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10 CFR 50.4
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U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555-0001

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

McGuire Nuclear Station, Unit 1 and 2
Docket Numbers 50-369, and 50-370/Renewed License Numbers NPF-9 and NPF-17

Subject: Duke Energy Carolinas, LLC (Duke Energy): Report Pursuant to 10 CFR 50.46, Changes to or Errors in an Evaluation Model

References:

1) Letter, D. C. Culp (Duke Energy) to USNRC, Subject: Catawba Nuclear Station Units 1 and 2, and McGuire Nuclear Station Units 1 and 2, Response to Information Request Pursuant to 10 CFR 50.54(f) Related to the Estimated Effect on Peak Cladding Temperature Resulting from Thermal Conductivity Degradation in the Westinghouse-Furnished Realistic Emergency Core Cooling System Evaluation and 30-Day Report Pursuant to 10 CFR 50.46, Changes to or Errors in an Evaluation Model," March 16, 2012. [ADAMS ML12079A180]
2) Letter, J. Thompson (USNRC) to K. Henderson and S. D. Capps (Duke Energy), Subject: Catawba Nuclear Station Units 1 and 2, and McGuire Nuclear Station Units 1 and 2, Closure Evaluation for Report Pursuant to Title 10 of the Code of Federal Regulations, Part 50, Section 50.46, Paragraph (a)(3)(ii) Concerning Significant Emergency Core Cooling System Evaluation Model Error Related to Nuclear Fuel Thermal Conductivity Degradation (TAC Nos. ME8447, ME8448, ME8449, and ME8450)" November 16, 2012 [ADAMS ML12314A031]

10 CFR 50.46 (a)(3)(ii) requires the reporting of changes to or errors in Emergency Core Cooling (ECCS) evaluation models (EMs). This report covers the time period from January 1, 2012 to December 31, 2012 for the Catawba Nuclear Station (CNS) and the McGuire Nuclear Station (MNS).

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The impacts to Large Break Loss of Coolant Accident (LBLOCA) peak cladding temperature (PCT) due to fuel pellet thermal conductivity degradation were previously reported to the NRC in Reference 1. NRC staff review and acceptance of the impact to PCT due to fuel pellet thermal conductivity degradation was documented in Reference 2. These impacts to the LOCA analyses are discussed in Table 1, and are included on the PCT reporting sheets, Tables 2 through 4.

Several other changes were made to the LBLOCA and Small Break LOCA evaluation models during the reporting period. The specific details of these changes are also provided in Table 1, and were evaluated by Westinghouse as having no impact on the calculated PCTs. Since there was no PCT impact due to these changes, they are not included in the PCT reporting sheets, Tables 2 through 4.

There are no regulatory commitments contained in this letter.

Please address any comments or questions regarding this matter to Paul Guill at (704) 382-4753 *(paul.guill@duke-energy.com)*.

Sincerely,

Michael J. Annacone,
Vice President - Organizational Effectiveness &
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Attachment

- Table 1 – Errors/Evaluation Model Changes
- Table 2 – Peak Cladding Temperature Summary – McGuire Units 1 & 2
- Table 3 – Peak Cladding Temperature Summary – Catawba Unit 1
- Table 4 – Peak Cladding Temperature Summary – Catawba Unit 2

xc (with attachment):

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ATTACHMENT

Table 1 – Errors/Evaluation Model Changes

Table 2 – Peak Cladding Temperature Summary – McGuire Units 1 & 2

Table 3 – Peak Cladding Temperature Summary – Catawba Unit 1

Table 4 – Peak Cladding Temperature Summary – Catawba Unit 2

References:

A) Letter, M. S. Tuckman (Duke Energy) to USNRC, "Report Pursuant to 10 CFR 50.46, Changes to or Errors in an ECCS Evaluation Model," May 3, 2001

B) Letter, M. S. Tuckman (Duke Energy) to USNRC, "Report Pursuant to 10 CFR 50.46, Changes to or Errors in an ECCS Evaluation Model," April 3, 2002

C) Letter, W. R. McCollum, Jr. (Duke Energy) to USNRC, "Report Pursuant to 10 CFR 50.46, Changes to or Errors in an ECCS Evaluation Model," July 29, 2003

D) Letter, W. R. McCollum, Jr. (Duke Energy) to USNRC, "Report Pursuant to 10 CFR 50.46, Changes to or Errors in an ECCS Evaluation Model," May 26, 2004

E) Letter, J. R. Morris (Duke Energy) to USNRC, "Report Pursuant to 10 CFR 50.46, Changes to or Errors in an ECCS Evaluation Model," June 21, 2005

F) Letter, T. C. Geer (Duke Energy) to USNRC, "Report Pursuant to 10 CFR 50.46, Changes to or Errors in an ECCS Evaluation Model," March 13, 2007.

G) Letter, D. C. Culp (Duke Energy) to USNRC, Subject: Catawba Nuclear Station Units 1 and 2, and McGuire Nuclear Station Units 1 and 2, Response to Information Request Pursuant to 10 CFR 50.54(f) Related to the Estimated Effect on Peak Cladding Temperature Resulting from Thermal Conductivity Degradation in the Westinghouse-Furnished Realistic Emergency Core Cooling System Evaluation and 30-Day Report Pursuant to 10 CFR 50.46, Changes to or Errors in an Evaluation Model," March 16, 2012. [ADAMS ML12079A180]

H) Letter, J. Thompson (USNRC) to K. Henderson and S. D. Capps (Duke Energy), Subject: Catawba Nuclear Station Units 1 and 2, and McGuire Nuclear Station Units 1 and 2, Closure Evaluation for Report Pursuant to Title 10 of the Code of Federal Regulations, Part 50, Section 50.46, Paragraph (a)(3)(ii) Concerning Significant Emergency Core Cooling System Evaluation Model Error Related to Nuclear Fuel Thermal Conductivity Degradation (TAC Nos. ME8447, ME8448, ME8449, and ME8450)" November 16, 2012. [ADAMS ML12314A031]

Table 1
Errors / Evaluation Model Changes

Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown

Fuel pellet thermal conductivity degradation (TCD) and peaking factor burndown were not explicitly considered in the Large Break Loss-of-Coolant Accident (LBLOCA) Analysis of Record (AOR) for McGuire Units 1 & 2 and Catawba Units 1 & 2. The Nuclear Regulatory Commission (NRC) requested Duke Energy to provide an estimated effect of TCD on the peak cladding temperature (PCT) calculation for the emergency core cooling system at McGuire Units 1 & 2 and Catawba Units 1 & 2.

Affected Evaluation Model(s): BELOCA 1996 Model

A quantitative evaluation as discussed in Reference 2 was performed to assess the PCT effect of TCD and peaking factor burndown with other considerations of burnup on the LBLOCA analysis for McGuire Units 1 & 2 and Catawba Units 1 & 2, and concluded that the estimated PCT impact is +114°F for Reflood 1 and +15°F for Reflood 2 for 10 CFR 50.46 reporting purposes.

PAD Version 4.0 Implementation

The Large Break Loss-of-Coolant Accident (LBLOCA) Analysis of Record (AOR) for McGuire Units 1 & 2 and Catawba Units 1 & 2 utilizes fuel rod design inputs from PAD Version 3.4. Prior to explicitly considering fuel pellet thermal conductivity degradation (TCD) and peaking factor burndown, fuel rod design input with PAD Version 4.0 was implemented in order to estimate an effect of fuel pellet TCD that does not include unrelated PAD code version differences. The plant-specific implementation of PAD 4.0 into the LBLOCA AOR for McGuire Units 1 & 2 and Catawba Units 1 & 2 is considered a design input change into the LBLOCA analysis.

Affected Evaluation Model(s): BELOCA 1996 Model

A quantitative evaluation was performed to estimate a PCT impact resulting from a change in fuel rod design input parameters from PAD 3.4 to PAD 4.0. The evaluation concluded that the estimated PCT impact is -75°F for Reflood 1 and Reflood 2 for 10 CFR 50.46 reporting purposes.

General Code Maintenance

Affected Evaluation Model(s): BELOCA 1996 Model

Various changes have been made to enhance the usability of codes and to streamline future analyses. Examples of these changes include modifying input variable definitions, units and defaults; 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 on a forward-fit basis.

The nature of these code changes leads to an estimated Peak Cladding Temperature (PCT) impact of 0°F.

HOTSPOT Burst Temperature Calculation for ZIRLO Cladding

Affected Evaluation Model(s): BELOCA 1996 Model

A problem was identified in the calculation of the burst temperature for ZIRLO® cladding in the HOTSPOT code when the cladding engineering hoop stress exceeds 15,622 psi. This problem results in either program failure or an invalid extrapolation of the burst temperature vs. engineering hoop stress table. This problem has been evaluated for impact on existing analyses, and its resolution represents a Non-Discretionary Change.

The evaluation of existing analyses demonstrated no impact on the overall PCT results, leading to an estimated effect of 0°F.

HOTSPOT Iteration Algorithm for Calculating the Initial Fuel Pellet Average Temperature

Affected Evaluation Model(s): BELOCA 1996 Model

The HOTSPOT code has been updated to incorporate the following corrections to the iteration algorithm for calculating the initial fuel pellet average temperature: (1) bypass the iteration when the input value satisfies the acceptance criterion; (2) prevent low-end extrapolation of the gap heat transfer coefficient; (3) prevent premature termination of the iteration that occurred under certain conditions; and (4) prevent further adjustment of the gap heat transfer coefficient after reaching the iteration limit. These changes represent a closely-related group of Non-Discretionary Changes.

Sample calculations and engineering judgment lead to an estimated PCT impact of 0°F.

WCOBRA/TRAC Automated Restart Process Logic Error

Affected Evaluation Model(s): BELOCA 1996 Model

A minor error was identified in the WCOBRA/TRAC Automated Restart Process (WARP) logic for defining the Double-Ended Guillotine (DEG) break tables. The error has been evaluated for impact on current licensing-basis analysis results and will be incorporated into the plant-specific analyses on a forward-fit basis. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

These errors were evaluated to have a negligible impact on the Large Break LOCA analysis results, leading to an estimated PCT impact of 0°F.

Rod Internal Pressure Calculation

Affected Evaluation Model(s): BELOCA 1996 Model

Several issues which affect the calculation of rod internal pressure (RIP) have been identified for certain Best-Estimate (BE) Large-Break Loss-of-Coolant Accident (LBLOCA) evaluation models (EMs). These issues include the sampling of rod internal pressure uncertainties, updating HOTSPOT to consider the effect of transient RIP variations in the application of the uncertainty, and generating RIPs at a consistent rod power. These issues have been evaluated to estimate the impact on existing LBLOCA analysis results. The resolution of these issues represents a closely-related group of Non-Discretionary Changes.

The effects described above are either judged to have a negligible effect on existing LBLOCA analysis results or have been adequately incorporated into the thermal conductivity degradation evaluations, leading to an estimated PCT impact of 0°F.

WCOBRA/TRAC Thermal-Hydraulic History File Dimension Used in HSDRIVER

Affected Evaluation Model(s): BELOCA 1996 Model

A problem was identified in the dimension of the WCOBRA/TRAC thermal-hydraulic history file used in HSDRIVER. The array that is used to store the information from the WCOBRA/TRAC thermal-hydraulic history file is dimensioned to 3000 in HSDRIVER. It is possible for this file to contain more than 3000 curves. If that is the case, it is possible that the curves would not be used correctly in the downstream HOTSPOT execution. An extent-of-condition review indicated that resolution of this issue does not impact the Peak Cladding Temperature (PCT) calculation for prior Large Break Loss-of-Coolant Accident (LBLOCA) analyses. This represents a Discretionary Change.

Resolution of this issue does not impact the PCT calculation for prior LBLOCA analyses, which leads to a PCT impact of 0°F.

NOTRUMP-EM Evaluation of Fuel Pellet Thermal Conductivity Degradation

Affected Evaluation Model(s): SBLOCA, 1985 NOTRUMP Model

An evaluation has been completed to estimate the effect of fuel pellet thermal conductivity degradation (TCD) on peak cladding temperature (PCT) for plants in the United States with analyses using the 1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP (NOTRUMP-EM). This change represents a Non-Discretionary Change.

Based on the phenomena and physics of the SBLOCA transient, in combination with limited sensitivity calculations, it is concluded that TCD has a negligible effect on the limiting cladding temperature transient, leading to an estimated PCT impact of 0°F.

Table 2
Peak Cladding Temperature Summary – McGuire Units 1 & 2

LBLOCA	Cladding Temp (°F)	Comments
Evaluation model : WCOBRA/TRAC, CQD 1996		
Analysis of record PCT (Reflood 2)	2028	MNS/CNS Composite Model
Prior errors (ΔPCT) 1. Decay heat in Monte Carlo calculations 2. MONTECF power uncertainty correction 3. Safety Injection temperature range 4. Input error resulting in an incomplete solution matrix 5. Revised Blowdown Heatup Uncertainty Distribution 6. Vessel Unheated Conductor Noding	 8 20 59 25 5 0	 Reference A Reference B Reference C Reference D Reference E Reference F
Prior evaluation model changes (ΔPCT) 1. Revised Algorithm for Average Fuel Temperature	 0	 Reference F
Errors (ΔPCT) 1. Thermal Conductivity Degradation with Peaking Factor Burndown	 15	 Reference G
Evaluation model changes (ΔPCT) 1. PAD 3.4 to PAD 4.0 2. MUR Uprate to 101.7% of 3411 MWt 3. Peak FQ = 2.7 in bottom third of core	 -75 16 0	 Reference G
Absolute value of errors/changes for this report (ΔPCT)	106	
Net change in PCT for this report	-44	Reference G
Final PCT	2101	
SBLOCA		
Evaluation model : NOTRUMP		
Analysis of record PCT	1323	2 inch break
Prior errors (ΔPCT) 1. None	 0	
Prior evaluation model changes (ΔPCT) 1. None	 0	
Errors (ΔPCT) 1. Evaluation of Fuel Pellet Thermal Conductivity Degradation	 0	
Evaluation model changes (ΔPCT) 1. None	 0	
Absolute value of errors/changes for this report (ΔPCT)	0	
Net change in PCT for this report	0	
Final PCT	1323	

Table 2
Peak Cladding Temperature Summary – Catawba Unit 1

LBLOCA	Cladding Temp (°F)	Comments
Evaluation model : WCOBRA/TRAC, CQD 1996		
Analysis of record PCT (Reflood 2)	2028	MNS/CNS Composite Model
Prior errors (ΔPCT) 1. Decay heat in Monte Carlo calculations 2. MONTECF power uncertainty correction 3. Safety Injection temperature range 4. Input error resulting in an incomplete solution matrix 5. Revised Blowdown Heatup Uncertainty Distribution 6. Vessel Unheated Conductor Noding	 8 20 59 25 5 0	 Reference A Reference B Reference C Reference D Reference E Reference F
Prior evaluation model changes (ΔPCT) 1. Revised Algorithm for Average Fuel Temperature	0	Reference F
Errors (ΔPCT) 1. Thermal Conductivity Degradation with Peaking Factor Burndown	15	Reference G
Evaluation model changes (ΔPCT) 1. PAD 3.4 to PAD 4.0 2. Peak FQ = 2.7 in bottom third of core	-75 0	Reference G
Absolute value of errors/changes for this report (ΔPCT)	90	
Net change in PCT for this report	-60	Reference G
Final PCT	2085	
SBLOCA		
Evaluation model : NOTRUMP		
Analysis of record PCT	1323	2 inch break
Prior errors (ΔPCT) 1. None	0	
Prior evaluation model changes (ΔPCT) 1. None	0	
Errors (ΔPCT) 1. Evaluation of Fuel Pellet Thermal Conductivity Degradation	0	
Evaluation model changes (ΔPCT) 1. None	0	
Absolute value of errors/changes for this report (ΔPCT)	0	
Net change in PCT for this report	0	
Final PCT	1323	

Table 3
Peak Cladding Temperature Summary – Catawba Unit 2

LBLOCA	Cladding Temp (°F)	Comments
Evaluation model : WCOBRA/TRAC, CQD 1996		
Analysis of record PCT (Reflood 2)	2028	MNS/CNS Composite Model
Prior errors (ΔPCT) 1. Decay heat in Monte Carlo calculations 2. MONTECF power uncertainty correction 3. Safety Injection temperature range 4. Input error resulting in an incomplete solution matrix 5. Revised Blowdown Heatup Uncertainty Distribution 6. Vessel Unheated Conductor Noding	 8 20 59 25 5 0	 Reference A Reference B Reference C Reference D Reference E Reference F
Prior evaluation model changes (ΔPCT) 1. Revised Algorithm for Average Fuel Temperature	 0	 Reference F
Errors (ΔPCT) 1. Thermal Conductivity Degradation with Peaking Factor Burndown	 15	 Reference G
Evaluation model changes (ΔPCT) 3. PAD 3.4 to PAD 4.0 4. Peak FQ = 2.7 in bottom third of core	 -75 0	 Reference G
Absolute value of errors/changes for this report (ΔPCT)	90	
Net change in PCT for this report	-60	Reference G
Final PCT	2085	
SBLOCA		
Evaluation model : NOTRUMP		
Analysis of record PCT	1243	4 inch break
Prior errors (ΔPCT) 1. None	 0	
Prior evaluation model changes (ΔPCT) 1. None	 0	
Errors (ΔPCT) 1. Evaluation of Fuel Pellet Thermal Conductivity Degradation	 0	
Evaluation model changes (ΔPCT) 1. None	 0	
Absolute value of errors/changes for this report (ΔPCT)	0	
Net change in PCT for this report	0	
Final PCT	1243	