NUREG-0752

Control Room Design Review Report for TMI-1

Metropolitan Edison Company, et al.
Three Mile Island Nuclear Station
Unit 1 Docket 50-289

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation

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Manuscript Completed: December 1980
Date Published: December 1980

Division of Human Factors Safety
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ABSTRACT

Based on our human factors engineering review and evaluation of the TMI-1 control room, we conclude that correction of the deficiencies herein identified and discussed prior to restart will permit safe operation of the TMI Unit 1 nuclear plant. Prior to restart, we will arrange to audit the control room to ensure all human factors engineering improvements are implemented.

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TMI, UNIT 1

A. INTRODUCTION

In our letter of November 25, 1980 to Met-Ed (D. G. Eisenhut to R. C. Arnold), we documented certain requirements of NUREG-0694, "TMI-Related Requirements for New Operating Licenses", which we believed should be completed prior to restart of TMI-1. Among these is Item I.D.1, Control Room Design. As part of this requirement, members of the staff and a human factors consultant conducted a human factors review of the TMI-1 control room design from July 21 to July 25, 1980. This report presents the results of that review.

On the morning of July 21, 1980, we were given about a two hour presentation by Met-Ed's human factors consultants. They discussed preliminary findings of their control room assessment which had been underway several months prior to our CRDR visit. Many of the human factors design deficiencies noted during our design review were identified and discussed by Met-Ed's human factors consultants. The staff's CRDR included an evaluation of control room layout, the adequacy of the information provided, the arrangement and identification of important controls and instrumentation displays, the usefulness of the audio and visual alarm systems, the information recording and recall capability, lighting, and other considerations of human factors that have an impact on operator effectiveness. This review was performed by means of detailed inspection of the control panels, interviews with operators,

and observation and videotaping of operators as they walked through selected emergency procedures. A number of the human factors design deficiencies noted during the NRC review, and identified by Met-Ed's human factors consultants, were in the process of being corrected at the time of our review.

On October 10, 1980, the NRC staff met with the licensee at the office of their human factors consultant, MPR Associates. They and their consultant made a presentation on the status of their ongoing control room design review, and also discussed the NRC control room design review report transmitted to the licensee on September 16, 1980 (Appendix I). The licensee was not prepared to discuss the actions they would take to correct the deficiencies identified in the September 16th NRC report. The licensee stated that its response to the NRC report would be forthcoming within two weeks. On October 27th, we received a copy of the licensee's draft response to our September 16, 1980 report. The licensee's final response was received on November 7, 1980, and additional discussions were held with the licensee through early December, 1980.

B. POSITIVE DESIGN FACTORS OBSERVED DURING THE NRC CONTROL ROOM DESIGN REVIEW

Although our review identified some human factors design deficiencies, in general, we found that the control room was designed to promote effective operator actions. Some positive design factors are as follows:

In most instances, the annunciator planels are located above systems panels which they monitor.

The ambient background noise level is low.

Left to right and top to bottom organization of controls and displays are generally consistent with plant and stereotypical convention.

The normal lighting of the main control console is good.

The control panels are generally not overcrowded with controls and displays.

Switches on the SS-1 panel are all guarded against inadvertent actuation.

The process computer alarm will sound until an operator acknowledges the alarm.

The alarm and utility printers provide clear legible displays.

C. DEFICIENCIES IDENTIFIED IN THE CONTROL ROOM DESIGN REVIEW

The review team identified a number of human factors deficiencies which were documented in a draft report which was transmitted to the licensee (letter of September 16, 1980, to Mr. R. C. Arnold from Mr. Robert W. Reid). The draft report categorized the deficiencies as to their importance. On October 10, 1980, a meeting was held with the licensee and his consultant to discuss the draft report. The licensee raised concerns about the staff's scheme for categorizing the importance of control room deficiencies. We agreed to consider the licensee's concerns regarding the categorization scheme.

The draft report categorized the deficiencies as follows:

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.

The licensee questioned the categories in that the level of concern was based only on the consequence of human error and not on both the potential for human error and the consequence. In categorizing the deficiencies we did consider both the potential for error and the consequence of the error, however, we agree that the category definition given in the draft report did not clearly state the categories actually used. We concluded that the TMI-1 deficiencies had been properly categorized but the following more clearly described the categories:

> Observed human factor design deficiencies were given a priority rating of one to three, (high, moderate, low), based on the increased potential for operator error and the possible consequences of that error.

The licensee transmitted its response to the staff's September 16th draft report on November 7, 1980. The staff considered the licensee's response in its safety evaluation and in arriving at the corrective measures required.

The required corrections of control room deficiencies are discussed below. We require correction of most of these deficiencies prior to restart. The schedule for required corrections permitted later than restart is indicated.

Some deficiencies will need further analysis to arrive at permanent or optimum solutions. We will require the licensee to commit to address these deficiencies as part of their detailed control room design review required by Item I.D.1, and will expect final resolution of these deficiencies on a schedule to be proposed by the license as part of the detailed review. The nature of these deficiencies or temporary solutions that are required before restart are such that they present no significant safety risk that would preclude restart and full power operation. In addition to any deficiencies the licensee may identify as a result of its detailed control room design review the licensee will be required to address the deficiencies identified in the staff's draft report as category 3 items.

Category 3 items have been omitted from this report, however, they will be discussed and reported on in the licensee's detailed control room design review report which will be completed in accordance with the provisions of NUREG-0737. Items 6.k and 11.b of the September 16th draft report (Appendix I) have been omitted from this report as a result of clarification of 6.k by the licensee, and because 11.b is being covered in the procedures review. Items concerned with the shift supervisors office (10.a and 10.b) and the technical support center (13.a and 13.b) are not addressed in our report because of their dated requirements and the fact that construction of these areas is not far enough along for us to evaluate.

Deficiencies to be Corrected Prior to Restart

In the list of deficiencies to be corrected prior to restart which follows, paragraph numbers which are not comparable to the numbers used in the September 16, 1980 staff report are identified.

1. Annunciators and Alarms

a. The licensee's system lacks a separate acknowledge/silence control and permits operators to acknowledge alarms without reading alarm windows.

The licensee is evaluating an alarm system with a separate acknowledge and silence control which would permit saving the flashing tiles (last alarm received) for diagnostic purposes. The evaluation and final resolution of the alarm system deficiencies will be addressed in the licensee's detailed control room design review report for NRC review and approval.

In the interim, the licensee will ensure that alarms are not acknowledged until operators have reviewed and understood the significance of each alarm and flashing tile. This will be accomplished either by administrative procedure or operating procedure.

b. There is minimal annunciator prioritization. Some blue markings on ESAF alarm tiles are not readily identifiable.

The licensee will review each alarm for importance and the response required for each. The window tiles for the important safety alarms will be color coded. In addition, the tiles associated with the Engineered Safeguards Actuation System (ESAS) which have blue colored corners will be improved to aid operators by decreasing the search time necessary to identify such window tiles.

c. Some annunciator tiles have busy legends.

Safety significant window tiles with crowded legends and small print font will be replaced.

2. Process Computer

a. The CRT display was of poor quality and could increase the probability of reading error.

A new CRT display system will be installed in the control room.

b. The process computer capability is limited and its vintage raises the question of reliability of information presented to operators.

A new printer capable of providing more current information will be installed. In addition a new process computer will also be installed. The new computer will not be fully operational prior to restart, however, some functions, which will back up feactures of the original computer, are expected to be operational.

3. Controls (General)

a. A number of controls (J handle, etc.) located near the front edge of the operating console could be inadvertently activated.

A guard rail or an alternative means will be provided to protect against inadvertent actuation of "J" handle or other switches located near the front edge of the control console.

b. Set point knobs on Bailey controllers do not lock, and can be accidently rotated.

The licensee will emphasize during operator training and retraining the need to frequently check controller set point knob settings. Final resolution of this deficiency will be addressed in the Licensee's DCRDR report.

c. Plant convention is violated for auto/manual positions on some multiple position rotary controls (Sync. Scope and Voltage Regulator).

The licensee will implement an improved labeling program which will compensate for problems associated with violation of convention concerning multiple position rotary controls.

d. Legend switch covers are interchangeable.

The licensee will implement a program either through administrative or operating procedures, to lessen the possibility of interchanging switch covers. Final resolution of this deficiency will be addressed in the Licensee's DCRDR report.

e. Legend indicators contain numerous burned out bulbs.

A formal surveillance program will be implemented to detect and replace burned out indicator lamps for panels which do not have a lamp test capability. Final resolution of this deficiency will be addressed in the Licensee's DCRDR report.

f. Many illuminated legend switches are difficult to read.

Improved labeling will be installed which will lessen the operator's dependence on information contained on illuminated legends. Illuminated legends important to safety, which are difficult to read, will be replaced.

g. Bailey controllers indicate demand signal rather than valve position (3.h)*

The licensee will emphasize during operator training and retraining that controller indicators display the controller demand signal, rather than actual valve position. In addition, the licensee will improve labeling of the controllers, the meter selector switches, and certain controller meter scales. Final resolution of this deficiency will be addressed in the Licensee's DCRDR report.

Emergency feedwater flowmeters will be installed in the immediate vicinity of the controllers, and, near backup manual controllers, which will be added.

*References are to the HFEB Report transmitted to the licensee on September 16, 1980.

4. Displays (General)

Panel legend lights do not provide positive status indication because of poor contrast with panel background.

Panel legend lights will be adjusted and replaced to provide consistency of illumination and improve contrast with the panel background. If necessary, certain green colored tiles will also be replaced to improve contrast.

b. Glare is present on all vertical indicators resulting in reduced readability.

Light baffles or other means will be used to reduce light glare on vertical meters. In addition, new label plates which are not affected by glare will be installed.

c. Normal operating ranges or set points are not indicated on vertical meters.

Normal operating ranges or set points will be indicated on meters which have safety significance, where normal range/set point information can be identified.

d. Most meters fail at mid-scale position (4.e)*.

A system of annunciators and indicators to signal upsets in the power supplies to the ICS and NNI control systems will be installed. In addition, a distinctive mark to identify the mid-scale point will be placed on instruments to assist operators in identifying instrument failures.

e. For some motor driven valves, an open circuit breaker inhibits valve position indication because indicators are powered from the bus that the breaker drops (4.f)*.

A second independently powered position indication circuit is provided for certain valves to show valve position after the circuit breaker for a particular motor driven valve is tripped.

f. 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 (4.h)*

Same requirement as for Item 3.f.

g. No lamp test capability on control boards or panels. (4.i)*

Same requirement as for Item 3.e.

5. Labeling (General)

a. Color meaning is not consistent.

The licensee will utilize color codes which are consistent.

b. In general, labels are used only at the component level, not at the group, function, system, or panel level. (5.c)*

The licensee will provide for a hierarchial scheme of labeling.

c. The use of color labels is not consistent, for example, black/white background and print. (5.d)*

Same requirement as for Item 5.a.

d. Makeshift labeling was observed on many components including penciled on switch nomenclature, hand lettered labels and vertical meter scale values and the use of dymo tape. (5.e)*

Makeshift labels will be replaced with permanent label plates with consistent color coding and letter size.

e. Labels are not all permanently attached. (5.f)*

All labels will be permanently attached.

f. Little or no use of demarcation lines to separate systems, subsystems, functional grouping, etc. (5.g)*

Demarcation will be added to panels to separate controls/displays by system, subsystem and functional grouping.

g. Labels are wordy, because the function of a system is repeated on each switch of a group. (5.h)*

Implementation of a hierarchial system of labeling as noted in 5.a and improved labeling will provide operators with clear readable labels.

6.0 CONTROL DISPLAY RELATIONSHIP

6.1 General

Related controls and displays do not consistently have both nomenclature and component designation.

The licensee will assure that related controls and displays will be consistently labeled.

6.2 Makeup and Purification System:

a. Makup pumps are not grouped together.

The licensee will assure through effective labeling and demarcation that the relationships between the two control/display segments are clearly distinguishable.

b. Lacks positive indication of flow when makeup pump is running in the make-up mode.

Individual makeup pump flow indication is not provided, however, an indication of total makup pump flow is provided.

The licensee will assure through training and retraining that operators need to observe flow transients when a makeup pump is started.

c. 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). (6.2e)*

The required reading of 3 gpm, from the makeup system operating procedure, is accomplished locally on a meter which has a scale of 0 to 4 gpm. This will be made clear in the procedure.

d. Letdown flow meter is in gpm while scale on controller is in percent and must be converted before setting. (6.2g)*

The conversion between flow rate and valve position is not important because the operator will adjust valve position based on the flow meter reading to achieve desired flow rates rather than by adjusting for valve position. Therefore, this is not now considered a deficiency.

e. There is no Engineered Safeguards/Safety Injection annunciator window. (6.2h)*

The Engineered Safeguards System activation is currently indicated by a mislabeled alarm window. This will be corrected.

f. Engineered Safeguards Actuation Panel has blue status lights which are difficult to interpret as being "on". (6.2i)*

The ESAF panel blue status lighted windows will be modified to improve brightness and contrast for easier operator identification.

g. Valve positions (containment isolation) at bottom of Engineered Safeguards Actuation Panel cannot be seen from main console. There appeared to be no color sequence or pattern to help check which valves should be opened or closed. (6.2j)*

Valve position indications at the bottom of the ESAF panel are repeated on the upper ESAF panel section and therefore are not required to be read by an operator in front of the operator's console. The blue/yellow indicator lights used on the upper panel provide the operator information that is needed to determine whether the Engineered Safeguards positions are achieved. Therefore, this is not now considered a deficiency.

h. DHR temp and DHR cooler temp indicators are side by side but have different scale multipliers. (6.2l)*

The meter scales for the decay heat removal temperature indicators will be changed to be consistent.

i. DH, 5, 6, 7 valve controls are not included in mimic. (6.2n)*

The decay heat removal system mimic will be completed and the connection between the decay heat and makeup systems will be indicated.

6.3 HVAC System:

a. No separation or demarcation of grouped J Handle control switches (9 in a row).

Grouped controls and displays associated with control room ventilation will be functionally grouped through the use of demarcation lines and new labels. The remainder of the HVAC system labeling and demarcation will be completed on a schedule to be proposed by the Licensee as part of the detailed review.

b. 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.). (6.3d)*

Labels which include the time to depress and hold information for fan start controls will be provided.

7.0 SOUND LEVELS

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.

The process computer printers have been replaced with units which are approximately 8 dbA quieter than the original printers. Therefore, this item is no longer considered a deficiency.

b. Main control board alarm is below ambient noise level.

c. Panel Left (PL) alarm is only 1 dbA above ambient noise level.

d. Right Panel Front (RPF) alarm is only 1 dbA above ambient noise level.

e. Liquid Waste System alarm is below the ambient noise level.

The alarm levels for the main control board, panel left, right panel front and the liquid waste system alarms will be adjusted so that they will be from 6 to 10 dbA above the ambient noise.

8.0 OTHER OBSERVATIONS

a. Diesel Generator Governor has no indication on J handle switch for fast/slow speed control switch is inconsistent with other speed controls.

The yellow indicator lights which indicate "idle" and "high" speeds will be changed to white indicator lights. New labels will be added that will contain the speed control information.

b. On DHR system, controls for loop A and B were not associated with their displays which are located approximately 8 feet away. (8.c)*

c. One DHR indicator and control switch which are part of loop A panel are located on loop B panel. (8.d)*

Relabeling, color coding and demarcing will be used on the DHR system controls and displays to make their functions and relationships clearer to operators.

d. Discrimination between systems and subsystems is difficult because of lack of use of demarcation lines and color coding. (8.e)*

Color coding and demarcation lines will be added to aid in discriminating between systems, subsystems and functional grouping of controls and displays.

e. Auxiliary Feedwater system lacks a flow meter. (8.f)*

A flow meter for the auxiliary feedwater system will be installed.

f. Control/Display arrangements for the ICS (feedwater, steam level) are not apparent. (8.h)*

Improved labeling, color coding and demarcing of the ICS controls and displays will be added to improve their relationships.

9.0 REMOTE SHUTDOWN PANEL (RSP)

a. The panel is not independent of the Control Room - all actions other than the starting and stopping of RC pumps are required to be performed in the control room and local areas of the plant.

A newly designed remote shutdown panel and a revised emergency procedure using the new panel for cool down operation independent of the control room will be implemented.

b. Emergency lighting is not provided at this panel.

The remote shutdown panel will be provided with emergency lighting.

c. Communication from the RSP is by sound powered microphone with no microphone/head set located in the area.

A sound powered microphone/headset will be permanently available at the remote shutdown panel. To provide additional communications capability available in the Technical Support Center (TSC), keys to the TSC will be available in the control room, from the shift supervisor and from the person on duty responsible for the TSC.

d. No scott-air packs are provided at the RSP.

Scott air packs will not be needed in the RSP area during emergencies because habitability of the area is assured by the air recirculation system. Therefore, this item is not considered to be a deficiency.

10.0 COMMUNICATIONS IN THE CONTROL ROOM

a. Sound powered microphones/headsets are not readily available. (11.b)*

Two sets of sound powered microphones/headsets are kept in the computer cabinet in the control room. This will be emphasized to control room operators.

b. There are weaknesses in the radio communications system when communicating with a technician outside the CR area. (11.c)*

The plant paging system will be used for in-plant communications, the two-way radios will not be used. However, the licensee is studying the overall communications system at TMI-1 to determine improvements that can be made and will report on its findings in the detailed control room design review report, expected to be completed by the end of 1982.

c. There are some inoperable page telephones in the plant area. Some areas in the plant are not reachable by telephone. (11.d)*

Inoperable page telephones in the plant area will be repaired. Areas in the plant that should have paging system telephones will

be identified and phones will be installed. The plant paging system will be included in the licensee's study discussed in Paragraph 10.b above.

11.0 OPERATOR EMERGENCY EQUIPMENT

11.a Three Scott Air Packs are kept in the CR, however, during emergency operations there are eleven people planned to be in the CR. (12.a)*

Scott Air Packs are not required for operator use in the control room. Habitability of the control room is assured during emergency conditions by the control room air recirculation system. However, the units kept in the control room will be available for use by operators in the control room if needed.

12.0 EMERGENCY PROCEDURES

a. Immediate action steps in some procedures are too detailed and some require an excessive number of steps to be completed immediately. (14.a)*

b. Some immediate action steps which require two operators to implement are not so noted. (14.c)*

c. Some procedures, have "notes" which are actually immediate action steps. (14.d)*

d. Some procedures reference control and display labels which have functions different from the functions actually used on the labels. (14.e)*

These items will be corrected in the course of the review required by the letter from D. G. Eisenhut to R. C. Arnold, dated November 25, 1980.

Although these items were identified during our control room review, they will be considered in the course of the procedures review required by Item I.C.8, as identified in the letter from D. G. Eisenhut to R. C. Arnold, dated November 25, 1980.

13.0 LIGHTING

a. Normal and emergency lighting was not specifically designed for reading labels, displays and meters, i.e., problems with contrast, glare and illumination levels. (15.a)*

b. Direct glare from overhead lights on both controls and displays make readability difficult. (15.b)*

The licensee's lighting survey indicated that normal control room lighting levels are consistent with recognized standards (MIL-STD-1472B and IES Lighting Handbood). Glare problems associated with normal lighting are discussed in paragraph 4.b. Emergency lighting levels will be increased where needed and light fixtures will be moved to positions that will assure adequate illumination of controls and displays. Also, light baffles or other means will be utilized where necessary to reduce direct glare caused by the emergency lighting system.

c. No lighted exit sign in the control room. (15.c)*

A lighted exit sign is not needed in the control room because the control room will be illuminated for all anticipated situations. Therefore, this item is not considered to be a deficiency.

14 GENERAL COMMENTS

a. No formal system exists for providing operators feedback about suggestions made. (16.a)*

The licensee has a formal system by which operators receive feedback on suggestions made, through the operator's filing of a GPU Problem Report. Therefore this item is not considered to be a deficiency.

b. Sub-cooling instrumentation is not in place and operating. (16.b)*

Sub-cooling margin instrumentation and displays will be installed and operating.

c. In-core thermocouples (tc_s) have been connected to the process computer, a monitoring program (software) has been written and the system is in the checkout process. The applicant's system contains 52 in-core thermocouples with readout range up to 2300°F. Thermocouple information will be displayed on the Bailey computer console by use of a CRT, and hard copy printed on demand. A back-up system display with a capability for selective reading of a

minimum of 16 operable thermocouples, 4 from each quadrant, all within a time interval no greater than 6 minutes, powered from a power source independent of the process computer/CRTs will be required prior to restart. (16.c)*

The NRC will audit the TMI-1 control room to assure all corrective actions are implemented prior to restart.

D. CONCLUSIONS

Based on our review of the licensee's submittals and other clarifying information, we conclude that with the corrections required prior to restart, the potential for operator error leading to serious consequences as a result of human factors considerations in the control room is sufficiently low to permit restart of TMI-1.

We require the licensee to address deficiencies needing further analysis for optimum selections as part of the detailed control room design review required by Item I.D.1 of NUREG-0737, and will expect final resolution of these deficiencies on a schedule to be proposed by the licensee as part of the detailed review, and submitted for NRC approval.

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

APPENDIX I

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,

Robert W. Reid, Chief
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Draft

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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)

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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 accidently 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)

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 consistant. (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 runni[illegible]. (Category 2)

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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 of demarcation of grouped 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)

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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

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 inconsistant 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 2).

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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 symptons 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.

NRC FORM 335 (7.77)

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER (Assigned by DDC)
NUREG-0752

4. TITLE AND SUBTITLE (Add Volume No., if appropriate)
NUREG-0752
Control Room Design Review Report for TMI-1

2. (Leave blank)

3. RECIPIENT'S ACCESSION NO.

7. AUTHOR(S)

5. DATE REPORT COMPLETED
MONTH December YEAR 1980

9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
Office of Nuclear Reactor Regulation, Division of Human Factors Safety / Division of Licensing

DATE REPORT ISSUED
MONTH December YEAR 1980

6. (Leave blank)

8. (Leave blank)

12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code)
U. S. Nuclear Regulatory Commission
Washington, DC 20555

10. PROJECT/TASK/WORK UNIT NO.

11. CONTRACT NO.

13. TYPE OF REPORT

PERIOD COVERED (Inclusive dates)

15. SUPPLEMENTARY NOTES

14. (Leave blank)

16. ABSTRACT (200 words or less)

Based on our human factors engineering review and evaluation of the TMI-1 control room, we conclude that correction of the deficiencies herein identified and discussed prior to restart will permit safe operation of the TMI Unit 1 nuclear plant. Prior to restart, we will arrange to audit the control room to ensure all human factors engineering improvements are implemented.

17. KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

17b. IDENTIFIERS/OPEN-ENDED TERMS

18. AVAILABILITY STATEMENT
No restrictions on distribution.

19. SECURITY CLASS (This report)

21. NO. OF PAGES

20. SECURITY CLASS (This page)

22. PRICE
$

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
METROPOLITAN EDISON COMPANY, ET AL.	)	Docket No. 50-289
	)	
	)	
(Three Mile Island, Unit 1)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF TESTIMONY IN RESPONSE TO CONTENTIONS," dated December 22, 1980, in the above-captioned proceeding, has been served on the following, by deposit in the United States mail, first class, or, as indicated by an asterisk through deposit in the Nuclear Regulatory Commission's internal mail system, this 22nd day of December, 1980:

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