

10 CFR 50.46

March 18, 2021

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

Calvert Cliffs Nuclear Power Plant, Units 1 and 2
Renewed Facility Operating License Nos. DPR-53 and DPR-69
NRC Docket Nos. 50-317 and 50-318

Subject: 10 CFR 50.46 Annual Report and 30-day Report for Framatome's PROtect
Enhanced Accident Tolerant Fuel (EATF) Lead Test Assembly (LTA)

- References:
- 1) Letter from David P. Helker (Exelon) to U.S. NRC, "10 CFR 50.46 Annual Report," dated March 18, 2020.
 - 2) FS1-0054738-2.0, "Framatome's 2020 50.46 Annual Reporting for Calvert Cliffs and PROtect LTA PCT Evaluation" dated February 12, 2021.
 - 3) Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – Issuance of Amendment Nos. 339 AND 317 Regarding Accident Tolerant Fuel Lead Test Assemblies (EPID L-2019-LLA-0282)," dated January 26, 2021 (Adams Accession No. ML20363A242)

The purpose of this letter is to submit the 10 CFR 50.46 annual reporting information for Calvert Cliffs Nuclear Power Plant (CCNPP) Units 1 and 2. Reference 1 is the most recent annual 10 CFR 50.46 Annual Report submitted to the U.S. NRC. Reference 2 documents Framatome's annual summary deliverable to Exelon Generation Company, LLC (Exelon) to support this 10 CFR 50.46 annual report.

In addition, this letter is submitted pursuant to 10 CFR 50.46(a)(3)(ii) to provide notification of a significant change to the peak cladding temperature analysis result for the large break loss-of-coolant accident (LB LOCA) for Unit 2. Because the effect on the LB LOCA peak cladding temperature of the changes is greater than 50°F from the temperature calculated for the limiting transient using the last acceptable model, the analysis changes qualify as significant as defined in 10CFR50.46(a)(3)(i). This change was associated with the installation of Framatome's PROtect Enhanced Accident Tolerant Fuel (EATF) Lead Test Assembly (LTA) into the Unit 2 reactor core, which is also documented in Reference 2.

Attachment 1 provides the Peak Cladding Temperature (PCT) "rack-up" sheets for the annual report for CCNPP Units 1 and 2. Attachment 2 provides the Peak Cladding Temperature (PCT) "rack-up" sheets for the 30-day report for Framatome's PROtect EATF

LTA for CCNPP Unit 2. Attachment 3, "Assessment Notes", contains a detailed description of each model assessment and error reported.

There were no errors reported against the CCNPP Unit 1 and Unit 2 Small Break Loss-of-Coolant Accident (SBLOCA) Evaluation Model or Realistic Large Break Loss-of-Coolant Accident (RLBLOCA) Evaluation Model during the previous annual reporting period.

Framatome performed a technical evaluation to assess the potential impacts of the EATF LTA design on the CCNPP RLBLOCA and SBLOCA licensing bases. A bounding Δ PCT penalty for the potential impacts of the EATF LTA was determined. The process described for developing penalty factors associated with the EATF LTA was approved in Reference 3. The evaluation resulted in a PCT penalty of +75°F for RLBLOCA and +20°F for SBLOCA. Operation with the EATF LTA will commence following the CCNPP Unit 2 refueling outage in March 2021. Therefore, the penalty is only applicable to CCNPP Unit 2. The estimated PCT for Calvert Cliffs Unit 2 RLBLOCA will be 1709.0°F and the estimated PCT for CCNPP Unit 2 SBLOCA will be 1668.0°F. These penalties apply during operation with the EATF LTA.

Calvert Cliffs Unit 2 remains within the acceptance criteria set forth in 10 CFR 50.46. Based on the small number of EATF LTAs, minimal changes to co-resident fuel, and large margin to regulatory acceptance criteria for PCT, use of the bounding PCT penalty as approved in Reference 3 is acceptable and no re-analysis is required.

There are no regulatory commitments contained in this letter.

If you have any questions, please contact Frank Mascitelli at 610-765-5512.

Respectfully,



David P. Helker
Sr. Manager - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

- Attachments:
- 1) Peak Cladding Temperature Rack-Up Sheets for CCNPP, Units 1 and 2 for Annual Reporting
 - 2) Peak Cladding Temperature Rack-Up Sheets for CCNPP, Unit 2, for 30-day Report
 - 3) Assessment Notes CCNPP, Units 1 and 2

cc: USNRC Administrator, Region I
USNRC Project Manager, CCNPP
USNRC Senior Resident Inspector, CCNPP
S. Seaman, State of Maryland

ATTACHMENT 1

10 CFR 50.46

**"Acceptance criteria for emergency core cooling systems
for light-water nuclear power reactors"**

**Annual Report of the Emergency Core Cooling System
Evaluation Model Changes and Errors**

Assessments as of March 18, 2021

**Peak Cladding Temperature Rack-Up Sheets for CCNPP, Units 1 and 2,
for Annual Reporting**

**Attachment 1 – Peak Cladding Temperature Rack-Up Sheets for
 CCNPP, Units 1 and 2, for Annual Reporting**

PLANT NAME: Calvert Cliffs Unit 1
 ECCS EVALUATION MODEL: Small Break Loss of Coolant Accident (SBLOCA)
 REPORT REVISION DATE: 03/18/2021
 CURRENT OPERATING CYCLE: 25

ANALYSIS OF RECORD (AOR)

Evaluation Model: EMF-2328(P)(A), Revision 0, Supplement 1(P)(A), Revision 0
 Calculation: ANP-3641, March 2018
 Fuel: HTP 14 x 14 M5®
 Limiting EM Fuel Type: HTP 14 x 14 M5®
 Limiting Single Failure: Loss of one emergency diesel generator
 Limiting Break Size and Location: 0.34 ft² Break in the Cold Leg Pump Discharge
 Reference Peak Cladding Temperature (PCT) PCT = 1648°F

MARGIN ALLOCATION

A. PRIOR LOSS OF COOLANT ACCIDENT (LOCA) MODEL ASSESSMENTS (Note 12)

None	$\Delta PCT = 0^{\circ}F$
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NET PCT

PCT = 1648°F

B. CURRENT LOCA MODEL ASSESSMENTS

None	$\Delta PCT = 0^{\circ}F$
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

PCT = 1648°F

PLANT NAME: Calvert Cliffs Unit 1
ECCS EVALUATION MODEL: Realistic Large Break Loss of Coolant Accident
(RLBLOCA)
REPORT REVISION DATE: 03/18/2021
CURRENT OPERATING CYCLE: 25

AOR

Evaluation Model: EMF-2103(P)(A)
Calculation: ANP-3043(P), December 2011
Fuel: HTP 14 x 14 M5®
Limiting EM Fuel Type: HTP 14 x 14 M5®
Limiting Single Failure: Loss of one emergency diesel generator
Limiting Break Size and Location: Guillotine break (4.5832 ft²/side) in Cold Leg Pump Discharge
Reference PCT PCT = 1620°F

MARGIN ALLOCATION

A. PRIOR LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated March 20, 2014 (Note 5)	$\Delta PCT = 14\text{ }^{\circ}\text{F}$
10 CFR 50.46 report dated April 23, 2014 (Note 6)	$\Delta PCT = 0\text{ }^{\circ}\text{F}$
10 CFR 50.46 report dated July 14, 2015 (Note 7)	$\Delta PCT = 0\text{ }^{\circ}\text{F}$
10 CFR 50.46 report dated March 18, 2016 (Note 8)	$\Delta PCT = 0\text{ }^{\circ}\text{F}$
10 CFR 50.46 report dated October 1, 2019 (Note 13)	$\Delta PCT = 0\text{ }^{\circ}\text{F}$

NET PCT

PCT = 1634°F

B. CURRENT LOCA MODEL ASSESSMENTS

None	$\Delta PCT = 0\text{ }^{\circ}\text{F}$
Total PCT change from current assessments	$\sum \Delta PCT = 0\text{ }^{\circ}\text{F}$
Cumulative PCT change from current assessments	$\sum \Delta PCT = 0\text{ }^{\circ}\text{F}$

NET PCT

PCT = 1634°F

PLANT NAME: Calvert Cliffs Unit 2
ECCS EVALUATION MODEL: Small Break Loss of Coolant Accident (SBLOCA)
REPORT REVISION DATE: 03/18/2021
CURRENT OPERATING CYCLE: 24*

AOR

Evaluation Model: EMF-2328(P)(A), Revision 0, Supplement 1(P)(A), Revision 0
Calculation: ANP-3641, March 2018
Fuel: HTP 14 x 14 M5®
Limiting EM Fuel Type: HTP 14 x 14 M5®
Limiting Single Failure: Loss of one emergency diesel generator
Limiting Break Size and Location: 0.34 ft² break in the Cold Leg Pump Discharge
Reference PCT PCT = 1648°F

MARGIN ALLOCATION

A. PRIOR LOSS OF COOLANT ACCIDENT (LOCA) MODEL ASSESSMENTS (Note 12)

None	$\Delta PCT = 0^{\circ}F$
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NET PCT

PCT = 1648°F

B. CURRENT LOCA MODEL ASSESSMENTS

None	$\Delta PCT = 0^{\circ}F$
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

PCT = 1648°F

*CCNPP Unit 2 is currently in a refueling outage. CCNPP Unit 2 Cycle 24 Mode 4 entry is scheduled to occur March 2021.

PLANT NAME: Calvert Cliffs Unit 2
ECCS EVALUATION MODEL: Realistic Large Break Loss of Coolant Accident (RLBLOCA)
REPORT REVISION DATE: 03/18/2021
CURRENT OPERATING CYCLE: 24*

AOR

Evaluation Model: EMF-2103(P)(A)
Calculation: ANP-3043(P), December 2011
Fuel: HTP 14 x 14 M5®
Limiting EM Fuel Type: HTP 14 x 14 M5®
Limiting Single Failure: Loss of one emergency diesel generator
Limiting Break Size and Location: Guillotine break (4.5832 ft²/side) in the Cold Leg
Pump Discharge
Reference PCT PCT = 1620°F

MARGIN ALLOCATION

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

10 CFR 50.46 report dated April 22, 2013 (Note 4)	$\Delta PCT = 8^{\circ}F$
10 CFR 50.46 report dated March 20, 2014 (Note 5)	$\Delta PCT = 6^{\circ}F$
10 CFR 50.46 report dated April 23, 2014 (Note 6)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated July 14, 2015 (Note 7)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated March 18, 2016 (Note 8)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated October 1, 2019 (Note 13)	$\Delta PCT = 0^{\circ}F$

NET PCT

PCT = 1634°F

B. CURRENT LOCA MODEL ASSESSMENTS

None	$\Delta PCT = 0^{\circ}F$
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

PCT = 1634°F

*CCNPP Unit 2 is currently in a refueling outage. CCNPP Unit 2 Cycle 24 Mode 4 entry is scheduled to occur March 2021.

ATTACHMENT 2

10 CFR 50.46

**"Acceptance criteria for emergency core cooling systems
for light-water nuclear power reactors"**

**30-day Report of the Emergency Core Cooling System
Evaluation Model Changes and Errors**

Assessments as of March 18, 2021

Peak Cladding Temperature Rack-Up Sheets for CCNPP, Unit 2, for 30-day Report

**Attachment 2 - Peak Cladding Temperature Rack-Up Sheets for
CCNPP, Unit 2, for 30-day Report**

PLANT NAME: Calvert Cliffs Unit 2
ECCS EVALUATION MODEL: Small Break Loss of Coolant Accident (SBLOCA)
REPORT REVISION DATE: 03/05/2021
CURRENT OPERATING CYCLE: 24*

AOR

Evaluation Model: EMF-2328(P)(A), Revision 0, Supplement 1(P)(A), Revision 0
Calculation: ANP-3641, March 2018
Fuel: HTP 14 x 14 M5®
Limiting EM Fuel Type: HTP 14 x 14 M5®
Limiting Single Failure: Loss of one emergency diesel generator
Limiting Break Size and Location: 0.34 ft² break in the Cold Leg Pump Discharge
Reference PCT PCT = 1648°F

MARGIN ALLOCATION

A. PRIOR LOSS OF COOLANT ACCIDENT (LOCA) MODEL ASSESSMENTS (Note 12)

None	$\Delta PCT = 0^{\circ}F$
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NET PCT **PCT =** **1648°F**

B. CURRENT LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated February 12, 2021 (Note 14)	$\Delta PCT = 20^{\circ}F$
Total PCT change from current assessments	$\sum \Delta PCT = 20^{\circ}F$
Cumulative PCT change from current assessments	$\sum \Delta PCT = 20^{\circ}F$

NET PCT **PCT =** **1668°F**

*CCNPP Unit 2 is currently in a refueling outage. CCNPP Unit 2 Cycle 24 Mode 4 entry is scheduled to occur March 2021.

PLANT NAME: Calvert Cliffs Unit 2
ECCS EVALUATION MODEL: Realistic Large Break Loss of Coolant Accident (RLBLOCA)
REPORT REVISION DATE: 03/18/2021
CURRENT OPERATING CYCLE: 24*

AOR

Evaluation Model: EMF-2103(P)(A)
Calculation: ANP-3043(P), December 2011
Fuel: HTP 14 x 14 M5®
Limiting EM Fuel Type: HTP 14 x 14 M5®
Limiting Single Failure: Loss of one emergency diesel generator
Limiting Break Size and Location: Guillotine break (4.5832 ft²/side) in the Cold Leg
Pump Discharge
Reference PCT PCT = 1620°F

MARGIN ALLOCATION

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

10 CFR 50.46 report dated April 22, 2013 (Note 4)	$\Delta PCT = 8^{\circ}F$
10 CFR 50.46 report dated March 20, 2014 (Note 5)	$\Delta PCT = 6^{\circ}F$
10 CFR 50.46 report dated April 23, 2014 (Note 6)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated July 14, 2015 (Note 7)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated March 18, 2016 (Note 8)	$\Delta PCT = 0^{\circ}F$
10 CFR 50.46 report dated October 1, 2019 (Note 13)	$\Delta PCT = 0^{\circ}F$

NET PCT

PCT = 1634°F

B. CURRENT LOCA MODEL ASSESSMENTS

10 CFR 50.46 report dated February 12, 2021 (Note 14)	$\Delta PCT = 75^{\circ}F$
Total PCT change from current assessments	$\sum \Delta PCT = 75^{\circ}F$
Cumulative PCT change from current assessments	$\sum \Delta PCT = 75^{\circ}F$

NET PCT

PCT = 1709°F

*CCNPP Unit 2 is currently in a refueling outage. CCNPP Unit 2 Cycle 24 Mode 4 entry is scheduled to occur March 2021.

ATTACHMENT 3

10 CFR 50.46

**"Acceptance criteria for emergency core cooling systems
for light-water nuclear power reactors"**

**Annual and 30 day-Report of the Emergency Core Cooling System
Evaluation Model Changes and Errors**

Assessments as of March 18, 2021

Assessment Notes

CCNPP, Units 1 and 2

Attachment 3 – Assessment Notes

1. Prior LOCA Model Assessment

The 10 CFR 50.46 30-day report dated March 31, 2011 reported new analyses for (ANP-2834) RLBLOCA and (ANP-2871) SBLOCA applicable to Unit 2, Cycle 19. The licensing basis PCT value for Realistic Large Break LOCA (RLBLOCA) and Small Break (SBLOCA) reported was 1670°F and 1626°F, respectively. The analyses were done to support the transition from Westinghouse to AREVA-designed fuel. Unit 2 operation during 2014 uses the RLBLOCA Evaluation Model as summarized in ANP-3043(P). The PCT for RLBLOCA for Unit 2 is 1620°F.

2. Prior LOCA Model Assessment

The 10 CFR 50.46 30-day report dated January 19, 2012 reported an error in the S-RELAP5 Sleicher-Rouse correlation used for predicting heat transfer to single-phase vapor heat transfer. Preliminary assessments of the potential impact of using the alternate Sleicher-Rouse correlation were performed. The SBLOCA assessment resulted in a 69°F PCT impact to Calvert Cliffs Unit 2 (ANP-2871) SBLOCA. (ANP-2834) RLBLOCA was impacted by this correction, however it did not reach the 30-day reporting threshold (50°F PCT impact), therefore it was transmitted in the 2012 annual letter (See Note 3).

3. Prior LOCA Model Assessment

The 10 CFR 50.46 combined 30-day and annual report dated April 30, 2012 reported a new licensing basis PCT for Calvert Cliffs Unit 1 and errors, respectively. The 30-day report changed the (ANP-2834) RLBLOCA and (ANP-2871) SBLOCA, applicable to Unit 1, Cycle 21, licensing basis PCT to 1670°F and 1626°F, respectively. The 10 CFR 50.46 annual report transmitted 3 errors. A steam generator tube liquid entrainment modeling error resulted in a 0°F PCT impact to Calvert Cliffs Unit 1 and 2 (ANP-2834) RLBLOCA. Liquid fallback from the upper plenum to the hot channel resulted in a 0°F PCT impact to Calvert Cliffs Unit 1 and 2 (ANP-2834) RLBLOCA. An error in the S-RELAP5 Sleicher-Rouse correlation used for predicting the heat transfer to single-phase vapor heat transfer, as reported for SBLOCA in the 10 CFR 50.46 30-day report dated January 19, 2012 (Note 2) resulted in a 69°F PCT impact in support of AREVA fuel transition for Calvert Cliffs Unit 1 (ANP-2871) SBLOCA and resulted in an 8°F PCT impact to Calvert Cliffs Unit 1 and 2 (ANP-2834) RLBLOCA. No new assessments were applicable to Calvert Cliffs Unit 2 (ANP-2871) SBLOCA.

4. Prior LOCA Model Assessment

The 10 CFR 50.46 combined 30-day and annual report dated April 22, 2013 reported a new licensing basis PCT for Calvert Cliffs Unit 2 (ANP-3043) RLBLOCA applicable to once- and twice-burned fuel and a new error, respectively. The report changed the licensing basis to Calvert Cliffs Unit 2 RLBLOCA applicable to AREVA fuel to 1620°F PCT. The (ANP-2834) RLBLOCA analysis applicable to Notes 1 through 4 assumed fresh fuel was limiting and applied a statistical treatment to the multiplier on decay heat. The inclusion of the burnup dependent RLBLOCA report satisfies the Technical Specification Appendix C license

condition and allows for a full core of AREVA fuel in Calvert Cliffs Unit 2. The 10 CFR 50.46 report reported an error due to Cathcart-Pawel uncertainty implementation in RLBLOCA application resulting in a 0°F PCT impact. An error in the S-RELAP5 Sleicher-Rouse correlation used for predicting the heat transfer to single-phase vapor heat transfer resulted in an 8°F PCT to Calvert Cliffs Unit 2 RLBLOCA. No impacts reported for SBLOCA.

5. Prior LOCA Model Assessment

The 10 CFR 50.46 combined 30-day and annual report dated March 20, 2014 reported a new licensing basis PCT for Calvert Cliffs Unit 1 (ANP-3043) RLBLOCA applicable to once- and twice-burned fuel and a new error, respectively. The report changed the licensing basis to Calvert Cliffs Unit 1 RLBLOCA applicable to AREVA fuel to 1620°F PCT. The (ANP-2834) RLBLOCA analysis applicable to Notes 1 through 4 assumed fresh fuel was limiting and applied a statistical treatment to the multiplier on decay heat. The inclusion of the burnup dependent RLBLOCA report satisfies the Technical Specification Appendix C license condition and allows for a full core of AREVA fuel in Calvert Cliffs Unit 1. The 10 CFR 50.46 report reported an error due to an issue with S-RELAP5 routine associated with the RODEX3a fuel rod model resulting in a 6°F PCT impact to RLBLOCA. The error in the S-RELAP5 Sleicher-Rouse correlation used for predicting the heat transfer to single-phase vapor heat transfer in combination with the error due to an issue with S-RELAP5 routine associated with the RODEX3A fuel rod model resulted in a 14 °F PCT impact. No impact reported for SBLOCA.

6. Prior LOCA Model Assessment

The 10 CFR 50.46 30-day report dated April 23, 2014 reported an error in the correlation for vapor absorptivity use in S-RELAP5, applied outside of its intended range of applicability (no limit was imposed on the pressure at which the correlation was applied). The equation used for the absorption coefficient of vapor contains the term of the pressure which needs to be truncated in order to obtain the correct emissivity values for an optically thick steam. Correction of this error is expected to result in a 63°F PCT change to Calvert Cliffs Unit 1 and 2 SBLOCA. The estimated impact of this change on the RLBLOCA analysis calculated PCT is 0°F.

7. Prior LOCA Model Assessment

The revised 10 CFR 50.46 report dated July 14, 2015 reported an error in the modal decomposition method which led to a detailed examination of the actual axial shapes that were produced by the modal decomposition procedure and it was observed that some of these resulting shapes were significantly different from the 24-node shape that was generated by PWR Core Engineering. These shapes exhibit a super-imposed oscillation created by the modal decomposition that leads to non-physical artificial local peaks and valleys in the shape. When such shapes are generated and used in the LOCA analyses they tend to shift the PCT both in the positive and negative direction depending on application. This led to the conclusion that in future application, the modal decomposition method will not

be used and a linear interpolation will be used for the mapping. The linear interpolation provides a significantly better fit for the axial shapes. This evaluation led to a 0°F PCT impact to Calvert Cliffs Unit 1 and 2 RLBLOCA analysis. This issue is not applicable to the SBLOCA analysis.

8. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated March 18, 2016 identified once-burned fuel, UO₂ and Gadolinia-bearing (GAD) rods, are generally modeled at a reduced peaking in comparison with the hot fresh UO₂ rod. The reduction is achieved by imposing a burnup-dependent multiplier, or cutback factor, specifying the radial peaking as a fraction of the hot rod radial peaking. A review indicated that cutback factor for once-burned Gad rods were instead applied as a fraction of the once-burned UO₂ rod resulting in the inadvertent once-burned GAD being modeled at a reduced power. This evaluation led to a 0°F PCT impact to Calvert Cliffs Unit 1 and 2 RLBLOCA analysis. This issue is not applicable to the SBLOCA analysis.

9. Prior LOCA Model Assessment

The 10 CFR 50.46 report dated March 17, 2017 reported no model changes or errors for both the RLBLOCA and SBLOCA analyses.

10. Prior LOCA Model Assessment

CR 2017-3565 identified an update to the M5[®] swelling and rupture mode (SRM) had the potential to impact Calvert Cliff's SBLOCA analysis.

M5[®] SRM is used in several of AREVA LOCA methodologies and since approval of the M5[®] SRM in the M5[®] Licensing Topical Report, BAW-10227, Rev. 1 (P)(A) by the NRC in the early 2000s, additional M5[®] cladding rupture test data was obtained. Following the same approach as the original model, an updated M5[®] SRM was developed to consider the updated test data. The model changes do not change the predicted occurrence or conditions at the time of rupture, but would impact the post-rupture cladding characteristics for certain rupture temperatures.

Calvert Cliffs Units 1 and 2 SBLOCA uses M5[®] SRM. The analyses of record rupture temperatures were less than the range of the model changes, and therefore a 0°F PCT estimate was assigned. The Calvert Cliffs Units 1 and 2 RLBLOCA analysis was performed with a LOCA methodology which did not use the M5[®] SRM and therefore is not affected.

11. Prior LOCA Model Assessment

CR 2017-5630 identified an error in the S-RELAP5 calculations of oxidation due to high temperature metal-water reaction. In a LOCA event, the cladding can swell (and potentially rupture) due to the difference in pressure between the fuel and the system. As the clad radius increases, the thickness decreases. It was discovered that the S-RELAP5 oxidation calculations used cold cladding dimensions and therefore, did not fully account for the swelling phenomena. The error can lead to an under-prediction of the oxidation and heat from the metal-water reaction.

Calvert Cliffs Units 1 and 2 SBLOCA analysis utilizes S-RELAP5 and it was determined that the estimated PCT effect is +6°F. The local oxidation and whole core hydrogen remain well within the 10 CFR 50.46 acceptance criteria with the correction. The Calvert Cliffs Units 1 and 2 RLBLOCA analysis was performed with a LOCA methodology which did not model swelling and therefore is not affected.

12. Prior LOCA Model Assessment

Calvert Cliffs Units 1 and 2 SBLOCA was re-analyzed using Evaluation Model EMF-2328(P)(A), Revision 0, Supplement 1(P)(A), Revision 0. The local oxidation and whole core hydrogen remain well within the 10 CFR 50.46 acceptance criteria. The analysis establishes an AOR PCT of 1648 °F. No errors in or changes to the EMF-2328(P)(A), Revision 0, Supplement 1(P)(A), Revision 0 analysis have been reported.

There were no errors or changes reported against RLBLOCA during this reporting period.

13. Prior LOCA Model Assessment

There were no errors or changes reported against Calvert Cliffs Units 1 and 2 SBLOCA during this reporting period.

An error in the implementation of the Cathcart-Pawel correlation was discovered. The correlation is used for the calculation of metal-water reaction in the Framatome EMF-2103(P)(A) RLBLOCA methodologies. The correlation for the rate of oxide thickness was used instead of the correlation for the rate of total oxygen consumed. The correlation for the rate of total oxygen consumed is what is expected to be used for the 10 CFR 50.46 (b)(2) criterion. As compared to a total oxygen-based implementation, the use of the oxide-based implementation led to a more conservative prediction of the transient oxidation and heat released during the reaction. The additional heat from the reaction could have resulted in higher calculated values of the AOR peak clad temperature (PCT). For RLBLOCA though, the difference in results between the two correlation implementations has a negligible impact on PCT. The PCT impact for the Calvert Cliffs Units 1 and 2 RLBLOCA analysis is 0 F.

14. Current LOCA Model Assessment

There were no errors or changes reported against Calvert Cliffs Units 1 and 2 SBLOCA or RLBLOCA during the annual reporting period.

A Lead Test Assembly (LTA) with Framatome's PROtect Enhanced Accident Tolerant Fuel (EATF) will be operated in the Calvert Cliffs Unit 2 Cycle 24 core with Mode 4 entry currently planned for March 19, 2021. The Framatome PROtect product consists of Enhanced Accident Tolerant Fuel (EATF) with Chromia doped UO_2 pellets and Chromium coated cladding fuel rods.

To cover the PROtect LTA throughout its operating cycles a technical evaluation to assess the potential impacts of the EATF LTA design on the Calvert Cliffs RLBLOCA and SBLOCA licensing bases was performed. The presence of the LTA will not impact the system response characteristics during a LOCA but can impact the fuel performance under those conditions. Since the EATF product testing is ongoing, there is not a sufficient quantity of

data to fully support development of new analytical models or material property definition. Therefore, the evaluations were performed from first principles, conservative assumptions and supporting calculations. The potential LOCA performance impacts were evaluated individually. A bounding Δ PCT penalty for the potential impacts of the EATF was then determined. The process described for developing penalty factors associated with the LTA was approved in ML20363A242.

The evaluation resulted in a PCT penalty of +75°F for RLBLOCA and +20°F for SBLOCA. The penalty for SBLOCA is being provided for completeness. These penalties apply during operation with the EATF LTA. Calvert Cliffs Unit 2 remains within the acceptance criteria set forth in 10 CFR 50.46. Based on the small number of LTAs (1 for Calvert Cliffs Unit 2), minimal changes to co-resident fuel, and large margin to regulatory acceptance criteria for PCT, use of the bounding PCT penalty as approved in ML20363A242 is acceptable and no re-analysis is required.