SAFETY EVALUATION REPORT

FOR THE

SURRY 1 and 2

SAFETY PARAMETER DISPLAY SYSTEM

I. INTRODUCTION

All holders of operating licenses issued by the Nuclear Regulatory Commission (licensees) and applicants for an operating 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 from 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 prime importance. The staff's review of SPDS documentation 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 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, (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, and (d) confirming that the SPDS will be suitably isolated from electrical and electronic interference with equipment and sensors that are used in safety systems. 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 require or direct the licensee to cease implementation.

II. SUMMARY

The staff has reviewed the licensee's submittals (Refs. 1 and 2) regarding the Safety Parameter Display System (SPDS) and concludes that it is acceptable for the licensee to continue implementation of its SPDS program. The staff has not identified any serious safety questions or inadequacies of analysis thus-far in its review, and finds no reason to direct the licensee to cease implementation.

III. EVALUATION

Virginia Electric and Power Company (VEPCO) submitted two documents in which the Surry SPDS analysis and design process are described. The staff has reviewed these documents, and the results of that review are presented below.

A. SPDS DESCRIPTION

The Surry SPDS is part of the VEPCO Emergency Response Facilities computer system. Interface peripherals include multiple CRT/keyboard stations utilizing touch screen technology. The display pages consist of three hierarchically organized levels of display. The top level consists of a display of six, licensee-defined critical safety functions. The top level display is formatted as six bar graphs that change color (green, yellow, red) based on the status of the parameters that provide input to the particular safety function. The bar graphs depict the status of the least normal of the underlying parameters. Mid-level

displays provide information about the specific parameters that underly the safety functions of the top level. The low level displays provide trend plots of single SPDS parameters and variables versus time. Mid and low level displays contain status boxes to cue the operator to changes in the top level display page.

B. PARAMETER SELECTION

Section 4.1f 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 variables the staff considered the Westinghouse Owners' Group's "Westinghouse Emergency Response Guidelines (ERGs) Program," which was reviewed and approved by the

Staff (Ref. 3), as a principal technical source of variables important to safety. The SPDS variables selected by the licensee and their coordination with the CSFs are summarized in the Reference 1 submittal (Table 1, grouping made by licensee). The staff finds that the variables selected comprise a comprehensive list.

The variables in Table 1 do, for given scenarios, provide inputs to determinations of status for their respective CSFs.

For a rapid assessment of Radioactivity Control, the licensee has not demonstrated how radiation in the secondary system (steam generators and steamlines) is monitored by SPDS when the steam generators and/or their steamlines are isolated. The licensee should consider this capability in the verification and validation program.

Based on this review of the licensee's supporting analyses, and the observation that the selected variables appear to be consistent with the Westinghouse Owners' Group ERGs, the staff finds the proposed list of key variables to be acceptable.

Finally, design flexibility should be provided for possible future expansion of the SPDS. For example, with consideration of the Westinghouse Owners' Group ERGs and with possible amendments to the

ERGs, other key variables may be identified to assess the safety status of the CSFs.

C. DISPLAY DATA VALIDATION

The staff reviewed the licensee's submittals to confirm that means have been provided to assure that the data displayed are valid. The licensee stated in the February 8, 1984 submittal (Ref. 1) that the "SPDS Displays provide data (on CRTs) that has been checked for validity by comparison to certain limits and by comparison to redundant signals... To further ensure validity of the data presented, a number of checks are made for hardware and transmission errors." On November 5, 1984 the licensee clarified the data validation methodology further. Generally, all data is status checked (NOT SCANNED, OFF SCAN, OUT FOR MAINTENANCE), and all analog data is checked for high/low range violation. When available, comparison of redundant inputs is done using a deviation-from-average criteria to reject outlying data. Based on this use of range and status checking, as well as physical redundancy, the staff confirms that the licensee has provided means to assure that displayed data are valid. The staff suggests that the licensee consider using analytical redundancy for those cases where a redundant instrument is not available.

D. HUMAN FACTORS PROGRAM

The staff reviewed the licensee submittals to confirm that a human factors program had been committed to as part of the design process.

The licensee addressed human factors considerations by contracting the services of a human factors consulting firm. Human factors were considered in the design of both the system hardware and software. Human factors involvement appears to be on-going and a final review of the system will be done when the development phase is complete.

Based on the above findings, the staff confirms that VEPCO has committed to a human factors program in the design and implementation of its SPDS that will reasonably assure that the SPDS displays can be readily perceived and comprehended by SPDS users.

E. ELECTRICAL AND ELECTRONIC ISOLATION

In order to satisfy the NRC requirements concerning the SPDS, Virginia Electric and Power Company, the licensee for North Anna 1 and 2 and Surry 1 and 2, provided information in a February 8, 1984 Safety Analysis Report on the SPDS. This report did not address NUREG-0737, Supplement 1 requirements that the SPDS must be suitably isolated from equipment and sensors that are used in

safety systems to prevent electrical and electronic interference. On August 22, 1984, a request was sent to the licensee to obtain additional information on the isolation between safety systems and the SPDS. The licensee provided this information on November 5, 1984. After the staff reviewed the additional information a telephone conference was held with the licensee on February 27, 1985 to obtain clarification on the submitted information.

Virginia Electric and Power Company has implemented the SPDS at North Anna 1 and 2 and Surry 1 and 2 as part of the Emergency Response Facility Computer System (ERFC). The SPDS system is described as a computer based system consisting of 16 separate Class IE remote multiplexers which interface with Class IE instrument systems. The information is then transferred to submultiplexers via fiber optic data links. The information then goes from the submultiplexers via another fiber optic link to master receivers which receive the information to be processed and used by the computer. The licensee has installed the fiber optic links to provide isolation between the Class IE systems and the non-IE computer based SPDS. This unique isolator possesses inherent characteristics that are not found in other types of isolators normally used in nuclear power plants. The construction of the fiber optic cable is such that the cable contains no electrically conductive material. The relative permittivity (dielectric constant) of a material is a measure of the material's

isolation capability. The dielectric constant of a material is referenced relative to free space (a vacuum) and is a dimensionless number. Dry air possesses a dielectric constant of 1.00059. Glass possesses a dielectric constant in the range of 4.0 to 7.0 depending upon the specific type. The higher the dielectric constant, the greater the isolation that is provided. Thus, fiber optic cables have an isolation capability that is 4 to 7 times greater than dry air. The voltage breakdown rating of a typical fiber optic cable is on the order of 250 KV per meter.

A fault at either end of the data link might destroy the modem but will not propagate over the fiber optic cable. For example, one of the tests that must be performed to qualify an isolator is the application of the maximum credible fault (voltage, current) to the output of the device to verify that the fault does not propagate or degrade the input (Class IE) side. This postulated failure does not affect fiber optic cable, since as stated above, the optical fibers are totally dielectric (i.e., the electrical energy resulting from the fault will not propagate through the optical fiber). Another characteristic of the optical fiber cable is its nonsusceptibility to crosstalk and electromagnetic interference (EMI). Ground loop problems inherent with copper cables are also eliminated.

Based on an audit of the applicant's information on the isolation devices used in the Surry 1 and 2 design, the staff concludes that the design methodology and the hardware used for interfacing the SPDS with safety-related systems are acceptable, and that these isolators meet the Commission's requirements of NUREG-0737, Supplement 1.

IV. CONCLUSIONS

The NRC staff reviewed the Virginia Electric and Power Company submittals to confirm the adequacy of the parameters selected to be displayed to monitor critical safety functions, to confirm that means are provided to assure that the data displayed are validated, 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, and to confirm that the SPDS is suitably isolated.

Based on its review, the staff confirms that:

- The parameters selected for display are acceptable
- Means are provided in the SPDS design to assure that the data displayed are validated
- An appropriate commitment to a Human Factors Program was made in the design of the SPDS

- The SPDS will be suitably isolated from electrical and electronic interference with equipment and sensors that are used in safety systems.

The staff has not identified any serious safety questions or inadequacies in the licensee's analysis and, therefore, finds no reason to direct the licensee to cease implementation. The conclusion that SPDS implementation may continue does not imply that the SPDS meets or will meet the requirements of Supplement 1 to NUREG-0737. Such confirmation can be made only after a post-implementation audit or when sufficient information is available for the staff to make such a determination.

Principal Contributor:

G. W. Lapinsky, Human Factors Engineering Branch

TABLE 1

Safety Parameter	Measured Parameter
Reactivity Control	Source Range Monitors Intermediate Range Monitors Power Range Monitors Startup Rate RCCA's Full In Cold Leg Temperatures Boron Concentration
Core Heat Removal	Peak Core Exit Temperature Saturation Margin Reactor Vessel Liquid Level RCS Loop Flow Hot Leg Temperature Loop ΔT
Secondary Heat Removal	Steam Generator Level Steam Generator Pressure Total Feed Flow Steam Flow Condensate Storage Tank Level Residual Heat Removal Flowrate
RCS Integrity	Pressurizer Pressure Pressurizer Level Pressurizer Relief Paths Open Margin To NDT Limit HHSI Flow Containment Pressure Containment Sump Level Secondary Activity
Radiation Control	Condenser Air Ejector Radiation Vents and Stacks Radiation Liquid Release Radiation Primary Water Radiation Secondary Steam Radiation Containment Monitor Radiation Area Monitors Radiation
Containment Condition	Out Of Position Isolation Valves Phase I (Surry Only) Phase II (Surry Only) Phase III (Surry Only) Phase A (North Anna Only) Phase B (North Anna Only)

TABLE 1 (CONTINUED)

Safety Parameter	Measured Parameter
Containment Condition (Continued)	Containment Pressure Narrow Range (North Anna Only) Intermediate Range Wide Range Containment Temperature Hydrogen RWST Level

V. REFERENCES

1. Letter from W. L. Stewart (VEPCO) to H. R. Denton (NRC) with attachment, dated February 8, 1984.

2. Letter from W. L. Stewart (VEPCO) to H. R. Denton (NRC) with attachment, dated November 5, 1984.

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