TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

January 13, 1981

Director of Nuclear Reactor Regulation
Attention: Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Schwencer:

In the Matter of the Application of) Docket Nos. 50-390
Tennessee Valley Authority) 50-391

In a letter dated September 24, 1980, from R. L. Tedesco to H. G. Parris, TVA was requested to provide the results of a preliminary design review of the Control Room at Watts Bar Nuclear Plant. Enclosed is the requested information.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills, Manager
Nuclear Regulation and Safety

Sworn to and subscribed before me
this 13th day of Jan. 1981
Paulette D. White
Notary Public
My Commission Expires 9-5-84

Enclosure

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ENCLOSURE

PRELIMINARY CONTROL ROOM REVIEW
OF WATTS BAR NUCLEAR PLANT UNITS 1 AND 2

The purpose of this report is to inform you of the Tennessee Valley Authority's (TVA) position for meeting the requirements of performing a preliminary control room assessment of Watts Bar Nuclear Plant (WBN). This requirement is identified in NUREG-0660, item I.D. It is a requirement that must be met by near term operating license (NTOL) plants prior to obtaining an operating license.

The following summarizes all the activities that have been accomplished to make up the preliminary review of WBN.

The preliminary assessment of the WBN control room to identify significant human factors problem started on January 21, 1980. This initial two-day preliminary review revealed a number of areas that needed to be pursued. During the week of February 4, 1980, a preliminary control room review was accomplished on the Sequoyah Nuclear Plant (SQN) unit 1 control room prior to criticality. SQN unit 1 is similar (basically identical) to SQN unit 2 and WBN units 1 and 2. A preliminary assessment conducted for either unit is appropriate for the other units.

This assessment was conducted by the Essex Corporation (under contract to the Nuclear Regulatory Commission, NRC) with a team of NRC and TVA personnel actively involved. Essex Corporation issued a report (copy attached) summarizing their findings. NRC identified from the report the significant items requiring immediate attention.

TVA provided corrections to these items, and they were documented in the Sequoyah Safety Evaluation Report dated September 4, 1980. These changes are also needed on WBN. They will be completed prior to each unit's fuel loading. The modifications are as follows:

1. Dedicated panel telephones will be installed to improve control room communications between operators.

2. Panel guardrails will be installed to prevent inadvertent actuation of switches close to the front edge of the main control panels. Also, red carpet will be installed at the base of vertical panels to designate off-limit areas to employees not performing a required task.

3. Arrangements will be made to maintain procedures in a specific location in the control room, and an index will be added to assist operators in locating specific emergency procedures. Also, immediate action steps in emergency procedures will be revised to eliminate references made to external documents.

4. Alarms important to safety will be arranged by priority by color coding annunciator windows.

5. Common panels containing controls and displays from multiple units will be modified by using color coding and adding specific unit numbering to provide unique identification of each control and display.

6. The bezels will be painted black on each overhead annunciator display panel to improve contrast between annunciator windows and background.

7. Carpet will be added to the control room to reduce background noise levels.

8. Control room procedures will be revised to instruct operators to use the lamp test buttons on the status monitoring panels to verify that a lamp is burned out, rather than implying that a system is unavailable.

TVA has continued the preliminary review of the WBN main control room by proceeding with internal design studies and task analyses of the control boards and by making five trips to the plantsites and the plant simulators to identify human factor problems. These trips involved walk throughs of the operating instructions at both the Watts Bar plant and simulator. Detail interviews were conducted with the operators at the plants and at the simulator with the instructors.

The control rooms were also examined to identify any significant human engineering deficiencies. The information obtained from these sources was reviewed with engineering design groups to determine the significant items and identify possible ways to implement the desired changes. These changes were then reviewed and coordinated with the plant personnel to finalize the changes to be incorporated.

The following is a list of items TVA has identified and the action to be taken:

1. Further steps will be taken to reduce the noise generated by the area radiation monitoring equipment located in the main control room.

2. Operating ranges will be added to the scale of indicating meters where possible in the main control room with the following criteria applied:

   a. No color (clear) - Normal operation.

   b. Yellow - Abnormal operating condition; with caution being taken and/or first alarm point of a two-level alarm.

   c. Magenta - Abnormal operating condition; action should be taken immediately and/or second alarm point of a two-level alarm.

3. The pointer on all indicating meters will be painted fluorscent orange.

4. All nametags will be reviewed to verify proper nomenclature is used. The addition of a nametag to handswitches to provide the power source supplying that device being controlled is under review.

5. The control boards will be modified using functional grouping and demarcation of related control elements using black graphic plastic for demarcation of systems. This will require the movement of approximately 34 devices.

6. The use of 475 functional nametags will be installed in coordination with the functional grouping.

7. Three computer trend records will be moved from a back row panel (1M-10) to panels close to the operator on panels 1M-1.

8. The bezels of all meters will be changed to black to improve contrast of meter reading.

9. The test switches (25) located on panel 1M-6, which are infrequently used, are under study to be moved to back row panels. This will allow room for function grouping of devices and future additions on this panel, which is primarily made up of safety-related devices.

10. The proper scaling on indicators has been found to be a problem. Meters labeled in percent have been found to be a concern. There are 116 meters scaled in percent. A complete review of all meters is presently underway to determine proper units and ranges and to find meters that may require dual scaling (i.e., gallons and percent).

11. The nametags will be changed from black on grey to black on white to improve contrast.

12. The use of additional CRT's for alarm summaries and further alarm arrangement by priority is under study.

A set of Watts Bar drawings for panels 1M-1 through -6 are attached that show most of the above changes incorporated. The remaining changes will be completed on priority basis and in conjunction with TVA's compliance with NUREG-0700, "Human Engineering Guide to Control Room Evaluation."

The detail control room review (approximately 1 year in duration) will be conducted in accordance with NUREG-0700. However, we are continuing our own review and studies to identify changes that may be needed.

ESSEX

March 10, 1980

To: Leo Beltracchi

From: Ken Mallory

Subject: Findings of the CR review at Sequoyah - Unit 1

During the week of February 4-8, 1980, the Essex Corporation in cooperation with the NRC/NRR performed a human engineering review of the control room at TVA's Sequoyah - Unit 1 Nuclear Power Plant. The procedures and guidelines used by Essex were the first generation of those to be included in the guidebook.

Essex had three objectives for this review:

1. To identify features in CR design and procedures that could induce operator error under normal or emergency conditions..

2. To examine evaluation guidelines and procedures for the guidebook and modify accordingly.

3. To identify design and procedural problems and backfits common among control rooms.

1.0 SUMMARY CONCLUSIONS

a. The Sequoyah - Unit 1 control room exhibited a number of design and procedural features that were contradictory to human engineering standards and practices (Described below).

b. The Essex procedures were upgraded as a result of the Sequoyah review:

- Procedures for using checklists were altered
- Walk-through/talk-through procedures were formalized
- Surveys were expanded to include procedures, noise survey, ambient light survey.

2.0 OBSERVATIONS

Each of the objectives described below is given a Subjective Risk Assessment Weight based on the likelihood that a particular aspect of CR design will lead to an operator error in a safety-related activity. The likelihood is based on the opinion(s) of the Essex human engineer(s) reviewing the CR.

Category 1 — High Risk of Operator Error in Safety-Related Activity

Category 2 — Moderate Risk of Operator Error in Safety-Related Activity

Category 3 — Risk of Operator Error is Safety-Related Activity

Category X — Additional evaluation required

a. Communications — Distance and noise interferes with voice communication between the Unit 2 CRO at the panels, and the ASE at the common panels. This problem is particularly acute when a breathing apparatus is worn by both (Category 1).

b. Status Monitoring - Engineered Safety — In the matrix of indicator lights, failure to achieve a proper system status is often given by a light "off." No check is made during EP for failed lights. This could lead the operator to assume that an operating system had failed (Category 1).

c. Status Monitoring - Engineered Safety — In the matrix of lights, spares are intermixed with operating lights. Since the operator's task is to determine "all on," "spares off" creates a requirement for the operator to review all lights to assure that only the spares are off (Category 1).

d. Annunciators — No prioritization, low contrast between flashing and steady lights (Category 1). While an alarm is displayed (no auto clear) no other alarm can be announced unless the operator resets the annunciator (Category 1).

e. Steam Generator Strip Charts — Labels on chart windows contradict those under chart units. Appears that recorders were reinstalled incorrectly after maintenance (Category 2).

f. Inadvertant Actuation — Three "J" handle switches were mounted without protection 3/4" from edge of panel. Could be accidentally actuated (Category 1).

g. Label Obstruction — Discrete rotary star handles obscure switch position legends, and indicators obscure labels when mounted low on vertical panels (Category 2).

h. Convention Fault — The convention of valve "closed" being on the left and valve "open" being on the right is violated on controllers which require a 100% output signal to fully close the valve (Category 3).

i. Violation of Stereotype — Speed controller (panel 1-M-4) has max speed = 0% and min speed = 100% (Category 2).

j. No Labels — Turbine pump indicators have two red lights but no label for either.

k. Violation of Stereotype — Feedwater and condensate system - 480 THOV had a sequence of valves (left to right) CBABA (Category 2).

l. Violation of Stereotype — AMPS display for feedwater pump B is mounted over a vertical string of pump A related switches (Category 2).

m. Display Confusion — Several long strings (greater than 4) of vertical meters. Mounting in strings increases the likelihood that the operator will read the wrong display if it is near the middle of the string (Category 2).

n. Labeling — Font was too small, contrast poor, and information inconsistently placed on specific lines (Category 1).

o. Printers — One computer was out of alignment, printing all characters ½ black and ½ red. Should be checked regularly and corrected (Category 3).

p. Protective Clothing — There are several problems (Category 1):

- Donning is difficult.
- Changing air tanks is a two-man operation.
- With the five minute warning bell, there is perhaps too little time to change.
- Mask virtually prohibits the wearer from speaking to anyone.
- There are too many steps to don gear.

q. Procedures — Problems include (Category 1):

- Need for improved diagnostic aids
- One instruction per numbered step
- Need for all steps to be included
- Cross-references
- Steps CAUTIONS & PRECAUTIONS
- Synonyms
- Long, complex instructions
- Data, charts, etc., referenced
- Sequential deviations as shown in procedures and walk-throughs
- Ambiguous and confusing wording
- Locations of infrequently used components not given in procedure
- Text layout, font.

r. Reach — Short (five percentile) operators have difficulty in reaching a number of switches on vertical panels. Some switches require the operator to stand on one foot very close to the panel and other switches cannot be reached (on Power Distributor Panel) (Category X).

s. Readability Envelopes — TVA should examine the requirements to read various meters, annunciators windows, and labels against readability (distance-from-display) envelopes (Category X).

t. Pushbuttons & Legends — Difficult to visually distinguish between pushbuttons and backlighted legends (Category 3).

u. Acknowledge — The ACK-RESET switch for the permissive interlock is at the opposite end of 1-M-4 panel from the display (Category 3).

v. Switch Confusion — Large strings/matrices of switches are located at several places on panels (Category 2).

1) Component cooling water

2) Water service systems

3) Essential raw cooling water

d) Ventilation panel

w. Violation of Convention — SB switches on Electrical Distribution Panel reverse the trip/close convention for other switches (Category 3).

x. ASE Area — Tables may interfere with operations (Category X).

y. Operator View of Panel — Consoles on right and left of seated operator obstruct view of panels (Category X).

z. SMS — Display does not appear to replicate conditions as they are in the plant (Category X).

aa. SMS — There does not appear to be a display line reserved for checking keyed inputs to SMS (Category X).

bb. Violation of Stereotype — Operator must push control in (towards vertical part of console) for rods to move out, and pull back on control to move rods in. This is a definite violation of stereotypical response (Category 1).

cc. Confusion — There is no special indication for throttle controls (vs discrete controls) (Category X).

dd. Room Coloring — There are no clear visual boundaries between the control boards, overhead, and floor (Category X).

ee. Charging Pumps — Layout of charging pumps does not follow sequence of operation (Category X).

ff. Mirror Images — Shared (Unit 1 and 2) panels in common area are often nearly mirror images and could induce transfer of training errors (Category 1).

gg. Rest Room — Access to rest room requires passage through security port (could increase time off the panel significantly) (Category X).

hh. Phone Jacks — Phone jacks on panel provide little channel capacity to the operator (Category X).

ii. Vertical Meters — Pointer conspiguity of vertical meters is low, particularly at distances (Category X).

jj. Pressurizer Indicators — Pressurizer displays are difficult to read accurately at a distance, as may be required in a LOCA (Category X).

kk. Acknowledgement — Location of annunciator acknowledge switches may not be optimum during emergency operations (Category X).

ll. Lamp Test — A lamp test capability is not available for most lights on consoles and verticals (Category 1).

3.0 HUMAN ENGINEERING STRENGTHS

The following items of exemplary human engineering were noted at Sequoyah:

a. The Safety Status Monitor provides reasonably complete and current information on safety system status.

b. With some exceptions the annunciators are grouped above the systems they monitor.

c. Color coding of switches will help the relatively inexperienced operators to locate specific switches.

d. Vertical meters have pointers flush with the scale; therefore, parallax is not a serious problem.

e. First-out panel should help in problem diagnosis.