PRELIMINARY HUMAN ENGINEERING ASSESSMENT OF THE SAINT LUCIE UNIT 2 NUCLEAR POWER PLANT CONTROL ROOM

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1.0 INTRODUCTION

1.1 Background

On April 29th, 1981, the Essex Corporation was contracted by the Florida Power and Light Company (FP&L) to provide human engineering (HE) consulting services to assist in the assessment of several nuclear power plant control rooms. One task of Essex's was to conduct a preliminary prelicensing review of the Saint Lucie unit 2 control room (CR). This report presents the results of the preliminary HE review.

Saint Lucie unit 2 (SL-2) is a Combustion Engineering (CE) PWR with Westinghouse turbines and generators. The EBASCO Corporation serves as the Architect/Engineer. The plant is located by the Atlantic Ocean, approximately 12 miles south of Fort Pierce, Florida.

The plant is a two loop PWR that produces 880 Megawatt of electricity. The plant uses seawater for cooling. As of May, 1981, plant construction was approximately 70% complete.

The control room is configured as shown in Figure 1. As shown, the main boards of the control room (CR) are arranged more or less as a dogleg with plant support and monitoring panels and boards placed at various points in the room. More detailed descriptions of the main boards are provided here:

- o Panel 201 - This section contains the emergency diesel generators, main plant buses, turbine and generator controls and displays for the plant.
- o Panel 202 - Located here are controls and instruments concerning condensate system, circulating water, main and auxilliary feedwater system and steam generators.
- o Panel 203 - This panel contains the controls and displays for the primary core cooling system.
- o Panel 204 - Located here are the primary nuclear instrumentation and control element assemply drive mechanisms.
- o Panel 205 - This is the Chemical and Volume Control System panel.
- o Panel 206 - Controls and displays for the Emergency Core Cooling System and Component Cooling Water System are contained in the panel.

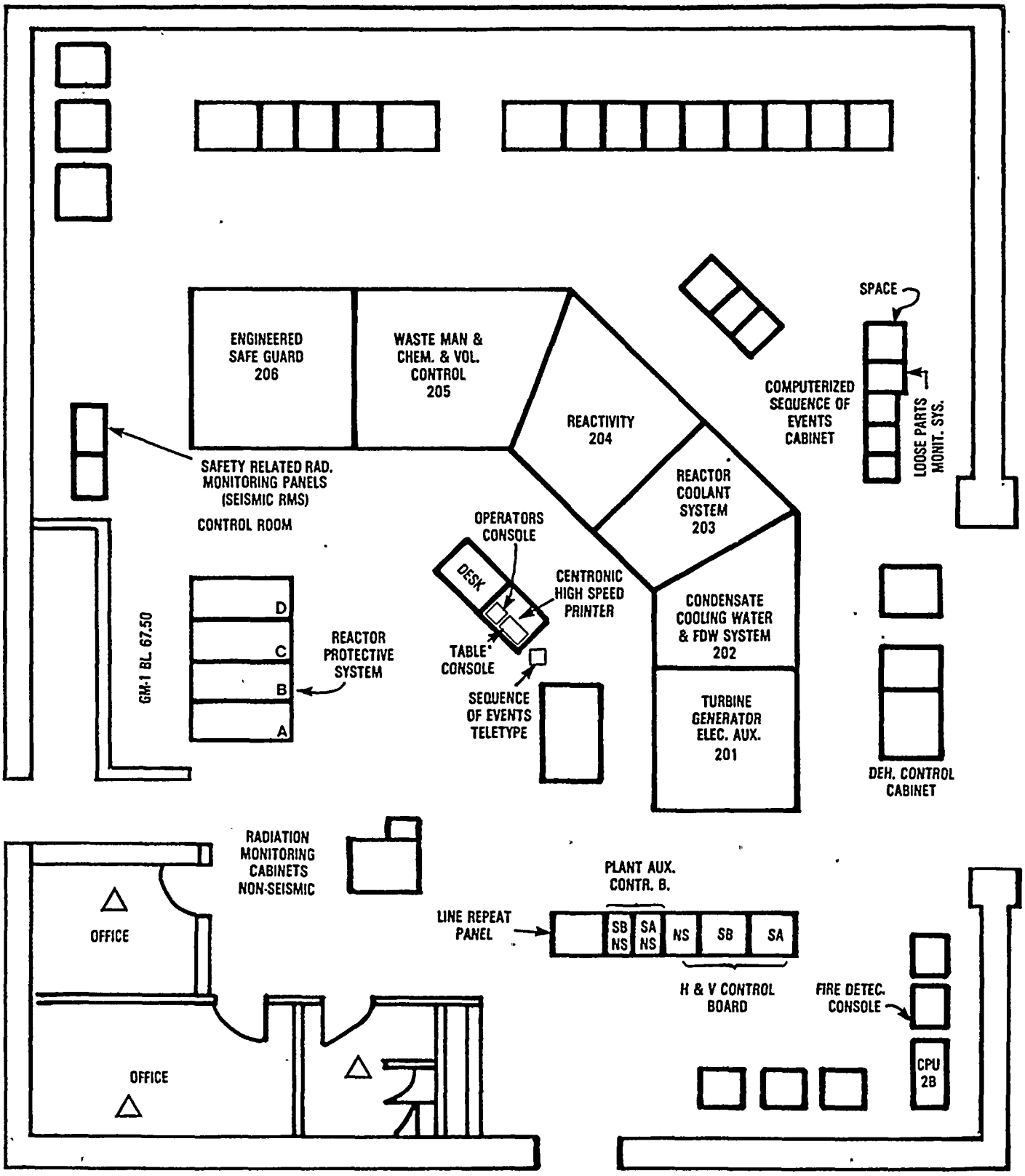
ENGINEERED SAFE GUARD 206
WASTE MAN & CHEM. & VOL. CONTROL 205
REACTIVITY 204
REACTOR COOLANT SYSTEM 203
CONDENSATE COOLING WATER & FDW SYSTEM 202
TURBINE GENERATOR ELEC. AUX. 201
SPACE
COMPUTERIZED SEQUENCE OF EVENTS CABINET
LOOSE PARTS MONIT. SYS.
SAFETY RELATED RAD. MONITORING PANELS (SEISMIC RMS)
CONTROL ROOM
OPERATORS CONSOLE
DESK
CENTRONIC HIGH SPEED PRINTER
TABLE CONSOLE
SEQUENCE OF EVENTS TELETYPE
GM-1 BL 67.50
D
C
B
A
REACTOR PROTECTIVE SYSTEM
DEH. CONTROL CABINET
RADIATION MONITORING CABINETS NON-SEISMIC
OFFICE
OFFICE
PLANT AUX. CONTR. B.
LINE REPEAT PANEL
SB NS
SA NS
NS
SB
SA
H & V CONTROL BOARD
FIRE DETEC. CONSOLE
CPU 2B

FIGURE 1

1.2 Overall CR Assessment Purposes, Methods and Objectives

The purpose of the effort was to identify human engineering design discrepancies in the SL-2 control room.

The effort extended to the evaluation of:

- CR workspace and environment,
- Labels and job performance aids,
- Controls,
- Displays,
- Annunciators and warnings,
- Computer display systems,
- Control and display layout and integration.

The assessment was conducted in a set of discrete tasks discussed in the next section.

2.0 EVALUATION APPROACH, BY TASKS

2.1 Assemble Project Library

2.1.1 Objectives

- To assemble a library of CR related documentations to support the NTOL review,
- To organize the documentation for easy access by all NTOL review team members.

2.1.2 Method

- The following documents were acquired for inclusion in the library:

  System descriptions (FSAR)

  P&IDs

  Software descriptions

  Training materials

  Panel layout drawings/CR floor plan

  Annunciator response procedures

  Instrument lists

2.1.3 Data Reduction and Analysis

None.

2.2 Develop Photo Mosaic

2.2.1 Objectives

- To photograph the CR panels for assembly into a 1/4 scale mosaic of the current CR configuration,
- To prepare a photomosaic suitable for panel evaluation and development of typical reports.

2.2.2 Method

CR panels were filmed in color in uniform sections (same sized photo representation of panel areas). Each frame was developed into a 1/4 scale of original. Photos were then pieced together into a mosaic for each major panel section, pasted to a board, and covered with an acetate material.

2.2.3 Data Reduction and Analysis

None. The mosaic was used for: 1) surveys (selected); 2) checklists (selected); 3) examination of control/display layout; 4) HED reviews by Essex; and 5) development of typical backfits.

2.3 Conduct of Surveys

Control room surveys are presented in this section. These include:

1. Lighting,
2. Emergency gear,
3. Noise,
4. Generic checklist applications.

Given that the St. Lucie 2 CR has not yet been completed, lighting, emergency gear, and noise survey data have been taken from St. Lucie 1. To the extent that these data generalize to the sister plant, St. Lucie 2, they may be used for discrepancy generation. Specifications for the above were also supplied to FP&L, since unit 1 data will not be precisely coincident with unit 2. Where discrepancies were identified in unit 1, this is indicated in the Results section of this report.

Objectives, instrumentation, methods, data reduction and analysis, and findings (where applicable) for each survey is described below.

2.3.1 Lighting Survey

2.3.1.1 Objectives

The objective of this evaluation was to measure the ambient illumination in the control room and to assess its impact on the operators' ability to read and interpret displays, controls, labeling, and printed matter such as drawings and procedures.

2.3.1.2 Instrumentation

The ambient illumination was measured using a Techtronics J-16 photometer and probe, calibrated prior to use.

2.3.1.3 Method

The ambient lighting survey was conducted under normal lighting conditions. Measurement of ambient illumination was taken at 15 operator positions. These positions included the following:

- Reactor Operator's work desk,
- Senior Reactor Operator's work desk,
- Each panel,
- Each point where reading of printed material might be required,
- Back panels behind the main control boards.

The measurements were taken for all positions selected under normal lighting conditions. The light meter was held with the meter pointed at the ceiling, where the position required reading a specific type of printed material. The data were recorded on a form for subsequent analysis.

2.3.1.4 Data Reduction and Analysis

Data were placed on the form shown in Appendix A, and compared to the NUREG 1580 Guidelines covering control room illumination.

2.3.2 Emergency Garments

2.3.2.1 Objective

This task yields information needed to complete the human engineering checklists. In general the results indicate problems in performing control room operations while using the protective clothing and/or breathing apparatus.

2.3.2.2 Method

The accessibility and usability of CR emergency garments was evaluated by visual observation of the equipment, and a cursory use of selected items (e.g., face masks), by a HE analyst.

2.3.2.3 Data Reduction and Analysis

A list was made that describes factors that might reduce operator reliability, for instance:

- Visibility of breathing apparatus face mask,
- Tactile discrimination through gloves,
- Speech impairment through face plate,
- Hearing impairment (noise of breathing apparatus),
- Size of gloved hand (inadvertent actuation).

2.3.3 Generic Checklists

2.3.3.1 Objective

The objective of this review was to determine if the SL-2 control room manifests human engineering shortcomings characteristic of other nuclear power plants.

The objective in reviewing the issues listed as generic industry problems was to provide the reviewer with 1) a point of reference, and 2) a broad, general review of the control room with emphasis on identifying major issues which are highly likely to occur based on reviews of similar plants.

2.3.3.2 Method

Using a list of generic discrepancies, a panel by panel and system by system review was conducted. Noted were CR characteristics which violated human engineering practices listed in the generic checklist.

2.3.3.3 Data Reduction and Analysis

Application of generic checklists immediately identifies human engineering discrepancies from the guidelines. As they are identified, discrepancy reports are written and entered into the HED review process.

2.3.4 Noise

2.3.4.1 Objective

The objective of this survey was to measure the ambient noise levels in the control room from various operator positions and to assess its impact on the operators' ability to verbally communicate and/or discriminate audible signals. The measurements were made using the Saint Lucie unit 1 control room.

2.3.4.2 Instrumentation

In the performance of this study a General Radio Corporation, Model 1983 sound level meter was used.

2.3.4.3 Method

The performance of this evaluation required the consideration of not just normal control room noise but any factors that can add to the overall noise level. Included in this were the occasional noises of very short duration that can cause high peak levels.

a. Noise Conditions — The noise survey started with a basal noise level. This is the ambient noise without alarms, printers, or communications equipment contributing. Once this measurement has been taken, potential noise sources were integrated into the ambient environment, by measurement of peak noise levels. The following were considered as potential noise sources:

- Audible alarms,
- Typers and printers,
- Communications equipment (ringing telephones, P.A.s, radios),
- Emergency or atypical environmental control systems (air conditioning, exhaust fans),
- Loud conversation,
- External to the Control Room,
- Open doors leading out of the control room.

b. Survey Conduct — Noise measurements were taken at 13 operator positions that required verbal communication and/or auditory discrimination of a signal. This included the Reactor Operator's desk position, the Senior Reactor Operator's desk position, two points on the each panel/board, and two positions at back panels requiring communication. Two measurements were taken at each position, one measuring basal noise levels, the other measuring peak noise over approximately a two minute interval. Measurements were taken flat (dB), and in a weighting (dB"A"). A form used to collect those data is contained in Appendix A. The instrument was calibrated before, during and after conduct of the survey.

2.3.4.4 Data Reduction and Analysis

The collected data were compared to the 1580 guidelines. Values that exceed the established limits were noted and a Human Engineering Discrepancy Report was completed.

2.3.5 Design Convention Survey

2.3.5.1 Objective

This survey yielded a listing of design conventions used in the control room, and was used to identify interfaces that violate CR established conventions.

2.3.5.2 Method

Examples of controls, displays, labels, etc., were surveyed and conventions recorded. Where design conventions were used (most or all interfaces surveyed follow the same operational rules) the convention was noted, and deviations from the conventions documented for discrepancy reporting purposes.

2.3.5.3 Data Reduction and Analysis

Where deviations from predominant CR conventions were noted, Human Engineering Discrepancy reports were generated.

2.3.6 Checklisting

2.3.6.1 Objective

The objective of completing the checklist was to compare the details of the control room design to the Human Factors Guidelines. The detailed items contained in the checkists allowed for a sampling evaluation from the system, panel and generic component level.

2.3.6.2 Instrumentation

Certain checklist items require that physical measurements be performed (tape measures, sound meters, and so forth).

2.3.6.3 Methods

The completion of the checklists required access to the control room, a basic familiarity with the control room and the systems being evaluated, and the assistance of a qualified operator.

Once appropriate checklists were selected, a packet of checklists was made up for panels or systems to be evaluated. The checklists were then completed in the following manner. Each checklist item was considered, in the CR. When the item did not apply, an "N/A" was placed in the check column. If the item was complied with, a "yes" was placed in the check column. Where the item was not complied with, a "no" was placed in the check column and the discrepancy was described in detail in the notes column. Where appropriate, examples of discrepant components were noted for reporting purposes.

2.3.6.4 Data Reduction and Analysis

The checklists were reviewed for discrepancies (items marked "no") and compared to the relevant 1580 Guidelines. A Human Engineering Discrepancy Report was completed for each item that did not comply with the guidelines.

2.3.7 Procedure Review and Development

2.3.7.1 Objectives

Two objectives of this task were: 1) to assist FP&L in generating procedures (emergency, startup, and shutdown) using CE procedure specifications as a baseline, and 2) to evaluate the procedures according to the guidelines (format, writing style, and so forth).

2.3.7.2 Development

Essex involvement with procedure development involves provision of a procedure specification to aid in the development of human engineered procedures.

2.3.8 HED Reviews

HED reviews entail two activities: preparation of human engineering discrepancy reports (HEDs) and review processing.

2.3.8.1 Preparation of Human Engineering Discrepancy Reports

Personnel involved in the Data Collection task (3.0) were instructed to complete a Human Engineering Discrepancy (HED) form for each and every identified incidence where the control room design does not comply with Human Engineering Guidelines. No attempt was made during actual data collection to determine whether or not a particular discrepancy was sufficiently important to report.

HEDs were completed for all discrepancies including environmental, layout, instrumentation, job design, etc.

2.3.8.2 Objective

The objective of this task was to provide complete and accurate documentation of all human engineering discrepancies in the control room; to anticipate the specific human errors that might result from the discrepancy; to report the guidelines violated; and where necessary, to record the likely response of the plant system to the error.

2.3.8.3 Method

The SL-2 control room was reviewed by data collection personnel and operator-control room interfaces that did not meet the Human Engineering Guidelines were identified. These discrepancies were recorded on a form, "Human Engineering Discrepancy Report" (see Appendix A), which included:

a. A short title for the discrepancy;

b. Hardware or procedures items, nomenclature (label) and panel locations;

c. Human engineering guidelines which were violated;

d. Operator error(s) that might result from the discrepancy;

e. As required, plant and system level consequences of these errors.

Where there are a number of interfaces with the same discrepancy, the same procedures involved, and the same consequences of operator error, one "generic" HED was generated.

The final step in HED preparation was the identification of suitable backfits to reduce/eliminate the discrepancy. Most discrepancies were considered correctable by any of several backfits with different potentials for reducing operator error likelihood and different costs. For instance:

- Change of instrumentation type or location
- Addition of repeating displays to improve control/display relationship
- Demarcation lines to improve operator localization of controls and/or displays
- Use of switch guards to reduce the likelihood of inadvertent or accidental operation
- Use of alarms or warnings to advise of a potential error
- Use of switch or display color coding to improve operator localization
- Use of display range markings (e.g., normal, emergency) to improve display discriminability at a distance
- Use of mimic lines to improve sequential control/display operations

- Use of warning labels to caution against specific actions
- Use of procedural cautions requesting a double-check of a difficult setting
- Use of shape coding on switch handles to tactually "separate" switches which could be interchanged in operation
- Attention given during training to difficult or error-prone control/display operations
- Use of indications with set points and out-of-tolerance alarm lights to improve discriminability at a distance.

2.3.9 HED Review Processing

2.3.9.1 Objectives

- To supply HEDs to FP&L personnel, as they are generated, for review and access
- To ensure the adequacy and accuracy of the discrepancy data (by FP&L operations and Essex review)
- To prepare HEDs for reporting purposes.

2.3.9.2 Method

As HEDs were generated, copies were forwarded to: 1) Essex for review; and 2) FP&L operations for review. Meetings were conducted to discuss HEDs with FP&L personnel to meet the objectives of accuracy of discrepancy data.

2.3.10 Draft Report Preparation and Review

2.3.10.1 Objective

To provide FP&L a draft report of the NTOL CR assessment, for review and comment prior to release.

2.3.10.2 Method

Report writing was ongoing throughout the effort, task objectives, instrumentation, and methods having been written at the beginning of the effort. Findings (HED reports) were continuously reviewed by Essex and FP&L personnel, for inclusion in the report. FP&L was provided several copies of the draft for operations, engineering, and management review.

3.0 FINDINGS

Findings in the SL-2 control room are discussed in three sections, as follows; (1) panel by panel discrepancies in layout, control/display integration, and discrepancies unique to specific panels, (2) generic discrepancies with controls/displays used in the control room and pervasive discrepancies such as labeling, etc., and (3) other topics such as ambient lighting, noise and so on, not covered by the above.

Discrepancies have been categorized, according to the following:

Category 1	-	High risk of operator error in safety-related activity
Category 2	-	Moderate risk of operator error in saftey-related activity
Category 3	-	Some risk of error in safety-related activity
Category 4	-	Risk of error in non-safety related activity
Category 5	-	Additional evaluation required.

Assignment of category was made by Essex providing subjective determination of error risk (High, moderate, some) and FP&L assignment of safety relatedness of the operational activities.

3.1 Discussions of Discrepancies by Panels. Panel layout and discrepancies unique to specific panels are discussed below.

3.1.1 Panel 201 — Electrical, Turbine, and Generator

A) Controls and displays are not consistently arranged in stereotypic order. For example, mainsteam drain valves indicator lights are arranged as follows:

DV1		DV3
DV2		DV4
	DV5	
DV6		DV8
DV7		DV9

No action is planned. Category 3

B) Turbine support system (gland steam) indication and control are separated by reheater controls and temperature controls. No action is planned. Category 4

C) Generator Speed and Megavar Indication are separated. The indications are located at the top of the vertical portion of the boards while controls are located at the bottom portion of the benchboard. No action is planned. Category 4

D) Turbine and Reactor Trip pushbuttons are located high on the vertical portions of the boards, rendering them difficult to access by short operators. No action is planned. Category 3

E) The Generator Megavars (VARM-881) displays indicate negative and positive values, the displays are not labeled as to which directions are which. In addition, negative values are located to the right of the zero position (as is an industry convention). FP&L will address the problem by labeling the directions "lead" and "lag" as appropriate. Category 4

F) Layout of the Diesel Generator controls and displays is somewhat confusing due to separation. FP&L will address the problem by demarcation of these systems. Category 3

G) DEH Valve Test pushbuttons and legend lights are visually similar. Control/display substitution errors are likely. FP&L will address the problem through labeling and demarcation. Category 4

H) DIESEL GEN 2B FREQUENCY FIM-1616 meter information is obscured by glare. FP&L will install non-glare glass on the meter face. Category 3

3.1.2 Panel 202 — Feedwater and Condensate

A) Chemical recorders are located between Aux Feedwater controls and indicators.

Examples of chemical recorders:

1. CONDENSATE
   DISSOLVED OXYGEN
   O_2-05-1

2. FEEDWATER & STM GEN

BLOWDOWN PH
PHR-05-01

FP&L is to relocate the recorders. Category 3

B) The HEATER DRAIN PUMP 2B control appears to be directly associated with the Aux Feedwater Pump controls. By layout, the steam bypass permisive appears to be the control for HEATER DRAIN PUMP 2A. Substitution errors are likely. FP&L to address the discrepancy by demarcation and labeling. Category 1

C) Some of the Aux Feedwater Pump and valve controls have unlabeled "Auto" positions. For example:

AUX FW PUMP 2A
DISCH to SG 2A
VALVE MV-09-9

FP&L will address this problem by providing appropriate labels. Category 5

D) Aux Feedwater Header Flow trend recorders are arranged, from left to right, as follows:

AUX FEEDWATER HDR B&C FLOW FR-09-2B/2C	AUX FEEDWATER HDR A FLOW FR-09-2A

with recorders 2B/2C to the left of recorder 2A. This may lead to substitution errors. FP&L is to reverse the recorders. Category 1

E) The Primary Water Makeup Pump controls and PRIMARY WATER STORAGE TANK LEVEL display are located on this panel, not panel 205 where the remainder of the makeup controls and displays are located. No action is planned. Category 4

F) The Main Steam Isolation Valve controls and Feedwater Blocks are located on panel 206, not on panel 202. FP&L believes that the positioning of these controls is appropriate for mitigating potential accidents, and should not be moved to enhance startup activities. Layout to be studied via operations analysis. Category 5

3.1.3 Panel 203 — Reactor Coolant System

A) PRIMARY RCS TEMPERATURE indicator intrudes into pressurizer controls and display (LOOP 2A COLD LEG TEMP and LOOP 2B COLD LEG TEMP). FP&L to address via system demarcation. Category 3

B) Layout of Pressurizer level and pressure controls and displays is inconsistent and misleading. Pressure controls are located to the left of level controllers while the level display is located to the left of the pressure display. Further, LOOP 2A/2B HOT LEG TEMPERATURE display segregates the pressurizer level and pressure displays. A high likelihood of control and display substitution errors is expected. No action is intended. Category 5

C) Reactor Coolant Pump controls are stacked vertically, while associated displays are horizontally oriented (except pump amps, flow, and coolant temperature which are located directly above the controls). Annunciator controls, located at the bottom portion of the angle in the boards, intrude into the RCP controls and displays. FP&L is examining movement the annunciator controls to panel 204. FP&L will demarcate RCP controls and displays. Category 3

D) REACTOR COOLANT PUMP 2B2 appears to be associated with the string of PRESSURIZER BACKUP HEATERS. Control substitution errors are likely. FP&L will address this problem by 1) shape coding RCP control handles and 2) demarcation of the controls for both RCPs and pressurizer backup heaters. Category 1

E) The upper scale on horizontally oriented meters (STM GEN ΔP CORE FLOW and COOLANT LOOP TEMP TCOLD/THOT) is difficult to see without crouching. FP&L to either coat or reorient displays. Category 2

3.1.4 Panel 204 — Nuclear Instrumentation

A) The Reactor Power Recorder Selector control is located above the RCS temperature recorder. No action is planned. Category 4

B) The T-AVG and T-REF displays are located well to the right of the control rod controls. No action. Redundant display is also provided to the immediate right of the CEA controls. Category 3

C) There is no "First out" indication of the annunciator system for the reactor. No action is planned. Category 2 (indication of "first out" is available on the sequence of events recorder).

D) The Reactor Trip controls are located high on the vertical portion of the boards, rendering them difficult to access by a short operator. No action is planned. Category 3

E) CEA CRT is unreadable for the following reasons: dark glass covering obscures setpoint information; the display is subject to excessive glare; bank 7 information is not stable; bank and step labels are obscured by anti-glare glass. This observation was made in the unit 1 control room. If the design and HE discrepancies are reproduced at unit 2 the problem will be addressed by 1) removing anti-glare glass from CRT cover, and 2) placing a shield over the CRT to reduce incident light to the display. Category 1

3.1.5 Panel 205 — Chemical Volume and Control System

A) The control:

LETDOWN LEVEL
HIC-1110

label is misleading. In actuality, pressurizer level controls letdown, and the controller sets the pressurizer level which halts letdown. FP&L will address the problem by more accurately labeling the control. Category 3

B) The VOLUME CONTROL TANK DISCH VALVE V-2501 and the REFUELING WATER TO CHARGING PUMPS VALVE V-2504 are spacially separated by other letdown, charging and VCT controls. There is a general lack of logical layout of charging, letdown, and VCT controls on this panel. FP&L and EBASCO are to examine alternatives and address prior to fuel load. Category 5

C) PRIMARY WATER MAKEUP PUMPS 2A and 2B are located on panel 202, not on panel 205. No action is planned. Category 4

D) Annunciator controls are guarded and TEST is color coded (red), inconsistent with coding of other annunciator controls. FP&L will consistently code annunciator controls. Category 4

E) Association of LIQUID WASTE FLOW VALVEs FCV-6627Y and FCV-6627X with control position violates stereotypes. The top set of lights (valve Y) is selected by the control being in the righthand position. FP&L will correct by reversing the positions of the valve lights and labels. Category 4

F) A nonlinear scale (REACTOR MAKEUP WATER FLOW FRC-2210X) is used and not operationally required. FP&L will install a square root converter in the signal line and rescale the display. Category 4

3.1.6 Panel 206

A) Low Head Safety Injection and High Head Safety Injection are intermixed, rather than grouped by low head or high head. HPSI controls will be demarcated . Plans for relaying out SI controls and displays are not scheduled. Category 2

B) Emergency Core Cooling equipment is grouped by power supply rather than by function. FP&L will conduct an engineering review. Labeling and demarcation may also be provided. Priority 1

C) Hydrazine Pump status lights (HYDRAZINE PUMP 2A and HYDRAZINE PUMP 2A DISCH VALVE I-SE-07-38) are located well to the right of the HYDRAZINE SPRAY FLOW meter and well to the left of the associated HYDRAZINE 2B pump and Discharge Valve simple indicator lights. HYDROZINE TANK LEVEL and SPRAY FLOW meters are similarly not located near other hydrazine displays. No action is planned. Category 3

D) Shutdown displays are located well to the right of shutdown cooling controls. No action is planned. Category 3

E) CCW FROM RC PUMPS HX FLOW meters are, located to the far right of the CCW controls. These indicators include 1) FIS-14-15-A, 2) FIS-14-15-B, 3) FIS-14-15-C, and 4) FIS-14-15-D. No action is planned. Category 2

F) The SI LOOP CHECK VALVE LEAKAGE HIC-3638 process controller operates in a reversed (nonconventional) fashion from other process controls. FP&L will address the problem by achieving consistency for this control with the CR convention. Category 1

3.1.7 Miscellaneous Panels

Human Engineering Discrepancies identified on Auxilliary and Support Panels are as follows:

A) The MATRIX RELAY HOLD pushbutton on the RPS Panel is difficult to use due to control resistance. In addition, the control must be pushed in while controls up to about five feet distant are simultaneously operated. It is possible to fail to reset Reactor Trip Breakers. This observation was made at SL-1. Category 4

B) Many controls are located below 34 inches on the HVAC Panel and above 74 inches on the back panels (REACTOR REGULATING SYSTEMs 1 and 2). No action is planned. Category 3

C) Impact trend recorder information on the HVAC Panel is obscured by chart identifying points. FP&L will remove and relocate labels. Category 2

D) The CONTAINMENT CONT./H2 PURGE CONTROL VALVE FCV-25-8 on the HVAC Panel violates color coding of indicator lights (green indicates valve open, red indicates valve closed). FP&L will change lenses on the indicator lights. Category 3

E) Provisions for key storage and access are not provided to make keys immediately accessible. Particular problems exist for the Remote Shutdown Panel. FP&L will address by providing keys at the RSP. No action will be taken in control room. Category 1

3.2 Generic Discrepancies. Control room components and design practices which transcend particular panels are discussed in the section. Table 3 summarizes these identified discrepancies, and is arranged in the following manner:

- o Discrepancy description - Brief statement of the human engineering discrepancy
- o Examples - Specific examples of CR components which evidence the discrepancy
- o Location - Location in the control room for the cited examples which evidence the discrepancy
- o Action/Comments - Contains brief statements regarding FP&L responses to design discrepancies. Where direct corrective action is taken, problems have not been prioritized. Where there has been no direct corrective action, the discrepancy is prioritized.

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
LABEL CONTENTS			
1. Abbreviations are not used consistently in labels	CCW PUMP 2A (component cooling water)	Panel 206	To be addressed as part of relabeling effort.
	CCW FROM RCP 2A1 FLOW FIA-1158 (core cooling water)	Panel 203	Category 3
	COMP COOL'G WATER	Panel 205	
2. Content of labels is not consistent.	VAPOR CAVITY PIA-1163, 1183	Panel 203	1) To be addressed as part of relabeling effort.
	BLEED-OFF CAVITY PIA-1153, 1173	Panel 203	2) Examples given should both be labeled Bleed-off cavity or vapor cavity. Category 3
3. Incorrect labels	BATTERY VOLTS 2B (VM-001) BATTERY VOLTS 2B (VM-001) meter VM-001 should be cut as BATTERY VOLTS 2A	Panel 201	To be corrected during relabeling effort. Category 1

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
LABEL CODING			
1. Labels are highly similar.	BORIC ACID GRAVITY FEED VALVE V-2508	Panel 205	To be addressed as part of relabeling effort. Category 1
	BORIC ACID GRAVITY FEED VALVE V-2509	Panel 205	
	HPSI TO HOT LEG 2B VALVE V-3551	Panel 206	
	HPSI TO HOT LEG 2B VALVE V-3523	Panel 206	
2. Pushbuttons have two labels which present redundant information.	TURBINE TRIP, TRIP	Panel 201	Redundant tags will be removed. Category 3
	RCP 2A1 VIBRATION RESET, RESET	Panel 203	
3. Component labels are not larger than component position labels.	SPILLOVER BYPASS VALVE M/BP2	Panel 201	To be corrected as part relabeling effort. Category 3
4. Labels are color coded based on power supply, not system.	CSAS CHANNEL SA	Panel 206	To be addressed as part of relabeling and demarcation effort. Category 1
	CGAS CHANNEL SB	Panel 206	
5. Some labels are difficult to read due to insufficient color contrast between label surface and print.	Pink labels with white print Orange labels with white print		To be addressed as part of relabeling and demarcation effort. Category 1

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
LABEL READABILITY			
1. Characters on labels are separated by less than the minimum recommended space (1/6) character height).	REFUELING WATER TANK LEVEL LIS-07-2C LOWER CAVITY TEMPERATURE TIA-1171	Panel 206	To be addressed as part of relabeling effort. Category 3
2. Line spacing on labels is inadequate (less than 1/2 the character height).	THERMAL MARGIN LOW SETTING PIA-1102D	Panel 203	To be addressed as part of relabeling effort. Category 3
3. Many abbreviations in labels on the HVAC, plant auxiliaries and line repeat panels are followed by periods.	CONTINUOUS CONT./H2 PURGE CONTROL VALVE FCV-25-8	HVAC Panel	To be addressed as part of relabeling effort. Category 3
4. Readability of labels is reduced because of font style.	HOLDUP TANK 2A PRESSURE PIA-6610	Panel 205	To be addressed as part of relabeling effort. Category 3

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
LABEL LOCATION AND MAINTENANCE			
1. Pointers overlap index on large horizontal trend recorders.	GENERATOR TEMPERATURE TR-22-30	Panel 201	No action. Category 3
2. Key-operated switches have taped-on labels.	125 V DC BUS TIE 2A-2AB	Panel 201	Will be addressed as part of relabeling effort. Category 3
3. Engraved labels were not filled in and have now become obscured by grease, grime, and dirt.			Will be addressed as part of relabeling effort. Category 3
4. Labels have been placed under displays in almost all cases and are often obscured by the equipment they are intended to identify.	Trend recorder above Reheater Control System	Panel 201	Will be addressed as part of relabeling effort. Category 2
5. Labels are not directly on controls and displays.	GENERATOR TEMPERATURE TR-22-30	Panel 201	Will be addressed as part of relabeling effort. Category 3

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
LABEL LOCATION AND MAINTENANCE (Cont.)			
6. Labels are not located in a consistent manner throughout the control room, making it difficult to identify controls and component groupings.	HPSI HOT LEG 2B VALVE V-3523 HPSI-HDR B TO LOOP 2A2 VALVE HCV-3616	Panel 206 Panel 206	Will be addressed as part of relabeling and demarcation effort. Category 2
7. Labels are not located on the most uncluttered surface.	CONDENSER VACUUM BREAKER VALVES MV-10-1A, MV-10-1B	Panel 202	Will be addressed as part of relabeling effort. Category 3
8. Labelling of units on trend recorders, counters and process controllers is inconsistent and often redundant to the control label.	Control Label: FEEDWATER TO SG REG VALVE BYPASS LIC-9005 Unit Label: FEEDWATER BYPASS CONTROL SCALE RDG x 1 = % LEVEL	Panel 202	Will be addressed as part of relabeling effort. Category 3
9. There is no indication on two color trend recorder as to which color represents an actual reading and which represents the set point.	Unit Label: FRC-2210Y • IND. x 1 = GPM FRC-2210Y • IND. x 1 = GPM (no display label on panel)	Panel 205	To be addressed as part of relabeling effort. Category 1

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
LABEL LOCATION AND MAINTENANCE (Cont.)			
10. There are unlabelled positions on rotary control (observation made in Unit #1 RPS Panel).	MATRIX RELAY TRIP SELECT	RPS Panel	To be addressed as part of relabeling effort. Category 2
11. Many trend recorders have blank labels or labels which do not explain the displays' function.	BORIC ACID FLOW (missing)	Panel 205	To be addressed as part of relabeling effort. Category 3
	FLOW RECORDER FR-25-18	HVAC Panel	
12. A number of controls and displays have labels which are either missing or appear to be incorrect.	Rotary control switch on panel 201 — label missing		To be addressed as part of relabeling effort. Category 1
	VAPOR CAVITY PRESSURE PIA-1172 should read: UPPER SEAL CAVITY PRESS PIA-1172	Panel 203	

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
DEMARCATION			
1. Summary labels and demarcation lines are not used to identify and separate systems surrounding mimics. Labels do not always appear above mimic areas.	Electrical Distribution Buses	Panel 201	To be addressed as part of relabeling and system demarcation. Category 4
2. There is little or no use of summary labelling or demarcation to identify functionally related components.	All systems and subsystems in CR		To be addressed as part of relabeling and system demarcation. Category 1

TABLE 3

ST. LUCIE UNIT #2

LABELS AND JOB PERFORMANCE AIDS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discprepancy Description	Examples	Location	Action/Comments
MIMIC USABILITY			
1. Mimics are not consistently color coded.	Electrical Distribution 240 KV Electrical Distribution 6.9 KV (both mimics are yellow)	Line Repeat Panel Panel 201	FP&L will address through mimic improvements. Category 3
2. Not all mimic lines terminate at a label or labelled component.		Line Repeat Panel	FP&L will address through relabeling effort and mimic improvements. Category 2
3. Insufficient use of mimics in control room. At present, they are only used for electrical systems.	Safety Injection System, as well as a number of other systems, would benefit from the use of mimics.		No action. Category 2

TABLE 3

ST. LUCIE UNIT #2

CONTROLS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
CONTROLS DIFFICULT TO USE			
1. Process controllers on benchboard indicate set point with a green strip attached to cover, causing serious parallax problems.	PRESSURIZER PRESS PIC 1100-X PRESSURIZER PRESS PIC 1100-Y	Panel 203	Parallax to be removed by mounting a pointer closer to display scale. Category 2
2. Critical pushbuttons are located 69, 64 and 60 in., respectively, above the standing surface.	REACTOR CHANNEL MB REACTOR CHANNEL MD REACTOR CHANNEL MA	Panel 204 Panel 204 Panel 201	No action. Category 3
3. Not all controls and displays used in normal operations are located between 34 and 74 in. above the floor.	ANNUNCIATOR TEST, ACK and RESET Outdoor light swithes, purge switches	Annunciator box of line repeat panel Heating and Ventilating panel	No action on all items except annunciator buttons, which are redundant (not used), and will be removed. Category 3
4. Feedback provided for control use is breaker position rather than actual pump state.	BORIC ACID MU PUMPS	CVCS Panel	No action. Category 3

TABLE 3

ST. LUCIE UNIT #2

CONTROLS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
CONTROLS SUBJECT TO IN-ADVERTENT ACTIVATION			
1. Once setpoints are set on process controllers, no means are provided to guard against accidental moving of the controls.	PRESSURIZER PRESS PRESSURIZER LEVEL	Panel 204 Panel 204	No action. Category 3, controls are generally located in low body and hand traffic areas.
2. Critical controls are unguarded.	TURBINE TRIP	Panel 201	Pushbutton guard will be installed by FP&L. Category 3

TABLE 3

ST. LUCIE UNIT #2

CONTROLS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
VIOLATIONS OF CONTROL CONVENTIONS			
1. All switch keys are inserted with teeth pointing down.	All key operated switches in control room.	Panel 206	No action. Category 3
2. Off position is not vertical in key operated switches.		Panel 206	No action. Category 3
3. Rotary switch position conventions are violated in a number of cases.	NITROGEN TO SI TANK 2B1 VALVE V-3632	Panel 206	1) Relationships of control positions (e.g., close to the left, open to the right) is conistent. However, open, for example, may be in the 12 o' clock or 2 o' clock position. Category 5
	LETDOWN STOP VALVE V-2515	Panel 206	

TABLE 3

ST. LUCIE UNIT #2

CONTROLS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
CONTROL LAYOUT AND SUBSTITUTION ERRORS			
1. Functionally related controls and displays are not collocated.	MS ISOLATION VALVES	Panel 206	Demarcation lines will be applied to alleviate some problems. No controls will be relocated. Category 1
	CCW FROM RC pumps HX FLOW	Panel 206	
	SG level and pressure displays	Panels 203,206	
	Low head and high head SI	Panel 206	
2. Controls used together are not in close proximity.	CSAS Channel SA	Panel 206	Problem will be addressed by FP&L by color coding changes in labels. No controls will be relocated. Category 1
	SIAS Channel SA	Panel 206	
	RAS Channel SA	Panel 206	
	CSAS Channel SB	Panel 206	
	SIAS Channel SB	Panel 206	
	RAS Channel SB	Panel 206	
3. Functionally similar or identical primary controls are not consistently arranged and located from panel to panel.	HEATER PUMP 2A	Panel 202	FP&L will address problem through demarcation. No controls to be relocated. Category 4
	HEATER DRAIN PUMP 2B	Panel 202	
	INSTR AIR CONT ISOL HCV-18-1	Panel 206	
	PRIMARY WATER CONT ISOL HCV-15-1	Panel 206	

TABLE 3

ST. LUCIE UNIT #2

CONTROLS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
CONTROL LAYOUT AND SUBSTITUTION ERRORS (Cont.)			
4. Minimum separation for controls not achieved.	Reactor Regulator System "1" and "2" Continuous rotary selectors	Panel 204 Loose Parts Monitor	No action. Category 4
5. Controls not arranged by importance or frequency of use.	ANNUNCIATOR TEST, ACK, RESET Reactor Coolant Pumps	Panel 203 Panel 203	FP&L to study feasibility of relocating annunciator buttons to Panel 204. Category 3

TABLE 3

ST. LUCIE UNIT #2

CONTROLS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
CONTROL CODING			
1. Key operated switches are not consistently color coded.	CHARGING LINE CONTAINMENT ISOL VALVE V-2523	Panel 205	FP&L will correct to make color coding consistent. Category 2
	CCW HDR A FROM FUEL POOL HX VALVE MV-14-18	Panel 206	
	CCW HDR B TO FUEL POOL HX VALVE MV-14-18	Panel 206	
2. Key operated switches have unlabelled positions.	SIAS BLOCK CHANNEL SB SIAS BLOCK CHANNEL SA MSIS BLOCK CHANNEL SB MSIS BLOCK CHANNEL SA	Panel 206 Panel 206 Panel 206 Panel 206	FP&L will label blank positions. Category 3
3. Flags on breaker controls are obscured by control handles.	CIRC WATER PUMP 2A1 and DISCH VA MV-21-1B1	Panel 202	FP&L to correct by 1) providing different handles or 2) modifying existing handles. Category 3

TABLE 3

ST. LUCIE UNIT #2

CONTROLS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
CONTROL CODING (Cont.)			
4. Covers on all legend push-buttons are interchangeable.	Aux Feedwater Valve Controllers ESFAS Turbine Controls	Panel 202 Panel 204 Panel 203	FP&L will address via panel and display markings. Category 1
5. Directional arrows on top of T-handle RESET controls are the same color as the rest of the rest of the handle.	VOLTAGE ADJUSTER BASE ADJUSTER	Panel 201	FP&L will correct by filling in arrows with contrasting paint. Category 3
6. A number of rotary selector switches have directional markings or arrows which are not presently filled with a contrasting paint pigment.	EXCITER SUPPLY BREAKER GENERATOR GROUND DETECTOR	Panel 201 Panel 201	FP&L will fill in with contrasting paint. Category 3
7. Controls have no differential coding for pumps, fans, or valves (except in label wording).	SPILLOVER BYPASS VALVE MV BP2	Panel 201	No action Category 3
	GLAND STM CONDENSER TRANSFER PUMP	Panel 201	

TABLE 3

ST. LUCIE UNIT #2

ANNUNCIATORS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
ANNUNCIATOR INFORMATION UNCLEAR OR NOT PROVIDED			
1. There are a number of unnecessary annunciators.	ANNUNCIATOR POWER SUPPLY	Annunciator Panel K	Will be addressed as part of annunciator study.
	LAUNDRY AND CHEM. DRAIN SUMP. HIGH LEVELS	Annunciator Panel N	Category 5
2. There are no annunciators for the Hydrazine system.	None		FP&L will add "OFF NORMAL LINEUP" alarm. Category 1
3. Some annunciators used in start up will be normally on during full power situations.	POWER HIGH RATE OF CHANGE TRIP BYPASSED	Annunciator Panel L	FP&L to examine feasibility of providing additional software to defeat selected annunciators above 15% power. Category 1 Alternative is to color code "Normally On" Tiles Green.
	SI TANK ISOL V-3614, V-3624 MOTOR OVERLOAD ALARM TRIP	Annunciator Panel Q	
4. The only indication that an annunciator has been cleared is the extinguishment of the light.	All annunciators		No action. Category 1

TABLE 3

ST. LUCIE UNIT #2

ANNUNCIATORS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
PRIORITIZATION NOT PROVIDED			
1. Permissive displays are located on annunciator panels which should be reserved for alarm displays.	MSIS ACTUATION CHANNEL A BLOCK PERMISSIVE MSIS ACTUATION CHANNEL B BLOCK PERMISSIVE	Annunciator Panel P Annunciator Panel P	No action. Category 1
2. Important annunciators are not color or position coded except on annunciator panel C. That panel is also the only one with a first out reset function.	DROPPED CEA CEDMICS CEA POSITION DEVIATION ±4" (DATA PROCESS)	Annunciator Panel K	Annunciator study is to be performed to develop prioritization schemes. Category 1

TABLE 3

ST. LUCIE UNIT #2

ANNUNCIATORS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
ANNUNCIATOR TITLES DIFFICULT TO READ/INTERPRET			
1. Annunciator font size is not sufficient for reliable reading, particularly at distances greater than several feet.			To be addressed as part of FP&L annunciator study. Category 1
2. Many annunciator titles are too wordy.	CHARGING PUMP 2A LOW OIL PRESS TRIP STUFFING BOX LOW OIL LEVEL LOW WATER LEVEL	Annunciator Panel M	To be addressed as part of annunciator study. Category 1
	SHUTDOWN CODING ISOL V-3561, V-3562 OPEN HIGH SHUTDOWN PRESS	Annunciator Panel G	

TABLE 3

ST. LUCIE UNIT #2

ANNUNCIATORS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
ANNUNCIATOR CONTROLS MISLEADING			
1. Annunciator button labels are unreadable.	TEST RESET (ACK labels missing)	Plant Aux Panels	Will be addressed as part of relabeling effort. Category 2
2. Location of similar buttons is not the same from panel to panel, and they are not in the same order from panel to panel.	ANNUNCIATOR TEST RESET ACKNOWLEDGE	Panels 201, 203 and 205	FP&L will arrange buttons in same order from panel to panel. Category 2
3. Annunciator pushbuttons are inconsistently labelled. Summary labels are sometimes used, sometimes missing. Abbreviations are used inconsistently.	ANNUNCIATOR ACKNOWLEDGE ACKN Acknowledge label missing	Line Repeat Panel Panel 201 Plant Aux Panel	To be addressed as part of relabeling effort. Category 2

TABLE 3

ST. LUCIE UNIT #2

ANNUNCIATORS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
INCONSISTENT ANNUNCIATOR LAYOUT			
1. Annunciator windows are not above the systems they address.	CONDENSATE STORAGE TANK HIGH LEVEL	Annunciator Panel G	Hold for FP&L scheduling and review — to be addressed as part of study. Category 1
	CONDENSATE STORAGE TANK LOW LEVEL	Annunciator Panel G	
	These should be located on panel F.		
	Component cooling annunciators for RCPs located over panel S, while indication is provided on panel 3.	Annunciator Panel J & S	

TABLE 3

ST. LUCIE UNIT #2

ANNUNCIATORS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
AUDIBLE ANNUNCIATORS POORLY CODED			
1. Annunciator audibles are located behind the panels, making it difficult for operators to localize the alarm.		Panels 201, 203 and 205	FP&L will move audibles to top of panel. Category 1
2. Annunciator audibles sound at ambient (bosal) noise levels.			1) Noise levels to be surveyed at unit #2 by Essex. Moving sources to exterior of the boards should dramatically increase signal detection. 2) Sound levels taken at unit #1. Category 1

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
CODING IS UNCLEAR OR MISLEADING			
1. Two of the three lights associated with each of the listed switches are red.	CONTAINMENT FAN COOLERS 2HVS-1A, 2HVS-1B, 2HVS-1C, 2HVS-1D	Heating and Ventilating Panel	FP&L will correct through I&C lights. Category 2
2. Vertical scale indicator lights have multiple meanings. The same light can mean either "high setpoint exceeded", or "scale power on".	CCW FROM RC PUMPS HX FLOW FIS-14-15-D CONTAINMENT PRESSURE PIS-07-20	Panel 206	FP&L will correct through I&C. Category 3
3. Labels for rotary switch control positions are not oriented horizontally and position labels are obscured by the control handle.	AMMETER CONTROLS FOR BUS 2A1, 2A2; 2B1, 2B2; DIESEL GEN 2A, 2B; EMERGENCY BUS 2A3, 2AB, 2B3.	Panel 201	To be corrected or part of relabeling effort. Category 2
4. Because of the layout of displays and labels, unrelated displays appear related.	S1 TANK 2B2 ISOLATION VALVE HYDRAZINE PUMP 2B		FP&L to handle as part of demarcation effort. Category 1

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
LACK OF LAMP TESTING/ LAMP ADJUSTABILITY			
1. There are no lamp testing capabilities for simple indicator lights, legend lights, or the CEA Position Display.	Simple indicators lights CEA Position Display Legend lights	All panels Panel 204 Panels 201, 202, 205	FP&L will study the feasibility of using dual filament bulbs. Category 1
2. There is no dimming control for illuminated displays.			No action. FP&L does not expect ambient lighting to vary. Category 3

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
DISPLAY INFORMATION IS OBSCURED			
1. LEDs are not constructed to minimize reflection of ambient illumination from the display cover.	PRESSURIZER PRESS PI-1105D PRESSURIZER PRESS PI-1103D	Panel 203 Panel 203	Essex will re-evaluate when ceiling light covers are installed and LEDs are functional. Category 5
2. Extreme values are obscured on vertical meters due to meter design.	CONTROLLED BLD-OFF FLOW FIA-1150	Panel 203	No action. Category 2
3. The pointers on all process controller vertical scales and all circular meters obscure scale numerals.	AUX FW PUMP 2A AMPERES AM-629	Panel 202	No action. Category 3

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
DISPLAY INFORMATION IS OBSCURED (Cont.)			
4. Glare makes displays difficult to read.	Linear Scales	Panel 206	Essex to look again after ceiling light diffusers ("egg crates") have been installed. Category 2
	% OPEN OPSI HDRD TO LOOPS		
	% OPEN SI TNK ISOL VALVES	Panel 206	
	Legend Lights	Panel 202	
	Condensate 2A, 2B, 2C Valves		
5. Displays are located well above eye level.	Loose parts monitor alarms	Back Panel	No action. Category 4
	Midway line megawatts	HVAC Panel	
	Rx Regulating System (1 and 2)	Back Panel	

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
DISPLAYED INFORMATION IS DIFFICULT TO INTERPRET OR READ			
1. Multiple decimal points appear on NIXIE tube displays.	NIXIE Tube Displays		1) Essex to check Unit #2 Priority = 2 2) Observation made at unit #1
2. Coding is not used on multiple scale trend recorders to denote which scale is associated with which trend information.	WASTE GAS FLOW FR-6648	Panel 206	To be addressed as part of relabeling effort. Category 1
3. Small vertical trend recorders on CR panels use indices which are difficult to read and have no scale markings.	UPPER OIL RSVR LEVEL LIA-850	Panel 203	FP&L will add graduated scales. Category 4
4. There are more than 9 minor marks on many large trend recorders.	CIRC AND INTAKE COOLING WATER TEMP TR-21-3	Panel 202	No action. Category 3
	BEARING TEMP TR-22-1	Panel 201	
	FLOW RECORDER FR-25-1B	HVAC Panel	

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
DISPLAYED INFORMATION IS DIFFICULT TO INTERPRET OR READ (Cont.)			
5. Major marks on small vertical indicators are less than .5 inch apart.	UPPER OIL RSVR LEVEL LOWER OIL RSVR LEVEL	Panel 203 Panel 203	No action. Category 4
6. Information from some vertical indicators, trend recorders and process controllers is not presented in a directly usable form (values multiplied by a constant).	FEEDWATER PUMP DISCH HDR PRESS PSI-09-05 x 100 PSIG	Panel 202	FP&L will investigate possibly of rescaling displays.
	STEAM CHEST PRESS PI-22-38A x 10 PSIG	Panel 201	Category 3
7. Paper on trend recorders does not match scale.	REFUELING WATER TANK LR-07-20	Panel 206	To be handled administratively by FP&L.
	WATER GAS FLOW FR-6648	Panel 205	Category 3

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
DISPLAYED INFORMATION IS DIFFICULT TO INTERPRET OR READ (Cont.)			
8. Parallax exists between the display scale and the pen on trend recorders.	FW AND SG BLOWDOWN PH RX MU FLOW AXIAL POWER RATIO RWST LEVEL		No action. Category 2
9. Radiation monitor trend recorders are of the impact variety. Portions of the numeric symbols do not print, symbols are printed over one another, and there are too many symbols (up to 23 on an individual recorder), making the output impossible to interpret.			1) Essex to check Unit #2. 2) Observation made at unit 1.

TABLE 3

ST. LUCIE UNIT #2

DISPLAYS

HUMAN FACTORS ENGINEERING DISCREPANCY REPORTS

Discrepancy Description	Examples	Location	Action/Comments
DISPLAY LAYOUT IS MISLEADING, DIFFICULT TO USE			
1. Strings of five or more vertical meters are used, which makes the mid-string components difficult to identify.	STEAM CHEST AREA	Panel 203	Will be addressed as part of relabeling and demarcation effort.
	VAPOR CAVITY AREA	Panel 203	
	EXPANSION STEAM AREA	Panel 201	Category 2
	CONDENSOR STEAM AREA	Panel 201	

3.3 Special and Other Topics

Several areas of CR review were addressed by evaluating components and environment in the Saint Lucie Unit 1 CR, since the associated equipment or state of control room completion prohibited the taking of the data in unit 2. These areas are discussed in this section.

3.3.1 Digital Data Processing System (DDPS) and Sequence of Events Recorder. An operationally and visually identical system is to be placed in the unit 2 CR. Given this, the DDPS was evaluated in the unit 1 CR. The following discrepancies were noted:

A) Information is not provided in units readily usable by operators, as indicated by a tape-on label providing a constant to convert from thermal power to electrical output. No action is to be taken by FP&L. Category 3

B) Projection displays on the DDPS (and on the main CR boards), 1) are of low figure to background contrast, 2) are poorly maintained in that often no symbols are projected, and 3) offer other poor brightness uniformity. FP&L will address the problem by improving maintenance of the bulbs. Category 5

C) DDPS hourly logs output data, but the units are often not indicated. They must be referenced in documents. FP&L has referred the discrepancy to I&C. Category 3

D) DDPS nomenclature and abbreviations do not correspond to that on the actual boards. No action is intended. Category 4

E) The last line printed on the DDPS printer is not readable without scrolling the paper up several lines. Outputted information is, therefore, not immediately available. FP&L intends to take no action. Category 4

F) Information outputted is frequently not highlighted by color, labels, or other means. For example, the following was observed as output:

Ø9 Ø3 #326 *Ø2 8.12.8 #327 N 8Ø2.3
#326 N 8Ø2.8 BELIEVABLE STM PRESS
FROM 1A DEADBAND = 9.9

(all of the above printed on one line).

FP&L has referred the problem to I&C for review. Category 5

G) The sequence of events recorder does not necessarily output in alarm sequence. To determine, for example, "First out," operators must sort alarm outputs by time of alarms. No other reactor trip first out is provided. FP&L has referred the problem to I&C for review. Category 5

3.3.2 Control Room Environment and Layout

Saint Lucie unit 1 was used to evaluate CR environment in terms of lighting and noise. These data are deemed somewhat generalizable to the unit two control room for the following reasons:

- Lighting systems are highly similar. Exceptions include 1) use of colored lights in some places in the unit 1 CR, and 2) reduced lighting achieved by operators in the unit 1 CR by turning off several banks of lights. These exceptions will reduce incidence light in the control room. Light measurements were taken under the above conditions.
- Layouts of the CRs is highly similar, as are placements of noise/sources such as vents, cooling fans, etc., located within the control room. It is pointed out, however, that sound attenuating features are evident in the unit 1 CR (wall panels), which may not be provided in unit 2. Further, noise sources outside the unit 2 CR (for example, the turbine) will probably have different effects on CR ambient noise. Noise data from unit 1 are somewhat more suspect than ambient lighting data.

Workspace arrangement and visibility observations were also taken, in part, from the unit 1 Control Room. Since overall CR layouts are highly similar, these data are considered generalizable to the unit 2 CR.

Survey results indicate that ambient lighting levels are generally good. Incident light in the main operation area ranged from 68 to 107 foot-candles in the bench portion of the boards, and 38 to 54 foot-candles on the vertical portion of the boards. Lighting levels behind the control boards was somewhat less, as low as 22 foot-candles. Incident light at the Reactor Operator's console was measured to be 87 foot-candles. With all lights turned on, a maximum of 170 foot-candles was noted by the Reactor Operator's desk. One potential area of concern is incident light uniformity on the main boards. Nonuniformity of incident light does not appear to pose a problem, however, to the operators.

A problem noted with lighting was that there are no direct means to test the operability of emergency CR lighting. FP&L is examining means to provide emergency lighting test capability.

Ambient (basal) noise was generally within the NUREG 1580 Guidelines. One point over the safeguards panel measured 67 dB(A), two dB(A) above the Guidelines' limit. This is not considered to be excessively above the limit. However, there may exist other unidentified noise sources in unit 2, or fewer noise sources. Direct evaluation of unit 2 noise levels cannot be made until the unit is operational. Peak noise levels reached 80 dB(A) at the safeguards panel. The primary source of noise seemed to be a low frequency resonance coming from the turbine deck.

Two problem areas which were identified in CR layout, are as follows:

A) Handrail running along the front of the benchboard obscures vision to many controls and displays. FP&L will resdesign the rail for unit 2 such that obscuring vision to controls and displays will not take place.

B) Portions of several boards (Radiation Monitors, HVAC) are obscurred by other boards. (The HVAC controls and displays are not located in the same location at SL-1.) Priority 2

3.3.3 Communications

The communications system for Saint Lucie 2 has, as yet, not been designed in terms of control room locations, accesses, etc. Further, the communications console in unit 1 will probably not be reproduced in unit 2. An evaluation of CR communications has not, therefore, been conducted.

3.3.4 Personal Protective Gear

Evaluation of personal protection equipment was conducted in the SL-1 control room. The gear, storage and packaging is to be the same in unit 2. The following are discrepancies identified with the equipment:

A) Respirator and air pack face masks limit vertical and horizontal vision. In addition, respirator masks had stickers placed on the front of the visors, totally obscuring vision. Category 1

B) Face masks do accommodate eyeglasses, but appropriate corrective lenses are not stored in the Control Room. Category 1

C) Masks severly limit speech communication. FP&L will evaluate alternatives (throat mikes, etc.). Category 1

D) Full suits are not stored in packages. To don a full suit, an operator would have to unpackage appropriately sized suits, gloves, etc, each separately stowed and located. FP&L will package and store while suites individually. Category 3

3.3.5 Procedures Documents

Emergency procedures for the SL-2 CR were under preparation at the time of review. FP&L will generate the following emergency procedures based on CE guidelines for NRC CRDR audit review:

- Main Steam Line Break
- Blackout operation
- Loss of Reactor coolant
- Steam Generator Tube Rupture

These procedures are being written using a format discussed in the report, Analysis of Effectiveness of Emergency Procedures for Operator Use, written by Lund Consulting, for Combustion Engineering. The format being employed is the "Layered Format," suggested by the authors as being preferably to narrative type format (as is used in SL-1). Further, language, syntax, and nomenclature is to be constrained to achieve consistency. FP&L has taken this position in order to expedite their procedure preparation effort in a timely and effective manner..

Essex has not currently reviewed the procedures, nor reviewed in depth the document from which the procedure format is being selected. Walkthroughs using the emergency procedures have not been conducted. However, the NRC has conducted a review of the CE Guidelines and FP&L is preparing those emergency operating procedures required for the prelicensing in accordance with the subject reviewed procedure guidelines.

3.3.6 Radiation Monitors

The radiation monitoring system at SL-2 was not available at the time of the evaluation. The radiation monitors in Saint Lucie-1 is not representative of those planned for SL-2. The units to be purchased for SL-2 are designed and built by the General Atomics Company (GA). An indication of the human engineering of these units is provided in Appendix B. The evaluation was conducted, initially, for the Carolina Power & Light Company. The system evaluated by Essex is the standard GA system and is similar to that to be installed in the SL-2 control room.

4.0 CONCLUSIONS/RECOMMENDATIONS

A variety of human engineering discrepancies have been noted in the SL-2 control room. Backfits to be conducted at SL-2 by FP&L will greatly enhance operability of the CR. For systems not evaluated (e.g., communications) due to uncompleted designs, FP&L commitment fo achieve adquate HE design prior to fabrication should serve to avoid discrepancies and, therefore, enhance operation of these systems. Where discrepancies have been identified, but appropriate and suitable backfits have not been identified, further examination of the discrepancies is required in order to select and schedule backfits.

Essex Corporation will continue to work closely with FP&L and EBASCO to resolve open items in backfitting and achieve means to adequately address human engineering discrepancies.

APPENDIX A

NOISE SURVEY

PLANT:	DATE:	TIME:
TEST CONDUCTED BY:		
SOUND LEVEL METER MODEL: SERIAL NUMBER:	MICROPHONE MODEL: SERIAL NUMBER:	CALIBRATION DATE:
OPERATOR POSITION:		

NOISE CONDITION/SOURCE/DIRECTION OF MEASUREMENT	dB	dB(A)	dB(C)	REMARKS

LIGHTING SURVEY FORM

PLANT:	DATE:	TIME:
TEST CONDUCTED BY:		
PHOTOMETER MODEL: SERIAL NUMBER:	CALIBRATION DATE:	

OPERATOR/MEASUREMENT POSITION	LIGHTING CONDITIONS		REMARKS
	NORMAL	EMERGENCY	

REV. 2

HUMAN ENGINEERING DISCREPANCY REPORT

NO:_____ PLANT/UNIT:_____ DATE:_____

REVIEWER NAME: _____

a) HED TITLE: _____

_____

_____

b) ITEMS INVOLVED:

ITEM TYPE	NOMENCLATURE	LOCATION	PHOTO NO.

c) PROBLEM DESCRIPTION (CITE GUIDELINES VIOLATED):

d) SPECIFIC OPERATOR ERROR(S) THAT COULD RESULT FROM HED:

e) SUGGESTIONS FOR POTENTIAL BACKFITS:

UTILITY ACTIONS

	NAME	DATE
REVIEWER		
SITE MGR.		
PROG. MGR.		

ITEMS f & g ARE TO BE COMPLETED ONLY IF UTILITY QUESTIONS THE NECESSITY FOR THE BACKFIT.

f) LIST THE PROCEDURES OR OPERATIONS THAT USE THE LISTED ITEMS IN A MANNER TO INDUCE THE OPERATOR ERROR:

g) LIST THE CONSEQUENCES OF OPERATOR ERROR DURING ALL MODES OF OPERATION:

APPENDIX B

INTRODUCTION

1. On November 21, 1980, Essex Corporation-San Diego Facility personnel and one Carolina Power and Light (CP&L) representative visited the General Atomic facilities at La Jolla, California. The purpose of the visit was to perform a Human Factors (HF) review of the RM-11 and RM-23 Radiation Monitoring equipment.

2. Essex personnel performing the evaluation were: Dr. Robert Kinkade, Mr. Larry Durham, and Mr. Charlie Wright. The CP&L representative was Mr. David Phipps. General Atomic representatives present during the evaluation were Mr. Bud Perkins (Contract Administrator) and Mr. Jim Ward (Engineering).

3. A review was conducted on one RM-23 cabinet (containing 12 RN-23 modules and 8 Leeds and Northrup strip chart recorders), one RM-11 CRT terminal and a supporting line printer.

4. Figures 1 through 5 illustrate typical RM-23 modules, strip chart recorders, and a CRT terminal.

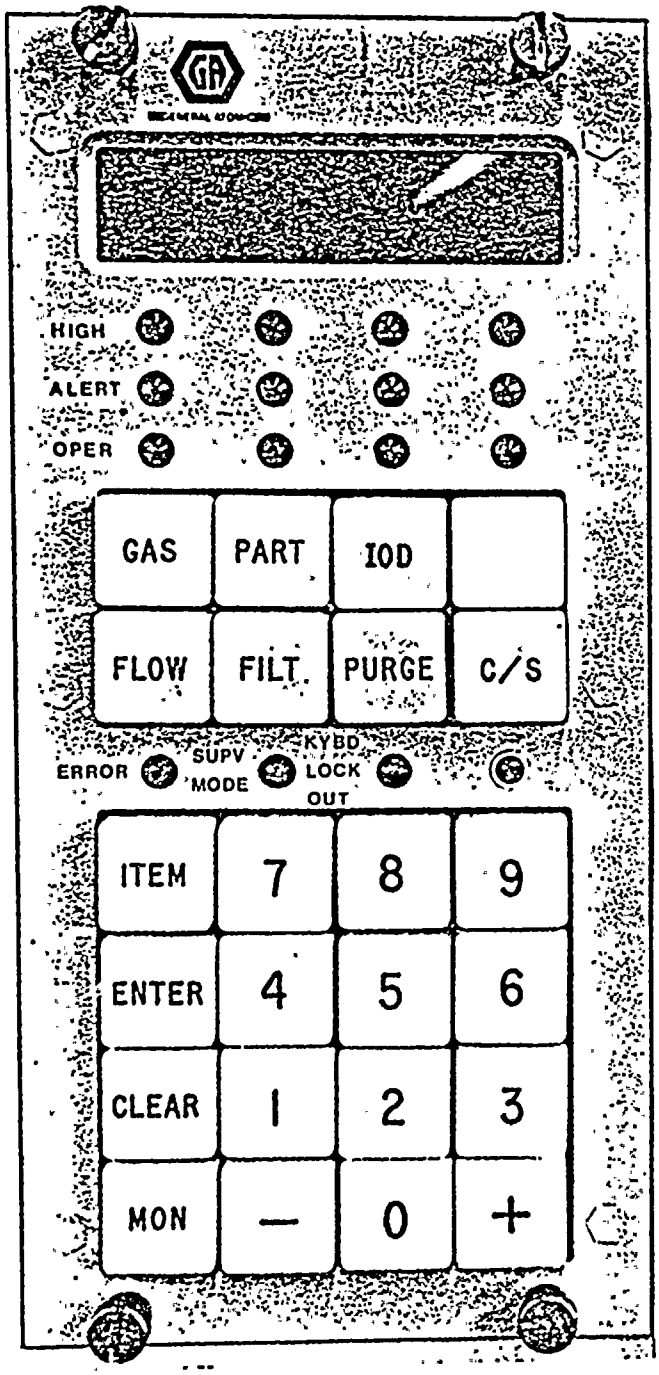

FIGURE 1 - A typical RM-23 module. Labeling of the eight-pushbutton matrix is a client specified option and varies with the desired monitoring function.

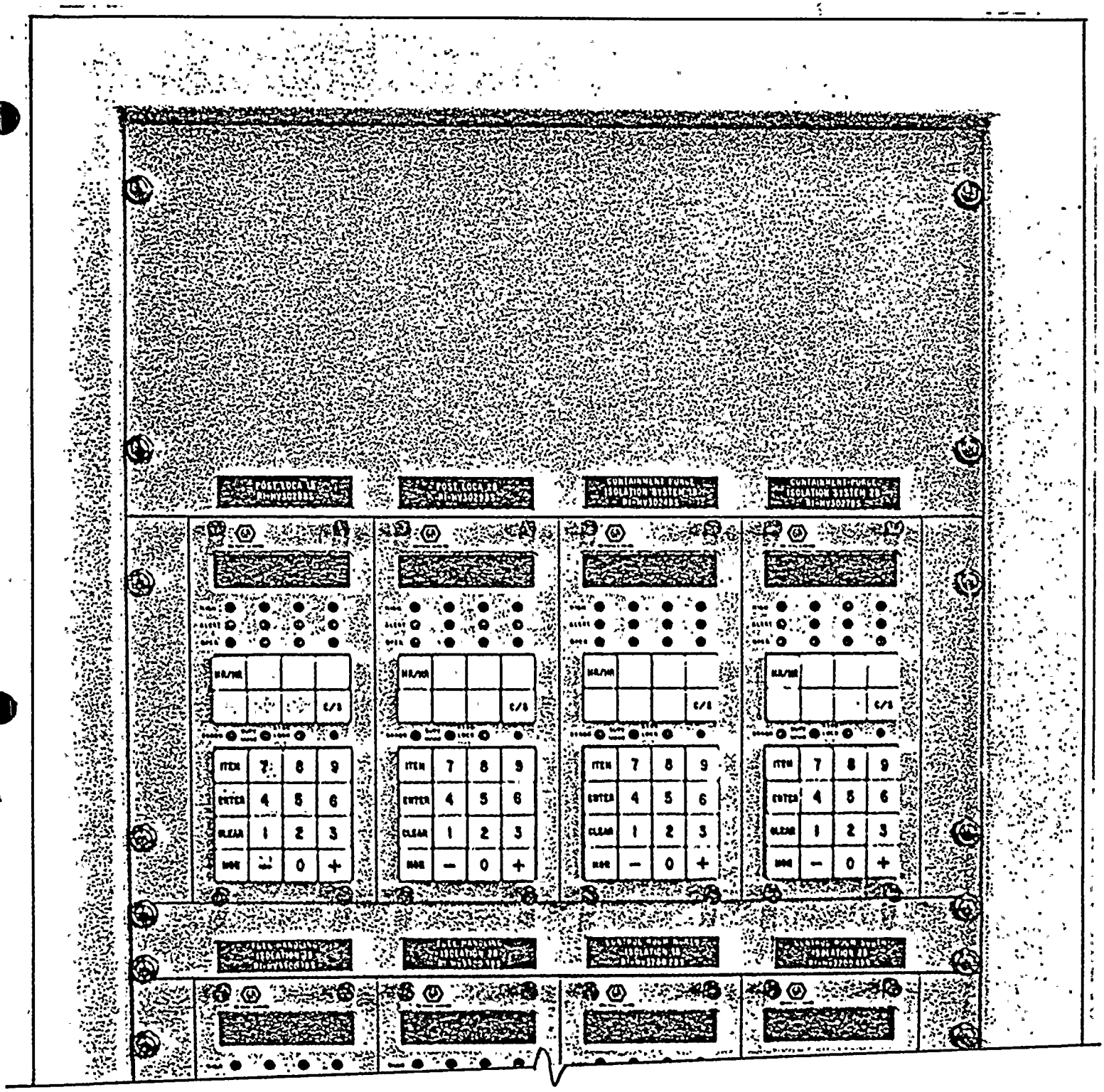

Figure 2 - Typical RM-23 module installation in the RM-23 cabinet. Locations and labels are dependent upon client requirements.

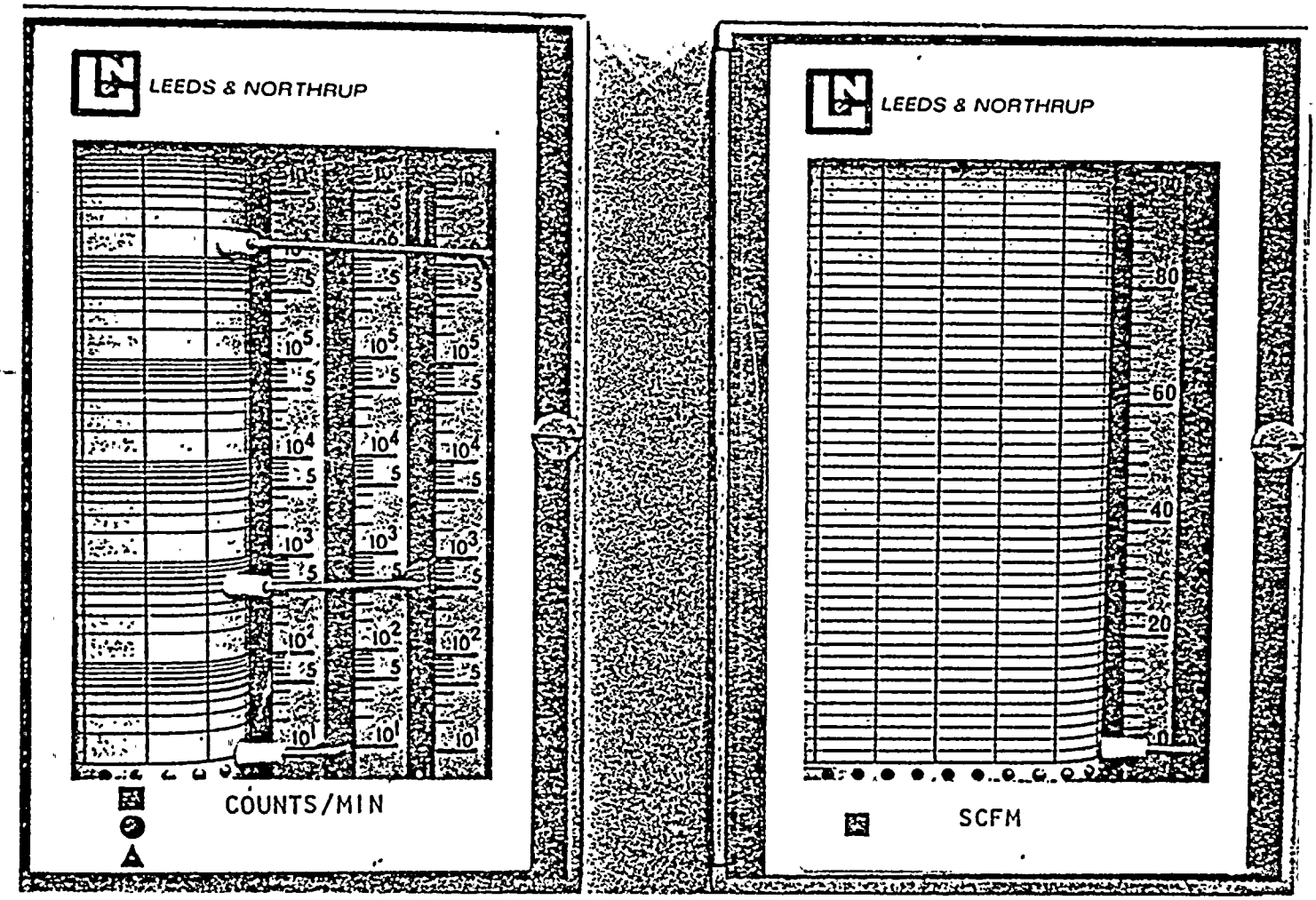

Figure 3 - Examples of the Leeds and Northrup strip chart recorders. Number of pens and linear vs. logarthmic scales are dependent upon client requirements.

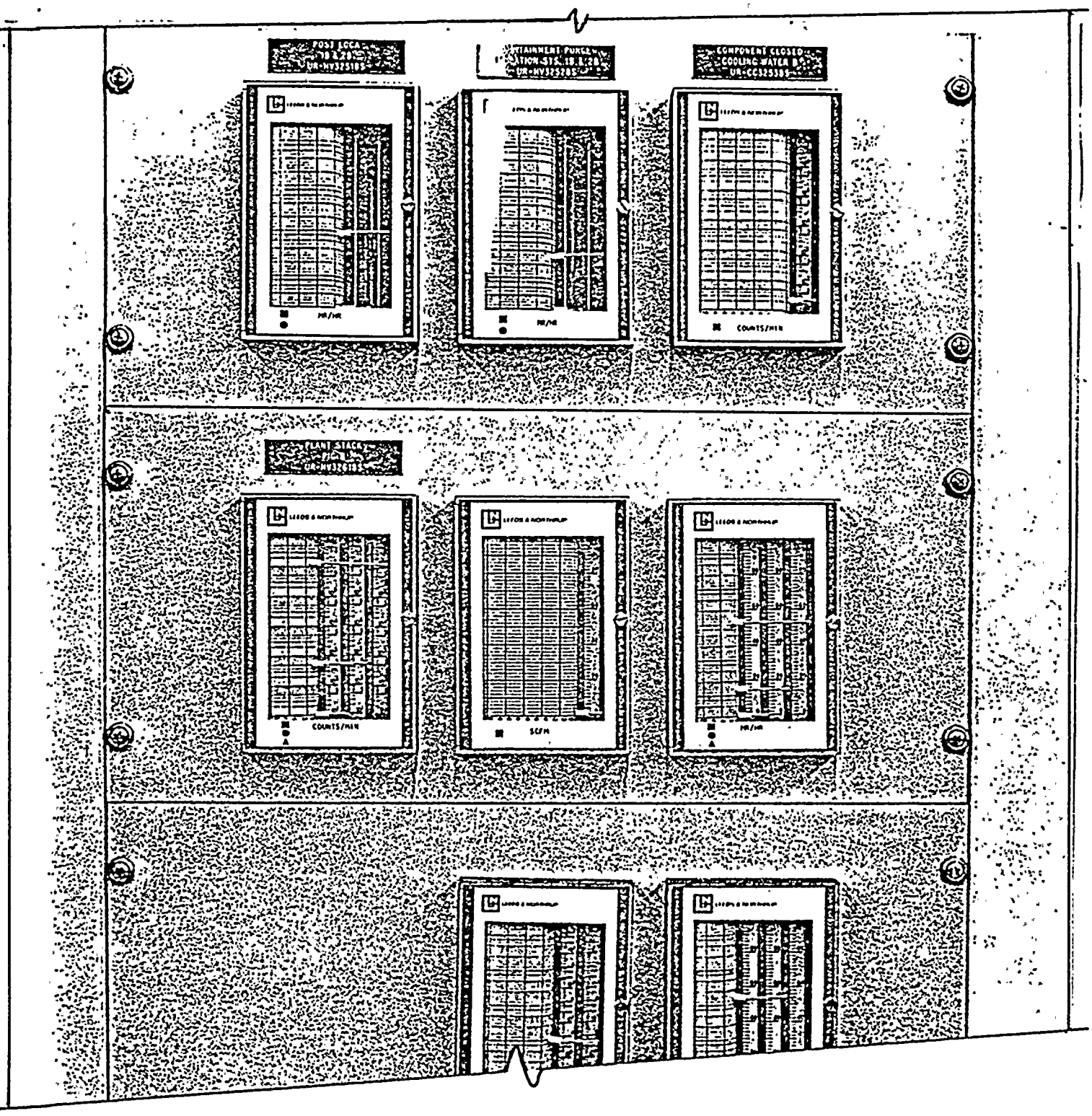

Figure 4 - Examples of the L&N strip chart recorder installation in the RM-23 cabinet. Locations, labels, and number of recorders are dependent upon client requirements.

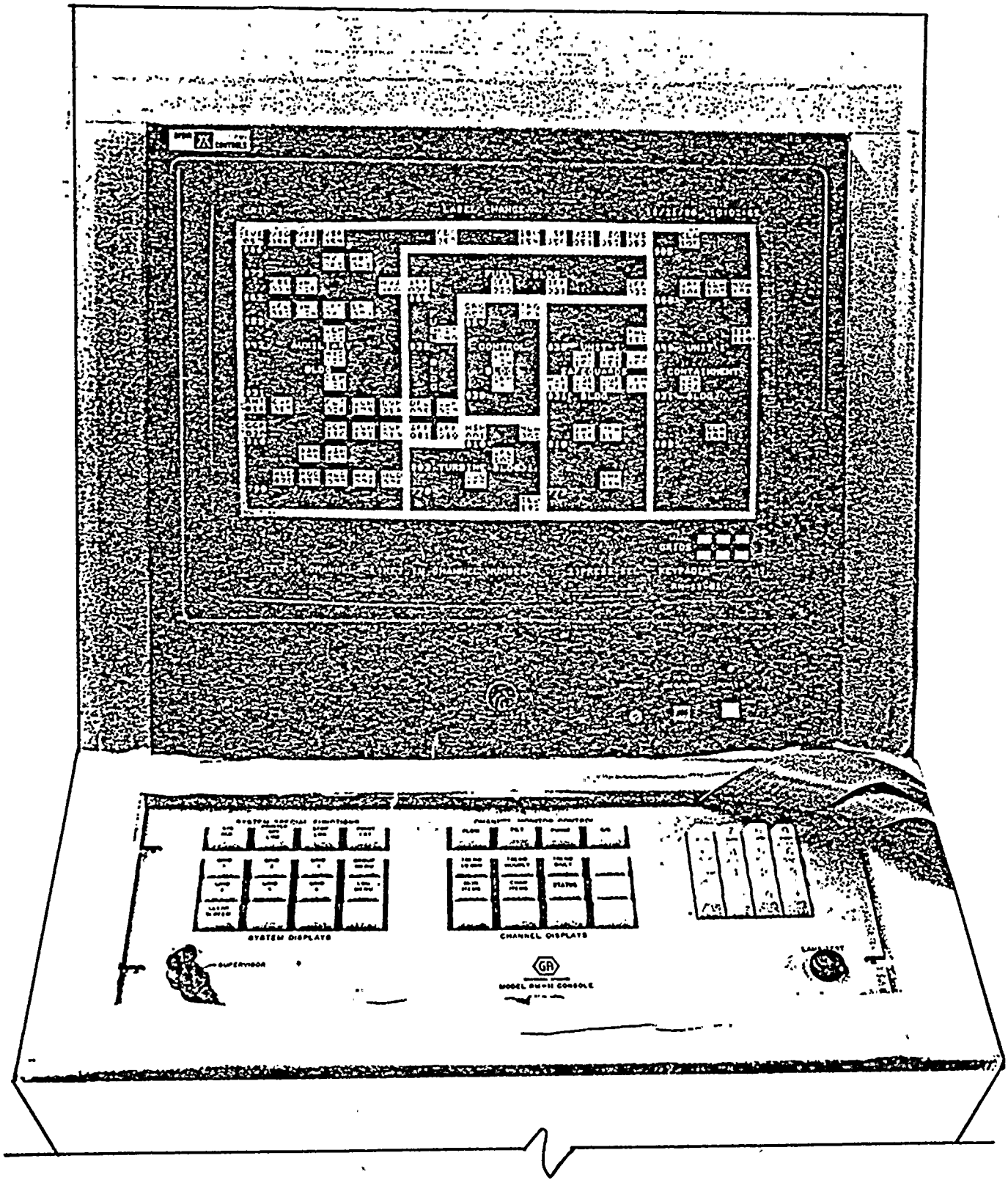

Figure 5 - A typical RM-11 CRT Console (base not shown). Conductor tapes at lower right of CRT are for testing and are not part of the permanent console.

RESULTS OF REVIEW

OVERALL SYSTEM

1. The light intensity of both digital displays and CRT displays appear to be satisfactorily clear and legible.

2. The noise output from the printer could affect efficient CR voice communications and efficient use of the CRT terminal. Noise damping, such as internal (to the printer cabinet) acoustic foam, and/or transparent noise shields over the printer should be considered.

3. Labeling of all equipment will be a key factor and should be addressed as early as possible thereby avoiding A&E recommended labeling that may be unclear or confusing.

4. GA reports the system is limited to six grids and six display terminals. From an engineering standpoint these could be significant limiting factors. It also appears that this system does not address perimeter or outlying radiation monitors. If not, where these monitor outputs are displayed should be considered if CR operators may have need for this information.

5. Each CRT terminal is reported to be capable of addressing any monitor or grid in this system. There will be a CRT terminal located in each CR, one in the health physics laboratory, and one in an undetermined auxiliary location.

RM-11 CRT TERMINAL

1. The RM-11 CRT Terminal appears to be the primary operator station for this system. There will be a CRT terminal located in each CR, one in the health physics laboratory, and one in an undetermined auxiliary location.

2. The reviewed CRT display uses colors to code boundries, headings and abnormal values. The colors are easily discriminated with both hue and saturation varied.

3. The RM-11 system uses a grid display (schematic layout) to represent monitor locations within the plant. A grid display logo located in the lower right corner of the screen will flash when an alarm condition is found, directing the operator to the correct grid. This grid logo lacks specific grid numbers but resembles the location of the Grid Selection buttons. Labeling of function and selection buttons is not the best, but could be sufficient with proper training.

4. The Lamp Test button only lights those buttons that have an on/off functions; however, as these appear to be the only simple indicator lights (or backlight pushbuttons) on the keyboard this appears to be adequate.

5. The display terminal has a "HEALTH" label near the "POWER" label and is reported by GA to represent power to the terminal. However, they are not entirely sure of this. If this is true, the label should be changed to "POWER ON".

6. The "ENTER" function button is located on the left side of the numeric keyboard, the second in a column of identically appearing buttons and could cause some delay in operating. This is not a time critical system; however, better location of the "ENTER" button could improve operator performance.

7. The brightness control is located right on the front for individual operator use, with the other control buttons (Vertical/Horizontal hold, etc.) located behind a locked panel on the CRT.

8. There is also a Degaussing button located on the front panel. GA says the CRT needs to be degaussed at intervals. With all the automation of this system, it seems logical that this function could also be automatic, otherwise a Preventative Maintenance program needs to be included for it.

9. The "LIT" button converts all function keys to alphabetical keys for system programming. This capability imposes the requirement for a number of buttons that are not used by Control Room Operators. This could cause some confusion; however, this is not a time critical system. It is recommended that this label be changed to one more descriptive of its function such as "NOR/ALPHA" for normal or alphabetic. Additionally, all function keys should carry a double label indicating function (under normal conditions) and the alpha character (when programming function is on).

RM-23 CABINET, MODULES AND RECORDERS

1. The RM-23 display/control modules are digital display units that are backup units for safety system monitors only. This is due to the CRT not being seismically qualified. The RM-23's will primarily be used by maintenance personnel or in the event of an accident that includes failure of the CRT terminal. RM-23's will require extensive operator training as all failure indications are in numerical code.

2. The "ON", "ALERT" and "HIGH ALARM" lights are very small and not very intense. This makes them difficult to detect under normal illuminance conditions. These should be enlarged and their intensity increased if there is any possibility that they must function as primary displays (i.e., primary radiation annunciators).

3. There are an unequal number of strip chart recorders compared to the RM-23 modules. Different combinations of readings from RM-23 modules (up to 3) will be displayed on these recorders. The rationale for this is unclear at this time.

4. The strip chart recorders must be read up close. Beyond four feet an observer cannot determine if they are standard scale or log scale.

5. There is no alarm mechanism to notify the operator of strip chart failure, paper running out, or exhausted ink supply.

6. The strip chart recorders can be fully removed from the cabinet once the retainers are loose. Locks should be installed such that they cannot be inadvertently pulled all the way out and dropped when changing ink and paper.

7. The pen/channel to color on these Leeds and Northrup recorders are different from the majority found in NPP CRs. Based upon a previous recommendation, it is suggested that the sequence be changed to the following:

Pen/Channel	Color
1	Red
2	Green
3	Blue

8. The status indicator lights located on the RM-23 cabinets between the modules and recorders are reported by GA to indicate which RM-23 module is not in service. The fuel handling area monitors have redundant RM-23's, one set in Unit 1 and the other in Unit 4. This option, and the reason for the redundancy is unclear at this time. Also, the location of the switch for determining Unit 1 or Unit 4 operation is not known. It is possible that these lights, when lighted will indicate a deactivated unit. This could be confusing as it establishes a lighted = off and unlighted = on relationship. Alternatives to this type relationship should be seriously considered.

9. It should be required that no RM-23 modules be mounted such that the readout and associated "HIGH" and "ALERT" lamps are above 70 inches or below 41 inches from the standing surface. If any such modules are to be used as primary displays which must be read precisely and frequently, these modules should be mounted such that their displays are not higher than 65 inches or lower than 50 inches from the standing surface.

RECOMMENDATIONS

Based on the above results, the GA Digital Process Radiation Monitoring System appears to have some human engineering design problems. The above evaluation is based on a very preliminary and cursory review and should not be considered definitive. The CRT displays and the interactive sequences could not be adequately evaluated. The recommendation of Essex is that the configuration, once operational, be evaluated in detail.