EVALUATION
OF THE
DETAILED CONTROL ROOM DESIGN REVIEW
PROGRAM PLAN
FOR
VERMONT YANKEE NUCLEAR POWER CORPORATION'S
VERMONT YANKEE NUCLEAR POWER PLANT

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Science Applications, Inc., (SAI) has evaluated the Program Plan submitted by Vermont Yankee Nuclear Power Corporation (VYNPC) for conduct of a Detailed Control Room Design Review (DCRDR) at the Vermont Yankee Nuclear Power Plant (VYNPP). The disciplines of human factors engineering and mechanical engineering were represented on the evaluation team. All team members were familiar with nuclear power plant control rooms and experienced in evaluating DCRDRs. The purpose of the evaluation was:

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

4. To provide constructive feedback to the VYNPC

Evaluation was against the requirements of Supplement 1 to NUREG-0737. Additional guidance was provided by Generic Letter 83-18, NUREG-0700, and draft NUREG-0801. This report provides the results of the evaluation. Comments of the NRC staff member responsible for evaluation of the VYNPP DCRDR have been integrated into the report in order to represent the consolidated observations, conclusions, and recommendations of the NRC staff and its consultants (SAI).

DISCUSSION:

Establishment of a qualified multidisciplinary review team.

The Vermont Yankee Program Plan describes a two level hierarchy of personnel for conducting the DCRDR. That hierarchy includes:

1. A management review team
2. A design review team

The management review team is comprised of the engineering services manager, simulator manager, and operations superintendent. This team has the overall responsibility for the program, including implementation, resolution of findings and authorization for recommendations. The design review team includes a human factors consultant to VYNPC, a plant operator, an instrument and controls engineer, and the program manager. The design review team will evaluate all findings from previous control room efforts, conduct supplemental and additional reviews as needed, conduct the task analysis, evaluate all findings, propose suitable modifications, and prepare the summary report.

With the exception of a nuclear engineer, the disciplines represented on the design review team are those suggested in draft NUREG-0801. The Program Plan indicated that the design review team may be supplemented as necessary by personnel from disciplines including nuclear, mechanical, electrical, and civil engineering. Guidance in draft NUREG-0801 suggests that participation of supplemental personnel to provide the design review group with nuclear engineering expertise would be particularly beneficial during the operating experience review and the function and task analyses. The remaining supplemental disciplines are among those suggested by draft NUREG-0801. Participation of personnel from those disciplines should contribute to the success of the DCRDR.

Resumes for the design review team were provided. Personnel representing the disciplines of human factors, instrument and control engineering, and plant operations had education and experience consistent with guidance in draft NUREG-0801. Resumes for the management review team and supplemental personnel were not provided.

VYNPC did not specify personnel assignments by task. Draft NUREG-0801 provides guidance for such assignments. Adherence to that guidance would contribute to the success of the DCRDR. One concern is the availability of human factors specialists. The success of a DCRDR depends heavily on the contribution of human factors specialists to accomplish the technical tasks. Only one member of the design review team has training and experience in the human factors area. Given the number and magnitude of the technical tasks needing human factors expertise, increasing the number of human factors specialists would increase the likelihood of a successful DCRDR at Vermont Yankee.

The Program Plan does not indicate an orientation program for the VYNPC DCRDR. Such a program could provide personnel at all levels with a basic understanding of the DCRDR process, the contribution of various professions to its accomplishment, and the roles of various levels of organization.

Function and task analyses to identify control room operator tasks and information and control requirements during emergency operations. VYNPC has stated that information in the FSAR on plant systems and subsystems in the control room will serve as a reference base for the task analysis and assessment phases. In addition, Emergency Operating Procedures (EOPs) will be reviewed to select operating scenarios for walk-throughs during task analysis. On the assumption that EOPs have been evaluated and approved for use, the VYNPC team will:

1. Identify discrete steps in the EOP in order of performance

2. Describe the operators' tasks per step

3. Determine operator decisions and/or actions linked to task performance

4. Identify information and control requirements

5. Identify instruments and controls to satisfy the information and control requirements

The process described by VYNPC is basically sound, but raises several concerns. One concern is that, although the Procedures Generation Package (PGP) for VYNPP has been received by the Procedures and Systems Review Branch, it is not scheduled for review until late 1984. That review may result in changes to the PGP and ultimately to the EOPs. The task analysis should be redone for revised EOPs in order to satisfy the DCRDR requirement in Supplement 1 to NUREG-0737. A second concern is that Supplement 1 to NUREG-0737 requires that EOP development be based on a process which identifies operator tasks, and information and control needs (i.e., a task analysis). VYNPC appears to propose the reverse process (i.e., a task analysis which follows EOP development). This situation may allow satisfaction of the Supplement 1 to NUREG-0737 DCRDR requirement if the EOPs developed for VYNPP are at a high level (e.g., "operate specified system") typical of those generated from BWROG Emergency Procedure Guidelines. VYNPC should ensure that the identification of operator information and control requirements based on tasks needed to satisfy the functions identified in the generic guidelines is independent of the existing control room in order to satisfy the requirements. The result would be instrument and control needs based on information and control requirements, not on the existing controls and displays at VYNPP. Instrument and control needs thus identified would be appropriate input to the verification of task performance capabilities (i.e., comparison of function and task analysis results with a control room inventory). A final concern is the selection of operating scenarios for walk-through during the task analysis. The selection process should be such that all tasks involved in the EOPs are analyzed. Analysis of all tasks will satisfy the DCRDR requirement in Supplement 1 to NUREG-0737.

A comparison of display and control requirements with a control room inventory. VYNPC stated that it would conduct a verification of task performance capabilities. That verification would confirm that instrumentation and controls identified in the task analysis as being required by the operator are:

1. Present in the control room

2. Effectively designed to support correct procedure performance

The process will generate HEDs when instrumentation or controls are unavailable or unsuitable.

The described process is consistent with NRC guidelines for the comparison of display and control requirements with a control room inventory. However, the success of the task depends heavily on the quality and content of the function and task analyses and the control room inventory. Previous comments were directed at ensuring suitable function and task analyses input to the verification task. VYNPC states that the function of a control room inventory will be performed as part of the task analysis effort and related verification and validation efforts. The specific form the control room inventory would take was not stated. However, there is a major concern that development of a control room inventory as part of the task analysis efforts will be a self-fulfilling exercise rather than a method for identifying unavailable or unsuitable instrumentation and controls. An adequate control room inventory would be separate from the task analysis effort and would include the characteristics of existing instruments and controls which will allow meaningful comparison with the characteristics of needed information and control capabilities determined from the function and task analysis.

A control room survey to identify deviations from accepted human factors principles. A preliminary survey of the Vermont Yankee control room was performed by Wyle Laboratories in August 1980. In January 1982, the BWROG conducted a control room survey at Vermont Yankee. In addition, the Program Plan indicates that VYNPC will:

1. Use the BWROG Control Room Survey Checklist Supplement to resurvey areas of the control room surveyed previously

2. Use the original BWROG Control Room Survey Program checklists to survey modifications to the control board and control room since the BWROG survey. The effort will include the alternate shutdown panels

VYNPC did not state that they intended to comply with the requirements of Generic Letter 83-18, but the above actions would satisfy those requirements with one exception. The BWROG Control Room Survey Checklist Supplement should also be used in surveying modifications to the control boards and

control room. With that addition, the survey should satisfy the requirements of Generic Letter 83-18 and Supplement 1 to NUREG-0737.

Assessment of human engineering discrepancies to determine which HEDs are significant and should be corrected. Vermont Yankee has stated that the DCRDR review team will assess and categorize all HEDs identified during the DCRDR process. Four categories are described. Those categories are based on judgments about the likelihood an HED will result in an operator error and on the potential consequences of such an error. Consideration of cumulative and interactive effects with other HEDs is included in the assessment. The Program Plan implied that all HEDs, regardless of category, would enter the process for selection of design improvements. If that is the intent, the assessment process should satisfy the Supplement 1 to NUREG-0737 requirement. If that is not the intent, satisfaction of the Supplement 1 to NUREG-0737 requirement would appear to require that all but Category IV HEDs (i.e., those judged not to increase the potential for causing or contributing to a significant operating crew error, to have adverse safety consequences, or to have cumulative or interactive effects) should enter the selection of design improvements process.

Selection of design improvements. Recommendations for HED resolution correction will be made by the review team for each identified HED. VYNPC states that highest priority (reviewer's note: priority system not defined) HEDs will be evaluated first and that Category IV HEDs will be documented but it is likely that no corrective action will be taken. Proposed corrective techniques will include enhancement, design changes, and training. Enhancement techniques will be mocked-up on drawings to allow the review team to evaluate their effectiveness. Design changes will be evaluated by having operators walk through portions of EOPs involving affected components.

As described, the process for selection of design improvements is consistent with NRC guidance. There is, however, some concern that the HED-by-HED approach will result in piecemeal corrections. There are several means for reducing the above concern. One is development of design conventions (e.g., a labeling convention or control room-wide color convention) which will be applied throughout the control room, remote shutdown panel, and other operator stations (if desired). A second is to take the fullest advantage of

mock-up techniques to assure that the total correction package provides a consistent, coherent, and integrated interface between operators and the control room. It is recommended that VYNPC add means for resolving the concern about piecemeal correction of HEDs to the process for selection of design improvements.

Verification that selected design improvements will provide the necessary correction and verification that improvements will not introduce new HEDs. VYNPC has indicated that the above verification requirements will be satisfied during the selection of design improvements. After arriving at a recommended solution for each HED, the following two steps will be performed:

1. Verification that the recommended solution adequately addresses the HED, is feasible, cost effective, and adheres to accepted human factors principles

2. Validation that this solution does not introduce another HED

The mechanism for accomplishing the two steps was not described.

The intent to satisfy the requirements to verify that HEDs are corrected and no new HEDs are introduced was indicated. Use of mock-up techniques, particularly for the verification that no new HEDs are introduced, is recommended.

Coordination of control room improvements with changes from other programs such as the SPDS, operator training, Reg. Guide 1.97 instrumentation and upgraded emergency operating procedures. VYNPC addressed coordination of control room improvements with changes from other programs as follows:

1. No device specifically identified as an SPDS is planned for VYNPP. VYNPC indicated that the DCRDR may result in additional methods of displaying safety parameters

2. Coordination with training was not specifically addressed by VYNPC except as potential resolutions for some HEDs

3. With respect to Reg. Guide 1.97, the verification of task performance capabilities will be used to give insight into the monitoring instrumentation that is available, and to whether indication is required but missing

4. Upgraded EOPs will serve as the starting point for the task analysis used to identify operator tasks and information and control needs

Several concerns are raised by the proposed coordination activities. One concern is that submission of the SAR for the VYNPP SPDS is not scheduled until February 1, 1985. NRC review of the SAR may indicate that existing instrumentation and controls do not satisfy the SPDS requirements of Supplement 1 to NUREG-0737. In that case, satisfaction of the DCRDR coordination requirement would mean review of any added SPDS equipment for human factors suitability and for consistency with the remainder of the control room. A second concern is that while training is viewed as a means for resolving HEDs, training to familiarize operators with changes to the control room was not mentioned. Such training appears necessary for satisfaction of the Supplement 1 to NUREG-0737 coordination requirement. Simulator upgrade which precedes control room upgrade might enhance this process and aid in evaluation of corrections. A third concern is that all Reg. Guide 1.97 instrumentation may not fall within the scope of the EOPs. Satisfaction of the coordination requirement appears to require that all Reg. Guide 1.97 instrumentation added to the control room be compared with accepted human factors principles and reviewed for consistency with the rest of the control room. Final concerns, related to coordination with the EOPs, are discussed in the paragraph on function and task analysis.

Other. The VYNPC program plan indicated that an operating experience review has been conducted as a part of the 1982 BWROG control room survey. In addition they intend to update the operating experience review to cover the approximately two years of elapsed time since that review. Consistent with guidelines in NUREG-0700 both a review of operating history and operator interviews will be included. An operating experience review is not required by Supplement 1 to NUREG-0737, but it is expected to contribute to the success of the DCRDR. Development of a plan for keeping the operating

experience review current after completion of the DCRDR is recommended. Such a plan may have value throughout the life of the plant.

The VYNPC Program Plan also indicated that a validation of control room functions would be conducted. Walk-throughs will be performed to identify dynamic performance problems. HEDs will be documented for input to the assessment process. As described, the validation process should contribute to the success of the DCRDR.

The VYNPC control room survey will also include the alternate or remote shutdown panels. The review of the remote shutdown panel in the DCRDR should enhance operability of VYNPP.

CONCLUSION

The Vermont Yankee program plan addressed all of the DCRDR requirements stated in Supplement 1 to NUREG-0737. Information in the program plan indicated understanding and intent to satisfy most of the requirements. The review did, however, identify some concerns. Those concerns were:

1. Amount of human factors expertise available for accomplishment of technical tasks is limited

2. Lack of specific personnel assignments

3. Apparent lack of an orientation program for those involved in the DCRDR

4. The possibility that EOPs used in the task analysis will subsequently require revision based on NRC review of VYNPP's PGP

5. The possibility that identification of operator information and control requirements will not be independent of the existing control room

6. The possibility that all tasks in the EOPs will not be subjected to task analysis

7. Inclusion of appropriate equipment characteristics in the control room inventory

8. The indication that modifications to the control room and control boards will be compared only with the BWROG Control Room Survey Program checklist and not the supplement to that checklist

9. The possibility that HED-by-HED solution of design improvements will result in piecemeal correction

10. Gaps in the efforts to coordinate control room improvements with changes from other programs

Resolution of the above concerns would increase the benefits of the DCRDR.

Several recommendations also resulted from the program plan review. The recommendations are not intended as additional requirements. They are intended to encourage the fullest possible benefit from the DCRDR. They do not appear to require major changes to the current organization and process of the DCRDR. These recommendations are:

1. Development of a plan to keep the operating experience review current after completion of the DCRDR

2. Use of a control room mock-up to assess the integrated effect of the fullest possible range of design improvements and enhancements

3. Simulator upgrade which precedes control room upgrade to aid coordination with training, and if practicable, evaluation of corrections

4. Development of control room design conventions

Based on the review of the program plan, an in-progress audit of the Vermont Yankee DCRDR is recommended.