WCAP-11890
ADDENDUM 1

WESTINGHOUSE CLASS 3

RESPONSES TO NRC QUESTIONS ON RTD BYPASS ELIMINATION LICENSING REPORT

OCTOBER, 1988

H. B. ROBINSON 2 RTD BYPASS ELIMINATION
NRC QUESTIONS & RESPONSES

1. In table 2.1-1 of Attachment 4 (WCAP-11889) of Reference 1, the response time parameters for the RCS temperature measurement are presented for both the existing RTD bypass system (old system) and the proposed system (new system). The new system, which has the bypass system removed, uses fast response thermowell RTDs manufactured by WEED Instruments Inc. Adding the times given in Table 2.1-1 for the components, the system response time is 5.0 seconds for the old system (Rosemont RTD) and 4.75 seconds for the new system. However, a footnote explains that you cannot simply add all the response time parameters because of transfer functions which have different forcing functions as inputs. Since it is a staff position that the RTD response time and surveillance schedule (as it affects the overtemperature delta T and overpressure delta T) needs to be addressed in the plant Technical Specifications, the following information is needed for our evaluation:

QUESTION (a): What RTD response time in seconds was used for the FSAR Chapter 15 accident analyses for the hot and cold leg RTDs for transients depending on overtemperature delta T (as performed in the ANF-88-094 report) and overpower delta T trips?

RESPONSE: As presented in Table 2.1 of the Report ANF-88-094, the overtemperature deltaT reactor trip response time used in the accident analysis matches Table 2.1-1 of WCAP-11889. This is an upper limit of a 4-second leg time constant in combination with a 0.75 second electro-mechanical delay. In this respect, the equipment specification was directly incorporated in the accident analysis caluclations.

QUESTION: What is expected value of the RTD system response time?

RESPONSE: The RTDs will have a response time of 4.0 seconds or less. The remaining channel electronics response time will be 0.75 seconds or less.

QUESTION: What data supports these response time values?

RESPONSE: The RTD response times were measured at the manufacturer utilizing an industry standard plunge test in water flowing at 3 ft/sec. The measured response times varied between 2.7 to 3.7 seconds. All RTDs tested less than 4.0 seconds. When the RTDs are installed in the plant the in-situ response times will be measured by the Loop Current Step Response (LCSR) test. The higher fluid velocities and elevated temperatures in the plant should result in slightly better response times. The RTDs were tested inside thermowells from the production run to be used at HBR2.

1. (Continued)

QUESTION (b): If total system response time data is not available, discuss the supporting data for each of the components of the total response time and how a bounding value for the total response time is derived. Include each of the elements listed in Table 2.1-1 as well as a discussion of the affects on response time of the scoop and the gap between the scoop and the WEED RTD.

RESPONSE: The RTD data is discussed above. The electronics response time is typical of response times measured at other plants with analog electronics. While the conservatism normally found in other plants electronics response times has been removed, the value quoted in table 2.1-1 will bound the actual response time.

QUESTION: Discuss the effects on response time of the scoop and the gap between the scoop and the WEED RTD.

RESPONSE: [

] +a,c

There is no radial gap between the RTD and the thermowell with the WEED design. Only the RdF thermowell mounted RTDs have this gap.

2. You have stated that your WEED RTD is similar to other WEED RTDs installed at other plants. However, it is noted that two other plants that are using WEED RTDs have quoted "total response" times that are 1.25 to 3 seconds longer than for the H. B. Robinson plant. Their combined "RTD/thermowell" response times excluding electronics are 0.25 to 2.5 seconds longer than for the H. B. Robinson plant.

QUESTION: How do you account for the faster response times for the H.B. Robinson plant? Does H.B. Robinson plant have a design difference to account for a faster RTD response time measurements than at other plants?

RESPONSE: There are two other plants that utilize the same 4.0 second WEED RTD that will be used at Robinson. Both of these plants elected to include excess response time margin in their safety analyses. One plant requested that the safety analysis assume a 5-1/2 second RTD response time. Subsequent plant measurements indicated that, on average, the RTD response time was 3-1/3 seconds. Clearly significant response time margin was assigned to the RTDs. Robinson has elected to not include excess RTD response time margin in the analysis, and instead, will rely on the RTD's performance. The factory tests mentioned earlier showed that the slowest RTD was 3.7 seconds. Based on this information and the data from the plant mentioned above the Robinson RTD responses will be faster than the safety analysis value.

3. Regarding the problem of drift of the RTD response time identified in NUREG-0809 (Reference 2).

QUESTION: Describe (a) the method(s) for checking RTD response time after installation, (b) the frequency of the checks and (c) the safety allowance or other methods to provide assurance that the response times do not drift outside acceptable limits between the required 18-month checks.

RESPONSE (a): The response time of the installed RTDs will be checked using the Loop Current Step Response (LCSR) test prior to initial criticality.

RESPONSE (b): The RTDs will be checked on a refueling basis not to exceed every 18 months.

RESPONSE (c): 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 above surveillance schedule is designed to monitor 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.

5. In section 1.2.1 of Attachment 4 of Reference 1 (WCAP-11889), it was stated that because of interference, one of the three RTDs in each of loops A and B will have a changed position and will be located downstream from the other RTDs. Also, as shown in Figure 1.2-3 of WCAP-11889, these RTDs are shown as not being placed in a scoop as the other RTDs are.

QUESTION: Please provide the dimensions that locate both the downstream and circumferential location of these displaced RTDs in relation to the others.

RESPONSE: Since the the submittal of WCAP-11889 a plant outage has allowed for a detailed inspection of the loop piping and interferences. It has been determined that Loop B will not have any thermowells relocated. All three RTD/thermowells will be mounted in the existing scoops. On Loop A it was determined to move all three thermowells out of the scoops and mount them 24 inches downstream. The thermowells will maintain their original circumferential spacing with one thermowell top dead center and the other two 120 degrees to either side.

5. (Continued)

QUESTION: Will the immersion depth be the same as the others which are in the scoops?

RESPONSE: Yes. The RTD heat sensitive tip will be located at the same radial position as the center flow hole of the scoop, but 24 inches downstream of the scoop location.

QUESTION: What will be the relative affect of not having these RTDs in the scoops, as the others are, on the response time and accuracy of the reading?

RESPONSE: The response time of the RTD in the hot leg free stream should, theoretically, be slightly faster than those located in the scoops. However, data from another plant indicates that this slight advantage is not reflected in a faster measured response time with respect to the scoop mounted RTD/thermowells.

Since all three RTDs are being moved downstream together the accuracy of their combined measurement will be the same as if they were all three still in the scoops. The flow perturbation caused by the scoop upstream of the new RTD location will have dissipated prior to reaching the RTD. It is expected the this small perturbation will help mix the hot leg fluid and somewhat reduce the magnitude of the temperature streaming.

QUESTION: What data supports the response time and accuracy of the RTDs in this configuration?

RESPONSE: The response time data from another plant, as mentioned above, indicates that there is no systematic difference in response times between the RTD mounted in the scoops and those in the free stream. Since all three relocated RTDs in Loop A are being kept together the accuracy of their measurement will be the same as the three scoop mounted RTDs. The data referred to in Section 2.2 of WCAP-11889 is therefore applicable to this configuration.

6. Provide the value of the latest indicated RCS flow measurement for the H. B. Robinson Unit 2 plant in lb/hr and gpm and also the value for the thermal design flow (TDF) in lb/hr and gpm.

QUESTION: What is the current flow measurement uncertainty value?

6. **RESPONSE:** The results of the latest precision calorimetrics RCS flow measurement are:

NOMINAL	WITH ALLOWANCE FOR MEASUREMENT UNCERTAINTY
103.8×10^6 lb/hr (1-0.0187*) =	101.9×10^6 lb/hr
273,400 gpm (1-0.0187*) =	270,250 gpm

* Measurement Uncertainty

From Tables 15.2.1-1, 15.4.2-1, and 15.4.3-1 in ANF-88-094, the corresponding thermal design flow is:

97.29×10^6 lb/hr @ 550.2°F

With a density of 46.85 lb/ft^3, this translates to:

$(97.29 \times 10^6 \text{ lb/hr})(1 \text{ ft}^3/46.85 \text{ lb})(7.48 \text{ gal/ft}^3)(1 \text{ hr}/60 \text{ min.}) =$ 258,900 gpm

7. In Section 3.1 of WCAP-11889, there is reference to using standard Westinghouse methodology previously approved for the flow measurement uncertainty analysis.

QUESTION: Please provide the reference for the methodology and also indicate if the H. B. Robinson analysis has any deviations from this methodology.

RESPONSE: The Westinghouse methodology used to calculate RCS Flow Measurement Uncertainty has been in use for many years and was first definitively noted in a Westinghouse letter to the NRC with respect to the use of the Improved Thermal Design Procedure (ITDP) on D. C. Cook Unit 2; Westinghouse letter NS-TMA-1806, to E. G. Case (NRC), from T. M. Anderson (Westinghouse), 5/30/78. Subsequent to this submittal, the methodology was used for all ITDP RCS Flow Measurement Uncertainty calculations, e.g., McGuire, Catawba, Ginna, Point Beach, Byron and Braidwood. The methodology was explicitly reviewed and approved by the Staff for McGuire in an NRC letter; to H. B. Tucker (Duke Power) from E. G. Adensam (NRC), 6/23/83. Modifications were made to this methodology to specifically address the use of three Hot Leg RTDs and Hot Leg Streaming with the calculations performed for RTD Bypass Elimination. The results of these calculations were submitted on the dockets for the following plants (most of which are currently in operation with this plant change); McGuire, Catawba (WCAP-11308), Bryon/Braidwood (WCAP-11323), Millstone Unit 3 (WCAP-11273), Salem (WCAP-11580), and South Texas Project (WCAP-11273 for the protection system setpoints). The Westinghouse methodology is consistent with that outlined in NUREG/CR-3659, "A Mathematical Model for Assessing the

7. **RESPONSE:** (Continued)

Uncertainties of Instrumentation Measurements for Power and Flow of PWR Reactors". The calculational methodology used to perform the calculations for this parameter for H. B. Robinson has no deviations from that presented for the above noted plants.

8. A flow measurement uncertainty analysis was presented in WCAP-11889 for the H. B. Robinson plant in which the uncertainties of the new WEED RTDs was factored into the analysis. However, the effect of the uncertainty due to the readings from cold leg elbow taps was omitted in arriving at the final uncertainty value. It is understood that verification is made of the RCS flow by a calorimetric heat balance performed after return to full power operation following a refueling shutdown. At that time, the cold leg elbow tap pressure drop indication is taken as the corresponding flow reading. Because the cold leg elbow tap reading is subject to additional drift and other uncertainties, it is usual (as performed for your Shearon Harris plant) to include these additional uncertainties in the flow measurement uncertainty analysis.

QUESTION: Please provide a flow measurement uncertainty that includes the effect of cold leg elbow tap uncertainty. Also, no mention was made of the uncertainty for feedwater venturi fouling. It is a staff position that a 0.1% venturi fouling penalty should be added unless the venturi tubes are cleaned at each refueling before the precision heat balance is made and that the total flow measurement uncertainty should also be included in the plant Technical Specifications. The uncertainty factor can be placed either in a section addressing F delta H or a section pertaining to DNB parameters.

RESPONSE: Table 1 notes the instrument uncertainty breakdown for the Cold Leg Elbow Tap indication of RCS Flow with the use of the plant process computer. The 0.1% venturi fouling penalty has been added.

9. The calibration of the RTDs is performed before the calorimetric heat balance at each refueling. It is understood that this is by a cross calibration method in which it is assumed that variation occurs in a random manner from the original calibration from the manufacturer. Therefore, the mean value is assumed to be the correct value. However, over a 40 year life, the RTDs may drift in one direction. One manufacturer has indicated a 1°F drift in five years. It is noted that several references indicate that although platinum RTDs are quite stable, there is evidence of drift (Refs. 2, 3 and 4).

QUESTION: How is the original calibration accuracy of the RTD established? How will you be able to tell if there is unacceptable drift in one direction and what steps will be then taken?

9. **RESPONSE:** The recommended means for confirming installed RTD accuracy is through RTD cross calibration testing, whereby each RTD is compared to the average of all RTDs at several isothermal temperatures during plant heatup or cooldown. Evaluation of the test data supports confirmation of RTD accuracy, recalibration to the plateau average temperatures, or RTD replacement, as necessary. Cross calibration will be performed following installation of new RTDs to check for calibration shifts resulting from shipping, storage, or installation, and at refueling outages to confirm stability and to check for drift.

   Cross calibration requires the determination of accurate plateau average temperatures, which requires that calibration errors be random, and not systemmatic. This is considered the case for vendor supplied calibrations. In addition, Westinghouse experience suggests that RTD drift is random, if it occurs. Therefore, the existence of drift does not degrade the plateau average temperature accuracy. Consequently, RTDs that have drifted significantly will be detected and realigned to the average, or replaced if gross stability is in question.

   The Westinghouse position on RTD drift is based on experience, in conjunction with the limited literature published on this subject. In several cross calibration test data evaluations the absence of drift was confirmed through comparison of existing installed RTDs to newly installed units. The literature, most notably References 3 and 5, indicate that drift is generally small, can be positive and negative, and, when extreme, can be detected and corrected through cross calibration testing.

   The [$]^{+a,c}$ drift allowance incorporated in the H. B. Robinson calculations is judged to bound any unanticipated drift. In Westinghouse judgement, RTDs that exceed this allowance are of questionable stability and should be considered for replacement.

10. Your new method of obtaining the hot leg temperature differs from the previous method. In the previous method, the flow in each hot leg was sampled from the scoops in the pipe cross section. This sampled flow was measured in a mixing plenum to obtain an average temperature value. Your present method replaces the sampled flow from a scoop with a single temperature measurement of the scoop flow which is used to be equivalent to the former sampled flow value.

    QUESTION: Please indicate how you plan to check and confirm the accuracy of this new hot leg average temperature measurement method (new system) against the former RTD bypass method (old system). The staff should be informed of the results of such a test.

10. **RESPONSE:** The hot leg temperature measured with the thermowell RTDs can be compared with the hot leg temperature previously measured with the RTDs in the bypass system by comparing delta Ts (normalized to full power) measured before and after the modification. Since there are uncertainties in both RTD system measurements, and differences in streaming patterns from cycle to cycle, it is not likely that the two measurements will be exactly the same. Any difference between the two delta T's considered to be an indication of the error in both measurments rather than an indication of an error in just the new thermowell RTD measurment. The staff will be informed of the results of this analysis.

12. In WCAP-11889 you have discussed the method for detecting failed RTDs which may go offscale or fail gradually.

    QUESTION: What is the amount of temperature deviation in degrees that will cause Tavg and delta T alarms? What is the frequency of channel checks?

    RESPONSE: For the present channel configuration Tavg is calculated by adding Thot and Tcold and dividing the sum by two. With the deviation alarm set at two degrees F the alarm will enunciate when a Thot RTD has shifted four degrees F. In the proposed new configuration, Thot is calculated using the input of three RTDs. Since the contribution of each RTD is divided by three in this averaging process a single Thot RTD will have to shift three times the original four degrees (twelve degrees F) to trigger an alarm. Even though a single RTD must shift further to trigger an alarm, the controling function (Tavg) has still only moved two degrees F.

    The same logic can be applied to Delta T. Delta T is calculated by subtracting Tcold from Thot. Again the influence of a single Thot RTD is only one third of the total. Therefore a single Thot RTD must shift six degrees before the two degree deviation alarm is triggered. Channel checks are performed on a shift basis.

TABLE 1

COLD LEG ELBOW TAP FLOW UNCERTAINTY INSTRUMENT UNCERTAINTIES

+a,c

PMA =

PEA =

SCA =

SPE =

STE =

SD =

RCA =

M&TE=

RTE =

RD =

ID =

A/D =

RDOT=

BIAS=

FLOW CAL. BIAS =

FLOW CALORIMETRIC =

INSTRUMENT SPAN = 120.0 % FLOW

+a,c
% FLOW

SINGLE LOOP ELBOW TAP FLOW UNC =

N LOOP ELBOW TAP FLOW UNC =

N LOOP RCS FLOW UNCERTAINTY (WITHOUT BIAS VALUES) =

N LOOP RCS FLOW UNCERTAINTY (WITH BIAS VALUES) =

N LOOPE RCS FLOW UNCERTAINTY (WITH BIAS VALUES)

WITH VENTURI FOULING PENALTY =