TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

September 22, 1981

RECEIVED SEP 28 1981 U.S. NUCLEAR REGULATORY COMMISSION

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

Enclosed for NRC review is information concerning the Watts Bar Nuclear Plant reactor fuel. This information is provided in response to an informal NRC request for information in the areas of (1) thermal performance analysis, (2) cladding collapse, (3) fuel rod bowing, and (4) cladding swelling and rupture modes as discussed with the NRC during a telephone conference call on August 26, 1981.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

L. M. Mills

L. M. Mills, Manager
Nuclear Regulation and Safety

Sworn to and subscribed before me
this 22nd day of Sept. 1981.
Bryant M. Lowery
Notary Public
My Commission Expires 4/4/82

Enclosure

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ENCLOSURE
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
RESPONSE TO NRC CORE PERFORMANCE
BRANCH QUESTIONS

Question 1

Update the response to Question 231.3 to reflect current Westinghouse practice.

Response

Westinghouse will utilize the NRC approved[1] thermal performance code PAD 3.3[2] for the fuel rod design of Watts Bar Units 1 and 2. In conjunction with the fission gas releases predicted by PAD 3.3, the following fuel rod internal pressure design basis will be used:

> "The internal pressure of the lead fuel rod in the reactor will be limited to a value below that which could cause (1) the diametral gap to increase due to outward cladding creep during steady state operation and (2) extensive DNB propagation to occur."

The acceptability of this criteria has been demonstrated in WCAP-8963[3] and approved by the NRC[4].

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(1) Letter J. F. Stolz to T. M. Anderson, dated February 9, 1979.

(2) Miller, J. V. (Ed.), "Improved Analytical Model Used in Westinghouse Fuel Rod Design Computations," WCAP-8720 (Proprietary) and WCAP-8785 (Non-Proprietary), October 1976.

(3) Risher, D. H., et. al., "Safety Analysis for the Revised Fuel Rod Internal Pressure Design Basis," WCAP-8963 (Proprietary) and WCAP-8964 (Non-Proprietary), November 1976.

(4) Letter J. F. Stolz to T. M. Anderson, dated May 19, 1978.

Question 2

What model does Westinghouse plan to use to predict clad flattening for Watts Bar fuel?

Response

Westinghouse will utilize the NRC approved cladding collapse model (WCAP-8377 [Proprietary) and -8381 [Non-Proprietary]) consistent with the conditions given in the NRC's SER[1] for this topical report. Thus, there is assurance that cladding collapse will not occur for the design life of the fuel.

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(1) Letter D. B. Vassalo to C. Eicheldinger, dated February 14, 1975.

Question 3

Describe what methods will be used to determine the applicable rod bow penalties.

Response

The penalties applied to $F^N_{\Delta H}$ to account for Rod Bow as a function of burnup are consistent with those described in Mr. John F. Stolz's (NRC) letter to T. M. Anderson (Westinghouse) dated April 5, 1979 and Westinghouse 8691 Rev. 1 (partial rod bow test data).

Question 4

Evaluation of the potential impact of using fuel rod models presented in draft NUREG-0630 on the Loss of Coolant Accident (LOCA) analysis for Watts Bar.

Response

This evaluation is based on the limiting break LOCA analysis identified as follows:

BREAK TYPE - DOUBLE ENDED COLD LEG GUILLOTINE

BREAK DISCHARGE COEFFICIENT 0.6 PERCENT MIXING

WESTINGHOUSE ECCS EVALUATION MODEL VERSION 1978 UHI

CORE PEAKING FACTOR 2.32

HOT ROD MAXIMUM TEMPERATURE CALCULATED FOR THE BURST REGION OF THE CLAD - 1820 °F = PCT_B

ELEVATION - 7.5 Feet

HOT ROD MAXIMUM TEMPERATURE CALCULATED FOR A NON-RUPTURED REGION OF THE CLAD - 2095 °F = PCT_N

ELEVATION - 6.75 Feet

CLAD STRAIN DURING BLOWDOWN AT THIS ELEVATION 10 Percent
MAXIMUM CLAD STRAIN AT THIS ELEVATION 10 Percent

Maximum temperature for this non-burst node occurs when the core reflood rate is (MORE) than 1.0 inch per second and reflood heat transfer is based on the (FLECHT) calculation.

AVERAGE HOT ASSEMBLY ROD BURST ELEVATION - 8.0 Feet

HOT ASSEMBLY BLOCKAGE CALCULATED - 28 Percent

1. BURST NODE

The maximum potential impact on the ruptured clad is expressed in letter NS-TMA-2174 in terms of the changes in the peaking factor limit (FQ) required to maintain a peak clad temperature (PCT) of 2200°F and in terms of a change in PCT at a constant FQ. Since the clad-water reaction rate increases significantly at temperatures above 2200°F, individual effects (such as ΔPCT due to changes in several fuel rod models) indicated here may not accurately apply over large ranges, but a simultaneous change in FQ which causes the PCT to remain in the neighborhood of 2200°F justifies use of this evaluation procedure.

From NS-TMA-2174:

For the Burst Node of the Clad:

- 0.01ΔFQ → ~ 150°F BURST NODE ΔPCT

- Use of the NRC burst model and the revised Westinghouse burst model could require an FQ reduction of 0.027

- The maximum estimated impact of using the NRC strain model is a required FQ reduction of 0.03.

Therefore, the maximum penalty for the Hot Rod Burst node is:

$$\Delta PCT_1 = (0.027 + .03)\ (150°F/.01) = 855°F$$

Margin to the 2200°F limit is:

$$\Delta PCT_2 = 2000°F - 1820\ PCT_B = \underline{\ 380\ }\ °F$$

The FQ reduction required to maintain the 2200°F clad temperature limit is:

$$\Delta FQ_B = (\Delta PCT_1 - \Delta PCT_2) \left(\frac{.01\ \Delta FQ}{150°F}\right)$$

$$= (\underline{855} - \underline{380}) \left(\frac{.01}{150}\right)$$

$$= \underline{.032} \text{ (but not less than zero).}$$

2. NON-BURST NODE

The maximum temperature calculated for a non-burst section of clad typically occurs at an elevation above the core mid-plane during the core reflood phase of the LOCA transient. The potential impact on the maximum clad temperature of using the NRC fuel rod models can be estimated by examining two aspects of the analyses. The first aspect is the change in pellet-clad gap conductance resulting from a difference in clad strain at the non-burst maximum clad temperature node elevation. Note that clad strain all along the fuel rod stops after clad burst occurs and use of a different clad burst model can change the time at which burst is calculated.

To account explicitly for the impact of NUREG-0630 curves in the non-burst node, it is necessary to evaluate the effect on hot rod burst time as it relates to strain at the PCT location (non-burst). By comparing the hot rod non-burst node clad temperature and hoop stress transients to the burst temperature model in NUREG-0630 and by taking credit for the approved 65°F reduction in pellet temperature uncertainty, the hot rod would conservatively have been predicted to burst at 50 seconds when the clad had accumulated 3.8 percent strain.

The maximum decrease in clad strain that must be considered here is the difference between the "maximum clad strain" and the value of 3.8 percent as demonstrated below:

$$\Delta PCT_3 = \left(\frac{20°F}{.01 \text{ strain}}\right) (\text{max strain-pre-burst blowdown strain})$$

$$= \left(\frac{20}{.01}\right) (.10 - .038)$$

$$= \underline{124°F}$$

The second aspect of the analysis that can increase PCT is the flow blockage calculated.

Since PCT_N occurs when the core reflood rate is greater than 1.0 inch per second, $\Delta PCT_4 = 0$.

The total potential PCT increase for the non-burst node is then:

$$\Delta PCT_5 = \Delta PCT_3 + \Delta PCT_4 = 124°F$$

Margin to the 2200°F limit is:

$$\Delta PCT_6 = 2200°F - PCT_N = 2200 - 2095 = 105°F$$

The FQ reduction required to maintain the 2200°F clad temperature limit is (from NS-TMA-2174)

$$\Delta FQ_N = (\Delta PCT_5 - \Delta PCT_6) \left(\frac{.01 \Delta FQ}{10°F \ \Delta PCT}\right) = (124 - 105) \left(\frac{.01}{10}\right) = .019$$

ΔFQ_N = .019 but not less than zero

The peaking factor reduction required to maintain the 2200°F clad temperature limit is therefore the greater of ΔFQ_B and ΔFQ_N, or;

$\Delta FQ_{PENALTY}$ = .032

B. The NRC has recently approved the removal of the 65°F uncertainty on the hot rod fuel pellet temperature for ECCS analysis. The effect of removing this uncertainty on the calculated PCT has been determined based on previously established sensitivities performed to quantify this effect (WCAP-9180). From these, it is estimated that this reduction in applied model uncertainty would result in a decrease in calculated PCT of 22°F for Watts Bar. Applying the same sensitivity used in calculating ΔFQ_N,

$$\Delta FQ_{CREDIT} = 22°F \left(\frac{.01 \Delta FQ}{10°F \ \Delta PCT}\right) = .022$$

C. The peaking factor limit adjustment required to justify plant operation for this interim period is determined as the appropriate ΔFQ credit identified in section (B) above, minus the $\Delta FQ_{PENALTY}$ calculated in section (A) above (but not greater than zero).

FQ ADJUSTMENT = .022 - .032 = -.01

D. The revised peaking factor is then FQ FSAR minus the FQ ADJUSTMENT or:

FQ = 2.32 - .01 = 2.31