ENCLOSURE

DETAILED CONTROL ROOM DESIGN REVIEW

SUMMARY REPORT EVALUATION FOR

DRESDEN STATION, UNITS 2 AND 3

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FOREWORD

This Summary Report Evaluation (SRE) was prepared by Science Applications International Corporation (SAIC) under contract NRC-03-82-096, Technical Assistance in Support of NRC Licensing Actions: Program III. The evaluation was performed in support of the Division of Human Factors Safety, Human Factors Engineering Branch (HFEB). HFEB previously evaluated Commonwealth Edison Company's (CECo's) generic Program Plan for conducting Detailed Control Room Design Reviews (DCRDRs) at all of their nuclear stations, including Dresden Station, Units 2 and 3. Because the CECo Program Plan provided insufficient details, the NRC staff met with CECo on June 14, 1983 where additional information was provided to describe CECo's Program Plan. NRC evaluative comments were prepared and transmitted to the licensee on July 11, 1983. An in-progress audit was also conducted at this plant, in February 1984. No pre-implementation audit was conducted at Dresden Station, however, the NRC did audit another CECo plant, Quad Cities, Units 1 and 2. This report includes the SAIC evaluation of the Detailed Control Room Design Review (DCRDR) for Commonwealth Edison Company's Dresden Station, Units 2 and 3, and information provided in the previously submitted Program Plan, and during the in-progress audit at Dresden, and the pre-implementation audit at Quad Cities Stations.

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This report documents the findings from an evaluation of the DCRDR Summary Report submitted to the Nuclear Regulatory Commission (NRC) in May 1985, by Commonwealth Edison Company for the Dresden Station, Units 2 and 3 Detailed Control Room Design Review (DCRDR) (Reference 1). The review by CECo at Dresden was conducted in accordance with a generic Program Plan submitted to the NRC in March 1983 for performing DCRDRs for all of CECo's nuclear stations (Reference 2). The CECo Program Plan had insufficient details addressing the processes to accomplish the DCRDR objectives; therefore, the NRC staff met with CECo on June 14, 1983 in order to obtain additional information to describe CECo's Program Plan. NRC staff reviewed the Program Plan and forwarded their comments to Commonwealth Edison on July 11, 1983 (Reference 3). A result of the staff review of CECo's generic DCRDR Program Plan was the decision to conduct an in-progress audit of this process to ensure that CECo was not proceeding with an inadequate program and to provide CECo with feedback on their approach. The in-progress audit was conducted at CECo's Dresden Units 2 and 3 since these were the first units to which CECo's DCRDR process was applied. Results of the NRC in-progress audit at Dresden, Units 2 and 3 conducted January 31 through February 2, 1984, were transmitted to CECo on March 6, 1984, (Reference 4). While no pre-implementation audit was conducted at Dresden Station, the NRC did perform such an on site audit at another CECo plant, Quad Cities Station, Units 1 and 2. This audit was conducted on June 10-13, 1985. Since both Quad Cities Station and Dresden are using the same basic review process for the DCRDR, this report will reference the Quad Cities pre-implementation audit (Reference 5) when appropriate.

Results of the SAIC evaluation follow a brief overview of the background leading up to the DCRDR Summary Report.

BACKGROUND

Licensees and applicants for operating licenses are required to conduct a Detailed Control Room Design Review (DCRDR). The objective is to "...improve the ability of nuclear power plant control room operators to

prevent accidents or cope with accidents if they occur by improving the information provided to them" (NUREG-0660, Item I.D) (Reference 6). The need to conduct a DCRDR was confirmed in NUREG-0737 (Reference 7) and in Supplement 1 to NUREG-0737 (Reference 8). DCRDR requirements in Supplement 1 to NUREG-0737 replaced those in earlier documents. Supplement 1 to NUREG-0737 requires each applicant or licensee to conduct its DCRDR on a schedule negotiated with the NRC. Guidelines for conducting a DCRDR are provided in NUREG-0700 (Reference 9) while criteria for NRC evaluation of a DCRDR are contained in NUREG-0800 (Reference 10).

A DCRDR is to be conducted according to the licensee's own Program Plan (which must be submitted to the NRC). According to NUREG-0700, it should include four phases: (1) planning, (2) review, (3) assessment, and (4) reporting. The product of the last phase is a Summary Report which must include an outline of proposed control room changes, their proposed schedules for implementation, and summary justification for human engineering discrepancies (HEDs) with safety significance to be left uncorrected or partially corrected. Upon receipt of the licensee's Summary Report and prior to implementation of proposed changes, NRC must prepare a Safety Evaluation Report (SER) indicating the acceptability of the DCRDR (not just the Summary Report). The NRC's evaluation encompasses all documentation as well as briefings, discussions, and audits if any were conducted.

The purpose of this Summary Report Evaluation is to assist the NRC in the technical evaluation process by providing an evaluation of the Dresden Station DCRDR process and results.

The DCRDR requirements as stated in Supplement 1 to NUREG-0737 can be summarized in terms of nine specific issues, a list of which provides a convenient outline of the areas covered in this technical evaluation. The nine issues are:

1. Establishment of a qualified multidisciplinary review team.

2. Use of function and task analyses to identify control room operator tasks and information and control requirements during emergency operations.

3. A comparison of display and control requirements with a control room inventory.

4. A control room survey to identify deviations from accepted human factors principles.

5. Assessment of human engineering discrepancies (HEDs) to determine which HEDs are significant and should be corrected.

6. Selection of design improvements that will correct those discrepancies.

7. Verification that selected design improvements will provide the necessary correction.

8. Verification that improvements can be introduced in the control room without creating any unacceptable human engineering discrepancies.

9. Coordination of control room improvements with changes resulting from other improvement programs such as SPDS, operator training, new instrumentation, Reg. Guide 1.97, and upgraded emergency operating procedures.

PLANNING PHASE

1. Preparation and Submission of a Program Plan

The NRC staff reviewed Commonwealth Edison Company's generic Detailed Control Room Design Review Project Program Plan submitted for all of their nuclear stations including Dresden Station, Units 2 and 3. The NRC staff met with CECo on June 14, 1983, where additional information was provided that described the DCRDR process to be used by CECo. The NRC reviewed the Program Plan with reference to the requirements of Supplement 1 to NUREG-0737 and the guidance contained in NUREG-0700 and NUREG-0800 and transmitted comments to CECo by memo dated July 11, 1983. A result of that review was the decision to conduct an in-progress audit at the first plant to which the DCRDR process was to be applied, Dresden 2 and 3.

2. Establishment of a Qualified Multidisciplinary Review Team

Both the Program Plan and the Summary Report for Dresden Station included a description of the staffing and management that were established to conduct the Control Room Design Review. The structure and management of the DCRDR appeared to be flexible enough to permit a multidisciplinary effort. Management and administration of the CECo DCRDR at Dresden Station was the responsibility of the Technical Services Nuclear Department. Within this department, the DCRDR Program Administrator reported to the Technical Services Nuclear Department Manager who reported directly to an Assistant Vice President and hence to a CECo Executive Vice President.

The Dresden DCRDR team consisted of a group of professionals from CECo and Advanced Resource Development Corporation (ARD) with a wide range of skills necessary for the performance of the DCRDR. As indicated by resumes provided in Appendix C of the Summary Report, the eleven members of the core team appeared qualified to perform DCRDR activities. Expertise of the team included:

- instrumentation and control engineering
- engineer/architect with control room design experience
- operations
- human factors engineering.

Nine subject matter experts (SMEs) were available to work on the project as needed. They provided the appropriate level of plant design and operational knowledge.

The skill mix of the team is consistent with the guidance provided in NUREG-0800. Furthermore, it appears that the review team, as established, did have the freedom to carry out the review and access records, information, and facilities as needed. A task assignment summary matrix was presented at the Quad Cities pre-implementation audit on June 11, 1985 that indicated which team specialists were involved with each of the different phases of the DCRDR project. It indicated that the necessary skills were available and that they were properly utilized. A similar task assignment matrix for the review team at Dresden Station should be documented and submitted to the NRC for review.

In summary, it appears that CECo has met the requirement of establishing a qualified multidisciplinary review team, pending submittal of documentation indicating task assignment and levels effort for each team member.

REVIEW PHASE

CECo review phase plans and activities included:

1. Historical event review and review of operating experience

2. Task analysis

3. Control room inventory

4. Verification of task performance

5. Validation of control room functions

6. Control room survey.

The above activities are those recommended by NUREG-0700 guidelines as contributing to the review phase objectives. Activities 2, 3, 4, and 6 contribute to the accomplishment of specific DCRDR requirements contained in Supplement 1 to NUREG-0737. Activities 1 and 5 are recommended by NUREG-0700 guidelines.

1. Review of Operating Experience

A review of operating experience is not explicitly required by NUREG-0737, Supplement 1. However, it is an activity recommended by NUREG-0700 as contributing to the accomplishment of review phase objectives.

CECo conducted a two-part operating experience review at Dresden Station to identify conditions which impact probability for those operator errors which could affect safe operation of the plant. The first part of the effort, the historical event review, included a review of the operating history of the plant to document recurring problems and an examination of

generic industry-wide problems applicable to the plant. The second part of the review, the operating experience review, included the conduct of an operator survey and interviews with operators to obtain feedback based on previous operating experience.

To accomplish the review of plant operating history and industry-wide experience, five sources of historical reports were collected and reviewed. In-house documentation including Dresden Licensee Event Reports (LERs), Dresden Deviation Reports (DVRs), and Dresden Professional Committee Reports (PROs) for six years were reviewed by a Human Factors Specialist (HFS). Industry-wide Significant Event Reports (SERs) and Significant Operating Event Reports (SOERs) for the past five years also were reviewed by the HFS. All reports collected were reviewed to identify those reports that involved control room operator, procedural and/or control board equipment failure and/or design arrangement errors. Over 1,500 reports were reviewed and found relevant to Dresden Station.

Criteria were developed for analyzing the above-mentioned reports to identify and prioritize those reports which documented a control room problem as defined by specified criteria. Each high priority report that described a problem relevant to the control room was investigated to determine if the problem already had been adequately addressed from a human factors perspective. If the problem had not been adequately addressed and additional human engineering corrective action could be taken to minimize the probability of the problem recurring, a control room Human Engineering Discrepancy form (HED) was completed. Using this process, six problems were evaluated as uncorrected and had HEDs written, resulting in a very thorough and productive historical review.

The Dresden operator survey effort entailed administration of an open-ended, self-administered questionnaire to staff members, including non-licensed operations personnel, licensed operations personnel, and licensed non-operations personnel at Dresden. The survey was structured to address the nine content areas suggested in NUREG-0700. The objective of the survey was to obtain special, pertinent knowledge that operating personnel at the Dresden plant possess regarding both positive and negative control room system features which they had experienced and/or observed in the course of preparing for operations or during operations. Personnel were also asked to

provide background/biographical information. The effort put into this survey instrument produced a useful tool for the review process.

Ninety-one surveys were mailed out for completion. Thirty-eight (41%) were returned by mail to CECo and given to the HFS unopened. Confidentiality was assured by assigning each questionnaire a number. The list of potential respondents and corresponding numbers were kept in confidence by HFS personnel.

As some information relevant to operator experience could not be solicited easily by using a structured questionnaire approach, individual semistructured interviews also were conducted by the HFS with selected plant personnel. The licensee has not identified the interviewer and has not provided information to describe the number or characteristics of operators that were interviewed. The objectives of the follow-up interviews were: (1) to clarify ambiguities in an individual's written responses to the self-administered questionnaire; and (2) to gather additional details pertaining to that individual's responses.

Once interview data were collected, all information from the completed survey activities were compiled, reduced, and analyzed. Findings, written as prospective HEDs, later were reviewed during the assessment process. Forty-three HEDs were identified as a result of the survey activities.

In summary, CECo's operating experience review at Dresden appears extensive, thorough, and appropriately conducted. Consistent with NUREG-0700 objectives and guidelines, it entailed a systematic examination of industry-wide reports and plant-specific documents. Structured questionnaires and semistructured interviews were administered to and conducted with a range of operating personnel. The two activities conducted resulted in the identification of 49 HEDs which were not identified as a result of other DCRDR activities.

2. System Function and Task Analysis

Since Dresden and Quad Cities used the same process for this phase of the DCRDR, comments in this section reflect both the Dresden Summary Report and the pre-implementation audit at Quad Cities.

The objective of the Dresden system function and task analysis was to establish the input and output requirements of control room operators' tasks under emergency conditions. To accomplish this, the generic Boiling Water Reactor Owner's Group (BWROG) Emergency Procedure Guidelines (EPGs) were made plant-specific by subject matter experts who eliminated references to those systems and equipment not found at Dresden. Once the site-specific document was developed, operator actions which were implied or stated were written as task statements. All unique tasks were identified, coded with a task number, and grouped into the prevailing system being exercised or acted upon.

The tasks subsequently were broken down into task elements and/or action steps by subject matter experts (SMEs) in order to reflect a step-by-step procedural set of actions that must be carried out in order to accomplish the task. These task reduction activities were accomplished by a series of questions about each task such as task conditions, initiating cues, frequency performed, and performance criteria were asked in order to provide additional information about task performance which gave the subject matter experts a context in which to discern operator tasks. This information was first collected on task development forms, later entered in a database, and then sorted by task number. This process resulted in the development of the primary data base for the entire DCRDR.

This process was performed outside the control room as much as possible. As described by the licensee, the task analysis performed for DCRDR purposes was not done from a "what exists" perspective, but rather from the perspective of "what should be." However, the proximity of procedures, piping & instrument diagrams, electrical schematics, additional expertise and cues which would enable the SMEs to be more thorough, necessitated frequent referral to resources which could have compromised the independence of the analysis effort. While this process was not accomplished completely independent of the control room, the DCRDR team members, in an iterative process, continued to probe SME responses to ensure that their responses reflected "what should be" as opposed to "what exists" in the control room.

While task development was underway, display and control requirements were collected and coded on Task Analysis Instrument and Control Requirement Forms for each action step. Like the task elements, the display and control

requirements were coded from a "what is needed" perspective for action steps. Coded variables included: displayed parameter and type of display, manual control type and action, automatic controller type, parameter units, range, and division. After the requirements of the action steps had been defined by the SMEs, the availability phase of the verification process was performed by checking for the existence of required instrumentation in the control room. If the required instrumentation were found to be present, then a code number representing that particular item was entered onto the data recording sheets confirming the availability of the required instrumentation. However, if the required displays or controls did not match what was physically available in the control room, this was coded on the data collection form as a discrepancy or "no match". Many HEDs were identified as a result of this process.

Overall, CECo's system function and task analysis was conducted in a comprehensive and systematic fashion. The analysis was based on the BWROG's EPGs which were made site-specific, by the deletion of equipment and systems that were not applicable to the Dresden Station. Task statements derived from the site-specific document were reduced to task elements which were further reduced to action steps necessary to accomplish each task. Information and control requirements and their associated characteristics were derived for each action step. After the SMEs had defined the instrument and control requirements for each action step, they were compared to existing control components and a code number corresponding to applicable existing control room components was assigned to the action step. During the conduct of this analysis, SMEs were able to use schematics, procedures, and other aids from the control room to "enable SMEs to be more thorough."

The primary factor that indicated that these "in control room" task analysis steps did not bias the results of the analysis was the existence of numerous "no-matches" which often resulted in HEDs. The HFS also lead the SMEs taking part in the analysis with appropriate questioning to make sure that they did not bias their requirements-based analysis through their familiarity with the installed equipment. The process described above resulted in an integrated task analysis and inventory comparison rather than two isolated steps. In this instance, the procedure described above appears to be one of the better task analyses conducted in the industry.

3. Control Room Inventory

The Dresden inventory effort included compilation of an inventory followed by verification of task performance. As both activities were necessary to satisfy the inventory requirement of Supplement 1 to NUREG-0737, both are described below.

The objective of the Dresden control room inventory was to establish a reference set of data which identified all instrumentation, controls, and equipment within the control room for comparison with the equipment requirements identified during the task analysis. All displays, controls, controllers, annunciators, and other equipment in the control room with which the operators interact were included in the very comprehensive inventory. Consistent with NUREG-0700 guidelines, human factors specialists and nuclear systems operators compiled the inventory using direct observation in the control room, and instrumentation diagrams of the control room panels.

All equipment on the front panels, back panels, and common panels for Dresden Units 2 & 3, as well as equipment on the desks and other workstations in the center area of the control room were inventoried. Each piece of equipment on the control boards and its relevant characteristics were identified by codes that had been used to characterize equipment requirements from the task analysis. Inventory data was stored in the computerized data base management system.

Once this was accomplished, a verification of equipment availability and suitability was accomplished. The objective of the verification process was to ensure that operator tasks derived from the plant-specific EPGs could be performed in the existing control room with minimum potential for human error.

There were two aspects to the verification process. First, it was determined whether appropriate equipment was available in the control room to perform each task required by emergency operations. This availability check was performed immediately after the task analysis, resulting in a confirmation (match) or nonconfirmation (no match) that was then entered directly onto the task analysis form. Second, for equipment that had been identified as available, criteria specified on pages 6-33 through 6-35 of

the Summary Report were used to determine whether the characteristics of each piece of equipment made it suitable for the task (whether it offered the operator sufficient control and display capabilities to accomplish the task efficiently). This latter step, performed by using the computer system, compared the characteristics identified during the task analysis phase and the control room inventory. Any "no match" items were noted as deviations and an effort was made to resolve these discrepancies. Those deviations that could not be resolved were recorded as HEDs.

Overall, CECo has provided a detailed description of what appears to have been a well-planned and executed control room inventory. The inventory itself was extremely comprehensive and numerous HEDs were identified as a result of comparison of the control room inventory with task analysis results. The documentation process and data management system have been used effectively in an integral manner that helped to produce a successful control room inventory. Furthermore, this inventory will be a useful tool when the control room is being modified. CECo has met the control room inventory requirement of Supplement 1 to NUREG-0737.

4. Control Room Survey

The licensee's control room survey considered the extent to which equipment and the environment in the control room were designed to accommodate basic human characteristics such as physical size and perceptual-motor capabilities.

To conduct the survey, human factors specialists and Commonwealth Edison operations personnel observed and measured control room features using human factors guidelines derived from those in Section 6 of NUREG-0700. As indicated on page 6-42 of the Dresden Summary Report, some CECo guidelines differed from those presented in NUREG-0700. The licensee further states that "many of the items were quantified, or reworded, so as to make them clearer and more concise for evaluation." Objections to some of these CECo checklist criteria were raised during the NRC in-progress audit at Dresden. While the CECo checklist criteria were re-evaluated to resolve the NRC objectives, the results of this re-evaluation process were not documented in the Dresden Summary Report. At the Quad Cities audit, a copy documenting the differences between NUREG-0700 guidelines and CECo

checklist was presented (Appendix B). Due to the extensive coordination between the Quad Cities and Dresden DCRCRs, it is assumed that the revised CECo guidelines presented at the Quad Cities audit represents the revision resulting from the in-progress audit mentioned in the Dresden Summary Report.

If the CECo checklist revision in Appendix B is being used at Dresden, the following review of the differences between NUREG-0700 and the CECo checklist are applicable. However, if the CECo checklist used at Dresden is different from that of Quad Cities, it is recommended that CECo document with the NRC any differences between the Dresden CECo checklist and NUREG-0700 guidelines.

Review of Differences Between NUREG-0700 Guidelines and CECo Checklist

The majority of differences between the guidelines of NUREG-0700 (Section 6) and the CECo checklist are in areas which require evaluation using task analysis results. Since the task analysis was accomplished only on emergency operations, CECo revised the applicable NUREG-0700 guidelines to show that they are limited to emergency operations. The audit team agrees with this interpretation as long as improvements to instrumentation used in emergency operations do not result in inconsistencies with nonemergency (and thus unimproved) instrumentation. To avoid adding to operator confusion, improvements to instrumentation used in emergency operations should be applied to all similar instrumentation.

Several other differences are based on (1) misprints in NUREG-0700; (2) qualitative guidelines which CECo chose to make quantitative to improve review objectivity; and (3) very minor differences on guidelines of lesser significance. We find these modifications to be acceptable.

The audit team disagrees with the modifications made by CECo on the three NUREG-0700 guidelines discussed below:

1.2.3.D.2 0700 Other controls may be mounted as far back as 25 inches from the console edge. This distance accommodates the extended functional reach of the 5th percentile as defined.

CECo Controls are no more than 30 inches from the console edge.

JUSTIFICATION:
The extended functional reach of 5th percentile female is 28.9 inches without stretching. Locating controls 30 inches from the console edge is realistic in that most operators exceed the value of the 5th percentile female, and they will tend to bend slightly over the console to manipulate controls.

TEAM POSITION:
Extended functional reach is measured from a wall to the tip of the right index finger with the arm extended and the right shoulder extended out from the wall as far as possible with the left shoulder against the wall. In order to minimize the potential for inadvertent activation of controls the operator should not be forced to lean over the benchboard to operate controls on the back portion. Since the measurement referred to in the guideline is taken from the front edge of the benchboard, it is not equivalent to the extended functional reach measurement. In fact, it is 8 to 10 inches less than an extended functional reach. At 25 inches for control board depth, the guideline of NUREG-0700 has already accounted for some amount of bending by most operators.

1.2.3.F.1 0700 For control and monitoring actions that must occur in sequence, all necessary controls and displays should be within the maximum extended reach and the viewing range of the seated operator from a single reference point.

1.2.3.F.2 0700 For the situation described in Item 1 above, and (for) sustained or precise control action, the operator should be able to reach the controls without having to bend/stretch significantly.

CECo For the situation described in Item 1 above, and sustained or precise control action is required, the controls are within 29 inches.

JUSTIFICATION:
The extended reach for 5th percentile female is 28.9 inches without bending or stretching. By bending slightly she can reach the 29 inches. This limit more clearly quantifies the criteria.

TEAM POSITION:
As in the previous guideline (1.2.3.D.2), if a measurement could be used, the guideline would probably be that controls should not be farther than 25 inches from the front edge of the console. The reason a measurement was not used is that, depending on the task difficulty and duration, 25 inches may be too great a distance to reach.

3.2.1 C 0700 LIMITS - The signal should capture the operator's attention but should not cause irritation or a startled reaction.

CECo LIMITS - The signal intensity does not exceed 90 dB(A).

JUSTIFICATION:
The establishment of 90 dB(A) provides a standard to be utilized across all CECo stations. This standard does not exceed the maximmum intensity of 90-115 dB(A) found in Guidelines 2.2.6.C for maximum intensity for signals.

TEAM POSITION:
If a quantitative value were to be specified, it should be some maximum value over ambient noise level, not an absolute value of 90 dB(A). Depending on the ambient noise level, 90 dB(A) may very well startle or cause irritation to the operator. In addition, intensity is not the only signal quality that might startle or cause irritation.

CECo's survey effort is in accordance with the intent of Supplement 1 to NUREG-0737. Instrumentation, control, and other equipment items were examined for human engineering acceptability as components without reference to their specific uses in task performance. Discrepancies were based on design incompatibility with human perceptual, motor, psychological, or size characteristics. The survey effort resulted in the identification of more than 580 HEDs.

In summary, the survey effort was complete in that it covered the nine content areas suggested in NUREG-0700 (e.g., workspace, panel design, annunciator warning system, etc.). Environmental conditions, including sound, lighting, and the HVAC system, were also surveyed. CECo should either provide assurance that Appendix B is the CECo checklist revision being used at Dresden and respond to the comments provided in this section or submit to the NRC the specific CECo checklist revision being used at Dresden along with justification for any deviations from NUREG-0700.

If the survey checklist used at Dresden is the same as that of Quad Cities, the following comments are also applicable. While primarily using the guidelines in NUREG-0700 as the basis for their survey, it appears that CECo modified three guidelines to which the audit team at Quad Cities did not agree. The control room should be rechecked for these three items and responses provided if it is not in compliance. And finally, although recommended for review in NUREG-0700, the remote shutdown capability was not considered as part of the CECo review.

5. Validation of Control Room Functions

Commonwealth Edison Company conducted a validation review at Dresden to determine whether the functions allocated to the control room operating crew could be accomplished effectively within both the structure of the established emergency procedures and the design of the control room as it exists.

In the Dresden Summary Report, the licensee indicates that they will validate their control room functions using a real-time simulator "run through" of all major unit systems at every control room workstation. The events which were used in the validation were:

- a normal reactor startup
- a normal reactor shutdown
- a small break loss of coolant accident (LOCA)
- inadequate core cooling
- an anticipated transient without reactor scram following the loss of offsite power
- a reactor scram
- a main steam line break inside the drywell.

The DCRDR coordinator, who is a licensed BWR SRO, and a human factors specialist arranged for and supervised the validation effort at the Morris simulator. Operating crews consisted of two Dresden SRO-licensed managerial personnel and two certified Dresden simulator instructors. During the event simulation, which was recorded on videotape, operators were instructed to call out all relevant actions, directions of movement, the displays and indicators used as well as their responses. Other than functioning in the roles of balance of plant personnel, the review team members did not assist the operating crews during the event scenarios. The event and recording efforts were terminated when the subject matter expert (SME) determined that the crew had successfully mitigated the event.

After recording the events, a human factors specialist (HFS) and an SME jointly reviewed and analyzed the data on an as close to a procedural step-by-step basis as possible. During this review process, the Dresden procedures were referenced, the HFS would stop the tapes for viewing as needed, and the SME would clarify operator actions. Where the human factors specialist observed instances in which equipment availability, suitability or location could be enhanced, or in which operator uncertainty due to procedural ambiguity could be minimized, HEDs were written.

Using a real-time simulator, the licensee implemented a validation procedure consistent with the guidelines of NUREG-0700. The events chosen were consistent with those suggested in NUREG-0700 and exercised all control room work stations. From the analyses performed, six HEDs were generated.

ASSESSMENT AND IMPLEMENTATION

HED assessment and implementation procedures are described in Sections 7 and 8 of the Summary Report. Volume 2, Sections 1-12 of the Summary Report present review findings.

1. HED Assessment Methodology

The assessment of HEDs generated by the previously described DCRDR activities was accomplished by the HED Assessment Team (HEDAT) composed of the lead human factors specialist, the DCRDR coordinator, the I&C engineer, the Station Nuclear Engineering Department Station Project Engineer, and the Station Assistant Superintendent for Operations. The team met and reviewed the HEDs. Based on team consensus, HEDs were classified into one of three categories (I, II, or III) based on the level of safety relatedness of the equipment in question. The HEDAT then determined to which of three levels (A, B, or C) of severity each HED should be assigned within each category using specified criteria relating factors described on page 5-3 of the Program Plan, including the plant safety implications of the HED.

The HEDAT-assigned categories are as follows:

Category I: Discrepancies associated with engineered safeguard systems (ESS) or engineered safety features (ESF).

Category II: Discrepancies associated with plant systems not included in Category I.

Category III: Discrepancies not falling into either Category I or II.

The HEDAT assigned levels of severity as follows:

Level A: Includes HEDs with documented errors, documented control-based problems or, in the judgment of the HEDAT, may have a significant impact on plant safety and/or productivity.

Level B: Includes HEDs which may have a moderate influence on plant performance (consequences may delay or impact, but not significantly, the efficient operation of the plant).

Level C: Includes HEDs with a relatively minimal impact on plant performance (consequence of human error will not lead to degraded plant safety system).

As defined above, it appeared that the classification of Category I was only applicable if the deviation was associated with either ESF or ESS. This limitation presented a concern since other systems besides ESF and ESS can impact plant safety. However, at the Quad Cities pre-implementation audit, CECo indicated that all HEDs with plant safety implications as described in the Final Safety Analysis Report (FSAR) and a number of support systems would be classified as a Category I HED.

Level assignment was the determining factor in the recommendation to correct HEDs. HEDs in Level A are to be corrected, while HEDs in Levels B and C may or may not be corrected, depending on their relative operational significance. Once assessed, personnel from the Station Operations and Station Nuclear Engineering Departments met with the lead human factors specialist, the DCRDR coordinator, and the I&C engineer to review the assessed HEDs and decide which to correct. Those HEDs to be corrected were differentiated from those not to be corrected, and justifications for HEDs not to be corrected were prepared.

From a review of both the Program Plan and the Summary Report assessment phase methodologies, certain differences were found. While the following differences were discussed at the Quad Cities pre-implementation audit with representatives of CECo, the NRC audit team indicated that further documentation by CECo would be desirable for clarification.

1. The reasoning behind CECo's switch from the rating system to be used during the assessment phase as presented on page 5-3 of the Program Plan to the consensus method that actually was used by CECo.

2. The reasoning why the Pre-Assessment Form described on page 5-3 of the Program Plan and included in Appendix A of the Summary Report was not considered to be necessary and was not used by CECo.

3. The reason why CECo changed from the four-tiered level rating system of ABCD as presented on page 5-5 of the generic Program Plan to the three-tiered level rating of ABC used by CECo.

4. Assurances that cost factors will not impact decisions to correct HEDs as presented by CECo at the audit since this is contrary to the statements on page 7-2 of the Summary Report.

5. Assurance that the audit team's understanding that benefit ratios will not be considered during the assessment phase since page 7-3 of the Summary Report indicates otherwise.

During the Quad Cities audit, it was noted that many HEDs were cancelled by the HEDAT. If cancelled, the HED was dropped from the computerized data base and received no further processing. A subsequent audit of these cancelled HEDs revealed the weakest link in an otherwise superior documentation system. The records of the HEDAT review process as to why certain changes and cancellations were made are not complete. For instance, the cancelled HEDs were often noted "cancelled, not a HED" with no further explanation. The record provided to the audit team was the rough notes of the CECo DCRDR coordinator. If the same process was used at Dresden Station, more detailed minutes of all HEDAT reviews should be kept, noting the disposition and reasons for actions taken on all HEDs.

The HEDs were reviewed individually by the HEDAT, but some of them were grouped in the Summary Report. During the Quad Cities audit, it was noticed that the category and levels assigned to the grouped HEDs in the Summary Report frequently did not reflect the categorization and level of the most significant HED in the group. The worst case noted was a grouping of four HEDs either classified as IA or IB individually; however, when grouped, they were assigned the classification IIIC. If Dresden followed this practice, the licensee should review all grouped HEDs in the Summary Report for proper assignment of Category and Level.

The process as applied was generally satisfactory, yet there were assessment practices that should be improved at subsequent CECo station reviews. Furthermore, CECo should document those items described above to help this phase of the DCRDR meet the requirements of Supplement 1 to NUREG-0737.

2. Selection of Design Improvements

The purpose of selecting design improvements is, as a minimum, to correct safety significant HEDs. Selection of design improvements should include a systematic process for development and comparison of alternative means of resolving HEDs. Furthermore, according to NUREG-0737, Supplement 1, the licensee should document all of the proposed control room changes.

CECo's Summary Report described the process for development and comparison of alternative means for correcting HEDs. However, the major weakness in the selection activity and the DCRDR as a whole is the large number of HEDs that are unresolved. Both the Summary Report and the audit discussions indicate that many studies and reviews designed to resolve HEDs have yet to be accomplished. This makes the Dresden Summary Report incomplete as required by Supplement 1 to NUREG-0737. The numerous studies and additional reviews listed in Appendix C are intended to address the many problems that are contained in the Dresden HED descriptions. The results of these studies and reviews will be combined into design packages tailored for correcting HEDs at Dresden Station. The solutions presented by the design packages will be in accordance with good human factors engineering principles and ensure consistency throughout the control room.

Although the licensee has described a process for implementing design improvements which indicates its awareness of the need for conventions and implementation of improvements in the control room in an integrated fashion, it has not presented adequate descriptions of design improvements. According to NUREG-0737, Supplement 1, the Summary Report of the completed review should indicate which HEDs they intend to correct and how they will do this and indicate those HEDs that will be left uncorrected or partially corrected and why. Presently, Dresden has a large number of HEDs that are unresolved. Dresden intends to perform numerous studies and reviews that will result in a Dresden-specific design packages that should resolve the

HEDs. While this seems to be a very thoughtful process, it needs to be documented and submitted as part of the Summary Report. In addition, this documentation must include justification for not correcting or partially correcting HEDs with safety significance. This will remain an open item until the NRC reviews the proposed design packages and justifications.

3. Verification that Selected Design Improvements Will Provide the Necessary Correction and Can Be Introduced in the Control Room Without Creating Any Unacceptable Human Engineering Discrepancies

CECo has described a process which will provide verification of the effectiveness of corrective actions. Verification will be performed using panel mock-ups incorporating the corrective actions, consultation with operators and systems experts, human factors specialist reviews, and possible use of the control room simulator. Should verification show that a corrective action will have a negative effect on control room operations, the corrective action will be cancelled or altered as appropriate. When accomplished, this process should meet the requirement of Supplement 1 to NUREG-0737.

4. Coordination of Control Room Improvements With Changes Resulting from Other Improvement Programs

Based on information provided in the Summary Report, it would appear that Commonwealth Edison Company has a coordinated program in place to address each of the Supplement 1 to NUREG-0737 initiatives. The Summary Report further states that the program extends throughout its system of nuclear generating stations and has specific provisions for each station. The program is headed by CECo Station Nuclear Engineering Department which provides the necessary coordination and support to ensure that a systematic approach is adopted for the inclusion of each of the recommended design changes resulting from these initiatives. Should the licensee link the results of all the separate efforts using automated databases, this will permit the evaluation of all corrections in terms of their synergistic effects as well as their individual value. Although this process as outlined appears to meet the Supplement 1 to NUREG-0737 requirement to coordinate control room improvements with changes resulting from other improvement programs, it is preferred to have this information documented to facilitate

the review process. For example, at the Quad Cities pre-implementation audit, CECo presented a well-organized flow diagram of the Station's coordination program. Inclusion of a copy of a similar document along with a detailed explanation of how it applies to Dresden Station should help to satisfy this requirement.

DESCRIPTION OF PROPOSED DESIGN CHANGES AND JUSTIFICATION FOR HEDs WITH SAFETY SIGNIFICANCE TO BE LEFT UNCORRECTED OR PARTIALLY CORRECTED

Licensees are required by Supplement 1 to NUREG-0737 to submit an outline of proposed design changes, including their proposed schedules for implementation and a summary justification for HEDs with safety significance to be left uncorrected or partially corrected.

1. Proposed schedules for implementing HED corrections

Proposed schedules for implementing HED corrections were provided in the cover letter which accompanied the Summary Report when it was transmitted to the NRC. As cited in that letter, proposed schedules are predicated upon NRC approval of CECo's disposition of each of the HEDs as the schedule is sensitive to the size of the current scope of work. The schedules are subject to the availability of equipment, outage dates, and engineering design lead time. Finally, the impact of Reg. Guide 1.97 was not factored into the schedules. As a result, the proposed schedules submitted will be finalized after receipt of NRC input and completion of the Reg. Guide 1.97 review.

As proposed, the schedules for completion of the corrective actions have been designated as the completion of the first refueling outage or the second refueling outage for Dresden Station Units 2 and 3. CECo identifies September 1986 and March 1988 refueling outages as the expected first and second dates for installation of DCRDR modifications at Unit 2. October 1987 and April 1989 are the anticipated refueling outage dates for installation of modifications at Unit 3.

From a review of the proposed outage dates at Dresden Station, it appears that the plants follow an eighteen (18) month refueling cycle. If this schedule is being implemented at Dresden Unit 3, one would expect that

the "first" refueling outage date for this unit is in March 1986 rather than October 1987. If in fact this is the case, we believe the HED correction schedule should reflect the actual outage number rather than "first" and "second." Although implementation dates have been assigned to the specific HEDs on the bases of safety significance category and level, the length of time between identification and possible correction of some HEDs appears to be unrealistic. Supplement 1 to NUREG-0737 indicates that improvements involving an enhancement program should be done promptly.

2. Proposed corrective actions and justifications for HEDs to be left uncorrected.

HEDs identified during the DCRDR are presented in Volume 2, Sections 1-13 of the Summary Report. Findings are presented by section numbers which correspond to the DCRDR activity which resulted in identification of the HED. Section numbers and corresponding DCRDR activity include:

1 = Survey checklist - Control Room Workspace
2 = Survey checklist - Communications
3 = Survey checklist - Annunciator Warning Systems
4 = Survey checklist - Controls
5 = Survey checklist - Visual Displays
6 = Survey checklist - Labels and Location Aids
7 = Survey checklist - Process Computers
8 = Survey checklist - Panel Layout
9 = Survey checklist - Control Display Integration
10 = Historical Review
11 = Operator Survey
12 = Verification
13 = Validation

Appendix A of this report contains the complete list of HEDs for which proposed corrective actions or justification for not correcting were found to be inadequate for one of the reasons described below. An example of an actual HED which falls within each reason category is provided for clarification of the category. The proposed corrective actions or justifications for all other HEDs not cited in Appendix A are found to be satisfactory.

A1. The description of the proposed corrective action is too brief, ambiguous, or general to allow an adequate evaluation to be made.

HED 1.5.5.A-1/A-2/A-3: The discrepancy described is that the background noise levels in the primary operating area exceed recommended level of 65 DB(A). CECo's response is that the ambient noise level will be reduced using noise-attenuating techniques and materials on sources of noise emissions. Although CECo intends to correct this HED, it neither specifies what noise-attenuating techniques and materials will be employed to reduce ambient noise levels, nor does CECo specify the sources of the noise emissions. This lack of specificity may be indicative of either an unfinalized backfit to the control room or a lack of specificity of the HED documentation given in the Summary Report.

A2. The proposed corrective action only partially corrects the discrepancy.

HED 5.0 V,1: The discrepancy described is as follows:

1. The parameter GPM is not listed on the EM (response).
2. Divisions are "2" instead of "1".
3. The valve position demand does not have % valve opening listed.
4. The thumbwheel type does not have GPM on it.
5. The deviation meter has no units and is not zone banded.

CECo's response to this HED is "The CRD flow control needs several modifications. First, the units of GPM will be replaced on the EM. This is necessary to avoid confusion with another set of units (e.g., % flow). Percent valve opening cue will be placed on the demand indicator. The thumbwheel will also be labeled with GPM. The deviation meter will be zone banded, and labeled with meaningful units (% deviation)." However, in its response, CECo does not address the second portion of the HED regarding scale divisions of "2".

B1. The justification for not correcting the HED and/or the description of the discrepancy is too brief, ambiguous, or general to allow an adequate evaluation to be made.

HED 1.5.3.G-21: This discrepancy indicates that the reflectance of the control room walls is considerably lower than the recommended guidelines. CECo's response is that due to the design of the control room, the reflectance from the walls does not affect operations. CECo should further explain how the design of the control room can minimize the effects of the reduced reflectance from the wall.

HED 4.4.4.C.1.A-3: This discrepancy indicates that fingertip grasp rotary controls are less than the guideline height of .5 inches. CECo's response is that no significant effort is necessary to operate the control. While stating that fingertip rotary controls are below the minimum required, the quantitative results of the survey are not stated. Furthermore CECo should indicate how it was determined that the surveyed deviations present no problem when operating the control.

B2. The basis for the justification is not adequate for one or more of the following reasons:

1. It does not address operational or behavioral factors or issues.
2. It does not sufficiently address the discrepancy.
3. It cites absence or previous operator error.
4. It cites utility, industry, or manufacturer's standard.

HED 1.2.5.B.1-43: The discrepancy is that four displays exceed the specified maximum criterion height of 70.0 inches by being between 67.0 and 72.5 inches above the floor. CECo's response is the fact that the displays are never more than 2.5 inches above the criterion and that their present location poses no operator problems. This response does not explain why the present display locations pose neither operational nor behavioral problems for the operators.

HED 5.2.3.C-3: The discrepancy is an inconsistent use of color that could cause confusion. While red is generally used to indicate an abnormal condition, red is also used to indicate the N_2 level. CECo's response is that in this case red is not used as a color code to indicate a condition but just to specify the tank level. However, this is still an inconsistent use of the color red. CECo should consider using another, more neutral color for the N_2 indicator.

B3. The justification of individual HEDs does not consider the cumulative or interactive effect of other HEDs.

HEDs in this category are related to the process computer peripherals installed at Dresden. While each individual HED is not considered to be a serious problem, the review team is concerned that such a large quantity of HEDs are written against a particular system. The responses to these discrepancies should further clarify issues concerning operational or behavioral factors and address the topic of cummulative and interactive effects. A complete list of the HEDs is presented in Appendix A.

C. Additional review or study is required before a solution or justification for not correcting the HED can be provided.

HEDs 1.5.3.A-1, 1.5.3.A-2, 1.5.3.A-3, 1.5.3.B-4, 1.5.3.3-5, and 1.5.3.B-6: These discrepancies relate to illumination levels that either vary or are below minimums. CECo's responses are that modifications will be provided following lighting studies. The results of the comprehensive lighting study is one of several that is planned to be performed for the Dresden DCRDR and should result in an integrated design package to be used at Dresden Station. Until the results of these studies are reviewed by the NRC, HED awaiting the results of studies or reviews will remain open items.

D. HED corrective actions that need to be implemented by completion of first refueling outage.

HED 6.5.2.B.3-7: This discrepancy is that there is a lack of procedural guides for determining the content of temporary labels. CECo's response is that a procedure will be established. However, the time frame for this corrective action is excessive. Administrative procedures for the control and use of temporary labels should be in place by completion of the first refueling outage. Several HEDs that address the use of temporary labels are listed in Appendix A under Category C since they are also presently under study.

CONCLUSIONS AND RECOMMENDATIONS

Commonwealth Edison Company's Summary Report for the DCRDR conducted at Dresden Station Units 2 and 3 demonstrates a strong commitment towards meeting the requirements of NUREG-0737, Supplement 1. The documentation submitted provided extensive discussions of the review activities conducted to perform a DCRDR and indicates that Commonwealth Edison basically met most of the requirements. However, additional information is required from the licensee to provide assurances that all requirements as stated in NUREG-0737, Supplement 1 are satisfied.

While the report of the Planning ase generally satisfied the requirements of NUREG-0737, Supplement 1, there were still questions regarding the levels of effort and staffing for the DCRDR tasks. From our review of the Summary Report, there were concerns with the methodology by which the Review Phase was conducted. Finally, there was a general lack of reported HED resolutions that indicated that the Implementation Phase was incomplete.

The following is a summary of comments on Commonwealth Edison's compliance with each of the DCRDR review steps and requirements documented by the Dresden Summary Report and confirmed during discussions at the Quad Cities pre-implementation audit. In general it appears that CECo's effort is one of the better DCRDR efforts to have been conducted by a utility. The review portion was comprehensive, with the task analysis being conducted

early enough in the process to become a key factor during the remaining phases of the DCRDR.

- CECo had described a well qualified, adequately staffed DCRDR team, which was composed of a good skill mixture to conduct the DCRDR. However, information relevant to levels of effort and staffing on DCRDR tasks needs to be provided.

- Although not a requirement of Supplement 1 to NUREG-0737, a review of operating experience was conducted consistent with NUREG-0700 guidelines and objectives.

- CECo described a system function and task analysis based on the generic BWROG EPGs which were made plant-specific. All unique tasks were identified and broken down into task elements. Instrument and control requirements and relevant characteristics were identified for task elements. The methodology appears comprehensive and systematic. While there was a preliminary concern about the independence of the task analysis it is apparent that the existing instrumentation did not bias the process. Instrument and control requirements were developed and subsequently checked using an iterative process resulting in numerous HEDs, which is indicative of a properly executed process. The system function and task analysis of this DCRDR satisfactorily meets the requirements of Supplement 1 to NUREG-0737.

- The licensee compiled a complete and comprehensive control room inventory. A verification of equipment availability was then conducted by comparing information and control requirements determined from the task analysis with the equipment present in the control room as identified by the inventory. With assurance that the information and control requirements were derived from a well-executed task analysis, it has been determined that this comparison satisfactorily meets the requirements of Supplement 1 to NUREG-0737.

- The DCRDR documentation management system, which was automated, proved valuable and well used in all phases of the DCRDR.

- A human factors survey of the control room was conducted in what appears to be a comprehensive and thorough manner. The methodology and objectives of the survey essentially were in accordance with the guidance provided in NUREG-0700 and meet the requirement of Supplement 1 to NUREG-0737. CECo's deviations from 0700 in conjunction with applicable justifications for such deviations should be documented and submitted for NRC review.

  If the Dresden checklist deviations are the same as those presented at the audit at Quad Cities, CECo should amend its checklist to reflect the concerns previously delineated in this report. In particular, CECo should re-evaluate the control room in the three areas in which the audit team disagreed with the CECo checklist.

- The process Commonwealth Edison developed to assess the significance of HEDs does not appear to meet fully the requirement of Supplement 1 to NUREG-0737. During the Quad Cities audit, it was noted that the HEDAT eliminated HEDs without providing documentation necessary to justify this action. Further, some HEDs that had been grouped generally reflected a category/level lower than the highest individual HED category/level. These consolidated HEDs must be considered and resolved at the highest category/level among the single elements. In the Summary Report, it appeared that the Category I HEDs were only associated with engineered safety features (ESF); however, it was the Quad Cities audit team's understanding that all safety-related equipment, as specified in the final safety analysis report, and all applicable supporting equipment were included in the assessment.

  The Pre-Assessment Form, as described in the Program Plan was included in the list of forms in Appendix A of the Summary Report. However, its use was not described in the text. During the audit at Quad Cities, it was learned that this form was not considered necessary and was not used at all during the control room review assessment phase.

- While the process developed by CECo to select design improvements is satisfactory, the studies and reviews to develop the design packages for improvements have not been completed. Until these resolutions of improvements can be detailed, this phase does not meet the requirements in NUREG-0737, Supplement 1.

- Commonwealth Edison has described a formal verification process to ensure that selected design improvements will provide the necessary correction without introducing new HEDs. This process, when accomplished, should meet the requirement to NUREG-0737, Supplement 1.

- The additional information provided by CECo during the Quad Cities audit indicates that it is meeting the requirement to coordinate control room improvements with changes resulting from other improvement programs.

In addition to these general comments, the following is a list of the activities, areas of improvement, and documentation that CECo should satisfactorily perform in order to meet the NUREG-0737, Supplement 1 requirements for a DCRDR. It is recommended that this information be documented in a supplement to the Summary Report.

1. Multidisciplinary Review Team

   - Provide detailed description of task assignments and levels of effort on DCRDR tasks.

2. Control Room Survey

   - Confirm that the Dresden CECo checklist revision is the same as Appendix B or document how Dresden's version of the CECo checklist deviates from NUREG-0700 along with submitting CECo's justifications.

   - Modify, if applicable, the three CECo checklist guidelines discussed at the Quad Cities audit and restated in this paper so they will be in accordance with the criteria of NUREG-

0700. These revised guidelines should then be incorporated into CECo's review process and applied to the Dresden Station control room review.

- Ensure that the revised checklist guidelines using task analysis results do not lead to improvements to instrumentation used only in emergency operations that would be inconsistent with nonemergency instrumentation.

3. Assessment of HEDs

- Document the reasoning behind CECo's switch from the rating system, presented in the Program Plan to be used during the assessment phase to the consensus method that was actually used.

- Document why CECo changed from the four-tiered level rating system presented in the Program Plan to the three-tiered level rating used.

- Ensure the NRC staff that cost factors will not impact decisions to correct HEDs as presented by CECo at the audit since this is contrary to what was printed in the Summary Report.
- Ensure the NRC staff that benefit ratios as described in the Summary Report will not be applied during the assessment phase.

- Provide detailed documentation for the HEDAT's justification for cancelling HEDs during the assessment process if this practice was used at Dresden as at Quad Cities.

- Provide assurance that those HEDs that have been grouped together reflect the categorization and level of the most significant HED in the group.

- Document the reasoning for not using the Pre-Assessment Form as indicated in the Program Plan.

4. Selection of Design Improvements

   - Complete the studies and reviews listed in Appendix C. Provide the NRC with a description of the design packages that result from these studies and how these results will be used to correct the control room discrepancies.

   - Resolve the inadequacies in the proposed corrective actions and justifications for not taking corrective actions for the HEDs specified in Appendix A of this report.

5. Coordination of Control Room Improvements

   - Provide to the NRC a detailed functional explanation of the station's coordination program.

REFERENCES

1. "Commonwealth Edison Company Dresden Station, Units 2 and 3 Detailed Control Room Design Review Final Summary Report," Commonwealth Edison Company, May 1985.

2. "Generic Detailed Control Room Design Review Project Program Plan for Commonwealth Edison Company," Section 1-3 of Attachment to letter to N.R. Denton from C. Reed, Commonwealth Edison Company, RE: Response to Generic Letter No. 82-33, April 14, 1983.

3. "NRC Staff Comments on the Commonwealth Edison Company Generic Detailed Control Room Design Review Project Program Plan," July 11, 1983.

4. "Results Of In-Progress Audit of Dresden, Units 2 and 3 Detailed Control Room Design Review," March 6, 1984.

5. "Audit Report of the Detailed Control Room Design Review for Quad Cities Station, Units 1 and 2," Science Applications International Corporation, August 5, 1985.

6. NUREG-0660, Vol. 1., "NRC Action Plan Developed as a Result of the TMI-2 Accident," USNRC, Washington, D.C., May 1980; Rev. 1, August 1980.

7. NUREG-0737, "Requirements for Emergency Response Capability," USNRC, Washington, D.C., November 1980.

8. NUREG-0737, Supplement 1, "Requirements for Emergency Response Capability," USNRC, Washington, D.C., December 1982, transmitted to reactor licensees via Generic Letter 82-33, December 17, 1982.

9. NUREG-0700, "Guidelines for Control Room Design Reviews," USNRC, Washington, D.C., September 1981.

10. NUREG-0800, "Evaluation Criteria for Detailed Control Room Design Review," USNRC, October 1981.

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APPENDIX A

HEDs listed in Volume 2 of the Summary Report for which Corrective Actions or Justifications for Not Correcting were proposed.

A1. The description of the proposed corrective action is too brief, ambiguous, or general to allow an adequate evaluation to be made.

HED No.	Section-Page
1.1.3.C.1-4	1-5
1.5.5.A-1	1-86
1.5.5.A-2	1-86
1.5.5.A-3	1-86
8.8.2.A-2	8-7
6.3.2.A.HR7	10-5
5.3.1. OS,5	11-24

A2. The proposed corrective action only partially corrects the discrepancy.

HED No.	Section-Page
1.2.2.B.1-30	1-17
1.2.2.C-31	1-17
1.2.2.D.2	1-17
1.2.3.C-3	1-17
1.3.2.A-1	1-75
1.3.2.B-1	1-75
6.2.4.B-1	6-14
6.5.2.A-2	6-45
6.5.1.A-1	6-45
6.5.2.B.6-13	6-45
6.5.2.B.4-9	6-45
6.5.2.B.1-3	6-46
8.1.2.A-2	8-2
8.1.2.A-3	8-3
9.2.2.A.1-1	9-3
4.1.2.B-HR-2	10-4
8.2.2.B,HR1	10-6
3.0 V,2	13-16
5.0 V,1	13-21
5.0 V,3	13-23
5.0 V,12	13-30
5.0 V,13	13-31
5.0 V,14	13-32
5.0 V,15	13-33
5.0 V,16	13-34

B1. The justification for not correcting the HED and/or the description of the discrepancy is too brief, ambiguous, general or does not cover all cases, to allow an adequate evaluation to be made.

HED No.	Section-Page	HED No.	Section-Page
1.1.3.A-2	1-2	4.5.1.C.2-1	4-46
1.2.2.E.2-18	1-22	5.1.1.C.2	5-2
1.2.2.E.2-19	1-23	5.1.3.C.1-7	5-7
1.2.2.E.2-20	1-24	5.1.3.D.1-9	5-8
1.2.3.B.2	1-26	5.1.3.D.2-11	5-9
1.2.3.E.2-4	1-27	5.1.3.D.3-13	5-10
1.2.5.A.1-10	1-33	5.1.3.D.4-15	5-11
1.2.5.B.1-6	1-48	5.1.3.D.6-17	5-12
1.2.5.B.1-26	1-51	5.1.5.B-6	5-17
1.2.5.B.1-29	1-53	5.2.4.A-1	5-32
1.2.5.B.1-30	1-53	5.3.3.B.2-6	5-38
1.2.5.B.1-31	1-53	5.6.2.B.4-3	5-53
1.2.5.B.1-32	1-54	8.2.1.B.1-1	8-5
1.2.5.B.1-33	1-55	8.2.1.B.1-2	8-5
1.2.5.B.1-37	1-59	8.2.1.A-3	8-5
1.2.5.B.1-39	1-61	8.2.2.A-1	8-6
1.2.5.B.1-50	1-70	8.3.2.A-1	8-14
1.5.3.G-21	1-85	8.3.2.C.1-5	8-18
2.1.6.A-1	2-6	8.3.2.C.1-6	8-19
2.1.6.A.2-2	2-7	8.3.2.C.1-11	8-21
2.1.6.E.2-5	2-7	0.0 OS,4	11-4
2.1.6.C.1-3	2-7	5.1.1.A.1 OS,6	11-22
4.3.2.A.1-1	4-10	1.0 V,1	13-1
4.3.2.A.1-4	4-12	1.0 V,3	13-2
4.3.3.B.3-14	4-20	1.0 V,5	13-3
4.3.3.D.1-9	4-22	1.0 V,4	13-5
4.3.3.D.1-10	4-23	1.0 V,7	13-6
4.3.3.E.1-11	4-24	1.0 V,8	13-7
4.3.3.E.1-12	4-25	1.0 V,9	13-8
4.4.4.C.1.A-3	4-32	1.0 V,13	13-11
4.4.5.B.4-14	4-39	1.0 V,15	13-13
4.4.5.E.4-2	4-43	5.0 V,4	13-24

HED No.	Section-Page
5.0 V,7	13-26
5.0 V,36	13-50
6.0 V,11	13-60
8.0 V,2	13-68
8.0 V,3	13-69
9.0 V,2	13-73
9.0 V,3	13-74

B2. The basis for the justification is not adequate for one or more of the following reasons:

1. It does not address operational or behavioral factors or issues.
2. It does not sufficiently address the discrepancy.
3. It cites absence or previous operator error.
4. It cites utility, industry, or manufacturer's standard.

HED No.	Section-Page	HED No.	Section-Page
1.1.3.F.1-8	1-7	3.1.2.C.2-10	3-2
1.1.3.F.3-10	1-10	3.1.3.B-2	3-5
1.2.2.B.1-3	1-16	3.3.1.C.1-3	3-12
1.2.5.A.1-1	1-29	3.3.3.B-7	3-14
1.2.5.A.1-2	1-30	4.2.2.F.3-5	4-8
1.2.5.A.1-3	1-31	4.3.2.A.2-3	4-13
1.2.5.A.1-4	1-31	4.3.2.D-5	4-14
1.2.5.A.1-11	1-34	4.5.5.B.4-13	4-38
1.2.5.A.1-12	1-35	4.5.5.B.4-15	4-38
1.2.5.A.1-13	1-36	4.4.5.D.2-6	4-40
1.2.5.A.1-20	1-42	4.4.5.D.2-7	4-40
1.2.5.A.1-21	1-43	4.4.5.E.1-8	4-41
1.2.5.B.1-25	1-50	4.4.5.E.3-9	4-42
1.2.5.B.1-36	1-58	4.4.5.E.3-10	4-42
1.2.5.B.1-38	1-60	4.4.5.E.3-11	4-42
1.2.5.B.1-40	1-62	4.5.2.B.2-11	4-50
1.2.5.B.1-41	1-63	5.2.3.C-3	5-31
1.2.5.B.1-42	1-64	5.3.1.A.1-1	5-34
1.2.5.B.1-43	1-65	5.3.3.B.5-7	5-39
1.2.5.B.1-44	1-66	5.5.1.A.3-2	5-47
1.2.5.B.1-45	1-67	5.5.1.A.4-3	5-48
1.2.5.B.1-46	1-68	6.3.8.C-3	6-36
2.2.1.B-1	2-11	6.3.8.C-5	6-36
2.2.1.B-2	2-12	6.5.1.F-3	6-44
2.2.2.A-1	2-14	6.5.1.H-4	6-44
2.2.3.A.1	2-14	6.6.3.B.4-10	6-66
2.2.2.A-2	2-14	8.2.4.B-1	8-13
2.2.3.A.2	2-14	8.3.2.A-2	8-15

HED No.	Section-Page
9.2.2.A.1-1	9-3
0.0 OS,6	11-5
1.1.7-OS-1	11-8
3.0 OS,3	11-11
5.1.1.A.1 OS-5	11-21
1.1.1.A VL,7	12-1
1.1.5 VL,6	12-2
1.2.2.E VL,5	12-3
4.1.1.A.1 VL,4	12-4
1.0 V,6	13-4
1.0 V,14	13-12
4.0 V,2	13-18
4.0 V,3	13-19
5.0 V,34	13-48
6.0 V,4	13-53
8.0 V,4	13-70
8.2.2.B V,4	13-71
9.0 V,1	13-72

B.3 The justification of individual HEDs does not consider the cumulative or interactive effect of other HEDs.

HED No.	Section-Page
7.1.4.E.1.A-1	7-3
7.1.4.G-5	7-6
7.1.7.B-1	7-9
7.2.1.F.2-7	7-16
7.2.1.F.4-1	7-17
7.2.2.G.2-1	7-17
7.2.2.A-1	7-19
7.2.2.B.1-2	7-20
7.2.2.D-4	7-21
7.2.2.E-1	7-22
7.2.3.C.1.A-1	7-23
7.2.3.D.1.A-2	7-24
7.2.3.D.1.B-3	7-25
7.2.4.E.2-3	7-28
7.2.4.K-6	7-30
7.2.4.M.1-5	7-31
7.2.5.H-3	7-34
7.2.6.I-2	7-36
7.2.8.A.1-1	7-38
7.2.8.A.2-2	7-38
7.2.8.B-3	7-39
7.3.1.D-4	7-45

C. No proposed solution or justification for not correcting is provided as the HED is undergoing study or additional review.

HED No.	Section-Page	HED No.	Section-Page
1.5.3.A-1	1-78	4.3.3.B.1-2	4-19
1.5.3.A-2	1-78	4.4.3.A-5	4-27
1.5.3.A-3	1-78	4.4.3.A-4	4-27
1.5.3.B-4	1-79	4.5.1.D.2.B-2	4-47
1.5.3.B-6	1-79	4.5.1.D.2.B-3	4-47
1.5.3.B-5	1-79	4.5.1.E.2.C-4	4-47
1.5.3.E.2-10	1-81	5.1.1.B.1-1	5-1
1.5.3.E.2-11	1-81	5.1.3.A-1	5-4
1.5.3.E.2-12	1-81	5.1.5.A.1-1	5-15
1.5.3.F-13	1-82	5.5.5.F-9	5-19
1.5.3.F-14	1-82	5.3.3.B.1-10	5-36
2.1.6.F-6	2-9	5.3.3.B.6-12	5-40
3.1.2.C.1-5	3-1	5.3.3.D-9	5-41
3.1.4.A-1	3-6	6.1.1-1	6-1
3.1.5.A-1	3-7	6.1.1-2	6-1
3.3.1.A-5	3-10	6.1.1-3	6-1
3.3.1.A-6	3-10	6.1.1-4	6-1
3.3.2.B-1	3-13	6.1.1.5	6-2
3.3.3.C.3-1	3-16	6.1.2-4	6-3
3.3.5.A.1-6	3-20	6.1.2.A-1	6-3
3.3.5.A.2-7	3-21	6.1.2.A-3	6-3
3.3.5.B.2-1	3-22	6.1.2.A-3	6-3
3.3.5.B.3-9	3-23	6.1.2.A.3-1	6-4
3.3.5.C.1-3	3-24	6.2.1.A-1	6-5
3.3.5.C.2-5	3-25	6.2.1.A-5	6-5
3.3.5.D.1-11	3-26	6.2.1.B-2	6-6
3.3.5.D.2-13	3-27	6.2.1.B-6	6-6
3.3.5.D.3-15	3-27	6.2.1.B-9	6-6
3.3.5.D.4-17	3-27	6.2.1.B-11	6-6
3.3.5.D.5-19	3-28	6.2.1.C-3	6-7
3.3.5.D.6-21	3-29	6.2.1.C-7	6-7
4.3.3.A-1	4-18	6.2.1.C-10	6-8
5.3.3.C-8	4-18	6.2.1.E-4	6-9

HED No.	Section-Page	HED No.	Section-Page
6.2.1.E-8	6-10	6.3.7.A-7	6-31
6.2.1.E-12	6-10	6.3.7.B-2	6-32
6.2.2.A-1	6-11	6.3.7.B-3	6-32
6.2.2.A-2	6-11	6.3.7.B-6	6-32
6.2.2.A-3	6-11	6.3.8.A-6	6-33
6.2.2.A-4	6-11	6.3.8.A-5	6-33
6.2.2.A-5	6-12	6.3.8.B-1	6-34
6.2.3.A.2-2	6-13	6.3.8.A-4	6-34
6.2.3.A.1-1	6-13	6.3.8.B-4	6-34
6.2.4.B-3	6-15	6.3.8.C-2	6-35
6.2.4.B-5	6-16	6.4.1.A.1-1	6-37
6.2.4.C.2.1	6-17	6.4.1.A.2-2	6-38
6.2.4.C-4	6-17	6.4.1.A.2-8	6-38
6.2.4.C-6	6-17	6.4.1.A.2-5	6-38
6.3.1.A-1	6-19	6.4.1.B.1-3	6-39
6.3.1.B-3	6-20	6.4.1.B.1-6	6-39
6.3.1.B-OS,2	6-20	6.4.1.B.1-7	6-39
6.3.2.A-3	6-22	6.4.1.B.1-9	6-39
6.3.2.B-4	6-23	6.4.2.A.1-1	6-40
6.3.2.B-5	6-24	6.4.2.A.1-2	6-40
6.3.3.A-1	6-26	6.5.1.A-8	6-41
6.3.3.A-4	6-26	6.5.1.A-9	6-41
6.3.3.A-7	6-26	6.5.1.B-10	6-42
6.3.3.B-5	6-27	6.5.1.B-5	6-42
6.3.3.B-8	6-27	6.5.1.C-2	6-43
6.3.3.B-2	6-27	6.5.1.C-6	6-43
6.3.3.C-3	6-28	6.5.2.B.1-3	6-46
6.3.3.C-9	6-28	6.5.2.B.2-5	6-47
6.3.3.C-6	6-28	6.5.2.B.3-7	6-48
6.3.4.E-1	6-29	6.5.2.B.7-15	6-49
6.3.6-1	6-30	6.5.2.B.8-17	6-50
6.3.6-2	6-30	6.5.2.B.8-19	6-50
6.3.6-3	6-30	6.6.1.A-1	6-51
6.3.7.A-1	6-31	6.6.1.B-2	6-51
6.3.7.A-4	6-31	6.6.1.B-5	6-52
6.3.7.A-5	6-31	6.6.2-1	6-53

HED No.	Section-Page	HED No.	Section-Page
6.6.2.2	6-54	8.2.3.B-2	8-10
6.6.3.A.1-12	6-55	8.2.4.A-1	8-11
6.6.3.A-13	6-55	8.3.2.C.1-3	8-15
6.6.3.A.2-1	6-56	8.3.2.C.1-4	8-16
6.6.3.A.2-6	6-57	8.3.2.C.1-10	8-19
6.6.3.A.3-2	6-58	8.3.2.D.1-7	8-21
6.6.3.A.3-7	6-59	8.3.2.D.1-9	8-21
6.6.3.A.3-10	6-60	8.3.2.D.1-8	8-22
6.6.3.A-4	6-61	9.1.1.A-1	9-1
6.6.3.A.4-14	6-62	3.2.1 OS,2	11-12
6.6.3.A.4-15	6-63	4.1.1.A.1 OS,6	11-15
6.6.3.B.3-3	6-64	5.3.3.A.1 OS,7	11-25
6.6.3.B.3-8	6-65	6.5.1.B OS,1	11-26
6.6.3.B.5-11	6-67	6.6.3 OS,3	11-27
6.6.3.B.6-4	6-68	7.0 OS,1	11-28
6.6.3.B.6-9	6-68	7.0 OS,2	11-29
7.1.4.I-7	7-7	8.1.2 OS,11	11-30
7.1.5.C.1-1	7-8	8.2.2.A OS,7	11-39
7.2.4.J.2-4	7-29	1.0 V,12	13-10
7.2.7.B.1-1	7-37	3.0 V,1	13-15
7.3.1.C-3	7-46	3.0 V,2	13-16
7.3.2.F.1-1	7-47	3.0 V,3	13-17
8.1.2.A-1	8-1	5.0 V,5	13-25
8.1.2.D-6	8-4	6.0 V,14	13-63
8.1.2.D-7	8-4	6.0 V,15	13-64
8.1.3.B-1	8-9	6.0 V,16	13-65
		6.0 V,17	13-66

D. HED corrective actions that need to be implemented by completion of first refueling outage.

HED No.	Section-Page
1.5.5.A-1	1-86
1.5.5.A-2	1-86
1.5.5.A-3	1-86
6.5.2.B.3-7	6-48
8.2.1. OS,5	11-33
8.2.1. OS,6	11-34
8.2.1. OS,10	11-36
8.2.1. OS,11	11-37
8.2.1. OS,12	11-38
8.2.1 VL,2	12-5
8.2.1 VL,3	12-6

APPENDIX B

Differences Between NUREG-0700 and CECo Checklist Presented at Quad Cities Station Pre-Implementation Audit on June 11, 1985

1.1.1.A 0700 PRESENT IN THE CONTROL ROOM-Control room instrumentation and equipment should include all controls and displays needed for (1) detection of abnormal conditions, and (2) bringing the plant to a safe shutdown condition.

CECO PRESENT IN THE CONTROL ROOM-The control room contains all controls and displays required by the Task Analysis for emergency operations.

JUSTIFICATION: Abnormal conditions and shutdowns are covered in the task analysis.

1.1.1.B 0700 ARRANGED TO FACILITATE COVERAGE-Operators should not have to leave the primary operating area (see Exhibit 6.1-1) to attend to control room instrumentation on back panels during operational sequences in which continuous monitoring or the timing of control actions may be critical.

CECO ARRANGED TO FACILITATE COVERAGE-All controls and displays needed during emergency operation are contained within the primary operating area (see Exhibit 1-1).

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

1.1.2.A 0700 COVERAGE-Control room manning and task assignments should ensure complete and timely coverage of controls, displays, and other equipment required during all modes of operation.

CECO COVERAGE-Control room manning and task assignments ensure complete and timely coverage of controls, displays, and other equipment required during emergency operations.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

1.1.2.B 0700 UTILIZATION OF ADDITIONAL PERSONNEL-Additional onsite or offsite personnel may augment the normal crew complement under certain conditions (e.g., refueling). If so, activities and task assignments should be planned to ensure proper coordination. (Note: special training for this situation may be required.)

1.1.2.B CECO UTILIZATION OF ADDITIONAL PERSONNEL-Procedures/policies address the need for additional onsite or offsite personnel to augment the normal crew complement under certain conditions as defined by CECO Generating Station Emergency Plan.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

1.2.3.D.2 0700 Other controls may be mounted as far back as 25 inches from the console edge. This distance accomodates the extended functional reach of the 5th percentile as defined.

CECO Controls are no more than 30 inches from the console edge.

JUSTIFICATION: The extended functional reach of 5th percentile female is 28.9" without stretching. Locating controls 30" from the console edge is realistic in that most operators exceed the value of the 5th percentile female and they will tend to bend slightly over the console to manipulate controls.

1.2.3.E 0700 DISPLAY POSITIONING-The principal factors affecting the readability of displays, including annunciator tiles, are (1) display height and orientation relative to the operator's line of sight when he/she is standing directly in front of the display; (2) display distance and orientation relative to the operator's straight-ahead line of sight when the operator must read the display from an off-side position; and (3) the size of display markings relative to the distance at which the display must be read. Marking/character size is addressed in Guideline Section 6.5.1, and is not considered here. Except as specifically noted, measurements of angles should be made with the eye point in line with the leading edge of the benchboard. This is illustrated in Exhibit 6.1-7.

CECO DISPLAY POSITIONING-The principal factors affecting the readability of displays, including annunciator tiles, are: (1) display height and orientation relative to the operator's line of sight when he/she is sitting directly in front of the display; (2) display distance and orientation relative to the operator's straight-ahead line of sight when the operator must read the display from an off-side position; and (3) the size of display markings relative to the distance at which the display must be read. Marking/character size is addressed in Guideline Section 5.1, and is not considered here. Except as specifically noted, measurements of angles should be made with the eye point in line with the leading edge of the benchboard. This is illustrated in Exhibit 1-10.

1.2.3.E

JUSTIFICATION: Possible misprint in 0700. The word "standing" has been changed to "sitting" in item one of the description of display positioning for "sit-down" consoles.

1.2.3.F.1

0700 For control and monitoring actions that must occur in sequence, all necessary controls and displays should be within the maximum extended reach and the viewing range of the seated operator from a single reference point.

CECO For control and monitoring actions that must occur in sequence during emergency operations as determined from the task analysis, all the necessary controls and displays are within the maximum extended reach and the viewing range of the seated operator from a single reference point.

JUSTIFICATION: The scope of DCRCR covers only those instruments required during emergency operations.

1.2.3.F.2

0700 For the situation described in item 1, above, and sustained or precise control action, the operator should be able to reach the controls without having to bend/stretch significantly.

CECO For the situation described in item 1, above, and sustained or precise control action is required, the controls are within 29 inches.

JUSTIFICATION: The extended reach for 5th percentile female is 28.9" without bending or stretching. By bending slightly she can reach the 29 inches. This limit more clearly quantifies the criteria.

1.2.5.A.2

0700 Controls requiring precise or frequent operation and emergency controls should be placed in an area between 34 inches and 53 inches above the floor.

CECO Emergency controls, as identified in the task analysis, are placed in an area between 34 inches and 53 inches above the floor.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

1.2.8.C 0700 ARMRESTS-Where personnel may remain seated for relatively long periods, chairs with armrests are preferred. Adjustable or retractable armrests may be necessary to allow the elbows to rest in a natural position and for compatibility with a particular desk/console.

CECO ARMRESTS-Where personnel may remain seated for relatively long periods, chairs with armrests are provided.

JUSTIFICATION: Adjustable armrests are not viewed necessary. Operators do not sit for long periods performing manual tasks. Armrests are provided on chairs.

1.2.8.F 0700 SEAT ADJUSTABILITY-For chairs at sit-down stations, seat height should generally be adjustable from 15 to 18 inches (Exhibit 6.1-19). For chairs at sit-stand stations, seat height should be adjustable from 26 to 32 inches (Exhibit 6.1-20).

CECO SEAT ADJUSTABILITY-For chairs at sit-down stations, seat height is adjustable from 15 to 18 inches (Exhibit 1-17). For chairs at sit-stand stations, seat height is adjustable from 26 to 30 inches (Exhibit 1-18).

JUSTIFICATION: Woodson, 1981 pg. 682, allows for chairs, used at sit-stand stations, to adjust to a maximum of 30 inches.

1.5.3.B 0700 UNIFORMITY-The level of illumination should not vary greatly over a given work station.

CECO UNIFORMITY-The level of illumination does not vary more than 10 fc over a given work station.

JUSTIFICATION: The establishment of 10 fc provides a standard to be utilized across all CECO stations.

3.2.1.C

0700 LIMITS-The signal should capture the operator's attention but should not cause irritation or a startled reaction.

CECO LIMITS-The signal intensity does not exceed 90 dB(A).

JUSTIFICATION: The establishment of 90 dB(A) provides a standard to be utilized across all CECO stations. This standard does not exceed the maximum intensity of 90-115 dB(A) found in Guideline 2.2.6.C for maximum intensity for signals.

3.2.1.D

0700 DETECTION-Each auditory signal should be adjusted to result in approximately equal detection levels at normal operator work stations in the primary operating area.

CECO DETECTION-All auditory signals are within ($\pm$2.5dB) of the average of all annunciator auditory signals.

JUSTIFICATION: 0700 criteria is based on "HFEB Preferred Practice". ($\pm$2.5dB(A)) better quantifies this criteria and are detectable.

DIFFERENCES BETWEEN NUREG-0700 AND CECO CHECKLIST

4.1.1.A

0700 ADEQUACY-Each control should be adequate for the function it performs.

CECO ADEQUACY-Each control used for emergency operations should be adequate for the function it performs.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

4.1.1.B

0700 ECONOMY-Each control should be necessary, and the simplest effective control for the task concerned.

CECO ECONOMY-Each control should be necessary, and the simplest effective control for the emergency tasks performed.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

4.2.1

0700 DIRECTION OF MOVEMENT-To minimize operator error, control movements should conform to the following population stereotypes (for U.S. population only):

CECO DIRECTION OF MOVEMENT-Control movements conform to the following population stereotypes (for U.S. population only):

JUSTIFICATION: 0700 specifications for "raise" and "lower" are too strict. MIL-STDC, pg 63, 5.4.1.2.1 and Van Cott and Kinkade, p 350, table 8-2 are less strict.

4.2.2.C.4

0700 When knob thickness is a coding parameter, differences between thicknesses should be at least 0.4 inch.

CECO When knob thickness is a coding parameter, the difference between thicknesses is at least 0.375 inch.

JUSTIFICATION: When knob thickness is a coding parameter, the difference between thickness of at least 0.375 inches is supported in McCormick.

DIFFERENCES BETWEEN NUREG-0700 AND CECO CHECKLIST

4.2.2.B

0700 LOCATION CODING-Controls should be located so as to be easily related to functions and functional groupings. Controls with similar functions should be in the same location from panel to panel. (See Guideline 6.8.2.3.)

CECO LOCATION CODING-Controls are located so as to be related to functions and functional gruopings.

JUSTIFICATION: 0700 wording creates confusion. 0700 criteria implies that all controls with certain functions (i.e., pumps, valves, fans, etc.) are in the same location from panel to panel. Guideline 8.2.3.A implies that all control sets (i.e., inlet valve-pump-discharge valve) are consistently grouped. CECO changes the words to be more consistant with Guideline 8.2.3.A.

4.3.2.A.1

0700 Unguarded and nonrecessed pushbuttons Minimum 0.385

CECO Unguarded and nonrecessed pushbuttons. Minimum 0.375 - Maximum 0.75.

JUSTIFICATION: A minimum diameter of .375 for unguarded and nonrecessed pushbuttons is supported in MIL STD 1472.

4.4.3.C.1

0700 Displacement (A) (degrees)
Minimum 80°
Maximum 90°

CECO Displacement (A) (degrees)
Minimum 30°
Maximum 90°

JUSTIFICATION: In MIL-STD 1472C, pg 74, minimum displacement for key operated controls is 30°. (Possible misprint in 0700).

4.4.5.E 0700

CECO Displacement (A) (degrees)
Minimum 15
Maximum 90

JUSTIFICATION: CECO is making "displacement" for rotary controls a Guideline (from Exhibit 6.4-13 in 0700).

DIFFERENCES BETWEEN NUREG-0700 AND CECO CHECKLIST

5.1.1.A

0700 TASK ANALYSIS-Analysis of operator tasks in relation to system engineering and system functional objectives is recommended as the surest means of establishing operator information requirements.

CECO TASK ANALYSIS-Analysis of operator tasks in relation to system engineering and system functional objectives is recommended as the surest means of establishing operator information requirements.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

5.1.2.A

0700 SCALE SELECTION-Scale units should be consistent with the degree of precision and accuracy needed by the operator.

CECO SCALE SELECTION-Scale units are consistent with the degree of precision and accuracy needed by the operator to perform tasks during emergency operations.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

5.1.2.D.1

0700 Span the expected range of operational parameters, or

CECO Span the expected range of emergency operational parameters, or

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

5.1.4.B

0700 AVOIDANCE OF EXTRANEOUS ITEMS-Categories of information not needed in using the display should be avoided (e.g., patent notices, manufacturer's trademark or address).

CECO AVOIDANCE OF EXTRANEOUS ITEMS-Categories of information not needed in using the display do not interfere with reading of the display, (e.g., patent notices, manufacturer's trademark or address).

JUSTIFICATION: Word changes have not altered the direction of the criteria. New wording makes the criteria easier to evaluate.

DIFFERENCES BETWEEN NUREG-0700 AND CECO CHECKLIST

6.6.1 0700 NEED FOR LOCATION AIDS-Operator performance can be enhanced through the use of location aids such as demarcation, color, and mimics.

CECO Deleted from checklist

JUSTIFICATION: Eliminated from checklist due to the fact that it is not an item to be evaluated.

6.6.3.B.1 0700 Appears as 6.6.4.B.1
Differential line widths may be used to code flow paths (e.g., significance, volume, level).

CECO If line width is used to code mimics there should be a 25% difference in the size of each of the widths used.

JUSTIFICATION: Based on MIL-STD 1472C, 5.2.4.2, pg 32 - requiring pictorial graphics to meet the criteria of visibility stated within the MIL-STD 5.5.6.2.5. for size graduation of labels. Graduations of 25% should be used to more clearly quantify the criteria.

DIFFERENCES BETWEEN NUREG-0700 AND CECO CHECKLIST

8.1.1.A

0700 GROUPING BY TASK SEQUENCE-Controls and displays should be assigned to work stations so as to minimize operator movement. To the extent practical, this assignment should consider both normal and emergency procedures. It should be practical to perform all frequently occurring routine tasks, and time-sensitive emergency tasks, with a minimum of human movement from panel to panel.

CECO GROUPING BY TASK SEQUENCE-Controls and displays for tasks sequences performed during emergency operations are grouped together.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

8.1.1.C

0700 GROUPING BY IMPORTANCE AND FREQUENCY OF USE-Within the constraints of grouping by task sequence and by system function, controls and displays should be assigned to panels depending on their importance and frequency of use. Controls or displays which are neither important to plant safety nor frequently used should be installed in secondary panel locations.

CECO GROUPING BY IMPORTANCE AND FREQUENCY OF USE-Within the constraints of grouping by task sequence and by system function, controls and displays are assigned to panels depending on their importance and frequency of use during emergency operations.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

8.2.1 0700 SEQUENCE, FREQUENCY OF USE, AND FUNCTIONAL CONSIDERATIONS
8.2.1.A
8.2.1.A.1
8.2.1.A.2
8.2.1.A.3

The layout of panels is a compromise among a number of considerations. In some instances, various human factors principles will conflict, not only with each other but also with other design requirements. Because it is difficult to rate the conflicting considerations for importance, final decisions must be based on careful evaluation and sound judgment. This subsection deals with the analysis of the factors of task sequence, frequency of use and function.

a. SEQUENCE-Controls and displays which are used together during a normal task sequence should be grouped together.

(1) Displays which are observed in a specified sequence, as during hot-leg temperature check for all reactor coolant loops, should be grouped together. It is desirable that they be positioned so that they are normally used in a left-to-right, top-to-bottom, or other natural sequence.

(2) Controls which are operated in sequence, as in energizing a system or aligning a series of valves for a particular function, should be grouped together. It is desirable that they be positioned so that they are normally used in a left-to-right, top-to-bottom, or other natural sequence.

(3) When there is a set of related controls and displays, the layout of displays should be symmetrical with the controls they represent.

8.2.1 CECO SEQUENCE, FREQUENCY OF USE, AND FUNCTIONAL CONSIDERATIONS
8.2.1.A
8.2.1.A.1
8.2.1.A.2
8.2.1.A.3

a. SEQUENCE-Controls and displays which are used together during an emergency task sequence should be grouped together.

(1) Displays which are observed in a specified sequence, are grouped together. They are positioned so that they are normally used in a left-to-right, top-to-bottom, or other natural sequence.

(2) Controls which are operated in sequence, are grouped together. They are positioned so that they are normally used in a left-to-right, top-to-bottom, or other natural sequence.

(3) When there is a set of related controls and displays, the layout of displays is consistent with the controls they represent.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

8.2.1.B
8.2.1.B.1
8.2.1.B.2

0700 FREQUENCY OF USE-Frequently used controls and displays should be arranged to reduce search time and minimize the potential for error during use.

(1) They should be near the center of the preferred visual and manual areas.

(2) They should be positioned so as to be easily identified.

CECO FREQUENCY OF USE-Controls and displays used frequently during emergency operations are arranged to reduce search time.

(1) These controls and displays are near the center of the preferred visual and manual areas.

(2) These controls and displays are positioned so as to be easily identified.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

8.2.1.C
8.2.1.C.1
8.2.1.C.2

0700 FUNCTIONAL CONSIDERATIONS-Functionally related controls and displays should be grouped together when they are:

(1) Used together to perform tasks related to a specific function (e.g., operation of the residual heat removal system).

(2) Identical in purpose (e.g., reactor coolant pumps).

CECO FUNCTIONAL CONSIDERATIONS-Functionally related controls and displays are grouped together when they are:

(1) Used together to perform tasks related to a specific function during emergency operation.

(2) Identical in purpose.

JUSTIFICATION: The scope of the DCRCR covers only those instruments required during emergency operations.

APPENDIX C

Incomplete Studies and Reviews

These studies and reviews should result in potential corrective actions and/or will be described in design packages that will be tailored for use in modifying the Dresden control room.

- Control Room Enhancement Package

  - Labeling Package
    - Characteristics
    - Supplemental information for instruments
    - Width to height ratios of letters
    - Readability
    - Functional relationship
    - Valve identification numbers
    - Inappropriate identification of components
    - Summary lead labeling
    - Placement
    - Clarity
    - Nomenclature
    - Mounting
    - Cleaning
    - Consistency
    - Standardization of:
      - Acronyms
      - Abbreviations
    - Procedure for handling temporary labels
    - Hiearchical labeling

  - Mimics
    - Standardization of use
    - Color
    - Flow direction
    - Background shading

- Lines of demarcation

- Annunciator Design Change Package

  - Alarm message/legend consistency
  - Auditory coding
  - Alarm printout and capability
  - Reflash
  - Content/wording on tile
  - Functional grouping
  - Prioritization

- Control Room Habitability Package

  - Auditory environment
  - Lighting review package
    - Glare
    - Shadowing
    - Luminance
    - Reflectance
    - Full core display SCRAM lights

- Controls

  - Inappropriate key locks will be replaced with different controls (HEDs 4.4.3.A-5/4.4.3.A-4)

- Meter and Display Package

  - Scale
  - Multiple scale meters
  - Color banding
  - Meter face review

- Rod Worth Minimizer Redesign

- Integration Plans with Regards to Reg Guide 1.97

- Computer Display Guidelines to be Established

  - Differentiate unused key from active key
  - Software change
  - Review display for:
    display of data
    color
  - Cross reference code matrix for printouts

- Panel 6 Enhancement Program (HED 8.1.2 OS,11)