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MIDDLE SOUTH UTILITIES SYSTEM

October 9, 1986

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QA

Mr. George W. Knighton, Director
PWR Project Directorate No. 7
Division of PWR Licensing-B
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

SUBJECT: Waterford SES Unit No. 3
Docket No. 50-382
Safety Parameter Display System

REFERENCE: (1) Letter dated May 21, 1986 from J.H. Wilson to LP&L

(2) Letter W3P86-0021 dated February 14, 1986 from K.W. Cook to G.W. Knighton

(3) Letter dated December 2, 1985 from G.W. Knighton to R.S. Leddick

Dear Mr. Knighton:

As documented in Reference 1, a meeting was held on May 13, 1986 between the NRC staff and LP&L staff to discuss the design and implementation of the Safety Parameter Display System (SPDS) at Waterford 3. In the meeting, the NRC staff identified areas in which additional information was requested. As a result, LP&L agreed to submit both a justification for the new list of parameters and a cost-benefit analysis for several alternatives that could be implemented to address the NRC's concerns noted in the present SPDS design. Since the above meeting, LP&L personnel have reviewed the February 14, 1986 letter that was submitted in Reference 2 with respect to the areas mentioned above.

It may be beneficial to review several important aspects of the Reference 2 letter. Originally, LP&L elected to design a SPDS with the objective of meeting the needs of a variety of users (i.e., the system was not limited to



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control room use). A broad base of critical parameters was selected to meet this objective. In your report that was submitted in Reference 3, the audit team observed that "status information for all important SPDS parameters is not available on a single display...". Based on our evaluations of the SPDS, we agreed with the audit team assessment. In our efforts to optimize the SPDS, it appears that the scope of the SPDS grew beyond strictly a regulatory application, i.e., a means for a "rapid and reliable assessment of plant status". As a result of the large number of parameters selected, the system became less efficient and more complex to use.

In order to address the audit findings promulgated in Reference 3, a LP&L Task Force reviewed, among other things, the scope of the SPDS. During the course of the review, it became obvious that a major concern with the original SPDS design was that the critical parameters selected provided the primary user with more information than was needed to make a "rapid and reliable assessment of plant status". For example, parameters that provide supplemental information for the purpose of diagnosing or controlling an event were also included. (It is important at this stage to note that the SPDS was not intended to be used by the Nuclear Plant Operator (NPO) to operate the plant. The Waterford 3 SPDS is designed to be used by the Shift Supervisor and Shift Technical Advisor to quickly determine plant status.) The number of original parameters necessitated placing the numerical values for each parameter on a summary display and spreading the information throughout numerous displays. Therefore, the basic purpose of the SPDS was denigrated.

To address this concern, the Task Force decided that the original scope of the SPDS should be narrowed to meet the requirements of Supplement 1 to NUREG 0737 while making the system a more useable tool. With the primary user in mind, the SPDS was redesigned to address the NRC's concerns with the original design. The critical parameters were reviewed with respect to the functional based Emergency Operating Procedures (which were not available during the initial parameter selection). For each design basis event category a minimal set of parameters was selected on the basis that the primary user would be capable of rapidly assessing plant conditions. The criteria and justification for each parameter selected is enclosed as Attachment 1. The parameters selected were displayed in accordance with human factors standards and were placed on a single SPDS display. As a result, several of the parameters previously identified as critical parameters were removed from the SPDS display to facilitate a clear, continuous and concise display of plant parameters which will allow the primary user to rapidly ascertain plant status. From the SPDS, the Shift Supervisor for example, can determine plant status, clarify an event if necessary, and quickly instruct plant operators on the steps needed to mitigate any consequences of the event. It was felt

that only those parameters identified in Reference 2 were needed to perform this function (refer to Attachment 1). However, parameters that provide supplemental information for the purposes of diagnosing an event are displayed elsewhere in the control room.

As a result of the May, 1986 meeting, LP&L has re-evaluated the SPDS design submitted in Reference 2. Based on operations considerations (including the justification provided in Attachment 1), we have determined that the parameters selected are adequate to perform the functions of the SPDS. Additionally, a cost analysis was performed on the options available to enhance the present SPDS design. The options available are to implement the design proposal submitted in Reference 2, (Option 1), to restructure the present design to include the incorporation of a few alternatives that could remedy some of the concerns noted in Reference 3, (Option 2), or to purchase a vendor approved SPDS system, (Option 3). Due to the monumental impact that the implementation of Option 3 would have on plant operations (e.g., implementation would have to be done during a refueling outage, several cable penetrations would have to be removed and rerouted, and existing hardware and software would have to be replaced) as well as the extremely high cost associated with it, Option 3 was deleted from the analysis. The following represents a cost breakdown of Options 1 and 2:

OPTION 1

To implement one SPDS display based on the proposal submitted in Reference 2 (See Attachment 2)

- Software changes only
- Approximately 10 man-months
- Estimated cost $50,000

OPTION 2

To restructure the present design, the following would be required as a minimum:

(a) reducing the key strokes from 21 to 4 on a minimum of 3 - 4 displays
- Software changes would be necessary
- Vendor support would be needed
- Approximately 22 man-months to implement
- Estimated Cost $140,000

(b) adding perceptual cues
- Lengthy analysis would be necessary
- Operations input would be required
- Software changes would be needed
- Approximately 8 - 10 man-months in addition to (a)
- Estimated Cost $100,000

Total Estimated Cost of Option 2: $240,000

It is important to note that the time and cost estimates listed above assume both a normal work load and LP&L employee utilization only (except in Option 2(a)) and includes the testing and writing of specifications. The estimates above do not include a benefit analysis since no benefit can be achieved by implementing these options on the basis that the SPDS is a non-safety related system and therefore no reduction in the probability of core melt can be demonstrated. These estimates also do not include a cost for implementing data validation techniques since this alternative is dependent on the ultimate decision that is reached and therefore is not warranted at this time.

Based on the operations considerations and the cost analysis presented above, LP&L feels that the expenditure of an additional $50,000 (Option 1) for the SPDS is justifiable and that the expenditure of an additional $240,000 (Option 2) is cost prohibitive.

Should you have any questions or comments regarding this matter, please contact R.M. Nelson.

K.W. Cook

K.W. Cook
Nuclear Support & Licensing Manager

KWC/TJG/smb

Attachments
cc: B.W. Churchill, W.M. Stevenson, R.D. Martin, J.H. Wilson, L. Beltracchi, NRC Resident Inspector's Office (Site)

ATTACHMENT 1

JUSTIFICATION FOR THE PARAMETERS SELECTED
IN THE FEBRUARY 14, 1986 PROPOSAL

In the discussion which follows, it is important to distinguish between the primary SPDS user (i.e., the Shift Supervisor or Shift Technical Advisor) and the plant operators who are tasked with carrying out the emergency operating procedures (including the safety function checklist).

1. INCREASED HEAT REMOVAL

An increase in Reactor Coolant System (RCS) heat removal results in a rapid cooldown and depressurization of the RCS. A rupture of a steam pipe (e.g., Main Steam Line Break) is one example of this event.

Indications during the initiation of this event are as follows:

| | EVENT SYMPTOMS | SPDS INDICATION |
|---|---|---|
| a. | Steam Generator level - decreasing | Steam Generator level indication |
| b. | RCS temperature - decreasing | CET temperature indication |
| c. | RCS pressure - decreasing | Pressurizer pressure indication |
| d. | Pressurizer level - decreasing | Pressurizer level indication |

The relative location of a steam line break (i.e., inside or outside containment) can be determined from the following indications:

| | EVENT SYMPTOMS | SPDS INDICATION |
|---|---|---|
| a. | Containment pressure - increasing/normal* | Containment pressure indication |
| b. | CSAS (if needed) - Actuated/ N/A* | "CSAS actd" box |
| c. | CIAS (if needed) - Actuated/ N/A* | "CIAS actd" box |

* Break is Inside/Outside of containment.

A review of the SPDS display in conjunction with the Safety Function Checklist in procedure OP-902-004, "Excess Steam Demand Recovery Procedure", requires operations' personnel to verify several functions. The successful completion of these functions indicates that the plant is under control and recovering from the event. As shown below, the SPDS provides the indications necessary to allow the primary user to rapidly determine that all of the safety function criteria are successfully met.

| | SAFETY FUNCTION CRITERIA | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - decreasing | Reactor power and "Reactor Trip" indication |
| b. | Pressurizer level - 33% - 60% | Pressurizer level indication |
| c. | RCS pressure - maintaining or restoring | Pressurizer pressure indication and rate of change |
| d. | Subcooling Margin - $\geq$ 28°F | RCS Subcooling indication |
| e. | RCS temperature - CET < 600°F and steady | CET temperature indication |
| f. | Steam Generator level - $\geq$ 50%, constant or rising | Steam Generator level indication |
| g. | Containment pressure - < 17.7 psia/ normal* or CSAS | Containment pressure indication, "CSAS actd" box |
| h. | Containment temperature - < 220°F | Not available |
| i. | $H_2$ concentration - < .5% | $H_2$ concentration indication |
| j. | Vital Auxiliaries - 4.16 KV safety bus energized if needed | Vital auxiliaries box |

* Break is Inside/Outside of containment.

SUMMARY

All of the increased heat removal indications needed to rapidly assess plant status during both the event initiation and recovery can be determined directly from the SPDS. Since Containment pressure, $H_2$ concentration, CSAS and CIAS indications are displayed on the SPDS, the primary user has the necessary indications available to assess plant conditions even though containment temperature is not available on the display. However, containment temperature is available on the main control board. (It should be emphasized that the purpose of the SPDS is not to assist the operators in performing the Emergency Operations Procedures Safety Function Checklist.)

2. DECREASED HEAT REMOVAL

A decrease in RCS heat removal results in an initial increase in RCS temperature and pressure. A loss of main feedwater flow is one example of this event. Indications during the initiation of this event are as follows:

| | EVENT SYMPTOMS | SPDS INDICATION |
|---|---|---|
| a. | RCS temperature - increasing | CET temperature indication |
| b. | RCS pressure - increasing | Pressurizer pressure indication |
| c. | Steam Generator level - decreasing | Steam Generator level indication |

Should a main feedwater line break occur, it will be possible to determine the relative location of the break (i.e., inside or outside containment). The indication needed to determine the position of the break is similar to event 1 - Increased Heat Removal.

A review of the SPDS display in conjunction with the Safety Function Checklist in procedure OP-902-006, "Loss of Main Feedwater Recovery Procedure", requires operations' personnel to verify several functions. The successful completion of these functions indicates that the plant is under control and recovering from the event. As shown below, the SPDS provides the indications necessary to allow the primary user to rapidly determine that all of the safety function criteria are successfully met.

| | SAFETY FUNCTION CRITERIA | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - decreasing | Reactor power and "Reactor Trip" indication |
| b. | Pressurizer level - maintaining or restoring between 7% - 40% | Pressurizer level indication and rate of change |
| c. | Subcooling Margin - $\geq$ 28°F subcooled | RCS Subcooling indication |
| d. | RCS pressure - maintaining or < 2300 psia | Pressurizer pressure indication and rate of change |
| e. | Steam Generator level - constant or rising $\geq$ 50% | Steam Generator level indication and rate of change |
| f. | Containment pressure - < 17.1 psia/ normal* | Containment pressure indication |
| g. | $H_2$ concentration - < .5% | $H_2$ concentration indication |
| h. | Vital auxiliaries - 4.16 KV safety bus energized if needed | Vital auxiliaries box |

* Break is Inside/Outside of containment.

SUMMARY

Upon reviewing the above charts, all of the indications needed to rapidly assess plant status during both the event initiation and recovery can be determined directly from the SPDS.

It is important to note that other parameters not available on the SPDS could also be used to diagnose an event, however, they are not required to rapidly assess plant status. For example, for a loss of main feedwater event, feedwater flow rate could also be used to diagnose the event. For a quick assessment of plant status, however, the exact feedwater flow rate is unnecessary. Rather, the primary user can rapidly assess plant status by ensuring that all relevant safety functions are met. In this particular event, a review of the RCS CORE HT REMOVAL (steam generator level and RCS temperature indications) and RCS PRESSURE (RCS pressure indication) safety functions will allow the primary user to rapidly assess plant status. Therefore, as long as these safety functions are satisfied (or being satisfied) the plant is in a safe condition (or returning to a safe condition).

3. LOSS OF RCS FLOW

A loss of reactor coolant flow (e.g., Reactor Coolant Pump Trip) during power operation reduces the ability for heat removal from the core. This will cause an increase in RCS temperature and pressure. Indications significant to this event are as follows:

| | EVENT SYMPTOMS | SPDS INDICATION |
|---|---|---|
| a. | RCS pressure - increasing | Pressurizer pressure indication |
| b. | RCS temperature - increasing | CET temperature indication |
| c. | Reactor power - trip & decreasing | Reactor power & "Reactor Trip" indication |

A review of the SPDS display in conjunction with the Safety Function Status Checklist in procedure OP-902-003, "Loss of Forced Flow Recovery Procedure", indicates that all of the safety functions can be quickly verified. The following indications are of primary concern:

| | SAFETY FUNCTION CRITERIA | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - decreasing | Reactor power and "Reactor Trip" indication |
| b. | Pressurizer level - maintained between 7% - 40% | Pressurizer level indication and rate of change |
| c. | RCS pressure - maintain < 2300 psia | Pressurizer pressure indication and rate of change |
| d. | Subcooling Margin - $\geq$ 28°F | RCS subcooling indication |
| e. | Steam Generator level - constant or rising and $\geq$ 50% | Steam Generator level indication and rate of change |

SUMMARY

Upon reviewing the above charts, all the indications needed to rapidly assess plant status during both the event initiation and recovery can be determined directly from the SPDS.

It is important to note that other parameters not available on the SPDS could also be used to diagnose an event, however, they are not required to rapidly assess plant status. For example, for a loss of RCS flow event, RCS flow rate could also be used to diagnose the event. For a quick assessment of plant status, however, the exact flow rate is unnecessary. Rather, the primary user can rapidly assess plant status by ensuring that all relevant safety functions are met. In this particular event, a review of the RCS CORE HT REMOVAL (RCS temperature indication), RCS Inventory (pressurizer level and RCS subcooling indications) and RCS PRESSURE (RCS pressure indication) safety functions will allow the primary user to rapidly assess plant status. Therefore, as long as these safety functions are satisfied (or being satisfied) the plant is in a safe condition (or returning to a safe condition).

4. REACTIVITY EVENTS

Reactivity Events are generally associated with an inadvertent insertion of positive reactivity into the reactor core. These events can be either slow developing (e.g., inadvertent dilution) or very rapid (e.g., Control Element Assembly ejection). In either case, the symptom of such an event is as follows:

| | EVENT SYMPTOM | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - increasing | Reactor power (including rate of change) and "Reactor Trip" indication |

If the positive reactivity insertion is due to an ejected Control Element Assembly the reactor would trip on high Reactor Power.

A review of the SPDS display in conjunction with the Safety Function Checklist in procedure OP-902-008, "Safety Function Recovery Procedure", requires operations' personnel to verify several functions during the recovery. The successful completion of these functions indicates that the plant is under control and recovering from the event. As shown below, the SPDS provides the indications necessary to allow the primary user to rapidly determine that all of the safety function criteria are successfully met.

| | SAFETY FUNCTION CRITERIA | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - constant or decreasing | Reactor power (including rate of change) and "Reactor Trip" indication |

SUMMARY

Upon reviewing the above charts, all the indications needed to rapidly assess plant status during both the event initiation and recovery can be determined directly from the SPDS.

It is important to note that other parameters not available on the SPDS could also be used to diagnose an event, however, they are not required to rapidly assess plant status. For example, for an inadvertent CEA withdrawal event, CEA position could also be used to diagnose the event. For a quick assessment of plant status, however, the exact CEA position is unnecessary. Rather, the primary user can rapidly assess plant status by ensuring that all relevant safety functions are met. In this particular event, a review of the REACTIVITY (reactor power and "reactor trip" indications) safety function will allow the primary user to rapidly assess plant status. Therefore, as long as this safety function is satisfied (or being satisfied) the plant is in a safe condition (or returning to a safe condition).

5. INCREASE IN RCS INVENTORY

An increase in RCS inventory is caused by an inadvertent start of a charging pump that injects coolant into the RCS faster than letdown. The symptoms of such an event are as follows:

| | EVENT SYMPTOMS | SPDS INDICATION |
|---|---|---|
| a. | RCS pressure - increasing | Pressurizer pressure indication |
| b. | Pressurizer level - increasing | Pressurizer level indication |

A review of the SPDS display in conjunction with the Safety Function Checklist in procedure OP-902-008, "Safety Function Recovery Procedure", requires operations' personnel to verify several functions during the recovery from an increase in RCS inventory event. The successful completion of these functions indicates that the plant is under control and recovering from the event. As shown below, the SPDS provides the indications necessary to allow the primary user to rapidly determine that all of the safety function criteria are successfully met.

| | SAFETY FUNCTION CRITERIA | SPDS INDICATION |
|---|---|---|
| a. | Reactor Power - decreasing | Reactor power and "Reactor Trip" indication |
| b. | Pressurizer level - 7% - 60% | Pressurizer level indication |
| c. | RCS pressure - maintaining or < 2300 psia | Pressurizer pressure indication and rate of change |

SUMMARY

Upon reviewing the above charts, all the indications needed to rapidly assess plant status during both the event initiation and recovery can be determined directly from the SPDS.

It is important to note that other parameters not available on the SPDS could also be used to diagnose an event, however, they are not required to rapidly assess plant status. For example, for an inadvertent excess charging flow event, charging and letdown flow rates could be used to diagnose the event. For a quick assessment of plant status, however, these flow rates are unnecessary. Rather, the primary user can rapidly assess plant status by ensuring that all relevant safety functions are met. In this particular event, a review of the RCS INVENTORY (pressurizer level indication) and RCS PRESSURE (pressurizer pressure indication) safety functions will allow the primary user to rapidly assess plant status. Therefore, as long as these safety functions are satisfied (or being satisfied) the plant is in a safe condition (or returning to a safe condition).

6. LOSS OF RCS INVENTORY

A loss of coolant accident is defined as a hypothetical break in a pipe in the reactor coolant pressure boundary resulting in the loss of reactor coolant at a rate in excess of the capability of the charging pumps. Examples of this event are a large break LOCA or a Steam Generator tube rupture. The symptoms of such an event are as follows:

| | EVENT SYMPTOMS | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - trip & decreasing | Reactor power and "Reactor Trip" indication |
| b. | RCS pressure - decreasing | Pressurizer pressure indication |
| c. | Containment pressure - increasing | Containment pressure indication |
| d. | Pressurizer level - decreasing | Pressurizer level indication |
| e. | SIAS - actuated | "SIAS actuated" indication |
| f. | Secondary activity - increasing (for tube rupture) | "Condenser off-gas activity" indication |

A review of the SPDS display in conjunction with the Safety Function Checklist in procedure OP-902-008, "Safety Function Recovery Procedure", requires operations' personnel to verify several functions during the recovery from a loss of inventory event. The successful completion of these functions indicates that the plant is under control and recovering from the event. As shown below, the SPDS provides the indications necessary to allow the primary user to rapidly determine that all of the safety function criteria are successfully met.

| | SAFETY FUNCTION CRITERIA | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - decreasing | Reactor power and "Reactor Trip" indication |
| b. | Pressurizer level - 7% - 60% | Pressurizer level indication |
| c. | Subcooling Margin - $\geq$ 28°F | RCS Subcooling indication |
| d. | RCS pressure - restoring or maintaining | Pressurizer pressure indication |
| e. | RCS temperature - CET < 700°F and steady | CET temperature and rate of change indication |
| f. | Steam Generator level - $\geq$ 50%, constant or rising | Steam Generator level indication and rate of change |
| g. | Containment pressure - < 17.7 psia | Containment pressure indication |
| h. | Containment temperature - < 220°F/N/A (LOCA/SGTR) | Not available |
| i. | Vital auxiliaries - 4.16 KV safety bus energized if needed | Vital auxiliaries box |

SUMMARY

All of the indications needed to rapidly assess plant status during both the event initiation and recovery can be determined directly from the SPDS (see event 1 - Increased Heat Removal).

It is important to note that other parameters not available on the SPDS could also be used to diagnose an event, however, they are not required to rapidly assess plant status. For example, for a loss of RCS Inventory event, safety injection flow rate could also be used to diagnose the event. For a quick assessment of plant status, however, the exact safety injection flow rate is unnecessary. Rather, the primary user can rapidly assess plant status by ensuring that all relevant safety functions are met. In this particular event, a review of the RCS CORE HT REMOVAL (steam generator level, and "core uncovered" indications), RCS PRESSURE (RCS pressure indication), RCS INVENTORY (pressurizer level, RCS subcooling, SIAS indications), CONTAINMENT ISOLATION (CIAS and condenser off-gas activity indications), CONTAINMENT TEMP & PRESS (containment pressure and CSAS indications), and CONTAINMENT $H_2$ GAS ($H_2$ concentration indication) safety functions will allow the primary user to rapidly assess plant status. Therefore, as long as these safety functions are satisfied (or being satisfied) the plant is in a safe condition (or returning to a safe condition).

7. ANTICIPATED TRANSIENT WITHOUT SCRAM

An Anticipated Transient Without SCRAM (ATWS) is characterized by an initiating event (e.g., loss of feedwater) which should have but did not result in a reactor trip.

The indication during an ATWS event is as follows (the event which precipitates the event is not discussed here):

| | EVENT SYMPTOM | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - constant with reactor trip signal in | "Reactor Trip" box illuminated and Reactor power indication |

The event which precipitates the transient can be classified in a manner similar to those events described above. However, classifying the ATWS is quite easy with the SPDS.

A review of the SPDS display in conjunction with the Safety Function Checklist in procedure OP-902-008, "Safety Function Recovery Procedure", requires operations' personnel to verify reactor power indications. The indications available to the primary user from SPDS to allow rapid assessment of plant status during and after an ATWS are:

| | SAFETY FUNCTION CRITERIA | SPDS INDICATION |
|---|---|---|
| a. | Reactor power - <1.0E-4% and constant or decreasing | Reactor power and "Reactor Trip" indication |

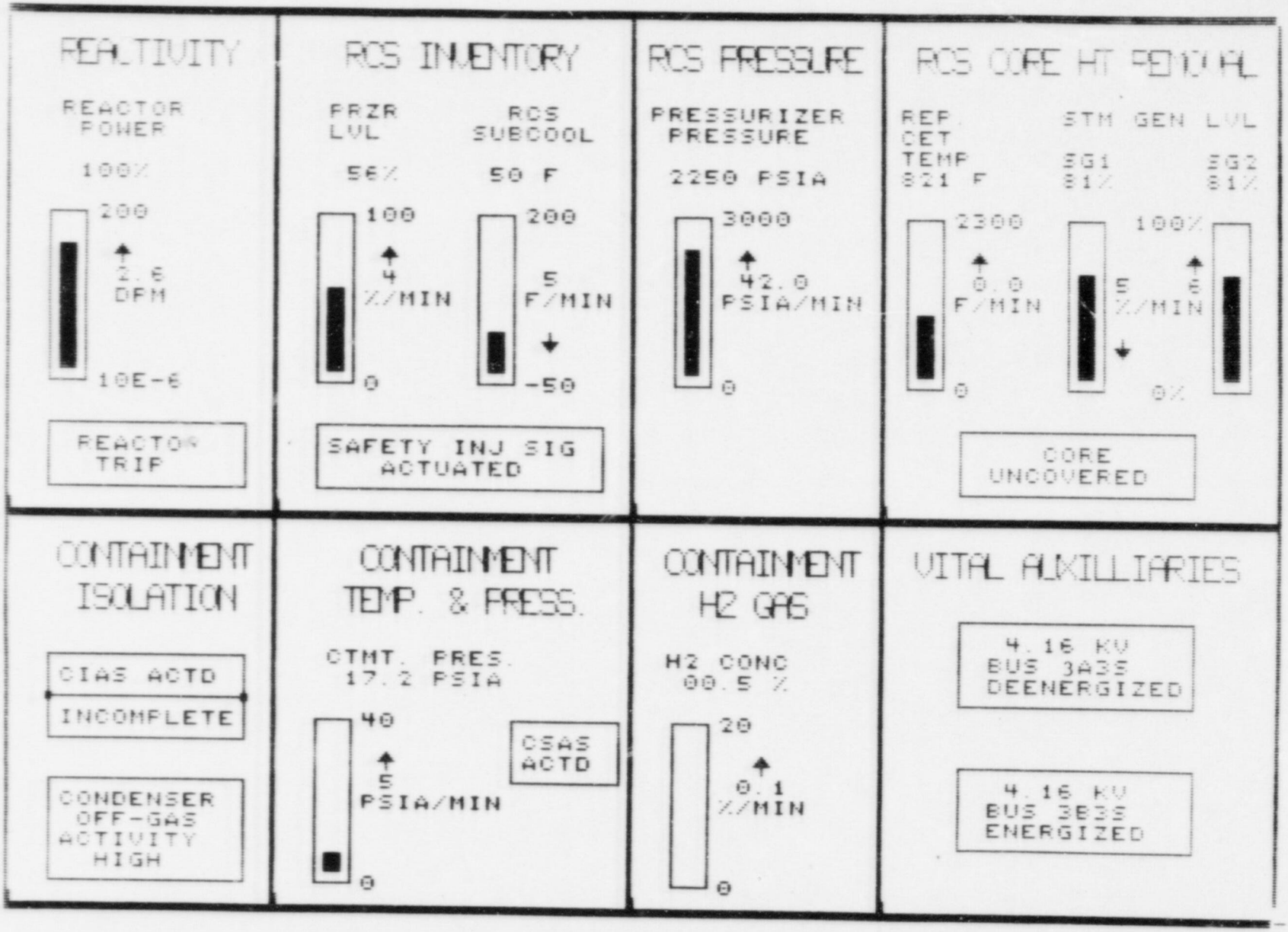
SUMMARY

Upon reviewing the above charts, all of the indications needed to rapidly assess plant status during both the event initiation and recovery can be determined directly from the SPDS.

It is important to note that other parameters not available on the SPDS could also be used to diagnose an event, however, they are not required to rapidly assess plant status. For example, for an ATWS event, boration flow rate would be helpful during this event. For a quick assessment of plant status, however, the exact boration flow rate is unnecessary. Rather, the primary user can rapidly assess plant status by ensuring that all relevant safety functions are met. In this particular event, a review of the REACTIVITY (reactor power and "reactor trip" indications) safety function will allow the primary user to rapidly assess plant status. Therefore, as long as this safety function is satisfied (or being satisfied) the plant is in a safe condition (or returning to a safe condition).

**ATTACHMENT 2**

**TENTATIVE SPDS DISPLAY**

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