

7.10 SAFETY PARAMETER DISPLAY SYSTEM (SPDS)

7.10.1 Functional Description

The Safety Parameter Display System (SPDS) serves as an aid to control room personnel in determining the safety status of the plant during abnormal and emergency conditions. The SPDS serves to concentrate a set of plant parameters to aid in assessing plant safety status without surveying the entire Control Room. The SPDS is based on the Safety Analysis Report provided in Reference 9. The requirements for SPDS are defined in Supplement 1 of NUREG-0737, NUREG-0696, and NUREG-0835.

The SPDS consists of seven (7) Safety Functions. A list of Supplement 1 of NUREG-0737 Safety Functions associated with Salem Safety Functions are in Table 7.10-2. One (1) of the Safety Functions, Radioactivity Control, is represented by the Radiation Monitoring displays.

Six (6) of the Safety Functions represent the Emergency Operating Procedures (EOP) Critical Safety Functions (CSF). The EOP CSF Status Trees were identified and developed based on the Westinghouse emergency response guidelines, Revision 1. The CSF Status Trees and the procedures associated with them are contained within the EOP set, which was also developed based on the Westinghouse Owners Group Emergency Response guidelines. For any transient or accident condition which results in a Reactor Trip, Safety Injection or Loss of all Offsite Power, the EOP will direct the operator to monitor the SPDS status trees. These status trees monitor plant conditions that relate directly to the barriers to prevent the release of fission products to the environment. These barriers are the fuel matrix and cladding, RCS pressure boundary and containment. The CSF associated with the barriers are listed in Table 7.10-3.

7.10.2 System Description

The SPDS is a redundant computer system with monitors located in Units 1 and 2 Control Rooms, Technical Support Center (TSC) and Emergency Operations Facility (EOF). This system is independent of the Plant Computer. The major components are as follows:

1. Four 1E multiplexer cabinets per unit
2. One Non-1E multiplexer cabinet per unit
3. Two data servers
4. Two monitors per unit Control Room
5. Four monitors for TSC
6. At least two monitors for EOF
7. Two 40KVA Uninterruptible Power Systems

7.10.3 Computer Subsystem

The computer subsystem utilizes two data servers in a redundant configuration. Each server acquires and processes the data from all multiplexers. One server is designated as the primary unit.

7.10.4 Display Subsystem

The display subsystem provides the primary means of information presentation to the operator. Man-Machine Interface (MMI) considerations have been addressed by utilizing a monitor/keyboard configuration.

The SPDS consists of four (4) levels of dynamic displays. The Top Level display provides an overview of plant conditions in the form of seven (7) blocks representing each of the Safety Functions. The Second Level displays provide more detailed information in the form of status trees for the CSF and Emergency Action Limits (EAL) status for the Radiation Monitoring. The Third Level displays list the point parameters associated with the Safety Functions. The Fourth Level displays are trend plots.

7.10.4.1 Top Level Display

The Top Level display consists of seven (7) color bars representing the status of each Safety Function. The blocks change color depending on Status. The status colors in order of severity starting from the less severe are green, yellow, purple, and red, as defined in the EOP's. This display is duplicated in miniature form on the top of all SPDS displays.

The following is a list of the seven (7) Safety Functions for Salem Generating Station:

1. Shutdown Margin
2. Core Cooling
3. Heat Sink
4. Thermal Shock
5. Containment Environment
6. Coolant Inventory
7. Radiation Monitoring

7.10.4.2 Second Level Display

There is a Second Level display for each of the seven (7) Safety Functions.

Six (6) of the displays are based on the EOP CSF status trees. The seventh display is Radiation Monitoring which is based on the Event Classification Guides (ECG). The Radiation Monitoring display shows a message referring the user to the ECG. The Radiation Monitoring message is color coded as to the severity level as defined in the EOP.

7.10.4.3 Third Level Display

For each Safety Function, there is a Third Level display. This display consists of the following information:

- Point Identification
- Point Description
- Point Value with Engineering Units
- Quality of Point

7.10.4.4 Fourth Level Display

For each Safety Function, there is a Fourth Level display of two (2) dynamic trend plots. The two (2) trend plots (one parameter per plot) show the previous 30 minutes of data.

7.10.5 Human Factors

Accepted Human Factors Principles are incorporated in the design of the SPDS so that the displayed information can be readily perceived and comprehended by SPDS users. The guidelines of the reference documents listed in section 7.10.9 were used to ensure adequate Human Factors were incorporated into the SPDS design.

7.10.6 Isolation

The Data Acquisition System consists of five (5) multiplexer cabinets per Unit and is configured to meet redundancy requirements. Four (4) of the cabinets are 1E which are physically separated and the one (1) dual cabinet is Non-1E. All 1E field signals are isolated at the 1E multiplexer cabinets. The signals from these cabinets are transmitted to the data server by means of fiber optic cables. These cables isolate the multiplexer cabinets from the data server and the rest of the system.

7.10.7 Parameter Selection

The parameters that make up the database for the Safety Parameter Display System were selected using Regulatory Guide 1.97 as a guideline. These parameters are listed on Tables 7.10.1. A subset of these parameters are used in the status trees.

7.10.8 Data Validation

Signal validation is accomplished by the software by inputting sets of redundant database variables.

The software sets a "non-valid" signal indicator in the database when it determines that a measurement is not consistent with a subset of its redundant measurements. Six (6) SPDS parameters are validated using this method because of the availability of redundant sensors. The parameters are as follows:

1. RCS pressure
2. Containment pressure
3. Containment sump water level
4. Pressurizer level
5. Steam generator pressures
6. Power range power levels

The remaining parameters which are directly related to the CSF Status Trees and the Radiation Monitoring displays can not be validated by the above method because of the unavailability of redundant sensors. However, range and limit checks are performed and quality flags are generated for all parameters in the database.

References

1. Regulatory Guide 1.97, "Instrumentation for Light-Water-Cooled Nuclear Power Plants and Environs Conditions During and Following an Accident."
2. NUREG-0700, Section 6, "Guidelines for Control Room Design Reviews."
3. NUREG-0835, Section 6, "Human Factors Acceptance Criteria for the Safety Parameter Display System."
4. INPO 83-036, "Human Engineering Principles for Control Room Design Review", Section 3.7, Published by the Nuclear Utility Task Action Committee.
5. GP-R-211010, (Revised) "Human Factors SPDS Guidelines Checklist", prepared by General Physics Corporation for PSE&G, August 8, 1985.
6. NUREG-0737, Supplement 1, "Clarification of TMI Action Plan Requirements, Requirements for Emergency Response Capability".
7. NUREG-1342, "Status Report Regarding Industry Implementation of Safety Parameter Display System".
8. NUREG-0696, "Functional Criteria for Emergency Response Facilities".
9. PSE&G Letter NLR-N87058 dated April 20, 1987, C.A. McNeill, Jr., to NRC Document Control Desk.