10 CFR 50.46

RS-04-051

April 14, 2004

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D.C. 20555-0001

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. STN 50-456 and STN 50-457

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Annual Report of the Emergency Core Cooling System Evaluation Model Changes and Errors Required by 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors"

In accordance with 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," paragraph (a)(3)(ii), Exelon Generation Company (EGC), is submitting the annual report of the Emergency Core Cooling System (ECCS) Evaluation Model changes and errors for Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2. This annual report is to be submitted to the NRC by April 14, 2004.

Attachment 1, "Peak Cladding Temperature Rack-Up Sheets," provides updated information regarding the peak cladding temperature (PCT) for the limiting small break and large break loss of coolant accident (LOCA) analyses evaluations for the Byron and Braidwood Stations. Attachment 2, "Assessment Notes," contains a detailed description for each change or error reported.

Please contact Mr. David Chrzanowski at (630) 657-2816 should you have any questions concerning this report.

Respectfully,

Kenneth A. Ainger
Manager, Licensing

Attachment 1: Peak Cladding Temperature Rack-Up Sheets
Attachment 2: Assessment Notes

Attachment 1

10 CFR 50.46
"Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors"

Report of the Emergency Core Cooling System Evaluation Model Changes and Errors

Assessments as of March 3, 2004

Peak Cladding Temperature Rack-Up Sheets

Attachment 1

PLANT NAME: Braidwood Station Unit 1
ECCS EVALUATION MODEL: Small Break Loss of Coolant Accident (SBLOCA)
REPORT REVISION DATE: 3/3/04
CURRENT OPERATING CYCLE: 11

ANALYSIS OF RECORD (AOR)

Evaluation Model: NOTRUMP
Calculation: Westinghouse CN-LIS-00-208, December 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Steam Generator Tube Plugging (SGTP) = 5%
Limiting Break Size: 2" Low Tavg

Notes: Zr-4/ZIRLO Clad Fuel

Reference Peak Cladding Temperature (PCT) PCT = 1624.0°F

MARGIN ALLOCATION

A. PRIOR LOSS OF COOLANT ACCIDENT (LOCA) MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F

NET PCT **PCT = 1624.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

NOTRUMP Bubble Rise/Drift Flux Model Inconsistency Corrections (see note 6)	ΔPCT = 35 °F
Inconsistencies in Vessel Geometric Input Data (see note 7)	ΔPCT = 0 °F
NOTRUMP Drift Flux Model Inconsistencies (see note 8)	ΔPCT = 0 °F
NOTRUMP Inverted T-Node Sign Convention (see note 9)	ΔPCT = 0 °F
NOTRUMP Vapor Region Formation Logic (see note 10)	ΔPCT = 0 °F
SBLOCTA Burst Logic (see note 11)	ΔPCT = 0 °F
SBLOCTA ZIRLO Cladding Creep Constants (see note 12)	ΔPCT = 0 °F
SATIMP/SPADES Updates (see note 14)	ΔPCT = 0 °F
SBLOCTA Oxide-to-Metal Ratio (see note 15)	ΔPCT = 0 °F
SBLOCTA Gap Conductance Model (see note 16)	ΔPCT = 0 °F
General Code Maintenance (Appendix K) (see note 17)	ΔPCT = 0 °F

NET PCT **PCT = 1659.0°F**

Attachment 1

PLANT NAME: Braidwood Station Unit 1
ECCS EVALUATION MODEL: Large Break Loss of Coolant Accident (LBLOCA)
REPORT REVISION DATE: 03/03/04
CURRENT OPERATING CYCLE: 11

AOR

Evaluation Model: WCOBRA/TRAC
Calculation: Westinghouse CN-LIS-00-7, September 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Steam Generator Tube Plugging (SGTP) = 5%
Limiting Break Size: Guillotine

Notes: Zr-4/ZIRLO Clad Fuel

Reference PCT PCT = 2044.0°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 12 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F
Axial Power Shape Distribution Violation (see note 5)	ΔPCT = 80 °F

NET PCT **PCT = 2136.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

Inconel 690 Material Properties Capability (see note 13)	ΔPCT = 0 °F
Implementation of Automated Steady State and Restart (see note 18)	ΔPCT = 0 °F
General Code Maintenance (Best Estimate) (see note 19)	ΔPCT = 0 °F

NET PCT **PCT = 2136.0°F**

PLANT NAME: Braidwood Station Unit 2
ECCS EVALUATION MODEL: SBLOCA
REPORT REVISION DATE: 03/03/04
CURRENT OPERATING CYCLE: 11

AOR

Evaluation Model: NOTRUMP
Calculation: Westinghouse CN-LIS-00-208, December 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Steam Generator Tube Plugging (SGTP) = 10%
Limiting Break: 2" Low Tavg

Notes: Zr-4/ZIRLO Clad Fuel

Reference PCT PCT = 1627.0°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 3 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F

NET PCT **PCT = 1630.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

NOTRUMP Bubble Rise/Drift Flux Model Inconsistency Corrections (see note 6)	ΔPCT = 35 °F
Inconsistencies in Vessel Geometric Input Data (see note 7)	ΔPCT = 0 °F
NOTRUMP Drift Flux Model Inconsistencies (see note 8)	ΔPCT = 0 °F
NOTRUMP Inverted T-Node Sign Convention (see note 9)	ΔPCT = 0 °F
NOTRUMP Vapor Region Formation Logic (see note 10)	ΔPCT = 0 °F
SBLOCTA Burst Logic (see note 11)	ΔPCT = 0 °F
SBLOCTA ZIRLO Cladding Creep Constants (see note 12)	ΔPCT = 0 °F
SATIMP/SPADES Updates (see note 14)	ΔPCT = 0 °F
SBLOCTA Oxide-to-Metal Ratio (see note 15)	ΔPCT = 0 °F
SBLOCTA Gap Conductance Model (see note 16)	ΔPCT = 0 °F
General Code Maintenance (Appendix K) (see note 17)	ΔPCT = 0 °F

NET PCT **PCT = 1665.0°F**

Attachment 1

PLANT NAME: Braidwood Station Unit 2
ECCS EVALUATION MODEL: LBLOCA
REPORT REVISION DATE: 03/03/04
CURRENT OPERATING CYCLE: 11

AOR

Evaluation Model: WCOBRA/TRAC
Calculation: Westinghouse CN-LIS-00-7, September 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Steam Generator Tube Plugging (SGTP) = 10%
Limiting Break Size: Guillotine

Notes: Zr-4/ZIRLO Clad Fuel

Reference PCT PCT = 2088.0°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 12 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F

NET PCT **PCT = 2100.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

Axial Power Shape Distribution Violation (see note 5)	ΔPCT = 8 °F
Inconel 690 Material Properties Capability (see note 13)	ΔPCT = 0 °F
Implementation of Automated Steady State and Restart (see note 18)	ΔPCT = 0 °F
General Code Maintenance (Best Estimate) (see note 19)	ΔPCT = 0 °F

NET PCT **PCT = 2108.0°F**

Attachment 1

PLANT NAME: Byron Station Unit 1
ECCS EVALUATION MODEL: SBLOCA
REPORT REVISION DATE: 03/03/04
CURRENT OPERATING CYCLE: 13

AOR

Evaluation Model: NOTRUMP
Calculation: Westinghouse CN-LIS-00-208, December 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Steam Generator Tube Plugging (SGTP) = 5%
Limiting Break: 2" Low Tavg

Notes: Zr-4/ZIRLO Clad Fuel

Reference PCT PCT = 1624.0°F

MARGIN ALLOCATION

A. PRIOR LOSS OF COOLANT ACCIDENT (LOCA) MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F
10 CFR 50.46 report dated November 7, 2003 (see note 4)	ΔPCT = 0 °F

NET PCT **PCT = 1624.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

NOTRUMP Bubble Rise/Drift Flux Model Inconsistency Corrections (see note 6)	ΔPCT = 35 °F
Inconsistencies in Vessel Geometric Input Data (see note 7)	ΔPCT = 0 °F
NOTRUMP Drift Flux Model Inconsistencies (see note 8)	ΔPCT = 0 °F
NOTRUMP Inverted T-Node Sign Convention (see note 9)	ΔPCT = 0 °F
NOTRUMP Vapor Region Formation Logic (see note 10)	ΔPCT = 0 °F
SBLOCTA Burst Logic (see note 11)	ΔPCT = 0 °F
SBLOCTA ZIRLO Cladding Creep Constants (see note 12)	ΔPCT = 0 °F
SATIMP/SPADES Updates (see note 14)	ΔPCT = 0 °F
SBLOCTA Oxide-to-Metal Ratio (see note 15)	ΔPCT = 0 °F
SBLOCTA Gap Conductance Model (see note 16)	ΔPCT = 0 °F
General Code Maintenance (Appendix K) (see note 17)	ΔPCT = 0 °F

NET PCT **PCT = 1659.0°F**

PLANT NAME: Byron Station Unit 1
ECCS EVALUATION MODEL: LBLOCA
REPORT REVISION DATE: 03/03/04
CURRENT OPERATING CYCLE: 13

AOR

Evaluation Model: WCOBRA/TRAC
Calculation: Westinghouse CN-LIS-00-7, September 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Steam Generator Tube Plugging (SGTP) = 5%
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Limiting Break Size: Guillotine

Notes: Zr-4/ZIRLO Clad Fuel

Reference PCT PCT = 2044.0°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 12 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F
10 CFR 50.46 report dated November 7, 2003 for Axial Power Shape Distribution Violation (see notes 4 and 5)	ΔPCT = 80 °F

NET PCT **PCT = 2136.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

Inconel 690 Material Properties Capability (see note 13)	ΔPCT = 0 °F
Implementation of Automated Steady State and Restart (see note 18)	ΔPCT = 0 °F
General Code Maintenance (Best Estimate) (see note 19)	ΔPCT = 0 °F

NET PCT **PCT = 2136.0°F**

Attachment 1

PLANT NAME: Byron Station Unit 2
ECCS EVALUATION MODEL: SBLOCA
REPORT REVISION DATE: 03/03/04
CURRENT OPERATING CYCLE: 12

AOR

Evaluation Model: NOTRUMP
Calculation: Westinghouse CN-LIS-00-208, December 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Steam Generator Tube Plugging (SGTP) = 10%
Limiting Break: 2" Low Tavg

Notes: Zr-4/ZIRLO Clad Fuel

Reference PCT PCT = 1627.0°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 3 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F

NET PCT **PCT = 1630.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

NOTRUMP Bubble Rise/Drift Flux Model Inconsistency Corrections (see note 6)	ΔPCT = 35 °F
Inconsistencies in Vessel Geometric Input Data (see note 7)	ΔPCT = 0 °F
NOTRUMP Drift Flux Model Inconsistencies (see note 8)	ΔPCT = 0 °F
NOTRUMP Inverted T-Node Sign Convention (see note 9)	ΔPCT = 0 °F
NOTRUMP Vapor Region Formation Logic (see note 10)	ΔPCT = 0 °F
SBLOCTA Burst Logic (see note 11)	ΔPCT = 0 °F
SBLOCTA ZIRLO Cladding Creep Constants (see note 12)	ΔPCT = 0 °F
SATIMP/SPADES Updates (see note 14)	ΔPCT = 0 °F
SBLOCTA Oxide-to-Metal Ratio (see note 15)	ΔPCT = 0 °F
SBLOCTA Gap Conductance Model (see note 16)	ΔPCT = 0 °F
General Code Maintenance (Appendix K) (see note 17)	ΔPCT = 0 °F

NET PCT **PCT = 1665.0°F**

Attachment 1

PLANT NAME: Byron Station Unit 2
ECCS EVALUATION MODEL: LBLOCA
REPORT REVISION DATE: 03/03/04
CURRENT OPERATING CYCLE: 12

AOR

Evaluation Model: WCOBRA/TRAC
Calculation: Westinghouse CN-LIS-00-7, September 2000
Fuel: VANTAGE+ 17 x 17
Limiting Fuel Type: VANTAGE+ 17 x 17
Limiting Single Failure: Loss of one train of ECCS flow
Heat Flux Hot Channel Factor (FQ) = 2.60
Nuclear Enthalpy Rise Hot Channel Factor (FNΔH) = 1.70
Steam Generator Tube Plugging (SGTP) = 10%
Limiting Break Size: Guillotine

Notes: Zr-4/ZIRLO Clad Fuel

Reference PCT PCT = 2088.0°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 12 °F
10 CFR 50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0 °F
10 CFR 50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0 °F

NET PCT **PCT = 2100.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

Axial Power Shape Distribution Violation (see note 5)	ΔPCT = 8 °F
Inconel 690 Material Properties Capability (see note 13)	ΔPCT = 0 °F
Implementation of Automated Steady State and Restart (see note 18)	ΔPCT = 0 °F
General Code Maintenance (Best Estimate) (see note 19)	ΔPCT = 0 °F

NET PCT **PCT = 2108.0°F**

Attachment 2

10 CFR 50.46,
"Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,"

Report of the Emergency Core Cooling System Evaluation Model Changes and Errors

Assessment Notes

Attachment 2

1. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated June 11, 2001, reported new LBLOCA and SBLOCA analyses to support operations at uprated power conditions. The same report assessed the impact from a decay heat uncertainty error in Monte Carlo calculations on the LBLOCA analysis and the impact from annular axial blankets on the SBLOCA analysis. Evaluations for plant conditions and the LBLOCA and SBLOCA model changes which resulted in 0°F PCT change were reported. Cycle specific evaluations related to an axial power shape distribution envelope violation were reported for the applicable operating cycles.

2. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated April 18, 2002, reported evaluations for LBLOCA and SBLOCA model changes which resulted in 0°F PCT change. Cycle specific evaluations related to axial power shape distribution envelope violation were reported for the applicable operating cycles.

3. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated April 14, 2003, reported evaluations for LBLOCA and SBLOCA model changes which resulted in 0°F PCT change. Cycle specific evaluations related to axial power shape distribution envelope violation were reported for the applicable operating cycles.

4. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated November 7, 2003, reported an 80°F PCT assessment related to axial power shape distribution envelope violation for Byron Unit 1 Cycle 13 for the LBLOCA analysis. The SBLOCA is not impacted.

5. Axial Power Shape Distribution Envelope Violation (PMID,PBOT)

The LBLOCA analysis is performed based on assuming an axial power shape distribution envelope (PMID, PBOT), where PMID is the power in the middle one-third of the core; and PBOT is the power in the lower one-third of the core. The envelope is pertinent to the BELOCA analysis and is presented as Figure 11-1 of WCAP-15585, “Best Estimate Analysis of the Large Break Loss of Coolant Accident for the Byron /Braidwood Units 1 and 2 Nuclear Plant,” November 2000. For every reload cycle Westinghouse verifies that the envelope remains limiting. If there is a violation then a PCT penalty is calculated.

For Braidwood Unit 1, Cycle 11 there was a violation and a PCT penalty of 80°F was calculated. This penalty has been reported in the 10 CFR 50.46 report dated April 14, 2003.

For Braidwood Unit 2, Cycle 11 there was a violation and a PCT penalty of 8°F was calculated.

For Byron Unit 1, Cycle 13 there was a violation and a PCT penalty of 80°F was calculated. This penalty has been reported in the 10 CFR 50.46 report dated November 7, 2003.

For Byron Unit 2, Cycle 12 there was a violation and a PCT penalty of 8°F was calculated.

For Braidwood Unit 1 Cycle 11, Westinghouse identified two types of violations. For the violations outside of the sampling range shown in Figure 11-1 of WCAP-15585 but inside the response surface shown in Figure 9.2-1 of WCAP-15585, a PCT penalty of 80°F was calculated. This is the same type of violation as the cycles discussed above.

The second type of violation is for power shapes slightly outside the response surface shown in Figure 9.2-1 of WCAP-15585. These violations were determined to be non-limiting power shapes and were evaluated by extrapolating the power distribution response surface in order to predict PCT. In all cases, the predicted PCT was non-limiting as compared to the LBLOCA PCT reported in the Attachment 1 LBLOCA PCT sheet. The Westinghouse reload methodology approved by the NRC, WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," March 1978, allows evaluation of key parameters slightly out of bounds using a conservative quantitative evaluation. The extrapolation methodology used in this evaluation is consistent with the methodology for extrapolating FQ and FΔH described in WCAP-12945-P-A.

6. NOTRUMP Bubble Rise/Drift Flux Mode Inconsistency Corrections

The NOTRUMP computer code was updated to resolve some inconsistencies in several drift flux models as well as the nodal bubble rise/droplet fall models. In summary, these changes include the following. Bubble rise and droplet fall model calculations were made consistent with flow link calculations. Corrections were made to the limits employed in the vertical counter-current flooding models. Checking logic was added to correct situations where drift flux model inconsistencies could result (i.e., prevent liquid flow from an all vapor node and vapor flow from all liquid node). Also, a more rigorous version of the Yeh Drift Flux Model was implemented since the previous version of this model was incorrectly restricted to a 50% void fraction limit. This represents a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

Representative plant calculations using the NOTRUMP code demonstrate that the implementation of these corrections leads to a bounding 35°F increase in the calculated PCT for 10 CFR 50.46 purposes.

7. Inconsistencies in Vessel Geometric Input Data

Several inconsistencies were identified in the specification of vessel geometric data for plant-specific input models. These changes were evaluated for impacts on current licensing-basis analyses and will be incorporated into the corresponding input databases on a forward-fit basis. These changes represent a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

A combination of sensitivity calculations and engineering evaluations led to the conclusion that the identified changes have a negligible effect on large and small break LOCA analysis results. These changes will therefore be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

8. NOTRUMP Drift Flux Model Inconsistencies

The NOTRUMP computer code was updated to resolve some inconsistencies in the resetting of certain parameters in the drift flux models when single-phase conditions are determined to exist. The previous coding had inadvertently omitted certain conditions on

drift velocity and void fraction which are now included. Also, in the node boundary mixture level crossing logic, several partial derivatives for liquid and vapor volumetric fluxes with respect to mass flux in the void fraction model were erroneously set to zero. The correct partial derivative calculations were added to the code. In addition, those instances (i.e., stacking logic, accumulator empty logic and pump critical flow logic) where flow link specific volumes were incorrectly always based on saturated conditions, were corrected. These changes represent a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

The subject changes involve logic that is seldom used in standard evaluation model (EM) calculations. As such, the estimated effect on PCT calculations is 0°F for 10 CFR 50.46 reporting purposes.

9. NOTRUMP Inverted T-Node Sign Convention

This change deals with the correction of the sign convention for inverted T-nodes, which was incorrectly applied via input into the EM. An incorrect sign convention can potentially impact the reactor vessel lower plenum node and the lower reactor coolant pump node in the standard EM. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

This error affected the mixture/vapor interfacial area within a fluid node. Because these conditions only exist momentarily within the pump stack node and never in the reactor vessel lower plenum, it is judged that the impact of this error correction is insignificant. Based on this judgment, coupled with the fact that plant model calculations show this to be the case, the correction of this error will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

10. NOTRUMP Vapor Region Formation Logic

The logic governing formation of a vapor region within a fluid node in the NOTRUMP computer code was corrected to allow superheated conditions where appropriate, instead of saturated conditions which may not exist at that instant. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Typically, region formation conditions in standard EM calculations occur at saturation. If a region is formed at superheat conditions, the amount of superheat is usually small and the region quickly reaches saturated conditions. As such, the nature of these changes leads to an estimated PCT impact of 0°F.

11. SBLOCTA Burst Logic

The rod burst logic in the SBLOCTA computer code was updated to preclude burst from occurring at more than one axial elevation on a given rod. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Most SBLOCTA calculations predict burst at no more than one axial elevation per rod and are therefore unaffected by this discrepancy. For the affected cases, SBLOCTA calculations and/or engineering evaluations led to the conclusion that resolving the discrepancy would not produce an increase in the limiting PCT. This change is therefore assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

12. SBLOCTA ZIRLO Cladding Creep Constants

The SBLOCTA computer code was updated to correct two of the constants in the high temperature creep model for ZIRLO cladding, which were found to disagree with the basis documentation. These changes represent a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

The changes identified above lead to a small change in the creep rate over a limited range of temperatures, which is considered to have a negligible effect on results and will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

13. Inconel 690 Material Properties Capability

The WCOBRA/TRAC computer code originally had built-in properties for Inconel 600, which is a material commonly used in steam generator tubes. Several replacement steam generator designs use steam generator tubes made of Inconel 690. A SECY UPI version of WCOBRA/TRAC that includes Inconel 690 material properties was released for general use in 2003.

The capability to model Inconel 690 material properties had previously been implemented in the Best Estimate version of WCOBRA/TRAC along with a variety of other built-in property options. This code version was released for general use in 2000, but the change was not included in the 2000 annual report. This capability is reported here to correct that omission.

The capability of modeling Inconel 690 material properties is considered a Non-Discretionary change in accordance with Section 4.1.2 of WCAP-13451. There is no impact on the analysis of record.

14. SATIMP/SPADES Updates

The SATIMP and SPADES computer codes are used to generate the plant-specific input models for the SATAN-VI and NOTRUMP computer codes, respectively. Some minor improvements were made to the SATIMP and SPADES codes, primarily to provide more rigorous calculations of certain SATAN-VI and NOTRUMP inputs. An example of these changes is to replace linear interpolation with parabolic interpolation in the SATIMP calculation of the reactor coolant pump head at steady-state operating conditions. These changes represent Discretionary Changes that will be implemented on a forward-fit basis in accordance with Section 4.1.1 of WCAP-13451.

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

15. SBLOCTA Oxide-to-Metal Ratio

An option has been added to the SBLOCTA computer code to allow conversion of the user-specified zirconium-oxide thickness into equivalent cladding reacted. This adjustment is made during problem initialization, and the cladding outside diameter is modified accordingly. This change represents a Discretionary Change that will be implemented on a forward-fit basis in accordance with Section 4.1.1 of WCAP-13451.

A sample SBLOCTA calculation showed that this change has a minimal effect on PCT. This change will be implemented on a forward-fit basis and will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

16. SBLOCTA Gap Conductance Model

The convective term in the SBLOCTA pellet-to-cladding gap conductance model was updated for consistency with the corresponding model in the LOCBART computer code. Included in this change is the implementation of a PAD-version-specific value of the gap reduction factor, which is specified by the user in the SBLOCTA computer code input file. This change represents a Discretionary Change that will be implemented on a forward-fit basis in accordance with Section 4.1.1 of WCAP-13451.

Sample SBLOCTA calculations showed that this change has a negligible effect on PCT. This change will be implemented on a forward-fit basis and will be assigned a 0°F PCT impact for 10 CFR 50.46 reporting purposes.

17. General Code Maintenance (Appendix K)

Various changes in code input and output format have been made to enhance usability and to help preclude errors in analyses. These include both input changes (e.g., more relevant input variables defined and more common input values used as defaults) and input diagnostics changes 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 to enhance usability and to facilitate code debugging when necessary. These changes represent Discretionary Changes that will be implemented on a forward-fit basis in accordance with Section 4.1.1 of WCAP-13451.

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

18. Implementation of Automated Steady State and Restart

Westinghouse has submitted a revised treatment of uncertainties for its Large Break LOCA evaluation models for NRC review and approval. The Automated Statistical Treatment of Uncertainties Methodology is described in WCAP-16009-P. As part of the implementation of the revised methodology, enhancements were introduced that help to automate convergence of the steady state solution to the desired set of conditions, as well as automating the restart process for beginning the LOCA transient. These changes were determined to be Discretionary Changes in accordance with Section 4.1.1 of WCAP-13451.

These changes are for forward-fit automation purposes only and have no effect on existing analyses.

19. General Code Maintenance (Best Estimate)

A number of coding changes were made as part of normal code maintenance. These include improvements in user flexibility for non-standard (non-design basis) analyses, and enhancements in the information available via output edits or for plotting purposes. All of these changes are considered to be Discretionary Changes in accordance with Section 4.1.1 of WCAP-13451.

None of these changes affects the results of design basis analyses. Therefore, the estimated effect is zero.