L 04/14/78

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REC: NRC ORG: UHRIG R E DOCDATE: 04/10/78
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DOCTYPE: LETTER NOTARIZED: NO COPIES RECEIVED
SUBJECT: LTR 3 ENCL 3
FURNISHING INFO CONCERNING INCONSISTENCY EXISTING IN TWO OF THE COMPUTER CODES (SATAN-VI(1) & LOCTA-IV(2)) USED IN WESTINGHOUSE LOCA ECCS EVALUATION MODEL, WHICH HAS AFFECTED APPLICANT"S ANALYSIS, INVOLVING ZIRCONIUM-WATER REACTION HEAT GENERATION CALCU

PLANT NAME: TURKEY PT #3 REVIEWER INITIAL: X.JM
TURKEY PT #3 DISTRIBUTER INITIAL: DA

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FLORIDA POWER & LIGHT COMPANY

April 10, 1978
L-78-127

Director of Nuclear Reactor Regulation
Attention: Mr. Victor Stello, Director
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Stello:

Re: Turkey Point Units 3 and 4
Docket Numbers 50-250 and 50-251
ECCS Analysis

Florida Power & Light Company has been informed by Westinghouse Electric Corporation that a logic inconsistency exists in two of the computer codes used in their LOCA ECCS Evaluation Model. The SATAN-VI[1] and LOCTA-IV[2] codes are the affected computer codes. All versions of the Westinghouse Appendix K evaluation model are affected[3,4,5,6]. Therefore, our analysis on record is also affected.

This logic inconsistency involves the interface between the zirconium-water reaction heat generation calculation and the heat conduction equation. Both the zirconium-water reaction equation (Baker-Just) and the heat conduction equation are solved correctly. However, the heat conduction equation uses a volumetric heat flux from the zirconium-water reaction calculation. The output of the zirconium-water reaction calculation is a surface heat flux. This surface heat flux is modified to obtain a volumetric heat generation rate by dividing by the thickness of the radial mesh size between the surface temperature node and the first node inside the clad. It is this calculation which was performed incorrectly. The inconsistency underestimates the volumetric heat generation rate due to the zirconium-water reaction by a factor of 2.

The presence of this logic inconsistency has been verified by visual inspection of the computer codes and by performing energy balances on some sample calculations. Correction of this error will result in higher calculated peak clad temperatures.

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3/3

Westinghouse Electric Corporation has studied the effect of correcting this error on calculated peak clad temperature. In addition to correcting this error, some beneficial model changes were also studied. The result of their studies indicated a net increase in peaking factor from the proposed beneficial model improvements. Some details of these calculations follow.

Westinghouse Electric Corporation has proposed the use of the following improvements to the October 1975 version of their evaluation model:

1. Change the transition boiling correlation used during blowdown from the W Transition Boiling Correlation to the Dougall-Rohsenow correlation. Both correlations have been documented by Westinghouse[3] and both termed "acceptable" in Appendix K of 10CFR50.46 and the NRC SER for the Westinghouse evaluation model.

2. Use of an emissivity in the refill radiation heat transfer model of 0.9[7].

3. Multiply the volumetric heat generation from the zirconium-water reaction calculation by a factor of 2 to correct the logic inconsistency.

4. Use of maxi-convolution to improve the peaking factors being calculated[8].

5. Use of a new 15x15 FLECHT correlation[9].

All of these modifications were discussed by Westinghouse with the staff on March 29, 1978. We understand that it will take the staff three months to review all of these model changes. We will work with Westinghouse and the NRC until then to arrive at a new approved LOCA ECCS Evaluation Model. At that time, we will submit to the Nuclear Regulatory Commission a schedule for reanalysis of the present limiting break size with the new model. A reanalysis will be performed for Turkey Point Units 3 and 4 as soon as possible following NRC approval of the Westinghouse model changes.

Until the Westinghouse model changes are approved and a new ECCS analysis can be performed for Turkey Point Units 3 and 4, Florida Power & Light Company will administratively limit F_q for Turkey Point Unit 3 to 2.03 and to 1.91 for Turkey Point Unit 4.

These levels are conservative since Westinghouse estimates levels of F_q of 2.21 and 2.06 respectively, when credit is taken for the proposed model improvements with the October 1975 evaluation model. The estimates have been confirmed by many actual calculations.

The derivation of the interim values of F_q of 2.03 and 1.91 are documented in the attached two tables. They are based on calculations and sensitivity studies performed by Westinghouse and interim credits and penalties imposed by the NRC staff on the basis of these studies.

The revised F_q limits will require K(z) curves which are also attached.

The following clarification may be helpful in interpreting the attached tables. First of all, when talking about margin in the amount of steam generator tubes plugged, we are referring to the difference between the value assumed in the analysis of record and the actual percent of tubes currently plugged. Then the Westinghouse Perturbation technique[10] is used to obtain a change in peaking factor related to this difference. The table lists the assumed percent steam generator tubes plugged versus the actual. You should also note that a small allowance has been made for the future possibility of having to plug additional tubes as a result of primary to secondary leakage.

Secondly, when correcting for as-built fuel temperatures, a sensitivity of 111°F initial pellet temperature per 0.1 change in peaking factor was used. This value is based on the 37°F pellet temperature at end of blowdown per 0.1 change in F_q (reported to the staff on March 29, 1978) and a bounding ratio of 3°F initial pellet temperature per 1°F pellet temperature at end of blowdown. Both sensitivities were conservative bounds of some actual calculations.

Based on Westinghouse core physics calculations, the maximum values of F_q that could occur for the remainder of the current cycles are as follows:

Turkey Point, Unit 3, Cycle 5 - Max. F_q = 2.02
Turkey Point, Unit 4, Cycle 4 - Max. F_q = 1.97

For Turkey Point Unit 3, operation with a F_q less than or equal to 2.03 is ensured by the maximum predicted F_q being 2.02. For Turkey Point Unit 4, operation with a F_q less than or equal to 1.91 is ensured by the implementation of operating procedures as discussed below.

The actual measured value of F_q is a well behaved function of exposure for a particular base loaded plant, and for the Turkey Point Unit 4, cycle 4 it has been about 1.7 for equilibrium conditions. The Westinghouse design strategy, however, is based on defining a bounding envelope of F_q's resulting from the most adverse control rod placements and xenon oscillations permitted by the plant's technical specifications. The maximum F_q predicted by this most adverse envelope of values when increased by specified uncertainty factors is generally below the F_q limit established by the ECCS analysis, therefore requiring only monthly surveillance.

In the interim, while the maximum predicted F_q (1.97) exceeds the allowable F_q (1.91), Turkey Point Unit 4 will be operated as a base loaded plant. Procedures have been established and reviewed by the Plant Nuclear Safety Committee to provide for augmented surveillance when the reactor power exceeds the ECCS threshhold power, i.e., percent power greater than 1.91/1.97x 100%.

These procedures provide for Turkey Point Unit 4 to be at steady state equilibrium conditions prior to increasing power above the threshhold. Two incore detector thimbles will then be monitored to establish that sufficient F_q margin exists before increasing power above the ECCS threshhold.

Operation at power levels above the ECCS threshhold level will require that Bank D be inserted no more than 20 out of 228 steps. In the event that Bank D is inserted beyond this limit, and moved more than an accumulated $\pm$ 5 steps, augmented surveillance will be instituted using two incore detector thimbles. Appropriate procedures have been established to reduce reactor power below the ECCS threshhold within 15 minutes if the measured F_q exceeds the F_q limit (1.91) by >4%. If the measured F_q exceeds the Fq limit by $\leq$4%, power would be reduced 1% for each 1% deviation. If the measured F_q is not within its limit within two hours, power would then be reduced below the ECCS threshhold level.

This matter has been reviewed by the Turkey Point Plant Nuclear Safety Committee and the Florida Power & Light Company Nuclear Review Board. They have determined that operation of Turkey Point Units 3 and 4 as described herein will ensure the continued safe operation of the plant and will not endanger the health and safety of the public.

Very truly yours,

Robert E. Uhrig
Vice President

cc: J. P. O'Reilly, Region II
Robert Lowenstein, Esquire

I. CURRENT ANALYSIS: [redacted]$_q$ = 1.90 PEAK CLA[redacted] TEMPERATURE = 2019°F

Tubes Plugged = 15% Turkey Point Unit 3

II. CHANGES TO CURRENT ANALYSES

MODIFICATION	F_q CHANGE	JUSTIFICATION/BASIS
1. Zirc/Water Reaction Correction	0.00	Incorporated in base case
2. Current Analysis Margin to 2000°F	0.00	20°F/ % F_q - NRC
3. Current Analyses Margin to 2200°F	+0.14	25°F/ % F_q - NRC
4. Use of New 15x15 Flecht	-0.03	Included in Analysis Performed by Westinghouse (-.03 is conservatism imposed by NRC)
5. No use of Dougall-Rohsenow	0.00	NRC Interim Position
6. No use of ε=0.9	0.00	NRC Interim Position
7. ESDR Power Used in Current Analysis	0.00	Margin already included in current analyses
8. Margin to Amount of Steam Generator Tubes Plugged	+0.02	(See note below)*
9. Use of As-Built Fuel Temperature	0.00	
10. Margin In Containment Back Pressure	0.00	
Net Change	+0.13	

Current F_q	plus	Net Change	=	New F_q
1.90	+	+0.13	=	2.03

* Actual tubes plugged on Turkey Point Unit No. 3 is 11.7% as compared to 15% used in analyses. Therefore, using 12.2% tubes plugged to allow some margin for additional plugging, a credit of .02 is applicable on the basis of .007 units of F_q/per cent tubes plugged.

I. CURRENT ANALYSIS: F_q = 2.05 PEAK CLAD TEMPERATURE = 2195°F

Tubes Plugged = 19%

II. CHANGES TO CURRENT ANALYSES Turkey Point Unit 4

MODIFICATION	F_q CHANGE	JUSTIFICATION/BASIS
1. Zirc/Water Reaction Correction	-0.20	NRC
2. Current Analysis Margin to 2000°F	0.00	20°F/ % F_q - NRC
3. Current Analyses Margin to 2200°F	0.00	25°F/ % F_q - NRC
4. Use of New 15x15 Flecht	+0.05	(See note below)*
5. No Use of Dougall-Rohsenow	0.00	NRC Interim Position
6. No use of E=0.9	0.00	NRC Interim Position
7. ESDR Power Used In Current Analysis	0.00	Margin Already Included in Current Analysis
8. Margin to Amount of Steam Generator Tubes Plugged	+0.01	(See note below)**
9. Use of As-Built Fuel Temperature	0.00	
10. Margin In Containment Back Pressure	0.00	
Net Change	-0.14	

Current F_q	plus	Net Change	=	New F_q
2.05	+	-0.14	=	1.91

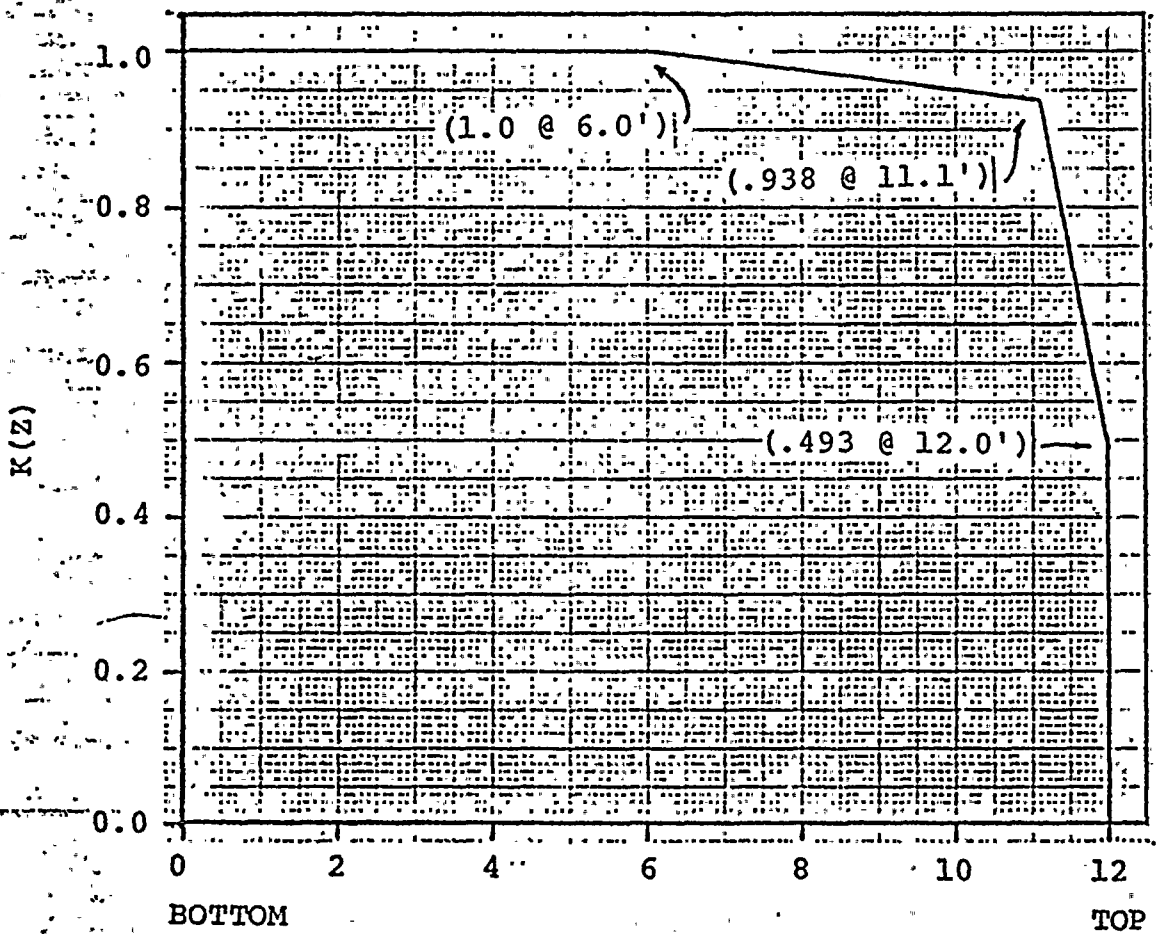
* Sensitivity study performed by Westinghouse indicated a 100°F benefit in PCT. NRC converted this to +0.05 F_q benefit.

** Actual tubes plugged on Turkey Point Unit No. 4 is 16.9% as compared to 19% used in the analysis. Therefore, using 17.2% tubes plugged to allow some margin for additional plugging, a credit of .01 is applicable on the basis of .007 units of F_q/per cent tubes plugged.

REVISED K(Z) FUNCTION

FOR TURKEY POINT UNIT 3 CYCLE 5

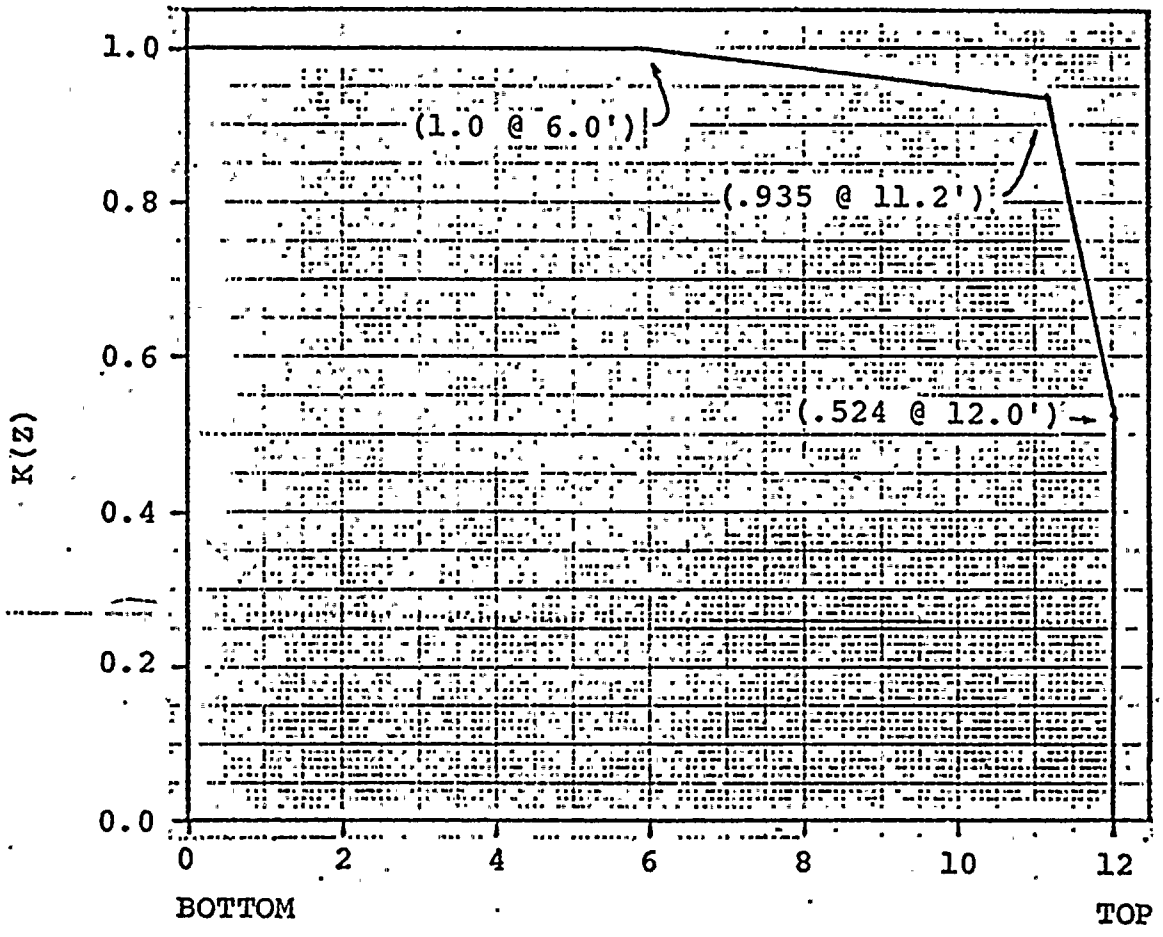
$F_Q = 2.03$



REVISED K(Z) FUNCTION

FOR TURKEY POINT UNIT 4 CYCLE 4

$F_Q = 1.91$



References

1. Bordelon, F. M., et al., "SATAN-VI Program: Comprehensive Space-Time Dependent Analysis of Loss-of-Coolant", WCAP-8306, June 1974.

2. Bordelon, F. M., et al., "LOCTA-IV Program" Loss of Coolant Transient Analysis", WCAP-8305, June 1974.

3. "Westinghouse ECCS Evaluation Model - Summary", WCAP-8339, Bordelon, F. M., Massie, H. W., and Zordan, T. A., July 1974.

4. Bordelon, F. M. et al., "Westinghouse ECCS Evaluation Model - Supplementary Information, WCAP-8471, April, 1975, (Proprietary) and WCAP-8472, April, 1975 (Non-Proprietary).

5. "Westinghouse ECCS Evaluation Model October 1975 Version", WCAP-8622, November 1975, (Proprietary), and WCAP-8623, November 1975, (Non-Proprietary).

6. Letter from C. Eicheldinger of Westinghouse Electric Corporation to D. B. Vassallo of the Nuclear Regulatory Commission, Letter NS-CE-924, 1/23/76.

7. "High Temperature Properties of Zircalloy - Oxygen Alloys", EPRI Report NP-524, March, 1977.

8. Little, C. C. et al., "Consideration of Uncertainties in the Specification of Core Hot Channel Factor Limits", WCAP-9180, September 1977.

9. "Westinghouse ECCS Evaluation Model, February, 1978 Version", WCAP-9220, February, 1978 (Proprietary), WCAP-9221, February, 1978 (Non-Proprietary).

10. Thompson, C. M. and Esposito, V. J., "Perturbation Technique for Calculating ECCA Cooling Performance", WCAP-8986, February 1977 (Non-Proprietary).