UCID- 19122

MASTER

Draft Audit Report, Human-Factors Engineering-Control-Room Design Review: Shoreham Nuclear Power Station

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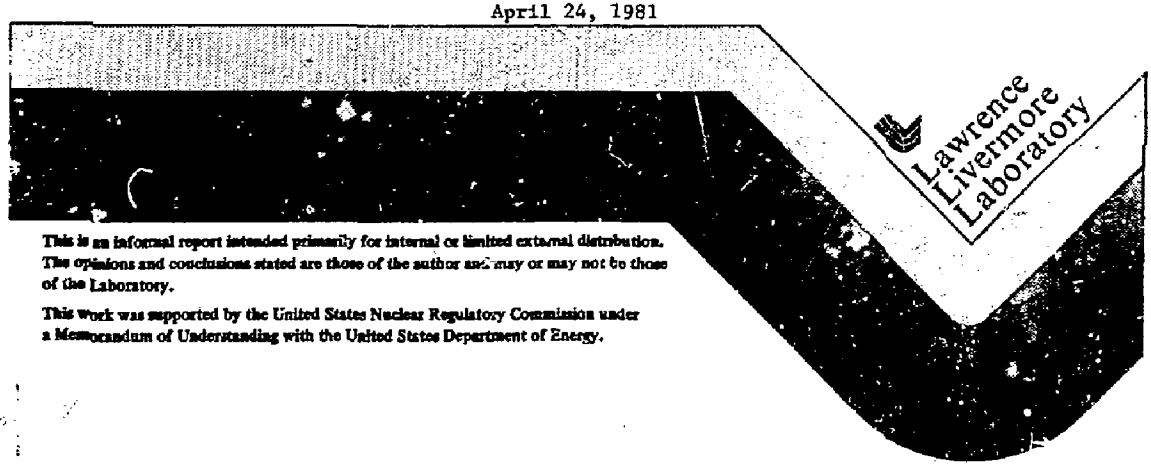
April 24, 1981



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

DRAFT AUDIT REPORT

UCID--19122

Human Factors Engineering
Control Room Design Review/Audit

DE82 007851

SHOREHAM NUCLEAR POWER STATION

Long Island Lighting Company

April 24, 1981

A human factors engineering preliminary design review of the Shoreham control room was performed at the site on March 30 through April 3, 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.

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 listed in the Preliminary Human Factors Engineering Recommendations submitted to the NRC Human Factors Engineering Branch by Long Island Lighting Company.

April 24, 1981

1. WORKSPACE

PHOTO ID	REVIEWER	CTGY	FINDING
K5	MB,RP	2	1. The computer console obstructs the view of the MXP and VC1 auxiliary panels from the seated operator position at the operator's desk.
K16	MB,RP	1	2.* The security console is unnecessary in the control room. It obstructs movement and obstructs the view of the MXP panel from the operator desk and the reactor control console.
K6	MB,RP	1	3. Construction of the supervisor's office is not complete. The adequacy of visual and voice contact between that office and the control room could not be evaluated.
K2	MB,RP	1	4.* Grounding cable covered by a metal sleeve on the floor between the operators' desk and the reactor control console is a tripping hazard.
K7	MB,RP	1	5. Tangled and kinked sound powered phone cords lying on the floor are a tripping hazard. Use of non-kink or self retracting cords is recommended.
K9,K11	MB,RP	2	6. Controls mounted on vertical boards of Panels 601 and MCB, which are 30 inches from the front edge of the benchboard, are difficult for short persons to reach. Recommended: 24 inches maximum reach distance to any control.
H6	JS	3	7. The annunciator panels on Panels MXP, VC1, and VC2 and on all of the back panels are not tilted forward to enhance readability.
	MB,RP	2	8. Hand held radio (walkie-talkie) transmission and reception is variable between the control room and other areas of the plant. Hand held radios cannot communicate between personnel in the control room and in the reactor building.

* Discrepancy also noted in Long Island Lighting Company report of Preliminary Human Factors Engineering Recommendations.

1. WORKSPACE (continued)

PHOTO ID	REVIEWER	CTGY	FINDING
	WR	1	9.* Sound powered phone jacks for the Remote Shutdown Room are located outside of the room behind the entrance door.
	WR	1	10. No sound powered phone headsets are stored in the Remote Shutdown Room.
	MB,RP	1	11.* Emergency equipment is stored in temporary storage locations. Operational storage, identification, availability, adequacy, and maintenance of emergency equipment could not be evaluated.
	MB,RP	1	12. No provisions are made for speech transmission or communications while wearing emergency breathing apparatus face masks.
K13	MB,RP	1	13. Documentation is stored in temporary shelves on the back side of the computer console. Operators at the operator desk or the reactor control console must walk around the computer console to obtain reference documents Final design and organization of reference document storage in the control room is unknown.
	GS	1	14. There are no emergency procedures stored in the Remote Shutdown Room.
	MB,RP	1	15. Procedures are not adequately cross referenced. Could not determine whether adequate procedures exist for: a.) Periodic testing of emergency alarms and communications systems, b.) Periodic testing of sound powered phone systems, c.) Periodic inventory and inspection of emergency equipment, and d.) Training and practice in use of emergency equipment.

2. WORKPLACE ENVIRONMENT

PHOTO ID	REVIEWER	CTGY	FINDING
	JP-S	1	1. Permanent control room ventilation system could not be evaluated since it is not operational. The temporary ventilation system has excessive air flow.
	RE	1	2. The lighting of the operational control room could not be accurately evaluated because ceiling diffuser panels had not been installed below the light fixtures.
	RE	3	3. There are no procedures or plans to conduct periodic lighting intensity surveys in the control room.
	RE,GL	1	4. The emergency DC lighting in the back panel areas is inadequate. Measured lighting illuminance ranged from less than one (1) foot candle to seven (7) foot candles. Recommended: 30 foot candles minimum for safety related panels and 7.5 foot candles minimum for non-safety related panels.
	GS	1	5. No emergency lighting is provided in the Remote Shutdown Room.
E1	RE,GL	1	6. Contrast between displays and the panel background exceeded the maximum recommended 1:3 luminance ratio at many locations in the control room: a.) Contrast between dark meter faces and panel backgrounds had luminance ratios ranging from 1:3 to 1:10, b.) Contrast between the CRT displays and the Panel 603 background had luminance ratios of 1:5.
	JJ	3	7. The 63 dB(A) ambient noise level in the control room is moderately high and limit communication in normal conversational voice levels to 6 to 8 feet speaker to listener separation distances. Normal ambient noise levels in the control room could not be measured accurately because of construction activites.
	JP-S	1	8.* There is no lamp test capability or other positive means of determining failed indicating lights except for annunciator lights.

2. WORKPLACE ENVIRONMENT (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
J6	JP-S	2	9. Light bulb replacement and service of all Weston meter displays must be done from the back of the panel cabinet.
J5	JP-S	1	10. Changing light bulbs of indicator lights for switches controlling air and motor operated valves is unwieldy and requires a special wrench/extractor that is difficult to use.
K14	MB.RP	1	11.* Maintenance tags hanging down on vertical panels can obscure indicator lights and labels of switches mounted below.
E2	RE	3	12. The tag-out system used to identify controls that are not to be operated does not physically preclude operation of the controls.

3. ANNUNCIATORS AND AUDITORY SIGNALS

PHOTO ID	REVIEWER	CTGY	FINDING
H5	RH	1	1.* The annunciator panel identification scheme is *inconsistent and does not follow a conventional* sequential order around the main control boards.
	RH,RP	1	2. The controls provided for operator response to the annunciator system provide only SILENCE, ACKNOWLEDGE, and TEST controls. Recommended: provide SILENCE, ACKNOWLEDGE, RESET, and TEST controls for annunciators.
	RH	1	3. No first-out alarm system is provided in the annunciator system to identify trip initiating events.
	RH	1	4. There is no audio or visual annunciator indication to signify that an alarmed condition has cleared. Once an alarm occurs, the annunciator tile remains illuminated until the operator presses the Acknowledge control. Then the tile illumination turns off if the alarm has cleared.
H4	RH	1	5.* Annunciator tile locations are not identified by a matrix identification scheme with the matrix location code inscribed on each tile. Each tile is number coded but the there is no systematic correlation between the number code and the tile location. Tiles are not physically keyed to prevent placement in an incorrect location.
	RH	3	6. The flash rate of annunciator displays (approximately 1.5 - 2 flashes per second) is slower than recommended. Recommended: 3 - 5 flashes per second flash rate.
	RH	1	7. Failure of an annunciator flasher circuit, which may control flashing indicators on more than one annunciator panel, does not necessarily result in steady illumination of the annunciator tiles that were flashing. If flasher failure occurs the affected annunciator tiles will stay either in the steady ON or the steady OFF condition, depending on their ON/OFF state at the instant flasher failure occurs.

3. ANNUNCIATORS AND AUDITORY SIGNALS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
H9	RH	3	8. Some annunciator legends are difficult to read because of inadequate spacing between characters and because character proportions are too thin.
H10	RH	1	9.* It is difficult to distinguish whether dark red colored tiles, amber colored tiles, backlit red tiles, and backlit green tiles of annunciator displays are ON or OFF.
H12,C7	RH,JS	1	10.* Annunciator response controls are not easily identifiable from other controls and do not have special markings or demarcation to make them stand out as individual control groups from other controls nearby. The green, red, and black collars around the individual annunciator control pushbuttons are not adequate to distinguish the annunciator controls from other pushbutton controls that are also color coded by use of colored collars.
H17	RH	1	11. Panels 654 and 655 Annunciator response controls have one more button than is used on the other panels (a RESET button).
	JS	1	12. Annunciator alarm control pushbuttons for Silence, Acknowledge, and Test can be operated in any sequence.
	RH	1	13. Alarm procedures are not keyed to annunciator panel identifiers and annunciator tile matrix coordinates. They are indexed only to the four digit code on each tile which is not systematically related to the tile location.
A8	JJ	1	14. There is no input to the Annuciator Inoperative alarm when the HPCI and RCIC controls are switched from AUTO to MANUAL.
	RH	1	15. Localizing quality of audible alarms is not adequate. While the frequencies of the annunciator alarms at the RCC benchboard and at the RWC and RCIC benchboard are different, their separation is not sufficient to provide a clear localizing quality. It is difficult to determine which annunciator panel is alarming when only one alarm is sounding.

3. ANNUNCIATORS AND AUDITORY SIGNALS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
	JS	1	16. The five coded audible station emergency signals, which can be broadcast throughout the plant by the Gai-Tronics system, have not been assigned to specific station emergency conditions.
	JJ	1	17.* Annunciator alarms on the feedwater and electrical areas of Panel MCB are not loud enough. They are barely audible above the 64 dB(A) ambient background noise level.

4. CONTROLS

PHOTO ID	REVIEWER	CTGY	FINDING
K29	MB,RP	3	1. The Recirculation Master Flow Control at the left end of Panel 603 is beyond convenient reach of the reactor operator manipulating the reactor control rods at the center of Panel 603 during reactor startup and power level changes.
C1	JS,RH	3	2.* Recirculation Master Flow Controller on the reactor control benchboard Panel 603 should be grouped on the reactor recirculation benchboard Panel 602 with the Recirculation A and B Flow Controllers.
B2	MB	2	3. The IRM range switches on Panel 603 are laid out in a mirror image arrangement of switch locations, colors, and labels with an unconventional left to right sequence ACEG - HFDB.
K10	MB	1	4.* J handle controls are too close to the front edge of the Panel 602 benchboard and are vulnerable to accidental actuation.
K21	MB	2	5.* A violation of "open-right", "close-left" convention exists on the MAIN TURBINE LO Bailey control on Panel MCB.
F1	MB,RP	1	6. The RCIC Reset keyswitches on Panel 602 rotate in reverse direction from the normal control room convention of clockwise to reset.
K17	MB	1	7.* The switch position does not match the label, with label being incorrect on the Hydrogen Recombiner Panel.
K22	MB	2	8.* The top two switches on Panel ACH are too high for easy operation.
K18	MB	1	9.* Lack of contrasting color marking makes switch handle arrows on Panel 602 difficult to see.
K20,K35 J18	MB	1	10.* Inconsistent color coding of throttle valve switches occurs on Panels 602 and MCB.
K32 K33	MB MB	1	11. An inconsistent use of different types of switches for same function exists between handles on Panel 602 and pushbuttons on MCB.
	WR	2	12.* The Remote Shutdown panel inappropriately uses some green switch handles. Green is used elsewhere to identify throttle valves.

4. CONTROLS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
K31,D23	MB,GS	1	13. There is an inconsistent use of switch handle shapes in several locations (Panels MCB, 601, 602).
K34	MB	2	14. The RB SVC WATER override switches under annunciator Panel E on Panel MCB rotate in two directions instead of only in one direction.
K23	MB	1	15.* The small diameter, flush mounted pushbuttons on Bailey flow controllers are difficult to depress.
	MB	1	16. The backlit pushbuttons on MCB use only one bulb per switch and do not have a provision for a lamp test.
K24	MB	3	17.* The removable handle allows dirt to get into the switches on the MCB.
	RP	3	18. No specific storage hook or clip is provided on Panel MCB for the removeable handle that is used to manipulate several switches in the emergency power distribution system.
K25	MB	1	19.* The REACTOR MODE switch is very difficult to turn.
	MB	3	20. There are inconsistencies in key tooth orientation of key operated switches.
	RP	2	21. The key can be removed from the REACTOR MODE switch in any reactor mode position. Removal of the key locks the mode switch in whatever mode was selected at the time the key is removed. This allows the switch to be locked in the RUN position which may be undesireable.

5. DISPLAYS

PHOTO ID	REVIEWER	CTGY	FINDING
	RH	3	1. Operators need visual indication on Panel 603 to verify that diesel generators are running.
	JP-S	?	2. Control indicator lights for safety related system components indicate only that the command logic has been completed but do not indicate actual component activation or status.
J1,J2	JP-S	2	3.* Glare on almost all meter faces and chart recorder windows makes reading displays difficult and fatiguing.
J15,E11 E5	RE,GL	1	4. Meters that have positive and negative values within their ranges do not have a clear indications of positive/negative or lead/lag. a.) At least six meters have "+" markings in both directions from the zero mark (meters 126A, 126B, 127A, 127B, 100A, 108B for the drain tank levels), b.) Meters indicating reactive power for the diesel generators and the plant have no lead/lag or +/- indications.
E19	GL	1	5.* Lettering of scales on MILLION LB/HR LOOP A FLOW and MILLION LB/HR LOOP B FLOW is too small and is difficult to read.
E13	GL,RE	2	6.* Numerals for exponents on scales of counts per second meters for the SRM A, B, C, and D neutron detectors are too small to read from the center of the reactor operating console and are obscured from view of a standing reactor operator by the meter bezel.
L14,L16	GL	2	7.* The meters for KILOAMPS AC M-G SET MOTORS A and B and for KILOAMPS AC GENERATORS A and B on Panel 602 are scaled in decimal notation which is undesireable.
E12	RE,GL	2	8.* The HEATER LEVEL meters within the RFP Water Quality Recirc Line have scales with negative values upscale and positive values downscale from the zero.

5. DISPLAYS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
L3	GL	1	9.* Pressure indicators, MSIV Outbd. Div 1; MSIV Inbd Div. 2; Main Steam Line A, B, C, D Lo Press; Steam Line Lo Pressure, have confusing scale labeling. Positive pressure is measured in PSIG and vacuum is measured in inches of Hg. The meter scales do not coincide with the scale pressure and vacuum range labels. A clear demarcation extending from the meter zero and between the pressure and vacuum scale labels would avoid confusion.
E15	RE	1	10. *The DEGREE F CLEANUP SYS TEMP meter on Panel 602 has scale numerals in blue. This is less readable and different from all other meter faces in the control room.
J11	JP-S	1	11. Weston meters have no units designated on the meter scale. Instead, units appear on the meter label.
E18,E17 E5,J7 J8	GL,RE, JP-S	2	12. Several meters use non preferred scale graduations such as PSIG REG HX INLET PRESS on Panel 602, and four meters for TRAVEL SCREEN AMPS on Panel MCB are graduated in units of three, RB VENT CFM EXH AIR FLOW and RB NORM VENT DEGREE F SUPPLY AIR TEMP in units of 5 or 2.5. Graduations of 3, 2.5, 7.5, 15, 80 are not recommended.
J7,J10 J13,J14 E4	GL,JP-S	2	13. There are many instances of adjacent meters having different scales.
L9,J13	RE,JP-S	2	14. Several meters use nonlinear scales without operational justification. These include Service Water Inlet flow on Panel 601 which is logarithmic and others such as Reactor Core Cooling Shutdown Head CLG and SVC Water Inlet Flow which have an expanded scale at high value.
J9,E3 J3,E25	JP-S	2	15. Pointers on Weston Meters vary in size, shape, and contrast. Contrast generally is too low. This is due in part to construction dust within the meters and to the high levels of room illumination.

5. DISPLAYS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
E25,E20	JP-S	2	16. Pointers on some Weston meters are reversed in pointer/scale orientation from the prevailing orientation used in the control room. Examples of pointers reversed from the prevailing orientation include: KILOVOLTS AC, KILOAMPS AC, KILOAMPS AC M-G SET MOTOR, CRD PUMP AMPS, and RUNNING VOLTS on the diesel generators.
	GL,GS	1	17.* Meters and recorders are not marked with normal operating limits, trip values, and alarm points.
J20	GS	1	18. Bottom indicator scale on Main Turbine Lubricating Oil Temperature controller is a valve position. On this scale 100% denotes 100% CLOSED. On all other valve indicators in the control room 100% denotes 100% OPEN. All indicators in the plant should follow the same convention.
L13	GL	1	19.* Indicator lights on Panel 654 do not comform to the green-blue-red convention; they are in blue-green-red order.
L4	GL	3	20. Color-coded relay protection and open/closed indicator lights for ACB12-13 and ACB11-10 are in different orders.
E30	GL	1	21.* The CRAC Isolation Valve Manual Override indicator lights have a white lens on the top indicator light and blue lens on the bottom. The lenses for indicator lights on adjacent systems are both white.
B9	MB	3	22. Rod Display legend lights on Panel 603 are too small and too high for a 5th percentile operator to read rod designations and positions. Tall operators find the high information density arrangement confusing.

6. PANEL LAYOUT

PHOTO ID	REVIEWER	CTGY	FINDING
H1	RH	1	1.* There are two unused controls located on the Reactor Recirculation Benchboard (Panel 602).
	MB,RP	3	2. The inboard and outboard Nuclear Steam Shutdown System control/display groups and the operationally related Nuclear Boiler Process control/display group are separated from each other by the Reactor Water Cleanup System, the Reactor Core Cooling Isolation System, and the Auto Depressurization System control/display groups. This layout causes unnecessary operator movement between the NSSS and NBP controls and displays during some reactor operations.
K3,K4	MB,RP	1	3.* The square root extractors are unnecessary equipment located on the vertical boards of Panels 601 and 602. They have no control or display function.
K28	MB,RP	3	4. The Emergency Power Distribution System diesel generator control/display groups are not laid out in numerical or functional sequence.
C6	JS	1	5. Insufficient demarcation is provided between C/D groups on Panels 601 and 602 that have different functions. Example: Reactor Water Cleanup system and Reactor Recirculation system.
E27	RE	1	6. Two sound powered phone jacks are located within the CO_2 Purge System black demarcation box on the turbine Building and Miscellaneous Ventilation Panel (VCI). Jacks should have separate demarcation.
E25	RE	1	7. Annuciator control buttons should have standard demarcation pads within the control room which clearly identify and separate them from other panel controls. For example, the alarm control buttons for VC1 and VC2 boards are within the demarcation of the turbine Building Air Exhaust System. Similar Conditions exist at all alarm controls.
C3,C4 C5,H11 H13	JS	2	8. Multiple systems on Panel MXP include mixed sets of unrelated controls and displays that are not clearly segregated by layout or by lines of demarcation.

6. PANEL LAYOUT (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
H3	RH	2	9. Vacuum Priming Pump Controls A through D are located vertically on Panel MCB adjacent to unrelated controls which are laid out in a horizontal arrangement. No clear demarcation is provided between the two control arrangements.
H16	RH	3	10. The Reactor Feedwater Pump Turbine controllers are on Panel 603 and are not integrated into the mimic of the RFPT system on the adjacent Panel MCB.
H19	RH	2	11. The operator has no way of determining Main Turbine Stop Valve and/or Control Valve positions while at the Main Control Board. The operator must go to Panel ECH to obtain this information.
H20	RH	2	12. Service Air Controls (not yet labeled) are located on the Miscellaneous Control Panel (MXP). Associated meter displays are on the Main Control Board (MCB). These controls are safety related and should be on MCB.
	RH	2	13. Unlabeled controls and displays for turbine building Service Water are located on the Miscellaneous Control Panel (MXP). They should be located with the rest of the Reactor Building Service Water System C/D on the Main Control Board (MCB).
L18	GL	3	14. Reactor Building Standby Ventilation System (RBSVS) Chiller Inoperative Alarm Controls are located on the Turbine Building Air Exhaust Panel which is 10-12 feet from the RBSVS panel and RBSVS annunciator panel A2.
E24	RE	3	15. The spring loaded RESET control switch for RBSVS is located high on the VC2 board and must be held down while the operator moves other controls located much lower on the panel and offset to the left and right. This is unreasonably awkward.
E35	GI	2	16.* On the Hydrogen Recombioner Panel, the Leeds and Northrup recorders are too low to read easily.

6. PANEL LAYOUT (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
C12	RE	2	17. On Panel ACH, meters are more than 70 inches above floor level.
L2	GL	3	18.* Top row of chart recorders on HVAC Board (over 1T47 and 1M50) and two meters are too high to be read easily. Poor readability is compounded by glare.
	GL	2	19. The annunciators for NSSS A/B Isolation and NSSS C/D Isolation read logically from left to right although they are on different annunciator panels. The associated Manual Isolation control buttons are arranged in left to right sequence CDAB.
E23	RE	2	20. Containment Purge Control Valves 38 C and D are reversed with respect to their depiction on the mimic above.
K26,K27	MB,RP	2	21. Reactor Building Closed Loop Cooling Water Pump ABC and Service Water Pump ABCD control sequences are not in standard sequential order.
C2	JS	1	22. On the Reactor Recirculation System mimic on Panel 602, the mimic flow paths for Recirculation Loop A and Recirculation Loop B are not the same. On A the flow path line passes through the flow control, on B it passes through it's % speed and % speed demand meter displays.
J4	JP-S	3	23. *Two strings of six meters each are grouped on the HVAC Board for Air Conditioning System 1X41. There should be no more than five in one string.
G26,D11	GS,WR	2	24. The Primary Containment Atmosphere Control (ACH) Panel layout is poor. Arrangement is mirror image with some controls on the panel not mirror imaged. Units are in BA order from left to right. Switches IEII * MOV 057 A and IEII * MOV 057 B are interchanged and therefore located incorrectly on the mimic. Temporary labels are used on the switches.
H2	RH	2	25. On the Reactor Control Benchboard (Panel 603) the IRM range switches are mirror imaged on either side of the rod control. The left to right order is ACEG - rod controls - HFDB.

6. PANEL LAYOUT (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
E21	RE	2	26. Transfer switch MST 113B and related switch MG 113B are separated by switch 112 and a breaker. Similar arrangements are found for switch 111 and switches 113A.
H15	RH	2	27. On the Main Control Board (MCB) mirror imaging is used inconsistently outside of the Reactor Feedwater System mimic. Within the mimic the mirror imagery is consistent.
J19	RP	2	28. Inconsistent use of mirror image layout and parallel side by side layouts are used in the mimic of the Reactor Recirculation System on Panel 602. The Recirculation Pump Suction Valves and Generator Drive Motors are arranged in a mirror image layout. The Recirculation Flow controllers and displays, and M/G Generator, Recirculation Pump Discharge, Pump Differential Pressure, and Jet Pump Flow displays are in parallel side-by-side arrangement.
A6	JJ	2	29. The Reactor Water Level display located on Panel 602 near the RCIC system has a 0 - 400 inches range. If the water level falls below the zero reference level on this display, as it could during a loss of feedwater, the operator must go to the Wide Range Water Level meter on Panel 603 to determine the water level in the reactor.

7. CONTROL/DISPLAY INTEGRATION

PHOTO ID	REVIEWER	CTGY	FINDING
A4	JJ	2	1. On Panel 603 the SRM A,B,C, and D displays are located too far from the Rod Pull controls for easy readability.
D20	WR	3	2. The computer printer outputs are too far from the computer console to be read easily.
B13	MB,RP	3	3. On Panels 601 and 602, the Rosemont SRV pressure indicators are too far from the SRV auto-depressurization controls to be read.
F11	MB,RP	2	4. On Panel 603 the "Withdraw" or "Continuous Withdraw" pushbuttons are located too far from the SRM counts/second and period meters and SRM recorders.
	MB	2	5. Controls related to annunciators on annunciator panel "E" on Panel MCB are located remotely on Panel MXP.
	MB,RP	3	6. The Safety Valve Temperature Indicator/Recorder, which provides positive indications of open safety relief valves, is on a back-panel behind Panel 601.
	MB	2	7. The safety relief valves located on Panel 602 have corresponding annunciator tiles located remotely on annunciator panel G on Panel MCB.
H22	RH	2	8. The controls located under Panel MCB annunciator panel 209-H relate to annunciators located remotely on annunciator panels 209-C and 209-D.
H24	RH	2	9. The Seal Water Pump controls on Panel MCB relate to annunciators located remotely on annunciator panels 209-A and 209-B.
H23	RH	2	10. The controls for by-pass valves on Panel MCB under annunciator panel 209-B relate to remotely located valve position indicators under annunciator panel 209-F. Separate indicator lights for the by-pass valve controls are needed either above the EHC panel or below the feedwater and condensate mimic.

7. CONTROL/DISPLAY INTEGRATION (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
	RH,JS	2	11.* Some annunciators are separated too far from reactor system controls associated with the annunciator and are not readable from the control location. Examples: Condensate controls, Automatic depressurization system safety relief valve controls.
H7	RH	2	12. Some annunciators are separated too far from their annuciator response controls and are difficult to read from the annunciator control location.
B4	MB	2	13. On Panel 603 the arrangement of selector controls and recorder displays for the IRM/RBM/APRM 2 pen recorders is confusing and does not show which rod block monitor is selected.
H21	RH	1	14. The Feedwater Turbine Test group on Panel MCB contains control shapes and colors which are inconsistent with corresponding indicators.
E22	RE	1	15. On Panel 602 there is an inconsistent relationship among the valve switches and the corresponding indicator lights in both position and orientation.
D22	WR	2	16. On Panel 654 the relationships between switches and indicators is confusing. The left switch corresponds to the bottom light and the right switch corresponds to the top light.
F8	MB,RP	2	17. On Panel 603, the IRM bypass switch handles (G,A,C,&E), the APRM switch handles (A,C,E) and the flow unit switch handles (A,C) are not easily correlated with the displays selected.
L19	GL	3	18. Reactor Building Supply Fans which are given a vertical portrayal on the mimic (A above B) are associated with controls (IT41-FN002A and IT41-FN002B) arranged horizontally reading in BA order from left to right.
B15	MP,RP	2	19. On Panel 604, the relationship between the reset selector positions and the upscale and downscale trip indicators is not clear.

8. LABELS AND LOCATION AIDS

PHOTO ID	REVIEWER	CTGY	FINDING
D10,G34 G17	WR,GS	1	1. Some labels are located below the controls they identify. Example: Panel ACH - Primary Containment Gas Analyzer Control.
G24	GS	1	2. Throughout the control room, display labels are not consistently located either above or below the displays they identify.
G20	GS	1	3. Labels on panel below recorders that protrude from the panel are hidden from view of standing operators. Example: MXP Panel and Panel 603
A12	JJ	1	4. Label on reactor water cleanup return J-switch that states TO REACTOR VESSEL is misleading since the return flow path is through HPIC, RCIC, and feedwater lines to reach the reactor vessel.
G35,D19 G12,G13	GS,WR	1	5. Temporary labels are used presently at various locations in the control room.
G23	GS	1	6. Some labels are detached or not mounted securely.
K8	GS	1	7.* The labels on the Gai-Tronics alarm control at the operators desk identify the type of sound associated with each switch but they do not show what emergency conditions are associated with each switch.
	GS	2	8. There are no instruction labels for operation of the control transfer switches on the remote shutdown panel.
D8	WR,MB	1	9. Labels are inconsistent in the formats of component identifiers and there is no distiction between the letter "O" and the numeral zero when they are used in alpha-numeric identifiers.
	RE	1	10. Different abbreviations are used for the same word. The control room abbreviation list shows two and three different abbreviations for each of approximately 16 words.

8. LABELS AND LOCATION AIDS(Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
G7	GS	1	11. The label on a display that has two indicators identifies the indicators as sensors at locations 1 and 2 but does not identify the actual locations of the sensors being read. Example: Panel VC2 - Containment and Drywell Moisture Recorder.
F3,F4	MB.RP	1	12. Switch positions are not clearly labeled on some switches.
D21	WR	1	13.* Control positions of rotary switches are not adequately labeled to identify the function associated with each switch position.
G27,G29 G31	GS	1	14. Some labels do not adequately identify the function of the associated control or display. Examples: Panel ACH - Amber light labeled COMMON ALARM. Panels A2A and A2B - Pushbuttons labelled TEST.
A9	JJ	1	15. Some annunciator labels are misleading. Example: Tile 0403 - 125 VDC BUS A1 BRKR OC TRIP on Annunciator Panel 210A.
G32	GS	1	16. Lettering has been rubbed off of some labels.
G8	GS	1	17.* Use of white lettering on black background for labels is less desireable than use of black lettering on white background for the lighting conditions present in the control room.
	GS	1	18. There is no sign on the outside of the room housing the Remote Shutdown Panel that identifies it.
K30	MB,RP	1	19. There are unlabeled rotary switches at several locations.
A1	JJ	1	20. The flow transmitter FT-002 scale is incorrectly marked. It reads 0-12 CFM but actually denotes 0-1200 CFM.
G14	GS	1	21. Scales on Feedwater Level Control (LIC 10) are not labeled.
K21,A10 G33	GS,GL	1	22. Labels of displays do not clearly identify the variables displayed, the units displayed, and the scaling parameters of the displays.

8. LABELS AND LOCATION AIDS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
B5	MB	1	23. On Panel 603, lines of demarcation do not separate the related sets of selector switches and recorders.
G21	GS	1	24. The CRT display control pushbuttons on the Panel 603 Reactor Operator's Console are not demarcated from other controls or labeled by function.
B16	MB,RP	3	25. On Reactor Building Vent and Offgas displays on Panel 604 there is an inconsistent relationship between color coding of push buttons and meter scales.
G18,E22 B1	GS,RE	2	26. Color coding of controls, position indicators, meter displays, recorder displays, CRT displays, mimics, and demarcation lines are not consistent throughout the control room.
B17	MB,RP	3	27. The color code labeling scheme of meter ranges and selector switch positions of the Off-Gas Radiation Monitor on Panel 604 is confusing and use of x1 and x.316 scale multipliers make interpretation difficult.
B7	MB	2	28. The use of red/black color coding to denote the alternate ranges for each pen of the 2 pen IRM/RBM/APRM recorders and to correlate the color of each recorder pen trace with its associated range selector control is confusing.
J13	MB,RP	2	29. On Panel 603, the color coding of Rod Drift, Rod Motion Override, RCDS Status, RIPS Status, Rod Motion Blocks, and Rod Insert and Withdraw Pushbuttons are not correlated with other controls and displays.
D13,D14 D17,J17 A2,G19	WR,JJ	1	30. Some panels, controls, displays, and components of mimics are not labeled.
	WR	2	31. Use of different shades of the same color on mimics is confusing. Example: Remote shutdown panel and Panel 601.

8. LABELS AND LOCATION AIDS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING	
L17,L20	GL	1	31a.	Mimic labels and labels for corresponding controls or displays do not use the same identification nomenclature. Example: Panels VC1 and VC2
D9,F12	WR,GS MB,RP	1	32.*	Mimics do not have arrows indicating direction of flow.
F12	MB,RP	2	33.	Convoluted flow path of Reactor Water Cleanup System mimic detracts from its usefulness.
C2	MB,RP	1	34.	On Panel 602, the flow mimic showing pump suction valves B-31-F023A, MOV031A and MOV031B is inconsistent and confusing.

9. COMPUTERS AND CRT DISPLAYS

PHOTO ID	REVIEWER	CTGY	FINDING
	WR	1	1. Addresses of analog data points are indexed by system only. A cross reference index by point name and point alpha-numeric address code is needed.
	GS	2	2. Excessive referencing of printed documentation located at the computer control console is needed to interpret CRT displays. Information needed to interpret each CRT display should be an intergral part of the display.
D5	WR	2	3.* There is excessive reflected glare from ceiling lights on the CRT video displays on Panel 603.
	WR	2	4.* The video display brightness contrast between the signal and background is not sufficient on the Alarm CRT.
	WR	2	5. It is difficult to read CRT video displays on Panel 603 from the operator's desk and the computer control console which are located more than 12 feet away from the displays.
	GS	2	6. The reactor operator has no control to selectively limit the amount of information being displayed on CRT displays. This lack of information control options can result in possible information overload for the operator.
J16	GS	2	7. Panel 603 CRTs are mounted with the bottom of the screen 69 inches above floor level making it difficult to read the upper portion of the displays. Recommended maximum mounting height is 61 inches.
	RP	2	8. The location and orientation of the CRT displays on Panel 603 combined with the curvature of the CRT screens make it impossible to read the upper edge and far edge portions of the CRT displays from the operator's position at the center of the reactor console.
	WR	1	9. The wording used to identify alarms displayed by the computer and the wording used on annunciator tiles differ for the same alarm conditions. Example: Annunciator - CRD HYDRAULICS TEMP HI Computer - CONTROL ROD DRIVE TEMP ALARM

9. COMPUTERS AND CRT DISPLAYS (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
G11	GS	2	10. There is inconsistent use of color conventions between the CRT displays and conventional control board and annunciator displays.
	GS	2	11. Unconventional symbols are used on the CRT displays.
	GS	2	12. There is inconsistent use of color coding between different computer generated CRT displays.
	GS	1	13. It is difficult to read printer printouts of decimal data because decimal points are not aligned on the printouts.
	WR	2	14. Some annunciator alarms for auxiliary systems are not shown by the computer alarm display.
	WR	2	15. The alarm printer print speed, (30 characters per second)is too slow to provide timely printouts when a large number of alarms occur simutaneously or in rapid succession. The recommended minimum printer speed is 300 lines per minute, (200 characters per second at 40 characters per line).
		2	16. Use of flashing yellow 99.9 to indicate that data should be ignored is confusing.
	GS	2	17 The computer generated CRT display system does not have prompting or structuring features to assist the operator request additional or corrected information.
	WR	2	18 The computer generated digital displays and trend recorder displays on Panel 602 do not have any identification of the variables being displayed.

10. DATA RECORDING AND RETRIEVAL

PHOTO ID	REVIEWER	CTGY	FINDING
	WR	2	1. Combined use of red and black to distinguish between the high and low range scales and to identify the two pen traces of the IRM, APRM, and RBM recorders is confusing.
G3	GS	3	2. The 12 channels of data displayed on the turbine vibration multipoint recorders on Panel MCB are difficult to read because: a.) the sensor identification numbers are too small, b.) the color coding of the printed data points is not distinct, c.) the chart is arranged in a three column format without deliniation between the parallel columns, and d.) the sensor channels displayed in each column are not consistently grouped in numerical order.
D1	WR	1	3. Strip chart recorders are loaded with chart paper having scales that do not match the recorder scales.
G2	GS	2	4. Multipoint recorders have an excessive number of sensor channels displayed on a single chart, (up to 12 channels per chart).
	WR	1	5. It is difficult to distinguish between the blue and green traces of some recorders.
D3	WR	1	6. Full scale deflections of the IRM and APRM 0-125 and 0-40 ranges do not match. The difference between the full scale deflections is nearly 1/4 inch. The recorder chart paper is printed with the two scales alternating every 1.5 inches. A single 0-100 scale for all ranges would be satisfactory for operator use since absolute values of the neutron production rate or power rate are not used by the operators.
D18	WR	1	7. Units associated with recorder scales are not identified.
G1,G9	GS	1	8. Setpoints and normal operating values or ranges are not shown on recorder scales.

10. DATA RECORDING AND RETRIEVAL (Continued)

PHOTO ID	REVIEWER	CTGY	FINDING
	GS	1	9. Most chart recorders are not operational and could not be evaluated completely.
	WR	1	10. Data recording and retrieval could not be evaluated because the procedures are not fully operational.

LIGHTING SURVEY

LOCATION	ILLUMINANCE (Foot Candles)		LUMINANCE (Foot Lamberts)			LUMINANCE RATIO	
	Full AC Ambient	Full DC Ambient	Panel Backgrnd	Dark Meter Face	Benchboard	Mtr:Pnl	CRT:Pnl
A	176	68	71	10		1:7	
B	216	160	77	13		1:6	
C	191	151	65				
D	166	107	69	7	90	1:10	
E	255	167	102	14	135	1:7	
F	272	174	104	39 20 CRT	119	1:3	1:5
G	267	181	89	12	132	1:7	
H	158	109	52	8	82	1:6	
I	204	38					
J	276	100					
K	141	54	44	9		1:5	
L	143	20	42	8		1:5	
M	181	7	51				
N	223	1	54				
O	166	1					
P	158	1					
Q	160	1					

ANNUNCIATOR LUMINANCE MEASUREMENTS

Tile Type	Condition	Luminance (Foot Lamberts)	Luminance Ratio
White w/White backlight	Lighted (A8-1295)	50.5	1.8:1
	Unlighted (A8-1289)	28.7	
White w/Amber backlight	Lighted (A3-1159)	53.7	1.5:1
	Unlighted (A3-1164)	35.1	
White w/Green backlight	Lighted (A2-1365)	35.3	1.2:1
	Unlighted (A2-1412)	29.8	
White w/Red backlight	Lighted (A6-1330)	42.5	1.2:1
	Unlighted (A6-1371)	36.0	
Amber	Lighted (A1-1114)	33.3	1.7:1
	Unlighted (A1-1146)	19.9	
Red	Lighted (A6-1083)	20.3	1.2:1
	Unlighted (A5-1345)	17.4	

NOISE SURVEY

Data of Noise Measurements taken in the control room were not received by LLNL.

SHOREHAM PHOTO LOG

#	ID #	LABEL
1	A1	Scale multiplier
2	A2	No labeling
3	A4	Control/Display readability
4	A4	
5	A6	Range of indicators
6	A6	
7	A8	Annunciator feedback
8	A9	Annunciator labels
9	A10	No units on labels
10	A12	Misleading label
11	B1	Inconsistent color coding of operating parameters
12	B2	Mirror imaging of controls and displays
13	B2	
14	B2	
15	B2	
16	B2	
17	B2	
18	B2	
19	B5	No demarcation of related controls and displays is misleading
20	B5	
21	B7	Poor correlation between recorder ranges and range selector switches
22	B7	
23	B9	Rod display location and size
24	B9	

SHOREHAM PHOTO LOG

#	ID #	LABEL
25	B9	
26	B13	Improper separation of displays from functionally related controls
27	B13	
28	B13	
29	B15	Unclear control/display relationship
30	B16	Inconsistent color coding of control/display relationship
31	B17	Problem interpreting meter and control readings
32	C1	Pump control 101 is not located with the controllers it overrides
33	C1	
34	C1	
35	C2	Mimic not clear
36	C3	Multiple system panel with no tape demarcation
37	C4	Multiple system panel with no tape demarcation
38	C5	Multiple system panel with insufficient tape demarcation
39	C6	Lack of demarcation among several mingled displays
40	C7	Inconsistent use of color
41	D1	Paper scale different than recorder scale
42	D3	Scale mismatch
43	D5	Video display glare
44	D8	Control label inconsistency
45	D9	Mimic should have directional arrows to indicate flow
46	D10	Label confusion
47	D11	Ordering of systems
48	D11	
49	D12	Meter too high

SHOREHAM PHOTO LOG

#	ID #	LABEL
50	D12	
51	D13	Few labels
52	D14	Panels not clearly labeled
53	D17	No label
54	D18	No unit scales on recorders
55	D19	Use of temporary labels for limits
56	D20	Printer distant from console
57	D21	Control positions not interpreted by labels
58	D22	Valve indicator lights
59	D23	Confusion of control coding
60	D23	
61	D23	
62	E1	Luminance ratio too high
63	E2	Tagouts do not physically preclude operation of controls
64	E3	Low intensity on pointers at bottom of some vertical scales
65	E3	
66	E4	Adjacent meters with different scales
67	E4	
68 values	E5	Multiple scale gradations not according to recommended
69	E5	
70	E5	
71	E5	
72	E5	
73	E5	
74	E11	Indicators show '+' to '+' rather than '+' to '-'

SHOREHAM PHOTO LOG

#	ID #	LABEL
75	E12	Negative indicators on top, positive indicators on bottom
76	E13	Meter bezel covers exponent values
77	E13	
78	E14	Incompatible, unconventional scaling
79	E15	Scale numerals blue in color - less readable
80	E17	Scale graduated in units of 3's
81	E18	Scale graduated in units of 3's
82	E19	Small numerals are difficult to read
83	E21	Poor arrangement of related controls
84	E22	Indicator light banks not oriented like related valve switches
85	E23	Controls not oriented in same relative position as in mimic
86	E24	Reset control poorly locatd for two handed operation
87	E24	
88	E25	Pointers facing in wrong direction
89	E26	Alarm control buttons should have some form of standard demarcation
90	E27	Communication jacks located within subsystem demarcation are not part of subsystem
91	E30	White lens on top indicator light, blue lens on bottom
92	E30	
93	E35	Too low to be read easily
94	F1	Reset keyswitches rotate counter-clockwise to reset
95	F3	No position labeling on rotary switches
96	F4	Positions on rotary control unlabeled
97	F8	Awkward selector position sequence
98	F8	

SHOREHAM PHOTO LOG

#	ID #	LABEL
99	F8	
100	F11	Improper location of related controls and displays
101	F12	Mimic flow direction confusing
102	G1	Multiple scales for a single recorder
103	G1	Cannot determine what normal operating value or range is
104	G2	Too many tracings per chart
105	G3	Numbers too small to be easily read
106	G7	Label does not indicate position of sensor within building
107	G8	White on black labels should not be in control room
108	G9	Normal operating value or range not marked
109	G11	CRT color coding is different from general control room color coding
110	G12	Temporary labeling on operator console
111	G13	Temporary labeling on J-handles
112	G14	Use of scales not labeled
113	G17	Labels in wrong location
114	G18	Inconsistent color coding on panels
115	G19	Missing labels
116	G20	Labels hidden from view
117	G20	
118	G21	Pushbuttons not demarcated or labeled
119	G21	
120	G24	Inconsistent label location
121	G26	Mirror imaged mimic
122	G27	Labling does not indicate real functions of indicator lights
123	G29	Label does not reflect meaning of indicator

SHOREHAM PHOTO LOG

#	ID #	LABEL
124	G31	Incorrect labeling
125	G32	Labeling rubbed off
126	G33	Incorrect labeling
127	G34	Incorrect label location
128	G35	Temporary labeling
129	H1	Unneeded controls on a main panel
130	H2	Mirror imaging of controls
131	H2	
132	H2	
133	H3	Controls not part of apparently related group
134	H3	
135	H4	Annunciator not matrix identified
136	H5	Inconsistent identification of annunciator panels
137	H6	Annunciator panel not labeled
138	H7	Annunciator tiles not readable from acknowledge control
139	H8	Red tiles used for other than first-outs only
140	H9	Inadequate character spacing and proportions
141	H10	Difficult to distinguish 'on' indication from 'off'
142	H10	
143	H11	Controls mixed with unrelated control/display group
144	H12	Annunciator response controls not easily identified
145	H13	Poor control/display integration
146	H15	Inconsistent use of mirror image control location
147	H16	Panel layout of related controls
148	H17	Nonstandard response controls

SHOREHAM PHOTO LOG

#	ID #	LABEL
149	H19	No indication of valve position
150	H20	Controls on wrong panel
151	H21	Inconsistent control/display coding
152	H22	Annunciator tiles mislocated
153	H22	
154	H22	
155	H23	Needed indicator not readily available
156	H23	
157	H23	
158	H24	Annunciator tiles not grouped
159	H24	
160	H24	
161	H24	
162	H24	
163	J1	Glare on meter faces
164	J2	Glare on chart recorder faces
165	J3	Weston meter pointer contrast highly variable
166	J3	
167	J4	Meter strings too long
168	J5	Wrench/extractor required to change bulb
169	J5	
170	J5	
171	J6	Bulb replacement from back of panel
172	J6	
173	J7	Adjacent meters have different scales

SHOREHAM PHOTO LOG

#	ID #	LABEL
174	J7	
175	J7	
176	J8	Scale is graduated in intervals of 5's and 5/2's
177	J9	Variation in size and position of pointer
178	J11	No unit designations on meter scales
179	J13	Exponential scale used for no operational reason
180	J13	
181	J14	Several different scales on adjacent meters
182	J15	No lead/lag indications on the scale
183	J16	CRT too high
184	J17	Unlabeled meter
185	J18	Unnecessary color coding
186	J18	
187	J19	Mixed use of mirror-image and side-by-side layouts of controls and displays
188	J20	Reversal of scale meaning
189	K2	Tripping hazard - covered ground wire
190	K3	Unnecessary instrumentation in control room - square root extractors
191	K4	Unnecessary instrumentation in control room - square root extractors
192	K5	View obstruction - computer console
193	K6	Supervisor's access from office
194	K7	Tripping hazard - sound-powered phone
195	K8	Emergency communications system
196	K9	Location of equipment selector control out of reach of 5% operator

SHOREHAM PHOTO LOG

#	ID #	LABEL
197	K9	
198	K10	J-handle location too close to edge of the benchboard
199	K10	
200 away	K11	Benchboard depth greater than 24" making controls too far
201	K11	
202	K12	Annunciators 82" above floor
203	K13	Documentation storage
204	K14	Tagouts obscure indicator lights of switches underneath
205	K16	Location of security console
206	K17	Label location misleading
207	K18	No contrast color on arrows on controls
208	K20	Throttle valve controls not color coded green as adjacent J-handles
209	K21	Violation of 'open' and 'closed', right and left convention
210	K21	Meter and scale for '% open' not labeled
211	K22	Switch too high
212	K23	Small diameter of pushbuttons
213	K23	
214	K24	Removable handle allows debris to accumulate in switch
215	K25	Reactor mode switch is hard to actuate
216	K26	Pump controls not located in sequential pattern
217	K27	Pump controls not located in standard sequence - A, C, B
218	K28	Panel grouping not in standard numerical sequence
219	K28	
220	K28	
221	K28	

SHOREHAM PHOTO LOG

#	ID #	LABEL
222	K29	Flow control in poor location for operator
223	K30	Unlabeled spring-return switch in steam drain control area
224	K31	Shape coding of control knobs
225	K32	Different type controls for same functions
226	K33	Different type controls for same functions
227	K34	Control wrong type of switch
228	K35	Lack of throttle control color coding
229	L2	Parallax and glare on vertical meters
230	L2	
231	L3	Confusing, incompatible scales on multi-range meters
232	L4	Color coded indicator lights inconsistent in location
233	L4	
234	L4	
235	L9	Rate indicators use exporential scale
236	L10	Scale gradations unconventional
237	L11	Incompatible adjacent scales (with label missing)
238	L13	Color indicator location inconsistent
239	L14	Scale gradations unconventional
240	L16	Scaled in decimal fractions
241	L17	Control labels do not correlate easily with mimic
242	L17	
243	L17	
244	L18	RBSUS Chiller Inop alarms located under Turbine, not RBSUS
245	L19	Fan controls reversed from preferred orientation
246	L20	Damper controls not identified as on mimic