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VALDECABALLEROS

NUCLEAR POWER PLANT

CONTROL ROOM DESIGN

REVIEW

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INTRODUCTION

As a result of experiences and incidents that have occurred during the operation of nuclear power plants, some basic action areas that improve safety during emergency situations have become evident. These areas have been extensively developed by the nuclear industry and set forth in regulations such as NUREG-0700, NUREG-0737 supplement 1, NUREG-0800, etc. One of these action areas is the Control Room Design Review (CRDR). Following is a description of the Control Room Design Review work performed for the Valdecaballeros Nuclear Power Plant.

PRELIMINARY WORK PERFORMED DURING THE DESIGN PROCESS

In 1982, before fabrication of the BOP panels was begun, Valdecaballeros NPP signed a contract with TECNATOM to perform a study of the general arrangement of the panels so as to check their correct location from the operational standpoint. Likewise, the proper arrangement of the systems within the panels and the interfaces between panels were tested.

The panels included in this review were the main BOP panels and the Control Room electrical panels.

On the basis of the study findings, the following improvements were made:

- Relocation of the Control Room panels.
- Edition of mimics.
- Relocation of systems within the panels.
- Modification of instrument locations on the panels.

The last three improvements only affected the main BOP panels since, in TECNATOM's opinion, the initial design of the electrical panels satisfied the relevant requirements for correct operation.

Valdecaballeros' Architect-Engineers incorporated these improvements in the panel design before fabrication commenced.

CONTROL ROOM DESIGN REVIEW

On the basis of this preliminary situation, Valdecaballeros NPP decided, at the end of 1985, to perform the Control Room Design Review work with their own means, in accordance with existing standards and recommendations.

This work was carried out throughout 1986 and its purpose was to verify that the design provided the operators with suitable means to prevent accidents or, in the event that accidents occurred, to take the necessary measures to mitigate their consequences. The panels included in the scope of this review were those located in the Control Room's primary operating area and the Remote Shutdown panels.

METHODOLOGY

The Control Room Design Review was performed in accordance with the instructions set forth in NUREG-0700, "Guidelines for Control Room Design Reviews", in the PLANNING, REVIEW, ASSESSMENT and REPORTING phases (see Figure 1). Following is a description of these phases.

PLANNING PHASE

The purpose of this phase was to plan the job to be performed and to establish the methodology to be followed. In order to achieve this purpose, the following activities were carried out:

- Create the review team.
- Organize and prepare the documentation.
- Establish the job schedule.
- Develop the CRDR methodology.

Starting with a working group consisting of operators that had developed the Emergency Operating Procedures, CN Valdecaballeros created a review team formed with operating and engineering personnel exclusively devoted to this job.

During this phase, the group developed a Basic Performance Plan and some method procedures to be used in the

following phases. Likewise, the group was structured as an individual project with its own job scheduling, activity planning and control of external costs and internal hours spent to perform this job.

REVIEW PHASE

The purpose of this phase was the following:

- Determine whether the control room provides the system status information, control capabilities, feedback and performance aids necessary for control room operators to accomplish their functions and tasks effectively.
- Identify characteristics of the existing control room instrumentation, controls, other equipment and physical arrangements that may detract from operator performance.

In order to perform this phase, the following steps were taken in accordance with NUREG-0700:

REVIEW OF OPERATING EXPERIENCES

This was intended to identify factors or conditions that have been or could be the cause of problems and that could be corrected through human factors engineering improvements.

To achieve this goal, the information supplied by INPO on contingencies occurring in power plants in different countries has been used. Out of the information provided by the INPO's network system, the SOER's (Significant Operating Experience Reports) for the years 1981 to 1985 inclusive were selected for use as they were applicable to the Valdecaballeros Nuclear Power Plant.

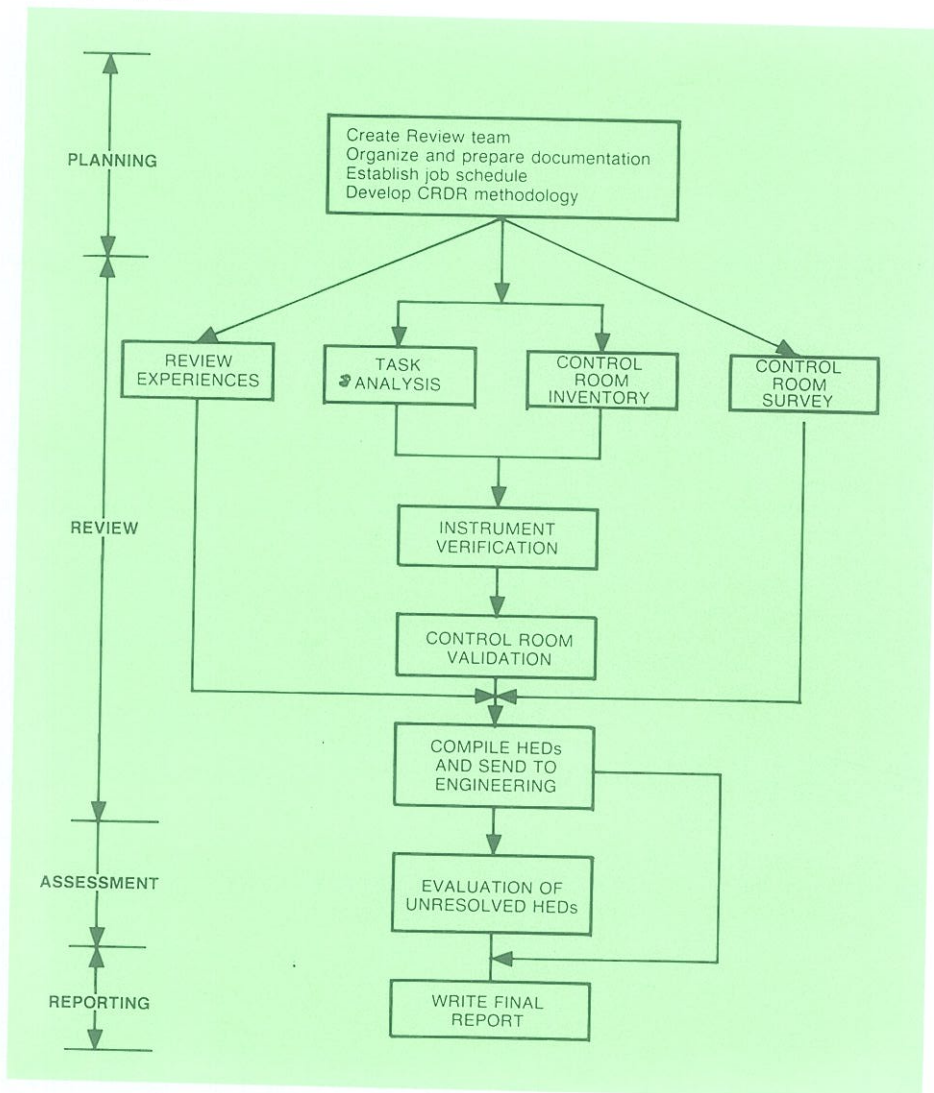
After studying these documents, a series of recommendations were formulated. These recommendations have been evaluated to find out their impact on Valdecaballeros NPP and in some cases Human Engineering Discrepancies (HEDs) have appeared.

ANALYSIS OF THE OPERATOR'S TASKS

The purpose of this analysis was to determine the informations and control requirements needed for the operators to perform emergency operations with the required reliability and efficiency. The performance of the task analysis was based on the Emergency Operating Procedures (POEs) established by the operational work group.

The task analysis consisted in subdividing each POE step into specific tasks. Each task was then analyzed with the help of an ordered list of existing elemental subtasks in order to determine

FI CRDR phases



those involved in the task, thus identifying the information and control required for safe Plant operations.

CONTROL ROOM INVENTORY

This consisted of a systematic review of all the existing instruments, controls and equipment, to provide a basis to determine if the instrumentation and control required to support safe plant operation are available in the Control Room.

For this purpose, a common data base was generated in the UNIVAC S/80 computer based on the magnetic supports of the following:

- BOP Instruments.
- NSSS Instruments.

An interactive program was used to generate a specific file for this inventory application.

From this file, different selective lists were obtained that were classified by identification, panel or type of instrument. These were used to identify the information and control provided to perform safe plant operation.

CONTROL ROOM SURVEY

The purpose of this survey was to identify any characteristics of instruments equipment, layout and ambient conditions that do not confirm to precepts of good human engineering practice, regardless of the particular system or task requirements.

The performance of this survey was based on the following NUREG-0700 checklists criteria (section 6):

- Control Room workspace.
- Communications.
- Annunciator warning systems.
- Controls.
- Visual displays.
- Labels and locations aids.
- Panel layout.
- Control display integration.

On applying these criteria, it was borne in mind that some of them are applicable to the Control Room in general, some are applicable to individual panels or sections of panels and others correspond to different instrument models.

VERIFICATION

This was meant to systematically verify that the information and control elements identified in other plants operating experiences and in the task analysis, and which are required by the operator, are:

- Present in the Control Room and on the Remote Shutdown Panels. The presence or absence of an element

was ascertained by systematically comparing the elements required by the operator and the elements contained in the inventory.

- Designed to suitably support safe plant operation. This involved verifying the suitability of the existing components in relation to the human factors engineering criteria.

VALIDATION

The purpose of this was to ensure that the Control Room design permits the satisfactory performance of the functions pertaining to the operating crew in accordance with the Plant's operating procedures.

For this purpose, an operating crew backed up by a supervisor who identified any HEDs, simulated the execution of emergency procedures of the walk through method.

The Control Room of Valdecaballeros Nuclear Power Plant Unit 1 was used to carry out this simulation, and the existing panels and a model of those that were not built at the time of the validation were used.

The model was a wooden structure with the same shape and dimensions as the panels it was replacing, and drawings of the fronts of these panels, scale 1:1, were placed on it.

ASSESSMENT PHASE

This consisted of categorizing the HEDs found and recommending corrective measures to resolve them. The following steps were taken during this phase:

ANALYSIS AND CATEGORIZATION OF HEDs

All identified HEDs were evaluated according to their potential impact on plant safety.

The review group analyzed the HEDs in accordance with the following criteria:

- Probability of causing an operator error (Probability of error, PE).
- Influence of error on plant safety (Consequences of error, CE).

High, medium and low classifications were established for each of these criteria on the basis of the sum of the scores assigned, on a scale of 0 to 5 points, to each of the questions included in the lists of criteria used. The final category and the priority for resolution assigned to each HED was obtained by using a double input table with the previous criteria and their high, medium or low classifications.

EVALUATION OF CORRECTIVE MEASURES

The review team made a series of recommendations to resolve the HED found during the review process. In the proposed corrective measures, it was suggested that their implementation should not produce new HEDs.

The execution of the definitive corrective measures required an interactive review process, since once the first proposal was made, the planned corrective measures were discussed with the Valdecaballeros NPP organization to decide on the best way to resolve each HED.

Once the corrective measure was defined for each HED, they were completely documented in their corresponding formats.

REPORTING PHASE

The purpose of this phase was to prepare a report which documented the processes and activities performed, as well as the results of the Review Phase.

This report included all the HEDs identified during the review process, both those resolved during the course of it and those that were categorized and whose corrective measures are still pending.

CONCLUSIONS

This paper has tried to demonstrate the high priority attached by Valdecaballeros NPP to improvements in its Control Room from the human factors standpoint, as they are the cause of the most significant incident occurring in nuclear power plants.

The results of this work are the following:

- A confirmation of the good design of this plant's Control Room, as proved by number and significance of HEDs found.
- Confirmation of the importance that the integration of operating personnel in the review team has had for the performance of this job.
- Benefit has been taken of the operating personnel's actual operating experiences.
- In the present mothballing situation work was performed to improve the design and operability of the plant, which has also induced an increased participation by Valdecaballeros personnel in desing activities.
- The timing chosen to perform this review has also been beneficial for correcting and implementing improvements in the Control Room.