SAFETY EVALUATION REPORT

FOR THE

SUSQUEHANNA, UNITS 1 AND 2

SAFETY PARAMETER DISPLAY SYSTEM

I. INTRODUCTION

Prompt implementation of the SPDS in operating reactors is a design goal of primary importance. The NRC review 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 to implementation unless a preimplementation 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 (a) to confirm the adequacy of the parameters selected to be displayed to detect critical safety functions, (b) to confirm that means are provided to assure that the data displayed are valid, and (c) to confirm that the licensee has committed to a human factors program to ensure that the displayed information can be readily perceived and comprehended, and is not misleading to 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 September 30, 1983 (Reference 1), the Pennsylvania Power and Light Company submitted a Safety Analysis Report (SAR) regarding the Safety Parameter Display System (SPDS) for Susquehanna, Units 1 and 2, in response to NRC Generic Letter No. 82-33 (Reference 2). This safety evaluation discusses the staff's evaluation of the SAR and presents our results and conclusions regarding the SPDS design.

II. SUMMARY

The staff has reviewed the Susquehanna SPDS Safety Analysis and concludes that it is acceptable for the licensee to continue implementation of its SPDS program provided that certain human factors aspects are improved and that the SPDS is suitably isolated from electrical and electronic interference with equipment sensors used for safety systems. Further, the licensee should provide sufficient information to permit a confirmatory staff review of the adequacy of the isolation and resolution of human factors discrepancies. The staff's information needs to conduct the confirmatory review are defined herein.

III. EVALUATION

A. Parameter Selection

The selection of the Susquehanna SPDS display parameters was made by the licensee based on industry guidance provided in NSAC-21 (Reference 3) and Regulatory Guide 1.97 (Reference 4). Extensive supporting

discussion was also provided in the licensee's submittal. The parameters selected by the licensee and their relationship to the Critical Safety Functions are summarized in the enclosed Table 1 (grouping was done by the licensee).

Based on the licensee's supporting analyses, and the staff's observation that the selected parameters appear to be consistent with the BWR Owners' Group Emergency Procedure Guidelines (EPGs), we find the proposed list of key parameters to be acceptable.

B. Data Validity

The staff reviewed the licensee's Safety Analysis Report to confirm that means are provided in the design to assure that displayed data are valid. In the SAR it is stated that, "... In the Susquehanna SPDS information displayed is processed in such a manner that it is less susceptible to error. This is accomplished by using redundant input signals and comparator logic to select parameter values that are confirmed by one or more redundant sensors whenever possible. The safety monitor parameter reliability is improved by performing (1) on-line diagnostic checks for signal validity, transmission, propagation, and status, (2) off-line diagnostics that will assist in the pinpointing of equipment failures and verification of proper equipment operation, and (3) hardware parity or check sum logic, to detect bulk transmission errors." (Reference 1, p. 1.) In addition, on page 12 of the licensee's Safety Analysis Report, it is stated that, "Algorithms

are prepared for each group of input signals representing a process variable. The algorithms are designed to ensure that the process variables are accurate and reliable and insensitive to the variation of individual instrumentation channels.

The purposes of the algorithms are:

1. To check for unreasonable signals due to common mode failure or instruments out-of-service.

2. To ensure that offscale readings are processed properly.

3. To take full advantage of the information that overlapping signal ranges for various instruments provide.

4. To process any redundant instruments within the same signal range, and to ensure that the resulting process variable is the most accurate value that can be obtained.

5. In summary, to improve the accuracy and reliability of SPDS process variables above that of the individual instrument channels.

The algorithms produce diagnostic messages of system signal degradation. Diagnostic messages are narrative descriptions of the signals which are

in disagreement, out-of-reasonable limits, out-of-service, offscale or contain incongruous information. These messages are generated within the logic structure of the algorithm logic where they are dated and time tagged."

Based on these statements the staff concludes that means are provided in the design to assure that the data displayed are valid.

C. Commitment to Human Factors Program

The staff reviewed the licensee's Safety Analysis Report to determine whether the licensee has committed to a human factors program to ensure that displayed information can be readily perceived and comprehended, and is not misleading to the operator. The licensee indicated in the SAR that the general guidance of NUREG-0700 and the specific guidance of a human factors engineering consultant were used during the design phases. The licensee also stated that a human factors review/analysis was conducted. The review covered 93 specific review areas, including four requests for modification by users. The human factors program will culminate in a formal system validation that will attempt to measure the effectiveness of the SPDS system including hardware, software, personnel, training, and procedures. The licensee will perform this validation at the Susquehanna simulator if possible. Based on this information the staff confirms that the licensee has committed to a human factors program. However, several details of the design seem to be in conflict with accepted human factors principles and, as a result,

may mislead the operators of the SPDS. During implementation these areas of concern should be corrected to avoid misleading the operator so as to assure compliance with Supplement 1 of NUREG-0737. A commitment to correct or a justification for noncorrection should be submitted to the NRC within 60 days of receipt of this Safety Evaluation Report.

The areas of concern are:

1. On page 15 of the SAR, the licensee states, "The primary display is meant to be continually displayed." The words "is meant to be" imply to the staff some uncertainty about whether the primary display will be continually displayed. Supplement 1 of NUREG-0737 requires that the licensee provide continuous display of the minimum parameter set necessary to assess plant status.

2. The licensee states that the Technical Support Center and Emergency Operations Facility have SPDS function keyboards and terminals. The design should assure that actions taken on the TSC and EOF Keyboards will not affect SPDS displays in the control room without the knowledge and consent of the control room operator. Any simulation or test mode displays should be obviously indicated as such on the displays.

3. Based on the text and photographs in the SAR, it seems that the SPDS includes unconventional color-coding, i.e., yellow for "normal," red for "caution," and magenta for "danger." These colors should be in accordance with the accepted convention of green for "normal," yellow or amber for "caution," and red for "danger."

4. As currently designed, there is no indication of poor quality data on the primary SPDS display other than the ambiguous word "message" on the left side of the display. Data of questionable quality should be more directly indicated. Validity information should be near or embedded in the displayed output so that the operator immediately recognizes questionable data and is not misled by it. For example, question marks following the data, reverse field, or color coding could be used.

D. 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 with 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 be suitably isolated from electrical and electronic interference with equipment and sensors used for safety systems; and

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, describe the specific testing performed to demonstrate that the device is acceptable for its application(s). This description should include elementary diagrams when 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 measures 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 staff's review of the Susquehanna SPDS safety analysis concludes:

- The parameters selected for display appear to be consistent with the staff approved BWR Emergency Procedure Guidelines and are acceptable,

- That means are provided in the display's design to assure that the data displayed are valid.

- With some exceptions human factors engineering principles are being considered in the display's design to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator.

With these review results, the staff concludes that it is acceptable for the licensee to continue implementing its SPDS program. However, continued implementation of the SPDS by the licensee is subject to the adequate resolution of the staff's human factors concerns as stated in Section C of this SER and to providing adequate isolation devices between the Safety Parameter Display System and Safety Systems.

REFERENCES

1. Letter, N. W. Curtis (PP&L) to A. Schwencer (NRC) dated September 30, 1983 (with enclosures).

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

3. NSAC-21 "Fundamental Safety Parameter Set for Boiling Water Reactors."

4. Regulatory Guide 1.97 (Revision 2), "Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Plant and Environs Conditions During and Following an Accident," December 1980.

TABLE 1
SUSQUEHANNA STEAM ELECTRIC STATION
MEASURED PARAMETERS SUPPORTING DISPLAYS

Safety Functions	Measured Parameters
Containment of Radioactivity (Radiological Release)	1. Turbine Building and Reactor Building Vent Radiation 2. Primary Containment Activity 3. SBGT Vent Radiation 4. Liquid Effluent Radiation 5. Off-gas Pretreatment Radiation
Barrier Integrity (Containment Integrity)	1. Suppression Pool Water Level 2. Drywell Pressure 3. Suppression Chamber Pressure 4. Containment H_2 & O_2 Concentration 5. S/RV Position 6. Containment/RPV Isolation Valve Positions
Heat Transport (Reactor Core Cooling and Heat Removal) (Reactor Coolant System Integrity)	1. Reactor Vessel Water Level 2. Reactor Vessel Pressure 3. Reactor Core Flow 4. Reactor Core Spray Flow 5. Suppression Pool Water Temperature 6. Drywell Temperature
Reactivity Control	1. APRM Power 2. SRM Flux 3. SRM Positions 4. Scram Demand 5. Mode Switch Positions