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10 CFR 50.46

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

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

Subject: Duke Energy Carolinas, LLC (Duke Energy): 10 CFR 50.46 - 30-Day Report for Oconee Nuclear Station, Units 1, 2, and 3; Estimated Impacts to Peak Cladding Temperature due to Fuel Pellet Thermal Conductivity Degradation

References:

- 1) Letter, B. C. Waldrep (Duke Energy) to USNRC, *10 CFR 50.46 – Annual Report for 2013 for Oconee Nuclear Station, Units 1, 2, and 3*, July 7, 2014 (ML14205A280)
- 2) Duke Energy Notification per 10 CFR 50.72(3)(ii)(B), Event No. 50640, November 25, 2014.

10 CFR 50.46 (a)(3)(ii) requires the reporting of changes to or errors in Emergency Core Cooling System (ECCS) evaluation models, or in the application of such models that affect the temperature calculation. On November 25, 2014, Duke Energy received a letter from AREVA identifying two changes which affect the Large Break Loss of Coolant Accident (LBLOCA) analysis of record for Oconee Units 1, 2, and 3. AREVA has evaluated the effect on initial fuel temperatures due to burnup-dependent fuel pellet thermal conductivity degradation (TCD) using the fuel performance code COPERNIC2 which explicitly accounts for fuel pellet TCD. AREVA has determined that the middle-of-life (MOL) and end-of-life (EOL) initial fuel temperature predictions using COPERNIC2 are significantly higher than values calculated for a similar set of conditions using the fuel performance codes TACO3 and GDTACO, which are currently a part of the approved LOCA evaluation model for B&W plants. The TACO3 and GDTACO fuel performance codes do not model TCD. The increase in initial fuel temperatures when TCD is appropriately accounted for does impact the Oconee LBLOCA calculations for peak cladding temperature (PCT), previously reported in Reference 1.

The Oconee Small Break LOCA (SBLOCA) analyses are not affected by the TCD issue, and no

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changes to the PCT for SBLOCA analyses are being reported. This issue has been entered into Oconee's corrective action program.

Oconee has initiated actions to reduce the allowable linear heat rates (LHR) at MOL and EOL, based on recommendations provided by AREVA. Additionally, when AREVA notified Duke Energy of the deficiency, Duke Energy confirmed that existing administrative limits bound the AREVA recommendations. The LHR penalties are sufficient to ensure that the initial fuel temperatures used in the current LBLOCA analysis of record remain bounding, when the effects of TCD are considered using the COPERNIC2 fuel performance code. Duke Energy has determined that the LHR penalties do not impact the full incore operational imbalance limits currently specified in the Core Operating Limits Reports for the operating cycles. Administrative limits have been imposed on the operational imbalance limits when using the minimum incore detectors, or the excore detectors.

The enclosed Attachment provides a detailed description of each reported change which affects the PCT calculation, and the associated impact to the Oconee LBLOCA analysis of record. The first PCT change results from a change (increase) in the uncertainty factors applied to the initial fuel temperature predictions obtained from the TACO3 and GDTACO fuel performance codes at MOL and EOL to account for the effects of TCD. AREVA has characterized this as a change to the approved LBLOCA evaluation model. AREVA's assessment of this change to the initial fuel temperature results in a peak cladding temperature (PCT) increase of 428°F for the limiting MOL case, if no other actions are taken.

Since the estimated change in PCT would result in a PCT which exceeds the acceptance criteria of 2200°F per 10 CFR 50.46(b)(1) without the administrative limits, and if the plant were to have operated at the maximum allowed LHR limit currently documented in the LBLOCA analysis of record, Oconee provided an 8-hour notification on November 25, 2014 to the NRC in accordance with 10 CFR 50.72 (b)(3)(ii)(B), per Reference 2.

The second reported PCT change is due to a change (reduction) in the input values for allowable linear heat rates (LHR) used in the LBLOCA analysis, and is therefore characterized as a change in the application of the approved LBLOCA evaluation model. The allowable LHR values at MOL were penalized (reduced) by 2 kW/ft at all core elevations in order to maintain the MOL initial fuel temperatures at or below the fuel temperatures predicted by TACO3 and GDTACO in the current LBLOCA analyses of record. AREVA has estimated the impact of the LHR penalty as a reduction in PCT of -428°F for the limiting MOL case. Therefore, these two reported PCT changes offset each other, resulting in no net change to the PCT results for the Oconee LBLOCA analysis of record previously reported in Reference 1.

The sum of the absolute value of these reported changes to PCT is greater than 50°F, and therefore the changes are considered to be significant. 10 CFR 50.46(a)(3)(ii) requires the licensee to provide a report within 30 days, including a proposed schedule for providing a reanalysis or taking other action as may be needed to show compliance with 10 CFR 50.46.

AREVA's recommendation to Duke Energy with respect to a LBLOCA reanalysis for Oconee is to perform an explicit analysis of the limiting PCT case. COPERNIC2 will be used to obtain the appropriate uncertainty factors with TCD effects considered, to be applied to the initial fuel temperature predictions from TACO3 and GDTACO. Based upon the estimated changes in PCT reported herein, the limiting LBLOCA PCT case for Oconee occurs at MOL at a core elevation of 2.506 feet. The results from this explicitly analyzed case will be used to estimate

the cladding temperatures for all other MOL cases for UO<sub>2</sub> and gadolinia rods. The EOL cladding temperatures will also be estimated for UO<sub>2</sub> and gadolinia rods. When combined with the unaffected BOL cladding temperatures for all rods, a complete set of cladding temperatures is produced and the limiting PCT of all cases will be reported.

The following commitment is made in this letter:

Duke Energy will perform a Large Break LOCA reanalysis for the highest PCT case at Middle-of-Life for Oconee Nuclear Station, Units 1, 2, and 3 by September 17, 2015. The effects of fuel pellet thermal conductivity degradation will be accounted for by use of a fuel temperature uncertainty adjustment factor based on COPERNIC2.

This information satisfies the 30-day reporting requirement and required proposal for a reanalysis schedule as governed by 10 CFR 50.46(a)(3)(ii).

Please address any comments or questions regarding this matter to Thomas R. Byrne at (980) 373-3249 (trbyrne@duke-energy.com).

Sincerely,

A handwritten signature in black ink, appearing to read "Ernest J. Kapopoulos Jr.", written in a cursive style.

Ernest J. Kapopoulos Jr.  
*Vice President Nuclear  
Corporate Governance & Operations Support*

Attachment

U.S. Nuclear Regulatory Commission

December 17, 2014

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xc (with attachment):

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**Attachment**

**Duke Energy Carolinas, LLC**

**Oconee Nuclear Station, Units 1, 2, and 3**

**10 CFR 50.46**

**Acceptance Criteria for Emergency Core  
Cooling Systems for Light-Water Nuclear Power Reactors**

**Report of Significant Changes to AREVA LBLOCA ECCS Evaluation Model  
Which Affect the Peak Cladding Temperature Calculation**

**Table 1: LOCA Peak Cladding Temperature Margin Summary – All Oconee Units**

## **Report of Significant Changes to AREVA LBLOCA ECCS Evaluation Model Which Affect the Peak Cladding Temperature Calculation**

By letter dated November 25, 2014, AREVA notified Duke Energy of two changes which affect the Large Break Loss of Coolant Accident (LBLOCA) analysis of record for Oconee Units 1, 2, and 3. AREVA has evaluated the effect on initial fuel temperatures due to burnup-dependent fuel pellet thermal conductivity degradation (TCD) using the fuel performance code COPERNIC2, a code that models TCD adequately. AREVA has determined that the middle-of-life (MOL) and end-of-life (EOL) initial fuel temperature predictions using COPERNIC2 are significantly higher than values calculated for a similar set of conditions using the fuel performance codes TACO3 and GDTACO, which are currently used as part of the approved LOCA evaluation model (EM) for B&W plants (BAW-10192P-A). The TACO3 and GDTACO fuel performance codes do not model TCD. The increase in initial fuel temperatures when TCD is appropriately accounted for impacts the Oconee LBLOCA calculations for peak cladding temperature (PCT), previously reported to the NRC (ADAMS Accession No. ML14205A280).

TACO3 and GDTACO do not model TCD with burnup explicitly, but have adjustments to the methodology and increases in the LOCA initial fuel temperature inputs that can compensate for TCD not being modeled. These adjustments were intended to compensate for the non-conservative thermal conductivity models in TACO3 and GDTACO. The continued use of these codes was previously evaluated by AREVA in 2009 following the NRC issuance of Information Notice 2009-23. In 2009, AREVA concluded that sufficient conservatism in both code predictions and LOCA methodology compensated for a lack of TCD models based, in part, on comparisons to an early version of the GALILEO code.

However this evaluation has been challenged and reversed based on recent GALILEO LOCA initialization studies performed by AREVA. Based on these new LBLOCA initializations, AREVA has concluded that the LOCA EM that uses TACO3 and GDTACO must be modified by application of additional fuel temperature uncertainty ( $U_{TCD}$ ) to account for the effects of TCD based on COPERNIC2.

An evaluation was performed by applying the EM change to the Oconee LBLOCA plant model with an axial power shaped peaked at the 2.506-ft core elevation with a middle-of-life (MOL) burnup conditions. The steady-state 95/95 volume-average fuel temperature from the limiting PCT case was increased by 230°F. The results of the evaluation show that the original limiting MOL case cladding temperatures at the 2.506-ft core elevation were increased by 481°F for the ruptured node and 288°F for the unruptured node. These ruptured and unruptured node cladding temperature increases were applied to the full spectrum of  $UO_2$  and gadolinia fuel MOL cases. When applying the analyzed PCT increases based on the cladding conditions with the revised EM approach, the limiting PCT was estimated to be 2280°F for the 6.021-ft MOL case, which is in excess of 2200°F. The difference between this estimated PCT and the previously reported one of 1852°F, results in a limiting PCT increase of 428°F. This LBLOCA EM model change results in a significant increase to the calculated PCT per 10 CFR 50.46(a)(3)(i).

In order to reduce the peak cladding temperature to less than 2200°F AREVA recommended linear heat rate (LHR) limit reductions on 10/23/2014 as a prudent measure. AREVA recommended a 2 kW/ft reduction in the LHR limits at MOL, and EOL LHR reductions of 0.5 –

0.6 kW/ft at the 0 and 12 feet core elevations. Imposition of the LHR limit reductions assures that the peak cladding temperature will be less than or equal to the peak cladding temperature prior to the EM correction. This is supported by use of a similar steady-state fuel temperature at a lower LHR, with an estimated PCT reported as the same value prior to the EM change. Thus the estimated PCT with the uncertainty error correction and input LHR reduction is reported as 1852°F, which is less than 2200°F. The local oxidation and whole core hydrogen generation also remain similar and they are well within the 10 CFR 50.46 acceptance criteria for the LBLOCA scenarios. With the MOL LHR limit reduction, the core geometry remains amenable to cooling and acceptable long-term cooling is unaffected by these changes.

The impact of the EM correction and LHR limit reductions is summarized in Table 1. The SBLOCA analyses are not sensitive to the initial fuel temperatures and thus the estimated impact on the SBLOCA peak cladding temperature is zero.

**Table 1: LOCA Peak Cladding Temperature Margin Summary – All Oconee Units**

<b>LBLOCA</b>	<b>PCT(°F)</b>	<b>Comments</b>
Evaluation model: RELAP5/MOD2-B&W		
Analysis of record PCT	1852	References A, B 2.506-ft MOL case
Prior 10 CFR 50.46 Changes or Error Corrections ( $\Delta$ PCT) 1. Transient fuel pellet thermal conductivity degradation (considered a change in the application of the evaluation model)	+2	References A, B
Current 10 CFR 50.46 Changes or Error Corrections ( $\Delta$ PCT) 1. PCT increase due to higher initial fuel average temperatures when fuel pellet thermal conductivity degradation is considered.	+428	Updated uncertainty to account for TCD in TACO3/GDTACO 6.021-ft MOL case
2. PCT decrease due to MOL linear heat rate penalty of 2 kW/ft at all core elevations.	-428	
Final licensing basis PCT	1854	
<b>SBLOCA Full Power -100% FP</b>	<b>PCT(°F)</b>	<b>Comments</b>
Evaluation model: RELAP5/MOD2-B&W		
Analysis of record PCT	1598	References A, B (2 HPI Case) 0.15 ft <sup>2</sup> break
Prior 10 CFR 50.46 Changes or Error Corrections ( $\Delta$ PCT) 1. None		
Current 10 CFR 50.46 Changes or Error Corrections ( $\Delta$ PCT) 1. Updated uncertainty to account for TCD in TACO3/GDTACO	0	
Final licensing basis PCT	1598	
<b>SBLOCA Reduced Power [1]</b>	<b>PCT(°F)</b>	<b>Comments</b>
Analysis of record PCT	N/A	Has been reported under a separate LAR (Reference C)
Prior 10 CFR 50.46 Changes or Error Corrections ( $\Delta$ PCT)	N/A	
Current 10 CFR 50.46 Changes or Error Corrections ( $\Delta$ PCT)	N/A	
Final licensing basis PCT	N/A	Operation Not Justified [2]

Notes

1. Partial power SBLOCA analysis with one HPI pump out of service, supports 30 day LCO for TS 3.5.2 Condition B. Also supports TS 3.5.2 Condition C1 and C2.
2. Pending review and approval of separate LAR. Refer to Reference C for additional details.



References for Table 1:

- A) Letter, G. D. Miller (Duke Energy) to USNRC, *30-Day Report Pursuant to 10 CFR 50.46, Changes to or Errors in an Evaluation Model*, December 16, 2013 (ML13353A137)
- B) Letter, B. C. Waldrep (Duke Energy) to USNRC, *10 CFR 50.46 – Annual Report for 2013 for Oconee Nuclear Station, Units 1, 2, and 3*, July 7, 2014 (ML14205A280)
- C) Letter, S. L. Batson (Duke Energy) to USNRC, *License Amendment Request (LAR) to Reduce Allowed Maximum Rated Thermal Power When High Pressure Injection (HPI) Equipment is Inoperable – License Amendment Request No. 2013-03*, June 30, 2014 (ML14184B384)