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Branch Office of Nuclear Reaction Regulation
U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

U. S. Nuclear Regulatory Commission
10 CFR 50.46 Annual Notification and Reporting for 2000

References:
1. ET-NRC-92-3755, "W Methodology for Implementation of 10 CFR 50.46 Reporting", Liparulo, W to NRC Document Control Desk, 10/30/92. (WCAP-13451)
2. NSBU-NRC-00-5970, "1999 Annual Notification of Changes to the Westinghouse Small Break LOCA and Large Break LOCA ECCS Evaluation Models, Pursuant to 10 CFR 50.46," Sepp, W to J. S. Wermiel, 5/12/2000.

Dear Mr. Wermiel,

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, "2000 Annual Notification of Changes to the Westinghouse Small Break LOCA and Large Break LOCA ECCS Evaluation Models", is provided as Attachment 1, Westinghouse has categorized these changes or errors into three separate groups:

- Non-Discretionary Changes with PCT Impact
- Non-Discretionary Changes with no PCT Impact
- Enhancements/Forward Fit Discretionary Changes

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 the appropriate reportable changes.

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For future referencing convenience, the 2000 10 CFR 50.46 Reportable changes provided in Attachment 1, together with the "1999 Formulation" offered in Reference 2 constitute the "2000 Formulation" of the Westinghouse ECCS Evaluation Models.

In 2000, efforts were continued to recompile LOCA Evaluation Model codes on the HP-UX B.10.20 ACE UNIX operating platform. This change is not considered an evaluation model change, as none of the models, correlations, or numerical solution techniques were changed. As such, code recompilation on the HP-UX B.10.20 ACE UNIX operating platform will be implemented on a forward-fit basis.

If you have any questions concerning this information, please call me at (412) 374-5282.

Very truly yours,

G. W. Whiteman for

H. A. Sepp, Manager
Regulatory and Licensing Engineering
Westinghouse Electric Co.

cc list:

S. D. Bloom, NRR/OWFN/DRPW/PDIV2 (Rockville, MD) 1L, 1A

NON-DISCRETIONARY CHANGES WITH PCT IMPACT

LOCBART Cladding Emissivity Errors
LOCBART Vapor Film Flow Regime Heat Transfer Error
LOCBART Dispersed Flow Regime Wall Emissivity Error
NOTRUMP – Mixture Level Tracking/Region Depletion Errors
Channel Splitting Error in SECY UPI EM Analyses
Decay Heat Uncertainty Error in Monte Carlo Calculation

NON-DISCRETIONARY CHANGES WITH NO PCT IMPACT

BASH Isotherm Initialization Error
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Inadequately Dimensioned Core Reflux Flow Link Error in NOTRUMP
LOCBART Rod-to-Rod Radiation Error
LOCBART NUREG-0630 Coding Errors
LOTIC2 Nitrogen Addition Logic Error
LOTIC2 Time Step Logic Error
NOTRUMP Core Heat Transfer Error
SATAN6 Momentum Flux Logic Error
SATAN6 Reactor Coolant Pump Logic Error
Large Break LOCA Single Failure Assumption
Accumulator Line Resistance Used in Current SECY UPI/BELOCA EM Analyses
WCOBRA/TRAC Gap Input Error in SECY UPI/BELOCA EM Analyses
GEDM Interface Error
Drop Diameter Plot Tape Storage Error
Cladding Oxidation Edit Error
Output Edit Error for SI Units
Radiation Heat Transfer to Vapor Phase Error
Grid Heat Transfer Error
Pressure Drip Error For ID Connections to 3D Vessel

ENHANCEMENTS/FORWARD-FIT DISCRETIONARY CHANGES

Simplified Isothermal Solution for LOCBART Subroutine RATE
PAD 4.0 Implementation
LOCBART Rod Internal Pressure Model Revisions
Improved Code I/O and Diagnostics, and General Code Maintenance
Accumulator Line Resistance Used in Future SECY UPI/BELOCA EM Analyses

NON-DISCRETIONARY CHANGES WITH PCT IMPACT

LOCBART CLADDING EMISSIVITY ERRORS

Background

Section 2-17 of Reference 1, Section 3.2.5 of Reference 2, and Section 3-2 of Reference 3 describe expressions that are used to model radiation heat exchange between the rod, grid, and fluid during the reflood phase of the transient. It was discovered that the cladding surface emissivity values used with Equation 2-93 of Reference 1, Equation 3-47 of Reference 2, and Equation 3-8 of Reference 3 were substantially lower than the values that would be expected to exist during a large break LOCA reflood transient. A review of existing documentation was inconclusive as to the exact values that were intended for use with the equations, so a constant, representative value of 0.7 was used, based on the value used in WCOBRA/TRAC for a similar application (Reference 4). These errors were determined to be a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

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

Estimated Effect

Representative plant calculations using the LOCBART code showed that these error corrections generally result in a small-to-moderate PCT benefit for plants with burst-node-limited PCTs occurring coincident with the onset-of-entrainment in reflood and a small PCT benefit or penalty for other plants. The generic PCT assessments for this issue were derived from the representative plant calculations as the bounding values for each of the two plant/transient categories (i.e. early-PCT, burst-node-limited plants and other plants) that were defined specifically for this purpose.

References

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients", M. Young, et al., March 1984.
2. WCAP-7437-L, "LOCTA-R2 Program: Loss of Coolant Transient Analysis", W.A. Bezella, et al., January 1970.
3. WCAP-10484-P-A, "Spacer Grid Heat Transfer Effects During Reflood", M. Young, et al., March 1991.
4. WCAP-12945-P-A Volume I (Revision 2) and Volumes II-V (Revision 1), "Westinghouse Code Qualification for Best Estimate Loss of Coolant Accident Analysis", S.M. Bajorek, et al., March 1998.

LOCBART VAPOR FILM FLOW REGIME HEAT TRANSFER ERROR

Background

As discussed in Reference 1, the Berenson model for film boiling is used in LOCBART to compute the cladding-to-fluid heat transfer coefficient for conduction across the vapor film in the vapor film flow regime, which occurs near the quench front and is assumed to consist of a conduction component and a radiation component. An error was discovered in LOCBART whereby the multiplier on this correlation was programmed incorrectly, resulting in a relatively minor underprediction of the cladding-to-fluid heat transfer coefficient. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

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

Estimated Effect

Representative plant calculations using the LOCBART code showed that this error correction generally results in a small-to-moderate PCT benefit for plants with burst-node-limited PCTs occurring coincident with the onset-of-entrainment in reflood and a small PCT benefit or penalty for other plants. The generic PCT assessments for this issue were derived from the representative plant calculations as the bounding values for each of the two plant/transient categories (i.e., early-PCT, burst-node-limited plants and other plants) that were defined specifically for this purpose.

Reference

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients", M.Y. Young, et al., March 1984.

LOCBART DISPERSED FLOW REGIME WALL EMISSIVITY ERROR

Background

As discussed in Section 2-18 of Reference 1, the Sun, Gonzalez, and Tien model is used in LOCBART to predict radiant heat exchange between the fuel rod, vapor, and droplets in the dispersed flow regime. An error was discovered in LOCBART whereby the wall emissivity in the dispersed flow regime was substantially lower than the corresponding value identified in Section 2-18 of Reference 1. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

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

Estimated Effect

Representative plant calculations using the LOCBART code showed that this error correction generally results in a small PCT benefit for plants with PCTs occurring early in reflood and a small-to-moderate PCT benefit for plants with PCTs occurring late in reflood. The generic PCT assessments for this issue were derived from the representative plant calculations as the bounding values for each of the two plant/transient categories (i.e., early-reflood - PCT plants and late-reflood - PCT plants) that were defined specifically for this purpose.

Reference

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients", M.Y. Young, et al., March 1984.

NOTRUMP - MIXTURE LEVEL TRACKING/REGION DEPLETION ERRORS

Background

Several closely related errors have been discovered in how NOTRUMP deals with the stack mixture level transition across a node boundary in a stack of fluid nodes. Firstly, when the mixture level attempts to transition a node boundary in a stack of fluid nodes, it can occasionally have difficulty crossing the interface (i.e. level hang). When a mixture level hang occurs at a node boundary, this leads to situations where the flow for a given time step is reset and becomes inconsistent with the matrix solution of the momentum equation for an excessive period of time. This results in local mass/energy errors being generated. In addition, it was discovered that the code was not properly updating metal node temperatures as a result of the implementation of the nodal region depletion logic which can be incurred when a fluid node empties or fills. It is noted that several aspects of these errors, namely mixture level tracking and flow resets, are not directly tied to erroneous coding; rather, they are a direct result of modeling choices made and documented in the original code development/licensing. These errors affect all code versions up to and including NOTRUMP Version 37.0. These error corrections were determined to contain both Discretionary and Non-Discretionary Change aspects in accordance with Sections 4.1.1 and 4.1.2 of WCAP-13451.

Affected Evaluation Model

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The nature of this error leads to a bounding 13°F increase of the calculated PCT for all standard EM applications. Plant specific PCT impacts will be assessed where required.

References

1. NSBU-NRC-00-5972, "NRC Report for NOTRUMP Version 38.0 Changes", (Non-Proprietary), June 30, 2000.

CHANNEL SPLITTING ERROR IN SECY UPI EM ANALYSES

Background
A survey of current SECY UPI LBLOCA analyses utilizing WCOBRA/TRAC identified an error in the inputs used to determine momentum area when one channel connects vertically to two channels above (known as "channel splitting"). The error resulted in an incorrect momentum area used in the calculation. This error was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

Estimated Effect
A survey of all SECY UPI analyses revealed that only two analyses contained this error. Both analyses contained the same erroneous inputs. Correction of this error for one plant resulted in a 52°F penalty in reflood PCT. This penalty of 52°F was applied to the other plant reflood PCT as an estimated PCT impact of the error.

DECAY HEAT UNCERTAINTY ERROR IN MONTE CARLO CALCULATIONS

Background
It was determined that an error existed in the calculation of decay heat uncertainty in the Monte Carlo code used for calculation of the 95th percentile PCT for Best Estimate LBLOCA. This issue was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
Plant specific PCT calculations were performed to assess the impact of this error for all analyses using the affected EMs. The current code version contains the correction.

NON-DISCRETIONARY CHANGES

WITH NO PCT IMPACT

BASH ISOTHERM INITIALIZATION ERROR

Background

As discussed in Section 3-6 of Reference 1, the quench front progression in BART is computed using the isotherm migration method. An error was discovered in BASH whereby a variable was not being initialized for cases where a user entered the initial isotherm temperatures and elevations into the BASH input file, instead of letting the code calculate the initial isotherms internally. This error existed in BASH Versions 18.0 and 19.0. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect

A survey of BASH-EM analyses under Westinghouse Pittsburgh LBLOCA analysis cognizance found no usage of the erroneous option which is not accessed for standard production applications. As a result, the correction of this error is treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

Reference

1. WCAP-9561-P-A, "BART-A1: A Computer Code for the Best Estimate Analysis of Reflood Transients", M.Y. Young, et al., March 1984.

BASH IMPLEMENTATION OF LOCBART CORRECTIONS

Background
Since BART coding is used in both LOCBART and BASH, the following changes described elsewhere in this report have also been implemented into BASH for consistency:

- LOCBART Cladding Emissivity Errors
- LOCBART Vapor Film Flow Regime Heat Transfer Error
- LOCBART Dispersed Flow Regime Wall Emissivity Error

These changes were determined to be a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
1981 Westinghouse Large Break LOCA Evaluation Model with BASH

Estimated Effect
Representative plant calculations using the BASH code showed that these error corrections had a relatively minor effect on the core inlet flooding rate during reflood, which in turn would be expected to have a negligible effect on PCT. As a result, these corrections are being treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

INADEQUATELY DIMENSIONED CORE REFLUX FLOW LINK ERROR IN NOTRUMP

Background
An error has been discovered which results in the termination of the NOTRUMP code when attempting to model more than 12 active core nodes. The problem results from an inadequately defined maximum number of core reflux flow links in the code externals. The nature of the error is such that code execution can not be performed when attempting to model more than 12 core nodes due to compiler options selected. This problem only exists in the NOTRUMP Version 37.0 code. This error correction 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

Estimated Effect
The nature of this error leads to no PCT impact for all EM applications due to the core modeling assumed in these models (i.e. <= 12 core nodes).

LOCBART ROD-TO-ROD RADIATION ERROR

Background
An error was discovered in LOCBART whereby a variable was not being defined for the rod-to-rod radiation calculations. This error caused the radiation heat flux for the hot rod to be calculated incorrectly and caused the radiation heat flux for the adjacent rod to be zero. This error is present only in LOCBART Version 20.0. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

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

Estimated Effect
Representative plant calculations using the LOCBART code showed that this error correction had a negligible effect on results. As a result, this correction is being treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

LOCBART NUREG-0630 CODING ERRORS

Background
The following errors were discovered in the LOCBART code related to the programming of the NUREG-0630[1] burst and blockage models for Zircaloy-4 cladding:

1. In Subroutine FBLOK, the assembly blockage corresponding to a burst temperature of 700°C (1292°F) and a temperature ramp rate of 25°C/s (45°F/s) was programmed as 13.6%, instead of the correct value of 13.8% from page 112 of Reference 1.

2. In Subroutine XPAND, the burst temperature corresponding to a burst strain of 48% (for a temperature ramp rate of 10°C/s or 18°F/s) or 45% (for a temperature ramp rate of 25°C/s or 45°F/s) was programmed as 1675°F, instead of the correct value of 1652°F (900°C) from pages 111 and 112 of Reference 1.

As discussed below, it was determined that correcting these errors would either have no effect on results or would be expected to result in a small PCT benefit, so LOCBART updates will be deferred to a future code release. When corrected, these error corrections will represent Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

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

Estimated Effect
The error in Subroutine FBLOK affects the calculation of assembly blockage for Zircaloy-4 cladding over the burst temperature range of 1247-1337°F, which is substantially lower than the burst temperatures that are encountered in typical licensing calculations. For a hypothetical case with a burst temperature in the affected range, the difference in assembly blockage is very small and would be expected to have a negligible effect on results.

The error in Subroutine XPAND affects the calculation of burst strain for Zircaloy-4 cladding over the burst temperature range of 1607-1697°F. It was determined that correcting the error would either have no effect on results or would result in a small reduction in burst strain, which would be expected to result in a small decrease in PCT with all other things being equal.

Based on the preceding information, these error corrections will be deferred to a future code release and are treated as having a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

Reference
1. NUREG-0630, "Cladding Swelling and Rupture Models for LOCA Analysis", R. O. Meyer and D. A. Powers, April 1980.

LOTIC2 NITROGEN ADDITION LOGIC ERROR

Background
LOTIC2 calculates the minimum containment backpressure during a large break LOCA transient for plants with an ice condenser containment design. When the accumulators empty, the nitrogen cover gas is released into containment. An error was discovered whereby some of the nitrogen was being released to the upper compartment, instead of correctly being released entirely to the lower compartment. The nitrogen addition logic was corrected to force all nitrogen releases into the lower compartment. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
1981 Westinghouse Large Break LOCA Evaluation Model
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect
Representative plant calculations using the LOTIC2 code showed that this error correction had a negligible effect on containment pressure, which in turn would have a negligible effect on PCT. As a result, this correction is being treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

LOTIC2 TIME STEP LOGIC ERROR

Background
An error was discovered in LOTIC2 whereby the transient time was being adjusted twice in a typical time step, which led to negative time step sizes under certain conditions. The time step logic was modified to force the transient time to change only once per time step, which eliminates the occurrence of negative time step sizes. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
1981 Westinghouse Large Break LOCA Evaluation Model
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect
Representative plant calculations using the LOTIC2 code showed that this error correction had a very minor effect on containment pressure, which in turn would have a negligible effect on PCT. As a result, this correction is being treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

NOTRUMP CORE HEAT TRANSFER ERROR

Background
An error has been discovered in NOTRUMP which results in either a code abort or the usage of invalid steam table properties and/or heat transfer correlations in the core region under certain conditions. The problem results from the steam cooling core heat transfer correlation attempting to pass sub-cooled properties to steam property routines. Since the property routines do not perform input validity checking, this can result in erroneous properties being returned/utilized by the correlation. This error can only occur when complete subcooling of the core cladding occurs in conjunction with core uncovery. This error affects all code versions up to and including NOTRUMP Version 37.0. This error correction 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

Estimated Effect
The nature of this error leads to no PCT impact for all standard EM applications due to the lack of this type of core uncovery process.

SATAN6 MOMENTUM FLUX LOGIC ERROR

Background
An error was discovered in the SATAN6 momentum flux logic whereby the sonic velocity limit was being applied incorrectly. In some instances, this caused the break flow to hang near the end of the blowdown transient, instead of allowing the calculation to proceed normally to the end of blowdown. The erroneous logic was corrected to ensure proper application of the sonic velocity limit. This error correction was determined to be a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

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

Estimated Effect
Representative plant calculations using the SATAN6 code showed that this error correction had a very minor effect on blowdown results for typical cases, which in turn would be expected to have a negligible effect on PCT. Even for a case with a more substantial effect on SATAN6 results, the effect on PCT was found to be small, due mainly to the fact that the core heatup near end-of-blowdown is essentially adiabatic. As a result, this correction is being treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

SATAN6 REACTOR COOLANT PUMP LOGIC ERROR

Background
An error was discovered in the SATAN6 reactor coolant pump logic where, during a time step in which the pump critical flow iteration failed to converge, the pump discharge mass flow rate was incorrectly reset to the value corresponding to the last iteration. This problem was resolved by removing the pump critical flow iteration from the code, since the corresponding logic was found to be of little use for standard licensing applications. This change was determined to contain both Discretionary and Non-Discretionary aspects in accordance with Sections 4.1.1 and 4.1.2, respectively, of WCAP-13451.

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

Estimated Effect
Representative plant calculations using the SATAN6 code showed that these changes had either no effect or a negligible effect on blowdown results, which would be expected to have either no effect or a negligible effect on PCT. As a result, these changes are being reported as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

LARGE BREAK LOCA SINGLE FAILURE ASSUMPTION

Background
A concern was raised by a licensee whereby a single failure in the Solid State Protection System (or Relay Protection System for older plants) could cause the loss of an entire train of safety injection pumps, without causing the loss of the corresponding train of containment heat removal equipment. This situation is contrary to Section 3.6 of Reference 1, which defines the limiting single failure for Appendix K LBLOCA and SECY UPI LBLOCA analysis as the loss of a low pressure injection pump. To address this concern, the analysis guidance has been modified to direct the analyst to assume the loss of an entire train of safety injection pumps, unless a less conservative single failure assumption can be justified. This was determined to represent a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
1981 Westinghouse Large Break LOCA Evaluation Model
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH
SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

Estimated Effect
Recent LBLOCA analyses have generally assumed the loss of an entire train of safety injection pumps as the limiting single failure, since the additional conservatism introduced by this simplification is typically small. A survey of BART-EM and BASH-EM analyses under Westinghouse Pittsburgh LBLOCA analysis cognizance found no domestic applications in which the analyst assumed the loss of a low pressure injection pump as the limiting single failure. As a result, this change is being treated as having a 0°F PCT effect for 10 CFR 50.46 reporting purposes.

Reference
1. WCAP-8471-P-A, "The Westinghouse ECCS Evaluation Model: Supplementary Information", F. M. Bordelon et. al., April 1975.

WCOBRA/TRAC GAP INPUT ERROR IN SECY UPI/BELOCA EM ANALYSES

Background
A survey of current SECY UPI, Best Estimate LBLOCA analyses and LBLOCA test simulations utilizing WCOBRA/TRAC identified an error in the application of the affected evaluation models. The error was in the specification of horizontal channel connections (gaps), which should be from lower numbered to higher numbered channel. The survey showed that only a few analyses contained this error. This error was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Potentially Affected Evaluation Models
SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
For SECY UPI EM analyses, a plant specific analysis was performed for a representative plant, correcting the errors in gap numbering and resulted in a small benefit in reflood PCT. Four other SECY analyses were found to have the same error. Since the error correction was found to be a slight benefit and is considered negligible; the current analyses are conservative and an estimated effect of 0°F PCT impact is being assessed to all of the affected SECY UPI analyses.

For Best Estimate LBLOCA analyses, three analyses were found to have the error, but since it appeared for only one gap in the upper head, the impact was judged to be negligible. An estimated effect of 0°F PCT impact is being assessed to these plants.

For Best Estimate LBLOCA test simulations, input decks for two tests were found to have this error. Correction of the error resulted in no impact on the methodology conclusions derived from these tests. Thus, there is no PCT impact to report.

The survey found no errors in the application of the 1999 Best Estimate EM for UPI plants.

GEDM INTERFACE ERROR

Background
A discrepancy between the inputs for the neutronics model and the way the code used the inputs was discovered that impacted the calculated gamma redistribution factors. This issue was determined to be a Non-Discretionary change in accordance with 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
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
It was determined that the error only concerns the neutronic input, which is not used in the code uncertainty/bias calculations, but only in plant calculations. A typical value of error in terms of the relative power is 0.001% or less than 0.01°F in peak average fuel temperature. This is well within the steady state tolerance criteria, such that estimated impact of the effect of this error on plant calculations is 0°F. The current code version corrects this error.

DROP DIAMETER PLOT TAPE STORAGE ERROR

Background
It was discovered the droplet diameter variable stored in the plot file contained a wrong value. This issue was determined to be a Non-Discretionary change in accordance with 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
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
There is no impact on analysis results, since the drop diameter edit output is not used in the calculation of PCT. A work around is available for old versions of the code. The current code version corrects this error. There is no PCT impact as a result of this error.

CLADDING OXIDATION EDIT ERROR

Background
It was determined that the hot rod fuel clad oxidation printouts after the end of fuel rod edits were incorrect. This issue was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
There is no impact on analysis results, since the guidance for the oxidation calculation uses the data in the plot file, which are correct. The current code version corrects this error. There is no PCT impact as a result of this error.

OUTPUT EDIT ERROR FOR SI UNITS

Background
It was determined that the fuel rod and 1D component edits were incorrect if the SI output option is selected. This issue was determined to be a Non-Discretionary change in accordance with 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
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
There is no impact on analysis results, since the reported PCT was not affected by this error. Users of older code versions have been advised to use English units for all WCOBRA/TRAC calculations. The current code version corrects this error. There is no PCT impact as a result of this error.

RADIATION HEAT TRANSFER TO VAPOR PHASE ERROR

Background
It was determined that the radiation heat transfer was set to zero when the void fraction in a channel exceeded 0.9999. This issue was determined to be a Non-Discretionary change in accordance with 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
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
Evaluations indicate that the single phase vapor heat transfer regime can occur during blowdown heatup, refill, and reflood. This error has negligible impact on existing analyses during the blowdown heatup and refill phases, since the single phase vapor heat transfer mode occurs only briefly in the blowdown heatup and refill. In reflood, single phase vapor conditions occur primarily during the downcomer boiling period for plants with late reflood PCTs. Under those conditions, the radiation heat transfer can account for approximately 20% of the total clad-to-vapor heat transfer. However, these conditions are nearly adiabatic, such that the effect can be considered negligible. The current code version corrects this error. There is no PCT impact as a result of this error.

GRID HEAT TRANSFER ERROR

Background
It was determined that the grid's turbulence enhancement to heat transfer coefficient is erroneously applied to Radiation Heat Transfer to vapor phase. The enhancement from these grids should only be applied to the convective single phase heat transfer coefficient. This issue was determined to be a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Models
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
The heat transfer multipliers used in the BE LBLOCA process include data from rod bundles with grids. Therefore, the effect of the error is compensated for by the multipliers, resulting in no impact on the analysis. The current code version corrects this error. There is no PCT impact as a result of this error.

PRESSURE DROP ERROR FOR 1D CONNECTIONS TO 3D VESSEL

Background
It was determined that the pressure drop was overestimated in the vertical momentum cell when the vessel vertical momentum flux is convected by the 1D component velocity. This issue was determined to be a Non-Discretionary change in accordance with 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
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect
A survey of all plant analyses and test simulations revealed that none used the option impacted by this error. Thus, there is no PCT impact as a result of this error. The current code version corrects this error.

ENHANCEMENTS/FORWARD-FIT

DISCRETIONARY CHANGES

SIMPLIFIED ISOTHERMAL SOLUTION FOR LOCBART SUBROUTINE RATE

Background

As discussed in Reference 1, LOCBART was revised in 1999 to correct a logic error that caused the Baker-Just metal-water reaction calculations to be performed three times per time step. During the review of the corresponding code logic, it was determined that the complicated solution technique described in Section 3.3.2 of Reference 2 could be replaced with a simplified isothermal solution, with only a minimal effect on results. This replacement has been accomplished and was determined to represent a Discretionary Change that will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

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

Estimated Effect

Representative plant calculations using the LOCBART code confirmed that this change has a negligible effect on results that will be implemented on a forward-fit basis and is being treated as having a 0 °F PCT effect for 10 CFR 50.46 reporting purposes.

References

1. Westinghouse Letter NSBU-NRC-00-5970, "1999 Annual Notification of Changes to the Westinghouse Small Break LOCA and Large Break LOCA ECCS Evaluation Models, Pursuant to 10 CFR 50.46 (a)(3)(ii)", H. A. Sepp, May 12, 2000.
2. WCAP-8301, "LOCTA-IV Program: Loss-of-Coolant Transient Analysis", F. M. Bordelon et. al., June 1974.

PAD 4.0 IMPLEMENTATION

Background

The Westinghouse Performance Analysis and Design Model (PAD) is used to generate fuel-related input data for use in LOCA licensing calculations. As documented in Reference 1, the Safety Evaluation Report for Version 4.0 of the PAD model was issued by the US NRC on April 24, 2000. Use of PAD Version 4.0 is considered to represent a Discretionary Change and will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

1981 Westinghouse Large Break LOCA Evaluation Model
1981 Westinghouse Large Break LOCA Evaluation Model with BART
1981 Westinghouse Large Break LOCA Evaluation Model with BASH
1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP
SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model, Application to PWRs with Upper Plenum Injection

Estimated Effect

The implementation of PAD Version 4.0 with respect to Appendix K Large Break LOCA and Small Break LOCA analyses will be handled on a forward-fit basis and is assigned a PCT estimate of 0°F for 10 CFR 50.46 reporting purposes.

References

1. WCAP-15063-P-A Revision 1, with Errata, "Westinghouse Improved Performance Analysis and Design Model (PAD 4.0)", J. P. Foster and S. Sidener, July 2000.

LOCBART ROD INTERNAL PRESSURE MODEL REVISIONS

Background

In the original LOCTA-IV model[1], the gas in the rod plenum was assumed to remain at a constant, steady-state temperature throughout the entire transient. In order to more accurately track the rod internal pressure history during a Large Break LOCA transient, the use of this assumption in LOCBART has been replaced with the temperature-dependent model that was implemented previously in the SBLOCTA code, as described in Reference 2. In addition, other minor changes were made to the LOCBART rod internal pressure model, including an option to specify the volumes corresponding to the upper and lower annular blankets, and a simplified treatment of the crack and dish volumes. These changes were determined to represent a closely-related group of Discretionary Changes and will be implemented on a forward-fit basis, in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

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

Estimated Effect

These changes will be implemented on a forward-fit basis and are assigned an estimated PCT impact of 0°F for 10 CFR 50.46 reporting purposes.

References

1. WCAP-8301, "LOCTA-IV Program: Loss-of-Coolant Transient Analysis", F. M. Bordelon et al., June 1974.
2. Westinghouse Letter NTD-NRC-94-4253, "Revision to the Rod Internal Pressure Model in the Westinghouse SBLOCTA Code (Proprietary)", N. J. Liparulo, August 9, 1994.

IMPROVED CODE I/O AND DIAGNOSTICS, AND GENERAL CODE MAINTENANCE

Background

Various changes in code input and output format have been made to enhance usability and help preclude errors in analyses. This includes both input changes (e.g. more relevant input variables defined and more common input values used as defaults) and input diagnostics designed to preclude unreasonable values from being used, as well as various changes to code output which have no effect on calculated results. In addition, various blocks of coding were rewritten to eliminate inactive coding, optimize the active coding, and improve commenting, both for enhanced usability and to facilitate code debugging when necessary. These changes were determined to be Discretionary Changes in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models

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

Estimated Effect

The nature of these changes leads to an estimated PCT impact of 0 °F.

ACCUMULATOR LINE RESISTANCE USED IN SECY UPI EM ANALYSES

Background
As a result of an audit of a plant specific SECY UPI EM analysis, it was noted that the accumulator line resistance used in the analysis was an average value. Investigation into the basis for this selection revealed that the approved EM WCAP-10924-P-A (Reference) specified that a maximum value was used in the analyses. Later guidance issued for Best Estimate analyses recommended the use of average values, without specifying that it was applicable for SECY. This later recommendation was incorporated into some SECY UPI EM analyses as well. Investigation of the impact of a change from maximum to average accumulator line resistance was conducted, as discussed below. This error in the application of the model was determined to be a non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451. For reasons discussed below, Westinghouse has determined that future SECY UPI EM analyses could use either average or maximum, and this is considered a Discretionary change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Models
SECY UPI WCOBRA/TRAC Large Break LOCA Evaluation Model

Estimated Effect
Appendix H of the reference briefly discusses the selection of maximum value of accumulator line resistance for SECY UPI analyses. The Appendix includes some sensitivity studies, but no single effect sensitivities to accumulator line resistance. Section 3-3-2-8 provides further discussion and states that changes in the accumulator parameters (including line resistance) are evidenced by changes in accumulator water delivery. Effects of changes in accumulator water delivery are overshadowed by the conservative nature of ECC bypass calculated by WCOBRA/TRAC. In addition, other accumulator parameters such as water volume and gas pressure are set to nominal values, as discussed in Section 5-2. Use of average line resistance is in keeping with these other choices. More recent work for two-loop UPI plants using the Best Estimate model has shown that the sensitivity to changes in accumulator line resistance is small (less than ± 5°F for ±20% change in line resistance). From this, it is determined that although the original EM intended to use maximum accumulator line resistance, a change to use of average value is judged to be a small effect compared to the overall conservatism calculated in ECC bypass. Thus, it is concluded that it is acceptable to use either maximum or average accumulator line resistance in the SECY UPI EM and an estimated PCT impact of 0°F is assessed as a result of this report.

Reference:

WCAP-10924-P-A, Volume 2, Revision 2, Addendum 1, "Westinghouse Large-Break LOCA Best Estimate Methodology, Volume 2: Application to Two-Loop PWRs Equipped With Upper Plenum Injection, Addendum 1: Responses to NRC Questions," December, 1988.