TECHNICAL EVALUATION REPORT

OF THE

DETAILED CONTROL ROOM DESIGN REVIEW

FOR

LOUISIANA POWER AND LIGHT COMPANY

WATERFORD UNIT 3

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1.0 BACKGROUND

Licensees and applicants for operating licenses shall conduct a Detailed Control Room Design Review (DCRDR). The objective is to "improve the ability of nuclear power plant control room operators to prevent accidents or cope with accidents if they occur by improving the information provided to them" (NUREG-0660, Item I.D.1). The need to conduct a DCRDR was confirmed in NUREG-0737 and Supplement 1 to NUREG-0737. DCRDR requirements in Supplement 1 to NUREG-0737 replaced those in earlier documents. Supplement 1 to NUREG-0737 requires each applicant or licensee to conduct a DCRDR on a schedule negotiated with the Nuclear Regulatory Commission (NRC).

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

1. Planning
2. Review
3. Assessment and implementation
4. Reporting

Supplement 1 to NUREG-0737 requires that the DCRDR include the following elements:

1. Establishment of a qualified multidisciplinary review team.

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

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

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

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

6. Selection of design improvements.

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

8. Coordination of control room improvements with changes from other programs such as the safety parameter display system (SPDS), operator training, Reg. Guide 1.97 instrumentation, and upgraded emergency operating procedures (EOPs).

Licensees are expected to complete Element 1 during the DCRDR's planning phase, Elements 2 through 4 during the DCRDR's review phase, and Elements 5 through 7 during the DCRDR's assessment and implementation phase. Completion of Element 8 is expected to cut across the planning, review, and assessment and implementation phases.

A Summary Report is to be submitted at the end of the DCRDR. As a minimum it shall:

1. Outline proposed control room changes.
2. Outline proposed schedules for implementation.

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

The NRC staff evaluates the organization, process, and results of the DCRDR. Results of the evaluation are documented in a Safety Evaluation Report (SER) published within two months after receipt of the Summary Report.

2.0 Discussion

Louisiana Power and Light Company (LP&L) submitted a DCRDR Program Plan for Waterford Unit 3 (Waterford 3) on September 28, 1984. NRC staff comments on that Program Plan were forwarded to LP&L on January 30, 1985. The NRC staff conducted a pre-implementation audit of the Warterford 3 DCRDR June 3-6, 1985. The evaluation of the Waterford 3 DCRDR provided in this TER is based on a review of the Program Plan, documentation reviewed and discussions conducted during the on-site audit, and the DCRDR Summary Report submitted April 30, 1985.

2.1 Establishment of a Qualified Multidisciplinary Review Team

Supplement 1 to NUREG-0737 requires the establishment of a multidisciplinary review team. Guidelines for team selection are found in NUREG-0700.

The Waterford 3 Summary report describes a multidisciplinary review team that appears to have the necessary expertise to perform an adequate DCRDR. The team consisted of a core group which included individuals from I&C engineering, Nuclear Systems Engineering, Human Factors Engineering, Operations, and Training. This core group was supplemented by other disciplines such as electrical, mechanical, and industrial engineering on an as needed basis.

A chart illustrating team members' involvement in various DCRDR tasks is contained in Fig. 2.2 on page 2-3 of the Waterford 3 Summary Report. Tasks

appear to have been assigned to team members with the appropriate expertise to effectively accomplish DCRDR tasks. The review team members were given a formal plant and DCRDR orientation. Based upon the Summary Report and discussions during the pre-implementation audit, we conclude that the review team members have the necessary expertise to perform an adequate DCRDR. In conclusion we believe that LP&L has met the requirement of Supplement 1 to NUREG-0737 for a multidisciplinary review team.

2.2 System Function and Task Analysis

Supplement 1 to NUREG-0737 requires the applicant to perform systems, function and task analyses to identify control room operator tasks and operator information and control requirements during emergency operations. Furthermore, Supplement 1 to NUREG-0737 recommends the use of function and task analyses that had been used as the basis for developing emergency operating procedures, technical guidelines, and plant-specific emergency operations procedures to define these requirements.

The Waterford-3 system, function and task analysis is based primarily upon plant specific Emergency Operating Procedures (EOPs) developed from Combustion Engineering Emergency Procedure Guidelines (CEN 152). Additional plant specific task analysis was conducted by LP&L to identify operator tasks for degraded electrical power conditions and for remote shutdown conditions not addressed by the CE guidelines. The EOPs evaluated by the task analysis encompass functional response guidelines and include supplemental operating procedures required to support the EOPs.

In order to minimize re-analysis of tasks that are common to several procedures, the EOPs were broken down into discrete tasks and a document was developed that lists once each operator task involved in executing the EOPs. Specific display and control requirements were not documented per se for each task. Rather a control room inventory was developed that documented existing display and control characteristics. Then a list of interview questions

regarding important control and display attributes was developed. Each set of operator tasks was analyzed using the list of questions as a discussion guide. Based on this questioning and discussions among review team members (human factors specialist and control room operators), required display and control characteristics that differed or were absent from the inventory listing were documented.

The use of EOPs developed from generic Combustion Engineering EPGs as the basis for the Waterford-3 system, function and task analysis is acceptable as discussed NUREG-0800, Section 18.1, Appendix A.

2.3 Comparison of Display and Control Requirements with a Control Inventory

Supplement 1 to NUREG-0737 requires the applicant to make a control room inventory and to compare the operator display and control requirements determined from the task analyses with the control room inventory to determine the suitability of existing controls and displays as well as any missing controls and displays.

A complete inventory of control room controls and displays was developed in the form of computer-stored documentation, including control and display characteristics and specific panel location, and control panel layout drawings. Teams comprised of a human factors specialist and a operator used these drawings to verify that the control room contains displays and controls that are suitable for performance of emergency operations. For each task a team recorded the controls and displays that would be used to perform the task, and the location of these devices. The human factors specialist on the team used the set of questions developed for the task analysis to interview the operator regarding the suitability of each control and display. Negative responses to the interview questions were recorded for review as potential HEDs.

The audit team walked through this process for some of the procedure steps

executed during a station blackout. The following potential discrepancies were noted that apparently were not identified by the LP&L comparisons of operator needs to control room inventory:

- An indicator giving only valve position demand indication was identified for use in verifying secondary steam dump valve position;

- Indication of emergency power sequencer relay status was identified as the means of verifying start of emergency loads instead of a direct indication of the load status (e.g., breaker position, motor current, or related process variable reading); and,

- A meter with a 0-100% scale that is readable to no more than +/- 0.5% discrimination was referenced to determine Condensate Storage Pond level within +/- 0.1% accuracy.

Control and displays that were needed but not available were documented during the task analysis/comparison effort. Because required control and display characteristics were not documented a priori, the audit team cannot verify whether these are potential discrepancies that were not identified by the LP&L task analysis and control room comparison, or whether the analysis of operator needs indicated that the controls and displays provided were sufficient for the operator's needs. In addition, this lack of documentation precluded the participation of LP&L team members other than the operators and human factors specialist in the control room comparison activity, although LP&L staff indicated that the necessary nuclear engineering knowledge was available through the operators.

We recommend that LP&L address each of the potential HEDs identified by the NRC audit team to determine whether they are indeed HEDs and whether they are symptomatic of a generic deficiency with the process used for the identification of required display and control characteristics and the comparison to the control room inventory. A written response on this issue

should be provided to the NRC for its review so the NRC staff can decide whether LP&L has fulfilled the requirements of Supplement 1 to NUREG-0737 for the conduct of a task analysis and the comparison of required display and control characteristics to the control room inventory.

2.4 Control Room Survey

Supplement 1 to NUREG-0737 requires that a control room survey be conducted to identify aspects of control room design that deviate from accepted human factors principles. NUREG-0700 provides guidelines for conducting a control room survey. The objective of the control room survey is to identify, for assessment and correction as appropriate, the characteristics of displays, controls, equipment, panel layout, annunciators and alarms, control room layout, and control room ambient conditions that do not conform to good human engineering practices.

LP&L has executed their DCRDR Survey in two parts both of which served to identify potential Human Engineering Discrepancies (HEDs):

- Preliminary Control Room Assessment (PCRA) (April 15, 1981), and
- Control room survey as part of the DCRDR for Waterford 3.

During the pre-implementation audit, the NRC audit team conducted an abbreviated survey of the control room. The NRC audit team found only a few instances of some rather subtle and minor HEDs. These HEDs were pointed out to LP&L personnel.

We found that LP&L has performed an acceptable systematic comparison of the control room against accepted human engineering guidelines. We conclude that LP&L as met the intent of Supplement 1 to NUREG-0737 to conduct a control room survey.

2.5 Assessment of HEDs

Supplement 1 to NUREG-0737 requires that HEDs be assessed to determine which HEDs are significant and should be corrected. NUREG-0700 and NUREG-0800 Appendix A to SRP Section 18.1 contain guidelines for the assessment process.

All HEDs were separated by the Lead Human Factors Specialist (LHFS) into groupings according to the phase of the DCRDR during which the HED was identified. Once this was done each team member received a binder containing a grouping of HEDs and performed an independent evaluation of HEDs assigned to him. Each HED was evaluated based on the following factors:

- Impact on physical performance (fatigue, discomfort, injury, control suitability, etc.);
- Impact on sensory/perceptual performance (distraction, visibility, readability, audibility, noise, display adequacy, inconsistency with stereotypes and conventions, etc.);
- Impact on cognitive performance (mental overload, confusion, stress, sequential/compound/cumulative/interactive errors, etc.);
- Interaction with task variables (communication needs, delay or absence of necessary feedback, concurrent task requirements, etc.);
- Impact or potential impact on operating crew error; and,
- Impact or potential impact on plant safety (safety of plant equipment, operability of plant equipment, personnel safety and health and safety of the public).

After evaluating each finding against the above factors, the team member assigned one of the following three categories of significance to each HED:

I Highest Significance - could substantially affect a safety system or operator response during an emergency situation;

II Significant - could substantially affect or has substantially affected a non-safety system or operator response during routine non-emergency operation; and,

III Least Significant - could or has affected operator response in a non-substantial way.

After all HEDs were evaluated by individual team members, the team met as a group and reviewed each HED until a team consensus was reached. When the group discussion was completed, the LHFS reviewed the HEDs again and provided a compilation of the results. During group discussions the team performed an evaluation of the cumulative effect of Category 3 HEDs.

We find that LP&L's assessment method, as described and reported, meets the requirement of Supplement 1 to NUREG-0737 to assess HEDs to determine which HEDs are significant and should be corrected.

2.6 Selection of Design Improvements

Supplement 1 to NUREG-0737 requires the selection of control room design improvements that will correct the significant HEDs. It also states that improvements that can be accomplished with an enhancement program should be done promptly.

The LP&L procedure for selection of design improvements as discussed during the pre-implementation audit and reported in the summary report is as follows:

1. The review team reviewed all HEDs and discussed each HEDs significance to clarify any points of concern.

2. The recommendation that the team determined to be the most feasible became the preferred recommendation which will be submitted to the station operations and Engineering Departments for consideration.

3. The LHFS's responsibility was to ensure that the recommendations developed and accepted by the review team are in accordance with applicable precepts of sound human factors engineering practice.

4. If a decision is made by Operations or Engineering not to accept any of the team recommendations, a written justification will be prepared and signed by the rejecting person and alternatives will be examined.

At the time of the pre-implementation audit, the selection of design improvements process was not yet complete. The methodology discussed during the audit and summary report appears adequate. However, we do have some concerns about suggested fixes and implementation schedules.

We are concerned with labeling in the control room and its maintainability. We suggest that a more permanent labeling scheme be considered. There is a serious question on our part whether the present labeling system can be effectively maintained.

Another area of concern is the recommended implementation schedule of many HEDs using color shading enhancements as a solution. Many of these corrective actions are scheduled at the second refueling outage. We believe this schedule is unacceptable and suggest that the implementation schedule for these enhancements be re-evaluated for implementation at the first refueling outage. (See Table B)

Based on discussions with operators and LP&L review team members, we were unable to determine with any degree of certainty whether the annunciator system does or does not have reflash capability. We believe LP&L needs to

resolve this matter as it will affect proposed annunciator corrective actions.

We recognize that the process for the selection of design improvements used by LP&L has incorporated sound human engineering techniques. It appears that LP&L intends to meet the intent of Supplement 1 to NUREG-0737. However, the selection of design improvements is not complete at this time and a final determination cannot be made. It is suggested that upon completion of this process that the NRC audit the results. (See Table A)

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

Supplement 1 to NUREG-0737 requires verification that selected design improvements will provide the necessary corrections of HEDs and will not introduce new HEDs into the control room.

As stated by LP&L in the Summary Report and during pre-implementation audit discussions, the verification process will consist of two approaches. One approach will be to produce a set of drawings for all control room panels containing intended enhancements. The corrections will then be reviewed by subject matter experts and human factors specialists. If any new problems arise from the improvement or if the improvement does not fix the HED, it will be altered or canceled as deemed appropriate by team members. The second approach will be to install corrections on the simulator and have them verified by the human factors specialists and subject matter experts. LP&L stated during audit discussion that they have developed a human factors design guide. This guide has been incorporated into the normal engineering design phase. LP&L stated that all present and future proposed design changes will be checked to ensure adherence to sound human engineering principles. This process will also ensure human factors input on a ongoing basis.

We find that Waterford 3 meets the intent of Supplement 1 to NUREG-0737 to

verify that selected design improvements will provide the necessary corrections and do not introduce new HEDs.

2.8 Coordination of The DCRDR With Other Programs

Supplement 1 to NUREG-0737 requires that control room improvements be coordinated with changes from other initiatives such as SPDS, operator training, RG 1.97 instrumentation, and upgraded EOPs.

LP&L stated during pre-implementation audit discussions that all proposed and actual engineering changes, as part of the normal design procedure, are distributed to training prior to final approval and implementation. The Waterford 3 Summary Report indicates that all R.G. 1.97 indications were assessed from a human factors viewpoint. The Summary Report goes on to state that the SPDS was reviewed in similar manner from a human factors viewpoint. At Waterford the EOPs were used as the basis for the DCRDR SFTA. The intergration with the DCRDR is therefore inherent. However, we recommend as changes are implemented into the EOPs that they are then folded back into the SFTA.

Based on the Waterford 3 Summary Report and pre-implementation audit discussions, we find that Waterford 3 meets the intent of Supplement 1 to NUREG-0737 for coordination of the DCRDR with other relevant initiatives.

3.0 Conclusions

Based on our review of the Waterford 3 Summary Report and the pre-implementation audit conducted June 3-6, 1985 we find LP&L has satisfied the requirements of Supplement 1 of NUREG-0737 with the following exceptions.

LP&L should address the potential task analysis HEDs identified by the audit to determine if they are legitimate HEDs and whether they are symptomatic of a generic deficiency in the process for identifying required control and display

characteristics and comparing these requirements with the control room inventory. A written summary of this assessment should be submitted to NRC to allow the staff to determine the acceptability of LP&Ls process in these areas.

To fully satisfy the requirement for selection of design improvements, LP&L must complete the process and the results are subject to review by the NRC.

We recommend that LP&L review their proposed corrective actions on labeling and evaluate the maintainability of the labels. It is our opinion that present labeling system should be replaced with a more permanent scheme. The present system appears to be questionable in its ability to be effectively and accurately maintained.

We also disagree with LP&L's present implementation schedule for HEDs using color shading enhancements as a solution. Second refueling outage is the present scheduled implementation. We think that this schedule is too slow for implementation of these enhancements.

LP&L needs to ascertain whether the annunciator system does or does not have reflash capability since this will affect proposed annunciator corrective actions.

REFERENCES

1. NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," May 1980: Revision 1, August 1980.

2. NUREG-0737, "Clarification of TMI Action Plan Requirements," November 1980; Supplement 1, December 1982 (Generic Letter No. 82-33).

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

4. NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," Section 18.1, Appendix A, "Evaluation Criteria for Detailed Control Room Design Reviews," September 1984.

5. Waterford 3 Detailed Control Room Design Review Program Plan. Submitted September 28, 1984.

6. Waterford 3 Detailed Control Room Design Review Summary Report. Submitted April 30, 1985.

7. LP&L Response to Audit Confirmatory Item. Submitted July 17, 1985.

WATERFORD 3 TER

Table A

The following table is a list of HEDs that do not have a fix contained within their response. Upon determination of a solution these fixes should be forwarded to the NRC for review.

HED #	
0107	0365
0138	0377
0139	0383
0140	0386
0141	0390
0182	0398
0185	0399
0227	0402
0228	
0270	
0277	
0281	
0283	
0284	
0335	

Table B

The following is a list of HEDs with implementation schedules which the NRC audit team finds unsatisfactory.

HED #		
0123	0165	0293
0142	0166	0294
0143	0167	0297
0144	0169	0298
0145	0170	0404
0146	0171	0405
0148	0172	
0149	0173	
0150	0178	
0151	0179	
0152	0230	
0153	0232	
0156	0251	
0162	0288	
0163	0289	
0164	0291	