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June 17, 1983

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Subject: Byron Generating Station Units 1 and 2
Braidwood Generating Station Units 1 and 2
Safety Parameter Display System
NRC Docket Nos. 50-454, 50-455, 50-456, and 50-457

Dear Mr. Denton:

This is to provide additional information regarding the Byron/Braidwood safety parameter display systems (SPDS). Review of this information should help close Outstanding Item 16 of the Byron SER.

Enclosed with this letter is an advance copy of a revision to Section E.17 of Appendix E to the Byron/Braidwood FSAR. This section describes the SPDS system and the basis for selection of the parameters monitored. These pages will be incorporated into the FSAR at the earliest opportunity.

One signed original and fifteen copies of this letter and the enclosure are provided for your review.

Please address questions regarding this matter to this office.

Very truly yours,

T. R. Tramm

T. R. Tramm
Nuclear Licensing Administrator

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Enclosure

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E.17 Plant Safety Parameter Display Console (I.D.2)

Design Basis

The Safety Parameter Display System (SPDS) is provided in response to NUREG-0696. That document addresses the requirements related to Emergency Response Facilities and states that a display system is to be installed in existing control rooms "...to help operating personnel in the control room make quick assessments of plant safety status." The Byron/Braidwood SPDS design is intended to meet this requirement and fulfills the further intent stated in NUREG-0696 that the display system should serve"...to concentrate a minimum set of plant parameters from which plant safety status can be assessed. The selection of parameters is based on the function of enhancing the operator's capability to assess plant status in a timely manner without surveying the entire control room."

As indicated in NUREG-0696, the Safety Parameter Display System is intended to provide a display of plant parameters from which the safety status of operations may be assessed in the control room, TSC and EOF. The primary function of the SPDS is to help control room operating personnel make quick assessments of plant status. Duplication of the SPDS displays in the TSC is intended to improve the exchange of information between these facilities and the control room, and assist in the decision making process.

NUREG-0696 indicates that SPDS should be responsive to transient and accident sequences and should be sufficient to indicate plant status. A display format consisting of a minimum set of parameters or derived variables from which the overall plant status may be determined, should be provided.

These paremeters, or derived variables, will be individual plant parameters or will be composed of a number of parameters or derived variables giving an overall system status.

The intent of the SPDS is to meet two specific operational goals:

1. Prevention - To provide a display system which will permit the operator to monitor the state of the plant process and detect any abnormalities for which corrective action might be taken to terminate the event prior to the initiation of automatic reactor trip and/or safeguards actuation.

2. Mitigation - In the case of events which the operator does not detect or cannot terminate, the goal is to enable the operator to assess the safety status of the plant and verify proper safeguard functions to mitigate the consequences of the event.

In addition, the SPDS display will be located so it is convenient to the control room operators. This system will be continuously available to display information so that the plant safety status can be readily and reliably assessed by control room personnel who are responsible for the prevention and mitigation of off-normal plant conditions.

The SPDS is driven by the plant process computer. It will not meet requirements of the single-failure criteria and will not be qualified to meet class 1E requirements. The SPDS will be suitably isolated from electrical or electronic interference with equipment and sensors used for safety systems. The SPDS will not be seismically qualified, and additional seismically qualified indication is not required for the sole purpose of being a backup for SPDS. The overall availability of SPDS is approximately equal to plant process computer availability.

Parameters Monitored

NUREG-0696 is the basis for the selection of parameters for the SPDS displays. That document requires important plant functions be monitored in each plant operating mode to inform control room operating personnel of overall plant status.

Plant functions considered in the selection of the Byron/Braidwood SPDS variables included the following:

Reactivity Control
Reactor Core Cooling
Reactor Coolant System Integrity
Reactor Coolant System Inventory Control
Containment Activity Level
Containment Integrity
Secondary System Status

The operational modes for Byron/Braidwood are listed below. Parameters selected for the SPDS displays provide the operator the ability to monitor plant status over the entire range of operating modes.

Mode	Reactivity Condition, K_{eff}	% Rated Thermal Power	Average Coolant Temperature
1. Power Operation	≥ 0.99	$> 5\%$	$\geq 350^{o}F$
2. Startup	≥ 0.99	$\leq 5\%$	$\geq 350^{o}F$
3. Hot Standby	< 0.99	0	$\geq 350^{o}F$
4. Hot Shutdown	< 0.99	0	$< 350^{o}F$ $> 200^{o}F$
5. Cold Shutdown	< 0.99	0	$\leq 200^{o}F$
6. Refueling	< 0.95	0	$\leq 140^{o}F$

The number of parameters on each display has been kept to a minimum so information can be readily interpreted by the operator. Also, each parameter consists of only one variable, with the exception of power mismatch and net charging/letdown flow, to assist the operator in recognizing the problem area independent of supplementary displays. The parameters have all been normalized to aid the operator in recognizing an off-normal condition.

The variables presented on the SPDS dislays are considered adequate to cover incidents of moderate frequency, infrequent incidents or limiting faults. Use of the power mismatch parameter will allow the operator to assess, more quickly, an increase or decrease in heat removal by the secondary system.

Increases and decreases in reactor coolant inventory are signaled by monitoring the net charging/letdown flow rate and pressurizer level. Off-normal reactivity changes are quickly observed by monitoring the power mismatch and Tavg parameters. In addition to the SPDS displays, the operator will have at his disposal other parameters for display to assist in assessing off-normal conditions.

The listing in Table 1 identifies each parameter displayed on the SPDS displays and how it relates to monitoring plant functions.

Location of Displays

Four SPDS CRT units will be installed for each station as follows:

Unit 1 Main Control Board
Unit 2 Main Control Board
Technical Support Center
Main Control Room Center Desk

Iconic Display

Two iconic displays are included in the Byron/Braidwood SPDS. The iconic format consists of eight parameters. Each parameter is represented by a spoke of a geometric figure.

For those iconic vectors which display more than one parameter, the parameter which is furthest from the reference value will be the parameter whose active value is displayed.

Figure 1 is an example of a basic iconic display with the elements labeled. Each spoke in the figure represents a normalized scale for a specific parameter. Reference points for all parameters are drawn as fixed points on the spokes such that when dotted lines connecting them are drawn the result is a regular geometric pattern. Deviations in active parameters from the reference parameters are represented as points plotted on the normalized scales drawn between fixed reference and high and low limit points. A positive deviation results in a point drawn between the reference point and the high limit and conversely a negative deviation results in a point drawn between the reference and the low limit point. Solid lines are drawn connecting the active points to form a second geometric figure.

The NAR RNG and WID RNG iconic displays for Byron/Braidwood are presented in Figures 2 and 3. The display labeled NAR RNG is specifically devoted to normal plant power operation. The display labeled WID RNG is devoted to the full range of plant operations from shutdown to full power operation. The operator may select either display for viewing at his discretion. Table 2 contains a description of each of the spokes which comprise the iconic display.

Table 1

Parameters Associated with Plant Function Monitoring

Reactivity Control

Power Mismatch
Tavg
Startup Rate
Core Exit Temperature

Reactor Core Cooling

Core Exit Temperature
NR SG Level
WR SG Level

Reactor Coolant System Integrity

NR SG Level
WR SG Level
WR RCS Pressure
Pressurizer Level
Pressurizer Pressure
Net Charging/Letdown Flow Rate

Reactor Coolant System Inventory Control

Net Charging/Letdown Flow Rate
Pressurizer Level
Containment Floor Drain Sump Level

Containment Activity Level

Containment Activity
Containment Floor Drain Sump Level

Containment Integrity

Containment Temperature
Containment Pressure

Secondary System Status

NR SG Level
WR SG Level
Power Mismatch
Tavg

Figure 1 - Basic Iconic Display

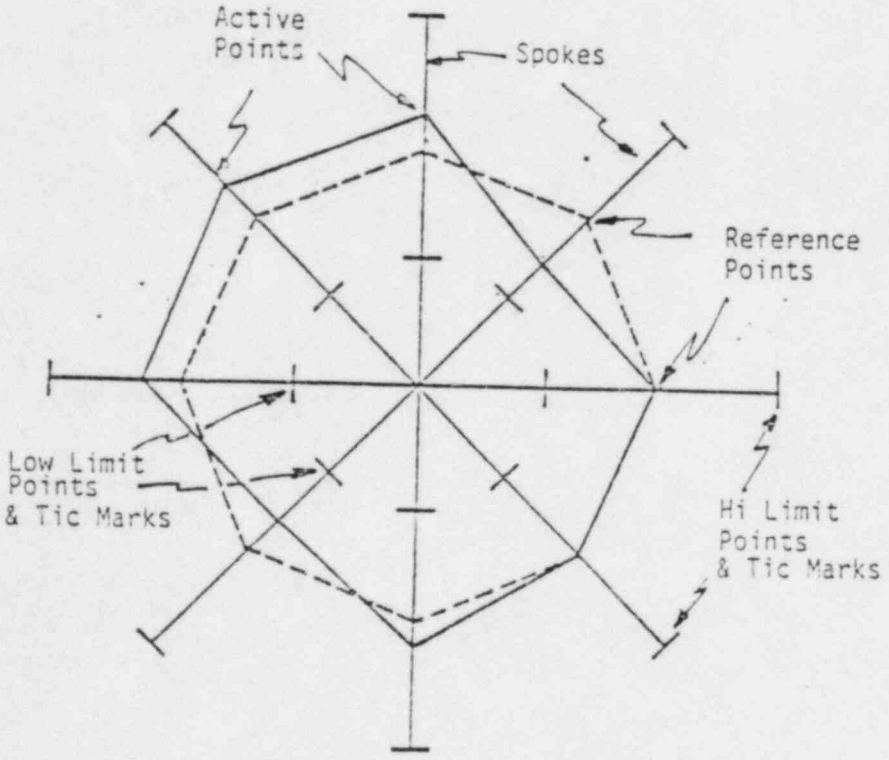

Figure 2
NAR RNG Display

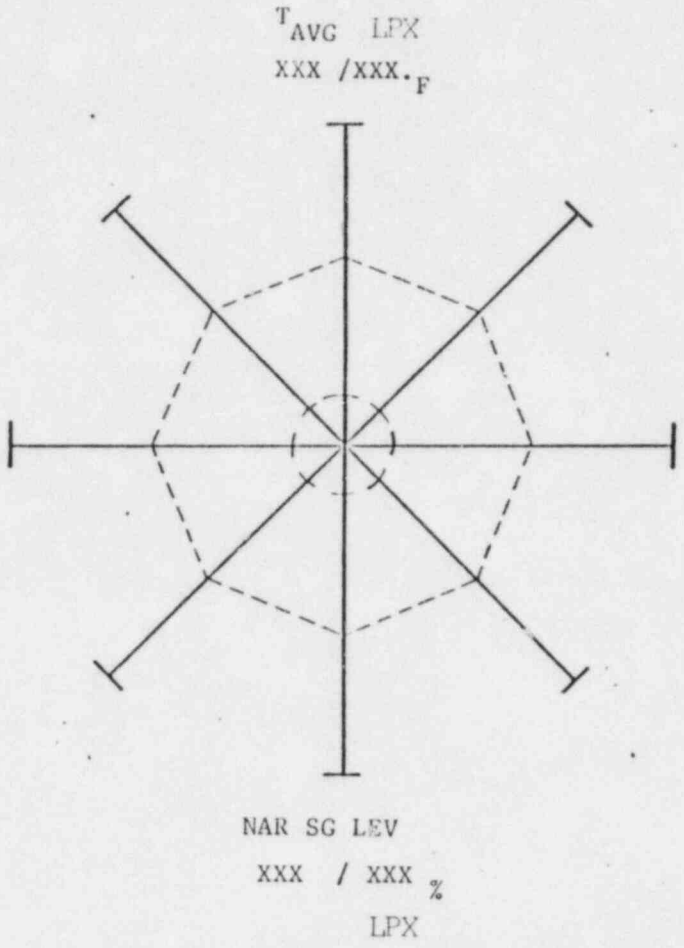

Figure 3

WID RNG Display

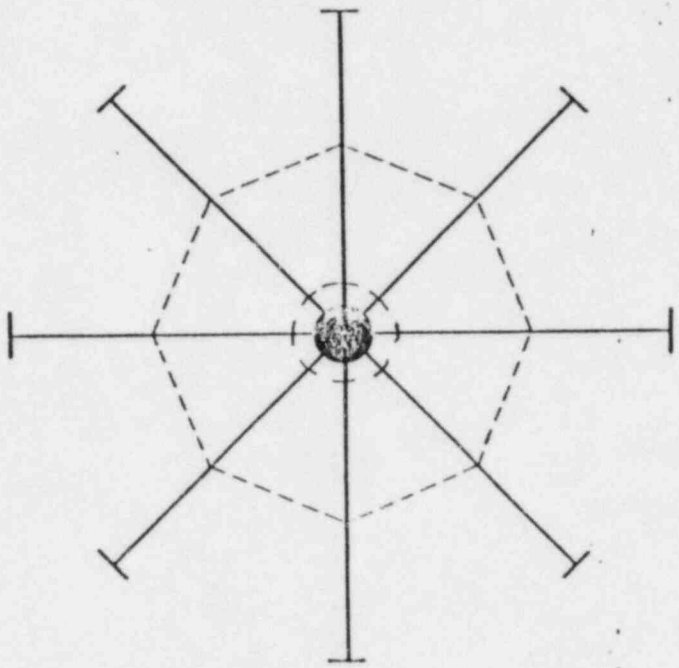

TABLE 2

Iconic Display Description

Analog Spokes

1. Tavg

   The value and loop number for the Tavg which corresponds to the maximum deviation (positive or negative) from the reference.

   a. Active value - maximum deviation of the loop Tavg with respect to the reference value.

   b. Reference value - plant input (Tref) obtained from turbine power.

   c. High limit - system constant equal to the Technical Specification DNB limit for Tavg.

   d. Low limit - system constant equal to the Technical Specification minimum temperature for criticality.

2. Power Mismatch

   Nuclear to Turbine Power Mismatch:

   a. Active value - nuclear power minus turbine power.

   b. Reference value - system constant equal to zero.

   c. High limit - system constant equal to 9 percent. (equivalent to High Flux Reactor Trip with turbine power equal to 100%).

   d. Low limit - system constant equal to minus ten percent.

3. Narrow Range Steam Generator Level

   The value and loop number for the steam generator whose narrow range level indication corresponds to the maximum deviation (positive or negative) from the reference value.

   a. Active value - steam generator narrow range level that corresponds to the maximum deviation from the reference value.

   b. Reference value - steam generator narrow range reference level.

   c. High limit - system constant equal to high steam generator level reactor trip setpoint.

   d. Low limit - system constant equal to low steam generator level reactor trip setpoint.

4. Net Charging Flow

The value of net charging flow is calculated by the difference in charging pump flow - letdown flow and total RCP seal return flow.

a. Active value - charging pump flow minus letdown flow and RCP seal return flow.

b. Reference value - system constant equal to zero.

c. High limit - system constant equal to the maximum makeup flow.

d. Low limit - system constant equal to the maximum letdown flow.

5. Pressurizer Level

a. Active value - pressurizer level average.

b. Reference value - pressurizer level reference as input from the plant. (Tavg)

c. High limit - 100 percent for wide range and RX TRIP for narrow range.

d. Low limit - 0 percent for wide range and heater interlock letdown isolation level for narrow range.

6. Pressurizer Pressure

a. Active value - pressurizer pressure average.

b. Reference value - system constant equal to normal operating pressure. (2235 PSIG)

c. High limit - PORV setpoint.

d. Low limit - pressurizer minimum pressure post reactor trip (2000 PSIG).

7. Core Exit Temperature

The value of the maximum incore thermocouple.

a. Active value - the value of the maximum incore thermocouple.

b. Reference value - reactor core exit reference temperature.

c. High limit - RCS saturation temperature.

d. Low limit - RCS low temperature limit.

8. Startup Rate

   a. Active value - nuclear flux rate of change.

   b. Reference value - system constant equal to zero.

   c. High limit - system constant equal to 2 DPM.

   d. Low limit - system constant equal to -0.5 DPM.

9. Containment Pressure

   a. Active value - containment average pressure.

   b. Reference value - system constant equal to the normal containment pressure.

   c. High limit - system constant equal to 18.2 psia (HI-1 setpoint).

   d. Low limit - system constant equal to 10 psia.

10. Steam Generator Wide Range Level

    The values and loop number for the wide range steam generator level which corresponds to the maximum deviation.

    a. Active value - maximum deviation of the loop steam generator wide range levels with respect to the reference value.

    b. Reference value - system constant equivalent to 50 percent of the narrow range steam generator level span.

    c. High limit - system constant equal to 100 percent.

    d. Low limit - system constant equal to 0 percent.

11. Reactor Coolant System Pressure

    a. Active value - reactor coolant system pressure average.

    b. Reference value - reactor coolant system pressure reference.

    c. High Limit - reactor coolant system pressure high limit.

    d. Low limit - reactor coolant system saturation pressure.

12. Containment Conditions

    The vector length is calculated using the parameter which corresponds to the maximum deviation from the reference value.

a. Active Value - containment average air temperature or containment floor drain sump average level.

b. Reference Value - system constant equal to the normal containment air temperature or normal containment floor drain sump level.

c. High Limit - for containment air temperature a system constant equal to 122°F. For containment floor drain sump level a system constant equal to HI-HI level.

d. Low Limit - for both containment air temperature and containment floor drain sump level a system constant equal to the low instrumentation limit.

13. Radiation

The vector length is calculated using the parameter which corresponds to the maximum deviation from the reference value.

a. Active Value - Containment activity level for particulate, gaseous, iodine or area which deviates the most from the reference level.

b. Reference Value - System constants equal to the normal containment activity levels.

c. High Limit - For all activity parameters a system constant equal to the alarm setpoint.

d. Low Limit - For all activity parameters a system constant equal to the low instrumentation limit.

Digital Spoke

1. Reactor Vessel Level

The vector length is calculated by checking for the existence of a low level condition from any one of the eight discrete vessel level sensors.

a. Active Value - Input from vessel level sensors and reactor coolant pump status.

b. Reference Value - The parameter is maintained at its maximum level except in mode 6.

c. High Limit - Equal to reference value.

d. Low Limit - Represents the lowest of the eight discrete vessel level sensors.