



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

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September 16, 1980

Docket No. 50-289

Mr. R. C. Arnold
Senior Vice President
Metropolitan Edison Company
100 Interpace Parkway
Parsippany, New Jersey 07054

Dear Mr. Arnold:

Enclosed is a copy of a draft of our Human Factors Engineering Control Room Design Review of TMI-1. We would like to arrange a meeting during the week of October 6, 1980 to discuss the report, your comments, and corrective actions you propose.

Sincerely,

A handwritten signature in cursive script, appearing to read "Robert W. Reid".

Robert W. Reid, Chief
Operating Reactors Branch #4
Division of Licensing

Enclosure:
Draft

cc w/enclosure:
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Human Factors Engineering Control Room
Design Review
Three Mile Island - Unit 1

During the week of July 21-25 a human factors engineering design review of the TMI-1 control room was conducted. The review was performed by the Human Factors Engineering Branch, Division of Human Factors Safety. The review team was assisted by human factors consultant Harold E. Price of BioTechnology, Inc.

The following sections summarize the staff's observations of control room design and layout, and of the control room operations interactions with that environment. Where possible, observed deficiencies were given a subjective rating based on the potential for that deficiency to induce an operator error during performance of a critical activity. These ratings are divided into three categories:

1. Serious Concern - Human/System performance degradation with serious potential safety consequence.
2. Moderate Concern - Human/System performance degradation with moderate potential safety consequence.
3. Other Concerns - These require an evaluation by the licensee for future resolution.

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1.0 Annunciators/Alarms

- a. System lacks a separate, audible alarm acknowledge/silence control. This in combination with the one acknowledge signal permits operators to acknowledge alarms without reading alarm windows. (Category 1)
- b. There is a minimal annunciator prioritization (Reactor Trip/Turbine Trip) and tiles with blue corners associated with Engineered Safeguards Actuation System (ESAS). Other system annunciators with safety significance have no priority. Some blue markings on ESAS alarm tiles are readily identifiable. (Category 1)
- c. Some annunciators tiles have busy legends. (Category 2)

2.0 Process Computer

- a. CRT display of poor quality and could increase the probability of reading error. (Category 1)
- b. Process computer capability is limited and its Vintage raises question of reliability of information presented to operators. (Category 1)
- c. Neither the CRT display nor the alarm printer utilize color coded displays. (Category 3)
- d. Computer backup control panel is not used by operators. (Category 3)

3.0 Controls (General)

- a. Controls (J handle, etc.) located near front edge of console could be inadvertently activated. (Category 1)
- b. Set points knobs on Bailey controllers do not lock, and can be accidentally rotated. (Category 2)
- c. Violation of plant convention for auto/manual positions on some multiple position rotary controls (Sync. Scope and Voltage Regulator). (Category 1)
- d. Legend switch covers are interchangeable. (Category 1)
- e. Legend indicators contain numerous burned out bulbs. (Category 2)
- f. Many illuminated legend switches are difficult to read. (Category 1)
- g. "J" handle switches are frequently in a position contrary to the flag indicator color. (Category 3)
- h. Bailey controllers indicate demand signal rather than valve position. (Category 2)

4.0 Displays (General)

- a. Panel legend lights do not provide positive indication because of poor contrast with panel background, especially for certain green colored tiles. (Category 1)
- b. Glare is present on all vertical indicators resulting in reduced readability. (Category 2)
- c. Normal operating ranges or set points are not indicated on vertical meters. (Category 2)

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-4-

- d. Normal or desired position in strings of meters does not line up for easy monitoring. (Category 3)
- e. Most meters fall at mid-scale position. (Category 1)
- f. For some motor driven valves, an open circuit breaker inhibits valve position indication (i.e. valve position cannot be determined). (Category 1)
- g. Bailey meter scales do not meet basic human engineering standards (scale internal were poor). (Category 3)
- h. Backlighted legends are difficult to read. Room lighting is dim, contrast is minimal, lettering is crowded and busy and discoloration on scratched surfaces is frequent. (Category 2).
- i. No lamp test capability on control boards or panels. (Category 1)

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5.0 Labeling (General)

- a. Color meaning is not consistent. (Category 1)
- b. Mimicing is used minimally. (Category 3)
- c. In general, labels are used only at the component level, not at the group, function, system or panel level. (Category 1)
- d. The use of colors labels is not consistent, for example, black/white background and print. (Category 2)
- e. Makeshift labeling was observed on many components including penciled on switch nomenclature, hand letters labeled and vertical meter scale value and the use of dyno tape. (Category 1)
- f. Labels are not all permanently attached. (Category 1)
- g. Little or no use of demarcation lines to separate systems, subsystems, functional grouping, etc. (Category 1)
- h. Labels are wordy, because the function of a system is repeated on each switch of a group. (Category 2)

6.0 Control Display Relationship

6.1 General - Related controls and displays do not consistently have both nomenclature and component designation. (Category 1)

6.2 Makeup and Purification System

- a. Makeup pumps are not grouped together. (Category 2)
- b. Lacks positive indication of flow when makeup pump is running. Indication by an Ammeter only that pump is running. (Category 2)

- c. Cannot see seal leak strip chart recorder when using seal injection flow. (Category 3)
- d. Dual purpose meter for RC Pump seal ΔP and Lab Seal DP has different scales which could be confusing. (Category 3)
- e. It is impossible to verify a required reading of 3 gpm flow on the RC Makeup Flow Meter which has Scale Values of 0 to 16 (x 10). (Category 1)
- f. Boration capability is on **the Liquid Waste** System which is remote to main control console (LWS). (Category 3)
- g. Letdown flow meter is in gpm while scale on controller is in percent and must be converted before setting. (Category 2)
- h. There is no Engineered Safeguards/Safety Injection annunciator window. (Category 1)
- i. Engineer Safeguards Actuation Panel has blue status lights which are difficult to interpret as being "on." (Category 1)
- j. Valve positions (containment isolation) at bottom at Engineered Safeguards Actuation Panel can't be seen from main console. Also, there appeared to be no color sequence or pattern to help check which valves should be opened or closed. (Category 1)
- k. No direct indication on a Decay Heat Removal (DHR) system is apparent. (Category 1)

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- l. DHR temp and DHR cooler temp indicators are side by side but have different scale multipliers. (Category 2)
- m. LPI valve alignment is not sequentially organized or grouped on panel. (Category 3)
- n. DH, 5, 6, 7 valve controls are not included in mimic. (Category 2)

6.2 HVAC System

- a. Train "A" controls are on right and train "B" controls are on left side. (Category 3)
- b. No separation or demarcation of grouped J handle control switches (9 in a row). (Category 2)
- c. Five trend recorders (air flow) are at top of panel (6'6") with excessive glare which requires standing on a stool and lifting covers to be read. (Category 3)
- d. Labeling does not contain information which indicates time required for depressing and holding manual fan start control to start fan (varies by fan, 30 to 90 sec.). (Category 3)

7.0 Sound Level Readings

- a. The IBM - Selectric printer is 65 dbA while typing. This level is 5 to 6 dbA above ambient and 4 to 5 dbA above most alarm levels. (Category 2)
- b. Main control board alarm is below ambient noise level. (Category 1)

- c. Panel Left (PL) alarm is only 1 dbA above ambient noise level. (Category 1)
- d. Right Panel Front (PRF) alarm is only 1dbA above ambient noise level (Category 1)
- e. Liquid Waste System alarm is below ambient noise level. (Category 1)

8.0 Other Observations

- a. Diesel Generator Governor has no indication on J handle switch for fast/slow speed control which is inconsistent with other speed controls. (Category 2)
- b. Unrelated "Reactor Building Emergency Cooler B&C" displays are located in the center of the diesel panel. (Category 3)
- c. On DHR system, controls for loop A and B were not associated with their displays which are located approximately 8 feet away. (Category 2)
- d. One DHR indicator and control switch which are located on loop B panel actually belong to loop A panel. (Category 2)
- e. Discrimination between systems and subsystems is difficult because of lack of use of demarcation lines and color coding. (Category 1)
- f. Auxiliary Feedwater system lacks a flow meter. (Category 1)
- g. The ICS system is spread out over 3 panels. (Category 3)
- h. Control/display arrangements for ICS (feedwater, steam level) are not apparent. (Category 2)

9.0 Remote Shutdown Panel (RSP)

- a. Is not independent of the Control Room - some actions are required in control room. (Category 1)
- b. No emergency lighting. (Category 1)
- c. Communication is by sound powered mike with no mike in area.
Communication is also by
Center (Key kept in CR). (Category 1)
- d. No scott-air packs near RSP. (Category 2)

10.0 Shift Supervisor Office

- a. No emergency lighting is provided in this office. (Category 3)
- b. No scott air packs are stored in this office. (Category 3)

11.0 Communication in Control Room

- a. Only one non-dedicated outside telephone line. (Category 3)
- b. No sound powered mikes are readily available (Category 1)
- c. Weaknesses in radio communications with technician outside the CR.
(Category 1)
- d. Some inoperable page telephones in the plant area. Some areas in plant are not reachable by phone. (Category 2)
- e. Page system unintelligible in some areas of plant due to ambient noise levels. (Category 3)

12.0 Control Room Equipment

- a. Three Scott Air Packs are kept in the CR, but there are eleven people planned to be in the CR during emergency operations. (Category 1)
- b. Air refill bottles are stored 3 floors below the CR. Elevator failures makes transport of airpacks difficult. (Category 3)

13.0 Tech Support Center

- a. No airpacks are available. (Category 1)
- b. No emergency lighting is provided. (Category 1)

14.0 Emergency Procedures

- a. Immediate action steps are too detailed some with an excessive number of steps required to be completed immediately. (Category 3)
- b. Steam Line Break procedure is written as an abnormal procedure rather than an emergency procedure. (Category ..)
- c. Some steps which require 2 operators to implement are not noted. (Category 3)
- d. Some procedures, have notes before symptoms which are actually action steps. Many notes in procedures are actually steps. (Category 3)
- e. Some procedures reference control and display labels by names different from the names actually used on the labels. (Category 2)....

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15.0 Lighting

- a. Lighting was not specifically designed for reading labels, displays and meters. (Category 2)
- b. Direct glare from overhead lights on both controls and displays made readability difficult. (Category 2)
- c. No lighted exit sign in the control room. (Category 2)

General Comments

- a. No formal system exists for providing operators feedback about suggestions made.
- b. Sub-cooling instrumentation is not in place and operating.
- c. In-core thermocouples (tc_s) have been connected to the process computer, a monitoring program has been written and the system is in the checkout process. An NRC team will review the functionability of the system from a human factors engineering point-of-view before restart.