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September 15, 1980

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Mr. B. J. Youngblood, Chief
Licensing Projects Branch No. 1

Re: McGuire Nuclear Station
Docket Nos. 50-369, 50-370

Dear Sir:

Attached is the response to Mr. Robert L. Tedesco's letter of August 5, 1980 which requested additional information regarding the McGuire ECCS evaluations. In particular, this response provides the results of supplemental calculations to demonstrate the potential impact of using fuel rod models presented in draft NUREG-0630 on the loss of coolant accident analysis for McGuire Unit 1.

If you have any questions regarding this matter, please advise.

Very truly yours,

William O. Parker, Jr.

William O. Parker, Jr.

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Attachment

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MCGUIRE NUCLEAR STATION

Response to NRC Letter of August 5, 1980
Clad Swelling and Rupture Models for LOCA Analysis

A. Evaluation of the potential impact of using fuel rod models presented in draft NUREG-0630 on the Loss of Coolant Accident (LOCA) analysis for McGuire Unit No. 1.

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

BREAK TYPE - DOUBLE ENDED COLD LEG GUILLOTINE

BREAK DISCHARGE COEFFICIENT C_D = 0.6 PERFECT MIXING

WESTINGHOUSE ECCS EVALUATION MODEL VERSION APRIL 78, UHI

CORE PEAKING FACTOR 2.32

HOT ROD MAXIMUM TEMPERATURE CALCULATED FOR THE BURST REGION OF THE CLAD - 1717°F of PCT_B

ELEVATION - 6.75 FEET

HOT ROD MAXIMUM TEMPERATURE CALCULATED FOR A NON-RUPTURED REGION OF THE CLAD - 2147°F OF PCT_N

ELEVATION - 5.5 FEET

CLAD STRAIN DURING BLOWDOWN AT THIS ELEVATION 10.0 PERCENT
MAXIMUM CLAD STRAIN AT THIS ELEVATION - 20.0 PERCENT

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

AVERAGE HOT ASSEMBLY ROD BURST ELEVATION - 5.75 FEET

HOT ASSEMBLY BLOCKAGE CALCULATED - 36.2 PERCENT

1. BURST NODE

The maximum potential impact on the rupture clad node is expressed in letter NS-TMA-2174 in terms of the change 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:

- $0.01\ \Delta FQ > -150^{o}F$ BURST NODE ΔPCT

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

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

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

$$\Delta PCT_1 = (0.027 + .03)\ (150^{o}F/.01) = 855^{o}F$$

Margin to the 2200°F limit is:

$$\Delta PCT_2 = 2200.^{o}F - PCT_8 = 483^{o}F$$

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

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

$$= (855 - 483)\ \left(\frac{.01}{150}\right)$$

$$= 0.025$$

2. NON-BURST NODE

The maximum temperature calculated for a non-burst section of clad occurs during the core reflood phase of the LOCA transient. The potential impact on that 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. Three sets of LOCA analysis results were studied to establish an acceptable sensitivity to apply generically in this evaluation. The possible PCT increase resulting from the change in strain (in the Hot Rod) is +20.ΔF per percent decrease in strain at the maximum clad temperature locations. The clad strain calculated during the reactor coolant system blowdown phase of the accident is not changed by the use of NRC fuel rod models from the "maximum clad strain" value of 10 percent as demonstrated below:

To account explicitly for the impact of NUREG 0630 curves on 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). This is done by determining the difference in strain at a given pre-burst time in the existing Westinghouse analysis and the strain present when burst is predicted according to the curves. The McGuire analysis case has a hot rod hoop stress at 60 seconds of 7.3 kpsi. This is the reference point for evaluation of burst temperature. Hot rod burst has not yet taken place in the current Westinghouse analysis, but the strain at the 5.5 ft. elevation has reached 10 percent.

There are two pellet temperatures for McGuire that were not accounted for in the existing analysis:

1. Effect of removal of 65°F model unertainty on hot rod burst time - (-65°F stored energy).

2. Use of as-built fuel parameters - (-30°F stored energy).

If these were accounted for in the existing McGuire analysis, hot rod burst would be later than that currently calculated. This result has been established by application of the sensitivity study of PCT to initial stored energy from WCAP-9180. The above two considerations account for a total initial stored energy reduction of 95°F. From WCAP-9180 this results in a reduction of PCT at 60 seconds of 56.4°F.

The existing Westinghouse analysis exhibits a 9.1°F/sec heatup rate at a 1529°F (maximum value) clad temperature elevation at 7.3 kpsi stress at 60 seconds. Construction of a NUREG-0630 curve leads to a burst temperature of 801.2°C - 1474°F the excess in calculated temperature above the NUREG-0630 burst temperature is 1529-1474 - 55°F.

Since the effect of stored energy would result in a decrease in clad temperature of 56.4°F, the stored energy effect more than compensates for postulated burst curve changes. Burst at 60 seconds still is not predicted to occur, so the maximum clad strain value of 10 percent will remain in effect at 5.5 ft. elevation.

Therefore:

$$\Delta PCT_3 = \left(\frac{20^\circ F}{.01 \text{ strain}}\right) \text{ (MAX STRAIN - REVISED BLOWDOWN STRAIN)}$$

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

$$= 0$$

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

$$\Delta PCT_5 = \Delta PCT_3 + \Delta PCT_4 = 0$$

Margin to the 2200°F limit is

$$\Delta PCT_6 = 2200^\circ F - PCT_N = 65^\circ$$

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

$$\Delta FQ_N = (\Delta PCT_5 - \Delta PCT_6)\left(\frac{.01\ \Delta FQ}{10^oF\ \Delta PCT}\right)$$

$$\Delta FQ_N = -.063 \text{ but not less than zero.}$$

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

$$\Delta FQ_{PENALTY} = .025$$

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 reducing pellet temperature 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 combined with the as-built fuel pellet temperature benefit of 30°F will result in a decrease in calculated PCT of 31°F for McGuire. Applying the same sensitivity used in calculating ΔFQ_N.

$$\Delta FQ_{CREDIT} = 32^oF\left(\frac{.01\ \Delta FQ}{10^oF\ \Delta PCT}\right) = .031$$

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).

$$FQ\ ADJUSTMENT = .031 - .025 \geq 0.$$