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RS-22-059

10 CFR 50.46

May 4, 2022

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

Quad Cities Nuclear Power Station, Units 1 and 2
Renewed Facility Operating License Nos. DPR-29 and DPR-30
NRC Docket Nos. 50-254 and 50-265

Subject: 10 CFR 50.46 Annual Report

Reference: Letter RS-21-052 from P. R. Simpson (Exelon Generation Company, LLC) to
U.S. NRC, "10 CFR 50.46 Annual Report," dated May 4, 2021

This letter provides the annual report required by 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," for Quad Cities Nuclear Power Station (QCNPS), Units 1 and 2. The attachments describe the changes in accumulated peak cladding temperature (PCT) since the previous annual report submitted in the referenced letter. In February 2022, the QCNPS facility operating licenses were transferred to Constellation Energy Generation, LLC (CEG).

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Ms. Rebecca L. Steinman at (630) 657-2831.

Respectfully,

A handwritten signature in black ink that reads "Patrick R. Simpson".

Patrick R. Simpson
Sr. Manager Licensing
Constellation Energy Generation, LLC

Attachments:

1. Quad Cities Nuclear Power Station Unit 2, 10 CFR 50.46 Report (Westinghouse Fuel) – USA5
2. Quad Cities Nuclear Power Station Unit 2, 10 CFR 50.46 Report (Westinghouse Fuel) – USA6
3. Quad Cities Nuclear Power Station Unit 1, 10 CFR 50.46 Report (Framatome Fuel)
4. Quad Cities Nuclear Power Station Unit 2, 10 CFR 50.46 Report (Framatome Fuel)
5. Quad Cities Nuclear Power Station Units 1 and 2, 10 CFR 50.46 Report Assessment Notes

cc: NRC Regional Administrator, Region III
NRC Senior Resident Inspector, Quad Cities Nuclear Power Station

ATTACHMENT 1
Quad Cities Nuclear Power Station Unit 2,
10 CFR 50.46 Report (Westinghouse Fuel) – USA5

PLANT NAME: Quad Cities Unit 2
 ECCS EVALUATION MODEL: USA5
 REPORT REVISION DATE: 05/04/2022
 CURRENT OPERATING CYCLE: 26

ANALYSIS OF RECORD

Evaluation Model: "Westinghouse BWR ECCS Evaluation Model: Supplement 3 to Code Description, Qualification and Application to SVEA-96 Optima2 Fuel," WCAP-16078-P-A, November 2004

- Calculations:
1. "Quad Cities 1 & 2 LOCA Analysis for SVEA-96 Optima2 Fuel," OPTIMA2-TR021QC-LOCA, Revision 5, September 2009
 2. "Quad Cities Nuclear Power Station Unit 2 Cycle 23 MAPLHGR Report," NF-BEX-13-168-NP, Revision 0, January 2014

Fuel Analyzed in Calculation: SVEA-96 Optima2
 Limiting Fuel Type: SVEA-96 Optima2
 Limiting Single Failure: Low Pressure Coolant Injection system injection valve
 Limiting Break Size and Location: 1.0 double-ended guillotine break in the recirculation pump suction line

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

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 Report dated May 7, 2010 (See Note 1)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 6, 2011 (See Note 2)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2012 (See Note 3)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 3, 2013 (See Note 4)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2014 (See Note 5)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 1, 2015 (See Note 6)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2016 (See Note 7)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2017 (See Note 8)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2018 (See Note 9)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2019 (See Note 10)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2020 (See Note 11)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2021 (See Note 12)	$\Delta PCT = 0^\circ F$
Net PCT	2150°F

B. CURRENT LOCA MODEL ASSESSMENTS

None (See Note 13)	$\Delta PCT = 0^\circ F$
Total PCT change from current assessments	$\sum \Delta PCT = 0^\circ F$
Cumulative PCT change from current assessments	$\sum \Delta PCT = 0^\circ F$
Net PCT	2150°F

ATTACHMENT 2
Quad Cities Nuclear Power Station Unit 2,
10 CFR 50.46 Report (Westinghouse Fuel) – USA6

PLANT NAME: Quad Cities Unit 2
 ECCS EVALUATION MODEL: USA6
 REPORT REVISION DATE: 05/04/2022
 CURRENT OPERATING CYCLE: 26

ANALYSIS OF RECORD

Evaluation Model: "Westinghouse BWR ECCS Evaluation Model Updates: Supplement 4 to Code Description, Qualification and Application," WCAP-16865-P-A, Revision 1, October 2011

- Calculations:
1. "Quad Cities 1 & 2 LOCA Analysis for SVEA-96 Optima2 Fuel," NF-BEX-13-143-P, Revision 3, April 2016
 2. "Quad Cities Nuclear Power Station Unit 2 Cycle 24 MAPLHGR Report," NF-BEX-15-174-NP, Revision 0, January 2016

Fuel Analyzed in Calculation: SVEA-96 Optima2
 Limiting Fuel Type: SVEA-96 Optima2
 Limiting Single Failure: Low Pressure Coolant Injection system injection valve
 Limiting Break Size and Location: 1.0 double-ended guillotine break in the recirculation pump suction line

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

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 Report dated May 2, 2016 (See Note 7)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2017 (See Note 8)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2018 (See Note 9)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 2, 2019 (See Note 10)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2020 (See Note 11)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2021 (See Note 12)	$\Delta PCT = 0^\circ F$
Net PCT	2150°F

B. CURRENT LOCA MODEL ASSESSMENTS

None (See Note 13)	$\Delta PCT = 0^\circ F$
Total PCT change from current assessments	$\sum \Delta PCT = 0^\circ F$
Cumulative PCT change from current assessments	$\sum \Delta PCT = 0^\circ F$
Net PCT	2150°F

ATTACHMENT 3
Quad Cities Nuclear Power Station Unit 1,
10 CFR 50.46 Report (Framatome Fuel)

PLANT NAME: Quad Cities Unit 1
 ECCS EVALUATION MODEL: EXEM BWR-2000
 REPORT REVISION DATE: 05/04/2022
 CURRENT OPERATING CYCLE: 27

ANALYSIS OF RECORD

Evaluation Model: "EXEM BWR-2000 ECCS Evaluation Model," EMF-2361(P)(A),
 Revision 0, May 2001

- Calculations:
1. "Quad Cities Units 1 and 2 ATRIUM 10XM Break Spectrum with Increased ADS Flow," ANP-3794P, Revision 0, September 2019
 2. "Quad Cities Units 1 and 2 ATRIUM 10XM LOCA-ECCS Analysis MAPLHGR Limits with Increased ADS Flow," ANP-3795P, Revision 0, October 2019
 3. "Quad Cities Unit 1 Cycle 27 Reload Safety Analysis," ANP-3896P, Revision 0, January 2021

Fuel Analyzed in Calculation: ATRIUM 10XM
 Limiting Fuel Type: ATRIUM 10XM
 Limiting Single Failure: High Pressure Coolant Injection system
 Limiting Break Size and Location: 0.13 ft² split break recirculation discharge pipe

Reference Peak Cladding Temperature (PCT): PCT = 2139°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 Report dated May 4, 2020 (See Note 11)	Δ PCT = 0°F
10 CFR 50.46 Report dated May 4, 2021 (See Note 12)	Δ PCT = 0°F
Net PCT	2139°F

B. CURRENT LOCA MODEL ASSESSMENTS

Inputs Correction (See Note 13)	Δ PCT = -1°F
Rankine vs Fahrenheit Change (See Note 13)	Δ PCT = +1°F
Total PCT change from current assessments	$\Sigma \Delta$ PCT = 0°F
Cumulative PCT change from current assessments	$\Sigma \Delta$ PCT = 2°F
Net PCT	2139°F

ATTACHMENT 4
Quad Cities Nuclear Power Station Unit 2,
10 CFR 50.46 Report (Framatome Fuel)

PLANT NAME: Quad Cities Unit 2
 ECCS EVALUATION MODEL: EXEM BWR-2000
 REPORT REVISION DATE: 05/04/2022
 CURRENT OPERATING CYCLE: 26

ANALYSIS OF RECORD

Evaluation Model: "EXEM BWR-2000 ECCS Evaluation Model," EMF-2361(P)(A),
 Revision 0, May 2001

- Calculations:
1. "Quad Cities Units 1 and 2 ATRIUM 10XM Break Spectrum with Increased ADS Flow," ANP-3794P, Revision 0, September 2019
 2. "Quad Cities Units 1 and 2 ATRIUM 10XM LOCA-ECCS Analysis MAPLHGR Limits with Increased ADS Flow," ANP-3795P, Revision 0, October 2019
 3. "Quad Cities Unit 2 Cycle 26 Reload Safety Analysis," ANP-3820P, Revision 0, January 2020

Fuel Analyzed in Calculation: ATRIUM 10XM
 Limiting Fuel Type: ATRIUM 10XM
 Limiting Single Failure: High Pressure Coolant Injection system
 Limiting Break Size and Location: 0.12 ft² split break recirculation discharge pipe

Reference Peak Cladding Temperature (PCT): PCT = 2139°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 Report dated May 4, 2020 (See Note 11)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 Report dated May 4, 2021 (See Note 12)	$\Delta PCT = 0^{\circ}F$
Net PCT	2139°F

B. CURRENT LOCA MODEL ASSESSMENTS

Inputs Correction (See Note 13)	$\Delta PCT = -1^{\circ}F$
Rankine vs Fahrenheit Change (See Note 13)	$\Delta PCT = +1^{\circ}F$
Total PCT change from current assessments	$\sum \Delta PCT = 0^{\circ}F$
Cumulative PCT change from current assessments	$\sum \Delta PCT = 2^{\circ}F$
Net PCT	2139°F

ATTACHMENT 5
Quad Cities Nuclear Power Station Units 1 and 2,
10 CFR 50.46 Report Assessment Notes

1. Prior Loss-of-Coolant Accident (LOCA) Assessment

The referenced letter reported a new Westinghouse LOCA analysis of record (AOR), which incorporated modifications for the newly added recirculation pump adjustable speed drives (ASD). The new AOR (Revision 5) updated the LOCA analysis to apply approved updated Westinghouse methods, incorporate previous corrections, and update plant specific inputs. The new Westinghouse LOCA analysis demonstrated that the limiting peak cladding temperature (PCT) was 2150°F.

The referenced letter also reported the impact of subsequent corrections for an incorrect bypass hole flow coefficient, and for updated vessel leakage values. The PCT impact of these two corrections on the limiting PCT was 9°F and 2°F, respectively. These PCT impacts will remain in effect only until the MAPLHGR limits for all bundles in future QCNPS Unit 2 cores are evaluated for this change. The MAPLHGR limits for all bundles in the QCNPS Unit 2 cores starting with Q2C25 were evaluated for these changes and these penalties no longer apply.

[Reference: Letter from J. L. Hansen (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46, 'Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,' Annual Report," dated May 7, 2010]

2. Prior LOCA Assessment

The referenced letter reported no new PCT assessment for the Westinghouse LOCA analysis. Also, no emergency core cooling system (ECCS)-related changes or modifications occurred at Quad Cities Nuclear Power Station (QCNPS) that affected the assumptions of the ECCS analyses.

[Reference: Letter from J. L. Hansen (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46, 'Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,' Annual Report," dated May 6, 2011]

3. Prior LOCA Assessment

The referenced letter provided the annual 10 CFR 50.46 report for Unit 2. The letter reported errors in the current Westinghouse QCNPS LOCA analysis associated with the use of incorrect R-factors. The impact due to this change was determined to be 18°F increase in PCT. This PCT will remain in effect only until the MAPLHGR limits for all bundles in future QCNPS Unit 2 cores are evaluated for this change. The MAPLHGR limits for all bundles in the QCNPS Unit 2 cores starting with Q2C25 were evaluated for this change and this penalty no longer apply.

[Reference: Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46, 'Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors,' Annual Report," dated May 4, 2012]

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4. Prior LOCA Assessment

The referenced letter reported no new PCT assessment for the Westinghouse LOCA analysis. Also, no ECCS-related changes or modifications occurred at QCNPS that affected the assumptions of the ECCS analyses.

[Reference: Letter from D. M. Gullott (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 3, 2013]

5. Prior LOCA Assessment

The referenced letter reported no new PCT assessment for the Westinghouse LOCA analysis. Also, no ECCS-related changes or modifications occurred at QCNPS that affected the assumptions of the ECCS analyses.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 2, 2014]

6. Prior LOCA Assessment

The referenced letter reported no new PCT assessment for the Westinghouse LOCA analysis. Also, no ECCS-related changes or modifications occurred at QCNPS that affected the assumptions of the ECCS analyses.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 1, 2015]

7. Prior LOCA Assessment

The new USA6 LOCA Evaluation Model and calculation was implemented for QCNPS Unit 2 for all fresh fuel starting with Cycle 24. This evaluation model and calculation supplement the existing Evaluation Model and calculation. This model reports a limiting PCT of 2150°F and has no additional PCT impacts or estimates.

Additionally, there are no new changes, error corrections, or enhancements in the current QCNPS LOCA analysis based on the USA5 LOCA Evaluation Model. Also, no ECCS-related changes or modifications occurred at QCNPS that affected the assumptions in the ECCS analyses.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 2, 2016]

8. Prior LOCA Assessment

The new AREVA/Framatome EXEM BWR-2000 Evaluation Model and calculation has been implemented for QCNPS Unit 1 for the fresh fuel of ATRIUM 10XM loaded into the Cycle 25 core. This model reports a limiting PCT of 2138°F and has no additional PCT impacts or estimates.

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Additionally, there are no new changes, error corrections, or enhancements in the current QCNPS LOCA analysis based on the USA5 LOCA Evaluation model, USA6 LOCA Evaluation model or EXEM BWR-2000 LOCA Evaluation model. Also, no ECCS-related changes or modifications occurred at QCNPS that affected the assumptions in the ECCS analyses.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 2, 2017]

9. Prior LOCA Assessment

The new AREVA/Framatome EXEM BWR-2000 Evaluation Model and calculation has been implemented for QCNPS Unit 2 for the fresh fuel of ATRIUM 10XM loaded into the Cycle 25 core. This model reports a limiting PCT of 2150°F and has no additional PCT impacts or estimates.

Additionally, updated LOCA/MAPLHGR analyses were performed for QCNPS Unit 2 for the Westinghouse fuel first introduced in the Cycle 23 reload. These analyses for QCNPS Unit 2 maintained the calculated PCT at 2150°F and accounted for the incorrect vessel leakage and bypass hole coefficient outlined in Note 1 and the incorrect R-factors outlined in Note 3. All other Westinghouse fuel from before Cycle 23 that was impacted by these errors within Unit 1 and 2 has been discharged. Therefore, the previous penalty of 11°F in Note 1 and 18°F in Note 3 no longer apply for QCNPS Unit 2. The penalty in Attachment 3 listed for Notes 1 and 3 have all been changed to 0°F.

Additionally, there are no new changes, error corrections, or enhancements in the current QCNPS LOCA analysis based on the USA5 LOCA Evaluation model, USA6 LOCA Evaluation model or EXEM BWR-2000 LOCA Evaluation model. Also, no ECCS-related changes or modifications occurred at QCNPS that affected the assumptions in the ECCS analyses.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 2, 2018]

10. Prior LOCA Assessment

There were no new changes, error corrections or enhancements in the USA5 or USA6 Westinghouse LOCA analyses for QCNPS Units 1 and 2. There were no new changes, error corrections or enhancements in the Framatome EXEM BWR-2000 Evaluation Model for QCNPS Units 1 and 2. Also, no ECCS-related changes or modifications occurred at QCNPS Units 1 and 2 that affected the assumptions to any of the LOCA AORs.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 2, 2019]

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Quad Cities Nuclear Power Station Units 1 and 2,
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11. Prior LOCA Assessment

There are no new changes, error corrections or enhancements in the USA5 or USA6 Westinghouse LOCA analyses for QCNPS Units 1 and 2. A new calculation of the Framatome EXEM BWR-2000 Evaluation Model was implemented for QCNPS Unit 2.

There were two assessments to the Framatome EXEM BWR-2000 Evaluation Model that apply to both the QCNPS Unit 1 and Unit 2 analyses. The first assessment was a coding issue in the RODEX4 thermal-mechanical code interpolation process of the RODEX4 Pellet-Cladding Mechanical Interaction routine with an estimated impact on PCT of +1°F. The second assessment was that some of the RODEX2-2a inputs associated with the fuel rod geometry were not being appropriately prepared with an estimated impact on PCT of -1°F. There was one assessment to the Framatome EXEM BWR-2000 Evaluation Model for QCNPS Unit 1 where a new lattice type was utilized. This new lattice type assessment resulted in a penalty of +1°F to the Unit 1 Framatome model resulting in a limiting PCT of 2099°F.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 4, 2020]

12. Prior LOCA Assessment

There are no new changes, error corrections or enhancements in the USA5 or USA6 Westinghouse LOCA analyses for QCNPS Units 1 and 2.

A new calculation of the Framatome EXEM BWR-2000 Evaluation Model has been performed for QCNPS Unit 1 with a limiting Peak Clad Temperature (PCT) of 2139°F. This referenced PCT is an increase of 40°F from the previously reported referenced PCT. This calculation incorporates all previous errors and impacts to the LOCA model with the exception of the RODEX2-2a input error discussed in Note 11. The previously discussed impact of 0°F to the limiting PCT remains valid. Overall, the implementation of this new calculation along with the one impact represents an increase of the PCT of +40°F from the previously reported limiting PCT which is below the [50°F | threshold for the 30-day reporting requirement in 10 CFR 50.46.

There were no new changes, error corrections or enhancements to the Framatome EXEM BWR-2000 Evaluation Model for QCNPS Units 1 and 2.

Lastly, no ECCS-related changes or modifications occurred at QCNPS Units 1 and 2 that affected the assumptions to any of the LOCA AORs.

[Reference: Letter from P. R. Simpson (Exelon Generation Company, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 4, 2021]

13. Current LOCA Assessment

There are no new changes, error corrections or enhancements in the USA5 or USA6 Westinghouse LOCA analyses for QCNPS Unit 2. All Westinghouse fuel for QCNPS Unit 1 has been discharged so those methods are no longer applicable for Unit 1.

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There were two new changes to the Framatome EXEM BWR-2000 Evaluation Model for QCNPS Units 1 and 2. The utilization of the RDS2_2_RDX4 code created two changes impacting the effects of exposure-dependent thermal conductivity degradation (TCD) of the EXEM BWR-2000 LOCA methodology.

1. The RDX2_2_RDX4 code corrected the input conversion process for the cladding and pellet roughness values. The assessment showed that the estimated impact on PCT of this RDX2_2_RDX4 coding adjustment is +1°F.

2. The calculation of the TCD multiplication factor is based on the ratio of pellet temperatures. As part of the implementation of RDX2_2_RDX4, the process was modified to use pellet temperatures in degrees Rankine instead of degrees Fahrenheit. The assessment showed the estimated impact on PCT of using degrees Rankine to calculate the TCD factor is -1°F.

The overall impact of these changes was 0°F with an absolute value of both changes being 2°F. Lastly, no ECCS-related changes or modifications occurred at QCNPS Units 1 and 2 that affected the assumptions to any of the LOCA AORs.