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Mr. J. S. Abel
Director of Nuclear Licensing
Commonwealth Edison Company
Post Office Box 767
Chicago Illinois 60690

Dear Mr. Abel:

SUBJECT: CONTROL ROOM DESIGN REVIEW REPORT, LA SALLE COUNTY STATION, UNIT NO. 1

Enclosed is our Human Factors Engineering Control Review report for La Salle County Station, Unit No. 1 as a result of the site visit on the week of September 15, 1980. A meeting has been set for November 6, 1980, and the purpose of the meeting will be to discuss the content of this report. Therefore, we are transmitting this report for your review and will obtain your comments at this meeting.

Sincerely,

Original signed by
Robert L. Tedesco

R. L. Tedesco, Assistant Director
for Licensing
Division of Licensing

Enclosure

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Mr. J. S Abel
Director of Nuclear Licensing
Commonwealth Edison Company
Post Office Box 767
Chicago, Illinois 60690

ccs:
Mr. William Kortier
Atomic Power Distribution
Westinghouse Electric Corporation
P. O. Box 355
Pittsburgh, Pennsylvania 15230

Paul M. Murphy, Esq.
Isham, Lincoln & Beale
One First National Plaza
42nd Floor
Chicago, Illinois 60603

Mrs. Phillip B. Johnson
1907 Stratford Lane
Stratford, Illinois 61107

Ms. Julianne Mahler
Center for Governmental Studies
Northern Illinois University
DeKalb, Illinois 60115

C. Allen Bock, Esq.
P. O. Box 342
Urbanan, Illinois 61820

Thomas J. Gordon, Esq.
Waaler, Evans & Gordon
2503 S. Neil
Champaign, Illinois 61820

Ms. Bridget Little Rorem
Appleseed Coordinator
117 North Linden Street
Essex, Illinois 60935

Kenneth F. Levin, Esq.
Beatty, Levin, Holland,
Basofin & Sarsany
11 South LaSalle Street
Suite 2200
Chicago, Illinois 60603

Mr. Edward R. Crass
Nuclear Safeguards and Licensing Division
Sargent & Lundy Engineers
55 East Monroe Street
Chicago, Illinois 60603

Nuclear Regulatory Commission, Region III
Office of Inspection and Enforcement
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Myron Cherry, Esq.
Cherry, Flynn and Kanter
1 IBM Plaza, Suite 4501
Chicago, Illinois 60611

Marshall E. Miller, Esq., Chairman
Atomic Safety and Licensing
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. A. Dixon Callihan
Union Carbide Corporation
P. O. Box Y
Oak Ridge, Tennessee 37830

Dr. Richard F. Cole
Atomic Safety and Licensing
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

HUMAN FACTORS ENGINEERING CONTROL ROOM REVIEW
LASALLE COUNTY STATION UNIT 1

A human factors engineering design review of the Commonwealth Edison Company LaSalle County Station Unit 1 control room was conducted during the week of September 15-19, 1980. The review was conducted by the Human Factors Engineering Branch, Division of Human Factors Safety. The review team was assisted by human factors consultants H. E. Price of BioTechnology, Inc. and V. Pezoldt, National Bureau of Standards.

The objective of this review was to identify those control room design factors which could contribute to or induce operator error under abnormal or emergency operating conditions. This involved observations of (1) control room design, layout and functional operation; and (2) control/display use in selected emergency operating procedures under simulated emergency conditions.

The staff also reviewed and commented on the preliminary human factors assessment review prepared by the Commonwealth Edison Company in compliance with Task 1.D.1 of NUREG-0660, the NRC Action Plan. The document reviewed by the staff was a draft version of this assessment, dated September 15, 1980.

A. STAFF OBSERVATIONS

The following section summarizes the staff's observations of control room design and layout, and of the control room operator interfaces with that environment. Observed design deficiencies were given a rating based on the possible consequences of the operator error or errors that could be caused by that particular deficiency. The staff's ratings are as follows:

Category 1: Major concern for potential operator errors that could affect plant safety.

Category 2: Moderate concern for potential operator errors that could affect plant safety.

Category 3: Minor concern for potential operator errors that should not affect plant safety.

The staff was unable to complete some reviews, where major design modifications of control room panels were incomplete, or where licensee-identified enhancement of panels or consoles had not been accomplished. In general, the staff has rated these items as Category 1 until they are completed and reviewed.

In general, the staff's selection of design deficiency categories in the following analysis has attempted to factor in the cumulative effects of stress, fatigue, increased sound levels, etc., that could accompany an emergency situation.

1. Annunciators and Alarms

   a. Positive Factors

      (1) "Black Panel" concept. Annunciator tiles will not be used as indicators.

      (2) Annunciator response sequence. Silence while retaining flashing tile; acknowledge and retain illuminated tile; slow flash and audio signal for cleared alarms; test capability.

      (3) Annunciators must be acknowledged at their respective panel locations.

      (4) "First out" capability.

      (5) Reflash capability. (Not demonstrated, however. See item A.1.b(10).)

      (6) Lamp test capability.

      (7) Separated audio signals, both tone and location. (However, improvement is possible. See item A.1.b(7).)

   b. Design Deficiencies

      (1) Some annunciator tiles are not located above the affected system or control/display. Category (3)

(2) Poor organization of annunciator tiles within panels. Category (2)

(3) Lack of distinction between serious alarms with direct plant safety implication and alarms not having a direct effect on plant safety. Category (1)

(4) Tile readability is impaired by use of too many words and small character size and weight. Category (2)

(5) Inconsistent arrangement of annunciator response controls. Horizontal rows, vertical rows, 2 x 2 square arrangement. Category (3)

(6) Panel 1PM03J (Feedwater and Condensate) does not have a set of annunciator response controls. Alarms on these two 5 x 12 annunciator panels must be acknowledged at adjacent Panel 1PM02J (Turbine Control). Category (2)

(7) Audible alarms are not specific by panel. Although general directional cueing (left, right, front, back) is presented to an operator stationed at the reactor control panel, additional discreet panel alarms would speed up location of alarms and avoid the possibility of overlooking alarmed tiles when a multiple-alarms condition exists. Example: only one audible alarm for all of panel 1H13P601 plus panel 1H13P602, which two panels have a total of three annunciator controls, two for P601 and one for P602. Category (2)

(8) Audible signals vary in intensity and should be adjusted to result in equal detection levels for all alarms. Category (1)

(9) Intensity/frequency combination for the reactor control panel (1H13P603) alarm could render this alarm undetectable under stress/high ambient noise level conditions to operators with moderate hearing deficiencies. Category (1)

(10) Annunciator tile reflash capability not demonstrated. Category (1) until evaluated.

2. Controls

a. Positive Factors

(1) Controls are generally well laid out and are within easy reach of most operators.

(2) Pump, valve, motor and breaker multiple-position controls follow the conventional use of right-center-left positions.

(3) Level and flow controllers follow design convention. Up for high/increase, down for low/decrease.

(4) Switches have adequate displacement for indication of position and have adequate resistance to motion.

b. Design Deficiencies

(1) Some J-handle controls (e.g., 1PM03J Feedwater and Condensate Panel) are spaced too close to each other. The crowding can lead to excessive operator search time for specific controls and accidental actuation of adjacent controls. Category (2)

(2) J-handle controls are located too close to benchboard edges. Without protection (e.g., a guardrail), there is a high potential for accidental actuation of these controls. Category (1)

(3) J-handles obscure some control labels. Category (2)

(4) The Feedwater Turbine speed changer control moves counterclockwise to increase speed (violation of design convention). Category (2)

(5) Rod insert and withdraw pushbutton resistance to motion is great enough to require use of a temporary operator aid to avoid fatigue during startup or shutdown normal operation. Category (3)

(6) There is no consistent guide or plan for coding controls. Identical J-handles are used for switches, pumps, shutoff valves, and throttling valves. This can result in excessive operator search time or selection of the wrong control. Category (1)

(7) Covers on control indicator lights are interchangeable. Category (2)

(8) Lamp replacement for indicator lights is difficult. Tools for lamp replacement are not available in the control room. Category (2)

(9) No positive means to determine indicator light failure or degradation. Indicator lights are single filament. Category (1)

(10) Pushbutton trip switches do not provide a positive armed/disarmed indication at the switch location. Category (2)

3. Displays

a. Positive Factors

(1) Visual displays are generally adequate with respect to meaning and interpretation, viewing distance and location, legibility, scale design, illumination and luminance contrast.

(2) The "green board" concept is good.

(3) Use of bar and circle indicators for valve positions minimizes confusion as to valve conditions.

b. Design Deficiencies

(1) Vertical indicators located directly below annunciator panels are about 78 inches above floor level, and are difficult to read at this height. There is some glare on these indicators at this time, and this problem may become more severe as additional workspace lighting is provided. Category (2)

(2) There are strings of more than 5 meters, which interferes with prompt identification of specific indicators. Category (3)

(3) Normal operating ranges or setpoints are not marked on scales. Category (1)

(4) Meter failure is not always apparent. Category (1)

(5) The large array of meters on the electrical panel (1PM01J) has no apparent organization. Category (2)

(6) There are some hand-made scales in the control room. Category (1)

(7) Positive association of some legend lights with their associated labels is not readily apparent. Category (2)

(8) Status light mirror-imaging on the Reactor Control panel (1H13P603) is not good human engineering practice. Category (3)

(9) Luminance contrast for some blue indicator lights is low. Lamps are too dim. Category (2)

(10) Backlighted indicators are not always readable when not illuminated. This is particularly true for the blue indicators (e.g., "live bus" on 1PM01J), and some red and green indicators (e.g., barometric condenser pump on 1H13P601). Category (2)

4. Control/Display Relationships

a. Positive Factors

(1) Use of mimics enhances control/display relationships.

(2) Controls and displays are generally well organized on a system-by-system basis.

(3) Functional and sequential arrangement of controls and displays is generally good.

b. Design Deficiencies

(1) ADS System and Safety Relief Valves: All valve indications on panel 1H13P601 are demand position and do not provide positive indication of valve status. Operators must leave the immediate control room area and note SRV outlet temperatures on a recorder (on panel 1H13P614) to identify/confirm open SRVs. This recorder requires about 4 minutes to cycle through all recorder positions (24 positions, 19 SRVs). The control room annunciator must be reset from 1H13P614. Annunciator tile is not directly over the valve controls on 1H13P601. Category (1)

(2) Outboard Isolation Valves, Div. I: Main Steam Line meter groups are labeled ABCD. The mimic lines relating to these valves are labeled AEJN. This creates potential for operator confusion. Category (2)

(3) Isolation valve pressure displays are not positively identified (by labels) as inboard or outboard. Category (2)

(4) High Pressure Core Spray System, Div. I: The HPCS pump flow and pressure displays are labeled "pump." Positive identification suggests that they be labeled HPCS pump. Category (2)

(5) HPCS System, Div. II: The HPCS motor ammeter is located in the array of meters for the diesel generator on the HPCS System Div. I Panel. Association of this display with the pump control (on the Div. II panel) should be more obvious. Category (1).

(6) RHR System, Loop B Div. II:

(a) Pump B meters are arranged pressure-flow-amps, while pump A meters are arranged amps-flow-pressure. A potential for operator confusion is caused by this arrangement. Category (2)

(b) Penetration Pressurization B/C Duct and B/C Room Temperature meters are physically side-by-side but have slightly different scales (0-250° F and 0-300° F). Temperature comparisons would be facilitated if both scales were identical. Category (2)

(c) Some labels are partially obscured by the indicator lights located at the base of the vertical portion of 1H13P601 (e.g., Containment Spray, RHR injection). Category (2)

(d) White indicator lights are used on some valves to indicate a not-normal condition (e.g., containment spray and RHR injection). However, white indicator lights are used to indicate normal conditions on other components (e.g., Turbine Oil Lift Pump). Category (2)

(7) LPCS System, Div. I: LPCS pump cooler valve (a) is not labeled, (b) can be mistakenly considered as part of the LPCS mimic. Category (1)

(8) RCIC Div. I: Water leg pump is not included in the mimic. Category (3)

(9) Containment Isolation and Leak Detection: Panel and console (1PM13J and 16J) appear generally satisfactory, but major

modifications now underway prevent any findings at this time. Further assessment, including review of completed panels, is necessary. Category (1) until completion of assessment.

(10) Standby Gas Treatment:

(a) This panel (1PM07J) is generally mirror-imaged with the integral Unit 2 panel (2PM07J). Category (3)

(b) Indicator lens caps are missing. Category (1)

(c) Strip chart recorders are not labeled. Incorrect chart paper may be installed. Category (1)

(d) Panel mimic is incomplete. Category (2)

(e) Control/Annunciator labels are inconsistent. (Demister/ Moisture Separator). Category (2)

(f) Controls are set up to require manual (operator) initiation of the deluge system, but there are no direct alarms or displays to direct the operator to take this action. Category (1)

(11) Feedwater and Condensate Panel 1PM03J:

(a) Other than use of mimics (which were considered good operator aids), other coding methods (color, demarcation) to enhance system/subsystem/group/subgroup discrimination were not used to any great extent. Category (3)

(b) The relationship between similar control/display components and layouts of unrelated groups and subgroups may introduce confusion or hesitation in identifying and selecting particular controls or in relating controls to their associated displays. Category (2)

(c) Nonrelated groups of controls and displays are located too close to each other. This affected the control/display relationship of specific panel groups. Category (2)

(d) Location of valve position indicators is such that there is more space between a given control's indicators than

there is between the left/right indicators of adjacent controls. This problem exists on several panels (e.g., 1PM02J). Category (2)

(e) The turbine speed control turns counterclockwise to increase speed. The related dial indicator rotates clockwise to show increased speed. Category (2)

(f) Motor-driven feedwater pump C control is located to the left of controls for turbine-driven pumps A and B. Category (2)

(12) Auxiliary Systems Panel/Console 1PM09J/10J

(a) Control/display relationships can be improved by relocation of displays (e.g., interchange the station air compressor and turbine building CCW pump meters). Category (3)

(b) Other than limited use of mimics, little use is made of other coding techniques (color, demarcation) to enhance discrimination of systems, subsystems, etc. There are many subsystems on this panel/console, and some form of demarcation is needed. Category (3)

(c) Console-to-panel control/display arrangement layouts could be improved to minimize control selection errors. Category (3)

(13) Electrical Control Panel 1PM01J

(a) Poor control/display relationships. There are many meters on this panel, with no significant demarcation or other coding to relate them to their associated controls. Category (3)

(b) Some annunciator tiles appear inappropriate for this panel (e.g., Misc. Auto Control System Power Failure). Category (3)

(c) Dial indicators located above related controls are not installed in the same sequence as the controls. Category (3)

(14) Turbine Control Panel - IMP02J

(a) Physical relationships between controls, displays, and annunciators are deficient. Examples include:

- Emergency bearing oil pump - Annunciator on panel A, control located beneath panel B. Category (3)
- Feedwater Pump Turbine Vibration - Annunciator on Panel A of 1PM02J, associated strip chart recorder located below and to right of this panel, associated control located on left side of 1PM03J. Category (3)

(b) Labeling errors

- Main stm to MSR 1A - 2d stage shutoff should be 2d stage drain. Category (2)
- Stm Packing - E1 and E2 designations reversed. Category (2)

(c) Control/Display Grouping

- Main Stop Valve -2 is located in a string of other valves: IV-1, MSV-2, IV-2, IV-3. Category (2)
- Turbine Bearing Lift Pump status indicators are off-on-autotrip-normal, while most other applications are off-autotrip-on. Category (3)

(d) Panel includes instrumentation (e.g., Turbine Vibration Phase Selector) not used by control room operators. Category (3)

(15) Reactor Water Cleanup and Recirculation Panel - 1H13P602

(a) Filter Demineralizer status light sequence (on benchboard) does not match panel indicator sequence on vertical panel. Category (3)

(b) RWCU and Recirc graphics (on CRT display) do not coincide with control board mimics. Category (3)

(c) Jet pump flow indicators for Loops A and B are intermixed. Category (2)

(d) Labels are missing on some voltage and current meters. Category (1)

(16) Reactor Control Panel - 1H13P603

(a) Status indicators (Train A, Train B) are mirror imaged. However, placement and overall board arrangement is such that operator confusion is probably not expected. Category (3)

(b) Location of some displays (e.g., Rod Sequence Control) appears to require unnecessary operator motion to read the display. Category (3)

(c) SRM bypass controls and indicators are not consistent. Category (3)

(d) Heat Flux Detector vertical sequence is not consistent with standard design convention. Category (3)

(e) Range Switch A label is missing. Category (1)

(f) Color coding of IRM controls (A, black, B, red) does not appear to be needed, and may overemphasize the importance of train B. Category (2)

(17) HVAC Console and Panel - 1PM05J/06J

(a) Control/Display relationships are unclear. The principal HVAC systems controlled and monitored from this workstation (control room, reactor building, turbine building, offgas building) are not segregated or otherwise well-distinguished as systems. Control associated with particular displays are not always readily apparent. Category (1)

(b) Subsystem controls/displays are not identified by labels, demarcation, or other coding methods for rapid and accurate operator access. Category (1)

(c) A & B trains of the containment building controls located on panel 1PM06J are not grouped together (they are located at opposite ends of the panel) and are arranged as mirror impages. Category (2)

5. Labels

a. Positive Factors

(1) The general approach to labeling is good. A hierarchial scheme is used which identifies areas of the main control boards, and proceeds through major systems, subsystems, some smaller groups, and individual components.

(2) Labeling is generally black-on-white, readable from normal viewing distances, and generally consistently located.

(3) Labeling is reasonably descriptive, and uses standard abbreviations and descriptions.

b. Design Deficiencies

(1) System or major function labels should be more readily detected/located on the main panels (e.g., use larger lettering). Category (2)

(2) Temporary labels are in use throughout the control room, and should be replaced with permanent labels. Category (1)

(3) Annunciator panel designations for panel 1H13P601 proceed from A to D, then F, then E. Category (2)

(4) Labeling of Auxiliary Systems indicator lights in 10 x 11 matrix could be improved. Matrix is too crowded and labeling is repetitious. Category (2)

(5) Labels having white legends on red backgrounds are very difficult to read and should be replaced with black legends on white backgrounds. Category (1)

(6) Note: Specific labeling discrepancies identified in the draft LaSalle Preliminary Assessment of 5 September 1980 (items 1d, 2-5 and 3i, 1-6) were observed and the proposed changes appear to be necessary and adequate. Category (1)

b. Recorders

a. Positive Factors

(1) Recorders are provided for most essential plant systems.

(2) Most recorders were well labeled as to the parameters recorded, and scales were readable from reasonable distances.

(3) Most recorders were located directly above or adjacent to the controls for that system.

b. Design Deficiencies

(1) Note: Recorders were not operating. An assessment of recorder operability/maintenance (inking, paper supplies, general recorder performance) could not be made. Category (1) until assessed.

(2) Color selection for dual-pen recorders is inconsistent. Although red and blue have been selected for pen colors, there is no consistent selection of color for the upper/lower pens. Potential problems in parameter identification, chart maintenance (inking). Category (2)

(3) Pen positions and labels on dual-pen recorders are inconsistent. Upper label often corresponds to lower pen. Category (2)

(4) Pen color does not always match indicated label color (e.g., condenser normal makeup pen color was red, label indicated black; condenser emergency makeup pen color was blue, label indicated red). Category (1)

(5) Some dual-pen recorders had no labels indicating which pen recorded what function. (Panel 1PM07J) Category (1)

(6) Recorder scales and chart paper scales do not always correspond. Category (1)

(7) Several dual-pen recorders used dual-scale chart paper to accommodate the dissimilar pen scales. Potential operator confusion in matching ink (or pen) colors to sequential sections of chart paper with different scales could lead to erroneous conclusions. Category (2)

(8) The SRV temperature recorder (Panel 1H13P614) channel indicator shows portions of two channels (SRVs) simultaneously. It is possible to be confused as to which channel is being displayed. Category (2)

7. Workspace, Layout and Environment

a. Positive Factors

(1) Control Room layout is good. No significant problems with access to controls, physical or visual obstructions, panel dimensions, reach envelopes, or traffic patterns. Control room access is adequately controlled.

(2) In general, the use of color has been well considered and consistently carried out.

(3) Good use of functional mimics. Good mimic techniques include varying line widths, color-coded flow paths, directional arrows, and origin/destination labels.

(4) Approach to demarcation (where used) is good.

(5) Background sound level is acceptably low.

(6) Adequate communication systems are available to the operator. A well-laid-out communication system has been provided at the remote shutdown panel. Provisions have been made for communications control during emergency conditions.

b. Design Deficiencies

(1) Layout and Workspace

(a) Shift supervisor's office is physically and visually remote from the control room. Supervisory access to the control room under emergency conditions (i.e., control room isolation) requires additional operational procedures to gain access to the control room. Supervisor's office does not have the same degree of environmental protection as the control room. Category (2)

(b) Potential parallax problems exist in reading vertical meters located more than 6 ft from the floor (e.g., panels 1H13P601, 1H13P603). Category (3)

(c) Minimal clearance (27 inches) between high desk and computer console creates operator traffic problems. Category (3)

(d) Large numbers of manuals, procedures, etc., stored at center desk. Identification and selection of emergency operating procedures is difficult. Category (1)

(e) Specific EOPs within a particular procedure are difficult to access. For example, there are more than 100 tabbed procedures within LOA #25. Category (1)

(f) Distance and orientation of center desk presents accurate visual observation of all control room displays/annunciators. Category (2)

(g) There are no provisions for installing CRT status monitor panels at the center desk. Category (3)

(h) Console/Panels 1PM13J/16J, 1PM9J/10J, 1N62P600/P601, and 1PM05J/06J are mirror-imaged with the Unit 2 control room. Category (2)

(i) Meteorological data is displayed only on panel 1PM10J and recorded meteorological data is not available in the control room. Operators must leave the reactor control panel area or the center desk area to determine meteorological conditions. Category (2)

(2) Use of Color

(a) White (indicator lights) is used for both normal and abnormal operating conditions. Category (2)

(b) Some emergency trip pushbuttons are black (instead of red). Category (1)

(c) No use of color (except for red "first out" tiles) in the annunciator panels. Color should be used to categorize the degree of severity or potential safety consequences of individual alarms. See item A.1.b(3). Category (1)

(d) Note: Additional control room coding is planned but has not been evaluated. Category (1) until evaluated.

(3) Use of Mimics

No deficiencies in mimics presently used. The general techniques now in use should be extended to other systems. The descriptions of additional mimics to be added to the control panels appear to represent the additional improvement, but this improvement cannot be assessed at this time. Category (1) until evaluated.

(4) Demarcation

No deficiencies in demarcation techniques used. Additional demarcation is needed (and planned), but cannot be evaluated at this time. Category (1) until evaluated.

(5) Illumination

(a) Workspace illumination levels are below minimum illuminance standards. Measurements (in low-illumination level areas, but with all control room lights on) at the front of benchboards ranged from 11 to 18.5 ft candles, at rear of benchboards from 3.6 to 10.2 ft candles, and at 6-ft elevation on vertical panels from 3.5 to 7.5 ft candles. Category (1)

(b) Luminance contrast is inadequate, particularly for blue status monitor lights. Category (2)

(c) Some glare problems exist along front portions of benchboards, upper portions of vertical panels, and on computer console. These problems may be increased as a result of increasing illumination levels at these surfaces, and must be reevaluated. Category (1) until reevaluated.

(d) Note: Illumination problems have been identified in other items throughout Section A.

(6) Noise

Background sound levels under normal operating conditions are expected to be in the 40-50 dbA range, which is good. However, sound levels for some alarms will be in the 65-80 dbA range. At this high differential sound level, these alarms can (a) cause operator irritation and (b) interfere with verbal communications under circumstances of multiple alarm conditions. Category (2)

(7) Heating, Ventilating, and Air Conditioning

(a) The "effective temperature" (69°F) is outside the recommended comfort zone. This must be reevaluated after completion of construction. Category (3) until reevaluated.

(b) Air velocities at the center desk appeared to be greater than normal acceptance limits. This must be reevaluated after completion of construction. Category (3) until reevaluated.

(8) Communications

(a) Visual access to phone jacks or rear control room panels is poor, and should be improved by some form of coding. Category (2)

(b) "Address" labels and an appropriate index are lacking on the control room sound-powered phone patch panel. Patch cords and one sound-powered phone should be stored at the patch panel location. Category (2)

(c) Communications equipment located at the center desk is adequate, but disorganized. Improved layout is needed to assist operators in identifying and selecting appropriate level/priority of communications equipment. Exposed line should be concealed or protected. Category (2)

(9) Emergency Equipment

(a) Provisions for portable fire extinguishers are inadequate. Additional extinguishers and permanent, easily accessible mountings are needed. Category (1)

(b) Accessibility of operator protective equipment is poor. Equipment should be stowed in a readily accessible and well-identified location. Category (1)

(c) Current control room operator protective equipment is deficient in the following areas: Vision, provisions for use of corrective lenses, air supply, and communications. New equipment on order is expected to resolve these problems, but evaluation at this time is not possible. Category (1) until evaluated.

8. Remote Shutdown Panel

a. Positive Factors

(1) Panel area is appropriately secured, and within reasonable distance (about 2-minutes' walking time) from the control room.

(2) Panel Area is well equipped with communications systems.

b. Design Deficiencies

(1) Panel lacks mimics and demarcation. Category (1)

(2) Basic power is available from Division I. There is no second (isolated) panel with Division II power. Category (1)

(3) Emergency lighting is not provided in the panel area. Category (1)

9. Computers

a. Positive Factors

(1) The process computer system has the potential for a high availability via the redundant computer architecture and multiple power supply configurations.

(2) Color coding is used on the CRT displays.

(3) P&ID mimics are used at the system and sub-system level.

(4) There is a dedicated mini-computer for logging annunciator alarms.

(5) Good formating is used on the periodic log nuclear printouts from the stand point of readability of critical information.

(6) The control room operator has no access to stored algorithms in the process computer.

(7) Functional menu selection on the operator's console is structured for rapid access and use.

(8) Display of ESFS operability status is structured for rapid status identification.

b. Design Deficiencies

(1) Trending capability limited to 4 operator selectable parameters on two pen strip chart recorders which do not provide parameter identification or the units of the trended parameters. Category (2)

(2) Glare on the CRT display affects readibility. Category (2)

(3) Poor readibility (narrow strokewidth) of specific color characters on the CRT (dark blue on black and red on black). Category (2)

(4) There are no operating procedures for operator action following total loss of the process computer system. Category (1)

(5) Violation of stereotype on operators console. (e.g., labeling of point I.D. display is misleading to the operator and inconsistent with the thumbwheel control). Category (3)

(6) Violation of stereotype on location of number thumbwheel switch and the function thumbwheel switch. (Category 3)

(7) Poor organization of the point I.D. index. This could be improved by grouping of systems/subsystems. (Category (1)

B. REVIEW OF EDISON ASSESSMENT

The following section provides the staff's analysis and comments on the Commonwealth Edison draft Preliminary Assessment of the Human Factors Review of the LaSalle County Station Control Room. In general, the review and findings to date show an understanding and concern for human factors engineering improvement. The composition of the review team, including professional human factors personnel, and the conduct of empirical studies supports the apparent understanding and importance of human factors.

The staff has been able to review a majority of those findings and suggested improvements provided in the draft assessment where an inspection of the affected control room panel or environmental parameter was possible and the suggested improvement readily apparent. However, some of the improvements which were less specific and more conceptual in nature could not be readily assessed in the control room or evaluated on the basis of the descriptions provided in the draft assessment. These improvements included

- Extensive demarcation
- Color coding and shading
- Extensive new or revised mimics
- Extensive control of display relocation.

Pre-implementation assessment of these improvements would require preparation and review of mockups, full-sized drawings, or temporary simulation of the control room panels with colored paper, tape, simulated meters, etc.

The following staff comments are directed to Section E of the draft Assessment, Control Room Improvement and Implementation Schedule. The numbering system follows that of Section E.

1.a. CONTROLS - Arrangement and Grouping

1. Finding. We concur.

   Improvement. The suggested improvement should reduce operator search time. However, as noted in staff comment A.1.b(5), the

inconsistent arrangement of these annunciator controls may contribute to a major portion of the operator search time. Other solutions, such as consistent 2x2 arrangement, or a horizontal arrangement just below the front edge of the benchboard, should also be considered.

2. Finding. We concur.
Improvement. We concur, but note that additional demarcation should be applied to panels in the main control room as well (e.g., Turbine Control Panel 1PM02J).

1.b. CONTROLS - Coding

1. Finding. We concur.
Improvement. The suggested improvement will enhance discrimination, but does not take advantage of the further enhancement that could be provided by shape discrimination. Considering the large number of J-handle controls in the control room, the use of other types of control handles (e.g., star handles) should be considered.

2. Finding. We concur.
Improvement. We concur. Will the one guarded trip button be treated similarly?

3. Finding. We concur.
Improvement. We concur, but wish to be advised of the proposed method of coding prior to implementation. (See comment on item 1.b.1.)

1.c. CONTROLS - Accidental Activation

1. Finding. We concur.
Improvement. We concur.

1.d. CONTROLS - Labeling

1. Finding. We concur.
Improvement. We concur. Note that this improvement must extend to all "collared" arm/disarm switches. Acceptable improvements would include an indicator light at the switch positions, or a readily visible projection on the arming collar.

2. Finding. We Concur
Improvement. We concur.

3. Finding. We concur.
Improvement. We concur.

4. Finding. We concur.
Improvement. We concur.

5. Finding. We concur.
Improvement. We concur.

1.e. CONTROLS - Knobs, Dials, and Switches

1. Finding. We concur, with the understanding that this is principally a concern during startup or shutdown.
Improvement. We do not concur. Providing additional J-handles in the LaSalle control room is not recommened. We would suggest that other options be considered. We request that a proposed improvement be identified.

2. Finding. No comment.
Improvement. We do nto concur. Providing additional J-handles in the LaSalle control room is not recommened. We request that a proposed improvement, if desired, be identified.

2. ANNUNCIATORS/ALARMS

1. Finding. We concur.
Improvement. We concur, but question if any annunciator windows will be identified for relocation at a time after fuel loading.

3.a. VISUAL DISPLAYS - Arrangement and Grouping

1. Finding. We concur.
Improvement. We concur. We request further details of the proposed demarcation plan (drawings, photographs of mockups, etc.) by October 15, 1980. Consideration should be given to providing functional labels

for these systems and to minimizing redundant wording on present labels on this panel.

2. Finding. We concur.
Improvement. We concur.

3. Finding. We concur.
Improvement. We concur.

4. Finding. We concur.
Improvement. We concur. We note that attachment 3 shows that 5 different major systems that will use color for control/display association. The proposal appears reasonable and does not suggest that excessive color use or mixing of colors will occur. A valid assessment of this improvement cannot be made on the basis of this written description, however. As noted, use of a mockup to check results would be useful. This is recommended, since indiscriminate use of color can lead to visual distraction. We request further information on plans for color shading.

5. Finding. We concur.
Improvement. Further information is necessary. We will require identification of those controls and displays to be moved, and a proposed schedule for their relocation. We recognize that some relocation information will be obtained as a result of startup testing and initial operation, but believe that some changes may be needed prior to fuel loading or startup. Preliminary identifications and schedules are requested by October 15, 1980.

6. Finding. Not evaluated.
Improvement. We concur.

7. Finding. We concur

Improvement. We concur.

3.b. VISUAL DISPLAYS - Meters

1. Finding. We concur.

Improvement. We concur.

3.c. VISUAL DISPLAYS - Scale Design

1. Finding. We concur. The described study appears to have been a good one, with credible results.

Improvement. We do not concur. Recommend that pointer color be changed from black to orange and that green normal operating range markers be applied to external surfaces of meters before fuel loading. We further recommend that use of range markers to indicate abnormal (warning) operating ranges also be considered. Transfer of range markers to the meter faces should be done shortly after intial startup. Identification of meters to be provided with range markers should be provided.

3.d. VISUAL DISPLAYS - Indicators and Counters

1. Findings. We concur.

Improvement. We concur.

3.e. VISUAL DISPLAYS - Chart Recorders

1. Finding. We concur.

Improvement. We concur. It is also important that all recorders be properly labeled and identified and that duel-pen recorders be organized in a consistent manner. Scale multipliers (when needed) are to be clearly identified. See item A.6.b.

3.f. VISUAL DISPLAYS - Plotters and Printers.

No findings. We concur.

3.g. VISUAL DISPLAYS - CRTs

No findings. The following cautions are noted.

a. Glare on CRTs may become objectionable after workspace lighting levels are increased to above minimum acceptable levels.

b. The use of CRTs to provide graphic displays should consider that any such graphics should correlate with mimics displayed on the control boards.

3.h. VISUAL DISPLAY - Flashing Lights.

No findings. We concur. Comment. We concur.

3.i. VISUAL DISPLAYS - Labeling

1. Finding. We concur.
   Improvement. We concur

2. Finding. We concur.
   Improvement. We concur.

3. Finding. We concur.
   Improvement. We concur.

4. Finding. We concur.
   Improvement. We concur.

5. Finding. We concur.
   Improvement. We concur. As a general note, all mimics should be reviewed to identify and/or clarify flow origins and destinations.

3.j. VISUAL DISPLAYS - Mimics

1. Finding. We concur.
   Improvement. We concur, but note that a valid assessment of the proposed improvement cannot be made on the basis of the information provided. Full-scale drawings, mockups, etc., should be used to evaluate these improvements prior to their incorporation on the control boards.

2. Findings. We concur. Attempts to standardize colors throughout the control room would be difficult. However, where it is possible to apply dedicated colors to specific control panel functions (e.g., yellow/blue for Division I/II), these colors should not be repeated in the mimics. We also concur that a number of improvements in incomplete and inconsistent mimics must be made.
Improvement. We concur, but cannot assess the improvements on the basis of the information supplied. A sampling of the 21 proposed improvements confirms our opinion that they will enhance the mimics. However, the improvements will need to be reviewed after they have been implemented.

4.a. CONTROL ROOM ENVIRONMENT - Layout
No findings. Refer to Section A.7.b(1) for staff comments.

4.b. CONTROL ROOM ENVIRONMENT - Sound Levels
1. Finding. We concur.
Improvement. We concur.

4.c. CONTROL ROOM ENVIRONMENT - Ventilation
No finding. Refer to Section A.7.b(7) for staff comments.

4.d. CONTROL ROOM ENVIRONMENT - Protective Equipment
1. Finding. We concur.
Improvement. We do not concur. Operator protective equipment, satisfactorily stowed and identified in the control room, and with satisfactory, tested communications provisions, must be available in the control room prior to fuel loading.

4.e. CONTROL ROOM ENVIRONMENT - Communication Systems
1. Finding. Not evaluated.
Improvement. Satisfactory.

2. Finding. We concur.
   Improvement. We concur.

3. Finding. We concur.
   Improvement. See staff comment, item B.4.d.1.

4.f. CONTROL ROOM ENVIRONMENT - Lighting

1. Finding. We concur, but have identified significant problems with workspace lighting. See item A.7.b(5).
   Improvement. We concur. Improved lighting must be reevaluated and approved prior to fuel loading.

5. MAINTENANCE

1. Finding. We concur.
   Improvement. We do not concur. The staff is concerned that the proposed improvement could result in no significant changes in control room labeling until after plant startup. It would appear that a majority of permanent labels could be in place by fuel loading and all permanent labels in place by plant startup. We request that a preliminary plan for controlling the use and replacement of non-permanent labels be provided by October 15, 1980.

2. Finding. We concur.
   Improvement. Conditional concurrence, based on staff review of the proposed administrative procedure for verifying indicator light operability.

3. Finding. We concur.
   Improvement. We concur, based on the understanding that the lamp replacement tool or tools will be available in the control room and successfully tested and adopted by Station operators.

6. COMPUTERS

No findings. (See staff analysis of computers in Section A.9).

7. EMERGENCY PROCEDURES WRITING GUIDE

Not evaluated by the HFEB staff.