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April 28, 1994

Docket No. 50-423
B14824

Re:10CFR50.46(a)

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

Millstone Nuclear Power Station, Unit No. 3
Reporting of Changes to and Errors in
Emergency Core Cooling System Models or Applications

Pursuant to the provisions of 10CFR50.46(a)(3)(ii), Northeast Nuclear Energy Company (NNECO) hereby submits, on behalf of Millstone Unit No. 3, the changes to and errors in the Emergency Core Cooling System (ECCS) evaluation model or application of the model.

The last update was submitted to the NRC Staff on December 29, 1993.(1) This represented the combined annual 10CFR50.46 report for Millstone Nuclear Power Station, Unit Nos. 1, 2, and 3 and covered the period from June 30, 1992, to September 30, 1993. Since that time, Westinghouse Electric Corporation, by copy of its February 8, 1994,(2) letter, notified NNECO of additional changes to or errors in the small break loss of coolant accident (SBLOCA) analysis and large break loss of coolant accident (LBLOCA) analysis performed for Millstone Unit No. 3.

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(1) J. F. Opeka letter to the U.S. Nuclear Regulatory Commission, "Millstone Nuclear Power Station, Unit Nos. 1, 2, and 3 - Annual Reporting of Changes to and Errors in Emergency Core Cooling System Models or Applications," dated December 29, 1993.

(2) J. R. Gasperini letter NEU-94-203 to F. R. Dacimo, "Northeast Nuclear Energy Company - Millstone Nuclear Power Station, Unit No. 3 - 10 CFR 50.46 Notification and Reporting Information," dated February 8, 1994.

Attachment 1 to this letter summarizes the ECCS evaluation model changes and errors. Attachment 2 provides the small and large break ECCS Evaluation Model Margin Utilization sheets which account for (A) the analysis of record, (B) prior permanent 10CFR50.46 LOCA model assessments, (C) 1993 10CFR50.46 LOCA model assessments including those for which this notification is being performed, and (D) margin utilization attributable to 10CFR50.59 evaluations up to the present.

Westinghouse recently completed 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. Resolution of this issue resulted in a peak cladding temperature (PCT) penalty of 136°F. This effect is considered significant with respect to 10CFR50.46(a)(3)(i) and, as such, is being reported as required by 10CFR50.46(a)(3)(ii).

Considering the changes summarized in Attachments 1 and 2, the corrected PCT's for the limiting small and large break LOCA remain below the 2200°F limit as defined by 10CFR50.46(b)(1).

NNECO has concluded that this submittal satisfies the reporting requirements of 10CFR50.46(a)(3)(ii). Although the referenced letter from Westinghouse, informing us of the analyses changes, was dated February 8, 1994, telephone discussions between NNECO and Westinghouse followed receipt of this letter. On April 11, 1994, NNECO and Westinghouse reached final agreement on the model changes. Since this report is being submitted within 30 days of April 11, 1994, the reporting requirements are fulfilled.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY

J. F. Opeka
Executive Vice President

cc: See Page 3

cc: T. T. Martin, Region I Administrator
V. L. Rooney, NRC Project Manager, Millstone Unit No. 3
P. D. Swetland, Senior Resident Inspector, Millstone Unit Nos. 1, 2, and 3

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Attachment 1

Millstone Nuclear Power Station, Unit No. 3

SUMMARY OF ECCS EVALUATION MODEL CHANGES AND ERRORS

April 1994

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.

Affected Evaluation Models

1985 SBLOCA Evaluation Model
1981 ECCS Evaluation Model with BASH

Estimated Effect

Representative plant calculations indicate a net Peak Clad Temperature (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 ISHII 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.

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

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

NOTRUMP Point Kinetics Error

Background

An error was discovered in the coding used in the NOTRUMP User External SUBROUTINE VOLHEAT. This coding did not correctly perform the calculation described by Equation 3-12-28 of WCAP-10054-P-A. This calculation is only used during the time when the Point Kinetics option is used to determine the core power before reactor trip. Therefore, any 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.

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

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

NOTRUMP Drift Flux Flow Regime Map Errors

Background

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_∞ contrary to the original intent of the source of this equation. This allowed a discontinuity to exist in the flow regime map under some circumstances. This was corrected by placing an upper limit of 1.3926 on the parameter C_∞ as reasoned from the discussion in the original source. As stated, this correction returned NOTRUMP to consistency with the original source for the affected equation.

Further investigation of the DFCORRS subroutine uncovered an additional closely related logic error which led to discontinuities under certain circumstances. This error was also corrected, and returned the coding to consistency with WCAP-10079-P-A.

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

Representative plant calculations indicated PCT effects ranging from -13°F to -55°F. For the purposes of tracking PCT, an estimated effect of -13°F will be assigned to this change.

Core Node Initialization Error

Background

An error was discovered in how 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.

Affected Evaluation Models

1985 SBLOCA 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.

Affected Evaluation Models

1985 SBLOCA 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

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

The cumulative effect of the error corrections and convergence criteria change was found to have 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 book-keeping logic associated with clad thinning.

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.

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 those plants which are affected.

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.

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. This translates to a PCT penalty of 14°F. However, this penalty is being offset by the Revised Burst Strain Limit Model described on the following page. 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, identical to that previously approved for use for Appendix K analyses of Upper Plenum Injection plants with WCOBRA/TRAC, is 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.

Affected Evaluation Models

1985 SBLOCA Evaluation Model
1981 ECCS Evaluation Model with BASH

Estimated Effect

The estimated effect on Large Break LOCA PCTs ranges from negligible to a moderate benefit which will be inherent in calculations once this model is implemented. For the purposes of tracking PCT, the effect is conservatively assumed to be 0°F.

In Small Break LOCA, representative plant calculations indicate that the magnitude of the benefit is conservatively estimated to exactly offset the penalty introduced by the Hot Assembly Average Rod Burst issue documented on the previous page. This results in a PCT benefit of 14°F. This model will be implemented in both Large Break and Small Break Evaluation Models during 1994.

Large Break LOCA Rod Internal Pressure Issues

Background

Westinghouse recently completed an evaluation of a potential issue concerning the impact of increased beginning of life rod internal pressure (RIP) uncertainties on LOCA analyses. Historically, beginning of life fuel pressure and temperature uncertainties were based upon end of life considerations. These RIP uncertainties were found to be potentially nonconservative. During the evaluation of this issue, a second issue related to the applicability of generic IFBA fuel analyses to updated LOCA Evaluation Models was also identified and combined with this issue since the underlying mechanisms were the same.

Affected Evaluation Models

1981 ECCS Evaluation Model with BASH

Estimated Effect

The technical evaluation of this issue concluded that both the RIP uncertainty and the current IFBA designs with 200 psig initial fill pressure fuel typically will result in a maximum ±15°F PCT variation. Consequently, RIP manufacturing uncertainties and 200 psig initial fill pressure IFBA fuel do not have significant effects on the Large Break LOCA analyses. Also, based on these results, it was concluded that only nominal RIP (with an upper bound bias) should be used in the LOCA analyses for fuel designs with an initial cold fill pressure ≥ 200 psig. This is consistent with past LOCA analysis.

Specific analyses were performed for all plants with initial fill pressure < 200 psig. It was demonstrated that the acceptance criteria of 10 CFR 50.46 continued to be met for each of these plants.

Small Break LOCA Limiting Time in Life - Zirc/Water Oxidation Temperature Excursion

Background

Westinghouse recently completed 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 analysis of record.

Affected Evaluation Models

1985 SBLOCA Evaluation Model

Estimated Effect

Resolution of this issue resulted in a PCT penalty of 136°F for small break LOCA.

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Attachment 2

Millstone Nuclear Power Station, Unit No. 3

REPORTING OF 10CFR50.46 MARGIN UTILIZATION

Small Break LOCA
Large Break LOCA

April 1994

U.S. Nuclear Regulatory Commission
B14824/Attachment 2/Page 1
April 28, 1994

Reporting of 10CFR50.46 Margin Utilization
Small Break LOCA

PLANT NAME: Millstone Unit No. 3
Eval. Model: NOTRUMP
Vendor: Westinghouse
Fuel: VANTAGE 5H
FQ=2.6
FΔH=1.7
SGTP=10%

		Clad Temperature	Notes
A.	Analysis of Record (6/90)	PCT = 1891°F	
B.	Prior Permanent LOCA Model Assessments (Thru 1992)		
	1. ECCS Evaluation Model Changes	ΔPCT= 27°F	
C.	1993 10CFR50.46 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 Model Errors	ΔPCT= -13°F	
	4. LUCIFER Error Corrections	ΔPCT= -16°F	
	5. Ishii Drift Flux Error	ΔPCT= 0°F	
	6. NOTRUMP Point Kinetics Error	ΔPCT= 0°F	
	7. Core Node Initialization Error	ΔPCT= 0°F	
	8. NOTRUMP Heat Link Pointer Error	ΔPCT= 0°F	
	9. Fuel Rod Model Errors in SBLOCA	ΔPCT= 0°F	
	10. Average Rod Burst Strain	ΔPCT= 14°F	
	11. Fuel Rod Burst Strain Limit	ΔPCT= -14°F	
	12. Burst and Blockage/Time in Life	ΔPCT= 136°F	(1)
D.	10CFR50.59 Safety Evaluations		
	1. Increased Pressurizer Pressure Uncertainty	ΔPCT= 14°F	
	2. Effect of ZIRLO Fuel Cladding	ΔPCT= 24°F	
	3. Fuel Rod Crud	ΔPCT= 2°F	
	4. Reduced Thermal Design Flow	ΔPCT= 12°F	
	LICENSING BASIS PCT + MARGIN ALLOCATIONS	**PCT= 2077°F**	

Notes:
1. The base PCT used for calculating this penalty includes the Fuel Rod Crud Safety Assessment performed to address the Cycle 4 axial offset anomaly. The Fuel Rod Crud Evaluation is found in Item D, above.

Reporting of 10CFR50.46 Margin Utilization
Large Break LOCA

PLANT NAME: Millstone Unit No. 3
Eval. Model: BASH
Vendor: Westinghouse
Fuel: VANTAGE 5H
FQ=2.6
FΔH=1.7
SGTP=10%

			Clad Temperature	Notes
A.	Analysis of Record (8/90)		PCT = 1974°F	(1)
	1.	Transition Core Penalty	ΔPCT= 50°F	(2)
B.	Prior Permanent LOCA Model Assessments (Thru 1992)			
	1.	Fuel Rod Initial Condition Inconsistency	ΔPCT= 10°F	
	2.	SG Tube Seismic/LOCA Assumption	ΔPCT= 7°F	
	3.	Structural Metal Heat Modeling	ΔPCT= -25°F	
	4.	Spacer Grid Heat Transfer Error in BART	ΔPCT= -107°F	(3)
C.	1993 10CFR50.46 Model Assessments (Permanent Assessment of PCT Margin)			
	1.	LUCIFER Error Corrections	ΔPCT= -6°F	
	2.	Large Break LOCA Fuel Rod Model Errors	ΔPCT= 0°F	
	3.	Fuel Rod Burst Strain Limit	ΔPCT= 0°F	
	4.	Large Break LOCA Rod Internal Pressure Issues	ΔPCT= 0°F	
D.	10CFR50.59 Safety Evaluations (Permanent Assessment of PCT Margin)			
	1.	Increased Pressurizer Pressure Uncertainty	ΔPCT= 1°F	
	2.	Effect of ZIRLO Fuel Cladding	ΔPCT= 6°F	
	3.	Reactor Vessel Flange Radiation Shield	ΔPCT= 1°F	
	4.	Reduced Thermal Design Flow	ΔPCT= 12°F	
	ANALYSIS OF RECORD PCT + MARGIN ALLOCATIONS		**PCT= 1923°F**	

Notes:

(1) Because the LOPAR fuel has achieved sufficient burnup to become non-limiting, the V5H PCT of 1974°F will now be used instead of the LOPAR PCT of 2134°F.

(2) A transition core penalty must be added to the Vantage 5 results until all the LOPAR fuel is removed from the core.

(3) The Safety Assessment for the Millstone Unit 3 Fuel Assemblies with ZIRLO Cladding indicates that the limiting large break case was reanalyzed for Zircaloy-4 cladding as well as ZIRLO in order to determine the direct effect on PCT of ZIRLO cladding. Because the grid error had been corrected, the new Zircaloy-4 PCT was lower than the Analysis of Record PCT. Consequently, a benefit is assessed for this model change.