

WCAP-11702

RESPONSES TO NRC QUESTIONS
REGARDING FAST RESPONSE,
NARROW RANGE, THERMOWELL
MOUNTED RTDs

DECEMBER 1987

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Question 1

Regarding the problem of drift of the RTD response time identified in NUREG-0809 (Reference 1), describe (a) the method(s) for checking RTD response time, and (b) the safety allowance or other methods to provide assurance that the response times do not drift outside acceptable limits between the 18 month checks.

Answer 1a

The response time of the individual RTDs will be checked using the Loop Current Step Response (LCSR) test prior to initial criticality. The RTD response time will also be checked as part of the data reduction from the full power plant trip test which will be conducted during initial power operations.

Answer 1b

The plant safety analysis has assumed an overall protection channel response time that has been shown to provide adequate protection from design basis transients. The various elements which make up this assumed response time were chosen so as to bound the actual performance of each hardware constituent. When the channel response time is measured it can be compared to the assumed value and the difference will be the excess margin that exists.

The present 18 month surveillance schedule is designed to monitor such critical hardware as the RTDs and determine if adverse trends may be developing. If such a trend were to exhibit itself with this model RTD/thermowell then at that time appropriate steps would be taken. The present surveillance interval is appropriate for identifying those trends and no further steps need to be taken at this time.

Question 2

There is evidence of a slow drift in RTD readings with time, possibly all in one direction. Discuss how long term drift would be detected before it reached unacceptable levels. The staff has accepted one licensee's commitment to replace two RTDs after each of the next two refueling outages to check the calibration of the removed RTDs.

Answer 2

Westinghouse recommends the performance of an RTD cross-calibration during the heatup after each refueling. This procedure requires multiple measurements at three or four different temperatures. To date, Westinghouse has evaluated the data from over four hundred RTDs using this technique, far more than any other recent testing. Several repeat tests performed one to three years apart have not shown any indication of drift in only one direction. The results of the tests indicate that the RTDs drift less than []^{a,c} assumed for uncertainty calculations for the protection system. The

procedure sensitivity is sufficient to discern a random drift of less than 1.0 degree F by one or several RTDs. At that time, either the calibration of the R/E(s) for the affected RTD(s) would be adjusted to account for the shift, or the RTD(s) would be declared inoperable and would be replaced.

Question 3

Failure of an RTD in a particular loop would be signalled and alarmed by the deviation of the Tavg and delta T values for that loop compared to the values for the other three loops.

Question 3a

What are the deviation values that will activate the alarm?

Answer 3a

There presently exists as part of the plant electronics both a Tavg and a Delta T deviation alarm. This alarm compares the four signals; either Tavg or Delta T, one from each channel, to a pre-set threshold value. This value is nominally set to + or - 2 degrees F and is adjusted during startup and subsequent operation such that it is just beyond the range of normal operating variations.

Question 3b

What is the minimum temperature error in a single failed RTD that will cause the deviation alarm to go off?

Answer 3b

Tavg is calculated by adding the average hot leg temperature (Thot) and cold leg temperature (Tcold) and dividing the sum by two. If we assume the deviation threshold remains at + or - 2 degrees F, then the deviation alarm will enunciate when the Thot average value has shifted four (4) degrees F. However, Thot average is first calculated by averaging three (3) independent RTDs. This Thot signal is then used to calculate Tavg. Since Thot relies on three (3) RTDs instead of one (1) the shift in any one RTD could be twelve (12) degrees F. This still represents the same Thot shift of four (4) degrees that would have existed if the RTD Bypass Elimination had not been implemented and provides the same level of warning that the Thot channel is experiencing problems.

The same logic can be applied to the Delta T deviation alarm. Delta T is calculated by : $T_{hot} - T_{cold}$. In this case, Thot average is allowed to shift by two (2) degrees F before the + or - 2 degree F threshold value is met. Since there are three (3) RTDs used to generate Thot, any one RTD could shift six (6) degrees F.

The allowable channel to channel deviation remains the same as the original design. The additional shift that individual RTDs are allowed is a direct result of the averaging nature of the modification. The impact of any one RTD changing is reduced by a factor of three (3) and, therefore, its allowable shift can be larger.

Question 3c

How often will individual RTDs be monitored in normal operation?

Answer 3c

The individual RTDs will be monitored during the normal periodic surveillance routine when the bias data is recorded and updated.

Question 4

Indicate your plans to check and confirm the accuracy of the new method for hot leg temperature measurements by comparison against other plant measurements. The staff has accepted one licensee's commitment on a plant which is removing their existing RTD bypass system, to obtain confirmatory information by comparing pre-installation and post-installation calorimetric data on RTD temperature measurements in their plant for matching operating conditions. The staff intends to review this confirmatory information.

Answer 4

South Texas will enter initial operation with the thermowell RTD temperature measurement only. There will be no prior operating data to use as a comparison to the present temperature measurements. The plant will be performing the normal intensive startup test program which is designed to evaluate plant system performance. This testing is much more involved than the normal post-refueling startup testing that operating plants routinely perform. It is expected that the testing to be performed at South Texas will uncover any gross instrumentation errors prior to the plant entering commercial operation. The successful completion of the startup test program will provide confirmation that the integrated plant systems, including primary system temperature measurement, are performing in an acceptable manner. No other special tests or comparisons are needed.

REFERENCES

1. NUREG-0809, Safety Evaluation Report, Review of Resistance Temperature Detector Time Response Characteristics, August 1981.
2. NUREG/CR-2928, Degradation of Nuclear Plant Temperature Sensors, June 1987
3. K.R.Carr, An Evaluation of Industrial Platinum Resistance Thermometer Temperature - Its Measurement and Control in Science and Industry, ISA Publication, Vol. 4, Part 2, 1972, Pages 971-982.
4. B.W.Mangum, The Stability of Small Industrial Platinum Resistance Thermometers, Journal of Research of the NBS, Vol. 89, No. 4, July-August 1984, Pages 305-350.