actions reported as part of the long term design review that will be required after issue 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 fuel loading.

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

Finding numbers followed by an asterisk (*) denote discrepancies which were observed during the Preliminary Human Engineering Assessment made by Essex Corporation and submitted to the NRC Human Factors Engineering Branch by Florida Power and Light Company.

A list of those items that could not be evaluated is presented at the end of the nine major sections of this report. The construction status of these items at the time of the site visit was not sufficiently finalized to permit review.

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1. CONTROL ROOM WORKSPACE

PRIORITY	FINDING	
3	1.*	The view of portions of the Radiation Monitoring Panel and the HVAC Panel from the Operator Console is obscured by other boards.
2	2.*	There are two large floor obstructions in the form of thick plywood sheets attached to the floor. One is between the control console mockups and one is near the restroom location.
2	3.	The temporary phone attached to Panel 202 has a long cord which presents a tripping hazard in an operator pathway. It was noticed that phone cords in Unit 1 presented a similar tripping hazard.
3	4.	The two Control Transfer Panels for the Remote Shutdown Panel are both at distant locations from the shutdown panel. These separated remote transfer locations can delay and complicate transfer of control between the Control Room and the Remote Shutdown Panel
3	5.	The Turbine Backpanel and the DEH Control Cabinet were 53 inches apart. This is less than the 96 inches minimum separation distance recommended for opposing vertical control panels.
1	6.*	There are no provisions for key storage and no procedures for key access control for keys used in the Control Room and for keys used at the Remote Shutdown Panel.

* Discrepancy also noted in Florida Power and Light Company report of Preliminary Human Engineering Assessment of the Saint Lucie 2 control room.

PRIORITY	FINDING	
1	7.	The shift supervisor's office location beyond Panel 206 will not provide him with good voice and visual contact with the main control area.
3	8.*	Controls on the vertical boards of some standup consoles are located too high and are beyond the reach of a 5th percentile female operator. Examples: a.) Panel 204: Reactor Channels MB and MD Reactor Trip pushbuttons b.) Panel 201: Reactor Channel MA Reactor Trip pushbutton
3	9.*	Some displays and annunciators were located outside of the visual fields of the extreme height operators. In particular, a line of sight from the viewer to the instrument face made less than a 45 degree angle with the display plane.
1	10.	All of the panels had controls which were less than 3 inches from the front edge of the benchboard. The benchboard handrails had not been installed at Unit 2 at the time of the review. It was noted that the Unit 1 benchboard rails obscure the view of many controls and displays from the operator console.
3	11.*	Displays and controls on vertical panels throughout the control room are located above and below the guideline heights. For vertical panels, controls and displays should be located between 34 inches to 70 inches above floor level. Examples: a.) HVAC Panel b.) Radiation Monitoring Panel
1	12.	The normal lighting level in the backpanel areas was inadequate . The level at Backpanel 206 was 5.5 ft-candles, which is even less than the minimum requirement of 10 ft-candles for a passageway.
2	13.*	Glare was a problem throughout the control room. At the time of the review, no diffusing grid had been placed over the fluorescent lighting as has been done in Unit 1. The glare in Unit 2 had a varying impact from one instrument to the next, with the worst case being nearly total obscuration of displayed information.

1. CONTROL ROOM WORKSPACE (Continued)

PRIORITY	FINDING	
2	14.*	There is no direct means of testing the operability of control room emergency lighting.
1	15.	The emergency lighting illumination levels were too low for accurate reading of panel displays and labels. Readings varied from 22.6 to 1.9 ft-candles. The Panel 204 reading was 8.3 ft-candles.
1	16.	The two separate Control Transfer Panels for the Remote Shutdown Panel are not provided with security devices to prevent unauthorized transfer of control between the Control Room and the Remote Shutdown Panel.

2. COMMUNICATIONS

PRIORITY FINDING

THE COMMUNICATIONS EQUIPMENT AND PROCEDURES FOR UNIT 2 WERE NOT COMPLETED AND COULD NOT BE EVALUATED.

3. ANNUNCIATORS

PRIORITY	FINDING	
2	1.*	The function of the annunciator tile labeled ANNUNCIATOR POWER SUPPLY on annunciator Panel K is not clear.
1	2.*	There are no annunciators for the HYDRAZINE system.
1	3.	There is no annunciator or alarm to warn of unauthorized transfer of control from the Control Room to the Remote Shutdown Panel.
1	4.	Some annunciator tiles with multiple inputs do not have reflash capability.
1	5.	The annunciator system does not have a separate First Out Panel for the reactor systems. Annunciator Panel C, for the turbine, is the only annunciator panel with First Out reset capability
3	6.	There is a general lack of prioritization in the control room annunciator alarms. A consistent prioritization coding scheme, based on importance, severity, or need for operator action, has not been applied.
2	7.	On all annunciator panels, the only indication that an annunciated condition has been cleared is where the light is extinguished.
1	8.*	The annunciator audible alarms are only marginally louder than the ambient noise in the control room.
1	9.*	The annunciator audible alarm devices for Panels 201, 203, and 205 are located behind the panels, making it difficult for operators to localize the source of an alarm.
1	10.	The annunciator illumination system does not ensure that an indication of alarmed conditions will be provided to the operator if failure of an annunciator light flasher occurs. In case of flasher failure of an alarmed tile, the tile light should illuminate and burn steadily.
1	11.*	Some annunciators used in startup will be normally lit during full power operation. Examples: a.) POWER HIGH RATE OF CHANGE and TRIP BYPASSED tiles on annunciator Panel L

3. ANNUNCIATORS (Continued)

PRIORITY	FINDING	
1	12.	None of the annunciator panels in the control room have labeling of their vertical or horizontal axes to aid in matrix location and identification of individual tiles.
1	13.	Blank annunciator tiles on almost all annunciator panels are illuminated during normal operation.
1	14.*	Many annunciator tile legends are wordy. Some tiles have as many as 14 words.
1	15.*	Annunciator font size (.2 inches in height) is too small for reliable reading from the operator annunciator control positions.
1	16.	The operator cannot read all of the annunciator tiles on Panels 205 and 206 from the annunciator acknowledge control location because of the oblique viewing angle from the control location.
1	17.	The space between legend lines on annunciator tiles is less than 1/2 the character height.
2	18.	One annunciator board on the Line Repeat Panel has two redundant sets of controls located within 12 inches of each other.
2	19.*	There are no separate silencing controls on any annunciator control systems.
2	20.*	The relative location of annunciator control button groups is not the same from panel to panel and the annunciator control buttons are not arranged in the same order in the control group at each panel.
3[1]	21.	Annunciator Panel N contains a tile with a temporary label. The WASTE MANAGEMENT LOCAL ALARM GROUND DETECTED POWER FAILURE tile label is handwritten on the face of the tile.

4. CONTROLS

PRIORITY	FINDING	
1	1.	Some controls needed to perform system operating tasks are not in the control room. Examples: a.) Auxiliary Feedwater Pump Start Bypass control b.) Condensate Pump 2C control
2	2.	The Fire Pump 1A and 1B Stop controls on Panel 202 are unnecessary controls on that panel. These controls are not related to systems operations controlled from that panel.
2	3.	Some process controllers on Panels 205 and 206 have inoperative OPEN/CLOSE pushbuttons that are disconnected and have no control function. Examples: a.) HIC-3618 b.) HIC-3628 c.) HIC-3638 d.) HIC-3648 e.) SI Loop 2A2 Check Valve Leakage
1	4.*	The Turbine Trip pushbutton is not protected to prevent unintentional operation.
1	5.*	The SI Loop Check Valve Leakage HIC-3638 process controller operates in reverse of the conventional operation of other process controllers in the control room.
2	6.	Some rotary switches do not conform to the OPEN-Right (Clockwise) / CLOSE-Left (Counterclockwise) convention for switch positions. Examples: a.) Generator No. 2 switch on Line Repeat Panel has OPEN-Left / CLOSE-Right positions. b.) Turbine Drain Valve controls on Panel 201 have OPEN-Left / AUTO-Center / CLOSE-Right positions. c.) Loop 2A2 and Loop 2B1 Charging Line Valve controls have RESET-Left / CLOSE-Middle / OPEN-Right positions.
3	7.*	Some keyswitches have a black ring that might be interpreted as a color code while other keyswitches do not. There is no apparent significance of this difference.

4. CONTROLS (Continued)

PRIORITY	FINDING	
1	8.*	The Matrix Relay Hold pushbuttons on the RPS Panel are difficult to depress for the period of time required to perform system tests. The control resistance of these pushbuttons is too high for tasks requiring activation for more than a few seconds.
2	9.*	The backlit legend pushbuttons and the backlit legend indicator lights in several arrays on Panels 201 and 202 are identical in appearance, size, and shape. control/display substitution errors are possible. Examples: a.) DEH Valve Test panel b.) Generator Megavar displays c.) Diesel Generator controls and displays
2	10.*	Covers on backlit legend pushbuttons and indicators are interchangeable and are not coded to identify their correct location in the control/display arrays.
3[1]	11.*	Some keyswitches do not conform to the keyswitch orientation convention used in the control room.. Examples: a.) Minimum Flow Header A Isolation Valve V-3496 switch on Panel 206. b.) DEH Turbine Control OPC switch on Panel 201.
1	12.*	Rotary switches and keyswitches have unlabelled positions. Examples: a.) SIAS Block Channel SA and SB keyswitches on Panel 206 b.) MSIS Block Channel SA and SB keyswitches on Panel 206 c.) Trip Circuit Reset rotary switches on the RPS Panel
2	13.	Some rotary selector switches can be stopped in positions between the detented operating positions. Example: a.) Seal Cooler Heat Exchanger Isolation Valves HCV-14-11A1, A2, B1, and B2 on Panel 203.
3	14.	The handles of rotary control switches on Panel 201 obscure the view of position markings on the switches. Examples: a.) Generator Field Ground Detector b.) Voltage Adjuster c.) Base Adjuster d.) Diesel Generator Ammeter e.) 4.16KV 2B3 Ammeter

4. CONTROLS (Continued)

PRIORITY	FINDING	
3	15.*	Status indicator flags on some J-handle and rotary pointer switches are obscured by the switch handle. Examples: (Panel 202) a.) Circulating Water Pump 2A1 control b.) Circulating Water Discharge Valves MV-21-2A1 and 2B1 c.) Screen Wash Pumps 2A and 2B
3	16.*	Rotary selector switches on Panel 201 have pointers engraved in the switch handle that are not marked with a contrasting color to make them readable. Examples: a.) Exciter Supply Breaker b.) Generator Ground Detector c.) Voltage Adjuster d.) Base Adjuster
3	17.*	There is unacceptable parallax between the indicator pointer and the green band used to indicate the operating setpoint band on some process controllers. Examples: a.) Pressurizer Pressure PIC 1100-X and 1100-Y on Panel 203 b.) Boric Acid Flow FRC-2210Y on Panel 205 c.) Reactor Makeup Water Flow FRC-2210X on Panel 205 d.) Liquid Waste Flow FIC-6627 on Panel 205

5. DISPLAYS

PRIORITY	FINDING	
2	1.	Assuming its label is correct, the AUX FEEDWATER HDR C FLOW/PRESSURE indicator FI-09-2C/PI-09-8C on Panel 202 should display values of two different variables. The installed meter can display only one variable.
1	2.	There is no distinction between the three backlit indicators labeled HI POWER TRIP on the RPS Matrix Test Panel nor between the two indicators labeled HI RATE.
2	3.	The data channel identification labels for HVAC Panel trend recorders PR-25-1A, PR-25-1B, and PR-25-2 do not indicate which recorder scale to use with each variable displayed on the multi-range, multi-channel recorders.
3[1]	4.*	On Panel 201, the GENERATOR EXCITER FIELD DC VOLTS meter scales are not marked to indicate positive and negative values.
3[1]	5.	On Panel 201, the VIBRATION PHASE ANGLE METER-VBI-22-1 and the ECCENTRICITY PHASE ANGLE METER ECC-22-1 do not have indications of positive or negative above and below zero. Also, their scales are graduated in 10's above zero and in 30's below zero.
3	6.*	The upper scale on horizontally oriented meters is difficult for a standing operator to see without crouching. Examples: a.) STEAM GENERATOR DELTA P b.) CORE FLOW c.) COOLANT LOOP TEMPERATURE TCOLD/THOT) d.) PRESSURIZER PRESSURE
3	7.*	Extreme values at the top and bottom of the scales on vertical meters are obscured due to meter design. Example:(Panel 203) a.) CONTROLLED BLD-OFF FLOW FIA-1150
1	8.	The LED displays generally have poor readability due to glare, scratchable face plate surfaces, and poor contrast. Example: a.) LINE REPEAT PANEL b.) PANEL 203 c.) MEGAVAR PANEL d.) PRESSURIZER PRESSURE

5. DISPLAYS (Continued)

PRIORITY	FINDING	
3[1]	9.	On Panel 204, the CEA Secondary Rod Position display is made up of a high contrast checkerboard pattern of bright yellow on white. This pattern is very disturbing to look at because of color afterimages.
3[1]	10.	Several meters, primarily G.E. circular meters, have confusing scale markings. The scale spacing is non-linear and there are no graduations near the zero marking on the meter scale. Also, it is not clear what downscale meter pointer position indicates a meter failed condition. Example: a.) GENERATOR AMPERES AM-8810B and AM-8810C on Panel 201 b.) GENERATOR KILOVOLTS VM-881
3[1]	11.	Several meter scales have thick black marks to extend major tick marks to the scale numerals. These marks give the misleading appearance of minus (-) signs in front of the meter scale numerals. Examples: (HVAC Panel) a.) PDIS-25-1B b.) PDI-25-15B
1	12.*	There are several displays which use unconventional scale graduations. Examples: a.) Panel 201: DIESEL GENERATOR 2B MVARS VARM-1616 b.) Panel 204: WIDE RANGE ▪ POWER JI-001B c.) Panel 203: LOOP 2A COLD LEG TEMP TIC-111 d.) Diesel Gen 2B Frequency
3[1]	13.	Green FPL tape (denoting equipment turnover to FPL) and meter calibration certification stickers obstruct labels and meter scales in several places and generally clutter the appearance of the boards.
2	14.	Some meters in the control room have white bezels while others have black bezels. There is no well defined difference in meaning between the two bezel colors.
2	15.	On the Line Repeat Panel there is either a reversal of Green-Left / Red-Right convention of indicator light positions or the colored lamps are incorrectly installed.
3[1]	16.	There is a widespread use of amber and bluecolors for electrical system status lights while a red/green/amber convention used on most other systems in the control room.

5. DISPLAYS (Continued)

PRIORITY	FINDING	
3[1]	17.*	The CONTAINMENT H2 PURGE CONTROL VALVE FCV-25-8 on the HVAC Panel violates the conventional color coding of indicator lights by using green to indicate OPEN and red to indicate CLOSED.
1	18.	On Panel 203, the PRESSURIZER PRESSURE METERS PIC-1105 and PIC-1106 indicate an increase in pressure by a downward movement of the pointer.
3[1]	19.*	On process controller vertical scales, circular meters, and large horizontal trend recorders, the pointers obscure scale numerals. Example: a.) GENERATOR TEMPERATURE TR-22-30
3[1]	20.	The CONDENSATE & STM GEN BLOWDOWN CONDUCT CR-05-1 trend recorder does not have a legend to distinguish between pen colors.
2	21.	The 0-5 psi operating band on the CONTAINMENT PRESSURE PIS-07-2B display on Panel 206 is very small compared to the full range of the display scale (0-100 psi).
1	22.*	Throughout the control room, there is a lack of demarcation of the "normal", "safe", "caution", and "danger" ranges on display instruments.
1	23.	The Reactor Protection System Trip Status Panel has indicator lights which indicate OPEN on the bottom or left and CLOSED on the top or right. Both of these indicator light positions are opposite of normal convention.
1	24.*	There are no lamp tests in the control room other than those for the annunciators.
3[1]	25.	On Panel 201, the BATTERY 2A and BATTERY 2B status lights are single blue lights. There is no indication whether the light indicates normal or abnormal state when lit.
2	26.*	On the HVAC Panel, each of the following systems has three associated indicator lights, two of which are red: CONTAINMENT FAN COOLERS: 2HVS-1A, 1B, 1C, 1D

5. DISPLAYS (Continued)

PRIORITY	FINDING	
2	27.	Several recorders are supplied with paper which is scaled differently than the scale on the recorder face. For example, the BORON CONCENTRATION RECORDER AP-2203 on PANEL 205, if installed as planned, will have four selectable ranges but will have only a single full range paper (0-2000). Thus, if the operator selects (0-500) range, a reading of 250 will be recorded as 1000, etc. Other examples: a.) Panel 201: GENERATOR FREQUENCY RECORDER F-REC-881 b.) Panel 202: FEEDWATER AND STEAM GENERATOR BLOWDOWN PHR-05-1.
3[1]	28.*	The trend recorders on the HVAC Panel have data legend labels on the glass window which obscure the graph paper. The operator must open the recorder in order to read information.
1	29.	Multipoint impact recorders have too many data channels on each recorder. Some recorders have as many as 24 data channels. Similar impact recorders in Unit 1 were found to be overprinting their data.
3[1]	30.*	A (0-125) nonlinear scale is used on the REACTOR MAKEUP WATER FLOW FRC-2210X display where a linear scale would do just as well.
1	31.	Several displays have no labeling to indicate what units their scales are measured in. Examples: a.) Panel 205: WASTE GAS FLOW RECORDER-FR-6648 b.) Panel 203: PRESSURIZER SPRAY-HIC-1100 c.) Panel 206: REFUELING WATER TANK LEVEL-LR-07-20
3[1]	32.	The ∗ POWER METER on the Reactor Protection System Panel has a broken glass face.

6. LABELS AND LOCATION AIDS

PRIORITY	FINDING	
1	1.*	A number of controls and displays on Panel 203 have labels which are either missing or appear to be incorrect.
1	2.*	Many trend recorders on Panel 205 and the HVAC Panel have blank labels or labels which do not identify the display's function.
3[1]	3.	On the back of Panel 201, the AUX and MAIN TRANSFER switches and indicator lights are not labeled.
3[1]	4.	There are missing labels on the Plant Auxiliary Panel for switches and for switch position indicators.
1	5.*	Some of the Auxiliary Feedwater Pump and Valve controls have unlabeled "Auto" positions. Example: a.) AUX FW PUMP/2A DISCH to SG2A VALVE
1	6.*	The MATRIX RELAY TRIP SELECT rotary control on the RPS Panel has unlabeled positions.
1	7.*	On Panel 201 the BATTERY VOLTS 2A meter VM-001 is incorrectly labeled as BATTERY VOLTS 2B.
3[1]	8.	The LOOSE PARTS MONITOR CABINET contains switches whose control functions and positions are not labeled.
3[1]	9.	Several toggle switches on the Reactor Regulating System Panel and on the Reactor Coolant Pump Vibration Monitor Panel have unlabeled switch positions.
1	10.	On Panel 206, the key switch positions on the MSIS block switch are not labeled.
2	11.	LPSI LOOP 2A FLOW METER on Panel 206 is mislabeled. It should read 2A1.
1	12.	The LPSI HEADER PRESSURE METERS 2A and 2B on Panel 206 are either mislabeled or in the wrong panel locations.
3[1]	13.	The CONDENSER VACUUM DISPLAY (PI-10-7B) on Panel 201 has a mislabeled scale. It should read "Inches Hg Vacuum" instead of "Inches Hg ABS".
1	14.	The BORON CONTROL VALVE on Panel 205 is mislabeled. It should read BLENDING VALVE.

6. LABELS AND LOCATION AIDS (Continued)

PRIORITY	FINDING	
3[1]	15.	The FEEDWATER PUMP 2A FLOW label on Panel 202 is incorrect. It should read FEEDWATER PUMP 2B FLOW.
1	16.	The functional difference between the dual Steam Generator meters on the four ENGINEERING SAFEGUARDS LOGIC CABINETS is not labeled.
1	17.	There is no hierarchical arrangement of labels by system and subsystem throughout the control room.
3[1]	18.*	On Panel 201, component identification labels are not consistently larger than component status (e.g. "start", "stop", "auto") labels.
1	19.	Label placement convention is inconsistent throughout the control room.
3[1]	20.*	Labels on Panel 201 have been placed under displays and are often obscured by the overhanging bezel of the display they are intended to identify.
3[1]	21.	The label for the backpanel that contains the L & N PROCESS AND COOLING WATER TEMP. SELECTOR is below the switch array and is obscured.
1	22.*	The WASTE GAS FLOW trend recorder on Panel 205 has no label to indicate what parameter is being monitored.
3[1]	23.	On Panel 202, the labeling for the light pairs representing the UHS CANAL BARRIER VALVES (I-S3-21-13, 14) is ambiguous. There is one label for two light pairs.
3[1]	24.*	On Panel 201, labels for rotary switch control positions are not oriented horizontally and switch position labels are obscured by the control handle. Example: a.) AMMETER CONTROLS FOR BUS 2A1.
1	25.*	On Panel 205, there is no indication on two-color trend recorders as to which color represents an actual reading and which represents the set point.
1	26.	The REACTOR CHANNEL TRIP BUTTONS on Panel 204 are not labeled as to function. The buttons should be labeled "TRIP".
3[1]	27.	Most of the component labels on the FEEDWATER REGULATING RACK do not contain component identification numbers.

6. LABELS AND LOCATION AIDS (Continued)

PRIORITY	FINDING	
3[1]	28.*	Labels on Panels 205 and 206 are very similar and can be confusing. Examples: a.) BORIC ACID GRAVITY FEED VALVE V-2508 and BORIC ACID GRAVITY FEED VALVE V-2509. b.) HPSI TO HOT LEG 2B VALVE V-3551 and HPSI TO HOT LEG 2B VALVE V-3523
1	29.	On Panel 206, there is an error on the HPSI HDR B TO LOOP 2B2 label. It should read LPSI instead of HPSI.
1	30.*	Abbreviations are not used consistently in labels. Examples: a.) Panel 206: CCW PUMP 2A (CCW = component cooling water) b.) Panel 203: CCW FROM RCP 2A1 FLOW (FIA-1158) (CCW = core cooling water) c.) Panel 205: COMP COOL'G WATER.
3[1]	31.*	Labeling of units on scales of trend recorders, counters, and process controllers on Panel 202 is inconsistent and often is redundant with the control label. Example: a.) FEEDWATER TO SG 2A REG VALVE BYPASS LIC-9005
2	32.*	Pushbuttons on Panels 201 and 203 have two labels which present redundant information. Example: a.) Panel 201: TURBINE TRIP and TRIP b.) Panel 203: RCP 2A1 VIBRATION RESET and RESET.
1	33.	On Panel 203, two controllers that are labeled PRESSURIZER LEVEL CONTROL have different functions.
1	34.*	Some labels are difficult to read due to insufficient color contrast between label surface and lettering.
1	35.*	Engraved labels on all panels in the control room have become obscured by grime.
1	36.*	On the Plant Auxiliary Panel, the annunciator control button labels are illegible and the ACKNOWLEDGE buttons are not labeled.

6. LABELS AND LOCATION AIDS (Continued)

PRIORITY	FINDING	
3[1]	37.*	Panels 203 and 206 have labels whose characters are separated by less than the minimum recommended space (1/6 character height).
3[1]	38.*	Line spacing is less than 1/2 character height on almost all labels in the control room.
3[1]	39.	Several controls on Panel 201 have temporary labels to indicate associated circuit breakers.
3[1]	40.	The permanent label for the STATION BATTERY 2B VOLTS meter is incorrect and has been replaced by a temporary label. However, both labels are still in place.
3[1]	41.	On Panel 201, the label for the 480V BUS TIE SWITCH 2AB-2 is handwritten in ink on the panel surface.
1	42.	Tag outs on Panel 201 obscure displays located below them on the control panel.
3[1]	43.*	On Panel 201, summary labels and demarcation lines are not used to identify and separate systems surrounding mimics. Labels do not always appear above mimic areas. Example: a.) Electrical distribution buses
1	44.	REACTOR TRIP A and C pushbuttons on Panel 201 are adjacent to the TURBINE TRIP pushbutton. REACTOR TRIP is a safety function and its controls should be readily distinguishable from the TURBINE TRIP control.
1	45.	The color coding and shading of control labels on the HVAC Panel is inconsistent with the rest of the control room.
1	46.*	Mimics in general are not consistently color coded. For example, there is an inconsistent use of color in the Power Distribution Mimic on Panel 201. The colors yellow and blue are used for voltages of 6.9KV and 4.16KV and yellow and blue are also used for protective channels B and D.
1	47.*	On Panel 205, the annunciator TEST control is color coded red, which is inconsistent with coding of other annunciator controls.
3[1]	48.	The Line Repeat Panel Mimic has incomplete mimic lines and arrows.

6. LABELS AND LOCATION AIDS (Continued)

PRIORITY	FINDING	
1	49.*	Color codes of labels are generally based upon the power supply for the component instead of the component function. This color code scheme is helpful for maintenance but is not a useful aid for the operator.
3	50.	On Panel 201, the 480V BUS BREAKER controls are interspersed with controls which are part of a system mimic. This tends to confuse the mimic arrangement.
2	51.	There is a lack of grouping of Diesel Generator controls on Panel 201.

7. PROCESS COMPUTERS

PHOTO ID REVIEWER PRIORITY FINDING

THE PROCESS COMPUTER INSTALLATION FOR UNIT 2 WAS NOT INSTALLED AND COULD NOT BE EVALUATED.

There will be significant differences between the Unit 2 Process Computer and the Process Computer system now operating in Unit 1.

8. PANEL LAYOUT

PRIORITY	FINDING	
3	1.*	Controls that are used together are not functionally grouped on Panel 206. Example: a.) CSAS CHANNEL SA, SIAS CHANNEL SA, and RAS CHANNEL SA
2	2.	On Panel 203, the Pressurizer Relief Line Temperature and the Safety Valve Discharge Temperature meters are installed in unconventional left to right order (1107,1108,1109,1106).
2	3.	On Panel 206 unrelated displays have been placed between related displays for CCW FROM SHUTDOWN, CCW FROM FUEL POOL, and CONTAINMENT SPRAY.
2	4.*	The VOLUME CONTROL TANK DISCH VALVE V-2501 and the REFUELING WATER TO CHARGING PUMPS VALVE V-2504 on Panel 205 are spacially separated by other letdown, charging and VCT controls. There is a general lack of logical layout of charging, letdown, and VCT controls on this panel for task oriented optimization.
3	5.	On Panel 203, there is a lack of consistency in the column alignment of similar displays. For example, UPPER CAVITY PRESSURE indicators are not aligned vertically in the same column.
3	6.	There is a general lack of system grouping on Panel 202. Examples: a.) The Primary Water Makeup Pump controls and PRIMARY WATER STORAGE TANK LEVEL displays are located on Panel 202. The remainder of the makeup controls and displays are located on Panel 205 . b.) The Chemical recorders are located between Auxiliary Feedwater controls and indicators.
2	7.	On Panels 205 and 206 it is difficult to locate and identify specific controls located in large matrices of controls which are identical in appearance. The control arrays do not have aids such as system funtional grouping, functional color coding, or demarcation to facilitate operator actions.
1	8.*	The CONDENSATE STORAGE TANK HIGH LEVEL and CONDENSATE LOW LEVEL annunciator tiles on annunciator Panel Q are not near or above associated system displays.

8. PANEL LAYOUT (Continued)

PRIORITY	FINDING	
2	9.	The indicator lights for DIESEL GEN. 2A LOADING status on Panel 201 are not arranged in the conventional operational loading sequence.
3	10.*	On Panel 203, some controls are not arranged by importance or frequency of use. Examples: a.) ANNUNCIATOR controls b.) REACTOR COOLANT PUMP controls
2	11.	There is a poor grouping of indicator lights in several places on Panel 206. Examples: a.) CSAS CHANNEL SB b.) SIAS CHANNEL SB c.) RAS CHANNEL SB
3	12.	On Panel 203, several controls/displays are arranged horizontally on the upright panel while related controls/displays are arranged vertically on the benchboard. Example: a.) Reactor Coolant Pumps 2A1, 2A2, 2B1, 2B2
2	13.	There is a reversal from normal left-to-right convention of the indicator lights for the LPSI HDR A TO LOOP 2A1 VALVE and the LPSI HDR A TO LOOP 2A2 VALVE on Panel 206.
3	14.	Columns of similar control switches on Panel 206 are separated by two columns of miscellaneous controls. Examples: a.) Control switches V3612 and V3622 b.) Control switches V3613 and V3623
3	15.*	The AUX FEEDWATER HEADER FLOW trend recorders on Panel 202 are arranged in BCA left-to-right sequence instead of ABC.
2	16.	There are many locations in the control room where components are not arranged left-to-right and/or top-to-bottom, and are not identified in alphabetical or numerical sequence. Examples: a.) The HOLDUP TANK LEVEL INDICATORS on Panel 205 are arranged from right to left. b.) On Panel 206, the HDR B ISOL VALVE is above the HDR A ISOL VALVE. c.) The Line Repeat Panel MEGAVAR meters are numbered from right to left.

8. PANEL LAYOUT (Continued)

PRIORITY	FINDING	
2	17.*	The locations of LIQUID WASTE FLOW VALVES FCV-6627Y and FCV-6627X status indicator displays and valve control switch positions violate the upper/left - lower/right layout convention for associated controls and displays in a mixed horizontal and vertical layout. The upper set of indicator lights for valve Y is associated with the right position of the valve control. The lower set of indicator lights for valve X is associated with the left position of the control.
1	18.	On Panel 206 the meter for SI TANK 2A2 LEVEL is a narrow range instrument. It should be a wide range meter to be consistent with similar level displays on the panel.
3	19.*	The controls for the REACTOR REGULATOR SYSTEM "1" and "2" on Backpanel 204 and the continuous rotary selectors on the LOOSE PARTS MONITOR panel do not meet minimum separation guidelines for controls.
2	20.*	There are excessively long meter strings of more than five vertical meters per string on Panels 201 and 203. Examples: a.) EXPANSION STEAM AREA b.) CONDENSER STEAM AREA
2	21.	There is string of 10 J-handles on Panel 203. It is difficult to readily distinguish individual controls in the string.
1	22.	The REACTOR COOLANT PUMP 2B2 control on Panel 203 is located in cluster with the PRESSURIZER BACKUP HEATER BANK controls. The pressurizer heater controls are used frequently. This location of the reactor coolant pump control among frequently operated controls increases the likelihood of accidental shutoff of the reactor coolant pump.
1	23.	The CRT display on Panel 204 is difficult to view from the operators position at the ROD POSITION CONTROLS because of the poor viewing angle.
3	24.	Electrical test points for Reactor Coolant Temperature are included in front panel. If they are used only for calibration, they should be placed in other than prime control areas. If they are used for operations, they should be replaced by an appropriate display.

9. CONTROL/DISPLAY INTEGRATION

PRIORITY	FINDING	
2	1.	There is little system functional logic to the layout of Panel 205. For example, a normal blending operation would involve the use of the BORIC ACID MAKEUP PUMP 2A, the BORIC ACID MAKEUP FLOW VALVE, the REACTOR MAKEUP WATER STOP VALVE, and the REACTOR MAKEUP FLOW VALVE controls and the indicators for BORIC ACID FLOW, REACTOR MAKEUP WATER FLOW and VOLUME CONTROL TANK LEVEL. These controls and displays are not logically grouped to perform this operation.
2	2.	Panel 202 benchboard controls are mirror imaged while corresponding vertical displays are not.
1	3.*	On Panel 203, there is a poor layout of Pressurizer Level and Pressurizer Pressure controls and displays. Pressure controls are to the left of Level controls, while Pressure displays are to the right of Level displays. Furthermore, the LOOP 2A/2B HOT LEG TEMPERATURE display is located between the Level and Pressure displays.
3	4.	The SHUTDOWN COOLING HX OUTLETS 2A and 2B (TEMP-TI-3303X and TEMP-TI-3303Y) displays are located at the opposite end of the panel from the SHUTDOWN HX CCW VALVES (HCV-14-3A and HCV-14-3B) controls. These controls and displays are used together during a failed pump condition.
2	5.	The right portion of Panel 202 contains 5 different subsystems, (circulating water, condensate, primary makeup, intake, and screen wash), which are not arranged in a logical layout.
1	6.	Fisher-Porter controllers are inconsistent with each other. Some are fixed scale/moving pointer, while others are moving scale/fixed pointer. This requires operator to move the set point rotary wheel up to increase on some controls and down to increase on others. Examples: (Panel 205) a.) REACTOR MAKEUP FLOW (FRC-2210X) b.) FLASH TANK LEVEL (FCV-6627Y)
3	7.	The FEEDWATER TO STEAM GENERATOR ISOLATION VALVES (HCV-09-1A,2A,1B,2B) on Panel 206 are widely separated from the FEEDWATER PUMP 2A FLOW (FI-09-1A,1B) and FEEDWATER AND STEAM FLOW SG2A/SG2B displays found on Panel 202.
2	8.	The COND PIT SUMP YARD SUMP HIGH LEVEL annunciator tile on Panel 205 should be associated with the CONDENSATE PUMP 2A and 2B controls on Panel 202.

SYSTEMS WHICH COULD NOT BE EVALUATED

* Because of the state of completion, it was not possible to evaluate the following General Layout aspects of the Control Room:
  - Furniture and Equipment Layout
  - Document Organization and Storage
  - Spare Parts, Operating Expendables, and Tools
  - Supervisor Access
  - Nonessential Personnel Access

* Operator consoles were represented by cardboard mock-ups which were only approximate replicas of the consoles to be installed. Thus, no studies of the operator consoles or any associated equipment were possible, preventing evaluation of such items as:
  - Anthropometrics
  - Console Dimensions
  - Desk Dimensions
  - Operator Chairs

* Unit Integration and Interference between the Unit 2 and the Unit 1 Control Rooms under operational conditions could not be fully evaluated. It was observed that, if present plans are implemented, there will be differences between the two control rooms that may have significant human factors implications.

* Emergency equipment was not present for evaluation of:
  - Operator Protective Equipment
  - Fire, Radiation, and Rescue Equipment
  - Emergency Equipment Storage

* The Control Room environment was not in its final state. The following environment topics could not be evaluated:
  - Temperature and Humidity
  - Ventilation
  - Illumination
  - Emergency Lighting
  - Auditory Environment
  - Personal Storage
  - Ambience and Comfort

* The following Voice Communication Systems items were not available for evaluation under operating conditions:
  - Conventional-Powered Telephone Systems
  - Sound Powered Telephone Systems
  - Walkie-Talkie Radio Transceivers
  - Fixed-Base UHF Transceivers
  - Announcing Systems
  - Point-to-Point Intercom Systems
  - Emergency Communications

* No evaluation could be made of the Auditory Signal System including:
  - Use of Auditory Signals
  - Signal Meaning
  - Auditory Coding Techniques
  - Signal Propagation
  - Signal Frequency
  - Signal Intensity
  - System Reliability

* Numerous controls and displays throughout the control room were missing or represented by photo mock-ups and could not be evaluated completely.

* The Plant Process Computer was not installed in Unit 2 and could not be evaluated from the Unit 1 computer installation. Items which need to be addressed include:
  - Computer Access
  - Cathode Ray Tube (CRT) Displays
  - Hard Copy Printers