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10 CFR 50.46

RA-11-025
May 27, 2011

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

Oyster Creek Nuclear Generating Station
Renewed Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: 10 CFR 50.46 30-Day Report

References:

1) Letter from David P. Helker (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "10 CFR 50.46 Annual Report," dated June 4, 2010

2) GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-01 for Oyster Creek Nuclear Generating Station, "Impact of CORCL Bundle Power Correction – Part-length Rods," April 29, 2011

3) GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-02 for Oyster Creek Nuclear Generating Station, "Impact of database error for heat deposition on the Peak Cladding Temperature (PCT) for 10x10 fuel bundles," April 29, 2011

4) GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-03 for Oyster Creek Nuclear Generating Station, "Impact of updated formulation for gamma heat deposition to channel wall for 9x9 and 10x10 fuel bundles," April 29, 2011

5) GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-04 for Oyster Creek Nuclear Generating Station, "Impact of Droplet Flow Distribution Array Alignment to Rod Groupings Error," April 29, 2011

6) GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-05 for Oyster Creek Nuclear Generating Station, "Impact of Update in CORCL Code Version," April 29, 2011

The purpose of this letter is to submit a 30-day 10 CFR 50.46 report for Oyster Creek Nuclear Generating Station (OCNGS). This report is required as a result of multiple 50.46 notifications that resulted in a cumulative increase in Peak Cladding Temperature (PCT) that exceeded 50°F. The most recent 50.46 report for OCNGS (Reference 1) provided the cumulative impact of errors on the Peak Cladding Temperature (PCT) for the most recent fuel designs through June 4, 2010.

Subsequent to the issuance of Reference 1, multiple vendor notifications of Emergency Core Cooling System (ECCS) model errors/changes that are applicable to OCNGS have been issued by GE Hitachi Nuclear Energy that are applicable to OCNGS (References 2 through 6). No ECCS-related changes or modifications have occurred at OCNGS that affect the assumptions of the ECCS analyses. It should also be noted that since the last annual report (Reference 1), the GNF2 fuel design has been introduced into the OCNGS core. The vendor notifications are summarized below:

1) Notification 2011-01: Impact of CORCL Bundle Power Correction – Part-length Rods (Reference 2)

   An option in the CORCL code distributes power in a manner considering part-length rods in the bundle. It has been found this modeling technique is non-conservative, slightly under predicting the total power generated in the hot bundle. PCT results, as well as resulting fuel cladding oxidation in calculations employing that option would be non-conservative. This error impacted the GE11 fuel PCT by 50°F. This error did not impact the GNF2 fuel PCT.

2) Notification 2011-02: Impact of database error for heat deposition on the Peak Cladding Temperature (PCT) for 10x10 fuel bundles (Reference 3)

   A discovery was made regarding input coefficients used to direct the deposition of gamma radiation energy produced by fuel. These input coefficients determine whether the gamma radiation would heat the fuel rod, cladding, channel, or control rod structure materials. The input caused the heat deposited in the fuel channel (post scram) to be over-predicted and the corresponding heat to the fuel to be under-predicted. This effect was seen to be non-conservative. The error only applies to 10x10 fuel. This error impacted the GNF2 fuel PCT by 65°F. This error did not impact the GE11 fuel PCT.

3) Notification 2011-03: Impact of updated formulation for gamma heat deposition to channel wall for 9x9 and 10x10 fuel bundles (Reference 4)

   In the input formulation for SAFER, input coefficients are used to direct the deposition of gamma and neutron radiation energy produced by fuel fissions and decay heat. These input coefficients determine whether the gamma and neutron radiation energy would heat the fuel rod, cladding, channel, or control rod structural materials. While investigating an input anomaly regarding energy deposition, the formulation of these terms was examined. The contribution of heat from gamma ray absorption by the channel was found to have been minimized. The method had been simplified such that initially all the energy was assumed to be deposited in the fuel rods prior to the Loss of Coolant Accident (LOCA) and then adjusted such that the correct heat deposition was applied after the scram. This modeling was concluded to be potentially non-conservative, as not accounting for this small fraction of total power generation outside

the fuel rod would tend to suppress the hot bundle power required to meet the initial operating Peak Linear Heat Generation Rate (PLHGR). Further, there is a small effect on the initial conditions for the balance of the core as these are set in relation to the hot bundle condition. This error impacted the GE11 fuel PCT by -20°F and the GNF2 fuel PCT by 30°F.

4) Notification 2011-04: Impact of Droplet Flow Distribution Array Alignment to Rod Groupings Error (Reference 5)

   Programmed enhancements to the CORCL code allowed an increased number of rod groupings to be defined so as to more accurately represent bundle configuration in the ECCS-LOCA analysis. It was noted that an array in the model, which describes distribution of droplets and film cooling from core spray across the several groupings of rods and the channel was not populated with corresponding additional elements. This had the effect of denying the channel and peripheral groupings of this core spray distribution, preferentially distributing liquid film and droplets with cooling effect to represented rod groupings. This condition is potentially non-conservative for calculating temperatures in the rod groups where the PCT might occur. This error impacted the GE11 fuel PCT by 55°F and the GNF2 fuel PCT by 40°F.

5) Notification 2011-05: Impact of Update in CORCL Code Version (Reference 6)

   Notification of a change in the CORCL code is conveyed by this letter. CORCL has been updated to Version CORCL07E3 for the purpose of addressing acknowledged errors which have been discovered in modeling (subject of prior notification letters), as well as to provide added functionality of the code with respect to power distribution, increasing the number of rod groups that can be modeled, inclusion of PRIME-based properties on fuel, correction on film cooling credited, and to provide other updates by way of code maintenance. The effect of these changes on the licensing basis PCT has been seen to have minor sensitivity according to the fuel bundle analyzed, as would be expected. The Version CORCL07E3 is documented as the default version of CORCL for pending and future analyses using this code going forward. This change impacted the GE11 fuel PCT by 30°F and the GNF2 fuel PCT by 10°F.

The combined impact on PCT of the errors/changes described above is 115°F for the GE11 fuel and 145°F for the GNF2 fuel. These increases in PCT result in the licensing basis PCT exceeding the 10 CFR 50.46 acceptance criterion of 2200°F. Therefore, the PCT impact of these notifications has been offset by the calculation and implementation of revised Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) values such that the maximum PCT values for both the GE11 and GNF2 fuel designs are returned to their original values of 2150°F as documented in the vendor 10 CFR 50.46 notifications. Accordingly, this reanalysis meets the requirements of 10 CFR 50.46.

Two attachments are included with this letter that provide the current OCNGS 10 CFR 50.46 status. Attachment 1, "Peak Cladding Temperature Rack-Up Sheet," provides information regarding the PCT for the limiting large break LOCA analysis evaluations for OCNGS. Attachment 2, "Assessment Notes," contains a detailed description for each change or error reported.

There are no commitments contained in this letter. If you have any questions, please contact Tom Loomis at 610-765-5510.

Respectfully,

Michael D. Jesse
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Attachments: 1) Peak Cladding Temperature Rack-Up Sheet
2) Assessment Notes

cc: W. Dean, USNRC Administrator, Region I
G. E. Miller, USNRC Project Manager, OCNGS
J. A. Kulp, USNRC Senior Resident Inspector, OCNGS

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 May 27, 2011

Peak Cladding Temperature Rack-Up Sheet

Oyster Creek Nuclear Generating Station

PLANT NAME: Oyster Creek
ECCS EVALUATION MODEL: SAFER/CORCL/GESTR-LOCA
REPORT REVISION DATE: 5/27/11
CURRENT OPERATING CYCLE: 23

ANALYSIS OF RECORD

Evaluation Model:

1. NEDC-23785-1-PA, Rev. 1, "The GESTR-LOCA and SAFER Models for the Evaluation of the Loss-Of-Coolant Accident Volume II, SAFER – Long Term Inventory Model for BWR Loss-Of-Coolant Analysis," October 1984.

2. NEDC-30996P-A, "SAFER Model for Evaluation of Loss-of-Coolant Accidents for Jet Pump and Non-jet Pump Plants, Volume I, SAFER – Long Term Inventory Model for BWR Loss-of-Coolant Analysis," October 1987.

3. NEDC-32950P, "Compilation of Improvements to GENE's SAFER ECCS-LOCA Evaluation Model," January 2000 (Application Methodology Description).

4. NEDC-30996P-A, "SAFER Model for Evaluation of Loss-of-Coolant Accidents for Jet Pump and Non-jet Pump Plants, Volume II, SAFER Application Methodology for Non-jet Pump Plants," October 1987. (Non-jet Pump Plant – SAFER/CORCL)

Calculations:

1. GNF Letter Report CFL-EXN-EN1-11-031, "Transmittal of Updated Exposure-Dependent GE11 and GNF2 Fuel MAPLHGR Limits for Oyster Creek Cycle 23," dated April 29, 2011

2. Report 0000-0098-3503-R2, "Oyster Creek Generating Station GNF2 ECCS-LOCA Evaluation," GEH Nuclear Energy, dated November 2010.

3. GE-NE-0000-0001-7486-01P, "Oyster Creek Generating Station Loss-of-Coolant Accident Evaluation for GE11," GE Nuclear Energy, dated July 2002.

Fuel: GE11, GNF2
Limiting Fuel Type: GE11/GNF2 (same)
Limiting Single Failure: ADS Valve
Limiting Break Size and Location: 4.66 ft^2 Double-Ended Guillotine (DEG) in a Recirculation Discharge Pipe

Reference Peak Cladding Temperature (PCT) PCT = 2150°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

New LOCA analyses were performed for GE11 fuel in support of operating cycle 19 (See Note 1)	ΔPCT = 0°F
WEVOL Code Error (See Note 2)	ΔPCT = 0°F
Hydrogen-Oxygen Recombination (See Note 3)	ΔPCT = +25°F
CORCL Boundary Conditions (See Note 4)	ΔPCT = 0°F
Hydrogen-Oxygen Recombination (See Note 5)	ΔPCT = -25°F
2007 Annual Report (See Note 6)	ΔPCT = 0°F
2008 Annual Report (See Note 7)	ΔPCT = 0°F
2009 Annual Report (See Note 8)	ΔPCT = 0°F
2010 Annual Report (See Note 9)	ΔPCT = 0°F
NET PCT (GE11)	**2150°F**

B. CURRENT LOCA MODEL ASSESSMENTS

See Note 10*	ΔPCT = 0°F
Total PCT Change from Current Assessments*	$\sum\Delta$PCT = 0°F
Cumulative PCT Change from Current Assessments*	$\sum\lvert\Delta$PCT$\rvert$ = 0°F
NET PCT (GE11/GNF2)*	**2150°F**

* The PCT impact of the reported errors/changes in Note 10 (total PCT increase of 115°F for GE11 fuel and total PCT increase of 145°F for GNF2 fuel) have been offset by the calculation and implementation of revised MAPLHGR values (calculation Reference 1 above) such that the licensing basis PCT values for both the GE11 and GNF2 fuel designs are returned to their original values of 2150°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

Assessments as of May 27, 2011

Assessment Notes

Oyster Creek Nuclear Generating Station

1. Prior LOCA Assessment

New LOCA analyses were performed for both GE9 and GE11 fuel in support of operating cycle 19. These analyses supersede all prior LOCA assessments. These analyses incorporate all errors and changes known at that time (as of July 2002).

[Reference: GE-NE-0000-0006-3699-01P-R1, "ECCS-LOCA Evaluation for Oyster Creek with Improved GE9 LHGR Limits," GE Nuclear Energy, dated September 2002.]

[Reference: GE-NE-0000-0001-7486-01P, "Oyster Creek Generating Station Loss-of-Coolant Accident Evaluation for GE11," GE Nuclear Energy, dated July 2002.]

From August 2002 until May 2004, GE notified Exelon of two errors applicable to Oyster Creek, identified below (Notes 2 and 3).

The annual 50.46 report for Oyster Creek erroneously reported no update to the LOCA model assessment for GE9 fuel and correctly reported the new LOCA analysis for the introduction of GE11 fuel. A Peak Clad Temperature of 2183°F was erroneously reported for GE9 fuel (correct value was 2150°F).

[Reference: Letter from Michael P. Gallagher (AmerGen Energy Company, LLC) to U.S. Nuclear Regulatory Commission, "10 CFR 50.46 Reporting Requirements," 2130-02-20349, dated December 18, 2002.]

2. Prior LOCA Assessment

GE reported that an error was found in the WEVOL code, which affects the calculated vessel volume in the downcomer region. The free volume in the region of the shroud head is calculated incorrectly, resulting in the calculated value to be underpredicted by 4 – 10 ft^3.

[Reference: GE Letter, "10 CFR 50.46 Notification Letter," 2002-05, August 26, 2002.]

3. Prior LOCA Assessment

GE reported that a new heat source term has been postulated. This heat source involves the recombination of hydrogen and oxygen within the fuel bundle during the core heatup. The additional heat will raise the temperature of the steam heat sink in the bundle, resulting in a potential increase in the peak cladding temperature and local oxidation. This recombination is spontaneous at temperatures above approximately 900°F. The hydrogen is generated by the steam-zirconium reaction during heatup. The oxygen enters the vessel either as a dissolved gas in the ECCS water or through the break when the vessel fully depressurizes and draws the containment non-condensable gases back into the vessel. The current LOCA evaluation models do not include this new heat source. Pending disposition of this phenomenon, a change notification was supplied to provide the impact of hydrogen-oxygen recombination on the cladding temperature and local oxidation.

[Reference: GE Letter, "10 CFR 50.46 Notification Letter," 2003-05, May 13, 2004.]

4. Prior LOCA Assessment

GE reported that the representative exposure point at which the 'long duration' SAFER run is performed to provide the boundary conditions for the CORCL evaluations may not be bounding and can have a non-conservative effect on the CORCL results. 'Short duration' SAFER runs are performed at each analyzed exposure point to provide the fuel bundle initial conditions. Long duration SAFER runs were performed for each analyzed exposure point. The PCT impact for the reported condition was determined to be 0°F for GE9 and GE11 fuel.

[Reference: GE Letter, "10 CFR 50.46 Notification Letter," 2005-01, April 1, 2005.]

5. Prior LOCA Assessment

In item 3 above, GE reported that a new heat source term has been postulated. This heat source involves the recombination of hydrogen and oxygen within the fuel bundle during the core heatup. GE has performed a detailed evaluation of this phenomenon and has determined that there is sufficient conservatism in the Appendix K analysis which bounds the Upper Bound PCT and Oxidation with hydrogen-oxygen recombination in both PCT limited and oxidation limited exposure ranges. Therefore, the current SAFER/CORCL application methodology for conformance of the Appendix K analysis 10 CFR 50.46 limits remains applicable. The hydrogen-oxygen recombination phenomenon does not need to be considered in the Appendix K analysis.

[References: GE Letter, "10 CFR 50.46 Notification Letter," 2003-05, Rev. 2, April 27, 2006, and letter from David P. Helker (AmerGen Energy Company, LLC) to U.S. Nuclear Regulatory Commission, "10 CFR 50.46 Annual Report," 2130-06-20347, dated June 8, 2006.]

6. Prior LOCA Assessment

The reference letter documented that no ECCS model errors/changes were reported since the prior Oyster Creek annual report was issued.

[Reference: Letter from David P. Helker (AmerGen Energy Company, LLC) to U.S. Nuclear Regulatory Commission, "10 CFR 50.46 Annual Report," 2130-07-20499, dated June 7, 2007.]

7. Prior LOCA Assessment

The reference letter documented that no ECCS model errors/changes were reported since the prior Oyster Creek annual report was issued.

[Reference: Letter from David P. Helker (AmerGen Energy Company, LLC) to U.S. Nuclear Regulatory Commission, "10 CFR 50.46 Annual Report," RA-08-050, dated June 6, 2008.]

8. Prior LOCA Assessment

The reference letter documented that no ECCS model errors/changes were reported since the prior Oyster Creek annual report was issued.

[Reference: Letter from David P. Helker (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, "10 CFR 50.46 Annual Report," RA-09-047, dated June 5, 2009.]

9. Prior LOCA Assessment

The reference letter documented that no ECCS model errors/changes were reported since the prior Oyster Creek annual report was issued.

[Reference: Letter from David P. Helker (Exelon Generation Company, LLC) to U.S. Nuclear Regulatory Commission, RA-10-046, "10 CFR 50.46 Annual Report," dated June 4, 2010.]

10. Current LOCA Assessment

Since the last annual report (see Note 9), the GNF2 fuel design has been introduced into the Oyster Creek core and all GE9 fuel has been discharged. Also, since the last annual report, multiple vendor notifications of Emergency Core Cooling System (ECCS) model error/changes that are applicable to Oyster Creek have been issued. No ECCS-related changes or modifications have occurred at Oyster Creek that affect the assumptions of the ECCS analyses. The errors/changes are summarized below:

An option in the CORCL code distributes power in a manner considering part-length rods in the bundle. It has been found this modeling technique is non-conservative, slightly under predicting the total power generated in the hot bundle. PCT results, as well as resulting fuel cladding oxidation in calculations employing that option would be non-conservative. This error impacted the GE11 fuel PCT by 50°F. This error did not impact the GNF2 fuel PCT.

A discovery was made regarding input coefficients used to direct the deposition of gamma radiation energy produced by fuel. These input coefficients determine whether the gamma radiation would heat the fuel rod, cladding, channel, or control rod structure materials. The input caused the heat deposited in the fuel channel (post scram) to be over-predicted and the corresponding heat to the fuel to be under-predicted. This effect was seen to be non-conservative. The error only applies to 10x10 fuel. This error impacted the GNF2 fuel PCT by 65°F. This error did not impact the GE11 fuel PCT.

In the input formulation for SAFER, input coefficients are used to direct the deposition of gamma and neutron radiation energy produced by fuel fissions and decay heat. These input coefficients determine whether the gamma and neutron radiation energy would heat the fuel rod, cladding, channel, or control rod structural materials. While investigating an input anomaly regarding energy deposition, the formulation of these terms was examined. The contribution of heat from gamma ray absorption by the channel was found to have been minimized. The method had been simplified such that initially all the energy was assumed to be deposited in the fuel rods prior to the LOCA and then adjusted such that the correct heat deposition was applied after the scram. This modeling was concluded to be potentially non-conservative, as not accounting for this small fraction of total power generation outside the fuel rod would tend to suppress the hot bundle power required to meet the initial operating Peak Linear Heat Generation Rate (PLHGR). Further, there is a small effect on the initial conditions for the balance of the core as these are set in relation to the hot bundle condition. This error impacted the GE11 fuel PCT by -20°F and the GNF2 fuel PCT by 30°F.

Programmed enhancements to the CORCL code allowed an increased number of rod groupings to be defined so as to more accurately represent bundle configuration in the ECCS-LOCA analysis. It was noted that an array in the model, which describes distribution of droplets and film cooling from core spray across the several groupings of rods and the channel was not

populated with corresponding additional elements. This had the effect of denying the channel and peripheral groupings of this core spray distribution, preferentially distributing liquid film and droplets with cooling effect to represented rod groupings. This condition is potentially non-conservative for calculating temperatures in the rod groups where the PCT might occur. This error impacted the GE11 fuel PCT by 55°F and the GNF2 fuel PCT by 40°F.

The CORCL code has been updated to Version CORCL07E3 for the purpose of addressing acknowledged errors which have been discovered in modeling (subject of prior notification letters), as well as to provide added functionality of the code with respect to power distribution, increasing the number of rod groups that can be modeled, inclusion of PRIME-based properties on fuel, correction on film cooling credited and to provide other updates by way of code maintenance. The effect of these changes on the licensing basis PCT has been seen to have minor sensitivity according to the fuel bundle analyzed, as would be expected. The Version CORCL07E3 is documented as the default version of CORCL for pending and future analyses using this code going forward. This change impacted the GE11 fuel PCT by 30°F and the GNF2 fuel PCT by 10°F.

The PCT impact of the reported errors/changes in the above notifications have been offset by the calculation and implementation of revised MAPLHGR values such that the maximum PCT values for both the GE11 and GNF2 fuel designs are returned to their original values of 2150°F. Therefore, the reported change in PCT for both the GE11 and GNF2 fuel designs is 0°F.

[Reference: GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-01 for Oyster Creek Nuclear Generating Station, "Impact of CORCL Bundle Power Correction – Part-length Rods," April 29, 2011]

[Reference: GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-02 for Oyster Creek Nuclear Generating Station, "Impact of database error for heat deposition on the Peak Cladding Temperature (PCT) for 10x10 fuel bundles," April 29, 2011]

[Reference: GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-03 for Oyster Creek Nuclear Generating Station, "Impact of updated formulation for gamma heat deposition to channel wall for 9x9 and 10x10 fuel bundles," April 29, 2011]

[Reference: GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-04 for Oyster Creek Nuclear Generating Station, "Impact of Droplet Flow Distribution Array Alignment to Rod Groupings Error," April 29, 2011]

[Reference: GE Hitachi Nuclear Energy 10 CFR 50.46 Notification Letter 2011-05 for Oyster Creek Nuclear Generating Station, "Impact of Update in CORCL Code Version," April 29, 2011]

[Reference: GNF Letter Report CFL-EXN-EN1-11-031, "Transmittal of Updated Exposure-Dependent GE11 and GNF2 Fuel MAPLHGR Limits for Oyster Creek Cycle 23," dated April 29, 2011]