ENCLOSURE

IN-PROGRESS AUDIT

OF THE

DETAILED CONTROL ROOM DESIGN REVIEW

FOR

ZION STATION, UNITS 1 AND 2

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FOREWORD

This Audit Report 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 assessment 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 its nuclear stations, including Zion Station, Units 1 and 2. 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. The NRC performed audits at other CECo plants (Dresden Nuclear Station, Units 2 and 3; and Quad Cities Station, Units 1 and 2) which used the same review process as Zion Station. This report includes the SAIC evaluation of the Detailed Control Room Design Review (DCRDR) for Commonwealth Edison Company's Zion Station, Units 1 & 2.

An in-progress audit was conducted at Zion Station, Units 1 & 2, on November 12-14, 1985. This audit report is based upon the information provided by the licensee during the Zion in-progress audit and the two previous DCRDR audits conducted at CECo nuclear stations, and in the CECo Program Plan.

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This report documents the findings from an in-progress audit, November 12-14, 1985, of the Detailed Control Room Design Review (DCRDR) program being conducted at Commonwealth Edison's Zion Station, Units 1 & 2. The review by CECo at Zion was being 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 1). 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 2). 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 its approach.

Results of the SAIC evaluation follow a brief overview of the background leading up to the in-progress audit findings.

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 3). The need to conduct a DCRDR was confirmed in NUREG-0737 (Reference 4) and in Supplement 1 to NUREG-0737 (Reference 5). 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 6) while criteria for NRC evaluation of a DCRDR are contained in NUREG-0800 (Reference 7).

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, the 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 audit report is to assist the NRC in the technical assessment process by providing an appraisal of the Zion 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 audit report. The nine issues are:

1. Establishment of a qualified multidisciplinary review team.

2. Use of function and task analysis 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 its nuclear stations including Zion Station, Units 1 and 2. The NRC staff met with CECo on June 14, 1983, at which time 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 Zion 1 and 2.

2. Establishment of a Qualified Multidisciplinary Review Team

The Program Plan for Zion 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 Zion 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 then to a CECo Executive Vice President.

The Zion 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 the information and documentation provided at the audit, the members of the core team appeared qualified to perform DCRDR activities. Expertise of the team included:

- o Instrumentation and control engineering
- o Engineer/architect with control room design experience
- o Operations
- o Human factors engineering.

Eight 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 (Appendix A) was presented at the on-site audit 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. However, information of the SMEs' qualifications was not provided at the audit. It is recommended that CECo should include the above information in the Zion Summary Report.

In summary, we believe CECo has demonstrated a process which will satisfy the requirement for establishing a qualified multidisciplinary review team.

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 Zion Station to identify conditions which impact probability for those operator errors which could affect safe operation of the generating stations. 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 will be reviewed. All in-house documentation including Zion Licensee Event Reports (LERs), Zion Deviation Reports (DVRs), and Zion Professional Committee Reports (PROs) will be reviewed by a Human Factors Specialist (HFS). Industry-wide Significant Event Reports (SERs) and Significant Operating Event Reports (SOERs), acquired from the Institute of Nuclear Power Operators (INPO), for the past five years also will be reviewed by the HFS. All reports collected will be reviewed to identify those reports that involved control room operator, procedural and/or control board equipment failure, and/or design arrangement errors.

Criteria were developed for analyzing the above-mentioned reports to identify and prioritize those reports which documented a control room problem. Each high priority report that describes a problem relevant to the control room will be investigated to determine if the problem already had been addressed adequately from a human factors perspective. If the problem had not been addressed adequately 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) will be completed. To date, this review effort has progressed to a point where the data collection is almost completed, with the analysis remaining to be finished.

The Zion 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 Zion. 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 Zion 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.

The questionnaires were mailed out for completion and returned by mail to CECo and given to the HFS unopened. Confidentiality was ensured 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 will be 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 will be interviewed. The objectives of the follow-up interviews will be (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 are collected, all information from the completed survey activities will be compiled, reduced, and analyzed. Findings, written as prospective HEDs, later will be reviewed during the assessment process.

At the audit, it was learned that approximately seventy questionnaires were distributed to Zion personnel as a result of this effort. However, so far about fifteen (21.4%) have been returned to the HFS. The audit team expressed a concern regarding this low number of respondents when compared with an industry average of forty to fifty percent. Audit team experience indicates that operator questionnaires and interviews typically provide the most significant assessment of control room conditions. A review of the content and the distribution technique of the questionnaire indicated a number of problems that may be the reason for the low turnout. These include:

- The questionnaire was constructed using the critical incident technique that emphasized not only the recall of negative situations, but also possible identification of co-workers involved.

- On the front page of the questionnaire, where the bibliographical data are entered, it is noted that the return address is through the Plant Superintendent. While the HFS will be the only person to read the questionnaires, the mailing system may appear to the

respondents as a possible compromise of the ensured confidentiality.

- The questionnaires were distributed during an early phase of the DCRDR program before a good rapport had been built between the plant operations personnel and the review team. If the questionnaire had been administered later on during the program after the HFS had gained the confidence of the plant operations personnel, it is possible that the response rate could have been higher.

The utility indicated that it may conduct this activity again. If so, the utility may consider the above concerns, and undertake efforts to reconcile the perceived problems to achieve a more fruitful result.

In summary, CECo's operating experience review at Zion appears extensive, and thorough. Consistent with NUREG-0700 objectives and guidelines, it entailed a systematic examination of industry-wide reports and plant-specific documents. Structured questionnaires and semi-structured interviews will be administered to and conducted with a range of operating personnel. However, the operator experience review activity has not resulted in the anticipated amount of feedback from plant personnel, as indicated by the low return rate of the questionnaires. It is recommended that the utility consider the concerns outlined above, and undertake appropriate measures to obtain further inputs from Zion plant personnel and subsequent CECo stations.

2. System Function and Task Analysis

The objective of the Zion 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 Westinghouse Owner's Group (WOG) Emergency Response Guidelines (ERGs) were made plant-specific by subject matter experts who eliminated references to those systems and equipment not found at Zion. 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 scope of the system function and task analysis includes all events listed in the WOG's ERGs.

The tasks subsequently were broken down into task elements and/or action steps by 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 asked about each task, such as task conditions, initiating cues, frequency performed, and performance criteria, 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 (Appendix A), later entered in a data base, 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 and 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. At the time of the audit, the task development phase was almost finished.

While task development was underway, display and control requirements are being collected and coded on Task Analysis Instrument and Control Requirement Forms (Appendix A) for each action step. Like the task elements, the display and control requirements will be 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 will be performed by checking for the existence of required instrumentation in the control room. If the required

instrumentation is found to be present, then a code number representing that particular item will be entered onto the data recording sheets confirming the availability of the required instrumentation. However, if the required displays or controls do not match what is physically available in the control room, this will be coded on the data collection form as a discrepancy or "no match."

Overall, CECo's system function and task analysis is being conducted in a comprehensive and systematic fashion. The analysis was based on the WOG's ERGs which were made site-specific by the deletion of equipment and systems that were not applicable to the Zion 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 will be derived for each action step. After the SMEs have defined the instrument and control requirements for each action step, they will be compared with existing control components and a code number corresponding to applicable existing control room components will be assigned to the action step. During the conduct of this analysis, SMEs will be able to use schematics, procedures, and other aids from the control room to "enable SMEs to be more thorough." At this time, the utility is almost finished with the system function and task analysis.

The primary factor that indicates that these "in control room" task analysis steps do not bias the results of the analysis is the existence of numerous "no-matches." These "no matches" often resulted in HEDs, identified during other CECo stations' DCRDRs (such as Quad Cities and Dresden) that followed the same methodology. The HFSs also lead the SMEs, who will be taking part in the analysis, with appropriate questioning to make sure that they do not bias their requirements-based analysis through their familiarity with the installed equipment. The process described above will result in an integrated task analysis and inventory comparison rather than two isolated steps. The audit team agreed that 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 Zion inventory effort included compilation of an inventory followed by a verification for suitability. As both activities are necessary to satisfy the inventory requirement of Supplement 1 to NUREG-0737, both are described below. At the present time, the control room inventory for Unit 1 has been completed, while Unit 2 inventory is still in progress.

The objective of the Zion 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 are 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 Zion Units 1 and 2, 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 is accomplished, a verification of equipment availability and suitability is performed. The objective of the verification process was to ensure that operator tasks derived from the plant-specific Emergency Operating Procedures (EOPs) could be performed in the existing control room with minimum potential for human error.

There were two aspects to the verification process. First, as described in the system function and task analysis, it was determined whether appropriate equipment was available in the control room to perform each task required by emergency operations. Second, for equipment that had been identified as available, criteria such as those specified on pages 6-34 through 6-36 of the Quad Cities Summary Report (Reference 8) found in

Appendix A, 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 resulting from a lack of control room item suitability.

Overall, CECo has provided a detailed description of what appears to have been a well-planned and executed control room inventory process. 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. If CECo follows the process described at the audit, it would appear that the control room inventory requirement of Supplement 1 to NUREG-0737 will be met.

4. Control Room Survey

At the audit, it was indicated that the control room survey process at Zion was the same one used at Quad Cities and Dresden. Due to this similarity, the comments solicited at the Quad Cities pre-implementation audit are also applicable for the survey process at Zion.

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 shown in Appendix C, some CECo guidelines differed from those in NUREG-0700. The licensee states "Some of the items were quantified or reworded so as to make them clearer and more precise." During the pre-implementation audit, these differences between NUREG-0700 and the CECo

checklist were reviewed in detail. The differences are discussed in the following sectio .

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 that 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 that 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 four 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 (probably about 20 dB(A)), 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.

At the Zion in-progress audit, the above differences were again discussed with CECo. The licensee indicated that it intends to perform an anthropometric study to justify its position on the first three differences identified above (NUREG-0700, items 1.2.3.D.2, 1.2.3.F.1, and 1.2.3.F.2). For the last deviation, item 3.2.1.C, the licensee has agreed with the team position. However, it was not amended in the survey checklist currently used at Zion.

In summary, the survey effort was complete in that it covers 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, are also surveyed. While primarily using the guidelines in NUREG-0700 as the basis for its survey, CECo did modify four guidelines to which the audit team did not agree. As described above, these differences were discussed at the Zion audit, and as a result, it is recommended that CECo provide the findings of its anthropometric study in the Zion Summary Report, and incorporates the resolution on item 3.2.1.C into the survey checklist. The control room should be rechecked for these items and responses provided if it is not in compliance. Although recommended for review in NUREG-0700, the remote shutdown capability was not considered as part of the CECo review at Zion.

Remote Shutdown Panel Survey

The NRC has recommended that a human engineering evaluation of the remote shutdown capability be included within the scope of the DCRDR, although not explicitly identified as a requirement in Supplement 1 to NUREG-0737. Members of the NRC audit team did review the Zion remote shutdown capability and felt that it has many problems summarized as follows:

- o There was a lack of human factor input to the design of the remote shutdown panels.

- o While it appears that there were modifications of the remote shutdown panels, these were not incorporated or updated in the operating procedures for remote shutdown.

Appendix D provides a more detailed description of the remote shutdown capability and its perceived problems.

5. Validation of Control Room Functions

Commonwealth Edison Company will conduct a validation review at Zion 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.

Due to the fact that many of Zion's systems, instruments, and controls are identical to the Westinghouse simulator located at Zion, it was decided that the validation for Zion could be conducted at the Westinghouse simulator using a walk-through/talk-through approach. The events which will be used in the validation were not finalized at this time. However, the licensee indicated that the events recommended by NUREG-0700, such as normal reactor startup and shutdown, small break loss of coolant accident, and multiple failure of tubes in a single steam generator and tube ruptures in more than one steam generator will be examined in addition to plant specific events.

Operations personnel will walk through procedural steps of selected emergency events which are unique to Zion. Selected emergency events will be chosen to provide for the exercise of all major systems and every control room workstation. Operations personnel will walk through each procedural step and describe the action being taken, the information sources used, any uncertainties involved, the controls used, the expected system response, and how the response would be verified.

An HFS will accompany each operator and observe the relationship between operator performance and control board/control room design and evaluate the walk-through against a number of procedurally-related criteria including (1) whether units of measurement displayed were appropriate and consistent with procedure; (2) labels associated with various controls, displays, and annunciators referenced/used were readily identifiable; and (3) the operator actions expressed or implied by the procedure were within the capability of the operator (pg. 4-30 of the Program Plan). Where the HFS observes instances in which equipment availability, suitability or location could be enhanced, or in which operator uncertainty due to procedural ambiguity could be minimized, HEDs will be written.

The simulator validation will be videotaped and reviewed to generate HEDs. The validation process is scheduled to start on 12/02/85 and to last approximately three weeks until the review of the videotapes is completed.

The licensee will implement a validation procedure consistent with the guidelines of NUREG-0700. Events chosen for walk-through will be consistent with those suggested in NUREG-0700 and exercise all control room work

stations. Real-time simulator results applicable to Zion will also be considered in the validation.

ASSESSMENT AND IMPLEMENTATION

1. HED Assessment Methodology

At the Zion audit, CECo indicated that the assessment process to be applied at Zion will be the same method used at Quad Cities. Therefore, the following comments raised at Quad Cities' audit should be considered applicable to the assesment phase at Zion.

The assessment of HEDs generated by the previously described DCRDR activities will be 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 (SNED) Station Project Engineer, and the Station Assistant Superintendent for Operations. The team will meet and review the HEDs. Based on team consensus, HEDs will be classified into one of three categories (I, II, or III) based on the level of safety relatedness of the equipment in question. The HEDAT will then determine 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 Categories I or II.

The HEDAT-assigned levels of severity are as follows:

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

Level B: Includes HEDs that 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. However, at the Quad Cities 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 Category I HEDs.

Level assignment will be 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. Personnel from the Station Operations and Station Nuclear Engineering Departments will meet 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 will be differentiated from those not to be corrected, and justifications for HEDs not to be corrected will be prepared.

From a review of both the Program Plan and the Quad Cities Summary Report assessment methodologies (which are applicable to Zion DCRDR), certain differences were found. While the following differences were discussed at the pre-implementation audit with representatives of CECo, the NRC audit team indicated that further documentation by CECo is necessary 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 reason why the Pre-Assessment Form described on page 5-3 of the Program Plan, and included in Appendix A of the Quad Cities 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 Quad Cities 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 Quad Cities Summary Report indicates otherwise.

In addition, two assessment practices used at Quad Cities were found to be inappropriate.

1. During the audit at Quad Cities, 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. An audit of these cancelled HEDs revealed the weakest link in an otherwise superior documentation system since there was no documented reasons for cancelling these HEDs. At Zion, it is recommended that more detailed minutes of all HEDAT reviews should be kept, noting the disposition and reasons for actions taken on all HEDs.

2. The HEDs were reviewed individually by the HEDAT, but some of them were grouped in the Quad Cities Summary Report. During the 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. It is recommended that the licensee should review all grouped HEDs in the Summary Report for proper assignment of Category and Level.

During the audit at Zion, it was also noted that there are vast differences between the configuration of the front and the back panels. While the front panels are generally well laid out, the back panels are poorly designed. On one occasion, the audit team observed that the operators were confused when using the instruments and controls on the back panels. An audit of the control room survey activities indicated that the front as well as the back panels were reviewed with the same degree of completeness and thoroughness. Since Zion still is in the process of conducting its DCRDR, it is recommended that such treatment of the front and back panels will be followed during the later phases of the DCRDR which include the assessment and resolutions of HEDs.

The assessment process as will be applied at Zion is generally satisfactory, yet there were assessment practices used at Quad Cities that should be improved at Zion. Furthermore, CECo should document in the Summary Report 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.

At the audit, CECo described the process for development and comparison of alternative means for correcting HEDs. This process can be divided into two categories: 1 - control room enhancement projects such as labeling, demarcation, and mimics will be effected by the plant (Zion) management; and 2 - control room design projects that involve relocations and modifications of equipments will be the responsibility of the Station Nuclear Engineering Department (SNED). When modifications that are determined to have major

impacts on plant operations, architectural and engineering (AE) consultants will also be called upon for assistance. The HFS will be involved in all phases of the selection of design improvements process.

The process for the selection of design improvements at Zion as described by CECo is satisfactory. As required by Supplement 1 of NUREG-0737, the licensee should document all proposed control room modifications in the Summary Report. It has been found that the Summary Reports previously submitted to NRC for other CECo stations such as Quad Cities and Dresden were incomplete because there were many HEDs left unresolved, or studies or reviews designed to resolve the HEDs are yet to be accomplished.

The audit team has expressed concern that some of the DCRDR activities are a little behind schedule as presented in the Project Activity Network diagram. These scheduling delays may result in not having enough time for completing the selection of design inprovements process by the scheduled date for submission of the Zion's Summary Report. The NRC audit team suggest that CECo take appropriate actions to ensure that all HED resolutions are complete and incorporated in the Summary Report due in May of 1986.

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, HFS 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 at the audit, it appears that CECo has a coordinated program in place to address each of the Supplement 1 to NUREG-0737 initiatives. This information was presented in a well-organized process flow diagram, the "Project Activities Network for Zion Station." This flow diagram depicted all NUREG-0737 upgrade programs including EOPs upgrade, DCRDR, SPDS, and Regulatory Guide 1.97. Training was also integrated into each of these major activities.

While it appears that the coordination process is well established, the audit team is concerned that some aspects of this process may hamper the successful completion of the coordination program. These are as follows:

- It appears that several DCRDR activities are a little behind the schedule as outlined in the Project Activities Network diagram. These delays may inhibit the completion of the Summary Report as required by Supplement 1 to NUREG-0737.

- It is noted that the EOPs and DCRDR programs did not share the same system function and task analysis (SFTA). As explained at the audit, the SFTAs for both of these programs used the generic WOG ERGs as the initiating document for the task development. The SFTAs for these two programs were performed on parallel paths, with the coordination to occur after the submission of the DCRDR Summary Report to the NRC. While CECo indicated at the audit that the new EOPs will be used during the validation of control room functions conducted in the DCRDR, this process is not indicated on the Project Activities Network diagram.

- While the new EOPs used the WOG ERGs as the basis for the SFTA, it is noted that the SPDS is based on a system analysis that was developed by Quadrex. It is possible that these two different sources may introduce an incompatability between the SPDS program and the new EOPs. CECo should review both of these systems to ensure that the parameters displayed on the SPDS are consistent with those called for in the EOPs.

In conclusion, it appears that the coordination efforts will cover all NUREG-0737 initiatives and be coordinated by the CECo program coordinator. However, the NRC audit team is concerned that verification activities may be delayed until after the submittal of the Summary Report, an apparent lack of early coordination between the DCRDR and the EOPs, and the need to ensure coordination between the EOPs and the SPDS. These concerns should be addressed by CECo in the Summary Report.

CONCLUSIONS AND RECOMMENDATIONS

Commonwealth Edison Company's DCRDR being conducted at Zion Units 1 and 2 demonstrates a strong commitment towards meeting the requirements of NUREG-0737, Supplement 1. The documentation reviewed provided extensive discussions of the review activities being conducted to perform a DCRDR and indicates that Commonwealth Edison basically will meet 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.

The following is a summary of comments on Commonwealth Edison's compliance with each of the DCRDR review steps and requirements documented by the Program Plan and confirmed during discussions and review of documentation at the pre-implementation audit. In general, it appears that CECo's effort is one of the better DCRDR efforts being conducted by a utility. The review portion is 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 has described a well-qualified, adequately staffed DCRDR team, which is composed of a good skill mixture to conduct the DCRDR. Information relevant to levels of effort and staffing on DCRDR tasks was provided at the pre-implementation audit. However, information on the SMEs' qualifications still is required to be documented in the forthcoming Zion Summary Report.

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

- CECo described a system function and task analysis based on the generic WOG ERGs which were made plant-specific. All unique tasks are identified and broken down into task elements. Instrument and control requirements and relevant characteristics are being identified for task elements. The methodology appears comprehensive and systematic. While there was a preliminary concern about the independence of the task analysis from the existing control room, it is apparent from the audit that the existing instrumentation will not bias the process. If followed as indicated, the system function and task analysis of this DCRDR will satisfy the requirements of Supplement 1 to NUREG-0737.

- The licensee is compiling a complete and comprehensive control room inventory. A verification of equipment availability will then be 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 are derived from a well- executed task analysis, it is determined that this comparison will satisfactorily meet the requirements of Supplement 1 to NUREG-0737.

- The DCRDR documentation management system, which is automated, will be valuable and well used in all phases of the DCRDR.

- A human factors survey of the control room is being conducted in what appears to be a comprehensive and thorough manner. The methodology and objectives of the survey essentially are in accordance with the guidance provided in NUREG-0700 and meet the requirement of Supplement 1 to NUREG-0737. CECo's checklist deviations from NUREG-0700 in conjunction with applicable justifications for such deviations were discussed at the pre-implementation audit. While these discussions resolved a majority of the differences between NUREG-0700 and CECo's checklist, CECo should

amend its checklist to reflect the concerns previously delineated in this report and should report the results of the anthropometric study designed to justify the deviations in the three areas in which the audit team disagrees with the CECo checklist.

- The process Commonwealth Edison developed to assess the significance of HEDs appears to meet the requirement of Supplement 1 to NUREG-0737. However, there are a number of concerns and practices that CECo should consider and take appropriate actions during their assessment of HEDs. CECo should also provide the necessary justifications for the discussed concerns, and document these in the Zion Summary Report.

- While the process developed by CECo to select design improvements is satisfactory, it is noted that several DCRDR activities are a little behind the schedule as depicted in the Project Activities Network diagram. This may hamper a successful completion of the remaining DCRDR activities as required by 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 information provided by CECo indicates that there exists a process for coordinating all NUREG-0737 initiatives at Zion. However, the audit team is concerned that there is little coordination between the EOPs and the DCRDR and the need to ensure coordination between the EOPs and the SPDS. These concerns should be addressed by CECo in the Zion Summary Report.

REFERENCES

1. "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.

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

3. 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.

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

5. 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.

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

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

8. Audit Report of the Detailed Control Room Design Review for Quad Cities Station, Units 1 and 2, SAIC, August 1985.

APPENDIX D

Brief Description of Remote Shutdown Capability and Comments

Zion Remote Shutdown Capability Comments

Although not specifically required by Supplement 1 to NUREG-0737, NUREG-0700 recommends that the DCRDR include a review of the remote shutdown capability. The Commonwealth Edison Company's generic plan for accomplishment of the Supplement 1 NUREG-0737 initiatives does not include a review of the remote shutdown capability within the DCRDR process. However, members of the NRC Zion DCRDR IP audit team were provided with a tour of the various stations from which remote shutdown of Unit 2 would be accomplished. The tour was conducted by the station Production Superintendent, a licensed SRO.

At Zion, remote shutdown of a single unit to hot standby is accomplished by sending control room personnel to 4 separate areas within the plant. Additional stations must be staffed to carry the plant beyond safe hot shutdown.

Primary communications between stations is via dedicated portable radios stored in trickle chargers inside the evacuation locker located immediately outside the primary control room access. Backup communication is provided by GAITRONICs units or by sound-powered phones. Outlets for the station's B line sound-powered phone system are available near each of the primary shutdown stations as well as within the main control room.

Emergency lighting is provided by head lamp units stored in the evacuation locker in trickle charge units and by wall-mounted battery packs. Lighting appeared to be adequate.

Evacuation of the main control room and activation of the remote shutdown capability commences with entry into either procedure AOP-4, Control Room Inaccessibility, or FOP-1, Safe Shut Down Procedure for a Fire in the Control Room. The former procedure presumes no damage to the plant, e.g., the toxic gas situation, while FOP-1 presumes loss of offsite power with damage to control room circuits. FOP-1 responds to Appendix R requirements.

In either case, control room personnel attempt to trip the units, then obtain keys from a wall-mounted breakfront key locker, and evacuate to the storage locker immediately outside the control room where they pick up

predesignated scramble kits and radios and proceed to preassigned remote shutdown stations. The kits also contain copies of appropriate sections of the procedures.

Unit 1 has achieved "interim" capability with respect to Appendix R remote shutdown requirements. Upon completion of the current outage, Unit 2 will have achieved "final" capabilities. Unit 2 panels were reviewed.

During the procedure review, the auditor noted that the shift supervisor's copy of FOP-1 was not the latest revision. Therefore, although inconsistencies between the equipment and the procedure were noted they were not itemized. However, it was noted that calibration curves for conversion of digital voltmeter readouts obtained from remote shutdown panel terminal strips were provided for only one of a family of similar parameters, e.g., steam generator C level rather than A-D.

A sample check of one board indicated that terminal strips were marked to facilitate hookup of portable test equipment and jumpers.

Although the shutdown panels reviewed were undergoing outage modification, it was obvious that human factors input to the panel modification process was lacking. For example, on two of the shutdown panels, the vertical layout for charging pumps was as follows:

- Indicator, charging pump auxiliary lube oil pump.
- Indicator, charging pump.
- Switch, charging pump.
- Switch, charging pump auxiliary lube oil pump.

Reorientation to a more acceptable sequence was not included in the modification package (design change package).

No prepositioned breaker rackout tools were identified.

Balance of plant stations were not inspected.

In summary, although it may be assumed that the Unit 2 remote shutdown panels will achieve Appendix R final capability upon completion of this

outage, the result will be unacceptable from a human factors engineering standpoint. This is particularly unfortunate since the panels are rarely used and when used assume paramount significance to continued safe operation of the power plant.

CECo should be encouraged to reverse its position that the remote shutdown capability is not included in the DCRDR review process and to revise the modification package system to include human factors engineering in design changes.

APPENDIX A

Documentation Provided at the Zion In-Progress Audit

TASK	PA LARRY DAVIS	DC ROBERT HOWARD	DDC BOB HOWARD MIKE O'CONNOR CHRIS PROTT	LHFS ROBERT KERSHAVER	HFS See Page 30	T&C SPEC JIM KRASS
1. Program Definition	X	●		●		
2. Master Schedule Preparation	X	●				
3. Sub-schedule preparation		X		●		
4. Schedule Maintenance		X		●		
5. Periodic update reports		O		X		
6. Define DCRDR technical requirements		X	●	●	●	●
7. Define DCRDR Human Factors requirements		X	●	O	●	●
8. Authorize changes in #2 and #3		X				
9. Detail schedule for plant-specific review (DCRDR)		X	●	●		
10. Conduct plant-specific review (DCRDR)		X	●	●	●	●
11. Review and approve changes (HEDs)		O		X	●	●
12. Manage changes		X		●		●
13. Program assessment		X	●	●		
14. Corrective action sign-off		X		●		●
15. Final report preparation		O	X	●	●	
16. Final report review	●	O	●	X		
17. Final report approval	●	O				
18. Final report delivery	O					

X = Primary Responsibility
● = Support Responsibility
O = Approval Authority

Figure 2.2 COMMONWEALTH EDISON COMPANY DCRDR Task Responsibility Chart for Project Management

	DC (ROBERT HOWARD)	LHFS (ROBERT KERSEMER)	HFS ★	I&C ENG (JIM KRASS)	SME ★	DESIGN ENG (SVED / MIKE PETERSON)	NSO ★	SPE (MIKE PETERSON)	SASO (ED FUERST / BILL KIRTH)	T&P SPEC (OAD, et. al.)	DDC (BOB HOWARD / MIKE O'HARA / CHRIS PLOTT)
Examination of Available Documents	•	•	X SC NN	X	•	•					•
Operation Personnel Survey	X	•	X DT SC	•	X	•			•		•
System Function Review and Task Analysis	•	•	X SC, KB DT, NN	X	X	•	•				•
CR Inventory			X VARIOUS	•		•	X				•
CR Survey		•	X CP, KS, M	X	•	•	•			•	•
Verification of Availability			X CP SC	X	X	•				•	•
Verification of Human Engineering Suitability	•	•	X CP SC	X	X	•	•				•
Validation of CR Functions	X	•	X CP SC	X	X	•			•		•
HED Assessment	X	X	• VARIOUS	X	•	•		X	X		•
Recommendation Selection	X	X	• VARIOUS	X	•	•		X	X		•
Preparation of Final Report	X	X	• VARIOUS	X							X

X = Involvement Required
• = Involvement As-Needed

FIGURE 2.3 Participation Responsibility Chart Review Process

★ SC - STEPHEN COOLEY
CP - CHRIS PLOTT
DT - DONALD TAYLOR
KS - KIM SILER
KB - KAREN BUDZEIKA
NN - DONNA TERAN

★ DAVE KALEY
ADAM NYKIEL
BEN RENDALL
RANDY THORNTON
GARY MARINOFF
DAN GIERNOTH
BILL GREEN
XAVIER POLANSKI

} SME'S UTILIZED AS OF 11/11/85 ON AN AS AVAILABLE BASIS

CONTROL ROOM REVIEW
TASK DEVELOPMENT

JOB TITLE: _____ TASK NO. _____

PREPARED BY: _____ STA. NO. _____

TASK DESCRIPTION

ACTION:

ACTION STEPS: (Sequence of what must be done to accomplish ACTIONS)

TASK CONDITIONS: (Givens, Denials, Environment)

Frequency: Shift Day Wk. Mo. Bi. Mo. Quar. 6 Mos. Year Cycle Other
Once A

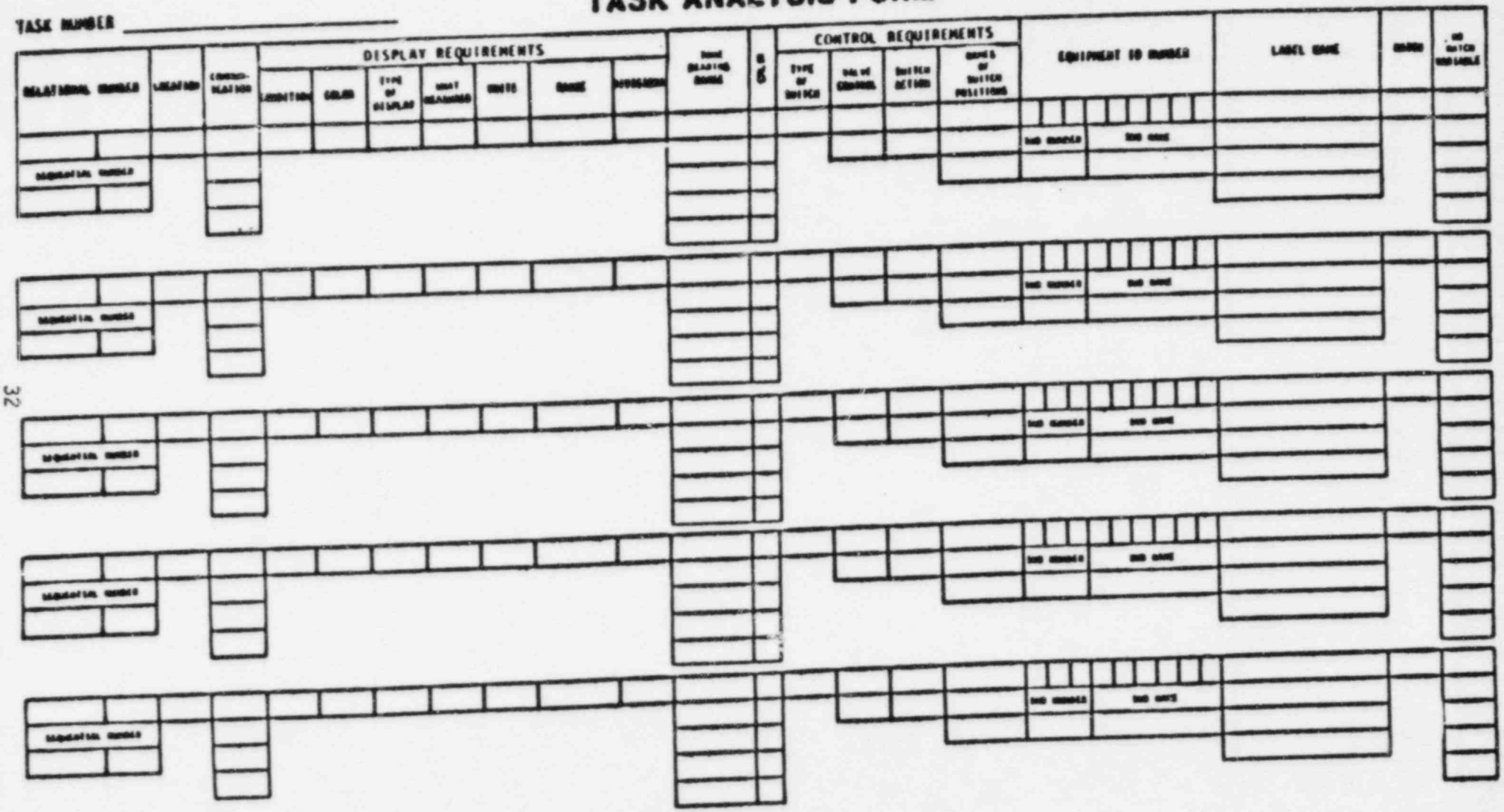
Initiating Cues: (When Does the task start)

Performance Criteria: (What Does Job Incumbant Have To Accomplish)

TASK ANALYSIS FORM

PAGE ___ OF ___

TASK NUMBER _____



INVENTORY FORM

PAGE ________ OF ________

EQUIPMENT ID NUMBER		LABEL NAME	DISPLAY REQUIREMENTS						ZONE BANDING	[illegible]	CONTROL REQUIREMENTS						
			COLOR	TYPE OF DISPLAY	WHAT [illegible]	[illegible]	RANGE	[illegible]			TYPE OF SWITCH	VALVE CONTROL	SWITCH ACTION	NAMES OF SWITCH POSITIONS			
SUB NUMBER	SUB NAME																
EPN																	
SYSTEM																	
SUB NUMBER	SUB NAME																
EPN																	
SYSTEM																	
SUB NUMBER	SUB NAME																
EPN																	
SYSTEM																	
SUB NUMBER	SUB NAME																
EPN																	
SYSTEM																	
SUB NUMBER	SUB NAME																
EPN																	
SYSTEM																	

CONTROLLER INVENTORY FORM

SYSTEM NUMBER ____________ PAGE ___ OF ___

EQUIPMENT ID NUMBER		LABEL NUMBER	TYPE OF CONTROLLER	CONTROLLED PARAMETER	CONTROL			DISPLAY REQUIREMENTS						ZONE READING RANGE
					TYPE OF CONTROL	WHAT CONTROLLED	SWITCH POSITIONS	COLOR	TYPE OF DISPLAY	WHAT MEASURED	UNITS	RANGE	DIVISIONS	
SUB NUMBER	SUB NAME													
EPN														
SYSTEM														
SUB NUMBER	SUB NAME													
EPN														
SYSTEM														
SUB NUMBER	SUB NAME													
EPN														
SYSTEM														
SUB NUMBER	SUB NAME													
EPN														
SYSTEM														
SUB NUMBER	SUB NAME													
EPN														
SYSTEM														

APPENDIX B

Attendance List for In-Progress Audit

Zion DCRDR Entrance Meeting

November 12, 1985

Name	Organization	Phone
George Pliml Plant Manager	CECo	746-2084
Terry Rieck Service Sup.	CECo	746-2084
Richard J. Eckenrode	USNRC	(301)492-4882
Robert E. Howard	CECo	294-3940
Ed Fuerst Production Sup.	CECo	746-2084 X213
Terry Printz	CECo	746-2084 X244
G. R. Bryan	NRC (Comex)	
Peter LeBlond	CECo	(312)294-3965
W.R. Kurth Asst. Sup.	CECo	746-2084 X432
F.G. Lentine	CECo-SNED	294-2833
Juan Marianyi	CECo-SNED	(312)294-2826
Kim Siler	ARD-Human Factors	872-6965
Chris Plott	ARD	837-6965
Donna Sera	ARD	872-6965
Steve Cooley	ARD	837-6161
J.M. Kriss	CECo-SEED	274-4417
Karen Budzeika	ARD	872-6965
R.L. Kershner	ARD Corp (LHFS)	(301)596-5845
Mike V. Peterson	SNED CECo (for Zion)	(312)294-2858
L.E. Davis	CECo	8147
Kathi Hesse	CECo	X 3458
Don Taylor	ARD	872-6965
J.B. Winter	ARD Corp	(804)353-1653
Phuoc T. Le	SAIC/NRC	(703)821-4488
Joe Moyer	SAIC/NRC	(703)827-4862

Zion DCRDR

Wednesday, November 13, 1985

Name	Organization	Position
Joe Moyer	SAIC	Research Psychologist
Phuoc Le	SAIC	Systems Engineer
Steve Cooley	ARD	Sr. HFS
Mike V. Peterson	SNED (Zion)	Engineer
R. Kershner	ARD	LHFS
Kim Siler	ARD	Human Factors Engineer
Chris Plott	ARD	Human Factors Engineer
Kathi Hesse	CECo	H.F. Management Assistant
R.J. Eckenrode	USNRC	DCRDR Team Leader
Robert E. Howard	CECo	DCRDR Coordinator
Jim Krass	CECo	SEED
G.R. Bryan Jr.	NRC (Comex)	
David Kaley	CECo	Procedure Coordinator

Zion DCRDR Exit Briefing

Thursday, November 14, 1985

Name	Organization	Position
Phuoc T. Le	SAIC/NRC	Engineer
Joe Moyer	SAIC/NRC	Psychologist
Mike V. Peterson	CECo (Eng.)	Engineer
Steve Cooley	ARD Corp.	Sr. HF Engineer
Kathi Hesse	CECo	H.F. Management Assistant
Don Taylor	ARD	Sr. H.F. Engineer
Robert Howard	CECo	Staff Engineer DCRDR
Terry Rieck	CECo	Zion Superintendent, Service
Gordon R. Bryan, Jr.	NRC (Comex)	Auditor
Robert Kershner	ARD Corp	Lead H.F. Specialist
Richard Eckenrode	USNRC	DCRDR Team Leader
Chris Plott	ARD	H.F. Engineer
Kim Siler	ARD	H.F. Engineer

APPENDIX C

Differences Between NUREG-0700 and CECo Checklist
Presented at Quad Cities Pre-Implementation Audit
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 (±2.5dB) of the average of all annunciator auditory signals.

JUSTIFICATION: 0700 criteria is based on "HFEB Preferred Practice". (±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.

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 groupings.

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.

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, 5.2.8.2, 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.

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
8.2.1.A
8.2.1.A.1
8.2.1.A.2
8.2.1.A.3

0700 SEQUENCE, FREQUENCY OF USE, AND FUNCTIONAL CONSIDERATIONS

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
8.2.1.A
8.2.1.A.1
8.2.1.A.2
8.2.1.A.3

CECO SEQUENCE, FREQUENCY OF USE, AND FUNCTIONAL CONSIDERATIONS

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.