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LIC-94-0184

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, DC 20555

SUBJECT: 10 CFR 50.46 Report for 1993 on Loss of Coolant Accident (LOCA) / Emergency Core Cooling System (ECCS) Models

REFERENCES:
1. Docket No. 50-285
2. WCAP-13027-P, "Westinghouse ECCS Evaluation Model for Analysis of CE-NSSS," dated July 1991
3. Letter from Westinghouse Electric Corporation (N. J. Liparulo) to NRC (R. C. Jones), "Extension of NUREG-0630 Fuel Rod Burst Strain and Assembly Blockage Models to High Fuel Rod Burst Temperatures," dated September 16, 1992 (ET-NRC-92-3746)
4. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," dated October 1992
5. Letter from Westinghouse Electric Corporation (R. G. Creighton) to OPPD (K. C. Holthaus) dated June 22, 1993 (93CF*-G-0017)
6. Letter from OPPD (W. G. Gates) to NRC (Document Control Desk) dated November 2, 1993 (LIC-93-0266)

Gentlemen:

In accordance with 10 CFR 50.46(a)(3)(ii), Omaha Public Power District (OPPD) is submitting the 10 CFR 50.46 report for 1993. This report updates changes or errors in the LOCA/ECCS codes and methods used by Westinghouse Electric Corporation (W) to model Fort Calhoun Station (FCS) Unit No. 1. Reference 2 describes the methodology utilized by W to model Combustion Engineering Plants such as FCS. Westinghouse summarizes the changes or errors in the LOCA/ECCS models and provides them to OPPD in accordance with Reference 4. During the 1993 reporting period, W identified the following eight errors and three applicable changes.

Errors

1. Errors were found in the VESCAL subroutine of the LUCIFER code. These errors were in the geometric and mass calculations of the vessel and steam generator portions of the needed data. The errors were corrected in a manner to maintain the consistency of the LUCIFER code. All LOCA analyses using the LUCIFER code outputs are affected by these error corrections. This error is being reported as part of the W 10 CFR 50.46 notification to OPPD. Since VESCAL was not run as part of the FCS evaluation model, these errors are not applicable to FCS.

2. An error was discovered both in WCAP-10079-P-A, "NOTRUMP Code," and the relevant coding in NOTRUMP SUBROUTINE ISHIIA which led to an incorrect calculation of the drift flux in NOTRUMP when a laminar film annular flow was predicted. The affected equation in WCAP-10079-P-A is Equation G-74 wherein the gravitational constant (g) was inadvertently omitted from both the documentation and the equivalent coding. The correction of this error returned NOTRUMP to consistency with the ultimate reference for the affected correlation. The effect of this error on peak clad temperature (PCT) is estimated to be 0°F.

3. An error was discovered in the coding used in the NOTRUMP User External SUBROUTINE VOLHEAT. The coding did not correctly perform the calculation described in WCAP-10054-P-A, "NOTRUMP Evaluation Model for CE Plants," Equation 3-12-28. This calculation is only used when the Point Kinetics option is used to determine the core power before reactor trip. Therefore, the FCS analysis which used the more conservative assumption of constant core power until reactor trip time is not affected by this error. The correction of this error returned NOTRUMP to consistency with WCAP-10054-P-A. The effect of this error on PCT is estimated to be 0°F.

4. As noted in Reference 6, errors were discovered in both WCAP-10079-P-A and related coding in NOTRUMP SUBROUTINE DFCORRS where the improved TRAC-P1 vertical flow regime map is evaluated. In Evaluation Model applications, this model is only used during counter-current flow conditions in vertical flow links. The affected equation in WCAP-10079-P-A is Equation G-65 which previously allowed for unbounded values of the parameter C_o contrary to the intent of the source of the equation.

4. Continued

This allowed a discontinuity to exist in the flow regime map under some circumstances which was corrected by placing an upper limit of 1.3926 on the parameter C_∞ based on discussion in the source of the equation.

Further investigation of DFCORRS discovered an additional closely related logic error which led to discontinuities under certain other circumstances. Both of these errors were corrected and the coding is now consistent with WCAP-10079-P-A. The cumulative effect of these errors on PCT is estimated to be -13°F.

5. An error was discovered in how the properties of CORE NODE components were initialized for nonexistent regions in the adjoining FLUID NODE. This resulted in artificially high core temperatures during the timestep when the core mixture level crossed a node boundary, conservatively causing slightly more core mixture level depression than appropriate during this timestep. Correction of this error allows for a smoother mixture uncovery transient during node crossings. The effect of this error on PCT is estimated to be 0°F.

6. An error was discovered in how NOTRUMP initialized certain HEAT LINK pointer variables at the start of a calculation. Correction of this error returned NOTRUMP to consistency with the original intent of this section of coding. The effect of this error on PCT is estimated to be 0°F.

7. A number of minor programming errors were corrected in the fuel rod heat up code used in Small Break LOCA (SBLOCA) analyses. These corrections were related to:

   a. Individual rod plenum temperatures
   b. Individual rod stack lengths
   c. Clad thinning logic
   d. Pellet/clad contact logic
   e. Corrected gamma redistribution
   f. Including ZrO_2 thickness at t=0 initialization
   g. Numerics and convergence criteria of initialization

7. Continued

Also, minor errors in the rod heat up code used in Large Break LOCA analyses were corrected. These errors concerned conditions which exist during periods of pellet/clad contact and the internal bookkeeping logic associated with clad thinning.

The cumulative effect of both the Small Break and Large Break LOCA errors on PCT is estimated to be 0°F.

8. Reference 6 reported a significant error (150°F PCT penalty) in the NOTRUMP SBLOCA model due to the effect of safety injection (SI) flow into a broken reactor coolant system loop. This penalty was offset by a PCT credit of 150°F due to an improved condensation model. Therefore, the net effect of these errors on PCT is 0°F.

Changes

1. A model for calculating the prediction of zircaloy cladding burst behavior above the previous limit of 1742°F was implemented. This model was described to the NRC in Reference 3. FCS results are not within the range of changes provided by this model and therefore, the effect on PCT is 0°F.

2. The rod heat up code used in SBLOCA calculations contains a model to calculate the amount of clad strain that accompanies rod burst. However, the methodology which has historically been used is to not apply this burst strain model to the hot assembly average rod. This was done so as to minimize the rod gap and therefore maximize the heat transferred to the fluid channel, which in turn would maximize the hot rod temperature.

   Due to mechanisms governing the zirc-water temperature excursion (which is the subject of the SBLOCA Limiting Time-in-Life penalty for the hot rod), modeling of clad burst strain for the hot assembly average rod can result in a penalty for the hot rod by increasing the channel enthalpy at the time of PCT. Therefore, the methodology has been revised such that burst strain will also be modeled on the hot assembly average rod. FCS results are not within the range of changes provided by this model and therefore, the effect on PCT is 0°F.

3. A revised burst strain limit model which limits strains is being implemented into the rod heat up codes used in both Large Break and Small Break LOCA analyses. This model, which is identical to that previously approved for use for Appendix K analyses of Upper Plenum Injection plants with WCOBRA/TRAC, as described in WCAP-10924-P-A, Rev. 1, Vol. 1, Add. 4, "Westinghouse Large Break LOCA Best Estimate Methodology: Volume 1: Model Description and Validation, Addendum 4: Model Revisions," 1991. FCS results are not within the range of changes provided by this model and therefore, the effect on PCT is 0°F.

In addition to the errors/changes discussed above, FCS had been assessed the following plant specific permanent 10 CFR 50.46 reportable PCT penalty in 1993: A 3°F penalty, described in Reference 5, was assessed for failure to incorporate fuel rod internal pressure uncertainties into the analysis of record. As part of the resolution of the Large Break LOCA rod internal pressure issue, a change in methodology was agreed upon which utilizes nominal rod internal pressure without uncertainties. As a result, the 3°F penalty associated with the Large Break LOCA "Fuel Rod Internal Pressure Correction" is no longer applicable to Fort Calhoun Station Unit No. 1.

In conclusion, the summation of errors/changes identified or implemented in 1993 was a net reduction of 13°F PCT for a Small Break LOCA with no change in PCT for a Large Break LOCA. Attachment 1 summarizes the Small Break LOCA/ECCS peak clad temperature margin utilization. Attachment 2 summarizes the Large Break LOCA/ECCS peak clad temperature margin utilization.

If you should have any questions, please contact me.

Sincerely,

W. G. Gates

W. G. Gates
Vice President

WGG/mle

Attachments

c: LeBoeuf, Lamb, Greene & MacRae
L. J. Callan, NRC Regional Administrator, Region IV
S. D. Bloom, NRC Project Manager
R. P. Mullikin, NRC Senior Resident Inspector

1993 SMALL BREAK PEAK CLAD TEMPERATURE MARGIN UTILIZATION
FORT CALHOUN STATION UNIT NO. 1

		CLAD TEMPERATURE
A.	Analysis of Record (8/91)	PCT = 1444°F
B.	Prior Permanent ECCS Model Assessments	ΔPCT = -108°F
C.	10 CFR 50.59 Safety Evaluations	ΔPCT = 0°F
D.	1993 10 CFR 50.46 Model Assessments (Permanent Assessment of PCT Margin)	
	1. Effect of SI in Broken Loop	ΔPCT = 150°F
	2. Effect of Improved Condensation Model	ΔPCT = -150°F
	3. Drift Flux Flow Regime Errors (DFCORRS)	ΔPCT = -13°F
E.	Temporary ECCS Model Issues	
	1. None	ΔPCT = 0°F
F.	Other Margin Allocations	
	1. None	ΔPCT = 0°F
LICENSING BASIS PCT + MARGIN ALLOCATIONS		PCT = 1323°F

1993 LARGE BREAK PEAK CLAD TEMPERATURE MARGIN UTILIZATION
FORT CALHOUN STATION UNIT NO. 1

		CLAD TEMPERATURE
A.	Analysis of Record (8/91)	PCT = 2066°F
B.	Prior Permanent ECCS Model Assessments	ΔPCT = -25°F
C.	10 CFR 50.59 Safety Evaluations	ΔPCT = 0°F
D.	1993 10 CFR 50.46 Model Assessments (Permanent Assessment of PCT Margin)	
	1. None	ΔPCT = 0°F
E.	Temporary ECCS Model Issue	
	1. None	ΔPCT = 0°F
F.	Other Margin Allocations	
	1. None	ΔPCT = 0°F
LICENSING BASIS PCT + MARGIN ALLOCATIONS		PCT = 2041°F