ATTACHMENT 2 TO JPN-86-08

JAMES A. FITZPATRICK
NUCLEAR POWER PLANT
DETAILED CONTROL ROOM DESIGN REVIEW
SUMMARY REPORT

NEW YORK POWER POWER AUTHORITY

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1.0 INTRODUCTION AND BACKGROUND

1.1 Background

In April of 1981, the Authority completed a control room survey based on the BWR Owners Group "Control Room Survey Program" in an effort to implement the NRC's "Lessons Learned" program following the TMI 2 accident. The Owners' Group program was conditionally approved two years later by the NRC in Generic Letter 83-18 (Reference 1). The Authority subsequently committed to submit a revised program plan taking into consideration Generic Letter 83-18. To fulfill this commitment, and as required by Supplement 1 to NUREG-0737 (Reference 2), the Authority submitted a program plan for the FitzPatrick Detailed Control Room Design Review (DCRDR) as an attachment to Reference 2. This plan described documentation and document control, methodology to conduct the control room review, methodology used to assess the significance of HEDs, and qualifications of the review team.

In Reference 3, the NRC Staff provided comments on the program plan. A meeting between the Authority and the NRC was held May 10, 1984 to discuss the plan and the staff's comments (Reference 4). The Authority subsequently responded formally to the staff's comments in Reference 5. As part of that response, Section 4.3, "Systems Function Review and Task Analysis" of the DCRDR Program Plan was revised to reflect staff comments. This supplement also provided additional information not included in the program plan. Appendix B to the DCRDR Program Plan (Resumes of DCRDR Team Members) was transmitted to the NRC staff as part of Reference 6.

1.2 Introduction

This is a summary report. It does not unnecessarily repeat or duplicate portions of the DCRDR program described elsewhere. Specifically, this report fulfills the commitments described in the program plan (Reference 7), the supplement to the program plan (Reference 5), and the 1981 BWR Owners Group Control Room Survey Program.

The format and content of this summary report reflect the NRC Staff guidance included in the Standard Review Plan, the Authority's DCRDR Program Plan (Reference 2) and the supplement to the program plan (Reference 5). Sections 2, 3 and 4 correspond to the areas that will be reviewed by the NRC Staff in its evaluation of the summary report as described in Appendix A to SRP Section 18.1,(page 18.1 - A23). Sections 5 through 9 include the additional information the Authority committed to provide (Reference 5). A schedule for implementing the resulting modifications is submitted separately.

1.3. Objectives

Section 5.1.a of Supplement 1 to NUREG-0737 states the objectives of the control room design review as follows:

> "The objective of the 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 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 in the safety of operation. Decisions to modify the control room will 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."

The Authority's DCRDR program was developed to achieve this objective.

1.4 Fundamental Requirements

Section 5.1.b of Supplement 1 to NUREG-0737 lists four fundamental requirements of a control room design review:

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

A multidisciplinary review team was established by the Authority. DCRDR. Team member qualifications were described in Section 2.3 of the program plan. This summary report includes a chart detailing the involvement of each discipline in DCRDR activities (Section 9). Resumes of DCRDR team members were included as Appendix B to the program plan.

A DCRDR Program Plan was prepared and submitted to the NRC Staff for review. The methodology used during the review was described in the program plan and supplement to the program plan. As a result of a subsequent meeting with the NRC Staff, the plan was revised, supplemented and resubmitted.

"(ii) 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."

Function and task analysis was used to identify control room operator tasks and information and control requirements during emergency operations. This analysis is described in revised Section 4.3 of the DCRDR Program Plan and in Section 5.1 of this summary report.

The use of this task analysis in developing training and staffing needs is outside the scope of the Fitzpatrick DCRDR.

The use of this analysis for verifying SPDS parameters was documented in the Authority's SPDS Parameter Safety Evaluation (Reference 8).

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

Sections 4.3 and 4.4 of the program plan described how missing displays or controls were identified.

> "(iv) 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."

Section 4.2 of the program plan described how the DCRDR control room survey was performed.

2.0 SIGNIFICANT CHANGES FROM PROGRAM PLAN

No significant changes were made to the approach and methodologies as described in the Program Plan (Reference 7), as amended by the program supplement (Reference 5), and Appendix B (Reference 6) to the program plan.

In addition to the individuals whose resumes were included in Appendix B, additional personnel participated in the assessment and categorization phases of the program.

3.0 DESCRIPTION OF CONTROL ROOM MODIFICATIONS

Human Engineering Deficiency (HED) resolutions encompassed a variety of methods, ranging from the enhancement (paint, label & tape), application of demarcation lines to design effort (modification, relocation and/or addition of components.)

Approximately 90 HEDs, (almost 25 percent of the total of 400 HEDs), have already been resolved by execution of one or more of the corrective actions described below. These HEDs are not included in the totals given in the description of the corrective actions. Additionally, the number of HEDs given in the corrective actions do not add up to the total number of HEDs as some HEDs will be corrected by more than one method.

ENHANCEMENT

1. Demarcation - the continuation, alteration or application of lines of demarcation and mimics. Approximately 20 HEDs will be resolved by demarcation.

2. Labeling - the correction, addition, alteration, or relocation of a component label. Approximately 72 HEDs will be resolved by labeling.

3. Color Coding - the development and application of a color code in the control room. Approximately 4 HEDs will be resolved by the development and application of a color coding standard.

DESIGN

4. Scale Modification - will involve the alteration of instrument scales. The modifications may include the addition of process units or multipliers, the standardization of fonts (lettering), or the addition of range markings (color banding). Approximately 21 HEDs will be resolved by scale modification.

5. Relocation - will entail the relocation of controls or instruments. Relocations will improve control/display relationships, and separate components of unrelated systems or functions. Approximately 18 HEDs will be resolved by relocation.

6. Modification - existing equipment will be modified. This may include: resequencing pens on strip chart recorders to improve consistency; switch modification to achieve consistency; stereotypical direction of movement; rearrangement of annunciators to provide logical groupings; or addition of new components. Approximately 28 HEDs will be resolved by modification.

7. EPIC - (Emergency and Plant Information Computer) involves the installation and operation of the EPIC system. The installation of this system will correct HEDs by rearranging the control room workspace or by improving the accessibility of a parameter by displaying it on the EPIC CRTs. Approximately 36 HEDs will be resolved by the installation of the EPIC system.

8. Standard - this method of HED resolution will result in the development and subsequent implementation of standards. The standards will be developed to address mimics, demarcation, color coding, labeling (including hierarchical labeling, abbreviations and legend plate content), coding of switch handles, meter banding and annunciator legend wording and lettering. Approximately 30 HEDs will be resolved by the development and implementation of standards.

9. Procedure - the HEDs will be resolved by the development, or revision, and implementation of procedures. These will be administrative procedures, operations department standing orders, instructions, or other written guidance. Approximately 13 HEDs will be resolved by developing and implementing new procedures.

10. Review - a more detailed engineering review of the HED, the associated DCRDR task analysis, and the proposed recommendation will have to be completed before a control room modification, if any, is decided upon to resolve the HED. Approximately 13 HEDs will require further review. (Refer to Section 4.0 of this report for details.)

11. Miscellaneous - the control room modification did not correspond to any of the categories described above. Approximately 4 HEDs are in this category.

12. No Change Recommended - Assessment Categories I and II HEDs with no change recommended are addressed in Section 4.0. Approximately 83 HEDs are in this category.

Table 3-1 indicates the number of HEDs in each assessment category for each of the 12 resolution methods described above.

RESOLUTION METHOD

CATEGORY	TOTAL NUMBER OF HEDs PER CATEGORY	Demarcation	Labeling	Color Coding	Scale Modification	Relocation	Modification	EPIC	Standard	Procedure	Review	Miscellaneous	No Change Recommended	Resolved
1: HEDs Associated with Documented Errors	5						1	1						3
2: HEDs Associated with Potential or Interactive Errors	209	12	52	3	6	8	15	13	25	11	6	0	22	60
3: HEDs Associated with Low Probability Errors of Serious Consequences	107	6	15	1	10	9	11	13	4	1	5	4	28	10
4: Non-significant HEDs	69	2	5	0	3	1	1	9	1	1	2	0	31	17
TOTAL NUMBER OF HEDs PER RESOLUTION METHOD	390	20	72	4	21	18	28	36	30	13	13	4	83	88

Table 3-1.

4.0 SUMMARY JUSTIFICATIONS FOR HEDs CATEGORY I AND II WHICH WILL BE LEFT UNCORRECTED OR PARTIALLY CORRECTED.

All category I HEDs will be corrected. Fourteen HEDs that have been assigned to category II will not be corrected. Each of these 14 HEDs are described below followed by a summary justification for leaving them uncorrected.

A. Discrepancy: Forty four "J" handle switches (for a variety of control functions) are located at the outer edge of the bench board apron. This location may lead to inadvertent operation of the switches.

Justification: The typical corrective action for this HED is the installation of a guard rail. However, the installation of a guard rail at the Fitzpatrick plant is inappropriate for several reasons. The arm depth of reach of the bench board already exceeds applicable ergonomic criteria by two inches. Installation of a horizontal guard rail would effectively increase panel depth by at least 5 inches.

Installation of a vertical guard rail could obstruct operator manipulation of edge mounted controls. In addition, operations personnel, who have experience with guard rails in other control rooms, believe that guard rails tend to encourage leaning or sitting at the board edge. This could actually increase, rather than decrease, the probability of unintentional switch actuations.

Inadvertent switch operation can result from poor switch location in conjunction with either personnel congestion in the panel area or carelessness by personnel. These conditions are most effectively mitigated by eliminating personnel congestion and restricting access to qualified personnel, rather than by the installation of additional hardware. Recognizing the importance of this condition, the Authority has implemented new administrative controls concerning control panel area access and control room demeanor. A new work activity control center has been established which effectively eliminates the need for non-operators to access the control area for administrative purposes. In addition, a distinctive line will be applied to the control room floor to clearly demarcate the area restricted to essential personnel.

B. Discrepancy: Parallax on meter scales makes them difficult to read.

Justification: These meters and controllers are no longer used. This equipment was previously used to control electric heaters in the steam tunnel for the purpose of raising the ambient temperature to test area temperature detectors in the steam tunnel. These detectors are part of the steam tunnel leak detection system. These temperature detectors have recently been replaced as part of the Analog Transmitter Trip System (ATTS). This new RTD equipment will be locally tested using other methods.

In addition, steam tunnel area ambient temperatures may be read on a new digital device installed next to the obsolete meters.

C. Discrepancy: Eleven meters installed since 1981 on ECCS panel 09-3 do not fail off-scale.

Justification: These eleven meters monitor a total of five different parameters: (1) primary containment pressure, (2) primary containment water level, (3) reactor vessel pressure (4) suppression chamber water level and, (5) wide-range reactor vessel water level.

A total of four meters display primary containment pressure. Primary containment water level, reactor vessel pressure and suppression chamber water level each have two meters. A single meter displays wide-range reactor vessel water level. Each meter in a pair has a different, independent power source. Because four of the five parameters are monitored by two or more independently powered meters, the failure of one meter will be readily apparent by comparison with its companion meter located on the same control panel.

The wide-range reactor vessel water level meter can be compared to other reactor water level displays to detect the failure of this meter.

In addition, the SPDS/EPIC system will provide an independent means to verify these parameters.

D. Discrepancy: There is no means of diagnosing failed indicator lights.

Justification: A two lamp system (red/green for open/closed or on/off) is used in the FitzPatrick Control Room. In a two light system, one of the two lights (either red or green) associated with each control is illuminated during normal operation. The control room operators visually check for failed indicator lamps three times each day by verifying that one lamp of each pair is illuminated. If both lamps are extinguished, the operator checks for failed lamps and replaces them as required.

If lamp replacement does not result in illumination of one of the pair, the system is checked for possible problems.

E. Discrepancy: Solenoid condition, as opposed to actual valve position, is indicated for the off gas vent pipe sample line purge valves.

Justification: Position indication is not important for these valves. The value of the process parameter regulated by the value is displayed near the valve control switch and provides a positive indication of valve position.

F. Discrepancy: The intensity of flashing annunciator tiles for cleared annunciators does not readily command attention

G. Discrepancy: Cleared alarms flash at the same rate as activated alarms.

F&G. Justification: When a plant parameter exceeds the pre-established alarm value, an alarm is received in the control room. At this time, the annunciator window flashes. When the operator acknowledges the alarm, the annunciator window changes to continuously lit. If the parameter then returns to its normal range, the alarm clears and the annunciator window flashes at the same rate, but with less intensity than it would for an alarm.

This difference in intensity is intentional and provides the necessary visual cue to inform the operator of the annunciator status i.e. alarm or clear. Operations personnel consider the annunciator intensities and flashing rates adequate. The BWROG survey program provides no objective criteria concerning intensity. Therefore, the Authority considers these findings to be subjective and not supported by operating experience at FitzPatrick.

H. Deficiency: Operating procedures for HPCI, RCIC, RHR and Core Spray are not cross referenced in Small Break Accident Procedure F-EOP-33.

I. Deficiency: Procedures do not provide the physical panel locations of referenced instrumentation and hardware, especially those that are infrequently used.

J. Deficiency: Operators must use a second procedure in parallel to perform immediate operations.

H&I&J. Justification: F-EOP-33, and other procedures, have been replaced by new symptom-based Emergency Operating Procedures.

These procedures were written using Emergency Procedure Guidelines and a writers guide, both of which received a human factors review.

The new procedures were specifically written to be brief, streamlined and lead the operator to take appropriate action rapidly. As a result, symptom-based procedures do not always reference system operating procedures or panel locations. Panel locations are called-out in procedures where specific or infrequently used instruments or controls are referenced.

Inclusion of this information for other instruments or controls would needlessly lengthen the emergency procedures. In addition, operators receive extensive training on both emergency and normal operating procedures. Much of this training is plant-specific to FitzPatrick. Operators have learned the location of instruments and controls through this training and daily work experience. A plant-specific FitzPatrick reactor simulator is currently under development; this will further improve the operators ability to locate an instrument or control.

In general, the control room panels group the instruments and controls associated with a specific system together. Other control room improvements (such as hierarchical labeling, color coded labels and mimics) completed to correct other HEDs, will also significantly improve the operators ability to quickly find any switch or meter.

The need to use a second procedure in parallel to perform immediate operations was identified in the 1981 survey. However, this is still true and is a result of using procedures developed in accordance with the Emergency Procedure Guidelines Writer Guide. As noted above, operators are thoroughly trained in their use.

K. Deficiency: When reference material is identified in a procedure, the latest available revision is not specified.

Justification: The Authority considers it unnecessary to specify the revision number of references in the body of procedures.

The control room is routinely provided with the most up to date applicable references available. Placing the revision number of reference materials into controlled procedures would require procedure revisions each time a reference was revised. This in turn would result in a large increase in the purely administrative workload for the Plant Operations Review Committee (PORC). (All changes to operating procedures require PORC review prior to implementation.) This increase in work load with no reduction in probability for operator error is not justified.

L. Discrepancy: Controls for drywell fans and the emergency water supply for drywell coolers, which are used for temperature control, are located on the back panel.

M. Discrepancy: Drywell cooling and containment HVAC cooling water system flow, noted as being required by the task analysis, is not available.

Justification: This deficiency will be partially corrected by the SPDS which will display drywell temperature in the front panel area. This will insure that operators are provided with information which will permit sufficient time to go to the back panel, (approximately 20 feet away), to take required action.

Neither normal nor emergency operation requires frequent operation of these controls. These controls are simple start/stop switches for fans and open/close switches for valves. No variable controls are involved. In an emergency situation, the operator is only concerned with achieving the maximum available cooling. This is accomplished in a single trip to the back panel. He is unlikely to need to return to stop fans during an emergency. Similarly, there is no need for cooling system flow measurement instrumentation.

In addition, there is no available space on the front panels to locate these controls. There is no justification for moving them there do to the low frequency of use and the lack of a requirement for immediate operator response.

N. Discrepancy: Turbine valve indications are small, pointers are difficult to distinguish.

Justification: Accurate readings are not required and the monitoring of discrete values is unnecessary. These meters are used principally during weekly valve testing to indicate that the valve being tested is in fact moving in the open or closed direction. No information about intermediate valve position is required, only the indication of valve movement in a specific direction.

O. Discrepancy: Secondary containment area radiation level instruments do not have the range required by task analysis (0 to 1,000,000 R/hr).

Justification: Secondary containment area radiation level is a Regulatory Guide 1.97 Revision 2 variable. In Reference 23, the Authority justified the existing Area Radiation Monitoring System (ARMS) range in response to a NRC Technical Evaluation Report. The Authority considers the existing ARMS range to be adequate for the reasons described in Reference 23.

4.1 Engineering Studies Required

There was a total of 13 HEDs associated with five common issues. These require further engineering review to determine both the nature and feasibility of corrective modifications which may be made.

Annunciator Relocation

There are two HEDs concerning annunciator windows. One of which was initially placed in assessment category II, the other in category III. These HEDs concern the lack of a consistent method of arranging annunciator windows within system groupings. Many types of alarms, including trips, warnings, diagnostics, and equipment status indications are randomly interspersed. A program to standardize labeling and color coding will be developed and implemented which will improve the operators ability to distinguish between various types of annunciator information. The correction of these HEDs may require significant rewiring and modification of the control room panels. Until an engineering review has been completed, the Authority can not select the best means of correcting the HEDs. Specific corrective actions will depend on the results of the color code and standardization study, and subsequently on the feasibility and extent of rewiring.

Glare

There was one HED which was initially placed in assessment category III. It involves glare free lighting of adequate brightness on several panels. Occasional glare on isolated instruments is not a major concern. An engineering study will be performed to quantify the extent of the problem and recommend possible solutions.

Manual Initiation of ECCS

A single HED identified that no single manual initiation capability existed for several ECCS systems. This HED was initially placed in assessment category II. Manual initiation of ECCS presently requires multiple steps. A "single button" initiation theoretically provides rapid and error free initiation of these systems. It should be noted that even with "single button" actuation, the operator must still verify correct operation of the system.

Because there are seven modes of RHR system operation, the RHR system will not be considered for a "single button" initiation modification. The HPCI and RCIC systems will be considered as possible candidates. A detailed engineering study is required to insure that new safety issues are not introduced by modifications to the logic circuits. In addition, the study must assure that the single fail re criterion is met and fully define the engineering scope and f ancial costs associated with this modification. Following corpletion of this study, a decision will be made concerning both the feasibility and the cost benefit of a "single button" ECCS initiation modification.

Control Layout or Replacement for Feedwater and Main Turbine Auxiliary Controls

Four HEDs (one initially classified in assessment category II and the remaining three in assessment category III), are associated with a particular type of push button switch used primarily for the feedwater and turbine auxiliary controls. These controls have never presented a safety issue and due to the need to replace a large number of switches (approximately 100) in a limited space, there may be limitations on possible solutions. Further engineering review is necessary to determine if a practical and cost beneficial means of correcting these HEDs exists.

Two HEDs (both assessment category III) have been identified concerning layout and arrangement of indicators and controls on the turbine auxiliary control panel No safety concern exists. These involve no safety related systems. Due to the potential complexity of the changes required, additional engineering is required before the Authority can determine if a practical and cost beneficial means of correcting these HEDs exists.

Control Room Sound Levels

Six HEDs concern control room sound levels. Four of these were placed in assessment category II, and two were placed in category III. The HEDs addressed such concerns at total control room ambient sound level, suitability of annunciator alarm volume, distractions related to the Gaitronics page and phone system, and the Secondary Security Alarm Status (SAS) panel.

The SAS panel will be relocated. Further engineering study is required to determine the best combination of increasing audible alarm volume and reducing control room ambient sound levels. The study will consider installation of sound absorbing material subject to the ability to meet appropriate fire protection requirements.

5.0 METHODOLOGY AND CRITERIA

This section describes the methodology utilized for the Systems Functions Review and Task Analysis, and the methodology and criteria used for HED assessment, and correction. Details on the methodology and criteria used during the DCRDR are included in Sections 4 and 5 of the program and program plan supplement.

5.1 Systems Functions Review and Task Analysis

The purpose of Systems Functions Review and Task Analysis portion of the DCRDR is to determine the information and control requirements of the control room crew for emergency operation; and, to ensure that the required systems can be efficiently and reliably operated under emergency conditions.

The BWROG/EPRI/DOE Functional Analysis of the BWROG Emergency Procedure Guidelines (EPGs) were used to perform the DCRDR Task Analysis. The Functional Analysis was reviewed to determine the differences between the BWROG EPGs and the FitzPatrick EOPs. The BWROG/EPRI/DOE document was used to determine information and control requirements where there were no differences, the EOPs were used where differences were identified.

The steps which comprised the Systems Functions Review and Task Analysis are shown in Figure 5-1 and are described in the following sections.

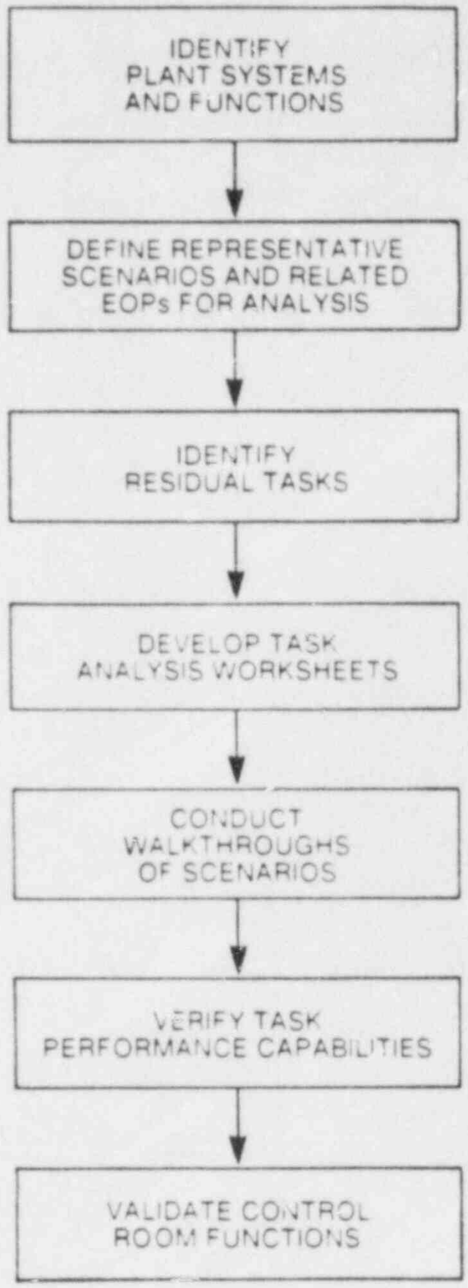

Figure 5-1. Systems Functions Review and Task Analysis Steps

5.1.1 Systems Functions Descriptions

System functions descriptions identify plant systems and subsystems operated from the FitzPatrick control room emergencies. Plant documentation (e.g., FitzPatrick FSAR and Training Department system descriptions) served as a prime information source.

Descriptions of the functions of each of the identified systems were prepared. These system descriptions included: the function(s) of the system; the conditions for which the system is used; and a brief explanation of how the system operates.

The systems functions descriptions served as a reference for subsequent task analysis. Additionally, a list of plant systems was used to assist in the selection of operating scenarios for each walkthrough.

5.1.2 Task Analysis

The BWR Owners Group Emergency Procedures Guidelines and the list of the FitzPatrick systems and subsystems were used to define a set of scenarios which sampled various emergency conditions and the plant systems and system functions used in those conditions. The related FitzPatrick EOPs were also identified in this step.

The four scenarios that were developed are listed below:

- Scenario A - Inadequate Core Cooling
- Scenario B - Steam Leak in the Drywell (with Containment Temperature and Pressure Abnormal)
- Scenario C - Large Break Loss of Coolant Accident
- Scenario D - Anticipated Transient Without SCRAM

A brief narrative description of each scenario was prepared which established the limits and conditions of the events to be analyzed. These scenario descriptions were useful for orienting operators to the scenarios prior to walkthroughs. The description included: initial plant conditions; sequence initiator; progression of action; final plant conditions; and, major systems involved.

5.1.3 Residual Tasks

Residual tasks are defined as EOP tasks exercised during the Task Analysis scenarios. Task Analysis scenarios were developed so that there were no residual tasks; all EOP tasks were included in the scenarios listed in Section 5.1.2.

5.1.4 Develop Task Analysis Worksheets

Task Analysis Worksheets (see Figure 5-2) were developed which document the operational steps required in each scenario along with the appropriate information and control requirements, means of operation, and instrumentation and controls present on the control boards. The operator tasks were analyzed using plant-specific EOPs and the BWROG EPGs. The Task Analysis Worksheets were prepared in the following manner.

1. Discrete steps in the FitzPatrick EOPs and corresponding EPGs were identified in order of performance. These steps were recorded in the "Procedure Number" column of the Task Analysis Worksheet. (Note that there may be more tasks subsequently identified than there are procedural steps. In this case, a dash was entered in the column when no explicit procedure step was present in the EOPs and/or EPGs). A brief description of the operator's tasks (in order of procedural steps) was then recorded in the "Tasks/Subtasks" column of the Task Analysis Form. All tasks, both explicit and implicit, were documented by BWR operations subject matter experts and human factors specialists.

2. The operator decisions and/or actions linked to task performance were noted in the "Decision and/or Contingent Action Requirements" column.

TASK ANALYSIS WORKSHEET

SCENARIO
PAGE OF

Procedure No		Task/Subtask	Scen Resp	Crew Mem	Loc	Decision and/or Contingent Action Requirements	Information & Control Req	Means	I&C Ident		Verification		Comments/ Candidate HEDs
JAF	EPG								Panel	No	Avail	Suf	

Figure 5-2. Task Analysis Worksheet

3. Information and control requirements for successful task performance were recorded in the "Information and Control Requirements" column. These were parameters, components or procedural information necessary for operators to adequately assess plant conditions or system status (e.g., reactor vessel water level, reactor coolant system flow, etc.). Specific values for parameter readings or control selection were noted.

4. Once the tasks, decision requirements, and information and control requirements had been specified, the specific instrumentation and controls required by the operator for each procedural step were entered on the form. All instrumentation and controls needed to either (1) initiate, maintain or remove a system from service, (2) confirm that an appropriate system response has or has not occurred, i.e., feedback, or (3) make a decision regarding plant or system status, were listed. The "Means" column refers to how the information and control requirements are ultimately presented on the control boards (e.g., switch, meter, etc.). The "I&C Identification" column provides the specific panel number and identification number of the control or instrument.

   <u>It is important to note that Steps 1 through 3 were completed on the Task Analysis Worksheet using independent sources of data, not the actual information and controls present in the control room.</u>

   Step 4 essentially completes the first step in the Verification Process by identifying whether or not the necessary instrumentation and controls for task performance are <u>available</u> in the control room.

   The remaining columns of the Task Analysis Worksheet were used during the Verification of Task Performance Capabilities, which is described in Section 5.1.6. The remaining columns are described below.

5. "Verification" column: "Availability" (or presence) of the necessary instrumentation and controls for successful operator task performance is documented in this column; "Suitability" of the instrumentation and controls to meet the information and control requirements of operator task was documented in the column.

6. "Comments/Candidate HEDs" column: Comments or candidate HEDs were noted in the column.

The Task Analysis Worksheets serve as the complete record of operator tasks; decisions; and, information and control requirements, availability, and suitability for the selected scenarios. The record was developed through the steps described above.

5.1.5 Conduct Walkthrough of Scenarios

Using the Task Analysis Worksheets, human factors engineers and operations engineers performed walkthroughs of each scenario with four FitzPatrick control room operators at a full-scale, photomosaic control room mockup. The walkthroughs were videotaped to provide a record of the process for subsequent review. The walkthroughs were conducted over the course of three and one-half 8-hour days. During this walkthrough, the tasks required by the procedural steps were analyzed in terms of: the presence of necessary instruments and controls and job aids (the Verification of Task Performance Capabilities specified in NUREG-0700); and, the suitability of equipment, job aids and control room design for reliable execution of the required tasks (the Validation of Control Room Functions specified in NUREG-0700).

Real-time walkthroughs were then conducted to document the tasks involved for all crew members. A complete description of the walkthrough method is described in the validation process in Section 5.1.7. The task data was subsequently examined in both the verification and validation processes described in the sections that follow.

5.1.6 Verification of Task Performance Capabilities

The purpose of the Verification of Task Performance Capabilities was to systematically verify that the Instrumentation and Controls that were identified in the Task Analysis as being required by the operator are:

- o Present in the Control Room
- o Effectively designed to support correct procedure performance

The Verification of Task Performance Capabilities utilized a two-phase approach to achieve the purpose stated above. In the first phase, the presence or absence of the instrumentation and controls that were noted in the Task Analysis was confirmed. This was done by comparing the requirements in the "I&C Requirements" column of the Task Analysis Form to the actual control room by using the control room mockup, or by reviewing the videotapes of the walkthroughs.

The presence or absence of required instrumentation and controls was documented in the "yes" or "no" areas, respectively, in the "Availability" column of the Task Analysis form. If it was discovered that required instrumentation and controls were not available to the operator, any such occurrence was identified as an HED and documented accordingly on an HED form.

The second phase determined the human engineering suitability of the required instrumentation and controls. For example, if a meter used in a particular procedure step exists in the control room, that particular meter was examined to determine whether or not it has the appropriate range and scale to support the operator in the corresponding procedural step. If the range and scale were found to be appropriate, it was documented in the "yes" area in the "I&C Suitability" column of the Task Analysis Form. Conversely, if the meter range or scale was found to be inappropriate for the parameter, the "no" area in the "I&C Suitability" column of the Task Analysis Form will be checked. This type of occurrence was defined as an HED and documented accordingly.

5.1.7 Validation of Control Room Functions

The purpose of the Validation of Control Room Functions step in the DCRDR process is to determine: (1) whether the functions required to execute the FitzPatrick - specific EOPs can be effectively accomplished in the exiting control room; and, (2) the human factor engineering of the control room as it exists. Additionally, this step provided an opportunity to identify HEDs that may not have become evident in the static processes of the DCRDR, for example, in the control room survey.

Utilizing the partially completed Task Analysis Forms, walkthroughs were performed at the control room mockup. Four licensed operators assuming the rolls of shift supervisor, assistant shift supervisor, senior nuclear operator, and nuclear control operator participated in the three and one-half day walkthrough task which was recorded on video tape at the full scale photographic control room mock-up. The purpose of the walkthrough was to evaluate the operational aspects of control room design in terms of control/display relationships, display grouping, control feedback, and manning levels and traffic patterns.

The operating crew was provided with copies of the EOPs to follow as they walked through the events. DCRDR team members used the partially completed Task Analysis Worksheets to record observations and potential HEDs.

One event at a time was walked-through. Operators performed the walkthrough in slower than real time to provide a slow-paced version of the event. During the walkthroughs, the operators were instructed to speak one at a time and describe their actions. Since this forced serial action, the operations were not performed simultaneously. Specifically, the operators verbalized: the component or parameter being controlled or monitored; the purpose of the action; the expected result of the action in terms of system response; each control or display that they utilized; and, which annunciators were involved.

For the validation process, Link Analyses (which trace the movement patterns of the operating crew) were developed by reviewing videotapes to assess whether the existing control room layout hinders operating crew movement or control access while performing the scenarios.

5.2 Assessment and Categorization

The purpose of the HED Assessment phase of the DCRDR project was to examine the identified HEDs and categorize them in terms of their significance and potential to cause operator error during operations. This was accomplished by analyzing and evaluating the problems that could arise from the identified HEDs.

All HEDs identified during the DCRDR process were assessed and categorized. Additionally, recommendations for the correction or resolution of HEDs were developed.

5.2.1 HED Categorization

Nine members of the DCRDR review team met at the mockup for five days to evaluate HEDs for their potential to increase operator error. As each HED was reviewed, it was assigned an Assessment Category based on the following category definitions:

1. Assessment Category I - HEDs Associated with Documented Errors

   HEDs which have been previously documented (as identified during the Operating Experience Review) as having contributed to a significant operating crew error were assigned to Category I.

2. Assessment Category II - HEDs Associated with Increased Potential for Operator Error or Interactive Effects. HEDs assigned to this category come from two sources:

   a. If it was judged that the HED degrades performance and if the effects of the HED were judged to be serious enough to cause or contribute to increasing the potential for operator error, the HED was assigned to Category II.

   b. If it was judged that the HED has any cumulative or interactive effects with other HEDs, it was assigned to Category II. Cumulative HEDs are those that were placed in this category by their number of occurrences, such as improper labeling characteristics throughout the entire control room. Interactive HEDs were those HEDs that exacerbate each other such as improper scaling on a meter combined with the absence of a parameter designation.

3. Assessment Category III - HEDs Associated with Low Probability Errors of Serious Consequences

   All HEDs that were judged by the DCRDR review team to have a low potential for error <u>but</u> could result in serious consequences if the error did occur were placed in Category III.

4. Assessment Category IV - Non-Significant HEDs

All HEDs that were judged by the DCRDR review team to neither increase the potential for causing or contributing to an operating crew error, nor to have adverse safety consequences, nor to have any cumulative or interactive effects were assigned to Category IV.

5.3 HED Correction

In an attempt to develop recommendations to correct problems associated with HEDs, the DCRDR review team met at the mockup for five days. Recommendations for HED corrections were made for each HED. Recommended resolutions were based upon two criteria:

1. The recommended correction adheres to accepted human factors engineering principles.

2. The recommended correction is cost-effective and feasible from an implementation perspective.

During the Assessment and Resolution Phase of the DCRDR, the review team identified additional HEDs. These HEDs were recorded on HED forms and subsequently subjected to the same assessment and categorization process as HEDs identified during the Review Phase.

6.0 HOW HED CORRECTIONS WILL BE ASSURED NOT TO INTRODUCE NEW HEDs

The process described below will be performed as part of each modification to assure that the corrective modifications provide the desired results and do not introduce new HEDs.

- o Control room modifications will be implemented on a control room mockup prior to installation in the actual control room, where appropriate and feasible.
- o Mocked-up modifications will be reviewed by operations personnel to ensure that the modifications are operationally correct and will be beneficial.
- o Engineering procedures will be revised to address human factors concerns as a design input when modifying control room panels.

This process will reduce any inconsistencies in the operator-control room interface and ensure the effectiveness and correctness of control room modifications.

7.0 INTEGRATION OF THE CONTROL ROOM DESIGN REVIEW WITH OTHER HUMAN FACTORS ACTIVITIES

7.1 BWROG Control Room Survey Program

In April 1981, the BWR Owners' Group conducted a control room survey at the James A. FitzPatrick Nuclear Power Plant. A team comprised of operations and engineering personnel from four utilities performed the checklist survey with the assistance of consultants from General Electric Company and the Massachusetts Institute of Technology. The survey consisted of four phases: (1) an analysis of plant Licensee Event Reports (LERS) and scram reports to identify possible design-related operator errors; (2) interviews with approximately one-third of the plant operators; (3) panel evaluations using checklists developed from previous surveys and accepted human factors standards; and, (4) task analyses and walkthroughs of selected emergency procedures. The result of the survey was a summary report and the completed checklists.

The intent of the 1981 BWROG Control Room Survey report for FitzPatrick was to identify areas of the control room where modifications should be considered.

The 1985 FitzPatrick DCRDR relied on this 1981 survey and a 1983 BWROG supplemental checklist for identification of those panel deficiencies which could be found by use of a checklist and operator interviews. The updating and integration of this 1981 effort with the 1985 continuation of the DCRDR is addressed in Section 8 of this report.

7.2 INPO NUTAC on Control Room Design Review

The Nuclear Utility Task Action Committee (NUTAC) on Control Room Design Review (CRDR) was established by a group of utilities in recognition of the need for guidance on performing a CRDR. The principal objectives were: (a) to determine the boundaries of the CRDR; (b) to develop a methodology; (c) to define terms; (d) to integrate other initiatives with the CRDR e.g., SPDS development, EOP development, staffing, and training), and (e) to provide practical implementation guidelines that included:

- CRDR Methodology and Implementation Guideline
- Guideline on the Development of CRDR Survey Checklists
- CRDR Task Analysis Guideline
- Human Engineering Review Principles

The NYPA DCRDR project coordinator served as chairman of this NUTAC. NYPA and its independent human factors contractor used selected portions of these publications as guidance in preparing the program plan and task analysis methodology.

7.3 Eme gency Operating Procedure (EOPs)

The development and NRC review of the FitzPatrick EOPs was accomplished separately from the DCRDR project organization. Two distinctly separate task analyses and walkthroughs were conducted; one for the EOP program and a second analysis and walkthrough for the DCRDR. The responsibility for meeting NUREG-0737, Supplement 1, Section I.C.1 requirements for EOPs rests with that project and is outside the scope of the DCRDR project. The DCRDR addresses itself exclusively to the requirements of Section I.D.1 and its task analyses was designed to identify control room design deficiencies rather than EOP procedural deficiencies. However, DCRDR and EOP programs interacted in the following ways:

7.3.1 Common EPG Basis for Task Analysis

The DCRDR task analysis used the BWROG/EPRI/DOE graphic display committee function analysis of the BWROG EPG's as the basis for its independent task analysis. This was done to ensure an independent task analysis information and control section which was not influenced by the FitzPatrick control room. The EOPs were created from a procedures generation package which used the same BWROG EPGs as a technical basis.

7.3.2 DCRDR Walkthrough of EOPs

The DCRDR task analysis verification walkthrough, while using the independently derived task analysis, did use the EOPs to execute the scenarios. Thus, the FitzPatrick EOPs were subject to two independent task analysis walkthroughs at different times using different human factors teams. One was completed for the DCRDR to identify control room deficiencies, one for the EOP validation to identify procedural deficiencies.

7.4 Safety Parameter Display System (SPDS/EPIC)

The SPDS/EPIC is a completely separate project from the DCRDR, designed to meet the requirements of NUREG-0737, Supplement 1, Section I.D.2. However, there are several areas of commonality between the SPDS/EPIC, the EOPs, and the DCRDR.

7.4.1 Function Analysis

The SPDS portions of the SPDS/EPIC were based on the same BWROG/EPRI/DOE Graphics Display committee functional analysis, as an initial basis for its displays, that the DCRDR task analysis used for its basis. This was specifically identified as a requirement in the DCRDR contractor bid specifications to contribute to integration of these two projects.

7.4.2 Shared EPG Base SPDS/DCRDR/EOPs

All three of these projects have in common the same set of BWROG Emergency Procedure Guidelines (EPGs). The EPGs served as a basis for creation of the EOPs. The same EPGs were the basis for the BWROG/EPRI/DOE Function Analysis used to develop the SPDS and as a base for the DCRDR Task Analysis.

7.4.3 SPDS/EPIC Basis for HED Resolution

The FitzPatrick SPDS/EPIC computer system will correct approximately 36 HEDs identified during the DCRDR.

7.4.4 SPDS Human Factors Program

The SPDS displays were subjected to a specific human factors program during their development.

7.4.5 SPDS/EPIC System Human Factors Program

Because the new SPDS/EPIC computer system is not yet installed, it was not included in the 1981 or 1985 DCRDR project. However, the SPDS/EPIC, system, including its control room hardware and operator interfaces, have been subjected to a detailed human factors program as part of the SPDS/EPIC project. This portion of the SPDS/EPIC program will n ot be completed until installation is completed.

8.0 HOW CONTINUITY WAS ASSURED BETWEEN THE 1981 BWROG SURVEY AND THE 1985 DCRDR

Four distinct methods have been used to assure continuity between the 1981 BWROG Survey and the DCRDR.

8.1 Personnel Continuity

Mr. Hamilton C. Fish, Jr. (Assistant to the Superintendent of Power at FitzPatrick) has been continuously assigned to the DCRDR project from October 1980 through the current date. He was a BWR Owners' Group Team leader in five 1981 BWROG surveys, including the 1981 FitzPatrick survey. Mr. Fish is the 1985 DCRDR Project Coordinator, providing the desired personnel continuity.

8.2 Common Basis for HEDs

HEDs were extracted from the 1981 Survey Summary Report and checklists completed during the 1981 Survey. These HEDs were entered into the DCRDR Database Management System along with those resulting from the 1985 activities.

8.3 Review of Control Room Changes 1981-1985

Modifications that were made to the control room after the 1981 survey were identified by comparing the existing control room with photographs of the control room taken in 1981. Post-1981 modifications were then surveyed using the 1981 BWROG checklist. In addition, the operating review was updated from 1981 through 1985.

8.4 The BWROG 1983 Survey Supplement

The BWROG 1983 Survey Supplement was completed on all control room panels, including post-1981 modifications.

9.0 STRUCTURE OF THE REVIEW TEAM

The DCRDR project has collectively involved the efforts of 28 people divided between the staffs of NYPA and its independent consultants. Table 9-1 shows the participation of each discipline in each of the ten DCRDR activities defined in the program plan. (Reference 2, page 9, and Reference 18, page 31).

The human factors engineering effort was supported by seven qualified independent consultans comprising approximately 25 percent of the total project staff. With the exception of the "Systems Description" activity, one or more members of this group actively participated in each of the other nine project activities.

Operations experience was provided to the review team by eight persons specifically assigned for this purpose. It was supplemented by four additional persons with operating experience who were assigned to the team primarily for other purposes. Eleven of these twelve DCRDR team members held currently valid USNRC senior operator licenses or certification on BWR plants; seven indiciduals were licensed on the FitzPatrick plant. Emergency Operating Procedures (EOPs) experience was available from seven members of this group. At least one of the primary members of this group participated in seven of the ten program phases.

Table 9-1 DCRDR Task by Discipline Matrix

Engineering Experience/ Discipline	Planning	Control Room Survey	Operating Experience Review	Systems Descriptions	Task Analysis & Walkthrough	Walkthrough Verification	Walkthrough Validation	HED Assessment	HED Correction	Summary Report
Human Factors	•	•	•		•	•	•	•	•	•
Reactor Operations including SPDS & EOP		•		•	•	•	•	•	•	•
Instrumentation & Control		•						•	•	
Mechanical/Elect' ical								•	•	
Computer								•	•	
Management	•									•
Licensing	•									•
Training			•					•	•	

At least one of the three persons experienced with instrumentation and control participated in the control room survey, assessment, and correction phases. A qualified mechanical engineer, electrical engineer, and computer specialist actively participated in the assessment and correction phases. Plant management and licensing engineers participated in project planning and preparation of the summary report. Persons experienced in training participated in the operating experience review, assessment, and correction phases. While the SPDS system has not yet been installed, the NYPA DCRDR project coordinator and the computer specialist (who have both been actively involved in that project) provided the necessary integration by recommending HED solutions which could be effectively accomplished by the SPDS/EPIC computer.

10. REFERENCES

1. NRC Generic Letter 83-18, dated April 19, 1983, D.G. Eisenhut to All BWR Licensees regarding NRC staff review of the BWR Owners' Group (BWROG) Control Room Survey Program.

2. NRC Generic Letter No. 82-33, dated December 17, 1982, D.G. Eisenhut to All Operating Reactors transmits Supplement 1 to NUREG-0737.

3. NRC letter, D.B. Vassallo to J.P. Bayne, dated February 22, 1984 regarding review of Program Plan for Detailed Control Room Design Review. Includes attachment entitled "NRC Staff Comments on the James A. FitzPatrick Detailed Control Room Design Review Program Plan."

4. NRC June 27, 1984 Summary of the DCRDR meeting on May 10, 1984 for FitzPatrick, H.I. Abelson.

5. NYPA letter, J.P. Bayne to D.B. Vassallo, dated August 31, 1984 (JPN-84-57) regarding Supplement 1 to NUREG-0737, Item I.D.1, Detailed Control Room Design Review (DCRDR). Transmits Supplement to October 19, 1983 DCRDR Program Plan (Attachment 1) and a Revised Section 4.3 of Program Plan (Attachment 2).

6. NYPA letter, J.C. Brons to D.B. Vassallo, dated November 21, 1985 (JPN-85-85) transmits Appendix B (Resumes of DCRDR Team Members) to DCRDR Program Plan.

7. NYPA letter, J.P. Bayne to D.B. Vassallo, dated October 24, 1983 (JPN-83-90). Transmits FitzPatrick DCRDR Program Plan, dated October 19, 1983.

8. NYPA letter, C.A. McNeill, Jr. to D.B. Vassallo, dated November 30th, 1984 (JPN-84-79) transmits the Safety Parameter Display System Safety Evaluation.

9. NYPA letter, J.P. Bayne to D.B. Vassallo, dated March 28, 1984 (JPN-84-20) regarding Supplement 1 to NUREG-0737 Item I.D.1 - Control Room Design Review. Commits to provide DCRDR Summary Report and schedule for implementing final recommendations by November 15, 1985.

10. NRC letter, V.A. Moore to H.C. Fish, dated April 11, 1984 transmits NRC staff comments on: "Control Room Design Review Implementation Guide"-INPO 83-026 (NUTAC): "Human Engineering Principles for Control Room Design Review" INPO 83-036 (NUTAC): "Control Room Design Review Task Analysis Guideline"-INPO 83-046 (NUTAC) and; "Component Verification and System Validation Guidance"-INPO 83-047 (NUTAC). Also requests meeting to discuss comments.

11. NYPA letter, J.P. Bayne to D.B. Vassallo, dated April 15, 1983 (JPN-83-33) transmits initial response to NUREG-0737, Supplement 1.

12. NYPA letter, J.P. Bayne to D.B. Vassallo, dated June 3, 1983 (JPN-83-50) regarding NUREG-0737 Item I.D.1, Control Room Design Review.

13. General Electric Co. letter, G.W. Burnette to BWROG committee members and CRDR primary representatives, dated October 17, 1983 (OG3-271-3) transmits final approved version of "Human Factors Engineering Control Room Survey Supplement".

14. NRC memorandum, S.H. Weiss to V.A. Moore, regarding task analysis requirements of Supplement 1 to NUREG-0737, May 4, 1984 meeting with BWR Owners Group Emergency Procedures Guidelines and Control Room Design Review Committee.

15. PASNY letter, J.P. Bayne to S.S. Hanauer, dated January 5, 1982 (JPN-82=3) provides comments on draft NUREG-0801, "Evaluation Criteria for DCRDR-October 1981."

16. PASNY letter, J.P. Bayne to D.B. Vassallo, dated June 30, 1983 (JPN-83-60) transmits EOP Generation Package and Technical Guidelines for EOPs.

17. INPO 83-036 (NUTAC), "Human Engineering Principles for Control Room Design Review".

18. INPO 83-026 (NUTAC), "Control Room Design Review Implementation Guide".

19. INPO 83-046 (NUTAC), "Control Room Design Review Task Analysis Guideline".

20. INPO 83-047 (NUTAC), "Component Verification and System Validation Guidance".

21. NUREG-0801, "Evaluation Criteria for Detailed Control Room Design Reviews." October 1981, draft report.

22. NUREG-0800, U.S. Nuclear Regulatory Commission Standard Review Plan, Sections 18.0, "Human Factors Engineering - Introduction", Rev. 1, September 1984, and Section 18.1, "Control Room", Rev.0, September 1984.

23. NYPA letter, J. C. Brons to D. R. Muller, dated December 24, 1985 (JPN-85-91) regarding emergency response capability - conformance to Regulatory Guide 1.97 Revision 2. Responds to NRC Technical Evaluation Report on Authority plans to implement Regulatory Guide 1.97 Revisions.