SAIC-87/3001

TECHNICAL EVALUATION OF COMMONWEALTH EDISON COMPANY'S DETAILED CONTROL ROOM DESIGN REVIEW OF ZION STATION - UNITS 1 AND 2

TECHNICAL EVALUATION REPORT

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SAIC

Science Applications International Corporation

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TECHNICAL EVALUATION REPORT
OF COMMONWEALTH EDISON COMPANY'S
SUMMARY REPORT
OF THE
DETAILED CONTROL ROOM DESIGN REVIEW
OF ZION STATION, UNITS 1 AND 2

1. INTRODUCTION

The Commonwealth Edison Company (CECo) submitted a generic Program Plan to the NRC on April 14, 1983, for conducting Detailed Control Room Design Reviews (DCRDRs) at all of its nuclear stations, including Zion Station, Units 1 and 2 (Reference 1). The NRC staff reviewed the Program Plan. Since the CECo Program Plan provided insufficient details, the NRC staff met with the licensee on June 14, 1983, at which time additional information was provided that described the DCRDR process to be used by CECo. NRC evaluation comments were prepared and transmitted to the licensee on July 11, 1983 (Reference 2). A result of the NRC's review of CECo's Program Plan was to conduct an in-progress audit at Zion Station 1 and 2. The NRC also conducted DCRDR audits at the CECo nuclear stations (Dresden, Quad Cities, and LaSalle) which used the same review process as Zion Station. The in-progress audit was conducted at Zion Station, Units 1 and 2, on November 12-14, 1985. The audit report was based upon the information provided by the licensee during the Zion audit, previous DCRDR audits conducted at other CECo nuclear stations, and the CECo Program Plan. This in-progress audit report was transmitted to CECo on January 24, 1986 (Reference 3). The audit report addressed all of the nine elements of the DCRDR process required for conformance with Supplement 1 to NUREG-0737 (Reference 4). Additional review guidance is provided by NUREG-0700 (Reference 5) and NUREG-0800 (Reference 6). Additional information was requested in order to assist in verifying compliance with NUREG-0737, Supplement 1. CECo responded to the NRC by submitting the Final Summary Report for Zion Station, dated April 18, 1986 (Reference 7).

A review of the submitted Summary Report indicated that there were several issues that required further clarification from the licensee. Thus, to expedite resolution of these outstanding issues, it was suggested that a meeting be held with the licensee. A proposed meeting agenda was developed

and forwarded to the NRC on August 21, 1986 (Reference (8). On December 11, 1986, the NRC met with the utility, and the majority of the originally raised issues were resolved. A list of the meeting attendees is attached in Appendix B of this report. The results of this meeting were also documented with the NRC in a letter and attachments dated December 30, 1986 (Reference 9). This report is an evaluation of the DCRDR for CECo's Zion Station Units 1 and 2.

2. EVALUATION

Science Applications International Corporation (SAIC) has reviewed all available information on the DCRDR at Zion Station, Units 1 and 2 to date. The purpose of this review was to evaluate whether the DCRDR requirements of Supplement 1 to NUREG-0737 have been satisfied. The evaluation of CECo's DCRDR is provided below on an element-by-element basis, followed by other DCRDR requirements and review team observations.

2.1 Establishment of a qualified multidisciplinary review team

During the in-progress audit at Zion Station, the NRC audit team reviewed the process for establishing a qualified multidisciplinary review team and found it to be adequate. However, information detailing the subject matter experts' (SME) qualifications was still required to be documented in Zion's DCRDR Summary Report. This information was provided in the Summary Report, and the review team has found the SMEs' qualifications to be acceptable. Based on the information provided, the review team concludes that the licensee has met this requirement of NUREG-0737, Supplement 1.

2.2 Function and task analysis to identify control room operator tasks and information and control requirements during emergency operations

This element of the DCRDR process was previously detailed in the audit report (Reference 3) and was judged as meeting the requirements of Supplement 1 to NUREG-0737. The information provided by the Summary Report is consistent with the previous findings, further assuring that this element of the DCRDR has been completed satisfactorily.

2.3 Comparison of display and control requirements with a control room inventory

This element was previously detailed in the audit report (Reference 3) and was judged at that time to meet the requirements of Supplement 1 to NUREG-0737 satisfactorily. This evaluation has been reinforced by the information provided in the Summary Report.

2.4 Control room survey to identify deviations from accepted human factors principles

The survey was conducted in general conformance with the applicable NUREG-0700 guidelines; however, CECo had modified the following three guidelines to an extent unacceptable to the NRC audit team:

- o 1.2.3.D.2 Sit-Down Console Dimensions, Control Distance From the Front Edge of the Console
- o 1.2.3.F.1-F.2 Sit-Down Console Dimensions, Lateral Spread of Controls and Displays
- o 3.2.1.C Signal Detector, Limits

A review of the differences between NUREG-0737 guidelines and the CECo checklist guidelines to include CECo's justifications and the NRC team position was included in the Zion Audit Report (Reference 3).

The NRC recommended that CECo amend these three CECo survey checklist guidelines to conform with NUREG-0700 criteria and reapply them in the control room survey process. In the Summary Report, the licensee indicated that they concurred with the NRC position and have modified these three guidelines and reevaluated the control room. The review team concludes that the licensee has satisfied the requirement to conduct a control room survey as stated in Supplement 1 to NUREG-0737.

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

While the audit report (Reference 3) indicates that the assessment process was generally satisfactory, certain differences were found between the methodologies proposed in the Program Plan and those presented at the audit. These differences were discussed with representatives of CECo, and the NRC audit team indicated that CECo should provide additional information. This request for further clarifying documentation was reiterated in the January 1986 audit report. The licensee responded by providing the information in the Summary Report (pages 9-3, 9-4, 9-5) for Zion Station. Based on the discussions at the audit and the documentation provided in the Summary Report, CECo has satisfactorily resolved these differences in the assessment methodology. The review team concludes that CECo has met this requirement of NUREG-0737, Supplement 1.

2.6 Selection of design improvements that will correct the identified discrepancies

During the audit, the NRC review team determined that the process for selection of design improvements was acceptable. Since the NRC performed an in-progress audit, the solutions to the HEDs were still under study and, thus, were not yet available for review. Having completed the studies and reviews, CECo has presented in the Summary Report the following descriptions of the resulting control room design standards:

- o Labeling standard
- o Annunciator standard
- o Display standard
- o Abbreviations standard
- o Color coding standard
- o Enhancements (such as background shading/demarcation/mimics)

A review of the above control room design standards indicated that the majority conformed to the guidelines of NUREG-0700. However, two concerns associated with the use of background shading for resolving HEDs were originally identified. First, independently of the six colors used in the licensee's color coding standard, the background shading program appears to

introduce 28 additional colors that are associated with various systems found in the control room. Second, examination of the proposed solutions to HEDs suggests an overuse of background shading on the control panels. CECo's application of this technique may lead to a reduction in the effectiveness of this technique to resolve HEDs and possibly introduce operator confusion and errors. It was then suggested that the licensee should reexamine the use of color and background shading at Zion Station and provide assurance that the proposed applications will not be counterproductive.

During the December 11, 1986 meeting, the licensee made a distinction between the colors proposed for the background shading technique to be used as tools for static perceptual enhancement and color coding of dynamic processes. Additionally, the licensee clarified that only nineteen (19) colors would be used for background shading instead of the 28 colors mentioned in the Summary Report. The licensee further pointed out that due to the large size of the Zion control room, the proposed enhancements could be incorporated, provided that the colors are applied systematically and based on appropriate human engineering guidelines.

A visual inspection of the background shading scheme developed by the licensee for the Zion control room showed that the colors selected were acceptable and followed a system-by-system approach. Additionally, this enhancement technique was apparently not used to relate system components located two or more panels away. Furthermore, color shading did not represent any system status or state. It was determined that the background shading technique proposed by the licensee is effective in this instance, and would help delineate related system components.

With the additional clarification provided by the licensee, the review team concludes that this DCRDR activity has been completed satisfactorily.

2.7 Verification that selected design improvements will provide the necessary corrections and will not introduce new HEDs

At the audit, CECo described an approach which would provide verification of the effectiveness of corrective actions. This process was to be performed using panel mock-ups incorporating the corrective actions, consultation with operators and systems experts, and human factors specialists,

and the possible use of the control room simulator. Should this verification show that a corrective action would have a negative effect on control room operators, it would be cancelled or altered as appropriate. However, the NRC expressed concern that verification activities described by the licensee at the audit might be delayed until after the submittal of the Summary Report. In response, a statement on page 9-6 in the Summary Report indicates that the verification process has been completed, resolving the NRC's concern. The audit report (Reference 3) indicated that this verification process, when accomplished, should meet this requirement of Supplement 1 to NUREG-0737.

However, as previously discussed, a review of the background shading program in the Summary Report raised a concern that this problem stemmed from an ineffective application of the verification process. With the resolution of the concern over the use of color for background shading, and the confirmation at the meeting that the verification process was being applied in a rigorous and integrated manner, the concern raised during the review of the Summary Report was resolved.

In summary, CECo has responded to the concerns originally raised during the review of the Summary Report, and thus appears to have met the requirement of this element of NUREG-0737, Supplement 1.

2.8 Coordination of DCRDR improvements with other NUREG-0737 Supplement 1 improvement programs including Safety Parameter Display System (SPDS), operator training, Reg. Guide 1.97 instrumentation, and upgraded emergency operating procedures (EOPs)

This activity was reviewed previously and found to be adequate in that the coordination efforts will cover all NUREG-0737 Supplement 1 initiatives and be coordinated by the CECo program coordinator. However, the NRC audit team had two concerns. First, an apparent lack of early coordination between the DCRDR and the EOPs could have led to delay of the verification activities (Section 2.7). This concern was resolved in the discussion of the last element. Second, a need to ensure coordination between the EOPs and the SPDS in a timely manner was identified. CECo indicates that the EOP and SPDS activities will be completed at a date after submittal of the Summary Report as previously approved by the NRC. CECo has responded to the

NRC concerns and appears to have met the requirement for this element to Supplement 1 to NUREG-0737.

2.9 Other DCRDR issues

2.9.1. Review of operating experience

CECo's operating experience review at Zion appears to have been 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 semistructured interviews were administered to and conducted with operating personnel. However, at the in-progress audit, it was found that the operator experience review activity did not result in the anticipated amount of feedback from plant personnel, as indicated by the low return rate of the questionnaires. It was recommended that the utility consider this concern and undertake appropriate measures to obtain further input from Zion plant personnel and subsequent CECo stations. In response, the licensee indicated that thirty-seven operator surveys from the 1981 Preliminary Design Assessment (PDA) were incorporated into this activity to supplement the DCRDR operator surveys. This operating experience review effort generated 77 potential HEDs which were not identified as a result of other DCRDR activities. In the reviewers' judgment, the operating experience review was a useful addition to the review phase of the Zion DCRDR.

2.9.2 Remote shutdown

The licensee maintained in the Summary Report that a review of the remote shutdown capabilities is not required by NUREG-0737, Supplement 1, and it does not intend to include such a review in the scope of the DCRDR program. In light of a May 8, 1986 incident (LER #86-012-00) which concerned a human error committed by the operator at the remote shutdown panel during testing the auxiliary feedwater pump system, it is suggested that the licensee reconsider its position regarding a review of the remote shutdown capabilities, and perform such a review as a supplement to its DCRDR, as recommended by the NRC at the audit.

2.10 DCRDR results

2.10.1 Implementation schedule for HED resolutions

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 noted, this information is a correction to the dates supplied on page 8-2 of the Summary Report. CECo also indicates that proposed schedules are predicated upon NRC approval of CECo's disposition of each of the HEDs as the schedule is sensitive to the scope of work. The schedules are also subject to the availability of equipment, outage time, and engineering design lead time. Furthermore, schedules may shift in order to ensure that all affected emergency response activities are correctly integrated. As a result, it is the review team's understanding that the proposed schedules submitted will be finalized after receipt of NRC confirmation on HED resolutions.

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 Zion Station, Units 1 and 2. CECo identifies October 1987 and March 1989 as the expected first and second refueling outage dates for installation of DCRDR modifications at Unit 1. September 1988 and January 1990 are the anticipated refueling outage dates for installation of modifications at Unit 2. CECo further notes that due to the lead time required to plan for an outage, Unit 1 would require NRC approval by March 1987 in order to consider the October 1987 refueling outage. A concern was that the implementation schedule, which extended to January 1990 for Unit 2, appeared to be a considerable delay for resolving the identified deficiencies. Discussions during the December 11, 1986 meeting about the current plans for outages at Zion Units 1 & 2 led to an agreement between NRC and the licensee that the proposed schedule would be acceptable.

2.10.2 Proposed control room changes

As a result of the review of the HEDs documented in the Summary Report, several corrective actions, justifications for not correcting some HEDs, and implementation schedules for corrective actions were found to be inadequate. A list of these concerns was included in the proposed meeting agenda dated August 21, 1986 (Reference 8). During the meeting on December 11, 1986, the

licensee provided additional information that led to satisfactory resolutions of the majority of the concerns raised in the proposed agenda. However, there remained seven (7) unresolved issues that required further clarification by the licensee. Subsequently, in its December 30, 1986 submittal (Reference 9) that documented the results of the December 11 meeting, the licensee identified six (6) additional issues that required modifications to the information presented in the Summary Report, as open items. These remaining thirteen (13) unresolved open items are listed in Appendix A of this report. The licensee indicated that the information needed to resolve these thirteen (13) issues would be provided to the NRC by July 1, 1987.

3. CONCLUSIONS

CECo's DCRDR Final Summary Report for Zion Station, Units 1 and 2, demonstrates a strong commitment toward meeting most of the requirements of NUREG-0737, Supplement 1. The in-progress audit findings, together with the Summary Report and information provided during the subsequent meeting indicate that most requirements have been met. However, in order to complete the DCRDR for Zion Station Units 1 and 2, the licensee is required to provide full resolution to the thirteen (13) remaining open items listed in Appendix A of this report. As a partial fulfillment of this requirement, the licensee should provide additional information on these unresolved issues to the NRC by July 1, 1987 for further evaluation.

The following is a summary of the technical evaluation of CECo's Zion Station, Units 1 and 2 Summary Report and DCRDR.

1. The DCRDR team for Zion Station meets the requirement of a qualified multidisciplinary review team.

2. The system function and task analysis meets the requirement of Supplement 1 to NUREG-0737.

3. The inventory, as well as the comparison of display and control requirements established in the task analysis, meets the requirement

of Supplement 1 to NUREG-0737.

4. Based on the information provided at the audit and in the Summary Report, the review team concludes that the control room survey meets the requirement of Supplement 1 to NUREG-0737.

5. Based on the discussion at the audit and the documentation provided in the Summary Report, CECo has met the requirement for assessing HEDs as stated in NUREG-0737, Supplement 1.

6. During the audit, the review team determined that the on-going process for selection of design improvements was acceptable. A review of the Summary Report resulted in some concerns with the background shading proposed by the licensee. However, during subsequent discussions with the licensee and careful examination of the proposed corrective actions, it was agreed that, in this instance, the technique was appropriately applied, and should enhance control room operation. Thus, it appears that the licensee has satisfied this requirement of Supplement 1 to NUREG-0737 by providing design improvements for all of the HEDs, except for the thirteen (13) remaining open items listed in Appendix A. Full resolution of these remaining HEDs should lead to the completion of this DCRDR requirement.

7. Information provided at the audit and during the December 11, 1986 meeting indicated that the process to verify that control room improvements correct HEDs and do not introduce additional HEDs in the control room should meet the requirement of Supplement 1 to NUREG-0737, provided that the same process will be followed in the resolution of the thirteen (13) open items listed in Appendix A of this report.

8. Based on the program outlined at the audit and the information provided in the Summary Report, it appears that CECo has met the requirement of NUREG-0737, Supplement 1, for coordinating control room improvements with changes from other programs.

9. The Summary Report outlines an acceptable schedule for the implementation of corrective actions as required by Supplement 1 to NUREG-

0737. In order to satisfactorily complete this requirement, the licensee should provide an acceptable implementation schedule for the thirteen (13) remaining open items.

In summary, it appears that the processes used by the licensee in the DCRDR program were generally satisfactory and met all the requirements of Supplement 1 to NUREG-0737. These processes should be followed in the resolution of the remaining thirteen (13) open items listed in Appendix A. Receipt and evaluation of the promised additional information will determine the completion of the DCRDR program at Zion Units 1 and 2.

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. "Results of In-Progress Audit of the Detailed Control Room Design Review for Zion Units 1 and 2," Memo for Jan Norris, USNRC with attached SAIC Audit Report, January 3, 1986, from C.E. Rossi, USNRC, Washington, D.C., January 24, 1986.

4. 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.

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

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

7. "Commonwealth Edison Company, Zion Station, Detailed Control Room Design Review, Final Summary Report," Volumes I and II, Commonwealth Edison, April 18, 1986.

8. "Proposed agenda for meeting between NRC staff and Commonwealth Edison Company to resolve issues concerning the DCRDR at Zion Station Units 1 and 2," attachment to letter from S.A. Varga, USNRC to D.L. Farrar, CECo, August 21, 1986.

9. "Zion Nuclear Power Station Units 1 and 2, Detailed Control Room Design Review - NUREG-0737, Item I.D.1," letter and attachments from P.C. LeBlond, CECo to H.R. Denton, USNRC, December 30, 1986.

APPENDIX A

Open Items that required further clarification by the Licensee

Section 1

The following HEDs are those found as open items during the December 11, 1986 meeting. These HEDs are documented in CECo's December 30, 1986 submittal (Reference 9). Additional clarifications will be forwarded to the NRC by July 1, 1987.

HED	Page	Concerns
363, 403	5-5	Justification for the delay to the second refueling outage is inadequate and does not respond to the concern raised in the meeting agenda (Reference 8). The licensee should justify its assertion that the lack of this instrumentation in the control room will not affect the safe operation of the plant.
285, 186, 188, 151, 367	5-6	Within 6 months, a scope of work is required to justify the delay of the implementation date which is set for the third refueling outage. Additionally, the numerals on the point display for four (4) of the recorders that have been rubbed off should be replaced in the near future.
124	5-7	The licensee is required to provide information explaining the "time-criticality" of multi-input alarms and the number of alarms associated with this HED.
54	5-8	The licensee is required to provide justification for the delay of the implementation schedule (second refueling outage) for this HED corrective action. The NRC's present position is to have this HED corrected by the end of the first refueling outage.

HED	Page	Concerns
290	5-41	The licensee should describe which option will be implemented and the implementation date.
406	5-42	The label proposed by the licensee is an inadequate solution. Additional clarification is needed.
307	5-57	Additional information is required to ensure that burnt-out fuses are replaced correctly.

Section 2

The following HEDs are those that required modifications to the information presented in the Summary Report and listed in CECo's December 30, 1986 submittal (Reference 9).

HED	Page	Concerns
133,322, 391, 134	5-52	Two out of three "time-critical" annunciators will be relocated by the first refueling outage. The licensee should provide additional justification for not relocating the third annunciator.
234, 392, 435, 79, 227, 222	(146,150, 124,148, 147)*	The licensee should provide additional information justifying the replacement (instead of removal) of key lock switches.
42	263*	This HED is related to HED 54 of page 5-8.
43	264*	Additional information is required to explain the modification to the previously accepted HED corrective action.
233	157*	Additional information is required to ascertain the licensee's position on this HED.

HED	Page	Concerns
72	118*	Additional clarification is required to justify the change in periodic testing of annunciators from once-per-shift to once-per-day.

*These page numbers refer to those of the Summary Report.

APPENDIX B

List of attendees at the
Meeting with Commonwealth Edison Company
on DCRDR - Zion Station Units 1 and 2

December 11, 1986

Name	Affiliation	Phone
Jan Norris	NRC/PAD-3	301-492-9735
Richard J. Eckenrode	NRC/PAEI/DPLA	301-492-7244
Phuoc T. Le	SAIC	703-821-4488
Robert E. Howard	CECo	312-294-3940
Kathleen A. Hesse	CECo	312-294-3458
Mike V. Peterson	CECo	312-294-2858
Jason J. Enwright	ARD	301-596-5845
Bob Kershner	ARD	301-596-5845
Peter LeBlond	CECo	312-294-3965
Steve Cooley	ARD	301-596-5845
Frank Lentine	CECo	312-294-2833
Joe Moyer	SAIC	703-827-4862