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May 29, 2019

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Serial No. 19-254
VCS LIC/TS/Rev 0
Docket No. 50-395
License No. NPF-12

SOUTH CAROLINA ELECTRIC & GAS COMPANY
VIRGIL C. SUMMER NUCLEAR STATION (VCSNS) UNIT 1
EMERGENCY CORE COOLING SYSTEM EVALUATION MODEL REVISIONS ANNUAL
REPORT

South Carolina Electric & Gas Company (SCE&G), acting for itself and as agent for South Carolina Public Service Authority, hereby submits the 2018 Emergency Core Cooling System (ECCS) Evaluation Model Revisions Annual Report for VCSNS. This report is being submitted pursuant to 10 CFR 50.46, which requires licensees to notify the NRC on at least an annual basis of corrections to or changes in the ECCS Evaluation Models.

Summary sheets describing changes and enhancements to the ECCS Evaluation Models for 2018 are included in Enclosure I. Peak Clad Temperature (PCT) Rackup Sheets are included in Enclosure II.

On April 29, 2019, South Carolina Electric & Gas Company (SCE&G), which is authorized under Facility Operating License NPF-12 to operate and possess Virgil C. Summer Nuclear Station Unit 1, changed its name to Dominion Energy South Carolina, Inc. SCE&G will be requesting a license amendment to reflect this name change in the near future.

Should you have any questions, please contact Michael Moore at (803) 345-4752.

Sincerely,

A handwritten signature in blue ink, appearing to read "George A. Lippard".

George A. Lippard
Site Vice President
V.C. Summer Nuclear Station

Commitments contained in this letter: None

Enclosure I: Changes and Enhancements to the ECCS Evaluation Models for 2018

Enclosure II: Peak Clad Temperature (PCT) Rackup Sheets

cc: (Without Enclosures unless noted)

G. J. Lindamood – Santee Cooper

C. Haney – NRC Region II

S. A. Williams – NRC

NRC Resident Inspector

Enclosure I

CHANGES AND ENHANCEMENTS TO THE ECCS EVALUATION MODELS FOR 2018

VIRGIL C. SUMMER POWER STATION – UNIT 1
SOUTH CAROLINA ELECTRIC & GAS COMPANY

UO₂ FUEL PELLETT HEAT CAPACITY

Background

A typographical error was discovered in the implementation of the UO₂ fuel pellet heat capacity as described by Equation C-4 of WCAP-8301 [1] for fuel rod heat-up calculations within the Appendix K Large Break and Small Break LOCA evaluation models. The erroneous formulation results in an over-prediction of heat capacity that increases with fuel temperature. The corrected formulation results in a maximum decrease in heat capacity on the order of approximately 1.2 percent for existing analyses of record. This represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

The small over-prediction in UO₂ fuel pellet heat capacity has been evaluated to have a negligible effect on existing large and small break LOCA analysis results due to the small magnitude of the change, leading to an estimated PCT impact of 0 degrees Fahrenheit.

Reference

1) WCAP-8301, "LOCTA-IV Program: Loss-of-Coolant Transient Analysis," June 1974.

VAPOR TEMPERATURE RESETTING

Background

In the WCOBRA/TRAC AND WCOBRA/TRAC-TF2 codes, when the vapor temperature is greater than the wall temperature, and several other conditions are met, the vapor temperature is reset to the saturation temperature for heat transfer calculations. It was discovered that this vapor temperature resetting logic results in an inconsistency between the conduction solution and the hydraulic solution, such that energy is not conserved between the two solutions. The correction of this error represents a Non-Discretionary Change in the Evaluation Model as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

Estimated Effect

Engineering judgement supported by sensitivity calculations showed that correcting this error had minimal impact on LOCA transient calculations, leading to an estimated peak cladding temperature impact of 0 degrees Fahrenheit.

Enclosure II

PEAK CLAD TEMPERATURE (PCT) RACKUP SHEETS

VIRGIL C. SUMMER POWER STATION – UNIT 1
SOUTH CAROLINA ELECTRIC & GAS COMPANY

LOCA Peak Cladding Temperature (PCT) Summary

Plant Name: VIRGIL C. SUMMER
Utility Name: South Carolina Electric & Gas
EM: NOTRUMP
AOR Description: Appendix K Small Break
Summary Sheet Status: Current

	PCT (°F)	Reference #	Note #	
ANALYSIS-OF-RECORD	1775	9	(a,b,c,d)	
	Delta PCT (Δ°F)	Reference #	Note #	Reporting Year
ASSESSMENTS				
1. Upflow Conversion	148	10,11		2008
AOR + Assessments	PCT =	1923.0 °F		

REFERENCES

- CGE-94-205, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Notification and Reporting Information," February 1994.
- CGE-94-228, "South Carolina Electric and Gas Company, Virgil C. Summer Station, SBLOCTA Axial Nodalization," October 1994.
- CGE-95-201, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Notification and Reporting Information," February 1995.
- CGE-96-202, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Notification and Reporting Information," February 1996.
- CGE-96-213, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Small Break LOCA Notification and Reporting Information," July 1996.
- CGE-00-044, "South Carolina Electric and Gas Company, Virgil C. Summer Nuclear Station, 10 CFR 50.46 Appendix K (BART / BASH / NOTRUMP) Evaluation Model, Mid-Year Notification and Reporting for 2000," June 1996.
- CGE-03-80, "10 CFR 50.46 Mid-Year Notification and Reporting for 2003," January 2004.
- LTR-LIS-06-344, "Transmittal of Updated V. C. Summer SBLOCA PCT Rackup Sheets," November 2006.
- LTR-LIS-06-662, "Transmittal of V. C. Summer SBLOCTA PCT Rackup Sheets for HHSI Throttle Valve Replacement," November 2006.
- WCAP-16980-P, Revision 1, "Reactor Internals Upflow Conversion Program Engineering Report V. C. Summer Nuclear Station Unit 1," December 2008.
- LTR-LIS-09-18, "10 CFR 50.46 Report for the V. C. Summer (CGE) Upflow Conversion Program Small Break LOCA Evaluation," January 2009.

NOTES:

- The Rebaseline Analysis includes the impacts of the following model assessments: (1) LUCIFER Error Corrections (Ref. 1), (2) Effect of SI in Broken Loop (Ref. 1), (3) Effect of Improved Condensation Model (Ref. 1),
- (4) Axial Nodalization, RIP Model Revision and SBLOCTA Error Corrections Analysis (Ref. 2), (5) Boiling Heat Transfer Error (Ref. 3), (6) Steam Line Isolation Logic Error (Ref. 3), (7) NOTRUMP Specific Enthalpy Error (Ref. 4),
- (8) SALIBRARY Double Precision Error (Ref. 40), (9) SBLOCTA Fuel Rod Initialization Error (Ref. 5), (10) NOTRUMP Mixture Level Tracking / Region Depletion Errors (Ref. 6),
- (11) NOTRUMP Bubble Rise / Drift Flux Model Inconsistency Corrections (Ref. 7), (12) Refined Break Spectrum (Ref. 8), (13) High head safety injection (HHSI) flow increase (Ref. 9)

LOCA Peak Cladding Temperature (PCT) Summary

Plant Name:	VIRGIL C. SUMMER
Utility Name:	South Carolina Electric & Gas
EM:	CQD (1996)
AOR Description:	Best Estimate Large Break - Composite
Summary Sheet Status:	Current

ANALYSIS-OF-RECORD	PCT (°F) 1988	Reference # 1	Note #	
ASSESSMENTS	Delta PCT (Δ°F)	Reference #	Note #	Reporting Year
1. Backfit Through 2001 Reporting Year	0	2		2003
2. Revised Blowdown Heatup Uncertainty Distribution	5	3		2004
3. PAD 4.0 Implementation	-118	6		2012
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	123	6	(a)	2012
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	6	(b)	2012
6. Revised Heat Transfer Multiplier Distributions	-35	7		2013
7. Changes to Grid Blockage Ratio and Porosity	24	8		2013
8. Error in Burst Strain Application	0	9		2013
9. Fan Cooler Performance Increase	2	2		2003
10. Upflow Conversion Evaluation	-29	4		2008
11. Additional Heat Sinks and Increased Spray Flow Rate	1	5		2010
AOR + Assessments	PCT =	1961.0 °F		

REFERENCES

1. WCAP-16043, "Best Estimate Analysis of the large Break Loss of Coolant Accident for the Virgil C. Summer Nuclear Station," June 2003.
2. CGE-03-12, "10 CFR 50.46 Annual Notification and Reporting for 2002," March 2003.
3. CGE-05-20, "10 CFR 50.46 Annual Notification and Reporting for 2004," April 2005.
4. LTR-LIS-08-578, Revision 2, "10 CFR 50.46 Reports for the V. C. Summer (CGE) Upflow Conversion Large Break LOCA Evaluation and Assessment of Transverse Momentum Cells with a Zero Cross-flow Boundary Condition Error," January 2009.
5. CGE-10-29, "BELOCA Summary Report," November 2010.
6. LTR-LIS-12-372, "V. C. Summer, 10 CFR 50.46 Notification and Reporting for Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown," September 2012.
7. LTR-LIS-13-353, "V. C. Summer 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.
8. LTR-LIS-13-476, "V. C. Summer 10 CFR 50.46 Report for Changes to Grid Blockage Ratio and Porosity," October 2013.
9. LTR-LIS-14-37, "V. C. Summer 10 CFR 50.46 Report for the HOTSPOT Burst Strain Error Correction," January 2014.

NOTES:

- (a) This evaluation credits peaking factor burndown, see Reference 6.
- (b) This input error was originally reported in Reference 4. That evaluation is superseded by the report in Reference 6.

LOCA Peak Cladding Temperature (PCT) Summary

Plant Name: VIRGIL C. SUMMER
Utility Name: South Carolina Electric & Gas
EM: CQD (1996)
AOR Description: Best Estimate Large Break - Blowdown
Summary Sheet Status: Current

ANALYSIS-OF-RECORD	PCT (°F)	Reference #	Note #	
	1860	1		
ASSESSMENTS	Delta PCT (Δ°F)	Reference #	Note #	Reporting Year
1. Backfit Through 2001 Reporting Year	0	2		2003
2. Revised Blowdown Heatup Uncertainty Distribution	49	3		2004
3. PAD 4.0 Implementation	-83	6		2012
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	0	6	(a)	2012
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	6	(b)	2012
6. Revised Heat Transfer Multiplier Distributions	-5	7		2013
7. Changes to Grid Blockage Ratio and Porosity	0	8		2013
8. Error in Burst Strain Application	0	9		2013
9. Fan Cooler Performance Increase	0	2		2003
10. Upflow Conversion Evaluation	-7	4		2008
11. Additional Heat Sinks and Increased Spray Flow Rate	0	5		2010
AOR + Assessments	PCT =	1814.0 °F		

REFERENCES

1. WCAP-16043, "Best Estimate Analysis of the large Break Loss of Coolant Accident for the Virgil C. Summer Nuclear Station," June 2003.
2. CGE-03-12, "10 CFR 50.46 Annual Notification and Reporting for 2002," March 2003.
3. CGE-05-20, "10 CFR 50.46 Annual Notification and Reporting for 2004," April 2005.
4. LTR-LIS-08-578, Revision 2, "10 CFR 50.46 Reports for the V. C. Summer (CGE) Upflow Conversion Large Break LOCA Evaluation and Assessment of Transverse Momentum Cells with a Zero Cross-flow Boundary Condition Error," January 2009.
5. CGE-10-29, "BELOCA Summary Report," November 2010.
6. LTR-LIS-12-372, "V. C. Summer, 10 CFR 50.46 Notification and Reporting for Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown," September 2012.
7. LTR-LIS-13-353, "V. C. Summer 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.
8. LTR-LIS-13-476, "V. C. Summer 10 CFR 50.46 Report for Changes to Grid Blockage Ratio and Porosity," October 2013.
9. LTR-LIS-14-37, "V. C. Summer 10 CFR 50.46 Report for the HOTSPOT Burst Strain Error Correction," January 2014.

NOTES:

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LOCA Peak Cladding Temperature (PCT) Summary

Plant Name: VIRGIL C. SUMMER
Utility Name: South Carolina Electric & Gas
EM: CQD (1996)
AOR Description: Best Estimate Large Break – Reflood 1
Summary Sheet Status: Current

ANALYSIS-OF-RECORD	PCT (°F)	Reference #	Note #	
	1808	1		
ASSESSMENTS	Delta PCT (Δ°F)	Reference #	Note #	Reporting Year
1. Backfit Through 2001 Reporting Year	0	2		2003
2. Revised Blowdown Heatup Uncertainty Distribution	5	3		2004
3. PAD 4.0 Implementation	-118	6		2012
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	113	6	(a)	2012
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	6	(b)	2012
6. Revised Heat Transfer Multiplier Distributions	5	7		2013
7. Changes to Grid Blockage Ratio and Porosity	24	8		2013
8. Error in Burst Strain Application	20	9		2013
9. Fan Cooler Performance Increase	1	2		2003
10. Upflow Conversion Evaluation	-44	4		2008
11. Additional Heat Sinks and Increased Spray Flow Rate	0	5		2010
AOR + Assessments	PCT =	1814.0 °F		

REFERENCES

1. WCAP-16043, "Best Estimate Analysis of the large Break Loss of Coolant Accident for the Virgil C. Summer Nuclear Station," June 2003.
2. CGE-03-12, "10 CFR 50.46 Annual Notification and Reporting for 2002," March 2003.
3. CGE-05-20, "10 CFR 50.46 Annual Notification and Reporting for 2004," April 2005.
4. LTR-LIS-08-578, Revision 2, "10 CFR 50.46 Reports for the V. C. Summer (CGE) Upflow Conversion Large Break LOCA Evaluation and Assessment of Transverse Momentum Cells with a Zero Cross-flow Boundary Condition Error," January 2009.
5. CGE-10-29, "BELOCA Summary Report," November 2010.
6. LTR-LIS-12-372, "V. C. Summer, 10 CFR 50.46 Notification and Reporting for Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown," September 2012.
7. LTR-LIS-13-353, "V. C. Summer 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.
8. LTR-LIS-13-476, "V. C. Summer 10 CFR 50.46 Report for Changes to Grid Blockage Ratio and Porosity," October 2013.
9. LTR-LIS-14-37, "V. C. Summer 10 CFR 50.46 Report for the HOTSPOT Burst Strain Error Correction," January 2014.

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LOCA Peak Cladding Temperature (PCT) Summary

Plant Name:	VIRGIL C. SUMMER
Utility Name:	South Carolina Electric & Gas
EM:	CQD (1996)
AOR Description:	Best Estimate Large Break – Reflood 2
Summary Sheet Status:	Current

ANALYSIS-OF-RECORD	PCT (°F) 1988	Reference # 1	Note #	
ASSESSMENTS	Delta PCT (Δ°F)	Reference #	Note #	Reporting Year
1. Backfit Through 2001 Reporting Year	0	2		2003
2. Revised Blowdown Heatup Uncertainty Distribution	5	3		2004
3. PAD 4.0 Implementation	-118	6		2012
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	123	6	(a)	2012
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	6	(b)	2012
6. Revised Heat Transfer Multiplier Distributions	-35	7		2013
7. Changes to Grid Blockage Ratio and Porosity	24	8		2013
8. Error in Burst Strain Application	0	9		2013
9. Fan Cooler Performance Increase	2	2		2003
10. Upflow Conversion Evaluation	-29	4		2008
11. Additional Heat Sinks and Increased Spray Flow Rate	1	5		2010
AOR + Assessments	PCT =	1961.0 °F		

REFERENCES

1. WCAP-16043, "Best Estimate Analysis of the large Break Loss of Coolant Accident for the Virgil C. Summer Nuclear Station," June 2003.
2. CGE-03-12, "10 CFR 50.46 Annual Notification and Reporting for 2002," March 2003.
3. CGE-05-20, "10 CFR 50.46 Annual Notification and Reporting for 2004," April 2005.
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