AUDIT REPORT

OF THE

DETAILED CONTROL ROOM DESIGN REVIEW

FOR

ARKANSAS NUCLEAR ONE, UNIT 1

October 1985

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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 Arkansas Power & Light Company's (AP&L) generic Program Plan for conducting Detailed Control Room Design Reviews (DCRDRs) at Arkansas Nuclear One (ANO), Units 1 and 2. Because the AP&L Program Plan provided insufficient details, the NRC staff met with AP&L on May 2, 1984, where additional information was provided to describe AP&L's Program Plan. A summary of this meeting along with NRC comments was prepared and transmitted to the license on June 7, 1984. AP&L submitted the DCRDR Final Summary Report for ANO, Unit 1 on August 14, 1985. Based on a preliminary review of this Final Summary Report, and on the fact that both ANO Unit 1 and 2 are using the same DCRDR process, the NRC decided to conduct an on-site, pre-implementation audit of the DCRDR for ANO-1 and an in-progress audit of ANO-2. This audit was conducted on September 16-20, 1985. This evaluation of ANO-1 is based upon both the Program Plan and Summary Report submitted by AP&L and the information provided by the licensee during the September 1985 pre-implementation audit.

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This report documents the findings from a pre-implementation audit,conducted on September 16-20, 1985, and the evaluation of the DCRDR Final Summary Report submitted to the Nuclear Regulatory Commission (NRC) on August 14, 1985, by Arkansas Power & Light Company (AP&L) for the Arkansas Nuclear One, Unit 1 (ANO-1) Detailed Control Room Design Review (DCRDR) (Reference 1). The DCRDR review by AP&L at ANO-1 was conducted in accordance with a generic Program Plan submitted to the NRC on November 25, 1983, for performing DCRDRs for both ANO Units 1 and 2 (Reference 2). The NRC staff reviewed the Program Plan and forwarded their comments to AP&L on February 2, 1984 (Reference 3). The AP&L Program Plan had insufficient details addressing the processes to accomplish the DCRDR objectives; therefore, the NRC staff met with AP&L on May 2, 1984, in order to obtain additional information to supplement AP&L's Program Plan. AP&L submitted the DCRDR Final Summary Report for ANO-1 on August 14, 1985. The decision was made by the NRC to conduct a pre-implementation audit of the DCRDR for ANO-1 in order to clarify certain aspects of the generic review process, and to confirm that the review had been conducted appropriately.

BACKGROUND

Licensees and applicants for operating licenses are required by the Nuclear Regulatory Commission 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 4). The need to conduct a DCRDR was confirmed in NUREG-0737 (Reference 5) and in Supplement 1 to NUREG-0737 (Reference 6). 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 7) while criteria for NRC evaluation of a DCRDR are contained in NUREG-0800 (Reference 8).

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, the DCRDR 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 overall DCRDR effort (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 SAIC's evaluation is to assist the NRC in the technical assessment process by providing an independent appraisal of the Arkansas Nuclear One, Unit 1 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 evaluation. The nine issues are:

1. Establishment of a qualified multidisciplinary review team.

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

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

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

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

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

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

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

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

PLANNING PHASE

1. Preparation and Submission of a Program Plan

The NRC staff reviewed Arkansas Power and Light Company's generic Detailed Control Room Design Review Project Program Plan submitted for both ANO Units 1 and 2. The NRC reviewed the Program Plan with reference to the requirements of Supplement 1 to NUREG-0737 and transmitted comments to AP&L by memo dated February 2, 1984. Since AP&L's generic Program Plan provided insufficient details, the NRC staff met with AP&L on May 2, 1984, where additional information on the DCRDR process was provided to supplement the Program Plan.

2. Establishment of a Qualified Multidisciplinary Review Team

Both the Program Plan and the Summary Report for ANO-1 included a description of the staffing and management that were established to conduct the DCRDR Team. The structure and management of the DCRDR team appeared to be flexible enough to permit a multidisciplinary effort. Management and administration of the AP&L DCRDR at ANO-1 were the responsibility of the

NUREG-0737, Supplement 1 Steering Committee. The Steering Committee is composed of five members representing the ANO Operations Manager and Units 1 and 2 Operations Superintendents along with the AP&L Engineering Services General Manager and the Project Manager for ANO. Its responsibility is to provide management assistance to ensure integration of major project objectives in a cost-effective manner. Working in conjunction with the Steering Committee was the NUREG-0737 Supplement 1 Program Coordinator who was responsible for planning and coordinating activities to ensure the integration of all objectives to meet NUREG-0737, Supplement 1. The DCRDR Team Leader reports to the Steering Committee through the NUREG-0737 Supplement 1 coordinator.

The ANO-1 DCRDR team consisted of a group of professionals from AP&L and Advanced Resource Development Corporation (ARD) with a wide range of skills necessary for the performance of the DCRDR. Based upon the resumes provided in Appendix C of the Summary Report, the members of the DCRDR team appeared qualified to perform DCRDR activities. Expertise of the team included:

- I&C engineering
- Nuclear systems engineering
- Human factors engineering
- Operations
- Electrical engineering
- Operations assessment.

During the audit, a matrix was presented that indicated which team members were assigned to each task of the DCRDR program. From this matrix, it appeared that the appropriate skills were available and properly utilized.

Prior to beginning the review, team members were familiarized with the general design and operation of the plant, relevant NRC documentation, and general human factors engineering principles and methodology through seminars given to AP&L employees by ARD and through informal instruction. DCRDR team members also were encouraged to document dissenting opinions and were provided access to plant facilities, personnel, documentation, and other information as needed to perform their tasks.

Additional support was provided to the DCRDR program from AP&L support organizations. During the assessment process, assistance was provided by the technical analysis staff, the plant computer support group and the plant training department. The plant drafting department helped with the control room panel drawing updating process while the Operations staff assisted during the validation and task analysis efforts.

The continuity during the review process appeared to be excellent with only one member of the original team having left since the review started. However, his function was immediately assumed by his supervisor for the remainder of the review process. In summary, we believe that AP&L has satisfactorily met the requirements of establishing and supporting the efforts of a qualified multidisciplinary DCRDR team.

REVIEW PHASE

AP&L review phase plans and activities included:

1. Review of historical events and 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

AP&L conducted a two-part operating experience review at ANO-1 to identify conditions which impact on the probability for those operator errors which could affect safe operation of the plant. The first part of the effort, the historical event review, included a review of the documented operating history of the ANO-1 plant to identify any recurring problems and an examination of industry-wide sources 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 on previous operating experience.

To accomplish the review of plant operating history and industry-wide experience, five sources of historical information were collected and reviewed. Industry-wide reports that included Licensee Event Reports (LER), the Significant Event Reports (SER), and the Significant Operating Event Reports (SOER) for the past five years were reviewed by a Human Factors Specialist (HFS). The in-house documentation included Unit Transient Reports and Transient Assessment Program (TAP) Reports. Because ANO-1 did not include a large number of events found in the industry-wide reports, the scope of the review was expanded to cover TAPs from all Babcock and Wilcox (B&W) plants. All available ANO-1 Unit Transient and B&W TAP reports were reviewed for the DCRDR, resulting in a total of 527 historical reports.

Criteria were developed to determine if the historical reports described and documented a problem specifically related to control room equipment, procedures, or personnel error. All reports that met any one of the criteria cited in the Summary Report were retained in the Historical Review Notebook that documented ANO-1's historical experience review. These reports were then recorded onto a two-page Problem Analysis Report (PAR) that captured the pertinent information necessary to analyze each event and determine if the problem was applicable to ANO-1 and uncorrected at the plant. Using this process, the historical event review resulted in the surfacing of many problem areas; however, the majority of these problems were not applicable to ANO-1 or were previously addressed and resolved by AP&L. As a result, only two problems were evaluated as uncorrected at ANO-1 and were documented as HEDs.

The ANO-1 operator survey effort entailed the administration of an open-ended, self-administered questionnaire to 48 staff members, including all licensed operating personnel, operators in training class for ANO-1 and instructors licensed on Unit 1. The survey was structured to address the nine content areas suggested in NUREG-0700, Section 6. The objective of the survey was to obtain pertinent knowledge that operating personnel at ANO-1 possess regarding both positive and negative control room features which they had experienced and/or observed in the course of preparing for operations or during operations.

Forty-eight surveys were distributed for completion, twenty-five (52%) were returned by mail to the HFS. Confidentiality was ensured by assigning each questionnaire a number rather than a name. The list of potential respondents and corresponding numbers were kept in confidence by HFS.

As some information relevant to operator experience could not be solicited easily by using a structured questionnaire format, subsequent individual semistructured interviews were conducted by the HFS with 18 of the questionnaire respondents and two operators who had not previously responded to the questionnaire. The objectives of the follow-up interviews were (1) to clarify ambiguities in an individual's written responses to the self-administered questionnaire; (2) to gather additional details pertaining to that individual's responses; and (3) to address issues on which the questionnaire responses revealed particular concern or for which no consensus emerged.

Once interview data were collected, all information from the completed operator survey activities were consolidated and summarized using descriptive statistics. Component and system information resulting from the interviews was used to enhance the questionnaire data where appropriate, and the comments were organized by topical areas to facilitate the review by the DCRDR team at a later date. Findings from the operator survey resulted in the identification of 103 HEDs of which 23 were rated as safety significant (Category 1).

In summary, AP&L's operating experience review at ANO-1 appeared extensive, thorough, and appropriately conducted. Consistent with NUREG-0700

objectives and guidelines, it entailed a systematic examination of industry-wide reports and plant-specific documents. Structured questionnaires and semistructured interviews were administered to and conducted with a satisfactory range of operating personnel. The activities conducted resulted in the identification of 105 HEDs which were not identified as a result of other DCRDR activities.

2. System Function and Task Analysis

The objective of the ANO-1 system function and task analysis was to establish the input and output requirements of control room operators' tasks performed under emergency conditions. The basis for system function analysis for ANO-1 was derived from the Abnormal Transient Operating Guidelines (ATOG), generic material from B&W. This ATOG document includes the following studies:

- Safety Sequence Diagrams (SSDs) developed to identify the specific plant systems and subsystems including necessary operator actions used to accomplish safety functions.

- Event Tree Diagrams constructed to determine the various plant conditions which could evolve following a postulated initiating event.

- System Auxiliary Diagrams (SAD) developed to identify the supporting equipment which must operate in order to support the functions of the front-line systems and subsystems.

The Safety Sequence Diagrams presented the specific plant actions that could occur in order to satisfy the accomplishment of a safety function. The event tree diagrams were developed for selected basic types of transients to account for all of the combinations in which plant actions might occur. The System Auxiliary Diagrams describe the components and supporting systems and subsystems which are necessary to enable each major system to perform properly. Using the Transient Operating Guidelines, the ANO-1 plant-specific EOPs were then developed. Subsequently, these plant-specific EOPs were used as a starting point to identify tasks to be conducted by operators during emergency situations. To accomplish the objectives of the

DCRDR task analysis, a detailed breakdown of the operator functions into tasks was performed at each stage of the symptom-oriented procedures. A task description breakdown was completed for each tabbed section of the ANO-1 EOPs for the four sets of observable symptoms listed below:

1. Loss of Subcooling Margin
2. Inadequate Primary to Secondary Heat Transfer (overheating)
3. Excessive Primary to Secondary Heat Transfer (overcooling)
4. Inadequate Core Cooling.

In addition, certain additional procedures were used to generate additional tasks and subtasks that might be performed in the control room during abnormal conditions. These procedures include the following:

Unit 1 Procedures

Diesel Generator Operation	Reactor Building Ventilation
Plant Startup	Fire Protection System
Remote Shutdown	Reactor Coolant Pump and Motor Problems
Plant Shutdown and Cooldown	Loss of Service Water
Loss of DHR	Load Reject
Turbine Trip	Loss of Reactor Coolant M/U
Pressurizer System Failure	Loss of S/G Feed
N/C Cooldown	Loss of Condenser Vacuum
CRD Malfunction	

Once the site-specific documentation was developed, operator actions which were implied or stated were written as task statements on the Task Description Form. All unique tasks were identified, coded with a task number, and grouped into the prevailing system being exercised or acted upon.

The tasks were broken down into task elements and/or action steps by AP&L Operations staff subject matter experts (SMEs) in order to reflect a step-by-step procedural set of actions that must be carried out in order to accomplish the task. These task reduction activities were accomplished by an iterative process involving a series of questions about each task, e.g., task conditions, initiating cues, frequency, and performance criteria. The

information and control needs for task performance were first collected on Task Description Forms and later entered into a database. This process resulted in the primary database for the entire DCRDR.

The above process was performed outside the control room as much as possible. The task analysis performed for the DCRDR was not done from a "what exists" perspective but rather in terms of "what should be." The process was not accomplished completely independent of the control room as the SMEs also utilized procedures, piping and instrumentation diagrams, and electrical schematics as reference sources. However, the DCRDR team members pursued an iterative process and continued to probe SMEs for responses that reflected "what should be" in the control room.

Task Analysis Instrumentation Requirement Forms were used to document the information and control requirements generated from the selected procedures. This was done by an HFS and an Operations SME outside the control room. Like the task elements, the information and control requirements were coded from a "what is needed" perspective for the various action steps identified in the task analysis. The level of detail recorded for instrumentation required, as shown by the "Task Analysis Instrumentation Requirement Form" in Appendix E, was found to be satisfactory. During the verification process, the availability of information and control requirements were checked with existing instrumentation (inventory) in the control room. If the required instrumentation was found to be absent, then a "dummy" code number representing that particular item was entered into the database and resulted in the generation of an HED. Similarily, during the suitability comparison, if the required characteristics of displays and controls did not match what was physically available in the control room, another HED was written. Forty-three HEDs were identified as a result of this process.

In conclusion, the ANO Unit 1 system function and task analysis was conducted in a comprehensive and systematic manner. The analysis was based on ANO's symtomatic Abnormal Transient Operating Guidelines (ATOG) Program resulting in plant-specific EOPs that were further defined into emergency task elements and/or action steps. The task analysis covered not only the emergency operations but also selected abnormal and normal operational procedures such as Reactor Startup, Reactor Shutdown, and Cooldown resulting in broad coverage of systems necessary to support emergency operation.

Subsequently, information and control requirements and their associated characteristics were derived for each action step. During the verification phase, availability and suitability comparisons were made with existing control room components, and appropriate HEDs were generated. This process resulted in an integrated task analysis that meets the requirements of Supplement 1 to NUREG-0737.

3. Control Room Inventory

The ANO-1 inventory process used by the licensee included all displays, controls, indicators, and annunciators in the control room primary operating area, and was followed by a verification of availability and suitability as required by Supplement 1 to NUREG-0737.

The inventory was completed primarily by an HFS with assistance from AP&L operations staff as required in a process consistent with NUREG-0700 guidelines. The objective of the ANO-1 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 display and control requirements identified during the task analysis.

All displays, controls, controllers, annunciators, and other equipment in the control room with which the operators interact, were included in the comprehensive inventory. A current set of as-built drawings were marked up to reflect the present configuration of the ANO-1 control room. A systematic inventory was developed on a panel-by-panel basis where instruments were assigned a coded sequence number, inventoried, and checked off the as-built drawings. Each piece of equipment on the control boards and its characteristics were identified by codes that had been used to characterize information and control requirements identified in the task analysis. The inventory data was stored in the computerized database management system to be used as the basis of the verification process.

The objective of the verification process was to ensure that operator tasks derived from the plant-specific EOPs could be performed in the existing control room with minimum potential for human error. There are 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. A total of 29 HEDs were identified during the verification of availability. Second, for equipment that had been identified as available, a suitability determination was made by comparing the characteristics identified during the task analysis phase and the control room instrumentation documented during the inventory. This step was performed using the database by "matching" the two lists. 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. A total of 14 HEDs were recorded as a result of the verification of suitability.

In conclusion, AP&L has provided a detailed description of what appears to be a well-planned and well-executed control room inventory for ANO-1 that helped to produce a total of 43 HEDs from the verification phase of the DCRDR. The documentation process of the control room inventory utilizing the database management system was effective, and well-integrated, and produced a successful control room inventory that meets the requirements of Supplement 1 to NUREG-0737.

4. Control Room Survey

A comparison of instrument and control features to the ANO-1 human factors guidelines was conducted. These guidelines were derived from those given in Section 6 of NUREG-0700 and closely follow them in format and content. The ANO guidelines do differ from those in NUREG-0700 in that some of the items were quantified, or reworded, to make them clearer and more concise for evaluation. These modifications to NUREG-0700 guidelines, as shown in Appendix of this report, were reviewed in detail by the audit team. The results are presented in the following section:

Review of Differences Between NUREG-0700 Guidelines and AP&L Checklist

Several differences between the survey guidelines of NUREG-0700 (Section 6) and the AP&L survey checklist are based on (1) misprints in NUREG-0700; (2) qualitative guidelines which AP&L chose to make quantitative to improve objectivity; and (3) very minor differences on guidelines of lesser significance. We find these modifications to be acceptable.

However, the audit team disagrees with the modifications made by AP&L on the following NUREG-0700 guidelines as discussed below:

1.2.2.d(2), Exhibit 6.1-6, 1.2.3.b, 1.2.3.d(2)

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 inadvertant 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 guidelines 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(2)

TEAM POSITION:

As in previous guidelines, if a measurement could be used, the guidelines 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

TEAM POSITION:

If a quantitative value for auditory warning signals were to be specified, it should be specified as some maximum value over ambient noise level, not an absolute value of 90 db(A). Depending on the ambient noise level, 90 db(A) may very well startle or

cause irritation to the operator. In addition, intensity is not the only signal quality that might startle or cause irritation.

5.1.6.c(2)

TEAM POSITION:

The meanings recommended in the guidelines of NUREG-0700 for the use of red, green, and yellow as codes were determined to be within the stereotypical expectancy of our society's population. Any other use of these colors, as codes, should be justified on an operational basis taking into account the behavioral attributes of the current expected operator population.

6.5.1.g

TEAM POSITION:

Tag outs in the form of plastic covers can physically prevent actuation of a control while providing sufficient writing surface and format to inscribe all required administrative information. Military systems use what is termed as "safety pins" with streamers to physically prevent control actuation.

9.2.2.e

TEAM POSITION:

Guidelines on control/display packages should not be deleted since typical control rooms (including ANO) usually incorporate several modular vendor panels (e.g., turbine control, rad monitor).

The audit also disclosed that a number of checklist items had not been completed and that there were some apparent discrepancies in connection with the color-coding evaluation procedures.

Remote Shutdown Panel Survey

The NRC has strongly 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. Therefore, members of the NRC audit team did review the ANO-1 remote shutdown capability and felt that it has many problems due to procedural, labeling, and lighting deficiencies. Appendix D provides a more detailed description of the remote shutdown capability and its perceived problems.

In summary, the survey effort was complete, covering the nine content areas suggested in NUREG-0700 (e.g., workspace, panel design, annunicator warning system, etc.). Environmental conditions, including sound, lighting, and the HVAC system, also were surveyed and audited by the NRC. While primarily using the guidelines in NUREG-0700 as the basis for their survey, AP&L did modify six guidelines to which the audit team does not agree. The control room should be rechecked for these six items and responses provided if it is not in compliance. In addition, all sections of the checklist, including color-coding, should be completed properly. Although recommended for review in NUREG-0700, the remote shutdown capability, which was found to contain many problems, was not considered as part of the AP&L DCRDR at ANO-1. Although the survey was thorough, there are some items that have not been completed, along with six guidelines that should be reevaluated in the control room before this effort meets the requirements of Supplement 1 to NUREG-0737.

5. Validation of Control Room Functions

AP&L Company conducted a validation review at ANO-1 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 designing of the control room as it now exists.

The validation process was performed by using walk-through techniques on the ANO-1 simulator. The events which were used in the validation were:

- Automatic reactor trip with no abnormalities
- Reactor trip with overcooling margin
- Reactor trip with low subcooling margin
- Reactor trip with overheating
- Steam generator tube rupture
- Steam line break.

The validation process was arranged and supervised by an HFS with the assistance of the DCRDR SME. Operating crews consisted of two ANO operators. During the simulations, which were recorded on videotape, operators were instructed to call out relevant actions, directions of movement, the displays, and indicators used, as well as their responses. The events and recording efforts were terminated when the SME determined that the crew had successfully investigated the event.

After recording the events, an HFS and an SME jointly reviewed and analyzed the data on a step-by-step basis. During this review process, ANO-1 procedures were referenced, the HFS would stop the tapes for viewing as needed, and the SME would clarify operator actions and identify procedural steps. Where the HFS observed instances in which equipment availability, suitability or location could be enhanced, or in which operator uncertainty existed due to procedural ambiguity, HEDs were written to improve operator actions and provide for corrective actions when operator deviations were safety significant.

In conclusion, while using a real-time simulator, the licensee implemented a validation approach consistent with the guidelines of NUREG-0700. The events chosen were consistent with those suggested in NUREG-0700 and exercised all control room workstations. From the analysis performed, six HEDs were generated.

ASSESSMENT AND IMPLEMENTATION

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

1. HED Assessment Methodology

The DCRDR Assessment Team reviewed and assessed each HED based on its impact on plant safety and operability. The report states, "This review included a formal assessment of each HED and evaluation of the most appropriate action to initiate in order to further pursue correction of the HED."

Each member of the Assessment Team was provided with a notebook containing a complete set of HEDs for his individual assessment. Each member was also provided with HED Assessment Rating Forms containing 20 questions grouped under the following factors affecting plant safety, plant operability, and personnel safety:

- Impact on physical performance
- Impact on sensory/perceptual performance
- Impact on cognitive performance
- Interaction with task variables
- Impact or potential impact on operating crew error
- Impact or potential impact on plant sa ety.

Upon completing the review of each HED against the six factors, the Assessment Team member determined the safety significance of that HED based on the following categories:

I. HIGHEST SIGNIFICANCE: Could affect or has substantially affected a safety system or operator response during an emergency situation.

II. SIGNIFICANT: Could substantially affect or has substantially affected a nonsafety system or operator response during routine, nonemergency operation.

III. LEAST SIGNIFICANT: Could or has affected operator response in a nonsubstantial way.

The HED Assessment Rating Forms also provided for evaluation of the cumulative impact of Category 3 HEDs to ensure that the level of significance was fully considered.

Upon completion of the individual team member's assessments, a compilation was made and a copy provided each team member. The Assessment Team then met to discuss the ratings they assigned individually to each HED and to reach a team consensus regarding final HED categorization.

The only concern on the part of the reviewers of the Summary Report was that attempts at HED solution were being made during the assessment, an activity not properly part of the assessment phase (Reference 1, page 7-1). During the audit, this concern was dispelled by an AP&L explanation of the assessment process and by the absence of any documentary evidence that HED correction was considered in connection with the assessment process.

During SAIC's evaluation of the Summary Report, all HEDs were reviewed for appropriateness of categorization. All HEDs in Categories 1 and 2 and a sample of the HEDs in Category 3 were reviewed by the NRC audit team to validate the licensee's assessment process. The results indicated that the assessment process was generally detailed and correct.

The assessment process as applied was satisfactory and meets the requirements of Supplement 1 to NUREG-0737.

2. Selection of Design Improvements

The purpose of selecting design improvements is to determine corrections to HEDs identified from the review phase of the DCRDR. 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.

Although AP&L's Summary Report described a process for development of corrective actions for resolving HEDs, the major weakness in the selection activity and the DCRDR as a whole is the high number of HEDs that remain unresolved. Both the Summary Report and the audit discussions indicate many studies, evaluations, and reviews designed to resolve HEDs have yet to be accomplished. The results of these studies and reviews developed as a function of AP&L's design change process should provide HED solutions

developed in accordance with good human factors engineering principles that are approved by the DCRDR team.

The results of these studies and evaluations will be combined into design packages that incorporate a cohesive set of corrective actions involving not only Category 1 HEDs but, potentially, Categories 2 and 3 as well if they are part of the overall corrective action. Of the 42 Category 1 HEDs that were identified in the Summary Report (Table 8.2, page 8-4), 18 corrective actions have already been implemented in refueling outage 1R6 (Nov. 84 - Jan. 85). The NRC audit team reviewed the corrective actions implemented in the ANO-1 control room and found that these 18 HED solutions provided the appropriate correction of the deficiencies without creating any unacceptable human engineering discrepancies.

The selection of design improvements is incorporated into the Design Process Procedure (AP&L procedure No. 202) that normally is required of any change to plant systems being considered by AP&L. This process begins with an Engineering Action Request (EAR) which is written by the DCRDR team with AP&L engineering support as necessary. The EAR is a request for preparation of a design change package or a revision/amendment to an existing design change package. A project engineer will review the EAR and any attachments to scope the effort required to prepare the design change. If a Project Scoping Report (PSR) is necessary, then the Project Engineer will coordinate writing of the PSR with input from the Discipline Engineers to include Human Factors Specialists.

The PSR serves to inform management of the design approach being considered, and the requirements of the approach, before detailed engineering begins. The PSR is to be used only as a project coordination tool and is not used as design input. The PSR is reviewed by an HFS along with the Plant Operations Superintendent and the Plant Engineering Superintendent, and concurrence is required prior to developing a Design Change Package (DCP). The final authority for initiating a DCP is the Vice President of Nuclear Operations who will initiate a new EAR, which includes the PSR, requesting the preparation of a Design Change Package.

In conclusion, the licensee has developed a process for correcting and implementing improvements in the control room which is effective, judging

from a review of the 18 HEDs already implemented as part of 1R6. This process indicates AP&L's awareness of the need for implementation of corrective actions in an integrated fashion. However, the licensee has not presented adequate descriptions of design improvements for each HED identified in the Summary Report as required by Supplement 1 to NUREG-0737. Presently, ANO-1 has a number of HEDs that are still unresolved awaiting further review and selection of HED solutions as part of the Design Process Procedure (AP&L Procedure No. 202). The licensee must document all solutions of Category 1 HEDs and Categories 2 and 3 HEDs if they become part of a design change package. The licensee must also provide justifications for not correcting or partially correcting HEDs with safety significance. This issue will remain an open item until the NRC reviews the proposed design change solutions, implementation schedules, and justifications for safety-related HEDs that will not be corrected or only partially corrected.

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

While the licensee has not provided a formal process for the verification of the effectiveness of corrective actions, it appears that such a process does exist as part of the normal AP&L design process procedure.

As described in the previous section, each DCP will be evaluated with respect to the human factors aspect of any control room-related design changes (AP&L Procedure No. 202 pages 22 and 23). The Project/Discipline Engineer in charge of the DCP will determine whether a human factors review is required. The human factors review, when required, will be performed as directed by the I&C Section Procedures. A human factors review checklist will be completed using an Information Request Form (IRF) detailing the human factors review, and forwarded to the requesting engineer for inclusion into the DCP. Only one human factors review checklist is required per DCP.

The licensee indicated during the audit that verification of the effectiveness of HED resolutions might be performed by using panel mock-ups, the simulator, and the involvement of Human Factors Specialists. Photo-

graphs, blackboard walk-throughs, and panel blueline drawings were presented as techniques that are currently being employed.

In conclusion, the licensee has not finalized a formal process for accomplishing this effort. However, a human factors review will be performed for control room-related design changes. Additionally, AP&L is planning the use of various techniques such as mock-ups and blueline drawings for assessing the effectiveness of the HED resolutions. If the processes as discussed at the audit are included in this effort, this process will meet the requirements of NUREG-0737, Supplement 1.

4. Coordination of DCRDR Improvements With Other NUREG-0737, Supplement 1 Improvement Programs

The Summary Report states that AP&L has a coordinated program for the implementation of NUREG-0737, Supplement 1 initiatives which is intended to optimize the interface between the various initiatives. The organization for the effectuation of the program, the relationships between the various initiatives (i.e. DCRDR, SPDS, Reg. Guide 1.97, symptom-oriented EOPs, and ERF), and the dates for completion of the various program milestones are shown on a figure referred to but not included in the Summary Report. A copy of the referenced figure has been obtained and appears to demonstrate that a coordination program is established and functioning.

During the audit, the Audit Team attended a formal presentation on the coordination program and has concluded that this DCRDR element is being satisfactorily performed and meets the requirements of Supplement 1 to NUREG-0737.

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

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

1. Proposed Schedules for Implementing HED Corrections

AP&L's proposed approach for implementing HED corrections was provided in the cover letter which accompanied the Summary Report when it was transmitted to the NRC. As cited in that letter, the proposed four-phased program emphasizes an orderly and integrated process for the selection and implementation of HED solutions. While this process appears to be a satisfactory method for resolving ANO-1's HEDs, there is a concern that this proposed phased approach does not have a sense of urgency for completing the corrective actions and is not associated with formal completion dates.

At the audit, AP&L management, the NRC team leader and project manager proposed an agreement on a formal schedule for the completion of HED corrective actions. The formal agreement will be submitted by AP&L to the NRC within 30 days after the completion of the audit (September 19, 1985). Within six months after the 30-day agreement letter, AP&L will submit to the NRC a supplement to the Summary Report. This supplement will include all proposed HED corrective actions, and justification for any HEDs left uncorrected. In addition, a schedule for implementing these HED resolutions within the next two refueling outages (1R7 and 1R8) will be provided. Any corrective actions that can not be implemented by the second refueling outage (1R8) will be documented along with a justification for the delay.

2. Proposed Corrective Actions and Justifications for HEDs to be Left Uncorrected

HEDs identified during the DCRDR are presented in Volume 2 of the Summary Report. Findings are presented by HED categories:

- Category 1 - 42 HEDs
- Category 2 - 51 HEDs
- Category 3 - 369 HEDs

Examination of Volume 2 of the Summary Report indicated that several of the Category 3 HEDs were not included. When notified of this omission, AP&L was able to supply the missing material at the audit.

Appendix A of this report contains a listing of HEDs for which proposed

corrective actions, or justification for not correcting, were found to be inadequate. Four samples, with selected HEDs, of the kinds of ambiguities which are causing concern regarding AP&L's plans/capabilities for adequate disposition of HEDs are presented below.

1. There are Category 1 HEDs that have been partially corrected using interim solutions without permanent resolutions having been defined.

   HED QS:A3.5-1.042: The discrepancy described is the need for a core exit thermocouple indicator in the control room. AP&L's response states that such an indication has been provided on the SPDS. While the SPDS provides an interim non-class 1E solution for this problem, a better resolution needs to be developed and implemented.

2. There are Category 1 HEDs for which the licensee has not committed to implement proposed corrective actions until further evaluation. Final disposition of these HEDs should be documented.

   HED QS:A1.7-1.018: The HED described here is the need for remote control operation of the decay heat pump suction valves. AP&L's response indicates they <u>may</u> install a motor operator to the subject manual valves. While the proposed corrective action appears to be satisfactory, there is a concern that AP&L has not formally committed to proceed with this corrective action for this safety-significant (Category 1) HED.

3. There are Category 1 HEDs which require further review and/or study before a decision can be reached as to whether or how the HED can be corrected or whether no correction can be justified.

   HED QS:B3.17-1.071: This discrepancy indicates that the service water instrumentation is not well laid out. AP&L indicates they intend to perform an evaluation in order to determine a corrective action. Until a final solution is reviewed by the NRC staff, HEDs awaiting the results of studies or reviews will remain open.

4. The audit team is concerned with AP&L's position regarding certain HEDs.

   HEDs CK:1-1.007 and CK:1-1.006: The discrepancies described here are the location of 23 displays and 98 controls outside of the NUREG-0700-recommended evelopes. AP&L's response is that these deviations from NUREG-0700 do not create a significant problem for the control room operator. As a result, there are no plans for correcting these discrepancies at this time. This response does not identify the controls and displays affected or adequately address the problems created by the location of the controls and displays covered by these two HEDs. It is recommended that AP&L identify the affected controls and displays and provide a justification for not correcting them that addresses behavioral or operational factors and issues related to plant safety.

CONCLUSIONS AND RECOMMENDATIONS

Arkansas Power and Light (AP&L) Company's Summary Report for the DCRDR conducted at Arkansas Nuclear One, Unit 1 (ANO-1) demonstrates a strong commitment towards meeting the requirements of NUREG-0737, Supplement 1. The documentation submitted, in addition to extensive discussions of the review activities conducted to perform a DCRDR, indicates that AP&L basically met most of the requirements. However, additional information is required from the licensee to provide assurances that all requirements as stated in NUREG-0737, Supplement 1 are satisfied.

The following is a summary of comments on AP&L's compliance with each of the DCRDR review steps and requirements documented by the Summary Report and confirmed during discussion at the pre-implementation audit. The review portion was comprehensive, with the task analysis being conducted early enough in the process to become a key factor during the remaining phases of the DCRDR.

- AP&L established a well-qualified, adequately staffed DCRDR team, which was 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. This requirement of NUREG-0737 is satisfied.

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

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

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

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

- A human factors survey of the control room was conducted in what appears to be a comprehensive and thorough manner. The methodology and objectives of the survey were essentially in accordance with the guidance provided in NUREG-0700 and met the requirement of

Supplement 1 to NUREG-0737. AP&L's deviations from NUREG-0700 in conjunction with applicable justifications for such deviations were submitted and discussed at the pre-implementation audit. As a result, six differences between NUREG-0700 and AP&L's checklist were found unacceptable by the Audit Team. AP&L should amend its checklist to reflect the concerns and should reevaluate the control room in the areas in which the Audit Team disagrees with the AP&L checklist. Those checklist items found incomplete or discrepant should also be reevaluated.

- The validation approach implemented by the licensee was found to be consistent with the guidelines of NUREG-0700.

- The process AP&L developed to assess the significance of HEDs appears to meet the requirements of Supplement 1 to NUREG-0737. The HED assessment/categorization process resulted in the identification of 42 Category 1, 51 Category 2, and 369 Category 3 HEDs. All HEDs were reviewed for appropriateness of categorization by SAIC during the evaluation of the Summary Report. During the audit, all HEDs in Categories 1 and 2 and a representative sampling of HEDs in Category 3 were again reviewed. The conclusion reached was that there was no need for any category upgrades and that the HED assessment element of the DCRDR had been satisfactorily performed.

- While the process developed by AP&L to select design improvements is satisfactory, many HEDs are still unresolved awaiting further review to develop the design solutions. The licensee must document all solutions of Category 1 HEDs along with any Category 2 and Category 3 HEDs if they become part of a design change package or have a cumulative or interactive effort raising them to a Category 1. All safety-significant HEDs left partially or completely uncorrected must be justified. Until these resolutions or improvements can be detailed, this requirement of NUREG-0737, Supplement 1, will remain an open item.

- AP&L has not described a formal verification process to ensure that selected design improvements will provide the necessary correction

without introducting new HEDs. However, it appears that such a process does exist as part of the utility's normal design process change procedure. Additionally, the DCRDR review team may use mock-ups, the ANO-1 simulator, and blue line drawings and other techniques to accomplish the task of verification of HED resolutions. If AP&L follows a methodology that includes the above techniques, in conjunction with reviews by an HFS, it would appear that the licensee will meet this requirement to NUREG-0737, Supplement 1.

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

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

1. Control Room Survey

   - Modify the six AP&L checklist guidelines discussed at the audit and restated in this report so they will be in accordance with the criteria of NUREG-0700. These revised guidelines should then be incorporated into AP&L's review process and applied to the ANO-1's control room review.

   - During the audit, it was noted that a number of survey checklist items were not completed. It is recommened that the utility resurvey these items and incorporate any findings into the review process, especially those related to ANO-1's color-coding used in the control room.

2. Selection of Design Improvements

- Complete the HED studies and reviews that are outstanding. Provide the NRC with a description of the proposed design changes that will result from these studies and how these results will be used to correct the control room discrepancies.

- Ensure that related HEDs in Categories 2 and 3 are considered for cumulative and interactive effects when resolving HEDs in Category 1 (e.g., annunciator system HEDs).

3. Verification of HED Resolutions

- Formalize the process for this requirement detailing the use of personnel, equipment, procedures, or techniques that will ensure the satisfactory completion of this requirement, as AP&L's DCP does not go into great detail on how the HF review will provide for the proper resolution of HEDs.

4. Additional Activities Identified During the Audit

- Six months after receipt of the 30-day letter, the supplement to be submitted will provide resolutions for those HEDs that are to be implemented by the 1R7 and 1R8 refueling outages, respectively. In those cases where provision of this information may not be possible, justification will be provided.

- Reexamine the color-coding scheme and provide NRC with a matrix of color versus meaning wherein color is used as a code.

- Reexamine the high location of the meters on panels C14, 16 and 18 (e.g., decay heat meters) with an eye toward their relocation so that they may be read conveniently from the control room floor level. Use of a moveable ladder as a permanent solution in unsatisfactory.

- Provide a procedure for testing status lights in cases involving single bulb lights.

- Immediately ensure that there are no missing labels by using dymo-tape as an interim solution until the labeling study is implemented in IR7.

REFERENCES

1. "Arkansas Power and Light, Arkansas Nuclear One - Unit 1 Control Room Design Review Final Summary Report, Volumes I & II," Arkansas Power and Light Company, August 14, 1985.

2. "Control Room Design Review Program Plan for Arkansas Nuclear One - Units 1 & 2 Arkansas Power and Light Company," November 25, 1983.

3. "NRC Response to Arkansas Nuclear One Program Plant Submittal," USNRC, Washington, D.C., February 2, 1984.

4. 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.

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

6. 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.

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

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

APPENDIX A

HEDs listed in Volume 2 of the Summary Report for which corrective actions or justifications for not correcting were proposed.

1. The six HEDs listed below are Category 1 HEDs that are partially corrected using interim solutions. Permanent resolutions for these HEDs should be finalized.

HED NUMBER	SECTION-PAGE
CK:8-1.058	1 - 9
QS:A-1.17-1.001	1 - 11
QS:A-3.5-1.042	1 - 21
QS:1-1.097	1 - 31
QS:1-1.103	1 - 33
VR:1-1.006	1 - 34

2. The six HEDs listed below are Category 1 HEDs for which the licensee has not committed to implement proposed corrective actions until further evaluation. Final disposition of these HEDs should be documented in the Supplement to the Summary Report.

HED NUMBER	SECTION-PAGE
QS:A1.7-1.018	1 - 13
QS:A1.8-1.019	1 - 14
QS:A1.9-1.031	1 - 19
QS:E2.2-1.084	1 - 30
VR:1-1.013	1 - 36
VR:1-1/031	1 - 40

3. No proposed solutions or justifications for not correcting are provided as the HEDs listed below are undergoing study or additional review.

HED NUMBER	SECTION-PAGE
QS:B3.17-1.071	1 - 27
CK:4-1.003	2 - 7 & 8
CK:5-1.044	2 - 12
CK:8-1.039	2 - 17
CK:8-1.046	2 - 18
CK:8-1.055	2 - 20
CK:8-1.061	2 - 21
CK:9-1.007	2 - 22
QS:B8.7-1.003	2 - 23
QS:B8.2-1.006	2 - 24
QS:B8.3-1.007	2 - 25
QS:A1.2-1.015	2 - 28
QS:A1.19-1.038	2 - 35
QS:A3.12-1.045	2 - 36
QS:A3.23-1.054	2 - 37
QS:A3.30-1.061	2 - 38
QS:B3.18-1.072	2 - 39
QS:B8.2-1.092	2 - 43
QS:1-1.093	2 - 45
QS:1-1.098	2 - 46
VR:1-1.017	2 - 48
VS:1-1.017	2 - 50
VL:1-1.001	2 - 51
VL:1-1.004	2 - 52

- HEDs CK:4-1.008, CK:5-1.007, QS:B8.4-1.008

Presently, operator confusion can result from the failure of single bulb status lights. Apparently ANO-1 operators can use independent indicators to determine the status of questionable indicators; however, AP&L needs to provide a means that will make the operators aware of any

failed bulbs or indicator lights immediately and so that corrective actions can be taken before the failure produces a safety-significant problem.

- HEDs CK:7-1.047 CK:7-1.048 CK:7-1.049 CK:7-1.050 CK:7-1.051 CK:7-1.113 CK:7-1.119 CK:7-1.120 CK:7-1.121

The nine HEDs above related to the use of color on the SPDS and GERMS displays are not consistent with the rest of the control room. Furthermore, color usage within these two systems is not standardized. These inconsistent uses of coloring in the control room reduce opportunities to employ the color as a visual cue and may lead to operator confusion.

AP&L was requested in the NRC exit briefing to develop a matrix for the use of color as a code in the ANO-1 control room. This matrix should provide the relationship between the various colors and their associated meanings to establish whether AP&L has established a consensual coding schema in the control room.

- HED's

CK:5-1.009
CK:5-1.103
CK:5-1.029
CK:5-1.034
CK:5-1.035
CK:5-1.039
CK:5-1.042
CK:5-1.043
CK:5-1.046
CK:8-1.017
CK:8-1.028
CK:8-1.030
CK:8-1.053
CK:8-1.058
CK:9-1.005
CK:9-1.008
CK:9-1.009
CK:9-1.010

The 18 HEDs above describe numerous problems associated with the labeling in the ANO-1 control room. Included are problems such as labeling inconsistencies, incorrect abbreviations, the use of dymo-tape

and missing labels. The NRC understands that a program is underway to relabel the control room in an integrated fashion. Many of the HEDs listed do not contain corrective actions since they will be considered during this labeling program. While AP&L's relabeling program should be able to resolve the majority of ANO-1's labeling deficiencies, the NRC is concerned with the fact that many instruments are unlabeled at this time. Immediate action should be taken to ensure that all control room instruments are labeled. This situation cannot wait for the final resolutions and implementation of the relabeling program.

- HEDs

CK:1-1.004	CK:3-1.018
CK:3-1.003	CK:3-1.019
CK:3-1.004	CK:3-1.020
CK:3-1.007	CK:3-1.021
CK:3-1.008	CK:3-1.022
CK:3-1.009	CK:3-1.023
CK:3-1.010	CK:3-1.024
CK:3-1.011	CK:3-1.025
CK:3-1.012	CK:3-1.026
CK:3-1.013	QS:C2.4-1.010
CK:3-1.014	QS:C3.1-1.027
CK:3-1.015	QS:C3.18-1.022
CK:3-1.017	VR:1-1.004

The 26 HEDs listed above describe deficiencies related to the annunciator system. The Summary Report describes an annunciator upgrade program that is designed to address annunciator-related HEDs and a general upgrading of the annunciator system. Approximately half of the HEDs listed above will be evaluated by this program to determine the corrective action to be taken. Other HEDs should be recognized in light of the results of the annunciator study for cumulative or interactive effects. Of particular concern to the NRC is the present capability to acknowledge the annunciators from any work station. As a result, annunciators can be acknowledged from a distance where the tiles are not readable. The NRC disagrees with AP&L's position that this arrangement is appropriate for the ANO-1 control room. The NRC

takes the position that the operator should be able to read all the annunciator tiles from the position at the work station where the annunciator acknowledge control for those tiles is located (NUREG-0700, Guideline 6.3.3.5).

APPENDIX B

ANO PRE-IMPLEMENTATION AUDIT MEETING
SEPTEMBER 16, 1985

Richard J. Eckenrode	NRC/DHFS/HFEB	NRC Audit Team Leader
James M. Levine	AP&L	ANO General manager
Stephen L. McKissick	AP&L	I&C Supervisor-CRDR Team Leader
Robert L. Kershner	ARD Corp.	Lead Human Factors Specialist CRDR Team Member
Guy S. Vissing	NRC/DL/ORB4	Project Manager, Unit 1
P. Harrell	RI/ANO/NRC	Resident Inspector
Robert Lee	NRC/DL/ORB3	Project Manager, Unit 2
Joe Moyer	NRC/SAIC	Human Factors Specialist
James Hoyt	NRC/SAIC	Human Factors Specialist
Raymond Roland	NRC/SAIC	Engineering
Mark I. Good	NRC/COMEX	Operations
W.D. Johnson	NRC	Senior Resident Insp ector
James McWilliams	AP&L	NUREG-0737 Steering Committee Member
B.A. Baker	AP&L	NUREG-0737 Steering Committee Member
R.P. Wewers	ANO/AP&L	WCC Manager
G.D. Provencher	ANO/AP&L	
Gary G. Young	UESC/AP&L	CRDR Team Coordinator
Daniel Williams	AP&L	Engineering Nuclear Service CRDR Team Member
A.J. Wrape	AP&L	E.E. Supervisor CRDR Team Member
B.A. Terwilliger	AP&L	Operations Assessment Supervisor CRDR Team Member
D. Kent Barnes	ARD Corp.	Systems Technology Group
Bill L. Garrison	AP&L	Operations Technical Support CRDR Team Member
Curtis W. Taylor	AP&L	Operations Technical Support CRDR Team Member
Patti Campbell	AP&L	

ANO PRE-IMPLEMENTATION AUDIT MEETING
SEPTEMBER 17, 1985

Richard J. Eckenrode	NRC/DHFS/HFEB	NRC Audit Team Leader
Stephen L. McKissick	AP&L	I&C Supervisor CRDR Team Leader
Joe Moyer	NRC/SAIC	Human Factors Specialist
James Hoyt	NRC/SAIC	Human Factors Specialist
Raymond Roland	NRC/SAIC	Engineering
Mark I. Good	NRC/COMEX	Operations
Gary G. Young	UESC/AP&L	CRDR Team Coordinator
Robert Lee	NRC/DL/ORB3	Project Manager, Unit 2
Robert L. Kershner	ARD Corp.	Lead Human Factors Specialist CRDR Team Member
Daniel Williams	AP&L	Engineering Nuclear Service CRDR Team Member
B.A. Terwilliger	AP&L	Operations Assessment Supervisor CRDR Team Member
Bill L. Garrison	AP&L	Operations Technical Support CRDR Team Member
Curtis W. Taylor	AP&L	Operations Technical Support CRDR Team Member
D. Kent Barnes	ARD Corp.	Systems Technology Group
Don Taylor	ARD Corp.	

ANO PRE-IMPLEMENTATION AUDIT MEETING
SEPTEMBER 18 AND 19, 1985*

Richard J. Eckenrode	NRC/DHFS/HFEB	NRC Audit Team Leader
Stephen L. McKissick	AP&L	I&C Supervisor-CRDR Team Leader
Robert L. Kershner	ARD Corp.	Lead Human Factors Specialist CRDR Team Member
Joe Moyer	NRC/SAIC	Human Factors Specialist
James Hoyt	NRC/SAIC	Human Factors Specialist
Raymond Roland	NRC/SAIC	Engineering
Mark I. Good	NRC/COMEX	Operations
Gary G. Young	UESC/AP&L	CRDR Team Coordinator
Daniel Williams	AP&L	Engineering Nuclear Service CRDR Team Member
B.A. Terwilliger	AP&L	Operations Assessment Supervisor CRDR Team Member
Bill L. Garrison	AP&L	Operations Technical Support CRDR Team Member
Curtis W. Taylor	AP&L	Operations Technical Support CRDR Team Member
Cynthia Parr	ARD Corp.	

* Attendance was not taken on the 18th and 19th, but the above-listed persons are known to have comprised a portion of those in attendance.

ANO PRE-IMPLEMENTATION AUDIT MEETING
SEPTEMBER 20, 1985

Richard J. Eckenrode	NRC/DHFS/HFEB	NRC Audit Team Leader
James M. Levine	AP&L	ANO General manager
Stephen L. McKissick	AP&L	I&C Supervisor-CRDR Team Leader
Robert L. Kershner	ARD Corp.	Lead Human Factors Specialist CRDR Team Member
Guy S. Vissing	NRC/DL/ORB4	Project Manager, Unit 1
P. Harrell	RI/ANO/NRC	Resident Inspector
Robert Lee	NRC/DL/ORB3	Project Manager, Unit 2
Joe Moyer	NRC/SAIC	Human Factors Specialist
James Hoyt	NRC/SAIC	Human Factors Specialist
Raymond Roland	NRC/SAIC	Engineering
Mark I. Good	NRC/COMEX	Operations
Gary G. Young	UESC/AP&L	CRDR Team Coordinator
Daniel Williams	AP&L	Engineering Nuclear Service CRDR Team Member
A.J. Wrape	AP&L	E.E. Supervisor CRDR Team Member
B.A. Terwilliger	AP&L	Operations Assessment Supervisor CRDR Team Member
Bill L. Garrison	AP&L	Operations Technical Support CRDR Team Member
Curtis W. Taylor	AP&L	Operations Technical Support CRDR Team Member
Don Lomax	AP&L	Plant Licensing Supervisor
R.P. Wewers	AP&L	WCC Manager
D. Kent Barnes	ARD Corp.	Systems Technology Group
Jack Orlicek	AP&L	Field Construction Management
Basil Baker	AP&L	Operations Manager
M.L. Pendergrass	AP&L	Engineering and Technical Support Manager
L.W. Humphrey	AP&L	Administrative Manager
L.W. Schempp	AP&L	Manager, Nuclear QC

APPENDIX C

DIFFERENCES BETWEEN NUREG-0700 AND AP&L CHECKLIST PRESENTED AT ANO-1 PRE-IMPLEMENTATION AUDIT ON SEPTEMBER 18, 1985

* Indicates those items examined at the audit.

Resolution of Differences Between NUREG-0700 Section 6 and APL Checklist

Checklist Item Different From NUREG-0700	Resolution	Impact on APL Survey
1.1.1.a	Change to NUREG-0700 wording/value.	
.b	Change to NUREG-0700 wording/value.	
1.1.2.a	Change to NUREG-0700 wording/value.	
.b	Change to NUREG-0700 wording/value.	
1.1.3.e(1)	Change to NUREG-0700 wording/value.	
1.1.3.f(1)	Change to NUREG-0700 wording/value.	
(2)	Change to NUREG-0700 wording/value.	
(3)	Change to NUREG-0700 wording/value.	
Exhibit 1-3	Change to NUREG-0700 wording/value.	
1-4	Change to NUREG-0700 wording/value.	
1.2.2.b(1)	Change to NUREG-0700 wording/value-Add a page for Exhibit 6.1-6 and a space for drawing panel.	
(2)	Change to NUREG-0700 wording/value.	
* Exhibit 6.1-6	Change 0700 to extended reach value of 29" for 5th percentile female.	
* 1.2.2.d(2) ✓	Change value to 29" which is accepted extended functional reach for 5th percentile female.	
* 1.2.2.e(2)	NUREG-0700 suggests that the measurement for eye reference be taken from the leading edge of the benchboard. ARD takes the stand that the operator has some maneuverability when reading displays and his eye is closer to 4 inches back from the benchboard. Similarly, ARD suggests that the operators reference point for annunciators is 16 inches in lieu of the 12 inch nominal distance provided as guidance in NUREG-0700.	
* 1.2.3.c	The reach criteria has already been established in 1.2.3.b. The 0700 criteria does not provide guidance for an acceptable slope angle. The optimum angle of the benchboard surface would depend upon its use. If the surface	

Checklist Item Different From NUREG-0700	Resolution	Impact on APL Survey
	contained a keyboard the angle should be within 0-15% (Van Cott) whereas for viewing the optimum angle is 45° (Van Cott) . McCormick provides desirable ranges for the angle of the benchboard as 15°-30° for writing and typing surface and 30°-50° for benchboard containing primary controls and some related displays. Since the criteria refers to a benchboard and infers a slope of some kind, a reasonable range is 15°-45° (as shown in Exhibits 6.1-6). The optimum would depend upon the activity performed at the benchboard.	
* 1.2.3.b	See 1.2.2.d(2). Change value to 29".	
* 1.2.3.d(2)	See 1.2.2.d(2). Change value to 29".	
* 1.2.3.e(2)	Delete "The upper limit is 56 inches". Include Exhibit 6.1-10 and the words (see Exhibit ________).	
* 1.2.3.f(2)	See 1.2.2.d(2). Change value to 29".	
1.2.5.a(1)	Change to NUREG-0700 wording/value.	
1.2.5.b(1)	Change to NUREG-0700 wording/value.	
(2)	Change to NUREG-0700 wording/value.	
1.2.8.d	Change to NUREG-0700 wording/value.	
1.5.3.a	Change to NUREG-0700 wording/value.	
* 1.5.3.b	Greatly is too subjective of a term. Our experience is that 15fc is a good value for this quantification.	
* 1.5.5.a(2)	This value is again selected based upon our experience with noise measurements. This is to quantify a subjective requirement.	
2.1.1.b	"Effective" cannot be measured during periodic testing.	
2.1.1.c(2)	"and are known to operators" is a redundant statement. It is assumed that if procedures are in place, they are covered in training.	
2.1.2.b(6)	"by passing traffic" or by anyone, the concern is with knocking the phone out of the cradle.	
2.1.2.d	Change to NUREG-0700 wording/value.	
3.1.2.a(1)	Change to NUREG-0700 wording/value.	
3.1.2.b(1)	Missing some words. Change to NUREG-0700 wording.	
* 3.1.2.c(1)	Instead of using the word "avoided" you can use the multiple annunciator alarms if you have some backup information. See 3.1.2.c(2).	

Checklist Item Different From NUREG-0700	Resolution	Impact on APL Survey
*3.1.4.b(1)	Change to NUREG-0700 wording/value.	
*3.2.1.c	90 dB(A) is the accepted threshold of pain for auditory signals. This is provided to quantify checklist item.	
*3.2.1.d	Incremented steps in loudness are slightly noticeable at 2 dB steps and fully discernable at 5 dB. However, since different frequencies are being produced by the different alarms, the NRC did not specify a value. In order to evaluate the item ARD selected ±2.5 which will result in approximately equal sounding detection levels.	
3.2.1.f	Line skipped. Change to 0700 wording/value.	
3.3.1.a	Delete asterisk. Same as 0700.	
3.3.4.b	Delete asterisk. Same as 0700.	
4.1.1.a(2)	Delete asterisk. Same as 0700 except easily is deleted. Easily is a subjective, not quantifiable term.	
4.1.1.d	Easily is a subjective, not quantifiable term.	
4.2.1.e .f	MIL STD 1472, the reference for the guideline, makes no distinction between increase and raise and similarly between decrease and lower.	
*4.2.2.c(4)	Typo on thickness. Original source (McCormick) states that 3/8" in thickness can be identified very accurately by touch. These values were conv[illegible]ted to decimals in MIL STD 1472 and it was more convenient and conservative for them to use .4. The experimental evidence actually suggests 3/8" as a limit.	
4.2.2.e(1)	Typo. Change to Exhibit 4-3.	
(2)	Typo. Change to Exhibit 4-4.	
(3)	Typo. Change to Exhibit 4-5.	
4.3.1.a	Change to 0700 wording/value.	
*4.3.2.a(1)	Van Cott suggested a lower limit on pushbutton controls as 0.5. However, MIL STD 1472 suggested 3/8" or 0.375". 0.385 has no significance and it is believed that it is a misprint in NUREG-0700.	
4.3.3.c(1) (3)	Change to 0700 wording/value.	

Checklist Item Different From NUREG-0700	Resolution	Impact on API Survey
* 4.4.1.b	There are other types of coding other than shape which could serve the same purpose.	
* 4.4.3.g(1)	80° for the minimum was a typo in 0700. MIL STD 1472C states 30° for this value.	
* 4.4.4(c)	Thumb and finger encircled is ommitted because it is practically never used in nuclear power applications and the term is very confusing without a diagram demonstrating what it is. The fingertip actually refers to the gererally accepted continuous rotary control used in the nuclear industry which is grasped between the thumb and the forefingers. The thumb and finger encircled is larger because it is grasped using the thumb with the forefinger wrapping around the circumference of the knob similar to grasping a door knob.	
** 4.5.1.d(2)	Change the values to reflect the updated ones from MIL STD 1472 C. Affects minimum diameter and maximum trough distance only.	
4.5.3.c(2)	Change to 0700 wording/value.	
4.5.4.a	Statement for 4.5.4.a(1) was changed from 0700 to provide guidance for vertical orientation. The statement in 4.5.4.a(2) provides additional guidance based on MIL HDBK 759 A when horizontal orientation is used.	
4.5.4.b(1) ?	An integral light is best but should not be the only acceptable light feedback for a rocker type switch. A separate light located adjacent to the switch would also suffice.	
* 4.5.4.e(1)	These values are the updated values from MIL STD 1472 C.	
(4)	Change to 0700 wording/value.	
5.1.1	The numbering scheme has been changed from 0700 to provide more logical grouping of items.	
5.1.2.f	Change to 0700 wording/value.	
5.1.3.a	Delete preferred visual angle reference. Not a checklist consideration.	
*5.1.6.c.2(b)	Added to provide industry standard not acknowledged by 0700.	
	→ Delete "Amber (yellow): Auto trip". This is not an industry standard.	

Checklist Item Different From NUREG-0700	Resolution	Impact on APL Survey
5.1.6.e(2)	Delete asterisk. Same as 0700.	
5.2.2.a(2)	Delete asterisk. Same as 0700.	
5.3.1.a(1)	Change to 0700 wording/value.	
5.3.2.b	The intent of the criteria is to ensure the light intensity is sufficient to accurately determine if the indicator is lit. A spot photometer will give a very accurate reading of the intensity, however a simple photometer provides an accurate enough measure to meet the intent of the guideline.	
5.3.3.a(1)	See 5.3.2.b.	
5.4.1	Typo.	
5.4.1.i	Format (numbering scheme) change.	
5.5.1.a(5)	A matte finish is one good way to minimize glare and it is a good design criteria to have in MIL STD 1472, etc. However, the intent should be to evaluate whether the surface is free from glare regardless of the type of finish.	
5.5.2.a	Typo.	
* 6.1.1	This guideline refers to the physical presence of a label for every control, display, or other equipment.	
6.2.1.a	Change to 0700 wording/value.	
.c	Change to 0700 wording/value.	
.e	Change to 0700 wording/value.	
6.2.3.a(1)	"and read from left to right" is redundant to oriented horizontally.	
Exhibit 6.3	Grass green is not very descriptive. Dark green is a more familiar statement to describe the intended color.	
* 6.5.1.g	Tag outs cannot physically prevent actuation of a control. The best it can do is indicate which controls should not be actuated.	
6.6	The "Need for Location Aids" section is tutorial and does not contain guideline checklist material.	
* 6.6.3.b	The fact that differential line widths may be used to code flow is tuitorial. There is nothing to say other methods cannot be used or that this is the preferred method.	
7.1.2.a(4) (5)	Operators speak in terms of acronyms not syntax as do computer operators.	

Checklist Item Different From NUREG-0700	Resolution	Impact on APL Survey
* 7.1.4.g	Cakir, et al. in the VDT Manual recommends a 5°-15° keyboard slope based on experimental evidence. Galitz in Human Factors in Office Automation recommends 10°-15° and MIL STD 1472 C, 15°-25°. The 10°-25° range is a good compromise range betwen the conflicting documents.	
7.1.8.b(1)	Change to 0700 wording/value.	
Exhibit 7.2	Change to 0700 wording/value.	
7.2.1.a	Delete asterisk. Same as 0700.	
7.2.1.c(3)	Delete asterisk. Same as 0700.	
7.2.2.g(3)	Change to 0700 wording/value.	
7.2.4.n	Change to 0700 wording/value.	
7.3.1.f.(2)	Typo.	
8.1.1.a	Change to 0700 wording/value.	
8.1.1.b	The last part of the 0700 (geidpline is tutorial.	
* 8.1.2	"Effective Panel Layout" section is tutorial and does not contain guideline checklist material.	
* 8.2.1.a(3)	Symmetrical is too limited for this guideline. They are appropriate, logical patterns that are not necessarily symmetrical which could relate a set of controls to displays.	
*8.3.2.b	Less than two inches wide is a reasonable definition of small displays. Added for quantification.	
8.3.2.c(1)	Change to 0700 wording/value.	
(2)	Change to 0700 wording/value.	
8.3.2.d	Add "Large matrices are subdivided by appropriate demarcation".	
9.1.2.e(1)	Typo.	
* 9.2.2	Control/Display packages is deleted since modular construction not used in typical CRs.	
* 9.3.1.b(4)	Added to give sufficient guidance for display types.	
9.3.1.c(1)	"Apparent" added because there must be a time lag, but it should not be significant for operator feedback purposes.	
9.3.1.c(2)	Change to 0700 wording/value.	
9.3.2.a	Change to 0700 wording/value.	

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APPENDIX D

A BRIEF DESCRIPTION OF REMOTE SHUTDOWN CAPABILITY AND COMMENTS

The AP&L remote shutdown capability was not included in the DCRDR survey. However, two members of the NRC audit team had a walk-through with a Senior Licensed Operator using the procedure to demonstrate how the plant would be shutdown in the event the control room became inaccessible. Unit 1 has two procedures for shutting down the plant from outside the control room. The remote shutdown procedure (1203.29, Revision 1) was stated to be used when required control room evacuation is caused by anything but fire or some other emergency that might affect the cabling, circuits, and panels in the control room and cable spreading rooms. The alternate shutdown procedure (1203.02, Revision 0) would be used in case of a fire causing control room evacuation. The alternate shutdown procedure is broken down into three sections. The first section has two parts. Section IA covers any fire in the control room or cable spread room which requires an immediate control room evacuation. In this case, it is assumed that sufficient time is available to take a minimum number of actions prior to the evacuation. Section IB covers fires in the these areas that do not require an immediate control room evacuation, but that allow a certain number of specified actions to be taken prior to evacuation which will make the transition in plant control more orderly. Section II provides guidance for maintaining the plant at hot shutdown, reestablishing plant control from the control room, and reestablishing individual component control from the control room. Section III covers the steps required to perform an alternate shutdown plant cooldown using safe shutdown components. Sections IA or IB require four operators.

The licensed operator had minor difficulties in performing the alternate shutdown procedures due to procedural, labeling, and lighting deficiencies. The ability to shutdown the plant in an emergency with the added stress and confusion could be greatly enhanced by several minor procedural/ administrative changes.

PROCEDURE 1203.02

1. Page 8 of 47 Note specifies breaker charging tools but does not specifically mention diesel generator governor props or 480V breaker closing tools as being required. This would entail a return to the locker to get necessary tools in the middle of the procedure should the operator not remember what tools to take.

2. Step 5, procedure names do not match breaker label names.

3. Step 7, label missing on panel DO-1.

4. Step 7, modification to panel since procedure was written; breaker handle missing on exterior panel; panel had to be opened to operate breaker.

5. Normal lighting in the area of DO-1 not bright enough for operator to read breaker labels.

6. At D-11 double number labels on breakers because panel was modified, double pole breakers replaced with single pole breakers with double pole breaker numbering not removed. In addition, breaker labeling legend on panel door listed wrong components for labeled breakers.

7. Panel D1116A is not labeled.

8. At panel D-21, labeling deficiencies.

9. Certain breakers require pushing the trip button to open; operators generally do not stick their fingers in the hole to trip these breakers. A portion of a broom handle or other nonconductive device might be appropriate to clip to the side of a switchboard or have available to assist the operators.

   The format of Section 1203.02, Section IB is different from the format of Section IA. Because it is a procedure that may never or seldom be used, operators may be less familiar with it than other procedures and it might be appropriate to eliminate potential sources of confusion.

APPENDIX E

TASK ANALYSIS INSTRUMENTATION REQUIREMENT FORM

Page ____ of ____
Date ____________
Analyst __________

Same as:
____________ Task Number
Alt. to:
____________ Task Number

____________ Procedure Section
____________ Step Number
____________ Task Number
____________ Function/Purpose
____________ Task Title

ACTION STEP	OP	VERB	OBJECT: CONTROL: PARAMETER	EQUIPMENT	POSITION	STATUS	ID	TYPE	MODE	OTHER	INDICATOR/FEEDBACK: PARAMETER	STATE	TYPE	ID	UNITS	RANGE	DIV	OTHER	OTHER PERFORMANCE REQUIREMENTS	EXIT OR COMMENTS

VERB KEY
1.1 OBSERVES
2.1 COMPARES
2.2 CALCULATES
3.1 PUSH
3.2 TURN
3.3 LOCK-OUT
3.4 TOUCH
3.5 ADJUSTS
3.6 TYPES
3.7 PULL
4.1 INFORMS
4.2 REQUESTS
4.3 RECEIVES

CONTROL TYPE KEY
J J HANDLE
JS JOYSTICK
K KEY OPERATED
LP LEGEND PUSHBUTTON
NP NON-LEGEND PUSHBUTTON
R ROCKER SWITCH
RS ROTARY SWITCH
S SLIDE SWITCH
T T HANDLE
TG TOGGLE SWITCH
TW THUMBWHEEL
TS TOUCHSCREEN
KB KEYBOARD
C CONTROLLER
A AUTO
M MAN
A/M AUTO M/MAN OVERRIDE
M/A MANUAL M/AUTO OVERRIDE

CONTROL MODE
D DISCRETE
C CONTINUOUS

CONTROL OTHER KEY
SR SPRING RETURN
T THROTTLE
D DAZLIT

DISPLAY TYPE KEY
A ANNUNCIATOR
C DRUM COUNTER
EC ELECTRONIC COUNTER
M METER
R RECORDER
D DIGITAL DISPLAY
CSL CONTROL STATUS LIGHT
LL LEGEND LIGHT
NL NON LEGEND LIGHT
CRT CATHODE RAY TUBE
G GRAPHIC