

NSD-NRC-98-5575
Attachment 1
1997 Westinghouse 10 CFR 50.46 Annual Report

20 pages of Attachment 1 follow.

9804210409 980408
PDR TOPRP EMVWEST
C PDR

NON-DISCRETIONARY CHANGES WITH PCT IMPACT

SBLOCTA Clad Burst Strain Error
SBLOCA ECCS Spilling Assumption

NON-DISCRETIONARY CHANGES WITH NO PCT IMPACT

NOTRUMP Flow Regime Map Error
Interfacial Heat Transfer Courant Limit Error
SPIKE Specific Heat Error
LOCBART Post-Burst Rod Internal Pressure
Core-Average LOCTA Fuel Rod Initialization

ENHANCEMENTS/FORWARD FIT DISCRETIONARY CHANGES

Gadolinium Fuel Model
UO₂ Pellet Thermal Conductivity
BASH Initialization for Direct Downcomer Injection Modeling

WCOBRA/TRAC LARGE BREAK LOCA EVALUATION MODEL CHANGES AND ERRORS

NON-DISCRETIONARY CHANGES WITH PCT IMPACT

SECY UPI WCOBRA/TRAC Evaluation Models:

- Locked Rotor
- 1-D Transition Boiling Heat Transfer Error
- Vessel Channel DX Error

BE WCOBRA/TRAC Evaluation Model

- Intercell Force Gap Numbering Error
- Vessel Channel DX Error

NON-DISCRETIONARY CHANGES WITH NO PCT IMPACT

SECY UPI WCOBRA/TRAC Evaluation Models:

- TUBE Heated Conductor Error
- Intercell Force Gap Numbering Error

BE WCOBRA/TRAC Evaluation Model

- Transition Boiling Heat Transfer Error
- TUBE Heated Conductor Error
- Incorrect Wall Friction Factor for Convective Enhancement Term

ENHANCEMENTS/DISCRETIONARY CHANGES

SECY UPI WCOBRA/TRAC Evaluation Model:

- Input Consistency

BE WCOBRA/TRAC Evaluation Model

Miscellaneous Input/Output Revisions

SBLOCTA CLAD BURST STRAIN ERROR

Background

An error has been discovered in the SBLOCTA code related to improper calculation of clad post-burst strain. Specifically, the error occurs because although the burst node is predicted to strain out upon the occurrence of burst, incorrect coding logic causes this burst strain to be neglected in subsequent timesteps. The main effect of this for small break transient calculations is that for high peak clad temperature cases (in excess of 1800°F) which are also limited by the rapid zirc-water reaction accompanying incipient clad burst, the smaller clad diameters reduce the burst temperature spike, and upon correction of the coding a net PCT penalty may result. This correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Plant specific calculations for the affected analyses have been performed to assess the effect of this error.

SBLOCA ECCS SPILLING ASSUMPTION

Background

The applicability of the ECCS spilling assumption used in SBLOCA analyses that have been performed using SI in the broken loop was found to be incorrect for 2 and 3 loop plants. It was found that in some instances, the assumption of the faulted loop having a back-pressure of RCS pressure was not conservative. A modified methodology for determining the appropriate spilling assumption for these cases was developed. This was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Plant specific estimates of the PCT impact of this error have been assessed for all affected analyses.

NOTRUMP FLOW REGIME MAP ERROR

Background

An error was discovered in an exponent in a function used to define a boundary in the flow regime map used by NOTRUMP for some vertical flow situations. The error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Representative plant calculations have led to an estimated 0°F effect for this error.

INTERFACIAL HEAT TRANSFER COURANT LIMIT ERROR

Background

An error was discovered in the NOTRUMP logic dealing with the calculation of the material Courant timestep limit for interfacial heat and mass transfer. Due to this error, NOTRUMP allowed this limit to be violated, leading to the possibility of unrealistic fluctuations in the interfacial heat and mass transfer in a coolant leg with a small mixture or vapor region. This correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Representative plant calculations have led to an estimated 0°F effect for this error.

SPIKE SPECIFIC HEAT ERROR

Background

An error was discovered in the specific heat calculation employed by the SPIKE code which is used to estimate the effects of limiting time in life on SBLOCA. This was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1975 Westinghouse Small Break LOCA Evaluation Model with WFLASH
1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

There is no PCT impact for this error.

LOCBART POST-BURST ROD INTERNAL PRESSURE

Background

An error was discovered in a LOCBART code version related to improper calculation of post-burst rod internal pressure. After burst, the rod pressure should be set to the channel pressure, but due to an error in checking a flag in one portion of the code, the pressure continued to be calculated as if burst had not occurred. A review of the coding found that other than the pressure itself, the only other parameter incorrectly calculated was the thermal conductivity of the gas in the pellet-to-clad gap, which had a weak contribution to gap conductance. This was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effects

Representative plant calculations have led to an estimated 0°F effect for this error.

CORE-AVERAGE LOCTA FUEL ROD INITIALIZATION

Background

An error was discovered in the BASH code related to improper calculation of the core-average LOCTA fuel rod initialization. After the fuel rod initialization converges to the appropriate temperature, the density correction should be applied during the transient as during the initialization, to adjust the transient pellet radial node power density. A review of the coding found that this density correction was being applied incorrectly during the steady-state convergence. This was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effects

Representative plant calculations have led to an estimated 0°F effect for this error.

GADOLINIUM FUEL MODEL

Background

The ability to explicitly model Gadolinium (Gd_2O_3 -doped) fuel has been incorporated into the hot assembly fuel rod heat conduction codes for LOCA licensing basis analyses. This modification merely consists of coding in the appropriate correlations for calculating the thermal conductivity of this fuel pellet type. This change was determined to be a Discretionary Change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

This change has no impact on any existing analyses and will be applied on a forward fit basis.

UO₂ PELLETTHERMAL CONDUCTIVITY

Background

The basis for the steady-state fuel rod conditions in the LOCA codes is the matching of key values obtained from fuel performance design codes, which have slightly more sophisticated models. One consequent criterion is that the fuel rod material and physical properties used are generally obtained from those codes. The correlation for the thermal conductivity of UO₂ that is currently used in the LOCA codes has been updated for consistency with the latest version of the fuel performance design codes. This was determined to be a Discretionary Change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1975 Westinghouse Small Break LOCA Evaluation Model with WFLASH
1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

This change has a negligible impact on existing analyses and will be applied on a forward fit basis.

BASH INITIALIZATION FOR DIRECT DOWNCOMER INJECTION MODELLING

Background

In BASH, the mass flow rate from the cold leg to the downcomer at end-of-refill is used to initialize the NOTRUMP flow link calculations. Since BASH recalculates this flow rate beginning with the first timestep, the initial flow rate is not critical but should be reasonably close to the actual value to avoid convergence problems. For cases modelling direct downcomer injection, the initialization of the mass flow rate from the cold leg to the downcomer at end-of-refill was modified to exclude direct downcomer injection flow, to ensure that a converged solution can be obtained for these cases. This was determined to be a Discretionary Change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Model

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

This change has negligible impact on any existing analyses and will be applied on a forward fit basis.

LOCKED ROTOR IMPACT

Background:

During 1997, Westinghouse was asked to verify the assumption that allowing the reactor coolant pumps (RCPs) to run for the entire transient (vs. locking the RCP rotors at the beginning of reflood) resulted in the limiting PCT for SECY UPI Appendix K calculations. A transient was run which showed that locking the rotors at the beginning of reflood resulted in a PCT penalty. This change in the limiting assumption was attributed to the fact that the plant in question has a relatively late reflood PCT transient in which the impact of locking the rotor had a negative impact on the core cooling.

Based on this result, all plants with SECY UPI Appendix K calculations were re-analyzed to determine if their licensing basis contained the limiting assumption regarding locking the rotor.

This problem does not affect Superbounded calculations since the RCP rotors are already locked at the beginning of reflood for those transients.

This was determined to be a Non-discretionary change as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model -- Appendix K Calculations

Estimated Effect

All Appendix K calculations of UPI plants with the SECY UPI WCOBRA/TRAC Evaluation Model have been re-assessed for the impact of this error with plant specific calculations.

1-D TRANSITION BOILING HEAT TRANSFER ERROR

Background:

The transition boiling heat flux in 1D components double accounts for the contribution to the heat flux by the vapor phase. This heat transfer regime occurs only briefly in the steam generator component during a large break transient. The vapor phase contribution to the overall heat flux in this regime is very small compared to the liquid phase contribution, which is calculated correctly.

This was determined to be a Non-discretionary change as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect

For the SECY UPI Evaluation model, plant specific PCT assessments of the impact of this change have been generated.

For three- and four-loop plants using the Best Estimate Evaluation Model, this error has been estimated to have a 0°F impact on PCT.

TUBE HEATED CONDUCTOR ERROR

Background:

WCOBRA/TRAC allows metal structures to be modeled as either a "Heated Conductor" in which axial conduction is calculated, or as an "Unheated Conductor" in which axial conduction is assumed to be relatively unimportant. The geometry of either Conductor can be a "WALL", a "TUBE", or a "ROD". In PWR models, Heated Conductors with a ROD geometry are used for fuel rods only. Other metal structures are modeled using Unheated Conductor types. It has been discovered that no heat is transferred to the inside Channel of a Heated Conductor if it is modeled with a TUBE geometry.

This was determined to be a Non-discretionary change as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect

No SECY UPI or Best Estimate WCOBRA/TRAC calculation models heated conductors as TUBE geometry. This error does not occur for Unheated Conductors using the "TUBE" geometry type. Therefore, no estimated PCT effect is required to be assessed.

INTERCELL FORCE GAP NUMBERING ERROR

Background:

"Gaps" represent lateral flow connections in WCOBRA/TRAC. The intercell interfacial friction force was not correct if the Gap identification number exceeded the total number of Gaps. The error would only occur if the input deck gaps are numbered in such a way that the largest gap number exceeded the total number of gaps. Such a numbering convention was not prohibited according to the input manual, and was used in several calculations.

This was determined to be a Non-discretionary change as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect

The gap numbering sequence that could cause this error was not used in any Appendix K SECY UPI Large Break LOCA analyses, so this error has no PCT impact.

For three- and four-loop plants using the Best Estimate Evaluation Model, the gap numbering sequence that could cause this error was assessed in instances where it occurred. Plant specific estimates of the PCT impact of this error have been generated.

VESSEL CHANNEL DX ERROR

Background:

Incorrect cell height is used in calculating gap flow wall friction and interfacial drag coefficients at gap level J. The cell height, DX, is a function of the continuity/gap level J in the section. The error is that only cell 1 DX value is used, rather than cell heights specific to each level, 1 through J.

This was determined to be a Non-discretionary change as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect

Plant specific PCT impacts have been determined and assessed for all SECY UPI WCOBRA/TRAC Evaluation model analyses.

For the Best Estimate WCOBRA/TRAC Evaluation model, the assessment of the impact of this error is in progress and will be completed in 1998.

INPUT CONSISTENCY

Background:

A general review of all SECY UPI WCOBRA/TRAC analyses was conducted in 1997. A list of recommended procedures was generated and all plant calculations were reviewed for their compliance. This review revealed that input methods and input data transfer were not done consistently in all of the plant analyses. A decision was made to incorporate these changes into all SECY UPI Appendix K analyses along with the implementation of other code corrections, since the effect was estimated to be small. In all cases, these consistency refinements represent details not explicitly called out in the licensed methodology and therefore had been left to analyst discretion.

These changes were determined to be a Discretionary change as described in Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

Estimated Effect

All Appendix K calculations of UPI plants with the SECY UPI WCOBRA/TRAC Evaluation Model have been re-analyzed with the 1997 recommended input procedures. The PCT impact of these changes has been calculated for each plant and assessed.

INCORRECT WALL FRICTION FACTOR FOR CONVECTIVE ENHANCEMENT TERM

Background

WCOBRA/TRAC MOD7A contains a model for turbulent enhancement of convective heat transfer due to the presence of droplets in a high void fraction post-CHF flow. As part of the model, an incorrect wall friction factor was used.

This error is accounted for in the reflood heat transfer multiplier uncertainty distribution. Calculation of the 95th percentile PCT using HOTSPOT compensates WCOBRA/TRAC calculations for the error. Because this error is fully accounted for by application of reflood multipliers in the HOTSPOT calculation, this error will not be corrected until there is the need for a major code revision requiring a redetermination of the reflood heat transfer multiplier uncertainty distribution.

This was determined to be a Non-discretionary Change as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect

The error has no net effect on the 95th percentile PCT. Thus, for Best Estimate LOCA EM calculations, this error has a $\Delta PCT = 0^\circ F$.

MISCELLANEOUS INPUT/OUTPUT REVISIONS

Background

Several corrections to WCOBRA/TRAC MOD7A, Rev. 1 input and output routines were made. Included in the changes were two error corrections:

- (a) Several variables needed in the restart of a calculation were added to the output files. If transient restarts are not utilized in the licensing calculations, there is no PCT impact.
- (b) The pressurizer mass summary printout was corrected. Only the printout was inaccurate, thus there is no impact on calculations. The pressurizer mass summary was not used for any licensing evaluations.

These changes were determined to be a Discretionary change as described in Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect

These code revisions affect features that are not intended for use in licensing calculations. The estimated effect on the peak cladding temperature for BE LBLOCA is $\Delta PCT = 0^\circ F$.

Attachment 2

Compilation of Westinghouse Evaluation Model
10 CFR 50.46 Reportable Changes
Since the 1988 Rule Change

The following is a compilation of all the WEM changes reportable under 10 CFR 50.46 since 1988.

<u>Year</u>	<u>Annual Report</u>
1997	NSD-NRC-98-5575 Attachment 1
1996	NSD-NRC-98-5575 Attachment 5 (no prior NRC letter) *
1995	NSD-NRC-96-4639
1994	NTD-NRC-95-4409
1993	NTD-NRC-94-4130
1992	NSD-NRC-98-5575 Attachment 4 (no prior NRC letter) *
1991	NSD-NRC-98-5575 Attachment 3 (no prior NRC letter) *
1990	None (no reportable changes for 1990)
1988-89	ET-NRC-89-3463.

* Reports for 1991, 1992 and 1996 were indirectly presented to NRC via license holders.

Additional miscellaneous model changes not included in the above Annual Reports are as follows:

- WCAP-10924-P-A Volume 1 Rev 1 Addendum 4 (SECY)
- WCAP-13677-P-A (ZIRLO models, SECY)
- Appendices F&G of WCAP-12610-P-A (ZIRLO models, BASH/NOTRUMP)
- ***WCAP-10054-P-A Addendum 2 Rev 1 (NOTRUMP COSI)
- ET-NRC-92-3787 GEDM Model
- **Revised Burst Strain Limit Model (Attachment 6)
 - ** Originally intended for 1993 Annual Report, page was clerically omitted.
 - *** Note that the unapproved COSI was previously listed in NTD-NRC-95-4409.

These 10 CFR 50.46 Reportable changes, together with the originally approved Evaluation Models, constitute the "1997 Formulation" of the following Westinghouse ECCS Evaluation Models:

Ref.	
2	1975 Westinghouse Small Break LOCA Evaluation Model Using WFLASH
1	1985 Westinghouse Small Break LOCA Evaluation Model Using NOTRUMP
1	1981 Westinghouse Large Break LOCA Evaluation Model
1	1981 Westinghouse Large Break LOCA Evaluation Model Using BART
1	1981 Westinghouse Large Break LOCA Evaluation Model Using BASH
1	UHI ECCS Evaluation Model
3	SECY UPI WCOBRA/TRAC Large Break Evaluation Model
4	1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

References:

1. The documents comprising these originally approved EMs are identified in ET-NRC-89-3463.
2. WCAP-8970-P-A, W ECCS Small Break October 1975 Model, January 1979.
3. WCAP-10924-P-A Volume 1 Rev 1 with Addenda 1,2,3 & Volume 2 Rev 2 with Addendum 1.
4. WCAP-12945-P-A, Volume 1 (Revision 2) and Volumes 2 through 5 (Revision 1), "Code Qualification Document for Best Estimate LOCA Analysis," March 1998.