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

Dear Sir / Madam:

Subject: VIRGIL C. SUMMER NUCLEAR STATION (VCSNS) UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12
ECCS EVALUATION MODEL REVISIONS REPORT

South Carolina Electric & Gas Company (SCE&G), acting for itself and as agent for South Carolina Public Service Authority, hereby submits the 2013 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 2013 are included in Attachment I. Peak Clad Temperature (PCT) sheets are included in Attachment II.

If you have any questions, please call Bruce L. Thompson at (803) 931-5042.

Very truly yours,

Thomas D. Gatlin

TS/TDG/wm
Attachments

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A002
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Attachment I

Changes and Enhancements to the ECCS Evaluation Models for 2013

GENERAL CODE MAINTENANCE

Background

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 in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

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

ELEVATIONS FOR HEAT SLAB TEMPERATURE INITIALIZATION

Background

An error was discovered in WCOBRA/TRAC whereby an incorrect value would be used in the initial fuel rod temperature calculation for a fuel rod heat transfer node if that node elevation was specified outside of the bounds of the temperature initialization table. This problem has been evaluated for impact on existing analyses and its resolution represents a Discretionary Change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Based on inspection of plant analysis input, it was concluded that the input decks for existing analyses are not impacted by this error, leading to an estimated peak cladding temperature impact of 0°F.

HEAT TRANSFER LOGIC CORRECTION FOR ROD BURST CALCULATION

Background

A change was made to the WCOBRA/TRAC coding to correct an error which had disabled rod burst in separate effect test simulations. This change represents a Discretionary Change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Based on the nature of the change and the evaluation model requirements for plant modeling in Westinghouse best estimate large break LOCA analyses with WCOBRA/TRAC, it is judged that existing analyses are not impacted by this change, leading to an estimated peak cladding temperature impact of 0°F.

WCOBRA/TRAC U19 FILE DIMENSION ERROR CORRECTION

Background

A problem was identified in the dimension of an array used to generate the u19 file in WCOBRA/TRAC. The u19 file is read during HSDRIVER execution and provides information needed to generate the HOTSPOT thermal-hydraulic history and user input files. The array used to write the desired information to the u19 file is dimensioned to 2000 in WCOBRA/TRAC. It is possible, however, for more than 2000 curves to be written to the u19 file. If that is the case, it is possible that the curves would not be stored correctly on the u19 file. A survey of current Best Estimate Large Break LOCA analyses indicated that the majority of plants had less than 2000 curves in their u19 files; therefore these plants are not affected by the change. For those plants with more than 2000 curves, plant-specific sensitivity calculations indicated that resolution of this issue does not impact the peak cladding temperature (PCT) calculation for prior analyses. This represents a Discretionary Change in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

As discussed in the Background section, resolution of this issue does not impact the peak cladding temperature calculation for prior LBLOCA analyses, leading to an estimated peak cladding temperature impact of 0°F.

HEAT TRANSFER MODEL ERROR CORRECTIONS

Background

Several related changes were made to WCOBRA/TRAC to correct errors discovered which affected the heat transfer models. These errors included calculation of the entrained liquid fraction used in calculation of the drop wall heat flux, application of the grid enhancement factor for grid temperature calculation, calculation of the Reynold's number used in the Wong-Hochrieter correlation for the heat transfer coefficient from fuel rods to vapor, fuel rod initialization and calculation of cladding inner radius with creep, application of grid and two phase enhancement factors and radiation component in single phase vapor heat transfer, and reset of the critical heat flux temperature when J=2. These errors have been evaluated to estimate the impact on existing LBLOCA analysis results. Correction of these errors represents a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Based on the results of representative plant calculations, separate effects and integral effects test simulations, it is concluded that the error corrections have a negligible local effect on heat transfer, leading to an estimated peak cladding temperature impact of 0°F.

CORRECTION TO HEAT TRANSFER NODE INITIALIZATION

Background

An error was discovered in the heat transfer node initialization logic in WCOBRA/TRAC whereby the heat transfer node center locations could be inconsistent with the geometric node center elevations. The primary effects of this issue are on the interpolated fluid properties and grid turbulent mixing enhancement at the heat transfer node. This problem has been evaluated for impact on existing analyses and its resolution represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Based on engineering judgment and the results from a matrix of representative plant calculations, it is concluded that the effect of this error is within the code resolution, leading to an estimated peak cladding temperature impact of 0°F.

MASS CONSERVATION ERROR FIX

Background

It was identified that mass was not conserved in WCOBRA/TRAC one-dimensional component cells when void fraction values were calculated to be slightly out of the physical range (greater than 1.0 or smaller than 0.0). This was observed to result in artificial mass generation on the secondary side of steam generator components. Correction of this problem represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

This error was observed to primarily affect the mass on the secondary side of the steam generator. This issue was judged to have a negligible impact on existing LBLOCA analysis results, leading to an estimated peak cladding temperature impact of 0°F.

CORRECTION TO SPLIT CHANNEL MOMENTUM EQUATION

Background

An error was discovered in the momentum equation calculations for split channels in WCOBRA/TRAC. This error impacts the (1) continuity area of the phantom/boundary bottom cell; (2) bottom and top continuity area correction factors for the channel inlet at the bottom of a section and for the channel outlet at the top of a section; and (3) drop entrainment mass rate per unit volume and drop de-entrainment mass rate per unit volume contributions to the momentum calculations for split channels. This problem has been evaluated for impact on existing analyses and its resolution represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model

2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Based on the results from a matrix of representative plant calculations, it is concluded that the effect of this error on the quantities directly impacted by the momentum equation calculations for split channels (velocities, flows, etc.) is negligible, leading to an estimated peak cladding temperature impact of 0°F.

CHANGES TO VESSEL SUPERHEATED STEAM PROPERTIES

Background

Several related changes were made to the WCOBRA/TRAC coding for the vessel super-heated water properties, including updating the HGAS subroutine coding to be consistent with WCAP-12945-P-A Equation 10-6, updating the approximation of the enthalpy in the TGAS subroutine to be consistent with the HGAS subroutine coding, and updating the temperature iteration method and convergence criteria in the TGAS subroutine. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

The updates to the calculations of the superheated steam properties had generally less than 1°F impact on the resulting steam temperature values, leading to an estimated peak cladding temperature impact of 0°F.

UPDATE TO METAL DENSITY REFERENCE TEMPERATURES

Background

It was identified that for one-dimensional components in which heat transfer to stainless steel 304 or 316 is modeled, the reference temperature for the metal density calculation was allowed to vary; as a result the total metal mass was not preserved. Correction of this problem represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

This change primarily impacts the reactor coolant system loop piping modeled in the large break loss-of-coolant accident (LBLOCA) WCOBRA/TRAC models. It was judged that the effect of this change on the peak cladding temperature results was negligible, leading to an estimated peak cladding temperature impact of 0°F.

DECAY HEAT MODEL ERROR CORRECTIONS

Background

The decay heat model in the WCOBRA/TRAC code was updated to correct the erroneously coded value of the yield fraction directly from fission for Group 19 of Pu-239, and to include the term for uncertainty in the prompt energy per fission in the calculation of the decay heat power uncertainty. Correction of these errors represents a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

These changes have a negligible impact on the calculated decay heat power, leading to an estimated peak cladding temperature impact of 0°F.

CORRECTION TO THE PIPE EXIT PRESSURE DROP ERROR

Background

An error was discovered in WCOBRA/TRAC whereby the frictional pressure drop at the split break TEE connection to the BREAK component was incorrectly calculated using the TEE hydraulic diameter instead of the BREAK component length input. This error has been evaluated for impact on existing analyses and its resolution represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Based on the results from a matrix of representative plant calculations, it is concluded that the effect of this error on the pressure at the break and the break flow is negligible, leading to an estimated peak cladding temperature impact of 0°F.

VESSEL SECTION 7 MID-LEVEL ELEVATION MODELING

Background

Documentation deficiencies have been identified which are associated with the Large Break LOCA Evaluation Model and plant specific analyses. The first is an incorrect statement made on page 20-4-5 of WCAP-12945-P-A. The Section 7 mid-level elevation utilized in the sample analysis is stated as being at the bottom of the deep beam device. In the model, the Section 7 mid-level elevation is at the top of the topmost support column flow slot. In addition, the bottom of Section 7 is characterized as being at the bottom of the Hot Leg, but in the model, the bottom of the section is set at the top of the Hot Leg. The similar statement made at page 12-6 of WCAP-16009-P-A could also be incorrect. These are not considered changes to the methodology, but rather, corrections of the documentation. These changes represent a closely-related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Westinghouse considers that for 3 and 4 loop plants with the deep beam design (those with Upper Support Plates of design type 'Flat' and 'Top Hat' in nature), the choice of setting the level breakpoint at either position is equally correct, since there are no geometry aspects in this axial position of the vessel that warrant a critical modeling decision to capture LBLOCA transient phenomena. Furthermore, the level difference was only ~5" for a typical application.

Since either model is appropriate, there is no PCT penalty to assess for 10 CFR 50.46 Reporting purposes. Future analyses can use either coordinate.

GRID HEAT TRANSFER ENHANCEMENT CALCULATION

Background

An issue was identified which could affect the calculation of the heat transfer at gridded elevations for Best-Estimate (BE) Large-Break Loss-of-Coolant Accident (LBLOCA) Evaluation Models (EMs). For a specific input condition, the grid heat transfer enhancement factor is calculated based on an erroneous core geometry, which can cause an over-prediction of the heat transfer coefficient at gridded elevations. This issue has been evaluated to estimate the impact on existing LBLOCA analysis results. The resolution of this issue represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

The effect described above was judged to have a negligible effect on existing LBLOCA analysis results, leading to an estimated Peak Cladding Temperature (PCT) impact of 0°F.

REVISED HEAT TRANSFER MULTIPLIER DISTRIBUTIONS

Background

Several changes and error corrections were made to WCOBRA/TRAC and the impacts of these changes on the heat transfer multiplier uncertainty distributions were investigated. During this investigation, errors were discovered in the development of the original multiplier distributions, including errors in the grid locations specified in the WCOBRA/TRAC models for the G2 Refill and G2 Reflood tests, and errors in processing test data used to develop the reflood heat transfer multiplier distribution. Therefore, the blowdown heatup, blowdown cooling, refill, and reflood heat transfer multiplier distributions were redeveloped. For the reflood heat transfer multiplier development, the evaluation time windows for each set of test experimental data and each test simulation were separately defined based on the time at which the test or simulation exhibited dispersed flow film boiling heat transfer conditions characteristic of the reflood time period. The revised heat transfer multiplier distributions have been evaluated for impact on existing analyses. Resolution of these issues represents a closely related group of Non-Discretionary Changes in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

A plant transient calculation representative of V. C. Summer transient behavior was performed with the latest version of WCOBRA/TRAC. Using this transient, HOTSPOT calculations were performed with both the original and revised heat transfer multiplier distributions. Based on the change in the 95th percentile results, estimated PCT effects of -5°F for Blowdown, 5°F for Reflood 1, and -35°F for Reflood 2 have been established for 10 CFR 50.46 reporting purposes for V. C. Summer.

ERROR IN BURST STRAIN APPLICATION

Background

An error in the application of the burst strain was discovered in HOTSPOT. The equation for the application of the burst strain is given as Equation 7-69 in WCAP-16009-P-A and in WCAP-12945-P-A. The outer radius of the cladding after burst occurs should be calculated based on the burst strain, and the inner radius of the cladding should be calculated based on the outer radius. In HOTSPOT, the burst strain is applied to the calculation of the cladding inner radius. The cladding outer radius is then calculated based on the inner radius. As such, the burst strain is incorrectly applied to the inner radius rather than the outer radius, which impacts the resulting cladding geometry at the burst elevation after burst occurs. Correction of the erroneous calculation results in thinner cladding at the burst node and more fuel relocating into the burst node, leading to an increase in the Peak Cladding Temperature (PCT) at the burst node. This issue has been evaluated to estimate the impact on existing Best-Estimate (BE) Large-Break Loss-of-Coolant Accident (LBLOCA) analysis results. The resolution of this issue represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

A representative V. C. Summer case was run using HOTSPOT versions which only differ in the burst strain application. Based on the change in the 95th percentile results, estimated PCT effects of 0°F for Blowdown, 20°F for Reflood 1, and 0°F for Reflood 2 have been established for 10 CFR 50.46 reporting purposes for V. C. Summer.

CHANGES TO GRID BLOCKAGE RATIO AND POROSITY

Background

A change in the methodology used to calculate grid blockage ratio and porosity for Westinghouse fuel resulted in a change to the grid inputs for large break loss-of-coolant accident (LBLOCA) analyses. Grid inputs affect heat transfer in the core during a LBLOCA. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

The updates to the methodology to calculate grid blockage ratio and porosity used as input in Westinghouse LBLOCA models resulted in degraded heat transfer in the core for the fuel type used in V. C. Summer. The estimated penalty associated with the changes is 24°F for both Reflood 1 and Reflood 2 for 10 CFR 50.46 reporting purposes.

SBLOCTA CLADDING STRAIN REQUIREMENT FOR FUEL ROD BURST

Background

An error was discovered in the minimum local strain required for burst for ZIRLO^{®1} cladding in the SBLOCTA code. The coding does not enforce reaching the minimum percent local strain threshold prior to calculating fuel rod burst. However, a review of licensing basis analyses revealed no instances of this error impacting calculated results. Resolution of this issue represents a Non-Discretionary Change to the Evaluation Model as described in Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1985 Westinghouse Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Based on a review of current licensing basis analyses, and the phenomena and physics of a small break LOCA transient, it is concluded that this error has a negligible effect on small break LOCA analysis results, leading to an estimated Peak Cladding Temperature (PCT) impact of 0°F.

¹ ZIRLO is a registered trademark of Westinghouse Electric Company LLC, its affiliates and/or its subsidiaries in the United States of America and may be registered in other countries throughout the world. All rights reserved. Unauthorized use is strictly prohibited. Other names may be trademarks of their respective owners.

Attachment II

Peak Clad Temperature (PCT) Rackup Sheets

Westinghouse LOCA Peak Clad Temperature Summary for Best Estimate Large Break

Plant Name: V. C. Summer
Utility Name: South Carolina Electric & Gas

Revision Date: 2/27/2014

Composite

Analysis Information

EM: CQD (1996) **Analysis** 2/3/2003 **Limiting Break** Guillotine
FQ: 2.5 **FdH:** 1.7
Fuel: Vantage + **SGTP (%):** 10
Notes: Delta 75 Replacement Steam Generator Uprate Core Power 2900 MWt

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	1988	1	
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1. Backfit Through 2001 Reporting Year	0	2	
2. Revised Blowdown Heatup Uncertainty Distribution	5	3	
3. PAD 4.0 Implementation	-118	5	
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	123	5	(a)
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	5	(b)
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1. Fan Cooler Performance Increase	2	2	
2. Upflow Conversion Evaluation	-29	4	
C. 2013 ECCS MODEL ASSESSMENTS			
1. Revised Heat Transfer Multiplier Distributions	-35	6	
2. Changes to Grid Blockage Ratio and Porosity	24	7	
3. Error in Burst Strain Application	0	8	
D. OTHER			
1. None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1960	

Reference

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
5. 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 20, 2012.
6. LTR-LIS-13-353, "V. C. Summer 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.
7. LTR-LIS-13-476, "V. C. Summer 10 CFR 50.46 Report for Changes to Grid Blockage Ratio and Porosity," October 2013.

8. 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 5.
- (b) This input error was originally reported in Reference 4. That evaluation is superseded by the report in Reference 5.

Westinghouse LOCA Peak Clad Temperature Summary for Best Estimate Large Break

Plant Name: V. C. Summer
Utility Name: South Carolina Electric & Gas

Revision Date: 2/27/2014

Blowdown

Analysis Information

EM: CQD (1996) **Analysis** 2/3/2003 **Limiting Break** Guillotine
FQ: 2.5 **FdH:** 1.7
Fuel: Vantage + **SGTP (%):** 10
Notes: Delta 75 Replacement Steam Generator Uprate Core Power 2900 MWt

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	1860	1	
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1. Backfit Through 2001 Reporting Year	0	2	
2. Revised Blowdown Heatup Uncertainty Distribution	49	3	
3. PAD 4.0 Implementation	-83	5	
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	0	5	(a)
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	5	(b)
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1. Fan Cooler Performance Increase	0	2	
2. Upflow Conversion Evaluation	-7	4	
C. 2013 ECCS MODEL ASSESSMENTS			
1. Revised Heat Transfer Multiplier Distributions	-5	6	
2. Changes to Grid Blockage Ratio and Porosity	0	7	
3. Error in Burst Strain Application	0	8	
D. OTHER			
1. None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1814	

Reference

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
5. 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 20, 2012.
6. LTR-LIS-13-353, "V. C. Summer 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.

7. LTR-LIS-13-476, "V. C. Summer 10 CFR 50.46 Report for Changes to Grid Blockage Ratio and Porosity," October 2013.
8. 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 5.
- (b) This input error was originally reported in Reference 4. That evaluation is superseded by the report in Reference 5.

Westinghouse LOCA Peak Clad Temperature Summary for Best Estimate Large Break

Plant Name: V. C. Summer
Utility Name: South Carolina Electric & Gas

Revision Date: 2/27/2014

Reflow 1

Analysis Information

EM: CQD (1996) **Analysis** 2/3/2003 **Limiting Break** Guillotine
FQ: 2.5 **FdH:** 1.7
Fuel: Vantage + **SGTP (%):** 10
Notes: Delta 75 Replacement Steam Generator Uprate Core Power 2900 MWt

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	1808	1	
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1. Backfit Through 2001 Reporting Year	0	2	
2. Revised Blowdown Heatup Uncertainty Distribution	5	3	
3. PAD 4.0 Implementation	-118	5	
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	113	5	(a)
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	5	(b)
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1. Fan Cooler Performance Increase	1	2	
2. Upflow Conversion Evaluation	-44	4	
C. 2013 ECCS MODEL ASSESSMENTS			
1. Revised Heat Transfer Multiplier Distributions	5	6	
2. Changes to Grid Blockage Ratio and Porosity	24	7	
3. Error in Burst Strain Application	20	8	
D. OTHER			
1. None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1814	

Reference

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
5. 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 20, 2012.
6. LTR-LIS-13-353, "V. C. Summer 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.

7. LTR-LIS-13-476, "V. C. Summer 10 CFR 50.46 Report for Changes to Grid Blockage Ratio and Porosity," October 2013.
8. 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 5.
- (b) This input error was originally reported in Reference 4. That evaluation is superseded by the report in Reference 5.

Westinghouse LOCA Peak Clad Temperature Summary for Best Estimate Large Break

Plant Name: V. C. Summer
Utility Name: South Carolina Electric & Gas

Revision Date: 2/27/2014

Reflood 2

Analysis Information

EM: CQD (1996) **Analysis** 2/3/2003 **Limiting Break** Guillotine
FQ: 2.5 **FdH:** 1.7
Fuel: Vantage + **SGTP (%):** 10
Notes: Delta 75 Replacement Steam Generator Uprate Core Power 2900 MWt

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	1988	1	
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1. Backfit Through 2001 Reporting Year	0	2	
2. Revised Blowdown Heatup Uncertainty Distribution	5	3	
3. PAD 4.0 Implementation	-118	5	
4. Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	123	5	(a)
5. Transverse Momentum Cells for Zero Cross-flow Boundary Condition Error	0	5	(b)
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1. Fan Cooler Performance Increase	2	2	
2. Upflow Conversion Evaluation	-29	4	
C. 2013 ECCS MODEL ASSESSMENTS			
1. Revised Heat Transfer Multiplier Distributions	-35	6	
2. Changes to Grid Blockage Ratio and Porosity	24	7	
3. Error in Burst Strain Application	0	8	
D. OTHER			
1. None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1960	

Reference

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
5. 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 20, 2012.

6. LTR-LIS-13-353, "V. C. Summer 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.
7. LTR-LIS-13-476, "V. C. Summer 10 CFR 50.46 Report for Changes to Grid Blockage Ratio and Porosity," October 2013.
8. 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 5.
- (b) This input error was originally reported in Reference 4. That evaluation is superseded by the report in Reference 5.

Westinghouse LOCA Peak Clad Temperature Summary for Appendix K Small Break

Plant Name: V. C. Summer

Utility Name: South Carolina Electric & Gas

Revision Date: 2/27/2014

Analysis Information

EM:	NOTRUMP	Analysis	9/12/2006	Limiting Break	3 Inch
FQ:	2.45	FdH:	1.62		
Fuel:	Vantage +	SGTP (%):	10		

Notes:

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	1775	9	(a)
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1. None	0		
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1. Upflow Conversion	148	10,11	
C. 2013 ECCS MODEL ASSESSMENTS			
1. None	0		
D. OTHER			
1. None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	PCT = 1923		

Reference

1. CGE-94-205, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Notification and Reporting Information," February 8, 1994.
2. CGE-94-228, "South Carolina Electric and Gas Company, Virgil C. Summer Station, SBLOCTA Axial Nodalization," October 27, 1994.
3. CGE-95-201, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Notification and Reporting Information," February 3, 1995.
4. CGE-96-202, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Annual Notification and Reporting," February 9, 1996.
5. CGE-96-213, "South Carolina Electric and Gas Company, Virgil C. Summer Station, 10 CFR 50.46 Small Break LOCA Notification and Reporting," July 8, 1996.
6. 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,"
7. CGE-03-80, "10 CFR 50.46 Mid-Year Notification and Reporting for 2003," January 2004.
8. LTR-LIS-06-344, "Transmittal of Updated V. C. Summer SBLOCA PCT Rackup Sheets," November 2006.
9. LTR-LIS-06-662, Transmittal of V. C. Summer SBLOCTA PCT Rackup Sheets for HHSI Throttle Valve Replacement," November 2006.
10. WCAP-16980-P, Revision 1, "Reactor Internals Upflow Conversion Program Engineering Report V. C. Summer Nuclear Station Unit 1," December 2008.

11. 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:

- (a) 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. 4)
 - 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)