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CRITERIA FOR ABORTING ATTEMPT TO ESTABLISH NATURAL CIRCULATION

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CRITERIA FOR ABORTING ATTEMPT TO ESTABLISH NATURAL CIRCULATION

The purpose of this memo is to define criteria to be used by plant personnel for aborting an attempt to establish natural circulation at TMI-2.

The problem is approached by (1) identifying all parameters which affect the reactor coolant system (RSC) and can be measured with existing equipment, (2) identifying all detectors available for measuring the parameters identified in (1), (3) selecting those parameters which can be used to show that natural circulation has not been achieved, (4) identifying those parameters selected in (3) which can be interpreted by a plant operator unambiguously, (5) list the possible scenario's which lead to the attempt to reach natural circulation, (6) describe the sequence of events for each scenario listed in (5), and (7) define the criteria for aborting the attempt to reach natural ciruclation.

RCS Parameters (Measurable)

Temperatures

Pressures

Acoustic Signal

Neutron Detector

Gamma Detector

Volume (pressurizer and/or makeup tank level)

Thermal Noise

Pressure Noise

Instrument Degradation

Transient vs. Steady State Measurements (for each of above)

Available Detectors

Temperatures

T_{hot} (3 RTD's, 1 on B and 2 on A) - wide range (ambient to 550°F) $\pm$ 10°F

T_{cold} (4 RTD's, 1 in each leg) - narrow range (500°F to 650°F) $\pm$ 10°F

In Core T/C's - 44 working

Pressurizer RTD - wide range (liquid portion) (0 - 500°F) $\pm$ 10°F

Secondary system temps in steam generator

In Core Neutron detectors (SPND's can be used for ~1700°F indication)

Pressures

P (3 pressure transduces, 1 on B and 2 on A) 0-1000 psig

Containment pressure

Acoustic Signals

Upper tube sheet of A & B Gener. (2 each)

Lower tube sheet of A & B Gener. (1 each)

Acoustic Signals (Cont.)

Upper reactor vessel head (outside) (2, 90° apart on bolts)

Lower reactor vessel (2, 1 on center in core guide and 1 on outside guide, both outside vessel)

Both sound and CRT spectrum available from each of above.

Neutron detectors

Ex-Core
- Source range (BF_3 - thermal neut) (2, 180° apart)
- Intermediate range (2, 180° apart) compensated ion chambers
- Power range (4, 90° apart) uncompensated ion chambers

Gamma Detectors

Power range (4, 90° apart) ex-core uncomp. ion chambers

Volume

Make up flow + pressurizer level + letdown flow + P + T - no automatic calc available

Pressurizer level (3 DP's, 1 working, 1 questionable, 1 failed)

(Heater bank power spikes as each is uncovered)

(Press. RTD will eventually give info)

Thermal Noise

2 incore T/C's dedicated to thermal noise

Pressure Noise

Loop A & Loop B - 1 each press. transd.

Instrument Degradation

Pressurizer level

Incore SPND's

12 (on strip charts) incore T/C's

T_{hot} (A loop) on strip chart

Parameters which show Natural Circulation Not Achieved (Key Parameters)

Core Temperatures and rate of change

T_{hot}, T_{cold}, and rate of change

Pressure

Upper head acoustic detector (violent boiling)

Lower head acoustic detector (debris falling)

Source range BF_3 (criticality) - rate of change (approach to criticality)

Thermal noise (boiling)

Pressurizer level

Key Parameters Interpretable Unambiguously by Operator

T_{hot}, T_{cold}, and rate of change

Source Range BF_3

Pressurizer level

Other key parameters require the presence of an experienced diagnostician to interpret.

Initiation Scenario's

A. Current status; reactor coolant pump (RCP) trips; unable to start another pump.

B. Planned trip of RCP

Current status implies that experienced diagnosticians are not present in Cable Spreading and Control Rooms. Experienced diagnostician may be available within about two hours. No back-up analysts immediately available.

Plant trip implies: experienced diagnosticians in Control and Cable Spreading Rooms, back-up diagnosticians and analysts available on-site; other required diagnosticians and analysts immediately available via phone.

SEQUENCE OF EVENTS

Scenario A

1. Pump 2A trips with system at ~850 PSI.
2. Attempt to start 1A - call for assistance from diagnosticians.
3. If 1A doesn't start, reactor operator attempts to achieve natural circulation.
4. If natural circulation is not achieved, attempt to start 1B.
5. If 1B doesn't start, attempt to start 2B.
6. If 2B doesn't start, abort by going to HPIS while maintaining secondary side of 'A' steam generator at 580".

Scenario B

1. Pump is tripped at preselected pressure (>> 850 PSI)
2. Reactor operator attempts to achieve natural circulation
3. If natural circulation is not achieved, abort by attempting to start one of four pumps.
4. If no pumps start, go into reflux boiler mode; diagnosticians and analysts interpret results. ABORT BY GOING TO HPIS.

CRITERIA FOR ABORTING

Scenario A

If one of the RCP's starts, there will probably be mechanical movement of the core; this could change the distribution of "hot" and "cold" core T/C's. There is no current criteria to tell the operator what to do in this case. For example, if the temperatures rise rapidly on one or more T/C's, what should the operator do?

At this writing, there is a question on whether the BF_3 counters are showing a k_{eff} very near criticality. If the core moved, a rapid increase in BF_3 count rate would indicate approach to criticality. There is probably no

Scenario A (Cont.)

mechanical response which could be made before the increased heat generation would re-distribute any loose fuel pellets. Therefore, the operator could be left with a completely different distribution of "hot" and "cold" T/C's.

For the above reasons, there is no logical way that the core T/C's can be counted on to give an unambiguous signal to the operator. Therefore, the only criteria available are T_{hot}, T_{cold}, their rate of change, and the rate of change of the BF_3 counter. Since the rate of change of these instruments is not automatically printed out, an unambiguous interpretation cannot be assured. Therefore, only T_{hot}, T_{cold} are available. Consequently, one criteria for aborting the attempt to achieve natural circulation in this case is:

$$T_{hot} \text{ or } T_{cold} \geq T_{sat} - \text{Margin} \Rightarrow \text{Abort.}$$

The current B&W margin of $100^{o}F$ is adequate and (probably) conservative.