

RS-07-052

April 13, 2007

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

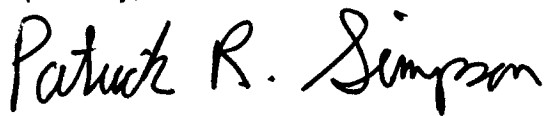
Subject: Annual Report of the Emergency Core Cooling System Evaluation Model Changes and Errors Required by 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors"

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, LLC, is submitting the annual report of the Emergency Core Cooling System Evaluation Model changes and errors for Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2.

Attachment 1, "Peak Cladding Temperature Rack-Up Sheets," provides updated information regarding the peak cladding temperature for the limiting small break and large break loss-of-coolant accident 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,



Patrick R. Simpson
Manager - Licensing

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

Attachment 1

Peak Cladding Temperature Rack-Up Sheets

BRAIDWOOD STATION
UNITS 1 AND 2

Docket Nos. 50-456 and 50-457
License Nos. NPF-72 and NPF-77

and

BYRON STATION
UNITS 1 AND 2

Docket Nos. 50-454 and 50-455
License Nos. NPF-37 and NPF-66

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

Attachment 1

Peak Cladding Temperature Rack-up Sheets

Byron and Braidwood Units 1 and 2 10CFR50.46 Report

PLANT NAME: Braidwood Station Unit 1
ECCS EVALUATION MODEL: Small Break Loss of Coolant Accident (SBLOCA)
REPORT REVISION DATE: 03/07/07
CURRENT OPERATING CYCLE: 13

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 (FN Δ H) = 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

10CFR50.46 report dated June 11, 2001 (see note 1)	Δ PCT = 0°F
10CFR50.46 report dated April 18, 2002 (see note 2)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2003 (see note 3)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2004 (see note 4)	Δ PCT = 35°F
10CFR50.46 report dated April 14, 2005 (see note 5)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2006 (see note 6)	Δ PCT = 0°F

NET PCT

PCT = 1659.0°F

B. CURRENT LOCA MODEL ASSESSMENTS

General Code Maintenance (see note 8)	Δ PCT = 0°F
NOTRUMP Refined Break Spectrum (see note 11)	Δ PCT = 0°F

NET PCT

PCT = 1659.0°F

Peak Cladding Temperature Rack-up Sheets

Byron and Braidwood Units 1 and 2 10CFR50.46 Report

PLANT NAME: Braidwood Station Unit 2
 ECCS EVALUATION MODEL: LBLOCA
 REPORT REVISION DATE: 03/07/07
 CURRENT OPERATING CYCLE: 13

AOR

Evaluation Model: CQD (1996)
 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 (FN Δ H) = 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**

10CFR50.46 report dated June 11, 2001 (see note 1)	Δ PCT = 12°F
10CFR50.46 report dated April 18, 2002 (see note 2)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2003 (see note 3)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2004 (see note 4)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2005 (see note 5)	Δ PCT = 5°F
10CFR50.46 report dated April 14, 2006 (see note 6)	Δ PCT = 0°F

NET PCT PCT = 2105.0°F

B. CURRENT LOCA MODEL ASSESSMENTS

Axial Power Shape Distribution Violation (see note 7)	Δ PCT = 8°F
Containment Heat Sink Addition (See note 9)	Δ PCT = 0°F

NET PCT PCT = 2113.0°F

Attachment 1

Peak Cladding Temperature Rack-up Sheets

Byron and Braidwood Units 1 and 2 10CFR50.46 Report

PLANT NAME: Byron Station Unit 1
 ECCS EVALUATION MODEL: SBLOCA
 REPORT REVISION DATE: 03/07/07
 CURRENT OPERATING CYCLE: 15

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

10CFR50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 0°F
10CFR50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2004 (see note 4)	ΔPCT = 35°F
10CFR50.46 report dated April 14, 2005 (see note 5)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2006 (see note 6)	ΔPCT = 0°F

NET PCT PCT = 1659.0°F

B. CURRENT LOCA MODEL ASSESSMENTS

General Code Maintenance (see note 8)	ΔPCT = 0°F
AXIOM LTAs (See note 10)	ΔPCT = 0°F
NOTRUMP Refined Break Spectrum (see note 11)	ΔPCT = 0°F

NET PCT PCT = 1659.0°F

Peak Cladding Temperature Rack-up Sheets

Byron and Braidwood Units 1 and 2 10CFR50.46 Report

PLANT NAME: Byron Station Unit 1
 ECCS EVALUATION MODEL: LBLOCA
 REPORT REVISION DATE: 03/07/07
 CURRENT OPERATING CYCLE: 15

AOR

Evaluation Model: CQD (1996)
 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

10CFR50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 12°F
10CFR50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2004 (see note 4)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2005 (see note 5)	ΔPCT = 5°F
10CFR50.46 report dated April 14, 2006 (see note 6)	ΔPCT = 0°F

NET PCT **PCT = 2061.0°F**

B. CURRENT LOCA MODEL ASSESSMENTS

Axial Power Shape Distribution Violation (see note 7)	ΔPCT = 80°F
Containment Heat Sink Addition (See note 9)	ΔPCT = 0°F
AXIOM LTAs (See note 10)	ΔPCT = 0°F

NET PCT **PCT = 2141.0°F**

Peak Cladding Temperature Rack-up Sheets

Byron and Braidwood Units 1 and 2 10CFR50.46 Report

PLANT NAME: Byron Station Unit 2
 ECCS EVALUATION MODEL: SBLOCA
 REPORT REVISION DATE: 03/07/07
 CURRENT OPERATING CYCLE: 14*

***Cycle 14 to start April 2007**

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 (FN Δ H) = 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**

10CFR50.46 report dated June 11, 2001 (see note 1)	Δ PCT = 3°F
10CFR50.46 report dated April 18, 2002 (see note 2)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2003 (see note 3)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2004 (see note 4)	Δ PCT = 35°F
10CFR50.46 report dated April 14, 2005 (see note 5)	Δ PCT = 0°F
10CFR50.46 report dated April 14, 2006 (see note 6)	Δ PCT = 0°F

NET PCT PCT = 1665.0°F

B. CURRENT LOCA MODEL ASSESSMENTS

General Code Maintenance (see note 8)	Δ PCT = 0°F
NOTRUMP Refined Break Spectrum (see note 11)	Δ PCT = 0°F

NET PCT PCT = 1665.0°F

Attachment 1

Peak Cladding Temperature Rack-up Sheets

Byron and Braidwood Units 1 and 2 10CFR50.46 Report

PLANT NAME: Byron Station Unit 2
 ECCS EVALUATION MODEL: LBLOCA
 REPORT REVISION DATE: 03/07/07
 CURRENT OPERATING CYCLE: 14*

***Cycle 14 to start April 2007**

AOR

Evaluation Model: CQD (1996)
 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

10CFR50.46 report dated June 11, 2001 (see note 1)	ΔPCT = 12°F
10CFR50.46 report dated April 18, 2002 (see note 2)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2003 (see note 3)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2004 (see note 4)	ΔPCT = 0°F
10CFR50.46 report dated April 14, 2005 (see note 5)	ΔPCT = 5°F
10CFR50.46 report dated April 14, 2006 (see note 6)	ΔPCT = 0°F

NET PCT PCT = 2105.0°F

B. CURRENT LOCA MODEL ASSESSMENTS

Axial Power Shape Distribution Violation (see note 7)	ΔPCT = 8°F
Containment Heat Sink Addition (See note 9)	ΔPCT = 0°F

NET PCT PCT = 2113.0°F

Attachment 2

Assessment Notes

**BRAIDWOOD STATION
UNITS 1 AND 2**

Docket Nos. 50-456 and 50-457
License Nos. NPF-72 and NPF-77

and

**BYRON STATION
UNITS 1 AND 2**

Docket Nos. 50-454 and 50-455
License Nos. NPF-37 and NPF-66

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

Attachment 2

Assessment Notes

Byron and Braidwood Units 1 and 2 10 CFR 50.46 Report

1. Prior LOCA Model Assessment

The 10CFR50.46 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 LBLOCA analysis and the impact from annular axial blankets on SBLOCA analysis. Evaluations for plant conditions and LBLOCA and SBLOCA model changes which resulted in 0°F PCT change were reported. Cycle specific evaluations related to axial power shape distribution envelope violation were reported for the applicable operating cycles.

2. Prior LOCA Model Assessment

The 10CFR50.46 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 10CFR50.46 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 10CFR50.46 report dated April 14, 2004, reported evaluations for LBLOCA model changes which resulted in 0 °F PCT change. A SBLOCA assessment related to NOTRUMP bubble rise/drift flux model inconsistency corrections, which resulted in 35°F PCT assessment, was reported. Cycle specific evaluations related to axial power shape distribution envelope violation were reported for the applicable operating cycles.

5. Prior LOCA Model Assessment

The 10CFR50.46 report dated April 14, 2005, reported evaluations for LBLOCA model changes, which resulted in a 5°F PCT change due to the Revised Blowdown Heatup Uncertainty Calculation. Assembly N10S was reconstituted with two stainless steel filler rods during Braidwood Unit 1 Refueling Outage 11. This assembly is reloaded into the core and is in use during Braidwood Unit 1 Cycle 12 operation. The introduction of up to five stainless steel filler rods has been evaluated and shown to have no impact on LBLOCA and SBLOCA analyses. The estimated PCT effect is 0°F. This assembly will be discharged during Reload 12 and will not be resident in the core for Braidwood Unit 1 Cycle 13. Cycle specific evaluations related to axial power shape distribution envelope violation were reported for the applicable operating cycles.

Attachment 2

Assessment Notes

Byron and Braidwood Units 1 and 2 10 CFR 50.46 Report

6. Prior LOCA Model Assessment

The 10CFR50.46 report dated April 14, 2006, reported evaluations for LBLOCA model changes which resulted in a 0°F PCT change due to the Revised Iteration Algorithm for Calculating the Average Fuel Temperature, Pellet Radial Profile, Improved Automation of End of Blowdown Time, Thermodynamic Properties from THERMO, Vessel Unheated Conductor Noding and Containment Relative Humidity Assumption. General Code Maintenance for SBLOCA model resulted in 0°F PCT change. Cycle specific evaluations related to axial power shape distribution envelope violation were reported for the applicable operating cycles.

7. 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 13 there was a violation and a PCT penalty of 80°F was calculated. This penalty has been reported in 10CFR50.46 report dated April 14, 2006.

For Braidwood Unit 2 Cycle 13 there was a violation and a PCT penalty of 8°F was calculated.

For Byron Unit 1 Cycle 15 there was a violation and a PCT penalty of 80°F was calculated, which was first reported for Byron Unit 1 Cycle 13 in the 30-day 50.46 notification to the NRC, dated November 7, 2003. The assessment for Byron Unit 1 Cycle 15 does not affect the net PCT.

For Byron Unit 2 Cycle 14 there was a violation and a PCT penalty of 8°F was calculated.

For Byron Unit 2 Cycle 14, Westinghouse found 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 8 °F. 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 conservative quantitative evaluation. The extrapolation methodology used in this evaluation is

Attachment 2

Assessment Notes

Byron and Braidwood Units 1 and 2 10 CFR 50.46 Report

consistent with the methodology for extrapolating FQ and FΔH described in WCAP-12945-P-A.

8. General Code Maintenance (NOTRUMP)

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 updates were made to eliminate inactive coding, improve active coding, and enhance commenting, both for enhanced 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.

9. Containment Heat Sink Addition

Addition of heat sink materials in containment was considered for LBLOCA PCT penalties for Byron and Braidwood Units 1 and 2. These additions included GSI-191, "Assessment of Debris Accumulation on Pressurized-Water Reactor (PWR) Sump Performance," sump screens and related materials and outage pre-staging materials such as lead shielding. The PCT effect was zero degrees.

10. AXIOM LTAs

Byron Unit 1 Cycle 15 implemented Westinghouse AXIOM Lead Test Assemblies (LTAs). The LTA program tests fuel rods clad with an advanced Westinghouse alloy. The PCT effect was zero degrees.

11. NOTRUMP Refined Break Spectrum

The Nuclear Regulatory Commission (NRC) questioned the break spectrum analyzed in the NOTRUMP evaluation model (EM). The NRC was concerned that the resolution of the break spectrum used in the NOTRUMP EM (1.5, 2, 3, 4, and 6 inch cases) may not be fine enough to capture the worst break with regard to limiting peak clad temperature as per 10CFR50.46. That is, the plant could be SBLOCA limited with regard to overall LOCA results. For plants with SBLOCA PCTs less than 1700 F, no explicit, plant-specific break spectrum calculations were performed. Based on generic sensitivity studies, the estimated PCT impact is 0°F.