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February 27, 1981
ST-HL-AE-623
SFN: C-0100
V-0100



Mr. Darrell G. Eisenhut
Division of Project Management
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Eisenhut:

South Texas Project
Units 1&2
Docket Nos. STN 50-498, STN 50-499
Cladding Swelling and Rupture
Models for LOCA Analysis

On October 14, 1980, Houston Lighting & Power Company received a letter from your office requesting additional information concerning the application of the cladding swelling and rupture models for Loss of Coolant Accident (LOCA) analysis. Specifically it was requested that HL&P provide supplemental information which utilizes the materials models of draft NUREG-0630. In response to the above mentioned request, attached is the evaluation of the potential of using fuel rod models presented in NUREG-0630 on the LOCA analysis for the South Texas Project, Units 1&2.

This evaluation is based on a ten (10) grid fuel design. The South Texas Project (STP) FSAR currently reflects the nine (9) grid fuel design and the STP-FSAR will be amended by May 1, 1981 to reflect the ten grid fuel design.

If there are any questions concerning this item, please contact Mr. Michael E. Powell at (713) 676-8592.

Very truly yours,

J. H. Goldberg

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J. H. Goldberg
Vice President
Nuclear Engineering & Construction

MEP/par
Attachment

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CLADDING SWELLING & 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 South Texas Project, Units 1 & 2.

his evaluation is base on the limiting break LOCA analysis identified as follows:

BREAK TYPE DOUBLE ENDED COLD LEG GUILLOTINE

BREAK DISCHARGE COEFFICIENT 1.0

WESTINGHOUSE ECCS EVALUATION MODEL VERSION FEBRUARY 1978

CORE PEAKING FACTOR 2.5

HOT ROD MAXIMUM TEMPERATURE CALCULATED FOR THE BURST REGION OF THE CLAD 1891.4 $^{o}F = PCT_B$

ELEVATION 7.0 Feet.

HOT ROD MAXIMUM TEMPERATURE CALCULATED FOR A NON-RUPTURED REGION OF THE CLAD 2055.8 $^{o}F = PCT_N$

ELEVATION 8.75 Feet

CLAD STRAIN DURING BLOWDOWN AT THIS ELEVATION 3.970 Percent
MAXIMUM CLAD STRAIN AT THIS ELEVATION 3.970 Percent

Maximum temperature for this non-burst node occurs when the core reflood rate is less than 1.0 inch per second and reflood heat transfer is based on the steam cooling calculation.

AVERAGE HOT ASSEMBLY ROD BURST ELEVATION 7.0 Feet

HOT ASSEMBLY BLOCKAGE CALCULATED 47.0 Percent

1. BURST NODE

The maximum potential impact on the ruptured clad node is expressed in terms of the change in the peaking factor limit (FQ) required to maintain a peak clad temperature (PCT) of 2200.0$^{o}$F and in terms of a change in PCT at a constant FQ (from the Westinghouse letter to the NRC, dated December 7, 1979; ref. NS-TMA-2174). Since the clad-water reaction rate increases significantly at temperatures above 2200.0$^{o}$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 2200.0$^{o}$F justifies use of this evaluation procedure.

From the December 7, 1979 Westinghouse letter to the NRC (ref. NS-TMA-2174) the following is provided:

For the Burst Node of the clad:

- $0.01 \Delta FQ = \sim 150.0^{o}F$ BURST NODE $\Delta$ PCT
- 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:

$$\Delta PCT_1 = (0.027 + .03)(150.0^{o}F/.01) = 855.0^{o}F$$

Margin to the $2200.0^{o}F$ limit is:

$$\Delta PCT_2 = 2200.0^{o}F - PCT_B\,^{o}F$$

$$PCT_B = 1891.4^{o}F$$

$$\Delta PCT_2 = 2200.0^{o}F - 1891.4^{o}F = 308.6^{o}F$$

The FQ reduction required to maintain the $2200.0^{o}F$ clad temperature limit is:

$$\Delta FQ_B = (\Delta PCT_1 - \Delta PCT_2)^{o}F \left(\frac{.01 \Delta FQ}{150.0^{o}F}\right)$$

$$= (855.0 - 308.6)\left(\frac{.01}{150.0}\right)$$

$$= 0.0364 \text{ (but not less than zero).}$$

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 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 a change in strain (in the Hot Rod) is $20.0^{o}F$ per percent decrease in strain at the maximum clad temperature locations. Since 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, the maximum decrease in clad strain that must be considered here is the difference between the "maximum clad strain" and the "clad strain during blowdown" indicated above.

Therefore:

$$\Delta PCT_3 = \left(\frac{20.0^{o}F}{.01 \text{ strain}}\right) \text{(MAX STRAIN - BLOWDOWN STRAIN)}$$

$$= \left(\frac{20.0}{.01}\right)^{o}F \; (.0397 - .0397)$$

$$= 0.0^{o}F$$

The second aspect of the analysis that can increase PCT is the flow blockage calculated. Since the greatest value of blockage indicated by the NRC blockage model is 75 percent, the maximum PCT increase can be estimated by assuming that the current level of blockage in the analysis (indicated above) is raised to 75 percent and then applying an appropriate sensitivity formula as shown in the December 7, 1979 Westinghouse letter to the NRC (ref. NS-TMA-2174).

Therefore,

$$\Delta PCT_4 = 1.25^{o}F \text{ (50 - PERCENT CURRENT BLOCKAGE)} + 2.36\,^{o}F \text{ (75-50)}$$

$$= 1.25^{o}F \; (50 - 47.0) + 2.36^{o}F \; (75-50)$$

$$= 62.75^{o}F$$

If $PCT_N$ occurs when the core reflood rate is greater than 1.0 inch per second, $\Delta PCT_4 = 0.0^{o}F$. The total potential PCT increase for the non-burst node is then

$$\Delta PCT_5 = \Delta PCT_3 + \Delta PCT_4 = 0.0^{o}F + 62.75^{o}F = 62.75^{o}F$$

Margin to the $2200.0^{o}F$ limit is

$$\Delta PCT_6 = 2200.0^{o}F - PCT_N{}^{o}F = 2200.0^{o}F - 2055.8^{o}F = 144.2^{o}F$$

The FQ reduction required to maintain this $2200.0^{o}F$ clad temperature limit is (from NS-TMA-2174)

$$\Delta FQ_N = (\Delta PCT_5 - \Delta PCT_6)^{o}F \left(\frac{.01 \Delta FQ}{10.0^{o}F \; \Delta PCT}\right)$$

$\Delta FQ_N$ = -0.08145 (but not less than zero).

The peaking factor reduction required to maintain the 2200.0$^{o}$F clad temperature limit is therefore the greater of $\Delta FQ_B$ and $\Delta FQ_N$,

or; $\Delta FQ_{PENALTY}$ = .0364

B. The effect on LOCA analysis results of using improved analytical and modeling techniques (which are currently approved for use in the Upper Head Injection plant LOCA analyses) in the reactor coolant system blowdown calculation (SATAN computer code) has been quantified via an analysis which has recently been submitted to the NRC for review. Recognizing that review of that analysis is not yet complete and that the benefits associated with those model improvements can change for other plant designs, the NRC has established a credit that is acceptable for this interim period to help offset penalties resulting from application of the NRC fuel rod models. That credit for two, three and four loop plants is an increase in the LOCA peaking factor limit of 0.12, 0.15 and 0.20, respectively.

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

FQ ADJUSTMENT = 0.20 - 0.04 = 0.16