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RS-24-046

10 CFR 50.46

May 6, 2024

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 from P. R. Simpson (Constellation Energy Generation, LLC) to U.S. NRC,
"10 CFR 50.46 Annual Report," dated May 4, 2023

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, Units 1 and 2. The attachments describe the changes in accumulated peak cladding temperature since the previous annual report submitted in the referenced letter.

There are no regulatory commitments contained in this letter. Should you have any questions concerning this letter, please contact Mr. Kenneth M. Nicely at (779) 231-6119.

Respectfully,

Mark D. Humphrey
Sr. Manager Licensing
Constellation Energy Generation, LLC

Attachments:

1. Quad Cities Nuclear Power Station Unit 1, 10 CFR 50.46 Report (Framatome Fuel)
2. Quad Cities Nuclear Power Station Unit 2, 10 CFR 50.46 Report (Framatome Fuel)
3. Quad Cities Nuclear Power Station Unit 1, 10 CFR 50.46 Report (GE Hitachi Fuel)
4. Quad Cities Nuclear Power Station Unit 2, 10 CFR 50.46 Report (GE Hitachi 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 1,
10 CFR 50.46 Report (Framatome Fuel) – ATRIUM 10XM

PLANT NAME: Quad Cities Unit 1
 ECCS EVALUATION MODEL: EXEM BWR-2000
 50.46 REPORT REVISION DATE: 05/06/2024
 CURRENT OPERATING CYCLE: 28

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 0A, March 2021
 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
 Limiting Break Size and Location: 0.12 ft² split break in the recirculation discharge line

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

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 Report dated May 4, 2021 (See Note 2)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2022 (See Note 3)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2023 (See Note 4)	$\Delta PCT = 0^\circ F$
Net PCT	2139°F

B. CURRENT LOCA MODEL ASSESSMENTS

RODEX4 Fuel Pellet Rim Porosity Model (See Note 5)	$\Delta PCT = 0^\circ F$
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	2139°F

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

PLANT NAME: Quad Cities Unit 2
 ECCS EVALUATION MODEL: EXEM BWR-2000
 50.46 REPORT REVISION DATE: 05/06/2024
 CURRENT OPERATING CYCLE: 28

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 0A, March 2021
 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 27 Reload Safety Analysis," ANP-3976P, Revision 0, January 2022

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

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 1)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2021 (See Note 2)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2022 (See Note 3)	$\Delta PCT = 0^\circ F$
10 CFR 50.46 Report dated May 4, 2023 (See Note 4)	$\Delta PCT = 0^\circ F$
Net PCT	2139°F

B. CURRENT LOCA MODEL ASSESSMENTS

RODEX4 Fuel Pellet Rim Porosity Model (See Note 5)	$\Delta PCT = 0^\circ F$
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	2139°F

ATTACHMENT 3
Quad Cities Nuclear Power Station Unit 1,
10 CFR 50.46 Report (GE Hitachi Fuel) – GNF3

PLANT NAME: Quad Cities Unit 1
 ECCS EVALUATION MODEL: SAFER/PRIME
 50.46 REPORT REVISION DATE: 05/06/2024
 CURRENT OPERATING CYCLE: 28

ANALYSIS OF RECORD

Calculation: "Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2 GNF3
 ECCS-LOCA Evaluation," GEH Report 006N1118, Revision 0,
 July 2022

Fuel Analyzed in Calculation: GNF3
 Limiting Fuel Type: GNF3
 Limiting Single Failure: Diesel Generator Failure
 Limiting Break Size and Location: Double-ended guillotine break of recirculation pump
 suction piping

Reference Peak Cladding Temperature (PCT): PCT = 2170°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 Report dated May 4, 2023 (See Note 4)	$\Delta PCT = 0^\circ F$
Net PCT	2170°F

B. CURRENT LOCA MODEL ASSESSMENTS

None (see Note 5)	$\Delta PCT = 0^\circ F$
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	2170°F

ATTACHMENT 4
Quad Cities Nuclear Power Station Unit 2,
10 CFR 50.46 Report (GE Hitachi Fuel) – GNF3

PLANT NAME: Quad Cities Unit 2
 ECCS EVALUATION MODEL: SAFER/PRIME
 50.46 REPORT REVISION DATE: 05/06/2024
 CURRENT OPERATING CYCLE: 28

ANALYSIS OF RECORD

Calculation: "Quad Cities Nuclear Power Station (QCNPS) Units 1 and 2 GNF3
 ECCS-LOCA Evaluation," GEH Report 006N1118, Revision 0,
 July 2022

Fuel Analyzed in Calculation: GNF3
 Limiting Fuel Type: GNF3
 Limiting Single Failure: Diesel Generator Failure
 Limiting Break Size and Location: Double-ended guillotine break of recirculation pump
 suction piping

Reference Peak Cladding Temperature (PCT): PCT = 2170°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

No prior LOCA model assessments are applicable since this is the first time the reference Analysis of Record is being reported (See Note 5)	$\Delta PCT = N/A$
Net PCT	2170°F

B. CURRENT LOCA MODEL ASSESSMENTS

None (See Note 5)	$\Delta PCT = N/A$
Total PCT change from current assessments	$\sum \Delta PCT = N/A$
Cumulative PCT change from current assessments	$\sum \Delta PCT = N/A$
Net PCT	2170°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

A new calculation of the Framatome EXEM BWR-2000 Evaluation Model was implemented for QCNPS Unit 2.

Two assessments of the Framatome EXEM BWR-2000 Evaluation Model applied to both the QCNPS Unit 1 and 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.

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

2. Prior LOCA Assessment

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

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

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

3. Prior LOCA Assessment

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

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Quad Cities Nuclear Power Station Units 1 and 2,
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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.

[Reference: Letter from P. R. Simpson (Constellation Energy Generation, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 4, 2022]

4. Prior LOCA Assessment

The new GE Hitachi SAFER/PRIME Evaluation Model and calculation have been implemented for QCNPS Unit 1 for the fresh fuel of GNF3 loaded into the Cycle 28 core. This model reports a limiting PCT of 2170°F and has no additional PCT impacts or estimates.

It was discovered that a change in 2011 was made to the decay heat (DH) input used in nominal calculations for the SAFER evaluation model. The updated DH model is a best estimate decay heat curve based on the 1979 ANS 5.1 standard and considers Service Information Letter (SIL) 636. This change was discovered during review of GNF3 new fuel introduction activities. Additional vendor assessments estimated an impact of 0°F upon GNF2 PCT. This change was already incorporated into the initial GNF3 LOCA evaluation and therefore has no impact on the GNF3 LOCA AOR.

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 (Constellation Energy Generation, LLC) to U.S. NRC, "10 CFR 50.46 Annual Report," dated May 4, 2023]

5. Current LOCA Assessment

One notification letter was issued for the Framatome ATRIUM 10XM fuel type. The effects of exposure-dependent TCD are accounted for in the heat-up analyses by applying a multiplication factor to the average pellet temperature, which includes the use of the RODEX4 code. The model in the standalone RODEX4 code used to determine the fuel pellet porosity near the edge or rim of the pellet was not implemented correctly for very high exposures. A corrected version of the code showed this issue has only small impacts. The estimated impact of this issue on PCT is 0°F. This PCT impacts both QCNPS Units 1 and 2.

The new GE Hitachi SAFER/PRIME Evaluation Model and calculation have been implemented for QCNPS Unit 2 for the fresh fuel of GNF3 loaded into the Cycle 28 core. This model reports a limiting PCT of 2170°F and has no additional PCT impacts or estimates.

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