Commonwealth Edison
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December 29, 1983

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

Subject: Dresden Station Units 2 and 3
Quad Cities Station Units 1 and 2
Zion Station Units 1 and 2
LaSalle County Station Units 1 and 2
Byron Station Units 1 and 2
Braidwood Station Units 1 and 2
NUREG 0737 Supplement 1 SPDS Safety Analysis
NRC Docket Nos. 50-237/249, 50-254/265,
50-295/304, 50-373/374, 50-454/455 and 50-456/457

References (a): Cordell Reed letter to H. R. Denton dated December 6, 1983

(b): E. D. Swartz letter to H. R. Denton dated July 20, 1983

(c): Cordell Reed letter to H. R. Denton dated November 15, 1983

(d): LaSalle County Station Unit 2 License NPF-18, Condition 18.(a) Item 1.(a).(i)

Dear Mr. Denton:

Reference (a) contains the latest negotiated schedules concerning NUREG 0737 Supplement 1 for each of our nuclear stations. References (b) and (c) provided specific clarifications to our SPDS Safety Analysis commitments. The purpose of this letter is to provide the SPDS information as committed to in References (a), (b), and (c), and required by Reference (d), due December 31, 1983.

Specifically, Reference (b) stated that Commonwealth Edison would "provide a description of the criteria for selection of parameters which provide information on the five critical safety functions" for each of our stations. Additionally, Reference (c) contained a commitment to provide a Verification and Validation (V&V) Plan for the SPDS for each of our Stations as a result of negotiations with NRC Staff. The Enclosures to this letter provide this information.

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It must be pointed out, however, that the extent to which the V&V Plan will be implemented at each of our Stations will vary and the NRC Staff is hereby so notified. This V&V Plan represents a general approach that the Commonwealth Edison Company intends to use as a flexible guideline which is subject to change when applied to each of our nuclear stations on a plant specific basis. Given the varying degree of SPDS implementation within our stations, we would expect that stations with a functional SPDS will place emphasis on the verification aspects of the V&V Plan, while those plants with the SPDS in the design stage will emphasize review and approval ahead of each activity. Additionally, the V&V Plan may be revised to incorporate changes resulting from experience gained from its initial implementation. By copy of this letter to Region III, the Region is also being notified of our intent in this matter.

To the best of my knowledge and belief the statements contained herein and in the attachment are true and correct. In some respects these statements are not based on my personal knowledge but upon information furnished by other Commonwealth Edison and contractor employees. Such information has been reviewed in accordance with Company practice and I believe it to be reliable.

Please address any questions that you or your staff may have concerning this matter to this office.

One (1) signed original and forty (40) copies of this letter with Enclosures are provided for your use.

Very truly yours,

CW Schroeder 12/29/83

for E. Douglas Swartz
Nuclear Licensing Administrator

EDS/rap

Enclosures

cc: J. G. Keppler - RIII
RIII Inspectors D/QC/Z/LSC/B/B

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ENCLOSURE

COMMONWEALTH EDISON COMPANY
SPDS SAFETY ANALYSIS

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Verification and Validation Plan for Safety Parameter Display Systems (The V&V Plan)

Objective: The V&V Plan describes the documentation which assures that the correct SPDS objectives are being met (Verification), and the documentation required for testing and acceptance of the SPDS during conception, design development, construction and turnover for station use (Validation).

Overview: The V&V Plan as described herein includes some description of the documents or procedures which provide overall control of the SPDS project. The V&V Plan ties together in one package the results of these procedures. A planned program for testing, reviews and modifications is required for a successful SPDS Project. The V&V Plan provides a method to control and coordinate the SPDS effort and document the results.

The V&V Plan: Figure 1 will be used as a reference to identify the control points discussed in the V&V Plan. Figure 1 is a line diagram of the SPDS project from conception to the end product.

The first phase of the SPDS Project is the identification of the SPDS requirements. These requirements established CECo policy on how the SPDS is to be designed, developed, assembled and used. The system requirements also identify why the SPDS is being built, references the regulations to be followed and met, and in general provides guidance on how CECo will meet the regulations. The system requirements address the project in general. Specific details of the system and any required component or item justifications are discussed in the next phase of the project which is the development of the design specifications. The system requirements discuss the following:

1. Who will use the SPDS and why.

2. What the SPDS will show in the display(s). The object here is not to design the display, but to identify the types of displays to be used and in general the kinds of information to be displayed. The type of display would be a pie slice, circle, a bar graph, or some other type of information representation that would be acceptable from a human factors viewpoint.

3. The SPDS hardware configuration, such as how many CRT's and where they will be located, whether existing computers will be used or if the purchase of new computers is required.

4. Provide guidance as to how the inputs to the display should be used. The object here is to identify where the inputs to the display come from. The inputs to the display are the specific instrumentation values such as containment sump water level.

Once the system requirements have been identified, they must be reviewed and approved. This is Control Point A. The review and approval must be documented and the documentation then becomes part of the V&V package for the SPDS. The review must consider the following:

1. Do the requirements address and meet the correct SPDS objectives as stated in NUREG 0737 Supplement 1? i.e does the manual show and give guidance on how to solve the SPDS problem? (verification). The SPDS requirements are listed in Table 1.

2. Are the requirements a practical approach to the SPDS considering alternative approaches?

3. Will the end result be practical and useful to station operations in "rapidly and reliably determining the safety status of the plant"?

The SPDS "System Requirements" should be a controlled document in the sense that any changes to it must be reviewed and approved. The review should be documented. The review must compare the desired change against the SPDS objectives to determine whether or not the change meets the objectives. Any approved changes must be controlled in that they must be incorporated into the design specifications for software development and hardware purchase. At the completion of the project these documents are passed on to the station as part of the SPDS documentation. At that time the station becomes responsible for review and control of the documents.

The design specifications for software and hardware are the next documents to be prepared. For ease in following Figure 1 and less confusion between software and hardware, this discussion will follow software development first, then hardware purchase.

The design specification document for the SPDS identifies the parameters that provide information on the status of the critical safety functions. At this point in the development of the SPDS the display must be chosen for content and graphics configuration. The measured plant parameters must be identified as inputs for each part of the displays. The algorithms for each display must also be identified in the specification. Other information, such as the NRC requested written safety analysis (describing the basis on which the selected parameters were made), and the human factors requirements, are also included as part of this specification.

TABLE 1. SPDS REQUIREMENTS*

- SHOULD BE LOCATED CONVENIENT TO C.R. OPERATORS (SUPPL. 1 NUREG-0737 PAR. 4.1.B)

- WILL CONTINUOUSLY DISPLAY PLANT SAFETY STATUS INFORMATION (SUPPL. 1 NUREG-0737 PAR. 4.1.B)

- SHOULD HAVE A HIGH DEGREE OF RELIABILITY (SUPPL. 1 NUREG-0737 PAR. 4.1.B)

- SHALL BE SUITABLY ISOLATED FROM ELECTRICAL OR ELECTRONIC INTERFERENCE WITH SAFETY SYSTEMS. (SUPPL. 1 NUREG-0737 PAR. 4.1.C)

- SHALL BE DESIGNED INCORPORATING ACCEPTED H.F.E. PRINCIPLES (SUPPL. 1 NUREG-0737 PAR. 4.1.E)

- MINIMUM INFORMATION DISPLAYED SHALL BE SUFFICIENT TO DETERMINE PLANT SAFETY STATUS. (SUPPL. 1 NUREG-0737 PAR. 4.1.F)

- PROCEDURES AND OPERATOR TRAINING ADDRESSING ACTIONS WITH AND WITHOUT SPDS SHOULD BE IMPLEMENTED (SUPPL. 1 NUREG-0737 PAR. 4.1.C)

*Source: Regional meeting handouts

Station operations should have considerable input into the graphics configuration (display layout) and measured plant parameters that will be used to drive the display.

Control Point B is a review to verify that the software design does the following:

1. The correct SPDS objective is being met. i.e. Table 1.

2. The measured plant parameters are current, i.e. no mods affecting the SPDS criteria have been made to the plant since the systems requirements document was prepared. If these mods have occurred they have been incorporated into the design spec.

3. The algorithms and selected measured plant parameter inputs have been reviewed and found acceptable.

The procedures used during software development are called the "Software Procedures". They describe the organization of the software development group, delineate the authority of members, identify when the procedures are to be followed, describe software documents control, describe configuration control, give examples of procedural forms to be completed for problem correction, reviews and modifications; in general, they describe programming practices.

Systematic approaches to problem solving, including software development, proceed through an iterative sequence of steps. Each step in the software development program should be identified. A review of completed material should be performed at appropriate development steps.

The review of the software should consider the following for the first part of Control Point C:

1. Is the SPDS software development following the correct procedures?

2. Does the program meet the requirements specified in the software design specification?

3. Are problems in the software development which deviate from the design specification reviewed and approved before inclusion in the program?

4. How is system design unity maintained with the design specification and system requirements if changes to the scope are approved?

As part of Control Point C, the software is thoroughly tested as specified in the Software procedures. The results are documented as part of the V&V package (Validation). The program test is an exercise of the software algorithms and the hardware display. To prepare for this test, a procedure (checklist) must be written which predicts what the algorithms will show on the displays for each of the selected signals. The acceptance criteria, including a check of the alarm setpoints and corresponding display color changes is part of this procedure. All test results must be reviewed, approved and documented (validation) as part of the V&V package for the SPDS.

The second review is performed after the SPDS software has been completed and required testing is finished. In addition to the four above items the review should include the following at Control Point C:

5. Has the SPDS software been adequately documented?

6. Were all parts of the (software) SPDS adequately tested?

7. Were test results which were outside of the recommended error units reviewed and any changes that were required documented?

The preparation of the SPDS Hardware Design Specification parallels the software effort. The design specification includes a description of the equipment required, performance specifications, and any testing which is required. If testing is required, acceptance criteria is defined at this time.

Control Point D consists of a review of the finished SPDS hardware design specification to verify and document that the specification conforms to the SPDS requirements.

The hardware purchase, assembly and testing is controlled through normal CECo procedures and methods. The testing is part of Control Point E and consists of checking to see that the equipment was not damaged during shipment to the plant and that when assembled an operational test is performed satisfactorily and is documented. Any problems should be documented and corrected before the equipment is released to the next step in the SPDS program.

After the software and the hardware have passed their independent testing, a test procedure is prepared to validate the integrated systems. The test consists of a prepared checklist and previously established acceptance criteria. The test performed as part of control point F is a functional type test. The object of the test is to validate that the inputs to the SPDS are correctly connected and the software algorithms are properly exercised. The displays are checked for value (number, bar length), color changes, and word changes.

The results of this test are documented, reviewed, and approved (validation). Any problems discovered during this phase of testing are documented. Each problem is reviewed by cognizant personnel (SNED, computer systems, or station), and approved and worked out in some manner consistent with the design specifications and system requirements manual. Problems requiring modification of hardware or software are controlled and documented with proper review.

Control Point F is the final review point. Questions to be considered here are:

1. Were problems which were discovered during testing, documented and resolved? (i.e. to pass this control point there must be no open issues or problems.)

2. Were all test results compared against the design specification and the system requirements manual?

3. Has all testing been completed and adequately reviewed and documented? Was the review favorable?

4. Was the SPDS testing sufficient to exercise a large portion of the SPDS software and hardware?

5. Were human factors considerations included as appropriate?

The human factors review of the SPDS evaluates the man/machine interface of the SPDS to determine whether it provides the necessary information for the control room operator to determine the safety status of the plant.

The V&V package for the SPDS consist of a documents which reference the reviews at each of the control points and in general ties together the development of the SPDS.

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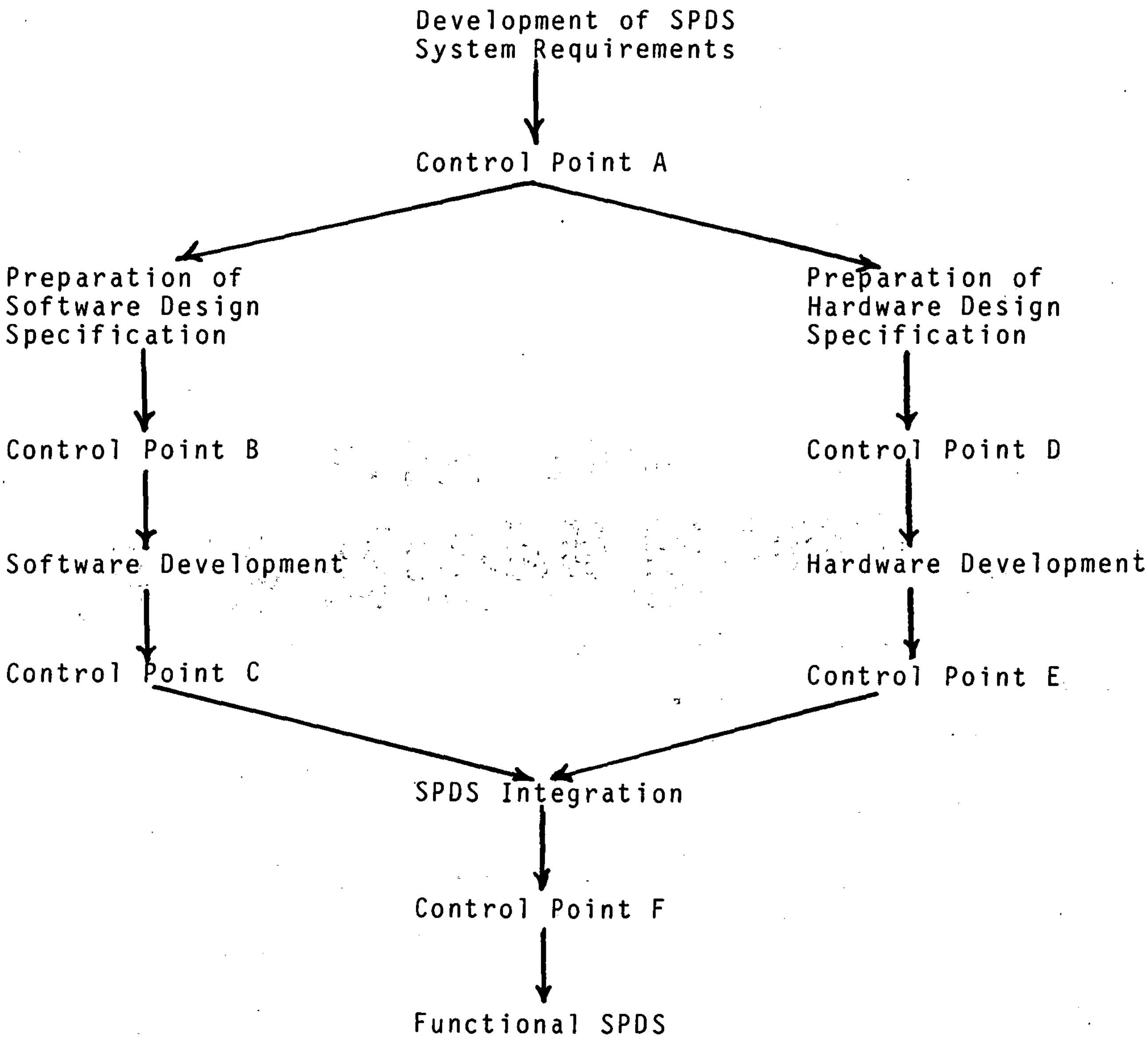
Figure 1. SPDS Project Control Points



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Criteria for Parameter Selection for Dresden, Quad Cities, and LaSalle County Stations

I. Purpose

The purpose of the Safety Parameter Display System (SPDS) is to provide to the reactor operator in a single location the value/status of primary variables which directly indicate the status of the safety parameters indicating the accomplishment or maintenance of plant safety functions. Plant safety functions are core cooling, reactivity control, reactor coolant system integrity, containment integrity, and radioactive effluents. The SPDS functions as an indicator only and it is intended that all SPDS readings be confirmed by the operator using existing control room instrumentation.

II. Bases for Selection

Each safety function is assessed by several parameters. Basis for parameter selection is provided below.

A. Core Cooling

The adequacy of core cooling is assessed by measuring reactor water level and operation of the core spray systems. Verification of reactor water level to be above 2/3 core height is sufficient to ensure adequate core cooling. If water level indication is lost or level cannot be determined, verification of design flow rates in either core spray system is sufficient to ensure adequate core cooling.

B. Reactivity Control

Reactivity control is assessed by measurement of reactor power level. The reactor power level is indicated using the RX POWER bar graph and associated digital value and trend displays. Inputs to the reactor power measurement are the APRM's and SRM's. If the APRM's are reading on scale in run or startup, they are used to determine power level; in shutdown or refuel when the APRM's are downscale the SRM's are used with preference given to SRM's which are inserted. Following a scram demand signal, an SRM reading above 10^5 or APRM's on scale could indicate a failure to scram.

C. Reactor Coolant System Integrity

Maintenance of reactor coolant system integrity is assessed by the measurement of reactor pressure, drywell pressure, containment activity, safety/relief valve (SRV) positions, and isolation of PCIS valves in Groups 1 and 2. Rapid RPV depressurization, high drywell pressures, high containment activity, open SRV's, and open isolation paths all indicate actual or potential breaches of the reactor coolant system integrity. In addition, excessively high reactor pressure would cause SRV's to open and could potentially threaten the reactor coolant system physical boundary.

D. Containment Integrity

Maintenance of containment integrity is assessed by the measurement of drywell pressure, drywell temperature, suppression pool level, suppression pool temperature, and containment isolation valve (Groups 1 and 2) positions. Excessive drywell pressure, drywell temperature, and suppression pool temperature, and high or low suppression pool level indicate conditions which may violate containment design basis and potentially degrade containment integrity. Open isolation paths would indicate a breach of the containment boundary.

E. Radioactive Effluents

Radioactive effluents are assessed by the measurement of radiation levels or release rates at the gaseous and liquid release points. Excessive releases or radiation levels are indicated using the RAD RELEASE NORM (HIGH) status box.

Inputs to the radioactive release status box come from the offgas pretreatment log rad monitor; SBGT and main chimney rad monitors; SBGT and main chimney flow meters; and the liquid radwaste, service water discharge, and RHR loops discharge rad monitors.

Although the offgas system at the monitor location does not provide a direct path to the environment, high radiation at this point would indicate degradation of a fission product barrier and the potential for a radioactive release.

Criteria for Parameter Selection For Zion Station

The basis for parameter selection for each safety function group is provided as follows:

Core Cooling

The core cooling adequacy is assessed by measuring the RCS cold leg temperatures, steam generator levels, and steam generator pressures. Verification of steam generator parameters ensure that a positive heat sink is provided for decay heat. Monitoring the cold leg temperatures and core exit temperatures confirm the temperature differential required in the primary system to remove this excess heat has been established. The core subcooling parameter has inputs from a) core exit temperature, b) wide range reactor pressure, and c) narrow range reactor pressure. Observed drops in all three of these parameters is again positive indication that the core is being cooled. Further, reference to the reactor vessel level indication gives evidence of water level over the core and allows for indication of the core cooling medium.

Reactivity Control

Reactivity control is monitored using the intermediate range and the source range power indications.

Power level is displayed in cps, amps, or % depending on plant conditions. If the reactor is not in a tripped condition and power range power indicates greater than 1%, power level in % is displayed. If the power level is less than 1% with the reactor not in a tripped condition, power level in amps is displayed. If the reactor is in a tripped condition, power level in amps is displayed until the high voltage comes on, then power is displayed in cps.

Reactor Coolant System Integrity

Reactor Coolant System integrity is monitored by use of the RCS wide range pressure indication, pressurizer level, reactor vessel level, and containment sump level wide range indication.

Rapid depressurization of the primary system in conjunction with falling pressurizer level and Rx vessel level, while containment sump level rises is indicative of a breach of reactor coolant system integrity.

Containment Integrity

The containment status is assessed by use of the containment narrow range pressure indication. A rising pressure indication would provide indication of potential containment failure and would allow time to take corrective action.

Radioactivity Control

Radioactive effluents are monitored by the containment rad monitor. Indication via this monitor can be indicative of abnormal operating conditions. In addition, the secondary gaseous and liquid radiation monitors at the air ejectors, steam generator blowdown, the steam generator relief discharge, and the vent stack give positive indication of direct radiation releases to the environment and provide a means for monitoring potential indirect radioactive releases.

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Criteria for Parameter Selection for Byron and Braidwood Stations

Design Basis

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.

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 minimim set of parameters or derived variables from which the overall plant status may be determined, should be provided.

These parameters, 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:

a. 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.

b. 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.

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 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 be normalized to aid the operator in recognizing an off-normal condition.

The variables presented on the SPDS displays 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 T_{avg} 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 E.17-1 identifies each parameter displayed on the SPDS displays and how it relates to monitoring plant functions.

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TABLE E.17-1

PARAMETERS ASSOCIATED WITH PLANT FUNCTION MONITORING

Reactivity Control

Power Mismatch
T_{avg}
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
T_{avg}