NTD-NRC-95-4409

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February 22, 1995

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

ATTENTION: Mr. R. C. Jones, Jr., Chief, Reactor Systems Branch,
Office of Nuclear Reactor Regulation

SUBJECT: 1994 Annual Notification of Changes to the Westinghouse Small Break LOCA ECCS Evaluation Model and Large Break LOCA ECCS Evaluation Model, Pursuant to 10 CFR 50.46 (a)(3)(ii)

The purpose of this letter is to report the impact of changes or errors in the Emergency Core Cooling System (ECCS) Evaluation Models used by Westinghouse. A description of these changes, "1994 Annual Notification of Changes to the Westinghouse Small Break LOCA and Large Break LOCA ECCS Evaluation Models", is provided as Attachment 1. This information is being provided since it affects information previously submitted in Westinghouse Topical Reports. It is noted that plant specific Peak Cladding Temperature (PCT) variations are not addressed in this letter. These should be treated, as appropriate, on a plant specific basis in accordance with other sections of 10 CFR 50. Westinghouse has notified licensees utilizing these Westinghouse ECCS Evaluation Models in their plant licensing basis of these changes.

In 1994, Westinghouse completed a migration of all LOCA Evaluation Model codes from a CRAY X/MP mainframe to an environment utilizing a number of workstations which use the UNIX operating system. This change in platform is not considered an evaluation model change, as none of the models, correlations or numerical solution techniques were changed. Observed variations in PCT resulting from the migration were not systematic, and were similar to variations observed with small changes in initial conditions. Any future LOCA evaluation which requires a reanalysis of the CRAY analysis of record will include the effects of the platform change in the final PCT assessment.

If you have any questions or comments, please call J. S. Ivey (412) 374-5072 or K.J. Vavrek at (412) 374-4302.

Very truly yours,

N. J. Liparulo, Manager
Nuclear Safety Regulatory and Licensing Activities

Enclosure

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Attachment 1

1994 ANNUAL NOTIFICATION OF CHANGES TO THE WESTINGHOUSE SMALL BREAK LOCA AND LARGE BREAK LOCA ECCS EVALUATION MODELS

WCOBRA/TRAC UPI CODE VERSION COMBINATION AND ERROR CORRECTIONS

CODE STREAM IMPROVEMENT

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SBLOCTA REVISIONS AND AXIAL NODALIZATION ERRORS

WCOBRA/TRAC UPI CODE VERSION COMBINATION AND ERROR CORRECTIONS

Background

Near the end of 1993, a decision was made to combine the three UPI versions of WCOBRA/TRAC (Appendix K blowdown and reflood, and superbounded versions) into one UPI code to reduce the number of codes to be maintained. To combine the codes, some updates were included to provide flags and input options to switch on various Appendix K models. In performing the code combination, several updates that were in the superbounded version were introduced into the Appendix K version (a decision had been made previously to not include these changes in the Appendix K version because they were not considered code errors which would affect code results). In addition, several undefined variables were identified and corrected. A user convenience update was added to have the code automatically stop at the end-of-blowdown conditions. This effort was completed in 1994.

In addition, several errors were found during preparation and review of the best estimate WCOBRA/TRAC code in 1994 which also apply to the UPI version. These corrections were also made in 1994. A summary of the corrections follows:

Corrections to add additional variables to the restart file, to reduce small differences which occur when a restarted case is compared to a non-restarted case.

Correction to lateral velocity for convection of axial momentum.

Correction to intercell drag force logic.

Corrections to two minor errors in 1-D components.

Correction to rod gap pressure calculation.

Correction of a typo in 1979 decay heat table. No effect on Appendix K results.

Correction of an error in the condensation model which was discovered earlier, but was not corrected properly.

Correction of a minor error in the 1-D/3-D junction.

Correction of an error in the Zirlo™ reaction rate constant. Too high a reaction rate was being calculated. Does not affect Appendix K results.

Correction of some errors in coding logic which improperly calculated the location of the zirc-oxide interface, and the momentum area following burst.

Affected Evaluation Models

UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

WCOBRA/TRAC UPI CODE VERSION COMBINATION AND ERROR CORRECTIONS
(continued)

Estimated Effect

An analysis was performed on a representative UPI plant to assess the effect on superbounded and Addendum 3 analyses. There is no effect on superbounded results. The representative Addendum 3 Appendix K analysis shows a 35°F PCT benefit, which could be applied to any future PCT Margin Utilization Sheets.

To assess the impact on Appendix K Addendum 4 analyses, all affected UPI plants were reanalyzed with the revised code. The PCT effect on the Small Break LOCA Evaluation Model for this issue varied depending on the affected plant ECCS configuration and capability. The plant specific PCT penalty, for affected plants, was reported to the plant licensees.

CODE STREAM IMPROVEMENT

Reference

Letter NTD-NRC-94-4143, "Change in Methodology for Execution of BASH Evaluation Model", NJ Liparulo (W) to WT Russell (NRC), May 23, 1994

Background

Revisions were made to the procedures used to interface the various codes that comprise the entire execution stream for performing a large break LOCA analysis with the BASH Evaluation Model. The previous use of the coupled WREFLOOD/COCO code for calculating containment pressure response, which was then transferred as a boundary condition to the BASH code, has been replaced with direct coupling of the BASH and COCO codes such that the same code used to calculated the RCS conditions during reflood, also supplies the boundary conditions for the containment pressure calculation. In conjunction with this, the portion of the WREFLOOD code which calculated the refill phase of the transient has been reprogrammed into a separate, but identical code called REFILL, which is also coupled with COCO.

This methodology revision was made only as a process improvement for conducting analyses and involved no changes to the approved physical models, nor basic solution techniques governing the solutions provided by the individual computer codes. The NRC was advised of the implementation of this methodology on a forward-fit basis via the reference letter.

Affected Evaluation Models

1981 ECCS LBLOCA Evaluation Model with BASH

Estimated Effect

Due to small perturbations in the boundary conditions resulting from this revised methodology for interfacing the codes, small differences in predicted results were observed. The effects were minor, with no observed bias. Since this methodology is a process improvement which is to be implemented on a forward-fit basis, there are no effects on existing licensing analyses, and any small effects on results will be implicitly accounted for in future analyses.

BASH: LOOP/CORE INTERFACE CORRECTIONS

Background

Corrections were made to the logic for interfacing the loop model and BART code model. One correction prevents the possibility of an occasional inconsistency in how the core timestep was limited by the loop timestep. Another corrects the fluid density used in the interface calculation when the inlet flowrate is negative.

Affected Evaluation Models

1981 ECCS LBLOCA Evaluation Model with BASH

Estimated Effect

Results from sensitivity studies for the corrections demonstrated negligible perturbations in the trends of the system parameters with a very minor net effect on peak clad temperature predictions relative to results from the previous version. Since this is an extremely small effect, with no apparent bias, the net effect on existing analyses is estimated to be zero degrees for margin tracking purposes. The change has been implemented on a forward fit basis only and will be incorporated implicitly in any future analyses.

PELLET POWER RADIAL FLUX DEPRESSION ERROR

Background

A coding error (an incorrect sign) was discovered and corrected in a subroutine that calculates radial distribution power factors in the fuel pellet for the LOCBART code.

Affected Evaluation Models

1981 ECCS LBLOCA Evaluation Model with BASH

Estimated Effect

Sensitivity studies found the error correction to result in less than a ± 0.1 F effect on predicted peak clad temperature. The net effect on existing analyses is therefore zero degrees for margin tracking purposes, and will be implicitly included in future recalculations.

IMPROVEMENTS TO FLOODING RATE SMOOTHING

Background

Part of the approved methodology for performing large break LOCA analyses with the BASH Evaluation Model is the requirement that the core inlet flooding rate calculated by the BASH code be linearized in a piece-wise manner to remove oscillations prior to use in the hot channel fuel rod calculation. This operation is termed "smoothing", and guidelines are provided to the analysts describing how to linearize the curve by observing inflections in the overall flooding rate. To facilitate consistency in performing this operation, the logic has been coded into a program named SMUUTH. A new version of the SMUUTH program has been implemented which incorporates improved logic for determining the inflection points gained through experience in utilizing the program for a broad range of plant transients.

Affected Evaluation Models

1981 ECCS LBLOCA Evaluation Model with BASH

Estimated Effect

There are no changes to the approved evaluation model methodology from this revision. The SMUUTH program merely represents a convenient way of automating the approved methodology and does not explicitly introduce any effects on the results. This revision is being reported only as a change to the code stream used for standard analyses. There are no effects on predicted results from using the new program version.

ACCUMULATOR WATER TEMPERATURE

Background

The choice of accumulator water temperature can affect the calculated Peak Cladding Temperature (PCT) associated with large break LOCA analyses. Early Westinghouse Evaluation Models had assumed a generic value of 90°F for the accumulator water temperature based on a conservatively low value of containment air temperature at 100% power in fulfillment of the Appendix K requirements associated with the calculation of a low containment back-pressure. These containment initial temperature and pressure assumptions in a plant's LBLOCA analysis have been consistently reported to the NRC in the Final Safety Analysis Report. The NRC had previously reviewed and approved this aspect of the LBLOCA Evaluation Model via plant specific Safety Evaluation Reports. Using these assumptions, and with the early Westinghouse models, 90°F was conservative with respect to the overall effect on large break LOCA PCT.

Newer evaluation models have demonstrated that a higher containment air temperature, coupled with higher accumulator water temperatures, may result in an even more conservative calculation for PCT, even if containment pressure is slightly higher than calculated with the 90°F assumption. Sensitivity studies performed with these newer evaluation models (identified below) have shown a small sensitivity to accumulator water temperature. The effect on PCT was a 1.3°F change in PCT for a 1°F change in accumulator water temperature when the accumulator water temperature varies over a range from 90°F to 120°F. Application of this sensitivity over its applicable range results in a PCT effect which is below the 10 CFR 50.46 threshold for determination of a significant change (i.e, <50°F). It is therefore Westinghouse's position that immediate implementation of this new methodology is not required. As such, application of the new plant specific methodology and associated change in analysis assumptions can be forward-fit to new large break LOCA analyses. This position was previously communicated to utilities in July, 1994.

In support of future analyses, Westinghouse has developed a set of criteria for selection of the accumulator water temperature for use in large break LOCA analyses which use either the 1981 Evaluation Model with BART or the 1981 Evaluation Model with BASH. These criteria will be provided to the plant licensees at the time a new large break LOCA analysis is performed.

Affected Evaluation Models

Westinghouse 1981 Large Break Evaluation Model using BART
Westinghouse 1981 Large Break Evaluation Model using BASH

Estimated Effect

As stated above, the estimated effect of a change in the accumulator water temperature methodology over a range from 90°F to 120°F is a 1.3°F change in PCT for a 1°F change in accumulator water temperature. As accumulator water temperatures are expected to vary greatly during plant operation and are difficult to measure directly, the plant specific effect of this new methodology may only be assessed once detailed accumulator water temperature data are available. As such, it is expected that these data will be provided when implementation of the new methodology occurs at the initiation of future plant specific LBLOCA analyses.

BOILING HEAT TRANSFER CORRELATION ERRORS

Background

This closely related set of errors deals with how the mixture velocity is defined for use in various boiling heat transfer regime correlations. The previous definition for mixture velocity did not properly account for drift and slip effects calculated in NOTRUMP. This error particularly affected NOTRUMP calculations of heat transfer coefficient when using the Westinghouse Transition Boiling Correlation and the Dougall-Rohsenow Saturated Film Boiling Correlation.

In addition, a minor typographical error was also corrected in the Westinghouse Transition Boiling 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 Model

1985 SBLOCA Evaluation Model (NOTRUMP)

Estimated Effect

Representative plant calculations for this issue resulted in an estimated PCT effect of -6 degrees for affected plants.

STEAM LINE ISOLATION LOGIC ERRORS

Background

This error consists of two portions: a possible plant specific effect which only applies to analyses which assumed Main Feedwater Isolation (FWI) to occur on S-signal, and a generic effect applying to all previous analyses.

The possible plant specific effect was the result of incorrect logic which caused the main steam line isolation to occur on the same signal as FWI. Therefore, when the S-signal was chosen through user input to be the appropriate signal for FWI, it also caused the steam line isolation to occur on S-signal. This is inconsistent with the standard conservative assumption of steam line isolation on Loss of Offsite Power coincident with the earlier Reactor Trip signal.

The generic effect was the result of incorrect logic which always led to the isolation functions occurring at a slightly later time than when the appropriate signal was generated.

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 Model

1985 SBLOCA Evaluation Model (NOTRUMP)

Estimated Effect

Representative plant calculations for this issue resulted in an estimated PCT effect of +12°F for the plant specific portion, if applicable, and +18°F for the generic portion.

CORE NODE ZIRC OXIDE INITIALIZATION ERROR

Background

NOTRUMP models two regions for each core node analogous to the two (mixture and vapor) regions in adjoining fluid nodes. During the course of a transient, NOTRUMP tracks region specific quantities for each core node. Erroneous logic caused incorrect initialization of the region specific, fuel cladding zirc oxide thickness at times prior to the actual creation of the relevant region during the core boiloff transient.

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 Model

1985 SBLOCA Evaluation Model (NOTRUMP)

Estimated Effect

Representative plant calculations led to an estimated generic PCT effect of 0°F for this effect.

PRESSURE SEARCH CONVERGENCE CRITERIA IN NOTRUMP

Background

The convergence criteria used during the pressure search in NOTRUMP have been found to not be adequately restrictive to ensure a sufficiently accurate value for Fluid Node pressure when conditions approach the boundary between subcooled and saturated in some cases. The resulting effects on predicted pressure were more pronounced at pressures below those normally seen during standard Evaluation Model calculations. The previously hardwired convergence criteria values have been made user input, appropriate values have been determined, and these will be implemented in all future analyses.

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 Model

1985 SBLOCA Evaluation Model (NOTRUMP)

Estimated Effect

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

FRICTION VALUE INPUT CORRECTIONS

Background

The SPADES code is used to generate input decks for the small break analysis code, NOTRUMP. An error was found in the code which involved the values assigned to some of the friction factor input. The erroneous values had no impact on transient calculations and were corrected in order to maintain the consistency of the SPADES code with the relevant documentation.

The errors were considered to be discretionary changes as described in Section 4.1.1 of WCAP-13451 and were corrected in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Model

1985 SBLOCA Evaluation Model (NOTRUMP)

Estimated Effect

Representative plant calculations indicate no effect on PCT analyses.

SAFETY INJECTION IN THE BROKEN LOOP

Reference

WCAP-10054-P, Addendum 2, "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code: Safety Injection into the Broken Loop and COSI Condensation Model," August, 1994.

Background

The referenced topical report presents a change to the Westinghouse SBLOCA methodology dealing with ECCS flows in the broken loop. It also presents a revised condensation model that will be used on the safety injection jet in future analyses.

This change is being implemented on a forward fit basis prior to formal approval in accordance with Section 4.1.3 of WCAP-13451.

Affected Evaluation Model

1985 SBLOCA Evaluation Model (NOTRUMP)

Estimated Effect

This change has been shown to typically produce PCT benefits in studies presented in the reference. Since it is being implemented on a forward fit basis, a net PCT impact of 0°F is being assessed against existing analyses.

AUTOMATIC CONTAINMENT SPRAY ACTUATION DURING SBLOCA

Background

Automatic containment spray actuation during a small break LOCA had not previously been addressed in the Westinghouse small break LOCA evaluation model. The containment pressure transient is not modeled because the small break PCT is not directly sensitive to this effect. While investigating this issue, however, Westinghouse concluded that containment spray actuation early in the small break transient is possible for a variety of containment types. Containment spray actuation could result in draindown of the RWST prior to conclusion of the small break transient. Switching to cold leg recirculation during the transient may reduce or briefly interrupt the modeled ECCS injection flow in some plants and elevate the enthalpy of ECCS injection water. Furthermore, an alternate single failure scenario could result in earlier draindown for the RWST and subsequent switchover to cold leg recirculation.

Future small break LOCA analyses will explicitly consider these issues.

Affected Evaluation Models

1975 SBLOCA Evaluation Model (WFLASH)
1985 SBLOCA Evaluation Model (NOTRUMP)

Estimated Effect

Plant specific evaluations of affected plants currently indicate no PCT effect due to SI interruption or reduction following switchover to cold leg recirculation. A generic evaluation for the increase in ECCS enthalpy with an alternate single failure has yielded a PCT penalty of 20°F for some plants.

SBLOCTA REVISIONS AND AXIAL NODALIZATION ERRORS

Reference

Letter NTD-NRC-94-4343, "Interim Report of an Evaluation of a Deviation or Failure to Comply Pursuant to 10CFR21.21(a)(2) - Closeout 94-002", NJ Liparulo (W), November 15, 1994

Background

Westinghouse has completed an evaluation of issues concerning the SBLOCTA code which is a part of both the NOTRUMP and WFLASH SBLOCA ECCS Evaluation Models. The potential issue originally identified was a deficiency in the amount of detail used for the axial nodalization of the fuel rod, as it affected the solution of the channel fluid equations. Further investigation identified several additional related issues associated with nodalization and the overall solution of the fluid conservation equations which have subsequently been corrected. As a separate, but related issue, a revised model for calculating transient fuel rod internal pressure was implemented in the SBLOCTA code. The NRC was informed of these modeling changes, which were summarized in the closeout notification of the reference.

Affected Evaluation Models

1985 SBLOCA Evaluation Model (NOTRUMP)
1975 SBLOCA Evaluation Model (WFLASH)

Estimated Effect

Since all of the issues relate to portions of the SBLOCTA code and/or its associated input methodology, they were reported as a single closely-related group of changes. Evaluations were performed for all plants and the results reported to the utilities. Revised SBLOCA Margin Utilization Summary tables were transmitted containing a compilation of the net effect as item "Axial Nodalization, RIP Model Revision and SBLOCTA Error Corrections", along with sufficient information for reporting, if necessary.