

EVALUATION OF THE  
DETAILED CONTROL ROOM DESIGN REVIEW  
PROGRAM PLAN  
FOR  
IOWA ELECTRIC LIGHT & POWER COMPANY'S  
DUANE ARNOLD ENERGY CENTER

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**INTRODUCTION**

Science Applications International Corporation (SAIC), has evaluated the Program Plan (Reference 1) submitted by Iowa Electric Light & Power (IEL&P) for conduct of a Detailed Control Room Design Review (DCRDR) at the Duane Arnold Energy Center (DAEC). The purpose of the evaluation was four fold:

- (1) To determine whether the planned program would result in a successful DCRDR;
- (2) To determine whether an in-progress audit was necessary;
- (3) To provide an audit agenda where appropriate; and
- (4) To provide constructive feedback to IEL&P.

Evaluation was conducted relative to the requirements of Supplement 1 to NUREG-0737 (Reference 2). Additional guidance was provided by NUREG-0700 (Reference 3), Section 18.1, revision 0, of NUREG-0800 (Reference 4), and Generic Letter 83-18 (Reference 5). This report provides the results of the evaluation.

**EVALUATION OF PROGRAM PLAN**

General Comment

The IEL&P DAEC Program Plan does not describe the proposed program of review in enough detail to allow SAIC reviewers to understand fully how the DCRDR objectives will be accomplished. To assure that IEL&P is developing

and using an adequate DCRDR methodology, SAIC has provided constructive comments and in addition, recommends an in-progress audit to clarify and confirm the details of the proposed DCRDR. The criteria to be used during this review and the in-progress audit will be the requirements of Supplement 1 to NUREG-0737 and their related guidelines.

1. Qualification and Structure of the DCRDR Team

The administrative structure of the DCRDR consists of two entities: the Director of Nuclear Generation and the review team. Responsibility for the DAEC DCRDR lies with the IEL&P Director of Nuclear Generation. From the title of the person assigned to direct the DCRDR project, it appears that DAEC is placing appropriate emphasis and attention upon the DCRDR since ultimate responsibility for the DCRDR lies with the utility.

The review team will be responsible for planning, scheduling, coordination and performance of the DCRDR effort on a daily basis. The Review Team Leader will provide the administrative and technical direction for the review team. Review team core members represent the following specialties:

- human factors specialists (HFS),
- senior reactor operator (SRO),
- reactor operator (RO),
- instruments and controls engineer (I&C), and
- design engineer (DE).

However, it appears that none of the review team core group is qualified as a nuclear engineer. Both the RO and the SRO will assist in the identification of operator tasks, and provide expertise on the operational constraints for the operation of DAEC plant systems. However, additional information provided by a Nuclear engineer who is familiar with both the design and operation of DAEC's nuclear steam supply systems and ancillary systems would be very helpful in assuring a successful DCRDR.

The licensee also plans to have a review team orientation which will provide a familiarization to team members on the principles of human factors engineering and their applications to the DCRDR program.

Responsibilities for each review team core member are provided in the DAEC Program Plan (p. 11). Resumes provided in Appendix C describe the qualifications of the people who will be participating in the DCRDR. However, the information provided does not define the level of effort to which each person will be committed. The DAEC Program Plan does describe the human factors specialist, who meets the NRC qualification guidelines, as participating in each phase of the DCRDR and providing the human factors technical leadership for the review. In addition, the HFS will be responsible for the coordination and quality of work performed by other required human factors personnel. However, due to the lack of information concerning specific task assignment, and the levels of effort proposed for each team member, SAIC is unable to gauge the extent of technical leadership the HFS will be providing to the human factors personnel.

DAEC makes a reference in the Program Plan (p. 10) to the fact that additional specialists with required disciplines will supplement the review team core as required. The licensee should be able to elaborate on the identity and level of involvement of these additional specialists in the DCRDR process during an audit. SAIC is concerned with the use of the proper personnel to perform the DCRDR activities at the proper level of involvement. Due to a lack of information in these areas, a conclusive evaluation of DAEC's plans for assigning personnel to the specific DCRDR activities cannot be made.

There appears to be sufficient authority available to provide access to needed information sources and/or facilities to acquire support for the DCRDR. In addition, DAEC plans to present an orientation in human factors engineering relevant to the DCRDR to the review team members. DAEC should maintain a description of the specific assignments and level of effort for the people involved in each activity of the DCRDR.

## 2. System Function and Task Analysis

The licensee proposes to perform a system function and task analysis (SFTA) that consists of three phases: a) Task identification and specification of requirements; b) Verification of instrumentation; and c) Validation of control room functions. Descriptions of these three phases are

provided in sections 4.5.1, 4.5.2 and 4.5.3 of the Program Plan, respectively.

In section 4.5.1, the proposed task analysis contains two subtasks: a) "specification of major steps (functions) to be accomplished by the given procedure," and b) identify the "detailed steps (tasks)" within those major steps. In addition to describing the tasks, the licensee describes the type of information on instrument and control requirements that will be determined during the task analysis such as characteristics of displays or controls required. However, no methodology has been detailed for accomplishing this task. Finally, the licensee states that the results of the task analysis will be documented and subsequently used in the verification phase.

There are major problems with the task analysis as presented in the Program Plan. The most apparent problem is the lack of methodology for conducting the SFTA. Without a methodology description, an evaluation of the licensee's approach to the SFTA at DAEC is impossible.

Also in section 4.5.1, the licensee states "the major steps (functions) to be accomplished by the given procedures" will be identified. The licensee goes on to indicate that task analysis work performed to develop emergency operating procedures (EOP) technical guidelines and plant specific EOPs were utilized as the basis for the DCRDR task analysis. Additional information is needed that describes the original task analysis work and how their results were utilized as a basis for the DCRDR task analysis effort.

In summary, while it appears that DAEC understands the objectives of a SFTA, the licensee has not described the methodology or the intended use of the results in sufficient detail and completeness to allow SAIC to fully understand and assess the SFTA process.

### 3. Control Room Inventory

The Supplement 1 to NUREG-0737 requirement to compare display and control requirements with a control room inventory to identify the availability of the displays and controls is addressed in section 4.5.2 of the Program Plan.

The licensee's verification of control room instrumentation will consist of 2 parts: a) performance of a control room inventory, and b) comparison of the displays and controls found in the control room inventory with requirements identified in Task Identification and Specification Requirements (section 4.5.1). The licensee proposes to conduct an inventory of existing control room instrumentation required by the EOPs and correlate it with the requirements identified during the task analysis. The information gathered during the inventory includes instrument descriptions and their exact locations in the control room. Instrumentation identified as missing during the comparison will be cited as a human engineering deficiency (HED). However, the licensee does not present any methodology for producing the inventory nor for the comparison. Due to this lack of detail, SAIC cannot complete its review of this process at this time.

Based upon the following statement from the Program Plan, "this verification step is required to determine if a meter for example, has the appropriate range and scale gradations to support the particular EOP under consideration," it appears that the licensee will compare the required display and control characteristics for EOP requirements identified during the SFTA. The lack of detail in the information provided prevents a complete review of the verification process at this time.

#### 4. Control Room Survey

According to Generic Letter 83-18 (Reference 5), the BWROG stated that NUREG-0700 and the BWROG checklists differed in the level of detail in certain respects. The BWROG stated that "NUREG-0700 addresses many topics on a detailed, quantitative basis, whereas the BWROG believes a more general, qualitative approach, coupled with survey team training, is more appropriate." This statement raises a concern about the training of the survey team. Generic Letter 83-18 states, "Since the NRC has not seen specific details on the BWROG Survey Program performed at each plant, utilities in their program plan submittals should provide the following information on the review phase: number and extent of plant personnel (especially operating personnel) participation during the review phase, attendance of plant personnel at BWROG Workshops and training courses, specific procedures walked through in the control room as part of the systems review, additional

work performed by the utility to complete the systems review, and plans for reviewing the remote shutdown panel."

DAEC states that a survey of the control room was performed by the Boiling Water Reactor Owner's Group (BWROG) in 1980. Furthermore, the licensee intends to perform a two part supplemental survey as part of the DCRDR to complement the original BWROG control room survey (p. 5). The first part of the supplemental effort will employ a new BWROG checklist against control items that have not changed since the original BWROG survey. This new checklist, designed to complement the original BWROG survey, will use the same methodology as the original BWROG survey (Appendix A). In the second part, where the control room has been altered since the application of the original BWROG checklist, both the original and the supplemental survey will be performed.

In addition, the licensee proposes to conduct a validation of control room functions. This activity will consist of talk-throughs and walk-throughs of the EOPs. Talk-throughs, described as, "a process in which an experienced operator steps through a procedure stopping at each step to describe his actions to review team members, and to answer questions about information and control requirements" will be used to determine whether an instrument is located appropriately for the operator's use. Walk-throughs will be used by the review team if a portion of a procedure is judged by the review team to be time-critical. Detailed procedures for walk-throughs are included in Appendix B. While not required, interviews conducted after a walk-through may help operators fully consider the adequacy of the indications described in the EOPs and the accuracy, range and locations of controls and displays.

The licensee on pages 13 and 14 of the Program Plan has provided a brief description of the orientation program that will be presented to the review team. A more detailed description of the orientation's agenda should be maintained to document that Generic Letter 83-18 has been satisfied.

In summary, DAEC appears to have addressed adequately the guidelines of Generic Letter 83-18. However, all pertinent information concerning the training of survey team members must be addressed in terms of documentation

maintained by the licensee to show that the orientation program satisfies Generic Letter 83-18.

5. Assessment of HEDs

DAEC provides a description of how HEDs identified in the supplemental survey, the review of the updated operating experience review (OER), and the task analysis will be evaluated for significance. Our concern is that the methodology used during the original BWROG control room survey and the related operating experience review has not been adequately described in the Program Plan as suggested by Generic Letter 83-18. The licensee should be able to present, at an audit, methodology and results for both the original BWROG survey and the supplemental survey performed.

Another concern relates to the criteria used to prioritize HEDs. According to NUREG-0800, section 2.5, HEDs are to be assessed to "determine their significance on operator performance and plant safety." The licensee has addressed this issue by evaluating HEDs relative to "potentially deleterious effects on emergency operation." NUREG-0800 goes on to state, "corrective action of each HED should be based on its significance as it affects the safety of the plant." However, the licensee's recommendations for modifications to the control room appear to be based on benefit-to-cost ratios, which suggests a departure from the NUREG-0800 objective of safety first. Cost considerations do not belong in the initial screening of HEDs but rather later in the Selection of Design Improvements. During the Assessment of HEDs, safety and potential to cause human error should be the only considerations. Further, on page 21 of the Program Plan it appears that additional considerations such as "operator confusion" or a "large increase in training requirements for operators with insufficient return" may allow HEDs to be screened out. Again, safety considerations appear to be relegated to a less than critical concern.

In summary, DAEC indicates that the BWROG survey methodology will be used to assess HEDs. However, the HEDs assessment methodology is not fully described in the Program Plan. In addition, benefit-to-cost ratios rather than safety appear to be the major criteria for assessing HEDs. Other criteria listed in the Program Plan can result in the HED possibly being eliminated prior to being fully assessed. While the licensee has

shown intent to address this requirement, the methods described do not provide adequate assurance of success. For the assessment of HEDs, DAEC should: examine all the HEDs generated during DCRDR activities; develop safety related criteria for the prioritization of HEDs; then attend to cost and logistical issues.

#### 6. Selection of Design Improvements

According to the Program Plan, the licensee intends to process all corrections of significant HEDs through the DAEC plant modifications, training, and administrative procedures already in existence. A description of these existing plant procedures, including criteria involved in developing corrections, would be helpful in assessing this portion of the DCRDR program plan.

To insure that control room modifications added after the completion of the DCRDR consider human factors in an adequate manner, the licensee has adopted human engineering guidelines and design standards to be used. This should help DAEC prevent the introduction of potential HEDs into the control room. A description of these guidelines and standards would have been helpful.

No implementation schedule for proposed changes relative to the categorization of HEDs is provided by the licensee in the Program Plan. The licensee indicates that a schedule of proposed changes, the needed integration with the other modifications, and completion dates will be provided in the summary report.

It is recommended that DAEC maintain a detailed description of the proposed methods to be used for the selection of design improvements. Furthermore, the licensee needs to present an implementation schedule in the Summary Report based on the categorization of HEDs for all proposed changes to the control room. Presently, SAIC is unable to assess the submittal with respect to the design improvement selection requirement of NUREG-0737, Supplement 1 due to the incompleteness of information provided.

7. Verification That Improvement Will Provide the Necessary Corrections and That Control Room Modifications Do Not Introduce New HEDs

DAEC indicates the planned use of walk-throughs or talk-throughs to ensure that corrections do not introduce new HEDs, yet the methodology has not been provided in this Program Plan to detail this process. The verification that the improvements selected will correct the HEDs is not addressed by the program plan.

8. Coordination of the DCRDR With Other Improvement Programs

DAEC recognizes that several other improvement programs will be addressed concurrently with the DCRDR. Specifically, the upgraded EOPs and SPDS are commented on. DAEC's discussion of the integration of the EOPs with the DCRDR addresses the upgrading of EOPs in providing the technical basis for the task analysis.

While benefitting from the increased awareness of the discipline of human engineering at DAEC as a result of the utility's participation in the DCRDR, the licensee does not intend to consider the SPDS as part of the DCRDR due to scheduling differences. Once the SPDS becomes available, the licensee then states that "the SPDS will be reviewed from a human factors viewpoint separately." It is our opinion that because the SPDS will be part of the control room, its evaluation should consider it as an integral part of the control room design.

DAEC does not address the following NUREG-0737, Supplement 1 issues:

- Regulatory Guide 1.97,
- Emergency Response Facilities (ERFs), and
- Training

In summary, there is little discussion on the specific interactions between the DCRDR and other improvement programs. Due to the lack of methodology for the coordination process, SAIC is unable to assess the DAEC plans for this DCRDR requirement.

## 9. Additional Comments

The licensee plans to review operating experience by examining plant specific documentation and conducting interviews of the control room operators. Although the performance of this task is not required by Supplement 1 to NUREG-0737, this effort was evaluated since it was submitted for review. Generic Letter 83-18 notes that licensees should update their operating experience review to incorporate recent operating history.

The licensee proposed to review Licensee Event Reports (LERs) and SCRAM reports. These two sources were examined during the original BWROG survey in 1980 to include the preceeding two years. They were screened by the survey team members to identify items that may have contributed to operator error. All LERs and SCRAM reports from the end of the 1980 BWROG survey to February 1, 1984 will be examined by the supplemental survey using the same methodology. Material from the original BWROG survey will not be re-evaluated at this time. The scope of the original BWROG survey was defined by the physical limits of the control room, i.e., the survey was limited to LERs and SCRAM reports which referenced equipment, procedures and personnel errors within the physical confines of the control room.

Operator interviews performed during the original BWROG survey examined plant specific problems, operation, and desirable features of plant design. The BWROG survey team interviewed nine individuals including shift supervisors, senior reactor operators and control room operators. The results of this original BWROG survey effort are to be included in the summary report.

Finally, the licensee does not intend to conduct formal interviews of the control room personnel in the supplemental survey. However, it is recommended in Generic Letter 83-18 that licensee update operating experience review (OER), and since operator interview is part of the OER, we recommend that it also be updated.

## CONCLUSIONS AND RECOMMENDATIONS

Except for the verification that design improvements provide the necessary correction, DAEC addresses all of the DCRDR requirements of NUREG-0737, Supplement 1 in the program plan. DAEC has demonstrated sufficient levels

of commitment towards performing some of the DCRDR activities including the establishment of a qualified DCRDR team and the control room survey. However, the DAEC Program Plan does not demonstrate that adequate methodologies have been developed for other DCRDR activities including the system function and task analysis, control room inventory, assessment of HEDs, selection of design improvements, verification of HED solutions, and the coordination of the DCRDR with other improvement programs. To ensure that DAEC does not proceed with an inadequate program, SAIC recommends that an in-progress audit be conducted. A tentative agenda for an in-progress audit is presented below.

#### **AGENDA FOR AN IN-PROGRESS AUDIT OF DUANE ARNOLD ENERGY CENTER**

The following procedures and agenda for an in-progress audit is suggested.

1. Hold a kick-off meeting with the licensee to discuss identified strengths and weaknesses in the program plan. The licensee should present any clarifications and additional information/documentation at this time.
2. The in-progress audit team should review the following areas of the licensee's DCRDR:
  - **Qualifications and structure of the DCRDR Team**
    - provisions for the involvement of a qualified nuclear engineer
    - qualifications of the supplemental staff
    - substantiation of HFS supervisory relationship to Human Factor personnel
    - levels of involvement per activity for each member of the review team

- Function and Task Analysis
  - description of the SFTA methodology. This should include but not limited to the following issues:
    - a. identification of information and control requirements
    - b. identification of the procedures used during the task analysis
  
- Control Room Inventory
  - description of the methodology
  - description of the process which DAEC will determine suitability of the displays and controls for EOP requirements
  
- Control Room Survey
  - description of the nature and extent of training received by the survey team
  - possible inclusion of "after action" personnel interview in walk-through/talk-through methodology
  
- Assessment of HEDs
  - description of the HED assessment methodology
  - criteria for prioritization of HEDs
  - discussion of the considerations listed on page 21 of the program plan
  
- Selection of Design Improvements
  - description of the existing IEL&P plant modifications, training, and administrative procedures

- description of the human engineering guidelines and design standards to be used by DAEC
  - criteria used for determining the acceptability of design solutions
  - Verification that Improvements Will Provide the Necessary Corrections and that Control Room Modifications Do Not Introduce New HEDs
    - discussion of methodology to be used
  - Coordination of the DCRDR With Other Improvement Programs
    - plans for integrating DCRDR inputs with the following programs:
      - o EOP upgrade
      - o SPDS
      - o Reg Guide 1.97 instrumentation
      - o ERFs
      - o Training
    - provisions for managing the coordination of the improvement programs
  - Operational Experience Review
    - description of the selection process and methodology to be used for reviewing LERs and SCRAM reports
    - discussion of personnel assignments and process to be used for this effort
3. The in-progress audit team should also:
- a. Interview review team members or review documentation to obtain any needed clarifications or additional information.

- b. Observe any ongoing DCRDR activities if necessary and possible.
  - c. Randomly audit the control room or interview control room operators to obtain additional information or clarifications.
4. Conduct an exit meeting with the licensee to dispose of action items and provide constructive feedback.

## REFERENCES

1. Detailed Control Room Design Review Program Plan, Duane Arnold Energy Center, Iowa Electric Light & Power Company, November 30, 1984.
2. Supplement 1 to NUREG-0737 - Requirements for Emergency Response Capability (Generic Letter No. 82-33), U.S. Nuclear Regulatory Commission, December 17, 1982.
3. NUREG-0700, Guidelines for Control Room Design Reviews, U.S. Nuclear Regulatory Commission, September 1981.
4. NUREG-0800 (Standard Review Plan), Revision 0, Section 18.1 and Appendix A to Section 18.1, September 1984.
5. "NRC Staff Review of the BWR Owner's Group (BWROG) Control Room Survey Program" USNRC, Washington, D.C., April 1983, transmitted to BWR licensees via Generic Letter 83-18, April 19, 1983.

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