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Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

Gentlemen:

Subject: VIRGIL C. SUMMER NUCLEAR STATION
DOCKET NO. 50/395
OPERATING LICENSE NO. NPF-12
ECCS EVALUATION MODEL REVISIONS REPORT (ANN 2300)

Attached is the annual Emergency Core Cooling System (ECCS) Evaluation Model Revisions Report for the Virgil C. Summer Nuclear Station (VCSNS). This report is submitted pursuant to 10CFR50.46 which requires licensees to notify the NRC on at least an annual basis of errors or changes in the ECCS Evaluation Models.

Tables 2 - 5 in the attachment summarize the changes in peak clad temperature from the previous analysis of record. None of the model changes is considered significant under 10CFR50.46.

I declare that the statements and matters set forth herein are true and correct to the best of my knowledge, information, and belief.

If you have any questions, please call.

Very truly yours,

John Skolds

John L. Skolds

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Attachment

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CHANGES TO THE WESTINGHOUSE ECCS EVALUATION MODELS

INTRODUCTION

Provisions in 10CFR50.46 require the annual reporting of corrections to or changes in the ECCS Evaluation Model (EM) approved for use in performing safety analyses for the loss of coolant accident (LOCA). This report describes corrections and revisions to the Westinghouse ECCS EM which are applicable to V. C. Summer Nuclear Station (VCSNS). The current Westinghouse ECCS EMs are listed in Table 1 and consist of several computer codes with specific functions.

Westinghouse has completed the evaluation of several items related to the Westinghouse ECCS Evaluation Models listed in Table 1. Each of these items is discussed in the following sections, which include a description of the item, the assessment which was performed, the resulting change to the Evaluation Model, and the effect of the change on the Peak Clad Temperature (PCT).

TABLE 1
SUMMARY OF WESTINGHOUSE
ECCS EVALUATION MODELS
FOR VCSNS

NAME: 1981 MODEL WITH BASH

APPLICATION: Analysis of Large Break LOCA

CODES USED:	PURPOSE:
SATAN-VI	Blowdown hydraulic transient
BASH	Reflood hydraulic transient
LOCBART	Hot assembly thermohydraulics and fuel rod thermal transient
WREFLOOD/COCO/LOTIC	Containment pressure transient

NAME: 1985 SBLOCA MODEL

APPLICATION: Analysis of Small Break LOCA

CODES USED:	PURPOSE:
NOTRUMP	System Hydraulic transient
SBLOCTA	Fuel rod thermal transient

Vessel and Steam Generator Calculation Errors in Lucifer

Background

The LUCIFER code is used to generate the component databases, from raw input data, to be used in the small and large break LOCA analyses. 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. All LOCA analyses using the LUCIFER code outputs are affected by these error corrections. The errors were corrected in a manner to maintain the consistency of the LUCIFER code.

The errors were determined to be a Non-Discretionary Change as described in Section 4.1.2 of WCAP-13451 and were corrected in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1985 SBLOCA Evaluation Model
1981 ECCS Evaluation Model with BASH

Estimated Effect

Representative plant calculations indicate a net PCT effect of -16°F for small break LOCA and a -6°F for large break LOCA.

ISHII DRIFT FLUX ERROR

Background

An error was discovered both in WCAP-10079-P-A 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 a factor of 'g', the gravitational constant, 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.

This was determined to be a Non-discretionary Change as described in Section 4.1.2 of WCAP-13451 and was corrected in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1985 Small Break LOCA Evaluation Model

Estimated Effect

Representative plant analyses were used to estimate a generic PCT effect of 0°F.

CORE NODE INITIALIZATION ERROR

Background

An error was discovered in how the properties of CORE NODE components were initialized for non-existent regions in the adjoining FLUID NODE. In particular this led to 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 level uncovery transient during node crossings.

This was determined to be a Non-discretionary Change as described in Section 4.1.2 of WCAP-13451 and was corrected in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1985 Small Break LOCA Evaluation Model

Estimated Effect

The nature of this error led to an estimated generic PCT effect of 0°F.

NOTRUMP HEAT LINK POINTER ERROR

Background

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.

This was determined to be a Non-discretionary Change as described in Section 4.1.2 of WCAP-13451 and was corrected in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1985 Small Break LOCA Evaluation Model

Estimated Effect

Representative plant analyses were used to estimate a generic PCT effect of 0°F.

FUEL ROD MODEL ERRORS IN SBLOCA

Background

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

1. Individual rod plenum temperatures
2. Individual rod stack lengths
3. Clad thinning logic
4. Pellet/clad contact logic
5. Corrected gamma redistribution
6. Including ZrO_2 thickness at $t=0$ initialization
7. Numerics and convergence criteria of initialization.

These changes were determined to be Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451 and were implemented in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

The cumulative effect of the error corrections and convergence criteria change was found to be less than approximately ± 4°F. This change is therefore judged to have a negligible effect on PCT and on a generic basis the estimated effect will be reported as 0°F.

LARGE BREAK LOCA FUEL ROD MODEL ERRORS

Background

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.

These changes were determined to be Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451 and were implemented in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1981 ECCS Evaluation Model with BASH

Estimated Effect

Representative plant calculations have shown that these corrections have a negligible effect on PCT for near Beginning-of-Life (BOL) fuel rod conditions (i.e. < 2000 MWD/MTU). These effects become prevalent as burnup increases, but are not expected to be of any significance until pellet/clad contact is predicted for steady-state operating conditions (typically > 8000 MWD/MTU). These corrections therefore result in a negligible PCT impact for Large Break LOCA licensing basis PCT's which are calculated with near BOL conditions. This impact is being reported generically as 0°F.

HIGH TEMPERATURE FUEL ROD BURST MODEL

Background

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:

> Letter ET-NRC-92-3746, N. J. Liparulo (W) to R. C. Jones (NRC), "Extension of NUREG-0630 Fuel Rod Burst Strain and Assembly Blockage Models to High Fuel Rod Burst Temperatures", September 16, 1992.

This was determined to be a Non-discretionary Change as described in Section 4.1.2 of WCAP-13451 and was corrected in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1981 ECCS Evaluation Model with BASH

Estimated Effect

The effect of the extended burst model has been directly incorporated in the Analysis of Record for VCSNS.

HOT ASSEMBLY AVERAGE ROD BURST EFFECTS

Background

The rod heat up code used in Small Break LOCA 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. However, 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.

This was determined to be a Non-discretionary Change as described in Section 4.1.2 of WCAP-13451 and was corrected in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

Representative plant calculations have shown that this change introduces an approximately 10% increase in the SBLOCA Limiting Time-in-Life penalty on the hot rod. However, this penalty is being offset in affected plants PCT Summary Sheets by the Revised Burst Strain Limit Model described on Page 11. These models will be implemented concurrently in the Small Break Evaluation Model rod heat-up code in 1994.

REVISED BURST STRAIN LIMIT MODEL

Background

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. 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.

This has been determined to be a Non-Discretionary Change as discussed in Section 4.1.2 of WCAP-13451 and is being implemented in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Models

1985 SBLOCA Evaluation Model
1981 ECCS Evaluation Model with BASH

Estimated Effect

The estimated effect on Large Break LOCA PCT's ranges from negligible to a moderate, unquantified benefit which will be inherent in calculations once this model is implemented. In Small Break LOCA, representative plant calculations indicate that the magnitude of the benefit is conservatively estimated to be exactly offsetting to the penalty introduced by the Hot Assembly Average Rod Burst issue documented on Page 10. This model will be implemented in both Large Break and Small Break Evaluation Models during 1994.

SMALL BREAK LOCA LIMITING TIME IN LIFE - ZIRC/WATER OXIDATION TEMPERATURE EXCURSION

Background

Westinghouse recently finalized an evaluation of a potential issue with regard to burst/blockage modeling in the Westinghouse small break LOCA evaluation model. This potential issue involved a number of synergistic effects, all related to the manner in which the small break model accounts for the swelling and burst of fuel rods, modeling of the rod burst strain, and resulting effects on clad temperature and oxidation from the metal/water reaction models and channel blockage.

Fuel rod burst during the course of a small break LOCA analysis was found to potentially result in a significant temperature excursion above the clad temperature transient for a non-burst case. Since the methodology for SBLOCA analyses had been to perform the analyses at a near beginning of life (BOL) condition, where rod internal pressures are relatively low, most analyses did not result in the occurrence of rod burst, and therefore may not have reflected the most limiting time in life PCT. In order to evaluate the effects of this phenomenon, Westinghouse has developed an analytical model which allows the prediction of rod burst PCT effects based upon the existing analysis of record.

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

The PCT effect of this item was previously reported to the NRC as a temporary penalty in the June 8, 1993, annual ECCS Evaluation Model Revision Report (Reference RC-93-0158) thereby meeting the intent of 10CFR50.46 reporting requirements. The Burst and Blockage/Time in Life penalty is a function of base PCT plus permanent margin allocation and as such will decrease/increase with margin allocation changes. SCE&G will report this penalty under the "Other Margin Allocations" category and will include any PCT change from the base penalty of 115°F to newly identified model assessments when considering 10CFR50.46 reporting requirements.

TABLE 2

Small Break Peak Clad Temperature Margin Utilization

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Revision Date: 1/24/94

Plant Name: Virgil C. Summer (CGE)	Eval. Model: NOTRUMP		Fuel: Vantage +
Utility Name: South Carolina Electric & Gas	FQ = 2.45	FΔH = 1.62	SGTP = 20%

		Reference *	Clad Temperature		Notes
A.	ANALYSIS OF RECORD (2/93)	1	PCT =	1948°F	
B.	PRIOR PERMANENT ECCS MODEL ASSESSMENTS	2	ΔPCT =	-13°F	1
C.	10 CFR 50.59 SAFETY EVALUATIONS	Table 4	ΔPCT =	1°F	
D.	1993 10 CFR 50.46 MODEL ASSESSMENTS (Permanent Assessment of PCT Margin)				
	1. Average Rod Burst Strain		ΔPCT =	12°F	
	2. Fuel Rod Burst Strain Limit		ΔPCT =	-12°F	
	3. LUCIFER Error Corrections		ΔPCT =	-16°F	
E.	TEMPORARY ECCS MODEL ISSUES				
	1. None		ΔPCT =	0°F	
F.	OTHER MARGIN ALLOCATIONS				
	1. Burst and Blockage/Time in Life	1	ΔPCT =	115°F	
	LICENSING BASIS PCT + MARGIN ALLOCATIONS		**PCT =**	**2035°F**	

* References for the Peak Clad Temperature Margin Utilization summary can be found in Table 5.

Notes:

1. Reference 2 provided a 10 CFR 50.46 thirty day report on the following assessments: "Effect of SI in Broken Loop," "Effect of Improved Condensation Model," and "Drift Flux Flow Regime Errors."

TABLE 3

Large Break Peak Clad Temperature Margin Utilization

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Revision Date: 1/24/94

Plant Name:	Virgil C. Summer (CGE)	Eval. Model:	BASH	Fuel:	Vantage +
Utility Name:	South Carolina Electric & Gas	FQ = 2.45	FΔH = 1.62		SGTP = 25%

		Reference *	Clad Temperature	Notes
A.	ANALYSIS OF RECORD (3/93)	1	PCT = 2195°F	
B.	PRIOR PERMANENT ECCS MODEL ASSESSMENTS		ΔPCT = 0°F	
C.	10 CFR 50.59 SAFETY EVALUATIONS	Table 4	ΔPCT = 2°F	
D.	1993 10 CFR 50.46 MODEL ASSESSMENTS (Permanent Assessment of PCT Margin)			
	1. Lucifer Error Corrections		ΔPCT = -6°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 = 2191°F**	

* References for the Peak Clad Temperature Margin Utilization summaries can be found in Table 5.

Notes:

None

TABLE 4 - 10 CFR 50.59 Safety Evaluations

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Revision Date: 1/18/93

Plant Name: Virgil C. Summer (CGE)
Utility Name: South Carolina Electric & Gas

	Reference	Clad Temperature		Notes
I. SMALL BREAK ECCS SAFETY EVALUATIONS				
A. Fuel Reconstitution		ΔPCT =	1°F	1
TOTAL 10 CFR 50.59 SMALL BREAK ASSESSMENTS		**PCT =**	**1°F**	
II. LARGE BREAK ECCS SAFETY EVALUATIONS				
A. Fuel Reconstitution		ΔPCT =	2°F	1
TOTAL 10 CFR 50.59 LARGE BREAK ASSESSMENTS		**PCT =**	**2°F**	

Notes:

1. This penalty is due to a fuel assembly reconstitution in assembly J64 for Cycle 8. The penalty will be removed when assembly J64 is removed from the core.

TABLE 5 - References

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1. RC-93-0158, "ECCS Evaluation Model Revisions Report (ANN 2300)," dated June 8, 1993.

2. RC-93-0279, "10 CFR 50.46, 30 Day Report," dated November 3, 1993.