



Exelon Generation

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RS-15-269

10 CFR 50.46(a)(3)(ii)

October 23, 2015

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

Clinton Power Station, Unit 1  
Facility Operating License No. NPF-62  
NRC Docket No. 50-461

Subject: Annual Report of Emergency Core Cooling System Evaluation Model Changes  
and Errors for Clinton Power Station

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 (EGC) is submitting the annual report of the Emergency Core Cooling System (ECCS) Evaluation Model changes and errors for Clinton Power Station, Unit 1 (CPS). This report covers the period from October 24, 2014 through October 23, 2015.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Mr. Timothy A Byam at (630) 657-2818.

Respectfully,

A handwritten signature in black ink, appearing to read 'Patrick R. Simpson', with a long horizontal flourish extending to the right.

Patrick R. Simpson  
Manager – Licensing

Attachments:

1. 10 CFR 50.46 Report (GE14 Fuel)
2. 10 CFR 50.46 Report (GNF2 Fuel)
3. 10 CFR 50.46 Report Assessment Notes

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cc: Regional Administrator – NRC Region III  
NRC Senior Resident Inspector – Clinton Power Station  
Illinois Emergency Management Agency – Division of Nuclear Safety

Attachment 1  
Clinton Power Station, Unit 1 | SAFER/GESTR-LOCA | GE14 Fuel  
10 CFR 50.46 Report

PLANT NAME:	Clinton Power Station, Unit 1
ECCS EVALUATION MODEL:	SAFER/GESTR - LOCA
EVALUATION MODEL VENDOR:	GNF/GEH
REPORT REVISION DATE:	October 23, 2015
CURRENT OPERATING CYCLE:	16

**ANALYSIS OF RECORD (AOR) CALCULATIONS**

1. NEDC-32974P, "Clinton Power Station SAFER/GESTR-LOCA Analysis Basis Documentation," October 2000.
2. GE-NE-A22-00110-27-02, Revision 1, "Project Task Report Clinton Power Station Extended Power Uprate Task T0407: ECCS-LOCA SAFER/GESTR," September 2001.
3. NEDO-33173, Supplement 4-A, Revision 1, "Licensing Topical Report Implementation of PRIME Models and Data in Downstream Models," November 2012.

Fuel Analyzed in Calculation and in Operation:	GE14
Limiting Fuel Type:	GNF2
Limiting Single Failure:	High Pressure Core Spray (HPCS) Diesel Generator
Limiting Break Size and Location:	1.0 Double Ended Guillotine of Recirculation Pump Suction Piping
<b>Reference Peak Cladding Temperature (PCT):</b>	<b>1570°F</b>

**MARGIN ALLOCATION**

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

10 CFR 50.46 report dated November 08, 2001 (See Note 1)	$\Delta PCT = 5^{\circ}F$
10 CFR 50.46 report dated November 05, 2002 (See Note 2)	$\Delta PCT = 15^{\circ}F$
10 CFR 50.46 report dated November 05, 2003 (See Note 3)	$\Delta PCT = 5^{\circ}F$
10 CFR 50.46 report dated November 05, 2004 (See Note 4)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated November 04, 2005 (See Note 5)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated November 03, 2006 (See Note 6)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated April 19, 2007 (See Note 7)	$\Delta PCT = 6^{\circ}F$
10 CFR 50.46 report dated November 02, 2007 (See Note 8)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated October 31, 2008 (See Note 9)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated October 30, 2009 (See Note 10)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated October 29, 2010 (See Note 11)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated August 10, 2011 (See Note 12)	$\Delta PCT = -15^{\circ}F$
10 CFR 50.46 report dated October 28, 2011 (See Note 13)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated October 26, 2012 (See Note 14)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated October 25, 2013 (See Note 15)	$\Delta PCT = 10^{\circ}F$
10 CFR 50.46 report dated October 24, 2014 (See Note 16)	$\Delta PCT = -15^{\circ}F$
<b>Net PCT</b>	<b>1581°F</b>

**B. CURRENT LOCA MODEL ASSESSMENTS**

None (See Note 17)	$\Delta PCT = 0^{\circ}F$
Total PCT change from current assessments	$\Sigma \Delta PCT = 0^{\circ}F$
Cumulative PCT change from current assessments	$\Sigma  \Delta PCT  = 0^{\circ}F$
<b>Net PCT</b>	<b>1581°F</b>

Attachment 2  
 Clinton Power Station, Unit 1 | SAFER/GESTR-LOCA | GNF2 Fuel  
 10 CFR 50.46 Report (GNF2 Fuel)

PLANT NAME: Clinton Power Station, Unit 1  
 ECCS EVALUATION MODEL: SAFER/GESTR - LOCA  
 EVALUATION MODEL VENDOR: GNF/GEH  
 REPORT REVISION DATE: October 23, 2015  
 CURRENT OPERATING CYCLE: 16

**ANALYSIS OF RECORD (AOR) CALCULATIONS**

1. GEH Report 0000-0121-9100-R0, Clinton Power Station, GNF2 ECCS-LOCA Evaluation, October 2011.
2. NEDO-33173, Supplement 4-A, Revision 1, "Licensing Topical Report Implementation of PRIME Models and Data in Downstream Models," November 2012.

Fuel Analyzed in Calculation and in Operation: GNF2  
 Limiting Fuel Type: GNF2  
 Limiting Single Failure: High Pressure Core Spray (HPCS) Diesel Generator  
 Limiting Break Size and Location: 1.0 Double Ended Guillotine of Recirculation Pump Suction Piping  
 Reference Peak Cladding Temperature (PCT): 1880°F

**MARGIN ALLOCATION**

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

10 CFR 50.46 report dated October 26, 2012 (See Note 14)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 report dated October 25, 2013 (See Note 15)	$\Delta PCT = 40^\circ F$
10 CFR 50.46 report dated October 24, 2014 (See Note 16)	$\Delta PCT = -15^\circ F$
<b>Net PCT</b>	<b>1905°F</b>

**B. CURRENT LOCA MODEL ASSESSMENTS**

None (See Note 17)	$\Delta PCT = 0^{\circ}F$
Total PCT change from current assessments	$\Sigma \Delta PCT = 0^{\circ}F$
Cumulative PCT change from current assessments	$\Sigma  \Delta PCT  = 0^{\circ}F$
<b>Net PCT</b>	<b>1905°F</b>

Attachment 3  
Clinton Power Station, Unit 1  
10 CFR 50.46 Report Assessment Notes

**1. Prior LOCA Model Assessment**

An inconsistent core exit steam flow was used in the pressure calculation in the SAFER code when there was a change in the two-phase level. The incorrect calculated pressure may result in premature termination of Emergency Core Cooling System (ECCS) condensation and will impact the second peak clad temperature (PCT). GE evaluated the impact of this error and determined that the impact is an increase of 5°F in the PCT. This error was reported to the NRC in the referenced letter. Although this error was reported in 2001, the error remains applicable to the Analysis of Record (AOR) reported in Note 2 below.

[Reference: Letter from K. A. Ainger (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated November 8, 2001.]

**2. Prior LOCA Model Assessment**

A new AOR was performed for the Extended Power Uprate (EPU) which resulted in a Reference PCT of 1570°F. This was an increase of 20°F over the pre-EPU Reference PCT. The EPU was implemented in Cycle 9 Reload.

In the referenced letter to the NRC, the impact of the Low Pressure Coolant Injection (LPCI) and Low Pressure Core Spray (LPCS) minimum flow valve flow diversion was reported and was found to have a 0°F impact. Also in the referenced letter GE LOCA errors were reported all of which had a 0°F PCT increase except for a SAFER Core Spray sparger injection elevation error that resulted in a 15°F increase in the PCT.

[Reference: Letter from Patrick R. Simpson (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated November 5, 2002.]

**3. Prior LOCA Model Assessment**

In the referenced letter to the NRC, the impact of an error found in the initial level/volume table for SAFER was reported. The level/volume tables were generated with incorrect initial water levels. This resulted in an incorrect volume split in the nodes above and below the water surface, and incorrect initial liquid mass. This error resulted in a 5°F increase in the PCT for all fuel types (i.e., GE10 & GE14).

[Reference: Letter from Patrick R. Simpson (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated November 5, 2003.]

**4. Prior LOCA Model Assessment**

In the referenced letter to the NRC, the impact of a GE postulated new heat source applicable to the Loss of Coolant Accident (LOCA) event was reported. This heat source is due to recombination of hydrogen and excess oxygen drawn into the vessel from containment during core heatup. The PCT impact for GE14 fuel was 0°F and the effect on local oxidation was negligible.

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[Reference: Letter from Patrick R. Simpson (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated November 5, 2004.]

**5. Prior LOCA Model Assessment**

In the referenced letter to the NRC, the impact of the 24-month cycle operation was reported. The evaluation determined that the LOCA AOR was performed with bounding assumptions and hence is not impacted with the 24-month cycle. A 0°F PCT impact was assigned.

[Reference: Letter from Patrick R. Simpson (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated November 4, 2005.]

**6. Prior LOCA Model Assessment**

In the referenced letter to the NRC, the impact of the top peak axial power shape on the small break LOCA was reported. The impact of the top peak axial power shape on the licensing basis PCT was 0°F for GE14 Fuel for Clinton Power Station (CPS).

[Reference: Letter from Kenneth M. Nicely (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated November 3, 2006.]

**7. Prior LOCA Model Assessment**

In the referenced letter, the impact of the core shroud repair on the PCT was reported to the NRC. The leakage flows through the repair holes result in slightly increased time to core recovery, following core uncovering. The effect has been conservatively assessed to increase the PCT for the limiting LOCA by less than 6°F.

[Reference: Letter from Patrick R. Simpson (Exelon Generation Company) to U.S. NRC, "Updated Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated April 19, 2007.]

**8. Prior LOCA Model Assessment**

In the referenced letter, Exelon submitted to the NRC the annual 10 CFR 50.46 report for 2007. There was no LOCA model assessment for the CPS LOCA analysis.

[Reference: Letter from Jeffrey L. Hansen (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated November 2, 2007.]



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**9. Prior LOCA Model Assessment**

In the referenced letter, Exelon submitted to the NRC the annual 10 CFR 50.46 report for 2008. There was no LOCA model assessment for the CPS LOCA analysis.

[Reference: Letter from Jeffrey L. Hansen (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated October 31, 2008.]

**10. Prior LOCA Model Assessment**

In the referenced letter, Exelon submitted to the NRC the annual 10 CFR 50.46 report for 2009. There was no LOCA model assessment for the CPS LOCA analysis.

[Reference: Letter from Jeffrey L. Hansen (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated October 30, 2009.]

**11. Prior LOCA Model Assessment**

In the referenced letter, Exelon submitted to the NRC the annual 10 CFR 50.46 report for 2010. Eight Isotope Test Assemblies (GE14i ITA) were loaded into the cycle 13 core, all the GE14 10 CFR 50.46 errors were applicable to the GE14i ITA and the PCT for GE14 fuel was applicable for GE14i ITAs. The GE14i ITAs were removed from the core during Reload 15 for Cycle 16.

[Reference: Letter from Jeffrey L. Hansen (Exelon Generation Company) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated October 29, 2010.]

**12. Prior LOCA Model Assessment**

In the referenced letter, the impact of two General Electric Hitachi Nuclear Energy (GEH) errors in the LOCA methodology associated with the GE14 fuel in the CPS core were reported. GEH reported an error related to the way input coefficients were used to direct the deposition of gamma radiation energy produced by the fuel. Accounting for this error resulted in a PCT increase of 25°F. GEH also reported an error related to the contribution of heat from gamma ray absorption by the channel. Accounting for this error resulted in a PCT decrease of 40°F. The cumulative impact of these errors resulted in a 15°F decrease in the licensing basis PCT.

[Reference: Letter from David M. Gullott (Exelon Generation Company, LLC) to U.S. NRC, "Plant Specific ECCS Evaluation Changes – 10 CFR 50.46 30-Day Report for Fuel Type GE14," dated August 10, 2011.]

**13. Prior LOCA Model Assessment**

In the referenced letter, Exelon submitted to the NRC the annual 10 CFR 50.46 report

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for 2011. There were no ECCS related changes or modifications that occurred which affected the assumptions in the CPS LOCA AOR.

[Reference: Letter from David M. Gullott (Exelon Generation Company, LLC) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated October 28, 2011]

#### **14. Prior LOCA Model Assessment**

In the referenced letter, it was reported that the GNF2 fuel design had been introduced into the CPS Unit 1 core during the Reload 13 (Cycle 14) outage. The assessment notes above (Notes 1-13) were not applicable to the GNF2 fuel. There were no ECCS related changes or modifications that occurred which affected the assumptions in the CPS LOCA AOR.

[Reference: Letter from Patrick R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated October 26, 2012.]

#### **15. Prior LOCA Model Assessment**

To address inaccuracies in thermal conductivity degradation (TCD), GEH replaced the GESTR-LOCA model with a newer model, PRIME. The most dominant effect impacting PCT is from the way the PRIME fuel properties treat thermal conductivity, which results in a higher fuel stored energy. The PCT impact identified in the referenced letter reflects the difference between the existing GESTR analysis PCT and a conservatively postulated PCT if the analysis were performed with the PRIME model. The ECCS-LOCA analysis methodology remains GESTR based and will not be PRIME based until the ECCS-LOCA analysis is re-performed using PRIME. The notification resulted in a 10°F PCT impact to GE14 fuel and a 40°F PCT impact to GNF2 fuel.

[Reference: Letter from Patrick R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated October 25, 2013.]

#### **16. Prior LOCA Model Assessment**

The referenced letter identified four vendor notifications. The first notification addressed several accumulated updates to the SAFER04A model. These code maintenance changes had an individually and collectively insignificant effect on calculated PCT. The second notification corrected a logic error that was isolated, occurring with an indication that the expected system mass diverges from the calculated actual system mass. This error affects the ECCS flow credited as reaching the core. Correction of this error did not impact the PCT for GE14 or GNF2 fuel. The third notification addressed an error with the imposed minimum pressure differential ( $\Delta p$ ) for droplet flow above a two-phase level in the core. This error can offer an inappropriate steam cooling benefit above the core two-phase level. To correct this error an explicit core  $\Delta p$  calculation was applied without regard to droplet condition resulting in a PCT of -15°F to both GE14 and GNF2. The fourth notification

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addressed an incorrect pressure head representation when defining the counter current flow limitation (CCFL). Correction of this error did not impact the PCT for GE14 or GNF2 fuel.

[Reference: Letter from Patrick R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "Annual Report of Emergency Core Cooling System Evaluation Model Changes and Errors for Clinton Power Station," dated October 24, 2014.]

**17. Current LOCA Model Assessment**

Since the last 10 CFR 50.46 report, no vendor notifications of ECCS model errors/changes applicable to CPS have been issued. No ECCS related changes or modifications have occurred at CPS that affect the assumptions in the LOCA analysis of record.