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U. S. Nuclear Regulatory Commission
Washington, DC 20555

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

SUBJECT: 1993 Annual Notification of Changes to the Westinghouse Small Break LOCA ECCS Evaluation Model and Large Break LOCA ECCS Evaluation Model

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, "1993 Annual Notification of Changes to the Westinghouse Small Break LOCA ECCS Evaluation Model and Large Break LOCA ECCS Evaluation Model", is provided as an attachment to this letter. 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.

The Westinghouse WCOBRA/TRAC UPI model is not explicitly addressed in the attachments, as there were no changes made in 1993 to this large break LOCA Evaluation Model.

If you have any questions or comments, please call M. E. Nissley (412) 374-4181 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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1993 ANNUAL NOTIFICATION OF CHANGES TO THE WESTINGHOUSE SMALL BREAK LOCA ECCS EVALUATION MODEL AND LARGE BREAK LOCA ECCS EVALUATION MODEL

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
1981 ECCS Evaluation Model with BART
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.

NOTRUMP POINT KINETICS ERROR

Background

An error was discovered in the coding used in the NOTRUMP User External SUBROUTINE VOLHEAT. The 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.

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.

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 intent of the original 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 uncovered an additional closely related logic error which led to discontinuities under certain other circumstances. This error was also corrected and returned the coding to consistency with WCAP-10079-P-A.

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

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 particularly this led to artificially high core temperatures during the time-step when the core mixture level crossed a node boundary, conservatively causing slightly more core mixture level depression than appropriate during this time-step. 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

1975 SBLOCA Evaluation Model
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.

CHARGING/SAFETY INJECTION SYSTEM ISSUES

Background

Westinghouse completed an evaluation of a potential safety issue regarding four specific issues related to the design and use of the miniflow line for the charging/safety injection (CHG/SI) pumps. Two of these issues involved SBLOCA PCT penalties for certain plants. One issue involves the operation of the centrifugal charging pump (CCP) miniflow line during accident conditions. A CCP runout condition may occur if the CCP injection lines were balanced with the CCP miniflow path closed and credit was taken for operator action to isolate the miniflow line during the accident. Also, the existence of this condition may impact the ECCS flows assumed in plant specific Small Break LOCA analyses. The other issue involves miniflow orifices that are used for the CHG/SI pumps. Westinghouse has supplied two different orifice types: 60 or 70 gpm orifice at a differential head of 6000 feet. Additional confirmation testing indicates that the orifice plates will allow a higher than design flow rate through the orifice at the design differential head. As a result, a discrepancy may exist between the installed miniflow line capacity and the ECCS analysis assumptions. The discrepancy would occur if the ECCS analysis assumed that the miniflow line resistance was based on the orifice allowing design flow at the design head as opposed to the higher as tested flow and head. Consequently, the miniflow path may permit more flow than previously determined which may reduce SI flow during injection.

Affected Evaluation Models

1975 SBLOCA Evaluation Model
1985 SBLOCA Evaluation Model

Estimated Effect

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.

DOUBLE-DISK GATE VALVE PRESSURE EQUALIZATION

Background

Westinghouse completed an evaluation of a potential issue concerning use of double-disk gate valves in the emergency core cooling system (ECCS) as hot leg isolation valves. Use of these double-disk gate valves may involve an inner disc pressure equalization line that could set up a leak path into the hot leg during cold leg injection following a loss of coolant accident (LOCA). This condition could lead to inadequate cold leg injection resulting in an increase in PCT.

The design characteristic of a double-disk gate valve provides isolation by the downstream disk sealing against the valve seat. The mechanical seating force and the hydraulic force from the upstream pressure (SI pump) act to provide force to the valve seal surfaces. The double-disk gate valve design results in a volume of fluid which is enclosed between the discs when the valve is closed. As the fluid volume heats up, pressure greater than system pressure may develop and may cause the disks to bind against the seats to the extent that the valves can not be opened. To avoid this, many double-disk gate valves have been modified to include a pressure equalization line or a small hole in one of the disks to relieve the pressure between the disks. Based on generic leakage calculations it was determined that the double-disk gate valves modified to eliminate concerns for thermal binding could leak as much as 30 gpm per valve. This leakage into the RCS hot legs will increase steam binding during reflood and result in an increase in the calculated peak cladding temperature.

Affected Evaluation Models

1975 SBLOCA Evaluation Model
1985 SBLOCA Evaluation Model
1978 ECCS Evaluation Model
1981 ECCS Evaluation Model
1981 ECCS Evaluation Model with BART
1981 ECCS Evaluation Model with BASH

Estimated Effect

The PCT effect on the Large Break LOCA Evaluation Model for this issue varied depending on the affected plant ECCS configuration and capability. The plant specific Large Break LOCA PCT penalty, for affected plants, was report to the plant licensees. An assessment of this issue on Small Break LOCA Evaluation Model PCT results showed a nominal benefit which is being reported generically as a 0°F impact.

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.

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 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.

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

1975 SBLOCA Evaluation Model
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 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.

GENERAL CODING MAINTENANCE

Background

Various changes in code input and output format have been made to enhance useability and help preclude errors in analyses. This includes both input changes (more relevant input variables defined and more common input values used as defaults) as well as input diagnostics designed to perform initial checks on input values to preclude unreasonable values from being used. It also includes increases in the dimensioning of input and output variables as well as relevant internal code variables.

In addition, various sections of coding were also refined to improve calculational efficiency and code maintainability. This includes logic restructuring, removing common algorithms to their own subroutines, and incorporating various property subroutines used in different portions of the Evaluation Models to a centralized library of such routines.

These improvements are considered to be Discretionary Changes as described in Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1975 SBLOCA Evaluation Model
1985 SBLOCA Evaluation Model
1978 ECCS Evaluation Model
1981 ECCS Evaluation Model
1981 ECCS Evaluation Model with BART
1981 ECCS Evaluation Model with BASH

Estimated Effect

The nature of the improvements allows an estimated PCT impact of 0°F for all affected models.