DETAILED CONTROL ROOM DESIGN REVIEW SUMMARY REPORT

Iowa Electric Light and Power Company

Duane Arnold Energy Center

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1.0 EXECUTIVE SUMMARY

1.1 HISTORICAL INTRODUCTION

The Iowa Electric Light and Power Duane Arnold Energy Center was one of the plants surveyed by the original BWR Owner's Group control room survey program. This review program was implemented to meet NUREG-0737 requirements that all licensees conduct a Detailed Control Room Design Review (DCRDR). However, the BWR Owner's Group (BWROG) review was not considered adequate to meet the later requirements of Supplement 1 to NUREG-0737. Generic Letter 83-13, NRC STAFF REVIEW OF THE BWR OWNER'S GROUP (BWROG) CONTROL ROOM SURVEY PROGRAM, was issued to outline the enhancements necessary for the BWROG review to meet these updated requirements.

Iowa Electric Light & Power Company submitted their Detailed Control Room Design Review Program Plan on November 30, 1984 describing the proposed implementation of the Generic Letter 83-18 requirements. Comments on the Program Plan were received from the NRC in February, 1985. Based on the Program Plan, the NRC conducted an in-progress audit of the Iowa Electric DCRDR in March, 1985. This audit reviewed and evaluated each element of the Program Plan with respect to Standard Review Plan (SRP) 18.1. The resulting NRC Audit Report listed the deficiencies found by the audit team, made recommendations for correcting the deficiencies, and addressed the Iowa Electric approach to correcting these deficiencies to meet the requirements of Supplement 1 to NUREG-0737 using SRP 18.1. Iowa Electric conducted a thorough review of the audit report and developed a revised Program Plan that incorporated its guidance.

1.2 METHODOLOGY

A qualified multi-disciplinary review team was established with full-time team members representing System and Nuclear Engineering, Reactor Operations, Human Factors, and Instrumentation and Controls experience. All team members were involved in all phases of the DCRDR to assure a comprehensive and valid review with the appropriate team members placing emphasis on phases requiring specific skills and knowledge. Figure 1.2.1 provides a simplified flowchart for the conduct of the DCRDR.

The DCRDR program focused on Control Room Human Engineering Deficiencies (HEDs). The integrated approach to identifying deficiencies using operator interviews, evaluation of historical operating data, inventory and survey of control panel controls/indications, and task analysis of the Emergency Operating Procedures (EOPs) resulted in evaluation of the DAEC "conduct of operations" as well. A number of important areas related to operating and maintaining DAEC that were beyond the DCRDR scope under the guidelines of SRP 18.1 and other pertinent scoping documents were included in the review. The DCRDR team, Corrections

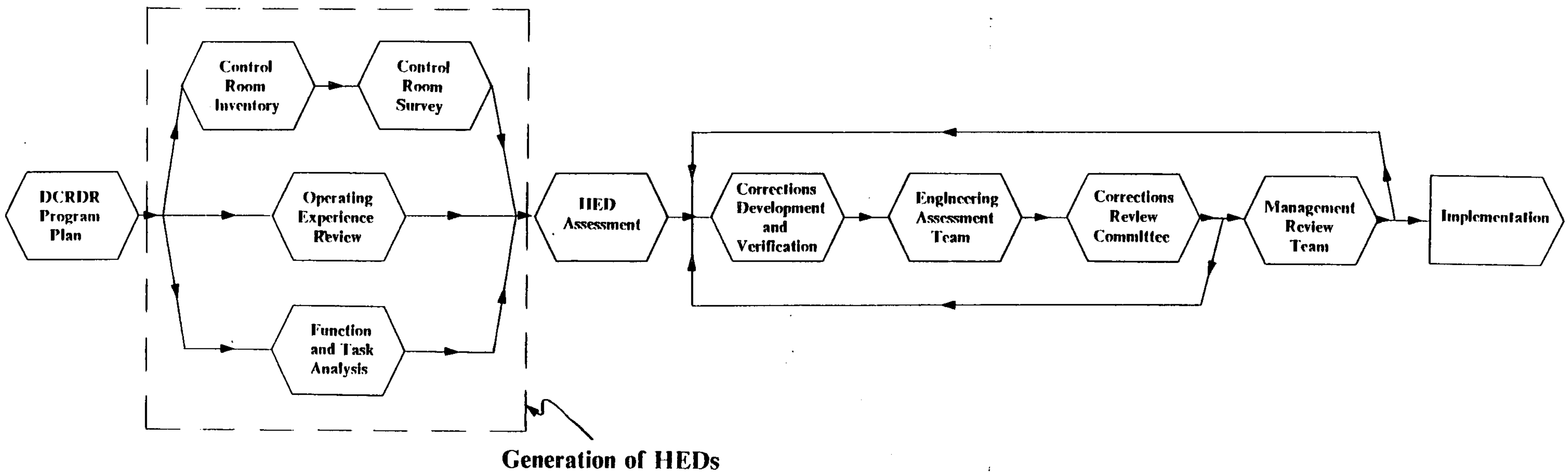


Figure 1.2.1 DCRDR Project Flowchart

Review Committee, and Management Review Team evaluated all HEDs and proposed corrections which, upon implementation, will provide improved operations, better design change integration and implementation, and better operations interface with maintenance, surveillance, and testing activities while meeting the requirements of Supplement 1 to NUREG-0737.

The general project philosophy was to identify all potential HEDs and allow the Assessment phase to evaluate these for significance with respect to impact on operator performance and/or plant safety. This conservative approach generated a greater number of HEDs than would be typically identified and allowed systematic evaluation of HEDs during Assessment.

A complete "as-built" Control Room Inventory was developed to provide a data base of all components in the control room and on the alternate shutdown panels. This data base allowed comparison of instruments and controls with standard human factors criteria and provided a base for the Function and Task Analysis.

The DAEC Control Room Survey compared all components in the control room and on the alternate shutdown panels to BWROG Human Factors Criteria. The Control Room Inventory data was used to assure that all components were surveyed. An independent examination of the control room was conducted by the human factors team member to provide additional assurance that a complete survey effort had been performed.

Licensee Event Reports and Deviation Reports were reviewed to identify design or procedural deficiencies or operating conduct which contribute to operator error. Approximately 50% of the Licensed Operators were interviewed and 80% of all operators completed questionnaires providing a good cross-section of opinions and varying degrees of experience.

Function and Task Analysis was conducted using the Emergency Operating Procedures and interrelated Operating Instructions and Integrated Plant Operating Instructions. The information needs (instrument and controls requirements and capabilities) were determined independent of the existing control room. These I&C requirements were compared to the existing control room components and HEDs generated when deficiencies were identified.

All identified HEDs were assessed and documentation of the results retained. The Assessment methodology conformed to NUREG-0801, EVALUATION CRITERIA FOR DETAILED CONTROL ROOM DESIGN REVIEWS (DCRDR), in subjecting the HEDs to a series of structured questions resulting in a 9-point rating scale (assessment priority number). The assigned number represented the level of significance of the HED on plant safety or operator performance with 1 being the most significant and 9 the least significant. An HED having an assessment priority of 9 was considered to be insignificant. Two teams, each consisting of a least five Review team members, were utilized for Assessment. Each team was staffed by at least one SRO and a Human Factors Specialist. The teams discussed the HEDs and related topics necessary to determine the integrated impact of the HED when responding to the assessment questions. Conservative assessments were chosen when response to the assessment questions resulted in differing opinions.

All HEDs, regardless of Assessment priority, were addressed in the Corrections phase. Those HEDs evaluated and not corrected have established bases and justifications for non-correction. Individual Review Team members were assigned specific control room panels and corrections were developed on a panel specific basis. The corrections were developed to: 1) bring the HED into agreement with acceptable Human Factors Engineering standards or to provide a solution that counteracts the effect of the HED; 2) ensure operator performance and/or plant safety is not degraded; 3) minimize undesirable interactions with other recommended corrections; and 4) ensure that no new HEDs are introduced to the control room while correcting an existing HED. Corrections were selected by a systematic process of development and comparison of alternative means for resolving HEDs. Costs were not considered in the development of corrections. The corrections provided were based on the current control room design, existing training topics and levels, and existing conduct of operations. Four types of corrections were recommended: 1) surface enhancements; 2) physical modifications to I&C components; 3) non-physical operational changes; and 4) no correction. All corrections were considered for surface enhancements. Interim corrections were recommended (where practical) for corrections that required development of a long term correction and subsequent implementation.

Physical modifications and surface enhancements to the front panels were mocked-up on a full-scale photomosaic of the DAEC control Room. Modifications to other panels were mocked-up on panel layout drawings or sketches. Corrections for the individual HEDs were documented and a Correction-Verification meeting was held by the DCRDR Review Team to discuss and approve or amend the corrections. The meetings also served as verification that the proposed correction was adequate and did not introduce other deficiencies. The approved correction was recorded and a verification record completed.

Following correction approval, an independent Engineering Assessment Team developed implementation costs for the Corrections Review Committee. The recommended correction and the associated costs were presented to the Corrections Review Committee and a Management Review Team. The management review groups either approved the correction or disapproved it with explanation and returned the package with suggested changes, alternate corrections, or recommendations for no correction. Disapproved corrections were then re-evaluated considering management direction and subsequently resubmitted. For cost-rejected corrections, the corrections team emphasized technical considerations in redeveloping corrections and did not address the cost-benefit determination made by the management teams. The management presentation, acceptance or rejection, and redevelopment of corrections continued until a correction was reached which was acceptable to the DCRDR Review Team, the Correction Review Committee and the Management Review Team.

1.3 INTERFACING WITH ONGOING WORK

Ongoing Design Change Packages and Engineering Work Requests affecting the control room panels were reviewed to assure that they adequately addressed human factors concerns and were coordinated with proposed corrections. Near-term modifications were reviewed for incorporation of related corrections proposed by the DCRDR team. References to applicable ongoing work were provided within the proposed corrections.

The DCRDR provided input to and participated in meetings and reviews of other programs such as the Safety Parameter Display System (SPDS), operator training, Reg. Guide 1.97 instrumentation upgrade, upgraded Emergency Operating Procedures, the simulator procurement project, and design change packages involving the control room. Assurance of effective communication across organizational boundaries was provided through the assignment of the DCRDR to the Nuclear Generation Division and through reviews by the Corrections Review Committee and Management Review Team. The task to coordinate Control Room long-term modifications was established through the DCRDR effort. In addition to the coordination activities outlined above, the DCRDR also reviewed pending Engineering Work Requests, made presentations to the DAEC Operations Committee, participated in seismic control panel qualification and analysis meetings.

1.4 RESULTS

A total of 3115 HEDs were generated during the DCRDR. This number includes both significant and insignificant HEDs as determined in the Assessment phase. The project philosophy of identifying all potential HEDs and allowing the Assessment phase to evaluate these for significance resulted in a large number of HEDs that were insignificant or did not actually violate any human factors criteria. HED corrections are discussed in Section 6.0. Appendix C contains the summary of all corrections developed by the DCRDR.

The Control Room Inventory generated 74 HEDs involving discrepancies between documentation data and as-built data. Most of these resulted in corrections to panel drawings and other documentation as well as improvements to component identification and labeling.

The Licensee Event Report and Deviation Report review portion of the Operating Experience Review phase resulted in 74 HEDs. Nineteen of these had previous corrective actions which completely resolved the cause of the errors and eliminated the HEDs. The remaining uncorrected HEDs were categorized as Non-operational Events or Situations, Procedure Errors, or Execution Errors as evidenced by the error described. The significant number of Non-operational Event or Situation errors and their impact on plant operations prompted recommendations for certain maintenance and testing activities. An example of an Operating Experience Report HED correction resulting from a historical SCRAM recommends improving recirculation pump speed control and indication to minimize the speed transient during transfer from scoop tube lockout to manual control.

The interview and questionnaire responses generated 532 HEDs. All comments and opinions indicating potential HEDs were documented as HEDs. This phase identified HEDs that directly affect the operator in numerous ways such as shift manning, Surveillance Test Procedure performance, and specific control and indication problems.

A total of 343 HEDs were generated from the Function and Task Analysis of the Emergency Operating Procedures. Some of the most significant HEDs were identified in this phase. Examples of some of the recommendations prompted to correct these HEDs are the installation of a Primary Containment Isolation System Status Board on panel 1C04, installation of Torus pressure indication adjacent to Drywell pressure indication on 1C03, and the use of "color banding" techniques for indicators and recorders to provide immediate setpoint and range information to the operator.

The Control Room Survey phase generated 2092 HEDs generally written on a component level. The Survey HEDs were the result of systematic evaluation of components against acceptable human factors criteria. These HEDs generally identified the need for standards for panel mounted components. Revisions to the Engineering Design Guide DGC-E101 to include "Human Factors Considerations for the Control Room" was developed to provide these standards to guide both DCRDR corrections and future control room modifications.

1.5 DCRDR IMPLEMENTATION

The DCRDR Implementation effort segregates the DCRDR corrections into short-term and long-term enhancements for the DAEC. These enhancements will resolve HEDs identified during the DCRDR. Short-term enhancements may be used as interim corrections for long-term items. Implementation details are provided in Section 7.0. The DCRDR Implementation effort will be divided into four phases:

Phase 1) SHORT-TERM ENHANCEMENTS -- These are scheduled for completion December 31, 1987 and will consist of relabeling, remimicking, and demarcating the DAEC control panels. In addition, general Control Room panel cleanup activities, including painting, will be performed.

Phase 2) LONG-TERM ENHANCEMENTS -- These are scheduled for completion prior to Cycle 10 Startup and will implement design modifications for correcting HEDs which would contribute to a significant reduction in operational risk as well as enhance the safe operation of the plant. The tentative schedule for Cycle 10 startup is October 1988.

Phase 3) LONG-TERM ENHANCEMENTS -- These are scheduled for completion prior to Cycle 11 Startup and will implement design modifications for correcting HEDs which would contribute to a significant reduction in operational risk as well as enhance the safe operation of the plant. The tentative schedule for Cycle 11 startup is May 1990.

Phase 4) LONG-TERM ENHANCEMENTS -- These are scheduled for completion prior to Cycle 12 Startup and will implement design modifications for correcting HEDs which are considered to be significant with respect to the improvement of operator performance at the DAEC. The tentative schedule for Cycle 12 startup is October 1991.

2.0 INTRODUCTION

2.1 HISTORICAL PERSPECTIVE

Since the incident in 1979 at Three Mile Island Unit 2, much effort has been expended to ascertain whether the control room design at that unit contributed to the incident and its severity and whether the design of nuclear generation control rooms are designed and constructed to prevent and mitigate such incidents using accepted human factors standards. Shortly after the incident the NRC staff developed NUREG-0660, an action plan to provide a comprehensive and integrated plan to improve the safety of power reactors. Specific items in NUREG-0660 were approved by the NRC for implementation by utilities and incorporated into NUREG-0737. NUREG-0737 Item I.D.1 stated that all licensees would be required to conduct a Detailed Control Room Design Review (DCRDR) using the final version of NUREG-0700, which was to be issued later as a guide. NUREG-0737 provided a list of items on which the emphasis would be placed during an onsite audit review of a utility's DCRDR, and stated that evaluation criteria would be quickly developed. NUREG-0737 did not address documentation requirements, but stated that they would be addressed later.

During this period the BWROG formed a DCRDR committee to develop a generic Control Room Design Review Program upon which all BWR owners could build a DCRDR, an approach advocated in the draft version of NUREG-0700. The BWROG plan for their HUMAN FACTORS ENGINEERING CONTROL ROOM SURVEY was developed before the final version of NUREG-0700 was issued. This survey program and followup communication with the NRC provided the groundwork for a DCRDR conducted by a BWR owner.

The final version of NUREG-0700 was subsequently issued as GUIDELINES FOR CONTROL ROOM DESIGN REVIEWS. The NRC also left open the possibility of control room design review techniques other than those detailed in NUREG-0700; as long as they sufficiently incorporate the human factors engineering (HFE) principles on which the guidance of that document was based. As guidance for both the utility and NRC staffs, the NRC developed NUREG-0801, EVALUATION CRITERIA FOR DETAILED CONTROL ROOM DESIGN REVIEWS (DCRDR) in draft form.

To clarify the requirements of NUREG-0737 and address those items left open in NUREG-0737, the NRC issued Generic Letter 82-33, SUPPLEMENT 1 TO NUREG-0737. Supplement 1 gives explicit requirements for control room design reviews. The emphasis in Supplement 1 is the use of human factors experts to review the design of the control room. Supplement 1 contains the requirements for documentation and NRC review that were missing from NUREG-0737. The requirements of Supplement 1 are generally considered to supersede similar requirements in NUREG-0737.

The NRC and Boiling Water Reactor Owners Group (BWROG) continued meeting to discuss the control room design reviews performed by the Owners Group intended to meet the requirements of NUREG-0737. The reviews were considered by the NRC to be inadequate to meet the requirements of Supplement 1. As guidance in augmenting the BWROG reviews to create an acceptable DCRDR, the NRC issued Generic Letter 83-13, NRC STAFF REVIEW OF THE BWR OWNERS' GROUP (BWROG) CONTROL ROOM SURVEY PROGRAM. Generic Letter 83-13 stated that additional plant-specific work was required to meet the requirements for the DCRDR, and outlined the tasks required to produce an acceptable product.

On November 30, 1984, Iowa Electric Light and Power (IELP) submitted their DCRDR Program Plan for meeting the requirements of Supplement 1 to NUREG-0737. Comments were received from the NRC in February, 1985. Subsequent to the review of the Program Plan, the NRC conducted an in-progress audit of the IELP DCRDR in March, 1985. The resulting Audit Report outlines the additional work necessary for the IELP DCRDR to meet the requirements of Supplement 1. The purpose of the current DCRDR effort was to meet the requirements of Supplement 1 and its referenced guidance by incorporating the guidance and suggestions of the Audit Report. This was accomplished using NUREG-0800 Standard Review Plan 18.1 which incorporates the former draft version of NUREG-0801 as Appendix A.

2.2 OBJECTIVES

The objective for the DCRDR stated in NUREG-0660, Item I.D.1 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." The review provides for the identification of any changes to control room configuration which would contribute to a significant reduction in operational risk as well as enhancements in the safe operation of the unit. In conjunction with the implementation of a Safety Parameter Display System and Upgraded Emergency Operating Procedures, the changes resulting from the DCRDR will improve the operations staff's capabilities to expeditiously respond to transients and other abnormal operational conditions.

Supplement 1 to NUREG-0737 denotes a four-part review to identify human engineering deficiencies (HEDs) as outlined below:

1. Establish a qualified multidisciplinary team and an adequate review program incorporating acceptable human factors engineering principles.

2. Use Function and Task Analysis to identify control room operator emergency operations tasks and from them derive the emergency operations information and control requirements.

3. Compare the requirements identified during the above task analysis with a control room inventory to identify any missing displays or controls, and

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

Following the review, the HEDs are to be assessed to discriminate between those which are significant and should be corrected, and those which are insignificant and require no correction. The proposed changes resulting from the DCRDR are to be examined to verify that the improvements will resolve the identified deficiencies without creating additional unacceptable human engineering discrepancies, unreviewed safety questions, or situations conducive to a temporary reduction in the margin of safe operation of the plant. These changes are to be coordinated with changes resulting from other NUREG-0737 correction items and ongoing plant modifications and improvements.

Finally, this report summarizing the entire DCRDR outlining the review process, discrepancies found, proposed control room changes, and a schedule for implementations is to be filed with the NRC. Improvements which can be accomplished with a surface enhancement program are to be implemented promptly. Documented bases and justifications are provided, in Appendix D, for the non-correction or partial correction of any HEDs with an Assessment priority of 1 to 6. Justifications for the non-correction or partial correction of HEDs with an Assessment priority of 7 or 8 are provided in the Verification documentation maintained in the DCRDR files.

2.3 REVIEW TEAM CONCEPT

The conduct of a successful DCRDR depends on establishing a qualified team of reviewers with adequate nuclear power experience and plant-specific knowledge. This core team, augmented by trained, experienced human factors personnel must also have sufficient authority to achieve its goals. The IELP DCRDR Review Team, under the direction of the Manager - Nuclear Generation Division the Manager - Design Engineering, consisted of a supervisory Lead Engineer, an Assistant Lead Engineer, experienced degreed engineers from the disciplines of nuclear systems, instrumentation and controls, nuclear engineering, experienced human factors specialists and an experienced Senior Reactor Operator. All team members were involved in all phases of the DCRDR. Experienced personnel from other disciplines were available, as necessary, to supplement the core Review Team. The balance and composition of this multidisciplinary approach ensured that HEDs identification was thorough and that the HEDs identified were provided with technically sound, human factors approved corrections.

The DCRDR team was given the authority necessary to accomplish a thorough review of the Control Room and alternate shutdown areas and propose corrections to any deficiencies with attention only to technical details. Interfacing with management was accomplished both through the normal channel of administration and through meetings with middle management (Corrections Review Committee) and upper management (Management Review Team) during review of the proposed corrections. This management interface served to allow the core team the flexibility to propose corrections to alleviate human engineering deficiencies without consideration of costs. Costs and benefits were weighed by management reviewers during their decision to implement the proposed corrections.

2.4 SUMMARY REPORT CONTENTS

This Summary Report submitted in accordance with Supplement 1 to NUREG-0737, Section 5.2.b, gives the qualifications of the Review Team members, describes the methodologies for each phase of the DCRDR effort, provides detailed and summarized results of the review including both identified deficiencies and their corrections, and provides an implementation plan for the proposed corrections which addresses both schedule and estimated scope. In addition, the Summary Report provides justification for the non-correction or partial correction of deficiencies with assessment priority numbers 1 to 6. Although the Verification documentation provides justification for non-correction or partial correction for all deficiencies, the justification for those deficiencies with assessment priority numbers of 7 or 8 are not provided within this report.

3.0 DCRDR STAFFING AND ORGANIZATION

3.1 INTRODUCTION

The organization of the DCRDR effort consisted of the following four groups of personnel:

1. DCRDR Review Team;
2. Engineering Assessment Team;
3. Correction Review Committee; and
4. Management Review Team.

The quality of the review effort and the results of the DCRDR depend on the composition and balance of the multidisciplinary team performing the review and correction. To ensure adequate HED identification and correction, the DCRDR was performed by experienced operations, nuclear systems, and human factors engineering personnel. Although the degree of participation of the individual DCRDR Review Team members varied for the different tasks, all team members participated to some extent in all team activities.

The two management review organizations and the supporting Engineering Assessment Team examined the Review Team's proposed corrections and, in conjunction with the Review Team, determined which proposed corrections would be implemented.

3.2 DCRDR REVIEW TEAM STRUCTURE AND QUALIFICATIONS

The IELP DCRDR Review Team conducted the review. The DCRDR Review Team consisted of specialists and engineers with the recommended wide range of skills necessary to perform the DCRDR. The expertise represented on the core team was as follows:

1. DCRDR Team Leader;
2. Assistant Team Leader;
3. Human Factors Specialist;
4. Training Specialist;
5. Operations (Licensed Senior Reactor Operator);
6. Nuclear Engineer;
7. Instrumentation & Controls Engineer; and

8. Systems Engineer.

During the course of the review, the review team was supplemented, as required, by other personnel of various skills and knowledge. These personnel included a Quality Assurance Engineer, maintenance and training personnel, as well as individuals familiar with plant construction, installation details, and operation specifications. In addition, licensing support was provided to ensure an integrated team approach.

To ensure adequate human factors support from the varying disciplines of the DCRDR Review Team, all team members were provided training in the area of human factors principles. In addition, each member of the Review Team received DAEC system training, as appropriate.

3.2.1 DCRDR Team Leader

An IELP employee filled the position of DCRDR Team Leader providing administrative leadership and responsibility for the overall effort. This provided appropriate knowledge of and experience at the Duane Arnold Energy Center (DAEC). The Team Leader coordinated access to information, facilities, and individuals providing input to the team. He provided a cohesive force for the various IELP department personnel and contractor organizations involved in the review. It was the responsibility of the Team Leader to resolve disagreements among team members on methodology and performance of the review.

An IELP employee with a degree in nuclear engineering, a Senior Reactor Operator's license and more than five years industry experience served as the DCRDR Team Leader.

3.2.2 Assistant Team Leader

An assistant Team Leader with project management experience in the ongoing Emergency Response Facility Program at IELP, served on the DCRDR to ensure adequate coordination with other DAEC activities. The assistant Team Leader is a registered professional engineer with a degree in nuclear engineering and greater than five years of instrumentation systems experience. He was the responsible design engineer for the Safety Parameter Display System (SPDS) installed at the DAEC in 1985. His previous experience includes performing operator task analysis during the conceptual development of the SPDS.

3.2.32 Human Factors Specialist(s)

Human Factors Specialist(s) participated in each phase of the DCRDR and provided the human factors technical leadership for the review. The human factors specialist(s) responsibilities included verifying that review performance quality was maintained at a level necessary for a valid and comprehensive review.

To ensure appropriate human factors perspective for the DCRDR effort, human factors specialists with varying work backgrounds were included in the DCRDR Review Team. One human factors specialist is a degreed, experimental psychologist with more than ten years of human factors experience in military applications. The other human factors specialist has a Ph.D. in engineering psychology and greater than five years of human factors experience, much of it in the nuclear industry. He has participated in two previous control room reviews and served as a human reliability analyst for a benchmark probabilistic risk assessment. Both human factors specialists are experienced in the application of human factors engineering and engineering psychology to complex human-machine systems and have experience in systems and task analysis.

3.2.4 Training Specialist

The Training Specialist was responsible for Review Team training on DAEC plant systems and coordination of the photomosaic development. He developed portions of the Function and Task Analysis steps and provided the training perspective during other phases of the DCRDR. He helped identify potential training impacts of DCRDR corrections. The training specialist has over 15 years of experience in the nuclear industry and is a certified operator with four years of experience in reactor operator training.

3.2.5 Senior Reactor Operator (SRO)

The SRO committed to the team was an experienced operations Shift Supervisor with ten years commercial nuclear power experience in addition to extensive Navy nuclear experience. He provided in-depth knowledge in identifying and clarifying operator tasks and served as the review team expert on operational constraints of plant systems. The SRO participated in all aspects of the DCRDR effort, with specific emphasis on control room survey activities. The SRO helped to identify those problems which the operators consider to be most in need of attention and ensured appropriate operator input to Review Team decisions on Assessment and Correction phases of DCRDR.

3.2.6 Nuclear Engineer

The Nuclear Engineer provided the engineering knowledge of plant system design goals and functions and served as the review team expert on factors affecting design guidelines used at the DAEC. The Nuclear

Engineer developed portions of the Function and Task Analysis steps and provided knowledge of plant systems operation during all phases of the DCRDR.

The nuclear engineer for the DCRDR effort has a B.S. and M.S. in nuclear engineering with five years of experience in the nuclear industry. His experience includes analyses of various systems associated with a nuclear power plant and two years of specific experience at the DAEC.

3.2.7 Instrumentation and Controls Engineer

The instrumentation and controls (I&C) Engineer provided the engineering knowledge of plant system design features and served as the review team's expert on the capabilities and limitations of controls and instrumentation. The I&C Engineer also developed portions of the Function and Task Analysis steps detailing appropriate I&C specifications to accomplish the EOP objectives and tasks. He provided I&C knowledge during the assessment phase of the review as well as specifications and design features when the review team considered recommendations for correcting HEDs.

The I&C engineer for the DCRDR effort is a degreed, nuclear engineer with over five years of experience in the commercial nuclear industry in addition to Navy nuclear experience. He has experience in the installation and testing of instrumentation in a nuclear power plant, plant startup testing, and plant modification. His previous experience includes performing operator task analysis and utilization of probabilistic risk assessment techniques in plant systems and man/machine interface evaluation.

3.2.8 Systems Engineer

The Systems Engineer provided knowledge of system design and operation and the interaction of various Control Room instrumentation and control systems. He assisted in the Function and Task Analysis phase and provided knowledge of plant systems during this and the Assessment and Correction phases of the DCRDR. He provided computer systems hardware and software expertise throughout the project.

The systems engineer is a registered professional engineer with both a B.S. and M.S. in nuclear engineering and over five years of experience. His experience in three years at the DAEC includes system acceptance testing, safety analysis and nuclear licensing. He was responsible for the design and implementation of the computerized data base management system used for the DCRDR inventory and survey of the DAEC control room.

3.3 DCRDR MANAGEMENT ORGANIZATION

The DCRDR management review organization consisted of two levels of management review, supported by an Engineering Assessment Team that independently provided correction implementation cost estimates.

3.3.1 Engineering Assessment Team

The Engineering Assessment Team (EAT) developed and provided cost estimates for implementing the DCRDR corrections. This group was under the direction of the Corrections Review Committee. In addition, the EAT provided administrative assistance to both the Management Review Team and the Corrections Review Committee for documenting management's activities.

The EAT consisted of degreed mechanical and electrical engineers familiar with the costs associated with nuclear construction and backfitting including installation and testing.

3.3.2 Correction Review Committee

The Correction Review Committee (CRC) examined the DCRDR Review Team's recommendations for corrections including cost estimates provided by the EAT. Upon correction approval, the CRC provided the Management Review Team with the recommended implementation scope and schedule of the corrections. The CRC group consisted of the following members, or designated alternates:

1. DAEC Operations Supervisor;
2. DAEC Training Supervisor;
3. Group Leader, Electrical Design Engineering;
4. Group Leader, Mechanical Design Engineering;
5. Group Leader, Nuclear Licensing;
6. DCRDR Team Leader; and
7. DCRDR Human Factors Specialist.

The CRC was responsible for recommending approved corrections to the MRT with emphasis on scope of work, estimated cost, and the schedule for performing the correction. Each DCRDR correction was evaluated by the

CRC considering resolution of the deficiencies, current control room design, training requirements and existing conduct of operations. Corrections were examined to assure that they adhered to accepted design conventions and criteria. The CRC was the first level of corrections review to consider the applicable costs.

3.3.3 Management Review Team

The Management Review Team (MRT) reviewed and approved the results of the DCRDR effort. This management group consisted of the following members, or designated alternates:

1. Manager of Nuclear Generation;
2. Plant Superintendent, DAEC;
3. Manager of Design Engineering;
4. Manager of Nuclear Licensing and Emergency Planning;
5. Manager of Nuclear Projects; and
6. DCRDR Team Leader.

The MRT's primary objective in the DCRDR effort was to review the scope, schedule, and cost associated with each DCRDR correction to ensure that each correction was consistent with:

1. Company philosophy and policies of safe operation of the DAEC;
2. Availability of qualified manpower resources to provide the DCRDR corrections;
3. Planned capital and operating budgets; and
4. The DAEC Integrated Plan.

4.0 METHODOLOGIES

4.1 INTRODUCTION

In order to assure a thorough, objective, and systematic completion of the DCRDR, detailed procedures were developed to control the work performed. The methodologies contained in this section are a discussion of how each phase was performed providing sufficient detail that the procedural objectives were met. The detailed procedures are provided in the Updated Program Plan.

Methodologies are provided for Control Room Inventory, Control Room Survey, Operating Experience Review, Function and Task Analysis, HED Assessment, HED Correction, Verification of Corrections, and Management Review phases. Although data collection phases of the DCRDR were performed concurrently, the structure of this section is primarily chronological.

All members of the DCRDR Review Team participated in every phase of the project. This inclusion of all members in all phases ensured the completeness and balance of the work performed.

4.2 CONTROL ROOM INVENTORY

4.2.1 Introduction

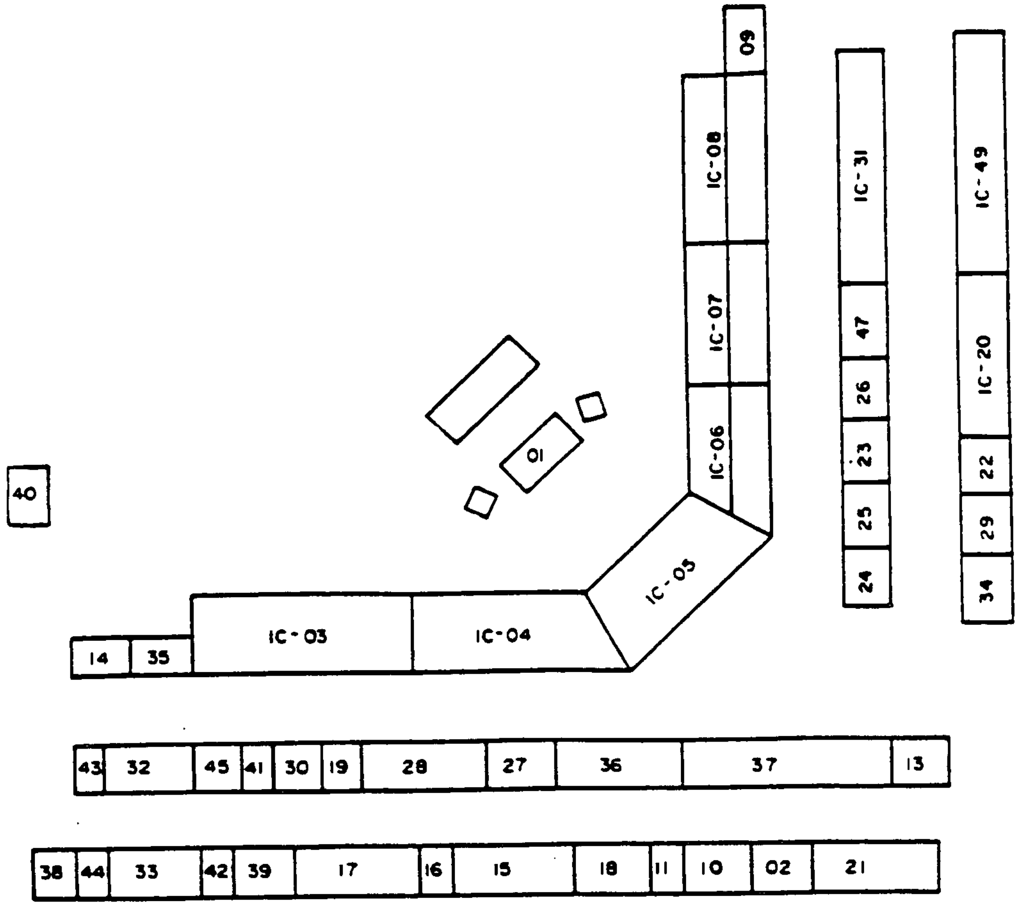
A control room design review requires that certain information for all indications and controls in the control room be available and documented. In addition, DCRDR guidance documents suggest that the components of interest in the control room be a part of a data base system. The uses of this data base can be many and varied and not necessarily confined to the control room design review project. The Control Room Inventory (CRI) was developed to provide a data base of all components in the DAEC control room and remote shutdown panels which exist on a panel face. The resulting as-built data base allowed analysis of the components for agreement with standard human factors criteria.

The DAEC control room layout is shown in Figure 4.2.1 reflecting the function and relative position of control panels within the control room. The control panels identified as 1C03, 1C04, 1C05, 1C06, 1C07, 1C08, 1C09, 1C14, 1C35 and 1C40 are considered within the primary operating area of the control room. All other panels are in the "back panel" area and are not directly visible from the primary operating area. All control room panels as well as remote shutdown panels were addressed and inventoried during the CRI.

All control room components were addressed during the CRI. The term 'component' does not refer strictly to indications and controls, but may also refer to nameplates, mimics, covers, and blank or spare panel patches. While a handswitch and associated indicating lights were inventoried as a single component, indicating lights not directly related to a control were inventoried as separate components. Multipoint recorders were assigned a unique component number for each channel by the addition of a channel suffix to the appropriate component identifier. Thus the number of components inventoried, 5047, does not directly indicate the number of controls and indications in the control room.

4.2.2 Control Room Inventory Methodology

The Control Room Inventory systematically recorded pertinent data for all control room components. The types of data gathered are shown in Figure 4.2.2. Data for the CRI was gathered in two discrete phases. The first phase consisted of gathering such data as was available from general plant documentation. The documentation reviewed included the panel physical layout drawings, panel engravings drawings, DAEC Instrument Index (M-400), Piping and Instrumentation Diagrams, and DAEC and General Electric electrical schematics. This Phase I data was gathered and placed on interim CRI forms for input into the data base by data



1C01 Communications Desk
1C02 Area and Process Radiation Recording VB
1C03 Emergency Core Cooling Sys VB & BB
1C04 Rx Recirc & Rx Water Clean-up VB & BB
1C05 Rx Control VB & BB
1C06 Feedwater and Condensate VB & BB
1C07 Turbine Control VB & BB
1C08 Generator & Auxiliary Power VB & BB
1C09 Containment & Accident Monitoring VB & BB
1C10 Process Radiation Monitoring VB
1C11 Area Radiation Monitoring VB
1C13 TIP Control and Monitoring VB
1C14 MSIVs - Leakage Control Sys VB
1C15 Trip Sys A Rx Protection Sys VB
1C16 Rx Protection Sys Test and Monitoring VB
1C17 Trip Sys B Rx Protection Sys VB
1C18 Feedwater and Rx Recirc VB
1C19 Process Instrumentation VB
1C20 Turbine Plant Instrumentation VB
1C21 NSSS Temperature Recorder VB
1C22 Meteorology (& Hydrogen Water Chemistry) VB
1C23 HVAC - Rx Bldg & Main Plant Sys VB
1C24 Standby Gas Treatment Sys VB
1C25 Drywell Ventilation & Nitrogen Inerting VB
1C26 HVAC - Turbine Bldg & Control Room Sys VB
1C27 Control Rod Position Information Cabinet
1C28 CRD Select Relay VB
1C29 Instrument Air Isolation Vlv VB
1C30 RCIC Relay VB
1C31 Generator & Plant Relay VB
1C32 Div 1 - RHR Relay VB
1C33 Div II - RHR Relay VB
1C34 Off-Gas Sys VB
1C35 Containment Atmospheric Dilution Sys VB
1C36 Start-up Range Neutron Monitoring VB
1C37 Power Range Neutron Monitoring VB
1C38 Jet Pump Instrumentation VB
1C39 HPCI Relay VB
1C40 Fire Protection VB
1C41 Inboard Valve Relay VB
1C42 Outboard Valve Relay VB
1C43 Div I - Core Spray Relay VB
1C44 Div II - Core Spray Relay VB
1C45 ADS Relay VB
1C47 Turbine Supervisory Instrumentation VB
1C49 Turbine EHC VB

Figure 4.2.1 DAEC Control Room Layout

DETAILED CONTROL ROOM DESIGN REVIEW

Component Number: ________

Device: ____

System: ________

Subsystem: ____

Panel Number: ____

Purpose: ____

Range: ____

Feedback: ____

Action: ____

Drawing Number: ________________

HFE Number: ________________

EOP Step: ________________

Component Location: ________________

Drawing Item Number: ________

Interviewed: ________________

HED Number: ____

SAMPLE

Comments: ____

____

Corrected by: ________________________

Date: ________ Source: ________________

Figure 4.2.2 Inventory Data Sheet

processing personnel. The original interim forms were maintained for documentation purposes in the DCRDR historical file. After input, computer printouts of entered data were compared with the interim forms for verification of entry accuracy and completeness. Phase I of the CRI was complete with the output of partially complete, verified printouts from the data base. These printouts contained the Phase I data, printed one component per page on the form shown in Figure 4.2.2, and sorted by panel number.

Phase II of the CRI was performed in the DAEC control room to establish an as-built data base. Sorting the Phase I output by panel allowed a systematic approach to this as-built data collection. As an individual panel's Phase I data was verified, it was then made ready for Phase II. Panel-specific information was gathered into panel packages. These panel packages included Phase I data base output, panel drawings, and panel and annunciator engraving drawings. These panel packages were taken to the DAEC and compared to the actual equipment in the Control Room. Panel drawings were marked-up to reflect as-built conditions, and discrepancies were noted on the Phase I data base printouts. Information gathered in Phase I was compared to the actual control room configuration and discrepancies noted. Components not found in documentation during Phase I were inventoried in Phase II. Information available from the panels was recorded on the printouts for incorporation into the data base as corrections for and supplements to the Phase I information.

The data compiled by Phase II of the CRI was also input into the data base by data processing personnel. The resulting printouts were verified against the Phase II input sheets for accuracy and completeness of data entry. These Phase II input sheets were archived as part of the historical DCRDR files.

A component number was assigned to each component on a panel using either the Bechtel or General Electric identifier available from Phase I documentation. Components for which the identifiers were not readily determined were identified during Phase II from panel labels and escutcheons to supplement and complete the data gathering. Components with neither a unique Bechtel or General Electric identifier were assigned a unique component number for the CRI. These numbers were sequentially assigned and preceded by the letter 'X'. These components consist primarily of labels, mimic pieces, and indicating lights distinctly separated from controls.

The device type recorded in Phase I for each component was compared to the actual component type. Corrections to Phase I device types and determination of device types not identified in Phase I were made in Phase II and discrepancies noted.

Applicable range and unit information was taken directly from indicators and recorders. Switch positions for all controls were also systematically recorded in the RANGE field to identify switch position order. Discrepancies between Phase I and as-built range information were noted.

Actual measurements were not taken in the control room. Component location was compared to panel equipment location drawings and qualitatively determined. Discrepancies between qualitative, relational component location on the drawings and as-built conditions were noted. The drawings were marked up to show as-built locations. The emphasis for component location information was to highlight any component not in the correct relative position per plant documentation.

All permanently affixed labels and escutcheons related to controls and indications were recorded verbatim in the printout COMMENTS field. Indicating lights associated with controls were recorded in the COMMENTS field indicating their color and relative position on the panel. Discrepancies between panel engraving drawings and labels were noted, as were discrepancies between documented and actual indicating light position and color. Temporary component labels (i.e. dymo tape) were recorded verbatim in the COMMENTS field as well.

Discrepancies between the information gathered in Phase I and the as-built conditions recorded in Phase II were documented in the COMMENTS field. The discrepancies noted included differences in range, device type, indicating light color, component locations, label engravings, and existing components. The majority of these documentation discrepancies affected the DAEC Instrument Index and the panel layout drawings.

The discrepancies noted between Phase I (document) data and Phase II (as-built) data were the source of the HEDs written from the CRI.

4.2.3 Inventory Database Output

The data collected by the CRI were used in other phases of the project. Use of the CRI data ensured that all components in the control room were addressed.

The primary use of the CRI data was the creation of the Control Room Survey data collection sheets. For a given panel, the control room components were separated into subpackages based on component types. Each subpackage was printed in panel location order from the top left to the lower right of the panel. This enabled a systematic and complete survey of each panel component, while greatly reducing the time required for data collection which would have been redundant to that in the CRI. The data printed onto the survey data collection forms by the CRI included component number, device type, component location, subsystem, purpose, and all comment fields. The comment fields included all temporary and permanent labels, indicating light information, and documentation discrepancies.

By selective sorting of and data extraction from the CRI data base, a list of all permanent and temporary labels existing in the control room was developed. From this list, an approved vocabulary for control room labeling was established. This list was also compared to the existing list of approved acronyms and abbreviations. Additional acronyms and abbreviations were proposed for this list, as appropriate.

Other uses of the CRI data base were: a listing of all device types found in the control room, a listing of discrepancies between the documentation from which data was acquired and the as-built condition, and the ability to determine the number of a certain type of component mounted on the control room panels.

4.3 CONTROL ROOM SURVEY

4.3.1 Introduction

The Control Room Survey compared the design of panel components in the control room and the alternate shutdown panels with respect to acceptable human factors criteria as developed by the Boiling Water Reactor Owner's Group. The environment, operator tools, and other topics pertinent to the integrated tasks of operating a nuclear power plant were evaluated using this same criteria. Generic checklists, as published in the BWROG Control Room Survey Workshop and the Survey Program Supplement, were used for data collection and evaluation. These checklists are provided in Appendix A.

4.3.2 Survey Methodology

The DAEC DCRDR Survey individually examined all controllers, indicators, recorders, annunciators, and switches in the control room and alternate shutdown panels. This approach resulted in a more comprehensive survey than the earlier, more general BWROG survey. Except as noted, items evaluated in the survey were compared to the selected guidelines, evaluation sheets, and compliance checklists, as described below. The use of these checklists was limited to determination of a component's compliance in response to the stated criteria. Although the checklists in Appendix A lend themselves to prioritizing the HEDs during survey, the "potential for error" (weighting) value and the product of the "compliance" value and the weighting value were not used. The Assessment phase of the project provided a more precise method to assign relative weighting and resulting Assessment priority.

The following eight checklist categories were evaluated:

Panel Layout and Design,
Instrumentation and Hardware,
Annunciator Warning System,
Computers,
Procedures,
Control Room Environment,
Maintenance and Surveillance, and
Training and Manning.

All members of the DCRDR task team were trained on general Human Factors Engineering principles and in the use of the survey checklists to assure a comprehensive and accurate survey effort. Survey teams of two or more members performed the survey. A licensed operator was available at all times to assist the team members, as necessary. The human factors specialist monitored the progress of the survey to insure good survey practices were used by members of the survey teams.

The applicable BWROG checklists were applied against each panel in the control room including auxiliary panels, backpanels, and peripheral equipment, as well as the alternate shutdown panels. Checklists were completed for each component on the panel. Deviations from the checklists were identified and documented as HEDs. The functional approach of the survey often required input from operations personnel to evaluate compliance to given checklist items. Specific individual component information was supplied from the Control Room Inventory Equipment Description Form, shown in Figure 4.3.1. This form provided the survey teams with component information on every component, improving survey efficiency and accuracy in completing the checklists.

Each checklist item was presented as a question for consideration by the survey team member(s). Following that question was a series of numbers by which the specific item being reviewed was evaluated. The first set of numbers (4 3 2 1) indicated the degree of compliance as follows:

4 -- indicated NO compliance
3 -- indicated SOMEWHAT compliance
2 -- indicated MOSTLY compliance
1 -- indicated FULL compliance
0 -- indicated the specific question is NOT APPLICABLE or cannot be considered.

As each question was evaluated, the team member(s) recorded the relative degree of compliance by circling the applicable number. All survey question items rated with less than full compliance to the checklist item were classified as HEDs.

Following the number indicating the degree of compliance for each item being evaluated, was a predetermined BWROG "potential for error" number ranging from one to three. This weighting factor was not used in the DAEC Survey, since it was intended as a method of assessment using a strict BWROG approach. For each specific checklist item identified to be not in compliance, comments were used to clarify the non-compliance. The scope of the review, the source of the data, and any qualifying statement judged to be appropriate to evaluation were entered in the appropriate spaces.

To provide additional documentation, photographs were taken of major items or components not in compliance such as mimic layouts, control and display groupings, labeling systems or equipment locations. These photographs are cross referenced to the specific checklist item by a notation in the comment space of the survey checklists.

The BWROG annunciator checklists were completed for all windows and all windows were reevaluated for correctness of nomenclature, uniform size, and other human factors criteria. Each annunciator window was assigned an "X", "1", or "2" to indicate no problem, slight problem, or large

Panel 1CXX Device type: Run Date - xx/xx/xx
Page x

Component Information	Checklist Item Number
Component #: Device: Location: Subsystem: Purpose: Comment:	
Component #: Device: Location: Subsystem: Purpose: Comment:	
Component #: Device: Location: Subsystem: Purpose: Comment:	
Component #: Device: Location: Subsystem: Purpose: Comment:	
Component #: Device: Location: Subsystem: Purpose: Comment:	

Surveyed by:_________ Date:______ Surveyed by:_________ Date:______

Reviewed by:_________ Date:______ Approved by:_________ Date:______

Figure 4.3.1 Inventory Equipment Description Form problem, respectively. This evaluation resulted in recommended changes to over 90% of the annunciators.

In addition to completing the computer-related BWROG checklists, the DCRDR participated in the development of design recommendations for the Plant Process Computer upgrade, replacing the computers and terminals in the control room during the Cycle 9 outage. The DCRDR participated in the development of design recommendations for a complete redesign of the operator's console layout in the control room.

An independent survey, separate from the BWROG checklist approach, was performed by the Human Factors Specialist to identify HEDs that may not have been identified by the BWROG checklists. The independent survey utilized general HFE principles such as may be found in NUREG 0700, MIL STD 1472, EPRI documents, and other HFE documents. Deviations from acceptable HFE criteria or standards were identified and documented as HEDs. Where possible, an attempt was made to associate a given HED with the most similar BWROG checklist item number.

At the conclusion of the BWROG checklisting and the independent survey all resulting HEDs were evaluated and checked for correctness by the Human Factors Specialist and the team SRO, annotated if required, and signed.

4.4 OPERATING EXPERIENCE REVIEW

4.4.1 Introduction

The Operating Experience Review consisted of two separate elements: 1) Operating History Review and 2) Operating Personnel Questionnaires and Interviews.

The Operating History Review examined the DAEC Licensee Event Reports (LERs) and Deviation Reports (DRs) for the years 1974-1985 in an effort to identify design deficiencies, procedural deficiencies, or plant technical or administrative operating conduct which was a contributing factor to "Operator Error".

The Operator Questionnaires and Interviews provided direct operator input identifying deficiencies in the control room layout or design, or deficiencies in operating procedures. Operations personnel were also given the opportunity to provide details regarding aspects of the control room which they considered in need of improvement.

4.4.2 Operating History Review

4.4.2.1 INTRODUCTION

The Operating History Review was performed to identify conditions or situations within the DAEC control room which have contributed to operator error or affected an operator in the performance of his tasks. For the purposes of the Operating History Review, an "Operator" is defined as any person located in the control room including both operations and maintenance personnel.

4.4.2.2 OPERATING HISTORY REVIEW METHODOLOGY

All of the licensee event reports (LERs) for the years 1984 and 1985 were reviewed to identify operator errors. Within the DAEC data base for LERs and Deviation Reports (DRs), the remaining LERs and all DRs were searched using the keywords "ERROR" and "OPERATOR". In addition, the DRs were searched using the keyword "SCRAM" since all reactor SCRAMs at the DAEC are recorded as a DR. The resulting LERs and DRs were selected for further evaluation by the DCRDR effort.

All identified errors in these reports were further evaluated to determine if the errors were associated with activities confined to the control room. Documented errors were screened according to the following criteria:

1. The equipment referenced was in the control room or on the Alternate Shutdown Panel.

2. The procedural steps were accomplished in the control room or on the Alternate Shutdown Panel.

3. The personnel errors occurred in the control room or on the Alternate Shutdown Panel.

These documented errors were used to generate HEDs.

During the process of reviewing and screening the documented errors for the purpose of generating HEDs, an analysis of the documented errors was conducted in order to determine any trends or correlations between errors which would be indicative of problems not explicitly stated in the LER or DR.

HEDs were further analyzed to determine if the corrective action described on the LER or DR resolved the cause of the error and eliminated the HED. Those HEDs for which the corrective action resolved the cause of the error and eliminated the HED or for which the HED was no longer applicable (due to subsequent equipment or procedure changes, etc.) were not considered for assessment and correction. Written justifications are attached to these HEDs. These HEDs were also reviewed by the SRO and Human Factors Specialist to ensure that the corrective actions were sufficient and that no further action was warranted.

4.4.3 Operating Personnel Questionnaires and Interviews

4.4.3.1 INTRODUCTION

The Operating Personnel Interviews allowed operations personnel to identify problems and desirable features of plant design and operation through the use of questionnaires and interviews. Questions focused on details of the control room environment associated with transient responses, emergency conditions, and plant operations safety.

4.4.3.2 OPERATOR QUESTIONNAIRE AND INTERVIEW METHODOLOGY

Questionnaires derived from the BWROG Control Room Improvements Subgroup were distributed to all operations personnel and their responses reviewed by the DCRDR Team to identify specific control room problems. Interview questions were expanded for responses to the questionnaires which warranted more detailed discussion. Supplementary questions derived from the Operating History Review analyses were also provided for interview response. The operator questionnaire and interview questions are given in Appendix B.

Completed questionnaires were received from 80% of the licensed operators (17 Reactor Operators, 16 Senior Reactor Operators, and 5 Shift Technical Advisors). Interviews were conducted with half the licensed operators (11 Reactor Operators and 9 Senior Reactor Operators). The questionnaires obtained from personnel not interviewed were screened in order to identify any comments or concerns not stated by those persons interviewed.

HEDs were generated using the Operator Interview Summary Sheets which summarized all of the operators comments for each specific question. All operator comments and opinions which indicated a problem were documented as HEDs and forwarded for assessment. Those comments and opinions that did not appear to violate any human factors criteria were documented as HEDs and forwarded for assessment. The commentor's opinion may not by itself indicate a problem (i.e. violate human factors criteria), but it may support HEDs produced from the other phases of the DCRDR, or be indicative of a related problem.

4.5 FUNCTION & TASK ANALYSIS

4.5.1 Introduction

The DAEC Emergency Operating Procedures (EOPs) and the interrelated procedural steps of Operating Instructions (OIs) and Integrated Plant Operating Instructions (IPOIs), referenced from the EOPs, were used to identify control room operator tasks during emergency operations. Since the EOPs and interrelated procedures were developed for a BWR/4 Mark I containment plant with DAEC's specific systems/equipment design, the entry conditions and procedural steps reference only existing alarms, indications, and controls as well as operating conditions, automatic actions, or other plant-specific symptoms. For this reason, the procedural steps were not used directly in the task analysis. They served, instead, to provide a basis for inferring the 'objective' of the procedural step or series of steps. The translation from procedural step(s) to their objective and the use of this objective, alone, assured that the Function and Task Analysis (FTA) steps were developed independently of existing control room components.

The format of the Task Analysis Development Sheets (FTA Form - Figure 4.5.1) was developed to provide an adequate mechanism to identify the procedural source of the objective, the stated objective, and the discrete task steps and decision points. From the objective(s), instrumentation (information) and controls were prescribed. The following EOPs were analyzed to identify HEDs:

* EOP - 1 Reactor Pressure Vessel Control
* EOP - 2 Primary Containment Control
* EOP - 3 Secondary Containment Control
* EOP - 4 Radiation Release Control
* EOP - 6 Shutdown Outside Control Room

4.5.2 Function and Task Analysis Methodology

The BWROG Emergency Procedure Guideline (EPG) functional objective approach, translated to symptom - oriented EOPs and resulting DAEC EOPs, provided the basis for deriving explicit functional objective(s) and parameter limits including prescription of general methods, systems, and components to accomplish these objectives. Explicit criteria were provided to determine success or failure of the methods.

DCRDR TASK ANALYSIS

PREPARED BY________________ DATE_______ PAGE___OF___

	EOP/ OI STEP	FUNCTION/TASK OBJECTIVE	TASK DESCRIPTION	STEP REF	SKILLS AND KNOW-LEDGE		SETPOINT OR PARAMETER LIMITS	PRESCRIBED INSTRUMENTATION	RECOMMENDED LOCATION	SUMMARY SHEET REF	
1											1
2											2
3											3
4											4
5											5
6											6
7											7
8											8
9											9
10											10
11											11
12											12
13											13
14											14
15											15
16											16
17											17
18											18
19											19
20											20
21											21
22											22
23											23

Figure 4.5.1 Task Analysis Development Sheet

The deviations between the BWROG Generic EPGs, DAEC EPGs, and DAEC EOPs were reviewed during the EOP development program (Ref 8.4.9). The results of this effort were reviewed by the Human Factors Specialists and the licensed Senior Reactor Operator team members to determine if there was any adverse impact on any parameter indication, operator decision or operator action. The referenced OIs provided detailed task steps to accomplish these objectives, identified the specific components and provided additional system and component information where appropriate.

This "objective oriented" approach was evaluated and determined to provide the necessary procedural guidance and existing component independence for the development of function and task identification, and specification of discrete task steps.

EOP Conditional Statements requiring operator decisions and subsequent actions based on those decisions, were developed as specific task steps within the FTA. Particular attention was paid to CAUTIONS and NOTES within the EOPs, OIs, and IPOIs to describe the objectives and task steps and determine the instrumentation needed. Tasks that were performed outside of the control room were shown as task steps that were performed locally.

The FTA FUNCTION/TASK OBJECTIVE and TASK DESCRIPTION field on the FTA Form generally identifies the EOP, OI, or IPOI step task objective and the discrete action(s) necessary to accomplish the objective. Many situations required two or more levels of objectives and/or tasks to adequately provide the information necessary to perform a detailed analysis of the integrated operator tasks. Regardless of the procedural step being reviewed, emphasis was placed on providing sufficient detail to allow prescription of instrumentation (information) and controls to accomplish the task(s).

For EOP entry conditions, the FTA entries reflect the task(s) necessary to determine if an entry condition has been exceeded and any associated or subsequent tasks that must be performed to determine or verify this. Following the entry conditions, the EOP steps provide general guidance for actions that must be performed to control the "out-of-limit" parameter(s) and provide direction to the operator to mitigate degradation of plant performance and restore plant conditions to normal. The FTA entries provide discrete steps to perform these general actions.

When an EOP referenced an OI or IPOI, the FUNCTION/TASK OBJECTIVE was derived from the procedural step and the discrete procedural step was described within the TASK DESCRIPTION. The OI steps (from the beginning of the EOP referenced step) were provided on the FTA Form without regard to the time frame or related circumstances that may be present during the task sequence. This resulted in task steps that may not be directly applicable to the task sequence for some anticipated related sequence of events. However, this was done to assure all potential steps were available for analysis and to enable referencing these steps from other portions of the task analysis that may use the steps. This approach resulted in a complete and conservative task analysis and an indication of the effort involved in performing plant task sequences.

The information provided in the PRESCRIBED INSTRUMENTATION field is the Instrumentation (Information) and Control (I&C) specification(s) and features needed to effectively perform the task step(s). Emphasis was placed on prescribing equipment specifications, features needed, and recommended locations. Setpoints or parameter limits were provided when available using the most appropriate units for the task step. When limits were not specifically restrictive, an appropriate range was specified. The recommended location for the I&C equipment, based on the specific task step or task sequence, was entered in the appropriate field using a descriptive panel identifier.

The 'objective-oriented' approach required evaluation of tasks and task sequences to determine the instrumentation and/or controls that should be prescribed to provide the operator with the ability to perform the step(s). Appropriate parameter indication and/or control characteristics are prescribed and evaluations of the task(s) determine if additional equipment should be prescribed that may improve the operator's ability to perform the step(s). Although this resulted in new instrumentation and control concepts for some systems or components, the FTA prescribed this equipment. An example would be the prescription of an auto-action for a series of steps that could be readily automated. Another example would be the prescription of a keylock switch for a task to defeat interlock logic.

A TASK ANALYSIS SUMMARY SHEET - PRESCRIPTION OF INSTRUMENTATION (Figure 4.5.2) was developed for each prescribed parameter or I&C equipment identified in the FTA. The large number of prescribed parameters and I&C equipment with varied levels of specified characteristics required a comprehensive assessment of the I&C equipment that would provide the overall characteristics necessary to perform the numerous tasks and provide for all of the conditions identified in the FTA. System related parameters and equipment were grouped together to allow summation of the characteristics needed to define acceptable I&C equipment.

The TASK ANALYSIS SUMMARY SHEET - VERIFICATION OF INSTRUMENTATION (Figure 4.5.3) was completed for the related FTA prescribed parameter or equipment identifying existing control room parameter indication(s) (information) or equipment. Specifications and features of these components were provided from knowledge of the component, available specifications and instructions, and the photomosaic mockup of the panels.

Determination if existing control room instrumentation (information) and controls provide the capabilities necessary for the FTA prescribed parameters and equipment was provided by making a comparison of the information on the two summary sheets and applying applicable plant knowledge provided by members of the Review team. Discrepancies were identified as HEDs.

SUMMARY SHEET NO.______

TASK ANALYSIS SUMMARY SHEET
PRESCRIPTION OF INSTRUMENTATION

PARAMETER: ________________________________

TASK REQUIREMENTS

EOP/OI STEP	CONDITION	A,M,C, I,T,F	LOCATION

SUMMARY CHARACTERISTICS

RANGE	UNITS	ACCUR.	RESDL.	REDUND.	LOCAT.	A,M,C, I,T,F

Comments:

Figure 4.5.2 Prescription of Instrumentation Form

SUMMARY SHEET NO.______

TASK ANALYSIS SUMMARY SHEET
VERIFICATION OF INSTRUMENTATION

PARAMETER: ____

DESIGN REQUIREMENTS

REF.	RANGE	UNITS	ACCUR.	RESOL.	REDUND.	LOCAT.	A,M,C, I,T,F

Comments:

ACTUAL INSTRUMENTATION

EQUIP. ID	RANGE	UNITS	ACCUR.	RESOL.	REDUND.	LOCAT.	A,M,C, I,T,F

Comments:

VERIFICATION:

HED NOS. ____

Figure 4.5.3 Verification of Instrumentation Form

Generally, HEDs were generated using the following criteria:

* I&C not located in recommended location

* Existing I&C not of the optimal type to satisfy the summarized I&C requirements

* Existing I&C not adequate to satisfy the summarized I&C requirements

* Existing I&C range, units, accuracy, resolution, etc. do not adequately satisfy the summarized requirements

* The summarized I&C requirements indicate the need for two components due to conflicting requirements

4.6 ASSESSMENT

4.6.1 Introduction

The objective of the assessment phase was to systematically prioritize all Human Engineering Discrepancies to reflect the degree to which operator performance may be degraded or plant safety may be impacted. The methodology used to evaluate the HEDs and determine the significance of each HED was derived from recommendations provided in NUREG-0801, EVALUATION CRITERIA FOR DETAILED CONTROL ROOM DESIGN REVIEW. The assessment provided a relative significance and correction priority for each HED by subjecting the HED to a series of questions. Responses to the questions allowed the review team to systematically relate HEDs to a 9-point rating scale which reflects the degree to which operator performance is degraded or plant safety is impacted, as well as the relative probability that an error will occur. The assigned number quantifies the level of significance of the HED on plant safety or operator performance with 1 being the most significant and 9 the least significant.

4.6.2 Assessment Methodology

4.6.2.1 GROUPING OF RELATED HEDS

Grouping was initiated by a Review team member and modified, as necessary, by the Review Team. HEDs were segregated within a panel package to group together those discrepancies which could be logically addressed together for assessment of safety significance and/or correction. It was recognized that grouping by BWROG Survey Checklist item number alone would have resulted in groups of HEDs containing similar discrepancies (or violations of Human Factors criteria) and would dilute the significance of interactions between HEDs on a given panel. This type of sorting would not have met the objective of HED assessment. Although further sorting could have been accomplished within BWROG items, it was determined that manually grouping HEDs on a particular panel would be the most effective. Manually grouping HEDs allowed sorting by component, system, similar discrepancies, etc. as deemed applicable by the team member grouping the HEDs.

4.6.2.2 ASSESSMENT MEETINGS

To facilitate the assessment process assessment meetings were conducted where the team member responsible for grouping the HEDs on a particular panel presented the HED or group of HEDs to a quorum of team members and the assessment was performed by all team members. A quorum for assessment purposes included as a minimum five team members - the team leader or assistant team leader; an SRO; a Human Factors Specialist; and at least two of the following: Nuclear Engineer, Systems Engineer, or I & C Engineer. The assessment phase was conducted over a five-week period during which a total of 15 assessment meetings were conducted.

4.6.2.3 ASSIGNMENT OF PRIORITY NUMBER

Each group of HEDs was presented to the review team and an Assessment and Correction Report (Figure 4.6.1) and Assessment Worksheet (Figure 4.6.2) were completed for each group. The Assessment Worksheet contained the questions used to determine the assessment priority provided as decision points on a flow chart. The Assessment Worksheet was completed by tracing the path through the decision points indicating the appropriate response to the questions resulting in the assessment priority.

The assessment worksheet structured the questions asked of each HED and produced a correction priority assignment. As written below, the actual questions on the worksheet are listed in UPPERCASE. Interpretation, as required, is listed in lowercase. The questions are:

1. DOES IT DEGRADE PERFORMANCE? Does the HED represent conditions that could degrade operating personnel performance?

2. DOES IT INCREASE THE POTENTIAL FOR ERROR? Is the effect of the HED serious enough to cause or contribute to increasing the potential for operating personnel error?

3. SERIOUS CONSEQUENCES? Does the HED have serious consequences?

4. IS IT A DOCUMENTED ERROR? Is the HED known to have previously caused or contributed to an operating error, as documented in an LER or other historical record, or as established by interview or questionnaire responses of operating personnel? It should be noted that to qualify as a documented error, operating personnel responses must describe an error that has actually occurred.

5. DOCUMENTED UNSAFE CONDITION/TECH SPEC VIOLATION? Does the HED involve a documented violation of a technical specification or other unsafe condition?

6. POTENTIAL UNSAFE CONDITION/TECH SPEC VIOLATION? Could the HED result in a potential violation of a technical specification or other unsafe condition?

DUANE ARNOLD ENERGY CENTER IOWA ELECTRIC LIGHT AND POWER CO. ASSESSMENT AND CORRECTION REPORT	Rev. No.	Assessment No.

HED TYPE:

HED NUMBERS: ______ ______ ______

______ ______ ______ ______

______ ______ ______ ______

______ ______ ______ ______

______ ______ ______ ______

SAMPLE

ASSESSMENT (Attach assessment decision chart) | PRIORITY : ______

By: ______ Date: ______

CORRECTION TYPE: |_|Equipment |_|Label |_|Procedure
|_|Mimic and Demarcation |_|Training |_|No Change
|_|Other:

Written justification not to change required? |_|Yes |_|No

DESCRIPTION OF CORRECTION:

By: ______ Date: ______

REVIEW TEAM LEADER: ______ DATE: ______

Figure 4.6.1 HED Assessment/Correction Form

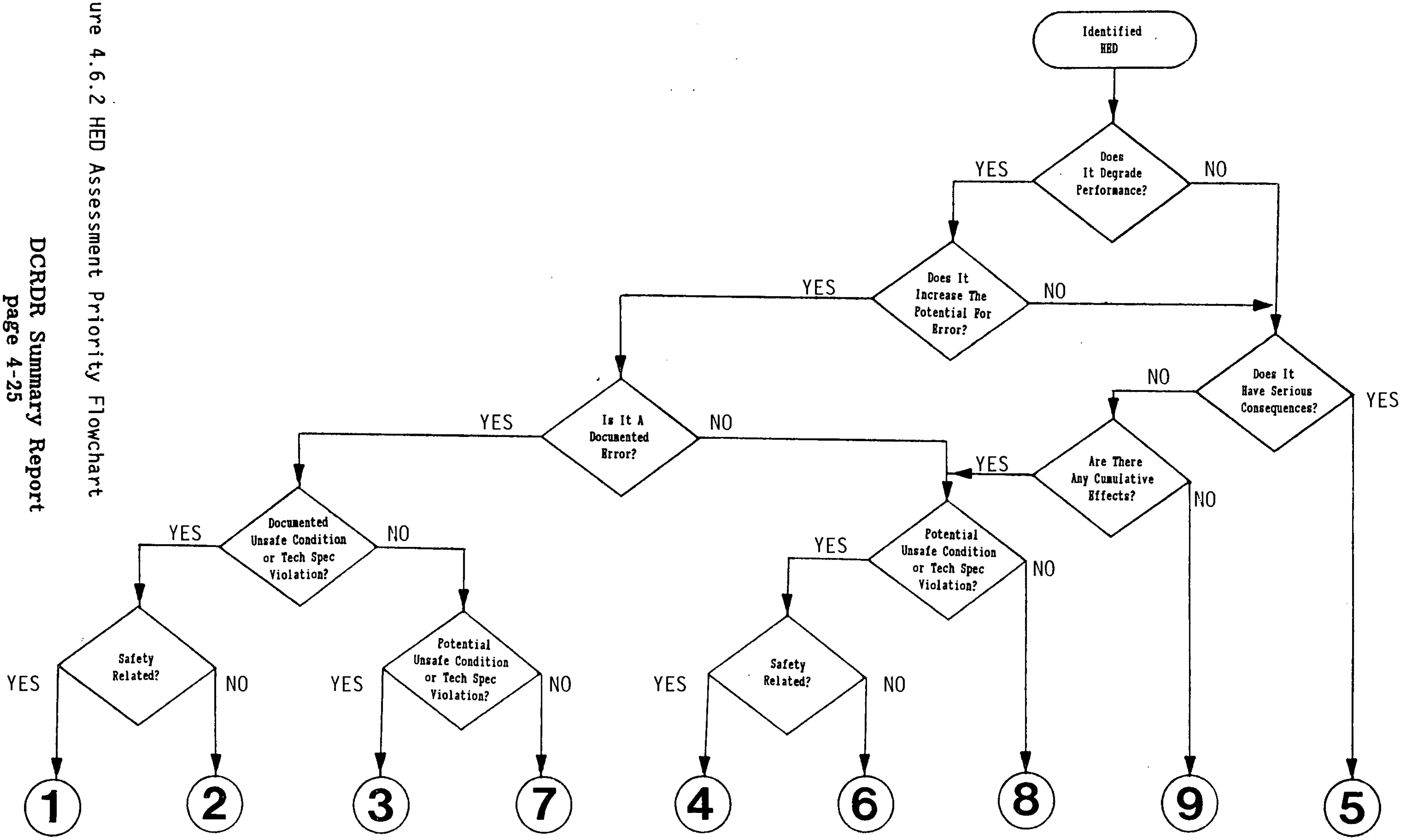


Figure 4.6.2 HED Assessment Priority Flowchart

7. SAFETY RELATED? Is the HED associated with a safety related function, or any function necessary to mitigate the consequences of an accident?

8. ARE THERE ANY CUMULATIVE EFFECTS? Does the HED, when taken in the larger context of other HEDs, have cumulative or interactive effects that would prompt affirmative answer to the above questions?

Additional questions, as provided in SRP 18.1, Appendix A, Exhibit 2.2, were used as necessary to clarify the above questions.

The assigned number represents the level of significance to plant safety or operability of the HED with 1 being the most significant and 9 being the least significant. An HED of priority 9 does not by itself degrade operator performance or increase the potential for error and does not have serious consequences. However, a priority 9 HED may have greater significance when taken in conjunction with other HEDs. For this reason, priority 9 HEDs were examined for cumulative effects during the Corrections phase.

If the assessment priority resulting from the worksheet was deemed to be inappropriate for the HEDs the review team, at its discretion, increased the assessment priority and noted the reasons for the change. For example, individual labeling deficiencies would usually rank low in priority (unless the label information was deceiving) due to the offsetting effects of operator experience and training. All label changes were given a cumulative priority of '4' due to the large number of marginal or inadequate labels and the use of temporary labels throughout the control room.

The Assessment and Correction Report was completed by assigning an A/C Number to the group of HEDs, listing the HED Numbers in the group and the assessment priority, and documenting any comments pertinent to the decisions made during the assessment.

4.6.2.4 EXAMINATION OF CUMULATIVE EFFECTS

Upon completion of the assessment of all HEDs, all priority 9 HEDs were reconsidered for cumulative effects to determine whether taken in the aggregate, or in conjunction with more significant HEDs, they degraded plant operability or operator performance.

4.6.3 Documented Errors

The methodology for determining the significance of an HED from NUREG-0801 places more significance on those HEDs which had previously contributed to operator error as documented in historical records. In addition to the documented errors obtained from review of LERs and DRs, there were several instances during the operator interviews in which operators identified errors which had occurred due to human engineering deficiencies. These interviews were another source of operating history errors. Often, no documentation existed to support these observations due to the relatively inconsequential nature of the errors and the reporting requirements for LERs and DRs in the years prior to 1984. For the purpose of assessment, all operator observations from the interviews which identified operator error and could be substantiated in any way were treated as documented errors.

4.6.4 HED Data Base

It was determined that a data base was necessary for control and tracking of the Assessment and Correction Reports (A/C forms) and the associated HED Numbers and Assessment Priorities. A data base was created for control and tracking of the Asesssment and Corrections Reports which included: A/C Number, Assessment Priority, and HED Numbers (for each A/C Number). The A/C Number assigned to each Assessment and Correction Report was of the form XXX-YYY, where XXX represented the panel number associated with the HED(s) and YYY was a sequential number assigned to the individual A/C form. Non-panel specific (general) HEDs were assigned a panel number of '000' for A/C identification.

4.7 CORRECTIONS

4.7.1 Introduction

The objective of the corrections phase was to provide recommended design improvements to bring significant Human Engineering Discrepancies into agreement with acceptable Human Factors Engineering standards. Selection of design improvements included a systematic process for development and comparison of alternative means for resolving HEDs. If it was determined that no corrective measure need be recommended, justification was provided for that recommendation.

A secondary objective of the corrections phase was to provide for maintenance of all documentation pertaining to HEDs assessed as insignificant. All HEDs were addressed in the corrections phase and many "insignificant" HEDs were corrected. Those not corrected and not classified as out-of-scope were provided with justification for no correction.

Review Team members were assigned to development corrections for all HEDs associated with a specific control panel. These corrections were presented to a group of team members for examination and the resulting approved correction was presented to management.

4.7.2 Assessment Methodology

4.7.2.1 ASSESSMENT PRIORITY

During assessment, HEDs were segregated into significant and insignificant categories. These two categories of HEDs were to be addressed separately during the corrections phase, but the assessed priorities were not the sole consideration for the determination of whether a correction should be recommended. Corrections were proposed for all HEDs which were considered to possibly affect operator performance. Only HEDs that would not benefit from correction due to their insignificant effect on operator performance were not offered proposed corrections.

4.7.2.2 CORRECTIONS GROUPING

Individual team members were allocated corrections packages containing all the HEDs associated with a given control panel, subdivided into Assessment/Correction (A/C) groups. Corrections were then developed and proposed to correct each HED within the A/C group and all A/C groups within the given control panel. Where a single correction was viable for more than one HED, this correction was recommended for the group or subgroup. These groups seldom encompassed the entire A/C grouping performed during Assessment due to the difference between the criteria used to sort HEDs for assessment and the criteria used to sort HEDs for correction. Corrections subgroups were created within A/C groups. These subgroups were linked to similar corrections within a panel, or control room-wide, by referencing the appropriate A/C and HED numbers. Movement of components from panel to panel was documented in a similar way. Given this grouping of HEDs for correction, it is obvious that individual HEDs within some subgroups were corrected within the group and not addressed separately. However each HED was addressed and corrected or justification for no correction was provided.

4.7.2.3 CONSIDERATIONS

One or more possible corrections were developed for all HEDs or justification was provided for no correction. The intent of the recommended correction(s) was to:

1. bring the HED into agreement with accepted Human Factors Engineering standards or provide a solution that counteracts the effect of the HED,

2. ensure that operator performance and/or plant safety will not be degraded,

3. minimize undesirable interactions with other recommended corrections, and

4. ensure that no new HEDs are introduced to the Control Room while correcting an existing HED.

In addition to the HFE considerations above, the corrections process considered the current Control Room design, existing training topics and levels, and existing conduct of operations. Existing design conventions and criteria as well as those developed for the DCRDR, guided the correction choices. Proposed corrections were examined to ensure minimal impact on previous training, existing procedures, other proposed corrections and conduct of operations.

4.7.2.4 DESIGN CONVENTIONS

Both explicit and implicit design conventions existed at the beginning of the DCRDR. Explicit conventions were modified to adhere to acceptable HFE standards and used as guidance for the corrections phase.

Conventions such as red-green light, labeling and control handle shape conventions were not explicitly identified at DAEC at the beginning of the project. Many of these implicit design conventions were made explicit and documented by the DCRDR team as a revision to the DAEC Human Factors Design Guide, DGC-E101, to ensure that future control room changes will adequately address human factors criteria.

4.7.2.5 CORRECTION METHODS

The review team members developing corrections generally did not perform a design trade-off study in developing them, or consider the costs of implementing their recommendations. Instead they identified alternative corrective measures, when appropriate, which were equally effective in resolving the HED. Many of the HEDs lent themselves to multiple corrections with varying effectiveness in resolution. Where multiple corrections were developed of equal effectiveness, either all correction options were approved by the Review Team members and presented to the Corrections Review Committee or the available options were reduced to those considered "best" or most viable by the Review Team. Where different corrections varied in effectiveness, only the "best" proposed correction was presented to CRC. This ensured that the corrections considered by the CRC were those which most completely resolved the HEDs without violating design guidance or good engineering judgement or, generally, considering costs. The options to be considered by management were all documented on the Assessment/Correction form, (Figure 4.6.1) along with the development process used and the advantages and disadvantages of each proposed correction.

Recommendations utilized the following four methods to address discrepancies:

1. Surface enhancements
2. Physical modifications to instrumentation and controls
3. Non-physical operational changes
4. No correction

4.7.2.5.1 Surface Enhancements

Many HEDs were corrected by the use of surface enhancements alone. Surface enhancement techniques include changing control and/or display labels and annunciator title legends, color coding, or adding demarcation or mimic lines to existing control panels and displays.

The time necessary for a design change to be investigated and completed for the control room corrections required the Corrections Team to recommend surface enhancement techniques as an interim solution for certain HEDs. These interim corrections were recommended to minimize the impact of the HEDs until an extensive design change can be studied and developed. Interim solutions were detailed as such on the Assessment and Correction Report form along with the final solutions. Interim solutions were developed in such a way to complement the long-term solution.

Surface enhancements were proposed in areas where future work would be required. For example, labels, mimics, and demarcation will be corrected in areas where long-term corrections may require that components be removed, relocated, or replaced. The long term solution will then include some rework of the early surface enhancements as a part of the proposed correction.

Correction of an HED by other methods did not preclude surface enhancements. All HEDs were considered for surface enhancement corrections. Nearly every control room instrument and control was impacted by surface enhancements, primarily label improvements.

4.7.2.5.2 Physical Modifications

Certain HEDs that could not be effectively resolved by surface enhancement alone required physical modification of instrumentation and controls. Such physical modifications necessitate a design effort. Physical modification efforts typically consist of the addition, deletion, modification or rearrangement of controls and instrumentation. Indicator scales were modified, instruments installed, and components relocated as necessary. Physical modifications were mocked up on the photomosaic, panel drawings or full-scale sketches to determine their viability.

4.7.2.5.3 Operational Changes

HEDs were also resolved through methods that do not require physical modifications or surface enhancements. Non-physical operational areas which were recommended to be modified included training, staffing levels, conduct of operations, and operations procedures. Training programs recommendations were provided to the appropriate organizations to alert personnel to particular control arrangements that are not in conformance with HFE criteria but cannot be reconfigured due to space considerations, separation criteria, or overriding HFE considerations. Increased training was recommended for controls, instruments, and systems which were identified by operators as difficult to operate or interpret. Components identified as unused by operations were investigated for purpose and recommended for removal if unnecessary. If component function and use were not completely understood by operators, training enhancements were recommended.

Procedure modifications were recommended to compensate for inadequacies in instrument and control layout or location where rearrangement was not feasible. Procedures were recommended to be more explicit in some particular areas of interest. Writer's guide improvements were suggested to ensure that procedures would be updated to recommended standards during revisions arising from other requirements.

Staffing change recommendations were minimized as it was understood that staffing has been the subject of recent indepth investigations that exceeded the effort DCRDR could provide.

The Control Room conduct of operations required was recommended to be modified to improve operator performance. Additional space was recommended as designated areas for conference or congregation of various support personnel. Rearrangement of the OSS office area and changes to the print laydown area were also recommended. The operator's desk and console area is being replaced by the DAEC PPC Upgrade. A human factors review for this replacement was provided by the DCRDR and used as correction for HEDs.

4.7.2.5.4 No Correction

The final means of addressing an HED was to decide not to correct it. This method was chosen when the correction effort was determined to be unfeasible, to introduce additional HEDs, or to decrease the margin of safety at the plant (despite the resolution). Certain minor deviations from HFE guidelines did not warrant correction. Several HEDs arising from Task Analysis recommended ideal instrumentation consolidating existing pieces of equipment. For example, a single indicator would be recommended to show system valve or electrical lineup, or a single "system operable" indicator would be recommended. Where the DCRDR Review team determined sufficient instrumentation existed to readily determine such status, no integrated component was recommended unless explicitly warranted. It was realized that tracing valve and electrical lineups after a fault could serve an effective troubleshooting function.

Justification was always provided to support the decision not to correct an HED. The justifications ranged from a simple statement that the HED had been assessed as insignificant to a detailed description of system interactions which would preclude correction because of design criteria or negative transfer of training. Appendix C contains the bases and justifications for HEDs with Assessment priorities between 1 and 6. Justification for HEDs with priorities 7 and 8 are not included in this appendix, but are available in the associated A/C Verification documentaion.

4.7.2.6 ADDRESSING INSIGNIFICANT HEDS

A secondary objective of the corrections phase was to provide for maintenance of all documentation pertaining to HEDs assessed as insignificant. Insignificant HEDs were addressed by the corrections phase, both directly and indirectly as they impact other corrections. These HEDs had been assessed for their impact on plant safety and operator performance degradation, excluding possible cumulative effects, and determined to be insignificant with respect to these criteria. Cumulative effects were taken into account when all corrections for a system or control panel were considered as a package. Many HEDs assessed as insignificant were corrected within the panel package where a significant benefit would result, where the change was easily accomplished within the other recommended changes, or where their collective impact was judged by the review team to warrant correction.

4.7.2.7 CORRECTION VALIDATION

Physical modifications were mocked up to determine their viability. Front panel changes were developed and attached to a full-scale photomosaic of the control panels. The photomosaic was covered with clear acetate and changes were mocked up to give a representation of the post-modification control room. This led to the integration of individual corrections and determination of the cumulative effects of the corrections in an easily obtained, straightforward manner. Lacking a photomosaic of the back panels and alternate shutdown panels, corrections were mocked up on panel layout drawings.

Not all corrections were mocked up. Label changes were generally addressed in the correction documentation and an example given on the mockup. The value of the mockup was more apparent when component changes, mimics, and demarcation were shown. Specific label wording was not always supplied, but left to the implementation phase, using the corrections wording as guidance.

4.7.2.8 TEAM CONCURRENCE

When all corrections for a control panel were completely developed, a Correction - Verification meeting was held to discuss and approve, or amend the proposed corrections. All Review Team members were involved during meetings to discuss corrections for specific HEDs. Meetings always involved an engineering group leader, a Senior Reactor Operator, a Human Factors Specialist, and engineers providing expertise in the areas of the instrumentation and controls, nuclear and systems disciplines.

During the correction meeting the mocked-up, corrected panel was presented by the team member responsible for its correction development. Each HED was read and discussed along with the proposed correction. Corrections were approved by the entire team or amended to provide a consensus correction. The meeting also served as verification that the proposed correction was adequate and did not introduce other deficiencies on the control panel. The approved correction was then recorded on the A/C form (Figure 4.6.1) by the responsible team member. A verification record (Figure 4.8.1) was also completed. These forms were forwarded to the review team leader for signature.

Following correction approval by the Review Team, the correction packages were forwarded to the Engineering Assessment Team for cost analysis for the implementation of the proposed corrections. The proposed corrections, complete with estimated costs, were then presented for management review.

4.7.3 Management Presentation

The proposed corrections were presented to management at two levels: the Corrections Review Committee and the Management Review Team. Corrections were either approved by management or disapproved and returned with suggested changes, alternate corrections, or a recommendation for no correction with an explanation of the disapproval. Management comments and suggestions were documented via the meeting minutes kept by DCRDR staff. Both management levels were given the prerogative to reject corrections on the basis of cost estimates developed by the Engineering Assessment Team. Corrections rejected for reason of costs were either redeveloped or accepted for non-correction by the Review Team.

Corrections returned from management were then reevaluated considering management direction and subsequently resubmitted by the Review Team. Redevelopment ranged from a completely new correction to further justification for the original proposed correction. The Review Team emphasized technical considerations in redeveloping cost-rejected corrections and did not address the cost/benefit determination made by the management team. Redeveloped corrections were recorded as revisions of the original correction as documented on the A/C and Verification forms.

The management presentation, rejection and redevelopment of HEDs continued until a solution was reached which was acceptable to the Review Team, the Corrections Review Committee and the Management Review Team.

4.7.4 Documentation

Completed, approved corrections were retained for documentation purposes for the implementation of the corrections. Mockups, modified panel drawings, full-size sketches, and photomosaic acetate covers depicting changes were retained as well.

4.7.5 Interfacing With Ongoing Changes

Ongoing Design Change Packages (DCPs) and Engineering Work Requests (EWRs) were interfaced with the corrections phase of the DCRDR. DCPs were reviewed to ensure that they adequately addressed human factors concerns. EWRs and DCPs were referenced during corrections proposal. Near term DCPs were reviewed, and changes to the packages were made to correct human factors deficiencies in the proposed design. DCRDR proposed modifications were incorporated into related DCPs when practicable. This coupling of ongoing design changes and related DCRDR corrections resulted in both a speedup of control room improvements and costs savings associated with non-duplication of design control and documentation.

4.8 VERIFICATION OF CORRECTIONS

4.8.1 Introduction

The proposed corrections developed in the correction phase were examined to ensure that they resolved the identified HED without introducing additional discrepancies.

The objectives of the verification of corrections phase of the DCRDR were to:

1. Determine whether the proposed correction adequately resolved the violation of human factors criteria which prompted the individual HED (or HED group).

2. Determine whether corrections which resolved individual HEDs did not adversely interact with each other.

3. Determine whether an individual correction or a group of corrections did not introduce additional HEDs or decrease the margin of safety while resolving the previously identified HEDs.

4.8.2 Verification Methodology

All corrections to a panel prepared by a Review Team member were examined by the Review Team in a Corrections - Verification Meeting (see Section 4.7.2.8). HEDs associated with a given panel, their assessed priority, and a mockup of the panel were examined in the verification process. When any team member disagreed with a proposed correction, alternative corrections were proposed and considered until the group reached a consensus.

The team member responsible for the correction and verification then completed the Verification Report (Figure 4.8.1). The completed HED package, which also included the HED and the Assessment and Correction Report, was then submitted to the Corrections Review Committee.

Where a partial correction was determined to be acceptable, a justification was usually entered in the "Description of Verification" block on the Verification Report Form. In some instances justification for providing no correction was entered in the "Corrections" block of the A/C form.

DUANE ARNOLD ENERGY CENTER IOWA ELECTRIC LIGHT AND POWER CO. VERIFICATION REPORT	Rev. No.	Assessment No.

VERIFICATION METHOD: |_| Review |_| Mockup |_| Talkthrough |_| Walkthrough

DESCRIPTION OF VERIFICATION:

SAMPLE

By: ______________________ Date: __________

REVIEW TEAM LEADER: ______________________ DATE: __________

Figure 4.8.1 Correction Verification Form

Varying levels of detail were employed in the verification process to ensure that the proposed corrections resolved the identified HEDs without introducing additional discrepancies. The appropriate level of detail was determined by the type of HED and the scope of the proposed correction. The three methods used for verification were Review, Mockup, and Walkthrough.

All proposed corrections were verified by review. All corrections involving changes to layout or surface enhancements other than labeling were verified by both review and mockup. Corrections to panel 1C03, which involved substantial additions of instrumentation, were verified by review, mockup and walkthrough. Descriptions of these methods are provided below.

4.8.2.1 VERIFICATION BY REVIEW

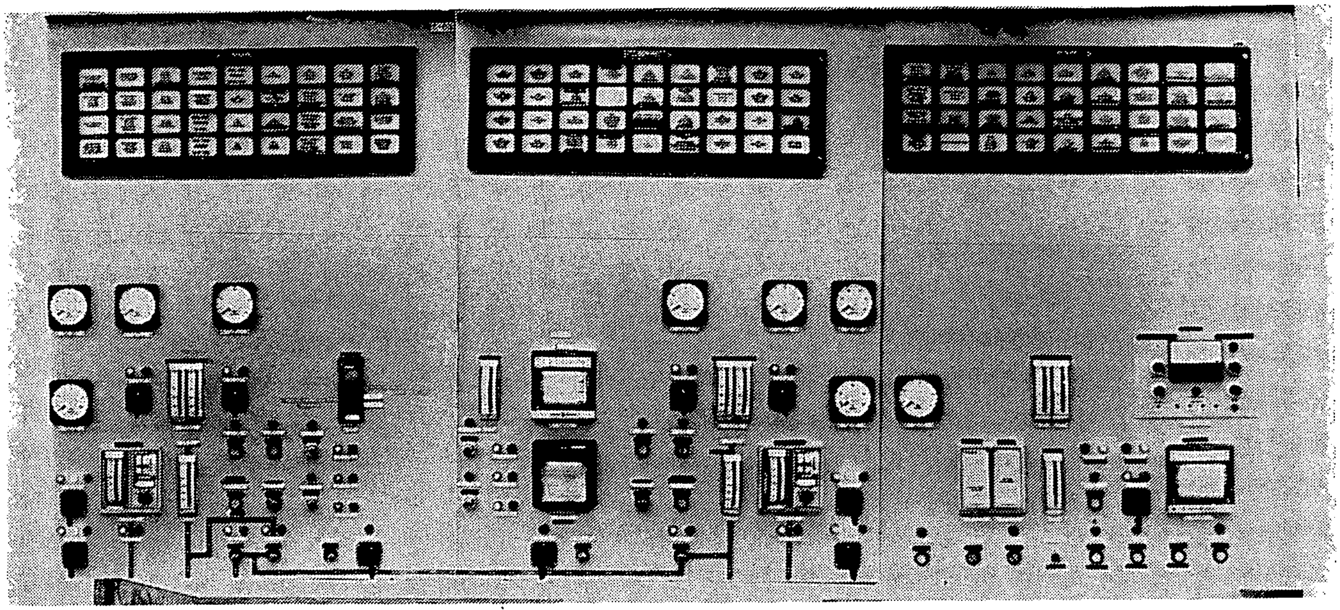
The HED and associated Assessment and Correction Report were reviewed to ensure that the information given completely described the human factors criteria used to identify the HED and that the proposed corrective action resolved the discrepancy.

If the proposed correction did not completely resolve the human factors discrepancy, a description of the violated criteria and the reason(s) why the correction did not completely resolve the discrepancy were entered in the "Description of Verification" block on the Verification Report Form and a justification for partial correction was provided.

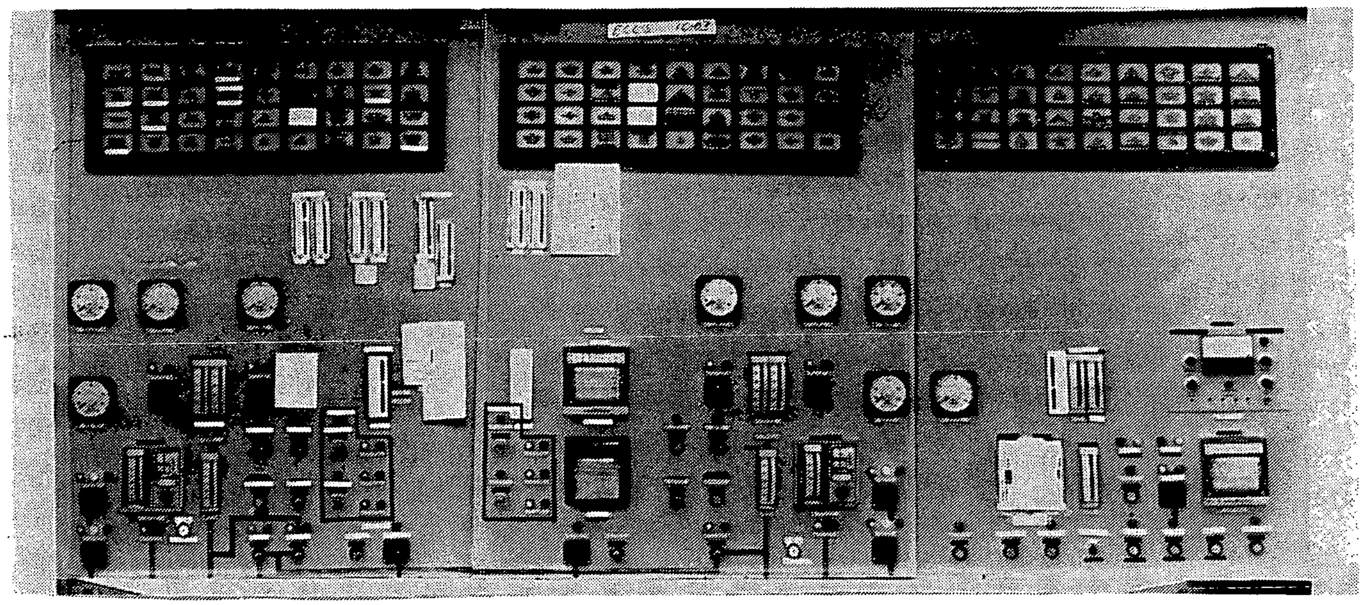
4.8.2.2 VERIFICATION BY MOCKUP

Representations of instruments, controls, demarcation lines, and mimics recommended in proposed corrections to front panels were mocked-up by incorporation onto panel photomosaics, existing panel drawings or full-scale sketches. Those corrections which involved changes to layout or surface enhancements other than labeling were incorporated onto the mockups to verify that the proposed corrections resolved the identified discrepancies and did not interact with other corrections to the panel to introduce new HEDs. An example of the use of the mockup during verification is given in Figure 4.8.2.

Mockups additionally served as a basis for walkthrough of the extensive corrections proposed to panel 1C03 and provided a visual aid for the Correction Review Committee and the Management Review Team.



Mockup Before Correction



Mockup After Correction

Figure 4.8.2. Example of Verification by Mockup

4.8.2.3 VERIFICATION BY WALKTHROUGH

A videotaped walkthrough of EOPs and related OI procedural steps performed at panel 1C03 was conducted using a mockup incorporating the proposed corrections. The walkthrough identified the effect of the corrections on operator actions and provided verification that the corrections allowed the operator to perform the required tasks without the introduction of new task-related HEDs.

The walkthrough was used to verify that proposed corrections resolved HEDs and did not introduce additional HEDs by monitoring the performance of operator actions at the panel. The walkthrough was conducted by a DCRDR qualified Human Factors Specialist and Senior Reactor Operator to ensure that both operational and human factors perspectives were represented. The task sequence was derived from EOP and EOP-referenced OI steps performed at the panel. The walkthrough was performed by a Reactor Operator after a brief introduction to the mocked up corrections to the panel. The videotaped record of the walkthrough provided a basis for the verification of corrections at the Correction Meeting and serves as archival documentation of the verification of these corrections.

4.8.3 Verification Documentation

A Verification Report was completed for all HEDs. Mockups, modified panel drawings and sketches, and the videotaped walkthrough were retained to provide additional documentation for these methods of verification. Attendance lists with signatures of attendees at Correction - Verification meetings have been retained as part of DCRDR documentation to provide an accurate record of team members concurring on verification decisions.

All verification documentation other than mockups and videotapes have been kept attached to their HED package which consists of the HED form, supporting HED documentation, the Assessment and Correction Report, Assessment worksheet, the description of the proposed corrections, and their verifications.

4.9 MANAGEMENT REVIEW

4.9.1 Introduction

The recommended corrections were presented to two levels of management: the Corrections Review Committee (CRC) and the Management Review Team (MRT). Both levels of management received an overview of Human Factors principles, as well as orientation to the project, its data collection methods, resulting HEDs, and correction development methods. The management groups received training regarding their function within the DCRDR program and the associated procedure providing guidance for the conduct of their review. Both levels were given the prerogative of rejecting corrections on the basis of a cost-benefit determination using cost estimates developed by the Engineering Assessment Team (EAT).

The Corrections Review Committee consisted of senior Iowa Electric technical personnel ultimately responsible for the implementation of DCRDR corrections. The CRC conducted the reviews of the corrections in a meeting with the DCRDR Team Leader or Assistant Team Leader presenting the corrections to the committee. A member of the EAT was present to provide input regarding the implementation cost estimates. The CRC provided additional plant specific knowledge assuring feasibility of corrections with consideration of cost.

The Management Review Team consisted of senior Iowa Electric management personnel responsible for the safe operation of the DAEC. This management group reviewed all proposed HED corrections to assure that the results were consistent with company policies and philosophy regarding the safe operation of DAEC, the availability of qualified manpower resources, planned capital and operating budgets, and the DAEC Integrated Plan.

4.9.2 Management Review Methodology

4.9.2.1 CORRECTIONS REVIEW COMMITTEE

The corrections developed by the DCRDR Review Team were viable in the sense that they resolved or minimized the impact of HEDs and had been determined to be effective and "workable". The CRC reviewed these corrections and either approved the correction and forwarded it to the MRT or disapproved and returned the correction to the Review Team with suggested changes, alternate corrections, or a recommendation for no correction. All disapproved corrections were provided with an explanation of the disapproval. Management comments and suggestions were documented via the meeting minutes kept by the Engineering Assessment

Team. The CRC also provided the MRT with an implementation scope, schedule, and cost estimate for the approved corrections.

Corrections for significant HEDs (assessment priority 1 - 8) were evaluated to ensure compliance with the following criteria:

1. The recommended HED correction provided sufficient detail to bring the HED into agreement with accepted Human Factors Engineering (HFE) standards. All specifications, component features, etc. that are considered necessary to assure resolution or improvement of the HED are provided.

2. The recommended HED correction did not degrade the safety of the plant.

3. The recommended HED correction did not introduce a new HED to the Control Room.

4. The recommended HED correction minimized undesirable interactions with other recommended HED corrections.

The CRC reviewed the justification provided by the Review Team to support the decision not to correct significant HEDs and either approved the non-correction or returned the package to the Review Team for development of an appropriate correction. The CRC could also make recommendations to change the Assessment Priority of the HED. Recommendation were documented in the meeting minutes and returned to the Review team.

For insignificant HEDs (assessment priority 9), a recommendation of non-correction required the HED to comply with the following criteria:

1. The HED has been assessed for impact on plant safety and operator performance degradation including possible cumulative effects and has been determined to be insignificant with respect to these criteria.

2. The HED has been assigned to a "no further action" category.

The CRC received HEDs assessed as insignificant and not corrected for information only.

The CRC evaluated the corrections for compliance with the stated criteria and ensured that existing design conventions were not violated. These design conventions include electrical separation, redundancy, seismic considerations, and other design criteria which could not be considered in detail during correction development. If more than one recommended correction was provided for resolving a HED, it was the responsibility of the CRC to choose between them. The CRC reviewed the estimated cost of the correction and either approved the correction and forwarded it to MRT or disapproved it with suggested changes, alternate corrections, or recommendation for no correction documented in the meeting minutes. Corrections rejected for reason of costs were either redeveloped or accepted for non-correction by the Corrections Team.

If any of the proposed corrections were rejected by the CRC, they were returned to the Review Team. For non-panel specific HEDs, the proposed correction was returned to the Review Team with reason for rejection and recommendations for Review Team resolution. For panel specific HEDs, all related corrections for the panel were returned to the Review Team with reason for rejection and any recommendations for Review Team resolution. Continued grouping of related HEDs assured that undesirable interactions with other corrections were minimized. If only a portion of a recommended correction was recommended, the CRC provided written justification for their decision to partially correct the HED and returned the recommended correction to the Review Team.

Once a HED package was reviewed and approved by the CRC, it was forwarded to the Management Review Team along with a preliminary implementation schedule based on assessed priority and estimated cost.

4.9.2.2 MANAGEMENT REVIEW TEAM

Corrections proposed by the Review Team were submitted to the MRT after their approval by the Corrections Review Committee. These corrections included any revisions resulting from CRC comments and guidance. No correction was forwarded to the MRT until a consensus of both the Review Team and the CRC was obtained.

To minimize the meeting time for the MRT members, the MRT was provided with correction summaries between meetings for their individual review. These corrections were then presented to the MRT by the DCRDR Team leader, or his designee, for MRT approval. The DCRDR team member responsible for the development of the correction was made available to respond to MRT inquiries. Based on both the individual review and the correction presentation, the corrections were either approved for implementation or rejected. The MRT reaction to proposed corrections was documented in meeting minutes kept by a member of the Engineering Assessment Team. Approved corrections were filed for retention.

Those proposed corrections with which the MRT did not concur were returned to the Review Team for re-evaluation of and possible changes to the proposed corrections. The reason for the nonconcurrence and any recommendations for resolution was documented and returned with the rejected correction. Any rejected corrections were returned as an entire Assessment/Corrections package. The return of all related HEDs ensured that any panel interactions for a reworked correction were properly addressed.

The corrections cycle then started again with the development of new corrections considering management comments or the provision of additional justification for the original correction. The Review Team emphasized technical considerations when addressing management comments and recommendations and did not address the cost/benefit determination made by the management teams. Corrections rejected for reason of costs were either redeveloped or accepted for non-correction by the Review Team. Redeveloped corrections were recorded as revisions of the original corrections and documented on the Assessment/Correction and Verification forms. All revisions of a given correction were retained in the corrections package for historical reference.

Any changes to the proposed corrections required the approval of the CRC before being resubmitted to the MRT. New cost estimates were developed by the Engineering Assessment Team if necessary.

The management presentation, rejection and redevelopment of proposed corrections continued until a solution was reached which was acceptable to both management teams and the DCRDR Review Team.

Upon approval of a proposed HED correction, the MRT included the correction into the scope of the DCRDR implementation effort.

5.0 RESULTS OF THE HUMAN FACTORS REVIEW

5.1 INTRODUCTION

The human factors review of the Duane Arnold Energy Center resulted in the identification and assessment of the human engineering deficiencies associated with the control room and the remote shutdown panels. HEDs identified during the control room inventory and survey, operating history review, and function and task analysis were documented and assessed with respect to their impact on plant safety and operator performance.

5.2 CONTROL ROOM INVENTORY RESULTS

The Control Room Inventory (CRI) provided a data base of all components on panel faces in the DAEC control room and remote shutdown panels. This as-built data base allowed comprehensive comparison with standard human factors criteria.

All control room components were addressed during the CRI. The term 'component' did not refer strictly to indications and controls, but also covered nameplates, mimics, covers, and blank or spare panel patches. Thus, the number of 'components' inventoried, 5047, does not directly indicate the number of controls and indications in the control room.

Each component was assigned a unique identifier. Where possible the familiar Bechtel or General Electric identifier was used. Approximately 930 components did not have Bechtel or General Electric numbers assigned. These components were identified by a sequential number preceded by an "X". These components consist primarily of labels, mimic pieces, and indicating lights distinctly separate from other components.

More than 2500 instances of the use of dymo tape or handwritten information affecting 1965 components were inventoried.

The control room as-built configuration was compared to existing documentation and discrepancies noted and documented. The documentation reviewed included the panel physical layout drawings, panel engravings drawings, DAEC Instrument Index (M-400), Piping and Instrumentation Diagrams, and DAEC and General Electric electrical schematics. The discrepancies noted included differences in range, device type, indicating light color, component locations, and label engravings. The noted discrepancies affected 561 components. The majority of these documentation discrepancies were with the DAEC Instrument Index and the panel layout drawings.

The discrepancies noted between Phase I (document) data and Phase II (as-built) data resulted in 74 HEDs being written.

5.3 CONTROL ROOM SURVEY RESULTS

The Control Room Survey compared the design of panel components in the control room and the alternate shutdown panels with human factors criteria developed by the Boiling Water Reactor Owner's Group (see Appendix A). The work environment, specific operator tools, and other aspects of the integrated tasks of operating a nuclear power plant were also addressed by this criteria. Generic checklists published in the BWROG Control Room Survey Workshop and the Survey Program Supplement were used for data collection and evaluation. An independent, unstructured review of the control room was conducted by the Human Factors Specialist to ensure that HEDs not covered by BWROG criteria were not ignored.

During the Survey portion of the DCRDR, 2092 HEDs were generated. Many of these HEDs included observations on groups of components rather than on single components (i.e. all hand switches, all labels). The independent survey resulted in an additional 600 HEDs. Many of these additional HEDs were generic and did not list individual discrepancies. For example, labels in the control room were checked for inconsistent use of accepted acronyms, abbreviation and nomenclature, but individual discrepancies were not recorded.

The survey was used to identify design conventions which were used in the control room and for developing consistent DCRDR modifications. The survey also resulted in DCRDR recommendations for generic problems with specific plant instrumentation (i.e., multipoint recorders, GMAC controllers, annunciators).

The survey was the primary source of data for evaluating:

* Anthropometric placements
* Adequacy of lights
* Adequacy of noise control

The survey also served to document as-built standards for:

* Terminology convention for labels and annunciators
* Mimic symbology
* Color coding
* Handswitch coding

5.4 OPERATING EXPERIENCE REVIEW RESULTS

The Operating Experience Review consisted of: 1) Operating History Review and 2) Operating Personnel Questionnaires and Interviews.

5.4.1 Operating History Review

The Operating History Review reviewed the DAEC Licensee Event Reports (LERs) and Deviation Reports (DRs) for the years 1974-1985 in order to identify design deficiencies, procedural deficiencies, or plant technical or administrative operating conduct which had been a contributing factor to "Operator Error".

The Operator Questionnaires and Interviews solicited operator comments and opinions to identify deficiencies in the control room layout, system or component design or operation, or deficiencies in operating procedures or operating conduct.

The Operating History Review found 128 documented errors associated with control room activities with human factors implications. For the years 1974-1985, 88 out of 725 LERs, or 12% of the LERs, were considered documented errors associated with control room activities. For the years 1975-1985, 40 out of 3853 DRs, or 1% of the DRs, were considered documented errors associated with control room activities. It should be noted that the reporting requirements for LERs were revised in 1983 and statistical comparisons cannot be performed for some periods.

All documented errors associated with activities in the control room were used as input for generating HEDs. LERs and DRs were grouped as appropriate for HED identification and human engineering deficiencies were documented on HED forms. Seventy-four HEDs were produced from the Operating History Review.

All HEDs were analyzed to determine if the corrective action described on the Operating Experience Review Report eliminated the HED contributing to the error. Those HEDs for which the corrective action eliminated the deficiency or for which the HED was no longer applicable, were not assessed. A written justification was attached to these HEDs indicating the nature of the corrective action and any additional information clarifying the error. Nineteen of the 74 HEDs were found to have corrective actions which eliminated the HED contributing to the error. These 19 HEDs were also reviewed by the SRO and Human Factors Specialist to ensure that the corrective actions were sufficient and that no further action was warranted.

There were 21 instances in which a surveillance test procedure (STP) was not performed as required. Each of these instances resulted in a documented error even though the STPs were not always associated with a control room action. A tracking system for STPs was implemented in January 1985 in an effort to resolve this problem. Subsequent to the implementation of this tracking system, only one documented error has occurred.

5.4.2 Operating Personnel Questionnaires and Interviews

The operating personnel questionnaires were completed by 80% of the licensed operators and interviews were conducted with 50% of the licensed operators. The questionnaires obtained from personnel not interviewed were screened in order to identify any comments or concerns not stated by those persons interviewed. A summarization of all the operators comments for each specific question was performed and HEDs were generated using this summarization. All operator comments were documented as HEDs.

A total of 477 HEDs were generated from the operator interviews. The screening of the questionnaires that were obtained from personnel not interviewed resulted in an additional 55 HEDs, resulting in a total of 532 HEDs generated from the Operating Personnel Questionnaires and Interviews.

5.5 FUNCTION & TASK ANALYSIS RESULTS

Function and Task Analysis (FTA) was used to identify instrumentation and controls (I&C) necessary to complete the steps of the EOPs and referenced OIs and IPOIs independent of existing instrumentation and controls. FTA prescribed I&C components and existing components were compared to identify HEDs.

HEDs were generated using the following criteria:

1. I&C not located in recommended location;

2. Existing I&C not of the optimal type to satisfy the summarized I&C requirements;

3. Existing I&C not adequate to satisfy the summarized I&C requirements;

4. Existing I&C range, units, accuracy, resolution, etc. do not adequately satisfy the summarized requirements; and

5. The summarized I&C requirements indicate the need for two components due to conflicting requirements.

The DCRDR function & task analysis resulted in the generation of 343 HEDs. Some of the most significant HEDs generated in the project are in this category because FTA HEDs were derived directly from EOP task sequences.

Comparison of the summarized I&C requirements to the Reg. Guide 1.97 design requirements was not emphasized due to the Reg. Guide's more restrictive requirements. Thus, most HEDs generated for these components involved location deficiencies. The DCRDR did, however, provide input to the "Engineering Specification For Reactor Water Level Instrumentation" which defines the design requirements at DAEC to address Reg. Guide 1.97.

The FTA HEDs resulted in corrections which would place new indicators adjacent to HPCI, LPCI (RHR), Core Spray,and RCIC system control panels. These indicators were required for action decisions and important feedback parameters during Primary Containment Control (EOP-2) task sequences. Other new instruments recommended were:

* Torus Pressure indication located adjacent to Drywell Pressure indication to provide direct feedback of Containment Spray operation results

* Averaged indications of the parameters: Torus Water Temperature, Torus Air Temperature, and Drywell Air Temperature to eliminate the operator's requirement to calculate these from separate indications existing on backpanels during critical task sequences

Numerous FTA HEDs prompted a correction which would provide a Primary Containment Isolation System (PCIS) Status Board on 1C04 initiated by the appropriate PCIS relays. Details of this comprehensive correction were reviewed by the DCRDR team, the CRC, and the MRT and determined to resolve all identified HEDs involving display of PCIS status.

Color banding techniques such as "red-lining" and "green-banding" were recommended extensively for indicators and recorders to provide immediate setpoint and range information for the operator.

FTA HEDs prompted corrections which would install "bypass" switches and/or "test" switches when specific task sequences required jumpers and/or lifted leads.

5.6 HUMAN ENGINEERING DEFICIENCY ASSESSMENT RESULTS

The objective of the assessment phase was to systematically prioritize all Human Engineering Discrepancies (HEDs) to reflect the degree to which operator performance or plant safety may be degraded. The methodology used to evaluate the HED and determine the significance of the HED was derived from recommendations provided in NUREG-0801, EVALUATION

CRITERIA FOR DETAILED CONTROL ROOM DESIGN REVIEWS. The assessment provided a relative significance and correction priority for each HED by subjecting the HED to a series of questions resulting in a 9-point rating scale. The assigned number represents the level of significance of the HED on plant safety or operator performance with 1 being the most significant and 9 the least significant.

The 3115 HEDS were segregated into a total of 830 groups. Each group was assigned an assessment priority by the Review Team as described above. Assessment and Correction Reports and Assessment Worksheets were produced during assessment for each HED group.

6.0 CORRECTIONS RESULTS

6.1 INTRODUCTION

The primary objective of the DCRDR effort was to identify HEDs in the control room and recommend corrections which would enhance the safe operation of the plant. These corrections, when implemented, will improve the operations staff's capabilities to expeditiously respond to transients and other abnormal operational conditions, as well as generally improve the man-machine interface within the control room.

A wide range of human engineering deficiencies have been identified as a result of the DCRDR review. The successful resolution of these deficiencies requires a careful evaluation process involving human factors, operations, and engineering personnel. IELP is instituting a plan of resolving some deficiencies immediately through short-term enhancements, while continuing to develop design modifications for long-term enhancements. All enhancements were reviewed for feasibility and acceptability before being included as recommended corrections for implementation.

6.2 HUMAN FACTORS CRITERIA

As a result of the DCRDR effort, acceptable design conventions associated with human factors criteria were developed. These human factors criteria were formulated into a Human Factors Design Guide for the DAEC. This design guide has been procedurally incorporated into design activities at the DAEC.

This design guide is applicable to all modifications which have the potential to impact the man-machine interface of the DAEC with specific emphasis on the DAEC Control Room. It provides the terminology and design criteria specific to DAEC for meeting the intent of established regulatory requirements and IELP commitments associated with human factors considerations at the DAEC. The procedurally required use of, and adherence to the human factors criteria set forth in the design guide satisfies the regulatory guidance in Appendix A to NUREG 0800 for the development of an ongoing human factors engineering program to examine ongoing and future modifications to the DAEC Control Room.

The design guide provides acceptable human factors criteria in the following areas:

1. Anthropometrics;

2. Labeling;

3. Panel demarcation;

4. Panel mimics;

5. Color coding;

6. Lighting;

7. Noise;

8. Communication;

9. Annunciators;

10. Computer systems and displays;

11. Control conventions; and

12. Display conventions.

Although these human factors criteria were developed during the DCRDR effort, the criteria were also used as the guideline evaluating and providing corrections for identified human engineering deficiencies. In addition to the design guide, human factors criteria as presented in Section 4.0 of this report, "Methodologies", were used for evaluating and correcting the identified human engineering deficiencies.

6.3 RESOLUTIONS OF DEFICIENCIES

Corrections for resolving human engineering deficiencies were prepared by the DCRDR Review team and concurred with by various levels of IELP management, as discussed in Section 4.0 of the report. In some cases, more than one correction was presented to management for consideration. In these cases, management selected the most viable correction based on whether the correction resolved the deficiency, the correction was technically feasible, and the correction was cost-effective. These corrections will be accomplished as either short-term enhancements or long-term enhancements.

Although all HEDs were considered for correction, HEDs with an Assessment priority of 7, 8, or 9 were not provided with justification within this report if it was determined that non-correction or partial correction was warrented. These HEDs were provided justification within the Correction Verification documentation for a decision of non-correction or partial correction. Bases and justification for HEDs with Assessment priorities between 1 and 6 which were not corrected or partially corrected are provided in Appendix D.

6.3.1 Short-Term Enhancements

Short-term enhancements will consist of surface enhancements, or enhancements which can be performed without affecting component or system operability, and non-physical operational changes. Surface enhancement techniques include the following:

1. Replacing control or display labels;
2. Replacing annunciator windows;
3. Adding panel demarcation or color patching;
4. Replacing or revising panel mimics;
5. Color coding or replacing scales on meters; and
6. Painting or cleaning panels.

Non-physical operational changes include modifications in training activities, in conduct of operations, and in operations procedures. Examples of non-physical operational changes include:

1. Increasing operator training in the area of print reading;
2. Increasing operator awareness of component placement which was not feasible to rearrange;
3. Improving available operator workspace;
4. Providing more explicit instructions for procedures; and
5. Providing improvements to the procedures Writer's Guide.

Many of the short-term enhancements will provide interim solutions for resolving deficiencies. Corrections involving design modifications require more time to perform and are more costly. In addition, the DAEC is an operational plant; therefore, all the corrections should not be accomplished simultaneously to avoid potential negative training impact on the operators. Interim solutions will be provided which will complement the long-term enhancement. As an example, annunciator windows will be reworded and replaced as a short-term enhancement, but the annunciator system will be rearranged as a long-term enhancement.

Short-term enhancements will be provided in accordance with the human factors criteria associated with the design guide discussed above. The detailed scope of the short-term enhancements is provided in Appendix C of this report.

6.3.2 Long-Term Enhancements

Long-term enhancements will consist of design modifications or engineering studies which could result in design modifications to the DAEC. These design modifications will consist of the addition, deletion, modification or rearrangement of controls or instrumentation at the DAEC.

The design modifications vary in magnitude from the removal of a disconnected component which is no longer in service to the rearrangement of the annunciator system. The following examples of long-term enhancements are representative of the results of the phases of the DCRDR effort:

1. <u>Operating Experience Review</u>

    a. An engineering study will be performed to investigate the requirements and use of the RHR Service Water controllers DPIC-1947 and DPIC-2046located on panel 1C03. The use of the existing controllers in 'auto' do not provide positive RHRSW to RHR differential pressure while maintaining necessary flow rates. The controllers will be replaced or modified based on the results of the study.

    b. The "A" Scram pushbutton is located adjacent to the Reactor Mode Switch (1C05) and has the potential of being inadvertently actuated. The scram pushbutton will be relocated to minimize the potential of inadvertent actuation.

    c. The handswitch for condensate demineralizer bypass valve MO-1708 is located adjacent to and is simjliar in appearance to the Condensate Pump start switches on 1C06. This has resulted in inadvertent pump stop during an attempted valve closure. The valve handswitch will be relocated so that it is physically separated from the condensate pump handswitches and will be tactilly coded for further switch differentiation.

2. <u>Control Room Survey</u>

    a. Conductivity recorder CR-1514 will be replaced to improve the readability of the data it displays.

    b. All controllers with integral valve position indication will be modified as appropriate to indicate 0 (closed) - 100% (open) from the left to right.

c. The annunciator system will be modified so that no annunciator windows are inappropriately illuminated during normal operation unless an alarm condition exists.

3. Function and Task Analysis

a. A digital indication of "time to ADS initiation" will be installed on 1C03 above the ADS RESET pushbuttons to provide direct indication of the time remaining until ADS initiates. This is not currently indicated.

b. A Primary Containment Isolation System status board will be provided on 1C04. This status board will include indications of group isolation initiation and group isolation accomplishment. This indication is not currently provided in the control room.

c. A wide-range Torus Pressure indicator for each electrical division will be added to 1C03. A wide-range Drywell Pressure indicator for each electrical devision will be added to 1C03. The Drywell and Torus indicators for the same division will be grouped together.

The above examples are typical of the type of corrections which have resulted from the phases of the DCRDR effort. The detailed scope of the long-term enhancements is provided in Appendix C of this report.

Most of the long-term enhancements will require significant engineering and documentation. Adequate time must be allowed for these enhancements. System operability requirements preclude implementation of many of the long-term enhancements during plant operation. These enhancements must be installed during a planned plant outage. Controlling the work performed in the control room limits the size and scope of the projects as well. It must also be considered that a large number of changes performed concurrently affect operator performance by negative transfer of training and confusion. Given that most changes can only be performed during outages, that the amount of concurrent work must be controllable, and that operators must be adequately trained on any changes, these long-term enhancements must be performed over several refuelling outages. Such a schedule relies on the prioritization of work. The long-term enhancements for DAEC will be prioritized by safety significance.

6.3.3 Deficiencies With No Correction

Certain human engineering deficiencies will not be corrected. These deficiencies were either assessed as insignificant or correcting the deficiencies was not considered to be warrented with respect to cost versus benefit. A justification for not correcting the deficiency was developed for each deficiency which will not be corrected. The justifications for not correcting deficiencies with Assessment priorities of 1 to 6 are provided in Appendix D of this report. The justification for not correcting deficiencies with Assessment priorities 7 and 8 are maintained in the Correction Verification documentation in the DCRDR files. The following are general instances where deficiencies were not corrected:

1. Some deficiencies were the result of operator interviews associated with the Operating Experience Review phase of the DCRDR effort. If an operator identified a deficiency with plant controls and instrumentation or conduct of operations, the deficiency was investigated by the DCRDR effort. Based on the results of this investigation, many of these deficiencies were considered merely expressions if opinion and, therefore, no correction was recommended.

2. Some deficiencies were the result of prescribed instrumentation associated with the Function and Task Analysis phase of the DCRDR effort. Given that the analysis performed was procedurally based, and that procedural steps required the operator to determine the operability of a system, deficiencies were identified which related to the lack of a single indication of a system's operability. Upon evaluation of the deficiency, it was determined that sufficient instrumentation was available for the determination of system operability. No single indicator of system operability was warranted and, therefore, no correction was recommended.

6.4 COORDINATION OF CORRECTIONS WITH ONGOING WORK

Through continual monitoring of ongoing design modifications at the DAEC, many DCRDR recommended corrections have been incorporated into existing design change packages (DCPs) for implementation. The following are examples of this coordination effort:

1. Rearranging the radiation recorders on 1C02 has been incorporated into DCP 1293 and DCP 1363 which is providing new radiation recorders;

2. Relocating the "A" Scram pushbutton on 1C05, adding a Standby Liquid Control flow indication to 1C05, and modifying the Standby Liquid Control pump control switch on 1C05 have been incorporated into DCP 1353 which modifies the SBLC pump control;

3. Replacing or modifying the main steam pressure indicators on 1C07 has been incorporated into DCP 1367 which modifies the indicators;

4. Rearranging the components on 1C25 has been incorporated into DCP 1341 which installs additional drywell cooling controls; and

5. Removing switches on 1C43 and 1C44 which are no longer in use has been incorporated into DCP 1343 which modifies these panels.

In addition, DCRDR recommendations have been incorporated into the SPDS enhancement program, the plant process computer upgrade program, and the Hydrogen-Water Chemistry program at the DAEC. These recommendations include incorporating the SPDS function into the plant process computer system, providing new operator work stations in the DAEC control room, and redesigning control panel 1C22 for the Hydrogen-Water Chemistry effort.

7.0 IMPLEMENTATION OF CORRECTIONS

7.1 INTRODUCTION

The DCRDR Implementation effort will incorporate short-term and long-term enhancements to resolve human engineering deficiencies associated with the control room and alternate shutdown panels. This implementation will require extensive work within the DAEC Control Room. The effort has been divided into four phases to minimize the impact on safe operation of the plant. The four phases are:

1. Short-Term Enhancements;
2. Long-Term Enhancements Prior to Cycle 10 Startup;
3. Long-Term Enhancements Prior to Cycle 11 Startup; and
4. Long-Term Enhancements Prior to Cycle 12 Startup.

Because DAEC is an operating plant, the primary emphasis will be control of work to be performed in the control room and the associated changes necessary to fully implement an enhancement. Implementation is scheduled so as to allow time for design change development, training, procedural changes, and associated activities which must precede the actual implementation to assure safe transition during and following implementation. Performing the DCRDR Implementation over four phases also enables IELP to plan the resource needs consistent with the Integrated Plan for DAEC.

7.2 SHORT-TERM ENHANCEMENTS

Phase 1 will relabel, re-mimick, and demarcate the control panels. General control room panel cleanup activities and painting will also be performed. These enhancements will be performed by a DCRDR Implementation staff trained in human factors principles. Work packages will be prepared for each panel which will encompass all activities associated with that panel.

The work packages will include as a minimum:

1. Marked-up panel drawings which reflect the as-built panel after correction;
2. New wording for each label on the panel with letter and label size and characteristics specified;
3. New mimic or demarcation layouts, as applicable, with size and color specification for the panel;

4. New meter, indicator, and recorder scales with colorbanding, as appropriate;

5. New switch escutcheons and bezels;

6. Special instructions for panel cleanup and painting;

7. Recommended maintenance activities associated with the panel components; and

8. Rewording of annunciator windows.

It should be noted that some activities associated with Phase 1 will be provided as interim corrections. Full implementation of the interim DCRDR enhancements will be provided with the long-term corrections, as appropriate. The details of the work packages will be consistent with the human factors criteria and corrections provided as a result of the DCRDR effort. All wording changes associated with labels, annunciators, and procedures, as applicable, will be provided in accordance with the approved abbreviation and acronym lists for the DAEC. Phase 1 of the DCRDR Implementation effort is scheduled to start in mid-October 1986 and to be complete by the end of December 1987.

7.3 PHASE 2 - LONG-TERM ENHANCEMENTS PRIOR TO CYCLE 10 STARTUP

Phase 2 will consist of design modifications for correcting human engineering deficiencies which would contribute to a significant reduction in operational risk as well as enhance the safe operation of the DAEC. The corrections will be performed in accordance with existing Iowa Electric procedures for design modifications for the DAEC.

Review of the DCRDR corrections indicates that the following panels should be corrected during Phase 2 of the DCRDR Implementation effort:

1C03 - Emergency systems panel;

1C09 - Containment recorder and analyzer panel;

1C05 - Reactor control panel;

1C08 - Generator and Auxiliary panel; and

1C388 - Alternate Shutdown panels.

The enhancements associated with the above are a significant effort; therefore, some Phase 2 activities will be performed concurrent with Phase 1. It is planned that engineering evaluations and design requirements will be specified prior to the completion of Phase 1. Phase 2 of the effort is scheduled to start in early 1987 and to be complete by Cycle 10 startup (tentatively October 1988).

7.4 PHASE 3 - LONG-TERM ENHANCEMENTS PRIOR TO CYCLE 11 STARTUP

Phase 3 will consist of design modifications for correcting human engineering deficiencies which would contribute to a significant reduction in operational risk as well as enhance the safe operation of the DAEC, but not corrected in Phase 2. The corrections will be performed in accordance with existing Iowa Electric procedures for design modifications for the DAEC. Review of the DCRDR corrections indicates that the following panels should be corrected during Phase 3 of the DCRDR Implementation effort:

1C04 - Reactor support systems panel;

1C06 - Condensate and Feedwater panel;

1C407 - Safety Parameter Display System console; and

Control Room Annunciator modifications.

The modifications associated with the annunciators are a comprehensive effort; therefore, some Phase 3 activities should be performed concurrent with Phase 2. As a minimum, it is planned that engineering evaluations and design requirements will be specified prior to the completion of Phase 2. Phase 3 of the effort is scheduled to start in early 1988 and to be complete by Cycle 11 startup (tentatively May 1990).

7.5 PHASE 4 - LONG-TERM ENHANCEMENTS PRIOR TO CYCLE 12 STARTUP

Phase 4 will consist of design modifications for correcting human engineering deficiencies which are considered to provide significant improvement of operator performance at the DAEC. The enhancements will be performed in accordance with existing Iowa Electric procedures for design modifications for the DAEC. These remaining DCRDR corrections will be implemented during Phase 4 of the DCRDR Implementation. Phase 4 of the effort is scheduled to start in early 1990 and to be complete by Cycle 12 startup (tentatively October 1992).

8.0 REFERENCES

The following documents were used as references for this Design Guide.

8.1 REGULATORY DOCUMENTS

1. NUREG-0700, *Guidelines for Control Room Design Reviews*, dated September 1981.

2. NUREG-0737, *Clarification of TMI Action Plan Requirements*, dated November 1980.

3. NUREG-0800, *Standard Review Plan (SRP), Section 18.0, Human Factors Engineering*, dated September 1984.

4. NUREG-0801, *Evaluation Criteria for Detailed Control Room Design Review*, dated October 1981.

5. Generic Letter 82-33, Supplement 1 to NUREG-0737, *Requirements for Emergency Response Capability*, dated December 1982.

6. Generic Letter 83-18, *NRC Staff Review of the BWR Owner's Group (BWROG) Control Room Survey Program*, dated April 1983.

7. NUREG/CR-2496, *Human Engineering Design Considerations for Cathode Ray Tube-Generated Displays*, dated April 1982.

8. NUREG/CR-3217, *Near-Term Improvements for Nuclear Power Plant Control Room Annunciator Systems*, dated April 1983.

8.2 ELECTRIC POWER RESEARCH INSTITUTE (EPRI)

1. EPRI NP-309, *Human Factors Review of Nuclear Power Plant Control Room Design*, dated March 1977.

2. EPRI NP-1118, *Human Factors Methods for Nuclear Control Room Design*, dated November 1979.

3. EPRI NP-2411, *Human Engineering Guide for Enhancing Nuclear Control Rooms*, dated May 1982.

4. EPRI NP-3701, *Computer-Generated Display System Guidelines*, dated September 1984.

8.3 BWR OWNERS GROUP (BWROG)

1. *BWROG Control Room Survey Program.*

2. *BWROG Control Room Survey Supplement.*

8.4 OTHER DOCUMENTS

1. INPO 83-026, Nuclear Utility Task Action Committee (NUTAC), *Control Room Design Review Implementation Guideline*, dated July 1983.

2. INPO 83-036, NUTAC, *Human Engineering Principles for Control Room Design Review*, dated September 1983.

3. TM 84942, National Aeronautics and Space Administration (NASA), *Human Factors Aspects of Control Room Design: Guidelines and Annotated Bibliography*, dated December 1982.

4. ERDA-76-45-2, Energy Research and Development Administration *Human Factors in Design*, dated February 1976.

5. MIL-STD-1472C, *Human Engineering Design Criteria for Military Systems, Equipment and Facilities*, dated May 1981.

6. *Human Engineering Guide to Equipment Design*, Library of Congress Catalog Card Number 72-600054, dated 1972.

7. *Noise and Man*, by William Burns, dated 1973.

8. MTR-9420/ESD-TR-84-190, The Mitre Corporation,*Design Guidelines for User-System Interface Software*, dated September 1984.

9. *Duane Arnold Energy Center - Emergency Operating Procedures Development Program*, 1983 - 1986.

Appendix A. BWROG Checklists and Supplements

BWR OWNERS' GROUP

CONTROL ROOM IMPROVEMENTS COMMITTEE

HUMAN FACTORS ENGINEERING

CONTROL ROOM SURVEY

Prepared by: D. R. Pankratz — 1/12/81
D. R. Pankratz
General Electric Company
Date

K. C. Ross — 1/12/81
K. C. Ross
General Electric Company
Date

Reviewed by: G. R. Mullee — 1/12/81
G. R. Mullee
Control Room Survey Project Mgr.
General Electric Company
Date

Approved by: W. J. Armstrong — 1/13/81
W. J. Armstrong
Chairman, Control Room Improvements Committee
BWR Owners' Group
Date

BWR OWNERS GROUP

CONTROL ROOM SURVEY

PLANT/UNIT: ______________________________

DATE PERFORMED: PHASE I ________________ II ________________

III ________________ IV ________________

SURVEY TEAM MEMBERS: ______________________ Team Leader

OTHER PARTICIPANTS (HFE CONSULTANT, GE A-E, etc.):

NOTE: CHECKLIST ITEMS FOR WHICH ADVANCE RESEARCH IS NECESSARY HAVE BEEN IDENTIFIED WITH AN ASTERISK IN FRONT OF THE ITEM NUMBER.

CONTROL ROOM SURVEY

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

I OPERATOR INTERVIEW

DISCUSSION

The purpose of the Operator Interview is to obtain direct operator input to aid in identifying potential or actual deficiencies in the control room layout or design or in operating procedures that result in confusion (mental activities), difficulty (manual activities) or distraction (the environment).

Using the attached questionaire, operators are asked to respond in writing based on their operational experience and knowledge of control rooms. Copies of the written responses will be sent to the survey team for a preliminary review prior to team arrival at the site. Interviewees will retain their copies and review them with a survey team member during a later oral interview. If additional space is needed, the attached Comment Form is to be used.

For the interview a representative group of one-third or more of the operators is selected covering a range of experience, education, ability and physical size. If available, at least two should have a current SRO license and two a current RO license.

The interviews should be conducted by utility personnel and survey team members with background or experience in operations and engineering or design with a position conducive to a free flow of information. It is expected that the oral interview will take one to two hours for each operator with the entire interview taking about one day.

Following the interviews, the survey team will consolidate the information obtained and analyze it to help identify specific areas of concern for detailed analysis during the control room review.

I OPERATOR INTERVIEW

INTRODUCTION TO QUESTIONAIRE

Job Position ____________________

Years Experience ____________ Commercial Nuclear ____________ Fossil

____________ Navy Nuclear

Date of first License ____________ RO ____________ SRO

Education/Degrees ____________________

Age ________ Sex ________ Height ________ Weight ________

In response to a post-TMI NRC requirement, your utility, along with other BWR owners, is conducting a control room review to identify and correct design deficiencies in the operator-control room interface to minimize the potential for human error. This review is performed by a survey team composed of representatives of several utilities using checklists prepared by the Control Room Improvements Subgroup of the BWR Owners Group.

You are asked to complete the attached questionaire basing your responses on your operational experience and knowledge of your control room and interfacing systems. You may complete this questionaire in the control room if you desire but please do so without discussing your detailed responses with other operators completing this survey. If additional space is needed, the attached Comment Form is to be used.

Following completion, a survey team representative will review your responses with you. Upon completion of all interviews, the survey team will consolidate the information obtained and apply it in their evaluation of your control room for compliance with human factor engineering principles.

The biographical information requested above will be used in compiling statistics on operating personnel physical characteristics. Current recommendations for panel design are based largely on data obtained from measurements of military personnel; there are few statistics presently available on, for example, the average height and weight of operators.

This survey provides you with a valuable opportunity for applying your knowledge and experience toward improving operating conditions in both your control room and future control room designs. Your honest and forthright opinions are not only welcomed, but needed.

I OPERATOR INTERVIEW

QUESTIONAIRE

A Would you recommend any changes in the following areas:

A1 shift coverage

A2 shift turnover

A3 training

A4 color coding

A5 control room access

A6 control panel layout or access

A7 communication systems

A8 heating or ventilation

I OPERATOR INTERVIEW

QUESTIONAIRE

A9 lighting or noise levels

A10 special test equipment

A11 maintenance or surveillance testing

A12 data recording and log entries

A13 information flow

A14 furniture, equipment or workspace

A15 computers

A16 other?

I OPERATOR INTERVIEW

QUESTIONAIRE

B Are any controls difficult to operate?

C Are any controls designed, positioned or labeled in a manner that causes risk of inadvertent operation?

D Are any recorders or indicators difficult or confusing to read?

E Are any important indicators located such that they are difficult to see during normal or emergency operation?

F Do you feel any control room displays are unnecessary, provide unimportant information or needlessly clutter the control panels?

G Based on your operational experience, does your control room lack any controls or displays needed in your response to normai or emergency situations?

I OPERATOR INTERVIEW

QUESTIONAIRE

H Do you consider the annunciator system to be effective in conveying important information to you?

I Do you have any problems locating or using procedures or operational instructions?

J Are individual responsibilities and chain-of-command clearly understood during all operating conditions?

K Is there an adequate number of operators available in the control room (or immediately available) to effectively operate the plant during all conditions?

L Are you required to perform any duties that you consider unreasonable or distracting in your responsibility as an SRO or RO?

M Based on your operational experience, have any errors or incidents occured which could have been averted through improved control room design?

I OPERATOR INTERVIEW

QUESTIONAIRE

N Have you experienced any problems using or understanding your procedures?

P Is there a particular panel which you consider more difficult or confusing to operate than the others?

Q General Comments:

I OPERATOR INTERVIEW

COMMENT FORM

This form is for use by the operator or interviewer for expanded responses to the Operator Interview questions. When used, each response will be identified by item number on this form and also so noted in the space following the applicable question to assure proper cross-referencing.

Item	Response
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I OPERATOR INTERVIEW

SUMMARY FORM

This form is used by the Interviewer to summarize the information obtained during the Operator Interview. Each entry is to be cross-referenced to the specific checklist item for further evaluation during the Control Room Review.

Item or Area of Concern	Checklist Item(s)

II LICENSEE EVENT REPORT ANALYSIS

DISCUSSION

The purpose of the Licensee Event Report (LER) Analysis is to identify plant specific design deficiencies known to have previously contributed to operator errors and to document the need for further evaluation during the Control Room Review.

Prior to the arrival of the survey team, the host utility will review their plant LERs and scram reports from the past two years. Any occurence for which operator error was identified as a contributing factor will be listed on the attached LER form indicating the LER number and a description of the operator error.

The survey team will then analyze each event to identify possible deficiencies in the human engineering design of the control room by cross referencing the corresponding criteria from the Control Room Review checklists. These items will be included in the detailed evaluation during the Control Room Review.

II LICENSEE EVENT REPORT ANALYSIS

LICENSEE EVENT REPORTS (LERs)

*LER NUMBER	*OPERATOR ERROR	CHECKLIST ITEM

III CONTROL ROOM REVIEW

DISCUSSION

The purpose of the Control Room Review is to review and assess the adequacy of the arrangement and identification of important controls and displays, the usefullness of audio and visual alarm systems, plant status information provided, procedures and training with respect to limitations of existing instrumentation, information recording and recall capability, the control room layout and environment, and other areas of human factor engineering that potentially impact operator effectiveness. The ultimate objective is to identify potential modifications of the operator-control room interface which will reduce the potential for human error.

Each Control Room Review is conducted by the survey team using the attached checklists which are titled, in order, (A) Panel Layout and Design, (B) Instrumentation and Hardware, (C) Annunciators, (D) Computers, (E) Procedures, (F) Control Room Environment, (G) Maintenance and Surveillance, and (H) Training and Manning. Checklist (A), (B), and (C) will be completed for each panel in the control room, including back panels, auxiliary panels and peripheral equipment that contain controls and displays normally operated by the control room operator. The remaining checklists will be completed only once for each control room since they are applicable to the entire control room.

In completing the checklists, particular attention must be given to items identified as a potential problem area in the Operator Interview or the LER Analysis to ensure complete coverage. These items will have been cross-referenced to the checklist items where applicable.

Supplemental information is provided in the workshop to give additional guidance in completing the checklists.

It is anticipated that performance of the Control Room Review will take approximately one week. Due to the functional approach of the survey, in many cases input from on-shift operations personnel will be necessary in evaluation compliance for a given checklist item. In other cases, additional technical information will be required. Checklist items for which advance research is necessary have been identified with an asterisk in front of the item number. It is expected the host utility will compile this information prior to the arrival of the survey team and also provide operations personnel support.

Each checklist item is presented in the form of a question for consideration by a survey team member. Following that question is a series of numbers in which the specific item being reviewed is evaluated. The first set of numbers (4 3 2 1 0) indicates the degree of compliance wherein 4 indications no compliance, 3 indicates somewhat compliance, 2 indicates mostly compliance, 1 indicates full compliance and 0 indicates the specific question being considered is not applicable or cannot be considered at this time since the plant being evaluated is not operational. As each specific question is evaluated, the team member(s) actually doing the evaluation of that question indicates the relative degree of compliance by circling the applicable number.

DISCUSSION (Continued)

Following the number indicating the degree of compliance for each item being evaluated is a predetermined number ranging from one to three which indicates the relative importance of that item with respect to the potential for causing or contributing to operator error. A 3 indicates high potential for operator error, 2 indicates moderate potential and 1 indicates low potential. In the final evaluation of each item considered, it is the product of the degree of compliance times the potential for operator error that determines if the consideration of corrective action is justified. Since some items will not be applicable for consideration in all control rooms, it should be noted that a general comparison of several control rooms by comparison of "scores" is not valid.

Following each checklist item is space for the person performing the evaluation to enter comments. For each specific checklist item, these comments will identify items or components of non-compliance, the scope of review, or any qualifying statement judged to be appropriate to the evaluation. If, for example, a large number of components are reviewed and only a few are in non-compliance, these would be specifically noted in the comment space and the general rating would be "mostly compliance". To provide additional documentation, still photographs will be taken of major items or components of non-compliance such as mimic layouts, control/display groupings, labeling systems or equipment locations. These photographs are cross referenced to the specific checklist item by a notation in the comment space. Due to the importance of comments in the evaluation, additional Comment Forms will be attached for more detail when necessary.

As an example, a review item would possibly be as follows:

		No	Somewhat	Mostly	Full	Not Applicable		Potential for error		Product
		Compliance								
E1	Does the control room operator have available:	4	3	(2)	1	0	x	3	=	6
	E1.1 a full set of up-to-date plant procedures	Surveillance procedures are incomplete and not all are latest revision; others are OK								

Since all procedures except surveillance procedures are available to the control room operator and are up-to-date, 2 is circled indicating "mostly" compliance and multiplying that by 3, the potential for error, gives a product of 6.

III CONTROL ROOM REVIEW

COMMENT FORM

This form is to be used during the performance of the Control Room Review to identify, for each specific checklist item as necessary, the scope of review, items or components of non-compliance, or any qualifying statements appropriate to the evaluation of that checklist item. When this form is used, the checklist item number is to be entered here, and a note is to be made in the space following the checklist item to identify the use of this comment form, assuring proper cross-referencing. This form is to be placed in the survey package directly following the page on which the checklist item appears.

Item	Comment
____	________________________________
____	________________________________
____	________________________________
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III CONTROL ROOM REVIEW

Panel ________

A PANEL LAYOUT and DESIGN

A1 For control panels:

A1.1	does the design generally meet measurement standards per the attached anthropometric diagrams (complete and attach)	4 3 2 1 0	x 2	= ____
A1.2	are they of the same layout and design on multi-unit plants (not mirror image)	4 3 2 1 0	x 2	= ____
A1.3	when panel components are permanently removed, are spaces covered to prevent debris or dust from entering panel internals and repainted to avoid visual distinctiveness	4 3 2 1 0	x 2	= ____
A1.4	have sharp corners and edges been eliminated?	4 3 2 1 0	x 1	= ____

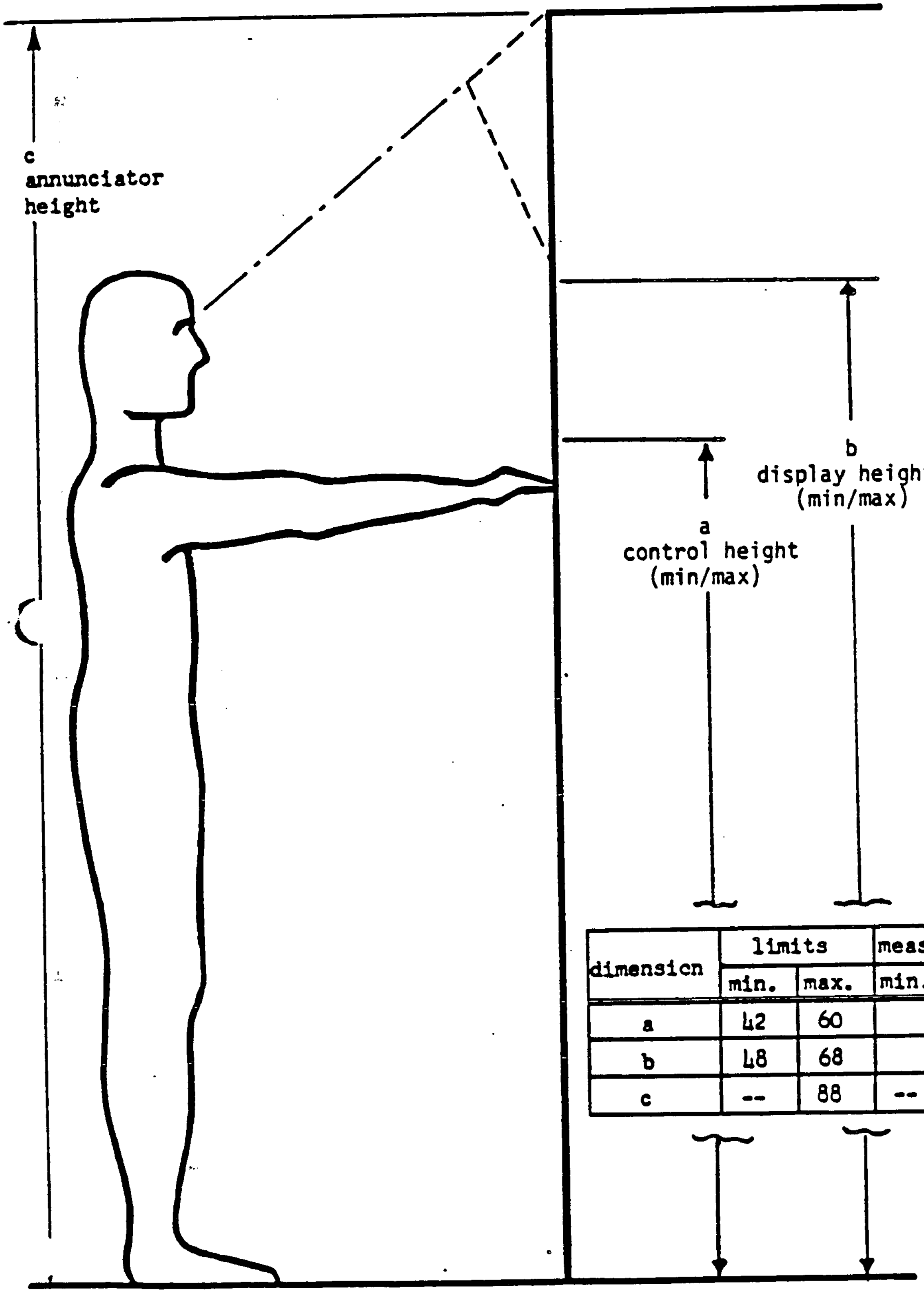
A2 Are lines of demarcation, mimics or other graphic displays:

A2.1	used to distinguish between commonly shared systems or components in control rooms	4 3 2 1 0	x 2	= ____
A2.2	used to enclose related displays	4 3 2 1 0	x 3	= ____

A PANEL LAYOUT and DESIGN (Continued)

(A1.1) Anthropometric Diagram

VERTICAL PANEL MEASUREMENT
PANEL ____________



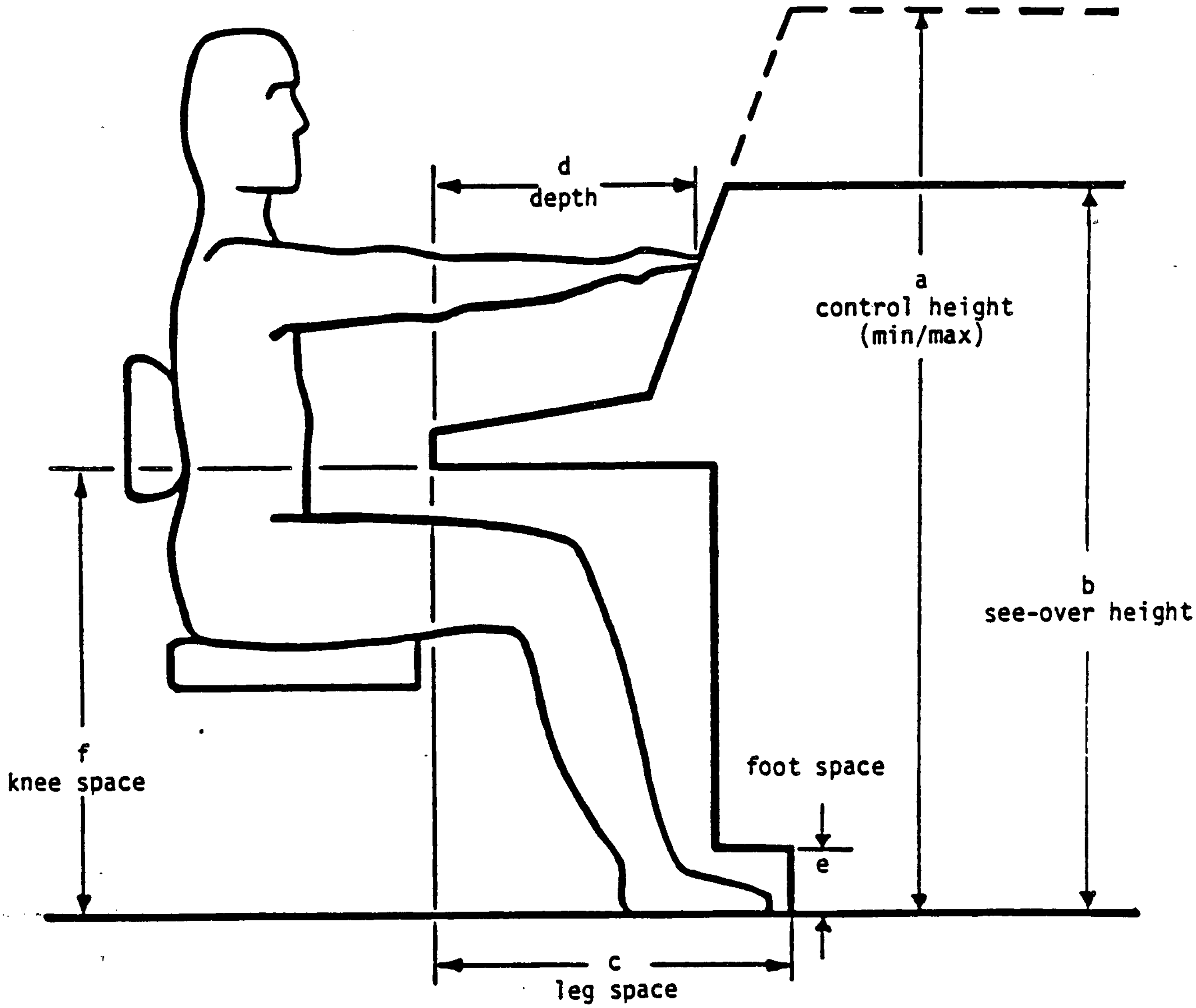
dimension	limits		measurement		comments
	min.	max.	min.	max.	
a	42	60			
b	48	68			
c	--	88	--		

III Control Room Review

A PANEL LAYOUT and DESIGN (Continued)

(A1.1) Anthropometric Diagram

CONSOLE/DESK MEASUREMENT
PANEL ________________

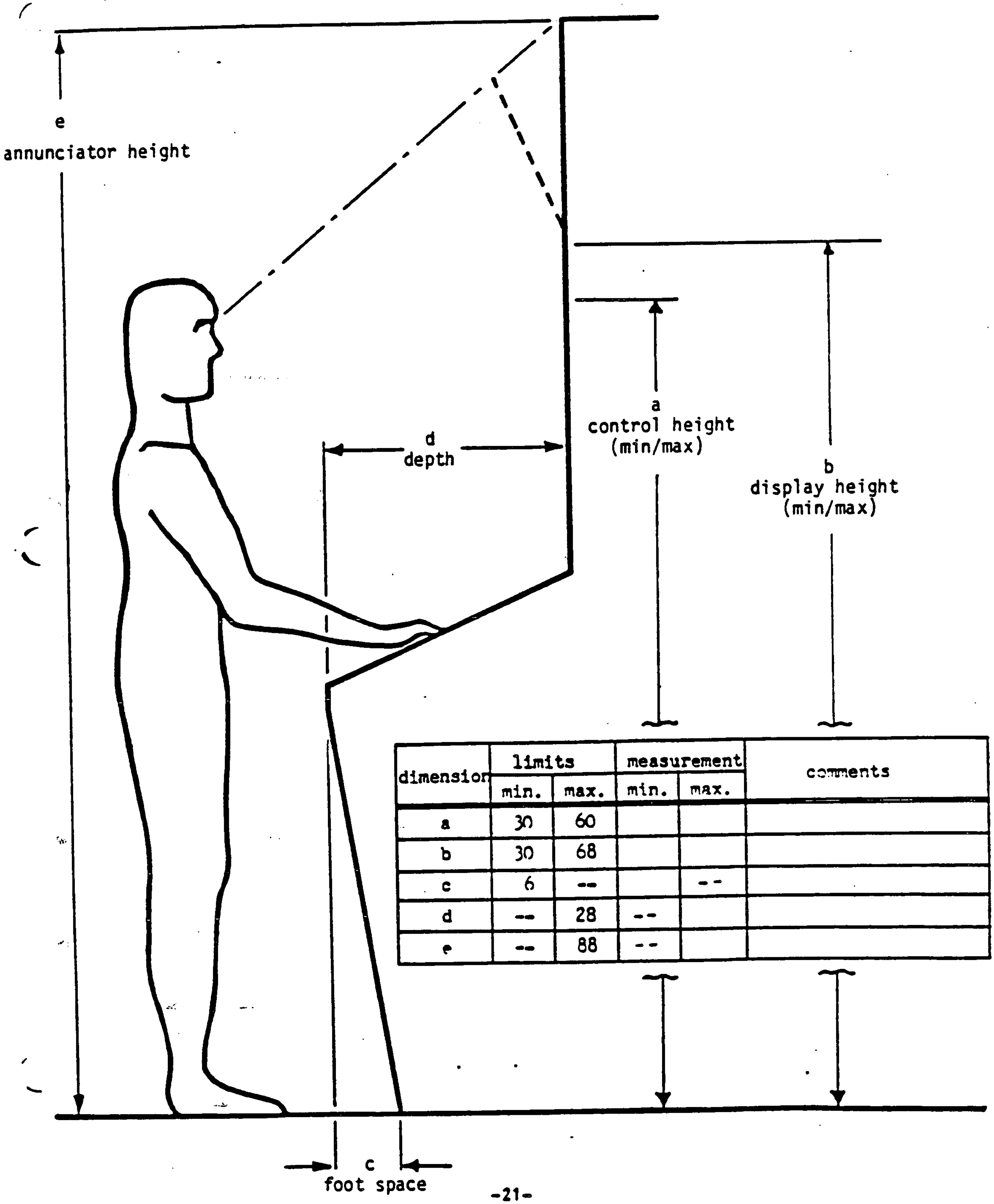


dimension	limits		measurement		comments
	min.	max.	min.	max.	
a	25	54			
b	--	42	--		
c	24	--		--	
d	--	25	--		
e	4	--		--	
f	25	--		--	

A PANEL LAYOUT and DESIGN (Continued)

BENCHBOARD MEASUREMENT
PANEL ______________

(A1.1) Anthropometric Diagram



dimension	limits		measurement		comments
	min.	max.	min.	max.	
a	30	60			
b	30	68			
c	6	--		--	
d	--	28	--		
e	--	88	--		

PANEL LAYOUT and DESIGN (Continued) Panel ________

A2.3	used to separate similar functions within system or component groupings	4 3 2 1 0	x	2	= ____
A2.4	used for divisional identification	4 3 2 1 0	x	2	= ____
A2.5	used to distinguish between primary and secondary flow paths	4 3 2 1 0	x	2	= ____
A2.6	visually distinctive between each other and panel/background	4 3 2 1 0	x	2	= ____
A2.7	permanent and maintained	4 3 2 1 0	x	2	= ____
A2.8	laid-out so that flow paths and arrangements are orderly and easily recognized	4 3 2 1 0	x	3	= ____

Panel ________

PANEL LAYOUT and DESIGN (Continued)

A2.9	identical in lay-out for repetitive groupings of components	4 3 2 1 0 x 3 = ____
A2.10	clearly marked with arrows to show direction of "flow"	4 3 2 1 0 x 2 = ____
A2.11	identified with starting and end points	4 3 2 1 0 x 2 = ____
A2.12	used to integrate switches, pumps, manual and remotely-operated valves, isolation paths, etc.	4 3 2 1 0 x 2 = ____
A2.13	consistent in the application of symbols for pumps, valves and other process elements (describe on Comment Form and attach)?	4 3 2 1 0 x 2 = ____

A3 For controls and displays:

A3.1	are they generally grouped by system (with identical lay-out for repetitive groups)	4 3 2 1 0 x 3 = ____

Panel ________

PANEL LAYOUT and DESIGN (Continued)

A3.2	is grouping for components of similar function consistently from left-to-right or top-to-bottom	4 3 2 1 0 x ~~2~~ 3 = ____
A3.3	arranged in functional or sequential relationships	4 3 2 1 0 x ~~2~~ 3 = ____
A3.4	when strings (6 or more) or matrices (greater than 4x4) of components of similar or common function are installed, are they visually distinguishable by lines-of-demarcation, hierarchical labeling, color contrast, spacing, shape, etc.	4 3 2 1 0 x ~~2~~ 3 = ____
A3.5	are coding methods consistently applied (list on Comment Form and attach)	4 3 2 1 0 x 3 = ____
A3.6	are they generally located in zone "a" or "b" on the anthropometric diagram (see A1.1)	4 3 2 1 0 x 3 = ____
A3.7	are control components located within an arms reach of feedback indications?	4 3 2 1 0 x 3 = ____

Panel ________

\ PANEL LAYOUT and DESIGN (Continued)

A4 For color use:

*A4.1 is there a plant standard (complete attached list) — 4 3 2 1 0 x 3 = ____

A4.2 is selected use of colors consistently applied for alarm prioritization, indicating lights, labels, lines-of-demarcation, legend plates, graphic displays, indicating devices, tags, eto. — 4 3 2 1 0 x 3 = ____

A4.3 when there is a possible dual meaning for colors, is there an additional indication for visual distinction? — 4 3 2 1 0 x 3 = ____

A5 Are labels, legend plates and escutcheons:

A5.1 used to identify component function — 4 3 2 1 0 x 3 = ____

*A5.2 used to identify operational limits or warnings — 4 3 2 1 0 x 3 = ____

PANEL LAYOUT and DESIGN (Continued)

A4.1) To evaluate the consistency of the application of color standards in the control room, complete the following for each meaning:

Color	Meaning
____________	Valve Open
____________	Valve Closed
____________	Breaker Open
____________	Breaker Closed
____________	Mid cr Transitional Position
____________	On or Operating
____________	Off or Not Operating
____________	Start
____________	Stop
____________	Danger or Warning
____________	Caution, Trouble or Pre-Trip
____________	Trip or Failure
____________	Automatic Operation or Control
____________	Manual Operation or Control
____________	Limit Condition
____________	General Status
____________	Hot
____________	Cold
____________	Other (specify) ____________ ____________
	CRTs
____________	Alpha-Numeric Identification
____________	Process Variable (in limits)
____________	Process Variable (out of limits)
____________	Process Diagram lines and Symbols
____________	Reference or Scale Markings
____________	Other (specify) ____________ ____________

Panel ________

PANEL LAYOUT and DESIGN (Continued)

A5.3	used to identify system and component designation	4 3 2 1 0 x 2 = ____
A5.4	used to identify panel by number and function	4 3 2 1 0 x 2 = ____
A5.5	consistent in nomenclature, use of acronyms, abbreviations, etc. (list on Comment Form and attach)	4 3 2 1 0 x 2 = ____
A5.6	consistent in type style and the application of type size (ie, larger letters in headings, all letters same height, etc.)	4 3 2 1 0 x 2 = ____
A5.7	size coded in a hierarchical system for components, components and displays	4 3 2 1 0 x 2 = ____
A5.8	visually distinctive (light letters on dark background or dark letters on light background)	4 3 2 1 0 x 2 = ____

Panel ________

PANEL LAYOUT and DESIGN (Continued)

A5.9	easily read when stationed at the panel (see A1.1)	4 3 2 1 0 x 3 =	____
*A5.10	succinctly worded and accurate with respect to function or input signal	4 3 2 1 0 x 3 =	____
A5.11	consistently positioned above or below devices and readily associated with corresponding controls and displays	4 3 2 1 0 x 3 =	____
A5.12	permanent but replaceable	4 3 2 1 0 x 2 =	____
A5.13	conspicuous and visually distinctive from the panel background	4 3 2 1 0 x 3 =	____
A5.14	oriented to read from left-to-right?	4 3 2 1 0 x 2 =	____

Panel ________

A PANEL LAYOUT and DESIGN (Continued)

A6 When temporary changes or modifications are made, are they:

A6.1	minimized	4 3 2 1 0 x 2 =	____
*A6.2	controlled in application (for information or status, corrective or cautionary purpose only)	4 3 2 1 0 x 2 =	____
*A6.3	consistent and controlled in nomenclature, font and color	4 3 2 1 0 x 2 =	____
*A6.4	accurate with respect to use or design intent	4 3 2 1 0 x 3 =	____
*A6.5	incorporated into procedures (if informative, cautionary or corrective)	4 3 2 1 0 x 3 =	____
A6.6	applied to not obscure adjacent or background information or colors	4 3 2 1 0 x 2 =	____

Panel ________

PANEL LAYOUT and DESIGN (Continued)

*A6.7 reviewed periodically and made permanent or removed? 4 3 2 1 0 x 2 = ____

A7 From the operator's primary control area:

A7.1 is the path to the control panel unobstructed 4 3 2 1 0 x 3 = ____

A7.2 are control surfaces visible 4 3 2 1 0 x 3 = ____

A7.3 are communication systems accessible 4 3 2 1 0 x 3 = ____

A7.4 are annunciator windows visible and identifiable

Panel ________

B INSTRUMENTATION and HARDWARE

B1 Are controllers that require manual operation:

B1.1 easily reached (see A3.6) — 4 3 2 1 0 x 3 = ____

*B1.2 designed to facilitate precise control where fine adjustments are required — 4 3 2 1 0 x 2 = ____

B1.3 marked to clearly show manual or automatic mode — 4 3 2 1 0 x 2 = ____

*B1.4 provided with mechanical stops at the beginning and end of travel — 4 3 2 1 0 x 1 = ____

B1.5 provided with space for hand support? — 4 3 2 1 0 x 1 = ____

B2 Are indicating devices:

B2.1 marked to show normal or abnormal, safe or unsafe, or expected or unexpected range of operation where applicable — 4 3 2 1 0 x 3 = ____

Panel ________

INSTRUMENTATION and HARDWARE (Continued)

B2.2	free from glare and parallax when stationed at the panel (see A1.1)	4 3 2 1 0 x 3 = ____
*B2.3	scaled in process units that relate to system operation	4 3 2 1 0 x 3 = ____
B2.4	provided with visual contrast or distinctiveness between scale graduations, process units, numerals, background and pointer	4 3 2 1 0 x 2 = ____
B2.5	designed so that pointers do not obscure graduation marks, numerals or process units	4 3 2 1 0 x 2 = ____
B2.6	designed so that pointers move from bottom-to-top, left-to-right or clockwise, depending on the display design and orientation	4 3 2 1 0 x 2 = ____
*B2.7	designed so that indicator direction follows control movement	4 3 2 1 0 x 2 = ____

Panel ________

B INSTRUMENTATION and HARDWARE (Continued)

*B2.8	easily correlated with backup indications, especially those instruments with elevated zeros	4 3 2 1 0 x 2 = ____
B2.9	aligned between pointer or moveable indicator and scale without need for visual extrapolation	4 3 2 1 0 x 2 = ____
B2.10	visually aligned and provided with identical scales to facilitate comparative reading in groups of similar displays	4 3 2 1 0 x 2 = ____
*B2.11	marked with subdivisions that are consistent with the accuracy needed by the operator	4 3 2 1 0 x 2 = ____
B2.12	scaled with a maximum of nine intermediate graduations between numbered markings	4 3 2 1 0 x 2 = ____
B2.13	scaled with subdivisions in decimal multiples of 1, 2 or 5	4 3 2 1 0 x 1 = ____

Panel ________

3 INSTRUMENTATION and HARDWARE (Continued)

B2.14 marked or colcr coded to provide visual distinctiveness between the case, panel or similiar components	4 3 2 1 0 x 1 =	____
B2.15 marked with numerals oriented in an upright position	4 3 2 1 0 x 1 =	____
*B2.16 maintained, calibrated and surveillance tested on a regular besis	4 3 2 1 0 x 3 =	____
*B2.1 designed so that a failure mode is evident and in a safe direction	4 3 2 1 0 x 3 =	____
B2.18 marked or color coded to differentiate between scales on multiple range meters?	4 3 2 1 0 x 2 =	____

B3 For recorder charts:

B3.1 are printed values easily read and distinguishable	4 3 2 1 0 x 3 =	____

Panel ________

B INSTRUMENTATION and HARDWARE (Continued)

B3.2	are printing devices properly aligned such that printed value corresponds to scale value	4 3 2 1 0 x 3 = ____
B3.3	is alarm point identified and does it correspond to scale value	4 3 2 1 0 x 3 = ____
B3.4	is there adequate distinction for markings on multi-pen recorders	4 3 2 1 0 x 3 = ____
*B3.5	where fast tracking rates or trends are periodically required, is there Hi/Lo speed capability and do administrative procedures require chart notation	4 3 2 1 0 x 2 = ____
B3.6	is point select capability available on multi-point recorders	4 3 2 1 0 x 2 = ____
B3.7	is recorder clearly marked indicating proper type and size of chart paper	4 3 2 1 0 x 1 = ____

Panel ________

B INSTRUMENTATION and HARDWARE (Continued)

*B3.8	is paper replaceable without physically disconnecting wiring or linkage	4 3 2 1 0 x 1 = ____
*B3.9	can the ink supply be maintained without disconnecting wiring or linkage	4 3 2 1 0 x 1 = ____
B3.10	are pen colors consistent from one recorder to another and/or is the color association unambiguous and clearly displayed	4 3 2 1 0 x 2 = ____
*B3.11	does chart paper not bind, eliminating frequent manual corrections	4 3 2 1 0 x 2 = ____
*B3.12	are charts marked periodically (at least once per shift) with date, time and initials to aid in data recovery	4 3 2 1 0 x 2 = ____
*B3.13	has administrative procedure been established for chart marking and used chart/record retention	4 3 2 1 0 x 2 = ____

Panel ________

B INSTRUMENTATION and HARDWARE (Continued)

B3.14	are they free from glare and parallax when stationed at the panel (see A1.1)	4 3 2 1 0 x 3 = ____
B3.15	marked to show normal or abnormal, safe or unsafe, or expected or unexpected or unexpected range of operation?	4 3 2 1 0 x 3 = ____

B4 For indicating lights:

B4.1	does intensity provide adequate visual distinction between lit and extinguished lights	4 3 2 1 0 x 3 = ____
*B4.2	does the use of lit indicating lights consistently indicate a positive state or positive response (an unlighted condition only indicates "power off")	4 3 2 1 0 x 3 = ____
B4.3	is the size and intensity of alarm lights adequate to command attention	4 3 2 1 0 x 3 = ____
*B4.4	is there a positive means of diagnosing failed indicating lights	4 3 2 1 0 x 2 = ____

Panel ________

B. INSTRUMENTATION and HARDWARE (Continued)

*B4.5	is bulb replacement easily and safely performed	4 3 2 1 0 x 2 = ____
B4.6	are sets of lights in alignment to facilitate comparison between related system elements	4 3 2 1 0 x 2 = ____
*B4.7	is direct indication used in preference to implied indication that a function has been performed	4 3 2 1 0 x 3 = ____
*B4.8	when direct indication is not practical, is there backup instrumentation to indicate that a function has occurred?	4 3 2 1 0 x 3 = ____

B5 For switches:

B5.1	do handles move consistently in the same direction in accordance with expectations (i.e., right for on or start; left for off or stop; center for tripped, standby, or normal; pull-to-lock, etc)	4 3 2 1 0 x 3 = ____
B5.2	is each position clearly marked	4 3 2 1 0 x 3 = ____

Panel ________

B INSTRUMENTATION and HARDWARE (Continued)

B5.3	is each reachable at a normal operating distance	4 3 2 1 0 x 3 = ____
B5.4	are handles that are located near the edge of the control panels protected with a guard to prevent inadvertent operation	4 3 2 1 0 x 3 = ____
*B5.5	do handles require normal hand pressure to operate (i.e. no thumb-busters)	4 3 2 1 0 x 3 = ____
B5.6	are handles durable and of adequate size	4 3 2 1 0 x 2 = ____
*B5.7	is switching action responsive and precise	4 3 2 1 0 x 2 = ____
B5.8	when operated, are displays, indicator lights and flags that are functionally associated free from visual obstruction by hand or arm	4 3 2 1 0 x 2 = ____

Panel ________

INSTRUMENTATION and HARDWARE (Continued)

B5.9 is there adequate hand space between them — 4 3 2 1 0 x 2 = ____

B5.10 are they physically or functionally distinguishable between pumps, valves, indicating lights, divisional separation, power source, etc. — 4 3 2 1 0 x 2 = ____

B5.11 are handles or knobs shaped so as to clearly indicate position without obstruction of legends or confusion of direction? — 4 3 2 1 0 x 2 = ____

B6 Are switches for emergency or abnormal use (such as turbine trip, scram, emergency trip, etc.):

B6.1 clearly marked — 4 3 2 1 0 x 3 = ____

B6.2 protected from inadvertent operation — 4 3 2 1 0 x 3 = ____

B6.3 readily accessible — 4 3 2 1 0 x 3 = ____

Panel ________

B INSTRUMENTATION and HARDWARE (Continued)

*B6.4 controlled by specific procedural instructions? — 4 3 2 1 0 x 3 = ____

B7 Where key-lock switches are used:

*B7.1 does normal operation or immediate action not require use of keys in key-lock switches — 4 3 2 1 0 x 3 = ____

B7.2 are keys conveniently located and immediately available — 4 3 2 1 0 x 3 = ____

B7.3 are keys clearly identified for specific use — 4 3 2 1 0 x 3 = ____

*B7.4 is key use administratively controlled — 4 3 2 1 0 x 3 = ____

*B7.5 do procedures provide specific instructions for use — 4 3 2 1 0 x 3 = ____

*B7.6 is switch action smooth and positive without use of excessive force? — 4 3 2 1 0 x 3 = ____

Panel ______

ANNUNCIATORS

C1 Are annunciators grouped:

C1.1	within annunciator box by specific systems	4 3 2 1 0	x 2	= ____
C1.2	above related controls and displays	4 3 2 1 0	x 2	= ____
C1.3	such that warning and diagnostic alarms are segregated from informational and advisory displays?	4 3 2 1 0	x 2	= ____

C2 Does alarm window:

C2.1	meet checklist criteria for labels, legend plates and escutcheons (see A5)	4 3 2 1 0	x 2	= ____
C2.2	meet checklist criteria for changes or modifications as established for labels, legend plates and escutcheons (see A6)	4 3 2 1 0	x 2	= ____
C2.3	accurately describe intent of input signal per design	4 3 2 1 0	x 3	= ____

Panel ________

ANNUNCIATORS

C2.4	Provide setpoints for parameters with multiple trip levels (water level, vacuum, containment pressure etc.)	4 3 2 1 0 x 2 = ____
C2.5	not use multiple choice indication (high/low level/pressure)	4 3 2 1 0 x 3 = ____
C2.6	prioritize alarm for required response level by legend plate color (preferred) or bulb color in accordance with color use standards (see A4.1)	4 3 2 1 0 x 3 = ____
C2.7	have an alpha-numeric code in addition to legends for positive and prompt response procedure identification	4 3 2 1 0 x 2 = ____
C2.8	meet checklist criteria for indicating lights (see B4)?	4 3 2 1 0 x 3 = ____
C3	Does the audible feature meet checklist criteria for audible displays (see F2)?	4 3 2 1 0 x 2 = ____

Panel ________

ANNUNCIATORS (Continued)

C4 For alarm response, are the following provided:

C4.1 audible-silence button	4	3	2	1	0	x	3	=	____
C4.2 visual acknowledge button	4	3	2	1	0	x	3	=	____
C4.3 visual reset button	4	3	2	1	0	x	2	=	____
C4.4 visual and audible test feature	4	3	2	1	0	x	3	=	____
C4.5 silence and reset buttons of consistent size, shape, color, sequence and location between panels	4	3	2	1	0	x	2	=	____
C4.6 a "first-out" feature or dual reset for information retrieval for high priority alarms?	4	3	2	1	0	x	2	=	____

Panel ________

ANNUNCIATORS (Continued)

C5 For visual annunciation, will each window:

C5.1 flash for initial alarm input — 4 3 2 1 0 x 3 = ____

C5.2 remain in alarm state (solid light) when acknowledged but alarm input has not cleared — 4 3 2 1 0 x 3 = ____

C5.3 reflash for second alarm input — 4 3 2 1 0 x 3 = ____

C5.4 automatically blink (at slower rate) when alarm input clears — 4 3 2 1 0 x 2 = ____

C5.5 clear only on operator action? — 4 3 2 1 0 x 2 = ____

*C6 Do annunciator response procedures meet procedure checklist criteria for:

C6.1 format (see E3) — 4 3 2 1 0 x 3 = ____

Panel ________

ANNUNCIATORS (Continued)

C6.2 content (see E4) | 4 3 2 1 0 x 3 = ____

C6.3 reference material (see E5)? | 4 3 2 1 0 x 3 = ____

*C7 For annunciator maintenance:

C7.1 if bulb replacement requires legend plate removal, is there a method to assure plate replacement in correct location | 4 3 2 1 0 x 3 = ____

C7.2 has an administrative procedure been implemented to allow prompt recognition of an out-of-service annunciator | 4 3 2 1 0 x 3 = ____

C7.3 are annunciators periodically tested? | 4 3 2 1 0 x 3 = ____

C8 Are only meaningful alarms present during a given operating state (list on Comment Form)? | 4 3 2 1 0 x 3 = ____

III CONTROL ROOM REVIEW

COMPUTERS

D1 Are the computer console and output devices:

D1.1 conveniently located and readily available for operator use	4	3	2	1	0	x	2	=	___
D1.2 generally laid-out per standards of the anthropometric diagrams (see A1.1)	4	3	2	1	0	x	2	=	___
D1.3 arranged for visual distinction and use of dials, buttons and switches?	4	3	2	1	0	x	2	=	___

*D2 Is the computer:

D2.1 capable of displaying selected input information	4	3	2	1	0	x	2	=	___
D2.2 equipped with display change capability	4	3	2	1	0	x	2	=	___
D2.3 available for on-demand use by the control room operator	4	3	2	1	0	x	2	=	___

D COMPUTERS (Continued)

D2.4	capable of receiving all inputs and performing programmed functions without becoming overloaded	4 3 2 1 0 x 2 = ___
D2.5	available after power transients or accident conditions	4 3 2 1 0 x 2 = ___
D2.6	capable of use in post-transient evaluation	4 3 2 1 0 x 1 = ___
D2.7	capable of automatic or manual switchover for processor failure ("failover")?	4 3 2 1 0 x 1 = ___

D3 Are CRT displays:

D3.1	accessible and easily visible when stationed at the controls	4 3 2 1 0 x 2 = ___
D3.2	comprehensible with a minimum of visual search	4 3 2 1 0 x 2 = ___

COMPUTERS (Continued)

D3.3	of adequate brightness for lighting conditions or equipped with conviently located focus, brightness, and/or contrast controls	4 3 2 1 0 x 2 = ____
D3.4	consistent with color standards (see A4.1)	4 3 2 1 0 x 2 = ____
*D3.5	color coded so that loss of a primary color gun does not result in loss of a numerical value or scale	4 3 2 1 0 x 2 = ____
D3.6	consistent with checklist standards for procedural format (see E3)	4 3 2 1 0 x 2 = ____
D3.7	identified by system or program	4 3 2 1 0 x 2 = ____
D3.8	provided with an access mode for display selection (either display menu or sectoring mode)	4 3 2 1 0 x 2 = ____

D COMPUTERS (Continued)

D3.9 provided with verification that the computer is operational and that data is being updated on a periodic basis? — 4 3 2 1 0 x 2 = ____

D4 For the typer/printer:

*D4.1 is output prioritized — 4 3 2 1 0 x 2 = ____

*D4.2 is output periodically reviewed and updated so that only useful information is printed — 4 3 2 1 0 x 2 = ____

*D4.3 is capacity sufficient (output not overloaded) — 4 3 2 1 0 x 2 = ____

D4.4 is the output identified by time, date, component and system — 4 3 2 1 0 x 2 = ____

*D4.5 is a backup available — 4 3 2 1 0 x 2 = ____

D COMPUTERS (Continued)

D4.6	is it silenced to not be a noise distraction	4 3 2 1 0 x 1 =	
*D4.7	are paper and ribbon easily replaced	4 3 2 1 0 x 1 =	
D4.8	are printout easily readable (spacing, headings, formats, print, etc.)?	4 3 2 1 0 x 2 =	

III CONTROL ROOM REVIEW

E PROCEDURES

E1 Does the control room operator have available:

E1.1	a full set of up-to-date plant procedures	4 3 2 1 0 x 3 =	___
E1.2	a full set of up-to-date emergency, abnormal and normal procedures for each unit on multi-unit plants with a common control room	4 3 2 1 0 x 3 =	___
E1.3	a complete set of up-to-date, as-built flow diagrams and schematics	4 3 2 1 0 x 3 =	___
E1.4	a set of up-to-date Technical Specifications	4 3 2 1 0 x 3 =	___
E1.5	storage space for procedures and reference materials	4 3 2 1 0 x 3 =	___
*E1.6	procedural instructions for the operation of both manual and automatic controllers	4 3 2 1 0 x 3 =	___

E PROCEDURES (Continued)

E1.7	lay down space for use of procedures and reference materials?	4 3 2 1 0 x 2 =	
E2	For immediate access and recognition:		
E2.1	are procedures readily available and centrally located	4 3 2 1 0 x 3 =	
E2.2	is each procedure binder or folder clearly marked	4 3 2 1 0 x 2 =	
E2.3	does each procedure binder or folder have an index or table of contents	4 3 2 1 0 x 3 =	
E2.4	are emergency procedures in a separate binder or folder	4 3 2 1 0 x 3 =	
E2.5	are annunciator response procedures in a separate binder or folder	4 3 2 1 0 x 2 =	

E PROCEDURES (Continued)

E2.6	are individual procedures readily located (i.e., through use of index tabs or alpha-numeric code)?	4 3 2 1 0 x 3 = ___

*E3 Has an administrative procedure been implemented to assure standardization of procedure format for:

E3.1	type size and style	4 3 2 1 0 x 2 = ___
E3.2	use of nomenclature, grammar, terminology, synonyms, acronyms, and abbreviations	4 3 2 1 0 x 2 = ___
E3.3	use of as-labeled designations for components, systems and process units	4 3 2 1 0 x 2 = ___
E3.4	numbering of procedures, paragraphs, steps and sub-steps for increased levels of detail	4 3 2 1 0 x 1 = ___
E3.5	step or paragraph spacing and page layout and identity	4 3 2 1 0 x 1 = ___

E PROCEDURES (Continued)

E3.6	identity of purpose or scope	4 3 2 1 0 x 1 =	____
E3.7	entry and exit conditions	4 3 2 1 0 x 2 =	____
E3.8	cross-referencing	4 3 2 1 0 x 1 =	____
E3.9	rapid identification and recognition of revisions or changes?	4 3 2 1 0 x 2 =	____

E4 Do procedures that require operator action:

E4.1	have succinct action verbs	4 3 2 1 0 x 2 =	____
E4.2	have succinct action statements	4 3 2 1 0 x 2 =	____

PROCEDURES (Continued)

E4.3	separate steps from eaoh other and from cautions, notes, reference material, etc.	4 3 2 1 0 x 2 = ___
*E4.4	provide cautionary statements (that are positioned to relate to the consequences or results of that action)	4 3 2 1 0 x 3 = ___
E4.5	minimize the need for memorization of actions	4 3 2 1 0 x 2 = ___
E4.6	distinguish between required (shall) and optional (should) aotions	4 3 2 1 0 x 3 = ___
E4.7	distinguish between automatic and manual actions	4 3 2 1 0 x 3 = ___
E4.8	provide symptomatic or diagnostic analysis or entry event guidance to assure correct procedure is in use	4 3 2 1 0 x 3 = ___

PROCEDURES (Continued)

*E4.9	give required operational sequencing of actions and identify actions which should be performed in parallel	4 3 2 1 0 x 3 = ____
*E4.10	identify critical steps where errors of omission, commission or sequence cannot be tolerated	4 3 2 1 0 x 3 = ____
E4.11	integrate charts, diagrams, and graphs into body of procedure as needed to directly supplement steps	4 3 2 1 0 x 2 = ____
E4.12	provide physical panel locations of referenced instrumentation and hardware, especially those that are infrequently used	4 3 2 1 0 x 3 = ____
E4.13	give normally expected results (such as valve positions, flow rates, currents, alarms indicating lights, etc.) where appropriate	4 3 2 1 0 x 2 = ____
E4.14	give setpoints and sensor identity for annunciator response	4 3 2 1 0 x 3 = ____

E PROCEDURES (Continued)

*E4.15	give equipment and administrative limits for operation	4 3 2 1 0 x 2 = ___
E4.16	give contingency actions or conditional instructions if expected results or actions are not achieved	4 3 2 1 0 x 3 = ___
E4.17	emphasize the use of multiple or independent indications to provide feedback that an action has occurred in response to a control command	4 3 2 1 0 x 2 = ___
*E4.18	limit actions to those that are essential and effective	4 3 2 1 0 x 2 = ___
*E4.19	explicitly contain all essential actions and not require use of reference material for those actions	4 3 2 1 0 x 3 = ___
E4.20	identify how or when emergency systems or automatic controls may be manually controlled or overridden after automatic initiation	4 3 2 1 0 x 3 = ___

E PROCEDURES (Continued)

E4.21	identify conditions under which instrumentation may be inaccurate and stress the use of multiple indications	4 3 2 1 0	x 2 =	____
*E4.22	provide direction for placing and maintaining the plant in cold shutdown	4 3 2 1 0	x 3 =	____

E5 When reference material is identified in a procedure:

E5.1	is it readily available	4 3 2 1 0	x 3 =	____
E5.2	is the latest available revision identified	4 3 2 1 0	x 2 =	____
E5.3	are steps or actions compatible with the procedure from which it is entered	4 3 2 1 0	x 2 =	____
E5.4	is it standardized or condensed for ease of use?	4 3 2 1 0	x 2 =	____

E PROCEDURES (Continued)

*E6 For revision or corrections to procedures, is there a controlled method:

E6.1	to assure operator review and walkthru to verify correctness, understanding and ability to use	4 3 2 1 0 x 3 =	____
E6.2	for operator feedback and to clarify intent of changes recommended by operators	4 3 2 1 0 x 2 =	____
E6.3	for feedback to the operator as to resolution of recommended change	4 3 2 1 0 x 2 =	____
E6.4	to permit temporary or interim revision by shift personnel to allow deviation from approved procedures	4 3 2 1 0 x 3 =	____
E6.5	to assure prompt revision (both interim and permanent) to incorporate design ohanges or operational deviations	4 3 2 1 0 x 3 =	____
E6.6	to assure prompt review and approval by personnel experienced in opsrations and engineering or design	4 3 2 1 0 x 2 =	____

E PROCEDURES (Continued)

E6.7	for prompt distribution and updating of controlled sets (especially control room)	4 3 2 1 0	x 3	= ____
E6.8	for destruction of superseded controlled copies	4 3 2 1 0	x 3	= ____
E6.9	for updating of Index or Table of Contents to show latest available revisions of all procedures	4 3 2 1 0	x 3	= ____
E6.10	to evaluate and incorporate changes made by operators on control panels such as scales or process units, cautionary or informative notes, power sources, charts and graphs, etc.?	4 3 2 1 0	x 2	= ____

*E7 Has an administrative procedure been established to require:

E7.1	recording of time, date and signature (or initials) on all log book entries	4 3 2 1 0	x 2	= ____
E7.2	marking of charts and graphs on a regular basis	4 3 2 1 0	x 2	= ____

E PROCEDURES (Continued)

E7.3	recording of both permanent and temporary plant and equipment status change, including maintenance and testing activities	4 3 2 1 0 x 2 = ___
E7.4	recording of verbal instructions and feedback on execution	4 3 2 1 0 x 2 = ___
E7.5	recording of cyclic operations or transients	4 3 2 1 0 x 2 = ___
E7.6	recording of other information useful to other operators or supervisors	4 3 2 1 0 x 2 = ___
E7.7	reading and initialing of log books by supervisory personnel on a regular basis	4 3 2 1 0 x 2 = ___
E7.8	retention of log books and recorder charts in permanent plant files for rsquired periods of time?	4 3 2 1 0 x 1 = ___

III CONTROL ROOM REVIEW

F CONTROL ROOM ENVIRONMENT

F1 Are communication systems:

F1.1	redundant, diverse or varied (such as hand-held, sound powered, dedicated to specific panels, radio, bell)	4 3 2 1 0 x 3 =	
*F1.2	available for emergency or abnormal use (such as a loss of normal power)	4 3 2 1 0 x 3 =	
F1.3	accessible, unobstructive, and organized	4 3 2 1 0 x 3 =	
*F1.4	available to the control room operator on a priority basis	4 3 2 1 0 x 3 =	
*F1.5	capable of accessing all in-plant areas	4 3 2 1 0 x 3 =	
F1.6	designed to permit hand free operation	4 3 2 1 0 x 2 =	

CONTROL ROOM ENVIRONMENT (Continued)

F1.7	equipped with channel seleot	4 3 2 1 0 x 2 =	
F1.8	physically adjustable for individual users	4 3 2 1 0 x 2 =	
F1.9	provided for dedicated links to the TSC, EOF and OSC	4 3 2 1 0 x 2 =	
F1.10	distinctive/color coded	4 3 2 1 0 x 1 =	
F1.11	clearly understood, intelligible and free from reverberation?	4 3 2 1 0 x 1 =	

F2 Are audible signals (such as bells, klaxons and sirens):

F2.1	distinguishable for alarm location	4 3 2 1 0 x 2 =	

F CONTROL ROOM ENVIRONMENT (Continued)

F2.2	prioritized	4 3 2 1 0 x 2 = ____
*F2.3	tested on a periodic basis	4 3 2 1 0 x 2 = ____
F2.4	audible in all parts of the control room	4 3 2 1 0 x 2 = ____
F2.5	not irritating or excessively loud (90 db maximum)	4 3 2 1 0 x 2 = ____
F2.6	loud enough to be heard during noisy periods (at least 20 db over background)?	4 3 2 1 0 x 3 = ____

F3 Is lighting:

F3.1	adequate at panel surfaces (30 footcandles minimum, 50 footcandles recommended. Measure at each operating area and record on Control Room Arrangement Diagram)	4 3 2 1 0 x 3 = ____

CONTROL ROOM ENVIRONMENT (Continued)

F3.2	diffuse or indirect to eliminate glare?	4 3 2 1 0 x 2 = ___
F4	Is control room heating and ventilation:	
F4.1	adequate for both operator comfort and equipment performance (normally between 65-75°F and 25-45% relative humidity)	4 3 2 1 0 x 2 = ___
F4.2	diffuse to eliminate areas of stagnation or direct blowing?	4 3 2 1 0 x 1 = ___
F5	In case of fire:	
F5.1	is fire-fighting equipment immediately accessible	4 3 2 1 0 x 3 = ___
*F5.2	is there an automatic warning system?	4 3 2 1 0 x 2 = ___
F6	During emergency situations:	
*F6.1	is access to the control room procedurally controlled	4 3 2 1 0 x 3 = ___

CONTROL ROOM ENVIRONMENT (Continued)

F6.2	is protective clothing accessible	4 3 2 1 0 x 3 = ____
F6.3	is breathing apparatus accessible	4 3 2 1 0 x 3 = ____
F6.4	is portable radiation monitoring equipment accessible	4 3 2 1 0 x 3 = ____
*F6.5	is special clothing or breathing equipment compatible with required operator functions for visibility, reach, tactile sensitivity, communication, hearing and weight	4 3 2 1 0 x 3 = ____
F6.6	are sanitary facilities and drinking water accessible	4 3 2 1 0 x 1 = ____
*F6.7	have provisions been made for handling of telephone communications when operator is occupied	4 3 2 1 0 x 2 = ____

F CONTROL ROOM ENVIRONMENT (Continued)

*F6.8	are emergency lighting levels adequate (20 footcandles minimum at panel surfaces. Measure at each operating area and document on Control Room Arrangement Diagram.)	4 3 2 1 0 x 3 = ____

F7 In general:

F7.1	is the noise level routinely below an interference level for normal conversation (65 db maximum. Measure at each operating area and document on Control Room Arrangement Diagram)	4 3 2 1 0 x 3 = ____
F7.2	have noise distractions from both inside and outside the control room been reduced	4 3 2 1 0 x 2 = ____
F7.3	is there adequate, organized storage space for protective gear, personal belongings, spare parts, tools, etc.	4 3 2 1 0 x 2 = ____
*F7.4	are smoking and eating aress controlled	4 3 2 1 0 x 1 = ____
F7.5	is the control room clean and free of unnecessary loose paper, books and other materials	4 3 2 1 0 x 1 = ____

CONTROL ROOM ENVIRONMENT (Continued)

F7.6	is the control room free of safety hazards such as loose floor mats, long phone leads, defective furniture, etc.	4 3 2 1 0 x 1 = ___
F7.7	is seating provided at consoles for control room operators adjustible from 15 to 18 inches?	4 3 2 1 0 x 1 = ___

G MAINTENANCE AND SURVEILLANCE

*G1 Are operator maintenance functions and surveillance responsibilities:

G1.1 clearly established — 4 3 2 1 0 x 3 = ____

G1.2 adminstratively controlled? — 4 3 2 1 0 x 2 = ____

*G2 Are jumpers and lifted leads:

G2.1 procedurally controlled — 4 3 2 1 0 x 3 = ____

G2.2 approved and periodically reviewed — 4 3 2 1 0 x 3 = ____

G2.3 distinctive or color coded — 4 3 2 1 0 x 3 = ____

G2.4 tagged and logged for traceability? — 4 3 2 1 0 x 3 = ____

G MAINTENANCE AND SURVEILLANCE

*G3 Are permanent modifications:

G3.1	recorded on as-built drawings to show specific changes	4 3 2 1 0	x 2 =	___
G5.2	incorporated into operational procedures?	4 3 2 1 0	x 3 =	___

*G4 Are tags:

G4.1	procedurally controlled	4 3 2 1 0	x 3 =	___
G4.2	readily available	4 3 2 1 0	x 2 =	___
G4.3	installed to not obscure components to which they are attached or adjacent components	4 3 2 1 0	x 3 =	___
G4.4	distinctive for each functional use	4 3 2 1 0	x 2 =	___

MAINTENANCE AND SURVEILLANCE (Continued)

G4.5	readable	4 3 2 1 0 x 3 = ____
G4.6	temporary	4 3 2 1 0 x 2 = ____
G4.7	logged for traceability	4 3 2 1 0 x 2 = ____
G4.8	periodically reviewed?	4 3 2 1 0 x 2 = ____

G5 For operational spare parts:

G5.1	is there an adequate supply of fuses, indicating lights, ink and inking pens, recorder charts, computar paper, etc.	4 3 2 1 0 x 2 = ____
G5.2	are they readily accessible	4 3 2 1 0 x 1 = ____

MAINTENANCE AND SURVEILLANCE (Continued)

*G5.3	are necessary or special replacement tools available	4 3 2 1 0 x 2 =	
G5.4	is adequate storage space available	4 3 2 1 0 x 2 =	
G5.5	where different types, sizes, or styles are required, are they clearly and distinctively marked to avoid misapplication	4 3 2 1 0 x 2 =	
G5.6	can they be installed without disconnecting linkags or removing component internals?	4 3 2 1 0 x 2 =	

*G6 Do maintenance and surveillance procedures require:

G6.1	operability verification when returning any system or component to service	4 3 2 1 0 x 3 =	
G6.2	notification of operations personnel both prior to and upon completion of all activities?	4 3 2 1 0 x 3 =	

MAINTENANCE AND SURVEILLANCE (Continued)

G6.3	out-of-service components and equipment to be clearly marksd at the control station to preclude inadvertent operation and to provide distinction of thet condition	4 3 2 1 0 x 3 = ____
G6.4	use of checklists or status boards to identify out-of-service equipment	4 3 2 1 0 x 3 = ____
G6.5	use of checklists or status boards for routine activities	4 3 2 1 0 x 2 = ____
G6.6	prioritization of control room maintenance?	4 3 2 1 0 x 3 = ____

III CONTROL ROOM REVIEW

H TRAINING AND MANNING

*H1 Does the training/requalification program:

H1.1	use new or revised procedures as they are implemented	4 3 2 1 0 x 3 =	
H1.2	identify known limitations of instrumentation displays in the control rocm	4 3 2 1 0 x 3 =	
H1.3	provide for perodic review and walkthru of emergency procedures by operators	4 3 2 1 0 x 3 =	
H1.4	include training in the use of the computer and CRT displays?	4 3 2 1 0 x 3 =	

*H2 For control room manning, are administrative guidelinss established:

H2.1	to limit the number of hours an operator may work in any given period of time	4 3 2 1 0 x 3 =	
H2.2	to evaluate the physical and mental condition of on-coming shift operators on a daily basis	4 3 2 1 0 x 3 =	

d TRAINING AND MANNING

H2.3	to define specific duties, responsibilities, work locations and authority for all shift members, especially during emergency situations?	4 3 2 1 0 x 3 = ___

*H3 During shift change:

H3.1	are congestion and potentially disruptive situations averted	4 3 2 1 0 x 2 = ___
H3.2	are administrative procedures established to require reading of log entries and review of status boards by on-coming shift personnel from time of previous shift coverage	4 3 2 1 0 x 3 = ___
H3.3	are written instructions and checklists used?	4 3 2 1 0 x 2 = ___

IV EMERGENCY PROCEDURE WALKTHROUGH

DISCUSSION

The purpose of the Emergency Walkthrough is to evaluate the operational aspects of control room design in terms of control/display relationships, display grouping, control feedback, visual and communication links, manning levels and traffic patterns.

As a minimum, walkthroughs will be conducted for emergency procedures for a small break inside the containment, a stuck open relief valve and a loss of feedwater. Additional procedures for normal or transient conditions may be selected at the discretion of the survey team.

The walkthrough is conducted in the following sequence:

1) Evaluate the selected procedure for conformance to procedure criteria as given in part III E of the Control Room Review checklists. Record the results of this evaluation in part IV A.

2) Develop a scenario for each selected procedure. Include the entry conditions, symptoms, transient trends, equipment failures and end points that the operators must take into consideration when performing the procedure. An experienced SRO should validate the developed scenario.

3) Develop a task analysis for each transient using the selected procedure and scenario. The task analysis should identify the task sequence, critical controls and displays, annunciators and required operator actions to be evaluated during the walkthrough. This task analysis is to be validated by an experienced SRO.

4) Perform a walkthrough of the transient using the procedure and task analysis. This is accomplished by first giving the control room operator the preselected symptoms (entry conditions). The operator must select the correct emergency procedure and complete a step-by-step simulation of that procedure, pointing out each control/display used or referenced and communication links or tasks where assistance is required. As the walkthrough progresses, additional information (contingencies, equipment failures, etc.) is presented to the operators as necessary to reach the predetermined end point. Additional operators may assist the control room operator only if they would normally be expected to be available.

   Traffic patterns, equipment locations and operating areas are recorded on the Control Room Arrangement drawing that most closely depicts the control room being evaluated. Solid, dashed or dotted lines may be used to identify operators by primary responsibility or function. Indicate the locations of desks, chairs, procedures, panels, cabinets, consoles or other pieces of equipment or furniture as near to scale as possible.

As each task is addressed, determine if adequate information is provided, if sufficient personnel are available to complete the task and whether each critical control and display meets checklist criteria givan in part III of the Control Room Survey. Note discrepancies in Column 5 of the Task Analysis as the walkthrough progresses. Notation should also be made of omissions or errors in the procedure or task analysis if identified by the operator during the walkthrough.

5) Summarize deficiencies noted in review of the arrangement drawings and column 5 of the task analysis. List these deficiencies by general category in part IV B of the Control Room Survey, cross referencing to checklist criteria where applicable.

IV EMERGENCY PROCEDURE WALKTHROUGH

TRANSIENT SCENARIO

Procedure Selected ____________________ SRO Review ______________

Include entry conditions, symptoms, transient trends, equipment failures and end points.

IV EMERGENCY PROCEDURE WALKTHROUGH

TASK ANALYSIS INSTRUCTIONS

(1) TASK

The task sequence is developed from the procedure being evaluated and the predetermined scenario. Each required operator action is listed as a separate task with diagnosis considered the first task for emergency procedures. Subtasks are listed in the same column, identified by indentation.

(2) DEVICE/LOCATION

For each task or subtask considered in Column (1), the primary control or display utilized by the operator in accomplishing this task is identified and located.

(3) ASSOCIATED DEVICES/LOCATION

Listed is this column are any devices associated with the primary control or display listed in Column (2). This may include backup instrumentation, indicating lights, alarms, etc.

(4) ASSISTANCE/COMMUNICATIONS

Notation is made in this column if assistance is required by the operator to complete the task or if a communication must be made.

(5) NOTES

Any item found discrepant in the walkthrough will be listed in this column. For each task, columns (1) through (4) are analyzed in terms of the following considerations:

- Is the sequence valid and complete?
- Is sufficient information immediately available to the operator to complete the task?
- Does each critical control and display identified in columns (2) and (3) conform to checklist evaluation criteria?
- Do control/display relationships meet checklist criteria?
- Are shift manning levels adequate to perform the task?
- Are traffic patterns unobstructive?
- Is direct feedback used to verify control functions?

TASK ANALYSIS

PROCEDURE SELECTED______________ SRO REVIEW ______________ SHEET _____OF_____

Task (1)	Device/Location (2)	Associated Devices/Location (3)	Assistance/ Communications (4)	Notes (5)

IV EMERGENCY PROCEDURE WALKTHRU

CHECKLIST

Procedure Selected: ______________________________

A Does the emergency procedure selected meet checklist standards for procedure:

A1	standardization and format (see III.E3)	4 3 2 1 0	x 2 =	____
A2	operator action (see III.E4)	4 3 2 1 0	x 3 =	____
A3	use of reference material (see III.E5)?	4 3 2 1 0	x 2 =	____

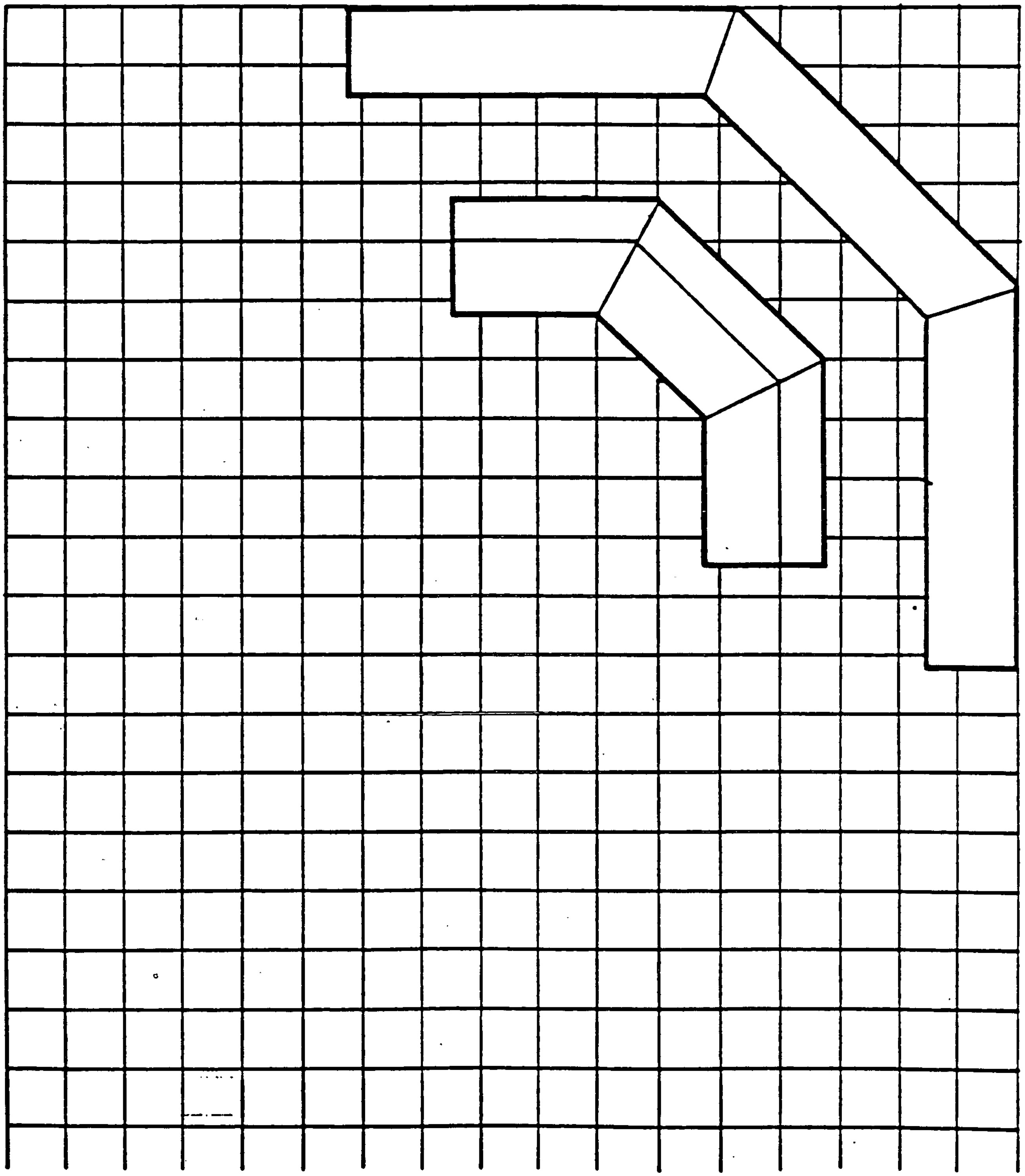
B. Summary:

Area of Concern	Checklist Item(s)

CONTROL ROOM ARRANGEMENT

PLANT/UNIT ________ PROCEDURE ________

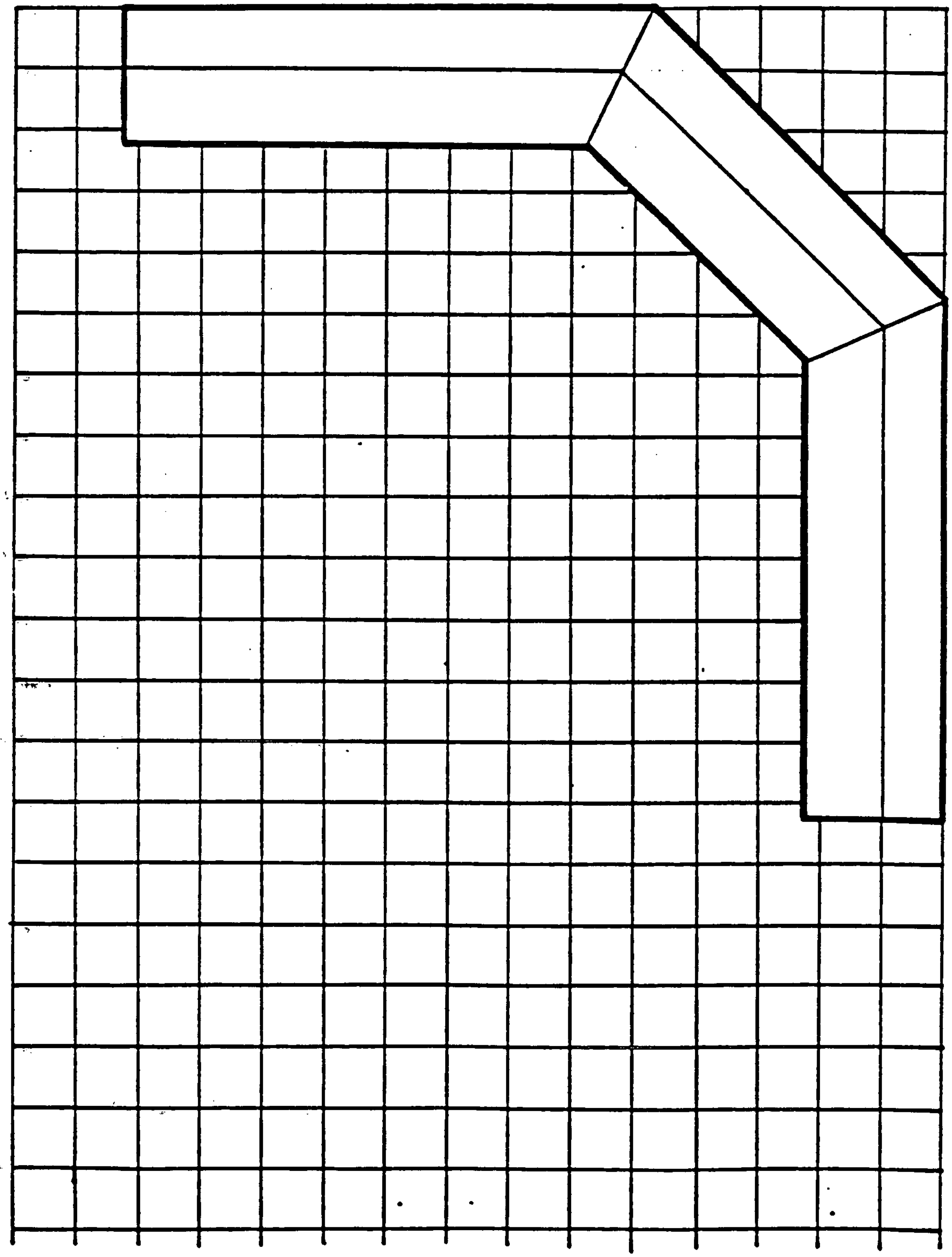
DATE ________ COMMENTS ________



CONTROL ROOM ARRANGEMENT

PLANT/UNIT ________ PROCEDURE ____________________

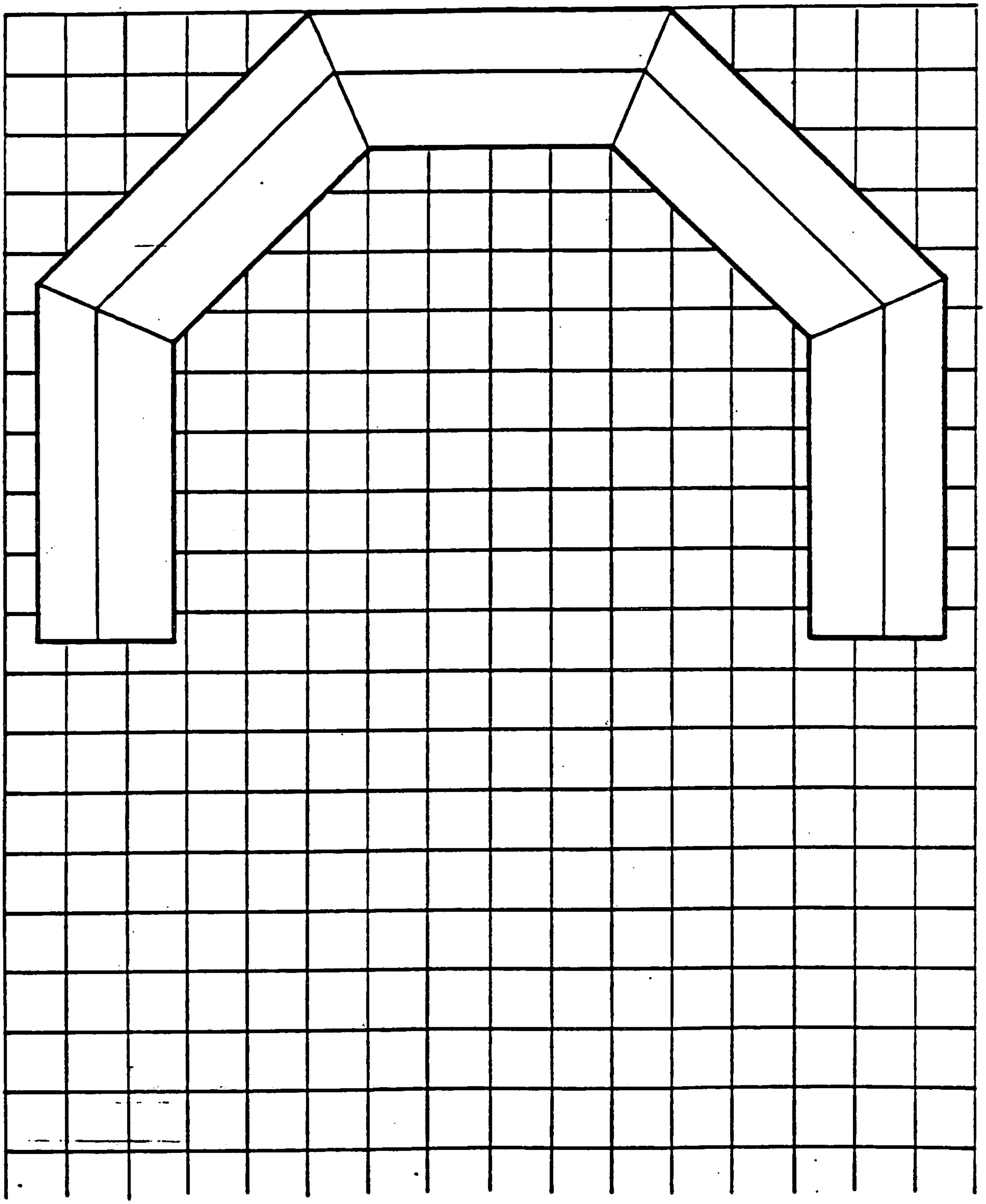
DATE ____________ COMMENTS ____________________



CONTROL ROOM ARRANGEMENT

PLANT/UNIT ________ PROCEDURE ________________________

DATE ________ COMMENTS ________________________



CONTROL ROOM SURVEY

PHOTO LOG

Plant/Unit ______________________________

Photo Number	Panel Number	Checklist Item	Notes

BWR OWNERS' GROUP

CONTROL ROOM DESIGN REVIEW COMMITTEE

HUMAN FACTORS ENGINEERING

CONTROL ROOM SURVEY

SUPPLEMENT

Prepared by: *Ronald S. Bunker* — *8/25/83*
Ronald S. Bunker — Date
Genaral Electric Company

Reviewed by: *G R Mullee* — *8/25/83*
G. R. Mullee — Date
Genaral Electric Company

Approved by: *A. G. Migas* — *9/28/83*
A. Migas — Date
Chairman, Control Room Design Review Committea
BWR Owners' Group

CONTROL ROOM SURVEY SUPPLEMENT

TABLE OF CONTENTS

INTRODUCTION

This supplement is intended to augment Revision 1 of the BWR Owners Group Control Room Survey (CRS) Program dated 1/1/81. It is to be included as part of the Control Room Review Checklists (Section III of the CRS Program) to further document proposed control room enhancements. The additional items listed in the supplement have been drawn from human engineering guidelines recommended in NUREG-0700 and verified through considerable experience of Owners Group Survey teams.

Major sections of the supplement checklists are identified by letters corresponding to section designations used in the original checklists. In order to differentiate between the two numbering systems, an "S" prefix has been assigned to each supplement item.

The CRS Supplement is to be implemented in accordance with the methodology discussed on page 15 of the CRS package. As before, Sections SA, SB, and SC are to be completed for each panel containing controls and displays normally operated by control room operators. The remaining sections apply to the entire control room and therefore need to be completed only once. Sections A, B, and C should also be completed for the remote shutdown panel.

In addition to the attached checklist supplement, several other modifications have been adopted in the CRS Program. These are listed in Table I. All other aspects of the program remain unchanged.

TABLE I

CRS PROGRAM MODIFICATIONS

The following modifications have been implemented in the BWR Owners Group Control Room Survey Program:

- Sections A, B, and C of the Control Room Roview Checklists are to be performed for the ramote shutdown panel in addition to those panels previously recommended.

- A supplement (attached) has been sdded to the Control Room Review Checklists.

- Task analyses and walkthroughs are performed besed upon symptom oriented emergency proceduros developed from the BWR Owners Group Emergency Procedure Guidelines. If plant-specific procedures are not yet available, the gnidelines thamselves should be utilized in the analysis. In this case, existing procedures for a scram, relief valve failure, snd loss of coolsnt sccident should slso be evaluated.

SA PANEL LAYOUT AND DESIGN

SA1 Anthropometrics

SA1.1 Is seeting area adjacent to deska and sit-down consoles sufficient to allow the operator to get into and out of a chair easily and to turn in the chair to view tbe equipment behind (30" laterel space, 36" hetween desk and opposing panal or surface)? 4 3 2 1 0 x 1 = ___

SA1.2 Is sufficient space allowed hetween the panel and opposing surfaces such that the operator may perform required tasks without hindrance? 4 3 2 1 0 x 2 = ___

SA1.3 If the operator is required to see over a stand-up console, does the console height not exceed 58 inches? 4 3 2 1 0 x 2 = ___

SA2 Control Room Layout

SA2.1 Does the location of the shift supervisor's office permit prompt access to the control room under all conditions? 4 3 2 1 0 x 2 = ___

Panel______

SA2.2 Are operator's desks and chairs comfortable and in good repair? 4 3 2 1 0 x 1 = ___

SA2.3 For a multi-unit plant, are senior operators who supervise or assist in the operations of more than one unit stationed such that they may communicate effectively with all operators and view each control board? 4 3 2 1 0 x 2 = ___

SA2.4 Are operators provided with sufficient desk and working space for performance of required tasks? 4 3 2 1 0 x 1 = ___

SA3 Control/Display Grouping

Is the association of feedback indication to related controls made readily apparent through labeling, mimics, demarcation lines or position? 4 3 2 1 0 x 3 = ___

Panel ______

SA4 Labels

SA4.1	Where abstract symbols are used, are they of standard configuration, distinguisheble from other symbels, and consistent in use within and across panels?	4 3 2 1 0 x 2 = ___
SA4.2	Are labels located such that they do not cover or detract from other necessary information?	4 3 2 1 0 x 3 = ___
SA4.3	Is extraneous information not included (e.g., manufacturer's trademark, patent notice, etc.)?	4 3 2 1 0 x 1 = ___

SA5 Unit Integration

SA5.1	For a multi-unit plant, are alarms for shared plant systems duplicated in all control rooms?	4 3 2 1 0 x 3 = ___
SA5.2	For multi-uait plants, if equipment is eharod between control rooms, is there administretive control over use of the equipment?	4 3 2 1 0 x 2 = ___

Panel______

SB INSTRUMENTATION AND HARDWARE

SB1 Indicators

SB1.1	Are indicator scales easily road when stationed at the panel?	4 3 2 1 0 x 3 = ___
SB1.2	Is the use of multiscale and logarithmic scale indicators minimized?	4 3 2 1 0 x 2 = ___
SB1.3	Are displays which reflect only a demand signal labeled accordingly?	4 3 2 1 0 x 3 = ___
SB1.4	Are process units and multipliers specified?	4 3 2 1 0 x 3 = ___
SB1.5	Are drum-type counters readable from the normal viewing position?	4 3 2 1 0 x 3 = ___

Panel______

SB1.6 Are digital displays readable from the normal viewing position?

4 3 2 1 0 x 3 = ___

SB2 Recorders

SB2.1 Is all recorder information visible through recorder windows (i.e. open-door operation not required)?

4 3 2 1 0 x 2 = ___

SB2.2 Do multi-channel recorders clearly dioplay the channel heing plotted?

4 3 2 1 0 x 2 = ___

SB3 Indicating Lights

Have procedural or design provisions been implemented to prevent inter-changiug indicating light lenses?

4 3 2 1 0 x 2 = ___

Panel______

SB4 Switches

SB4.1	Where contiguous legend pushbuttons are used, are barriers provided to prevent inadvertent actuation of adjacent pushbuttons?	4 3 2 1 0	x 3	= ____
SB4.2	Are key-operated switches used only where appropriate (i.e., to prevent unauthorized control actuation)?	4 3 2 1 0	x 2	= ____

Panel______

SC ANNUNCIATORS

SC1 Window Design

Is the density of annunciator matrices such thet the operator may quickly ascertain a window poaition?

4 3 2 1 0 x 3 = ___

SC2 Acknowledgement

Are annunciator response controls coded for ease of recognition (color, shepe, demarcation, etc.)?

4 3 2 1 0 x 2 = ___

SD **COMPUTERS**

SD1 **Console**

Item	Question	Rating		Weight		Score
SD1.1	Do typewriter keyboards conform to the standard "QWERTY" arrangement?	4 3 2 1 0	x	1	=	___
SD1.2	Do numeric keyboards conform to either the "telephone" style or the "calculator" style arrangement?	4 3 2 1 0	x	1	=	___
SD1.3	Do function keyboards contain only those keys which are used by the operetors (i.e. no irrelevent keys such as used by programmers)?	4 3 2 1 0	x	1	=	___
SD1.4	Are function controls segregated from alpha-numeric keys?	4 3 2 1 0	x	1	=	___
SD1.5	Are function controls clearly labeled to indicate their function?	4 3 2 1 0	x	2	=	___

SD2 Capability

SD2.1	Is computer use and software access administratively controlled?	4 3 2 1 0	x 2 = ___
SD2.2	Is the system designed such that data is not lost during printer down periods?	4 3 2 1 0	x 2 = ___

SD3 CRTs

SD3.1	Are CRTs free from glare and easily readable from normal viewing positions?	4 3 2 1 0	x 2 = ___
SD3.2	Are messages which require immediate operator response highlighted to attract the operator's attention?	4 3 2 1 0	x 3 = ___
SD3.3	Are prompts and error messages used to guide the operator in proper system operation?	4 3 2 1 0	x 2 = ___
SD3.4	Are abbreviations, acronyms, and synonyms used consistent with those used elsewhere in the control room?	4 3 2 1 0	x 2 = ___

SD4 Printers

SD4.1	Are printers located in a readily accesible area in the control room?	4 3 2 1 0 x 1 = ___	
SD4.2	De printers heve the capability to record alarm, trend, and plant status data?	4 3 2 1 0 x 1 = ___	
SD4.3	Is the system capable of providing a bard copy of any page appearing on the CRT?	4 3 2 1 0 x 1 = ___	

SE **PROCEDURES**

SE1 Are procedures, reference materials and other documenta readable (i.e. not dirty, torn, dog-eared or otherwise difficult to read)?

4 3 2 1 0 x 3 = ___

SE2 Is a set of computer operating procedures available in the control room describing the computer system, procedures necessary to accomplish operator-computer interface functiona and contingency actiona in the event of a computer failuro?

4 3 2 1 0 x 2 = ___

SF CONTROL ROOM ENVIRONMENT

SF1 Communications

SF1.1	Are periodic maintenance tests performed on all communications sytems?	4 3 2 1 0 x 2 = ___
SF1.2	Is sufficient communications equipment (cords, jacks, etc.) provided in well marked locations?	4 3 2 1 0 x 2 = ___
SF1.3	Is an intercom system provided connecting the control room with the shift supervisor's office?	4 3 2 1 0 x 2 = ___
SF1.4	Are instructions provided for the use of all communications systems?	4 3 2 1 0 x 2 = ___
SF1.5	Are operators trained in the use of all communications systems?	4 3 2 1 0 x 3 = ___

SF2 Lighting

SF2.1	Are local illumination levels at operator desks (e.g., desk lamps) adequate for the tasks being performed (50 footcandles minimum, 100 footcandles maximum, 75 footcandles recommended)?	4 3 2 1 0	x 3 =	___
SF2.2	Is illumination uniform over a given work station and from one station to another?	4 3 2 1 0	x 2 =	___
SF2.3	Is shadowing avoided on panels and other operator work areas?	4 3 2 1 0	x 2 =	___
SF2.4	Have direct sources of glare been avoided (e.g., light emitted from displays and indicators)?	4 3 2 1 0	x 2 =	___

SF3 <u>Emergency Response Equipment</u>

SF3.1	Is operator protective equipment periedically checked?	4 3 2 1 0 x 2 = ___	
SF3.2	Is a sufficient quantity of protective equipment and expendables provided?	4 3 2 1 0 x 2 = ___	
SF3.3	Are instructions provided for the use of protective equipment and expendables?	4 3 2 1 0 x 2 = ___	
SF3.4	Are operators trained in the proper use of protective equipment and expendables?	4 3 2 1 0 x 3 = ___	
SF3.5	Are fire and rescue equipment periodically checked?	4 3 2 1 0 x 2 = ___	
SF3.6	Are instructions provided for the use of fire and rescue equipment?	4 3 2 1 0 x 2 = ___	

SF3.7	Are operators trained in the proper use of fire and rescue equipment?	4 3 2 1 0 x 3 = ___
SF3.8	Is rediation monitoring equipment periodically checked?	4 3 2 1 0 x 2 = ___
SF3.9	Are instructions provided for the use of radiation monitoring equipment?	4 3 2 1 0 x 2 = ___
SF3.10	Are operators trained in the proper use of radiation monitoring equipment?	4 3 2 1 0 x 3 = ___

SG MAINTENANCE AND SURVEILLANCE

SG1 Tags

Are maintenance tags securely affixed to panel components?

4 3 2 1 0 x 2 = ___

SG2 Spare Parts

Are inventories kept for operational spare parts and expendables?

4 3 2 1 0 x 1 = ___

Appendix B. Operator Interview Questionnaires

OPERATOR INTERVIEW
INTRODUCTION TO QUESTIONNAIRE

Job Position ______________________________

Years Experience __________ Commercial Nuclear __________ Fossil

__________ Navy Nuclear

Date of First License __________ RO __________ SRO

Education/Degrees ______________________________

Age __________ Sex __________ Height __________ Weight __________

In response to a post-TMI NRC requirement, your utility is conducting a control room review to identify and correct design deficiencies in the operator-control room interface to minimize the potential for human error. This review is performed by a review team using checklists prepared by the Control Room Improvements Subgroup of the BWR Owners Group.

You are asked to complete the attached questionnaire basing your responses on your operational experience and knowledge of your control room and interfacing systems. You may complete this questionnaire in the control room if you desire, but please do so without discussing your detailed responses with other operators completing this survey. If additional space is needed, the attached Comment Form is to be used.

Folling completion, a survey team representative will review your responses with you. Upon completion of all interviews, the survey team will consolidate the information obtained and apply it in their evaluation of your control room for compliance with human factors engineering principles.

The biographical information requested above will be used in compiling statistics on operating personnel physical characteristics. Current recommendations for panel design are based largely on data obtained from measurements of military personnel; there are few statistics presently presently available on, for example, the average height and weight of operators.

This survey provides you with a valuable opportunity for applying your knowledge and experience toward improving conditions in both your control room and future control room designs. Your honest and forthright opinions are not only welcome, but needed.

OPERATOR INTERVIEW QUESTIONNAIRE

A. Would you recommend any changes in the following areas:

A1 shift coverage

A2 shift turnover

A3 training

A4 color coding

A5 control room access

A6 control panel layout or access

A7 communication systems

A8 heating or ventilation

OPERATOR INTERVIEW QUESTIONNAIRE

A9 lighting or noise levels

A10 special test equipment

A11 maintenance or surveillance testing

A12 data recording and log entries

A13 information flow

A14 furniture, equipment or workspace

A15 computers

A16 other?

OPERATOR INTERVIEW QUESTIONNAIRE

B. Are there any controls difficult to operate?

C. Are any controls designed, positioned or labeled in a manner that causes risk of inadvertent operation?

D. Are any recorders or indicators difficult or confusing to read?

E. Are any important indicators located such that they are difficult to see during normal or emergency operation?

F. Do you feel any control room displays are unnecessary, provide unimportant information or needlessly clutter the control panels?

G. Based on your operational experience, does your control room lack any controls or displays needed in your response to normal or emergency situations?

OPERATOR INTERVIEW QUESTIONNAIRE

H. Do you consider the annunciator system to b effective in conveying important information to you?

I. Do you have any problems locating or using procedures or operational instructions?

J. Are individual responsibilities and chain-of-command clearly understood during all operating conditions?

K. Is there an adequate number of operators available in the control room (or immediately available) to effectively operate the plant during all conditions?

L. Are you required to perform duties that you consider unreasonable or distracting in your responsibilities as an SRO or RO

M. Based on your operational experience, have any errors or incidents occurred which could have been averted through improved control room design?

OPERATOR INTERVIEW QUESTIONNAIRE

N. Have you experienced any problems using or understanding your procedures?

P. Is there a particular panel which you consider more difficult or confusing to operate than the others?

Q. General Comments:

OPERATOR INTERVIEW QUESTIONS

INTERVIEWER:____________________ DATE:____________

INTERVIEWER:____________________

A. Would you recommend any changes in the following areas:

A1 shift coverage

DO YOU FEEL SHIFT COVERAGE SHOULD BE INCREASED? BY WHOM?

A2 shift turnover

ARE THERE TOO MANY PEOPLE IN THE CR DURING SHIFT TURNOVER?

HOW WOULD YOU REOUCE THIS NUMBER?

A3 training.

DO YOU FEEL THAT "OOLIES" DRIVE YOUR TRAINING AND EXAMS?

A4 color coding

A5 control room access

ARE THERE USUALLY TOO MANY PEOPLE IN THE CONTROL ROOM?

A6 control panel layout or access

HOW WOULD YOU CHANGE 1C09?

A7 communication systems

WOULD YOU LIKE TO SEE A MULTI-CHANEL PA SYSTEM?

DO YOU NEED A RELIABLE DEDICATED OPERATIONS PAGE?

A8 heating or ventilation

ARE THERE MAINTENANCE PROBLEMS WITH THE CR HEATING/COOLING SYSTEM?

DO YOU KNOW HOW TO OPERATE THE CR HEATING/COOLING SYSTEM?

A9 lighting or noise levels

WOULD YOU LIKE A RADIO OR BACKGROUND MUSIC IN THE CR?

ARE THE ALARMS IRRITATING OR TOO LOUD?

IS THERE A GLARE PROBLEM?

A10 special test equipment

DO YOU NEED A STORAGE SPACE FOR TEST EQUIPMENT?

DO OPERATORS NEED MORE TRAINING ON TEST EQUIPMENT?

A11 maintenance or surveillance testing

DO YOU FEEL THE PHILOSOPHY OF TESTING LEADS TO EXCESSIVE TESTING?
(TEST 'TIL IT BREAKS)

HOW WOULD YOU CHANGE THE STP PROGRAM?

A12 data recording and log entries

IS THERE A SUPPLY PROBLEM FOR PAPER, BULBS, INK, ETC?

ARE THERE PROBLEMS WITH THE RECORDERS?

A13 information flow

TELL ME ABOUT MANAGEMENT COMMUNICATION WITH OPERATORS.

A14 furniture, equipment or workspace

HOW DO YOU LIKE THE FURNITURE IN THE CONTROL ROOM?

HOW ABOUT WORKSPACE?

HOW ABOUT LOCKERS?

DO YOU NEED A PLACE TO STUDY AND TO EAT?

A15 computers

ARE YOUR COMPUTERS USER-FRIENDLY?

DO YOU NEED MORE TRAINING ON THE COMPUTERS?

ARE THERE TOO MANY COMPUTERS IN THE CONTROL ROOM?

A16 other?

B. Are any controls difficult to operate?

(RWCU, 1C08 SYNCH CONTROL, MODE SWITCH, DIESEL PRELUBE)

C. Are any controls designed, positioned or labeled in a manner that causes risk or inadvertent operation?

TELL ME ABOUT THE ... RHR SPRAY VALVE CONTROL

MSIVs ON 1C03

CONDENSATE/DEMINERALIZER BIPASS

MODE SWITCH

DIESEL GENERATOR CONTROLS

D. Are any recorders or indicators difficult or confusing to read?

E. Are any important indicators located such that they are difficult to see during normal or emergency operation?

WHAT DO YOU THINK ABOUT TORUS AND DRYWELL INDICATIONS?

TELL ME ABOUT THE MET RECORDER.

F. Do you feel any control room displays are unnecessary, provide unimportant information or needlessly clutter the control panels?

TELL ME ABOUT ... MSIVS

RECIRC PUMP SPEED CONTROL

MIDAS

STEAM CONDITIONERS

G. Based on your operational experience, does your control room lack any controls or displays needed in your response to normal or emergency situations?

TELL ME ABOUT ... TORUS, DRYWELL INDICATIONS

GENERATOR CONTROLS

TURBINE LUBE OIL PRESSURE

EHC PRESSURE

FUEL POOL LEVEL INDICATION

H. Do you consider the annunciator system to be effective in conveying important information to you?

ARE THE HORNS TOO LOUD?

TELL ME ABOUT MULTIPLE ALARM SITUATIONS.

WOULD YOU LIKE TO HEAR DIFFERENT TONES FOR DIFFERENT SITUATIONS?

I. Do you have any problems locating or using procedures or operational instructions?

WHAT KIND OF DOCUMENT INDEX WOULD YOU LIKE TO SEE?

J. Are individual responsibilities and chain of command clearly understood during all operating conditions?

ARE THERE PROBLEMS WITH THE EPIPS?

K. Is there an adequate number of operators available in the control room (or immediately available) to effectively operate the plant during all conditions?

ARE THERE ENOUGH OPERATORS TO HANDLE A REAL EMERGENCY SITUATION?

ARE THERE ANY SPECIFIC TASKS OR COMBINATION OF TASKS THAT TEND TO OVERLOAD OPERATING PERSONNEL?

L. Are you required to perform any duties that you consider unreasonable or distracting in your responsibility as an SRO or RO?

M. Based on your operational experience, have any errors or incidents occurred which could have been averted through improved control room design.

TELL ME ABOUT ... POSSIBLE CONFUSION BETWEEN THE CONDENSATE DEMINERALIZER AND THE CONDENSATE PUMP

POSITIONING OF MSIV CONTROLS

ANY INCIDENTS INVOLVING LIFTED LEADS

TORUS LEVEL VIOLATIONS

INADVERTENT STARTING OF THE DIESEL FIRE PUMP

OPEN TIE BREAKER BETWEEN 1B34A and 1B44A WHILE SECURING GENERATOR

N. Have you experienced any problems using or understanding your procedures?

ARE THE NEW EOPS ADEQUATE?

ARE THE NEW EOPS AN IMPROVEMENT OVER THE OLD EMERGENCY PROCEDURES?

P. Is there a particular panel or system which you consider more difficult or confusing to operate than the others?

TELL ME ABOUT ... 1C09, ACCIDENT MONITOR PANEL

1C23, MAIN PLANT HVAC

1C06, CONDENSATE AND FEED

1C25, STANDBY GAS TREATMENT

Q. General Comments:

WHAT DO YOU THINK OF THE OVERALL APPEARANCE OF THE CR.

ADDITIONAL OPERATOR INTERVIEW QUESTIONS

OER 1. Do you feel that your technical specifications are "laid out" to allow quick reference for operational decisions? How often do you encounter situations where inadequate Tech Spec guidance results in unnecessary limiting condition(s) for operation declarations?

OER 2. Reviewing historical LERs, it is apparent that spurious Group V isolations are a common problem as well as Standby Filter Unit spurious initiations. Please identify other recurrent system or operational distractions that could be improved or eliminated.

OER 3. A significant number of LERs are generated due to maintenance activities during STPs. Can you offer suggestions that could improve the conduct of the STP program and PMARs with relation to operational personnel involvement?

OER 4. Can you point out any deceptive feedback indication that should be improved for any system or parameter? Please include common annunciators that should be separated into individual ones. (i.e. A & B, HI/LO, etc.)

OER 5. During outages it is apparent that the high number of maintenance and operational activities require additional manpower and/or "special control" over work to insure safe and efficient conduct of many activities. Please provide suggestions to improve this situation.

OER 6. Are there any annunciator windows that you feel are useless and could be removed? Any that give you misleading information (either alone or in combination with others) in pursuit of a problem solution?

OER 7. Tell us what you think of your annunciator system. Are there any things you would like to see changed? (i.e. alarm groupings, color codes, sound, etc.)

OER 8. Have you walked through the EOP-6 procedural steps, in the plant, as part of your plant training? Do you feel you can safely shutdown the plant from the remote shutdown panel using EOP-6?

OER 9. Are recent procedural changes covered on shift and/or during training week?

OER 10. Please discuss in general the improvements you think should be made int he plant documentation area (P&IDs, electrical schematics, component information, M-400, etc.).

1. Does more than one component identification system present problems (G.E. / Bechtel / Vendor)? Suggest improvements.

2. Is your resource documentation in the control room accurate? Adequate? Suggest changes.

3. Does more than one system designation for plant systems present problems in operation, maintenance, or communication? Suggest improvements

OER 11. Can you identify specifically or generally any parameter feedback that you think is inadequate (within the control room and back panels)?

OER 12. Are there any control or feedback actions / indications that require more personnel than should be required? Are there any "poorly positioned" controls / indications that you would liked changed?

OER 13. In general, are your panels labelled and identified accurately to avoid confusion during plant maneuvers?

1. Does training have to spend time "making up" for control room shortcomings by "training around" inherent problems that could be changed?

Appendix C. Correction Summaries

SHORT TERM ENHANCEMENTS

1. Step stools will be provided in the back panel area of the control room to aid operators in using controls and displays outside of recommended anthropometric limits.

2. An acronym and abbreviation list has been developed for use at the DAEC and will be implemented in labeling and procedure development.

3. Control room panels and components will be relabeled. The labels will incorporate the following human factors considerations:

   a. Component or panel identification number;

   b. Component or panel funtional description;

   c. Succinct and accurate wording;

   d. Component setpoint information, as appropriate;

   e. Hierarchical letter sizes;

   f. Consistent letter sizes;

   g. Hierarchical labels for grouped components;

   h. Consistent location of labels; and

   i. Consistent label sizes.

4. Labels for vital instrumentation will include a special code for easy identification.

5. Documents which are posted on the panels will be replaced with permanent placards where feasible.

6. Applicable control room panels will be remimicked. The mimics will incorporate the following human factors considerations:

   a. Consistent color conventions;

   b. Hierachical mimic sizes;

   c. Consistent equipment symbols; and

   d. Engraved mimic material.

7. Panel area demarcation or color patching will be provided.

8. Annunciator windows will be replaced. The replacement annunciator windows will incorporate the following human factors considerations:

a. Succinct and accurate wording;

b. Component setpoint information, as appropriate; and

c. Consistent letter sizes;

9. Panel drawings will be revised to reflect "as-built" condition.

10. Meter, indicator, and recorder scales will be replaced and revised, as appropriate.

11. Meter, indicator, and recorder scales will be color banded, as appropriate.

12. Special instructions for panel cleanup, hole patching, and painting will be developed and implemented.

13. Plant procedures will be upgraded, as appropriate, to reflect implemented corrections.

14. Switch escutcheons and bezels will be replaced, as appropriate.

15. The use of temporary tape will be minimized and controlled, as needed.

16. Tactile coding of cane handle switches will be provided.

17. A torque multiplier will be provided for use with difficult-to-operate thumbswitches.

18. The telephone cords for the telephones on 1C-22 will be replaced with retractible cords of sufficient length to perform their intended function.

19. The ENS telephone will be replaced with a red phone.

20. The red telephone on 1C-22 will be replaced with a telephone of a different color.

21. Miscellaneous housekeeping activities will be performed for the following:

a. Control room key locker;

b. Control room Health Physics locker;

c. Alternate Shutdown storage cabinet; and

d. General control room area.

22. An additional set of keys for the Alternate Shutdown panel will be provided to the DAEC Central Alarm Station.

23. Audible alarms will be adjusted to conform to human factors standards.

24. Maintenance activities will be performed for calibrating existing instrumentation and limit switches to provide instrument performance consistent with human factors considerations (e.g., both indicating lights on during a throttling condition).

25. Light diffusers will be installed in the Alternate Shutdown area to reduce glare.

26. A timer will be provided for use at the Alternate Shutdown area.

27. A consistent use of color coding for the pens of chart recorders will be implemented.

28. Maintenance activities will be performed for replacing or repairing non-essential parts of control room components.

29. Covers will be provided for components which could be inadvertently operated.

30. Pushbutton legend lights will be coded with a solid black line at the bottom of the bezel.

31. The "B" Diesel Generator will be renamed as 1G41.

32. The uninterruptible Motor/Generator set will be renamed.

33. A spare synch switch handle will be provided within easy access of the control room.

Long Term Enhancements 1C02 Area and Process Radiation Recording

1. The radiation recorders on 1C02 will be rearranged to group related components. This correction has been incorporated into existing design modifications, DCP 1293 and DCP 1363, which are in progress at the DAEC.

Long-Term Enhancements 1C03 Emergency Core Cooling System

1. A positive indication of valve open, an amber light, will be added to the Safety Relief Valve controls on 1C03. These indications will be driven by the installed pressure switches associated with each valve. In addition, these pressure switches will provide annunciator input to the "ADS/Safety Valve Leaking" annunciator.

2. The square root converter for HPCI pump discharge flow, FY-2309, and the power supply for the HPCI turbine governor test, ES-2257, will be moved from 1C03 to a back panel in the control room.

3. Two divisional indicators for narrow range RPV Pressure (0 - 250 psig) will be added to 1C03. Two divisional indicators for wide range RPV Pressure (0 - 1500 psig) will be added to 1C03. These indicators will be grouped together and located above the existing PASS controls on 1C03.

4. Two divisional indicators for wide range Torus Water Level (0 - 30 ft.) will be added to 1C03. Two divisional indicators for Drywell Water Level (-20 to 80 ft.) will be added to 1C03. These indicators will be grouped together and located above the existing PASS controls on 1C03.

5. An indicator for Average Drywell Air Temperature (0 - 350 degrees F) will be added to 1C03. An indicator for Average Torus Air Temperature (0 - 350 degrees F) will be added to 1C03. These indicators will be grouped together and located above the existing PASS controls on 1C03.

6. A two-pen recorder for narrow range Torus Water Level (0 - 100 %) and Average Torus Water Temperature (20 - 220 degrees F) will be added to 1C03 above the HPCI controls.

7. Two divisional indicators for wide range Torus Pressure (0 - 65 psig) will be added to 1C03. Two divisional indicators for wide range Drywell Pressure (0 - 65 psig) will be added to 1C03. These indicators will be grouped together and located above the existing PASS controls on 1C03.

8. A keylock switch will be installed on 1C03 for overriding the minimum flow valve interlock for HPCI with HPCI not running. This switch will be located above the control for the HPCI Minimum Flow Valve, MO-2318.

9. Keylock switches will be installed on 1C03 for overriding the RHR Service Water pump running logic for operating the RHR Service Water flow control valves, MO-1947 and MO-2046, while the RHR Service

Water pumps are not running. Positive indication of the override status, a lit amber light, will be provided with each keylock switch. These switches will be located near the associated RHR Service Water flow control valve controllers, PDIC-1947 and PDIC-2046.

10. An indication of time to ADS initiation will be installed on 1C03. This indication will be located above the ADS system controls on 1C03.

11. An indication of narrow range Drywell Pressure (-5 to 5 psig) will be added to 1C03. An indication of narrow range Drywell to Torus delta Pressure (-.5 to ~1.6 psig) will be added to 1C03. These indicators will be grouped together and located above the existing ADS system controls on 1C03.

12. The indicator for Jet Pump developed head, PDI-4567, will be removed from 1C03.

13. The actuator indicating lights for testable check valves CV-1906, CV-2002, CV-2118, CV-2138, and CV-2313 will be removed. The actuators for these check valves are no longer in service.

14. The RPV head vent flow indicator, FI-1930, on 1C03 will be replaced with an indicator with a 0 - 400 gpm scale.

15. The existing keylock switches for the Containment Spray to the Drywell valves, MO-1903 and MO-2001, will be replaced with cane handle handswitches tactilely coded as throttling valves. The existing cane handle handswitches for the Containment Spray to the Drywell valves, MO-1902 and MO-2000, will be replaced with keylock handswitches and labelled as seal-in valves.

16. The keylock switches for the RHR Heat Exchanger inlet valves, MO-1939 and MO-2029, will be replaced with cane handle handswitches tactilely coded for throttle valves.

17. The Primary Containment Isolation System mimic on 1C03 will be rearranged to be consistent with associated controls on the benchboard.

18. An engineering study will be performed to investigate the requirements and use of the RHR Service Water controllers on 1C03, DPIC-1947 and DPIC-2046. These controllers will be replaced or modified based on the results of this study.

19. An engineering study will be performed to investigate the requirements and use of the HPCI vibration monitor on 1C03. This monitor will be replaced or removed based on the results of this study.

Long-Term Enhancements 1C04 Reactor Recirculation and Reactor Water Cleanup

1. A Primary Containment Isolation System status board will be provided on 1C04. This status board will include indications of group isolation initiation and group isolation accomplishment.

2. The Recirculating Pump Seal "Mini-purge" valve controls will be relocated on the 1C04 benchboard from the right side of the panel to adjacent to the Recirculating pump controls. Demarcation of the Mini-purge valve controls will be provided.

3. The annunciator Acknowledge/Test pushbuttons for 1C04 will be relocated to between the handswitches for RCIC CV-2436 and DW Floor Drain Pump HS 1P-36B on the 1C04 benchboard and demarcated.

4. The square root converter for RCIC pump discharge flow, FY-2509, and the power supply for RCIC turbine test, ES-2462, on the vertical board of 1C04 will be relocated to the RCIC relay panel, 1C30.

5. The Reactor Recirculation Pumps voltage indicators, EI-9235 A&B, will be replaced with indicators that have a range of 0 - 5000 VAC to be consistent with present system design characteristics.

6. The actuator indicating lights for the testable check valve, CV-2513, will be removed. The actuator for this check valve is no longer in service.

7. Circuitry for the "Power Available" indicating lights on 1C04 for Recirculating pump Lube Oil Pumps will be modified to ensure consistent use of the green, amber, and red indicating lights.

8. The auto function of the Recirculating Pump Speed Controllers on 1C04, SIC 9245 A&B, will be disabled and removed. The deviation meters for these speed controllers will be modified to provide an accurate indication of deviation between speed demand and actual speed. Prior to resolving the deficiencies associated with the above speed controllers, an engineering evaluation will be performed to determine if the replacement of these controllers is a more effective correction.

9. An amber indicating light will be installed above the Recirculation Pump motor-generator set fluid coupler handswitches on 1C04 such that when the fluid coupler is locked, the amber light will be lit indicating an "unavailable" state.

10. The alarm relay for the Reactor Water Cleanup Hi/Lo Pressure annunciator window will be interlocked with the MO-2731 and MO-2732

valve position limit switches such that "full closed" states will result in bypassing this alarm.

11. An engineering study and subsequent modification will be performed for providing Heatup/Cooldown rate indication on 1C04.

12. A Spent Fuel Storage Pool level indicator will be provided on 1C04 next to the Reactor Vessel Flood Up level indicator, LI-4541.

Long-Term Enhancements 1C05 Reactor Control

1. The keylock switch on 1C05 for controlling the "A" and "B" Standby Liquid Control pumps will be replaced to incorporate switch positions associated with "OFF" or "BOTH PUMPS ON". This correction has been incorporated into an existing design modification, DCP 1353, which is in progress at the DAEC.

2. An indicator for Standby Liquid Control system flow will be added to 1C05. This correction has been incorporated into an existing design modification, DCP 1353, which is in progress at the DAEC.

3. The "A" Scram pushbutton will be relocated to minimize inadvertent actuation. This correction has been incorporated into an existing design modification, DCP 1353, which is in progress at the DAEC.

4. The locations for the A and B CRD Pump Start/Stop handswitches will be swapped so that their relative locations will be consistent with human factors criteria. in addition, the reactor pressure (PI-4563, 4564, and 4565) and level (LI-4559, 4560, and 4561) indicators on 1C05 will be rearranged in A, B, C order.

5. The Master Recirculating Flow Controller, SIC-9243, will be removed from 1C05.

6. The SRM/IRM drive logic will be modified to a "seal-in" logic to eliminate the need for the operator to constantly hold down the pushbutton during insertion.

7. The CRD drive water Differential Pressure indication range will be modified to 0 - 500 PSI to provide operators with a useful indication during rod adjustment. The new scale will be redbanded from 350 - 500 PSI to indicate an abnormal condition.

8. A display will be added to the upgraded Plant Process Computer which will graphically depict a full core display of rod positions.

9. The logic for the "Retract Permit" legend light on 1C05 for the SRM/IRM drive controls will be modified to provide a "Retract Not Permit" legend light. This modification will provide an indication (light on) when the detectors are to remain inserted.

10. The Group 8 Isolation function will be eliminated.

Long-Term Enhancements 1C06 Feedwater and Condensate

1. The Emergency Service Water flow indicating controllers on 1C06, FI-4938A and FI-4938B, will be replaced with flow indicators with a range of 0 - 1500 gpm.

2. The handswitch for the condensate demineralizer bypass valve on 1C06, MO-1708, will be relocated so that it is physically separated from the condensate pump handswitches.

3. The non-functional logic lights for the River Water Supply pumps will be removed. These indicating lights are currently located above HSS-2911A and HSS-2911B on 1C06.

4. The conductivity recorder on 1C06, CR-1514, will be replaced.

5. An indication of conductivity for condensate demineralizer input and output will be added to 1C06.

6. The locations of the River Water Makeup flow indicators on 1C06, FI-4916 and FI-4917, will be swapped.

7. The locations of the River Water Makeup flow recorders on 1C06, FR-4916 and FR-4917, will be swapped.

8. The locations of the Radwaste Dilution flow indicator, FI-4909A, and the General Service Water discharge header pressure indicator, PI-4903, on 1C06 will be swapped.

9. The handswitches on 1C06 for the Radwaste Dilution line test valves, HS-4910A and HS-4910B, will be replaced with cane handle handswitches. In addition, the indicating lights associated with these handswitches will be relocated so that the red light is to the right.

10. The well water system controls with indicating lights on 1C06 will be relocated and grouped with the well water controls and indicators on 1C23. Redundant indicating lights will be provided on 1C06.

11. The indicating lights on 1C06 for the Reactor Feedwater Pump recirculating valves, HS-1569 and HS-1611, will be relocated so that the red light is to the right.

12. An engineering study will be performed to determine the maximum Reactor Feedwater Pump recirculating flow requirements. The valve opening of the Reactor Feedwater Pump recirculating valves will be restricted accordingly.

Long-Term Enhancements 1C07 Turbine Control

1. An EHC pressure indicator will be provided on 1C07 and grouped with the existing EHC indicators.

2. An existing handswitch, HS-1100, which is no longer in service will be removed from 1C07.

3. Controls for operating the condenser vacuum breakers will be provided on 1C07. These controls will be placed below the condenser vacuum pump controls on 1C07.

4. A two-pen recorder will be provided above the rightmost computer trend recorder for recording Turbine Lube Oil temperature and pressure.

5. The Lift Pump logic associated with the lift pump logic indicating lights on 1C07 will be modified to indicate red lights on when power is supplied to the pump and the pump discharge pressure is adequate.

6. All full scale steam pressure indication on 1C07 will be modified to provide 0 - 1200 psig indication. This correction has been incorporated into an existing design modification, DCP 1367, which is in progress at the DAEC.

7. The Turbine Log light will be removed due to present conduct of operation associated with full-arc admission.

8. The rightmost two pushbuttons with indicating lights for the EHC load selector will be removed. The DAEC does not use the Automatic Dispatch System.

9. The following components on 1C07 will be rearranged in an effort to more adequately meet human factors criteria:

   a. The position of the EHC pump ammeters will be relocated so that the ammeter for 1P-97A is left of 1P-97B.

   b. Pressure indicators PI-1012 and PI-1013 will be relocated so that CIV-1 is left of CIV-2.

   c. The condenser vacuum indicators will be relocated so that 1C1B is left of 1C1C.

   d. The MSR drain tank pressure indicators will be rearranged to A 1st Stage, A 2nd Stage, B 1st Stage, B 2nd Stage when reading from left to right.

e. The Air Ejector pressure indication will be relocated so that 8A is left of 8B.

f. The Lift Pump handswitches will be rearranged in the following order: A, B, C first row; D, E, F second row. This arrangement is consistent with the lift pump test selector switch and indicating lights.

g. The computer trend recorders (or inputs) will be rearranged so that the pens are channel 1, 2, 3, 4 when reading left to right.

h. The Off-gas flow recorder inputs will be modified so that the "A" pen is above the "B" pen and appropriate colors are used.

i. The Turbine Exhaust Drains controls with indicating lights, the 2nd Stage Auxiliary Steam Isolation control, the 2nd Stage MSR controls with indicating lights, and the Auxiliary Steam Isolation control will be relocated to group controls of related systems.

j. The MSR controls with indicating lights will be grouped such that the pairs of associated indicating lights are in an A/B vertical order.

Long-Term Enhancements 1C08 Generator and Auxiliary Power

1. The frequency and voltage adjust hand controls for both diesels will be modified so that the "lower" adjustment is to the left and the "raise" adjustment is to the right.

2. An adjustable timer will be provided on 1C08 next to the prelube pushbutton for lubricating the diesels for up to 5 minutes. The existing pushbutton will be used to start the prelube for the amount of time prescribed on the timer.

3. The white lights associated with the 480V Breaker controls on 1C08 will be modified to be illuminated when the breaker is operable.

Long-Term Enhancements 1C09 Containment and Accident Monitoring

1. Two bays of six annunciator windows will be added to 1C09.

2. Two sets of annunciator Acknowledge and Test pushbuttons will be added to 1C09.

3. The wide range RPV Pressure recorders, PR-4599A and PR-4599B, will be replaced and relocated. The new recorders will be used as both a recorder and an indicator.

4. The wide range and narrow range Drywell Pressure recorders, PR-4398A and PR-4398B, will be replaced and relocated. The existing wide range and narrow range Drywell Pressure indicators will be removed from 1C09. The new recorders will be used as both a recorder and an indicator.

5. The wide range Torus Water Level and Drywell Water Level recorders, LR-4397A and LR-4397B, will be replaced and relocated. The new recorders will be used as both a recorder and an indicator.

6. The Drywell Oxygen and Hydrogen Concentration recorders, AR-4381 and AR-4382, will be replaced and relocated.

7. The Containment High Range Radiation recorders, RR-9184A and RR-9184B, will be replaced and relocated.

8. The following indicators will be moved from 1C09 to 1C03:

   a. Two divisional wide range RPV Pressure indicators.

   b. Two divisional Drywell Water Level indicators.

   c. Two divisional wide range Torus Water Level indicators.

9. A green "OFF" status light will be added to the hydrogen / oxygen analyzer heater switch and indicating unit to ensure consistent use of red and green indicating lights.

Long-Term Enhancements 1C14 Main Steam Isolation Valve Leakage Control System

1. The keylock switch for the Main Steam Isolation Valve Leakage Control System power on 1C14, HS-1379, will be modified such that the key will be removeable in a normal state.

Long-Term Enhancements 1C15 Trip System A, Reactor Protection System

1. A keylock switch with amber indicating light will be provided on 1C15 for bypassing the Lo-Lo-Lo Reactor Water Level interlock with the Main Steam Isolation Valves.

Long-Term Enhancements 1C17 Trip System B, Reactor Protection System

1. A keylock switch with amber indicating light will be provided on 1C17 for bypassing the Lo-Lo-Lo Reactor Water Level interlock with the Main Steam Isolation Valves.

Long-Term Enhancements 1C20 Turbine Plant Instrumentation

1. The GMAC controllers for the dump valves will be modified to indicate 0 - 100% open from left to right.

2. The Turbine Bearing and Bearing Drain Temperature recorder on 1C20, TR-3127, will be replaced. Selected points from the other multi-point recorders on 1C20 will be added to the plant process computer for display in the control room.

Long-Term Enhancements 1C23 HVAC - Reactor Building and Main Plant System

1. The indicator banks on 1C23 will be rearranged to group related systems variables.

2. Handswitch HS-5928 will be removed from 1C23.

3. The annunciator "Acknowledge/Test" pushbuttons on 1C23 will be rearranged to be consistent with the other annunciator pushbuttons in the control room.

4. The PASS system damper indicating lights on 1C23 will be relocated to above the associated key-locked isolation switches on 1C24.

5. The well water system controls/indicating lights on 1C06 will be relocated and grouped with the well water controls and indicators on 1C23. Redundant indicating lights will be provided on 1C06. In addition, well water controls which are currently inside 1C23 will be relocated and grouped with the associated components on 1C23.

Long-Term Enhancements 1C24 Standby Gas Treatment System

1. The PASS system damper indicating lights on 1C23 will be relocated to above the associated key-locked isolation switches on 1C24.

Long-Term Enhancements 1C25 Drywell Ventilation and Nitrogen Inerting

1. The components on 1C25 will be rearranged to group related components. This correction has been incorporated into an existing design modification, DCP 1341, which is in progress at the DAEC.

Long-Term Enhancements 1C26 HVAC - Turbine Building and Control Room System

1. The annunciator "Acknowledge/Test" pushbuttons on 1C26 will be relocated to a more operable location of the panel.

2. The battery ventilation controls on 1C26 will be relocated and grouped together.

3. The hot water heating controls on 1C26 will be relocated and grouped together.

Long-Term Enhancements 1C29 Instrumentation Air Isolation Valves

1. Equipment status indicating lights will be added and grouped with the Drywell Sampling Main and Auxiliary Pump controls, HS-8137A&B and HS-8142A&B, on 1C29. These pushbutton switches will be replaced with thumbswitches.

2. A white "Power On" indicating light will be added above the power-off Drywell Sampling Main Pump controls, HS-8139A&B.

3. The inputs for the Nitrogen Pressure and Torus Level recorder, LR-4384, will be switched so that the channels will agree with the redundant recorder, LR-4385.

Long-Term Enhancements 1C34 Off-Gas System

1. Pressure indicators, PI-4172 and PI-4130A, on 1C34 will be replaced with indicators with scales of 0 - 30 psia.

2. The GMAC controllers on 1C34 will be modified such that the demand signals are displayed as 0 - 100% open from left to right.

Long-Term Enhancements 1C40 Fire Protection

1. An engineering evaluation will be performed with regard to needed improvements to the Fire Protection/Alarm and annunciation system, identification of the location of the alarm, type of alarm, and alarm acknowledgement methods. The feasibility of displaying Area Fire Plans will be evaluated for the plant process computer terminals in the control room. These displays will incorporate dynamic and manual fire detection capabilities to be provided by the plant process computer. The results of this study will be incorporated into an extensive upgrade of 1C40 and its associated panels.

2. An indication of Fire System Header Pressure will be added to 1C40.

Long-Term Enhancements 1C43 Division I Core Spray Relays

1. A switch, E21-13A, will be removed from 1C43. This correction has been incorporated into an existing design modification, DCP 1343, which is in progress at the DAEC.

Long-Term Enhancements Division II Core Spray Relays

1. A switch, E21-13B, will be removed from 1C44. This correction has been incorporated into an existing design modification, DCP 1343, which is in progress at the DAEC.

Long-Term Enhancements 1C208 Remote Shutdown

1. The disconnected relief valve switches in 1C208 will be removed. Upon removal of those switches, the RCIC pump transfer switch in 1C208 will be reevaluated for ease of operation and modified, as appropriate.

2. An engineering study will be performed to evaluate the requirements for adding a RCIC flow indicator to 1C208.

Long-Term Enhancements 1C341 KAMAM Display Terminal

1. The transfer of the display functions of this terminal to the plant process computer terminals in the control room will be evaluated.

Long-Term Enhancements 1C388 Remote Shutdown

1. The Diesel Generator controls on 1C388 will be replaced with controls which are identical with the associated controls on 1C08. In addition, these controls will be consistent with respect to direction of movement with the associated controls on 1C08.

2. A 24-hour clock will be installed adjacent to 1C388.

3. The lighting in the area of 1C388 will be enhanced to ensure adequate lighting is available.

Long-Term Enhancements 1C407 Remote Shutdown

1. The functions of the SPDS will be incorporated into the plant process computer. This correction has been incorporated into the design modifications associated with the upgrade of the existing plant process computer system in progress at the DAEC.

2. The available SPDS displays will be expanded to include the graphs associated with the Emergency Operating Procedures (EOPs).

Long-Term Enhancements Annunciators

1. The annunciator system will be modified to incorporate color-coding for prioritizing alarms.

2. The annunciator system will be modified so that annunciator windows are relocated and grouped appropriately above related controls and indicators.

3. The annunciator system will be modified to minimize the occurrence of dual function annunciators.

4. The inputs to the annunciator system will be modified so that no annunciator windows are illuminated during normal operation.

5. The annunciator system will be modified so that each annunciator window has all the appropriate inputs associated with the alarmed state.

6. An engineering study will be performed to evaluate the feasibility of incorporating a "reflash" capability for annunciators with multiple inputs, to evaluate methods for discriminating visual alarms (e.g. distinguishable flash rates), to evaluate the feasibility of inhibiting "nuisance" alarms, and to evaluate methods for discriminating audible alarms (i.e. distinguishable tones by location). The annunciator system will be modified in accordance with the results of the engineering study.

7. The back panel trouble alarm logic will be modified to require a single alarm for annunciation on the front panels of the control room.

Long-Term Enhancements General

1. Human factors standards, which are specific to the DAEC, have been implemented to ensure consistency is maintained in all design activities for the DAEC. These standards address the following human factors considerations:

   a. Anthropometrics;

   b. System and component labeling;

   c. Panel demarcation;

   d. System mimicking;

   e. Color-coding standard;

   f. Controls standards;

   g. Displays standards;

   h. Annunciator system standards;

   i. Communication systems standards;

   j. Lighting standards;

   k. Noise standards; and

   l. Computer systems and display standards.

2. A Control Room atmospheric monitor will be installed to aid the Shift Supervisor in determining the habitability of the control room.

3. Control room lighting will be improved.

4. Selected operations department displays will be incorporated into the available displays for the plant process computer system.

5. A staff member will be designated as a liaison between the computer services and operations groups at the DAEC.

6. A management review of staffing practices and requirements for the control room will be performed with regard to the increased burdens imposed on operators by expansions in surveillance and ASME testing programs as well as regulatory requirements. Staffing levels will be modified based on the results of the review.

7. Training curriculum will be expanded to include more emphasis on interpreting plant drawings, specifically electrical prints.

8. A plant specific simulator will be provided for the DAEC.

9. Controlled access (egress only) through the back door of the control room will be provided for operation staff.

10. Push-to-test light sockets will be provided for amber lights. Administrative procedures for periodic testing of these indicating lights will be implemented.

11. All controllers with integral valve position indication will be modified as appropriate to indicate 0 (closed) - 100% (open) from left to right.

12. Analog and impact-printing multipoint chart recorders will be replaced with current technology instrumentation. Recorders which are used for determining plant performance during normal and emergency plant operation will be given priority for replacement. Recorders which are seldomly used will be replaced based on increases in maintenance activities. Preventive maintenance activities will be performed during the period prior to replacement.

13. A new plant paging system will be installed with facilities for multiplexed communications, a dedicated channel for operations use, and the capability for prioritizing the use of the system by page location. Page speakers will be added for the back panel area of the control room. This correction has been incorporated into an existing design modification, DCP 1348, which is in progress at the DAEC.

14. Engineering studies will be performed in an effort to resolve the following operational concerns:

    a. The RHR injection valves are difficult to use for controlling shutdown cooling flow due to their throttling characteristics in combination with isolation closure requirements.

    b. The repressurization of the Reactor Water Cleanup System is difficult to perform due to the high differential pressure across MO-2700 which affects its throttling characteristics.

    c. It is difficult to finely adjust the Control Rod Drive pressure control valves.

    d. MO-2112 and MO-2131 and valves used during RHR testing are difficult to operate within required precision to accommodate testing requirements.

    e. Sound quality of the existing radio system limits its use. In addition, an improved intercom system between the control room front and back panel areas will be integrated to improve communications capabilities in the control room.

Appendix D. Non-correction of HEDs

Non-correction of HEDs

This Appendix briefly describes the justifications for not correcting or partially correcting HEDs with Assessment priorities of 1 to 6. Although the Correction Verification documentation provides justification for non-correction or partial correction of all HEDs, non-corrected or partially corrected priority 7, 8, or 9 HEDs are not provided with justification in this Appendix due to their minimal impact on the operation of the plant. Priority 9 HEDs were assessed as insignificant with respect to effect on operator performance and the potential for inducing error. In addition, any potential error associated with a priority 9 HED would have no serious consequences. Priority 7 and 8 HEDs are not provided with justification in this Appendix because potential errors associated with these HEDs have no serious consequences and could not result in an unsafe condition or Technical Specification violation.

A/C 003-023 Priority 4 HED S-003-100

Description of HED:

The ADS timer override switches are actuated by pushing to reset or pushing and turning to lockout. This action is unique to these switches in the DAEC control room. The actuation is not properly denoted on permanent labels.

Justification of partial correction:

The actuation of these switches, although unique, does not detract from the operator's ability to safely operate these controls. Adequate labelling of the switches' operation along with training enhancements will mitigate the effects of this HED. Additionally, A/C 003-054 provides correction to add visible 'time remaining' indication associated with the use of this switch.

A/C 003-039 Priority 4 HEDs T-003-080
T-003-094

Description of HED:

The EOPs require that the operator determine the adequacy of the torus parameters to accept the blowdown and reject heat from the SRVs lifting. Task analysis recommends that the following indications be provided:

1. An indication of the torus air space for containing noncondensible gases be provided and an alarm be provided when less than the minimum required is available.

2. An alarm on loss of the torus' ability to condense blowdown steam.

3. A 'Torus Adequacy' indicator to guage the torus' heat sink capability.

4. An indicator showing the difference between the actual heat removal required and the torus heat rejection capacity.

Justification for non-correction

The addition of the specific indicators listed above is not considered feasible; therefore, the deficiencies were partially corrected. The following corrections were recommended to mitigate the consequences of these deficiencies:

1. Install an indication of Average Torus Water Temperature and narrow range Torus Water Level on 1C03 with a trend recorder which is colorbanded for abnormal conditions.

2. Install Drywell to Torus Differential Pressure indication on 1C03.

3. Provide displays of Heat Capacity Temperature Limit and Heat Capacity Level Limit for the torus on the SPDS.

4. Provide a display for Torus Level Limit on the SPDS.

Given the above recommendations in combination with other recommended corrections for 1C03, adequate information is available for mitigating the consequences associated with this deficiency. Therefore, the addition of unique indication of "Torus Adequacy" is not required.

A/C 003-047 Priority 4 HED T-003-032

Description of HED:

From a requirement in OI 52 (as called from the EOPs) that HPCI turbine vibrations be monitored and excessive vibrations be identified, it was recommended that high HPCI turbine vibrations be alarmed on 1C03.

Justification for non-correction:

There currently exists a HPCI turbine vibration recorder on 1C03, XVR-2283 and a HPCI Turbine vibration monitor, located directly above. The OI identifies the level of vibration that is considered 'excessive'. HPCI controls are located at 1C03, where the recorder is easily viewed. An audible alarm is not considered necessary as level is easily determined using the existing recorder. An engineering study has been initiated to review the adequacy of both the monitor and recorder.

A/C 003-050 Priority 4 HED T-003-005

Description of HED:

Controls for the Containment Spray Valves are recommended for both the RHR and CAMP (Containment Accident Monitoring Panel) panels by task analysis. The controls exist on 1C03 within the mimic layout with other RHR controls.

Justification for non-correction:

The Containment Spray valves are most appropriately located within the existing mimic layout on 1C03. Associated indication and feedback of containment parameters (pressure, levels) has been recommended to be provided on 1C03 adjacently located on the vertical board providing the best control/feedback arrangement for containment spray operation.

A/C 003-053 Priority 4 HED T-003-056

Description of HED:

OI 49 (as called from the EOPs) requires the determination of whether a sufficient heat sink is available through RHRSW to provide adequate cooling of RHR. Task analysis recommends that this determination be based on RHRSW pressure and flow. Indication of RHRSW flow exists on 1C03. There is no RHRSW pump discharge pressure indication to aid in determining whether RHRSW pressure is sufficient to maintain design flow through the RHR heat exchangers and to provide adequate torus cooling.

Justification for non-correction:

Periodic surveillance testing of the RHRSW system ensures that adequate pressure and flow are available to meet the requirements of the DAEC Technical Specifications. Among the bases for the Tech. Spec. limits are the provision of adequate heat rejection capability for cooling via the RHR and RHRSW systems. The design of the RHRSW control uses DPIC controllers to automatically control differential pressure across the RHR HXs to assure positive RHR service water to RHR pressure. For flow control, the DPICs are placed in Manual. A recommendation to study the design and operation of the DPIC control scheme and to develop any appropriate changes has been provided in a separate correction.

A/C 003-056 Priority 4 HED T-003-007

Description of HED:

The EOPs require monitoring of drywell (and torus) spray flow after its initiation. Task analysis suggests that this be accomplished via a drywell spray flow indicator on the CAMP and RHR panels. No drywell spray flow indication currently exists in the control room.

Justification for non-correction:

The purpose of drywell spray is to reduce drywell pressure by condensing steam in the drywell. Drywell spray is provided by the RHR system, for which loop flow instrumentation exists on 1C03 within the comprehensive RHR mimic. The loop flow indications alone are not accurate enough to provide adequate indication for spray flow due to the possibility of head spray initiation at the same time and the low flow rates anticipated during containment spray. However, the use of valve position indication within the comprehensive RHR mimic and the recommended correction to install drywell and torus pressure indications and drywell and torus average temperature indicators on 1C03 adjacent to these controls and indications provide sufficient feedback and indication that spray is initiated and providing its designed function.

A/C 003-056 Priority 4 HED T-003-027

Description of HED:

The EOPs require monitoring of torus spray flow after its initiation. Task analysis recommends a torus spray flow indicator on the CAMP and RHR panels. No direct torus spray flow indication currently exists in the control room.

Justification for non-correction:

The purpose of torus spray is to reduce torus pressure by condensing steam in the air space above torus water level. Torus spray is provided by the RHR system, for which loop flow instrumentation exists on 1C03 within the comprehensive mimic of RHR. The loop flow indications alone are not accurate enough to provide adequate indication for spray flow due to its range and the possibility of initiating head spray at the same time. However, the use of valve position indication available within the mimic and the recommended correction to install drywell and torus pressure indications and drywell and torus average temperature indicators on 1C03 adjacent to spray controls provide sufficient feedback and indication that spray has initiated and is providing its designed function.

A/C 004-017 **Priority 6** **HED B-004-338**

Description of HED:

During the operator interviews one operator noted that the recirculation pump lube oil level alarm on 1C04 is not clear in that it does not specify whether the alarmed condition is a high level or a low level.

Justification for non-correction:

The lube oil system is a reservoir system using a cooler. Any alarm, regardless of high or low condition requires the same operator response. The exact condition is determined by investigation of panel indications outside of the control room. Lube oil temperatures are provided on panel 1C21 in the back panel area of the control room. Dispatch of an operator is required to determine and correct the condition. Separate alarms are not required.

A/C 004-018 Priority 6 HED B-004-345

Description of HED:

During the operator interviews, three operators noted that having a common alarm (on 1C03) for both torus high and low level conditions could be improved. They suggested that the alarm be split into two separate alarms.

Justification for non-correction:

Torus level indication is currently provided on 1C09 (across the control room from the alarm) and on 1C29 (in the back panel area). The recommendation to install a torus level indicator on 1C03 will provide direct indication of alarm condition. The alarm can be compared to adjacent torus level indication and the source of the alarm known immediately. This recognition is enhanced by colorbanding the torus level indication. The preliminary review of the annunciator system suggests moving the torus level annunciator, even closer to the indication. Since immediate confirmation of the source of the alarm is available, separate alarms are not necessary.

A/C 004-026 Priority 6 HED B-004-173
(See A/C 005-043 priority 4, HED T-005-005)

Description of HED:

During the operator interviews two operators noted that the current reactor vessel level indication is less reliable than desired.

Justification for non-correction:

Improvement of the reactor vessel level instrumentation is an ongoing project to address Reg Guide 1.97 Revision 2 requirements and Generic Letter 84-23 REACTOR VESSEL WATER LEVEL INSTRUMENTATION FOR BWRS. The changes to the control room will be reviewed by human factors personnel before implementation to ensure that sound human factors principles are applied to its design. Further investigation by the DCRDR would be redundant.

A/C 004-036 Priority 6 HED H-004-056

Description of HED:

LER 84-031 records an instance of lack of positive indication for the RCIC barometric condenser vacuum pump operation status. The RCIC condenser high vacuum alarm was received when the vacuum pump indicating lights indicated that the pump was energized. The problem was traced to the pump motor commutator.

Justification for partial correction:

The recommended correction from the DCRDR to prevent recurrence of this event is the addition of the pump motor to the preventative maintenance program at DAEC. Additional pump instrumentation is not required. The existing indicating lights indirectly show pump status. The loss of the pump is adequately annunciated by the high vacuum alarm. A relief to radwaste prevents the condenser from overpressurizing. No further indication is necessary.

A/C 004-045 Priority 6 HED T-004-005

Description of HED:

Task analysis recommends annunciating the electrical and mechanical overspeed trips of the RCIC turbine and displaying the turbine speed in percent running speed on the ECCS panel.

Justification for non-correction:

Currently, a single annunciator (1C04C C-7) is provided adjacent to RCIC controls and indications to provide for alarm of two types of auto trips:

1. RCIC system trip on high RPV level (Steam Supply Valve MO-2404); and

2. RCIC turbine trips (Trip/Throttle Valve MO-2405) for all other trip signals.

A separate correction that recommends separation of the common annunciator to a "high level" trip and a "turbine" trip provides much better immediate indication of the source of the signal and required response. The use of a single annunciator for all turbine trip signals is typical of trip annunciation, providing sufficient alarm indication and minimizing use of annunciator space. Additionally, A/C 004-025 provides for positive indication of MO-2405 using valve stem indication placing red-green lights within the mimic of of RCIC steam supply.

The RCIC turbine speed indicator (SI-2457) is appropriately located with the other RCIC system components on 1C04. The use of RPM units instead of percent running speed is preferred for speeds greater than normal running speeds, however, red-banding of the scale at the 110% RPM equivalent provides indication of excessive speeds and trip setpoints. Also, training provides operators with system and turbine operating limits.

A/C 004-058 Priority 6 HED T-004-010

Description of HED:

Shutdown IPOI 4, as referenced from the EOPs, requires the operator to determine the difference between the reactor vessel temperature and the reactor vessel flange temperature. This temperature difference is to be maintained at less than 100 degrees Fahrenheit. Task analysis recommends an indicator for this temperature difference as well as an alarm for a temperature difference of greater than 100 degrees. Neither a direct temperature difference indication or alarm currently exist. Both are recommended for the reactor control panel.

Justification for non-correction:

An existing recorder, TR-4569, provides both temperatures on 1C04 adjacent to 1C05. The temperature difference can easily be determined by the operator from the recorder trace for the two points. During a controlled heatup or cooldown, the TR is monitored and an alarm would be potentially distracting.

A/C 005-008 Priority 1 HED B-005-336

Description of HED:

During operator interviews one operator suggested adding an annunciator for RSCS rod block.

Justification for non-correction:

Sources of control rod blocks (e.g., RWM, APRM, refueling interlocks) other than RSCS are annunciated or indicated. When a rod block is received, all sources are investigated. The source of the rod block is determined by eliminating the above sources. When it is determined that none of the above sources provided the rod block it is evident that the rod block came from RSCS. Increasing power with rod pulls is an evolution that is done with considerable care and any interlock preventing a pull results in placing the system in a safe condition. It is not necessary to provide a separate annunciator for RSCS rod block. In addition, the rod block functions of RSCS are adequately covered in operator training such that determination of these rod blocks is not excessively time consuming.

A/C 005-043 Priority 4 HED T-005-005

Description of HED:

Using a procedural CAUTION, the EOPs direct the operator to determine whether the RPV level instrumentation is accurate based on indicated drywell temperature and its relationship to RPV pressure saturation temperature and indicated RPV level when drywell temperature is abnormally high. Task analysis recommends indication to inform the operator when drywell temperature reaches the saturation temperature for a corresponding RPV pressure and provide compensated indication for these accident conditions. No instrumentation currently exists in the control room to provide either indication directly.

Justification for non-correction:

The EOPs provide a CAUTION to tell the operator that whenever the drywell temperature exceeds a stated temperature, and level instrumentation is below a corresponding level, indicated RPV level may not be accurate. The limitations of the existing level instrumentation system are adequately covered in operator training. The use of CAUTIONS within the EOPs at all appropriate procedure locations that conditions may exist resulting in inaccurate (uncompensated) level indication for abnormal drywell conditions is an adequate method of informing operators of potential misleading level indication. BWR RPV level instrumentation is an industry-wide concern being addressed separately in response to Generic Letter 84-23 REACTOR VESSEL WATER LEVEL INSTRUMENTATION IN BWRS. Review of resulting indicators and associated procedural changes shall be addressed following resolution of this design problem.

A/C 005-055 Priority 6 HED T-005-032

Description of HED:

Condensate service water is an alternate source of water for injection into the reactor vessel. This source can only be used if its pressure is greater than RPV pressure. Task analysis recommends that condensate service water header pressure be indicated on the reactor containment panel. No indication of condensate service water pressure currently exists in the control room.

Justification for non-correction:

IPOI 7 Section 3.5, as referenced from the EOPs, provides sufficient procedural guidance to accomplish Condensate Service Water injection to the RPV as an alternate injection source. Determination of the ability of this system to provide makeup requires knowing reactor Pressure to be less than Condensate Service Water System maximum discharge pressure which is approximately 150 psig. Therefore, no Condensate Service Water pressure indication is necessary as many local actions, indications, and controls are used to provide lineup. Status of the system will be evident from the local actions.

A/C 006-001 Priority 4 HEDs B-006-422
B-006-106
S-006-099
T-006-008

Description of HED:

The ESW flow control is not remote controlled and pump discharge pressure is not available in the control room.

Justification of non-correction:

The ESW system operation is operated continuously with the same loads. The system is required upon diesel initiation to provide cooling for the diesel. The system is set during an STP and manual valves are locked into place following flow balance. Local control is used throughout this system with local pump discharge pressure available locally also. This mode of operation for the system prevents disabling a system required by Technical Specifications due to to control room actions. Flow indication is available in the control room, and provides system status. For system status pump discharge pressure in the control room is not as good an indicator as system flow. Therefore, no correction is warranted.

A/C 007-023 Priority 5 HED S-007-081

Description of HED:

The main condenser mechanical vacuum pump control is not protected from inadvertent actuation. Inadvertent operation of this pump at greater than 10% power could send the noncondensible gases to the offgas system and thus release them without treatment. Also hydrogen and oxygen would not be recombined in a controlled manner.

Justification for non-correction:

The control is located on the panel benchboard near the vertical board boundary in an area that is recommended to be explicitly demarcated. The area is not crowded with controls. These two situations make inadvertent operation unlikely. Procedures prohibit its operation at greater than 10% reactor power. This prohibition is stressed in training. Protection from inadvertent operation is not necessary.

A/C 007-025 Priority 6 HED B-007-425

Description of HED:

During operator interviews two operators noted that operating the steam jet air ejectors requires "too many people" because local actions are required in the turbine building.

Justification of non-correction:

Initiation and operation of the SJAE controls is an infrequent task which is not time-critical. The SJAEs are initiated when establishing vacuum on the condenser. Control of the SJAEs from the control room does not provide a useful function for any anticipated sequence of events. Ability to break condenser vacuum is recommended in A/C 007-007, but does not require remote operation of the SJAEs.

A/C 008-001 Priority 1 HED H-008-028

Description of HED:

Two personnel errors during diesel generator testing are recorded by this HED. Deviation Report 84-264 records that an operator started a diesel generator without prelubing it per procedure. LER 79-029 records running a diesel generator during a special test until the fuel inventory was below Tech. Spec. limits.

Justification for non-correction:

Prelubing a diesel generator before starting it is specifically covered by procedure. DR 84-264 records an event which occured because personnel did not strictly follow an existing written procedure. Compliance to procedures is necessary and no procedural enhancement would result in eliminating this error.

The event described in LER 79-029 occurred during performance of a special test in response to NRC Bulletin 79-23. The Special Test Procedure used did not alert operations personnel to ensure that diesel fuel tank level was sufficient to run the extended test. Diesel fuel inventory is now regularly checked. Subsequent development of a procedure writer's guide and an extensive review and approval cycle for Special Test Procedures aid in identifying situations or circumstances not usually encountered during normal operation or surveillance tests.

A/C 009-002 Priority 4 HEDs S-009-056
B-009-402

Description of HED:

During operator interviews one operator noted that there is no direct indication of the hydrogen and oxygen sample locations. The indicating lights associated with the sample point selection hand switches indicate that the solenoid valves have power, not valve position.

Justification for non-correction:

The sample point selector switches provide adequate feedback for sample point selection. Periodic surveillance testing of these solenoid valves ensure that the valves will open or close when actuated. The knowledge that the valves are energized and that surveillance testing has demonstrated the actuation of the valves allows the operator to assume that valve position is as indicated by selector switch position. These small solenoid valves do not lend themselves to positive indication of valve position. With the confidence provided by testing and indication of power availability, no direct feedback is required.

A/C 009-003 Priority 4 HED B-009-411

Description of HED:

During operator interviews one operator suggested that the valve position indication for the drywell sampling lines is inadequate. These sampling lines are part of a Group 3 isolation. Positive indication of the valve position is not provided.

Justification for non-correction:

The isolation valves for these sampling lines are very small solenoid valves. Such valves do not lend themselves to positive valve position indication. Periodic surveillance testing of these valves provide the assurance that the valves are in the position indicated by the position of the controls located on 1C29.

A/C 009-003 Priority 4 HED B-009-477

Description of HED:

On an operator questionnaire, one operator suggested that the hydrogen and oxygen monitors on 1C09 do not belong in the front panel area.

Justification for non-correction:

The hydrogen / oxygen monitors were provided to satisfy the requirement of NUREG 0737 for continuous control room indication of hydrogen concentration in the containment atmosphere. Additionally, oxygen concentration in containment is continuously monitored when deinerting or inerting. The remote controls for the sample valves and pumps are located on 1C29, but the indication is provided in the front panel area on 1C09 where it can be monitored as necessary. Therefore, no correction is recommended.

A/C 009-003 **Priority 4** **HED S-009-005**

Description of HED:

The hydrogen and oxygen analyzers are located at a height of 40 inches, well below the BWROG suggested lower limit of 48 inches for indications. The power supplies for these analyzer monitors are below 11 inches.

Justification for non-correction:

The hydrogen and oxygen analyzers are located lower than the height suggested by BWROG. However these indicators and controls are infrequently used and are within the NUREG-0700 ranges for infrequently used instrumentation. In addition, abnormal conditions for these analyzers are annunciated. The annunciators are visible from the primary control area. When alerted to an abnormal condition, an operator can easily go to 1C09 to accurately read the monitors. The height of the monitors does not significantly affect the operator's performance.

The height of the power supply is of little consequence. The power supply has one indicating light to denote that the analyzers are energized. The light is clearly visible from the normal operating position, and with adequate labelling, will not adversely affect operator performance.

A/C 009-003 Priority 4 HED S-009-014

Description of HED:

The hydrogen and oxygen analyzers cannot be seen from the primary control area. They are blocked by the benchboard portion of 1C08.

Justification for non-correction:

The hydrogen and oxygen analyzers need not be seen from the primary control area. Abnormal conditions for these analyzers are annunciated. The annunciators are visible from the primary control area. When alerted to an abnormal condition, an operator can easily go to 1C09 to accurately read the monitors. The obstruction of the monitors does not significantly affect the operator's performance.

A/C 009-005 Priority 4 HED S-009-068

Description of HED:

The hydrogen and oxygen meters must be read with a relatively high degree of accuracy during normal shift checks. The control room survey suggests using a mirrored scale to eliminate the possibility of parallax.

Justification for non-correction:

Parallax is not a problem with these meters. The distance between the scale and the pointer is sufficiently small to eliminate any significant parallax when the meter is read from approximately the same height as the meter height. The use of a mirrored scale would provide insignificant improvement. Also, the information derived from these meters is for diagnostic purposes only. No automatic actions or immediate operator actions are required based on these indications.

A/C 009-006 Priority 4 HED S-009-043

Description of HED:

The hydrogen and oxygen analyzer meters can be viewed with parallax.

Justification of non-correction:

The hydrogen / oxygen analyzers are viewed from a very close range while standing directly in front of them. When using this indicator in this manner accurate readings are obtained. The instrument is not used in a time-critical situation; therefore, the potential of an operator mis-reading the instrument is minimized. No correction is recommended.

A/C 009-013 Priority 4 HED S-009-067

Description of HED:

The drywell and torus sampling point select switches do not have red and green lights to indicate sampling and non-sampling conditions. Only a red light currently exists which is illuminated during sampling.

Justification for non-correction:

The drywell and torus sampling point select switches are adequately indicated. The red light and position of select switch indicates when sampling has been selected and is being accomplished. The red light out indicates that no sampling is being performed. If the switch is in the "select" position and the light is not energized it is suspected that either the lamp has failed or there is an operational problem with that sampling point.

A/C 009-013 Priority 4 HED S-009-072

Description of HED:

The mode switch for the hydrogen / oxygen Analyzer has no associated indicating lights to show system status (OFF / STANDBY / ANALYZE).

Justification for non-correction:

The position of the mode switch provides adequate indication of the system status and is checked during normal shift checks. Three additional lights would provide negligible improvements in operator performance on a panel that is operated and used only at very close range. The lights would only provide indication which is unnecessary from outside this close range.

A/C 009-019 **Priority 4** **HED T-009-018**

Description of HED:

Task analysis recommends control and indication of a containment isolation bypass on the containment accident monitoring panel (CAMP) to allow venting containment under high pressure. The drywell/torus vent select mode switch currently exists on 1C05.

Justification for non-correction:

The drywell and torus isolation bypass handswitch on 1C05 must be used along with the individual isolation signal bypass switches on 1C03. Group isolation logic resets for groups 1-5 are provided on 1C05. This arrangement and the isolation reset/override operation requires considerable effort for an operator to bypass the isolations and prevents the possibility of removing isolation protection due to operator action. The location of the drywell and torus isolation bypass handswitch is recommended to be located adjacent to the associated alarms for PCIS. The PCIS status board is recommended to be located on 1C04 at the far left of panel directly adjacent to these other 1C05 controls and annunciators.

The controls on 1C05 are used more frequently for evolutions other than containment isolation bypass. Moving these controls and indications to 1C03 would interfere with prior operator training and create a more significant HED than the movement would correct.

A/C 009-020 Priority 4 HED T-009-007

Description of HED:

The EOPs direct the operator to check the drywell spray initiation permissive setpoints in order to know when drywell spray may be initiated. Task analysis recommends an alarm be provided to alert the operator that all permissive setpoints have been reached. No such alarm currently exists.

Justification for non-correction:

No alarm is needed. Procedural guidance provides the operator with parameter level limits for initiation of drywell spray. The decision to initiate drywell spray would result from the inability to control containment pressures. This alarm will be annunciated during a scenario with a number of considerably higher priority alarms. This annunciator is unwarranted since it is providing limited information for anticipated events and subsequent actions.

A/C 009-023 Priority 4 HED T-009-017
(See A/C 009-019 priority 4, HED T-009-018)

Description of HED:

The EOP steps involve resetting containment vent isolation logic in order to vent the drywell to relieve drywell high pressure. Task analysis recommends both a reset control and indication of successful reset be provided on the CAMP. The controls currently exist on 1C05. No current equipment indicates that the reset was successful and that containment vents may be opened.

Justification for partial correction:

The basis for the location of the containment isolation reset controls from task analysis is the reset of Group 3 isolation for containment venting. These controls on 1C05 are used for all isolation resets for groups 1-5 isolations. Parameters indicated on 1C05 are used for verifying many of these isolations. Moving these controls to the CAMP would create more serious deficiencies in control location than the one described in this HED. In addition, a negative transfer of training would occur relating to the operators prior training on the use and location of these controls. The improvement in operator performance from eliminating this HED is much less than the decrement created by moving the controls.

Indication that the reset of the containment vent isolation is successful is not necessary. The logic used in the PCIS design allows overrinding of individual signal actuations. The system prescribed from task analysis is a system reset and indication which does not consider the system's interaction with other systems and the necessity of overriding single actuations while maintaining the isolation capability for separate signal actuations. The ultimate indication of reset is obtained when the operator attempts to open the containment vents. If the vents open, the reset was successful.

A/C 009-029 Priority 3 HED T-009-021
(See also A/C 029-012 priority 3, HED 000-066)

Description of HED:

OI 73 (as called from the EOPs) requires the operator to determine the containment atmosphere radiation levels using the existing radiation monitors. Task analysis recommends that controls and indications to determine operability and levels be on the CAMP. A related historical HED identifies the potential for rendering a monitor inoperable without immediate identification to operators. Operability controls and indications and radiation level indications currently exist on 1C29 and monitor controls exist on a local panel in the reactor building.

Justification for non-correction:

The containment atmosphere radiation monitors are always in DETECT except during calibration by Health Physics personnel. Permission of the Operations Shift Supervisor is required before a monitor can be removed from DETECT and calibrated. Subsequent to the historical HED occurence, procedural controls and emphasized training were used to assure that the monitors are returned to DETECT immediately following calibration. No occurences following this improvement were evident from review, indicating previous procedure enhancement and instruction was adequate to resolve the historical HED. An indicator to provide this information is not necessary in the control room, since the monitors are always in the DETECT mode, except for calibration. Additionally, operators are required to check indicators on 1C29 at the beginning of each shift. If a monitor was inadvertently left out of DETECT mode, a low flow amber light, no source select light, and downscale readings on the radiation recorder would be indicated. Therefore, adequate indication is provided for radiation levels on 1C29 as well as necessary controls and indications for control room determination of operability. The local controls are appropriately located.

A/C 014-002 Priority 4 HED S-014-008

Description of HED:

The failure mode of the KDS timers for the MSIV-LCS is not evident.

Justification for non-correction:

The timers start on system initiation, alarming on the front panels. Failure of the timer is evident from an observation that the timer pointer is not moving, the red indicating light is not lit, as well as failure of timer-driven automatic actions (valve closure etc.). Also, steamline pressures and leakage flow would reflect failure of the KDS timers. The lack of an indicated failure mode does not significantly impair the operator's ability to use the MSIV-LCS. No correction is necessary.

A/C 014-003 Priority 4 HED S-014-025

Description of HED:

Indicators on 1C14 have glare from the undiffused light above the panel.

Justification for partial correction:

The glare will be reduced, but not eliminated, by the improvement of the light diffusers. Color banding of the indications will enhance readability. The remaining glare will not have a significant impact on operator performance. The glare is least noticable directly in front of the indicators. These indicators will be used when manipulating the associated controls on 1C14, at which time the operator will be directly in front of the indicators, minimizing the impact of the glare.

A/C 015-003	Priority 4	HEDs	S-015-001
			B-015-137
		B-015-099	B-015-454
		B-015-446	B-015-463

Description of HED:

Logic test switches and their associated indicating lights are above the BWROG anthropometric limits. During the operator interviews four operators noted that test switches on 1C15, especially the Condenser Vacuum Bypass switch, were 'too high.'.

Justification for partial correction:

The switches and associated indicating lights are above anthropometric limits. However, these switches are used only during plant startup, shutdown, and surveillance testing to provide a logic signal. The difficulty associated with using these test switches will be mitigated by providing a step stool in the backpanel area to be used while operating these switches. In addition, label enhancements including larger type styles are recommended to enable the switches to be more easily identified. The mitigation of the HED rather than total resolution is justified when frequency of use and purpose are considered.

A/C 015-003 Priority 4 HED S-015-002

Description of HED:

The test switches at the top of the panel are mirror imaged. Included in these are the low-lo set logic test, isolation valve logic test, and condenser vacuum test switches.

Justification for partial correction:

The test switches are used infrequently and then only by maintenance personnel for surveillance testing. The controls are operated infrequently enough that test switch labels, and not position, are the primary location aides. The mirror imaging does not adversely affect the completion of the surveillance tests. Label enhancements are adequate to sufficiently mitigate the effects of mirror imaging.

A/C 016-004 Priority 4 HEDs B-016-251
B-016-136
B-016-014

Description of HED:

The control to switch either RPS bus to an alternate power source is located at knee level on 1C16. The cane handle switch could be bumped and inadvertently operated. During operator interviews one operator noted that the switch was 'a problem.'

Justification for partial correction:

The 'problem' identified by the operator is a lack of adequate labels describing the function of an infrequently used control. Label enhancements will correct this deficiency with this control. In addition, a cover will be placed over the switch to preclude inadvertent operation by bumping. The height of the switch will not be changed. The height of the switch does not significantly affect overall operator perfromance due to the infrequent use of this control.

A/C 017-004 Priority 4 HEDs S-017-005
S-017-032

Description of HED:

The RPS test switches at the top of 1C17 have no local feedback.

Justification for non-correction:

These test switches are provided for use during surveillance testing. Feedback is provided to the operator in the front panel area via an "RPS TEST" annunciator when any test switch is actuated. The technicians performing the surveillance tests provide instrumentation for local feedback during the tests. Such feedback is sufficient. The switch position is sufficient local feedback for operations personnel.

A/C 017-005 Priority 4 HEDs S-017-001
B-017-445
B-017-462
S-017-010

Description of HED:

The test switches at the top of 1C17 are above anthropometric limits. The escutcheons for these switches are obscured by the switch bodies. Four operators commented on the height-related difficulties of these switches.

Justification for partial correction:

The switches and associated indicating lights are above anthropometric limits. However, these switches are used only during plant startup, shutdown, and surveillance testing to provide a logic signal. The difficulty associated with using these test switches will be mitigated by providing a step stool in the backpanel area to be used while operating these switches. In addition, label enhancements including larger type styles are recommended to enable the switches to be identified more easily thus negating the effects of the obscurred escutcheons. The mitigation of the HED rather than total resolution is justified when frequency of use and purpose are considered.

A/C 019-002 PRIORITY 4 HED S-019-010

Description of HED:

The failure mode for the drywell floor drain and equipment drain sump totalizers is not evident.

Justification for non-correction:

Design change package (DCP) 796 modified the flow loop characteristics so that flow is not indicated unless the sumps are actually pumping to the radwaste system making failure mode indication unnecessary. In addition, annunciators for high leakage and a flow recorder are provided on 1C04 for use by the operators.

A/C 021-002 PRIORITY 4 HED S-021-006

Description of HED:

The steam leak detection monitor modules exceed a 4 by 4 matrix without demarcation.

Justification of non-correction:

Only the width of the module matrix exceeds the recommended 4 units. The maximum number of units placed horizontally adjacent is five. This matrix size does not detract from the operator's ability to quickly identify a given module. When rapid identification is required (during alarm conditions) the operator searches for a red light indicating the channel which has exceeded its setpoint. The red light, and not the module's position in the matrix is the location aid used by the operator. The matrix's being five modules wide does not adversely impact operator performance. No correction is needed.

A/C 021-006 PRIORITY 4 HED S-021-043

Description of HED:

The steam leak detection temperature switch and temperature difference switch modules share two common indicators. Each module does not have its separate meter.

Justification for non-correction:

The indicators for the steam leak detection system are adequate. They allow greater resolution in a limited space than would individual meters. They are used only during shift checks and in response to alarm conditions. During shift checks values are recorded individually and not used for immediate comparison. Thus a shared indicator does not adversely affect shift checks. During alarm conditions, only the channel alarmed is of immediate interest. Thus, lack of individual meters does not adversely affect operators during alarm conditions either. Individual meters are not needed; only one channel is needed at a time and greater resolution is afforded by a shared indicator.

A/C 021-015 Priority 4 HEDs S-021-017
S-021-018

Description of HED:

The pointers on the floor drain and equipment drain sump timers obscure the scales on the timers and the failure of these timers is difficult to determine.

Justification for non-correction:

The pointers on these timers do not obscure the scales such that the determination of time running is a problem. Periodic surveillance testing of the floor drain and equipment drain sump timers ensures that the timers are available and operate as required. In addition, other control room indication is available for determining the operability of these timers.

A/C 022-002 Priority 6 HEDs S-022-026
B-022-125
B-022-149
S-022-004
S-022-012

Description of HED:

The meteorological data recorder, YR-9400, is difficult to read. This recorder prints meteorological data every 15 minutes. The recorder has no point select capability and has no capability for printing data on request. Interpreting data requires a chart to be posted near the recorder. In addition, the indicating lights on the recorder cannot be easily replaced.

Justification for non-correction:

The meteorological recorder is a data logging printer which prints 15 minute averages of 21 meteorological parameters. This printer provides a backup indication of meteorological data in the control room and a historical record of meteorological data. The primary indication of meteorological data in the control room is the SPDS. For its intended use, the printer is considered acceptable as-is. The indicating lights on this printer are not required to be easily replaced. They are LED-type lights mounted in the printer and will be replaced per manufacturers recommendations, as required.

A/C 024-014 Priority 4 HED S-024-023

Description of HED:

During the control room survey, it was noted that the requirements for keys for the keylock switches on 1C24 was not explicitly stated in the procedures.

Justification for non-correction:

Although the use of keys for keylock switches is not explicitly called out in the procedures, operator training is provided with respect to requirements associated with exercising these switches. The Operations Shift Supervisor maintains the keys and a key log which is reviewed daily to ensure that all requirements associated with the operation of these keylock switches is provided prior to actuation. Given the controls associated with the keylock switches, no further correction is recommended.

A/C 024-018 **Priority 4** **HEDs T-024-005**
T-024-008

Description of HED:

Task Analysis calls for an indication of Standby Gas Treatment (SBGT) system availability and system status. In addition, the Task Analysis calls for annunciators in the front panel area of the control room for the SBGT system alarms, for the SBGT system being in manual mode, and for a failure of a system initiation alarm.

Justification for non-correction:

The SBGT system controls, indicators, and annunciators are provided on 1C24 in the back panel area of the control room. SBGT system status and availability is determined based on the indications provided on this panel; therefore, a unique indicator of system status is not recommended. To further maintain the operators awareness of system status, shift turnover checks are performed. A "PANEL 1C24 TROUBLE ALARM" is provided on 1C07 for annunciating SBGT system alarm conditions in the front panel area of the control room. A group 3 isolation initiation and accomplishment indication will be provided on 1C04 in the front panel area via the Primary Containment Isolation System status board for adequate SBGT system initiation indication. An indication of the SBGT system being in a manual mode is provided when the panel trouble alarm is present without a group 3 isolation. Given the above indications, additional annunciators for the SBGT system are not recommended.

A/C 026-016 Priority 4 HED B-026-320

Description of HED:

During operator interviews one operator noted that spurious initiation of the control building Standby Filter Unit (SFU) due to design inadequacies was distracting to the operators. These design inadequacies were associated with SFU isolations due to outside weather conditions.

Justification for non-correction:

Maintenance and repair of the SFU inlet air preheat coils has resulted in the elimination of spurious SFU isolations associated with low outside temperatures. The addition of weather shielding (DCP 1086) to previously exposed radiation elements has resulted in the elimination of spurious SFU isolations associated with the instrumentation getting wet. Given the above repairs and modifications, the deficiency has been corrected, and no further action is required.

A/C 028-002 Priority 6 HED S-028-002

Description of HED:

During the control room survey, it was noted that several labels on 1C28 were glued on.

Justification for non-correction:

Having permanent labels glued onto the panel in lieu of mounted with screws is considered acceptable; therefore, no correction is recommended.

A/C 029-013 Priority 4 HED B-029-443

Description of HED:

During operator interviews one operator noted that the Emergency Service Water level recorder on 1C29 is poorly positioned.

Justification for non-correction:

Other Emergency Service Water (ESW) system controls and indicators are currently available on 1C06. In addition, "ESW LOW LEVEL" is currently annunciated on 1C06. The indication of ESW level is available on 1C29 for the control room via the subject recorder. Although the addition of ESW level indication to 1C06 is considered beneficial, current controls and indicators for the ESW system are considered adequate for normal and emergency operations; therefore, the addition of an indicator for ESW level on 1C06 is not considered cost effective. The ESW level recorder is used as a trending indication of ESW level during plant shutdown conditions by operations personnel. This recorder is above anthropometric limits on 1C29 and is therefore difficult to see. The difficulty associated with the height of this recorder will be mitigated by providing a step stool in the backpanel area for use during plant shutdown conditions. The mitigation of the HED rather than total resolution is justified due to the frequency of use.

A/C 029-017 Priority 6 HED S-029-031

Description of HED:

During the control room survey it was noted that there is no direct indication of the PASS sample/override select switches. The indicating lights associated with these selection hand switches indicate that the solenoid valves have power, not valve position.

Justification for non-correction:

The sample point selector switches provide adequate feedback for sample point selection. Periodic surveillance testing of these solenoid valves ensure that the valves will open or close when actuated. Knowing that the valves are energized and that surveillance testing has demonstrated the actuation of the valves allows the operator to assume that valve position is as indicated by selector switch position. These small solenoid valves do not lend themselves to positive indication of valve position. With the confidence provided by testing and indication of power availability, no direct feedback is required.

A/C 030-001 Priority 6 HED S-030-008

Description of HED:

The RCIC test switches at the top of 1C30 have no local feedback.

Justification for non-correction:

These test switches are provided for use during periodic surveillance testing. The technicians performing the surveillance tests provide instrumentation for local feedback during the tests. The position of these test switches is sufficient local feedback for operations personnel. No further correction is recommended.

A/C 030-003 Priority 6 HEDs S-030-001
S-030-002
S-030-005
S-030-006

Description of HED:

The switches at the top of 1C30 are above anthropometric limits. The escutcheons and labels for these switches are difficult to read due to the height of the switches.

Justification for non-correction:

These switches are used only during surveillance testing and not during normal operations. The difficulty associated these switches will be mitigated by providing a step stool in the backpanel area for use during surveillance testing. In addition, label enhancements will be provided to enable the switches to be more easily identified. The mitigation of the HED rather than total resolution is justified due to the frequency of use and the purpose of the switches.

A/C 032-002 Priority 4 HEDs S-032-001
S-032-002
S-032-008

Description of HED:

The switches at the top of 1C32 are above anthropometric limits. The escutcheons and labels for these switches are difficult to read due to the height of the switches.

Justification for non-correction:

These switches are used only during surveillance testing and not during normal operations. The difficulty associated these switches will be mitigated by providing a step stool in the backpanel area for use during surveillance testing. In addition, label enhancements will be provided to enable the switches to be more easily identified. The mitigation of the HED rather than total resolution is justified due to the frequency of use and the purpose of the switches.

A/C 033-002 Priority 4 HEDs S-033-001
S-033-002
S-033-008

Description of HED:

The switches at the top of 1C33 are above anthropometric limits. The escutcheons and labels for these switches are difficult to read due to the height of the switches.

Justification for non-correction:

These switches are used only during surveillance testing and not during normal operations. The difficulty associated these switches will be mitigated by providing a step stool in the backpanel area for use during surveillance testing. In addition, label enhancements will be provided to enable the switches to be more easily identified. The mitigation of the HED rather than total resolution is justified due to the frequency of use and the purpose of the switches.

A/C 034-013 Priority 6 HED S-034-036

Description of HED:

If the adsorber bypass valve, CV-4134B in the off-gas system, were inadvertently actuated while CV-4134A was in AUTO during a low radiation condition, the off-gas system would allow a release until the bypass valve automatically closed. The pushbutton switch for the bypass valve should be protected from inadvertent operation.

Justification for non-correction:

At DAEC, the normal operating mode for the offgas system is TREAT. However it was designed to operate in AUTO and shift to TREAT only on a "high radiation" closure of the bypass valve.

The setpoint for the automatic closure of this bypass valve is a release rate which, if continued for 48 hours, would require NRC notification; therefore, the untreated release would be insignificant. Inadvertent actuation of CV-4134B would result in operation of the offgas system as designed. Therefore, no correction is recommended.

A/C 045-002 Priority 4 HED S-045-016

Description of HED:

The low-low-set indicating lights are not consistent with existing conventions in the control room.

Justification for non-correction:

The low-low-set indicating lights are non-standard due to system design requirements for providing positive indication of operability while meeting single failure criteria. Operator training is provided to ensure correct interpretation of indicated system status. The sockets for these indicating lights will accept other types of bulbs, but the system was designed so that use of the wrong bulb will not actuate the system. However, the proper bulb must be used to ensure positive indication of system operability; therefore, a permanent label to indicate proper bulb replacement type will be provided on the panel. Given required design attributes and operator training emphasis, no further correction is recommended.

A/C 045-004 Priority 4 HED S-045-001

Description of HED:

The controls and indicators at the top of 1C45 are above anthropometric limits. The escutcheons and labels for these switches are difficult to read due to the height of the switches.

Justification for non-correction:

These controls and indicators are used only during surveillance testing and not during normal operations. The difficulty associated these devices will be mitigated by providing a step stool in the backpanel area for use during surveillance testing. In addition, label enhancements will be provided to enable the devices to be more easily identified. The mitigation of the HED rather than total resolution is justified due to the frequency of use and the purpose of the devices.

A/C 208-003 Priority 4 HEDs S-208-006
S-208-007

Description of HED:

During the control room survey, it was noted that the scales for the RHR and RHR Service Water flow indicators on 1C208 were not marked for operational characteristics and have intermediate markings which are not consistent with human factors standards.

Justification for non-correction:

The current indicators on 1C208 are consistent with the corresponding indicators on 1C03 in the control room. Due to the operational use of these indicators, the current meter scales are considered acceptable as-installed and, therefore, will not be replaced.

A/C 208-005 Priority 4 HED S-208-009

Description of HED:

All panels used for shutting down the plant outside of the control room are locked for security purposes. 1C208 is physically smaller than the other alternate shutdown panels; therefore, the security switch for the door to this panel partially obscures the transfer controls located inside the panel.

Justification for partial correction:

The functions of two of the switches located in 1C208, the relief valve control switches, have been relocated to 1C388, but the switches have not been removed from 1C208. The remaining functional switch in 1C208, the RCIC Pump transfer switch, is difficult to operate due to the congestion in this panel. The removal of the unused switches will be performed in an effort to minimize the congestion inside this panel. Upon removal of the unused switches, the panel will be reevaluated with respect to the remaining control being obscured by the security switch. At present, no further correction is recommended.

A/C 208-006 Priority 5 HED S-208-010

Description of HED:

Grooves are integrated into the floor at 1C208 which are used when moving a local shield plug. These grooves are a trip hazard for an operator when performing tasks at this panel.

Justification for non-correction:

The area including 1C208 is not a primary operating area. This panel is used for shutting down the plant upon control room evacuation. Upon further investigation, the trip hazard is considered minor. Given that the the area is not a primary operating area and that the trip hazard is minor, no correction is recommended.

A/C 341-006 Priority 6 HED S-341-011

Description of HED:

The KAMAN system, which provides radiation data associated with areas in the plant, is not redundant. The operator relies on this data for evaluating the safety status of the plant.

Justification for non-correction:

The failure of the subject radiological system processor would result in radiological data in plant areas being unavailable to the control room operator. This data would be available locally via remote microprocessors if required. In addition, there are no requirements for system redundancy, and the failure of a microprocessor will not cause the loss of the remaining microprocessors. These miroprocessors have historically operated with high reliability. Therefore, current system reliability obviates the need for system redundancy and no correction is recommended.

A/C 388-001 Priority 4 HEDs S-388-001
S-388-012
S-388-019
B-388-516

Description of HED:

During the control room survey and operator interviews, it was noted that many of the indicators on 1C388 are difficult to read due to being above anthropometic limits and having excessive glare on the meter faces.

Justification for non-correction:

These indicators are used only during alternate shutdown conditions and not during normal operations. The primary deficiency wiith these meters is glare on the meter faces. The difficulty in reading these devices will be mitigated by providing a step stool in the area for use. In addition, light diffusers will be provided for the area lighting to reduce the glare associated with these meters. The mitigation of the HED rather than total resolution is justified due to the frequency of use and the cost associated with modifying these panels.

A/C 388-002 Priority 4 HEDs B-388-056
B-388-100
B-388-273

Description of HED:

During the operator interviews, it was noted that the alternate shutdown panels were difficult to operate and that more operator training is needed on operating the panels.

Justification for non-correction:

Subsequent to the performance of the interviews, the procedures associated with the use of the alternate shutdown panels have been revised. Walkthroughs on the procedures were performed to ensure the adequacy of the procedures and panel designs. In addition, operator training has been provided specific to the use and design of these panels. Given the above actions, no further correction is recommended.

A/C 388-003 Priority 4 HEDs B-388-113
B-388-519

Description of HED:

During the operator interviews, it was noted that the diesel controls on 1C388 are difficult to use and that the addition of an indication of diesel output in kilowatts is desired.

Justification for non-correction:

During initial system testing of the alternate shutdown panels, the diesel system was difficult to control. The operating configuration associated with this test was determined to be the cause of the anomaly. Therefore, no corrective action was warranted. Further investigation into the adequacy of diesel controls and indications revealed that an operator will be stationed in the diesel generator room when using these controls from 1C388 and communications between these stations will have been established. Therefore, local indication at the diesels would be available for operator use when the diesel is operated from the 1C388. Given the above, no correction is recommended.

A/C 388-004 Priority 4 HEDs S-388-016
S-388-036
S-388-038

Description of HED:

During the control room survey, meter deficiencies for meters on 1C388 were noted. These deficiencies included:

1. Three meters have smaller numbers to indicate the extremes of the scales;

2. Six ammeters have compressed portions of the scales; and

3. The meter scale for Core Spray Discharge flow has divisions which are difficult to interpolate.

Justification for non-correction:

These deficiencies will not be corrected due to the following;

1. Having smaller numbers to indicate the extremes of a meter scale is not consistent with human factors standards, but it does not effect the operators ability to read the meters.

2. The normal operating range for the six ammeters is within the uncompressed portion of the scale; therefore, it enhances the operators ability to read the meters.

3. The current indicator for Core Spray Discharge flow on 1C388 is consistent with the corresponding indicator on 1C03 in the control room.

Due to the operational use of these indicators, the current meter scales are considered acceptable as-installed and, therefore, will not be replaced.

A/C 388-026 Priority 4 HED T-388-032

Description of HED:

Task analysis recommends that indication of SRV positions be available at the remote shutdown area. Positive indication of SRV position does not exist in the area.

Justification for non-correction:

The remote shutdown panels consist of controls and indicators from only one division. Therefore, positive indication of SRV position could be provided for only half of the SRVs. Indication of reactor pressure, reactor water level, torus water temperature, and torus water level are provided. These parameters are considered adequate for determining SRV position; therefore, no correction is recommended.

A/C 388-029 Priority 4 HED T-388-020

Description of HED:

Task analysis requires determination of the reactor vessel cooldown rate from the remote shutdown area. No cooldown rate indicator currently exists in the area.

Justification for non-correction:

A temperature recorder of the appropriate vessel temperatures currently exists in the area of the remote shutdown panels. Cooldown rate can be determined from the temperature traces available from this recorder. Therefore, a discrete cooldown rate indicator is not required and no correction is recommended.

A/C 388-034 Priority 4 HED T-388-009

Description of HED:

EOP 6 requires that the operator determine from the remote shutdown areas whether a sufficient water supply exists in the RHR Service Water and Emergency Service Water pit. This pit is filled by the river water supply system. Task analysis recommends that this determination be made based on the river water supply pump discharge pressure and motor amperes. This indication does not exist in the remote shutdown area.

Justification for non-correction:

Water for the suction side of the Emergency Service Water and RHR Service Water systems is provided by the river water supply system. Indication that adequate water level is provided by pump running indication for the Emergency Service Water and RHR Service Water pumps. These pumps trip on high vibration when inadequate water is available. In addition, indication that pit level is becoming inadequate would be provided by the RHR Service Water flow indication. The above indication is considered adequate; therefore, no correction is recommended.

A/C 389-004　　Priority 4　　HED S-389-005

Description of HED:

During the control room survey it was noted that, with the panel door closed, the panel door of 1C389 obscures the transfer switch status lights unless the operator is standing directly in front of the panel. The top of the door has a viewing port for determining transfer switch status.

Justification for non-correction:

During normal operations, the panel door for 1C389 is locked for security purposes. This panel is used during alternate shutdown conditions only. The status of these lights can easily be determined from directly in front of the panel; therefore, no correction is recommended.

A/C 389-005 Priority 4 HED S-389-001

Description of HED:

During the control room survey, it was noted that 1C389 was a locked panel with keylock switches inside. This redundant security was considered to be excessive and could result in an inefficient use of an operator's time during an emergency.

Justification for non-correction:

During normal operations, the panel door for 1C389 is locked for security purposes. This panel is used during alternate shutdown conditions only. The switches are keylocked in an effort to prevent inadvertent operation during the performance of plant shutdown outside of the control room.

A/C 390-005 **Priority 4** **HED S-390-004**

Description of HED:

During the control room survey, it was noted that 1C390 was a locked panel with keylock switches inside. This redundant security was considered to be excessive and could result in an inefficient use of an operator's time during an emergency.

Justification for non-correction:

During normal operations, the panel door for 1C390 is locked for security purposes. This panel is used during alternate shutdown conditions only. The switches are keylocked in an effort to prevent inadvertent operation during the performance of plant shutdown outside of the control room.

A/C 390-007 Priority 4 HED S-390-006

Description of HED:

During the control room survey it was noted that, with the panel door closed, the panel door of 1C390 obscures the transfer switch status lights unless the operator is standing directly in front of the panel. The top of the door has a viewing port for determining transfer switch status.

Justification for non-correction:

During normal operations, the panel door for 1C390 is locked for security purposes. This panel is used during alternate shutdown conditions only. The status of these lights can easily be determined from directly in front of the panel; therefore, no correction is recommended.

A/C 390-008 Priority 4 HED S-390-008

Description of HED:

Evacuation of the control room could leave the "A Logic Shutdown Cooling Valve, MO-1908, inoperative in the closed position. At 1C390, the electrical bus associated with this valve is temporarily transferred, the valve is opened, and then the bus is deenergized. Personnel error could result in the valve being left in the closed position and inaccessible from the alternate shutdown panels.

Justification for non-correction:

The design of the panels for shutting down the plant outside the control room was restricted due to electrical separation design requirements. Due to this design requirement, a design modification for correcting this deficiency is not evident. The procedural steps for opening this valve include considerable detail and operator training emphasizes the situation in an effort to reduce the potential for operator error. In addition, an alternate method for achieving shutdown cooling is available. Given the above, no correction is recommended.

A/C 391-002 Priority 4 HED S-391-001

Description of HED:

During the control room survey, it was noted that 1C391 was a locked panel with keylock switches inside. This redundant security was considered to be excessive and could result in an inefficient use of an operator's time during an emergency.

Justification for non-correction:

During normal operations, the panel door for 1C391 is locked for security purposes. This panel is used during alternate shutdown conditions only. The switches are keylocked in an effort to prevent inadvertent operation during the performance of plant shutdown outside of the control room.

A/C 391-003 Priority 4 HED S-391-005

Description of HED:

During the control room survey, it was noted that, with the panel door closed, the panel door of 1C391 obscures the transfer switch status lights unless the operator is standing directly in front of the panel. The top of the door has a viewing port for determining transfer switch status.

Justification for non-correction:

During normal operations, the panel door for 1C391 is locked for security purposes. This panel is used during alternate shutdown conditions only. The status of these lights can easily be determined from directly in front of the panel; therefore, no correction is recommended.

A/C 392-003 Priority 4 HED S-392-005

Description of HED:

During the control room survey, it was noted that, with the panel door closed, the panel door of 1C392 obscures the transfer switch status lights unless the operator is standing directly in front of the panel. The top of the door has a viewing port for determining transfer switch status.

Justification for non-correction:

During normal operations, the panel door for 1C392 is locked for security purposes. This panel is used during alternate shutdown conditions only. The status of these lights can easily be determined from directly in front of the panel; therefore, no correction is recommended.

A/C 392-004 **Priority 4** **HED S-392-002**

Description of HED:

During the control room survey, it was noted that 1C392 was a locked panel with keylock switches inside. This redundant security was considered to be excessive and could result in an inefficient use of an operator's time during an emergency.

Justification for non-correction:

During normal operations, the panel door for 1C392 is locked for security purposes. This panel is used during alternate shutdown conditions only. The switches are keylocked in an effort to prevent inadvertent operation during the performance of plant shutdown outside of the control room.

A/C 000-047 Priority 3 HEDs B-000-306
B-000-209

Description of HED:

During the operator interviews, it became apparent that the majority of operators considered the DAEC Technical Specifications difficult to use.

Justification for non-correction:

The Daec Tech Specs are beint improved by ongoing revisions. These revisions are reviewed by operations personnel for impact on operators. This review is being formalized by a revision to applicable review procedures. Operator review of changes will enable operators to denote those Tech Spec items which are difficult to interpret and enable changes to aid interpretation. In addition to these initiatives, IELP is participating in the BWROG Tech Spec Improvement Program to upgrade BWR technical specifications. This upgrade will enhance the interpretability of the Tech Specs. Licensing personnel are also on 24-hour call to assist the operators in Tech Spec interpretation.

A/C 000-095 Priority 4 HED S-000-066

Description of HED:

The indicating lights on the control room panels do not have a lamp test feature. This leads to a lack of indication for a failed bulb of an indicating light.

Justification for non-correction:

DAEC utilizes green, red, white and amber lights. Green and red lights are typically grouped together with one or the other of these lights being on. Having both lights off is indicative of an abnormal condition to the operator and bulbs are replaced as appropriate. White lights are used to indicate system availability. Having a white light off is indicative of an abnormal condition to the operator and the bulb is replaced as appropriate. Amber lights are used to indicate an abnormal condition. Where no secondary indication is provided, "push-to-test" sockets will be installed and administrative controls put in place for periodic testing of these indicating lights. This correction does not completely eliminate the deficiency but adequately reduces its effect. No further correction is recommended.

A/C 000-081 Priority 4 HED S-000-041

Description of HED:

The BWROG control room survey determines if plant operational excercises are conducted with operators wearing protective clothing and breathing gear. Excercises are not conducted in this manner.

Justification of Partial Correction:

It is not recommended to perform excercises in this manner. Training is to be provided on exchange of Scott Air-Packs used at DAEC. Use of protective gear in performing operations tasks requires extra effort in communicating, etc. and evaluation of performing these excercises on the simulator will be addressed during simulator training program development.

A/C 000-138 Priority 6 HED S-000-108

Description of HED:

When the Plant Process Computer (PPC) is inoperable, river water and canal temperatures must be determined using a multi-meter on the transmitter output connections and converting the signal level to temperature units. This parameter has limits governed by Technical Specifications and misreading may result in a violation.

Justification for Non-correction:

If the PPC is not available and river water and canal temperatures are needed, either converting the signal or dispatching an operator to the location is adequate.

A/C 000-101 **Priority 6** **HED S-000-047**

Description of HED:

Backpanel areas have ambient noise level adjacent to 1C31, 1C49, 1C25, and 1C34 above the acceptable 65dBA.

Justification of Non-correction:

The acceptance criteria for ambient noise levels are for primary operating areas and the levels are less than 65 dBA in the front panel area.

A/C 000-101 Priority 6 HED S-000-048

Description of HED:

Printers are not shrouded per recommended guidelines. Control room doors close loudly. Ventilation discharge is too loud.

Justification of Partial Correction:

New printers are to be installed as part of the Plant Process Computer upgrade and will be shrouded. Security door entering the control room will not be modified to assure positive closure. Regular maintenance on the HVAC equipment as proposed in separate corrections may result in HVAC noise reduction.

A/C 000-046 Priority 4 HEDs B-000-029
B-000-178

Description of HED:

Operator interview responses indicated a request for some process radiation monitors to be located in the front panel area and that there were too many significant displays on backpanels.

Justification of Partial Correction:

The addition of instrumentation identifiers to annunciator windows on 1C03 as correction NA-010-NA to panel 1C10 provides for a better relationship between annunciator and source of alarm. The indicators should be back panel indications due to the general philosophy of placement prioritization of indications and controls. The annunciators provide the needed front panel indication of these parameters. The general opinion that some significant displays are inappropriately located in the back panel area has been addressed on a panel-by-panel basis considering the applicable HEDs and resulted in movement of some parameter indications such as Torus temperature and Drywell temperature.

A/C ANNC-001 Priority 1 HED A-000-006

Description of HED:

NUREG-0700 recommends that controls for response to the annunciator system include separate silence, acknowledge, reset, and test controls for each panel. The recommended silence control should stop the audible alarm from any annunciator when actuated at any panel. The acknowledge control should stop flashing of an individual tile when actuated at the associated panel. The reset control should return the tile to its pre-alarm state (after the alarm has cleared) when actuated at the associated panel. The test control should initiate the audible alarms and flash all tiles when actuated at the associated panel. DAEC's annunciator system does not operate in this manner.

Justification of Non-correction:

The practice of remote silencing of audible alarms would be contrary to DAEC operating philosophy. The existing acknowledge control which serves both acknowledge and silence functions ensures prompt attention to incoming alarms. Because of the relatively low number of annunciators (about 700 on the front panels), this feature, which may be appropriate for large control rooms containing 2000 or more annunciators, is considered unnecessary and detrimental. Existing equipment is adequate. No change is required.

THe annunciator system has a ringback featrue. This provides a distinct audible alarm and visual indication when an alarm clears (returns to normal). The audible alarm is a tone of slightly lower frequency than the sound of an alarm coming in. The visual indication is an annunciator flach rate slower than that for an alarm coming in. To reset the annunciator after the alarm has cleared, the acknowledge pushbutton is used. With this ringback feature a separate reset control is not needed in that the existing acknowledge pushbutton adequately provides the function.

A/C ANNC-001 Priority 1 HED A-000-004

Description of HED:

The DAEC annunciator system has no feature to indicate the time sequence of a series of alarms. There is no 'first out' feature.

Justification for Non-correction:

First out information is not necessary to mitigate the effects of events as DAEC uses symptom-oriented EOPs. However this information is available from the alarm typer an the plant process computer alarm log. A first out feature is not needed at DAEC.

A/C ANNC-001 Priority 1 HED A-000-005

Description of HED:

The DAEC annunciator system has alarms with multiple inputs. Once an alarm has been received and acknowledged the alarm will not re-alarm upon receiving another input until the original alarm status has cleared. This could mask information from subsequent alarm inputs and reduce the information available to the operator. Multiple alarms should be eliminated where practical considering the nature of the alarm, available annunciator space and other pertinent criteria. Reflash is the perferred method to allow one annunciator to cover multiple inputs.

Justification for non-correction:

Two general instances of multiple-input alarms were not corrected. Other multiple alarms are being corrected where nearby feedback is not available to discriminate the source of the alarm and the operator has controls nearby to be manipulated to alleviate the alarm circumstances. The first instance not corrected is the use of "backpanel trouble alarms." Backpanel trouble alarms annunciate on the front panels, but automatically clear after about 15 seconds. The operator's response to these multiple-input alarms is to go to the backpanel in question to acknowledge the alarm and take the appropriate action. The auto-clear feature assures that the operator is informed when another alarm comes in on the backpanel. This feature performs the same function as reflash capability would. No change is needed.

The other instance of multiple-inputalarms are the Group Isolation alarms. Reflash for these alarms would be of limited use because the operator would still have to interpret other indications to determine which isolation was received. The proposed PCIS status lights will give the operator a concise, centralized display of group isolation status, making reflash of the group isolation alarms unnecessary.

Appendix E. Acronyms

A/C	Assessment / Correction
ADS	Automatic Depressurization System
APRM	Average Power Range Monitor
ASME	American Society of Mechanical Engineers
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners Group
CAMP	Containment Accident Monitoring Panel
CR	Control Room
CRC	Corrections Review Committee
CRD	Control Rod Drive
CRI	Control Room Inventory
DAEC	Duane Arnold Energy Center
dBA	decibels
DCP	Design Change Package
DCRDR	Detailed Control Room Design Review
DPIC	Differential Pressure Indicating Control
DR	Deviation Report
EAT	Engineering Assessment Team
ECCS	Emergency Core Cooling System
EHC	Electro-hydraulic Control
ENS	Emergency Notification System
EOP	Emergency Operating Procedure
EPG	Emergency Procedures Guidelines
EPIP	Emergency Plan Implementing Procedures
EPRI	Electric Power Research Institute
ESW	Emergency Service Water
EWR	Engineering Work Request
FTA	Function and Task Analysis
GMAC	General Electric Manual / Automatic Control
gpm	gallons per minute
HED	Human Engineering Deficiency
HFE	Human Factors Engineering
IPOI	Integrated Plant Operating Instructions
IRM	Intermediate Range Monitor
LED	Light Emitting Diode
LER	Licensee Event Report
MRT	Management Review Team
MSIV	Main Steam Isolation Valve
MSIV-LCS	MSIV-Leakage Control System
MSR	Moisture Separator Reheater
NRC	Nuclear Regulatory Commission
OI	Operating Instructions
OSS	Operations Shift Supervisor
pa	public address
PASS	Post-Accident Sampling System
PCIS	Primary Containment Isolation System
PPC	Plant Process Computer
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
RHR	Residual Heat Removal

RHRSW	Residual Heat Removal Service Water
rpm	revolutions per minute
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
RSCS	Rod Sequence Control System
RWM	Rod Worth Minimizer
SBGT	Standby Gas Treatment
SBLC	Standby Liquid Control
SFU	Standby Filter Unit
SJAE	Steam Jet Air Ejector
SPDS	Safety Parameter Display System
SRM	Source Range Monitor
SRO	Senior Reactor Operator
SRP	Standard Review Plan
SRV	Safety / Relief Valve
STP	Surveillance Test Procedure
vac	volts alternating current