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10 CFR 50.46

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

Brunswick Steam Electric Plant, Unit Nos. 1 and 2  
Renewed Facility Operating License Nos. DPR-71 and DPR-62  
Docket Nos. 50-325 and 50-324

Catawba Nuclear Station, Unit Nos. 1 and 2  
Renewed Facility Operating License Nos. NPF-35 and NPF-52  
Docket Nos. 50-413 and 50-414

H. B. Robinson Steam Electric Plant, Unit 2  
Renewed Facility Operating License No. DPR-23  
Docket No. 50-261

McGuire Nuclear Station, Unit Nos. 1 and 2  
Renewed Facility Operating License Nos. NPF-9 and NPF-17  
Docket Nos. 50-369 and 50-370

Shearon Harris Nuclear Power Plant, Unit 1  
Renewed Facility Operating License No. NPF-63  
Docket No. 50-400

Oconee Nuclear Station, Unit Nos. 1, 2 and 3  
Renewed Facility Operating License Nos. DPR-38, DPR-47 and DPR-55  
Docket Nos. 50-269, 50-270 and 50-287

**SUBJECT: Annual Report of Changes Pursuant to 10 CFR 50.46**

Ladies and Gentlemen:

Pursuant to 10 CFR 50.46(a)(3)(ii), Duke Energy hereby submits the enclosed annual reports of changes to, or errors in, Emergency Core Cooling System (ECCS) evaluation models. These reports cover the period from January 1, 2019 to December 31, 2019 for the Brunswick Steam Electric Plant, Catawba Nuclear Station, H. B. Robinson Steam Electric Plant, McGuire Nuclear Station, Oconee Nuclear Station, and Shearon Harris Nuclear Power Plant and are provided in Enclosures 1 through 6.

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No regulatory commitments are contained in this submittal.

Should you have any questions concerning this letter and its enclosures, please contact Art Zaremba, Manager - Nuclear Fleet Licensing at (980) 373-2062.

Sincerely,

A handwritten signature in black ink, appearing to read "Steve Snider". The signature is fluid and cursive, with the first name "Steve" and last name "Snider" clearly distinguishable.

Steve Snider

Vice President, Nuclear Engineering

Enclosures:

1. [Brunswick 10 CFR 50.46 Annual Report](#)
2. [Catawba 10 CFR 50.46 Annual Report](#)
3. [H.B. Robinson 10 CFR 50.46 Annual Report](#)
4. [McGuire 10 CFR 50.46 Annual Report](#)
5. [Oconee 10 CFR 50.46 Annual Report](#)
6. [Shearon Harris 10 CFR 50.46 Annual Report](#)

cc:

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**ENCLOSURE 1: [Brunswick 10 CFR 50.46 Annual Report](#)**

**Brunswick Steam Electric Plant, Units 1 and 2  
Docket Nos. 50-325 and 50-324 / Renewed License Nos. DPR-71 and DPR-62**

## Summary of Errors Reported

### 10 CFR 50.46 Report for Brunswick Steam Electric Plant Units 1 and 2

During this reporting period, one error notice on the MELLLA+ LOCA Analysis for A10XM was received and one error notice on the ATRIUM 11 Lead Use Assembly (LUA) LOCA analysis was received.

The A10XM error notice documents two new evaluations with a cumulative impact of +2 °F, bringing the A10XM PCT to 1925 °F. The two new evaluations involve: 1) a coding issue in the interpolation process in the RODEX4 Pellet-Cladding Mechanical Interaction (PCMI) routines; and 2) an issue with AUTOHUP's automated preparation of RODEX2-2A inputs associated with the fuel rod geometry.

The ATRIUM 11 LUA error notice documents two new evaluations with a cumulative impact of +2 °F, bringing the A11 LUA PCT to 1764 °F. The two new evaluations involve: 1) a coding issue in the interpolation process in the RODEX4 Pellet-Cladding Mechanical Interaction (PCMI) routines; and 2) an issue with AUTOHUP's automated preparation of RODEX2-2A inputs associated with the fuel rod geometry.

The ATRIUM 11 LUA error notice also documented a -5 °F impact on ATRIUM 11 fuel supported by the AURORA-B LOCA methodology, but no ATRIUM 11 fuel supported by this methodology was operated during this reporting period. The ATRIUM 11 impact will be reported during the 2020 calendar year reporting period.

**A10XM Summary**

**10 CFR 50.46 Report for Brunswick Steam Electric Plant Units 1 and 2**

Plant:	Brunswick Steam Electric Plant, Units 1 and 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):		
Evaluation Model:	EMF-2361(P)(A), Revision 0 EXEM BWR-2000 ECCS Evaluation Model, May 2001	
Fuel:	ATRIUM 10XM (A10XM)	
A. Analysis of Record PCT	1923 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1923 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period		
1. RODEX4 Pellet-Cladding Mechanical Interaction (PCMI) Onset	0 °F	
2. AUTOHUP input preparation of RODEX2-2A inputs	+2 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect +2 °F	Absolute PCT Effect +2 °F
F. Licensing Basis PCT (C + E)	1925 °F	

**A11 LUA Summary**

**10 CFR 50.46 Report for Brunswick Steam Electric Plant Units 1 and 2**

Plant:	Brunswick Steam Electric Plant, Unit 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):		
Evaluation Model:	EMF-2361(P)(A), Revision 0 EXEM BWR-2000 ECCS Evaluation Model, May 2001	
Fuel:	ATRIUM 11 (A11) Lead Use Assemblies (LUA)	
A. Analysis of Record PCT	1762 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1762 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period		
1. RODEX4 Pellet-Cladding Mechanical Interaction (PCMI) Onset	0 °F	
2. AUTOHUP input preparation of RODEX2-2A inputs	+2 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect +2 °F	Absolute PCT Effect +2 °F
F. Licensing Basis PCT (C + E)	1764 °F	

**ENCLOSURE 2: [Catawba 10 CFR 50.46 Annual Report](#)**

**Catawba Nuclear Station, Units 1 and 2  
Docket Nos. 50-413 and 50-414 / Renewed License Nos. NPF-35 and NPF-52**



## Summary of Errors Reported

### 10 CFR 50.46 Report for Catawba Units 1 and 2

Westinghouse identified and communicated in a letter that there were modeling changes and errors in the LOCA evaluation models that were assessed for impact to PCT in 2019. None of the assessments resulted in changes to PCT. The following items are included for information.

#### General Code Maintenance

Affected Evaluation Model(s): 1996 Westinghouse Best Estimate Large Break LOCA

Various changes have been made to enhance the usability of codes and to streamline future analyses. Examples of these changes include improving the input diagnostic checks; enhancing the code output; optimizing active coding; and eliminating inactive coding. These changes represent Discretionary Changes that will be implemented in accordance with Section 4.1.1 of WCAP-13451.

The nature of these changes leads to an estimated peak cladding temperature impact of 0 °F.

#### Removal of the Vessel Interfacial Heat Transfer Limit

Affected Evaluation Model: 1996 Westinghouse Best Estimate Large Break LOCA

The Westinghouse Code Qualification Document (CQD) Best-Estimate Large-Break LOCA (BE LBLOCA) evaluation model (EM) is documented in WCAP-12945-P-A [1]. A limit on the vessel interfacial heat transfer was implemented into the WCOBRA/TRAC code as presented in Equation 5-12 therein. The implementation of the limit was intended to prevent any extreme conditions which are detrimental to the robustness of the numerical method. During the licensing of the method, the application of the limit was found to have a small impact on predicted results as discussed in the response to RAI1-116 of WCAP-12945-P-A [1].

An error was found in the implementation of the vessel interfacial heat transfer limit which effectively negates the application of the limit. The error was corrected by removing the vessel interfacial heat transfer limit from the WCOBRA/TRAC code (as opposed to a direct correction of the error). Since the WCOBRA/TRAC code validation and sensitivity studies associated with the model from WCAP-12945- PA [1] all contained the error, the removal of the limit preserves the existing validation basis and sensitivity study conclusions that were presented in the topical report. Based on the validation and RAI responses therein, it was concluded that the as-coded interfacial heat transfer models and condensation behavior was acceptable.

The removal of the vessel interfacial heat transfer limit represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

The removal of the vessel interfacial heat transfer limit was found to have negligible impact on the WCOBRA/TRAC code validation results. The validation results in combination with pressurized water reactor large break LOCA transient calculations and engineering judgement support an estimated peak cladding temperature impact of 0 °F.

#### Reference

- 1) WCAP-12945-P-A, Volume I, Revision 2, Volumes II through V, Revision 1, "Code Qualification Document for Best Estimate LOCA Analysis," March 1998.

**10 CFR 50.46 Report for Catawba Unit 1 – Large Break LOCA**

Plant:	Catawba Nuclear Station, Unit 1	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	WCAP-12945-P-A, Revision 0 Code Qualification Document for Best Estimate LOCA Analysis	
Fuel:	17x17 RFA	
A. Analysis of Record PCT	2028 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect  +58 °F	Absolute PCT Effect  378 °F
C. Baseline PCT for assessing new changes for significance (A + B)	2086 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period  1. Removal of the Vessel Interfacial Heat Transfer Limit	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect  0 °F	Absolute PCT Effect  0 °F
F. Licensing Basis PCT (C + E)	2086 °F	

**10 CFR 50.46 Report for Catawba Unit 1 – Small Break LOCA**

Plant:	Catawba Nuclear Station, Unit 1	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Small Break	
Evaluation Model:	WCAP-10054-P-A, Revision 0 NOTRUMP	
Fuel:	17x17 RFA	
A. Analysis of Record PCT	1323 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +0 °F	Absolute PCT Effect 0 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1323 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. None	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1323 °F	

**10 CFR 50.46 Report for Catawba Unit 2 – Large Break LOCA**

Plant:	Catawba Nuclear Station, Unit 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	WCAP-12945-P-A, Revision 0 Code Qualification Document for Best Estimate LOCA Analysis	
Fuel:	17x17 RFA	
A. Analysis of Record PCT	2028 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +42 °F	Absolute PCT Effect 362 °F
C. Baseline PCT for assessing new changes for significance (A + B)	2070 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period  1. Removal of the Vessel Interfacial Heat Transfer Limit	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	2070 °F	

**10 CFR 50.46 Report for Catawba Unit 2 – Small Break LOCA**

Plant:	Catawba Nuclear Station, Unit 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Small Break	
Evaluation Model:	WCAP-10054-P-A, Revision 0 NOTRUMP	
Fuel:	17x17 RFA	
A. Analysis of Record PCT	1243 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +0 °F	Absolute PCT Effect 0 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1243 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. None	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1243 °F	

**ENCLOSURE 3: [H.B. Robinson 10 CFR 50.46 Annual Report](#)**

**H. B. Robinson Steam Electric Plant, Unit 2  
Docket No. 50-261 / Renewed License No. DPR-23**

## Summary of Errors Reported

### 10 CFR 50.46 Report for H.B. Robinson Unit 2

The NRC Staff evaluation of the RAI response submitted in Reference 1 is described in Reference 2. The NRC staff determined that the RAI response performed an adequate estimate of the impact of the modeling errors for cladding swelling and rupture, and that the 10 CFR 50.46 reporting requirements for the 2017 reporting period were satisfied for the issues discussed in Reference 1. RNP UFSAR Section 15.6.5.3 has been revised to show the current reported PCT of 2119 °F, inclusive of the cladding swelling and rupture error correction. As noted in Reference 1, Attachment 1, page 3 of 5, the PCT value reported in the UFSAR serves as the baseline for assessing subsequent PCT changes or error corrections. The RNP Large Break LOCA PCT summary reflects 2119 °F as the baseline PCT value.

One new issue was reported by the fuel vendor in the 2019 calendar year. Framatome Letter FS1-0046152-1.0, dated September 30, 2019, describes impacts to the RNP Large Break LOCA analysis due to an issue with implementation of the Cathcart-Pawel correlation. The correlation is used for the calculation of metal-water reaction in the Realistic Large Break LOCA methodology. The correlation for the rate of oxide thickness was used instead of the correlation for the rate of total oxygen consumed. When compared to the correct implementation based on total oxygen, the use of the oxide-based implementation led to a more conservative prediction of the transient oxidation and heat released during the reaction. For LBLOCA analyses, the degree of differences between the two correlation implementations has a negligible impact on peak cladding temperature. For RNP the estimated impact is 0 °F on the LBLOCA analysis of record. The Small Break LOCA methodology does not use the Cathcart-Pawel oxidation correlation, so the RNP SBLOCA analysis of record is not impacted by this issue.

#### References

- 1) Duke Energy Letter RA-18-0185, Joseph Donahue to USNRC, Response to Request for Additional Information (RAI) Regarding 10 CFR 50.46 Annual Report, Including Revised Robinson Large Break Loss of Coolant Accident Report, December 10, 2018 [NRC ADAMS Accession No. ML18344A656].
- 2) NRC Letter to Duke Energy Progress, LLC, Subject: H. B. Robinson Steam Electric Plant, Unit 2 – Staff Evaluation Related to the 2017 Annual Report of Changes and Error Corrections Affecting the Large-Break Loss-of-Coolant Accident Analysis (EPID L-2018-LRO-0028), June 11, 2019 [NRC ADAMS Accession No. ML19121A482].

**10 CFR 50.46 Report for H.B. Robinson Unit 2 – Large Break LOCA**

Plant:	H.B. Robinson, Unit 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	EMF-2103(P)(A), Revision 0 Realistic Large Break LOCA for PWRs	
Fuel:	15x15 HTP	
A. Analysis of Record PCT	2084 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +35 °F	Absolute PCT Effect 55 °F
C. Baseline PCT for assessing new changes for significance (A + B)	2119 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period  1. Use of oxide in S-RELAP5 Cathcart-Pawel equation for zirconium metal reacted.	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	2119 °F	



**10 CFR 50.46 Report for H.B. Robinson Unit 2 – Small Break LOCA**

Plant:	H.B. Robinson, Unit 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Small Break	
Evaluation Model:	EMF-2328(P)(A), Revision 0 PWR Small Break LOCA Evaluation Model	
Fuel:	15x15 HTP	
A. Analysis of Record PCT	1492 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +60 °F	Absolute PCT Effect 98 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1552 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. None	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1552 °F	

**ENCLOSURE 4: [McGuire 10 CFR 50.46 Annual Report](#)**

**McGuire Nuclear Station, Units 1 and 2  
Docket Nos. 50-369 and 50-370 / Renewed License Nos. NPF-9 and NPF-17**

## Summary of Errors Reported

### 10 CFR 50.46 Report for McGuire Units 1 and 2

Westinghouse identified and communicated in a letter that there were modeling changes and errors in the LOCA evaluation models that were assessed for impact to PCT in 2019. None of the assessments resulted in changes to PCT. The following items are included for information.

#### General Code Maintenance

Affected Evaluation Model(s): 1996 Westinghouse Best Estimate Large Break LOCA

Various changes have been made to enhance the usability of codes and to streamline future analyses. Examples of these changes include improving the input diagnostic checks; enhancing the code output; optimizing active coding; and eliminating inactive coding. These changes represent Discretionary Changes that will be implemented in accordance with Section 4.1.1 of WCAP-13451.

The nature of these changes leads to an estimated peak cladding temperature impact of 0 °F.

#### Removal of the Vessel Interfacial Heat Transfer Limit

Affected Evaluation Model: 1996 Westinghouse Best Estimate Large Break LOCA

The Westinghouse Code Qualification Document (CQD) Best-Estimate Large-Break LOCA (BE LBLOCA) evaluation model (EM) is documented in WCAP-12945-P-A [1]. A limit on the vessel interfacial heat transfer was implemented into the WCOBRA/TRAC code as presented in Equation 5-12 therein. The implementation of the limit was intended to prevent any extreme conditions which are detrimental to the robustness of the numerical method. During the licensing of the method, the application of the limit was found to have a small impact on predicted results as discussed in the response to RAI1-116 of WCAP-12945-P-A [1].

An error was found in the implementation of the vessel interfacial heat transfer limit which effectively negates the application of the limit. The error was corrected by removing the vessel interfacial heat transfer limit from the WCOBRA/TRAC code (as opposed to a direct correction of the error). Since the WCOBRA/TRAC code validation and sensitivity studies associated with the model from WCAP-12945- PA [1] all contained the error, the removal of the limit preserves the existing validation basis and sensitivity study conclusions that were presented in the topical report. Based on the validation and RAI responses therein, it was concluded that the as-coded interfacial heat transfer models and condensation behavior was acceptable.

The removal of the vessel interfacial heat transfer limit represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

The removal of the vessel interfacial heat transfer limit was found to have negligible impact on the WCOBRA/TRAC code validation results. The validation results in combination with pressurized water reactor large break LOCA transient calculations and engineering judgement support an estimated peak cladding temperature impact of 0 °F.

#### Reference

- 1) WCAP-12945-P-A, Volume I, Revision 2, Volumes II through V, Revision 1, "Code Qualification Document for Best Estimate LOCA Analysis," March 1998.

**10 CFR 50.46 Report for McGuire Units 1 & 2 – Large Break LOCA**

Plant:	McGuire Nuclear Station, Units 1 & 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	WCAP-12945-P-A, Revision 0 Code Qualification Document for Best Estimate LOCA Analysis	
Fuel:	17x17 RFA	
A. Analysis of Record PCT	2028 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +58 °F	Absolute PCT Effect 378 °F
C. Baseline PCT for assessing new changes for significance (A + B)	2086 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. Removal of the Vessel Interfacial Heat Transfer Limit	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	2086 °F	

**10 CFR 50.46 Report for McGuire Units 1 & 2 – Small Break LOCA**

Plant:	McGuire Nuclear Station, Units 1 & 2	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Small Break	
Evaluation Model:	WCAP-10054-P-A, Revision 0 NOTRUMP	
Fuel:	17x17 RFA	
A. Analysis of Record PCT	1323 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +0 °F	Absolute PCT Effect 0 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1323 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. None	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1323 °F	

**ENCLOSURE 5: [Oconee 10 CFR 50.46 Annual Report](#)**

**Oconee Nuclear Station, Units 1, 2 and 3  
Docket Nos. 50-269, 50-270 and 50-287  
Renewed License Nos. DPR-38, DPR-47 and DPR-55**

## Summary of Errors Reported

### 10 CFR 50.46 Report for Oconee Units 1, 2, & 3

Framatome identified several modeling changes and errors in the LOCA evaluation models that were assessed for impact to PCT in 2019. None of the assessments resulted in changes to PCT.

#### 1) The Evaluation Model (EM) Error Correction for M5 Cladding Properties

Two documentation errors from circa 2000 topical reports related to M5 cladding were discovered in 2019. One error was related to the clad outside emissivity used in the LOCA analysis and the other error did not report updated cladding thermal expansion models from 2001 in the M5 cladding topical report BAW-10227PA. Since the models used for current LBLOCA and SBLOCA licensing basis are consistent with the updated descriptions, there are no changes to current PCT reported via 10 CFR 50.46 for all ONS LOCA analyses.

##### a. Emissivity Inputs

The M5 topical report (BAW-10227PA-01) describes a single constant emissivity value that was to be used for both inside and outside of the cladding for radiation heat transfer. The LBLOCA demonstration cases contained in the M5 topical report, however, used a different approach for the outside emissivity. Reference 1 states "The LBLOCA demonstration cases followed the previously NRC approved ZR-4 approach that used a constant value for the inside clad emissivity and a variable model for the outside clad emissivity". This inconsistency is the source of M5 emissivity documentation error. The current B&W plant licensing basis analyses use the approach used in the topical report LBLOCA demonstration cases. An evaluation was performed and it concluded that the emissivity inputs used in the EM demonstration analysis and all current LBLOCA and SBLOCA are appropriate. Therefore, this issue is considered as an EM documentation error.

The impact of the documentation error in the M5 topical report was assessed and it concluded that impact of the use of emissivity inputs in the current 2019 licensing basis analyses is either negligible or more conservative than the input error stated in the M5 topical report. Thus, no change is needed to the current PCT related to this documentation error.

##### b. Thermal Expansion Input

In 2001, the thermal expansion inputs used in all B&W LOCA analyses were revised and they were used in the current ONS licensing LOCA analyses. The change in the thermal expansion should have been evaluated and reported in the 2001 time period. If it had been, it would have been reported as a negligible change in 2001. Therefore, this is considered a documentation error omission. Similar to the emissivity inputs, the thermal expansion model used in the current licensing basis is part of the currently acceptable EM input. Therefore, there is no change to the 2019 PCTs from the documentation error.

2) The EM Model Error Correction for the SBLOCA LOCA Holes and Slots Between the Core and Core Baffle

The EM incorrectly documented the modeling approach used for the junctions modeling the baffle plate holes and slots between the core and core baffle region in SBLOCA applications. The EM documentation described the modeling approach as different than the LBLOCA methods but all SBLOCA 177 FA analyses have applied it consistently with the LBLOCA modeling. The SBLOCA PCT results are not sensitive to how these minor crossflow junctions are modeled because there is little phase separation that occurs in the holes between the baffle and the core. However, the modeling guidance should be clear and consistent. For consistency of modeling the break range transition (e.g. where larger SBLOCAs meet the smallest LBLOCAs) and for having results with fewer oscillations, homogeneous modeling is selected as the modeling choice.

This issue does not impact LBLOCA results, therefore no change is required for LBLOCA analysis results. Since the SBLOCA analyses used the appropriate junction modeling option, the 177 FA AOR PCT, local oxidation, and whole core hydrogen results are unchanged. Nonetheless, a 0 °F PCT change for the EM junction modeling change is reported for SBLOCA results to address the incorrect EM documentation.

**References**

- 1) Framatome Letter FS1-0046102-1.0 to Chelsea Gorman (Duke Energy), "Evaluation of OCO for Condition Report 2019-526 for Potential Reporting Under 10 CFR 50.46", September 2019.



**10 CFR 50.46 Report for Oconee Units 1, 2, & 3 – Large Break LOCA**

Plant:	Oconee Nuclear Station, Units 1, 2, & 3	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	BAW-10192P-A, Revision 0, BWNT LOCA Evaluation Model for Once-Through Steam Generator Plants	
Fuel:	15x15 Mark-B-HTP	
A. Analysis of Record PCT	1852 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +2 °F	Absolute PCT Effect 858 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1854 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. Emissivity Documentation Error 2. Thermal Expansion Documentation Error	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1854 °F	

**10 CFR 50.46 Report for Oconee Units 1, 2, & 3 – Small Break LOCA**

Plant:	Oconee Nuclear Station, Units 1, 2, & 3	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Small Break	
Evaluation Model:	BAW-10192P-A, Revision 0, BWNT LOCA Evaluation Model for Once-Through Steam Generator Plants	
Fuel:	15x15 Mark-B-HTP	
A. Analysis of Record PCT <b>Full Power – 100% FP</b>	1598 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect  +0 °F	Absolute PCT Effect  0 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1598 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. Emissivity Documentation Error 2. Thermal Expansion Documentation Error 3. EM model error correction for LOCA holes and slots between the core and core baffle region	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1598 °F	
A. Analysis of Record PCT <b>Reduced Power – 50% FP</b>	1480 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect  +0 °F	Absolute PCT Effect  0 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1480 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. Emissivity Documentation Error 2. Thermal Expansion Documentation Error 3. EM model error correction for LOCA holes and slots between the core and core baffle region	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1480 °F	

**ENCLOSURE 6: [Shearon Harris 10 CFR 50.46 Annual Report](#)**

**Shearon Harris Nuclear Power Plant, Unit 1  
Docket No. 50-400 / Renewed License No. NPF-63**

## **Summary of Errors Reported**

### **10 CFR 50.46 Report for Shearon Harris Unit 1**

One new issue was reported by the fuel vendor in the 2019 calendar year. Framatome Letter FS1-0046151-1.0, dated September 30, 2019, describes impacts to the HNP Large Break LOCA analysis due to an issue with implementation of the Cathcart-Pawel correlation. The correlation is used for the calculation of metal-water reaction in the Realistic Large Break LOCA methodology. The correlation for the rate of oxide thickness was used instead of the correlation for the rate of total oxygen consumed. When compared to the correct implementation based on total oxygen, the use of the oxide-based implementation led to a more conservative prediction of the transient oxidation and heat released during the reaction. For LBLOCA analyses, the degree of differences between the two correlation implementations has a negligible impact on peak cladding temperature. For HNP the estimated impact is 0 °F on the LBLOCA analysis of record. The Small Break LOCA methodology does not use the Cathcart-Pawel oxidation correlation, so the HNP SBLOCA analysis of record is not impacted by this issue.

**10 CFR 50.46 Report for Shearon Harris Unit 1 – Large Break LOCA**

Plant:	Shearon Harris, Unit 1	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Large Break	
Evaluation Model:	EMF-2103(P)(A), Revision 0 Realistic Large Break LOCA for PWRs	
Fuel:	17x17 HTP	
A. Analysis of Record PCT	1935 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +160 °F	Absolute PCT Effect 160 °F
C. Baseline PCT for assessing new changes for significance (A + B)	2095 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period  1. Use of oxide in S-RELAP5 Cathcart-Pawel equation for zirconium metal reacted.	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	2095 °F	

**10 CFR 50.46 Report for Shearon Harris Unit 1 – Small Break LOCA**

Plant:	Shearon Harris, Unit 1	
Reporting Period:	January 1, 2019 – December 31, 2019	
LOCA Analysis Type (if applicable):	Small Break	
Evaluation Model:	EMF-2328(P)(A), Revision 0 PWR Small Break LOCA Evaluation Model	
Fuel:	17x17 HTP	
A. Analysis of Record PCT	1664 °F	
B. Net Cumulative 10 CFR 50.46 Changes and Error Corrections - Previously Reported	Net PCT Effect +63 °F	Absolute PCT Effect 63 °F
C. Baseline PCT for assessing new changes for significance (A + B)	1727 °F	
D. Cumulative 10 CFR 50.46 Changes and Error Corrections – This Reporting Period 1. None	0 °F	
E. Sum of 10 CFR 50.46 Changes and Error Corrections against Baseline PCT	Net PCT Effect 0 °F	Absolute PCT Effect 0 °F
F. Licensing Basis PCT (C + E)	1727 °F	