

Georgia Power Company  
Vogtle Electric Generating Plant Unit 1  
Detailed Control Room Design Review  
Supplemental Summary Report

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# DCRDR SUPPLEMENTAL SUMMARY REPORT

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## DCRDR SUPPLEMENTAL SUMMARY REPORT

### I. INTRODUCTION

This report provides additional information requested by the Nuclear Regulatory Commission in their Safety Evaluation Report on the Vogtle Electric Generating Plant (VEGP), Detailed Control Room Design Review. (DCRDR) The report also contains additional information requested as a result of the NRC audit of the DCRDR and the VEGP Safety Parameter Display System (SPDS).

## II. CONTROL ROOM SURVEYS

### A. Environmental Surveys

#### 1. Ambient Noise

This survey was completed prior to Unit 1 fuel load and results submitted to the NRC. Table I.A.1.1 summarizes the results of the Ambient Noise Survey.

Table I.A.1.1 Ambient Noise

Ambient Sound Level:	60.0 db
Annunciator Alarm Reset Bell:	84.5 db
QMCB Section A Annunciator Tone:	67.0 db
QMCB Section B Annunciator Tone:	67.5 db
QMCB Section C Annunciator Tone:	72.0 db
QEAB Annunciator Tone:	75.3 db

#### II.A.1 - Three Human Engineering Discrepancies resulted:

HED 1321 - Background noise (60 db) may impair verbal communication between two points in the primary operating area.

HED 1321 was evaluated as a category 4. Resolution was to repeat the Unit 1 survey in the Unit 2 DCRDR when the Unit 2 Control Room is complete. Noise levels are within the guideline for normal communication distances.

A temporary wall and ventilation modifications increase the noise level. The noise is expected to decrease when the Control Room is completed.

HED 1322 - The annunciator alarm tones may not permit operators to reliably discern the time above the ambient control room noise. The main control board alarms are less than + 10 db above ambient noise levels.

HED 1322 was evaluated as a category 3 (easy to correct) and the annunciators were set to + 10 db above ambient by Maintenance Work Order. This Unit 1 survey will be repeated as part of the Unit 2 DCRDR when the entire control room is complete.



HED 1323 - The annunciator reset bell sound level exceeds the guideline nominal value of +10 db above ambient.

HED 1323 was categorized as a level 3 (easy to correct) and the bell was muffled. No operator complaints have been reviewed. The Unit 1 survey will be repeated in the Unit 2 DCRDR when the control room is completed.

2. Illumination Survey

This survey was completed prior to Unit 1 fuel load and reports to the NRC. Table I.A.2.1 summarizes the results of the Illumination Survey.

Table I.A.2.1 Illumination Survey

Maximum illumination:	113.1 footcandles (Shift Supervisor's Workstation, north)
Minimum illumination:	11.9 footcandles (QMCB Section C, vertical board)

One HED resulted from the lighting survey.

HED 1324 - The control room lighting (when adjusted to minimum value) is less than the minimum requirements.

HED 1324 was evaluated as a category 4A (No action planned). The dimmer stop is in the Control Room at the Shift Supervisor station, and is normally left set for adequate light levels.

3. HVAC Survey

This survey was completed prior to Unit 1 exceeding 5% of rated thermal power. Table I.A.3.1 summarizes the results of the HVAC Survey.

Table I.A.3.1 HVAC Survey

Maximum temperature:	75F
Minimum temperature:	66F
Maximum humidity:	44%
Minimum humidity:	35%
Maximum air velocity:	220 fpm (at vent outlet)
	95 fpm (at 6 ft. elev.)
	45 fpm (at 4 ft elev.)
Minimum air velocity:	130 fpm (at vent outlet)
	45 fpm (at 6 ft elev.)
	5 fpm (at 4 ft elev.)

The Nuclear Regulatory Commission (NRC) expressed a concern, by letter dated May 4, 1987, that the Control Room temperature may be too low. Additional temperature and humidity surveys were requested by the NRC.

During January 1988 a survey was conducted of the Unit 1 Control Room ambient dry bulb temperature and relative humidity.

The survey consisted of continuous temperature and humidity recordings over a 48 hour period in early January, and a review of daily Control Room temperature readings taken during the performance of Operations Surveillance Procedure 14000-1 in June, July and August, 1987.

Recordings of the Unit 1 Control Room dry bulb temperature and relative humidity were made between January 5 and January 7, 1988. Data were collected both at the Operator's Workstation \* and Shift Supervisor's Workstation \*\* using a Honeywell Model 61 temperature/humidity recorder. The results of this survey are shown in Figures 2-1 and 2-2. The Table I.A.3.2 summarizes the results of the January 1988 HVAC Survey.

Table I.A.3.2 January 1988 HVAC Survey

	Max.	Min.	Avg.
Temperature	75F	72F	73F
Humidity	43%	39%	41%

\* "Floor" (operating) level

\*\* At approx. 6 ft. level

January represents the peak heating season at the Vogtle plant site, with outside air temperatures reaching the mid to lower twenties.

For the summer months of June, July and August 1987, the Control Room temperature recorded twice each day for Technical Specification 3.7.10 was reviewed. These data are illustrated in Figures 3-1 through 3-2. Table I.A.3.3 summarizes the results of the Three Month Temperature Survey.

Table I.A.3.3 Three Month Temperature Survey

	Max.	Min.	Avg.
June 1987	74F	69F	72F
July 1987	80F	70F	74F
August 1987	76F	71F	73F

June, July and August represent the peak air conditioning season at the Vogtle plant site, with outside air temperatures reaching the upper nineties.

No Human Engineering discrepancies were identified.

Although the data indicate that the average Control Room temperature is at the lower limit recommended in NUREG 0700, Section 6.1.5.1, and Operator surveys show 70% feel the control room climate is sometimes too cold, it should be pointed out that the Vogtle Control Room HVAC system is sized to serve both the Unit 1 and Unit 2 Control Rooms.

An air tight construction interface barrier currently separates the two Control Rooms and the HVAC system is not subjected to the heating and air conditioning loads expected during two unit operation. The construction barrier is scheduled to be removed in October 1988. The final Control Room environmental surveys will be conducted as part of the Unit 2 DCRDR when both Control Rooms are fully interconnected.

## B. Other Surveys

### 1. PSMS Computer Survey

This survey was completed prior to Unit 1 fuel load. No new HEDs were identified.

### 2. ATSI Computer Survey

This survey was completed prior to Unit 1 fuel load. No new HEDs were identified.

## C. Communications Survey

This survey was completed prior to Unit 1 fuel load and submitted to the NRC. Two HEDs were identified.

HED #1325      The Fixed Base UHF Transceiver gain can be adjusted below the point at which an audible signal can be heard.

HED 1325 was evaluated as a category 4A - no action is planned. Since the system is not used for operations communications except in special evaluations where contact is established by both parties, the minimum gain is not an operational problem. No action is warranted.

HED #1326      Procedures are not established or posted for use of the Fixed Base UHF Transceiver. HED 1326 was evaluated as category 3 (easy to correct).

The vendor instructions were placed in the control room. Due to the simple nature of the controls it is not necessary to post. On the job training is sufficient to assure correct operation.

### III. Cumulative and Interactive Effects

#### A. Background

HEDs not corrected during the implementation phase of the Unit 1 DCRDR (Category 4 "NO ACTION" and Category 4A) were evaluated to ensure that, by remaining uncorrected, they were not adding to operator workload or contributing to operator fatigue, confusion or discomfort.

#### B. Method

All uncorrected HEDs which contribute to operator workload were grouped into the following functional areas:

1. Annunciators
2. Main Control Board (QMCB)
3. Process Control Panel (QPCP) and Electrical Auxiliary Board (QEAB)
4. Generic Panels
5. Computers

These HEDs were incorporated into an operator questionnaire (appendix 2) which was distributed to Operations control room personnel.

The responses to this questionnaire were reviewed by the DCRDR Team Leader first, to determine if HEDs within the same functional area are singularly, or in combination with other related HEDs, leading to operator problems; and secondly, to determine if HEDs from the different functional areas are additively effecting operator performance.

#### C. Results

Evaluation of the survey returns is detailed in Appendix 3. Some HEDs which were initially evaluated as having no impact are in concert causing occasional problems for the operators. However, no consequential operator errors were related to these problems. Corrective actions underway to correct these problems are described in Appendix 3.

Some operator surveys were returned after the analysis was performed for this report. They will be reviewed and a supplemental report issued if the results change significantly (10% increase in problems noted).



#### IV. Annunciator Nuisance Alarms

##### A. Survey

A survey was conducted on December 21, 1987 to determine the extent to which operators were being distracted by annunciator nuisance alarms. The survey was taken at approximately 11:00 AM EST with Unit 1 operating at 100% power.

The following annunciator windows were in a alarmed condition at the time of the survey:

ALF01	E01	Condenser Circulating Water Isolation Valve Closed
ALB04	E02	Train B System Status Monitoring Panel Alert
ALB05	B04	Bypass Containment Ventilation Isolation: High Radiation Test
ALB10	A01	Source Range High Voltage Failure (normally lit, green window)
ALB11	A04	Reactor Coolant Pump 1 Oil Lift Pump Low Pressure (normally lit, green window)
ALB11	B04	Reactor Coolant Pump 2 Oil Lift Pump Low Pressure (normally lit, green window)
ALB11	C04	Reactor Coolant Pump 3 Oil Lift Pump Low Pressure (normally lit, green window)
ALB11	D04	Reactor Coolant Pump 4 Oil lift Pump Low Pressure (normally lit, green window)
ALB30	B08	Goshen Black Primary Pilot Relay
ALB34	E06	Starter 1CD1I5M Trouble (normally lit, green window)
ALB34	E07	Starter 1DD1I6M Trouble (normally lit, green window)
ALB34	F06	Starter 1DD1I6 Trouble (normally lit, green window)
ALB50	D02	Turbine Building HVAC System Trouble
ALB53	D02	Auxiliary Building level C Rooms Boric Acid Line Low Space Temperature
ALB53	F07	Chiller Train A Compressor High Vibration
ALB54	A06	Normal Chiller 2 Trouble



ALB54	D01	Technical Support Center HVAC Panel Alarm
ALB54	EG5	Normal Chiller Expansion Tank Hi/Lo Level
ALB62	F01	Main Feed Pump Turbine Low Pressure Steamline Drain High Level

In summary, the survey identified 20 annunciator windows in an alarm condition, 9 of which are normally lit (green windows) during full power operation. The reason for each alarm was not researched in this survey. There are 1548 annunciator windows on the control room panels. The eleven abnormal alarms represent a .7% static alarm rate at the time of the survey.

A second survey conducted on February 17, 1988 at 92% power following a startup is detailed in Appendix 5. In that survey, the number of abnormal alarms had increased to 18 due to a recent plant trip and startup. This represents a 1% static alarm rate which will decrease as startup anomalies are corrected.

#### IV. B. Operating Practice

The operations department procedures and practices are to maintain a 'dark board' during power operation. The nine alarms which are expected at power operation are coded green to distinguish them. Action is taken to correct alarms by initiating maintenance Work Orders. Alarms which are awaiting maintenance are disabled and logged by procedure to achieve a dark board. These practices keep the number of status alarms low to maintain the alerting power of new alarms.

#### IV. C. Management Review

Out of service alarms and other out of service control room instruments are tracked by the Maintenance department and reviewed by the Plant Management monthly. This Management attention assures an ongoing effort to maintain the control room instruments and alarms in service.

#### IV. D. Design Modifications

One design change was identified specifically to correct an alarm problem. A Unit 2 HED 2004 identified a continuous alarm due to containment humidity. Ongoing operator feedback from Unit 1, 2, and the Simulator to the DCRDR members is being tracked as Unit 2 HEDs. A design change was implemented to correct the alarm setpoint, clearing the alarm and returning that alarm to useful service.

## V. Resolution of Human Engineering Discrepancies

### A. Approach to Correction

The correction of Human Engineering Discrepancies (HEDs) was generally based on the following preferred order of approaches:

1. Guideline compliance - The first preference for correction of HEDs was to modify the Control Room to comply with the guidelines of NUREG 0700. This approach was used for labeling, procedural, and support equipment HED's. Control board arrangement HEDs used this approach when consistent with regulatory (train separation) and physical (panel space) limitations.
2. Compensatory measures - When conflicting regulatory or physical constraints prevented a straightforward change to achieve guideline compliance, changes were used which eliminated or reduced the impact of an HED on the operators.

### B. Engineering Consensus

The development and selection of corrections to HEDs was accomplished by group meetings of the DCRDR team. Discussions of alternate approaches, benefits, and costs were discussed and an engineering consensus was arrived at on the recommended approach to correct each HED. Minutes of team meetings did not completely record the details of all these discussions. The diverse backgrounds of team members was intended to provide input from all disciplines on the resolution of HEDs. The procedures in use called for final recording of the board recommendations. Brief summaries of the resolutions and supporting comments were reported in the DCRDR report of June 10, 1986.

### C. Cost-Benefit Analysis

The engineering concensus approach considered costs vs. benefits but did not perform a detailed, documented cost-benefit analysis. The emphasis was on correction of the HEDs to enhance operator performance. The correction of safety significant HEDs, called Category 1 in our study, was an a priori commitment without regard to cost. In all cases the team members sought to develop the most practical solution balancing constructability, schedule, and cost to achieve the objective of enhanced operator performance.

Some example cost considerations were:

1. Labeling and procedure changes were always implemented to achieve compliance with NUREG-0700. These were typically less than ten thousand dollar projects.
2. Panel rearrangements generally less than one hundred thousand dollars were implemented.
3. A major control room layout modification of three hundred thousand dollars was implemented.
4. Major control panel replacements which would cost several million dollars were not recommended. HEDs involving such changes for exact compliance with NUREG-0700 guidelines were addressed with alternate solutions.

### D. Revised Practices

For evaluation of HEDs for the Unit 2 DCRDR, team members are developing more comprehensive records of the considerations and rationale used in developing corrections to HED's. Appendix 4 illustrates the type of consideration used for HEDs which do not involve a simple implementation of NUREG 0700 guidelines.

## VI. Training Interface

Modifications to the Vogtle Control Room are controlled through the issuance of an approved Design Change Package (DCP). Engineering Procedure (EP) 50007-C "Engineering Review Of Design Change Packages" specifies the method by which DCPs are reviewed and approved.

EP 50007-C Data Sheet 4 "DCP Review Extent" identifies the areas which may be effected by the proposed design change and specifically mentions the operator training program. If operator training may be impacted, the Responsible Engineer is directed to complete Data Sheet 10 "Plant Modification Training Requirements." (Figure 6-1)

EP 50007-C, Data Sheet 10 requires the Responsible Engineer to determine if the proposed modification(s) will change the function of instruments, controls and annunciators, or alter the layout of the control panels. DCPs which may impact operator training are brought to the attention of the Training Department either by completion of Data Sheet 10A (Figure 6-2) which describes the proposed design change in detail, or by transmittal of the entire DCP for evaluation by Training Department personnel.

The Training Department processes all notifications of changes using Training Procedure 60005 "Incorporation of Changes in Training Material and Simulator". Procedure 60005 covers screening of changes for training impact, analysis to identify affected training courses, and implementation of needed training changes.

DATA SHEET 4

DCP REVIEW EXTENT DETERMINATION

DCP NO. \_\_\_\_\_ REV. \_\_\_\_\_ UNIT \_\_\_\_\_

Fire Protection Engineer Completes Data Sheet 6, Fire Protection Review.

The proposed modification has the possibility of affecting/causing:

	YES	NO
1. Additions, deletions, or alteration of Tech Spec Surveillance Test Requirements or scheduling. If YES, Data Sheet 5 must be completed.	_____	_____
2. Any of the items on the ALARA Qualification Checklist, Data Sheet 7. If YES, Data Sheet 7A must be completed by HP personnel.	_____	_____
3. Security detection or protection systems, equipment, or barriers. If YES, Data Sheet 8 must be completed.	_____	_____
4. Environmental impact. If YES, Data Sheet 9 must be completed by Chemistry Department personnel.	_____	_____
5. Operator/Maintenance personnel training. If YES, Data Sheet 10 must be completed.	_____	_____
6. ISI Program/Plan Requirements. If YES, Data Sheet 11 must be completed.	_____	_____
7. Alterations of, or additional electrical, hydrostatic, or functional testing or inspections not related to ISI Program/Plan requirements. If YES, Data Sheet 12 must be completed.	_____	_____

NOTE

Particular attention to Regulatory Guide 1.28 testing requirements after major modifications to the instrument and control air system, and to Regulatory Guides 1.6 and 1.32 after major modifications to onsite electrical power systems.



DATA SHEET 10  
PLANT MODIFICATION TRAINING REQUIREMENTS

DCP NO. \_\_\_\_\_ REV. \_\_\_\_\_ UNIT \_\_\_\_\_

This review is to identify Operator Training Requirements.

Does the DCP involve changes, additions or deletions in the following?

	YES	NO
1. Functions of installed switches or indicating lights	_____	_____
2. Functions of any alarms or annunciators	_____	_____
3. Implications of alarm conditions	_____	_____
4. Panel layout (location) of equipment	_____	_____
5. Power supplies (major buses, MCC's)	_____	_____
6. System interrelationships	_____	_____
7. Setpoints	_____	_____
8. Limitations of equipment operation	_____	_____
9. Technical Specifications	_____	_____
10. System response	_____	_____
11. Operational procedures	_____	_____

If any of the above are checked "YES", complete Sheet 10A. Operator training may be required and copies of both sheets should be completed and transmitted to the Plant Training and Emergency Preparedness Manager. If all answers are "NO", completion of Sheet 10A is not required.

Prepared by: \_\_\_\_\_ Date: \_\_\_\_\_

Engineering Supervisor: \_\_\_\_\_ Date: \_\_\_\_\_



DATA SHEET 10A

PLANT MODIFICATION TRAINING REQUIREMENTS

DCP NO. \_\_\_\_\_ REV. \_\_\_\_\_ UNIT \_\_\_\_\_

1. Detailed Description of changes (Attach Narrative Summary, or complete DCP if requested by Training Department personnel):

2. Referenced P&IDs and elementary drawing numbers:

3. Anticipated date of initial operability:

4. Reason for Modification:

5. Location of added or relocated equipment:

6. Operational procedures affected:

Prepared By: \_\_\_\_\_ Date: \_\_\_\_\_

Engineering Supervisor: \_\_\_\_\_ Date: \_\_\_\_\_

## VII. Control Room Modifications

A. Plant procedures and practices are in place to ensure that future control modifications preserve human factors considerations in the current design and avoid the introduction of new Human Engineering Discrepancies.

### B. Labeling

Georgia Power is participating in the Human Performance Evaluation System (HPES) run by the Institute for Nuclear Power Operations (INPO). The Vogtle HPES Coordinator is the Control Room Design Review team leader, E. J. Kozinsky. As part of HPES activities he coordinates all plant labeling activities, including control room labeling. All labels are maintained in accordance with Operations Procedure 10016-C "Plant Labeling". The label program is dedicated to improving human performance.

### C. Modifications

Control room modifications are controlled by Plant Administrative Procedure 00400-C "Plant Modifications" and Engineering implementing Procedure 50007 "Engineering Review of Design Change Packages". Procedure 50007 requires all design changes to be evaluated using the checklist shown in Figure 7.1. This check is performed by design engineers to ensure the guidelines of NUREG-0700 are maintained. The checklist is used to screen for changes in the operator interface and to compare the change to the appropriate section of NUREG-0700.

The human factors review of changes extends beyond the Control Room. All changes to operator interfaces are reviewed against NUREG-0700. Since many field and some Control Room situations are not covered by NUREG-0700, other human factors guidelines published by the Electric Power Research Institute are used as secondary standards.

DATA SHEET 15  
HUMAN FACTORS CHECKLIST  
DCP NO. \_\_\_\_\_ REV. \_\_\_\_ UNIT \_\_\_\_

SECTION A

1. Is any equipment requiring operator observation or action affected by this change in such a way that the visual appearance, location, or actions required are altered? Consider all interfaces for operation and calibration.

Yes            No

If the answer to question 1 is "yes", complete Section B.

SECTION B

1. Does this design change conform to NUREG-0700?

Yes            No            Not Covered

If yes, list applicable NUREG sections:

If no, provide justification:

2. Does the design change conform to Chapter 18.2 of the Vogtle FSAR?

Yes            No            Not Covered

If yes, list applicable criteria sections:

If no, provide justification:

3. If the design change is not covered by either NUREG-0700 or the Vogtle FSAR Chapter 18.2, list the applicable reference and section:

[ ] EPRI NP-1118 Human Factors Method For Nuclear Control Room Design, Section \_\_\_\_\_

[ ] EPRI NP-4350 Human Engineering Design Guidelines For Maintainability, Section \_\_\_\_\_

[ ] Other \_\_\_\_\_  
Section \_\_\_\_\_

PREPARED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

REVIEWED BY: \_\_\_\_\_ DATE: \_\_\_\_\_  
ENGINEERING SUPV.

#### D. Unit Differences

Georgia Power's policy is to maintain the Unit 1 and 2 plants in the same configuration. Design changes developed for either Unit will generally be implemented on both Units. The Unit 2 control room design review will provide another mechanism for Human Factors input to the Unit 1 control room, since applicable Unit 2 modifications will also be installed on Unit 1.



## VIII. Safety Parameter Display System

### A. NRC Audit

The NRC audit of the Vogtle Safety Parameter Display System (SPDS) found that it incorporated accepted Human Factors Engineering principles. However, the NRC consultants' Technical Evaluation Report (TER) suggested a number of areas for potential improvements. Operator input on those items was collected in conjunction with the Operator Survey (Appendix 2). A discussion of survey results and disposition of each item follows.

### B. Suggested Design Improvements

1. In the SPDS color-coding scheme, perceptual cues for challenges to CSFS are lost when a CSF parameter is of questionable validity. Some other cue should be provided to indicate questionable data.

**DISPOSITION** - The use of a purple Critical Safety Function Status Tree (CSFST) status, when the computer data is bad, is intended to alert the operator that the computer can no longer evaluate the status of that function. The Plant Operator is then required to monitor the CSFST using Operations Procedure 19200 "Critical Safety Function Status Trees" and control panel instruments. The software for determination of 'bad' status of the CSFST. This change and the backup procedures support operator monitoring of the CSFST. Operator Survey responses showed no problems with use of the SPDS for monitoring the CSFST in support of the Emergency Procedures; however, 35% expressed problems with the radiation function overview.

The Westinghouse developed Critical Safety Function Status Trees (CSFST) are logically 'ORed' to identify a single CSFST state for each function. If the computer cannot evaluate the CSFST it turns purple. The radiation overview is different. The overview blocks display a summary 'worst' state of any radiation instrument. If any instrument is 'bad' the overview turns purple. If any instrument is in alarm the overview turns red. Since some radiation monitor in the entire system is almost always under repair or test, the overview status is almost always 'bad'. This masks the subsequent failure of another instrument. To correct this problem the software will be changed to allow long term out of service instruments to be removed from the overview logic. This will then allow the overview to alert the operator if another instrument subsequently fails.

2. The Containment Isolation Valve status display uses the color codes red for open and green for closed. This is consistent with the convention for valve position lights, but is not consistent with the SPDS convention of green for safe, red for unsafe, conversely, use of the green/safe, red/unsafe convention would violate the valve status color convention. Operator input should be used in determining which convention is adopted.

not result in a misinterpretation, with the current convention. The alarm position for the containment isolation valves is open, so that there is no inconsistency in the presentation of the color codes. Any parameter in alarm is shown in red. A containment isolation valve is shown in red if it is open. This supports both conventions without conflict. The current coding will be retained unless operators have problems in the future.

3. Parameter alarm status is shown as green for normal, red for high, and flashing red for high-high or low-low. Parameter alarm color coding might be more easily understandable if the CSF color-coding scheme of green-normal, yellow-alert, orange-severe challenge, and red-unsafe is used.

**DISPOSITION** - The current color coding of red/green for parameter alarms is already consistent with the normal/unsafe convention for CSFST colors. This convention is also a populational stereotype. The use of yellow and orange intermediate steps for CSFST is a special application which is presented in special training. For individual parameters, there are no defined 'alert' and 'severe challenge' states defined. The current coding will be retained unless operators have problems in the future.

4. Few prompts are currently presented. Required user responses might be less ambiguous if prompts were used to guide parameter value selection with keyboard arrow keys and to guide numerical inputs via keyboard.



**DISPOSITION** - The functions requiring keyboard input are beyond the scope of the SPDS. The only operator input is for developing special plots retrieving background data on computer points, and using steam table calculations. The Operator Survey showed that no problems had been caused by the lack of prompts. A few operators did express a related problem with the requirement to use scientific notation to set trend limits. They find this awkward. A software change is planned to allow entry in either normal numeric or scientific notation.

5. The color of indicated setpoints and data plots is sometimes the same, making discrimination difficult or impossible. Acceptable operating levels are often not indicated on graphic displays.

**DISPOSITION** - The Operator Survey indicated no problems with the limit lines. However, the software will be modified to extend the limit line to the right of a trend data plot to make it more visible. Since the most current data is shown at the right side of the plot, the operators focus on that area and the extended limit line will enhance operation. Completion will be reported in the Unit 2 DCRDR Report.

6. Default values are generally not presented.

**DISPOSITION** - The default values of X and Y coordinates are shown on a plot whenever it is displayed. The default for time (x-scale) the 2.5 minute history which produces the most sensitive indicator for evaluating plant transients. It is stated in screens with a time scale selection. The parameter valve defaults (y-scale) are always to give the maximum resolution or screen for the time period displayed. Both these features were designed to provide the most useful information with the least operator input. In practice operators seldom use any but the default parameters. Since this was not identified as a problem in the Operator Survey, and only two operators thought it would be useful, the current coding will be retained. The suggested change would degrade operability.

7. Sometimes the underline cursor which is displayed is difficult to locate. The use of a block cursor should be considered as a solution.

**DISPOSITION** - This was reported as a problem by only one Supervisor. Cursor selection errors are rare and of no consequence. The underline cursor is not the best but it is a hardware feature of the terminals and can not be changed by software the current cursor will be retained.

8. Display may contain numerous numerical values, some of which may be selected to bring up additional data screens, and some of which may not. Differential coding of selectable and nonselectable values would avoid erroneous selections.

**DISPOSITION** - Although the Operator Survey reported no problems in this area, and only one supervisor thought a change would be beneficial, the pointer selection algorithm for the nonselectable numbers in group displays will be modified to allow selection of displayed numbers.

9. Indication of current parameter values should be presented on status tree displays.

**DISPOSITION** - The display of parameter values on CSFST displays was desired by 50% in the Operator Survey. The display will be modified to show numeric values for parameters when it will not reduce the usefulness of the display by clutter and crowding. Completion status will be reported in the Unit 2 DCRDR report.

10. The cursor often moves to a location from which it must be moved for data input or selection of options. Unnecessary, additional interaction steps could be eliminated if a cursor could move directly to an active data input or option selection area.

**DISPOSITION** - The software has been modified to automatically position the cursor to the first data field when data is entered.

11. Scroll keys would be easier to use if the forward and backward scroll keys were appropriately labeled.

**DISPOSITION** - The 'scroll' keys have been labeled as suggested.

12. User errors and uncertainty about the results of a selection might be reduced if parameter values selected by users (to produce subsequent screens) were displayed in reverse video for a second or two immediately after users designate such a selection through cursor positioning.

**DISPOSITION** - No Operators in the Operator Survey desired this feature. The desired display would be delayed by the suggested intermediate display and degrade system performance. The degrade was noted in previous software that could operate as suggested. The degrade in normal operation would outweigh any potential benefits in the few instances where an error is made in cursor pointing. The system response of about 1 second allows detection and correction of errors much more efficiently than an intermediate display. The current coding will be retained.

APPENDIX 1

CONTROL ROOM HEATING, VENTILATION AND

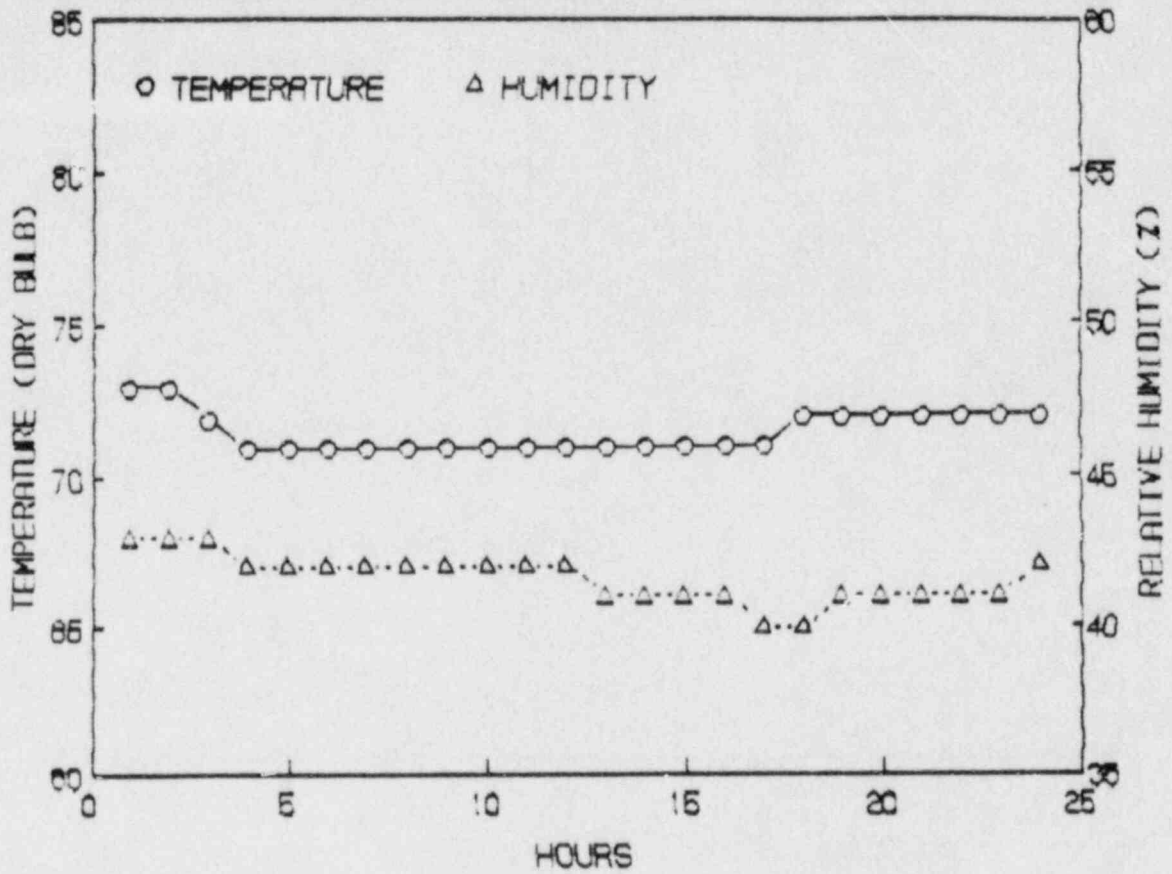
AIR CONDITIONING SURVEY



# UNIT 1 CONTROL ROOM TEMPERATURE & HUMIDITY

SHIFT SUPERVISOR'S WORKSTATION \*

1000 EST JAN 5, 1988 to 1000 EST JAN 6, 1988



VP-7011 (HONEYWELL MODEL 81) SER # 8525 884082019

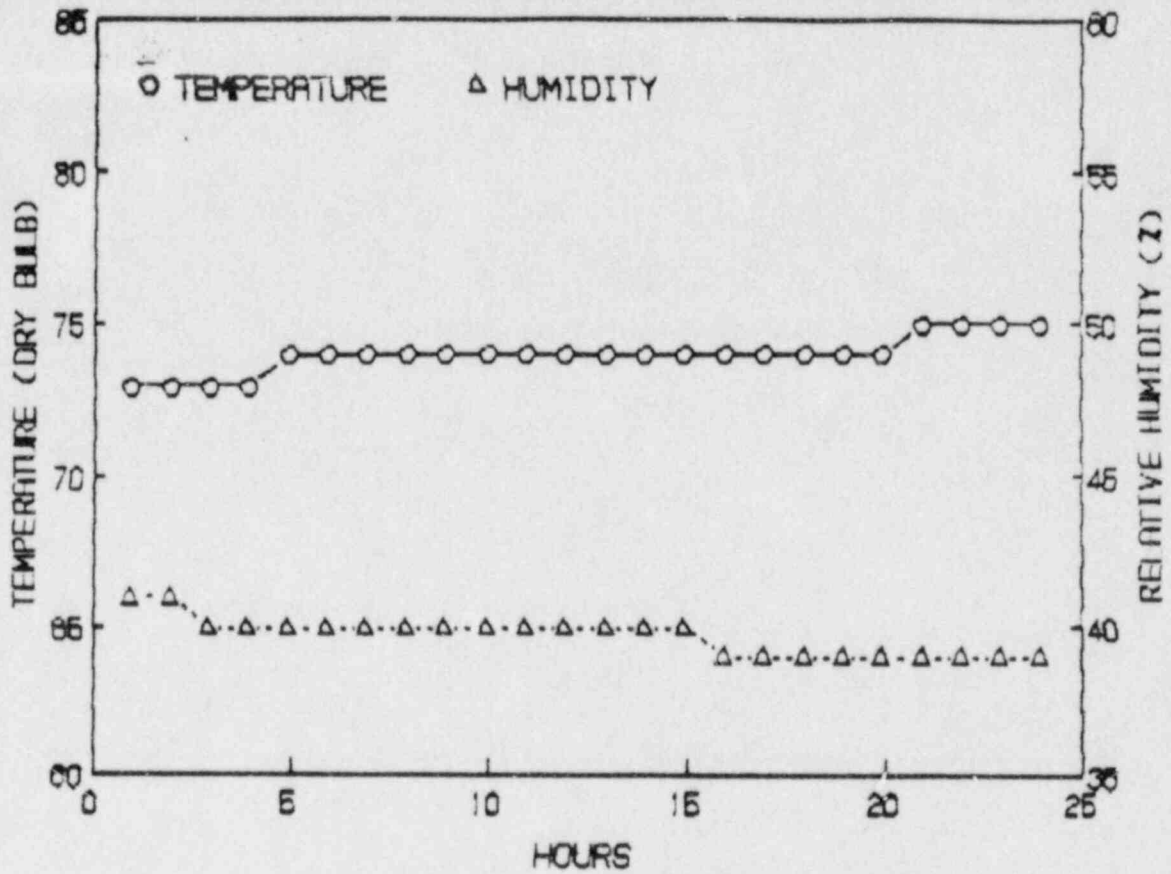
*R.J. Cimino 1/11/88*

\* At approx. 6 ft. level

# UNIT 1 CONTROL ROOM TEMPERATURE & HUMIDITY

OPERATOR'S WORKSTATION\*

1000 EST JAN 8, 1988 to 1000 EST JAN 7, 1988



VP-7011 (HONEYWELL MODEL 81) SER # 8525 884082019

*R.J. Cimino 1/11/88*

\* "Floor" (operating) level



UNIT 1 CONTROL ROOM TEMPERATURES

JUNE, JULY & AUGUST 1987

Data collected from OSP 14000-1 Surveillance Log Sheets

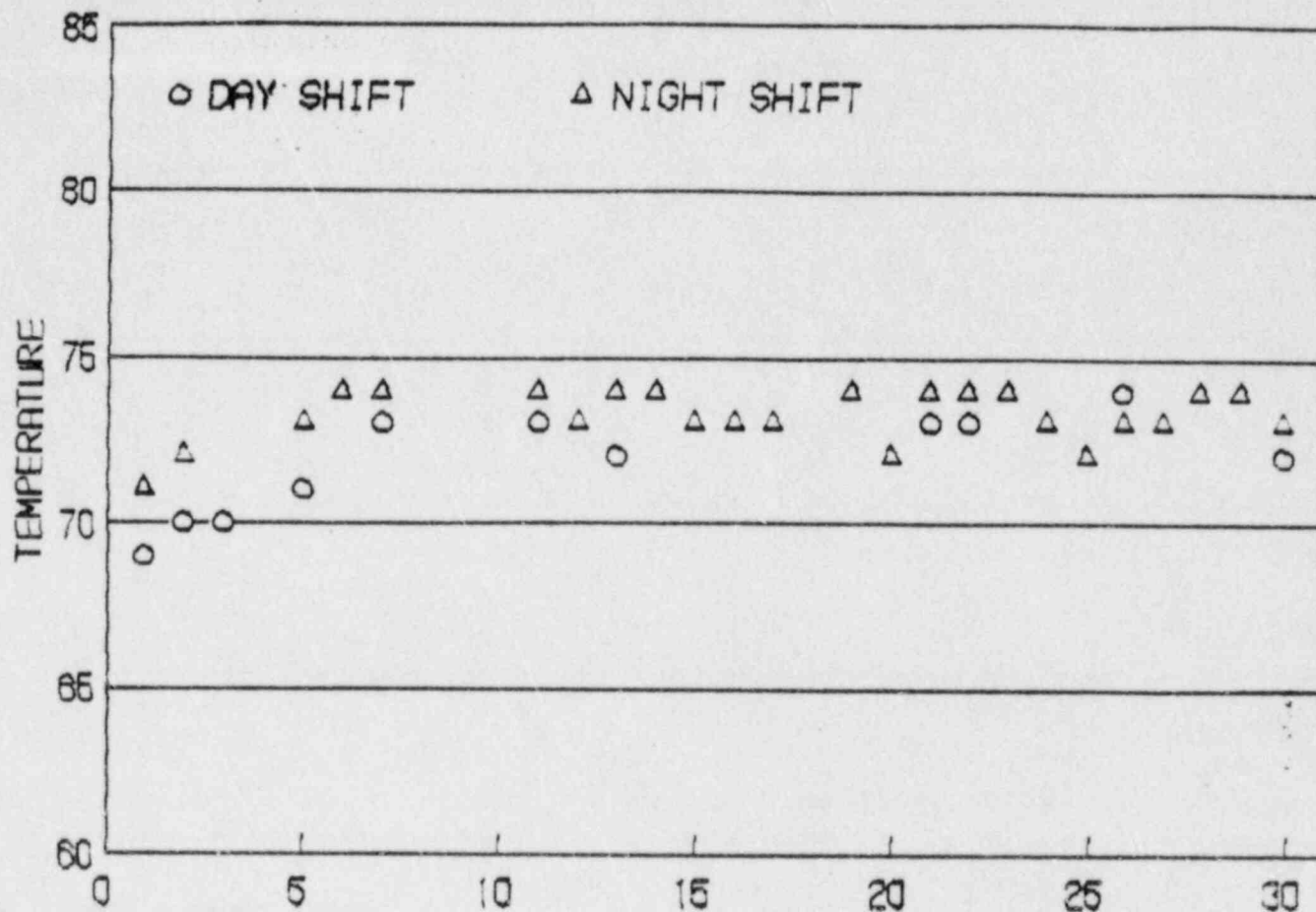
JUNE	DAY	NIGHT	JULY	DAY	NIGHT	AUGUST	DAY	NIGHT
06/01	69	71	07/01	74	73	08/01	73	74
06/02	70	72	07/02	*	75	08/02	73	73
06/03	70	*	07/03	74	74	08/03	73	74
06/04	*	*	07/04	73.4	74	08/04	72	73
06/05	71	73	07/05	73	73	08/05	*	74
06/06	74	74	07/06	73.4	74	08/06	74	73
06/07	73	74	07/07	72	74	08/07	*	*
06/08	*	*	07/08	74	*	08/08	74	76
06/09	*	*	07/09	*	*	08/09	74	73
06/10	*	*	07/10	*	*	08/10	74	*
06/11	73	74	07/11	*	73	08/11	74	74
06/12	73	73	07/12	74	74	08/12	72	73
06/13	71.8	74	07/13	74	73	08/13	74	73
06/14	74	*	07/14	74	74	08/14	74	73
06/15	*	*	07/15	75	73	08/15	74	74
06/16	*	*	07/16	*	73	08/16	73	73.5
06/17	*	*	07/17	73	73	08/17	73	73.5
06/18	*	*	07/18	*	*	08/18	74	74
06/19	*	*	07/19	73	74	08/19	74	73
06/20	72	72	07/20	73	76	08/20	74	73
06/21	73	74	07/21	74	80	08/21	71	74
06/22	73	74	07/22	74		08/22	74	72
06/23	74	74	07/23	73	72	08/23	73	74
06/24	*	73	07/24	74	73	08/24	74	74
06/25	72	72	07/25	74	74	08/25	74	73
06/26	74	73	07/26	72	73	08/26	74	74
06/27	*	73	07/27	*	*	08/27	72	74
06/28	74	74	07/28	74	74	08/28	74	74
06/29	74	74	07/29	74	74	08/29	74	73
06/30	72	73	07/30	74	73	08/30	74	74
			07/31	74	74	08/31	73	72

\* No reading taken

*R.J. Cimino 1/12/88*

# UNIT 1 CONTROL ROOM TEMPERATURE

JUNE 1987



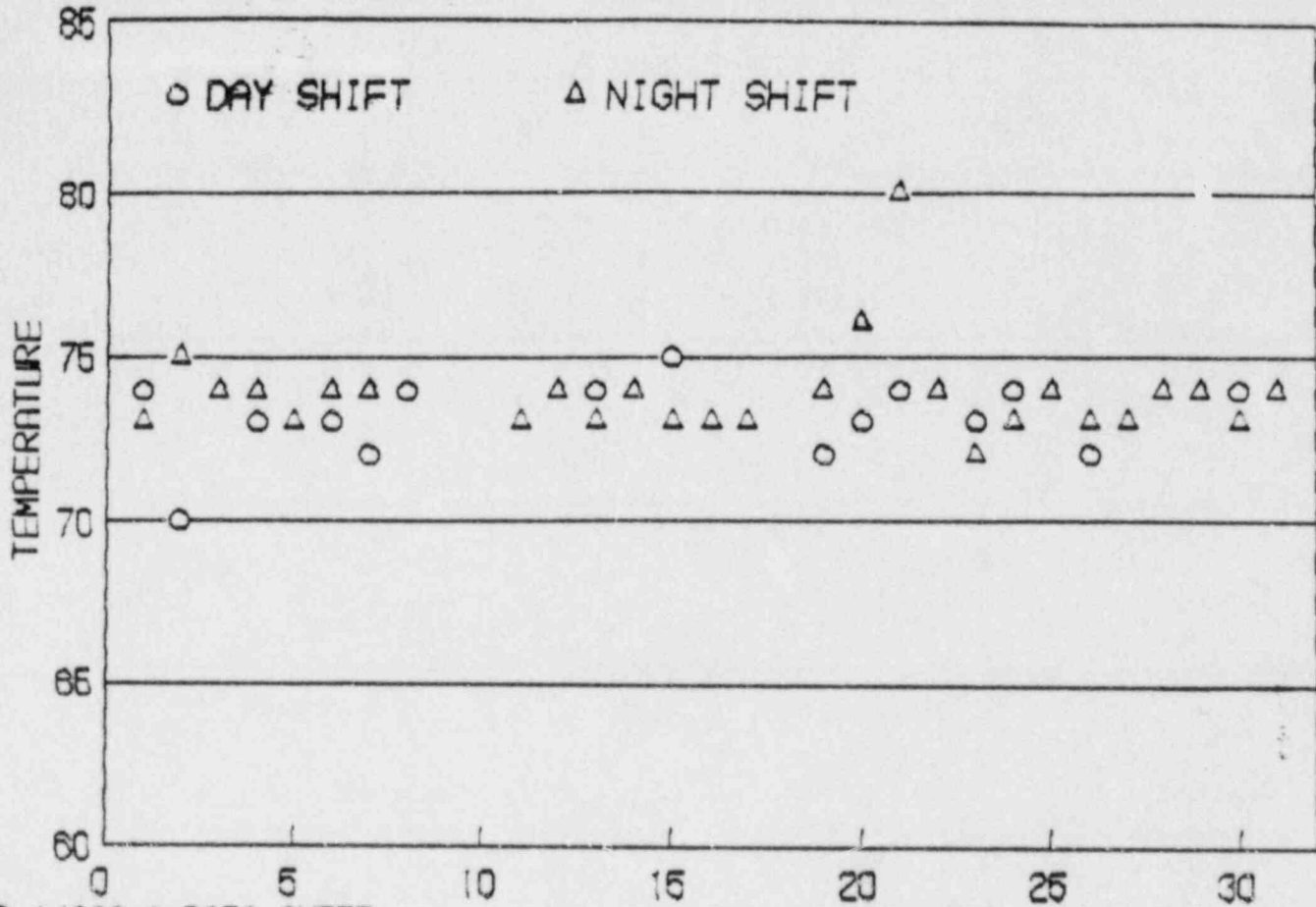
OSP 14000-1 DATA SHEET

JUNE 1987

*R.J. Curran 1/11/87*

# UNIT 1 CONTROL ROOM TEMPERATURE

JULY 1987



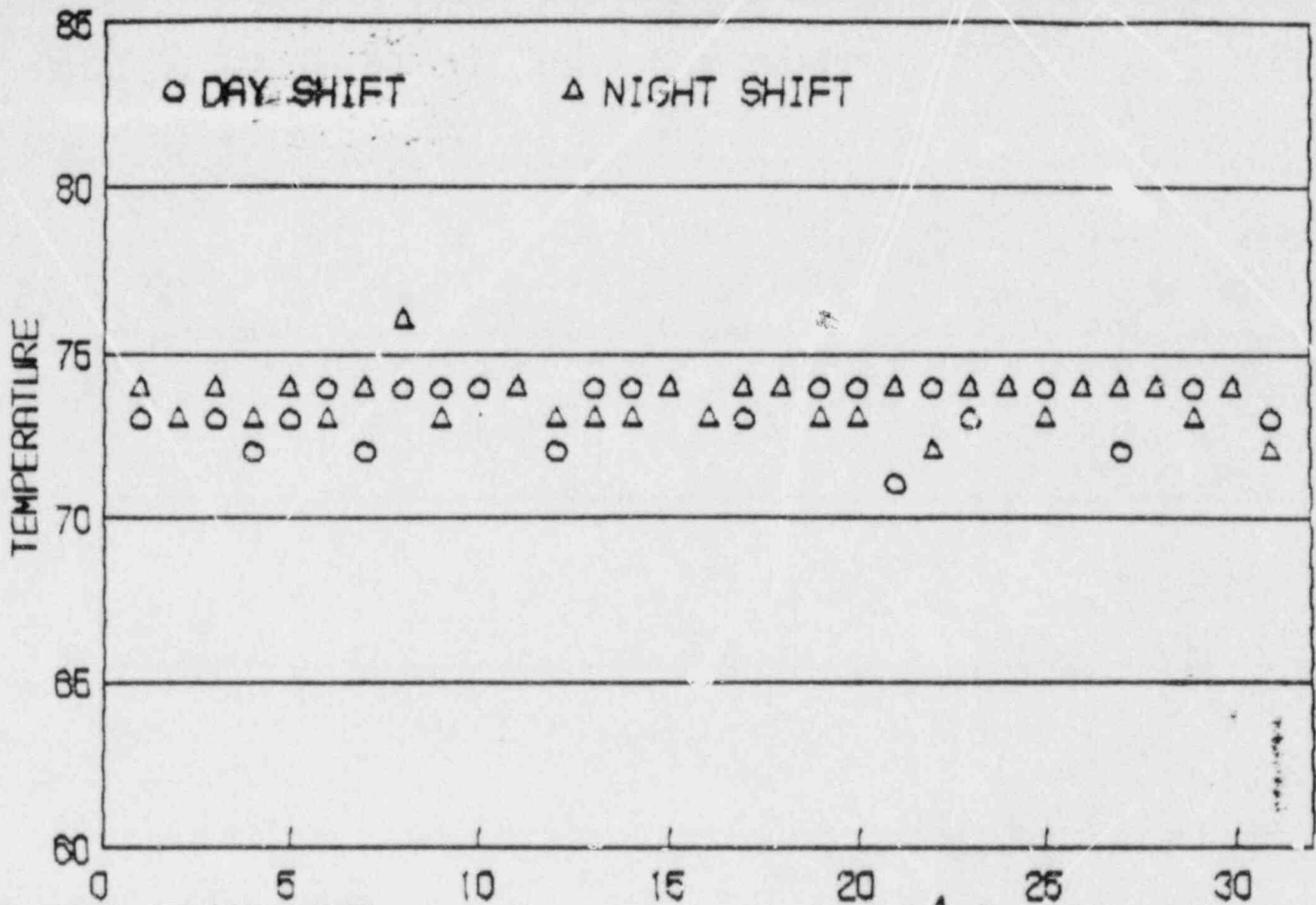
OSP 14000-1 DATA SHEET

JULY 1987

*R. J. Cervoni 1/11/87*

# UNIT CONTROL ROOM TEMPERATURE

AUGUST 1987



OSP 14000-1 DATA SHEET

AUGUST 1987

*R. J. Lemire 1/11/88*

APPENDIX 2

CONTROL ROOM DESIGN REVIEW OPERATOR SURVEY



Name \_\_\_\_\_

VOGTLE UNIT 1 CONTROL ROOM DESIGN REVIEW  
OPERATOR SURVEY

**PURPOSE**

During the human factors review of the Unit 1 Control Room you completed a questionnaire on the features of the Control Room which could have a positive or negative effect on operator performance. Your response to that questionnaire resulted in the identification of more than 65 human engineering discrepancies (HEDs), two thirds of which have been corrected as of this date.

The Control Room Design Review Task Force is now in the process of evaluating the HEDs which were not scheduled for corrective action during the Detailed Control Room Design Review conducted prior to startup. Your responses to this new survey will allow the Task Force to determine if these uncorrected HEDs are contributing to operator error, fatigue or discomfort.

**INTRODUCTION**

The questionnaire is divided into 5 sections, as shown below:

- I Annunciators
- II Main Control Board
- III Electrical Auxiliary Board and Process Control Panel
- IV Generic Discrepancies
- V Computers

Each section begins with general questions related to the topic. These are followed by questions concerning the specific HEDs associated with that topic. There will be space following each question for your comments. Please give concise, detailed answers whenever possible. The more you tell us about an actual or potential problem, the better we're able to evaluate it's impact and recommend corrective action.

SECTION I

ANNUNCIATORS

1. Which features of the Control Room annunciators do you feel have been most effective in helping you promptly identify specific system performance problems?

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2. Which features of the Control Room annunciators do you feel may have caused you to make an erroneous or ineffective response during a system malfunction?

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3. Annunciator alarms on the QPCP and QHVC cannot be silenced from the Main Control Board. Has this ever caused problems? (Item 1053)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe the problem.

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4. Following a reactor trip, many annunciator windows on ALB09 will illuminate. Has this ever caused confusion when trying to determine the actual "first out" annunciator?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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5. Do you think a Main Turbine first out annunciator panel would be of any benefit? (Item 1223)

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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6. There is no way to silence the annunciator alarms without also acknowledging them. Has this caused problems?  
(Item 1226)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the problems?

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It's been suggested that pushbuttons which would silence the alarm horns from any panel should be installed. In your opinion, would this feature cause operators to miss or ignore alarms on the back panels?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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7. Many annunciator windows are actuated by multiple input devices, e.g. the MCC trouble alarms. It has been suggested that every annunciator alarm should be printed out on a hard copy form. What do you think about this suggestion?  
(Item 1282)

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SECTION II

MAIN CONTROL BOARD QMCB

1. As a Reactor or Balance of Plant Operator, which operational task do you feel the most uncomfortable in performing?

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Would the re-arrangement of controls or instruments make this task any easier?

\_\_\_\_\_ (Yes, No or N/A)

Would re-labeling or the use of additional labels on the controls or instruments make this task any easier?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what changes or additions would you recommend?

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2. Has the arrangement of the RCS loop temperature meters ever caused you problems when trying to compare loop temperatures? (Item 1028)

\_\_\_\_\_ (Yes, No or N/A)

Has this ever prevented you from properly analyzing an abnormal condition?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe the circumstances.

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3. RCS temperature recorders TR-413A & B and TR-433A & B are different style recorders, and are not located in close proximity to each other. Has this ever caused problems? (Item 1030)

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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4. The loop delta T meters are not located directly above delta T selector switch HS-411E. Has this ever caused a problem? (Item 1037)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe the circumstances.

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5. The RCP seal injection meters, recorders and alarms are located on QMCB Section 1A2. The RCP control switches are located on QMCB Section 1C1 . Has the location of these instruments and controls ever caused problems? (Item 1029)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe the circumstances.

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6. Have you ever experienced problems when operating the Main Feed Pump controls on Section 1B1? (Item 1040)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe the problem.

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7. Has the location or arrangement of the SG blowdown controls or instrumentation ever caused problems when initiating, adjusting or terminating blowdown flow? (Item 1038)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the problems?

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Have you ever had difficulty in verifying SG blowdown isolation following an SI or APW actuation?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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8. What are your feelings about the arrangement of instruments and controls near the Turbine EHC Panel on QMCB Section 1B1? (Item 1042)

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Have you ever had difficulty locating impulse pressure indicators PI-505 & 506? (Item 1259)

\_\_\_\_\_ (Yes, No or N/A)

It's been suggested that relocating PI-505 & 506 to Section 1B2 would be an improvement. How do you feel about that suggestion?

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9. Have you ever misread or improperly adjusted AFW flow to the Steam Generators because of the location of the AFW flow meters and AFW throttle valve controls? (Item 1060)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what improvements would you recommend?

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10. The following indicators are not located in close proximity to their respective controls (Item 1085):

- SG level/flow recorders
- SI Accumulator pressure indicators
- PRZR pressure indicators
- MFP oil pressure indicators
- Aux Steam to FW Heaters 5A & 5B

Has this ever caused you to become confused or disoriented while operating these systems?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the specific problems?

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11. The blue indicating lights on the RCP Oil Lift Pump control switches are not labeled. Is a label needed? (Item 1103)

\_\_\_\_\_ (Yes No or N/A)

Why (or why not)?

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12. MLB-05 & 06 are labeled "On" for SI. However, at least one NSCW and one CCW pump status light is always off. Has this ever caused you to become confused or to misinterpret EGF component status? (Item 1114)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes," what were the specifics?

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It has been suggested that MLB-05 & 06 should have only two status lights for each NSCW and CCW train. What are your feelings?

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13. The majority of status lights on Panel ZLB-2 are arranged in horizontal order. The status lights for PVs 507A, B & C are arranged in vertical order. Has this ever caused problems? (Item 1132)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe the circumstances.

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14. The status lights for the TD-AFW Pump steam isolation valves are on MLB-01 & 02, which are located on QMCB Section 1A1. However, the control switches for those valves are on Section 1B2. Has this ever caused problems? (Item 1139)

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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15. Many EOP instructional steps require the operator to verify that Tavg is stabilized at 557 degrees F; however, the Tavg meters are scaled in 10 degree increments. Has this ever caused problems in complying with the EOPs? (Item 1146)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the circumstances?

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16. Each CVCS Letdown Orifice Isolation Valve control switch is labeled with the orifice flowrate. However, at low RCS pressures the actual flowrates are considerably less than those engraved on the switchplates. Should the flowrate be removed from the label? (Item 1159)

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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17. Can you recall any instances when the range, accuracy or scale resolution of any of the following instruments have caused problems? (Items 1314, 1315 & 1317)

1-TI-0103	Boric Acid Tank temperature
1-FI-0110	Blender flowrate
1-FI-0121C	Charging flow
1-FR-0156	RCP leakoff flow
1-FR-0158	RCP leakoff flow
1-LI-0470	PRT level
1-FI-0917A	Charging flow to BIT
1-LI-0931A	Spray Additive Tank level
1-FI-5150A	APW flow to SG 4

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the circumstances?

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18. The parameters listed below do not have indication on the Main Control Board (Item 1318):

RCP seal injection temperature  
ACCW RCP thermal barrier flow  
CCW flow to RHR heat exchangers  
Spent fuel pool level

Has this ever caused a problem?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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SECTION III

ELECTRICAL AUXILIARY BOARD AND PROCESS CONTROL PANEL

1. Can you recall any instances where an operator activated the wrong control or activated a control inadvertently on either the QEAB or QPCP?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the circumstances?

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Do you think that the panel layout or the arrangement of the controls may have contributed to the operator error?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what improvements could be made?

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2. Have you ever had problems locating the status light panel "Push-To-Test" pushbuttons on the QPCP? (Item 1204)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what improvements would you recommend?

\_\_\_\_\_ (Yes, No or N/A)



3. Have you ever been confused by the QEAB synchronizing switches which turn counterclockwise for "ON." (Item 1021)

\_\_\_\_\_ (Yes, No or N/A)

Has this feature ever caused problems?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe what happened.

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4. The Synchronizing Check Bypass toggle switches are not spring return to normal switches. Has this ever caused problems? (Item 1033)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", describe what occurred.

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5. When turned "OFF", the QEAB AC voltmeters continue to read on scale at 0 volts. Have you found this to be confusing? (Item 1272)

\_\_\_\_\_ (Yes, No or N/A)

Has this condition ever caused you to misinterpret the condition of an electrical bus?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what resulted from your misinterpretation of the bus condition?

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SECTION IV

GENERIC DISCREPANCIES

1. Most of the control switches on the Control Room panels do not have a "push-to-test" feature for the indicating lights. Has this ever caused a problem? (Item 1046)

\_\_\_\_\_ (Yes, No or N/a)

If "Yes", what happened?

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2. When adjusting a controller setpoint, have you ever been confused about which direction to turn the setpoint potentiometer in order to achieve the desired response? (Item 1047)

\_\_\_\_\_ (Yes, No or N/A)

Would a direction arrow on or near the potentiometer have been helpful?

\_\_\_\_\_ (Yes, No or N/A)

3. Many control switches have an amber light in the center position. This light is not labeled. Has the lack of a label ever caused problems? (Item 1099)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what happened?

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SECTION V  
PLANT COMPUTERS

1. What characteristics of the Proteus computer have you found to be most effective in providing you with timely, accurate, and easily usable data on plant or system status?

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2. What characteristics of the ERF computer have you found to be most effective in providing you with timely, accurate, and easily usable data on plant or system status?

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3. Which features of the Proteus computer do you consider awkward or difficult to use in attempting to retrieve data?

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4. Which features of the ERF computer do you consider awkward or difficult to use in attempting to retrieve data?

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5. Many computer programs store a listing of the most recent keyboard entries in a special file which can be displayed on request. Would this feature be of any benefit on the ERF and/or Proteus computers? (Items 1237 & 1250)

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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When calling up an ERF computer trend plot, would a software feature which displayed your keyboard entries in reverse video for several seconds be beneficial?

\_\_\_\_\_ (Yes, No or N/A)



6. The ERF computer does not use a typewriter style keyboard. Has this caused problems when entering or requesting data? (Item 1238)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what is the most common problem?

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7. The Proteus and ERF computers may utilize more than one "page" to display data on the CRT. Have you ever gotten lost trying to find the data on continuation pages? (Item 1267)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what improvements would you recommend?

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8. The ERF and Proteus computers both use "inverse video" to highlight data on the CRTs. Have you found this to be a useful feature? (Item 1248)

\_\_\_\_\_ (Yes, No or N/A)

Do you think inverse video is used excessively?

\_\_\_\_\_ (Yes, No or N/A)

Do you think the displays could be just as effective without using inverse video?

\_\_\_\_\_ (Yes, No or N/A)

9. In some cases the ERF and Proteus computers do not use standard color coding, i.e., red for open, energized or unsafe; green for closed, de-energized or safe, to indicate component status or alarm conditions. Has this ever caused problems?

\_\_\_\_\_ (Yes, No or N/A)

Has this ever caused you to misinterpret a display?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the circumstances?

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10. The SPDS uses purple to indicate when a parameter is questionable or invalid. This feature also overrides the green, yellow, orange and red colors on the CSF Status Trees regardless of the CSF's actual status. Has this ever caused problems?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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11. SOP 13504-1 is the Proteus operating instruction. Is this procedure adequate? (Item 1240)

\_\_\_\_\_ (Yes, No or N/A)

If "No", how could the SOP be improved?

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12. Does the Proteus computer provide adequate guidance in response to keyboard entry errors? (Item 1243)

\_\_\_\_\_ (Yes, No or N/A)

If "No", how could it be improved?

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13. The Proteus CRTs do not indicate if the computer is on, off or failed. Has this ever caused problems? (Item 1244)

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", what were the circumstances?

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14. Have you ever inadvertently or unintentionally caused a permanent alteration to the data in the Proteus computer?

\_\_\_\_\_ (Yes, No or N/A)

Would an entry check or verification message have prevented the error?

\_\_\_\_\_ (Yes, No or N/A)

15. Would the capability to print out Proteus alarm groups, e.g., system, subsystem, component be beneficial?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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16. The ERP computer does not provide many operator prompts when you are trying to select a parameter for display or entering numerical data. Have you found this to be a problem?

\_\_\_\_\_ (Yes, No or N/A)

If "Yes", which displays do you feel need user prompts for easier access or selection of data?

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17. What improvements, if any, would you recommend in the manner in which ERP data and trend graphs are generated and displayed?

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18. Unless a parameter is very near it's operating limits, the limit line is not usually visible on the ERF trend display. Has this ever caused problems?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)

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19. When selecting parameters for trending on the ERF computer, would a display of the default values for the x and y coordinates beneficial?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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20. When calling up an ERF computer display from the keyboard, the cursor does not go to the first data field and usually must be moved using the cursor keys. Have you found this to be a problem?

\_\_\_\_\_ (Yes, No or N/A)

Have you ever had difficulty in locating the cursor?

\_\_\_\_\_ (Yes, No or N/A)

Would a block rather than underline cursor be easier to see?

\_\_\_\_\_ (Yes, No or N/A)

Have you found the cursor scrolling keys difficult to use?

\_\_\_\_\_ (Yes, No or N/A)

21. An ERF computer display can contain many data points, some of which can be addressed in order to obtain additional information on the particular parameter. Would an on-screen method of uniquely identifying these addressable data points be of any benefit?

\_\_\_\_\_ (Yes, No or N/A)

How could an addressable data point best be identified without causing confusion for the user?

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22. The SPDS CSF status tree displays do not contain any information on the actual values of the parameters driving the display. Would this type of information be useful?

\_\_\_\_\_ (Yes, No or N/A)

Why (or why not)?

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This concludes the survey. We appreciate your help and your patience in answering the questions. Your responses, along with those of your co-workers will be carefully evaluated and, where appropriate, incorporated into Control Room modifications aimed at making your job a little easier.

HVAC SURVEY

Circle the number on each scale which best describes your opinion of the Control Room temperature, humidity and ventilation under normal operating conditions, i.e., normal HVAC in service.

SUMMER

AMBIENT TEMPERATURE

TOO COOL		OK		TOO WARM
1	2	3	4	5

RELATIVE HUMIDITY

TOO DRY		OK		TOO HUMID
1	2	3	4	5

VENTILATION

TOO LITTLE		OK		TOO MUCH
1	2	3	4	5

WINTER

AMBIENT TEMPERATURE

TOO COOL		OK		TOO WARM
1	2	3	4	5

RELATIVE HUMIDITY

TOO DRY		OK		TOO HUMID
1	2	3	4	5

VENTILATION

TOO LITTLE		OK		TOO MUCH
1	2	3	4	5

APPENDIX 3

OPERATOR SURVEY ON CUMULATIVE EFFECTS

HUMAN ENGINEERING DISCREPANCIES

AND

DISCUSSION OF SURVEY RESULTS



SECTION I  
ANNUNCIATORS

- 1053 There is no method of silencing an alarm on a back panel from any position on the main control board.

Fifty percent of the operators surveyed said the inability to silence back panel alarms caused problems. However, most of these cited examples of nuisance alarms which can be eliminated by design change. No action is planned since silencing a back panel would increase the probability of not investigating the alarm.

- 1222 In the event of a reactor trip, the tile associated with the event illuminates. Other tiles illuminate, counter to 0700.

No operator reported a problem with this design feature. No action is planned.

- 1223 There is no turbine trip first out. Turbine trips on ALB19 and ALB20 are not first out annunciators, as recommended in 0700.

Fifty percent thought a turbine trip first-out annunciator would be a benefit but some pointed out that the turbine Electro-Hydraulic Control (EHC) panel in the control room also provides this information on a back panel. Since the cause of a turbine trip is not needed immediately to establish stable control of the reactor plant, the back panel location is sufficient. However, this information is not used effectively. The reactor trip review procedure will be revised to collect turbine first-out trip data from the back EAC panel.

- 1226 There is no silence feature in the annunciator system, as distinct from acknowledge.

The lack of an alarm silence feature was cited in 50% of survey results as a problem. The high noise level set to achieve the NUREG-0700 guidelines coupled with the large number of alarms after a plant trip makes this a significant distraction to the operators. However, many feel that the ability to silence back panel alarms would increase the probability of not following up on an alarm condition. To balance these competing concerns, a silence feature is recommended for the central controls area alarms, but not for back panels. This design change is being processed.

- 1282 All annunciators should be recorded on hard copy and where multi-input annunciators are used an alarm printout should identify the individual alarm inputs in the alarm condition.

Only 20% felt such a feature would be beneficial. Others cited problems with noise, printer reliability, and review time against such a feature. Based on the minimal support from operators for such a feature and the complete lack of such a feature in the system design, no action is planned.

SECTION II  
MAIN CONTROL BOARD

- 1028 There is no provision for loop-to-loop comparisons of the reactor coolant temperature.

Only 14%, with no routine board operators, felt the loop temperature meter arrangement was a problem. Since the vertical loop sequence is the same as other areas of the panel, no action is planned.

- 1030 The reactor coolant loop temperature recorders 433A, 433B and 413A, 413B serve the same function on different loops, but they are different types of instruments, and are in different locations.

Only 21% felt the recorder placement was a problem. Based on the low rate of problems cited and since these are not routinely used in operation, no action is planned.

- 1037 TS-411E, OT Delta-T set point selector, is not in close proximity to its display.

No operators cited any problem with this arrangement. No action is planned.

- 1029 The flow indicators for the reactor coolant pump seals are not in close proximity to the pumps.

No operators cited any problem with this arrangement. No action is planned.

- 1040 HS-5208, HS-5209 & FIC/FI-4499 are not in close proximity to the main feed pumps.

Problems were reported by 28%, specifically with main feed pump speed controls, the transfer from manual to automatic control, and the slight difference in A and B instrument arrangement. The speed control/transfer problems are actually related to operating procedures which will be revised to clarify speed control/transfer. The arrangement of instruments cannot be modified since the board is full. If some feed nozzle delta-temperature meters are deleted in the future, the main feed pump instruments will be rearranged. A review of the deletion feasibility is in progress.

- 1038 The left hand corner of panel 1B1 is too crowded, and there is no direct indication for the SG blowdown valves (HS-7603 A, B, C, D). This indicator is on the QPCP.

Problems with steam generator blowdown operation were reported by 36%. The problems were with the control valves being on a back panel with the isolation valves in front. The procedures address this and good performance has been achieved. Verification of blowdown isolation was not a problem since those valves are on the main board. No action is planned to notify the Control room; however, the survey indicated a problem in communication when transferring control from a field panel. A change to the communications system is being processed to add a phone at the blowdown panel.

1042 The area above the turbine panel on 1B2 is not arranged in a functional manner, and does not include the turbine impulse pressure indicators PI-505 and PI-506.

The only concern expressed with turbine panel controls was the layout of the annunciator buttons next to the hydraulic pump handswitch. The operators concern was routine operation of the annunciator may lead to inadvertant misoperation of the pump control. Since the alarm is a push-button and the pump a J-handle hand switch, the probability of misoperation is very small. Autostart of a backup pump would also prevent plant effect. No action is planned.

1259 The impulse pressure indicators PI-505/506 on 1B1 are difficult to locate. They are in an area of many similar instruments.

Fifty percent expressed difficulty in locating the turbine impulse pressure indicators. This meter pair will be marked with a white (black letter) label to highlight it from the surrounding black labels. Since this is the only such white label on the panel it will serve to help visually locate the instruments.

1060 The auxiliary feedwater indicators are located too far away from the controls to be read accurately from there.

Twenty-one percent reported problems with AFW valve control location, but more related to indicators. The layout of valve controls is constrained by other controls and board space. The current arrangement enhances train relationships to the detriment of steam generator number consistency. The more desirable steam generator arrangement would degrade the association of motor driven pumps to specific generators. Alternate arrangements considered would increase probability of misoperation of pump suction valves with potential for equipment damage. No changes are planned.

1085 The following displays are not above or to left of their controls: S.G. recorders, S.I. accum. pressure, pressurizer pressure, main F.W. pump oil pressure, aux. steam to 5A & 5B F.W. heaters.

The only problems (21%) noted were in main feed pump oil controls, also discussed in HED 1040. No action is planned due to space constraints.

1103 Blue light on RCP lift oil pump does not have a legend describing blue light function.

Twenty-one percent felt a label for this light would be useful. We will add a light legend to the handswitch engraving.

1114 One CCW & NSCW pump light is normally off (MLB) in a block of "ON" lights for SI. RO's prefer this as it gives status of ESF all pumps on MLB. The alternative is to delete the 3rd pump light (2 normally start).

Only 14% felt that this was confusing or caused misinterpretation. However, since these are used to facilitate rapid evaluation of a safety injection, a review has been initiated to determine the technical feasibility and cost of replacing the three light display with a 2 of 3 logic for a system status light, or as an alternative deleting the third, normally off, pump light.

1132 A ZLB lights are horizontally for 3 only, vertical for all others on that box. Rearrange, may be negative training effect.

The three in question are not loop oriented like the other items on that light box. No operators noted any problems. This arrangement is specifically used as an aid in evaluating a turbine trip. No action is planned.

1139 Main steam valves for turbine driven AFW PMP C are on MLB train A & B, MLB 1, 2 possible confusion, not noted in EOP validation.

No specific problems were cited with this arrangement, though two operators thought the status lights would be better nearer the controls. This comment did not address the HED which had to do with train identification. The valve position is shown on handswitches at the control location. The monitor light box windows are a secondary summary indication to evaluate proper actuation of automatic systems. No action is planned.

1146 EØ step 19 requires temperatures to be verified at 557 F, meter increments are 10 °F.

No operators reported any problem with this feature. No action is planned.

1159 Orifice flows are reduced at low pressure, do not name in GPM.

No operators reported any problem with this feature. No action is planned.

1314 The following instrumentation does not meet the minimum range requirements of the ICCR: 1-FI-0917A, 1-FI-0110, 1-TI-0103, 1-FI-5150A, 1-FI-0121C and 1-FR-0156.

One operator noted a problem using auxiliary feedwater flow indicator FI-5150A. His concern was with resolution, not range (the subject of this HED) Since a digital value is available on the ERF computer and the exact value is not significant at low flow where the resolution is coarse (due to the flow detector), no action is planned.

1315 The following instrumentation exceeds the minimum loop accuracy as specified in the ICCR: 1-PI-0919, 1-LI-0931A, 1-LI-0470, 1-PI-0469, 1-FR-0110 and 1-TI-0103.

No operators reported any problems with loop accuracy. No action is planned.

1317 The following instruments exceed the minimum resolution as specified in the ICCR: 1-LI-0931A, 1-TI-0103, 1-FR-0158 and 1-SI-5136.

No operator reported a problem with minimum resolution on these instruments. No action is planned.



- 1318 The following parameters, as identified in the ICCR, are not indicated in the control room: 1) RCP seal INJ temp, 2) RCP ACCW thermal barrier flow, 3) CCW flow to RHR HX, 4) Spent fuel pool level, 5) Spent fuel cooling water flow.

No operators reported any problem with this feature. No action is planned.

### SECTION III ELECTRICAL AUXILIARY BOARD AND PROCESS CONTROL PANEL

- 1204 "Push to Test" push buttons on status light boards are not unique.

No operators identified problems with the status light test buttons. No action is planned.

- 1021 Some synchronizing switches were to be arranged so that they turn "ON" with a counter clockwise movement.

Although 14% of operators reported they had been confused by these switches, no operational problems have resulted. These are interlocks to prevent misoperation and the correct sequence of operation is required for the equipment to operate. Since this has not caused operational problems and is not involved with any safety equipment requiring emergency operation, no action is planned.

- 1033 The synch check bypass switch may be left in a parallel position.

No operators reported any problem with the feature. For this reason and the design impossibility of any consequences from misoperation, no action is planned.

- 1272 The AC voltmeters on QEAB do not read off - scale low when not selected.

No operators reported a problem with this design feature. No action is planned.

**SECTION IV  
GENERIC DISCREPANCIES**

- 1046 Control switch indicator lights have no "Push to Test" capacity.

Many operators (43%) indicated problems with the absence of a press-to-test lamp feature. This is cited as a problem when a control manipulation fails to produce the expected response. In that case, the operator does not know if the bulb is out (a common occurrence) or if the equipment has malfunctioned.

The operator must then swap a known good light bulb to determine actual equipment status.

Since this is actually a burnt-out bulb problem and since the press-to-test feature cannot be installed without complete replacement of main control panel handswitches, we are evaluating use of long life light-emitting diode (LED) type bulbs. The LED bulbs have service lives of approximately 150,000 hours. If a product of suitable color and intensity can be located, it will solve the burnt-out bulb problem.

- 1047 The set-point knobs for the controllers do not have directional markings.

The problems operators expressed with controller potentiometer settings (42%) were not related to the lack of a directional arrow but to a broader problem of controller conventions. A "process" convention was chosen in the CRDR; the "UP" button and a higher potentiometer setting should increase the process parameter (level, temperature, etc.) being controlled. Since this characteristic is not visible at the board, the DCRDR process was not able to verify conversion/correction. Based on the survey results, there may be multiple problems in this area. An engineering study is underway to verify and correct the implementation of a "process" controller convention.

- 1099 No legend exists for meaning of amber trip lights.

No operators expressed any problem with this feature. No action is planned.

SECTION V  
COMPUTERS

- 1237 The ERF computer does not provide a sequential history file of operator entries. Available upon request.

This feature was desired by 21% in the operator Survey, but evaluation of amplifying remarks showed that they were actually wanting more saved or pre-formatted ERF trend displays for operator callup. A software change is being processed to modify "SELECT TREND" function to provide an expanded menu of preformatted trends.

- 1250 Multiple page considerations, when pages are organized in a hierarchical fashion, containing different paths through a series, a visual audit trail of the choices made are not available upon operator request.

This feature was desired by 21% in the operator Survey, but evaluation of amplifying remarks showed that they were actually wanting more saved or pre-formatted ERF trend displays for operator callup. A software change is being processed to modify "SELECT TREND" function to provide an expanded menu of preformatted trends.

- 1238 The ERF computer does not conform to the standard "QWERTY" keyboard arrangement.

Problems with the ERF keyboard were reported (14%) by the few Supervisors who were proficient with a regular typewriter keyboard. Since an entry does not exceed two letters long, and most of our operators are not proficient with regular keyboards, no action is planned.

- 1267 Items contained in a numbered list and described in "continue pages" items are not sequentially numbered relative to the first page.

Problems with the Proteus were noted in 14% of the survey. No problems were reported with the ERF computer. The Proteus system is an early 1970's vintage computer; the operator interface is markedly inferior to more recent machines. However, the Proteus system can not be significantly improved due to hardware limits. The ERF system is being used by the operators much more than the Proteus and continued use and expansion of the ERF is planned, with eventual replacement of the Proteus.

1248 Inverse video is used for applications outside the Guidelines presented in 0700. The guidelines state inverse video should be used for highlighting in dense data fields, such as words in a paragraph, not entire CRT sections: Proteus-alarm, ERF-CSFST.

No operators had experienced problems with the inverse order. No action is planned.

1249 Use of color, colors used on both the proteus and the ERF CRTS to convey information are not consistent in use and meaning with other color codes (Red and Green) in the control room.

Only one operator felt that had ever been a problem, and that had not resulted in a misinterpretation. To further reduce the possibility of confusion the alarm state for valves was set as open, so that the red=open=alarm color convention is preserved. No further action is planned on this item.

1240 The proteus operating procedure 13504-1 , Rev. 0 does not describe the overall computer system, and the computer system components with which the operator can interface.

Only one supervisor felt the Proteus procedure was unsatisfactory and that concern dealt with system startup following a computer 'crash' ; a function normally performed by system engineers and technicians, not Control Room Operators. The procedure will be reviewed for potential improvement in this area.

1243 Error correction guidance error messages do not contain instructions to the operator regarding the required correction.

This was thought a problem by 43% in the survey. This is similar to the problems noted in HED 1267. The Proteus interface is recognized as poor, but hardware constrains improvements. No specific action is planned beyond eventual replacement.



1244 System status feedback, the proteus does not provide feedback to the operator as to computer system status (i.e. run, stop, failed, on line).

Half the survey indicated a problem with this. The Proteus fails with the current display; data is not updated and the clock on screen stops changing. The failure is not obvious until the clock error is noticed or some operator input is attempted. By contrast the ERF computer screen blanks out after a 15 second interruption of computer data. An Engineering review has been initiated to develop a computer failure indication.

1270 Provisions are not included to provide upon operator request, printouts by alarm group (eg. SYSTEM, SUBSYSTEM, COMPONENT).

While 26% of operators felt this would be beneficial, hardware limitations on changes preclude significant improvement. See HED 1267 for more information. No immediate action is planned.



APPENDIX 4

EXAMPLE UNIT 2

HUMAN ENGINEERING DISCREPANCY -

DISCUSSION OF PROBLEM AND SOLUTION

## HED 2022 -TRIP DETECTION

**Problem** - During a training exercise, one set of trip bistables was tripped for an instrument malfunction. A second temperature instrument failure caused multiple false alarms on ALB12 and a trip alarm in ALB 10. The trainee saw and read the trip alarm but, in conjunction with the other alarms, did not recognize the ATWT condition for several minutes.

**Training Suggestion** - Color the trip alarm boxes to improve detection of a trip condition on ATWT.

**Current Design Rational** - The safety injection alarms on ALB 10 are red to aid in identifying an SI in emergency operations. Most other windows on ALB 10 are reactor trips, but not all. The trip windows were not colored because the Control Room Design Review committee felt the location on the first out was sufficient, along with other indications to detect a trip condition.

**Current Work** - A Request for Engineering Review is in progress to install a separate acknowledge/reset switch for ALB-10, the first-out annunciator. It currently shares a control with three other alarm boxes and this has caused loss of first out information when acknowledging other alarms. The separate switch will improve detection of an ATWT condition.

### **Additional Options**

1. Color code trip alarms.
2. Add a separate horn or chime for the first-out light box.

### **Horn Considerations**

A separate horn would provide a distinct alert for the ATWT scenario which occurred, but it would add to the general post-trip noise level which is already noted as a problem in 'normal' trips.

### **Color Code Considerations**

The current convention uses four colors:

red - SI and other serious conditions  
amber - trip imminent or degraded conditions  
green - normally on  
white - all others

The NUREG-0700 design guide is to limit alarm color codes to 2-4 priority levels. A fourth code color would be possible within those guidelines, but only purple would be comparably discriminable. However, purple (magenta) is associated with radiation hazards in other contexts and so may be unsuitable for a trip indicator.

The use of red for trips would dilute the effectiveness of the safety injection alarms, so red should not be considered further.

Amber for trips would serve as a good alert because no amber alarms are present following a normal trip.

Recommendation

Replace 'TRIP' annunciator windows with amber backed lenses.

References

- NUREG-0700 Guidelines for Control Room Design Reviews
- EPRI-NP-4361 Power Plant Alarm Systems
- EPRI-NP-3659 Human Factors Guide for Nuclear Power Plant Control Room Development

HED 2-22  
ATWT DETECTION - SUPPLEMENT

David Hale was acquainted with the ATWT problem in the simulator and suggested color coding the trip bistables to improve detection of trip conditions on the Trip Status Light Boxes (TSLB).

This addition of color to the TSLB would improve detection of trip inputs since the TSLB also contains non-trip signals. To reinforce the color convention on the annunciators, the safety injection boxes should be red and the reactor trip boxes should be amber.

This change has been tried at the simulator with colored LED bulbs and gives good color discrimination. Request for Engineering Review (RER) # 88-0101 will determine if the light sockets are '+' or '-' polarity to identify the correct LED bulb. An 'operator aid' to control bulb color will be most efficient.

APPENDIX 5

ANNUNCIATOR SURVEY

FEBRUARY 17, 1988



Abnormal Control Room Annunciator Status

on 2-17-88 - Mode 1, Rx Power 92%

ALB04 E01 "Trn. A Sys. Status Mon Pnl Alert"

(because FHB Emergency HVAC Bypassed)

ALB04 E02 "Trn. B Sys. Status Mon Pnl Alert"

(because diesel starting air low press alarm is in, see ALB 38-F02))

ALB05 B04 "Bypass Chmt Vent ISO Hi Rad Test"

(because FHB Rad Monitors ARE-2533A & B are out of service)

ALB16 E05 "AFW Turb Mn Stm Drn To Cndsr Trbl"

(This is due to a drain oriface or condensing pot design problem.

A valve has been manually overridden as an interim measure and the alarm left in to identify the abnormal condition. Design/maintenance work continues to resolve this problem).

ALB17 A06 "Rhtr A Drn Tk Hi/Lo Lvl"

(because Hi Level Dump Vlv is jacked open. Level is right at low set point of -6.5 in.---a startup anomaly)

ALB17 D05 "Msr D Drn Tk Hi/Lo Lvl" (2-11-88 MWO written)

1LI-4398 indicates -2.5" which is above the low lvl setpt. of -6.5 in.-- a startup anomaly)

ALB17 D06 "Rhtr D Drn Tk Hi/Lo Lvl"

(because 1LI-14152 indicates -1.5" which is above the low lvl set pt. of -6.5" -- a startup anomaly)

ALB19 D01 "MN Turb Lube Oil Rsvr Hi/Lo Lvl"

(because lube oil reservior level is 1" above Hi set point --a startup anomaly)

ALB19 C01 "Turb Brg Lift Pumps Running" (MWO written 11-8-87)

(Problem in the Electrical curcuitry -- Lift Pumps are not running.)

ALB33 D05 "Inverter IND3I1 Trouble"

(The inverter is being supplied from the regulating XFMR In1BS18X)

ALB34 B05 "120 V AC Pnl 1DY1B Trouble" (MWO written 2-14-88)

(64-2 Relay will not rest -Ground)

ALB38 F02 "DG1B Disabled Low Pressure Starting Air" (MWO written 2-14-88) (Bad solenoid switch on air start compressor)

ALB53 F07 "Chiller Trn A Compressor Hi V1B" (MWO written) (Annunciator comes in and stays in when the chiller is shut down, clears when chiller is started up.)

ALB54 A06 "Norm Chiller No. 2 Trouble"

(Annunciator comes in when chiller is shut down and clears when chiller is started up.)

ALB54 D01 "TSC HVAC Panel Alarm" (due to annunciators in on local TSC HVAC panel)

ALB54 E05 "Norm Chiller Expansion Tank Hi/Lo Level" (MWO written)

(Pressure Control Vlv leaks by and keeps Lvl Hi)

2-17-88 QPCP

ALB61 E04 "WST Evap. Stm. Sply Sys ACCW Leak Detected"  
(ACCW to RE-0025 is isolated per clearance)

ALB61 F06 Lvl D Leak Detected

( This is due to a malfunctioning floor drain level switch which has not been located. An MWO has been written and the alarm has been left lit to support troubleshooting.