MILLSTONE NUCLEAR POWER STATION UNIT 2

control room design review

IMPLEMENTATION PLAN

NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

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February 26, 1985

Docket No. 50-336
A02959
A04121

Director of Nuclear Reactor Regulation
Attn: Mr. James R. Miller
Operating Reactors Branch #3
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Reference: (1) J. R. Miller letter to W. G. Counsil, dated June 14, 1984.

Gentlemen:

Millstone Nuclear Power Station, Unit No. 2
Supplement 1 to NUREG-0737
Control Room Design Review Implementation Plan

By Reference (1), the NRC issued an Order confirming various commitments made by Northeast Nuclear Energy Company (NNECO) on behalf of Millstone Unit No. 2 regarding the implementation of Supplement 1 to NUREG-0737. This Crder requires the submittal by February 26, 1985 of the Control Room Design Review (CRDR) program plan and a schedule for the submittal of the CRDR summary report. Accordingly, we hereby submit fifteen (15) copies of the Control Room Design Review Implementation Plan for Millstone Unit No. 2. In addition, we commit to submitting the CRDR summary report for Millstone Unit No. 2 by September 26, 1986.

A schedule for performing the various phases of the CRDR is included in the CRDR Implementation Plan. It is worth noting that, if this schedule is maintained, the CRDR summary report may be submitted as early as May, 1986. However, the September 26, 1986 date has been provided in response to the Order to allow for any uncertainties in our schedule and for the unexpected. As discussed in the CRDR Implementation Plan, we are relying on the Combustion Engineering Owners' Group (CEOG) to identify the operator's information and control requirements for a generic CE plant. We anticipate receipt of the results of the CEOG's efforts by August, 1985. Any major slippage in the CEOG's schedule could significantly impact our schedule for the performance of the CRDR for Millstone Unit No. 2.

In accordance with Supplement 1 to NUREG-0737, no NRC Staff approval of this CRDR Implementation Plan is necessary prior to the initiation of the CRDR for Millstone Unit No. 2. However, we trust that any NRC perceived major deficiencies in this plan will be brought to our attention in a timely manner.

Should you have any question, please feel free to contact us.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

W. G. Counsil
W. G. Counsil
Senior Vice President

W. F. Fee
By: W. F. Fee
Executive Vice President

MILLSTONE UNIT NO. 2

CONTROL ROOM DESIGN REVIEW

IMPLEMENTATION PLAN

NUREG 0737, Supplement 1, requests all licensees of nuclear power plants and applicants for operating licenses to conduct control room design reviews. This is Northeast Nuclear Energy Company's plan for its Millstone Unit No. 2 plant.

EXECUTIVE SUMMARY

The Control Room Design Review (CRDR) is a part of the efforts to upgrade the emergency response capabilities within the nuclear power industry. The need to conduct a CRDR was stipulated by the NRC in Supplement 1 to NUREG 0737. The purpose of the CRDR is to ensure that the control room will provide effective and safe control facilities during emergency operations.

Consistent with the criteria of Supplement 1 to NUREG-0737, this plan describes how the following elements of the CRDR will be accomplished:

1. Establishment of a qualified multidisciplinary review team.

2. Performance of task analysis to identify control room operator tasks and information and control requirements during emergency operations.

3. A comparison of the information and control requirements with the control room inventory to identify discrepancies.

4. A control room survey to identify deviations from accepted human engineering guidelines.

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

6. Selection of design improvements and establishment of implementation schedules.

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

8. Verification that improvements will not introduce new HEDs.

9. Coordination of control room improvements with other programs such as Safety Parameter Display System (SPDS), operator training, Regulatory Guide 1.97 instrumentation, and upgraded emergency operating procedures.

The CRDR will be performed by a multi-disciplined review team of qualified individuals with a wide range of skills. The key members of the team (referred to as the core team) provide expertise in human factors engineering, operations, controls engineering and operators training. Supplementing this core team are other individuals from various Northeast Utilities operations and engineering departments and consultants.

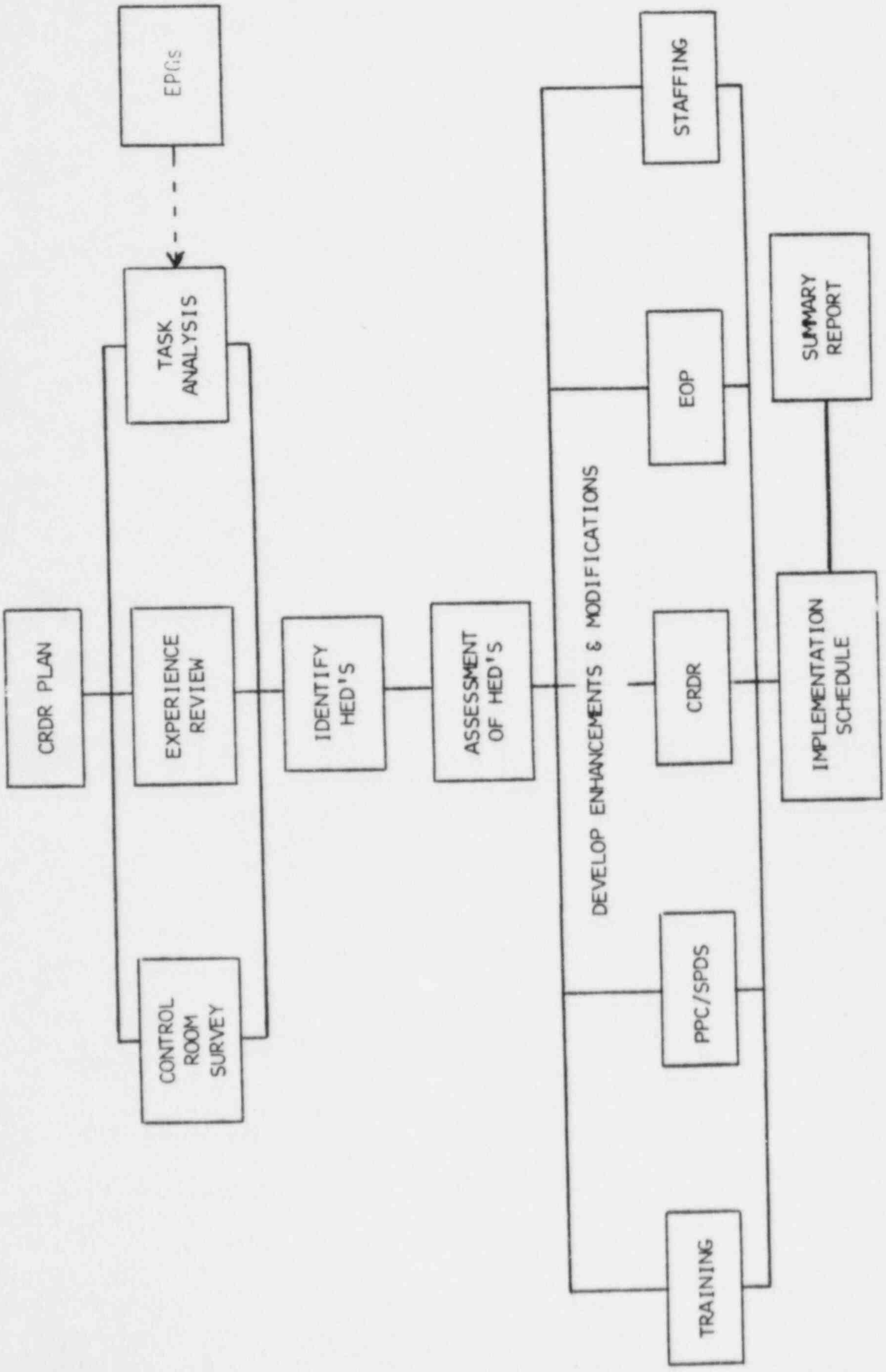
The following block diagram provides an overview of the Millstone Unit No. 2 CRDR process, starting with the preparation of this plan and concluding with a summary report.

To accomplish the CRDR we will perform a control room survey that compares the control room design with established human engineering guidelines. The operators of Millstone Unit No. 2 will also be asked for their analysis (likes and dislikes) of the control room. A walk-through of the emergency operations tasks (Task Analysis--walk-through of each operating scenario) will be performed to verify the presence and suitability of the instrumentation and controls in the control room. Any discrepancies (e.g., improper procedures, training, hardware, missing displays, etc.) will be identified, assessed, and corrective actions will be taken as applicable.

The recommended corrections will be verified to assure that they eliminate or mitigate the discrepancies and do not introduce any other discrepancies. The corrections will then be scheduled for implementation and a summary report will be prepared and submitted to the NRC.

MP2 - CRDR

CONTROL ROOM DESIGN REVIEW -- BLOCK DIAGRAM



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MILLSTONE UNIT NO. 2

CONTROL ROOM DESIGN REVIEW

1.0 INTRODUCTION

Millstone Point on Long Island Sound in Waterford, Connecticut, is the site containing three nuclear power plants operated by Northeast Nuclear Energy Company (NNECO), a subsidiary of Northeast Utilities (NU). The plants are Millstone Unit No. 1 (MP1) with a General Electric Boiling Water Reactor (BWR); Millstone Unit No. 2 (MP2) with a Combustion Engineering Pressurized Water Reactor (PWR), the subject plant for this review (Figure 1); and Millstone Unit No. 3 (MP3) currently under construction with a Westinghouse Electric Pressurized Water Reactor.

Millstone Unit No. 2 is a 2700 megawatts thermal (approximately 870 megawatts electric) pressurized water reactor nuclear unit which commenced commercial operation in December 1975. The reactor and its two coolant loop system were supplied by Combustion Engineering, the turbine generator by General Electric Company and the engineer-constructor was Bechtel Power Corporation of Gaithersburg, Maryland.

The Control Room Design Review (CRDR) is a part of the effort within the nuclear power industry and the Nuclear Regulatory Commission (NRC) to upgrade the emergency response capabilities. The need to conduct a CRDR was stipulated by the NRC in Supplement 1 to NUREG-0737. While the CRDR is directed toward the control room, other areas of concern [e.g., Safety Parameter Display System (SPDS), Post Accident Monitoring (PAM), Emergency Operating Procedures (EOP's)] that are interrelated with the control room and auxiliaries are also addressed in this document.

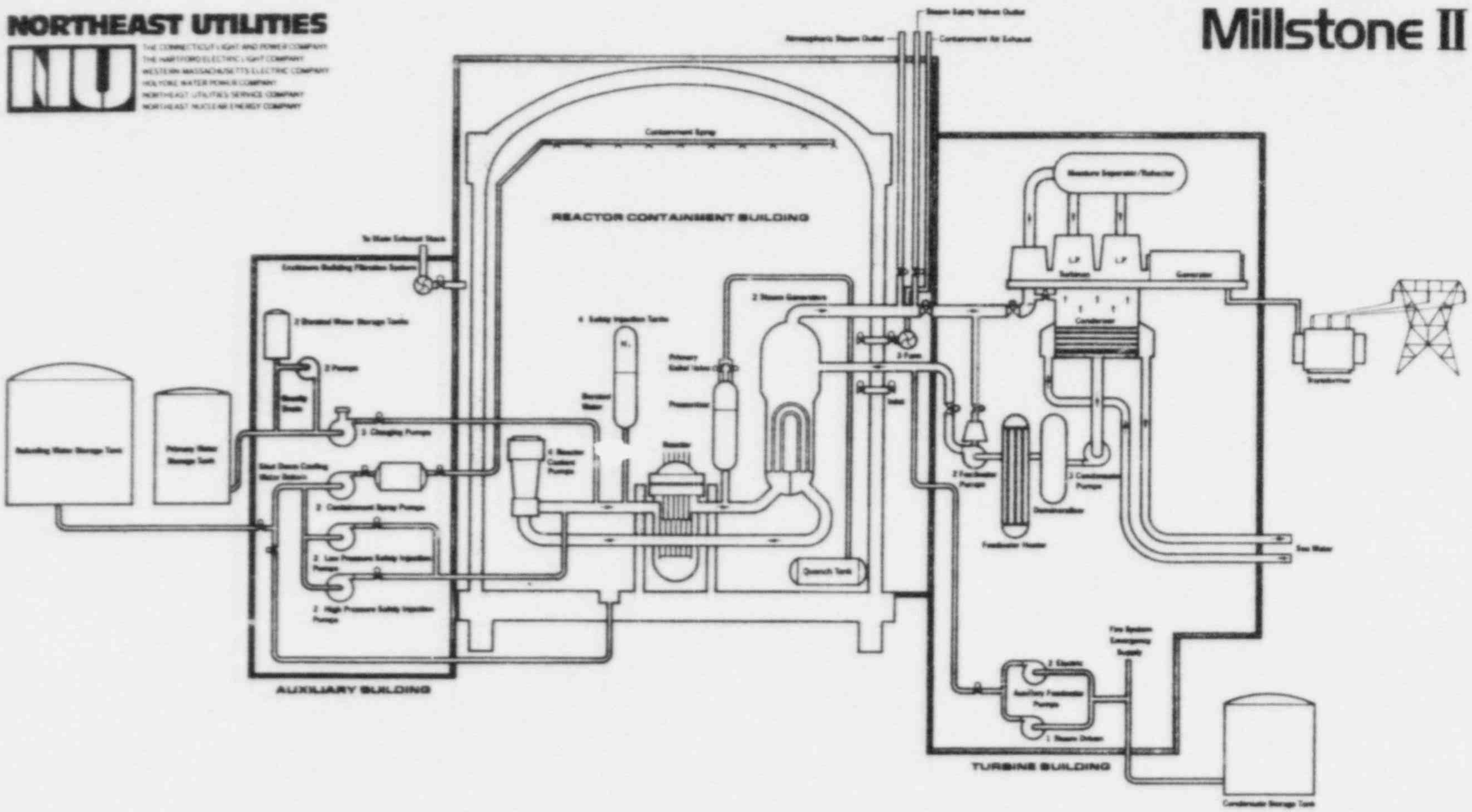


Figure 1 Millstone Unit No. 2 Plant Arrangement

The Millstone Unit No. 2 main control board's design has evolved from Northeast Utilities extensive operational experience (fossil and nuclear). Throughout its years of operation, efforts have continued to assess the plant control room with the objectives of providing a control room environment conducive to safe and efficient operation.

Guidance for the CRDR and related activities has been provided by the NRC in the form of various NUREG's and regulatory guides. A Nuclear Utility Task Action Committee (NUTAC) with staff support from the Institute of Nuclear Power Operation (INPO) was formed to develop a generic control room design review implementation plan from these guidelines. The purpose was to assist the individual utilities in their specific plan development for the implementation of the CRDR. These documents have been generally used by NNECO, however, some of the specific guidelines have been modified for adaptation to this particular plant. The structure of this plan and the methodology for conducting this CRDR is similar to that developed and implemented by our Millstone Unit No. 3 CRDR. It also incorporates lessons learned from that CRDR.

This implementation plan describes how NNECO will conduct a review of the Millstone Unit No. 2 control room. Although it is not necessary to receive NRC approval of this plan before commencing the review, we anticipate that any comments noted by the NRC Staff will be brought to NNECO's attention in a timely manner.

The schedule for the CRDR is included in Section 4.0 of this plan.

2.0 OVERVIEW

2.1 Purpose

The purpose of NNECO's CRDR is to ensure that the Millstone Unit No. 2 control room will provide effective and safe control facilities during emergency operation by:

- review and evaluation of the control room work space, instrumentation and controls, and other equipment from a human engineering point of view that takes into account both system demands and operator capabilities;

- identification, assessment, and schedule implementation of control room design modifications that correct inadequate or unsuitable items.

2.2 Scope

The CRDR will be performed utilizing the objectives and approach as provided in this plan, developed from the various guidelines and our ongoing Millstone Unit No. 3 CRDR effort. It is understood that the regulatory documents serve as guidance; not requirements or as inflexible criteria to be used by NRC reviewers. They include, but are not limited to, the following.

NUREG REPORT	TITLE
0696	Functional Criteria for Emergency Response Facilities
0700	Guidelines for Control Room Design Review
0899	Guidelines for Preparation of Emergency Operating Procedures
0801	Evaluation Criteria for Detailed Control Room Design Review
0737	Supplement 1: Requirements for Emergency Response Capability as Required by NRC Generic Letter 82-33, dated 12/17/82

REG. GUIDES	TITLE
1.47	Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems, Revision 0, May 1973
1.97	Instrumentation for Light Water Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following An Accident, Revision 2, December 1980

The equipment to be included in the review will be controls, displays, and other components on the control boards, peripheral consoles, communications equipment, ancillary devices, and procedures that the control room operators would be expected to interface with during emergency operations. The hot shutdown panel will also be included in this review.

Figure 2 is the general arrangement of the control room. Figure 3 is a comprehensive tabulation of the panels to be enveloped by the review process.

2.3 Objectives

To ensure that the CRDR fulfills its stated purpose, several objectives will be met during the review.

2.3.1 To compile all available criteria and standards used for design and layout of the main control boards.

2.3.2 To review relevant plant operational experience by conducting operator interviews.

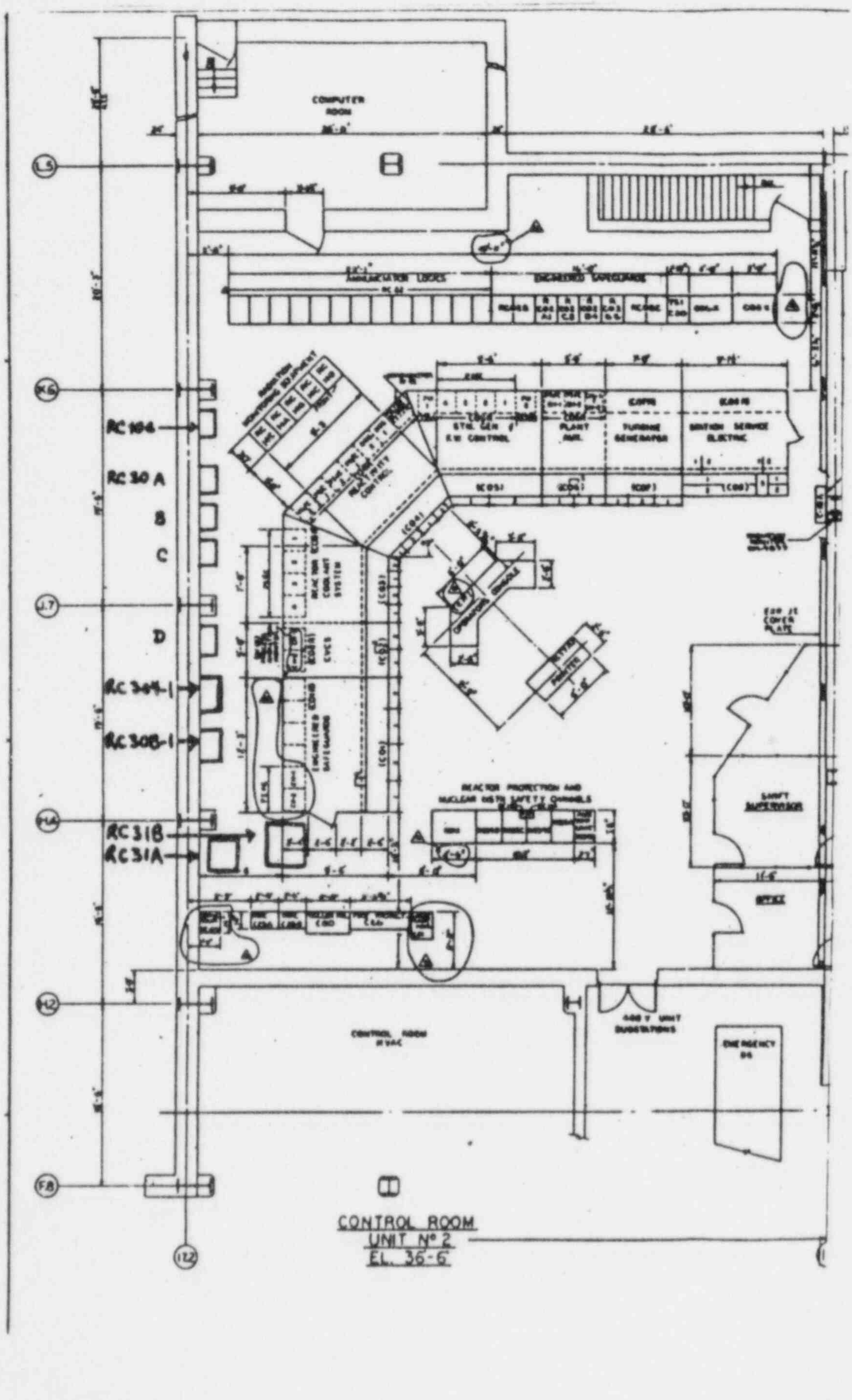

COMPUTER ROOM
L5
K6
J7
H4
H2
F8
122
RC104
RC30 A
B
C
D
RC30A-1
RC30B-1
RC31B
RC31A
CONTROL ROOM HVAC
CONTROL ROOM
UNIT N° 2
EL. 36-6'

Figure 2

FIGURE 3

CONTROL PANEL TABULATION

Main Board 1 (C01)	-	Engineered Safeguards
Main Board 2 (C02)	-	Chemical Volume Control
Main Board 3 (C03)	-	Reactor Control Panel
Main Board 4 (C04)	-	Reactivity Control
Main Board 5 (C05)	-	Steam Generator & Feedwater Panel
Main Board 6 (C06	-	Plant Auxiliaries
Main Board 7 (C07)	-	Turbine-Generator Exciter Control
Main Board 8 (C08)	-	Station Service Electric
Panel C26	-	Fire Protection
Panel C25A & B	-	Heating & Ventilating
RPS Panels	-	Reactor Protection and Nuclear Instrumentation
Panels RC14	-	Radiation Monitoring Panels
Panel C21	-	Hot Shutdown Panel (Switchgear Room)
Panel C01X	-	Engineered Safety Equipment (ESF) Status Panel
Panel RC101	-	Post Accident Monitoring

2.3.3. To perform a control room survey that compares the control room design with applicable human engineering guidelines of NUREG 0700, Section 6.

2.3.4 To determine Control Room operator tasks and information and control requirements during emergency operations.

2.3.5 To identify human engineering discrepancies (HED's).

2.3.6 To determine the extent and importance of any identified discrepancies.

2.3.7 To dispose of any identified discrepancies.

2.3.8 To verify that the proposed resolutions do, in fact, eliminate or mitigate the discrepancies for which they are formulated and do not introduce any new HEDs.

2.3.9 To validate that the changes eliminate or mitigate the discrepancies formulated and that the control room operators can safely and effectively accomplish their functions during emergency operations.

2.4 Description of CRDR Activities

To achieve the stated objectives, several activities will be completed during the review. A flow chart of these activities is presented in Figure 4. The CRDR has been divided into six phases--planning, investigation, assessment, correction, implementation scheduling, and reporting.

The activities within each phase will be described in more detail later, but a brief synopsis at this time will help give a general picture of the review process.

FIGURE 4

CONTROL ROOM DESIGN REVIEW FLOW CHART

PHASE	DESCRIPTION
PLANNING	DEVELOP IMPLEMENTATION PLAN
INVESTIGATION	CONTROL ROOM SURVEY; EXPERIENCE REVIEW; TASK ANALYSIS IDENTIFY HED'S
ASSESSMENT	ASSESSMENT OF HED'S
CORRECTION	DEVELOP ENHANCEMENT AND MODIFICATIONS
IMPLEMENTATION SCHEDULING	PROVIDE IMPLEMENTATION SCHEDULING
REPORTING	PROVIDE SUMMARY REPORT

2.4.1 Investigation

The investigation phase will constitute the data gathering portion of the CRDR.

A review of the design evolution (i.e., bases, experience, documents, etc.) will be performed compiling the criteria and standards used for the design and layout of the control boards.

This compilation will be utilized in the survey and as consideration in the assessment and correction phases of any discrepancies.

The control room survey will compare the characteristics of the control room with the applicable human engineering guidelines of NUREG 0700, Section 6 tc identify any discrepancies.

A survey of operating personnel will be conducted through a self administered questionnaire and follow-up interviews. The data obtained will be reviewed for their potential classification as HED's.

Task Analysis will be performed which will identify control room operator tasks and information and control requirements during emergency operations. The established information and control requirements and their associated characteristics will be compared against the available control room instrumentation and controls to determine any missing or discrepant items. Discrepancies will be documented as HEDs.

2.4.2 Assessment Phase

During the assessment phase, all discrepancies identified in the investigation phase will be evaluated and prioritized for resolution according to their potential impact on emergency operation.

2.4.3 Correction Phase

Recommended resolutions of discrepancies identified in the assessment phase will include methods by enhancement, modification, and/or other means (e.g., training or changes to procedures). The actions proposed to resolve HED's will be analyzed for their affect on operation. These HED resolutions will additionally be verified by their implementation on a full scale mock-up for final review and approval by the review team, NNECO personnel, and the CRDR project management. Discrepancies found to be non-significant will be documented for inclusion in the records of the review.

2.4.4 Implementation Scheduling Phase

A recommended schedule will be developed to ensure the integration of proposed control room changes with other post-TMI programs, as well as plant operating status. The schedule will take into account the training of operators imposed by pending changes. Administrative follow-up will be instituted to ensure the successful completion and validation of all control room changes. The actual implementation will occur subsequent to the reporting phase.

2.4.5 Reporting Phase

A summary report will be submitted to the NRC at the conclusion of the review that will:

- Summarize the results of the review in accordance with this plan.
- Summarize the resolutions for discrepancies.
- Schedule the implementation of these resolutions.
- Provide reference data for the detailed documentation material developed in the review.

2.5 Definition of Terms

2.5.1 Control Room Design Review (CRDR)

A post-TMI task listed in NUREG 0660 (Item I.D.1), "NRC Action Plan Developed as a Result of TMI-2 Accident", which discusses the need to conduct a detailed control room design review to identify and correct design discrepancies. Criteria for the performance of CRDR are provided by Supplement 1 to NUREG 0737.

2.5.2 Control Room Survey

One of the activities that constitutes a CRDR. The control room survey is a static verification of the control room performed by comparing the control room instrumentation, controls and layout with selected human engineering design guidelines.

2.5.3 Control Room Inventory

A listing of all instrumentation and controls in the control room. Its function is to provide the basis to determine whether the instruments and controls needed to support operations under emergency conditions are present in the control room. This function will be accomplished as part of the task analysis effort and related verification and validation activities.

2.5.4 Emergency Operating Procedures (EOP's)

Plant procedures directing the operator actions necessary to mitigate the consequences of transients and accidents that cause plant parameters to exceed their reactor protection setpoints and/or other appropriate technical limits.

2.5.5 Emergency Procedure Guidelines (EPGs)

Guidelines for the response to transients and accidents developed by Combustion Engineering Owners Group that provide the bases for plant-specific EOP's.

2.5.6 Function

An activity by one or more system parts that contributes to a larger activity or goal.

2.5.7 Function Analysis

An examination of the required functions with respect to available manpower, technology, and other resources to determine how the functions may be allocated and executed.

2.5.8 Human Engineering (HE)

"The science of optimizing the performance of human beings, especially in industry. Also, more namely, the science of design of equipment for efficient use by human beings."

2.5.9 Human Engineering Discrepancy (HED)

A characteristic of the control room that does not comply with human engineering guidelines.

2.5.10 Operator

An individual who is licensed to manipulate a control or device; e.g., Reactor Operator (RO), Senior Reactor Operator (SRO).

2.5.11 Operational Experience Review

One of the activities that constitutes a CRDR. The operating experience review relies primarily upon operator experience to discover human engineering shortcomings and favorable aspects of the control room.

2.5.12 Review Team

A group of individuals responsible for directing and enacting the CRDR of a specific control room.

2.5.13 Safety Parameter Display System (SPDS)

An aid to the control room operating staff for use in monitoring the status of critical safety functions that constitutes the basis for plant-specific, symptom-oriented EOP's.

2.5.14 Task

A specific action or individual step that contributes to the accomplishment of a function.

2.5.15 Task Analysis

The task analysis is a tool or method used to delineate system functions and the specific actions that must take place to accomplish those functions. In the CRDR context task analysis is used to review the individual control room operator tasks and corresponding information and control requirements to allow successful emergency operation.

2.5.16 Validation

The process of determining whether the control room operating staff can perform their functions effectively given control room instrumentation, procedures, and training. In the CRDR context, validation implies a dynamic performance evaluation.

2.5.17 Verification

The process of determining whether instrumentation, controls, and other equipment are present and suitable to meet the specific requirements of the emergency tasks performed by the operators. The control room survey is also a verification activity; a check of the control room equipment's suitability for use by the operator.

In the CRDR context, verification implies a static check of instrumentation against human engineering guidelines and operators required actions.

3.0 MANAGEMENT AND STAFFING (REVIEW TEAM)

3.1 Management

NNECO is a wholly owned subsidiary of Northeast Utilities (NU). The CRDR will be conducted under the normal project policy and organization of the NU System which utilizes the services of the Northeast Utilities Service Company (NUSCO) for its engineering and operation functions. The scope of responsibilities and definition of major functions for the Nuclear Engineering and Operations Group is contained in Northeast Utilities "Nuclear Engineering and Operations Policies and Procedures Manual".

Figure 5 is the project organization in accordance with these procedures for this CRDR.

The ultimate responsibility for the CRDR resides with the Senior Vice President of Nuclear Engineering and Operations.

The CRDR project manager was selected, who in turn commissioned members for the review team in accordance with NU policies and procedures. This review team provides NU management the oversight to ensure the integration of the project objectives and to fulfill the intent of the review.

3.2 Review Team

The review team is a multi-disciplined team of individuals with the wide range of skills necessary to perform the design review. They are responsible for planning, scheduling, and coordinating the entire integrated CRDR. The team includes members of NNECO, NUSCO, and consultants. Within this review team are the disciplines that constitute the core team, the personnel dedicated to this project. This core team includes the following expertise.

FIGURE 5

PROJECT ORGANIZATION

Senior Vice President
Nuclear Engineering & Operations
W. G. COUNSIL

Director
Generation Engineering & Design Department
G. L. JOHNSON

System Manager
Generation Electrical Engineering
A. R. ROBY

CRDR Program Manager
T. A. SHAFFER

CRDR Project Engineer
Z. A. UFNAL

CORE REVIEW TEAM

Z. A. Ufnal, Controls Eng.
J. D. Becker, Operations Engr.
A. M. Stave H. F. Spec.
M. J. Wilson, Assct. Trng. Supervisor
* Consultants

DISCIPLINE SUPPORT

J. J. Heg. Operations Assist.
P. A. Blasioli, Licensing Engr.
R. L. Beveridge, PRA/Safety Analysis
R. E. McMullen, Mechanical Engr.
R. F. Lubben, Instrumentation Engr.
M. Parikh, Computer Serv.
N. T. Thomas, Electrical Engr.

- o Operations Engineer (having SRO license).
- o Human Factors Specialist.
- o Controls Engineer.
- o Assistant Training Supervisor

Supplementing this core team as required are other disciplines including mechanical, electrical, instrumentation, and nuclear reactor engineering, computer operations, and licensing. These disciplines are from various NU operations and engineering departments, and consultants. During the course of the review, any additional specialists (e.g., lighting, acoustics, etc.) required for specific tasks will be made available as needed.

The review team has been provided with specific support as a part of the charge for enacting the CRDR, including the following.

- o Access to information (records, documents, plans, procedures, drawings, etc.).
- o Access to required facilities.
- o Access to personnel with useful or necessary information (reactor operators, management, consultants).
- o Freedom to document dissenting opinions.

3.2.1 CRDR Program Manager

The CRDR Program Manager will be responsible for implementing the provisions delineated within this plan. Specifics include the following.

- o Interface with upper management.

- o Provide licensing liaison support

- o Ensure the review is conducted in a professional, objective, and timely manner, consistent with this plan.

- o Select the review team's specific members.

- o Provide guidance as requested and required.

The CRDR Program Manager's qualifications include a baccalaureate degree in Electrical Engineering; the supervisor of the Controls Engineering Unit of the Electrical Engineering Branch of the Generation Engineering Department; and ten years of experience in the engineering of nuclear units. He is also the CRDR Program Manager for the Millstone Unit No. 3 CRDR. His resume is included in Appendix A.

3.2.2 CRDR Project Engineer

The project engineer is the team's coordinator. This individual provides the cohesive force for the different departments and consultants involved in the review.

The CRDR project engineer's specific responsibilities include the following.

- o Provide team orientation.

- o Preparation of the implementation plan.

- o Obtain training in selected areas, as required.

- o Direct and support day to day team activities.

- o Identify the need to management for specialists' support when necessary.

- o Direct all phases of the review.

- o Provide management with a regular status report of the team's activities and progress.

His resume is included in Appendix A.

3.2.3 Operations Engineer (Having SRO License)

This member of the core team is from NNECO and his expertise provides the operational factor of the review.

His specific responsibilities include the following.

- o Obtain orientation in selected areas.

- o Assist in the preparation of the implementation plan.

- o Assist in all phases of the CRDR.

- o Serve as core team member of the review.

- o Provide the review team with the operational aspects and constraints in assessing the discrepancies found during the investigation phase of the review.

- o Direct liaison with training and operations.

His resume is included in Appendix A.

3.2.4 Human Factors Specialist (HFS)

The Human Factors Specialist, as a member of the core team during all phases of the control room review, will direct the team with regard to the human factors guidelines for the entire project.

Specific responsibilities include the following.

- o Obtain orientation in selected areas.
- o Assist in the preparation of the implementation plan.
- o Assist in all phases of the CRDR.
- o Serve as core team members of the review.
- o Provide the review team with the human interface aspects in assessing the discrepancies found during the investigation phase of the review.

His resume is included in Appendix A.

Consultant(s) will be used where deemed appropriate throughout the review process.

3.2.5 Controls Engineer (CE)

The Controls Engineer will assist in the identification of plant system design features and will serve as the review team discipline on the capabilities and limitations of controls and instruments. He will also provide input to the team during the assessment phase of the review, especially when the review team considers proposals for mitigations of HED's.

His specific responsibilities include the following.

- o Obtain orientation in selected areas.
- o Serve as core team member of the review.
- o Provide his expertise in the assessment phase.

Note: The Controls Engineer is also the project engineer, a normal procedure in the NU System for projects that fall within the responsibility scope of the individual departments. See Section 3.2.2 for additional responsibilities and qualifications.

3.2.6 Assistant Training Supervisor

This member of the core team is from the NNECO Millstone Unit No. 2 Nuclear Training Department. His expertise will provide the operator training factor of the review.

Specific responsibilities include the following:

- o Obtain orientation in selected areas.
- o Assist in the preparation of the implementation plan.
- o Serve as core team member of the review.
- o Provide the review team with the operator training aspects and constraints during the assessment and correction phase.

o Direct liaison with training and operations.

His resume is included in Appendix A.

3.2.7 Discipline Support

As stated previously, other discipline support will be utilized to provide their individual expertise as required.

3.3 Consultants

In addition to the review team members from the NU System, additional expertise will be provided by consultants who will assist in the review. As members of the team they will provide input to all phases of the review through to the summary report.

3.4 Review Team Orientation

Each member of the review team will bring his own in-depth knowledge of specific topics to the team. It is important, however, that the team be able to conduct the CRDR from a common basis of understanding. The review team will undergo an orientation program designed to provide each team member with certain basic knowledge requirements. The purpose of this orientation is to acquaint each member with the other disciplines' perspective represented on the team--not to make each team member an expert in all specialties.

The orientation program will consist of the following minimum instructional areas.

3.4.1 Human Factors

Orientation provided for the core review team will familiarize them with principles of human factors and their application to the control room design review. This orientation area will be slanted toward those core team members who do not have extensive background in human engineering.

3.4.2 Plant Familiarization

The core team members will receive plant familiarization, consisting of a review of the available documentation, the actual control room, and the plant systems.

3.4.3 CRDR Familiarization

The full review team will receive a full indoctrination of the plan, the methodologies for performing the review, and their participation in the review by the members of the core team.

3.4.4 Miscellaneous

During the course of the review, any other areas requiring orientation that are identified will be obtained to meet the needs.

4.0 INVESTIGATION PHASE

To achieve the objectives outlined in Section 2.3 and to explain in detail the activities of the review (Section 2.4), the following will constitute the methodology in performing the Investigation Phase of the CRDR.

Figure 6 is the schedule for performing the CRDR, depicting the sequence and duration of major tasks.

This phase, the investigation and data gathering portion of the review, is divided into three parts: the operating experience review, the control room survey, and the task analysis review.

4.1 Operating Experience Review

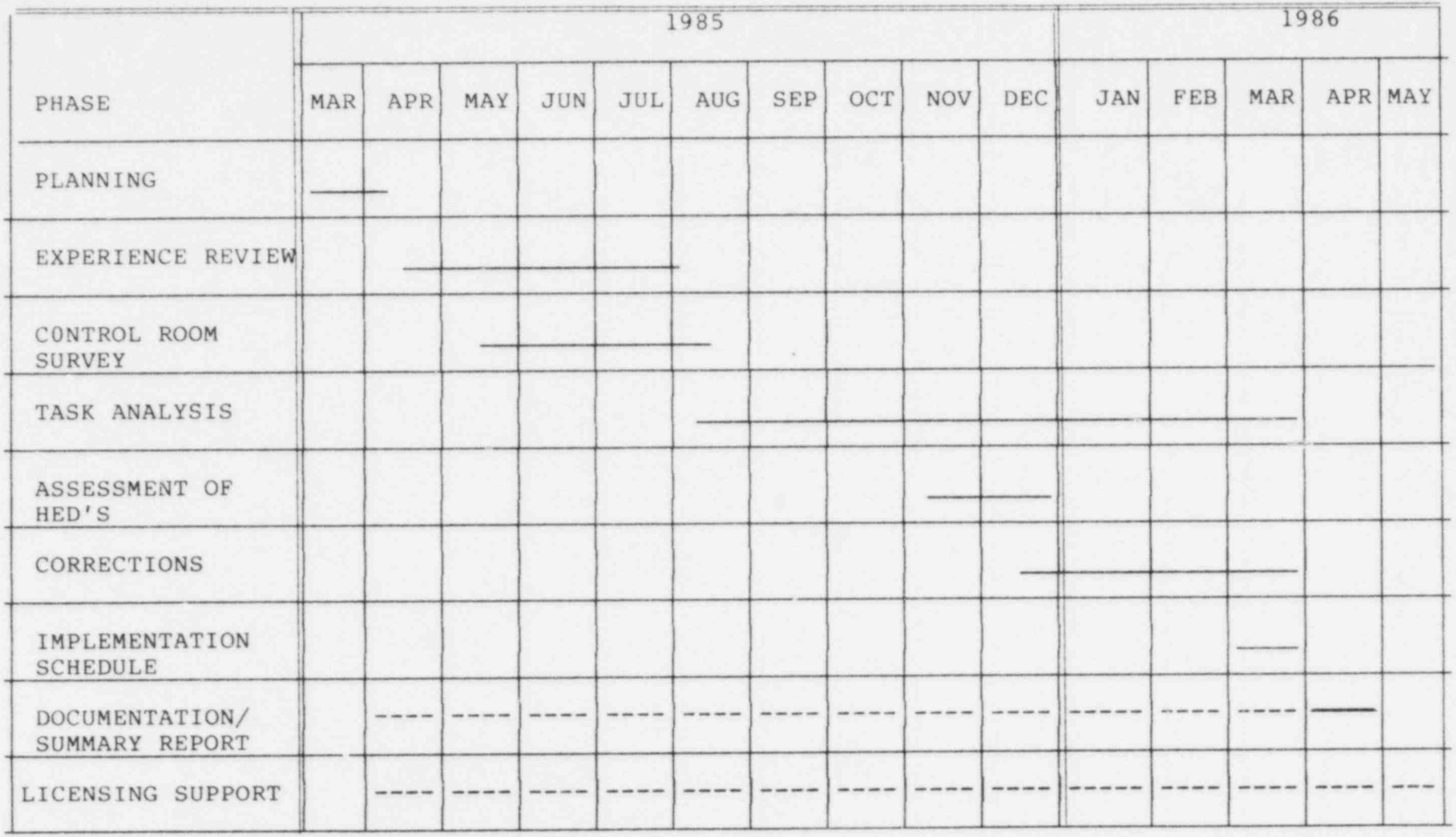
An operating experience review will provide information on potential problem areas in the control room by a survey of the Millstone Unit No. 2 operating personnel for their operational experience. This information will be utilized for the identification of possible HED's on this unit in the other phases of the review. In addition, discrepancies identified by the Millstone Unit No. 3 CRDR will be reviewed, where appropriate, for potential applicability to Millstone Unit No. 2.

4.1.1 Review of Operational Events

The NUSCO Nuclear Safety Engineering (NSE) Department reviews all Licensee Event Reports (LER's) for Connecticut Yankee in Haddam, Connecticut, and Millstone Unit No. 1 and No. 2 in Waterford, Connecticut.

In addition, they review all Significant Operating Experience Reports (SOER's) and Significant Event

Figure 6


1985
1986
PHASE
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
PLANNING
EXPERIENCE REVIEW
CONTROL ROOM SURVEY
TASK ANALYSIS
ASSESSMENT OF HED'S
CORRECTIONS
IMPLEMENTATION SCHEDULE
DOCUMENTATION/ SUMMARY REPORT
LICENSING SUPPORT

Reports (SER's) distributed by the Institute of Nuclear Power Operations (INPO) for applicability to the four nuclear plants involved in the NU system.

NSE is comprised of a number of personnel with a variety of different engineering disciplines including human factors and operational backgrounds. This provides for a comprehensive independent assessment of operational events.

A member of the NSE, designated by one of two supervisors first performs an initial assessment of the operating experience data, (i.e., LER, SER, SOER, etc.) to evaluate the potential significance relative to any of our four nuclear units. If any data is found to be "significant" relative to some or all of the plants, then an in-depth study is performed and a detailed report is issued for company distribution. During the screening process, the need to interface with INPO, other utilities, and vendors becomes a common occurrence. Routinely, we interface with INPO information contact when reviewing SERs and SOERs.

As discussed above, NU has a comprehensive and independent assessment of operational events. This mechanism has been in place for the past four years. In light of this, it was concluded that a rereview of this material by the CRDR review team is unnecessary. Instead, we will focus on the experience of the plant operators to bring to light potential problem areas over the life of Millstone Unit No. 2.

4.1.2 Operating Personnel Survey

A most valuable source of data on operational problems are the operators of this plant. The intent of this part of the survey is to make use of the experience gained during the years of MP2 operation by asking selected operation staff about the good and bad aspect of the control room.

(a) Questionnaire Construction

A self-administered questionnaire approach has been adopted. By this method the operating personnel can be questioned while still maximizing the use of their time and that of the core team. The survey will cover the following topics.

- o Work Space Layout (Ergonomics) and Environment
- o Panel Design
- o Annunciator Warning System
- o Communications
- o Displays
- o Procedures
- o Staffing
- o Training
- o Other Areas for Operator Comment

A sample of the initial questionnaire is included in Appendix B.

Assembly of the questionnaire is being done so that each topic area is sampled completely in item content. Suggestions for improvements in each topic area are solicited.

A cover letter will be included which (1) explains the purpose; (2) describes the questionnaire and provides instruction; (3) conveys what will be done with the results; and (4) requests biographical information.

(b) Questionnaire Distribution

The questionnaire will be given to selected operations personnel of the Millstone Unit No. 2 Operations Department. At the time of distribution the recipients will receive a briefing by the Operations Supervisor and/or a CRDR core team member. The briefing will emphasize the elements discussed in the cover letter.

(c) Questionnaire Data Analysis

After the questionnaires have been completed, responses will be summarized for further evaluation.

It is anticipated that both positive and negative features will be identified by the respondents. Positive responses will be recorded and retained for consideration in subsequent review processes (e.g., as possible recommendations for corrective action to HED's).

Negative responses will be investigated further by the control room design survey and the task analysis reviews.

(d) Interviews

Interviews may be conducted dependent upon the answers received by the questionnaire. The purpose of any interviews will be to clarify any unclear information obtained by the questionnaire and to ensure that all important areas have been addressed. The interviews will be performed by selected members of the core team.

4.1.3 Design Criteria and Standard Compilation

The documentation file of the design of the main control boards will be reviewed for all pertinent data (e.g., acronyms, abbreviations, switch type utilization, color standards, etc.). This data will be compiled and documented for utilization in the assessment phase and to a lesser extent during the control room survey. During the assessment phase, this compilation will establish guidance for disposing of differences between the design criteria and the CRDR acceptance criteria to present a frame of reference for resolving human engineering discrepancies.

4.1.4 Control Room Inventory

A control room inventory for Millstone Unit No. 2 exists in the form of the plant Bill of Materials and detailed drawings. From this inventory, the drawings, and numerous photographs of the actual control boards, a full scale mock-up was made. As part of the Task Analysis, a complete computer generated data base for all emergency-utilized equipment will be developed. Its development and utilization is discussed in the Task Analysis, Section 4.3.

4.2 Control Room Survey

4.2.1 Survey

The control room survey, a human factors engineering (HFE) review, will be a systematic evaluation of the Millstone Unit No. 2 control room using the criteria of NUREG 0700, Section 6, as referenced by NUREG 0737, Supplement 1, and other guidelines, as applicable to Millstone Unit No. 2. The survey will determine what items in the control room layout, equipment, instrumentation, controls, environmental conditions, communications, and process computer are not in compliance with these criteria.

This will be accomplished by conducting a systematic comparison of existing control room design features with the NUREG 0700, Section 6 human engineering guideline checklists. The checklists will be reviewed and finalized by the core team prior to administration to ensure plant specificity and to incorporate lessons learned from our Millstone Unit No. 3 CRDR.

Non-compliance items will be recorded as human engineering discrepancies (HED's) on the HED form in Appendix C. Photographic evidence of a non-compliance item will be made when deemed necessary to support the assessment and correction phases.

4.2.2 Survey Administration

Human Factors personnel from the core team will administer the checklists at the control room and mock-up, as indicated in Paragraph 4.2.1, Survey. The control room will be used, where possible, for the functionally oriented type of criteria (e.g. switch barrier separation, activation feedback, etc.) The mock-up will be used for the static or non-dynamic criteria as in panel arrangement, acronym, abbreviations, anthropometric, etc. Upon completion of the survey, the core team will review the checklists' results for completeness prior to the commencement of the assessment phase. Any core team member can document opinions concerning the potential classification of the control room features under concern, which may be in conflict with the opinion of the majority of the team. This opinion will be forwarded to the CRDR project manager for inclusion in the review documentation.

4.3 Task Analysis

4.3.1 Purpose

The objective of task analysis is to determine information and control requirements for the control room operator's tasks during emergency operations.

The information and controls requirements will be compared against the actual control room inventory to determine presence and/or absence of equipment and to verify its human engineering suitability. Discrepancies will be documented as HEDs.

4.3.2 Background

The Millstone Unit No. 2 upgraded Emergency Operating Procedures (EOPs) were written from the Combustion Engineering Owner's Group Emergency Procedure Guidelines (EPGs), Rev. 1. Millstone Unit No. 2 is a 2700 MW thermal design class CE plant and is the same class plant used as a generic plant for the EPGs.

Presently, CEOG is developing additional documentation to identify all the operator information and control requirements to support emergency operations of a generic CE plant in accordance with the EPGs. These generic information and control requirements will provide the bulk of information required for the Millstone Unit No. 2 plant specific task analysis. Plant specific requirements for tasks unique to Millstone Unit No. 2 and deviations from those developed by CEOG, will be determined as necessary by NU.

4.3.3 Methodology

The methodology for performing the task analysis will be very similar to that utilized by our Millstone Unit No. 3 CRDR, as documented in the MP3 CRDR Summary Report.

Millstone Unit No. 2 EOPs will be used by the CRDR Core Team to generate Task Sequence Charts (See Figure 7) which will document each step in the sequence of the procedures. The individual operator tasks for each step in the sequence will then be developed and recorded on the Task Data Forms (See Figure 8).

After the operator tasks are recorded, the corresponding information and control requirements will be added to the Task Data Forms. The associated information and control characteristics will be recorded on supplemental forms and will include specific information (as applicable) such as parameter type, dynamic range, setpoint, resolution/accuracy, speed of response, units, and the need for action such as trending and alarming. Control characteristics will include specific information (as applicable) such as type (discrete or continuous), information feedback associated with control use, response requirements, mode of operation, resolution, and range.

TASK SEQUENCE CHART (TSC)

PLANT, UNIT # ___________

SEQUENCE NO. _________ SEQUENCE TITLE ____________________________ REV. # ___________

TASKS IN MAIN SEQUENCE		SEQ./TASKS POTENTIALLY BRANCHED TO*			COMMENTS
NUMBER	TASK TITLE	SEQUENCE NUMBER	TASK NO.	TITLE	

*Enter only one task namely the task immediately branched to.

Page _____ of _____

Figure 7

TASK DATA FORM (TDF)

Plant Unit #______________________________

Operating Sequence Name______________________ Number__________ Rev.#______________ Page____of____

Task Title______________________________ Task #__________

Task Objective____

Task Cue____

SUBJECT			IMMEDIATE OBJECT OF ACTION (Control Room Component)				REMOTE OBJECT OF ACTION				COMM.	HED I.D.No.
WHO	LOCATION	BEHAVIOR VERB	NAME	DESCRIPTION	PLANT I.D.	LOCATION	PLANT COMPONENT	COMPONENT STATE	PARAMETER	PARAMETER STATE	(PARTY & LOCATION)	

COMMENTS:

Figure 8

With the operator tasks and information and controls requirements and associated characteristics identified and recorded, the next step will verify that those requirements are:

- o present in the control room; and,
- o the equipment is effectively designed to support correct task accomplishment (i.e., verification of human engineering suitability).

The presence and/or absence of the plant specific instrumentation and controls will be confirmed by the core team by systematically comparing the recorded information and control requirements to the actual control room inventory as displayed on the mock-up. Discrepancies will be identified as HEDs and recorded on the HED form, Appendix C.

Concurrent with this review, a computer generated data base will be developed for all emergency-utilized equipment. This data base will contain the instrument's identification number, its location, and all operator tasks utilized. By computerized sorting process of this data base, an inventory of emergency instruments and equipment by location, and by tasks will be generated.

The sequence and data charts will be reviewed for the "Status vs. Demand" criteria. Demand items will be noted on the task data forms and reviewed during the walk/talk through for potential discrepancies in the feedback information.

The human engineering suitability of the required information and controls requirements will be verified by performing walk/talk through of the emergency tasks at the mock-up.

The suitability review will be performed by the members of the core team including the human factors specialist, the operations engineer, the assistant training supervisor, and the controls engineer. Appropriate material extracted from the NUREG 0700, task analysis principles will be used as the review criteria (See Appendix D). Discrepancies will be recorded as HEDs on the HED form (See Appendix C).

4.3.4 Validation of Control Room Functions

The purpose of the validation process is to determine whether the operators can perform their functions effectively in a dynamic environment given control room instrumentation, procedures, and training. This process will also determine whether the CRDR enhancements and corrections do indeed correct the deficiencies found and that those enhancements and corrections do not introduce new deficiencies.

The validation process will be performed in two steps. First, walk-throughs will be performed of several selected plant specific procedures on the updated control room mock-up containing the CRDR corrections and enhancements. A normal complement of the control room operating crew will be performing the walk-throughs for observation and critique by the core team. Any problems in crew structure, Human Factors, or Procedures will be recorded, assessed and dispositioned.

In the second step, it is planned to exercise several specific operator functions on the plant simulator individually or during training. These functions will be chosen from operational experience of the plant for their sensitive tasks and dynamic control aspects. As in the mock-up validation, any problems will be recorded, assessed and dispositioned accordingly.

5.0 ASSESSMENT PHASE

5.1 Objective

The objective of this phase of the CRDR is to evaluate for significance the HED's defined in the previous phases of the review, including consideration of the design standards and objectives.

5.2 Evaluation Criteria

Human engineering discrepancies found during the control room survey, the operating experience review, and the task analysis review, will be evaluated and prioritized for resolution according to their potential to adversely affect emergency operation. The following four categories are designed to be unique so a consensus can be obtained from the team as to which priority each HED should be assigned.

5.2.1 Priority 1 (Safety Significant)

HED's that are judged likely to adversely affect the management of emergency conditions by the control room operators. Most of the HED's placed in this category will probably be found during task analysis, supported by the results of the survey and operating experience review.

5.2.2 Priority 2 (Operational/Reliability)

HED's that are known to have caused problems or appear to cause problems during normal operation. The HED's place in this category will probably emerge during operator interviews. Some support may come from the control room survey.

5.2.3 Priority 3 (Minor Consequences)

HED's that can be determined to have minor affect on the safety or reliability of operations.

5.2.4 Priority 4 (No Consequences)

HED's that do not fit into any of the above categories. These are judged by the review team as not affecting emergency operation and not previously documented as causing problems during operation.

The assessment process will be performed by the members of the core team in two stages in order to expedite this process; a triage or preliminary assessment (See Appendix E) and a final assessment.

The triage methodology will allow the team to resolve the HEDs with obvious solutions and reduce the number requiring more in-depth consideration for the final assessment.

The final assessment will be conducted in the same manner as the triage assessment with one further criteria, the "tie-breaker". The purpose of this criteria is to establish the significance of a HED as it relates to the performance of an operators task when needed to resolve judgmental differences of the team, considering the following:

- o The potential for causing or contributing to operator error.
- o The potential of detecting and recovering from the error.
- o The consequence of the error to plant operation and safety.

Thus - Significance = $\frac{\text{Pot. for error}}{\text{Pot. for recovery}}$ X Consequence

A scale of 1 to 10 shall be applied to the considerations.

Northeast Utilities has developed and is using Probabilistic Risk Assessment (PRA) methodologies for evaluating operator and equipment performance. These methodologies may be used by the review team to assist them in evaluating the priority classification of HED's.

Should the core team not be able to reach a consensus on the disposition of a particular HED, the majority will rule. Any core team member who feels strongly that a HED has been assessed as too low (or high) will be able to put that opinion in writing to the CRDR program manager, and have the statement included in the record of the CRDR.

6.0 CORRECTION PHASE

Correction is the process that resolves the discrepancies. Initially, the compiled list of HED's is reviewed for assignment to probable categories of solution. Experience has shown, however, that many of these initial assignments are eventually changed, so HED's will be grouped in broad improvement categories. These categories will be as follows.

- Enhancement

  The use of several techniques of surface demarcation, coloring, mimics, labeling, and swapping.

- Class Improvements

  A combination of minor changes to a particular type of control or indicator that will correct a whole class of problems.

- Individual Discrepancy Corrections

  A solution or combination of solutions that will correct one particular discrepancy.

Large numbers of HED's can be corrected through enhancements, including labeling and component swapping. Many more that are class problems can be corrected by specific improvement to the class of components. Additional solution methods that may be used individually or in combination if necessary are as follows.

- Operator organization and communications.

- CRT display alternatives.

- Procedural and administrative solutions.

- Special training requirements.
- Component replacement and panel alteration.

6.1 Enhancements

Enhancements include a number of techniques that involve surface improvements, such as demarcation lines, shading, and improved labeling. Also included in the enhancement category is the possibility of component swapping. This involves changing the location of a control or indicator with a like unit within the same grouping. Swapping involves simple exchanges of locations without the need for panel modifications. In some cases, this technique can greatly improve the effectiveness of surface enhancements, and can resolve many more HED's than would otherwise be possible with enhancements alone.

6.2 Class Improvements

The objective of this method is to consolidate classes of discrepancies that pertain to one type of control or indication, and design improvements for that class.

The enhancements discussed previously pertain to the panels and panel labeling, but do not include changes to the individual control or indicator. It is usually possible to make direct changes to a control or indicator, thereby correcting a whole group of problems. Labeling on an indicator, scale improvements, and deletions of extraneous markings are examples. Discrepancies on annunciators is a class of problems that will result in class improvement designs.

6.3 Individual Discrepancy Correction

The objective of this method is to correct HEDs one by one using the most performance/cost effective method or combination of methods. All resolutions that do not meet accepted, good human engineering practice will then be further analyzed to determine acceptable improvements.

6.4 Documentation and Disposition

6.4.1 Documentation

Documentation of the HED's will be accomplished in the following manner.

A HED Status Summary will be made and maintained in a computer file. It will be updated as changes occur and will be printed for distribution periodically and on request. The summary will indicate the current assignment, the status, and action required. This will be an important quality control tool for completion of work.

Criteria for the satisfactory completion of HED's is provided in Section 2.2 (Scope). These criteria have been consolidated and assigned a resolution code and as HED's are resolved, will be assigned to one of these codes.

Code	Description
A	Meets Human Factors Engineering (HFE) guidelines originally or as improved.
B	Minor deviation, but satisfies the underlying performance principle implied by HFE guidelines.
C	Meets HFE guidelines through a combination of solutions.
D	Does not meet HFE guidelines.
E	Solutions do not meet all guidelines, but are judged to be acceptable for safe operation for the reason stated.

6.4.2 Disposition

The documentation previously described will be compiled in a class format to be included in the summary report.

The resolutions will be incorporated into the design document panel prints as well as included and verified on the control room mock-up.

Following final approval by NU management, any recommended changes will be implemented by NNECO in accordance with the normal change process.

7.0 IMPLEMENTATION SCHEDULING PHASE

The actions required to resolve significant HED's will vary, as will the time required to complete proposed changes.

It also must be recognized that the preparation of a schedule without knowledge of the changes to be made is little more than a guess.

NNECO will proceed with the implementation as rapidly as practical upon completion of the correction phase. A number of factors will be considered in this implementation including but not limited to the following.

- Severity of the discrepancy.
- Safety consequence of errors that could be caused by the discrepancy.
- Impact on plant operation.
- Impact on operator training/retraining.
- Procurement schedules.
- Correction degree of difficulty.

A complete schedule will be included with the summary report.

8.0 REPORTING PHASE

Upon completion of the CRDR, a summary report of the results will be submitted to the NRC for review. This report will describe the results of the CRDR. It will summarize the review process by phases, the identified human engineering discrepancies, and the recommended corrective actions with implementation schedules for each action. All phases of the CRDR, and its complete documentation, will be available for NRC evaluation and review.

The format of the Summary Report will closely follow the implementation plan for ease of cross referencing and will be similar to our Millstone Unit No. 3 Summary Report.

Changes that have been categorized as Priority 1 (Safety Significant) but do not provide a full and complete correction of an identified HED, or decisions to allow a discrepancy to remain, will be justified and information pertinent to such decisions will be provided. Priority 1 HEDs which were uncorrected, if any, will be submitted in the Summary Report in accordance with NUREG 0737, Supplement 1. Identified design improvements, safety related or not, will be described.

Any deviation or personnel change from the CRDR plan described herein will be included and appropriate explanation provided.

9.0 DOCUMENTATION

Adequate documentation and document control creates a traceable and systematic translation of information from one phase of the CRDR to the next. It is mandatory that the CRDR team have access to a complete, up-to-date library of documents to:

- o Provide a support base to manage and execute the various steps of the control room review.
- o Provide a design data base from which future control room modifications may be made.

Therefore, a data base library is being established to ensure the success of the CRDR process.

This section describes the documentation system and management procedures that Millstone Unit No. 2 will use to support the control room review.

9.1 General Documentation Requirements

Many documents will be referenced and produced during the CRDR project. They will meet the following requirements.

9.1.1 Provide a record of documents used by the review team as references during various phases of the CRDR.

9.1.2 Provide a record of documents produced by the review team as project output.

9.1.3 Provide a record of correspondence generated or received by the review team during the review.

9.1.4 Allow an audit path to be generated through the project documentation.

9.1.5 Retain project files in a manner that allows future access to help determine the effects of control room changes proposed in the future.

9.2 Review Documentation

Throughout the review process, documents will be processed to record data, analyses, and findings. Whenever practical and appropriate, standard forms developed in this plan will be used. Any or all of these forms may be revised based on experience gained during the review. The documentation generated by the review is required to do the following.

9.2.1 Document the criteria used for each review activity.

9.2.2 Record the results of the survey, operating experience review, and task analysis.

9.2.3 Compile HED's and associated data for review and assessment.

9.3 Document Control

The control of documents, their final disposition as well as any reviews, will fall under the normal procedures of the NU System by the Nuclear Records Department and in accordance with the "Nuclear Engineering and Operations Policies and Procedures Manual". These procedures will be further reviewed for incorporation of the principles applied in this review to any future modifications to the control room.

9.4 References

The following documents are resources to be used during the review project. As the review progresses, it is anticipated that additional material and references will be identified and obtained.

9.4.1 Millstone Unit No. 2 Final Safety Analysis Report (FSAR).

9.4.2 Combustion Engineering Owners Group (CEOG) Emergency Procedure Guidelines (EPGs), Rev. 1, (CEN-152).

9.4.3 Millstone Unit No. 2 Emergency Operating Procedures (EOPs).

9.4.4 CEOG Generic Information and Control Requirements (to be generated).

9.4.5 NRC Guidance Documents, and Regulatory Guides as listed in Section 2.2 (Scope)

9.4.6 Control Room Drawings (Floor Plans, Panel Layouts, etc.).

9.4.7 Control Room Photographs.

9.4.8 Human Factors Design Information:

- o Van Cott & Kinkade
- o McCormick
- o MIL-STD-1472C

9.4.9 System Descriptions.

9.4.10 Piping and Instrument Diagrams (P&ID's).

9.4.11 Operating Training Manuals.

9.4.12 Instrument Tabulations.

9.4.13 Annunciator and Label Engraving Lists.

9.4.14 INPO/TVA Pilot Systems Review Report (INPO 82-014).

9.4.15 CRDR NUTAC INPO Documents.

9.4.16 NU Policy and Procedures Manuals.

9.4.17 Other ERC Plans--SPDS, EOP, AMI (1.97), ERF.

9.4.18 Millstone Unit No. 3 CRDR Human Engineering Discrepancies and Summary Report(s).

9.4.19 Human Engineering Guide for Enhancing Nuclear Control Rooms, EPRI NP-2411, May, 1982

10.0 COORDINATION WITH OTHER ACTIVITIES

Implementation of Supplement 1 of NUREG 0737 necessitates the integration of certain post-TMI activities. Specifically, these activities are:

- o Control Room Design Review (CRDR).
- o Emergency Operating Procedures (EOP's).
- o Regulatory Guide 1.97 Provisions (R.G. 1.97).
- o Safety Parameter Display System (SPDS).
- o Emergency Response Facilities.

A part of the integration will occur during the walk-through or verification stage of the task analysis as recommended in Supplement 1. As the core team walks through the specific operator tasks, they will record any and each shortcoming or discrepancy (e.g., special training required, control location, lack of computer display, etc.) as a HED. It should be noted that the CRDR team includes personnel involved with certain aspects of the Supplement 1 to NUREG 0737 activities including the operations representative involved with the writing of the upgraded EOPs and the Human Factors specialist involved with the development of the SPDS. During the assessment and correction phases of the CRDR, disciplines involved with other facets of Supplement 1 will supplement the core team in the resolution of these HED's (e.g., training may be modified, the control may be operated by a second operator, a display may be added to the SPDS, etc.).

Any hardware modifications or enhancement resolutions will be verified by an additional walk-through by the core team. Upon satisfactorily completing this phase, the task analysis documentation will assist the Operations Department in modifying, if necessary, the plant-specific EOP's.

Also as part of the CRDR, the control room instruments that are intended for use under accident conditions will be reviewed and where necessary, appropriately highlighted, to enable the operators to easily identify them, as requested by the Regulatory Guide 1.97.

In summary, the resolution of HED's (integrating all inputs from Supplement 1, to NUREG 0737 activities) could include:

- Plant Process Computer/SPDS display additions.

- Training to enhance operators' cognitive analysis.

- Requirements of additional or modified staffing.

- Utilization of Regulatory Guide 1.97 instrumentation.

- Modification of specific EOP's.

Finally, the dynamic validation step will be performed as discussed in Section 4.3.4 of this plan. This validation will be a true validation of the selected group of time-sensitive procedural steps rather than one to identify additional discrepancies.

11.0 SUMMARY

This implementation plan was developed to describe the process whereby NNECO will conduct the human factors review of the Millstone Unit No. 2 control room. A sincere effort has been made by NNECO to ensure that all major aspects of an effective CRDR have been considered during the development of this plan.

APPENDIX A   RESUMES

RESUME OF: Thomas A. Shaffer

EXPERIENCE:

1977 - Present Northeast Utilities Service Company, Berlin, Connecticut, Generation Electrical Engineering

1980 - Present Supervisor, Controls Engineering Unit of Generation Electrical Engineering

Plan, schedule, coordinate, and supervise engineering activities involving control systems for NU's generating plants (nuclear, fossil, and hydro) and LNG facilities. Responsible for coordinating activities necessary to install new and modified systems and equipment to improve safety, performance, and availability of generating plants. Responsible for supervision of all project/discipline engineering functions supporting projects and operations activities.

1977 - 1980 Engineer, Generation Electrical Engineering Group

Responsible for retrofit assignments at Connecticut Yankee and Millstone Units No. 1 and No. 2, utilizing skills in Systems Engineering and Control Systems Design, Process Instrumentation and Control, Cost and Scheduling, BWR/PWR NSSS Reactor Control and Protection Systems, Construction Supervision, Startup Testing, and Troubleshooting.

Responsible for review of related items of the Three Mile Island Accident such as Post Accident Monitoring Instrumentation, Human Factors Engineering for Control Board Designs, and Control System Logic relative to Man/Machine Interface.

Responsible for Design Review for Millstone Unit No. 3 in areas of specification review, instrumentation installation design documents, control systems design, standards and regulatory guides.

T. A. Shaffer (continued)

1974 - 1977 Bechtel Power Corporation, Gaithersburg Maryland, Gaithersburg Power Division

Engineer, Control System Group

Responsible for control systems specifications, engineered safety actuation system, flow elements, main and auxiliary control boards, seismic monitoring instrumentation, and access security systems. Preparation of instrument installation details, logic diagrams, loop diagrams, control board designs, instrument location diagrams, seismic and separation criteria documents. Vendor and field liaison, liaison with client-representative.

Projects: Millstone Unit No. 2 and SNUPPS (Standard Nuclear Unit Power Plant Systems).

Instrumentation/Electrical Engineer (1976), Calvert Cliffs Unit No. 2, field engineering.

Responsible for installation of instruments and their associated electrical circuits, startup testing.

6/73 - 6/74 Part Time - Student Engineer with AMP, Inc., Harrisburg, Pennsylvania, Automatic Machine Division.

Directly involved in all phases of machine design and product development. Duties included detailing machine components, electrical design, and troubleshooting.

EDUCATION:

1972 Associate Degree in Electrical and Electronic Design Technology

1974 Bachelor of Technology Degree in Electrical and Electronic Design with special emphasis on Solid State and Digital Logic Circuits; Pennsylvania State University

RESUME OF: Zenon A. Ufnal

EXPERIENCE:

1982 - Present Northeast Utilities Service Company, Berlin, Connecticut

1984 - Present Engineer, Generation Electrical Engineering - Controls Engineering

Responsible for engineering, procurement, and installation support for control systems projects within the nuclear power plants. Extensive involvement with the Millstone Units No. 1 and 2 plant process computer replacement projects.

1982 - 1984 Engineer, Nuclear Training

Responsible for the development, coordination, and class room presentation of power plants technical training programs.

1978 - 1982 STAGG Systems, Inc., Tustin, California

Project Manager

Responsible for conducting and managing engineering consulting projects involving the planning, specification and procurement of real-time computer based control systems for electric utility dispatch centers and hydroelectric power plants.

1973-1978 Combustion Engineering, Windsor, Connecticut

Applications Engineer - Instrumentation and Controls Engineering Department

Responsible for planning, directing, and coordinating departmental activities in the design and procurement of a broad range of process instrumentation, controls, and protection systems for the second and third generating units of the San Onofre Nuclear Power Plant.

Zenon A. Ufnal (Continued)

Group Leader

Responsible for group activities involving all phases of design, analysis and implementation of control systems for nuclear steam generators. Also responsible for budgets, schedules, proposals, sales support, training, and field support.

Staff Engineer

Involved in the design and performance analysis of control systems for nuclear power plants.

EDUCATION:

1973 B.S., Electrical Engineering, University of Hartford

RESUME OF: John Becker

EXPERIENCE:

1982 - Present Northeast Nuclear Energy Company, Waterford, Connecticut

Operations Engineer, Millstone Unit No. 2, Operations Department

Responsible for operations department support including plant incident investigations, operator training coordination, and operating procedures preparation.

Responsible for the development and implementation of upgraded Emergency Operating Procedures (EOPs) to meet NUREG 0737 Supplement 1 criteria. This includes active participation in all aspects of the EOPs upgrade including writing, reviewing and verification and validation activities.

Co-chairman of Combustion Engineering Owners Group-Operations Subcommittee. Involved with Operations Subcommittee work on Emergency Procedure Guidelines (CEN-152) since 1982.

Member of the Millstone Unit No. 3 SPDS Verification and Validation team.

1980-1982 Associate Engineer, Millstone Millstone No. 2, Engineering Department

Participated in refueling/backfit activities and operations support.

1977-1980 Turbine Generator Startup Engineer, General Electric Company, Installation and Service Engineering Department.

Responsible for the technical direction of turbine-generator installation, startup, operations and maintenance including balancing and troubleshooting of electrohydrolic control systems.

EDUCATION: B.S., Mechanical Engineering, Duke University

Senior Reactor Operator License on Millstone Unit No. 2.

RESUME OF: Allan M. Stave

EXPERIENCE:

1983 - Present	Northeast Utilities Service Company, Berlin, Connecticut
1965 - 1983	United Technology Corporation (Norden Systems and Sikorsky Aircraft)
1960 - 1965	General Electric Missile and Space Vehicle Department
1958 - 1960	Wright Air Development Center

More than twenty-five years of human factors applied and research experience while employed at listed organizations. Work during this time was in the following areas.

Member Core Team for Millstone Unit No. 3 CRDR

Member BWROG Committee on Integration of Procedures and SPDS

Design of SPDS displays for Millstone Unit No. 3

Manned and Unmanned Space Vehicles

Training Equipment (Aircraft)

Flight Simulator Design

Design of Training Programs

Military Aircraft

Helicopter Crew Compartments

Helicopter Maintainability

Military Command and Control Systems

Man/Computer Interfaces

Effects of Noise and Vibration on Pilot Performance

A. M. Stave (Continued)

Design and Execution of Experimental Studies

Design and Execution of Survey and Interview Type Studies

Work Space Layout

Control Panel Layout

Complex Display Design and Evaluation

Quantification of Human Performance

Task Analysis

Design and Execution of Training Programs

EDUCATION:

1954 Bachelor of Arts Degree, Psychology
University of Pennsylvania
Philadelphia, Pennsylvania

1955 Master of Arts Degree, Psychology
Boston University
Boston, Massachusetts

1964 Doctor of Philosophy Candidate
Industrial Psychology
Temple University
Philadelphia, Pennsylvania

Graduate work included courses in the following areas:

Statistics, Human Factoring Engineering, Experimental Design, Sensor/Perceptual Processes, Industrial Psychology, Test Construction/Design, Survey Techniques, Interviewing

RESUME OF: Michael J. Wilson

EXPERIENCE:

1985 - Present

Northeast Nuclear Energy Company
Millstone Station, Waterford, Conn.
Assistant Training Supervisor

Responsible for all aspects of training for Millstone Unit 2 dealing with the following programs:

- o Licensed Operators including Initial Training, Requalification Training and License Upgrade Training.
- o Non-Licensed Operators including Initial Training and Continuing Training
- o Maintenance
- o Instrumentation and Controls

1982 - 1984

Northeast Nuclear Energy Company
Millstone Station, Waterford, Conn.
Senior Instructor-Operators

Responsibilities:

Lead instructor for reactor operator and non-licensed operator training.

Planning, organizing, scheduling and coordinating reactor operator and non-licensed operator training.

Qualifications:

Hold current NRC Senior Reactor Operator License on Millstone Unit 2

1980 - 1982

Combustion Engineering, Inc.
Windsor, Conn.
Nuclear Training Specialist

Qualifications:

Integrated Plant Instructor (Combustion Engineering Senior Operator equivalent)

Michael J. Wilson (Continued)

Assignment:

On contract to Millstone Nuclear Power Station, Unit 2.

Responsible for preparing and delivering presentations dealing with all aspects of nuclear power plant systems and operations to reactor operator replacement candidates, non-licensed operators and licensed reactor operators and senior reactor operators.

1972-1980 Eight years active duty as a Machinist's Mate in the U.S. Navy Nuclear Power Program.

1977 - 1980 Operating and maintaining the U.S. Navy Nuclear Power Prototype Training Facility at Windsor, Connecticut.

Instructing students, both officer and enlisted, in reactor plant theory and operations in preparation for their qualification as Watch Officers and Mechanical, Electrical, and Reactor Operators.

Qualifications:

Engineering Watch Supervisor
Mechanical Operator Watchstations
Maintenance Instructor

Positions:

Training Coordinator: Supervisor of a staff of seven instructors. Responsible for the timely qualification of up to sixty Mechanical, Electrical, and Reactor Operator and Engineering Laboratory Technician students.

Duties include: Inplementation and coordination of a four-phase training program; maintenance of qualification records; student evaluation and counseling.

Classroom Instructor: Responsible for preparing and delivering lectures on the design, construction, and operation of reactor support systems to classes of thirty enlisted and officer students.

Michael J. Wilson (Continued)

1974 - 1977 - Operating and maintaining the reactor support systems aboard the USS Alexander Hamilton (SSBN 617)

Qualifications and Positions:

Engineroom Supervisor
Mechanical Operator Watchstations
Divisional Quality Assurance Petty Officer
Divisional Training Petty Officer

EDUCATION:

Naval Service Schools:

Nuclear Power Training Unit
Nuclear Power School
Machinist's Mate Class "A" School

Civilian Schools:

University of Hartford, Hartford, Ct.
Washburn University, Topeka, Ks.
Topeka High School, Topeka, Ks.

APPENDIX B COVER LETTER/QUESTIONNAIRE

QUESTIONNAIRE INSTRUCTIONS

A design review of the Millstone Unit No. 2 control room is being performed. Its purpose is to determine the design adequacy of the control room and shutdown panel from an operational standpoint. One of the best source of information for this review are the people who have had operational experience and have operated this unit. That is why we have requested your assistance.

The attached questionnaire is a part of the review process. It has been prepared by the review team. The purpose of the questionnaire is to highlight any categories of design errors you feel have been made for possible improvement. We are also interested in the good features you believe have been utilized in the design. Follow-up interviews where necessary will be performed to clarify interpretation of your answers.

Please respond to the questions as they apply to your job or position, and in relation to your experience. Where you feel unqualified to answer, please indicate so, and explain. Full explanatory sentences are much more useful than yes-no answers, so please be an informative as possible.

Feel free to ask the NU project team any questions you may have concerning the questionnaire. Phone numbers are included below for this purpose.

John Becker (NU)	447-1791 ext. 4071
Zen Ufnal (NU)	665-5027
Al Stave (NU)	665-3627

OPERATOR QUESTIONNAIRE

PERSONAL INFORMATION

Name:

Work Phone Number:

Education:

Position/Title:

Years Experience in Industry:

Years with Northeast Utilities:

Years at Millstone:

Training in Current position: (directly related to your work)

School/Facility (name if applicable)

Courses Completed:

On-Site Training:

Job Related Experience:

Military:

Other: (nuclear, fossil, etc.)

A. WORKSPACE LAYOUT AND ENVIRONMENT

1. (a) What do you think of the general layout of the control room?

_____ Best I have seen

_____ Good, I can work with it

_____ Average, I can work with it, but it could be better

_____ Poor, I cannot work with it

(b) What are the things you like best about the control room layout?

(c) What are the things that bother you about the control room layout?

Some things to consider are:

Panel-to-panel arrangement

Operational sequences

Two-man operation

Board accessibility

A. WORKSPACELAYOUT AND ENVIRONMENT

2. Below is a list of environmental factors which might cause control room problems. From your experience with MP2 or other control rooms, please rank them in the order of their potential to cause problems (lowest number for the worst offenders).

_____ Ventilation

_____ Temperature

_____ Humidity

_____ Illumination

_____ Noise (ambient)

_____ Excessive Control Room Traffic

_____ General Appearance (color coordination, etc.)

_____ Other (please specify)

Comment on your choices.

3. Is the lighting level inadequate for any areas in the control room? If yes, please indicated the relevant areas.

4. Is shadowing of (or glare on) instruments a problem?

5. Are there problems with the heating/air conditioning system?

   a. Is the control room comfortable?

   b. Are there problems with static electricity?

   c. Do control room panels or controls overheat?

   d. Is the air in the control room stale?

6. Does background noise in the control room interfere with speech communication?

7. Does the presence of excessive personnel in the control room ever cause a problem? If yes, describe how this has caused problems.

B PANEL DESIGN (Main Boards and Hot Shutdown Panel)

1. Are there controls and displays that must be used in conjunction with each other that are too far apart?

2. Are any controls difficult to adjust as precisely as needed?

3. Are there switches that do not "snap" into position or that can be left halfway between positions or, where appropriate, do not have spring return? Are there switches that are difficult to turn?

4. Are any controls too large, too small, or too close together to operate easily?

5. Are knobs for spring-loaded switches and selector controls large enough to be held easily against the spring torque without fatigue for as long as necessary to accomplish the control action?

6. Are there spring-loaded switches that must be held for an extended period.

7. Are there control knobs or handles that slip or move loosely on their shaft?

8. Are any meters scaled in different units than the procedures that reference them? In addition to listing the relevant meters, describe the discrepancies.

9. Do any controls and displays work together in confusing ways? In addition to listing the relevant controls and displays, describe why they are confusing.

10. Are any instruments difficult to compare with backups because of differences in scale units, elevated zeros, etc.?

11. Are any instruments hard to use because they have to be read more precisely than the scale allows?

12. Are any labels unclear about what is being displayed, what a control does, or the control's position?

13. Can the key for any key switch be removed when the switch is not in an "off" or a "safe" position?

14. Are there indicator lights where equipment status is indicated by a light being off (for example, pump is off when light is off)?

15. Are there any controls with no direct, immediate display feedback? Where there is a time lag between control activation and ultimate system state, are there any instances in which there is not immediate feedback indicating what is occurring and the direction of parameter change?

16. Are there chart recorders that lack Hi/Lo speed capability where fast tracking rates or trending is periodically required or desirable?

17. Comment on panel mimicing (e.g., do mimics aid in operation, are they clear and not confusing?).

18. In your opinion, are too many or too few functions performed automatically (i.e., should the operators have greater or less system control)? Please explain your answer

C. ANNUNCIATOR WARNING SYSTEM

1. Please rate the tiles with respect to:

	Great	OK	Need Fixing
Legibility	____	____	____
Color Coding	____	____	____
Grouping	____	____	____
Location on Proper Panel	____	____	____

Please comment on those areas you feel need fixing.

2. Do audible alarms aid or distract you in plant operation?

3. Do you get recurring or "nuisance" alarms when a system is deactivated intentionally?

4. Do you get any particular recurring invalid alarms?

5. Do any alarms fail to give operators adequate time to respond to warning conditions before a serious problem develops?

6. Are there conditions requiring a rapid response that are signaled by light indicators instead of annunciators?

7. Do any important instruments on the back panels have neither an alarm you can hear in the control room nor their own annunciator on the front panel?

8. Please comment on annunciator controls and different flash rates.

D. DISPLAYS

1. Are there displays for which illustrations or pictures could be used to better describe text or alphanumeric material?

2. Would it be helpful if procedural sequences were displayed on a CRT in addition to having hard copy formats (manuals, etc.)?

E. COMMUNICATIONS

1. Do you feel that the telephone and maintenance jack systems are adequate for all plant operations? Please elaborate.

2. Please rate the communications at Millstone Unit No. 2.

	Excellent	Good	Average	Poor
(a) Operator to Operator	____	____	____	____
(b) Supervisor to Operator	____	____	____	____
(c) Control Room to Remainder of Plant	____	____	____	____

Based on the above, how might things be improved?

2. Are there any problems with handling communications from outside the plant during an emergency? Briefly describe any problems.

F. STAFFING

1. In your opinion, what is the number of operators needed to operate the control room effectively during each of the following?

   (a) Steady state operations ______________

   (b) Transients (i.e., startup/shutdown) ______________

   (c) Off-normal/emergency operations ______________

APPENDIX C HUMAN ENGINEERING DISCREPANCIES

APPENDIX C

HUMAN ENGINEERING DISCREPANCY

HED No.

TITLE:

PRIORITY:

COMMENT:

Reviewer   Date   Ref.   Source

IDENTIFICATION: Panel:

Component Name:

ID or No.:

DESCRIPTION:

POSSIBLE SOLUTIONS:

RESOLUTION: (Code)

Approved Signature: ____________________ Date: __________

/ / Additional page(s) attached

HED FORM INSTRUCTIONS

HED NUMBER: Assign numbers consecutively using one of the following prefixes (reviewer assign prefix, admin. assign number):

- L = Labels and Location Aids
- P = Panel Layouts
- CD = Control-Display Integration
- D = Displays (CRT)
- V = Visual Displays
- A = Annunciator Warning Systems
- C = Communications
- W = Work Space and Environment
- PC = Process Computers

TITLE: One to four words that describe the system or component involved.

PRIORITY: To be assigned as required during Assessment and Correction Phases.

COMMENT: One sentence stating the general type of discrepancy.

REVIEWER: The reviewer's initials.

DATE: The date report prepared.

REFERENCE: List the reference or guideline number.

SOURCE: Which CRDR activity; Survey, TA, HE Suit., Interview, etc.

IDENTIFICATION: Panel; give panel number or name.

COMPONENT NAME: Give the name and/or number of the instrument or control that has the discrepancy.

ID or NUMBER: List identification numbers.

DESCRIPTION: Give details of the problem. (Do not say what should be done.)

POSSIBLE SOLUTIONS: Normally to be supplied later during assessment phase. If you know a simple solution, make a note here when initially filling out.

RESOLUTION: To be supplied during correction phase. Assign resolution code in parenthesis. Describe authorized resolution.

SIGNATURE: To be signed by the project manager having approval authority.

ADDITIONAL PAGE(S): Check box if additional page(s) attached.

APPENDIX D TASK ANALYSIS HED PRINCIPLES

MILLSTONE UNIT NO. 2 CONTROL ROOM DESIGN REVIEW (CRDR)

TASK ANALYSIS HED PRINCIPLES

1. Are all the controls and displays required to perform this task present in the control room?

   6111a 6411b

2. Are the controls and displays grouped by sequence, function, or use for the requirements of this task?

   6515d 6811 6821
   6911c 6921b

3. Are the controls and displays labeled according to the requirements of this task?

   6514e & f 6533c

4. Can the controls and displays used in this task be read accurately from the operators' view position? Can the displays be read while operating the associated controls?

   6113c(2) 6122e(2) & f 6125a(2) & b(2)
   6542b(2) 6911a

5. Do the controls and displays give the operator direct, readily usable information if required? (e.g.:

   Parameter values

   Range, band and limits

   Trend information

   Rate of change

   Scale compatibility

   Digital or analog information

   Status or demand information

   Precision and feedback information

   6411a & b 6511 6512
   6541g 6931c 6932

6. Is the control room arranged and staffed to ensure the requirements of this task?

   6111b 6112 6113d

APPENDIX E ASSESSMENT TRIAGE METHODOLOGY

MILLSTONE UNIT NO.2

CONTROL ROOM DESIGN REVIEW (CRDR)

ASSESSMENT TRIAGE METHODOLOGY

Prior to the formal significance evaluation and correction, every HED will be reviewed for the following.

1. Is the HED truly a deficiency?

2. Is the HED in the process of resolution with an existing design change?

3. Is the HED a logical candidate for management resolution? (e.g., training/procedures/PC display)

4. Is the HED part of a larger, duplicate or generic HED?

5. Are surface enhancements the logical resolution?

6. Is the HED resolution obvious and minor for change to both the control room and the simulator?

7. Does the HED require further study and assessment?