Commonwealth Edison Company

Preliminary Design Assessment of the Byron/Braidwood Generating Station Control Room Human Factors Engineering Review Supplement I

SUBMITTED BY:

Commonwealth Edison Company

April 1983

IN RESPONSE TO:

Task Action Plan Item
I. D. 1, Control Room Design Reviews

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FOREWORD

This document was prepared by the Commonwealth Edison Company (CE) Byron/Braidwood Project Engineering Department in conjunction with the Human Factors Technology Group of the ARD Corporation, Columbia, Maryland. This report contains the Commonwealth Edison Company responses to the Human Engineering Discrepancies (HEDs) identified by the Human Factors review and the Preliminary Design Assessment (PDA) Audit conducted by the NRC. Byron Station Unit 1 control room is a standard design to be used in several other plants. In addition to Byron Station Unit 1, this report is intended to be applicable to Byron Station Unit 2 and Braidwood Station Units 1 and 2.

This report is divided into two sections which include HED responses prepared for NRC review. The subsequent Appendices include previously discussed and approved HED responses. The information contained in this report supercedes any previous information concerning these topic issues.

Section I contains formal CE responses not previously submitted for NRC review. The response categories are:

- HEDs with a formal CE response prepared for NRC review
- HEDs which are deemed non-safety-related and difficult to back fit. Response to these items are requested to be deferred "until the conduct of a Detailed Control Room Design Review" (DCRDR).
- Priority 3[1] HEDs requiring further investigation during the DCRDR. We request your concurrence in reclassifying these HEDs to Priority 3.
- Closed items

Section II identifies items which were previously considered "closed" but the responses have been revised to include updated information.

Appendix A addresses discrepant items which have been discussed previously with the NRC as part of the SER and which are now considered "closed"; these items are identified throughout the report.

Appendix B identifies discrepant items which were discussed with the NRC in July 1982.

Appendix C identifies items which are acknowledged as "deffered until the conduct of a DCRDR" by the NRC.

PRIORITY RATING codes referenced in this report were established previously by the NRC. FINDINGS are listed sequentially within each section by Subsections:

1.0 Control Room Workspace
2.0 Communication
3.0 Annunciator Warning System
4.0 Controls
5.0 Displays
6.0 Labels and Location Aids
7.0 Process Computers
8.0 Panel Layout
9.0 Control Display Intergration

Section numbers from previously-referenced PDA documents appear in parentheses after each FINDING; these numbers are included to facilitate cross-referencing of this document to the PDA documents.

SECTION I

Previously Unresolved Human Engineering Discrepancies

1.0 CONTROL ROOM WORKSPACE

PRIORITY RATING	FINDING	
3	1.1	The design of the control room does not facilitate unobstructed movement and communication. For example, an operator seated at the center desk must traverse approximately 30 feet around the desk to reach a position that is only 10 feet away on a straight line. The design of the center desk may impair performance of the reactor operator/senior reactor operator stationed at the desk. (4.1.1) (2.1.1-1)

CE Response: The present center desk has been replaced by a center desk system designed to facilitate operator movement and communication both within the center desk work area and with the operators located at each unit. The center desk has been arranged to minimize obstacles which influence operator mobility and permit the operators to perform their designated duties at the work station.

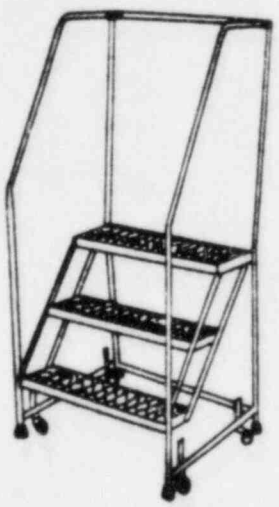
Implementation: Completed.

1 1.2 Some of the controls on the stand-up console are located out of reach of the 5% height operator. The highest control is located 65" from the floor (recommended maximum = 60").

CE Response: Several controls on 1PM04J (Feedwater Panel) are located 65" from the floor. These controls are separated into four groups with three controls (Steam Flow, Feed Flow, and Steam Generator Level) included in each group. The purpose of these controls is to select the controlling channel for the Steam Flow, Feed Flow, and Steam Generator Level parameters. The controls are used with an estimated frequency of two times a year (in addition to four times per year for calibration).

A step ladder will be available to aid the fifth percentile female in reaching the switches. The ladder will also be equipped with handrails, as shown below, to prevent falls and minimize contact with the boards.

Implementation: Prior to fuel load.



3 1.3 The 30" depth of the benchboard (recommended maximum = 25.2") will force the 5th% height operator to lean over the panel. This depth increases the probability that the controls on the benchboard edge will be accidentally activated. (4.1.2)

CE Response: Closed (Pg. C-1).

1 1.4 Some controls on the common vertical panels are mounted above and below the recommended 34"-70" height range. The lowest controls are 12" from the floor. The highest controls are 87" from the floor. (4.1.3)

CE Response: The incore thermocouple indicator switch box (controls) located 12" from the floor is periodically used by the Tech Staff. Those thermocouples that are to be used by the operator are being made available for display on the 1PM05J control board, as part of Reg. Guide 1.97 instrumentation. Since this is redundant information used by the tech staff, it is not critical that the controls on the vertical panel are mounted in the recommended 34"-70" envelope.

A step ladder will be available to aid the fifth percentile female in reaching controls higher than 70" from the floor. This ladder is shown in the Resolution of HED 1.2. This will be examined further during the conduct of a DCRDR.

Implementation: Prior to fuel load.

1 1.5 Some displays on the common vertical panels are mounted above and below the recommended 41"-70" height range. The lowest display is located 23" from the floor. The highest display is located 92" from the floor. The top rows of the annunciators are located 90" from the floor.

CE Response: The fifth percentile female is able to see all displays from the necessary areas in the control room. The switchyard displays on OPM03J are not safety related and therefore it is not critical for them to be located in the recommended 41" - 70" height envelope.

The requirements for viewing distance for annunciators is that the operator subtend a visual angle of 15 minutes of arc. This requirement is met by the current letter height of .25 inches and viewing distance of over 5 feet. In addition, annunciators meet the requirements of 6.1.2.2.(e1a) in that they are within the horizontal line of sight.

Implementation: None required.

1 1.6 Annunciator response controls on the vertical panels are located 77" from the floor, making operation of these frequently used controls difficult. (4.1.4)

CE Response: Closed (Pg. B-1).

1 1.7 The equipment located at OPM05J, Center Desk, and the desk's general location are inappropriate for the desk's primary function as the only senior reactor operator station.

The desk has fire alarm annunciator panels on most sections and it is surrounded by shared and auxiliary panels.

CE Response: The center desk OPM05J has been redesigned. The center desk operator's work area has been increased to improve the senior reactor operator's work station conditions. Center desk equipment essential for the performance of the various duties and responsibilities of the individuals working at the center desk have been installed. Inappropriate equipment, including all fire alarm annunciators, have been removed.

Implementation: Prior to fuel load.

3 1.8 The design of OPM05J, center desk, prevents the seated operator from having full view of all of the controls and indicators on OPM02J.

CE Response: The redesign of OPM05J in the Byron control room will enhance the operators' view of the controls and indicators on OPM02J.

Implementation: Prior to fuel load.

1 1.9 The copper pipes which will supply emergency breathing air currently stick out of the control room floor and present a tripping hazard.

CE Response: Closed (Pg. B-1).

3 1.10 The leg openings in the wing sections of OPM05J, center desk, do not provide the recommended 30" lateral leg space for a seated operator. The lateral leg space provided is 23".

CE Response: Closed (Pg. B-2).

1 1.11 The annunciators on the vertical panels are oriented at less than the recommended minimum 45 degree angle to the line of site from the position of the associated response controls.

CE Response: The only annunciators on the vertical panels which monitor safety related equipment are located in Window box 33. Since this Window box is located next to the existing acknowledge station and the alternative retrofits identified are not cost-beneficial, the addition of another annunciator acknowledge station is not recommended.

Implementation: None required.

1 1.12 Controls and displays on the Remote Shutdown Panel are mounted outside the recommended height ranges. Controls are located 29 inches to 68 inches from the floor (recommended range is 34 inches to 70 inches). Displays are located 41 inches to 88 inches from the floor (recommended range is 41 inches to 70 inches).

CE Response: The location of all controls and displays on the remote shutdown panel have been reviewed. The review indicated that there were a number of displays that were located out of the acceptable range. A systematic approach to the redesign of the Remote Shutdown Panel prompted the integration of a number of changes to the boards. The upper most displays will be relocated 8" below their present location. In addition, various systems and their interactions were enhanced through the addition of background shading, mimics, and hierarchical labeling.

The few controls located below this range are only used by maintenance personnel and therefore do not warrant a reconfiguration of the panel. Given the space contraints at the Remote Shutdown panel, the redesign optimizes basic human engineering principles and practices.

Implementation: Prior to fuel load.

2 1.13 No plans have been made to provide protective clothing for control room operators, except for full hood/face masks with air lines.

CE Response: Closed (Pg. II-1).

2.0 COMMUNICATIONS

PRIORITY RATING	FINDING	
3	2.1	The sound-powered phone headsets are uncomfortable to wear for long periods of time. (4.2.1) (2.1.2-1) CE Response: Closed (Pg. C-2).
2	2.2	Neither the PA system nor the conventional phone system handsets have cords long enough for use at all parts of the control board. (4.2.2) CE Response: Closed (Pg. A-1).
3^1	2.3	The Press-to-talk and Channel Select switches on the paging system are located too low to be operated effectively. (4.2.3) (2.3.3.2-3) CE Response: Closed (Pg. II-5).

3.0 ANNUNCIATOR WARNING SYSTEM

PRIORITY RATING	FINDING	
2	3.1	First-out indications occur on separate but undedicated panels for: o Reactor Trip (24 tiles) o Turbine Trip (10 tiles) o Generator Trip (20 tiles) o Feedwater Pumps Trip (2 tiles) The first-out tiles are intermixed with other tiles. (4.3.1) (2.1.3-2) CE Response: Closed (Pg. II-6).
1	3.2	Tiles on the following annunciator panels are not readable from acknowledge buttons: Annunciator Panels UL-AN026, 003, 007, 008, 012, 014, and 015. (4.3.4.) (2.1.1-2) CE Response: Closed (Pg. B-3).
3[1]	3.3	No procedure exists to describe annunciator tiles which must be "on" for extended periods of time. (4.3.4)

CE Response: Annunciator tiles will only be "on" for an extended period of time (greater than one week while the reactor is operating at greater than 30% power, P8 set point) when there is a component malfunction. For those few instances, administrative procedures have been written to identify and correct these tiles.

Implementation: Completed.

2 3.4 Some annunciator alarm tiles are not located above related controls and displays and do not reflect proper functional grouping or axis labeling. (4.3.4) (2.1.3-1)

Annunciator Tile	Comment
2EO2	Should be duplicated on 1PM01J
2DO7	Should be on 1PM01J
2E07	Should be on 1PM01J
3AO5	Should be on 1PM01J
6A06	Boron injection tank is re-
6B06	moved - tiles are unnecessary
6C06	
6A07	
6B07	
6C07	
6D07	
6E07	

15A10 15B10 15C10 15D10 15E07 15E08	Controls are far from MSIV annunciators. Consider duplicating these tiles on 1PM06J
17E01	Not located in a functional group on right of panel
17D11	Unnecessary
17E13	Not on common panel 0PM01J
18B03 18B16	Not located together
19A06	Not located in the first-out group.

CE Response: Closed (Pg. II-7).

1 3.5 A separate alarm horn is needed for each section of the control board. (4.3.6) (2.3.3.1-2)

CE Response: Closed (Pg. B-3).

1 3.6 A manually initiated annunciator audio block is available for the Feedwater, Condensate and Turbine Control panels. Two red alternating, flashing lights indicate when the block is in use. The annunciator silence buttons silence only a single audible alarm, whereas the guidelines state that is should be possible to silence an auditory alert signal from any set of annunciator

response controls in the primary operating area. (2.3.3.2-4)

CE Response: Any of the annunciator response controls in the primary operating area will silence all of the horns in that area. In addition, the red alternating flashing lights have been eliminated from the control boards.

In addition, the manually initiated timed annunciator audio block is available for the Condensate and Turbine Control Panels. A red steady-on light indicates when the block is in use. This block is permitted only after a turbine trip and is only in effect for the duration of the timed interval.

Implementation: Prior to fuel load.

3 3.7 The annunciator flash rate is about 2 flashes/second instead of the recommended 3 to 5 flashes/second.

CE Response: Closed (Pg. B-7).

3 3.8 Annunciator panels on 1PM01J, 1PM02J and 1PM03J have more than 50 tiles, the recommended maximum number of tiles per panel.

CE Response: Closed (Pg. C-3).

3[1] 3.9 Some annunciator tiles are not permanently engraved. Some annunciator tiles are labeled with temporary labels.

CE Response: Temporary labels are used only during the interim while permanent labels are being manufactured. All annunciator tiles will be appropriately engraved and temporary labels will be replaced with permanent labels. When it is necessary to use temporary labels, their use will be governed by the established plant administrative procedures.

Implementation: Prior to fuel load.

4.0 CONTROLS

PRIORITY RATING	FINDING	
3[1]	4.1	Two controls have deficiencies which make adjustment to the required level of accuracy cumbersome. For third-level accuracy adjustment of the Hagan M/A Station switches, the operator must lean over the board to read the meter scale. In addition, a right-handed operator will cover the linear scale of this control with his hand while operating the dial and pushbuttons that are located to the left of the scale. On the Hagan Control Station switches, the scale markings are difficult to read. Accumulation of dust and dirt in the scale window aggravates the problem. (4.4.1)
		CE Response: Closed (Pg. A-2).
2	4.2	The J-Handle switches close to the edge of the benchboard section of 1PM02J, the Heater Drain and Turbine Control areas, and all switches on the common vertical panels (OPM01J, OPM02J and OPM03J) can be activated accidentally. (4.4.2) (2.2.1-2)
		CE Response: Closed (Pg. II-9).

3^1 4.3 Operation of the star handle discrete rotary switches involves covering the discrete position labels with the operator's hand. This could result in an erroneous setting. (4.4.3)

CE Response: Closed (Pg. II-12).

3 4.4 The fractional rotation knobs on the In-Core Vertical Instrumentation panel do not conform to the plant shape code convention. (4.4.7) (4.4.12)

CE Response: Closed (Pg. II-12).

3 4.5 There are no guards or barriers between the contiguous EGC (ADC) panel pushbuttons. The likelihood of accidental/inadvertent actuation of the wrong pushbutton is thus increased. (4.4.9)

CE Response: Closed (Pg. A-3).

3^1 4.6 On Unit Two, the SAFETY INJECTION PUMPS DISCHARGE ISOLATION VALVE control is a keylock switch control. The keylock switch control was mounted upside down so that the open/close positions are at 4 o'clock and 8 o'clock. Two other keylock switch controls have the open/close positions at 10 o'clock and 2 o'clock. (This switch is properly installed on Unit One.) (4.4.10)

CE Response: Closed (Pg. A-3).

3^1 4.7 The three keylock switch controls on both Units One and Two can be operated by the same key. In addition, the key can be inserted and removed

regardless of the switch position. This could result in valves being accidentally left open or closed. (4.4.11) (2.2.2-2)

CE Response: Closed (Pg. A-3).

3[1] 4.8 There is no pointer on the NIS pen rotary selector switch. (4.413) (2.2.2-1)

CE Response: Closed (Pg. A-4).

3 4.9 The BORIC ACID/PRIMARY WATER batch make-up thumbwheels on 1PM05J are much smaller than recommended; this condition could cause operating difficulty. (4.4.14)

CE Response: Closed (Pg. C-4).

3 4.10 The IN-CORE THERMOCOUPLE toggle switches do not snap into position and are not labeled to indicate either the direction of movement or of activation. (4.4.15)

CE Response: Closed (Pg. A-4).

3[1] 4.11 The T_{ave} and DELTA T defeat switches do not have to be pulled to actuate, as do the corresponding switches at the Zion Station. (4.4.18) 2.3.3.22)

CE Response: Closed (Pg. II-13).

3[1] 4.12 On 1PM06J, the same type of control handles are used for valves with different functions. An

operator cannot differentiate among throttle open/close, and throttle open-seal close valves. (4.4.19) (2.3.3.1-9)

CE Response: Closed (Pg. II-13).

1 4.13 The REACTOR TRIP and REACTOR RESET functions are on the same switch. (2.3.3.2-1)

CE Response: The REACTOR TRIP and REACTOR RESET functions will be separated. Each will have a separate control switch.

Implementation: Prior to fuel load.

2 4.14 The J-handle control switches on the Remote Shutdown Panel can be inadvertently activated.

CE Response: A guardrail of 5/8" round steel bar will be placed 24" above the floor and 6" from the board.

Placement of a guardrail elsewhere on the panel would obscure the view of critical controls. The guardrail will act as a physical as well as perceptual deterrent.

Implementation: Prior to fuel load.

2 4.15 The PLANT EVACUATION ALARM and plant-wide FIRE ALARM pushbuttons on the Remote Shutdown panel can be accidentally activated.

CE Response: Closed (Pg. B-8).

3[1] 4.16 The Remote Shutdown panel J-handle switches do not have the pointer arrows filled in with contrasting pigment for easy visibility.

CE Response: Closed (Pg. B-8).

2 4.17 Several controls on the RAMTEC CRT are not useful to the operator and might interfere with the display if activated.

CE Response: The RAMTEC CRT has been replaced with an Aydin display. Nonetheless, a similar problem was identified and resolved by placing a guard over the controls.

Implementation: Prior to fuel load.

2 4.18 The alarm printer console control box has many keys and controls which the operator is not permitted to use. When locked "off" the printer keyboard is not available to the control room operator.

CE Response: This HED does not refer to the alarm printer console - but the English language unit (ELU). The operator is able to ZERO test, print off-normal summary, change paper, and make needed keyboard entries when the keyboard is locked. These are the only computer functions necessary for use by operators. They do not have access to the "on" mode which controls keyboard functions such as reprogramming.

Implementation: None required.

3 4.19 On 1PM08J the thermocouple toggle switch bank is subject to breakage because the switch handles extend into the traffic area.

CE Reponse: Closed (Pg. B-9).

2 4.20 The switch guards for the C-W MAKEUP EMERGENCY TRIP controls on OPM01J obscure the pushbuttons and their color coding when flipped open.

CE Response: Closed (Pg. B-9).

1 4.21 On OPM05J, the PLANT EVACUATION ALARM pushbutton guard has an ear for a padlock. If the ear was bent over, the guard could not be raised to operate the pushbutton.

CE Response: Closed (Pg. B-9).

3[1] 4.22 On the reactor end of 1PM05J, Reactor Chemical and Volume Control Panel, and on 1PM06J, Engineered Safeguards panel, one switch in each string maintains trip contact position while all the rest are spring return.

CE Response: The Main Steam Isolation Valves do not have seal-in capability. Therefore, they are not spring return.

Implementation: None required.

3 4.23 On 1PM12J, Miscellaneous Instrumentation panel, three modules (POWER SUPPLY, ALARM AND TRIP RELAY, and VIBR PHASE ANGLE) have slotted nonlocking

selector controls which are flush with the panel. The slot serves both to turn the control and to indicate its selected position. It is not clear which end of the slot indicates the position selected.

CE Response: Closed (Pg. B-10).

3[1] 4.24 On 1PM02J, Turbine panel, the legends on the REHEAT TURBINE controller pushbuttons do not relate to the system controlled:

- o GROUP 1 out of service corresponds to "Governor End"
- o GROUP 2 out of service corresponds to "Generator End"

CE Response: Closed (Pg. B-10).

1 4.25 On 1PM11J, Containment Isolation back panel, two rotary selector switches lack control position indications.

CE Response: Closed (Pg. B-11).

3[1] 4.26 On 1PM08J, In-Core Instrumentation panel, the DETECTOR E knob pointer mark does not extend to the position indication mark because of the knob's black skirt.

CE Response: Closed (Pg. II-14).

3^1 4.27 On 1PM05J, the LAMP TEST control knob pointer mark does not extend to the position indication mark on the panel because of the high raised knob. This situation also causes parallax.

CE Response: The LAMP TEST control knobs are located on 1PM05J. The controls are not safety related and non time critical. In addition, the potential for parallax causing an operator interpretation difficulty is remote and consequences are negligible. As a result, no further action is planned.

Implementation: None required.

3 4.28 On 1PM08J, In-Core Instrumentation panel, it is difficult to read the switch position on the 261 PICO AMP SOURCE controls because the knob obscures the switch position window.

CE Response: Closed (Pg. C-4).

3^1 4.29 On 0PM01J, two of the CW MAKE-UP PUMP EMERGENCY TRIP switches have red back plates while the third switch does not.

CE Response: Closed (Pg. B-11).

5.0 DISPLAYS

PRIORITY RATING	FINDING	
1	5.1	The 100% readings on some of the M/A Station Switches indicate that valves are 100% open; on others it indicates that the valves are 100% closed. This could cause incorrect valve operation. (4.4.5) (2.2.1-1) (2.3.3.1-8) CE Response: Closed (Pg. A-5).
3[1]	5.2	The ROD SPEED linear scale indicator increases down rather than up. This is inconsistent with other indicators and could lead to confusion. (4.4.6) CE Response: Closed (Pg. A-5).
1	5.3	All legend pushbuttons and indicator light lenses are removable from the front of the panel for bulb replacement, but they are also interchangeable within a particular panel or display. It is therefore possible that inadvertent changes can be

made in the locations of the pushbutton/indicator light lenses when more than one bulb is replaced. (4.4.8) (2.2.3-1)

CE Response: Closed (Pg. II-15).

3[1] 5.4 A 0-800 psi RCS pressure gauge by the LETDOWN/CHARGING system is needed for low pressure operations on RHR. (4.4.16) (2.2.3-5)

CE Response: Closed (Pg. A-6).

3 5.5 Inconsistent type styles are evident on the displays throughout the control room. (4.5.3) (4.5.6)

CE Response: Closed (Pg. A-6).

3 5.6 The meaning assigned to particular colors should be consistent across all applications within the control room, whether applied to panel surfaces, projected in red, green and amber colored lights, or on CRTs. Colors should be reserved for specific uses. Green board, RAD monitors, permissives and system status are not in compliance. (4.5.4)

CE Response: To be deferred until the conduct of a DCRDR.

3 5.7 Vertical meter pointer tips do not extend to within 1/16" of the smallest graduation marks on the scale. (4.5.5)

CE Response: Closed (Pg. C-5).

3^1 5.8 The LUBE OIL RESERVOIR linear scale display has no label indicating what is being read (i.e., inches, lbs., percent, etc.). The scale range is 0 to 120. (4.5.6) (2.2.3-4)

CE Response: Closed (Pg. B-12).

2 5.9 The recorders are not all designed to permit monitoring of data without open door operation.

CE Response: Examination of the recorders indicated that the labeling on the recorder windows was obscuring the display. These labels will be removed, and/or redesigned, allowing the operator access to all information displayed on these recorders.

Implementation: Prior to fuel load.

3 5.10 The PRIMARY WATER CONTROL PRE-COUNT digital groupings are longer than four digits, but they are not separated by commas, decimal points, or additional spaces, as recommended. (4.5.8)

CE Response: Closed (Pg. A-6).

3^1 5.11 The bus meters have too large a scale for accuracy of required readings. (4.5.9) (2.2.3-3)

CE Response: Closed (Pg. A-7).

2 5.12 The CENTRIFUGAL CHARGING PUMP mini-flow valves are required to be closed when reactor pressure falls below 2000 psig following a safety injection.

With no mini-flow available, there is a possibility of overheating the pumps if system pressure increases. During this activity, the operator is required to remember to monitor the REACTOR COOLANT SYSTEM pressure to assure that it does not exceed a set point. (4.5.10) (2.3.2-2)

CE Response: Closed (Pg. II-15).

3[1] 5.13 Zion Station operating experience showed that a semigloss fluorescent orange pointer on the vertical meters appeared to improve pointer recognition when presented on a white or green band background. (4.5.11) (2.3.3.1-1)

CE Response: Closed (Pg. II-16).

2 5.14 Zion Station operating experience indicated that the use of a green normal operating band would alert operators to abnormal conditions when the pointer was not in the appropriate range. (4.5.12) (2.3.3.1-4) (2.3.3.1-6)

CE Response: Closed (Pg. A-7).

2 5.15 Adequate tools for indicator bulb replacement are not present in the control room.

CE Response: Closed (Pg. B-12).

2 5.16 On the Remote Shutdown panel, normal operating limits are not marked on the meters.

CE Response: Closed (Pg. B-12).

3 5.17 The Westinghouse J-handle switches have incorporated indicator flags that originally indicated the status of the control. These flags have been made obsolete by the installation of a new system of NORMAL/ABNORMAL indicator lights. The colored flags are still visible and may present confusing information to the operator.

CE Response: Closed (Pg. B-13).

2 5.18 Illuminated legend pushbuttons are not readily distinguishable from illuminated legend indicators.

CE Response: Illuminated pushbuttons will be fitted with a 1/16" black colored dot. The dot will be engraved in the lower left corner of each pushbutton.

Implementation: Prior to fuel load.

3 5.19 The COMPONENT COOLING ammeter on OPM02J and several meters on the Remote Shutdown panel lack a number at the top-most end of the display scale. In addition, the ammeter scale has an unconventional end-point.

CE Response: Closed (Pg. C-5).

1 5.20 All top-level curved face meters on the Remote Shutdown panel are very high and have vertical labeling which is obscured by the meter curvature.

CE Response: The top-level curved face meters on the Remote Shutdown panel have been lowered. Also, the labeling on the panel will incorporate hierarchical labeling and meet acceptable Human Engineering practices.

Implementation: Prior to fuel load.

3^1 5.21 On 1PM04J, Steam Generator and Feedwater panel, the legend indicator type is too small to read easily.

CE Response: To be deferred until the conduct of a DCRDR.

3^1 5.22 Several meters have inconsistent unit labels.

- On 1PM06J, some labels read only "%" with "xxx" on an external label; others read "%xxx" on the meter face.

- On 1PM02J, the GENERATOR H_2 TEMP reads ^{o}C. All others read ^{o}F.

- On 1PM04J, different unit designations are used for identical units on the FEEDWATER FLOW meters:

  FW FLOW - PPH x 10^6

  FW PUMP DISFLOW - KLB/HR x 10^3

CE Response: The meter labels although discrepant from Human Engineering guidelines should not adversely affect operator performance. Nonetheless, they will be reviewed when the task analytical data is available during the conduct of the DCRDR.

. Implementation: Deferred to the conduct of a DCRDR.

1 5.23 The CONTAINMENT PRESSURE recorder scale on 1PM06J shows no units.

CE Response: Closed (Pg. B-13).

3[1] 5.24 Many abbreviations found on control room meters and annunciators are not in the standard abbreviation list. Many others are not consistent with the list.

CE Response: Closed (Pg. II-17).

1 5.25 The A, B, C, D STEAM GENERATOR LEVEL meter faces on 1PM04J have incorrect % signs and Roman numeral labeling within groups of 4 meters; i.e., I, II, III, II should be I, II, III, IV.

CE Response: Closed (Pg. II-17).

3[1] 5.26 The CNDS STORAGE TK LEVEL indicator meter on 1PM01J has a temporary meter scale.

CE Response: The temporary meter scale on the Condensate Storage Tank Level indicator will be removed and a permanent meter scale installed.

Implementation: Prior to fuel load.

3[1] 5.27 On the Remote Shutdown panel the SRI COUNT RATE meter has a log scale with very small intermediate graduation numerals.

CE Response: The SRI COUNT RATE meter on the Remote Shutdown Panel was evaluated in detail. The meter's function is to denote changes in criticality during shutdown. To realize that function, the operator needs to detect only the approximate magnitude of flux and its direction of movement.

Implementation: None required.

2 5.28 The green RODS IN and red RODS OUT indicator lights on 1PM05J are inconsistent with the plant color coding convention.

CE Response: Closed (Pg. B-14).

3[1] 5.29 The Gaitronics paging system has a red MERGE pushbutton and a green ISOLATE pushbutton; this is an inappropriate use of these colors.

CE Response: Closed (Pg. B-14).

3 5.30 On the Remote Shutdown panel the pointers on the Hagan Manual/Auto stations cover the numerals of the display.

CE Response: Closed (Pg. C-5).

3 5.31 On 1PM05J, there is severe parallax when reading the green pointer of the two pen recorders because it is behind the recorder scale.

CE Response: Closed (Pg. C-6).

2 5.32 The indicator light color coding convention used for the group of EXHAUST FANS controls on 1PM02J and the group of BOOSTER PUMPS controls on 1PM03J is green = off, blue = run, and amber = tripped. The normal condition for these lights is three blue (run) and the one green (off, but in standby). This violates the control room color coding convention of green = normal.

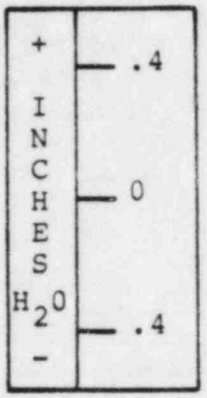
CE Response: Currently the BAP-399-4 (Green Board Concept-Control Panels) defines blue as a color used to indicate that the rotating equipment is running. When an operator sees the blue indicator, he realizes that the equipment has a standby or backup component. The blue lights up, however, only under normal conditions (when motor is running). Green is used when the motor is stopped.

This color scheme will be switched to insure consistency with the green = normal convention. Blue will indicate stop, and green will indicate run. These color conventions will be documented with the other control room conventions to be included in Byron Standard Operating Procedures.

Implementation: Prior to fuel load.

2 5.33 On OPM02J, DIFFERENTIAL PRESSURE meters are not consistent in the use of (-) and (+) values. The (-) and (+) symbols should be on the meter face.

CE Response: All three Differential Pressure meters on OPM02J are being changed as illustrated:



The use of (-) and (+) symbols will be consistent on all meters.

Implementation: Prior to fuel load.

2 5.34 There are incorrect bulbs of different brightness in some indicator lights. GE1819 should be for annunciators, GE1835 should be for indicators. When a GE1819 bulb is installed in an indicator, the indicator legend is too dim.

CE Response: Closed (Pg. B-14).

3[1] 5.35 There is an unknown and unlabeled indicator light on 1PM01J.

CE Response: Closed (Pg. B-15).

2 5.36 Multiple red/green indicator lights have no integral labeling to describe their function on 1PM04J (DRAIN VALVES) AND 1PM06J (SVAG VALVES).

CE Response: Multiple red/green indicator lights will be provided with labeling on their respective component retainer plates. The labeling will identify the function of each indicator light.

Implementation: Prior to fuel load.

2 5.37 On 1PM04J there is inconsistent use of color for indicator lights and some lights are not labeled.

CE Response: All indicator lights are presently consistent in the use of color. Also, all of the lights will be labeled appropriately.

Implementation: Prior to fuel load.

1 5.38 On 1PM04J, there are many cases of incorrect indicator legend caps, i.e., FW PUMP DISCHARGE valve open/close indicators are mounted opposite the proper indications, and the red lights for the FW PUMP 2C OIL PUMPS should be blue.

CE Response: Closed (Pg. B-15).

3[1] 5.39 There is an inconsistent use of 2 different styles of red and green switch indicator lights on 1PM06J.

CE Response: All red and green switch indicator lights on 1PM06J are presently consistent in terms of style.

Implementation: None required.

1 5.40 There is inconsistent color coding of indicator lights for the REACTOR CONTAINMENT FAN switches on 1PM06J. They are green-amber-green instead of green-amber-blue. This may be a problem on other panels.

CE Reponse: Closed (Pg. II-18).

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
1	6.1	The labeling on some of the 3-way valves is unclear. (4.4.17) (2.2.2-3) (2.3.3.1-7) CE Response: Closed (Pg. A-8).
1	6.2	Many controls, displays and other equipment items are unlabeled. (4.6.1) CE Response: Closed (Pg. A-8).
3[1]	6.3	Hierarchical and functional group labeling are not presently available on the control boards or on the Remote Shutdown panel to assist the operator and to simplify the component labeling. (4.5.2) (2.3.3.1-5) CE Response: Closed (Pg. A-8).

2 6.4 The Hagan controls have labeling that is inconsistent with the other labeling in the control room. The Hagan Manual/Auto stations have redundant labeling. (4.6.3)

CE Response: Closed (Pg. II-19).

1 6.5 On 1PM02J, display labels are generally placed below displays rather than above, as is recommended. (4.6.3)

CE Response: Although placement of all labels above instrumentation is recommended, space limitations prohibited this convention for consistent implementation. Label placement conventions for the main control room are now consistent. The location of labels is above controls and below displays.

Implementation: Prior to fuel load.

1 6.6 The maintenance tags obscure adjacent labels, displays and indicator lights. (4.6.4) (2.1.4-1)

CE Response: Maintenance tags have been examined in great detail. New maintenance tags which are designed not to obscure any adjacent labels, displays and indicator

lights were implemented on a trial basis at the Byron generating station. As a result, those modified maintenance tags will be implemented at the Byron Generating Station.

Implementation: Prior to fuel load.

3^1 6.7 Some of the labels and location aids in the control room can be easily removed. Also, demarcation lines are not permanently attached. (4.6.5) (4.5.7)

CE Response: Closed (Pg. A-9)

3^1 6.8 Some control board labels use inconsistent abbreviations. (4.6.6)

CE Response: Closed (Pg. A-9).

3^1 6.9 Some control board labels use inconsistent color coding schemes. ..1.4-2)

CE Response: A standardized color-coding scheme will be used for all labels on the control boards. Modification to existing labels will be implemented to adhere to this standardized convention.

Implementation: Prior to fuel load.

3[1] 6.10 The Zion operators specifically mentioned the need for mimics on the Chemical and Volume Control System, Boric Acid and Engineered Safeguards panels. (2.3.1-A, 2.3.3.1-3)

CE Response: Closed (Pg. B-16).

3[1] 6.11 There is a lack of background shading to enhance the operator's ability to differentiate among functional groupings of instruments and controls. (2.3.1-B)

CE Response: Closed (Pg. B-16).

3[1] 6.12 The circular meter displays used throughout the control room have curved descriptive labels on their faces.

CE Response: Closed (Pg. C-7).

3[1] 6.13 There are no panel number identification labels.

CE Response: Closed (Pg. II-20).

3[1] 6.14 A label on OPM02J has a misspelled word; VAVLE is used instead of VALVE. Another label on OPM02J incorrectly reads CLAND instead of GLAND.

CE Response: Closed (Pg. B-17).

3[1] 6.15 Several three-position J-handle controls in the control room have only two of the positions used. Mechanical stops have been provided to prevent moving the controls to the unused position, but the position indicator marks are still engraved and filled with dark pigment.

CE Response: Closed (Pg. C-7).

1 6.16 The AUXILIARY BUILDING FILTER PLENUM B control on OPM02J is missing the position labeling.

CE Response: Closed (Pg. B-17).

1 6.17 In the PHASE B CONTAINMENT ISOLATION on 1PM06J, manual actuation requires that two controls be activated simultaneously. There is no indication of this requirement on the controls.

CE Response: On 1PM06J, the Phase B Containment Isolation "Engineered Safeguards Actuation" controls require concurrent actuation. This will be identified on the component labels.

Implementation: Prior to fuel load.

3^1 6.18 There are several cases of labels being obscured by equipment in the control room, i.e., the label for the GENERATOR H_2 COOLING WATER VALVE indicator lights is obscured by the recorder located above them, and some labels at the top of 1PM07J are obscured by their associated controls.

CE Response: Closed (Pg. B-17).

3^1 6.19 The approximately 12x2 bank of CONDENSATE CONTROL controls on the vertical section of 1PM03J are not demarcated. This makes differentiation among the controls difficult.

CE Response: Closed (Pg. C-7).

3^1 6.20 The proposed demarcation lines on 1PM04J do not clearly associate the status light arrays on this panel with their functionally-related controls and displays.

CE Response: Closed (Pg. B-18).

3^1 6.21 The labels describing pen assignments on the ROD INSERTION LIMITS recorder and the CW COOLING TOWER TEMPERATURE recorder are placed on the glass face of the recorder where they obscure the chart paper.

CE Response: Closed (Pg. B-19).

3[1] 6.22 The recorder that displays the parameters selected by the process computer is not clearly labeled as to its function. The label for this recorder reads only COMPUTER.

CE Response: The two recorders on 1PM05J that display the parameter selected by the process computer will be labeled "Computer Pens" on a system level hierarchical label, placed above the chart legends. A second label has been designed to provide a writing space where the parameter displayed and range can be shown for each pen. This label will be centered on the lower horizontal frame of the recorder. Parameter and range information is temporary. The information changes by computer designation. Operators designate parameter and range information due to operational need. This information is transmitted to succeeding shifts by means of shift turnover sheets.

Implementation: Prior to fuel load.

2 6.23 On 0PM05J, Center Desk, engraved labels for TROUBLE, FIRE and WIRE-TROUBLE are not specific enough to provide the necessary information. The same labels are used on 280 different legend light indicators.

CE Response: The legend labels will be removed from the pushbutton indicators,

moved to the left of the modules, and placed on the control panels (1PM09J and 2PM09J). The label legend for "WIRE TROUBLE" should be changed to make the label message clearer. In addition, the label legend "FIRE" will be changed in the suppression system indicators to more clearly reflect the action in progress when the indicator illuminates. The revised label legends are shown below.

	F I R E
Detection	F I R E W I R E O P E N
System	T R O U B L E
	T R O U B L E W I R E O P E N

	A C T D
Suppression	A C T D W I R E O P E N
System	T R O U B L E
	T R O U B L E W I R E O P E N

Implementation: Prior to fuel load.

1 6.24 Many component labels do not indicate what is being displayed. For example, the labels for the WIDE RANGE RTD displays on the Remote Shutdown panel do not indicate that hot and cold leg temperatures are being displayed. Also, the labels for the meters on 1PM02J, which display the inlet pressure from the moisture separator reheater to the three low pressure turbines, do not clearly identify what is being measured by the meters.

CE Response: Labels associated with displays have been reviewed for proper and necessary indication of function and measurement units. "WIDE RANGE RTD" displays on the Remote Shutdown panel and 1PM02J panel inlet pressure/moisture separator/low pressure turbine labeling will be modified to identify the measurement parameter.

1 6.25 The nomenclature on the Remote Shutdown panel transfer control switches is unclear. The two position choices are "REMOTE" and "LOCAL". Although the panel is a "remote" panel, REMOTE means that the control is located at the control room. LOCAL indicates that the controls are located in the Remote Shutdown panel.

CE Response: Closed (Pg. B-19).

2 6.26 Grouped meters with different functions are not differentiated adequately by their component labels. For example, all six labels for the meters that display the inlet pressure from the moisture separator reheater to the three low pressure turbines are very similar, making differentiation between them difficult.

CE Response: All grouped meters with different functions have been reviewed and modified to ensure proper differentiation per NUREG-0700, Section 6.6.3.6. Proper label coding or label word selection is used to enhance differentiation.

Implementation: Prior to fuel load.

3[1] 6.27 The test positions on the SGFPT 2 C LUBE OIL RESERVOIR TEST control on 1PM04J are OLL for "oil level low" and OLH for "oil level high". Since these abbreviations are very similar, it is hard to differentiate between the two different meanings.

CE Response: Closed (Pg. B-20).

2 6.28 The labeling, lettering and terms used on the Westinghouse-provided panel inserts are not consistent with the other control room labeling.

CE Response: Closed (Pg. B-21).

3[1] 6.29 There are cases of adjacent controls of the same kind that have position labels with different size and style typeface.

CE Response: Closed (Pg. B-21).

3[1] 6.30 The standard black-on-white labels used in the control room come in several different "shades" of white and off-white. The engraving styles and depths are also not consistent for all the labels.

CE Response: Closed (Pg. B-21).

3[1] 6.31 Some of the color combinations used do not provide adequate contrast. For example, the labeling on the 1530/ST101 SCALER TIMER PANEL insert on 1PM07J is beige-on-beige and is very difficult to read. The black-on-orange labels used for training differentiation are also of poor contrast.

CE Response: The control room labeling has been reviewed and modified to follow standard black lettering on white background. However, labeling on the 1530/ST101 SCALER TIMER panel insert (on 1PM07J) is a vendor panel and will be filled in with black pigment to enhance the contrast. The train differentiation labels will be replaced by white labels with black print.

Implementation: Prior to fuel load.

3[1] 6.32 The annunciator response button legends and some of the control position label character heights are too small to be read by a 95th% height operator. The recommended character height (0.004 x viewing distance) is 0.15". The measured height was approximately 0.11". This finding applies to labels and legends on the lowest part of the sloping section of the benchboard.

CE Response: To be deferred until the conduct of a DCRDR.

3[1] 6.33 There are temporary caution notes on 1PM06J which should be rem ved or replaced prior to operation.

CE Response: The temporary caution notes have been removed. Operational limits on displays will be indicated by a line marker on the scale face. Temporary labeling will only be used when necessary to either 1) identify out-of-service equipment; 2) accommodate unique, one-time plant activities; or 3) improve operator understanding of out of service-caution card.

Implementation: Prior to fuel load.

1 6.34 The Remote Shutdown panel lacks any demarcation or other location aids to identify functionally-related groups of controls and displays.

CE Response: Closed (Pg. B-22).

3[1] 6.35 There is insufficient demarcation between the ACCUMULATOR, SAFETY INJECTION and RESIDUAL HEAT REMOVAL mimics. These mimics are intermingled on 1PM05J and 1PM06J.

CE Response: Closed (Pg. B-22).

3[1] 6.36 On 1PM03J, the indicator lights for the HEATER DRAIN TANK VALVE need demarcation and label changes.

CE Response: The Heater Drain Tank valve control and indicator lights have been enhanced by the use of background shading, hierarchical labeling and lines of demarcation. Specifically, a system level label identifies the "HEATER DRAIN TANK CONTROLS". This label spans the width of the indicator lights also identifying related controls on the benchboard section below. Background shading was applied to encompass the HD Pump Discharge valve control and the related two sets of two

indicator lights. Component labels, identifying each valve were located under each set of two lights. In addition, lines of demarcation were added.

Implementation: Prior to fuel load.

3^1 6.37 Sections of mimic lines are missing between two circuit breaker controls and some indicator lights in the AUXILIARY POWER mimic.

CE Response: Closed (Pg. B-23).

3^1 6.38 The BTRS DEMINERALIZER mimic and the REACTOR COOLANT PUMP SEALS mimic are designed around controls that are in one large array. It is difficult to see where one mimic ends and another mimic begins.

CE Response: Closed (Pg. B-23).

3^1 6.39 The CVCS LETDOWN mimic does not have a label identifying the flow origination point.

CE Response: Closed (Pg. B-23).

3^1 6.40 None of the mimics have arrows to indicate the direction of each flow path.

CE Response: Closed (Pg. B-24).

3	6.41	On the 345KV mimic on 1PM01J, the symbol for the DISCONNECT GROUNDING switch does not depict the switch functions as clearly as the corresponding symbol does for the same switch used in the mimic on OPM03J.

CE Response: Closed (Pg. B-24).

7.0 PROCESS COMPUTERS

PRIORITY RATING	FINDING	
3	7.1	The CRT terminal and the Sequence-of-Events printer have keyboards which are arranged differently. CE Response: Closed (Pg. C-9).
3^1	7.2	On 1CX05J, unnecessary Computer Operator console functions are now available to the control room staff. Unnecessary keys are also available to the control room operators. CE Response: To be deferred until the conduct of a DCRDR. (Pg. II-21)
2	7.3	Recovery procedures for process computer failures are not available to the operator. CE Response: Closed (Pg. B-25).
3^1	7.4	On 1CX05J, data point addresses are not cross-indexed by program name, system/subsystem and functional group. CE Response: Closed (Pg. II-21).

3[1] 7.5 Individual data groups or messages do not have descriptive titles which reflect the unique characteristics of the content of the data groups or messages.

CE Response: Closed (Pg. B-25).

3 7.6 There is no hard-copy facility available to print out displays which appear on the RAMTEC CRT.

CE Response: Closed (Pg. C-9).

2 7.7 The 1CX05J Terminet 1200 printer prints only 120 characters/second. The recommended speed is 300 lines/minute.

CE Response: An extensive review of the Byron control room computer system was performed. The present Terminet printers have the capacity to output information to a printer at approximately 60 LPM. Operating experience at Zion station, which has an identical computer system and printer capacity, indicated that during a reactor trip situation an alarm backlog of no more than ten minutes occurs. In addition, the computer has buffer capacity in excess of 45 minutes. Therefore, information will not be lost even in a "worst case scenario". Furthermore, a 300 LPM printer is located immediately adjacent to the control room in each units computer room. The Terminet operator printer has a "fail over" capacity so that the operator

can channel output to the high speed printer. Doing so, however, negates the differentation available on the terminal between alarms, printed in red, and returned to normal, printed in black. Given that the terminal has advantages to the operator not available on a high speed printer and that a high speed printer is immediately available to the operator adjacent to the control room, no further action is anticipated.

Implementation: None required.

3^{1} 7.8 The Terminet printers do not have a paper take-up device for the printed record.

CE Response: Closed (Pg. B-26).

3 7.9 The Sequence-of-Events recorder does not identify the associated annunciator tile which has alarmed.

CE Response: Closed (Pg. II-22).

8.0 PANEL LAYOUT

PRIORITY RATING	FINDING	
2	8.1	On 1PM04J, the FEEDWATER PUMP TURBINE CONTROL pushbuttons are not arranged in a natural stereotypical or logical sequence, increasing the probability of inadvertent/accidental activation of the wrong control (i.e., valve OPEN button is to the left of the valve CLOSE button). (4.4.4) CE Response: Closed (Pg. B-27).
3	8.2	There is inadequate separation between groups of displays on 1PM01J, Power Generation panel. (4.8.1) CE Response: Background shading and mimics will be used to distinguish groups of controls and displays on 1PM01J. Implementation: Prior to fuel load.
3	8.3	Sets of controls and displays on 1PM01J, Power Generation panel, are not laid out

consistently. Layouts of some repeated functions are mirror imaged, i.e., WATER ISOLATION VALVES, mini-flow valves for RHR PUMPS 2A and 2B and ACTIVATED VALVES. (4.8.2)

CE Response: Closed (Pg. C-10).

1 8.4 To avoid leaving the Reactor panel unattended during startup, operators require another person to change the range and volume of the SOURCE RANGE nuclear instrument. (2.3.3.2-5)

CE Response: Closed (Pg. II-23).

3 8.5 On 1PM06J, Essential Service Water panel, the meters are aligned $P_A P_B - T_{1A}$ T_{2A} T_{2B}. Pressures and temperatures are not to be compared. Better grouping would be P_A T_{1A} T_{2A} - P_B T_{1B} T_{2B}.

CE Response: Closed (Pg. C-10).

3 8.6 On 0PM05J, Center Desk, DETECTOR and SUPPRESSION indicators are on separate panels. Better grouping might be if all indicators for a given zone were in one area.

CE Response: The fire protection annunciators (DETECTION and SUPPRESSION indicators) have been removed from the center desk (0PM05J) and placed on a back

panel in the control room. Zones of detection and suppression that correspond, will be grouped together.

3 8.7 On 1PM01J, Generator and Auxiliary Power panel, grouped meters have different functions but are not differentiated. (2.3.3.1-5)

CE Response: Closed (Pg. II-24).

3 8.8 On 1PM06J, the AUXILIARY FW CONT indicator lights for S/G 1, S/G 2, S/G 3 and S/G 4 valves are not functionally grouped.

CE Response: On 1PM06J, background shading which provides adequate contrast will be used to indicate the functional relationship of indicator lights for S/G 1, S/G 2, S/G 3, and S/G 4 valves for trains A and B.

Implementation: Prior to fuel load.

3[1] 8.9 Because of the almost total lack of demarcation, it is not obvious that 1PM03J is well laid out and grouped functionally. Demarcation is specifically needed to separate the Condensate section of 1PM03J from the Turbine section of 1PM02J. Currently, there is no board break or demarcation between the closely spaced equipment.

CE Response: Demarcation lines, background shading and hierarchical labeling are included as part of the total systematic enhancement package on 1PM03J and 1PM02J and are used to assist the separation of the Condensate section from the Turbine section.

Implementation: Prior to fuel load.

3[1] 8.10 On 1PM05J, demarcation has not been used to separate intermingled groups of equipment, i.e., the NIS instrumentation and CVCS controls and displays.

CE Response: On 1PM05J, a combination of hierarchical labeling and background shading has been provided to separate intermingled groups of equipment on that panel. The NIS instrumentation and the CVCS controls and displays have been enhanced to promote discriminability.

Implementation: Completed.

3[1] 8.11 On 1PM05J the REACTOR COOLANT DRAIN TANK PUMP controls are located about 4 feet away from other functionally-related controls.

CE Response: The REACTOR COOLANT DRAIN TANK PUMP controls and their associated controls were examined. Background shading is provided to assist the operator in determining associated controls during plant operations.

Implementation: Completed.

3[1] 8.12 On 1PM05J, the REACTOR COOLANT DRAIN PUMP controls appear to be grouped functionally with RANGE MANUAL BLOCK controls located directly above them. Both groups use the same model switch but there is no demarcation line.

CE Response: Background shading was added to help differentiate the two systems (See HED 8.11).

3[1] 8.13 The REACTOR COOLANT SEALS mimic and the BTRS mimic are both on 1PM05J, Reactor and Chemical and Volume Control panel. Several controls which are not in either mimic are associated with one of the mimics. A third mimic intrudes, also on the BTRS mimic. It is difficult to tell what is in one mimic, what is in the other mimic and what is not in either mimic.

CE Response: The use of mimics on the 1PM05J panel has been examined. Other enhancement techniques to include background shading and hierarchical labeling will be added to alleviate any confusion that may occur as a result of using mimics that cover many systems.

Implementation: Prior to fuel load.

3[1] 8.14 Functionally-grouped systems are not adequately distinguishable on 1PM01J.

CE Response: The use of color mimics, background shading and hierarchical labeling on 1PM01J will be provided to assist the operator with identifying functionally-grouped systems.

Implementation: Prior to fuel load.

3[1] 8.15 On 1PM03J, Condensate panel, associated controls and displays are presently separated by unassociated controls and displays.

CE Response: Closed (Pg. C-11).

3^1	8.16	On the Remote Shutdown panel, the STEAM GENERATOR CONTROLS and meters are separated by the auxiliary feedwater controls. CE Response: Controls and displays on the remote shutdown panel have been reconfigured. Background shading, mimics, lines of demarcation and hierarchical labeling enhance the operability of the panel. Implementation: Prior to fuel load.
1	8.17	The legend light groups on 1PM06J, Engineered Safeguards panel, are disoriented by 90°. CE Response: Closed (Pg. B-27).
3	8.18	On 0PM02J, HVAC panel, the UNIT 1 and UNIT 2 CONTAINMENT and VENTILATION controls and displays are laid out identically except for the pressure meters which are mirror imaged. CE Response: Closed (Pg. C-11).
2	8.19	There is an inconsistent layout on 1PM05J, Reactor and Chemical and Volume Control panel. The ROD BANK COUNTER groups have SHUTDOWN on the left and CONTROL on the right, whereas DIGITAL ROD POSITION indicator shows the reverse, i.e., SHUTDOWN on right, and CONTROL on left.

CE Response: The inconsistent layout on 1PM05J, Reactor and Chemical and Volume Control Panel has been resolved. The ROD BANK COUNTER groups will have SHUTDOWN on the right and CONTROL on the left.

Implementation: Completed.

3	8.20	The DIGITAL ELECTRO HYDRAULIC TURBINE CONTROL and numeric pad (telephone type) are different from the computer numeric panels (adding machine type).

CE Response: Closed (Pg. C-11).

3	8.21	On 1PM06J, the STEAM GENERATOR and AUXILIARY FEEDWATER PUMP controls are mirror imaged; the remainder of the panel is not.

CE Response: Closed (Pg. C-11).

3	8.22	The CONTAINMENT SPRAY system on 1PM06J is mirror imaged for no apparent reason.

CE Response: Closed (Pg. C-12).

1 8.23 On the Remote Shutdown panel, the train A and B displays and controls are mirror imaged over a total distance of 12 to 13 feet.

CE Response: Mirror imaging on the remote shutdown panel, particularly for train A and train B, has been eliminated.

Implementation: Completed.

9.0 CONTROL DISPLAY INTEGRATION

PRIORITY RATING	FINDING	
2	9.1	The RCP SEAL FLOW control is adjusted while monitoring HEADER PRESSURE indicators, 1PM05J. The display and controls are not located within reasonable proximity (4.5.1) (4.9.1). CE Response: Closed (Pg. A-10).
2	9.2	The SEAL INJECTION FLOW indicators are located on the left at the top of 1PM05J. The HCV 182 control is on the left front diagonal panel at the bottom of the vertical display panel on 1PM05J. When adjusting the control and simultaneously reading the SEAL INJECTION FLOW indicators, the operator places himself in an awkward position. This position can readily lead to a parallax problem. (4.9.1) (2.3.2-1) (4.5.1). CE Response: Closed (Pg. A-10).
3	9.3	Displays should read off-scale (not zero) when not selected, especially if zero is a

possible parameter to be displayed. The Power Distribution panel displays do not reflect this requirement. (4.9.2)

CE Response: The parameters (amps, volts and watts and vars) displayed on the power distribution panels are primary readings. A very small proportion of the parameters being measured is diverted to each of these displays to move the indicator.

Since this "diverted" energy is the only energy required to move the pointer to its indicated value, this information is presented to the operator reliably and independently of any other plant equipment. This can be important to human safety.

The zero indicated values are not critical values. The important considerations are:

a. Is the equipment energized?
b. Is the equipment overloaded?
c. Is it permissible to connect this energized equipment to other energized equipment?

Historically, these simple, direct measurements are more reliable, trouble free and maintain their accuracy longer than the "secondary" measurement required in the rest of the plant.

Implementation: None required.

2 9.4 On 1PM05J and 1PM06J, the controls and displays required to stop the REACTOR COOLANT PUMPS, in conjunction with the CENTRIFUGAL CHARGING or SAFETY INJECTION PUMPS and REACTOR COOLANT SYSTEM WIDE RANGE PRESSURE indicators (1300 psig), are not located conveniently close to one another. (4.9.3)

CE Response: Closed (Pg. A-11).

1 9.5 On 1PM05J, switching of bypass breakers during surveillance testing can cause operator errors. (2.3.3.2-7)

CE Response: Closed (Pg. B-29).

3 9.6 Functionally-related controls and displays on 1PM01J, Generator and Auxiliary Power panel, and on 1PM02J, Turbine panel, should be rearranged so that they are aligned vertically. Consideration should also be given to demarcation lines and/or color shading.

CE Response: Functionally-related controls and their respective meters on 1PM01J and 1PM02J have been aligned vertically and/or instruments and controls have been arranged as part of a simple functionally-laid out mimic. Demarcation lines and background shading have been added where appropriate. (See 8.2 and 8.7)

Implementation: Prior to fuel load.

3 9.7 The control-display relationship for CONTAINMENT SPRAY TRAIN A and B on 1PM06J is unnecessarily complex and unclear.

CE Response: The control display relationship has been reviewed. The components have been relocated to facilitate a simple and clear mimic presentation of this system in order to eliminate complexity.

Implementation: Prior to fuel load.

3 9.8 On 1PM01J, Electrical Distribution panel, the normal switch position is "Auto" but there is no such indicating light. If either MAN EMERGENCY is selected, the associated red indicator will light.

CE Response: Closed (Pg. C-13).

3 9.9 There are several cases where displays associated with mimics are separated from the mimics by unrelated controls, i.e., on 1PM01J, ACCUMULATOR, SAFETY INJECTION and RESIDUAL HEAT REMOVAL display meters.

CE Response: Closed (Pg. C-13).

3 9.10 On 1PM01J, Electrical Distribution panel, the EXCITER VOLTAGE REG TRANSF NULL meter resets on "0" both when unpowered and when MANUAL and AUTO are in "SYNCH". No provision is made for it to (a) be

off-scale when unpowered or (b) provide a procedure to exercise it before closing the PERMANENT MAGNET supply.

CE Response: Closed (Pg. B-29).

1 9.11 On 1PM04J, the STEAM GENERATOR ATMOSPHERIC RELIEF VALVE controls (4) and the FEEDWATER SHUTOFF VALVE controls (4) do not have OPEN/CLOSED, NORMAL/ABNORMAL indicator lights.

CE Response: Indicator lights designated the OPEN/CLOSED and NORMAL/ABNORMAL configuration of the four STEAM GENERATOR POWER OPERATOR RELIEF VALVES (PORV) controls and the four FEEDWATER SHUTOFF VALVE controls on 1PM04J have been installed.

Implementation: Completed.

2 9.12 On 1PM03J, there is a reversed control-display relationship:

	LEFT	RIGHT
Meters	GSC	CNDS-CB
Controls	CNDS Booster	GSC

CE Response: These systems are not safety related and not time critical. While a small chance for error exists, the

consequences would have no effect on plant safety. We therefore request a downgrade to priority 3 and a deferral to the conduct of a DCRDR.

SECTION II

HUMAN ENGINEERING DISCREPANCIES ORIGINALLY "CLOSED" DURING SER OR JULY 1982 (RESPONSE HAS BEEN MODIFIED)

1.0 CONTROL ROOM WORKSPACE

PRIORITY RATING	FINDING	
2	1.13	No plans have been made to provide protective clothing for control room operators, except for full hood/face masks with air lines. CE Response: As noted in Byron/Braidwood FSAR 9.4.1.3, the following information regarding environmental protection describes the adequacy of relying solely on the full hood/face mask to protect control room personnel: a. The control room HVAC system is designed to ensure control of space environment conditions within specified maximum and minimum limits which are conducive to personnel habitability and prolonged service life of Safety Category I components under all normal and abnormal station operating conditions.

Redundant equipment is provided where needed to ensure system function. Power for the redundant equipment is supplied from separate ESF buses which are energized during all normal and abnormal conditions. All of the HVAC equipment and surrounding structures are seismically designed except heating and humidification equipment which is only seismically supported. Although all control equipment in the control room is rated for continuous operation at 86°F maximum temperature, the control room ambient temperature is maintained at 75°F.

b. Flood protection for this system is not applicable.

c. A local fire in the control room should not cause the abandonment of the control room because early detection, filtration and purging capabilities are provided in addition to local fire fighting apparatus.

d. Air distribution in the control room is designed to supply air into the occupied area and exhaust approximately half the supply quantity through the main control boards. In the event of smoke or products of combustion in the control panels, the ionization detection system automatically directs the mixed air (return and makeup) delivered to the conditioned spaces through a normally bypassed charcoal absorber, for smoke and odor removal. A manual override

is provided for this function as well as the ability to introduce 100% outside air to purge the spaces served by the system.

e. Two radiation monitors are provided in each control room HVAC system makeup air intake to detect high radiation. These monitors alarm in the control room. The intake monitors are described in detail in Subsection 11.5.2 and the area monitors are described in Subsection 12.3.4. The high radiation actuation signal causes: 1) automatic closure of the normal outside makeup air source to the system; 2) the opening of the turbine building makeup air intake; 3) as well as startup of the makeup air filter train to clean up the makeup air.

f. The makeup filter trains and control room shielding are designed to limit the control room operator dose below levels of 5 rem as required by Criterion 19 of 10 CFR 50, Appendix A.

g. A minimum quantity of makeup air, to maintain the control room and other spaces serviced by the control room HVAC system at a positive pressure with respect to surroundings.

h. There are no high energy lines in close proximity to or within the control room envelope which will affect the habitability of the control room.

Implementation: None required.

2.0 COMMUNICATIONS

PRIORITY RATING	FINDING	
3[1]	2 3	The Press-to-talk and Channel Select switches on the paging system are located too low to be operated effectively. (4.2.3) (2.3.3.2-3) CE Response: Channel select switches are relocated to the slant section of the board above the handset. The press-to-talk will be located in the handset. Implcmentation: Prior to fuel load.

3.0 ANNUNCIATOR WARNING SYSTEM

PRIORITY RATING	FINDING	
2	3.1	First-out indications occur on separate but undedicated panels for: o Reactor Trip (24 tiles) o Turbine Trip (10 tiles) o Generator Trip (20 tiles) o Feedwater Pumps Trip (2 tiles) The first-out tiles are intermixed with other tiles. (4.3.1) (2.1.3-2) CE Response: The turbine and generator first-out alarms will be grouped and will have lines of demarcation to distinguish them from other alarms in their respective window boxes. The Generator trips are in columns 1-5 of Box 19 (21 tiles); Turbine trips are in columns 1-3 of Box 18 (12 tiles); Feedwater trips are in column 1 of Box 16 (5 tiles);

Reactor trips make up all of Box 11 (24 tiles).

Implementation: Prior to fuel load.

2 3.4 Some annunciator alarm tiles are not located above related controls and displays and do not reflect proper functional grouping or axis labeling. (4.3.4) (2.1.3-1)

Annunciator Tile	Comment
2EO2	Should be duplicated on 1PM01J
2DO7	Should be on 1PM01J
2E07	Should be on 1PM01J
3AO5	Should be on 1PM01J
6A06	Boron injection tank is removed - tiles are unnecessary
6B06	
6C06	
6A07	
6B07	
6C07	
6D07	
6E07	
15A10	Controls are far from MSIV annunciators. Consider duplicating these tiles on 1PM06J
15B10	
15C10	
15D10	

15E07	
15E08	
17E01	Not located in a functional group on right of panel
17D11	Unnecessary
17E13	Not on common panel OPM01J
18E03	Not located together
18B16	
19A06	Not located in the first-out group.

CE Response: Tiles on annunciator panels UL-AN026, 003, 007, 008, 012, 014, and 015 have been reviewed and replaced to comply with readability standards NUREG-0700, 5.5.4.1). All annunciator alarms have been organized to reflect proper functional grouping (NUREG-0700, 6.1.2.2, 6.1.2.3, 6.3.3.3B), axis labeling (6.3.3.3C), and pattern recognition (6.3.3.3D). Annunciator labeling abbreviations have been reviewed and revised to conform to required standards for consistency (6.6.3.3).

Implementation: Prior to fuel load.

4.0 CONTROLS

PRIORITY RATING	FINDING	
2	4.2	The J-Handle switches close to the edge of the benchboard section of 1PM02J, the Heater Drain and Turbine Control areas, and all switches on the common vertical panels (OPM01J, OPM02J and OPM03J) can be activated accidentally. (4.4.2) (2.2.1-2)

CE Response: J-Handle switches located close to the edge of the benchboard which could be inadvertently actuated have been inventoried. They are located on the 1PM01J, 1PM02J, and 1PM03J panels. To prevent an inadvertent actuation, a 5/8" round steel guardrail will be installed on these benchboards. These guardrails will be located 4" above the boards (Figure A) and will connect with the top of the benchboard at varying intervals (Figure B).

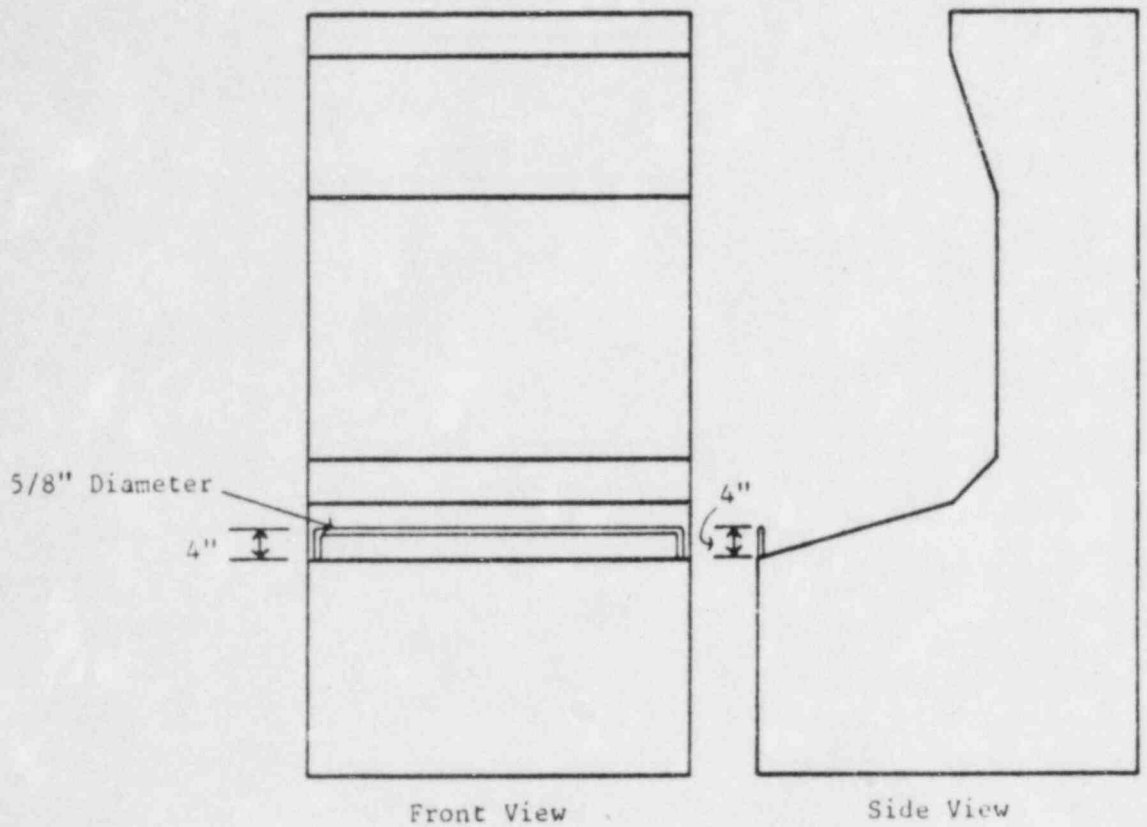


Figure A.

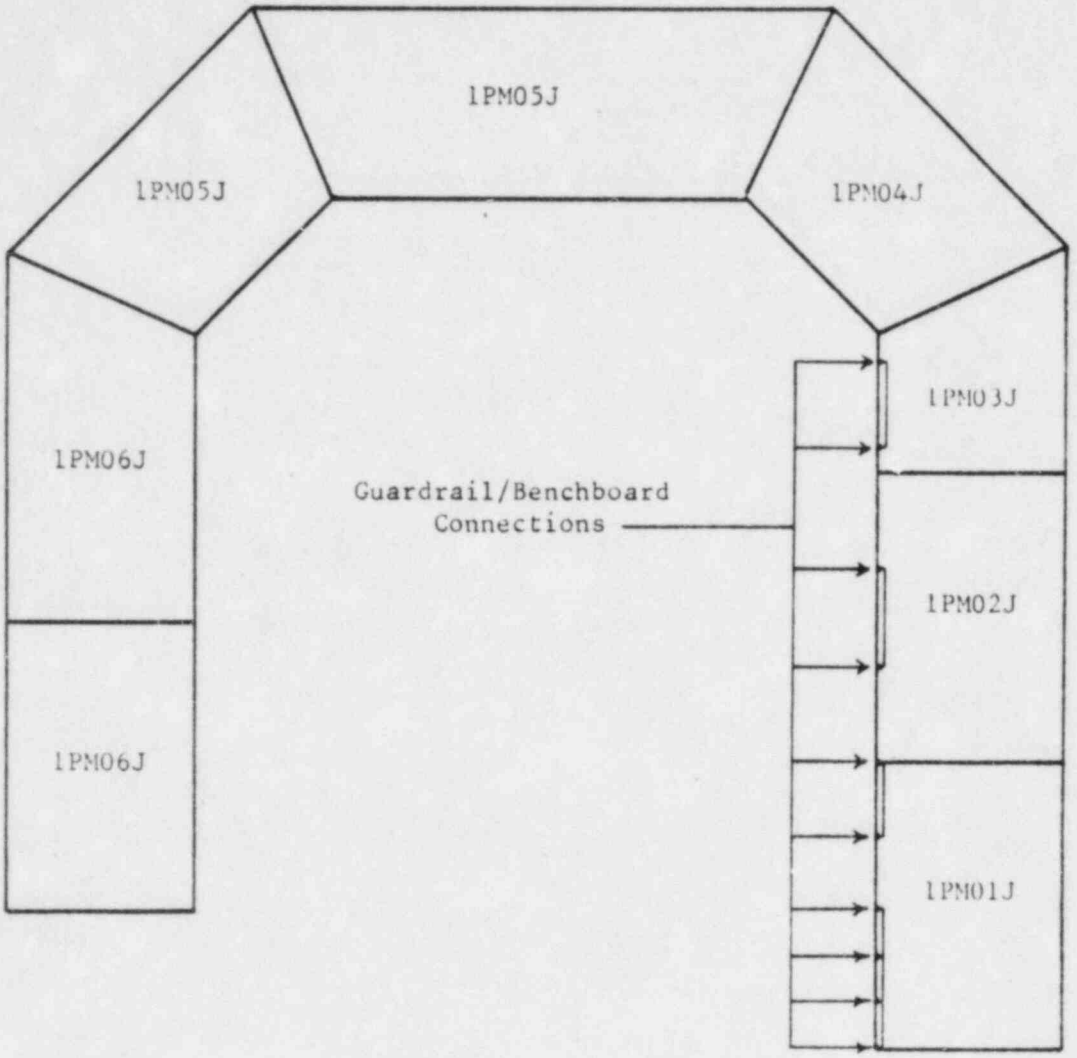

1PM05J
1PM05J
1PM04J
1PM03J
1PM06J
Guardrail/Benchboard
Connections
1PM02J
1PM06J
1PM01J

Figure B.

J-Handle switches on the vertical panels could also be inadvertently bumped by carts going through the passageway and people walking around the corners. A guardrail with the same specifications as above, will be placed 24" above the floor and 6" from the board across OPM01J, OPM02J, and OPM03J. Also, a guardrail will be placed vertically at the end of OPM03J to protect controls located near the side. This rail will be 23.4 inches long and located between 37.4 and 60.8 inches from the floor and 4 inches from the board.

Implementation: Prior to fuel load.

3[1] 4.3 Operation of the star handle discrete rotary switches involves covering the discrete position labels with the operator's hand. This could result in an erroneous setting. (4.4.3)

CE Response: Station will review and correct all star handle discrete rotary switches to minimize abscuration.

Implementation: Prior to fuel load.

3 4.4 The fractional rotation knobs on the in-core vertical instrumentation panel do not conform to the plant shape code convention. (4.4.7) (4.4.12)

CE Response: The controls are infrequently used, are not time-critical.

Implementation: Accept as-is.

3[1] 4.11 The T_{ave} and DELTA T defeat switches do not have to be pulled to actuate, as do the corresponding switches at the Zion Station.(4.4.18) (2.3.3.22)

CE Response: The T_{ave} and Delta T defeat switches will be supplied with an odd sized pistol grip unique only to these defeat switches to facilitate the operators' ability to differentiate the switches from others.

Implementation: Prior to fuel load.

3[1] 4.12 On 1PM06J, the same type of control handles are used for valves with different functions. An operator cannot differentiate among throttle, open/close and throttle open-seal close valves. (4.4.19) (2.3.3.1-9)

CE Response: Throttleable valves will be supplied with a non-lever type handle. All other valves will have lever type handles. There are no throttle open-seal close valves.

Implementation: Prior to fuel load.

3[1] 4.26 On 1PM08J, In-Core Instrumentation panel, the DETECTOR E knob pointer mark does not extend to the position indication mark because of the knob's black skirt.
CE Response: This equipment is only used infrequently and is non-time critical. Therefore, this issue will be deferred until the conduct of a DCRDR.

Implementation: To be deferred until the conduct of a DCRDR.

5.0 DISPLAYS

PRIORITY RATING	FINDING	
1	5.3	All legend pushbuttons and indicator light lenses are removable from the front of the panel for bulb replacement, but they are also interchangable within a particular panel or display. It is possible, that inadvertent changes can be made in the locations of the pushbutton/indicator light lenses when more than one bulb is replaced. (4.4.8) (2.2.3-1) CE Response: Removal of pushbutton and indicator light lenses are governed by a procedure developed by Byron operations, BAP 300-32. The procedure prohibits removal of more than one lens at a time and is in compliance with NUREG-0700 Section 6.5 guidelines. Implementation: Prior to fuel load.
2	5.12	The CENTRIFUGAL CHARGING PUMP mini-flow valves are required to be closed when reactor pressure falls below 2000 psig

following a safety injection. With no mini-flow available, there is a possibility of overheating the pumps if system pressure increases. During this activity, the operator is required to remember to monitor the REACTOR COOLANT SYSTEM pressure to assure that it does not exceed a set point. (4.5.10) (2.3.2-2)

CE Response: The centrifugal charging pump mini-flow valves will be altered to open and close automatically with RCS pressure in coincidence with safety injection.

Implementation: First refueling outage.

3[1] 5.13 Zion Station operating experience showed that a semigloss fluorescent orange pointer on the vertical meters appeared to improve pointer recognition when presented on a white or green band background (4.5.11) (2.3.3.1-1).

CE Response: An investigation was conducted by station Instrument Mechanics to determine the appropriate procedure for repainting the vertical meter pointers. The investigation revealed that repainting is impractical in that calibration is affected. In lieu of this finding and the fact that a black pointer on a white or light green background is satisfactory. No change is recommended.

CE Response: Accept as is.

3[1] 5.24 Many abbreviations found on control room meters and annunciators are not in the standard abbreviation list. Many others are not consistent with the list.

CE Response: A station-wide standard abbreviation list was updated as a result of the labeling program. These abbreviations were applied consistently in developing legends for all labels and annunciator tiles.

Implementation: Prior to fuel load.

1 5.25 The A, B, C, D STEAM GENERATOR LEVEL meter faces on 1PM04J have incorrect % signs and Roman numeral labeling within groups of 4 meters; i.e., should be I, II, III, IV.

CE Response: The proper % sign and Instrument Division Numbers will be used when all labeling corrections are completed on the control boards.

Implementation: Prior to fuel load.

1 5.40 There is inconsistent color coding of indicator lights for the REACTOR CONTAINMENT FAN switches on 1PM06J. They are green-amber-green instead of green-amber-blue. This may be a problem on other panels.

CE Response: The indicator lights for the REACTOR CONTAINMENT FAN switches on 1PM06J will be changed from green-amber-green to blue-amber-green. In addition, all panels will be reviewed to determine if similar problems exist. If so, they will be corrected.

Implementation: Prior to fuel load.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
2	6.4	The Hagan controls have labeling that is inconsistent with the other labeling in the control room. The Hagan Manual/Auto stations have redundant labelling. (4.6.3)
		CE Response: Labeling of the Hagan controls was made consistent with the other labeling in the control room. Redundant labeling was eliminated where system and subsystem labels were applied. Label placement was between the controls and respective indicator lights, where applicable, and always above the controls. The instrument piece number was located on a label placed in the 3/16" high label slip guide at the top of controls because of space limitations. The lower "slip guide" will contain no information because labels were not placed below controls.
		Implementation: Prior to fuel load.

3^{1} 6.13 There are no panel number identification labels.

CE Response: System descriptions based upon function were applied as system level hierarchical labels. Alphanumeric codes used to differentiate control panel boards (i.e., 1PM06J) were also designed. These labels were located on the vertical board section above annunciator windows and left justified above their respective panel. Vertical lines of demarcation were placed on the same board section, indicating the beginning and end points of each panel. Character heights on labels (.50 inch) subtended the appropriate visual angle for minimum viewing at 10 feet.

Implementation: Prior to fuel load.

7.0 PROCESS COMPUTERS

PRIORITY RATING	FINDING	
3[1]	7.2	On 1CX05J, unnecessary Computer Operator console functions are now available to the control room staff. Unnecessary keys are also available to the control room operators. CE Response: To be deferred until the conduct of a DCRDR.
3[1]	7.4	On 1CX05J, data point addresses are not cross-indexed by program name, system/subsystem and functional group. CE Response: The data point addresses on 1CX05J have been changed to permit cross-indexing by program name, system/subsystem and functional groups. Implementation: Completed.

3	7.9	The Sequence-of-Events recorder does not identify the associated annunciator tile which has alarmed. CE Response: The Sequence-of-Events recorder does identify the associated annunciator tile which has alarmed. It prints the functional description of the annunciator tile on the recorder. Implementation: None required.

8.0 PANEL LAYOUT

PRIORITY RATING	FINDING	
1	8.4	To avoid leaving the Reactor panel unattended during startup, operators require another person to change the range and volume of the SOURCE RANGE nuclear instrument. (2.3.3.2-5) CE Response: Westinghouse does not recommend moving either of these switches from their present location in the NIS cabinet. This particular equipment is very sensitive to electrical noise, and is designed so as to provide maximum shielding and short wire lengths to minimize noise induction into the functional equipment. To string wires externally over considerable lengths even though they may be shielded would be contrary to good design practice. No testing has been done on this equipment externally wired and therefore Westinghouse could not guarantee operability when modified as such. Thus,

modification of this equipment is discouraged. A procedure will be adopted to overcome separation difficulties.

Implementation: Prior to fuel load.

3 8.7 On 1PM01J, Generator and Auxiliary Power panel, grouped meters have different functions but are not differentiated. (2.3.3.1-5)

CE Response: Background shading, lines of demarcation and hierarchical labeling have been applied on 1PM01J to distinguish groups of controls and displays that are functionally independent. Mimics have also been integrated to enhance the functional process-flow designated by components. For example, under "auxiliary power," two subsystems were identified: Unit AUX XFMR and System AUX XFMR. Displays related to the former were background shaded. Under "Main Power," one subsystem was identified: GEN EXCITER. Controls related to the GEN EXCITER were demarcated. Under the system "4KV Division 11", three subsystems were identified by labeling: NON-ESF BUS 143, ESF BUS 141, and DIESEL GEN 1A. Both ESF BUS 141 control/display groups and those related to DIESEL GEN 1A were background shaded light blue and grey, respectively. The same enhancement was applied to the "4KV Division 12" control/display groups.

Implementation: Prior to fuel load.

APPENDIX A

HUMAN ENGINEERING DISCREPANCIES "CLOSED" IN SER

2.0 COMMUNICATIONS

PRIORITY RATING	FINDING	
2	2.2	Neither the PA system nor the conventional phone system handsets have cords long enough for use at all parts of the control board. (4.2.2) CE Response: Longer cords have been installed. Wireless phones are being investigated. Implementation: Prior to fuel load.

4.0 CONTROLS

PRIORITY RATING	FINDING	
3[1]	4.1	Two controls have deficiencies which make adjusment to the required level of accuracy cumbersome. For third level accuracy adjustment of the Hagan M/A Station switches, the operator must lean over the board to read the meter scale. In addition, a right-handed operator will cover the linear scale of this control with his hand while operating the dial and pushbuttons that are located to the left of the scale. On the Hagan Control Station switches, the scale markings are difficult to read. Accumulation of dust and dirt in the scale window aggravates the problem. (4.4.1)

CE Response: These are non-critical, non-time dependent adjustments. The problem does not warrant modifying or replacing the module. Dust/dirt on scale windows will be removed.

Implementation: Accept as-is.

3 4.5 There are no guards or barriers between the contiguous EGC (ADC) panel pushbuttons. The likelihood of accidental/inadvertent actuation of the wrong pushbutton is thus increased. (4.4.9)

CE Response: Operation of indicated systems is not critical and does not create a safety problem if accidental actuation of pushbuttons occur.

Implementation: Accept as-is.

3^{1} 4.6 On Unit Two, the SAFETY INJECTION PUMPS DISCHARGE ISOLATION VALVE control is a keylock switch control. The keylock switch control was mounted upside down so that the open/close positions are at 4 o'clock and 8 o'clock. Two other keylock switch controls have the open/close positions at 10 o'clock and 2 o'clock. (This switch is properly installed on Unit One.) (4.4.10)

CE Response: This particular switch will be properly re-installed prior to Unit 2 fuel load.

3^{1} 4.7 The three keylock switch controls on both Units One and Two can be operated by the same key. In addition, the key can be inserted and removed regardless of the switch position. This could result in valves being accidentally left open or closed. (4.4.11) (2.2.2-2)

CE Response: Replace key lock with alternative non-keylock controls or provide independent keying of keylock switches.

Implementation: Prior to fuel load.

3[1]	4.8	There is no pointer on the NIS pen rotary selector switch (4.413) (2.2.2-1)

CE Response: A pointer knob will be installed on the NIS pen selector switch.

Implementation: Prior to fuel load.

3	4.10	The IN-CORE THERMOCOUPLE toggle switches do not snap into position and are not labelled to indicate either the direction of movement or of activation. (4.4.15)

CE Response: This is a non-critical condition that does not warrant retrofit.

Implementation: Accept as-is.

5.0 DISPLAYS

PRIORITY RATING	FINDING	
1	5.1	The 100% readings on some of the M/A Station Switches indicate that valves are 100% open; on others it indicates that the valves are 100% closed. This could cause incorrect valve operation. (4.4.5) (2.2.1-1) (2.3.3.1-8) CE Response: 100% indication will be standardized to mean that the valve is full open. Implementation: Prior to fuel load.
3[1]	5.2	The ROD SPEED linear scale indicator increases down rather than up. This is inconsistent with other indicators and could lead to confusion. (4.4.6) CE Response: The Rod Speed Linear Scale indicator will be changed so that increases are registered upward and decreases downward. Implementation: Prior to fuel load.

3[1]	5.4	A 0-800 psi RCS pressure gauge by the LETDOWN/CHARGING system is needed for low pressure operations on RHR. (4.4.16) (2.2.3-5) CE Response: A zero to 800 pound gauge will be installed, attending to human factors concerns regarding control/display placement. Implementation: Prior to fuel load.
3	5.5	Inconsistent type styles are evident on the displays throughout the control room. (4.5.3) (4.5.6) CE Response: Control board displays manufactured by different manufacturers use different "type styles". Since each "type style" is clear and legible, the difference does not constitute a safety hazard. The displays will not be changed to meet this guideline. Implementation: Accept as-is.
3	5.10	The PRIMARY WATER CONTROL PRE-COUNT digital groupings are longer than four digits, but they are not separated by commas, decimal points, or additional spaces, as recommended. (4.5.8)

CE Response: The control setting and the resultant flow are non-critical, non-time dependent.

Implementation: Accept as-is.

3[1] 5.11 The bus meters have too large a scale for accuracy of required readings. (4.5.9) (2.2.3-3)

CE Response: All bus meters will be evaluated and zone banding will be installed.

Implementation: Prior to fuel load.

2 5.14 Zion Station operating experience indicated that the use of a green normal operating band would alert operators to abnormal conditions when the pointer was not in the appropriate range. (4.5.12) (2.3.3.1-4) (2.3.3.1-6)

CE Response: The Station will identify normal operating ranges of meters and instruments and add green, temporary transparent tape to the surface of selected meters prior to loading fuel. Once the temporary green banding is verified as being the correct range and helpful to the operator, it will be applied permanently to the face of the meter under the pointer. The permanent banding will be accomplished by completion of the first refueling outage.

Implementation: Prior to fuel load.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
1	6.1	The labelling on some of the 3-way valves is unclear. (4.4.17) (2.2.2-3) (2.3.3.1-7) CE Response: Labeling will be reviewed and corrected to ensure that it is consistent with valve operation. Implementation: Prior to fuel load.
1	6.2	Many controls, displays and other equipment items are unlabeled. (4.6.1) CE Response: Standard labels will be provided on controls and displays presently unlabeled. Implementation: Prior to fuel load.
3[1]	6.3	Hierarchical and functional group labeling are not presently available on the control boards or on the Remote Shutdown panel to assist the operator and to simplify the component labeling. (4.5.2) (2.3.3.1-5)

CE Response: Labeling problems will be corrected with the development and implementation of a hierarchical labeling standard.

Implementation: Prior to fuel load.

3[1] 6.7 Some of the labels and location aids in the control room can be easily removed. Demarcation lines also are not permanently attached. (4.6.5) (4.6.7)

CE Response: These descrepencies will be corrected.

Implementation: Prior to fuel load.

3[1] 6.8 Some control board labels use inconsistent abbreviations. (4.6.6)

CE Response: A standardized system of abbreviations will be established and applied.

Implementation: Prior to fuel load.

9.0 CONTROL DISPLAY INTEGRATION

PRIORITY RATING	FINDING	
2	9.1	The RCP SEAL FLOW control is adjusted while monitoring HEADER PRESSURE indicators, 1PM05J. The display and controls are not located within reasonable proximity. (4.5.1) (4.9.1) CE Response: Reposition the HCV 182 Control into the proximity of the injection flow indicators and provide a dead mimic. Implementation: Prior to fuel load.
2	9.2	The SEAL INJECTION FLOW indicators are located on the left at the top of 1PM05J. The HCV 182 control is on the left front diagonal panel at the bottom of the vertical display panel on 1PM05J. When adjusting the control and simultaneously reading the SEAL INJECTION FLOW indicators, the operator places himself in an awkward position. This position can readily lead to a parallax problem. (4.9.1) (2.3.2-1) (4.5.1).

CE Response: Reposition the HCV 182 control into the proximity of the injection flow indicators and provide a dead mimic.

Implementation: Prior to fuel load.

2 9.4 On 1PM05J and 1PM06J, the controls and displays required to stop the REACTOR COOLANT PUMPS, in conjunction with the CENTRIFUGAL CHARGING or SAFETY INJECTION PUMPS and REACTOR COOLANT SYSTEM WIDE RANGE PRESSURE indicators (1300 psig) are not located conveniently close to one another. (4.9.3)

CE Response: An existing wide-range pressure indicator (405) will be relocated to eliminate the discrepancy.

Implementation: Prior to fuel load.

APPENDIX B

HUMAN ENGINEERING DISCREPANCIES "CLOSED" JULY 1982

1.0 CONTROL ROOM WORKSPACE

PRIORITY RATING	FINDING	
1	1.6	Annunciator response controls on the vertical panels are located 77" from the floor, making operation of these frequently used controls difficult. (4.1.4) CE Response: A review by station personnel identified two annunciator response controls 77" from the floor. They are located on the switchyard panel section of OPM03J. These annunciator response controls will be relocated to comply with the NUREG-0700 control height guidelines. Implementation: Prior to fuel load.
1	1.9	The copper pipes which will supply emergency breathing air currently stick out of the control room floor and present a tripping hazard.

CE Response: This hazard has been eliminated with the installation of the new center desk.

Implementation: Prior to fuel load.

3 1.10 The leg openings in the wing sections of OPM05J, center desk, do not provide the recommended 30" lateral leg space for a seated operator. The lateral leg space provided is 23".

CE Response: According to NUREG-0700, guideline 6.1.2.7.(D)(7), the recommended knee room width (lateral leg space for a seated operator) is 20 inches minimum with a greater width preferred. The knee room width on the wing sections of OPM05J, center desk, is 23 inches and in compliance with the NRC guidelines. The center desk (OPM05J) has been redesigned and complies with accepted human engineering preferred practices.

Implementation: Prior to fuel load.

3.0 ANNUNCIATOR WARNING SYSTEM

PRIORITY RATING	FINDING	
1	3.2	Tiles on the following annunciator panels are not readable from acknowledge buttons: Annunciator Panels UL-AN026, 003, 007, 008, 012, 014, and 015. (4.3.4.) (2.1.1-2) CE Reponse: Additional annunciator acknowledge buttons will be placed on the control boards to comply with the NRC guidelines. The oblique angle from the line of sight to the display located to either side of the working position (annunciator acknowledge button) from which the display must be read will be within 45 degrees. Implementation: Prior to fuel load.
1	3.5	A separate alarm horn is needed for each section of the control board. (4.3.6) (2.3.3.1-2) CE Response: Section 6.10 of the Byron Generating Station Preliminary Human Factors Review, dated November 1981,

describes in detail the approach to be implemented in the control room. A separate alarm horn will be installed for each of the following panels:

a. Engineered Safeguards (1PM06J)
b. Reactor and Chemical Volume Control (1PM05J)
c. Balance of Plant (Feedwater, Condensate, Turbine, etc.) (1PM04J, 1PM03J, 1PM02J)
d. Generator and Aux Power (Diesels included) (1PM01J)
e. Switchyard (0PM03J)
f. HVAC (0PM02J)
g. General Services (0PM01J)

Each alarm horn will be located at or near the center of the associated annunciator panel. Characteristics of the alarm coding include:

1. Priority coding using waveform (physical acoustic structure)

2. System coding using frequency, period and location.

The characteristics for these horns are shown below:

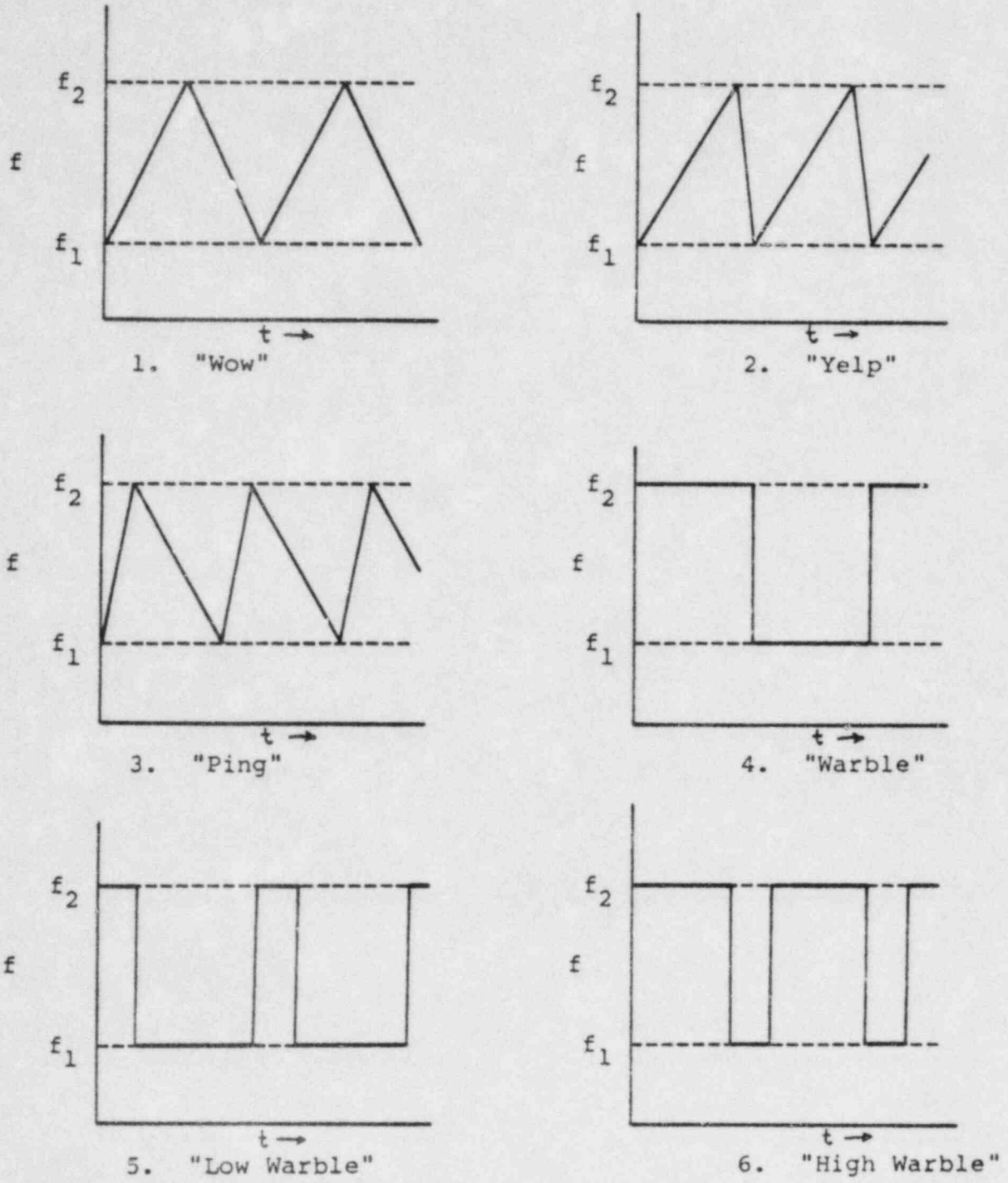
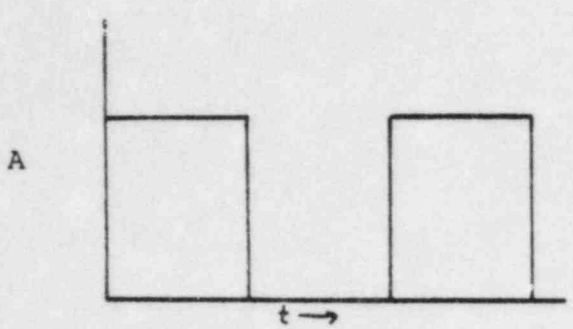
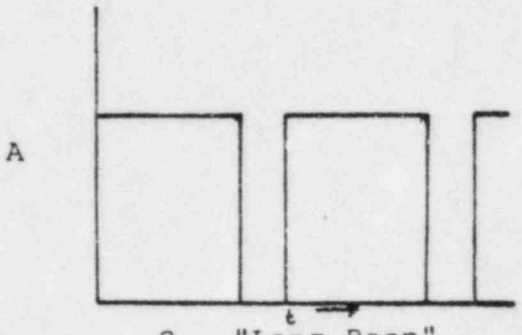


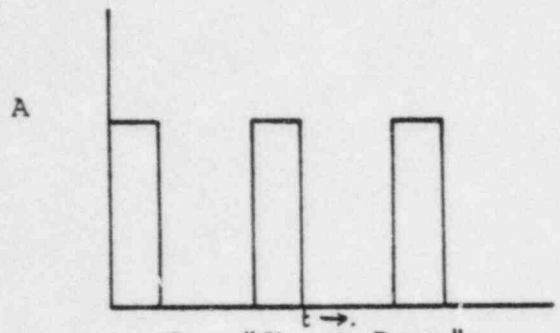
Figure 1: BETATONE III SOUND
(Constant Amplitude)



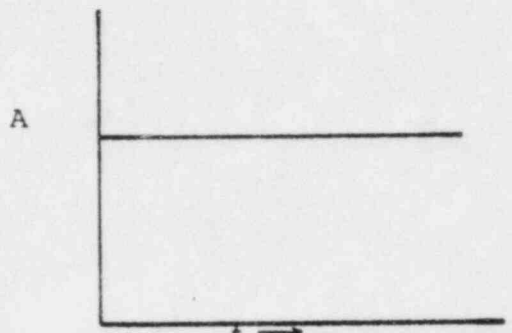
7. "Beep"



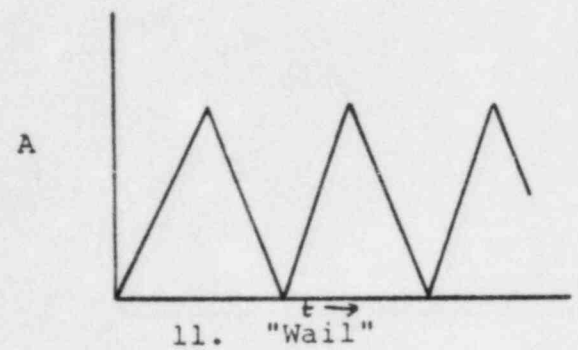
8. "Long Beep"



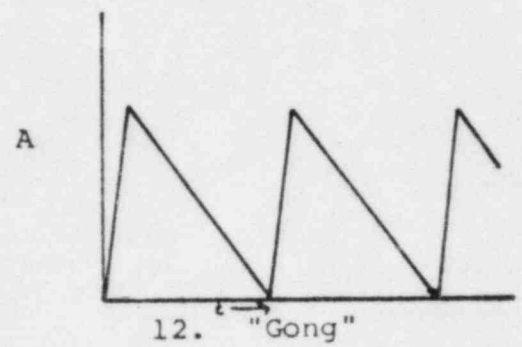
9. "Short Beep"



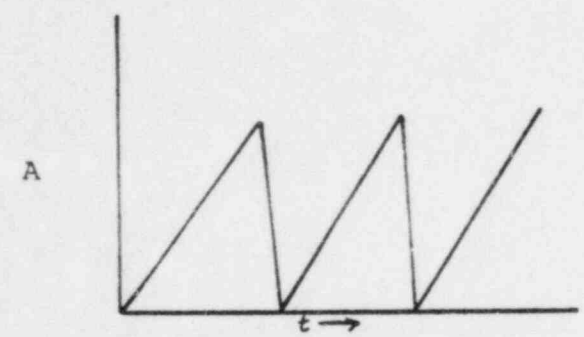
10. "Steady"



11. "Wail"



12. "Gong"



13. "Tweet"

Figure 2 : BETATONE III SOUNDS
(Constant Frequency)

Implementation: Prior to fuel load.

3	3.7	The annunciator flash rate is about 2 flashes/second instead of the recommended 3 to 5 flashes/second.

CE Response: A resistor in an RC time constant circuit has been changed to convert the annunciator flash rate to meet the recommended 3 to 5 flash/second rate as per NUREG-0700 Guidelines (6.3.3.2B).

Implementation: Completed.

4.0 CONTROLS

PRIORITY RATING	FINDING	
2	4.15	The PLANT EVACUATION ALARM and plant-wide FIRE ALARM pushbuttons on the Remote Shutdown panel can be accidentally activated. CE Response: A cover guard similar to the alarm guards in the control room will be installed on the Plant Evacuation Alarm and plant-wide Fire Alarm pushbuttons located on the Remote Shutdown panel. Implementation: Prior to fuel load.
3[1]	4.16	The Remote Shutdown panel J-handle switches do not have the pointer arrows filled in with contrasting pigment for easy visibility. CE Response: The pointer arrows on the Remote Shutdown Panel J-handle switches have been filled in with contrasting pigment to improve visibility. Implementation: Prior to fuel load.

3 4.19 On 1PM08J the thermocouple toggle switch bank is subject to breakage because the switch handles extend into the traffic area.

CE Reponse: The thermocouple toggle switch bank located on 1PM08J is not critical and is used infrequently. However, a guardrail will be installed to protect the switch handles from damage.

Implementation: Prior to fuel load.

2 4.20 The switch guards for the C-W MAKEUP EMERGENCY TRIP controls on OPM01J obscure the pushbuttons and their color coding when flipped open.

CE Response: The switchguards for the C-W MAKEUP EMERGENCY TRIP controls on OPM01J will be changed to clear, heavy plastic to permit easy reviewing of the color coding while flipped open.

Implementation: Prior to fuel load.

1 4.21 On OPM05J, the PLANT EVACUATION ALARM pushbutton guard has an ear for a padlock. If the ear was bent over, the guard could not be raised to operate the pushbutton.

CE Response: The pushbutton guard padlock ear for the PLANT EVACUATION ALARM located on OPM05J will be removed.

Implementation: Prior to fuel load.

3 4.23 On 1PM12J, Miscellaneous Instrumentation panel, three modules (POWER SUPPLY, ALARM AND TRIP RELAY, and VIBR PHASE ANGLE) have slotted nonlocking selector controls which are flush with the panel. The slot serves both to turn the control and to indicate its selected position. It is not clear which end of the slot indicates the position selected.

CE Response: On 1PM12J, the slotted non-locking selector controls position indicator does clearly indicate the position selected. The slot traverses from the edge of the circular housing a full 3/4 of the diameter. The open edge demarcates the position selected, the closed end indicates nothing.

Implementation: None Required.

3[1] 4.24 On 1PM02J, Turbine panel, the legends on the REHEAT TURBINE controller pushbuttons do not relate to the system controlled:

- GROUP 1 out of service corresponds to "Governor End"
- GROUP 2 out of service corresponds to "Generator End"

CE Response: The labeling program incorporates this to provide clarification

that Gov. End is Group 1 and Gen. End is Group 2.

Implementation: Prior to fuel load.

1 4.25 On 1PM11J, Containment Isolation back panel, two rotary selector switches lack control position indications.

CE Response: Control position indications on the rotary selector switches (1PM11J) will be added to and will comply with the recommended control position indicator guidelines noted in NUREG-0700.

Implementation: Prior to fuel load.

3[1] 4.29 On OPM01J, two of the CW MAKE-UP PUMP EMERGENCY TRIP switches have red back plates while the third switch does not.

CE Response: A red background will be included on the back plate of the third CW Emergency Trip Make-up pump switch on OPM01J. The background will be identical to the remaining two switches.

Implementation: Prior to fuel load.

5.0 DISPLAYS

PRIORITY RATING	FINDING	
3[1]	5.8	The LUBE OIL RESERVOIR linear scale display has no label indicating what is being read (i.e., inches, lbs., percent, etc.). The scale range is 0 to 120. (4.5.6) (2.2.3-4) CE Response: The LUBE OIL RESERVOIR linear scale display will be modified to indicate 0 to 100 percent. Implementation: Prior to fuel load.
2	5.15	Adequate tools for indicator bulb replacement are not present in the control room. CE Response: Bulb replacement tools have been purchased and will be made available for indicator bulb replacement in the control room. Implementation: Completed.
2	5.16	On the Remote Shutdown panel, normal operating limits are not marked on the meters.

CE Response: Normal operating limits will be marked on the meters (i.e., green banding), in accordance with the schedule for marking the meters in the control room (see 5.14).

Implementation: Prior to fuel load.

3 5.17 The Westinghouse J-handle switches have incorporated indicator flags that originally indicated the status of the control. These flags have been made obsolete by the installation of a new system of NORMAL/ABNORMAL indicator lights. The colored flags are still visible and may present confusing information to the operator.

CE Response: The dual-colored indicator plates, originally intended to indicate the status of the Westinghouse J-Handle control switches, will be eliminated to reduce the possibility of confusion.

Implementation: Prior to fuel load.

1 5.23 The CONTAINMENT PRESSURE recorder scale on 1PM06J shows no units.

CE Response: The Containment Pressure recorder scale on 1PM06J will be numbered and marked according to the general principles of scale gradation (6.5.1.5, 6.5.1.3 and 6.5.1.4).

Implementation: Prior to fuel load.

2 5.28 The green RODS IN and red RODS OUT indicator lights on 1PM05J are inconsistent with the plant color coding convention.

CE Response: The green RODS IN and red RODS OUT indicator light colors will be removed. The colors used for these indicator lights will follow the control room color coding scheme based on accepted human engineering principles and practices.

Implementation: Prior to fuel load.

3[1] 5.29 The Gaitronics paging system has a red MERGE pushbutton and a green ISOLATE pushbutton; this is an inappropriate use of these colors.

CE Response: Red and green will be removed from the Gaitronics paging system's MERGE pushbutton and ISOLATE pushbutton, respectively. The substitute colors selected will follow conventional human factors practices and will be coordinated with the other colors used in the control room.

Implementation: Prior to fuel load.

2 5.34 There are incorrect bulbs of different brightness in some indicator lights. GE1819 should be for annunciators, GE1835 should be for indicators. When a GE1819 bulb is installed in an indicator, the indicator legend is too dim.

CE Response: GE1819 bulbs will be installed in annunciators; indicators will be equipped with GE1835 bulbs to optimize brightness. An administrative procedure addressing the storage and installation of the light bulbs will be developed.

Implementation: Prior to fuel load.

3[1] 5.35 There is an unknown and unlabeled indicator light on 1PM01J.

CE Response: The light is the Bus Alive indication for Unit 2 bus feed to bus 034R and will be appropriately labeled.

Implementation: Prior to fuel load.

1 5.38 On 1PM04J, there are many cases of incorrect indicator legend caps, i.e., FW PUMP DISCHARGE valve open/close indicators are mounted opposite the proper indications, and the red lights for the FW PUMP 2C OIL PUMPS should be blue.

CE Response: The FW PUMP DISCHARGE valve open/close legend caps and the red lights for the FW PUMP 2C OIL PUMPS will be corrected. In addition, all legend cap indicators will be reviewed to identify those which are incorrectly mounted. Those identified as incorrect will be corrected.

Implementation: Prior to fuel load.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
3[1]	6.10	The Zion operators specifically mentioned the need for mimics on the Chemical and Volume Control System, Boric Acid and Engineered Safeguards panels. (2.3.1-A, 2.3.3.1-3) CE Response: Mimics have been developed and will be installed, where helpful, in the Chemical and Volume Control System, Boric Acid and Engineered Safeguards panels developed for each of these panels. Implementation: Prior to fuel load.
3[1]	6.11	There is a lack of background shading to enhance the operator's ability to differentiate among functional groupings of instruments and controls. (2.3.1-B) CE Response: Background shading is considered a viable design enhancement alternative. It will be included on the

control boards to enhance the operator's ability to differentiate selected functional groups of instrumentation and controls.

Implementation: Prior to fuel load.

3[1] 6.14 A label on 0PM02J has a misspelled word; VAVLE is used instead of VALVE. Another label on 0PM02J incorrectly reads CLAND instead of GLAND.

CE Response: All labels on 0PM02J were reviewed for proper spelling per NUREG-0700 Section 6.6.3, "Label Content". "VAVLE" and "CLAND" will be changed to read "VALVE" and "GLAND", respectively.

Implementation: Prior to fuel load.

1 6.16 The AUXILIARY BUILDING FILTER PLENUM B control on 0PM02J is missing the position labeling.

CE Response: A position label will be placed above the "AUXILIARY BUILDING FILTER PLENUM B" control on 0PM02J and will comply with the requirements of Section 6.6.2 of NUREG-0700.

Implementation: Prior to fuel load.

3[1] 6.18 There are several cases of labels being obscured by equipment in the control room, i.e., the label for the GENERATOR H_2

COOLING WATER VALVE indicator lights is obscured by the recorder located above them, and some labels at the top of 1PM07J are obscured by their associated controls.

CE Response: All labels throughout the control room will be reviewed for proper compliance to NUREG-0700, Section 6.6. Where labels are obscured, location improvements will be made to minimize potential concealment. The label for "GENERATOR H_2 COOLING WATER VALVE" indicator will be relocated to provide better visibility. Labels on panel 1PM07J will be reviewed and label location modifications will be made to minimize their concealment.

Implementation: Prior to fuel load.

3[1] 6.20 The proposed demarcation lines on 1PM04J do not clearly associate the status light arrays on this panel with their functionally-related controls and displays.

CE Response: All trip status light arrays including the two on 1PM04J contain system level hierarchical labels. Although these arrays correspond generally to the component groups on their respective panels; several of the individual status lights may also pertain to other systems, i.e., Turbine and Steam Generator (TSLB-2) on 1PM04J. Because of the non-independence of function, they were not included within

a general demarcation scheme. Lines of demarcation were applied on all panels to afford an independent functional grouping of controls and displays, e.g., Steam Generators. Because trip status lights applied to functions across entire panels, they were designated by a system level hierarchical label. In addition, their safety-related function was enhanced by the hierarchical scheme.

Implementation: Prior to fuel load.

3[1] 6.21 The labels describing pen assignments on the ROD INSERTION LIMITS recorder and the CW COOLING TOWER TEMPERATURE recorder are placed on the glass face of the recorder where they obscure the chart paper.

CE Response: Assignment labels on the "ROD INSERTION LIMITS" recorder and the "CW COOLING TOWER TEMPERATURE" recorder will be removed and properly placed to identify the recorders in a manner which will not detract from nor obscure information on the chart paper.

Implementation: Prior to fuel load.

1 6.25 The nomenclature on the Remote Shutdown panel transfer control switches is unclear. The two position choices are "REMOTE" and "LOCAL". Although the panel is a "remote" panel, REMOTE means that the

control is located at the control room. LOCAL indicates that the controls are located in the Remote Shutdown panel.

CE Response: Additions to the nomenclature on the remote shutdown panel transfer control switches will be included to alleviate any dicrepancy which may arise from using the terms "REMOTE" and "LOCAL". Parentheses will follow each term and will indicate the area to which they refer. That is, after REMOTE, the switch will read MCB (for Main Control Board) and after local it will read RSP (for Remote Shutdown Panel).

Implementation: Prior to fuel load

3[1] 6.27 The test positions on the SGFPT 2 C LUBE OIL RESERVOIR TEST control on 1PM04J are OLL for "oil level low" and OLH for "oil level high". Since these abbreviations are very similar, it is hard to differentiate between the two different meanings.

CE Response: "OLL and OLH" for the SGFPT 2C LUBE OIL RESERVOIR TEST control on 1PM04J will be eliminated. The labels will read "low level" and "high level" to minimize interpretation errors and to provide for proper label level differentiation per NUREG-0700, Section 6.6.3.6.

Implementation: Prior to fuel load.

2 6.28 The labeling, lettering and terms used on the Westinghouse-provided panel inserts are not consistent with the other control room labeling.

CE Response: All Westinghouse-provided panel insert labels have been reviewed and improvements will be made to ensure that control room labeling is consistent with NUREG-0700, Section 6.6.3.3.

Implementation: Prior to fuel load.

3[1] 6.29 There are cases of adjacent controls of the same kind that have position labels with different size and style typeface.

CE Response: All labels in the control room will be reviewed and modified to provide for design consistency across pieces of equipment.

Special attention will be devoted to ensure that all similar adjacent controls have similar position labels.

Implementation: Prior to fuel load.

3[1] 6.30 The standard black-on-white labels used in the control room come in several different "shades" of white and off-white. The engraving styles and depths are also not consistent for all the labels.

CE Response: The labels in the control room have been reviewed and appropriately modified to meet the color and lettering requirements, per NUREG-0700, Section 6.6.

Implementation: Prior to fuel load.

1 6.34 The Remote Shutdown panel lacks any demarcation or other location aids to identify functionally-related groups of controls and displays.

CE Response: Demarcation, through the use of background shading and mimics, will be provided on the remote shutdown panel to identify functionally-related groups of controls and diplays.

Implementation: Prior to fuel load.

3[1] 6.35 There is insufficient demarcation between the ACCUMULATOR, SAFETY INJECTION and RESIDUAL HEAT REMOVAL mimics. These mimics are intermingled on 1PM05J and 1PM06J.

CE Response: A systematic use of various enhancement techniques will be used on 1PM05J and 1PM06J panels. Background shading and demarcation lines will be coordinated with the use of mimics to improve discriminability.

Implementation: Prior to fuel load.

3^1 6.37 Sections of mimic lines are missing between two circuit breaker controls and some indicator lights in the AUXILIARY POWER mimic.

CE Response: The missing sections of the mimic between the two circuit breaker controls for the AUXILIARY POWER mimic have been identified and will be added to the control boards.

Implementation: Prior to fuel load.

3^1 6.38 The BTRS DEMINERALIZER mimic and the REACTOR COOLANT PUMP SEALS mimic are designed around controls that are in one large array. It is difficult to see where one mimic ends and another mimic begins.

CE Response: The use of mimics for the BTRS DEMINERALIZER and the REACTOR COOLANT PUMP SEALS have been reevaluated and will be altered so that the beginning points and the end points can be readily determined.

Implementation: Prior to fuel load.

3^1 6.39 The CVCS LETDOWN mimic does not have a label identifying the flow origination point.

CE Response: The mimic on the CVCS panel will be provided with a label or symbol which indicates the flow origination point.

Implementation: Prior to fuel load.

3[1] 6.40 None of the mimics have arrows to indicate the direction of each flow path.

CE Response: Arrows to indicate the direction of each flow path will be included on all mimics on the control boards.

Implementation: Prior to fuel load.

3 6.41 On the 345KV mimic on 1PM01J, the symbol for the DISCONNECT GROUNDING switch does not depict the switch functions as clearly as the corresponding symbol does for the same switch used in the mimic on 0PM03J.

CE Response: The mimic symbol for the DISCONNECT GROUNDING switch on 1PM01J will be changed to correspond to the mimic symbol for the same switch on 0PM03J.

Implementation: Prior to fuel load.

7.0 PROCESS COMPUTERS

PRIORITY RATING	FINDING	
2	7.3	Recovery procedures for process computer failures are not available to the operator. CE Response: Procedures for bootstrapping the computer to cover process computer failure, will be developed and made available to the operator. Implementation: Prior to fuel load.
3[1]	7.5	Individual data groups or messages do not have descriptive titles which reflect the unique characteristics of the content of the data groups or messages. CE Response: A review by the station computer section indicates that blocks of data groups have descriptive titles which reflect the characteristics of the data groups or messages. Implementation: None required.

3[1] 7.8 The Terminet printers do not have a paper take-up device for the printed record.

CE Response: All hard-copy recorders, TTYs, etc., will be provided with take-up devices which will require little or no operator attention and will have a capacity equal to the feed supply and provisions for removal of hard copy for storage.

Implementation: Prior to fuel load.

8.0 PANEL LAYOUT

PRIORITY RATING	FINDING	
2	8.1	On 1PM04J, the FEEDWATER PUMP TURBINE CONTROL pushbuttons are not arranged in a natural stereotypical or logical sequence, increasing the probability of inadvertent/accidental activation of the wrong control (i.e., valve OPEN button is to the left of the valve CLOSE button). (4.4.4) CE Response: The feedwater pumps and turbine control pushbuttons on 1PM04J will be rearranged in a logical sequence to decrease the probability of inadvertent actuation. Implementation: Prior to fuel load.
1	8.17	The legend light groups on 1PM06J, Engineered Safeguards panel, are disoriented by 90^{o}.

CE Response: This light box will be rotated 90^{o} to eliminate this problem.

Implementation: Prior to fuel load.

9.0 CONTROL DISPLAY INTEGRATION

PRIORITY RATING	FINDING	
1	9.5	On 1PM05J, switching of bypass breakers during surveillance testing can cause operator errors. (2.3.3.2-7) CE Response: Operator errors have occurred at other stations due to bypass breaker switching during surveillance testing. As a result, the bypass breaker switch was relocated onto the control board next to the bypass breaker open/close indication lights. Implementation: Completed
3	9.10	On 1PM01J, Electrical Distribution panel, the EXCITER VOLTAGE REG. TRANSF. NULL meter reset on "0" both when unpowered and when MANUAL and AUTO are in "SYNCH". No provision is made for it to (a) be off-scale when unpowered or (b) provide a procedure to exercise it before closing the PERMANENT MAGNET supply.

CE Response: A step will be inserted into the Byron general procedures which will require the operator to check the null meter for response before closing the PMG Supply Breaker.

Implementation: Prior to fuel load.

Commonwealth Edison Company

APPENDIX C

HUMAN ENGINEERING DISCREPANCIES DEFERRED TO THE DCRDR JULY 1982

1.0 CONTROL ROOM WORKSPACE

PRIORITY RATING	FINDING	
3	1.3	The 30" depth of the benchboard (recommended maximum = 25.2") will force the 5th% height operator to lean over the panel. This depth increases the probability that the controls on the benchboard edge will be accidentally activated. (4.1.2) CE Response: To be deferred until the conduct of a DCRDR.

2.0 COMMUNICATIONS

PRIORITY RATING	FINDING	
3	2.1	The sound-powered phone headsets are uncomfortable to wear for long periods of time. (4.2.1) (2.1.2-1) CE Response: To be deferred until the conduct of a DCRDR.

3.0 ANNUNCIATOR WARNING SYSTEM

PRIORITY RATING	FINDING	
3	3.8	Annunciator panels on 1PM01J, 1PM02J and 1PM03J have more than 50 tiles, the recommended maximum number of tiles per panel. CE Response: To be deferred until the conduct of a DCRDR.

4.0 CONTROLS

PRIORITY RATING	FINDING	
3	4.9	The BORIC ACID/PRIMARY WATER batch make-up thumbwheels on 1PM05J are much smaller than recommended; this condition could cause operating difficulty. (4.4.14) CE Response: To be deferred until the conduct of a DCRDR.
3	4.28	On 1PM08J, In-Core Instrumentation panel, it is difficult to read the switch position on the 261 PICO AMP SOURCE controls because the knob obscures the switch position window. CE Response: To be deferred until the conduct of a DCRDR.

5.0 DISPLAYS

PRIORITY RATING	FINDING	
3	5.7	Vertical meter pointer tips do not extend to within 1/16" of the smallest graduation marks on the scale. (4.5.5) CE Response: Deferred to the conduct of a DCRDR.
3	5.19	The COMPONENT COOLING ammeter on OPM02J and several meters on the Remote Shutdown panel lack a number at the top-most end of the display scale. In addition, the ammeter scale has an unconventional end-point. CE Response: To be deferred until the conduct of a DCRDR.
3	5.30	On the Remote Shutdown panel the pointers on the Hagan Manual/Auto stations cover the numerals of the display. CE Response: To be deferred until the conduct of a DCRDR.

3	5.31	On 1PM05J, there is severe parallax when reading the green pointer of the two pen recorders because it is behind the recorder scale. CE Response: To be deferred until the conduct of a DCRDR.

6.0 LABELS AND LOCATION AIDS

PRIORITY RATING	FINDING	
3^1	6.12	The circular meter displays used throughout the control room have curved descriptive labels on their faces. CE Response: To be deferred until the conduct of a DCRDR.
3^1	6.15	Several three-position J-handle controls in the control room have only two of the positions used. Mechanical stops have been provided to prevent moving the controls to the unused position, but the position indicator marks are still engraved and filled with dark pigment. CE Response: To be deferred until the conduct of a DCRDR.
3^1	6.19	The approximately 12x2 bank of CONDENSATE CONTROL controls on the vertical section of 1PM03J are not demarcated. This makes

differentiation among the controls difficult.

CE Response: To be deferred until the conduct of a DCRDR.

7.0 PROCESS COMPUTERS

PRIORITY RATING	FINDING	
3	7.1	The CRT terminal and the Sequence-of-Events printer have keyboards which are arranged differently. CE Response: To be deferred until the conduct of a DCRDR.
3	7.6	There is no hard-copy facility available to print out displays which appear on the RAMTEC CRT. CE Response: To be deferred until the conduct of a DCRDR.

8.0 PANEL LAYOUT

PRIORITY RATING	FINDING	
3	8.3	Sets of controls and displays on 1PM01J, Power Generation panel, are not laid out consistently. Layouts of some repeated functions are mirror imaged, i.e., WATER ISOLATION VALVES, mini-flow valves for RHR PUMPS 2A and 2B and ACTIVATED VALVES. (4.8.2) CE Response: To be deferred until the conduct of a DCRDR.
3	8.5	On 1PM06J, Essential Service Water panel, the meters are aligned $P_A P_B$ - T_{1A} T_{2A} T_{2B}. Pressures and temperatures are not to be compared. Better grouping would be P_A T_{1A} T_{2A} - P_B T_{1B} T_{2B}. CE Response: To be deferred until the conduct of a DCRDR.

3[1]	8.15	On 1PM03J, Condensate panel, associated controls and displays are presently separated by unassociated controls and displays. CE Response: To be deferred until the conduct of a DCRDR.
3	8.18	On 0PM02J, HVAC panel, the UNIT 1 and UNIT 2 CONTAINMENT and VENTILATION controls and displays are laid out identically except for the pressure meters which are mirror imaged. CE Response: To be deferred until the conduct of a DCRDR.
3	8.20	The DIGITAL ELECTRO HYDRAULIC TURBINE CONTROL and numeric pad (telephone type) are different from the computer numeric panels (adding machine type). CE Response: To be deferred until the conduct of a DCRDR.
3	8.21	On 1PM06J, the STEAM GENERATOR and AUXILIARY FEEDWATER PUMP controls are mirror imaged; the remainder of the panel is not. CE Response: To be deferred until the conduct of a DCRDR.

3	8.22	The CONTAINMENT SPRAY system on 1PM06J is mirror imaged for no apparent reason. CE Response: To be deferred until the conduct of a DCRDR.

9.0 CONTROL DISPLAY INTEGRATION

PRIORITY RATING	FINDING	
3	9.8	On 1PM01J, Electrical Distribution panel, the normal switch position is "Auto" but there is no such indicating light. If either MAN. EMERGENCY is selected, the associated red indicator will light. CE Response: To be deferred until the conduct of a DCRDR.
3	9.9	There are several cases where displays associated with mimics are separated from the mimics by unrelated controls, i.e., on 1PM01J, ACCUMULATOR, SAFETY INJECTION and RESIDUAL HEAT REMOVAL display meters. CE Response: To be deferred until the conduct of a DCRDR.

PRELIMINARY DESIGN ASSESSMENT
OF THE
BYRON/BRAIDWOOD GENERATING STATION CONTROL ROOM
HUMAN FACTORS ENGINEERING REVIEW
SUPPLEMENT II

SUBMITTED BY:
Commonwealth Edison Company
April 1983

IN RESPONSE TO:
Task Action Plan Item
I.D.1, Control Room Design Reviews

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1.0 INTRODUCTION

Several special inquiry groups were established by the Nuclear Regulatory Commission (NRC) to investigate the cause and consequences of the accident at Three Mile Island Unit #2 (TMI-2). It became clear during these investigations that human error played an important role throughout the accident. Therefore, special attention was focused on the extent to which factors incorporated within the discipline of human factors engineering (e.g., man-machine interface design, procedures, manning, and training) were identified as causing or contributing to the accident.

As part of the NRC task actions following the TMI-2 accident (Item I.D.1, NUREG-0660, May 1980; NUREG-0737, November 1980), the NRC required all businesses and applicants for operating licenses to conduct a Detailed Control Room Design Review (DCRDR). The applicants for operating licenses unable to complete this review prior to issuance of a license may perform a Preliminary Design Assessment (PDA) of their control rooms to identify HEDs and establish a schedule for correcting deficiencies.

As a result, Byron Station performed a PDA. Subsequent to the PDA, the NRC conducted an on site Control Room Design Review Audit. The audit conduted by the NRC included an evaluation of the control room layout including:

- the adequacy of the information provided
- the arrangement and identification of controls and displays
- the usefulness of the alarm systems
- the information recording and recall capability
- and other human factors considerations.

Resolution to, present status of, and the future schedule for completion of the actions required to resolve the HED's identified in these two reviews are contained in Supplement I to the Preliminary Design Assessment of the Byron/Braidwood Generating Station Control Room Human Factors Engineering Review.

The Byron SER identified a number of systems/items not available at the time of the NRC November 1981 onsite audit review and required that these systems/items be reviewed and evaluated. Also, the SER required that the "finding, proposed corrective action, and schedule for implementing the actions" be submitted to the NRC. That information is documented in this report (Supplement II to the Preliminary Design Assessment of the Byron/Braidwood Generating Station Control Room Human Factors Engineering Review).

Supplement II, presents the methodology, findings, and conclusions of the evaluation of the items not reviewed as of the Byron Station SER and lists the items which remain to be reviewed. Also presented in this supplement are a number of appendices which contain ancillary information to that presented in both supplements. Appendix A presents a diagram of the Byron/Braidwood Unit 1 and Common Area panel/equipment arrangement, to include the re-designed Center Desk workstation. Appendix B delineates the environmental surveys that remain to be performed.

Appendix C contains summaries of the major Human Engineering activities undertaken by the Human Engineering Task Force to enhance the Byron/Braidwood location aids. Appendix D contains a summary of the Task Force review efforts on the Annunciator Warning System. Finally, Appendix E presents the latest revision of the Byron/Braidwood stations' standard

abbreviations list. The information contained in these appendices supercedes any previous information concerning these topic issues. This report was prepared and submitted to show compliance with Task I.D. 1 of the TMI Action Plan.

The Byron Station Unit 1 control room is a standard design to be used in several other plants. This report is intended to be applicable to Byron Station Unit 2 and Braidwood Units 1 and 2. Any site specific panels or components in the control room of each unit will be independently evaluated. In addition, a complete environmental survey (temperature, humidity, ventilation, illumination and audition) will be performed and the results reported for each control room.

2.0 REVIEW PROCESS

The Byron/Braidwood Human Engineering Task Force (henceforth known as the Task Force) performed a considerable number of analyses and reviews prior to the NRC Human Factors Safety Branch (HFSB) audit. These coupled with the continuing efforts of the task force, form a comprehensive review of the Byron control room. The subsequent design changes reflect substantial application of human factors engineering principles and practices.

2.1 Review Task Force

The preliminary human factors engineering assessment was accomplished by applying the skills and training of the Task Force to identify and resolve Human Engineering Discrepancies. The composition of the Task Force and a description of the review are discussed.

The preliminary human factors engineering assessment was conducted by the Task Force. Task Force members included individuals from:

- CECo Station Nuclear Engineering
- Byron/Braidwood Station Project Engineering
- Byron/Braidwood Station Operations
- CECo Production Training
- Sargent and Lundy Engineers
- Advanced Resources Development (ARD) Corporation

2.2 Systems and Items Not Available for Review During NRC PDA Audit

This section contains a description of those systems and items which were not available for review in November, 1981. These systems and items were subsequently reviewed and evaluated. The results of the evaluation are described herein. At this time, due to construction schedules, all systems and items are not completed in their entirety. A complete list of these items and schedule for completion is included. The review of these open items will be completed as each system becomes operational. The results of these reviews will be provided in a supplemental report.

A human factors engineering review of the Byron Generating Station Control Boards was conducted using Section 6 of NUREG-0700 (Control Room Human Engineering Guidelines). The objective of this review was to perform a systematic comparison of the control room design features with accepted human factors design guidelines and standards. As existing HEDs were identified, appropriate notations were recorded.

2.2.1 Control Room Workspace Survey

Considerable attention has been paid to proper workspace layout. The center desk has been functionally redesigned to fully support personnel activities, as has the unit desk and several workstations within the control room. In addition, document organization and storage, the organization

and storage of spare parts, operating expendables and tools, emergency equipment, and other control room furnishings have been reviewed.

Provisions have been made to limit the access and movements of nonessential but authorized personnel within the control room.

Construction scheduling has impacted our ability to perform the environmental measurements as identified in NUREG 0700 (Appendix B). Illumination and luminence measurements will be taken upon completion of the control room. At this time the ceiling louvers, panel valances, carpeting, and some of the furniture, are not installed in the control room. The complete installation of these materials is necessary for the performance of these measurements. It is the intent of the Task Force to provide these measurements on the completed control room.

Construction scheduling also impacts our ability to perform the sound level, temperature/humidity and ventilation measurements (see Appendix B). The nature of the scheduling necessitates postponing these measurements until after fuel load but prior to the plant going critical. CECo will submit this data at that time.

A NUREG 0700 Section 6 checklist review was conducted on those systems and workstations completed after November 1981. The discrepant items identified are presented in Section 3. The guidelines remaining to be addressed prior to fuel load include:

6.1.1.3b Communications

6.1.1.3d(2) Circulation Patterns

6.1.5.3 Illumination

6.1.5.4 Emergency lighting

2.2.2 Communications

The six voice communications systems used in the control room were reviewed in accordance with the NUREG 0700 checklist. These systems include:

- Conventional-Powered Telephone Systems
- Sound-Powered Telephone Systems
- Walkie-Talkie Radio Transceivers
- Fixed-Base UHF Transceivers
- Plantwide Paging System
- Point-to-Point Intercom Systems

The following is a list of guidelines which will be addressed prior to fuel load:

6.2.1.2b	Handsets
6.2.1.2d	Telephone Ringing
6.2.1.3c	Ringing, Sound Powered Phones
6.2.1.3d	Jack Provisions
6.2.1.3e	Switching
6.2.1.6f	Plantwide Paging Systems: Priority
6.2.2.1b,c	Use of auditory signals
6.2.2.2	Signal meaning
6.2.2.3	Auditory Coding Techniques
6.2.2.4	Propogation of signals
6.2.2.5	Frequency
6.2.2.6	Signal Intensity

2.2.3 Annunciator Warning System

The Byron/Braidwood Annunciator System was reviewed extensively (Reference 15). The review included labeling issues, numbering scheme, functional grouping, auditory and visual coding, annunciator control stations, SER messages and Braidwood specific issues (Appendix D). However, two guidelines remain to be addressed prior to fuel load:

6.3.2.1d Signal Detection

6.3.4.1d(2) Controls: Testing Annunciators

2.2.4 Controls

The Byron SER required that all controls covered by or represented by mock-ups be reviewed once again. The Task Force using the NUREG-0700 Section 6 checklist repeated this review for panels 1PM04J, 1PM05J and 1PM06J as well as the items not addressed during the original review.

The SER also requested that measurements of resistance and/or displacement or torque of round pushbuttons, legend pushbuttons, key operated controls, continuous adjustment rotary controls, rotary selector controls, thumbwheels, and toggle switches be performed. These measurements have been made.

A list of discrepant items is presented in Section 3.0 Checklist item 6.4.3.3 has not been evaluated pending the completion of the legend indicator pushbutton engravings.

2.2.5 Displays

The legend lights were not engraved at the time of the NRC audit and were required to be reviewed to comply with the SER (e.g., ECCS, Auxiliary feedwater, bypass permissive, trip status and loop stop valve permissive). As with the controls, all the displays covered by or respresented by mock-ups required an additional Section 6 checklist audit (1PM04J, 1PM05J and 1PM06J). These reviews have been completed except for the following items:

6.5.1.1e(1)	Demand Information Versus Status Information
6.5.1.6e(3)	Principles of Color Selection
6.5.3.2b	Light Intensity
6.5.3.3a(1)	Visibility Factors
6.5.4.1e	Availability of Expendables
6.5.5.2b	Electronic Counters (rate of change)

2.2.6 Labels and Location Aids

The labeling of the Byron control boards underwent a complete change. Hierarchical labeling was adopted, adding system and subsystem level labels to new component labels (Reference 8). The new labeling encompasses the principles and guidelines detailed in the Byron/Braidwood labeling guide (Reference 7), which was based on the NUREG 0700 guidelines.

Tagging procedures were addressed in response to HED 6.6 identified during the NRC audit. The response is detailed in Supplement I.

2.2.7 Process Computers

All items in the process computer guidelines were addressed including data entry keyboards, computer function controls, data point indices, CRT display controls, operator-display relationships, printer characteristics, and alarm messages.

Those items which remain to be reviewed prior to fuel load include:

6.7.1.7 Computer response time

6.7.2.1 CRT Displays

6.7.2.2 Symbols and Characters

6.7.2.3 Operator-Display relationships

6.7.2.7 Graphic Coding and Highlighting

2.2.8 Panel Layout and Control-Display Integration

At the time of the NRC audit, panels 1PM01J and 1PM02J were unavailable for review. They had undergone an operational review with significant board changes recommended. However, these changes had not been implemented at the time. These panels have since undergone a Section 6.8 and 6.9 checklist review.

In addition, the NRC requested the Remote Shutdown Panel be re-evaluated after the planned mimic was installed. The Task Force performed an extensive review and redesign of the Remote Shutdown panel. Controls and displays were functionally grouped, mirror imaging was eliminated, and displays were lowered. Various enhancements were used systematically including hierarchical labeling, background shading, and a detailed mimic to provide the operator with the proper system layout and control-display integration.

2.3 Checklist Items Deferred to the DCRDR

There are seven Section 6 checklist items that cannot be meaningfully evaluated until operating interdependent plant systems have been fine tuned, integrated, and until actual system operating parameter norms have been established. We therefore propose to defer the following checklist items to the conduct of the DCRDR: 6.1.5.1; 6.2.1.7a; 6.3.1.2a; 6.5.1.1b; 6.5.1.2f; 6.9.3.1c; and 6.9.3.2 .

3.0 NEW DISCREPANCIES, IMPROVEMENTS AND SCHEDULE

3.1 Control Room Workspace

None

3.2 Communications

None

3.3 Annunciator Warning System

None

3.4 Controls

3.4.1 The resistance for fingertip operation of round pushbuttons exceeds the recommended maximum of 40 oz. (6.4.3.2d).

CE Response: Although the resistance is greater than that recommended in NUREG-0700, the difference appears to be acceptable with no significant impact on plant operations. As a result, we propose to defer resolution of this item until the DCRDR.

Implementation: None required

3.4.2 The resistance for operation of legend pushbuttons on the Turbine Panel ranges from 45-52 oz. The regulation states that this measurement should be = 40 oz. (6.4.3.3e(5)).

CE Response: Although the resistance is greater than that recommended in NUREG-0700, the difference appears to be acceptable with no significant impact on plant operations. As a result, we propose to defer resolution of this item until the DCRDR.

Implementation: None required.

3.4.3 The EH Fluid Reservoir Low Level Lockout switch moves to the left when it locks out, but the light indicating "lockout" is on the right.

CE Response: The lights will be re-arranged so that when the switch moves to the left, the left light will come on.

Implementation: Prior to fuel load.

3.5 Displays

3.5.1 Some displays on the upper vertical sections of the boards are calibrated to 0 (zero), because they are powered to a range of 0-10 volts. Other vertical displays are powered by 4-20 milliamps and indicate display failure below the 0 point when de-energized (6.5.1.1f).

CE Response: Two-Out-of-Four or Two-Out-Of-Three logic (and displays) are required for Reactor Protection and Safety related parameters. Because of this the operators are trained to assess and compare redundant instrument indications, regardless of whether or not they fail to below zero. Therefore, the operator will recognize that the failed instrument channel does not agree with its redundant indication. No modifications are necessary.

Implementation: None required

3.5.2 All displays should indicate values in a form immediately usable by the operator without requiring a mental conversion (6.5.1.2b). The RCFC system requires a calculation for humidity. The operator must devise dew point from the indicated dew cell temperature.

CE Response: The dew point and dry bulb temperature are applied against a psychometric chart to find humidity. Although the operator may be required to check humidity on a daily basis, this process is non time critical and can be easily accomplished using available tools.

Implementation: None required.

3.5.3 Breaker switches and pen recorders contain extraneous information such as manufacturers trademarks. This finding generally applies to most controls and displays (6.5.1.4b).

CE Response: These controls and displays are vendor supplied equipment and are delivered with this information permanently applied. The issue is not critical to the operation of the plant. In addition, the I&C labeling was designed to contrast vividly with vendor trademarks.

Implementation: None required.

3.5.4 The paper speed on pen recorders can only be adjusted on the NR-45 nuclear recorder. Other pen recorders have a fixed paper speed. (6.5.4.1i).

CE Response: The prime function of the recorders is to record historical data. Variable speeds on recorders could interfere with the interpretation of the historical data printed on the paper. If parameters are necessary to be varied at higher or lower speeds, a variable speed recorder can be wired in parallel to record the parameters of interest. No further action is warrented.

Implementation: None required.

3.5.5 The RC Wide Range Press Recorder scale (1PM12J) should have more graduation marks. (6.5.4(b)).

CE Response: The scale on the recorder has been replaced with a scale which provides additional graduation marks.

Implementation: Completed.

3.6 Labeling

3.6.1 On the FW Heater and MSR light boxes, it is difficult to tell if the valves are open or closed; the only indication provided is that green = normal, red = abnormal.

CE Response: Labels will be provided along the edge of each row of indicating lights stating the normal position (open or closed) of the valves in that row when in the green condition.

Implementation: Prior to fuel load

3.6.2 The center desk silence buttons are too close together for adequate labeling. Also, a label placed above the Plant Evac Alarm and Plant Wide Fire Alarm pushbutton would not be visible to a seated operator.

CE Response: The buttons will be moved apart to allow correct labeling. The labels for the Plant Evac Alarm and Plant Wide Fire Alarm will be placed on a raised block to allow proper visibility.

Implementation: Prior to fuel load

3.7 Process Computers

None

3.8 Panel Layout

None

3.9 Control Display Integration

None

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Appendix A
Control Room Layout and
Panel Identification

Appendix B
Environmental Surveys

Illumination and Luminance

Illumination and Luminance measurements will be made in the Byron Station Unit 1 Control Room. Illumination measurements will be taken in front of each panel, in the center of the control room, and in front of each back panel. At each position, full AC Ambient and full DC Emergency will be measured. Luminance and reflectance measures will be made at each panel with the reflectance pad on panel, panel background, meter faces and other display faces.

Sound Survey

The Sound Survey will be conducted at the Byron Station Unit 1 Control Room. Measurements will be taken at the Center Desk, unit desk, and other operator work stations including points near the center of each panel and back panel areas requiring communication with the primary operating area.

Measurements will include ambient noise levels, annunciator alarm levels under both ambient and high noise level conditions, telephones and other communication equipment, and evacuation signals and other alarms.

Humidity/Temperature Procedures

Humidity and temperature will be measured prior to plant criticality by setting up meters in areas where they will not be disturbed. Each location of the meter will be identified on a control room layout diagram. Readings at floor level and six feet above floor level will be taken hourly over a 24-hour period. Data will be recorded on a Humidity/Temperature Record.

Air Velocity Survey Procedures

Air velocity will be measured prior to criticality at principal operator workstations. Measurements will be taken at 6-foot elevations for standing positions and 4-foot elevations for sitting positions. Measurements will be recorded on the Air Velocity Survey Record identified in NUREG-0700.

Appendix C
Location Aids

Location Aids

The lack of a hierarchical labeling scheme and lines of demarcation on the control boards was identified in Commonwealth Edison's (CECo) Byron/Braidwood Preliminary Design Assessment (PDA), and the subsequent NRC Human Factors Engineering Control Room Design Review/Audit Report. CECo's response, "Labeling problems will be corrected with the development and implementation of a hierarchical labeling standard," is documented in the SER.

Location aids are used in the Byron plant control room to identify individual components as well as functional relationships among components. Many areas of concern were remedied by using location aids such as hierarchical labeling and functional demarcation lines. These backfits serve primarily to minimize the operators' search and selection uncertainties which could lead to delays, confusion and errors. Location aids also improve the efficiency of information transfer to the operator and assist his decision making process by organizing panel elements, minimizing existing visual clutter, optimizing desired associations between panel elements, and standardizing information presentation. Location aids also facilitate learning and retention of component and control location, especially for new operators.

Labels provide operators with information about the functions of components, subsystems, or systems. The reason for using labels is to convey information in a clear and functionally meaningful manner. One proven method of providing this information is hierarchical labeling, where information for a group of related components is combined to provide a hierarchy of this information.

Components appear to be associated or dissociated depending on how they are presented visually on the panel. Lines of demarcation can be used to aid the operator in identifying control display relations by visually associating related components.

ARD Corporation, in conjunction with the Byron/Braidwood Station Operation Department, developed a design package for labeling and lines of demarcation for the control room instrumentation and controls.

Hierarchical Labeling

The objective of hierarchical labeling is to simplify and highlight the presentation of information in such a way that functionally similar component groups are easily related and integrated at various levels. Hierarchical labeling also decreases the wordiness of individual labels, thereby reducing reading time.

A total-board evaluation supported the integration of the proposed hierarchical labeling in concert with existing perceptual aids and within the physical limitations imposed by the control board structure. Thus, the effort necessarily involved the comprehensive review of 1) mimics, demarcations and background shading 2) the operational meaning of existing label content, 3) the placement of instrumentation, and, 4) human engineering labeling discrepancies related to control room panels. The Byron/Braidwood Generating Stations Control Board Enhancements (Hierarchical Labeling and Lines of Demarcation) report details the application of hierarchical labeling installed as a result of a system-by-system, instrument-by-instrument approach.

Label plate sizes and character specifications were formulated following the identification of system-related instruments, the verification and meaningful change of label content, and the assessment of structural limitations imposed by component design.

All system and subsystem label information appeared on one content line. These labels span the vertical width above the component groups they describe. For example, system label plates are located above the vertical indicator display group of a system. Subsystem label plates are located below system labels and above respective subsystem control groups. In general, information is not repeated on labels below any given hierarchical level. Repeated information appears only where hierarchical labeling eliminated the meaningful identification of a component function with regard to label content, or where a system instrument group is physically bisected by general status indications. For example, Residual Heat Removal instruments appear above and below six arrays of status lights. A system-level label can be found above the RH indicator displays and above the RH controls that resume below the status light arrays. This application was used to afford system continuity.

Repeated information was also used where hierarchical labeling would eliminate the meaningful identification of a component's function with regard to label content. In this case, where redundancy was used, it appeared in the form of the system abbreviation. For example, pump controls of two adjacent systems on the 45 degree section of the benchboard would otherwise be similarly labeled, i.e., PP 1A, PP 1B, PP 1A, etc. The system abbreviation was applied as a prefix to avoid the inadvertent actuation of a wrong pump. For example, CS PUMP 1A. Also, the word "PUMP" was not abbreviated on pump switches.

Finally, redundant information, in the form of the system abbreviation, was applied to controls that governed a directional process. For example, several charging controls of the CVCS contained labels: CHG TO REGEN HX 1B ISOL VLV and CHG TO RC LOOP 1B ISOL VLV. In this case, CHG is the abbreviation for the system "Charging" within CVCS.

In summation, hierarchical labeling was applied as a result of a total-board evaluation that followed a system-by-system delineation. As an aid for operator performance: 1) excessive and redundant verbiage was appropriately removed, 2) alphanumeric characters were enlarged for optimal viewing at a sufficient working distance, 3) the operational flow, meaning and identification of systems were enhanced, and 4) procedural descriptions of components were preserved by "reading through" the hierarchical levels.

Label Characters

The size of characters required for adequate legibility depends on viewing distance and illumination levels. The letter heights selected for Byron/Braidwood hierarchical labeling adhere to the guidelines specified in NUREG-0700. The letter height for each level is 50% greater from bottom to top and are as follows:

System level labels	0.45 inches
Subsystem level labels	0.30 inches
Component level labels	0.20 inches

The spacing between lines and on the outside edge of each label varies with component level labels depending on the type of control or display.

With respect to letter height, letter specification constants were based on those recommended in Section 6.6 of NUREG-0700. These included:

1) Medium stroke width to character height = 1/7
2) Maximum letter width to character height = 3/5
3) Minimum space between characters = 1 stroke width
4) Minimum space between words = 1 letter width
5) Minimum space between lines = 1/2 letter height
6) Maximum number width to character height = 3/5
   Except 4; = add 1 stroke width
   Except 1; = one stroke width

Helvetica Medium uppercase letters were recommended for the lable fonts.

Demarcation

Lines of demarcation were applied to the control boards of the main control room to partially satisfy the discrepant items identified in the Byron/Braidwood SER.

Within systems identified by lines of demarcation, a further use of this technique helped identify subsystem control groups. For example, the Reactor Coolant System instruments were grouped by demarcation on 1PM05J. Within this system, on the lower board section, are controls associated with the four reactor coolant loops. The four loops were separated by vertical lines of demarcation. The subsystem distinction was achieved by the use of half-width lines with respect to the predominant system-related line width.

As a rule, lines of demarcation on the common panels were vertical, providing an adjacent organization of systems. Horizontal lines were applied to separate vertically positioned or "stacked" systems. Lines of demarcation were not applied to group-related components spaced across common panels. Background shading was applied in these cases and is addressed in a separate report.

Lines of demarcation design recommendations were a result of a total-board evaluation that followed a system-by-system approach. The design was applied to work in concert with other enhancement aids in order to provide an effective delineation of information to assist the operator.

Background Shading

Background shading was applied to the control boards of the main control room and the remote shutdown panel. Areas on the main conrol room boards included the main control panel benchboards, common vertical panels and back panels for both units. Principles for color use, outlined in sections 6.5 and 6.6 of NUREG-0700, guided the selection of colors to be used on the control panels. Colors were selected from a pool of high-contrast and matte finish shades applied against a "Kewanee Beige" board color. A total of 25 colors were applied across all control boards for background shading. An additional six were applied for electrical bus mimics. As an engineered retrofit, their application extended from a total-board design evaluation that followed a system-by-system approach.

Design

In general, controls and displays were found to be grouped by function with few "extraneous" or "maverick" components. However, in these few cases, background shading afforded a means to functionally group them. Relatively higher contrast colors were selected in these cases to compensate for relatively short distances. Both the main component group and their "maverick" components in a system were colored identically.

Safety-related component groups were background shaded. For example, the "Manual Engineered Safeguards Actuation and Reset" controls were located primarily on the Engineered Safeguards panel. However, these controls also appeared on panels across the total benchboard control area. Similarity of function, in these cases, served as the basis for their grouping by a common background shade. Higher contrast colors were selected to compensate for widely spaced component groups belonging to a common function.

A third use of background shading was applied to systems nested among others. In the few cases this technique was applied, the results showed vivid separation among three to five awkwardly shaped component groups. Thus, one centrally positioned system was given a background shade enhancing the separation of adjacent systems.

Finally, background shading was applied to component groups that were functionally related, but where that function was accomplished by independent inputs. For example, the General Services common panel controls the essential service water cooling towers. Towers OA and OB are shared by both units;

however, specific equipment within each tower is powered by either Unit 1 or Unit 2. Moreover, there are centrally located control/display groups that pertain to the SX system as a whole, and are not differentiated by SX Tower Basins.

Background shading facilitated the distinction by the application of different values and chroma of the same hue. For example, the common controls/displays of Unit 1 in both towers were assigned according to value and chroma. Additionally, controls governing the basins of Unit 2 in both towers were varied according to value and chroma.

On the whole, the selection and use of background shading was designed to work in concert with other perceptual aids and the placement design of instruments. The total-board design evaluation held in check the potential overuse of one or more perceptual aids. Thus, where background shading was applied, its use was conservative, necessary, and meaningful for operator performance.

Appendix D
Annunciator Review

Annunciator Review

The message display is the portion of the annunciator system which tells the operator the specific event that has occurred, or informs him that a critical set point has been exceeded and that a specific event may occur. Given this purpose, the design of message displays should facilitate rapid and accurate interpretation by operators. Common inadequacies of annunciator message displays that tend to degrade the presentation of information to operators include:

- Inadequate functional grouping of windows
- Inconsistent message formats and nomenclature
- Inadequate quality of lettering
- Inconsistent coding schemes

The Task Force performed two annunciator reviews for CECo's Byron/Braidwood stations. These reviews were performed to satisfy licensing requirements which specify that nuclear power plant control rooms undergo a human factors engineering design review. Both reviews were performed using NRC guidance criteria published as NUREG-0700. The first review (the Byron/Braidwood Preliminary Design Assessment-PDA) identified a number of Human Engineering Discrepancies (HEDs) associated with the annunciator system. The nature of these HEDs involved some of the inadequacies presented above including inconsistent message formats and nomenclatures, lettering quality, and inconsistent coding schemes.

Subsequently, the NRC (Human Factors Safety Branch) conducted an audit of this first review, published an audit review report, and indicated in the Byron/Braidwood SER their evaluation of which HEDs should be corrected prior to fuel loading.

The second review was performed to resolve these discrepancies. It consisted of a functional reivew of the common and unit-specific annunciator windows on both a box-by-box and a tile-by-tile basis. In addition, a survey was developed and administered to operating personnel so their accumulated experience could be factored into improving the annunciator system. The review was done in concert with the labeling review to ensure that the annunciator tile legend abbreviations would correspond to those being engraved on the system, subsystem and component labels as well as to the annunciator response procedure (BAR).

Appendix E
List of Byron/Braidwood
Station Abbreviations
(Revision 3)

III. APPROVED STATION ABBREVIATIONS

AB	Boric Acid Processing
ABSORB	Absorber
AC	Acid Feed & Handling (except Boric Acid)
ACCEL	Acceleration
ACCESS	Accessible
ACCUM	Accumulator
ACB	Air Circuit Breaker
ACT	Actuator
ACTD	Actuated
ACTL	Actual
ADD	Additive
ADJ	Adjust
AEER	Auxiliary Electric Equipment Room
AF	Auxiliary Feedwater
AMB	Ambient
AN	Annunciator
ANAL	Analyzer
AOV	Air Operated Valve
AP	Auxiliary Power 480V and Above
AR	Area Radiation Monitoring
ARG	Argon
AS	Auxiliary Steam
ASO	Auto Stop Oil
ASSY	Assembly
ATMOS	Atmosphere

AUCT	Auctioneered
AUTO	Automatic
AUX	Auxiliary
AVAIL	Available
AVG	Average
BA	Boric Acid
BAG	Administrative Guidelines
BAP	Administrative Procedures
BAR	Annunciator Response Procedures
BARR	Barrier
BAT	Boric Acid Storage Tank
BATT	Battery
BCA	Contingency Actions
BCG	Chemical Guidelines
BCMS	Boron Concentration Measurement System
BCP	Chemical Control Procedures
B/D	Blowdown
BEP	Emergency Procedures
BEP ES	Emergency Procedures - Event Specific
BFP	Fuel Handling Procedures
BFR	Functional Restorations
BG	Bottled Gas
BGP	General Operating Procedures
BHP	Maintenance Electrical Procedures
BHS	Maintenance Electrical Surveillance Procedures
BIP	Instrument Procedures
BIS	Instrument Surveillance Procedures

BIST	Bistable
BI	Boron Injection
BIT	Boron Injection Tank
BKG	Office Guidelines
BKWH	Backwash
BLDG	Building
BLNDR	Blender
BLR	Boiler
BMG	Maintenance Guidelines
BMP	Maintenance Procedures
BNK	Bank
BOA	Abnormal Procedures
BOG	Operating Guidelines
BOP	System Operating Procedures
BOS	Operating Surveillance Procedures
BR	Boron Thermal Regeneration
BRCH	Breeching
BRG	Radiation Protection Guidelines
BRKR	Breaker
BRNG	Bearing
BRP	Radiation Protection Procedures
BSG	Security Guidelines
BSN	Basin
BSP	Security Procedures
BST	Status Trees
BSTR	Booster

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BTG	Training Guidelines
B/U	Backup
BVG	Technical Guidelines
BVP	Technical Procedures
BVS	Technical Surveillance Procedures
BWG	Stores Guidelines
BYA	Rx Trip Bypass Brkr A
BYB	RX Trip Bypass Brkr B
BYP	Bypass
BZP	Byron Emergency Plan Implementation Procedure
CAB	Cabinet
CAL	Calibration
CAV	Cavity
CB	Condensate Booster System
CBA	Control Bank A
CBB	Control Bank B
CBC	Control Bank C
CBD	Control Bank D
CBL	Cable
CC	Component Cooling
CD	Condensate System
CDSR	Condenser
CENT	Centrifugal
CF	Chemical Feed & Handling
CH	Channel
CHEM	Chemical

CHG	Charging
CHGR	Charger
CHAR	Charcoal
CHLR	Chiller
CIRC	Circulating
CKT	Circuit
CL	Cold Leg
CLG	Cooling
CLR	Cooler
CMPSATING	Compensating
CNDS	Condensate
CNDSR	Condenser
CNMT	Containment
CMO	Carbon Monoxide
CO2	Carbon Dioxide
CO	Carbon Dioxide System
COL	Column
COLL	Collection
COMP	Compressor
CONC	Concentration
COND	Conductivity
CONT	Control
CONN	Connection
CONSTR	Construction
COST	Clean Oil Storage Tank
CPS	Counts per Second

CPTR	Computer
CQ	Communication (Code Call, Public Address, Telephone, Evacuation Alarm, Station Security, etc.)
CR	Cold Reheat Steam
CRDM	Control Rod Drive Mechanism
CS	Containment Spray
CSD	Cold Shutdown
CSR	Cable Spreading Room
CST	Condensate Storage
CUB	Cubicle
CU-FT	Cubic Feet
CV	Chemical and Volume Control System
CW	Circulating Water
CX	Computer and Power Supply
DA	Deaerator Tank
DC	Battery and DC Distribution
DEAER	Deaerator
DECON	Decontamination
DEG	Degrees
DEHC	Digital Electrical Hydraulic Control
DELTA T	THOT - TCLD (also "ΔT")
DEMIN	Demineralizer
DET	Detector
DETECT	Detection
DEV	Deviation
DG	Diesel Generator
DIFF	Differential

DIRECT	Direction
DISC	Disconnect
DISTIL	Distillate
DISTR	Distribution
DIV	Division
DM	Drains, Misc. Bldgs. (Crib House, Pumphouse) floor and roof including Sump Pumps - Non-Radioactive
DMPR	Damper
DP	Differential Pressure
DO	Diesel Fuel Oil
DOT	Dirty Oil Tank
DRM	Drum
DRN	Drain
DRPI	Digital Rod Position Indication
DRV	Driven
DSCH	Discharge
DV	Feedwater Heater Misc. Drains and Vents
DWST	Downstream
EA	Emergency Air
ECCEN	Eccentricity
ECCS	Emergency Core Cooling System
EDL	Equipment Daily Logs
EDUC	Eductor
EF	Engineered Safety features, Logic Testing & Actuation
EFF	Effluent
EH	Turbine EHC
ELEC	Electric

ELEV	Elevation
EM	Environs Monitoring (including Strong Motion - Seismic Instrumentation)
EML	Equipment Monthly Logs
EMER	Emergency
ENG	Engine
ENGD	Engaged
EPN	Equipment Piece Number
EQUAL	Equalizing
EQUIP	Equipment
ES	Extraction Steam
ESD	Engineered Safeguards Display
ESF	Engineered Safety Feature
EVAP	Evaporator
EW	Welder Outlets
EWL	Equipment Weekly Logs
EXC	Excess
EXH	Exhaust
EXP	Expansion
EXT	Extraction (Steam)
F	Fahrenheit
FAI	Failed As Is
FC	Fuel Pool (Pit) Cooling & Cleanup
FCLD	Failed Closed
FCV	Flow Control Valve
FD	Feed
FH	Reactor Fuel Handling & Transfer System

FHB	Fuel Handling Bldg
FI	Flow Indicator
FIS	Flow Indicating Switch
FLNG	Flange
FLTR	Filter
FLTRED	Filtered
FO	Fuel Oil
FOPN	Failed Open
FP	Fire Protection and Detection (excluding CO_2 Systems)
FREQ	Frequency
FT	Flow Transmitter
FU	Fuse
FUT	Future
FW	Main Feedwater
FWIV	Feedwater Isolation Valve
FWST	Filtered Water Storage Tank
FWTP	Filtered Water Transfer Pump
GAL	Gallons
GC	Generator Stator Cooling (including Excitation Cubicle Cooling)
GD	Grounding and Cathodic Protection
GEN	Generator
GENS	Generator Supervisory
GLND	Gland
GOV	Governor
GRD	Ground
GRP	Group

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GS	Turbine Gland Seal Steam
GSC	Gland Steam Condenser
GV	Governor Valve
GW	Radioactive Waste Gas (excluding Off-Gas)
H2	Hydrogen (in general)
HC	Hoists, Cranes, Elevators & Manlifts (except Fuel Handling and Transfer System)
HD	Feedwater Drains-Turbine Cycle (Heater Drains)
HDR	Header
HG	Mercury
HGA	Mercury Absolute
HI	High
HOV	Hydraulic Operated Valve
HP	High Pressure
HR	Hot Reheat Steam
HSD	Hot Shutdown
HST	Hot Standby
HT	Heat Tracing (excluding those associated with specific systems)
HTG	Heating
HTR	Heater
HTRS	Heaters
HUMID	Humidity
HUT	Hold-Up Tank
HVAC	Heating, Ventilation and Air Conditioning
HWT	Hot Water Tank
HX	Heat Exchanger
HY	Hydrogen System

HYD	Hydraulic
HYPO	Hypochlorite, Sodium
I&C	Instrumentation and Control
IA	Instrument Air Supply
IC	Incore Flux Mapping
ICNMT	Inside Containment
IN	Inches
IMB	Inside Missile Barrier
IMP	Impulse
INACCESS	Inaccessible
IND	Indicator
INDUCT	Induction
INF	Influent
INJ	Injection
INLT	Inlet
INSP	Inspection
INST	Instrument
INTERMED	Intermediate
IP	Instrument and Control Power (including Inverters, MG Sets)
IR	Intermediate Range
IS	Industrial Security (including Gate Operators and Gate TV)
ISOL	Isolation
IT	Incore Thermocouple System
JUNC	Junction
KLB/HR	Thousand Pounds Per Hour
LA	Lightning Arrestor

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B.O.S.R.

LBB	Local Breaker Backup
L.C.	Locked Closed
LCS	Level Control Switch
LCV	Level Control Valve
LCO	Limiting Condition for Operation
LCOAR	Limiting Condition for Operation Action Requirement
LD	Load Dispatcher
LI	Level Indicator
LIQ	Liquid
LIS	Level Indicating Switch
LK	Leak
LL	Lighting
LM	Loose Parts Monitoring
LO	Low
L.O.	Locked Open
LOCA	Loss of Coolant Accident
LP	Low Pressure
LSH	Lake Screen House
LT	Level Transmitter
LTD	Line Tension Disconnect
LTDWN	Letdown
LV	Auxiliary Power Low Voltage 120/208V Transformers Distribution
LVL	Level
LWR	Lower
MACH	Machine
MAN	Manual

MAX	Maximum
MB	Mixed Bed
MCC	Motor Control Center
MCR	Main Control Room
MECH	Mechanism
MEER	Misc. Electrical Equip Room
MET	Meteorological
METH	Methane
M/G	Motor-Generator
MIN	Minimum
MISC	Miscellaneous
MLB/HR	Million Pounds Per Hour
MOD	Motor Oper. Disconnects
MODER	Moderating
MON	Monitor
MOV	Motor Operated Valve
MP	Main Power (Generator, Exciter, Main Transformers, Bus Duct)
MPH	Miles Per Hour
MS	Main Steam
MSIV	Main Steam Isolation Valve
MSR	Moisture Separator Reheater
MSRMENT	Measurement
MSTR	Moisture
MTR	Motor
M/U	Makeup
N2	Nitrogen (in general)

NAOH	Sodium Hydroxide
NAR	Narrow
NEG	Negative
NIS	Nuclear Instrumentation System
NO	Number
NORM	Normal
NPSH	Net Positive Suction Head
NR	Neutron Monitoring (out of core)
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
NT	Nitrogen System
O2	Oxygen (gas or liquid)
OBSTRUCT	Obstruction
OC	Overcurrent
OCB	Oil Circuit Breaker
OCNMT	Outside Containment
OD	Equipment and Floor Oil Drain Disposal (including sump pumps)
OG	Off-Gas (including Hydrogen Recombiner)
OH	Caustic Handling
OMB	Outside Missile Barrier
OOS	Out of Service
OPDT	Over Power Delta Temperature
OPER	Operating
ORIF	Orifice
OT	Bearing Oil Transfer and Purification (for Turbine Generator & Turbine Drives)
OTDT	Over Temperature Delta Temperature

OUTLT	Outlet
OVRSPD	Overspeed
PA	Auxiliary Control Equipment Room & Computer Room Panels & Cabinets (Equipment Arrangement)
PC	Primary Containment Isolation
PCT	Percent
PCV	Pressure Control Valve
PD	Positive Displacement
PEN	Penetration
PERM	Permissive
PI	Pressure Indicator
PIND	Pressure Indicator
PL	Local Instrument Panels (Equipment Arrangement)
PLEN	Plenum
PM	Main Control Room Panels (Equipment Arrangement)
PMG	Permanent Magnet Generator
PMPS	Pumps (Plural)
PNEU	Pneumatic
PNL	Panel
PNT	Point
POP	Power Operation
POS	Position
POT	Potentiometer
PP	Pump
PPM	Parts per Million
PR	Process Radiation Monitoring
PRESS	Pressure
PREVENT	Prevention

PRG	Purge
PRI	Primary
PROT	Protection
PRT	Pressurizer Relief Tank
PRV	Pressure Regulating Valve
PS	Process Sampling Primary & Secondary System (including Chiller Equipment)
PT	Pressure Transmitter
PTL	Pull-to-Lock
PUR	Purifier
PW	Primary Water
PWR	Power
PWST	Primary Water Storage Tank
PZR	Pressurizer
Q	Nuclear Flux
RAD	Radiation
RADWASTE	Radioactive Waste
RB	Reactor Building
RC	Reactor Coolant (not including Pressurizer System)
RCDT	Reactor Coolant Drain Tank
RCFC	Rx Containment Fan Cooler
RCP	Rx Coolant Pump
RCVR	Receiver
RD	Control Rod Drive (full length & part length)
RDT	Reheater Drain Tank
RE	Reactor Building and Containment Equipment Drains to Radwaste (including Reactor Coolant Drain Tank & Pumps)

RECDR	Recorder
RCG	Receiving
RECIRC	Recirculation
RECOMB	Recombiner
REF	Reference
REFRIG	Refrigeration
REFU	Refueling
REG	Regulator
REGEN	Regeneration
REL	Relative
RES	Reserve
REV	Revision
RF	Containment Floor Drains to Radwaste (including Sump Pumps)
RH	Residual Heat Removal (RHR)
RHT	Reheat
RHTR	Reheater
RIL	Rod Insertion Limit
RLF	Relief
RLY	Relay
RM	Room
RMT	Remote
RMT/MNL	Remote Manual
RNG	Range
RP	Reactor Protection
RSH	River Screen House
RSN	Resin

RSRVR	Reservoir
RST	Reset
RTA	Rx Trip Brkr A
RTB	Rx Trip Brkr B
RTD	Resistance Temperature Device
RTRN	Return
RTS	Return to Service
RV	Reactor Vessel
RVLIS	Reactor Vessel Level Indication System
RWST	Refueling Water Storage Tank
RWT	Rinse Water Tank
RX	Reactor
RY	Reactor Coolant Pressurizer System
SA	Service Air
SAC	Service Air Compressor
SAF	Safety
SAMP	Sample
SAT	Station Auxiliary Transformer
SB	Service Building
SBA	Shutdown Bank A
SBB	Shutdown Bank B
SBC	Shutdown Bank C
SBD	Shutdown Bank D
SBE	Shutdown Bank E
SC	Strong Cation
SCRN	Screen

SD	Steam Generator Blowdown System
S/D	Shutdown
SEC	Secondary
SECT	Section
SEP	Separator
SEQ	Sequence
SER	Sequence of Events Recorder
SERV	Service
SFGD	Safeguard
SFP	Spent Fuel Pool
S/G	Steam Generator
SH	Station Heating (excluding ducted air systems)
SI	Safety Injection
SJAE	Steam Jet Air Ejector
SNUB	Snubbers
SOLN	Solution
SOV	Solenoid Operated Valves
SPEC	Specification
SPR	Spray
SPRD	Spreading
SPSO	System Power Supply Office
SR	Source Range
SRGE	Surge
SS	System Security (automatic dispatch)
ST	Sewage Treatment
STA	Station

STDBY	Standby
STG	Stage
STM	Steam
STO	Storage
STPT	Setpoint
STRN	Strainer
SUBCOOL	Subcooling
SUR	Startup Rate
SUCT	Suction
SUP	Supply
SUPERVSRY	Supervisory
S/U	Startup
SVAG	Spurious Valve Actuation Guideline
SW	Screen Wash
SWIT	Switch
SWGR	Switchgear
SWYD	Switchyard
SX	Essential Service Water
SYNC	Synchronize
SYS	System
T	Temperature (also "Temp")
TAVE	(TCLD + THOT)/2
TB	Turbine Building
TC	Thermocouple
TCLD	Cold Leg Temperature
TCV	Temperature Control Valve

TD	Turbine Drains and Vents
TE	Turbine Building Equipment Drains
TECH	Technical
TEMP	Temperature (also "T")
TEMPRNG	Tempering
TERT	Tertiary
TF	Turbine Building Floor Drains
TG	Turbine Generator Auxiliaries and Misc. Devices (Turning Gear, etc.)
TGTMS	Turbine Generator Temperature Monitoring System
THERM	Thermal
THOT	Hold Leg Temperature
THRT	Throttle
TI	Temperature Indicator
TIS	Temperature Indicating Switch
TK	Tank
TO	Turbine Oil (Bearing Oil & Seal Oil Systems furnished with Turbine Generator)
TR	Waste Water Treatment
TRAV	Traveling
TREF	Reference Temperature
TRN	Train
TS	Turbine Supervisory
TT	Temperature Transmitter
TURB	Turbine
TW	Treated Water (including Clarifier & filtered water)
TWR	Tower

U-0	Unit Common
U-1	Unit One
U-2	Unit Two
UAT	Unit Auxiliary Transformer
UPST	Upstream
UV	Undervoltage
VA	Auxiliary Building HVAC
VAC	Vacuum
VAP	Vaporizer
VAR	Variable
VC	Control Room HVAC System
VCT	Volume Control Tank
VD	Diesel Generator Room Ventilation
VE	Misc. Electrical Equipment Room Vent.
VF	Containment Building and Auxiliary Building Filtered Vents
VH	Pump House Ventilation
VI	Radwaste and Remote Shutdown Control Room HVAC
VIB	Vibration
VJ	Machine Shop Ventilation
VK	Switchyard Relay House HVAC
VL	Laboratory HVAC
VLV	Valve
VN	Containment Building and Auxiliary Building Non-Filtered Vents
VOL	Volume
VOLT	Voltage
VP	Primary Containment Ventilation

VQ	Primary Containment Purge
VR	Volume Reduction
VS	Service Building HVAC
VT	Turbine Building Ventilation
VV	Miscellaneous Ventilation (including Gate House, Receiving Building, Bottled Gas Enclosure, and Waste Water Treatment Building)
VW	Radwaste Facility Ventilation
VX	Switchgear Heat Removal
WC	Weak Cation
WD	Raw Water & Potable Water
WE	Fuel Handling Building Equipment Drains
WF	Aux. Bldg. Floor Drain Radwaste Reprocessing and Disposal
WG	Gland Water
WM	Make-Up Demineralizer (including Effluent & Flushing)
WNDG	Winding
WO	Plant Chilled Water
WR	Wide Range
WS	Non-Essential Service Water
WT	Weight
WTR	Water
WW	Well Water
WX	Solid (Wet and Dry) Radwaste Reprocessing and Disposal
WY	Laundry Equip. and Floor Drains Radwaste Reprocessing and Disposal
WZ	Chemical Radwaste Reprocessing and Disposal
XFER	Transfer
XFMR	Transformer

XTIE	Cross-Tie
1ST	First
2ND	Second
Δ F	Delta Flux
Δ T	Thot - T CLD (also "Delta T")

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