UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of)
)
CAROLINA POWER & LIGHT COMPANY)
AND NORTH CAROLINA EASTERN) Docket Nos. 50-400 OL
MUNICIPAL POWER AGENCY) 50-401 OL
)
(Shearon Harris Nuclear Power Plant,)
Units 1 & 2))

AFFIDAVIT OF ROBERT W. PRUNTY, JR., IN SUPPORT OF APPLICANT'S MOTION FOR SUMMARY DISPOSITION OF EDDLEMAN CONTENTION 132C(II)

County of Wake)
) s.s.
State of North Carolina)

ROBERT W. PRUNTY, JR., bring duly sworn according to law, deposes and says as follows:

1. I am employed by Carolina Power & Light Company (CP&L) as Principal Engineer - Electrical in the Harris Plant Engineering Section of the Harris Nuclear Project Department, New Hill, North Carolina. I have personal knowledge of the matters set forth herein and believe them to be true and correct to the best of my information, knowledge, and belief. A summary of my professional qualifications and experience is attached hereto as Exhibit 1.

2. Mr. Eddleman, in his Contention 132C(II), criticizes the layout of the Shearon Harris Nuclear Power Plant (SHNPP) Control Room. Specifically, Mr. Eddleman contends that certain control and display cabinets "block or impede" the view of others such that "operator inability to see, read accurately, or integrate the information on these panels can imperil public safety in an accident."

3. The purpose of this affidavit is to support the Applicants' Motion for Summary Disposition of Eddleman 132C(II) and to demonstrate that the configuration of the panels in Applicants' SHNPP control room has been thoroughly analyzed by experts from a human factors perspective in compliance with NRC regulations and in satisfaction of regulatory guidance, and is designed to assure operator protection of public safety.

4. A comprehensive human factors review of the SHNPP control room was conducted by CP&L, together with Ebasco Services, Inc. (Architect-Engineer), Westinghouse Corp. (Nuclear Steam Supply System vendor) and Essex Corp. (human factors consultants), from April 1980 to January 1981. This review was initiated by CP&L prior to the issuance of NUREG-0737, Supplement 1, Requirements for Emergency Response Capability (December 1982), which contains the specific direction for performing a control room design review, and prior to NUREG-0700, Guidelines for Control Room Design Reviews (September 1981), which contains guidance for conducting the review itself. Draft NUREG/CR-1580 was used as the primary source of criteria for the Shearon Harris control room review.

5. As the result of this review and per the recommendation of the resulting "Human Factors Design Evaluation Report for the Shearon Harris Unit 1 Control Room" (hereinafter DCRDR), first issued in January, 1981, at Appendix D (attached hereto as Exhibit 2), major equipment rearrangement was effected. Construction work in the area was halted until the layout design could be changed to reflect the equipment arrangement proposed by the DCRDR.

6. As stated in Appendix D of the DCRDR at page 8, three operating positions were chosen at the Main Control Board from which optimum viewing angles were determined for all panels other than the Main Control Board. The control room layout with the three operating positions indicated is contained in Exhibit 3. (Panel names and functions are described in Exhibit 2.) These positions were purposely chosen because of their proximity to Reactor Controls, Emergency Safeguards and Emergency Power

controls and displays. Viewing angles and distances were calculated. Signal densities and associated error rates, short term memory effects, label credibility and indicator light and flag discriminability were considered.

7. Changes made to maximize viewing angles were as follows:

1. Equipment panels 1 through 5 were moved closer to the three operator positions with positions 1 and 2 being the most important and position 3 being the least important;
2. Equipment panels numbers 12 through 15 were moved closer to all three positions; and
3. Equipment panels numbers 8 through 11 were moved closer to position 3.

These changes significantly reduced signal densities and error rate probabilities. DCRDR, Appendix D at 10.

8. Nevertheless, Mr. Eddleman asserts in Eddleman Contention 132C(II) that panels numbered 8, 9, 10 and 11 are obscured by panels numbered 12, 13, 14 and 15. This is true only if one is standing at panels 1 through 5 or at panels 6 and 7. NRC regulations require that for any operating nuclear power plant, a minimum of two operators including a senior operator must be in the control room at all times. 10 C.F.R. § 50.54(m)(2)(i) and (iii). It is anticipated that Applicants will have as many as three operators and a shift foreman in the control room a majority of the time. Of the operators on duty in the control room, at least one must be at the controls at all times. 10 C.F.R. § 50.54(m)(2)(iii). Accordingly, Applicants expect one of the operators to work at the operator desk itself much of the time.

9. Therefore, the operator position which Mr. Eddleman postulated located at panels 1 through 5 is not a typical position at which any of the operators required to man

the control room would remain. Should one of the operators be in this position, the other operator(s) would have a commanding view of panels 8 through 11 if needed.

10. Mr. Eddleman contends that panels 6 and 7 are obscured by panels 1 through 5. This is true, but the evaluation contained in DCRDR, Appendix D, indicates that equipment panels 6 and 7 (Cooling Tower and River Water Make-up Control and Condensate Booster Hydraulic Coupling Control) were deemed to have "minimal requirements for even occasional monitoring." DCRDR, Appendix D at 5 and 11. The Cooling Tower and River Water Make-up Control panel (#6) contains only a few controls and displays, id. , and those will be utilized very infrequently. The Condensate Booster Hydraulic Coupling panel (#7) contains no controls or displays on the front of the panel. Id. Neither of these panels is safety related nor required to be operated in an accident scenario.

11. Mr. Eddleman contends that the Incore Instrumentation panels (#16) and Nuclear Instrumentation System (NIS) panels (#17) are obscured by panels 1-5 and 6 and 7, and/or panels 12 through 15, and/or panels 8 through 11 positions. In this regard, Mr. Eddleman's contention assumes the location of the operator at various positions across the room from panels 16 and 17. First, these are not typical operating positions at which any of the required control operators manning the control room would remain. Second, the other operator(s) would have a commanding view of these panels (16 and 17) if needed. Third, although qualified to operate the Incore Instrumentation panels (#16), an operator is very seldom called upon to do so, as indicated by experience in other CP&L facilities. The operation of these panels is primarily an engineering function. Finally, the NIS panels (#17) have duplicate readouts on Main Control Board (MCB) section 1C, thereby requiring very infrequent access.

12. Applicants are in the process of finalizing the SHNPP Emergency Operating Procedures (EOPs). Various generic task analyses and verification and validation testing have been performed. Applicants have been involved in such analyses and testing of

Westinghouse emergency response guidelines and the H.B. Robinson Unit 2 EOPs. The control room has been laid out such that immediate actions and indication monitoring for design basis accidents will be accomplished from the Main Control Board, so that Applicants are unaware of any EOP which could be impeded by an obstructed view of the panels which are the subject of Contention 132C(II).

13. Thus CP&L's actions are in compliance with all NRC guidance and regulations to ensure a well designed, human engineered control room.

14. Accordingly, there will be no impediments to the control room operators' ability to read information off the control room panels and ensure safety of the public in routine or accident situations.

This is the 9th day of May, 1984

Robert W. Prunty, Jr.

Robert W. Prunty, Jr.

Sworn to and subscribed before
me this 9th day of May, 1984.

Marilyn V. Pease

Notary Public

My commission expires: 10/19/85

MARILYN V. PEASE
NOTARY
***
PUBLIC
WAKE COUNTY, NC

ROBERT WAYNE PRUNTY, JR.

Principal Engineer

BIRTH DATE: August 3, 1948

I. EDUCATION:

A. B.S. Degree in Electrical Engineering from University of South Carolina, Columbia, South Carolina - 1971

II. EXPERIENCE:

A. August 1971 to June 1979

1. U.S. Navy

a. Student in Nuclear Power School - August 1971 to September 1972

b. Nuclear Submarine Officer - October 1972 to September 1974

c. Student in Submarine Officer's Advanced Course - October 1974 to April 1975

d. Nuclear Submarine Officer - May 1975 to May 1977

e. Staff Instructor, Naval Nuclear Power School - June 1977 to june 1979

B. July 1979 to Present

1. Carolina Power & Light Company

a. Employed as Senior Engineer in the Engineering Pool Section of the Power Plant Engineering Department

b. December 1, 1979 - Transferred as Senior Engineer to the Harris Plant Engineering Section of the Nuclear Power Plant Engineering Department

c. April 5, 1980 - Promoted to Project Engineer - Harris Plant Engineering Section Nuclear Power Plant Engineering Department-located at New Hill, N.C.

d. August 8, 1981 - Promoted to Principal Engineer-Electrical in the Harris Plant Engineering Section, Nuclear Plant Engineering Department, New Hill, N.C.

Ex. 2

APPENDIX D
RECOMMENDED CONTROL ROOM EQUIPMENT ARRANGEMENT

A FINAL REPORT ON THE HUMAN FACTORS ENGINEERING ANALYSIS OF THE SHNPP UNIT 1 CONTROL ROOM EQUIPMENT ARRANGEMENT

Prepared For:

Carolina Power and Light
Raleigh, North Carolina

Prepared By:

Walter T. Talley

Essex Corporation
333 North Fairfax Street
Alexandria, Virginia 22314

16 January 1981

Revised
11 February 1981

TABLE OF CONTENTS

LIST OF TABLES

SECTION 1.0 INTRODUCTION

Background

a. An initial review of the SHNPP-1 control room (CR) design in June-July 1980 revealed possible human engineering (HE) problems associated with the arrangement of some of the CR furnishings, particularly the location of the Radiation Monitor cabinets and the vertical equipment cabinets along the east wall. This preliminary analysis was based upon the information contained on EBASCO drawing CAR-2166 G-324 Rev 2, 4-28-78 (Reactor Auxiliary Building Control Room Equipment Arrangement) and an incomplete set of cabinet outline drawings. A draft report submitted on 18 July 1980 documented the analysis of these problems and an alternative equipment arrangement which significantly improved visual access to these cabinets. Addendum 2 contains an overview of the initial analyses and recommendations.

b. At review meetings held with SHNPP Engineering and EBASCO on and after 25 July 1980 updated information was furnished which affected the initial analyses and recommendations. This new information consisted of additional cabinet outline drawings, sketches, and discussions concerning changes being made to EBASCO drawing CAR-2166 G-324 Open Rev 3 ("open" referring to a status of subject-to-change). In addition, staffing requirements were clarified which eliminated the need for a view window and rapid access between CRs 1 and 2, and the requirements for inclusion of a visitor's gallery were made mandatory.

c. New analyses were made and recommendations revised. In order to minimize the impact upon construction schedules, final recommendations were documented by memorandum on 13 August 1980, with documentation of the additional analyses to follow at a later date.

d. The main body of this report documents the final analyses and recommendations.

SECTION 2.0 FINAL ANALYSES

2.1 General

a. A review of the new engineering information listed in Addendum 1 indicated that, in spite of the movement of the Radiation Monitor cabinets (equipment numbers 12 through 15 in Table 1) to the north wall (Figure 1), some potential human factors problems still remained. The major areas of concern were:

- Monitoring accuracy of instruments in the string of vertical cabinets near the east and north walls
- Readability of displays and labels on the vertical cabinets and Radiation Monitors from various locations in the CR
- Adverse effects on operator short-term memory because of movement distances between various equipments
- Discrimination problems for simple indicators and/or nonilluminated flags on various instruments due to viewing distances
- Adverse effects upon display and label reading due to viewing distances.

b. Two major problems which limited the extent to which these new analyses could be developed (and also placed limitations upon the preliminary analyses) were a lack of clear operational understanding as to the criticality or importance of the majority of the vertical cabinets and the complete lack of adequate front panel detail which would have identified the controls, displays, and instruments contained thereon — the second lack compounding the problem of defining operational requirements. Therefore, certain assumptions were made. These assumptions, listed below, will provide the basic environmental definition on which the subsequent analyses were performed.

1) Relative importance of a particular cabinet or panel was estimated independent of any frequency-of-use or time criticality criteria as such criteria were not available. An assumption was made that if the equipment cabinet had front-mounted components, it would be used by the operator under some possible conditions.

2) Equipment cabinet names and possible functions were used to determine their application. This hypothesized application was used to determine preferred locations relative to the main control board. As an example, it appeared more reasonable for the start-up transformer and generator relay cabinets to be located closer to the turbine-generator area of the control board than elsewhere. Discussions with operationally experienced personnel attempted to impose some operational validity on these types of classifications.

TABLE 1

EQUIPMENT NUMBER IDENTIFICATION USED IN FINAL ANALYSES
(See Figures 1 and 2)

Equipment No.	Nomenclature
1	RCP Vibration Monitor Cabinet
2	Gross Failed Fuel Detection Console
3	Loose Parts Monitor Cabinet
4	Seismic Monitor Cabinet
5	Axial Power Distr & Monitor Panel
6	Cooling Tower and River Make-Up Control Cabinet
7	Cond Booster Hyd Coupling Cont Cab
8	Generator Relay Panel 1A
9	Generator Relay Panel 1B
10	Startup Transformer Relay Panel 1A
11	Startup Transformer Relay Panel 1B
12	Radiation Monitor Panel SA
13	Radiation Monitor Panel SB
14	Radiation Monitor Console
15	Radiation Monitor Printer
16	Incore Instrumentation
17	Nuclear Instrumentation System
18	Operator's Desk
19	Operator's Computer Console
20	Log and Alarm Typewriters and Console
21	Shift Foreman's Desk
22	Air Pack and Respirator Storage

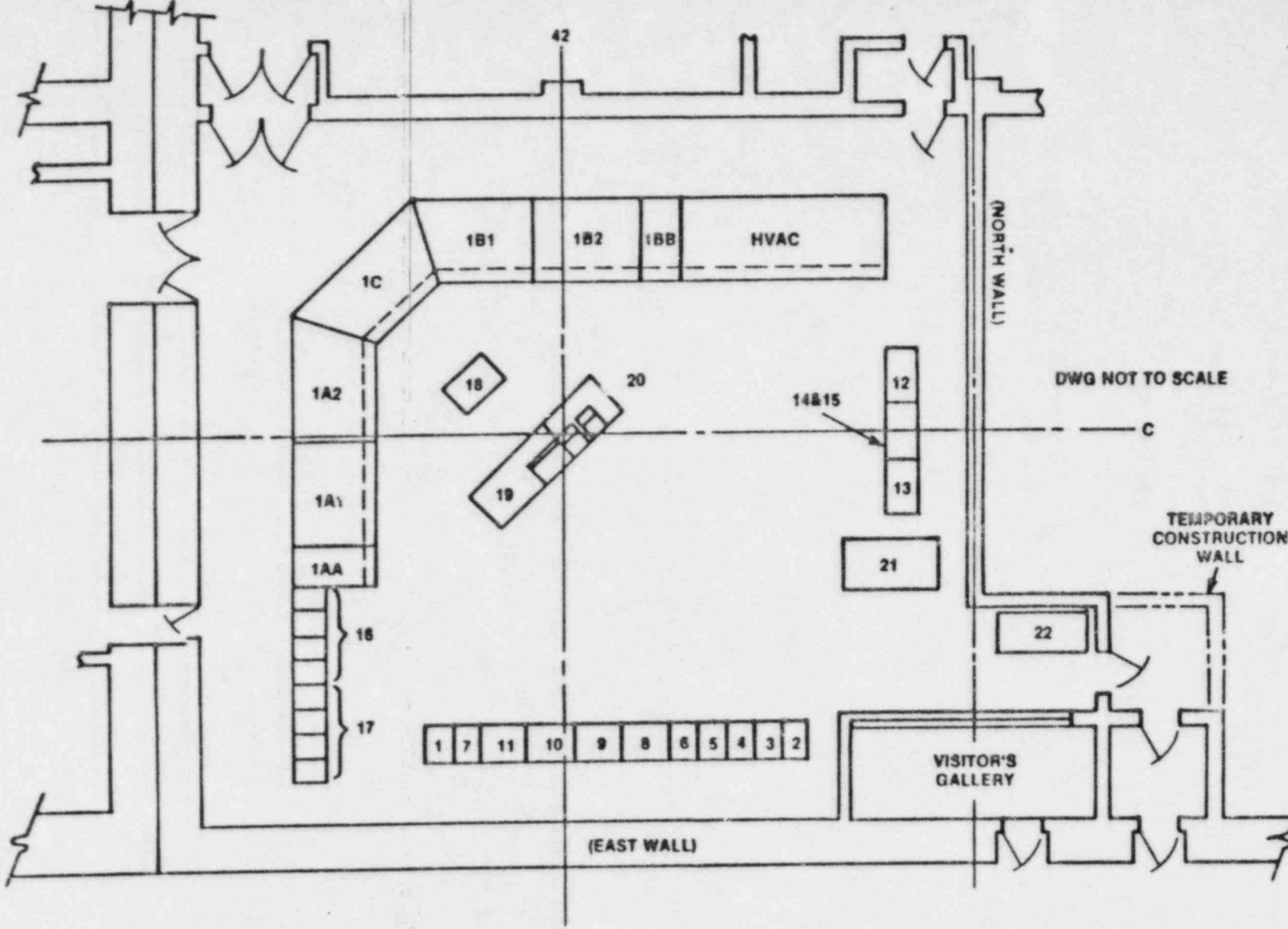


FIGURE 1

EBASCO PROPOSED ARRANGEMENT (REF CAR-2166 G-324, OPEN REV 3 AS OF 25 JULY 1980) FOR SHNPP UNIT 1 CONTROL ROOM. FOR EQUIPMENT IDENTIFICATION SEE TABLE 1.

3) Where some definition of types of instruments and their placement upon the panels could be found, such information was used.

2.2 Equipment Location Desirability

a. Equipment was classified for location desirability by using the criteria outlined in paragraph 2.1b, above. These classifications, which appear in Table 2, guided the analyses and subsequent recommendations.

b. Two cabinets, in particular, were estimated to have little or no significance in being located in the control room. The Condensate Booster Hydraulic Control Cabinet, which appeared not to have any front panel controls, and the Cooling Tower and River Water Make-up Control Cabinet, with few controls, were estimated to have minimal requirements for even occasional monitoring.

c. The Incore Instrumentation and Nuclear Instrumentation System cabinets were estimated to be located in an acceptable area based on discussions with operations personnel; therefore, no analyses were performed upon these.

d. The Radiation Monitoring consoles and cabinets were judged to have important use requirements associated with them. Additional information concerning their front panel characteristics was used to determine their need for a central location close to the control board, e.g., they contain large numbers of small monitor display readouts and alarm lights. A review of the front panel characteristics of these consoles is contained in the design evaluation file, index number 5.06.4.

2.3 Monitoring Accuracy

a. The accuracy and speed with which signals are detected by the human have been shown to be related to various elements of a complex monitoring task (complexity defined loosely as more than a single event occurring repetitiously). Some of these elements are frequency of event (or signal) occurrence; signal density (i.e., the total area wherein signals may occur, density increasing with the number of different signals which may occur within a given area); and irrelevant information (occurrence of signals that may be ignored at least temporarily). Accuracy of signal detection also appears to interact with the length of time on the monitoring task; however, the evidence is less clear in this area for complex monitoring tasks than it is for simple monitoring tasks. A significant increase in detection errors occurs when frequency of occurrence is low, density is high, and irrelevant signals may occur. This could possibly be further compounded by time on the task in excess of 1/2 to 1 hour. A search of relevant

TABLE 2

LOCATION CLASSIFICATION OF EQUIPMENT

Equip No.	Equipment Nomenclature	Preferred Location
1	RCP Vib Monitor	Close to associated CB Equip
2	Gross Failed Fuel Det	Close to associated CB Equip
3	Loose Parts Monitor	Close to associated CB Equip
4	Seismic Monitor	Close to associated CB Equip
5	APDM	Close to the Incore Instr
6	Clg Twr & River M-U Cont	Little or no request (see Text)
7	Cond Booster Hyd Cplg Cont	No requirement (see Text)
8	Gen Relay - 1A	Close to Turbine-Gen on CB
9	Gen Relay - 1B	Close to Turbine-Gen on CB
10	S-U Xfmr - 1A	Close to Turbine-Gen on CB
11	S-U Xfmr - 1B	Close to Turbine-Gen on CB
12	Rad Mon SA	Centrally located (see Text)
13	Rad Mon SB	Centrally located (see Text)
14	Rad Mon Console	Centrally located (see Text)
15	Rad Mon Printer	Centrally located (see Text)
16	Incore Instr	Either end of CB OK
17	NIS	Either end of CB OK
18	Operator's Desk	Centrally located-close to CB
19	Op's Comp Console	Close to operator's desk
20	Log & Alarm Equip	Close to operator's desk
21	Shift Supvr's Desk	Clear view of control board
22	Air Pack & Resp Equip	Low Emer Traffic Area, Easy Access

literature shows that signal densities have been varied from 4 to 46, occurrence frequencies have been varied from 10 to 100 per hour with intersignal intervals varying from 30 to 300 seconds, and relevant-to-irrelevant signal ratios shifted from 1:9 to 2:1 for a number of different investigations. These investigations also looked at signal heterogeneity, display (signal field) formats, response requirements, and kinds of signals (add vs. omit).

b. The control room of an NPP has frequently been defined as containing many of the following elements: low signal frequencies, as plants generally operate quite stably and well for the majority of time; signals occurring which do not require immediate responses; high signal densities due to enormous quantities of information present; and long monitoring periods. The placement of equipment cabinets 1 through 11 in a row as shown in Figure 1 would potentially aggravate problems of errors when monitoring their instruments. This also applies to equipment numbers 12 through 15. A major variable that appears controllable by moving cabinets around is the signal density (relative to the observer). This variable appears significant in affecting error rates for signal densities of from 4 to 32 in an area subtending a visual angle for the viewer of 20°. An approximate doubling of the density approximately doubles the error rate, and for higher densities appears to triple the error rate. It can be seen that, given a fixed area in which a fixed number of signals can occur, varying the distance from the observer to the area will vary the relative area presented to the central field of vision of the observer and, therefore, vary the observed signal density. The farther away the area is from the observer, the higher the signal density relative to the observer due to the increased area in the observer's central field of vision. This assumes detectability of all signals at the various distances. If visual angles could be increased (i.e., the relative size of the area in the central field of vision decreased) by moving equipment closer to the observer, a resultant decrease in signal density relative to the central field of vision will result. Assuming some monitoring error rate probability exists for the arrangement of Figure 1, then the probability of error should decrease if the equipment were closer to the viewer. The relationship of signal density to error rate previously discussed indicated an approximate direct relationship. Therefore, a decrease of signal density by 50 percent should result in a predicted decrease in error probability of approximately 50 percent. Three possible conditions could preclude the utility of this approach. First, given no error rate associated with the Figure 1 arrangement, obviously no predicted improvement would be made. This condition is highly unlikely based on past human performance data under highly varied conditions: it is almost a theoretical axiom that human performance has a

"built-in" error rate. Second, given that a predicted decrease in error rate probability was so small no significance could be assumed, the expense of moving equipment would be unjustified. And third, given an extremely high error rate associated with the arrangement, any decrease in error probabilities would still result in unacceptably high levels of predicted errors.

c. Based on the preceding synthesis, visual angles for various operator positions were calculated for equipment numbers 1 through 15 for the EBASCO arrangement shown in Figure 1. These visual angles were then assumed to represent a correlate with the approximate signal densities and their associated error rate probabilities for these various pieces of equipment. The following three positions were used for these calculations:

1) Position 1 — at the junction of panel sections 1A1 and 1A2 which placed the operator approximately center of the primary loop and emergency safeguard systems.

2) Position 2 — in front of panel section 1C1 which contains the reactor system instruments.

3) Position 3 — at the junction of panel sections 1BB and 1D1 which placed the operator approximately center of the two emergency diesel generators with the turbine-generator, the secondary system instrumentation to the left, and heating, ventilation, and air conditioning instruments to the right.

d. Equipment was then rearranged on sketches to a configuration approximating that shown in Figure 2. This was done with the following criteria in mind:

1) Attempt to bring equipment numbers 1 through 5 (RCP Vibration Monitor, Gross Failed Fuel Detection, Loose Parts Monitor, Seismic Monitor, and Axial Power Distribution and Monitor) all closer to the three operator positions with positions prioritized as: positions 1 and 2 most important and position 3 least important (refer to paragraph c, above, for control board instruments relative to these positions).

2) Attempt to bring equipment numbers 12 through 15 (Radiation Monitoring equipment) closer to all three positions, no position of higher priority.

3) Attempt to bring equipment numbers 8 through 11 (Start-Up Transformer Relays and Generator Relays) closer to operator position 3, which is near all generator instrumentation.

e. After the equipment was rearranged, new visual angles were calculated for the same three operator positions. These new angles were then compared to the old ones for the same cabinets, and an estimate of the percentage of reduction in signal densities (with associated error rate probabilities) was calculated. These estimated percentages appear in Table 3. As can be seen, the movement of the start-up transformer and generator relay

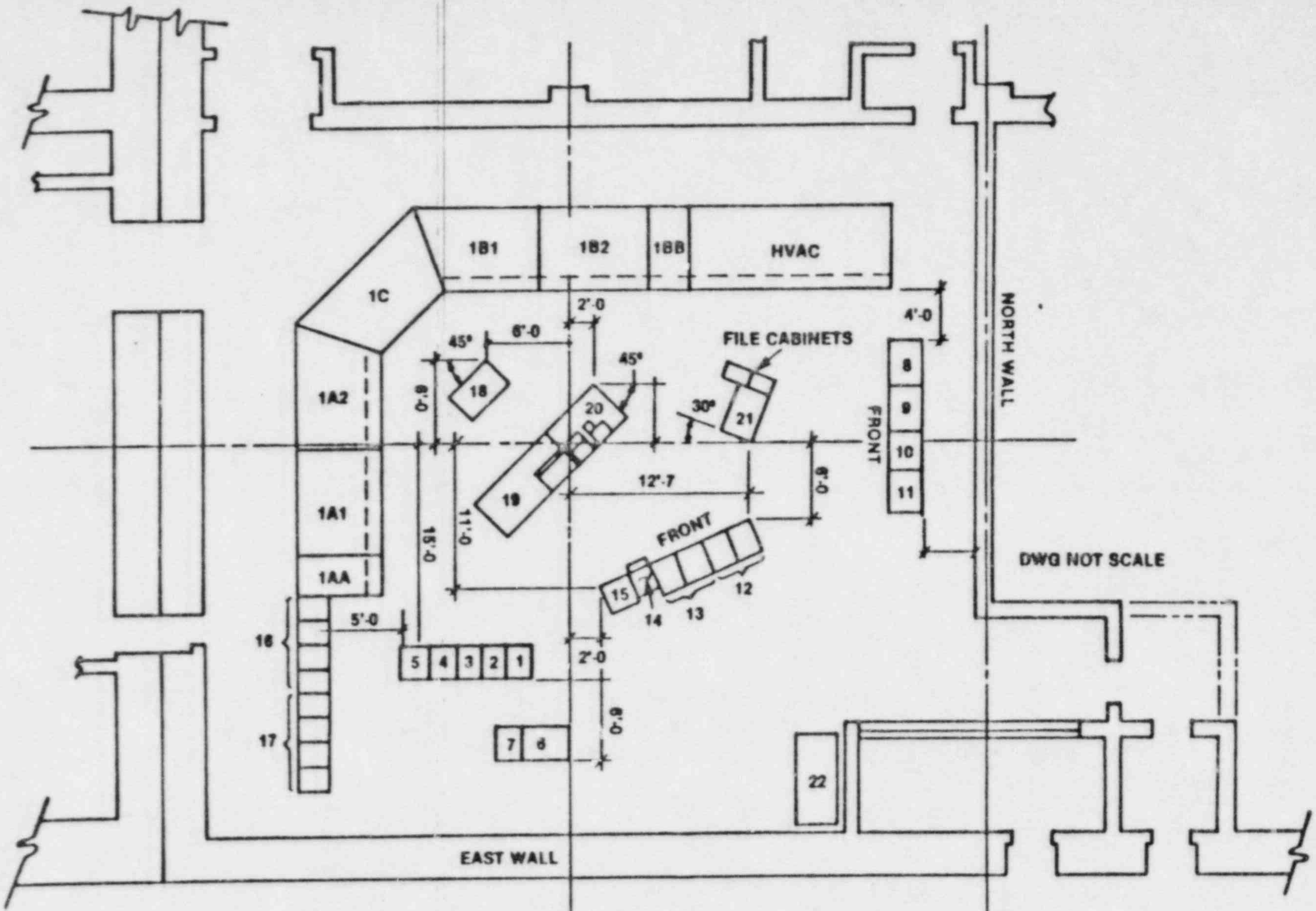


FIGURE 2

FINAL REARRANGEMENT RECOMMENDATIONS FOR SHNPP UNIT 1 CONTROL ROOM.
FOR EQUIPMENT IDENTIFICATION USE TABLE 1.

TABLE 3

ESTIMATED[1] DECREASES IN SIGNAL DENSITIES FOR EQUIPMENT NUMBERS 1 THROUGH 5, 8 THROUGH 11, AND 12 THROUGH 15 FROM ARRANGEMENTS SHOWN IN FIGURE 1 TO THOSE SHOWN IN FIGURE 2

Equipment Number	Estimated[1] Decrease in Signal Densities and Associated Error Rate Probabilities (%)		
	CB POS 1	CB POS 2	CB POS 3
1 thru 5	50%	37%	25%
8 thru 11	-22%[2]	3%	16%
12 thru 13	45%	32%	28%

1. Estimates based on the different visual angles, i.e., the difference in relative area seen by the observer, for different distances from the observer to the equipment (see text for discussion). Note also that the estimated decrease in error rate probabilities are percentages of an unknown rate.

2. This minus percentage indicates an increase in error rate probability.

cabinets resulted in a probable increase in error rate relative to position 1; however, the relationship to that position is minimal whereas the cabinets' relationship to position 3 is much more relevant.

Equipment numbers 6 and 7 (Cooling Tower and River Water Make-Up Control and Condensate Booster Hydraulic Coupling Control) were deemed to have little if any monitoring required. Discussions with EBASCO and CP&L Operations and Engineering staff indicated the former contained few, if any, front panel components and the latter contained none.

f. Using the EBASCO-proposed arrangement and the Essex-proposed preliminary rearrangement, additional comparative analyses were performed which addressed the issues of display and label readability, simple indicator and nonilluminated flag discriminability, and short-term memory effects upon operator performance.

2.4 Short-Term Memory Effects on Operator Performance

a. When equipment is located in such a way as to require considerable movement between two or more pieces of equipment in order to evaluate a condition, short-term memory can become a limiting factor for equipment separations if human performance is not to be degraded. Short-term memory refers to the transient and limited capacity for information storage in the human when learning does not take place. There are numerous, everyday examples of this phenomenon. A typical one would be to look up a phone number in the directory, close the directory, have someone interrupt with a question, and after answering, attempt to dial the number. Frequently the number has been forgotten. Within the control room this phenomenon can occur when an operator attempts to read various displays located around the room and then attempts to integrate all readings in order to make a decision concerning plant status or condition. Human factors and psychological investigations have determined a number of reasonably reliable and predictable characteristics concerning short-term memory, one of which is the fading or forgetting over time that occurs.

b. In-depth discussions concerning this phenomenon of short-term memory and its interaction with long-term memory may be found in the literature listed in the bibliography. For purposes in this report, an example taken from an investigation by B.B. Murdock, Jr. illustrates this principle quite well. His data show that within 3 seconds after being presented with a series of three consonant units (i.e., a series of three groups of consonants) or presented with a triad of words, subjects were only able to recall 75 percent of the information presented. This percentage decreases rapidly to about 30

percent at around 10 seconds and then slowly decreases to around 25 percent at 12 to 14 seconds. This is typical of much of the data on short-term memory retention rates. Other studies have used different presentation strategies and information, but most all show a marked degradation in retention within seconds after presentation.

c. Movement time between cabinets, or from the control board to a cabinet and return can be considered a significant factor in efficient, speedy, and accurate operator performance. Distances in excess of 28 to 30 feet walked at a fairly rapid pace can take approximately 6 seconds. In that period of time, retention probabilities can drop below 50 percent.

d. Before attempting to compare the two proposed arrangements on the basis of short-term memory it was necessary to determine readability characteristics of labels and discriminability characteristics of simple indicator lights and nonilluminated flags. These characteristics could allow for the distance traveled by an operator to be considerably reduced given optimum labels, lights, and flags.

2.4.1 Label Readability

a. The ability of an operator to read a label is dependent upon such factors as character size, character-to-surround contrast, ambient illumination levels, and exposure times. In the case of transilluminated displays and CRTs, ambient illumination levels interact with the display luminance. A low display luminance and/or a high ambient light level can reduce character-to-surround contrast. High ambient light levels can also compound the problems of direct and specular glare on all displays and labels. Recommended viewing distances for various character heights under different viewing conditions and levels of label (or display) importance can be calculated using various procedures developed for that purpose.

b. Table 4 lists viewing distances for five character heights under three viewing conditions and two levels of label importance. Experience has shown that few important labels or displays (other than possibly annunciators on the control board) will have character heights larger than 1/2 inch. In fact, 1/8-inch-high characters and smaller tend to predominate. Because of a lack of display and label information on the equipment cabinets under analysis, a conservative assumption was made that 1/8-inch-high labels would predominate and, therefore, operators must get within 2 1/2 feet of a cabinet in order to read displays and labels to any reasonable degree of accuracy. This adjustment was made in the movement distances discussed in paragraph 2.3.3 below.

TABLE 4

RECOMMENDED VIEWING DISTANCES FOR FIVE LETTER HEIGHTS UNDER THREE VIEWING CONDITIONS[1] AND TWO LABEL LEVELS OF IMPORTANCE[2, 3]

Letter Hgt (In)	Recommended Viewing Distances (Ft.)					
	Optimum		Nominal		Adverse	
	Norm	High	Norm	High	Norm	High
2.000	73	71	70	67	66	63
1.000	36	33	32	29	28	25
0.500	17	14	13	10	9	6
0.250	7	4	3	0.58	-	-
0.125	2.5	-	-	-	-	-

---

1. Viewing conditions (columns OPTIMUM, NOMINAL, and ADVERSE) are defined as:

   OPTIMUM = illumination above 1ftC, with favorable reading conditions

   NOMINAL = illumination above 1ftC, with unfavorable reading conditions or illumination below 1ftC, with favorable reading conditions

   ADVERSE = illumination below 1ftC, with unfavorable reading conditions.

2. Label importance (columns NORM and HIGH) are defined as:

   HIGH = critical labels necessary for accurate identification, such as scales on a continuous rotary control or emergency labels

   NORM = all others.

3. From G.A. Peters and B.B. Adams (Product Engineering, 25 May 1959, pages 55-57), and E.J. McCormick (Human Factors in Engineering and Design, 4th Edition, 1976).

2.4.2 Indicator Light and Flag Discriminability

The ability to discriminate the on-off condition of a simple indicator light depends on numerous variables, some of which are size, luminance, exposure time, light color, other background lights, and flash rates (if applicable). Nonilluminated flags have similar variables associated with them such as flag-to-surround contrast, size, exposure time, and other irrelevant shapes in the immediate surround. By adjusting ambient illumination to a nominal level, using adequately detectable light diameters and luminance characteristics, flag sizes and contrasts of acceptable values, and long exposure times with no flash rates for lights, distances for reliable detection can be estimated. Based on good viewing conditions, lights with good luminance characteristics should subtend a visual angle of approximately 1.2 minutes of arc to be detected 95 percent of the time. This would be approximately 1/8 inch in diameter for a viewing distance of 35 feet (note that luminance levels for such a light must exceed 1 millilambert). Sizes for corresponding flags should be possibly doubled to ensure adequate detection at 35 feet. Table 5 lists viewing distances where 95 percent detection of the on-off state for various diameter lights and condition states for flags of various square areas would seem reasonable. This table was developed assuming good to excellent luminance characteristics for lights and contrast ratios for flags. As can be seen, lights of 1/4-inch diameter and flags approximately 1/2-inch square have been estimated as detectable 95 percent of the time from a distance of 70 feet. Except for the Radiation Monitors, which are known to have a number of small (approximately 1/8-inch diameter) alarm lights of possible low luminance, detectability or change-of-state discriminability would not appear to be a major problem within the control room given the typical simple indicator lights and rotary switch flags currently in use.

2.4.3 Summary of Analyses for Short-Term Memory

a. In order to read a display on the vertical equipment panels and return to the control board, an operator must walk from the control board to the selected cabinet, read the display, and return to a desired position at the control board. Regardless of the starting position, the time required to return to a selected control board location can have an effect on the retention of information in the operator's short-term memory. Time estimates were made for movement distances between various equipment cabinet locations (shown in Figure 1) and the control board. These times are shown in Table 6 and represent movement time estimated between the three operator positions defined in paragraph 2.3.c and equipment numbers 2 and 11, and 12 through 15. The times shown for

TABLE 5

ESTIMATES OF VIEWING DISTANCES FOR LIGHTS AND SWITCH FLAGS FOR RELIABLE STATE DISCRIMINATION

Light Diameter (In)	Flag Area (In^2)[1]	Viewing Distance (Ft)
1.000	4.000	238
0.500	1.000	119
0.250	0.250	72
0.125	0.0625	36

1. Flags are assumed to be approximately square in shape, e.g., a 0.0625 sq in flag is 0.250 inches per side.

TABLE 6

ESTIMATED MOVEMENT TIMES FROM THREE OPERATOR POSITIONS[1] TO VARIOUS EQUIPMENT CABINETS[2] IN THE CONTROL ROOM FOR THE EBASCO PROPOSED ROOM ARRANGEMENT

Operator Position	Equipment Number	Estimated Travel Time (Sec)
1	2	8(3)
2	2	10(3)
3	2	8(3)
1	11	4
2	11	6
3	11	7
1	12 thru 15	8(3)
2	12 thru 15	7
3	12 thru 15	5

1. Operator positions are defined in paragraph 2.3.c.

2. Equipment names are in Table 2, locations are shown in Figure 2.

3. These times have 1 second added to compensate for a change in direction required to avoid desks.

the control board positions to equipment numbers 2 and 11 represent ranges such that estimated times for all other cabinets in that row would fall within those ranges. The times shown for the Radiation Monitors (equipment numbers 12 through 15) represent distances from the three control board positions to a position centered in front of this row of cabinets. All distances were adjusted for normal viewing distances as discussed in paragraph 2.3.2. Movement times in excess of 6 seconds (the time in which retention probabilities can drop below 50 percent) would probably be unacceptable for optimum operator performance, as decrements in information retention appear highly probable. Of the nine conditions shown, only three meet the criteria of 6 seconds or less.

b. Table 7 lists estimated movement times for the same three control board positions but to the rearranged cabinets shown in Figure 2. Decrements could still occur in information retention for 6-second retention intervals; however, these times appear to be a significant improvement. The one time in excess of 6 seconds also appears to have a low probability of occurrence as it would indicate that, somehow, relay equipment for the start-up transformers or generators was displaying information required by an operator at the control board area where the primary loop and emergency safeguard instrumentation are contained.

c. The only equipment where the discriminability of indicator lights (i.e., Is the light illuminated or not?) may be a problem in the EBASCO-proposed arrangement is the Radiation Monitors (equipment numbers 12 through 15) and then only for control board position 1. This distance is approximately 36 feet, the maximum for 1/8-inch diameter light detection given good light luminance. The Essex proposal, however, reduces this distance to approximately 23 feet, thereby increasing the probability of detection.

2.5 Desk and Storage Cabinet Locations

a. The operator's desk and operator's computer console with the log and alarm typers appear to be adequately located to support the operator's job requirements.

b. Based on a CP&L requirement for the shift supervisor to scan the control board, the supervisor's desk location better meets this requirement for the arrangement shown in Figure 2 than for the arrangement shown in Figure 1.

c. In Figure 1 the location of the Air Pack and Respirator Storage cabinet (equipment number 22) appears to be where traffic could interfere with operator access to it. The location shown in Figure 2 eliminates this potential problem.

TABLE 7

ESTIMATED MOVEMENT TIMES FROM THREE OPERATOR POSITIONS[1] TO VARIOUS EQUIPMENT CABINETS[2] IN THE CONTROL ROOM FOR THE ESSEX PROPOSED ROOM ARRANGEMENT

Operator Position	Equipment Number	Estimated Travel Time (Sec)
1	1 thru 5	3
2	1 thru 5	4
3	1 thru 5	6
1	8 thru 11	7(3)
2	8 thru 11	6
3	8 thru 11	5
1	12 thru 15	4(3)
2	12 thru 15	6(3)
3	12 thru 15	4

1. Operator positions are defined in paragraph 2.3.c.

2. Equipment names are in Table 2, locations are shown in Figure 4.

3. These times have 1 second added to compensate for a change in direction required to avoid desks.

SECTION 3.0 RECOMMENDATIONS

3.1 Equipment Arrangements

a. Analyses indicate that possible error rates associated with across-the-room monitoring of the vertical cabinets as shown in Figure 1 could be lowered with the equipment arrangement shown in Figure 2. This is based on assumptions concerning the front panel instruments on the cabinets that could not be adequately verified by available engineering and technical information; however, given an associated error rate of some significance for the Figure 1 arrangement, the Figure 2 arrangement is superior.

b. The analyses also indicate possible improvements in information retention rates for short-term memory (as a function of movement time) for the arrangement in Figure 2. Additionally, an improvement in the detection of alarm lights on the Radiation Monitors could be hypothesized from these analyses for the Figure 2 arrangement.

c. Essex recommends that the proposed arrangement shown in Figure 2 be adopted for the control room equipment in the SHNPP Unit 1. Latitude of placement from those locations shown for most equipment can be made to accommodate building structures such as steel beams and supports. Such accommodations should not exceed 6 inches forward or backward, or left or right for equipment numbers 1 through 5, 8 through 11, 12 through 15, and 18 through 21. Equipment numbers 6 and 7 may be moved back (east) to the limit needed for rear door access. They may also be moved left (north) 8 to 10 feet with no impact. Equipment number 22 should remain approximately where it is; however, aligning the long side against the east wall would be acceptable.

BIBLIOGRAPHY

Atkinson, R.C. & Shiffrin, Human memory: A proposed system and its control processes. In K.W. Spence and J.T. Spence (Eds.) The Psychology of Learning and Motivation, Vol. 2, New York: 1966, Academic Press, pp. 90-197.

Atkinson, R.C. & Shiffrin, R.M., The control of short-term memory, Sci Am, Aug. 1971, 225, 82-90.

Benzer, S., Genetic dissection of behavior, Sci Am, Dec. 1973, 229, 24-37.

Bransford, J. & Franks, J., The abstraction of linguistic ideas, Cognative Psychol, 1971, 2, 331-350.

Butter, C.M., Neuropsychology: The Study of Brain and Behavior, Belmont, Calif.: 1968, Brooks/Cole, chap. 8.

Christman, R.J., Sensory Experience, Scranton, Pa.: 1971, Intext Publishers.

Cooper, J.R., Bloom, F.E., & Roth, R.H., The Biochemical Basis of Neuropharmacology, New York: 1970, Oxford University Press, chap. 9.

Dallett, K.M., Practice effects in free and order recall, J Exp Psychol, 1963, 66, 65-71.

Deese, J. & Hulse, S.H., The Psychology of Learning, New York: 1967, McGraw-Hill, chap 11.

Epstein, W., Mechanisms of directed forgetting, In G.H. Bower (Ed.), The Psychology of Learning and Motivation, Vol. 6, New York: 1972, Academic Press, pp. 147-192.

Fergenson, P.E. & Teichner, W.H., Short-long-term memory interaction with underlearned long-term storage, J gen Psychol, 1971, 85, 51-61.

Fronkin, V.A., Slips of the tongue, Sci Am, Dec 1973, 229, 110-117.

Geldard, F.A., The Human Senses, New York: 1972, John Wiley & Sons, Inc.

Montague, W.E., Elaborative "Strategies in verbal learning and memory. In G.H. Bower (Ed.) The Psychology of Learning and Motivation, Vol. 6, New York: 1972, Academic Press, 225-302.

Murdock, B.B., Jr., The retention of individual items, J exp Psychol, 1961, 62, 619.

Norman, D.A., Memory and Attention: An Introduction to Human Information Processing, New York: 1969, John Wiley & Sons.

Rundus, D., Analysis of rehearsal processes in free recall, J exp Psychol, 1971, 89, 63-77.

Shiffrin, R.M., Forgetting: Trace erosion or retrieval failure? Sci, 1970a, 168, 1601-1603.

Shiffrin, R.M., Memory search, In D.A. Norman (Ed.), Models of Human Memory, New York, 1970b, pp. 375-450.

Slamecka, N.J., An examination of trace storage in free recall, J exp Psychol, 1968, 76, 504-513.

Sperling, G., The information available in brief visual presentations, Psychol Mono, 1960, 74, No. 498.

Waugh, N.C., Presentation time in free recall, J exp Psychol, 1967, 73, 39-44.

Waugh, N.C. & Norman, D.A., Primary memory, Psychol Rev, 1965, 72, 89-104.

ADDENDUM 1

APPROXIMATE EQUIPMENT SIZES

APPROXIMATE EQUIPMENT SIZES

Equipment Type	Dimensions (In) Hgt	Width	Depth	Source[1]
RCP Vib Mon Cab	90	24	30	Estimated
Gross Failed Fuel Det Console	90	24	30	Estimated
Loose Parts Mon Cab	91 5/16	22 1/16	30 1/2	EBASCO 1364-21756RO
Seismic Mon Cabinet	90	23 1/8	30	Vendor Drawing
APDM Panel	90	24	30	Estimated
Clg Twr and River MU Cont Cab	90	44	30	EBASCO CAR1364 ATT"B"
Cond Boost Hyd Cplg Cont Cab	90	24	30	Estimated
Gen Relay Pnl 1A	96	42	30	EBASCO 1364-21823RO
Gen Relay Pnl 1B	96	42	30	EBASCO 1364-21824RO
SU Xfmr Relay Pnl 1A	96	36	30	EBASCO 1364-21854RI
SU Xfmr Relay Pnl 1B	96	36	30	EBASCO 1364-21855RI
Rad Mon Pnl SA (2 ea)	81 5/16	24	30	EBASCO 1364-35048RI
Rad Mon Pnl SB (2 ea)	81 5/16	24	30	EBASCO 1364-35049RI
Rad Mon Console	52	22	22	Vendor Drawing
Rad Mon Printer	34	28	24	Vendor Drawing
Incore Instr Cabs	90	22	30	Estimated
NIS Cabinets	90	22	30	Estimated
SRO Desk	27	48	30	Estimated
RO's Comp Console	27	86 3/4	44	EBASCO 1364-4630RO
Comp Printer (Console Top)	12	28 1/2	22 5/16	EBASCO 1354-4630RO
Log and Alarm Console	27	62 3/4	44	TELECON FROM EBASCO 7-29-80
Log and Alarm Typer (Console Top)	15	19	15	HARRIS SIMULATOR
Shift Supervisor's Desk	27	84	44	Estimated
Air Pack & Resp Storage	90	80	36	Estimated

Note 1: Estimated dimensions except for heights were developed from measurements made on EBASCO drawing CAR-2166 G-324 open Rev 3 as of 25 July 1980. Heights for cabinets were estimted at 90 inches, desk heights were estimated at 27 inches.

DWGS RCV'D FROM EBASCO ON 25 JULY 80

Title and/or Identification	DWG No.
Operator's Console Assembly (Cabinet Outline Only)	Westinghouse 8846D49 - EBASCO 1364-4630RO 3/8/78
Generator Protective Relay Panel 1A - Construction	Frank Elec. Corp. E7-3964-10 - EBASCO 1364-21823RO 7/11/79
Generator Protective Relay Panel 1B - Construction	Frank Elec. Corp. E7-3964-11"D" EBASCO 1364-21824R3 2/11/80
Start-Up Transformer Protective Relay Panel 1A Construction	Frank Elec. Corp. E7-3964-2"A" EBASCO 1364-21854R1 8/27/79
Start-Up Transformer Protective Relay Panel 1B Construction	Frank Elec. Corp. E7-3964-3"A" EBASCO 1364-21855R1 8/27/79
Outline - Unit 1A & 4A Control Room Panel	General Atomic Co. 0352-0500"1" EBASCO 1364-35048R1 4/16/80
Outline - Unit 1B & 4B Control Room Panel	General Atomic Com 0352-0505"1" EBASCO 1364-35049R1 4/16/80
Digital Metal Impact Monitoring System Cabinet Outline	Westinghouse 1542E53 EBASCO 1364-21756RO 7/11/79
Cooling Tower and River Makeup Control Panel (Unit No. 1)	CAR 1364 SH-IN-15-1 Rev. 1 10/11/79, Att. "B," Sheet 1 of 3
System Interconnect and Cabinet Outline	Kinemetrics Inc. 104189 - 9/7/79 (outline for the Seismic Mon).

INFORMATION RCV'D FROM EBASCO 25 JULY 80

Ref Dwg Car-2166 G-324 Rev 3 (open)

1. Radiation Monitors SA, SB, NNS have a combined length of 12'-2".

2. Monitors will be located 3'-6" to the left of dividing wall (between units 1 and 2, ref. beam line 43) and centered on beam line C.

3. Computer Operator's Console will be rotated 180^{o}.

INFORMATION RCV'D FROM EBASCO 29 JULY 80 (TELCON)

1. Equipment dimensions for the Gen Relay Panels 1A & 1B, Start Up X four Relay Panel 1B, and Clg Tw & Riv MV Cont Cabinet are correct on vendor dwgs, incorrect on control room layout dwg (CAR-2166 G-324).

2. Computer Oper. Console is actually 2 pieces Operator's Console assy (West 8846D49, EBASCO 4630) and Printer Console (West 8846D65, EBASCO 4580). We do not have the Printer console drawings.

3. Dimensions of the Computer Oper's Console are as shown on Vendor dwg and the Printer Console dimensions are 44" deep by 62.69" wide. The combined width (or length) of the two are approximately as shown on CAR-2166 G-324).

4. The RAD MON unit identified as NNS on CAR-2166 G-324 consists of just the Display Console shown on General Atomics dwg 0352-0600. Outline RM-11 Equipment with dimensional corrections as shown for Stantron Cat. No. 200-43-22 (Section 5, Page 3 of the Vertical Cabinet "200" Series).

5. ~~No components are mtd on face of Cond Boost Hyd. Cont. Cab.~~

DWGS NOT SUPPLIED

1. Gross Failed Fuel Detection Cabinet.

2. RCP Vibration Monitor Panel.

3. Seismic Monitor Panel.

ADDENDUM 2

OVERVIEW OF THE INITIAL ANALYSIS AND RECOMMENDATIONS

OVERVIEW OF THE INITIAL ANALYSIS AND RECOMMENDATIONS

(Documented in draft report submitted 18 July 1980)

The original EBASCO control room equipment arrangement in Figure A shows the Radiation Monitor cabinets blocking the operator's view of the row of vertical cabinets located near the east wall. This problem can be solved by moving the Radiation Monitor Cabinets. However, an additional problem then surfaces.

Due to the distances from the operator's desk and control board sections 1A2, 1C, 1B1, 1B2, 1BB, and HVAC to these vertical cabinets, a large expanse of cabinet fronts, all on the same approximate visual plane, would be presented to the viewer's central visual field (the foveal area of the retina). Herein is the second problem. In attempting to look at any particular spot in this expanse of front panels, virtually all other predominant features on the panels would significantly compete for the observer's attention as these features are all in visual focus and in the central field of vision.

The Essex-proposed rearrangement shown in Figure B attempts to partially solve both problems. While part of the Radiation Monitor equipment is moved a little farther from the operator's desk and the control panel, it no longer significantly blocks the view to the vertical cabinets from the control board. Additionally, the long string of cabinets has been separated into two groups, reducing by half the amount of cabinet front panel area presented to the viewer when looking in either direction.

Other features of this proposed rearrangement would be: 1) to place the Generator and Start-Up Transformer Relay cabinets in a more accessible location to their related areas of the control board (sections 1B2 and 1BB which contain the main and emergency generators and the bus distribution controls and displays); and 2) to place the shift foreman's desk closer to the control board. This second feature better supports the CP&L operating philosophy of maintaining good visual access to the control board (for the shift supervisor) than does the EBASCO arrangement.

TABLE A

EQUIPMENT NUMBER IDENTIFICATION USED IN INITIAL ANALYSES
(See Figures A and B)

Equipment No.	Back Panel Nomenclature
1	Condensate Booster Hydraulic Coupling Control Cabinet
2	Gross Failed Fuel Detection Console
3	Loose Parts Monitor Cabinet
4	RCP Vibration Monitor Cabinet
5	Seismic Monitor Cabinet
6	Cooling Tower and River Make-Up Control Cabinet
7	Generator Relay Panel 1B
8	Generator Relay Panel 1A
9	Startup Transformer Relay Panel 1B
10	Startup Transformer Relay Panel 1A
11	Radiation Monitor Panel SA
12	Radiation Monitor Panel NNS
13	Radiation Monitor Panel SB
14	Radiation Monitor Console
15	CRO Desk
16	Log and Alarm Typewriters and Computer Console
17	Shift Foreman's Desk
18	Incore Instrumentation
19	Nuclear Instrumentation System
20	Air Pack and Respirator Storage

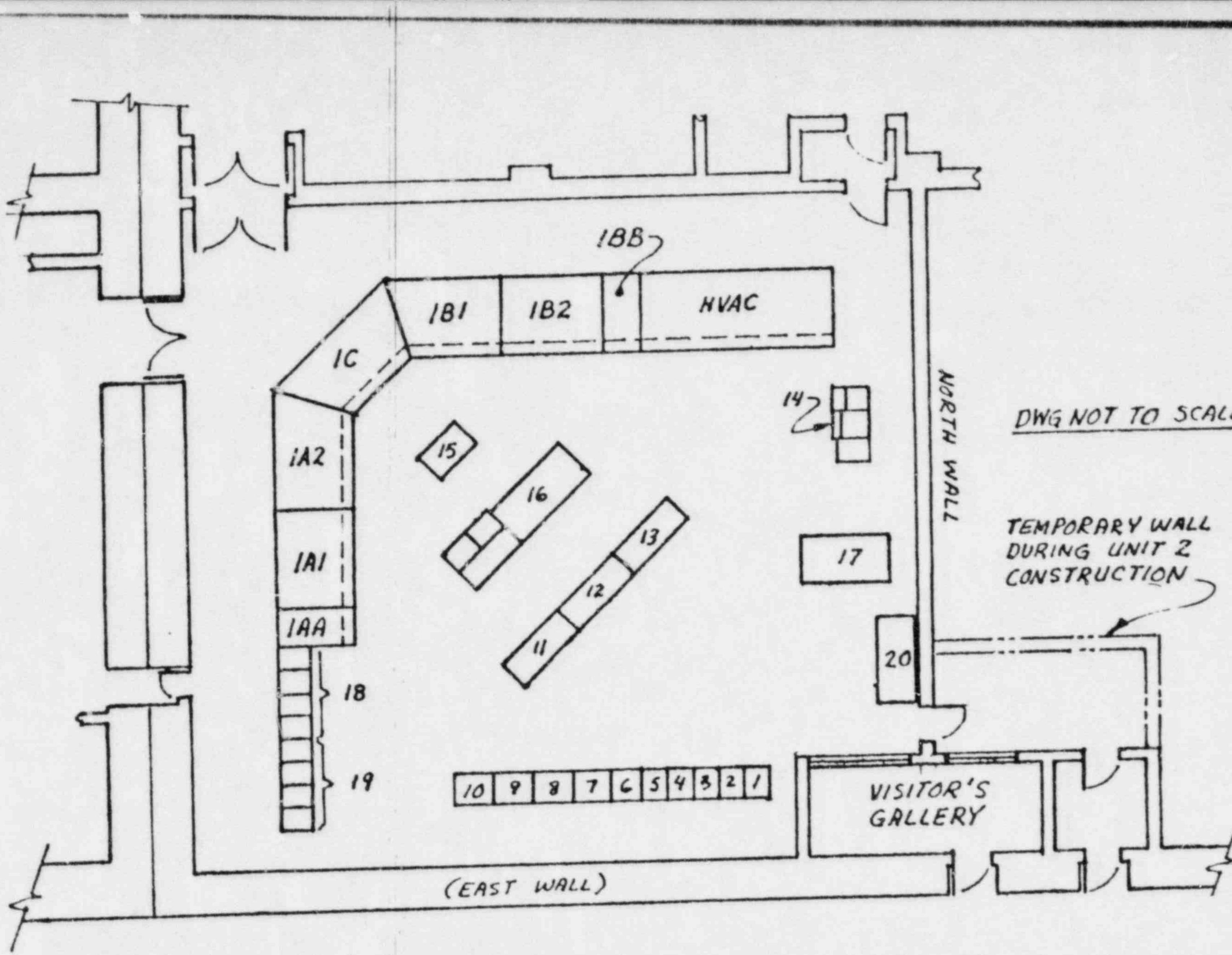


FIGURE A

EBASCO CONTROL ROOM EQUIPMENT ARRANGEMENT (REF CAR-2166 G-324, REV 2) FOR SHNPP UNIT 1. SEE TABLE A FOR EQUIPMENT IDENTIFICATION.

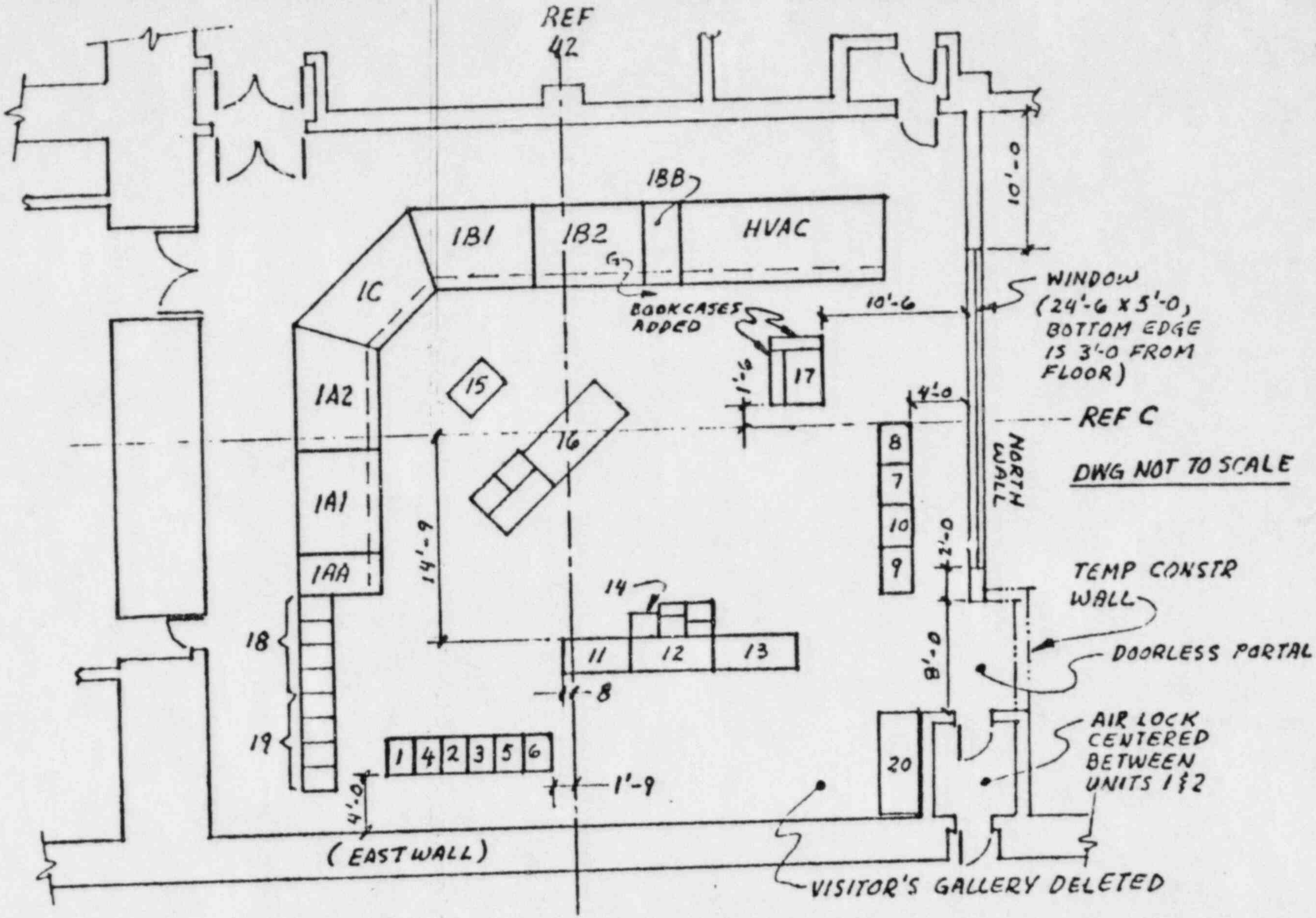
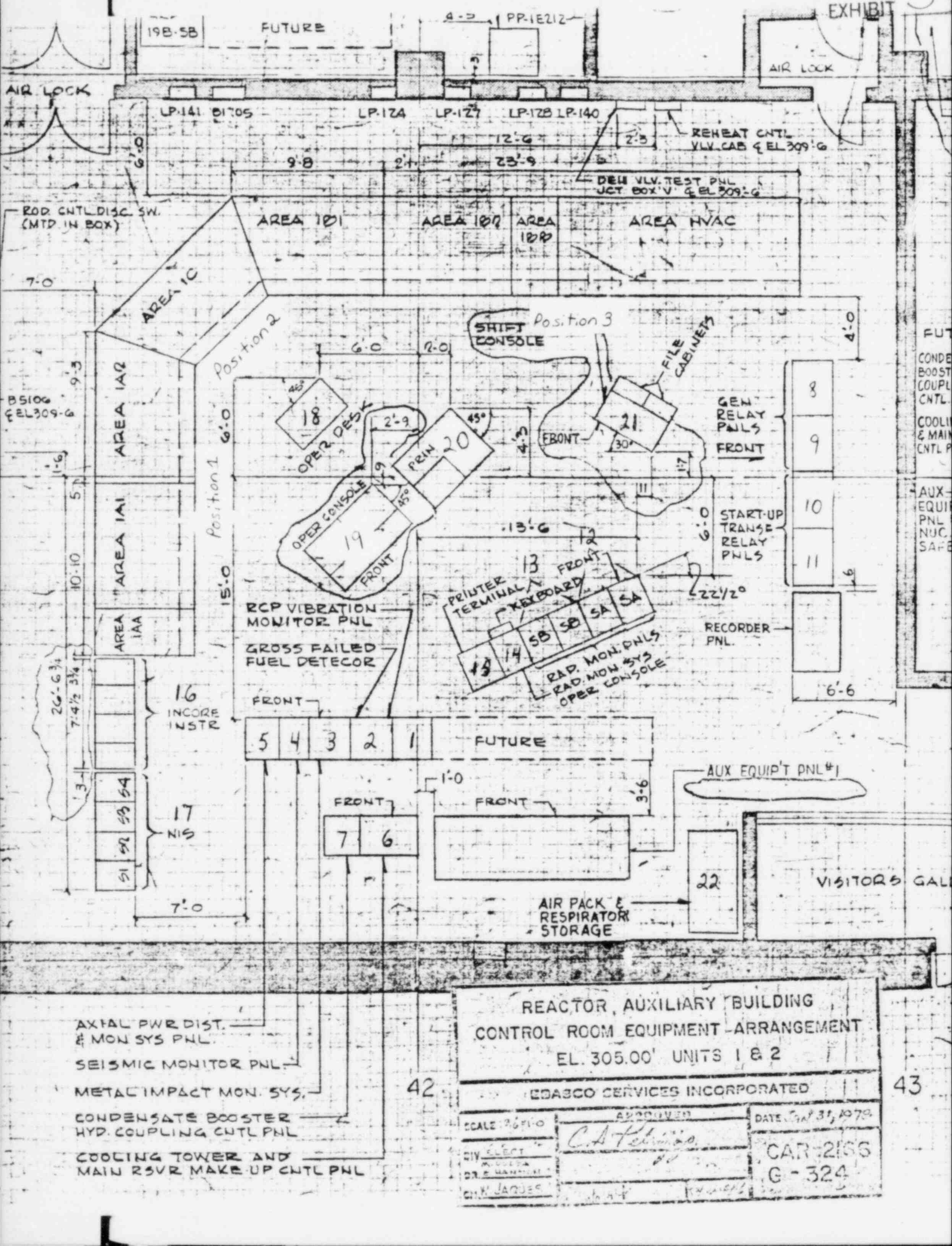


FIGURE B

ESSEX-PROPOSED CONTROL ROOM EQUIPMENT REARRANGEMENT.
SEE TABLE A FOR EQUIPMENT IDENTIFICATION.

EXHIBIT 3



19B-5B
FUTURE
PP-1E212
AIR LOCK
LP-141
LP-124
LP-127
LP-128
LP-140
REHEAT CNTL VLV. CAB ⊄ EL 309'-6
12'-6
2'-3
9'-8
2'-1
23'-9
DEH VLV. TEST PNL JCT BOX 'V' ⊄ EL 309'-6
ROD CNTL DISC. SW. (MTD IN BOX)
AREA 101
AREA 107
AREA 108
AREA HVAC
7'-0
AREA 1C
Position 2
SHIFT CONSOLE
Position 3
FILE CABINETS
4'-0
6'-0
2'-0
9'-3
B5106 ⊄ EL 309'-6
AREA 1A2
18
OPER DESK
2'-9
PRIN
20
45°
4'-3
FRONT
21
30°
GEN RELAY PNLS
FRONT
8
9
10
11
Position 1
AREA 1A1
OPER CONSOLE
19
FRONT
13'-6
6'-0
START-UP TRANSF RELAY PNLS
10'-10
15'-0
AREA 1AA
PRINTER TERMINAL
KEYBOARD
13
FRONT
12
22 1/2°
SB
SB
SA
SA
13
14
RAD. MON. PNLS
RAD. MON. SYS OPER CONSOLE
RCP VIBRATION MONITOR PNL
GROSS FAILED FUEL DETECOR
RECORDER PNL.
6'-6
16
INCORE INSTR
FRONT
5
4
3
2
1
FUTURE
26'-6 3/4
7'-4 1/2
AUX EQUIP'T PNL #1
1'-0
3'-6
FRONT
FRONT
7
6
17
NIS
S1
S2
S3
S4
22
VISITORS GAL
7'-0
AIR PACK & RESPIRATOR STORAGE
AXIAL PWR DIST. & MON SYS PNL
SEISMIC MONITOR PNL
METAL IMPACT MON. SYS.
CONDENSATE BOOSTER HYD. COUPLING CNTL PNL
COOLING TOWER AND MAIN RSVR MAKE-UP CNTL PNL
REACTOR, AUXILIARY BUILDING
CONTROL ROOM EQUIPMENT ARRANGEMENT
EL. 305.00' UNITS 1 & 2
EBASCO SERVICES INCORPORATED
APPROVED
DATE Jan 31, 1979
CAR-2166
G-324
42
43

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CAROLINA POWER & LIGHT COMPANY	)	
AND NORTH CAROLINA EASTERN	)	Docket Nos. 50-400 OL
MUNICIPAL POWER AGENCY	)	50-401 OL
	)	
(Shearon Harris Nuclear Power Plant,	)	
Units 1 & 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Applicants' Motion for Summary Disposition of Eddleman Contention 132C(II)", "Applicants Statement of Material Fact As To Which There Is No Genuine Issue" and "Affidavit of Robert W. Prunty, Jr." were served this 9th day of May, 1984 by hand delivery to Wells Eddleman; by hand delivery on the 10th day of May, 1984 to the NRC Staff; by deposit in the United States mail, on the 9th day of May, 1984, first class, postage prepaid, to other parties on the attached Service List.

Hill Carrow

Hill Carrow
Attorney
Carolina Power & Light Company
Post Office Box 1551
Raleigh, North Carolina 27602
(919) 836-6839

Dated: May 9, 1984

SERVICE LIST

James L. Kelley, Esquire
Atomic Safety and Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. Glenn O. Bright
Atomic Safety and Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dr. James H. Carpenter
Atomic Safety and Licensing Board
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Charles A. Barth, Esquire
Myron Karman, Esquire
Office of Executive Legal Director
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Docketing and Service Section
Office of the Secretary
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Mr. Daniel F. Read, President
Chapel Hill Anti-Nuclear
Group Effort
5707 Waycross Street
Raleigh, North Carolina 27606

Dr. Linda Little
Governor's Waste Management Board
513 Albemarle Building
325 Salisbury Street
Raleigh, North Carolina 27611

Mr. Steven Crockett, Esquire
Atomic Safety and Licensing
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

John D. Runkle, Esquire
Conservation Council of North Carolina
307 Granville Road
Chapel Hill, North Carolina 27514

M. Travis Payne, Esquire
Edelstein and Payne
Post Office Box 12643
Raleigh, North Carolina 27605

Dr. Richard D. Wilson
729 Hunter Street
Apex, North Carolina 27502

Mr. Wells Eddleman
718-A Iredell Street
Durham, North Carolina 27705

Thomas A. Baxter, Esquire
John H. O'Neill, Jr., Esquire
Shaw, Pittman, Potts & Trowbridge
1800 M Street, NW
Washington, D.C. 20036

Bradley W. Jones, Esquire
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street
Atlanta, Georgia 30303

Robert P. Gruber
Executive Director
Public Staff
North Carolina Utilities Commission
Post Office Box 991
Raleigh, North Carolina 27602