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MEMORANDUM FOR: Thomas M. Novak, Assistant Director
for Licensing
Division of Licensing

FROM: William T. Russell, Deputy Director
Division of Human Factors Safety

SUBJECT: SER FOR DIABLO CANYON'S SAFETY PARAMETER DISPLAY SYSTEM

The staff's Safety Evaluation Report for Diablo Canyon's Safety Parameter Display System (SPDS) is enclosed.

The staff's evaluation of the licensee's SPDS Safety Analysis concluded that it is acceptable for the licensee to continue implementing its SPDS Program. However, the staff requests the addition of several process parameters to the display and identified several potential human engineering discrepancies which should be evaluated by the licensee.

The licensee did not provide sufficient information on isolation devices between the SPDS and Safety Systems in the Safety Analysis Report to allow the staff to complete its review. The staff's information needs, along with the staff's review of the SPDS, are presented in the enclosed SER. Please forward the enclosed SER to the licensee and request a response with the information desired within 60 days of the date on the transmittal letter. Upon receipt of the information, the staff plans to conduct a confirmatory-type review and will only respond to the licensee if a serious safety question is detected from the review of the submittal.

The Instrumentation and Control Systems Branch, the Procedures and System Review Branch and the Human Factors Engineering Branch performed the review of the licensee's safety analysis. The reviewers are not aware of any

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OFFICE						
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DATE						

differing professional opinions with the conclusions stated in the Safety Evaluation Report. A SALP Report input is also enclosed.

for Vasa A. Moore
William T. Russell, Deputy Director
Division of Human Factors Safety

Enclosures:
As stated

cc: F. Rosa
D. Ziemann
G. Mazetis
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DIABLO CANYON SPDS SER/LB2

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SAFETY EVALUATION REPORT

FOR

DIABLO CANYON'S SAFETY PARAMETER DISPLAY SYSTEM

I. INTRODUCTION

All holders of operating licenses issued by the Nuclear Regulatory Commission (licensees) and applicants for an operation license (OL) must provide a Safety Parameter Display System (SPDS) in the control room of their plant. The Commission approved requirements for the SPDS are defined in Supplement 1 to NUREG-0737.

The purpose of the SPDS is to provide a concise display of critical plant variables to control room operators to aid them in rapidly and reliably determining the safety status of the plant. NUREG-0737, Supplement 1, requires licensees and applicants to prepare a written safety analysis describing the basis on which the selected parameters are sufficient to assess the safety status of each identified function for a wide range of events, which include symptoms of severe accidents. Licensees and applicants shall also prepare an implementation plan for the SPDS which contains schedules for design, development, installation, and full operation of the SPDS as well as a design verification and validation plan. The safety analysis and the implementation plan are to be submitted to the NRC for staff review. The results of the staff's review are to be published in a Safety Evaluation Report (SER).

Prompt implementation of the SPDS in operating reactors is a design goal of primary importance. The review of the human factors design of the SPDS for

operating reactors called for in NUREG-0737, Supplement 1 is designed to avoid delays resulting from the time required for NRC staff review. The NRC staff will not review operating reactor SPDS designs for compliance with the requirements of Supplement 1 of NUREG-0737 prior to implementation unless a pre-implementation review has been specifically requested by licensees. The licensee's safety analysis and SPDS implementation plan will be reviewed by the NRC staff only to determine if a serious safety question is posed by the proposed system or if the analysis is seriously inadequate. The NRC staff review to accomplish this will be directed at (a) confirming the adequacy of the parameters selected to be displayed to detect critical safety functions, (b) confirming that means are provided to assure that the data displayed are valid, and (c) confirming that the licensee has committed to a human factors program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator. If based on this review, the staff identifies a serious safety question or seriously inadequate analysis, the Director of IE or the Director of NRR may request or direct the licensee to cease implementation.

By letter dated August 2, 1983 (Reference 1), the Pacific Gas and Electric Company submitted a Safety Analysis Report dealing with the Safety Parameter Display System (SPDS) for Diablo Canyon Units 1 and 2. This submittal is in partial response to NRC Generic Letter No. 82-33 (Reference 2). Diablo Canyon Units 1 and 2 are Westinghouse 4-Loop Reactors. This safety

evaluation discusses the staff's review of Pacific Gas and Electric Company's Safety Analysis Report.

II. SUMMARY

The staff has reviewed the Diablo Canyon SPDS and concludes that it is acceptable for the licensee to continue implementing its SPDS program. However, the staff requests that additional process parameters be considered for addition to the display and that several potential human engineering discrepancies should be assessed for significance and need for correction prior to full implementation of the SPDS. Also, for a confirmatory review, the staff needs additional information concerning the adequacy of isolation devices between the SPDS and safety systems. The details of the staff's review are provided in the following evaluation.

III. EVALUATION

A. SPDS Description

The applicant's Safety Parameter Display Safety Analysis (Reference 1) contains information on its design, display and parameter selection, operation, verification and related human factors. The SPDS is described as a computer based system consisting of a data acquisition system, two master receivers, two data-handler computers, and two video generators all located in the Technical Support Center (TSC). There are two color video monitors located in both the control room and the TSC. The two separate channels of hardware are used in the design to achieve a high reliability for the display system.

The SPDS utilizes a single display format to present data to the operator. The display format contains several plant parameters presented in bar chart type display elements. In addition to the SPDS display format, sixteen additional display formats consisting of reactor coolant system, secondary mimics and decision trees are available to the operator. These additional display formats were not described in the Safety Analysis Report and are not part of the SPDS but should be reviewed by the licensee during his Detailed Control Room Design Review.

B. Parameter Selection

Section 4.1(f) of Supplement 1 to NUREG-0737 states that:

> "The minimum information to be provided shall be sufficient to provide information to plant operators about:
>
> (i) Reactivity Control
>
> (ii) Reactor core cooling and heat removal from the primary system
>
> (iii) Reactor coolant system integrity
>
> (iv) Radioactivity control
>
> (v) Containment conditions."

For review purposes, these five items have been designated as Critical Safety Functions.

In the evaluation of the SPDS parameters and in our recommendations, we have considered the Westinghouse Owners' Group, "Westinghouse Emergency Response Guidelines (ERG) Program," which was reviewed and approved by the staff (Reference 3), as a principal technical source of parameters important to operational safety. The SPDS parameters selected by the licensee and their coordination with the Critical Safety Functions are summarized in the enclosed Table 1 (grouping made by licensee).

While we find that the parameters selected do comprise a generally comprehensive list, we note that the following parameters are not proposed for the Diablo Canyon SPDS:

1. Steam Generator (or Steamline) Pressure

2. Hot Leg Temperature

3. RHR Flow Rate

4. Containment Sump Level

5. Containment Hydrogen Concentration.

The first three parameters provide significant information for the "Core Cooling and Heat Removal" critical safety function. Steam generator pressure is an indicator of secondary system integrity (heat removal). It is also used in the guidelines to determine the viability of natural circulation as a heat removal mode. Hot leg temperature is also a key indicator in the guidelines to determine the viability of natural circulation heat removal. During RHR and ECCS modes of cooling, when steam generators are not being used, RHR flow is a key indicator to monitor the viability of the heat removal system. As a key indicator to identify a LOCA-type breach of RCS integrity, particularly small leaks, containment sump level provides significant information for the "RCS Integrity" critical safety function. Containment hydrogen concentration is a key parameter used in the guidelines to monitor combustible gas control and to indicate a compromise of the "Containment Conditions" safety function.

The above parameters do, for given scenarios, provide unique inputs to determinations of status for their respective critical safety functions, which have not been discussed by the applicant as being satisfied by other parameters in the proposed Diablo Canyon SPDS list. We request that the licensee consider these parameters for addition to the Diablo Canyon SPDS, or (1) provide alternate added parameters along with justifications that these alternates accomplish the same safety functions for all scenarios, or (2) provide justification that parameters currently on the Diablo Canyon SPDS do in fact accomplish the same safety functions for all scenarios.

We noted in our review that the ERGs are not specifically identified as a document considered by the licensee for selection of the parameters. Since an important goal of a display system is coordination with the ERGs as defined in NUREG-0737, Supplement 1, and since plant-specific guidelines could also influence the selection of SPDS parameters, the licensee's submittal should be expanded to address these areas. Based on this review of the licensee's supporting analyses, and our observations that the selected parameters appear to be consistent with the Westinghouse Owners' Group ERGs, we find the proposed list of key parameters to be acceptable, with exceptions noted above.

C. Display Data Validation

The staff reviewed the licensee's SAR (Reference 1) to determine that means are provided in the display's design to assure that the data displayed are valid. The SAR states that data validation within the SPDS consists of an accuracy check between/among common sensors. If the maximum minus the minimum exceeds a predefined range, the parameter is designated as out of tolerance. The out of tolerance parameter is indicated on the video monitor with the display of a "?." Based on the information presented in the SAR, the staff confirms that means are provided in the SPDS design to assure that the data displayed are valid.

D. Human Factors Program

The staff reviewed Pacific Gas and Electric's SAR for SPDS design features indicative of a commitment to a human factors program to ensure that the

displayed information can be readily perceived and comprehended so as not to mislead the operator. Our review was hampered by the lack of detail on the design, but we did find both good and bad features about the display. The use of bars as display elements for the parameters should be familiar to operators as it is similar to the meters and displays on the control board. Thus, operators should easily associate with the parameters being displayed. The video monitor uses a 19-inch color cathode ray tube with a refresh rate of 60 Hz and is non-interlacing. This should minimize display flicker and be easily read by the operator. Distinctive color coding is used on the display to alert control room personnel to an abnormal condition. The color coding is redundant to setpoints which are defined on the parameter bars. These features should readily aid the operator in detecting abnormal plant behavior. Also, the display system was designed so that upon a reactor trip signal or a safety injection signal, the SPDS display format is automatically presented on the screen. This saves the operator the task of requesting the display frame and thus serves as an aid during times of stress.

The staff's review of the display format resulted in several potential human engineering discrepancies. We call them potential because we were unable to fully assess them because of a lack of detail in the SAR. We list our concerns below, most of which came from our review of Appendix 2 in the SAR:

- The unit for rate data is not available on the display.

- It is not apparent that all parameter bars also have rate data. It is also not apparent what happens when the rate is zero.

- It is not apparent how the display indicates a failure of a sensor, if this is a feature of the design. For example, temperature bars are scaled to zero. Does an indication of zero indicate a failed sensor? Or a failed display?

- Zero degrees of subcooled margin is labeled in Figure 1 but unlabeled in the illustration in Appendix 2. It should be clearly labeled.

- The containment pressure display bar does not have the zero psig point labeled. It should be clearly labeled.

- The containment isolation phase symbols are unlabeled.

The licensee stated that a human factors review of the display was performed by the Nuclear Power Generation Division of the Babcock & Wilcox Company. The results of the review were documented into a report and excerpts from the report were presented in the SAR. The excerpts provide evidence that a human factors review was conducted.

Based on the review of the material presented in the SAR, the staff concludes that Pacific Gas and Electric Company did commit to a human factors program in the design of the SPDS. However, based on the staff's review of the display format described in the SAR, we found several potential human engineering discrepancies. Pacific Gas and Electric Company should thoroughly assess their significance and need for correction prior to full implementation of the SPDS.

E. Electrical and Electronic Isolation

Adequate information was not provided by the licensee for the staff to confirm that the SPDS will be suitably isolated from electrical and electronic interference to equipment and sensors that are used in safety systems. The staff, however, concludes that it is acceptable for the licensee to continue implementing its SPDS Program provided:

1. The SPDS safety systems shall be suitable isolated from electrical or electronic interference to equipment and sensors that are in use for safety systems.

2. The licensee shall provide the following information to the NRC for confirmatory review:

a. For each type of device used to accomplish electrical isolation at Diablo Canyon describe the specific testing performed to demonstrate that the device is acceptable for its application(s). This description should include elementary diagrams where necessary to indicate the test configuration and how the maximum credible faults were applied to the devices.

b. Data to verify that the maximum credible faults applied during the test were the maximum voltage/current to which the device could be exposed, and define how the maximum voltage/current was determined.

c. Data to verify that the maximum credible fault was applied to the output of the device in the transverse mode (between signal and return) and other faults were considered (i.e., open and short circuits).

d. Define the pass/fail acceptance criteria for each type of device.

e. Provide a commitment that the isolation devices comply with the environmental qualifications (10 CFR 50.49) and the seismic qualifications which were the basis for plant licensing.

f. Provide a description of the measure taken to protect the safety systems from electrical interference (i.e., Electrostatic Coupling, EMI, Common Mode and Crosstalk) that may be generated by the SPDS.

IV. CONCLUSION

The NRC staff reviewed the Diablo Canyon SPDS SAR to confirm the adequacy of the parameters selected to be displayed to detect critical safety functions, to confirm that means are provided to assure that the data displayed are valid, and to confirm that the licensee has committed to a human factors program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator. Based on our review, we conclude:

- The parameter selection for the SPDS is acceptable, however, we request the addition of five parameters to the display or that justification be provided why they should be excluded,

- the licensee's submittal should be expanded to relate the basis for selection of the parameters to the Emergency Response Guidelines (ERGs),

- means are provided in the SPDS design to assure that the data displayed are valid,

- a commitment to a human factors program was made in the design of the SPDS. However, several potential human engineering discrepancies exist in the display format illustrated and described in the SAR. These should be assessed for significance and need for correction prior to full implementation of the SPDS.

- the staff needs additional information on isolation devices from the licensee to complete our review. The specific information needs are defined in Section III.E. Electrical and Electronic Isolation, of this report.

With these review results, the staff concludes that it is acceptable for the licensee to continue implementing its SPDS Program.

V. REFERENCES

1. Letter, J. D. Shiffer for J. O. Schuyler (PG&E) to D. Eisenhut (NRC) dated August 2, 1983 (with attachment).

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

3. Safety Evaluation of "Emergency Response Guidelines," Generic Letter 83-22. June 8, 1983.

TABLE 1

SAFETY FUNCTION PARAMETERS

PROVIDED FOR DIABLO CANYON UNITS 1 AND 2 SPDS

Critical Safety Function	
Reactivity Control	- Neutron Flux (Source, Intermediate, and Power Ranges) - Startup Rate - Control Rods in Alert
Reactor Core Cooling and Heat Removal	- Subcooling Margin - Highest Core Exit Thermocouple - Reactor Vessel Level - Narrow Range Steam Generator Level
RCS Integrity	- RCS Pressure - Pressurizer Level - Cold Leg Temperature
Radioactivity Control	- Containment Radiation Monitor - Vent Gas and Vent Iodine Monitors - Main Steam Radioactivity Monitors
Containment Integrity	- Containment Pressure - Isolation Phase A and Phase B Alert

ENCLOSURE 2

SALP REPORT FOR
DIABLO CANYON'S SAFETY PARAMETER DISPLAY SYSTEM SER

In accordance with Office Letter No. 44, the following HFEB SALP evaluation input is provided:

Evaluation Criteria	Category
1. Management Involvement and Control in Assuring Quality	2
2. Approach to Resolution of Technical Issue from Safety Standpoint	2
3. Responsiveness to NRC Initiatives	2

Attached are the applicable parts of NRC Manual Chapter 0516 Appendix, Part II appropriately annotated to provide specific details related to the evaluation criteria.

Attachments:
As stated

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TABLE 1 EVALUATION CRITERIA WITH ATTRIBUTES FOR ASSESSMENT OF LICENSEE PERFORMANCE

Category 1	Category 2	Category 3
1. Management Involvement and Control in Assuring Quality		
consistent evidence of prior planning and assignment of priorities; well stated, controlled and explicit procedures for control of activities	evidence of prior planning and assignment of priorities; stated, defined procedures for control of activities	little evidence of prior planning and assignment of priorities; poorly stated or ill understood procedures for control of activities
well stated, disseminated, and understandable policies	adequately stated and understood policies	poorly stated, poorly understood or nonexistent policies
decisionmaking consistently at a level that ensures adequate management review	decisionmaking usually at a level that ensures adequate management review	decisionmaking seldom at a level that ensures adequate management review
corporate management frequently involved in site activities	corporate management usually involved in site activities	corporate management seldom involved in site activities
audits complete, timely, and thorough	audits generally complete, timely, and thorough	audits frequently not timely, incomplete, or not thorough

	Category 1	Category 2	Category 3
	1. Management Involvement and Control in Assuring Quality (Continued)		
No Data	committees properly staffed and functioning in almost all cases	committees usually properly staffed and functioning	committees not properly staffed or functioning
No Data	reviews timely, thorough, and technically sound	reviews generally timely, thorough, and technically sound	reviews not timely, thorough, or technically sound
No Data	records complete, well maintained, and available	records generally complete, well maintained, and available	records not complete, not well maintained, or unavailable
No Data	procedures and policies strictly adhered to	procedures and policies rarely violated	procedures and policies occasionally violated
No Data	corrective action systems promptly and consistently recognize and address nonreportable concerns	corrective action systems generally recognize and address nonreportable concerns	corrective action systems rarely recognize and address nonreportable concerns
No Data	procurement well controlled and documented	procurement generally well controlled and documented	repetitive breakdown in procurement control
No Data	design well controlled and verified	rare breakdowns of minor significance in design control	repetitive breakdown in design control or verification

Category 1	Category 2	Category 3
2. Approach to Resolution of Technical Issues from a Safety Standpoint		
clear understanding of issues demonstrated	understanding of issues generally apparent	understanding of issues frequently lacking
conservatism routinely exhibited when potential for safety significance exists	conservatism generally exhibited	meets minimum requirements
technically sound and thorough approaches in almost all cases	viable and generally sound and thorough approaches	often viable approaches; but lacking in thoroughness or depth
timely resolutions in almost all cases	generally timely resolutions	resolutions often delayed
3. Responsiveness to NRC Initiatives		
meets deadlines	generally timely responses	frequently requires extensions of time
timely resolution of issues	few longstanding regulatory issues attributable to licensee	longstanding regulatory issues attributable to licensee

Category 1	Category 2	Category 3
3. Responsiveness to NRC Initiatives (Continued)		
technically sound and thorough responses in almost all cases	viable and generally sound and thorough responses	often viable responses, but lacking in thoroughness or depth
acceptable resolutions proposed initially in most cases	acceptable resolutions generally proposed	considerable NRC effort or repeated submittals needed to obtain acceptable resolutions
4. Enforcement History		
major violations are rare and are not indicative of programmatic breakdown	major violations are rare and may indicate minor programmatic breakdown	multiple major violations or programmatic breakdown indicated
minor violations are not repetitive and not indicative of programmatic breakdown	multiple minor violations or minor programmatic breakdown indicated	minor violations are repetitive and indicative of programmatic breakdown
corrective action is prompt and effective	corrective action is timely and effective in most cases	corrective action is delayed or not effective