U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

18.1 CONTROL ROOM

REVIEW RESPONSIBILITIES

Primary - Human Factors Engineering Branch (HFEB)

Secondary - None

I. AREAS OF REVIEW

Nuclear power plants are provided with a control room from which actions can be taken to operate the unit safely under normal conditions and to maintain it in a safe condition under accident conditions. In addition, equipment outside the control room is provided with a design capability for prompt hot shutdown of the reactor, including necessary instrumentation and controls to maintain the unit in a safe condition during hot shutdown, and with a potential capability for subsequent cold shutdown.

The HFEB has primary responsibility for reviewing the design of the control room and remote shutdown capability to confirm that their designs facilitate the ability of nuclear power plant operators to prevent accidents or cope with accidents if they occur. Other branches review applicants' evaluations of the susceptibility of systems, structures and components important to safety, to malfunctions and failures.

The HFEB reviews the design of the control room and remote shutdown capability to assure that the interfaces between the systems, structures and components, and the plant personnel expected to operate them have been designed and provided in conformance with good human factors engineering practice. The objectives of the review are to confirm that:

1. Operator tasks necessary for emergency operation have been identified and defined, and are appropriate to the functions they are designed to fulfill;

2. the information, displays, controls and other interfaces necessary for operators to successfully carry out the tasks required to implement all emergency procedures have been identified and are provided in the control room and remote shutdown areas; and

3. the information, displays, controls and other interfaces in the control room and other plant areas required for remote shutdown are designed and provided in a manner consistent with good human factors engineering practice. That is, the layout and environment where control stations are located, panel layout, individual control and display components, and the integration of controls, displays and other interfaces must be provided such that the personnel responsible for operating the plant from the control room and remote shutdown areas can perform their tasks in as error-free and timely a manner as possible.

A human factors engineering evaluation of designs, at operating reactors, of the remote shutdown capability provided to meet 10 CFR Part 50, Appendix A, GDC-19, and 10 CFR Part 50, Appendix R is not specifically required. However, the staff recommends that the scope of the DCRDR include a human factors engineering evaluation of the remote shutdown capability.

II. ACCEPTANCE CRITERIA

The HFEB acceptance criteria are applied in the review of all ORs, OLs, and CPs in accordance with the following:

A. The acceptance criteria for licensees and applicants with existing control rooms (OR reviews) or already designed control rooms (OL reviews) are based on meeting the applicable requirements of Task Action Plan Item I.D.1 of NUREG-0660 as clarified in Supplement 1 of NUREG-0737. Detailed criteria are presented in Appendix A to this SRP section.

B. The acceptance criteria for construction permit applicants are based on meeting the relevant requirements of General Design Criterion 19, as it relates to the control room being designed with appropriate human factors engineering design principles to assure that the operator-machine interfaces of the control room are adequate to support safe operations of the plant.

Specific areas which applicants must address in order to meet the relevant requirements of this regulation for control room designs to demonstrate acceptable human factors engineering design principles include control room work space, workspace environment, annunciator warning systems, controls, visual displays, auditory signal systems, labels and locator aids, process computers, panel layout, and control-display integration.

Applicants just starting the control room design process shall provide preliminary design information at a level consistent with that normally required at the construction permit stage of review. Applicants shall provide a general discussion of their approach to control room design that reflects human factors principles by specifying the design concept selected and the supporting design bases and criteria. Cosmetic revisions to conventional (1960 technology) designs are unacceptable. An advanced control room design should utilize CRT displays or other advanced display technologies and should provide means for data gathering, formatting and processing which support operator functions and tasks and aid decision making under normal and emergency conditions. Control rooms should be designed only after a full systems analysis similar to that described in Appendix B of NUREG-0700. Applicants shall also demonstrate that the design concept is technically feasible and within the state of the art, and that there exists reasonable assurance that the requirements will be implemented properly prior to the issuance of operating licenses. Applicants shall commit to control room designs reflecting human factors principles prior to issuance of a CP or ML.

III. REVIEW PROCEDURES

The procedures used to verify that the DCRDR performed on existing or already designed control rooms meets the acceptance criteria are given in Appendix A to this SRP section.

Applicants just starting the control room design process will be reviewed to verify that accepted human factors engineering principles are incorporated during the design phase and that a full systems analysis is performed as part of the design process. The review will verify full participation of human factors engineering during the design process to minimize post design problems and changes. The issues addressed in NUREG-0700 can be used as a checklist to assure acceptable human factors coverage.

IV. EVALUATION FINDINGS

The reviewer of a DCRDR performed on existing or already designed control rooms confirms that sufficient information has been provided and the review, including any in-progress and pre-implementation audits, supports conclusions of the following type to be used in the staff's safety evaluation report:

The staff concludes that the applicant/licensee meets the relevant requirements of Supplement 1 to NUREG-0737 for conducting a detailed control room design review and finds evidence to indicate that the operator-machine interfaces of the control room and remote shutdown areas are adequate to support safe operation of the plant.

The conclusion is based on the following:

1. The applicant/licensee established a qualified multidisciplinary review team.

2. The applicant/licensee has identified the functions to be accomplished by operators in the main control room and remote shutdown areas under emergency operating conditions.

3. The tasks which need to be performed for emergency operations have been defined and analyzed to identify the information, control, and display requirements and their pertinent characteristics.

4. The information, control and display requirements have been compared with the controls and displays available. Missing or inappropriate controls and displays have been identified.

5. Deviations from accepted human factors principles have been identified and assessed. Modifications to correct significant human engineering discrepancies have been implemented or are planned to be implemented on an acceptable schedule.

6. Acceptable justification has been provided for not correcting or only partially correcting any significant human engineering deficiencies.

7. Proposed or implemented design modifications have been verified to provide the necessary corrections without introducing additional human engineering discrepancies.

8. Improvements that have been or will be introduced have been coordinated with changes resulting from other improvement programs.

The safety evaluation report shall indicate whether, based on the review carried out, changes in the implementation plan are needed to assure operational safety.

The reviewer of an applicant that is just starting the design process will conduct the review in three consecutive stages:

1. The PSAR stage will cover the planning, preliminary design, and criteria.

2. The FSAR stage will cover the final design, drawings, and procedures.

3. The final review will include audits of the control installation(s) and interviews with operators and others to identify deficiencies not detected previously or nonconformance with the SAR commitments.

For CPs, the staff review should support conclusions of the following type to be used in the staff's safety evaluation report.

The staff concludes that the applicant has met the requirements of General Design Criterion 19 and has incorporated accepted human factors engineering principles in the design of the control room and remote shutdown capability and finds the operator-machine interfaces of the control room and remote shutdown capability adequate to support safe operation of the plant.

The conclusion is based on the following:

1. The applicant conducted and documented a system analysis, using existing guidelines and good HFE practice, to identify man/machine interface requirements, including allocation of functions to man and machine (manual and automatic) and identification of information and controls provided to the operators. The applicant demonstrated that all the information and controls needed for normal, abnormal, and emergency operation of the plant are identified and provided. The allocation of functions to man and machine were addressed and the applicant established that the systems have been optimized to take advantage of the strengths of human operators and automatic systems.

2. The applicant demonstrated that the design of the control room complies with accepted human factors engineering principles and submitted documentation adequately addressing:

   a. Control Room Work Space

   b. Workspace Environment

   c. Annunciator Warning Systems

   d. Controls

   e. Visual Displays

   f. Auditory Signal Systems

   g. Labels and Location Aids

   h. Process Computers

   i. Panel Layout

   j. Control-Display Integration

3. The applicant demonstrated that the design of control centers outside the main control room complies with accepted human factors engineering principles and that functional relationships to the main control room have been established which will assure compatibility during all modes of plant operation. The applicant submitted documentation adequately addressing:

a. Work Space

b. Workspace Environment

c. Annunciator Warning Systems

d. Controls

e. Visual Displays

f. Auditory Signal Systems

g. Labels and Location Aids

h. Process Computers

i. Panel Layout

j. Control-Display Integration

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this SRP section.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the methods discussed herein are contained in the referenced NUREGs and will be applied in the review of all ORs, OLs, and CPs in accordance with the following:

1. Acceptance criteria for Operating Reactors (ORs) and Operating Licenses (OLs) are implemented in accordance with subsection II A, of this SRP section.

2. Acceptance criteria contained in subsection II B of this SRP section are applied to all future CP application reviews.

VI. REFERENCES

1. General Design Criterion 19, "Control Room."

2. Supplement 1 to NUREG-0737, "Requirements for Emergency Response Capability" (Generic Letter 82-33), December 17, 1982.

3. NUREG-0700, "Guidelines for Control Room Design Reviews," 1982.

4. Appendix A to SRP Section 18.1

U.S. NUCLEAR REGULATORY COMMISSION

STANDARD REVIEW PLAN

OFFICE OF NUCLEAR REACTOR REGULATION

APPENDIX A to SRP Section 18.1

EVALUATION CRITERIA FOR DETAILED CONTROL ROOM DESIGN REVIEWS (DCRDR)

REVIEW RESPONSIBILITIES

Primary - Human Factors Engineering Branch

Secondary - None

This Appendix of the Standard Review Plan was Formerly Draft NUREG-0801

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

1 INTRODUCTION

1.1 Purpose and Scope

Item I.D.1, "Control Room Design Reviews," of the NRC Action Plan developed as a result of the TMI accident (NUREG-0660 and NUREG-0737) states that the NRC will require all licensees and applicants for operating licenses (OLs) to conduct a Detailed Control Room Design Review (DCRDR). The Commission has established various requirements and provided guidance for the performance of the DCRDRs in Supplement 1 to NUREG-0737. These requirements are imposed on the licensees/applicants as provided in 10 CFR 50.54(f) as a condition of their licenses. Supplement 1 to NUREG-0737 provides as follows:

(1) Identify modifications to control room configurations that would contribute to a significant reduction in risk and enhancement of the safety of operation. The objective of the Detailed Control Room Design Review 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" (from NUREG-0660, Item I.D.1). As a complement to improvements of plant operating staff capabilities in response to transients and other abnormal conditions that will result from implementation of the Safety Parameter Display System (SPDS) and from upgraded emergency operating procedures, this design review will identify any modifications of control room configurations that would contribute to a significant reduction of risk and enhancement of the safety of operation. Decisions to modify the control room would include consideration of long-term risk reduction and any potential temporary decline in safety after modifications resulting from the need to relearn maintenance and operating procedures. This should be carefully reviewed by persons competent in human factors engineering and risk analysis.

(2) Conduct a Detailed Control Room Design Review to identify human engineering discrepancies. The review shall consist of

   (a) The establishment of a qualified multidisciplinary review team and a review program incorporating accepted human engineering principles.

   (b) The use of function and task analysis (that had been used as the basis for developing emergency operating procedures technical guidelines and plant-specific emergency operating procedures) to identify control room operator tasks and information and control requirements during emergency operations. This analysis has multiple purposes and should also serve as the basis for developing training and staffing needs and verifying SPDS parameters.

   (c) A comparison of the display and control requirements with a control room inventory to identify missing displays and controls.

(d) A control room survey to identify deviations from accepted human factors principles. This survey will include, among other things, an assessment of the control room layout, the usefulness of audible and visual alarm systems, the information recording and recall capability, and the control room environment.

(3) Assess human engineering discrepancies to determine which are significant and should be corrected. Select design improvements that will correct those discrepancies. Improvements that can be accomplished with an enhancement program (paint-tape-label) should be done promptly.

(4) Verify that each selected design improvement will provide the necessary correction, and can be introduced in the control room without creating any unacceptable human engineering discrepancies because of significant contribution to increased risk, unreviewed safety questions, or situations in which a temporary reduction in safety could occur. Improvements that are introduced should be coordinated with changes resulting from other improvement programs such as SPDS, operator training, new instrumentation (Regulatory Guide (RG) 1.97), and upgraded emergency operating procedures.

Supplement 1 to NUREG-0737, as translated into license conditions, also specifies that documentation shall be provided by licensees and associated NRC staff review as follows:

(1) All licensees/applicants shall submit a program plan within 2 months of the start of the control room review that describes how items 1, 2, 3, and 4 above will be accomplished. The NRC staff will review the program plans as licensees conduct their reviews, and selected licensees will undergo an in-progress audit by the human factors staff of the Office of Nuclear Reactor Regulation (NRR) based on the program plans and advice from project managers and resident inspectors.

(2) All licensees/applicants shall submit a summary report of the completed review outlining proposed control room changes, including their proposed schedules for implementation. The report will also provide a summary justification for any human engineering discrepancies with safety significance that are to be left uncorrected or partially corrected.

(3) The staff will review the summary reports, and within 2 weeks after receipt of a licensee's/applicant's summary report, will inform the licensee whether a pre-implementation onsite audit will be conducted. The decision will be based on the content of the program plan, the summary report, and the results of NRR in-progress audits, if any. The licensees/applicants selected for preimplementation audits may or may not include licensees/applicants selected for in-progress audits.

(4) For a licensee whose control room is selected for pre-implementation onsite audit, within 1 month after receipt of the summary report, the NRC staff will conduct

(a) A pre-implementation audit of proposed modifications (e.g., equipment additions, deletions and relocations, and proposed modifications).

(b) An audit of the justification for those human engineering discrepancies with safety significance to be left uncorrected or only partially corrected.

The audit will consist of a review of the licensee's/applicant's record of the control room reviews, discussions with the licensee/applicant review team, and usually a control room visit. Within a month after this onsite audit, the NRC staff will issue its safety evaluation report (SER).

(5) For a licensee for whose control room NRC staff does not perform a preimplementation onsite audit, the NRC staff will conduct a review and issue its SER within 2 months after receipt of the licensee's summary report. The review shall be similar to that conducted for pre-implementation plants under paragraph 4 above, except that it does not include a site audit.

The SER shall indicate whether, on the basis of the review carried out, changes in the licensee's modification plan are needed to ensure operational safety. Flexibility is considered in the control room review, because certain control board discrepancies can be overcome by techniques not involving control board changes. These techniques could include improved procedures, improved training, or the SPDS.

(6) The following approach will be used for OL review: For OL applicants for whose plants the supplemental safety evaluation report (SSER) has been issued before June 1983, licensing may be based on either a preliminary design assessment (PDA) or a Detailed Control Room Design Review (DCRDR) at the applicant's option. However, applicants who choose the PDA option are required to perform a DCRDR after licensing. A completed DCRDR will be required before licensing applicants with an SSER dated after June 1983.

(7) After the staff has issued an SER and a licensee/applicant has addressed any open issues, the licensee/applicant should begin the upgrade according to an approved schedule that has been negotiated with the staff. Modifications to operating reactor control rooms based on the results of the DCRDR may be implemented without prior Commission approval unless the change involves an unreviewed safety question.

To help the licensee/applicant conduct the DCRDR, NRC developed and published NUREG-0700, "Guidelines for Control Room Design Reviews."

This present document provides criteria to be used by the NRC staff to evaluate the DCRDRs performed by the licensees/applicants. The NRC will use these criteria to confirm that the basic requirements established by the Commission and the objectives of the DCRDR program stated in NUREG-0700 have been met. The NRC staff will also use the information provided in this document as guidance for verifying the selection of a qualified DCRDR team and the preparation of acceptable DCRDR documentation.

Departures by licensees/applicants from the methodologies recommended in NUREG-0700 and in this document will be acceptable if the methodologies that are used accomplish the same objectives.

1.2 Integration and Coordination of the DCRDR With Other Programs

The NRC Action Plan, as described in NUREG-0660 and NUREG-0737 and in Supplement 1 to NUREG-0737, includes initiatives in addition to the DCRDR. These include the design of a Safety Parameters Display System (SPDS); the design of instrument displays based on RG 1.97 guidance; the development of function-oriented emergency operating procedures; and the training of the operating staff. It is essential that all of these initiatives be integrated with respect to the overall improvement of the operator's ability to comprehend plant conditions and cope with emergencies. Information needs and display formats and locations should be assessed by each licensee in conjunction with the design of the SPDS. Installation of the SPDS should not be delayed by slower progress on other initiatives, and should not be contingent on completion of the Detailed Control Room Design Review. Moreover, other initiatives, such as upgraded emergency operating procedures, should not be impacted by delays in SPDS procurement.

The requirements for these initiatives, as imposed by license conditions, are stated in Supplement 1 to NUREG-0737; the detailed guidance on performing and implementing them is described in the referenced NRC documents.

All programs described in Supplement 1 to NUREG-0737 that involve physical or operational changes to the control room should be integrated and coordinated with the DCRDR. In addition, the corrective action modifications resulting from the DCRDR should be evaluated for their effects on these other programs. The coordination of the DCRDR and these other programs should include provisions for any necessary operator retraining and upgrading of operating procedures to reflect the physical changes made to the control room.

Functions and tasks should be analyzed to determine information and control needs and identify operator tasks during emergency operations. This analysis should be used in writing the emergency operating procedure guidelines and should serve as the basis for developing training and staffing needs and verifying the SPDS parameters. Although additional analyses will be necessary, the function and task analysis referred to in NUREG-0899, "Guidelines for the Preparation of Emergency Operating Procedures. Resolution of Comments on NUREG-0799," can be used in defining the scope of the systems review described in NUREG-0700 and the improvements in operator training.

Although development of a human factors engineering program is not a requirement, the NRC recommends that each licensee/applicant develop an ongoing human factors engineering program to examine any future changes that may be proposed for the control room after the DCRDR corrective actions are implemented. A human factors analysis could then be performed as part of the design and validation of any future control room modification.

1.3 Overview of DCRDR and NRC Evaluation Activities

NUREG-0700 describes four phases of the DCRDR and provides applicants and licensees with guidelines for its conduct.

The phases are:

(1) Planning.

(2) Review.

(3) Assessment and Implementation.

(4) Reporting.

The NRC staff's evaluation activities are briefly identified in the subsections that follow. The criteria to be applied during this evaluation process are presented in detail in Sections 2 through 5.

A program plan is to be submitted within two months of the start of the DCRDR. Consistent with Supplement 1 to NUREG-0737, the program plan shall describe how the following elements of the DCRDR will be accomplished:

(1) Establishment of a qualified multidisciplinary review team.

(2) Function and task analyses to identify control room operator tasks and information and control requirements during emergency operations.

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

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

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

(6) Selection of design improvements.

(7) Verification that selected design improvements will provide the necessary correction, and will not introduce new HEDs.

(8) Coordination of control room improvements with changes from other programs such as SPDS, operator training, RG 1.97 instrumentation, and upgraded emergency operating procedures.

A summary report is to be submitted at the end of the DCRDR. As a minimum it shall

(1) Outline proposed control room changes.

(2) Outline proposed schedules for implementation.

(3) Provide summary justification for HEDs with safety significance to be left uncorrected or partially corrected.

The NRC will evaluate the organization, process, and results of the DCRDR. Evaluation will include review of required documentation (program plan and summary report) and may also include reviews of additional documentation, briefings, discussions, and onsite audits. In-progress audits may be conducted after submission of the program plan, but before submission of the summary report. Pre-implementation audits may be conducted after submission of the summary report. Evaluation will be in accordance with Supplement 1 to NUREG-0737. Additional guidance for the evaluation is provided by NUREG-0700. Results of the NRC evaluation of a DCRDR will be documented in a safety evaluation report (SER) or SER supplement.

2 EVALUATION OF DCRDR PROGRAM PLAN REPORT

The sections that follow contain the criteria to be used by the NRC staff for review of the program plan reports submitted by licensees/applicants. The licensees/applicants may also use the information provided in this chapter as guidance for selecting a qualified DCRDR team and preparing a program plan report.

2.1 Establishment of a Qualified Multidisciplinary Review Team

The quality of the review effort and the results of the DCRDR will depend on the composition and balance of the team performing the review. The composition of a good review team can vary widely. Each licensee/applicant will select a team from available internal and external resources. The NRC staff will confirm that the disciplines represented on the licensee/applicant review team are appropriate for the performance of a meaningful DCRDR and that human factors specialists and operational personnel will be involved in most phases.

Although the composition of each licensee's/applicant's DCRDR team may vary, there are some general evaluation guidelines that can be applied during the NRC staff review. These guidelines are categorized as follows:

(1) Management and Structure.

(2) Composition and Qualifications.

(3) Team Support and Interactions.

(4) Orientation.

2.1.1 Management and Structure

The management and structure of the review team will vary for the different DCRDR efforts because of the differing needs and capabilities of the various utilities and the differing resources available to them. The degree of utilization of in-house and outside personnel is left to the discretion of the individual licensee/applicant, as long as the necessary multidisciplinary expertise is provided.

The NRC staff recommends that the DCRDR team management and structure include the following:

Administration: Overall administrative leadership of the DCRDR program should be provided by a utility employee, because the ultimate responsibility for the DCRDR lies with the licensee/applicant.

Human Factors: The DCRDR team should have capabilities and extensive experience in the human factors field, with experience in coordinating projects similar to the overall performance of the DCRDR. Human factors should be especially considered in the program planning phase of the DCRDR.

Technical Review Leaders: The different tasks of the DCRDR program will have varying technical leadership needs. The licensee/applicant should select an

appropriately qualified technical review leader for each task. The licensee/applicant should also assign human factors specialists to support the technical leadership of each portion of the DCRDR program.

Extensive use of human factors specialists throughout all portions of the review is necessary to ensure that the DCRDR is conducted from the proper human factors perspective. Human factors specialists should be involved in the actual performance of the review tasks and in all decisions involving design changes; they should not be limited to purely advisory roles.

Any additional individuals or groups that support the DCRDR should be described in the program plan report. For example, the licensee/applicant may assign an individual or group of support personnel to manage the extensive DCRDR data base. This individual or group should be identified in the program plan report.

In evaluating the structure of the licensee's/applicant's review team, the NRC will consider the different aspects of the technical review tasks and the resources that the team will need. Although the degree of participation of the various team members will vary for the different tasks, all team members should participate to some extent in most team activities. This will help the team operate from a common perspective, and will preserve the multidisciplinary approach by having each specialist bring individual expertise to each task.

Exhibit 2-1 provides a sample list of some of the major review tasks of the DCRDR with the disciplines that should be emphasized for each effort. The NRC staff will use information provided in this exhibit as a guide in evaluating the review team structure proposed by the licensee/applicant. The recommendation of a particular discipline for a specific review task as shown in Exhibit 2-1 does not imply that only the team member with that expertise is needed to perform this task.

The proposed assignments and levels of effort of each review team member will necessarily be only estimates at the time the program plan report is submitted. The NRC staff will evaluate the appropriateness of the proposed assignments and responsibilities of each of the DCRDR team members based on the individual team member's qualifications.

2.1.2 Composition and Qualifications

It is recommended that the DCRDR team described in the licensee's/applicant's program plan report should have a core group of specialists in the fields of human factors engineering, plant operations (e.g., licensed operators), instrumentation and controls engineering, and nuclear engineering. This core group should be supplemented by other disciplines, as required, such as mechanical engineering, electrical engineering, industrial engineering, architectural engineering, reliability and risk analysis, systems engineering, operations analysis, etc. At various times during the course of the review, the licensee/applicant should plan to provide additional specialists (e.g., lighting and acoustics, visual performance assessment, etc.) for specific tasks, as required.

The program plan report should contain detailed documentation of the qualifications of the DCRDR team members. In partcular, the roles of the team members, including the human factors specialists, should be reported.

REVIEW PROCESS	DISCIPLINE EMPHASIS
1. Operating Experience Review	
a. Examination of Available Documents	a. Nuclear Systems Engineering/ Reactor Operations
b. Control Room Operations Personnel Survey	b. Human Factors/Reactor Operations
2. Review of System Functions and Analysis of Operator Tasks	
a. Identification of Event Sequences	a. Nuclear Systems Engineering
b. Function Identification	b. Nuclear Systems Engineering
c. Function Analysis	c. Human Factors/Systems Analysis
d. Operator Task Identification	d. Nuclear Systems Engineering/ Reactor Operations
e. Task Analysis	e. Human Factors/Systems Analysis
3. Control Room Inventory	Instrumentation and Control/ Reactor Operations
4. Control Room Survey	Human Factors/Subject Matter Specialists
5. Verification of Task Performance Capabilities	
a. Verification of Availability	a. Instrumentation and Control/ Reactor Operations
b. Verification of Human Engineering Suitability	b. Human Factors
6. Validation of Control Room Functions	Instrumentation and Control/ Reactor Operations/Human Factors/Systems Analysis

Exhibit 2-1: Sample List of Some Major DCRDR Tasks and Recommended Discipline Emphases

Whenever possible, the review team should have access to the original control room designers as resource persons and to original design documentation, if possible, especially during the delineation of system functions, operator task analyses, and control room inventory efforts. However, individuals who were extensively involved in the design of the existing control room should not be directly responsible for directing those portions of the DCRDR process that require objectivity about the quality of that design.

Criteria that can be used in evaluating the qualifications of the personnel who will make up the DCRDR team core group are given below.

2.1.2.1 Human Factors Specialist*

A qualified human factors specialist should have both relevant academic background and work experience. Neither credential alone is assurance of a completely qualified individual. Because qualified human factors specialists may have received their formal training in a variety of disciplines ranging from engineering to the behavioral sciences, the relevant work experience of each individual will determine whether that person has the appropriate perspective to provide human factors input to the DCRDR program.

Formal Education: A degree, preferably at the graduate level, in human factors engineering or engineering psychology, is recommended. If the education of the proposed human factors specialist is in the more traditional fields of engineering or psychology, supplemental course work should include some of the following subjects:

(1) Human factors engineering.
(2) Human performance theory.
(3) Sensory/perceptual processes.
(4) Experimental psychology.
(5) Quantitative methods/statistics.
(6) Ergonomics.
(7) Anthropometry.
(8) Survey design.
(9) Industrial engineering/design.

Professional Experience: As a guideline, at least 5 years of relevant human factors experience is recommended for the senior human factors specialist who is given the overall advisory role in the DCRDR program. Less experienced human factors personnel may share the technical leadership of the specific review tasks under the direction/advisory guidance of this senior human factors specialist.

Experience in process control system design and plant operations is preferred. Demonstration of extensive experience in the application of human factors engineering and engineering psychology to other large, complex human-machine

*This document uses the term "human factors specialist" rather than "human factors engineer" to avoid the possible implication that only human factors personnel with engineering degrees will be considered acceptable by the NRC staff to provide the human factors input to the DCRDR.

systems (e.g., command and control systems, submarine control-display layouts) would be an acceptable alternative. At least one of the human factors specialists included on the DCRDR team should have experience in systems analysis and task analysis.

Experience should include the application of human factors to the design and/or evaluation of the following subject areas:

(1) Operator job definition.
(2) Workspace layout.
(3) Panel design (control and display layout).
(4) Environmental conditions (e.g., lighting and acoustics).
(5) Procedures and training.

Although membership in the Human Factors Society may indicate that a person has some involvement in human factors engineering, membership alone does not necessarily indicate qualification as a human factors specialist for the DCRDR program.

2.1.2.2 Reactor Operator

It is recommended that the DCRDR team should include at least one currently licensed reactor operator because an operator can best provide the perspective of the "human" in the "human-machine interface." The participation of operators is especially important during the review of operator response to operating conditions.

Professional Experience: For operating plants, at least one reactor operator with a minimum of 2 years of experience, preferably in the specific control room being reviewed, should be included on the DCRDR team. For operating license applicants, a licensed operator of that plant and/or a licensed operator with 2 years of operating experience in a control room similar to the one being reviewed is recommended.

2.1.2.3 Instrumentation and Controls Engineer and Nuclear Engineer

It is recommended that at least one instrumentation and controls engineer and a nuclear engineer be included as members of the core group. Individuals with expertise in the disciplines of nuclear engineering are necessary participants in the review process. Their knowledge of plant systems makes them best qualified to determine what instrumentation and system changes are feasible without impairing plant safety.

Formal Education: A bachelor's degree in engineering or its equivalent is recommended as a minimum.

Professional Experience: At least 5 years of applied experience is recommended. Most, if not all, of this experience should have been gained in the nuclear field, preferably at a nuclear power plant similar to the one under review. The instrumentation and controls engineer should be familiar with the regulations, standards, and design constraints that have an impact on nuclear power plant control room design. The nuclear engineer should be familiar with the design and operation of the nuclear steam supply system and the auxiliary systems of the plant under review.

2.1.2.4 Other Disciplines

General evaluation criteria for the team members representing the other disciplines recommended in Section 2.1.2 for the DCRDR team are as follows:

Formal Education: A bachelor's degree or its equivalent in a course of study relevant to the specific discipline is recommended as a minimum.

Professional Experience: At least 3 years of relevant experience is recommended. Previous experience in power plants or other process control applications is preferred. Experience with other complex commercial, industrial, or military facilities and systems is an acceptable alternative.

Professional licenses or certification and appropriate society memberships should be considered in evaluating competency. However, membership in a technical society alone should not be considered as sufficient proof of acceptable qualification.

2.1.3 Team Support and Interaction

The program plan report submitted by the licensee/applicant should include a statement of how the DCRDR team will interact with other organizations within the utility. Of particular interest is the authority that will be given to the DCRDR team to carry out its mission. To ensure freedom of operation, it is recommended that the DCRDR team have certain access, support, and noninterference, including access to facilities, personnel, and information.

2.1.4 Orientation

The licensee/applicant should develop an orientation program for the personnel selected for the DCRDR team. This orientation should ensure that team members share a basic understanding of the DCRDR before they begin the review. The orientation could include seminars, workshops, training manuals, short courses, and other methods.

As a recommended minimum, the DCRDR team should receive orientation in the following areas:

(1) Human factors engineering objectives and methodologies.

(2) General design and operation of the plant under review.

(3) The contents of NUREG-0700 and this document.

(4) The DCRDR program plan, when developed, including the methodologies that will be used.

2.2 Use of Function and Task Analysis

Supplement 1 to NUREG-0737 has the following requirements as imposed by license condition:

The Detailed Control Room Design Review shall "consist of...the use of function and task analysis (that had been used as the basis for developing emergency operating procedures technical guidelines and plant-specific emergency operating procedures) to identify control room operator tasks and information and control requirements during emergency operations. This analysis has multiple purposes and should also serve as the basis for developing training and staffing needs and verifying SPDS parameters." (Section 5)

Utilities are also required to "reanalyze transients and accidents and prepare Technical Guidelines. These analyses will identify operator tasks, and information and control needs. The analyses also serve as the basis for integrating upgraded emergency operating procedures and the control room design review and verifying the SPDS design." (Section 7)

The EOP technical guidelines developed by the four owners' groups provide the functional and system bases for conducting the task analysis. An acceptable process for conducting the task analysis described in Supplement 1 to NUREG-0737 is as follows:

(1) Analyze the functions to be performed by systems in responding to transients and accidents to define and describe the tasks the operators are expected to perform. This step may have been performed on a generic basis during procedure guideline development.

(2) From the tasks identified in item 1 above, define the parameters necessary for the operators to determine the need to perform the task, and the parameters necessary to determine that the task has been performed successfully. (Note that no instrumentation has been identified yet, only parameters derived from the tasks.) Again, this step may have been performed on a generic basis.

(3) Analyze the operator tasks to determine the characteristics of the information and control capability needed to perform the task. (Information characteristics include parameter type, dynamic range, setpoints, resolution/accuracy, speed of response, units, and the need for trending. Control characteristics include type (discrete or continuous), discrete functions (e.g., on, off, auto), rate, gain and response requirements. These characteristics are defined on a plant-specific basis and are derived from the technical guidelines and associated background documentation, the results of the reanalyses of transients and accidents, and plant-specific documentation.

Since the task analysis that is to be described in both the DCRDR and EOP upgrade programs is in fact the same analysis, it would be acceptable to describe the task analysis in one program's documentation, and provide a suitable cross-reference in the other.

2.3 Comparison of Display and Control Requirements With Control Room Inventory

The results of the task analysis (see Section 2.2 above) should be used in both the DCRDR and the EOP upgrade programs to evaluate the adequacy of existing controls and displays to meet the needs identified. An inventory of existing control room instrumentation (for the DCRDR program) or a control

room walkthrough or desk-top review during validation/verification (for the EOP upgrade program) should be performed to determine if there are existing instruments or controls to satisfy the identified needs. With this information, a multidisciplinary review team should then analyze and determine whether the existing or planned instrumentation meets the needs identified in the task analysis and, if not, then assess the significance of discrepancies and the need for correction. This process starts with an identification of information and control needs and ends with instrumentation specifications based on the operators' needs.

Documentation of both the needed control and display characteristics and the results of comparison of these characteristics with the existing or planned controls and displays should be maintained by the licensee/applicant available for NRC audit purposes.

2.4 Control Room Survey

The control room survey is a systematic comparison of control room design features with human engineering guidelines. Section 6 of NUREG-0700 presents acceptable guidelines, but other comparable references will be acceptable. The objective of the control room survey is to identify any characteristics of instruments, equipment, layout, and ambient conditions that do not conform to precepts of good human engineering practice.

The licensee's/applicant's program plan should contain a description of the survey process and guidelines to be used as well as the procedure for documenting HEDs identified. Section 3.6 of NUREG-0700 provides additional guidance on the conduct of the control room survey.

2.5 Assessment of HEDs

The NRC staff recognizes that there are many methods of assessing HEDs to determine their significance on operator performance and plant safety. Any method that systematically assesses the effect of the HED on the operator's ability to perform the necessary tasks and considers the resulting consequences of an error on plant safety will be acceptable.

The guidelines that the NRC will use to evaluate the HED assessment methodology described in the program plan report are as follows:

(1) The relative degree of degradation of operator performance caused by each HED is adequately assessed.

(2) The effect on plant safety of each HED is adequately assessed.

(3) The possible interactions of HEDs are adequately considered.

(4) The resulting priority for implementing corrective action is appropriate. HEDs that have resulted in errors should have a high correction priority.

To evaluate the significance of design discrepancies, the DCRDR team must determine the effect of each HED on operator performance, both alone and in combination with other HEDs. Corrective action of each HED should be based on its significance as it affects the safety of the plant.

All HEDs that are known to have previously contributed to an operating crew error, as documented in an LER (licensee event report) or other historical record, or as established by interview or questionnaire responses, should be considered significant. All other HEDs should be systematically assessed to determine their significance.

It is suggested that these HEDs be subjected to a series of statements or questions that could aid the review team in assessing the impact of those HEDs on operating crew performance and plant safety. Sample questions are presented in Exhibit 2-2 for guidance.

To aid in assessing significance of HEDs, it is suggested that they be considered by categories. The categories will not only aid in ranking significance, but may suggest the priorities according to which the HEDs are considered for corrective action. The actual scheduling, using some systematic way of determining priorities, should be negotiated with the NRC staff.

2.6 Selection of Design Improvements

The DCRDR summary reports submitted by licensees/applicants should include descriptions of all corrective actions that are proposed. These descriptions should be sufficiently detailed so that the NRC staff can determine whether the proposed corrective actions adequately resolve the HED.

The NRC staff will evaluate the proposed corrective action to determine whether the licensee/applicant has adequately:

(1) Brought the HED into agreement with acceptable human factors engineering standards or provided another solution that counteracts the effect of the HED.

(2) Assessed the proposed corrective action to verify that the safety of the plant will no longer be degraded.

(3) Verified that the modification does not introduce new problems to the control room while correcting the HED.

The DCRDR summary report should include general descriptions of how the licensee/applicant performed the above tasks and arrived at the corrective action selected. To adequately perform these tasks, the licensee/applicant should refer to the guidance presented in Section 3 of NUREG-0700.

Some of the HEDs identified in performing the control room review will be correctable using approaches that can be implemented during normal plant operations or planned plant shutdown. Any one of several approaches (i.e., enhancement, procedures, training, relocation, or removal or addition of instrumentation, or any combination of these) can be considered for correcting an HED. Some corrective actions will be more involved and time consuming than others. Corrective actions such as enhancement or operator training can be accomplished with a minimum amount of disruption to plant operation or personnel. For the most part, "enhancement" will be limited to the application of paint, labels, and tape. This type of enhancement as well as others are discussed in the Electric Power Research Institute (EPRI) document NP-2411, "Human Engineering Guide for Enhancing Nuclear Control Rooms." The enhancement

Exhibit 2-2: Sample Questions for HED Assessment

To what extent do you agree with the following?

1. This discrepancy will cause undue operator fatigue.
2. This discrepancy will cause operator confusion.
3. This discrepancy will cause operator discomfort.
4. This discrepancy presents a risk of injury to control room pesonnel.
5. This discrepancy will increase the operator's mental workload (for example, by requiring interpolation of values, remembering inconsistent or unconventional control positions, etc.).
6. This discrepancy will distract control room personnel from their duties.
7. This discrepancy will affect the operator's ability to see or read accurately.
8. This discrepancy will affect the operator's ability to hear correctly.
9. This discrepancy will degrade the operator's ability to communicate with others (either inside or outside the control room).
10. This discrepancy will degrade the operator's ability to manipulate controls correctly.
11. This discrepancy will cause a delay of necessary feedback to the operator.
12. Because of this discrepancy the operator will not be provided with positive feedback about control tasks.
13. This discrepancy violates control room conventions or practices.
14. This discrepancy violates nuclear industry conventions.
15. This discrepancy violates population stereotypes.
16. Operators have attempted to correct this discrepancy themselves (by self-training, temporary labels, "cheaters," "helper" controls, compensatory body movements, etc.).
17. Tasks in which this discrepancy is involved will be highly stressful (i.e., highly time constrained, of serious consequence, etc.).

Exhibit 2-2: (Continued)

18. This discrepancy will lead to inadvertent activation or deactivation of controls.

19. If this discrepancy caused a specific error, it is probable that another error of equal or more serious consequence will be committed.

20. This discrepancy is involved in a task which is usually performed concurrently with another task (e.g., watching water level meter while manipulating a throttle valve control).

21. This discrepancy involves controls or displays that are used by operators while executing emergency procedures.

22. Assuming that this HED caused an operating crew error, it is likely that this error would result in:

    a. A violation of a technical specification, safety limit, or a limiting condition for operation.

    b. The unavailability of a safety-related system needed to mitigate transients or system needed to safely shut down the plant.

23. This discrepancy involves controls or displays that are part of an engineered safety function or are associated with a reactor trip function.

guide also addresses the violation of design conventions. It cautions that any changes involving design conventions carry the risk of violating an existing explicit or implicit convention. It also suggests that where explicit conventions do not exist they should be created and documented as part of the review and design process.

The determination of an appropriate corrective action implementation schedule should be based on the degree of degradation of operator performance caused by the HEDs, the effect of the HED on the safety of the plant, whether the equipment affected by the HED is part of a safety system, and the availability of resources needed for correction. Both operating and nonoperating plants are encouraged to implement all corrective actions on as short a schedule as possible to avoid problems with operator retraining.

2.7 Verification That Design Improvements Provide the Necessary Correction and Do Not Introduce New HEDs

Various approaches are available to licensees/applicants to ensure that proposed control room modifications provide the necessary correction of deficiencies discovered during the course of the DCRDR and do not introduce new HEDs or otherwise increase risk. The verification process should include review of the proposed changes by human factors and operations personnel and can be facilitated by the establishment of design conventions and standards and by subjecting proposed changes to the same human engineering guidelines that were used to identify HEDs initially.

Many corrective actions (e.g., labeling corrections) are obvious and straightforward and do not require an extensive verification process. For many other changes, however (e.g., the introduction of new instrumentation, rearrangements of displays and controls, etc.), a more formal, systematic verification process is necessary. This process can include the application of modifications to a plant-referenced simulator or, where this is not feasible, the development of mockups, mosaics, or other methods of simulating proposed changes before they are implemented in the control room. The use of mockups has many advantages. For example, they can be

(1) Economically constructed using cardboard, photographs, blueprints, or other representations of instruments and controls.

(2) Constructed in varying degrees of complexity and detail.

(3) Used to evaluate alternative devices, display formats, and arrangements.

(4) Used in training and in developing procedures.

In addition to the pre-implementation verification of proposed control room modifications, licensees/applicants are encouraged to provide postimplementation followup of control room changes as part of a continuing human factors program.

The staff will evaluate the licensee's/applicant's process for verification of design improvements to determine if a thorough, systematic process has been planned for evaluating the efficacy of control room modifications.

2.8 Coordination of Control Room Improvements With Other Programs

The mechanism for coordinating control room improvements with other programs such as SPDS, operator training, RG 1.97 instrumentation, and upgraded emergency operating procedures varies across plants. Generally, such coordination can be achieved by

(1) Having plant personnel or organizations involved in more than one initiative to enhance input to and feedback from each.

(2) Performing a task analysis in a way and at a time that its results can be applied in each program and may serve as the common base upon which each program is built.

(3) Assuring that a mechanism exists whereby the results of each program are integrated into the other programs in an iterative manner.

For example, the Detailed Control Room Design Review can define information inputs and display formats for the SPDS. Likewise, the SPDS may obviate the need for some control room design changes.

3 NRC IN-PROGRESS SITE AUDITS DURING THE REVIEW PHASE

3.1 Purpose

The NRC staff will select some licensees/applicants for onsite audits during the review phase of the DCRDR. Licensees/applicants will be selected for in-progress audits if the NRC staff evaluation of their submitted program plan reports reveals areas of concern. Additional licensees/applicants will be selected for audits if project managers or the resident inspectors at specific plants identify potential problem areas in the DCRDR programs. The purpose of these selective audits will be to resolve any questionable areas found in the program plan reports or identified by the resident inspectors. In addition, the NRC staff will try to determine whether the guidance provided in NUREG-0700 and in this document is adequate for the meaningful completion of the DCRDRs.

3.2 Scheduling

The NRC site audits will be preannounced and will be scheduled at various stages of the DCRDR programs. The scheduling of the visit to each selected site will be coordinated with the responsible NRC project manager and with the utility. The NRC staff will determine the appropriate times for the site audits from the DCRDR schedules submitted by the licensees/applicants in their program plan reports.

3.3 Performance

In visiting the selected plant sites, the NRC staff will perform a general audit of the status of the DCRDR program, with special emphasis given to those areas of concern identified during the staff evaluation of the program plan report or by the resident inspector. During the audit, the NRC staff may:

(1) Survey the control room.

(2) Interview review team members.

(3) Examine the licensee's/applicant's DCRDR information system.

(4) Review additional information about the program plan that was questionable or that was not submitted in the program plan report.

(5) Discuss the identified areas of concern regarding the program with the DCRDR team and the licensee/applicant.

3.4 Results

The NRC staff, in cooperation with the responsible project managers and utilities, will try to resolve any areas of the licensee's/applicant's program plan that it feels will not result in an acceptable DCRDR. The NRC staff may propose possible changes to the program if any are needed to accomplish the requirements established by the Commission.

4 EVALUATION OF DCRDR SUMMARY REPORT

To document the results of the review, the licensee/applicant should submit a summary report of the completed review outlining proposed control room changes, including the proposed schedule for implementation. This summary report should be submitted to the NRC after the DCRDR is completed and before the licensee/applicant begins any major modifications to the control room. Modifications to operating reactor control rooms may be implemented without prior Commission approval unless the change involves an unreviewed safety question. Within 2 weeks after receipt of the summary report, the NRC staff will inform the licensee/applicant whether a pre-implementation onsite audit will be conducted.

The following areas will be reviewed by the NRC staff in its evaluation of the DCRDR summary reports:

(1) A description of any significant changes that were made from the program plan report that was previously submitted, and an explanation of why these changes were made.

(2) A description of the proposed control room modifications with an explanation of how the HEDs were resolved (chosen for correction or noncorrection).

(3) A summary justification for HEDs with safety significance to be left uncorrected or partially corrected.

(4) A proposed schedule for implementing the modifications.

During the review of the summary report or during the pre-implementation onsite audit, the NRC staff may find it necessary to discuss or examine the documentation generated at the plant during the DCRDR. The NRC staff recommends that the licensee/applicant have available at the plant the following:

(1) A complete listing of all the HEDs identified during the DCRDR.

(2) A concise description of the HEDs including

(a) The system, subsystem, and task affected by the HED.

(b) The NUREG-0700 Section 6 guideline or other human factors engineering standard violated which resulted in the HED.

(c) Any numbering system used by the licensee/applicant to identify the HED and the corrective action.

(3) A description of any cumulative effects or interactions between the HED and other HEDs including a description of the effect of the HED on plant safety.

(4) A description of the proposed corrective action for the HED.

(5) A justification and analysis of any significant HED that the licensee/applicant does not intend to correct.

The above list need not be submitted to the NRC; it represents only a subset of the data that should be contained in the licensee's/applicant's information management system. All the data stored in the information management system should be available to the NRC upon request. Standardization of information management systems by the industry is recommended to facilitate communication and information exchange. In response to public comment, a sample format and procedure for documenting HEDs is presented in Appendix III to this appendix for guidance purposes.

5 PREPARATION OF SAFETY EVALUATION REPORT

5.1 Preimplementation Audit

On the basis of the NRC staff evaluation of the DCRDR summary reports, some licensees/applicants will be selected for pre-implementation audits. These audits will take place before the SER is issued and before the licensee/applicant begins any major modifications to the control room. A licensee/applicant may be selected for a pre-implementation audit if the NRC staff has any questions on the identification, assessment, or resolution of HEDs. During the onsite audits, the NRC staff will perform a more detailed evaluation of the licensee's/applicant's DCRDR. The evaluation will include examination of the licensee's/applicant's DCRDR documentation, discussions with the review team, inspection of the existing control room, and inspection of any mockups of proposed corrective action modifications.

5.2 Results

The result of the NRC staff evaluation of the licensee's/applicant's DCRDR effort will be a safety evaluation report (SER). This NRC staff SER will be based on the staff evaluation of the submitted program plan report, the results of any in-progress site audit, the evaluation of the submitted DCRDR summary report, and the results of any pre-implementation audit.

When the SER is issued, licensees/applicants should proceed with the corrective action implementation schedules they submitted in their DCRDR summary reports unless exceptions are taken in the SER.

(b) The NUREG-0700 Section 6 guideline or other human factors engineering standard violated which resulted in the HED.

(c) Any numbering system used by the licensee/applicant to identify the HED and the corrective action.

(3) A description of any cumulative effects or interactions between the HED and other HEDs including a description of the effect of the HED on plant safety.

(4) A description of the proposed corrective action for the HED.

(5) A justification and analysis of any significant HED that the licensee/applicant does not intend to correct.

The above list need not be submitted to the NRC; it represents only a subset of the data that should be contained in the licensee's/applicant's information management system. All the data stored in the information management system should be available to the NRC upon request. Standardization of information management systems by the industry is recommended to facilitate communication and information exchange. In response to public comment, a sample format and procedure for documenting HEDs is presented in Appendix III to this appendix for guidance purposes.

5 PREPARATION OF SAFETY EVALUATION REPORT

5.1 Preimplementation Audit

On the basis of the NRC staff evaluation of the DCRDR summary reports, some licensees/applicants will be selected for pre-implementation audits. These audits will take place before the SER is issued and before the licensee/applicant begins any major modifications to the control room. A licensee/applicant may be selected for a pre-implementation audit if the NRC staff has any questions on the identification, assessment, or resolution of HEDs. During the onsite audits, the NRC staff will perform a more detailed evaluation of the licensee's/applicant's DCRDR. The evaluation will include examination of the licensee's/applicant's DCRDR documentation, discussions with the review team, inspection of the existing control room, and inspection of any mockups of proposed corrective action modifications.

5.2 Results

The result of the NRC staff evaluation of the licensee's/applicant's DCRDR effort will be a safety evaluation report (SER). This NRC staff SER will be based on the staff evaluation of the submitted program plan report, the results of any in-progress site audit, the evaluation of the submitted DCRDR summary report, and the results of any pre-implementation audit.

When the SER is issued, licensees/applicants should proceed with the corrective action implementation schedules they submitted in their DCRDR summary reports unless exceptions are taken in the SER.

The SER will state whether the NRC staff concludes that the proposed modifications to the licensee's/applicant's control room equipment and operations as a result of the DCRDR will accomplish the basic requirements established by the Commission. Any additional corrections or schedule modifications necessary to comply with the basic requirements established by the Commission will be documented in the SER.

SER will state whether the NRC staff concludes that the proposed modifications to the licensee's/applicant's control room equipment and operations as a result of the DCRDR will accomplish the basic requirements established by the Commission. Any additional corrections or schedule modifications necessary to comply with the basic requirements established by the Commission will be documented in the SER.

APPENDIX I to APPENDIX A of SRP 18.1

REFERENCE DOCUMENTS FOR PROGRAMS RELATED TO DCRDRs

Electric Power Research Institute

Report NP-2411, "Human Engineering Guide for Enhancing Nuclear Control Rooms," May 1982.

Nuclear Regulatory Commission

NUREG-0585, "TMI-2 Lessons Learned Task Force," October 1979.

NUREG-0654, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," February 1980.

NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," May 1980.

NUREG-0696, "Functional Criteria for Emergency Response Facilities," July 1980.

NUREG-0700, "Guidelines for Control Room Design Reviews," September 1981.

NUREG-0737, "Clarification of TMI Action Plan Requirements," November 1980.

NUREG-0737, Supplement 1, "Emergency Response Capability,"

NUREG-0799, "Draft Criteria for Preparation of Emergency Operating Procedures," June 1981.

NUREG-0835, "Human Factors Acceptance Criteria for Safety Parameter Display System," October 1981.

NUREG-0899, "Guidelines for the Preparation of Emergency Operating Procedures. Resolution of Comments on NUREG-0799," August 1982.

Regulatory Guide 1.23, "Meteorological Programs in Support of Nuclear Power Plants."

Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems."

Regulatory Guide 1.97, Revision 2, "Instrumentation of Light Water Cooled Nuclear Power Plants To Assess Plant Conditions During and Following an Accident."

Nuclear Utility Task Action Committee

INPO 83-026 (NUTAC), "CRDR Implementation Guideline," July 1983.

INPO 83-036 (NUTAC), "Human Engineering Principles for CRDR," September 1983.

INPO 83-042 (NUTAC), "CRDR Survey Development Guideline," November 1983.

INPO 83-046 (NUTAC), "CRDR Task Analysis Guideline," December 1983.

INPO 83-047 (NUTAC), "Component Verification and System Validation Guideline," September 1983.

APPENDIX II to APPENDIX A of SRP 18.1

MANAGEMENT OF HED INFORMATION

II.1 INTRODUCTION

The quality of the DCRDR will be improved if a systematic process for the identification and documentation of HEDs is developed by the licensee/applicant before the review process begins. This system should preserve all pertinent information regarding the equipment, systems, and tasks involving each HED in an easily retrievable format. If such a system is not developed, information may be lost, which may mean that work must be redone to justify any HED resolution that is questioned during the NRC staff evaluation of the DCRDR.

In response to public comment, this appendix addresses suggested methods for three phases of HED information management. These phases are

(1) The organized identification of HEDs during the control room survey task of the DCRDR review phase.

(2) The recording of all pertinent HED information during the tasks of the DCRDR review phase.

(3) The storage and retrieval of all HED information resulting from the DCRDR.

II.2 IDENTIFICATION OF THE HEDs

The DCRDR team performing the control room survey portion of the DCRDR review phase (Section 3.6 of NUREG-0700) will be examining control room equipment for violations of human engineering guidelines (from Section 6 of NUREG-0700 or some other acceptable standard). It will be helpful if the licensee/applicant identifies applicable guidelines for each piece of equipment before the survey. For example, reviewers examining a pushbutton control would not need to consider the guidelines for rotary controls.

After the control room inventory portion of the review phase (Section 3.5 of NUREG-0700) is completed, a listing of applicable guidelines for each identified piece of equipment could be prepared. This listing could be done in tabular form and organized by individual equipment item, by system, and/or by panel. Multiple pages would be necessary to include all equipment identified during the control room inventory and to accommodate all applicable guidelines for each piece of equipment. The licensee/applicant may wish to include system information, label content, etc.

II.3 RECORDING

It is crucial that all pertinent HED data be recorded as they are identified. Unless a systematic process for such recording is developed, the DCRDR team may have to repeat work to reconstruct lost information that is needed later.

Section 3.6.2.2 of NUREG-0700 contains an example of a human engineering discrepancy record that was developed during the NRC human factors engineering design review/audits of operating license applicant control rooms. A form of this type would be useful during the control room survey portion of the DCRDR to record the data from that process. Similiar forms should be developed to record all pertinent data from any DCRDR process that results in the identification of HEDs.

II.4 STORAGE AND RETRIEVAL

A large volume of information will be generated during the DCRDR. The efficient management of this information will be a key element in performing an effective review. The easiest way to manage this volume of information will be to use an automated data processing method, such as a computer or a punched card sorter.

One benefit from the development of an efficient information management system will be the ability to identify and combine HEDs that are related in various ways. This could help the DCRDR team find interactions, cumulative effects, and problems that are widespread in the control room. An efficient system could also help the team when it is developing corrective actions, because the team should be able to retrieve all HEDs that involve a specific piece of equipment and coordinate all necessary corrections simultaneously.

It would be helpful to all users of the data generated from the various DCRDR processes if all pertinent information for each HED were organized according to a standard format. This format could be stored in a computerized file, a word-processing document, a conventional report sheet, or any other data management form. No matter what format is used, the information stored should be the same. Exhibit II-1 gives an example of a conventional report sheet. Exhibit II-2 provides a supplementary explanation of the sample report sheet in Exhibit II-1.

HED Report Sheet

Date: _____

Page _____ of _____

- Licensee: _____ Plant: _____ Reviewer: _____
- Plant System: _____ (Reactor Coolant, Reactivity Control, Environment, etc.)
- Plant SubSystem: _____ (Pumps, Valves, HVAC Controls, etc.)
- Equipment Item or Topic – Control Board Section (name/number) _____
  – Control Board Panel (panel identifier) _____
  – Component or Topic Item
  (e.g., C/D layout, lighting, maintenance procedures, etc.) _____
- Human Performance Modality (vision, hearing, decision making, etc.) _____
- NUREG-0700 ID: _____ (Applicable Section & Subsection of NUREG-0700, Section 6)

HED DESCRIPTION:

HED SERIAL NUMBER: *(if used)*

PHOTO ID NUMBER:

1. Description of HED:

2. This HED Relates to:
   a. Event: (From NUREG-0700 Section 3.4.2.2, 3.8.2, etc.)
   b. Function/Task: (Needed to mitigate the event, from NUREG-0700 Section 3.4.2.3, 3.4.2.4, Exhibits 3-3, 3-5, etc.)

3. Safety Consequences:

4. Interaction of HED with other HEDs, systems, events, functions/tasks, etc.

ACTION PROPOSED TO CORRECT HED:

(NUREG 0700 Section 4)

CORRECTION SCHEDULE

COMMENTS: This section contains other pertinent explanatory or supplementary information including:

- Identification of HED with applicable steps or substeps of system review (NUREG-0700 Section 3.2-3.8)

NOTE: This Report Sheet is not intended to be an additional task step to be done. It is meant to provide a single place to summarize the results of the review steps described in NUREG-0700.

Exhibit II-1: Sample HED Report Sheet

Supplementary Explanation of the HED Report Sheet

- System (Subsystem): The information for these items from the system analysis in NUREG-0700, Section 3. If numerical coding of system/subsystem has been used by the licensee, this should be included with the narrative description.

- Equipment Items or Topic Items: The purpose of this item is to identify the specific control board components or topic. Thus, board section or panel number, and instrument/control name/number should be indicated. In some cases, the HED may involve a whole panel or section, e.g., panel layout HED or more than one panel, e.g., control-display integration HED. For such situations all involved components/panels/sections should be identified. Also, if procedures, maintenance, etc. are involved in the HED, they should be specified on this line.

- The HED Serial number is a number which uniquely identifies each HED.

- The photo ID number will allow reference to photos which may have been taken to clarify the HED.

- HED Description: The purpose of these three parts is to describe the HED but also to show how the HED relates to operating events, functions, and tasks, and then, safety consequences. Examples of events, functions, and tasks with references to applicable NUREG-0700 sections are:

Events	0700 Ref.
Transients	3.4.2.2
Start Up	3.4.2.2
Shut Down	3.4.2.2
Change in power level	3.4.2.2

Functions/Tasks	0700 Ref.
Increase to 5% power	Exhibit 3-3
Place automatic control	Exhibit 3-3
Withdraw control rods	Exhibit 3-5
Determine IR detectors are on scale	Exhibit 3-5

- Action proposed to correct HED: The correction already made or proposed should be described here. If a partial or no-correction is proposed, the justification should be presented.

Exhibit II-2: Supplementary Explanation of the HED Report Sheet

APPENDIX III to APPENDIX A of SRP 18.1

REVIEW OF NUTAC DOCUMENTS

III.1 INTRODUCTION

A number of publications have been produced by Nuclear Utility Task Action Committees (NUTAC). These publications represent a consensus of only the utilities represented in the NUTAC and are not intended to be interpreted as industry standards. It is stated in the publications that they are offered as suggested guidance with the understanding that individual utilities are not obligated to use the suggested guidance.

The Control Room Design Review NUTAC (CRDR NUTAC) has developed four publications, and the Emergency Response Capabilities NUTAC (ERC NUTAC) has developed one publication which may be referenced by applicant/licensee submittals. These publications were prepared with the staff support of the Institute of Nuclear Power Operations (INPO). Vendors, architect-engineers, and the NRC staff were excluded from the development process.

It is the intent of this appendix to provide guidance to NRC staff reviewers on potential problem areas when these publications are referenced. The following NUTAC publications are covered:

(1) INPO 83-026 (NUTAC), "Control Room Design Review Implementation Guideline," CRDR NUTAC, July 1983.

(2) INPO 83-036 (NUTAC), "Human Engineering Principles for Control Room Design Review," CRDR NUTAC, September 1983.

(3) INPO 83-042 (NUTAC), "Control Room Design Review Survey Development Guideline," CRDR NUTAC, November 1983.

(4) INPO 83-046 (NUTAC), "Control Room Design Review Task Analysis Guideline," CRDR NUTAC, December 1983.

(5) INPO 83-047 (NUTAC), "Component Verification and System Validation Guideline," ERC NUTAC, December 1983.

As a general comment on the NUTAC publications, they were developed with the philosophy that they are not "how to" documents, but, rather, explanatory and educational tools. In many instances the NUTAC publication will identify what is needed but not describe a methodology for complying with the requirement. The NRC staff reviewer should verify that submittals do not merely reference the NUTAC publications without providing the needed plant-specific information.

III.2 CONTROL ROOM DESIGN REVIEW IMPLEMENTATION GUIDELINE

The NUTAC Implementation Guideline presents a format that utilities may use in preparing their program plan submittal. An example submittal is presented to provide a frame of reference for planning a plant-specific program. It does not present any guidance as to how technical tasks may be accomplished. The Implementation Guideline implies that the NRC will approve the program plan submittal. This is not so, the NRC staff only reviews the program plan for the purpose of providing early identification and feedback of potential problem areas in conducting the DCRDR.

III.3 HUMAN ENGINEERING PRINCIPLES FOR CONTROL ROOM DESIGN REVIEW

The NUTAC Human Engineering Principles is not useful in meeting specific regulatory requirements for conducting DCRDR. It does serve as an educational tool for utility personnel in describing what the basic human factors engineering principle might be in an identified design deficiency or a proposed correction.

III.4 CONTROL ROOM DESIGN REVIEW SURVEY DEVELOPMENT GUIDELINE

The NRC staff review of the NUTAC Survey Development Guideline is that this publication represents a relaxation of some specific guidelines from Section 6 of NUREG-0700. Objective measurement guidelines of NUREG-0700 have in some instance been replaced by subjective opinions with no foundation in human factors values. The industry group has stated that this is intended to eliminate many minor human engineering deficiencies during the survey phase. The NRC staff position is that all human engineering deficiencies should be identified during the survey and a decision made as to their significance during the assessment phase. This process allows consideration of multiple related deficiencies which when taken together may be significant. The industry group has also stated that although their guidelines are, in some cases, different from NUREG-0700 they are based on accepted human factors engineering principles. The NRC staff position is that when this NUTAC publication is referenced as forming the basis for developing survey checklists, the reviewer should verify either during an in-progress audit or a preimplementation audit that there are no additional human engineering deficiencies which may be assessed as being significant.

III.5 CONTROL ROOM DESIGN REVIEW TASK ANALYSIS GUIDELINE

The NUTAC Task Analysis Guideline presents an explanatory and educational discussion on task analysis. It does not provide a methodology for actually performing the task analysis and identifying operator information and control needs and display and control characteristics. The NRC staff also finds that it does not emphasize sufficiently the need to insure that information and control requirements are identified independently of existing control room displays and controls. Meetings have been scheduled with representatives of the various vendor owners' groups to identify the specific documentation to show how the characteristics of instruments and controls were derived from owners group generic or plant specific technical guidelines.

III.6 COMPONENT VERIFICATION AND SYSTEM VALIDATION GUIDELINE

The NUTAC Component Verification and System Validation Guideline provides guidance on the development of verification and validation (V&V) programs for use in the development and modifications of emergency response capability

initiatives as defined in Supplement 1 to NUREG-0737. This NUTAC publication provides significantly more detailed guidance than the four previously reviewed publications. It includes guidance on the coordination and integration of emergency response capability initiatives in addition to component verification. The NRC staff review, however, has raised some questions as to the completeness of the program for system validation of interactions within the emergency response capability initiatives. This last issue is still under review.

APPENDIX IV to APPENDIX A of SRP 18.1

CHANGES IN NRC POSITION ON DETAILED CONTROL ROOM DESIGN REVIEWS FROM POSITION PRESENTED IN NUREG-0700

This appendix presents a description of significant changes in the staff approach for Detailed Control Room Design Reviews from that covered in NUREG-0700, "Guidelines for Control Room Design Review," including reasons for the changes.

The requirements for the Detailed Control Room Design Review described in Supplement 1 to NUREG-0737 and imposed through license conditions are a condensation of the essential elements and goals of NUREG-0700. With the exception noted below, Supplement 1 to NUREG-0737 encompasses the full scope of NUREG-0700. Many of the tasks outlined in NUREG-0700 are not specifically mentioned in Supplement 1 to NUREG-0737. However, except as noted below, the performance of the tasks outlined in NUREG-0700 or comparable tasks is necessary to meet the requirements of license conditions established under Supplement 1 to NUREG-0737.

The Detailed Control Room Design Review approach outlined in NUREG-0700 divides the review into four major phases: (1) planning, (2) review, (3) assessment and implementation, and (4) reporting. Supplement 1 to NUREG-0737 addresses each of these phases. Except for the review phase of the control room design review, there are no significant differences between Supplement 1 to NUREG-0737 and the guidance of NUREG-0700.

The significant change between Supplement 1 to NUREG-0737 and NUREG-0700 is the review of system functions and control room tasks. NUREG-0700 recommends that the sequence of events include a spectrum of events with emphasis on abnormal and emergency conditions.

Supplement 1 to NUREG-0737 reduces the scope of the function and task analysis to consideration of only emergency operations. As a result, analysis of control room operator tasks associated with normal and abnormal operating procedures is not necessary. The scope was reduced to decrease the cost and effort of the control room review for licensees/applicants and keep the effort focused on those tasks considered to provide the greatest improvement in safety. Upgrading of abnormal and normal operating procedures will be considered in the long-term program, Item I.C.9 of the Task Action Plan.