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Your Ref: Docket No. 52-006
Our Ref: DCP_NRC_003328

March 23, 2018

Subject: 10 CFR 50.46 Annual Report for the AP1000® Plant Design

Pursuant to 10 CFR 50.46, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors", Westinghouse Electric Company, LLC is submitting this report to document emergency core cooling system (ECCS) evaluation model changes or errors for the 2017 Model Year (i.e., 01/01/2017 – 12/31/2017) that affect the peak cladding temperature (PCT) calculations for the AP1000 plant design.

As described below, three AP1000 analyses of record (AORs) are reported:

AP1000 Design Certification AOR:
On December 30th, 2011, the U.S. Nuclear Regulatory Commission certified an amendment to the Design Certification Rule for the AP1000 plant. As such, AP1000 Design Control Document (DCD) Revision 19 documents the AOR for the AP1000 Design Certification. The limiting transient for the AP1000 Design Certification is the Best Estimate Large Break Loss-of-Coolant Accident (LBLOCA). Westinghouse last provided an annual reporting letter to the NRC in March, 2017 (DCP_NRC_003311) which presented an estimated PCT of 2010°F for the LBLOCA evaluation. There are no new ECCS model changes that impact PCT for the 2017 model year. The estimated PCT for LBLOCA remains at 2010°F and does not exceed the 10 CFR 50.46 (b)(1) acceptance criterion of 2200°F.

The summary of the PCT margin allocations and their bases for the AP1000 Design Certification AOR are provided in the Attachment 1.

AP1000 V.C. Summer Units 2 & 3 AOR:
In addition to the AOR for the AP1000 Design Certification, the NRC has approved the AP1000 Core Reference Report (WCAP-17524-P-A), a generic topical which includes an ECCS "reanalysis" in the context of 10 CFR 50.46. The AOR contained in the Core Reference Report (CRR) has also been approved for incorporation into the V.C. Summer Units 2 & 3 licenses via license amendment request (LAR). There are no new ECCS model changes that impact PCT for the 2017 model year. The estimated PCT for LBLOCA remains at 1970°F and does not exceed the 10 CFR 50.46 (b)(1) acceptance criterion of 2200°F.

The summary of the PCT margin allocations and their bases for the AP1000 V.C. Summer Units 2 & 3 AOR are provided in the Attachment 2.

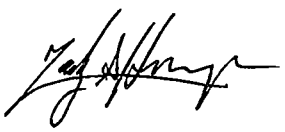
AP1000 Vogtle Units 3 & 4 AOR:
In addition to the AOR for the AP1000 Design Certification, the NRC has approved the AP1000 Core Reference Report (WCAP-17524-P-A), a generic topical which includes an ECCS "reanalysis" in the context of 10 CFR 50.46. The AOR contained in the Core Reference Report (CRR) has also been approved for incorporation into the Vogtle Units 3 & 4 licenses via NRC License Amendment 52. There are no new ECCS model changes that impact PCT for the 2017 model year. The estimated PCT for LBLOCA remains at 1970°F and does not exceed the 10 CFR 50.46 (b)(1) acceptance criterion of 2200°F.

The summary of the PCT margin allocations and their bases for the AP1000 Vogtle Units 3 & 4 AOR are provided in the Attachment 3.

By copy of this letter, COL Holders and COL Applicants are hereby notified of any changes or errors in the AP1000 standard plant design PCT calculations as required by 10 CFR 50.46(a)(3)(iii). This letter contains site-specific evaluations for V.C. Summer Units 2 & 3 and Vogtle Units 3 & 4.

Questions or requests for additional information related to content and preparation of this information should be directed to Westinghouse. Please send copies of such questions or requests to the respective COL Holders and COL Applicants referencing the amended AP1000 Design Certification Rule for the AP1000 nuclear power plant. A representative for each COL Holder and COL Applicant is included on the cc: list of this letter.

Very truly yours,



Zachary S. Harper
Manager, Structural and Mechanical Licensing

/Attachments

1. 10 CFR 50.46 Annual Report for the AP1000 Design Certification AOR, 2017 Model Year
2. 10 CFR 50.46 Annual Report for the AP1000 V.C. Summer Units 2 & 3 AOR, 2017 Model Year
3. 10 CFR 50.46 Annual Report for the AP1000 Vogtle Units 3 & 4 AOR, 2017 Model Year

Cc:

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A. Aughtman	- SNC	M. Corletti	- Westinghouse		
E. Wagner	- Duke/Progress	A. Schoedel	- Westinghouse		
S. Franzone	- FP&L	M. Yuan	- Westinghouse		

Attachment 1

10 CFR 50.46 Annual Report for the AP1000 Design Certification AOR, 2017 Model Year

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 [1].

Affected Evaluation Model(s)

1996 Westinghouse Best-Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM
1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

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

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

ERROR IN THE UPPER PLENUM FLUID VOLUME CALCULATION

Background

An error was found in the fluid volume calculation in the upper plenum where the support column outer diameter was being used instead of the inner diameter. The correction of this error leads to a reduction in the upper plenum fluid volume used in the **AP1000®** plant Small Break LOCA analyses. The corrected value represents a negligible change in the total reactor coolant system (RCS) fluid volume. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

The difference in the upper plenum fluid volume as a result of the error is extremely small (approximately 3 ft^3). The error will have a negligible impact on transient results due to the small magnitude of the change. As a result, the estimated PCT impact is 0°F.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

HENRY-FAUSKE / HOMOGENEOUS EQUILIBRIUM MODEL BREAK FLOW MODEL TABLE RANGE LIMITATIONS

Background

The Henry-Fauske / Homogeneous Equilibrium Model (HFHEM) break flow model is used in the NOTRUMP-AP600 evaluation model (EM) for the ADS Stage 1-4 flow paths. This break flow model utilizes a series of look up tables to determine the critical mass flux as a function of the stagnation pressure and stagnation enthalpy. The look up tables for the subcooled break flow have a limitation on subcooling (enthalpy) as well as pressure and the saturated break flow has a limitation on pressure. If the pressure or subcooling is exceeded, the critical mass flux will be truncated at the last value. This change represents a Non-Discretionary Change to the Evaluation Model as described in Section 4.1.2 of WCAP-13451 [1].

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

The **AP1000®** plant SBLOCA calculations were reviewed and it was determined that the use of the HFHEM break flow model falls within the model ranges. Therefore, the estimated Peak Cladding Temperature (PCT) impact is 0°F for the AP1000 plant.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

INCONSISTENT APPLICATION OF NUMERICAL RAMP APPLIED TO THE ENTRAINED LIQUID / VAPOR INTERFACIAL DRAG COEFFICIENT

Background

A numerical ramp which was used to account for the disappearance of the entrained liquid phase was applied to the entrained liquid / vapor interfacial drag coefficient. The numerical ramp was applied such that the interfacial drag coefficient used in the solution of the entrained liquid and vapor momentum equations was not consistent. WCOBRA/TRAC was updated to apply the numerical ramp prior to usage of the interfacial drag coefficient in the momentum equations, such that a consistent interfacial drag coefficient was used in the entrained liquid and vapor momentum equations.

This item represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

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 code validation results, the impact of correcting the error is estimated to have a 0°F impact on PCT.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

INAPPROPRIATE RESETTING OF TRANSVERSE LIQUID MASS FLOW

Background

In the WCOBRA/TRAC routine which evaluates the mass and energy residual error of the time step solution, the transverse liquid mass flow is reset as the liquid phase disappears. The routine is updated to remove the resetting of the transverse liquid mass flow since the routine is to only evaluate the residual error based on the time step solution values.

This item represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

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 code validation results and limited applicability of the logic removed, correcting the error is estimated to have a 0°F impact on PCT.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

STEADY-STATE FUEL TEMPERATURE CALIBRATION METHOD

Background

In the Automated Statistical Treatment of Uncertainty Method (ASTRUM) Best-Estimate (BE) Large-Break Loss-of-Coolant Accident (LBLOCA) Evaluation Model (EM), the steady-state fuel pellet temperature calibration method involves solving for the hot gap width (AGFACT) to calibrate the fuel temperature for each fuel rod. In some infrequent situations, small non-conservatisms can occur in the calibration process such that the resulting fuel pellet temperature will be slightly lower than intended and outside the acceptable range defined by Table 12-6 of WCAP-16009-P/NP-A [1].

This issue has been evaluated to estimate the impact on ASTRUM BE LBLOCA analysis results. The resolution of this issue represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [2].

Affected Evaluation Model(s)

2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

A review of licensing basis analyses concluded that the potential non-conservatisms in the fuel pellet temperature calibration did not occur for the limiting analysis cases. Therefore, an estimated PCT impact of 0°F is assigned for 10 CFR 50.46 reporting purposes.

References

1. WCAP-16009-P/NP-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment Of Uncertainty Method (ASTRUM)," January 2005.
2. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

Westinghouse LOCA Peak Clad Temperature Summary for ASTRUM Best Estimate Large Break

DCD

Plant Name: AP1000
Utility Name: Westinghouse Nuclear Power Plants
Revision Date: 3/1/2018

Analysis Information

EM:	ASTRUM (2004)	**Analysis Date:**	5/9/2008	**Limiting Break Size:**	Split
FQ:	2.6	**FdH:**	1.75		
Fuel:	RFA	**SGTP (%):**	10		

Notes:

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	**1837**	**1**	
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1 . Evaluation of Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	139	2	
2 . Revised Heat Transfer Multiplier Distributions	11	3	
3 . Error in Burst Strain Application	23	4	
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1 . None	0		
C. 2017 ECCS MODEL ASSESSMENTS			
1 . None	0		
D. OTHER*			
1 . None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =** 2010		

* It is recommended that the licensee determine if these PCT allocations should be considered with respect to 10 CFR 50.46 reporting requirements.

References

1 . APP-GW-GL-700, Revision 19, "AP1000 Design Control Document," Tier 2, Chapter 15, June 2011.

2 . LTR-LIS-12-288, "Information Regarding the Evaluation of Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown Including Analysis Input Changes for AP1000 Large Break LOCA Analysis," June 2012.

3 . LTR-LIS-13-357, "AP1000 Plant 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.

4 . LTR-LIS-14-41, "AP1000 Plant 10 CFR 50.46 Report for the HOTSPOT Burst Strain Error Correction," January 2014.

Notes:

(a) None

Westinghouse LOCA Peak Clad Temperature Summary for Appendix K Small Break

DCD

Plant Name: AP1000
Utility Name: Westinghouse Nuclear Power Plants
Revision Date: 3/1/2018

Analysis Information

EM:	NOTRUMP-AP	**Analysis Date:**	8/23/2002	**Limiting Break Size:**	10 Inch
FQ:	2.6	**FdH:**	1.65		
Fuel:	RFA	**SGTP (%):**	10		

Notes:

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	**1370**	**1**	**(a)**
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1 . Adiabatic Heat-up Calculation	264	2	(a)
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1 . None	0		
C. 2017 ECCS MODEL ASSESSMENTS			
1 . None	0		
D. OTHER*			
1 . None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =** 1634		

* It is recommended that the licensee determine if these PCT allocations should be considered with respect to 10 CFR 50.46 reporting requirements.

References

1 . APP-GW-GL-700, Revision 19, "AP1000 Design Control Document," Tier 2, Chapter 15, June 2011.

2 . LTR-LIS-10-373, "10 CFR 50.46 Report for the Evaluation of AP1000 SBLOCA 10-inch Transient Adiabatic Heat-up Calculation," June 2010.

Notes:

(a) This is an adiabatic heat-up calculated PCT.

Attachment 2

10 CFR 50.46 Annual Report for the AP1000 V.C. Summer Units 2 & 3 AOR, 2017 Model Year

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 [1].

Affected Evaluation Model(s)

1996 Westinghouse Best-Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM
1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

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

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

ERROR IN THE UPPER PLENUM FLUID VOLUME CALCULATION

Background

An error was found in the fluid volume calculation in the upper plenum where the support column outer diameter was being used instead of the inner diameter. The correction of this error leads to a reduction in the upper plenum fluid volume used in the **AP1000®** plant Small Break LOCA analyses. The corrected value represents a negligible change in the total reactor coolant system (RCS) fluid volume. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

The difference in the upper plenum fluid volume as a result of the error is extremely small (approximately 3 ft^3). The error will have a negligible impact on transient results due to the small magnitude of the change. As a result, the estimated PCT impact is 0°F.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

HENRY-FAUSKE / HOMOGENEOUS EQUILIBRIUM MODEL BREAK FLOW MODEL TABLE RANGE LIMITATIONS

Background

The Henry-Fauske / Homogeneous Equilibrium Model (HFHEM) break flow model is used in the NOTRUMP-AP600 evaluation model (EM) for the ADS Stage 1-4 flow paths. This break flow model utilizes a series of look up tables to determine the critical mass flux as a function of the stagnation pressure and stagnation enthalpy. The look up tables for the subcooled break flow have a limitation on subcooling (enthalpy) as well as pressure and the saturated break flow has a limitation on pressure. If the pressure or subcooling is exceeded, the critical mass flux will be truncated at the last value. This change represents a Non-Discretionary Change to the Evaluation Model as described in Section 4.1.2 of WCAP-13451 [1].

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

The **AP1000®** plant SBLOCA calculations were reviewed and it was determined that the use of the HFHEM break flow model falls within the model ranges. Therefore, the estimated Peak Cladding Temperature (PCT) impact is 0°F for the AP1000 plant.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

AP1000 PLANT LAR-114 EVALUATION

Background

The design changes associated with License Amendment Request (LAR) 114 are reductions to the automatic depressurization system (ADS) Stage 2, 3, and 4 flow areas. These changes impact the **AP1000®** small break loss-of-coolant accident (SBLOCA) analysis. These items represent changes in plant configuration or associated set points, distinguished from an evaluation model change in Section 4 of WCAP-13451 [1].

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

The updated ADS Stage 2, 3, and 4 flow areas were included in a simulation of the latest limiting SBLOCA transient to assess the combined impact of the design changes and concluded that the reduction in ADS Stage 2, 3, and 4 flow areas resulted in a 13°F PCT impact. As a result, a 13°F PCT penalty is assessed against the AP1000 Core Reference Report analysis [2].

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.
2. WCAP-17524-P-A, Revision 1, "AP1000 Core Reference Report," May 2015.

INCONSISTENT APPLICATION OF NUMERICAL RAMP APPLIED TO THE ENTRAINED LIQUID / VAPOR INTERFACIAL DRAG COEFFICIENT

Background

A numerical ramp which was used to account for the disappearance of the entrained liquid phase was applied to the entrained liquid / vapor interfacial drag coefficient. The numerical ramp was applied such that the interfacial drag coefficient used in the solution of the entrained liquid and vapor momentum equations was not consistent. WCOBRA/TRAC was updated to apply the numerical ramp prior to usage of the interfacial drag coefficient in the momentum equations, such that a consistent interfacial drag coefficient was used in the entrained liquid and vapor momentum equations.

This item represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

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 code validation results, the impact of correcting the error is estimated to have a 0°F impact on PCT.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

INAPPROPRIATE RESETTING OF TRANSVERSE LIQUID MASS FLOW

Background

In the WCOBRA/TRAC routine which evaluates the mass and energy residual error of the time step solution, the transverse liquid mass flow is reset as the liquid phase disappears. The routine is updated to remove the resetting of the transverse liquid mass flow since the routine is to only evaluate the residual error based on the time step solution values.

This item represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

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 code validation results and limited applicability of the logic removed, correcting the error is estimated to have a 0°F impact on PCT.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

STEADY-STATE FUEL TEMPERATURE CALIBRATION METHOD

Background

In the Automated Statistical Treatment of Uncertainty Method (ASTRUM) Best-Estimate (BE) Large-Break Loss-of-Coolant Accident (LBLOCA) Evaluation Model (EM), the steady-state fuel pellet temperature calibration method involves solving for the hot gap width (AGFACT) to calibrate the fuel temperature for each fuel rod. In some infrequent situations, small non-conservatisms can occur in the calibration process such that the resulting fuel pellet temperature will be slightly lower than intended and outside the acceptable range defined by Table 12-6 of WCAP-16009-P/NP-A [1].

This issue has been evaluated to estimate the impact on ASTRUM BE LBLOCA analysis results. The resolution of this issue represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [2].

Affected Evaluation Model(s)

2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

A review of licensing basis analyses concluded that the potential non-conservatisms in the fuel pellet temperature calibration did not occur for the limiting analysis cases. Therefore, an estimated PCT impact of 0°F is assigned for 10 CFR 50.46 reporting purposes.

References

1. WCAP-16009-P/NP-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment Of Uncertainty Method (ASTRUM)," January 2005.
2. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

AP1000 PLANT LAR-114 EVALUATION

Background

The design changes associated with License Amendment Request (LAR) 114 have been evaluated against the **AP1000®** Core Reference Report large break loss-of-coolant accident (LBLOCA) analysis performed in [1]. The evaluated design changes included changes to the ADS stage 2, 3, and 4 local flow areas. The LBLOCA ASTRUM model does not model the opening of ADS stages 1, 2, and 3, and the LBLOCA transients are terminated far before the actuation of ADS stage 4.

These items represent changes in plant configuration, distinguished from an evaluation model change in Section 4 of WCAP-13451 [2].

Affected Evaluation Model(s)

2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

A qualitative LBLOCA evaluation was performed to assess the impacts of the design changes included in LAR-114 to the ADS stage 2, 3, and 4 local flow areas. It was concluded that the design changes have no impact on the AP1000 plant Core Reference Report analysis [1]. Therefore, the estimated Peak Cladding Temperature (PCT) impact is 0°F for the AP1000 plant.

References

1. WCAP-17524-P-A, Revision 1, "AP1000 Core Reference Report," May 2015.
2. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

Westinghouse LOCA Peak Clad Temperature Summary for ASTRUM Best Estimate Large Break

Plant Name: AP1000 - V. C. Summer Units 2 & 3
Utility Name: South Carolina Electric & Gas
Revision Date: 3/1/2018

Analysis Information

EM:	ASTRUM (2004)	**Analysis Date:**	12/11/2012	**Limiting Break Size:**	DEG
FQ:	2.6	**FdH:**	1.72		
Fuel:	17x17 AP1000	**SGTP (%):**	10		

Notes: Plant specific adaptation of the ASTRUM EM which explicitly accounts for effects of thermal conductivity degradation and peaking factor burndown.

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	**1936**	**1**	**(a)**
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1 . Revised Heat Transfer Multiplier Distributions	11	2	
2 . Error in Burst Strain Application	23	3	
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1 . None	0		
C. 2017 ECCS MODEL ASSESSMENTS			
1 . None	0		
D. OTHER*			
1 . None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =** 1970		

* It is recommended that the licensee determine if these PCT allocations should be considered with respect to 10 CFR 50.46 reporting requirements.

References

1 . WCAP-17524-P-A, Revision 1, "AP1000 Core Reference Report," May 2015.

2 . LTR-LIS-13-357, "AP1000 Plant 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.

3 . LTR-LIS-14-41, "AP1000 Plant 10 CFR 50.46 Report for the HOTSPOT Burst Strain Error Correction," January 2014.

Notes:

(a) Value contains 2°F bias for PCT sensitivity to PRHR isolation, per Reference 1 response to CRR-008, Table 2 and Table 15.6.5-8.

Westinghouse LOCA Peak Clad Temperature Summary for Appendix K Small Break

Plant Name: AP1000 - V. C. Summer Units 2 & 3
Utility Name: South Carolina Electric & Gas
Revision Date: 3/1/2018

Analysis Information

EM:	NOTRUMP-AP	**Analysis Date:**	8/26/2013	**Limiting Break Size:**	2 Inch
FQ:	2.6	**FdH:**	1.75		
Fuel:	RFA	**SGTP (%):**	10		

Notes:

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	**663.5**	**1**	
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1 . NOTRUMP Bubble Rise/Drift Flux Model Inconsistencies	32	2	
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1 . LAR-114 Evaluation	13	3, 4, 5	(a)
C. 2017 ECCS MODEL ASSESSMENTS			
1 . None	0		
D. OTHER*			
1 . None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =** 708.5		

* It is recommended that the licensee determine if these PCT allocations should be considered with respect to 10 CFR 50.46 reporting requirements.

References

1 . WCAP-17524-P-A, Revision 1, "AP1000 Core Reference Report," May 2015.

2 . LTR-LIS-15-5, "Updates to the AP1000 Plant SBLOCA 10 CFR 50.46 PCT Rackups," January 2015.

3 . LTR-LIS-16-144, "Update to the AP1000 Plant SBLOCA 10 CFR 50.46 PCT Rackups for LAR-114," January 2017.

4 . LTR-LIS-18-53, "AP1000 Plant 10 CFR 50.46 Annual Notification and Reporting for 2017," March 2018.

5 . NND-16-0336 (ML16246A214), "Automatic Depressurization System (ADS) Stage 2, 3 & 4 Valve Flow Area Changes and Clarifications," September 2016. Approved by NRC March 17, 2017 as Amendment 64 (ML17039B008/ML17039B058).

Notes:

(a) The LAR-114 evaluation assesses the impact of reduced automatic depressurization system (ADS) Stage 2, 3, and 4 flow areas described in design change proposals (DCPs) 5051 and 5054.

Attachment 3

10 CFR 50.46 Annual Report for the AP1000 Vogtle Units 3 & 4 AOR, 2017 Model Year

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 [1].

Affected Evaluation Model(s)

1996 Westinghouse Best-Estimate Large Break LOCA Evaluation Model
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM
1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

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

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

ERROR IN THE UPPER PLENUM FLUID VOLUME CALCULATION

Background

An error was found in the fluid volume calculation in the upper plenum where the support column outer diameter was being used instead of the inner diameter. The correction of this error leads to a reduction in the upper plenum fluid volume used in the **AP1000®** plant Small Break LOCA analyses. The corrected value represents a negligible change in the total reactor coolant system (RCS) fluid volume. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

The difference in the upper plenum fluid volume as a result of the error is extremely small (approximately 3 ft^3). The error will have a negligible impact on transient results due to the small magnitude of the change. As a result, the estimated PCT impact is 0°F.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

HENRY-FAUSKE / HOMOGENEOUS EQUILIBRIUM MODEL BREAK FLOW MODEL TABLE RANGE LIMITATIONS

Background

The Henry-Fauske / Homogeneous Equilibrium Model (HFHEM) break flow model is used in the NOTRUMP-AP600 evaluation model (EM) for the ADS Stage 1-4 flow paths. This break flow model utilizes a series of look up tables to determine the critical mass flux as a function of the stagnation pressure and stagnation enthalpy. The look up tables for the subcooled break flow have a limitation on subcooling (enthalpy) as well as pressure and the saturated break flow has a limitation on pressure. If the pressure or subcooling is exceeded, the critical mass flux will be truncated at the last value. This change represents a Non-Discretionary Change to the Evaluation Model as described in Section 4.1.2 of WCAP-13451 [1].

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP.

Estimated Effect

The **AP1000®** plant SBLOCA calculations were reviewed and it was determined that the use of the HFHEM break flow model falls within the model ranges. Therefore, the estimated Peak Cladding Temperature (PCT) impact is 0°F for the AP1000 plant.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

INCONSISTENT APPLICATION OF NUMERICAL RAMP APPLIED TO THE ENTRAINED LIQUID / VAPOR INTERFACIAL DRAG COEFFICIENT

Background

A numerical ramp which was used to account for the disappearance of the entrained liquid phase was applied to the entrained liquid / vapor interfacial drag coefficient. The numerical ramp was applied such that the interfacial drag coefficient used in the solution of the entrained liquid and vapor momentum equations was not consistent. WCOBRA/TRAC was updated to apply the numerical ramp prior to usage of the interfacial drag coefficient in the momentum equations, such that a consistent interfacial drag coefficient was used in the entrained liquid and vapor momentum equations.

This item represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

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 code validation results, the impact of correcting the error is estimated to have a 0°F impact on PCT.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

INAPPROPRIATE RESETTING OF TRANSVERSE LIQUID MASS FLOW

Background

In the WCOBRA/TRAC routine which evaluates the mass and energy residual error of the time step solution, the transverse liquid mass flow is reset as the liquid phase disappears. The routine is updated to remove the resetting of the transverse liquid mass flow since the routine is to only evaluate the residual error based on the time step solution values.

This item represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [1].

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 code validation results and limited applicability of the logic removed, correcting the error is estimated to have a 0°F impact on PCT.

References

1. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

STEADY-STATE FUEL TEMPERATURE CALIBRATION METHOD

Background

In the Automated Statistical Treatment of Uncertainty Method (ASTRUM) Best-Estimate (BE) Large-Break Loss-of-Coolant Accident (LBLOCA) Evaluation Model (EM), the steady-state fuel pellet temperature calibration method involves solving for the hot gap width (AGFACT) to calibrate the fuel temperature for each fuel rod. In some infrequent situations, small non-conservatisms can occur in the calibration process such that the resulting fuel pellet temperature will be slightly lower than intended and outside the acceptable range defined by Table 12-6 of WCAP-16009-P/NP-A [1].

This issue has been evaluated to estimate the impact on ASTRUM BE LBLOCA analysis results. The resolution of this issue represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451 [2].

Affected Evaluation Model(s)

2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

A review of licensing basis analyses concluded that the potential non-conservatisms in the fuel pellet temperature calibration did not occur for the limiting analysis cases. Therefore, an estimated PCT impact of 0°F is assigned for 10 CFR 50.46 reporting purposes.

References

1. WCAP-16009-P/NP-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment Of Uncertainty Method (ASTRUM)," January 2005.
2. WCAP-13451, "Westinghouse Methodology for Implementation of 10 CFR 50.46 Reporting," October 1992.

Westinghouse LOCA Peak Clad Temperature Summary for ASTRUM Best Estimate Large Break

Plant Name: AP1000 - Vogtle Units 3 & 4
Utility Name: Southern Nuclear Operating Company
Revision Date: 3/1/2018

Analysis Information

EM:	ASTRUM (2004)	**Analysis Date:**	12/11/2012	**Limiting Break Size:**	DEG
FQ:	2.6	**FdH:**	1.72		
Fuel:	17x17 AP1000	**SGTP (%):**	10		

Notes: Plant specific adaptation of the ASTRUM EM which explicitly accounts for effects of thermal conductivity degradation and peaking factor burndown.

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	**1936**	**1**	**(a)**
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1 . Revised Heat Transfer Multiplier Distributions	11	2	
2 . Error in Burst Strain Application	23	3	
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1 . None	0		
C. 2017 ECCS MODEL ASSESSMENTS			
1 . None	0		
D. OTHER*			
1 . None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =** 1970		

* It is recommended that the licensee determine if these PCT allocations should be considered with respect to 10 CFR 50.46 reporting requirements.

References

1 . WCAP-17524-P-A, Revision 1, "AP1000 Core Reference Report," May 2015.

2 . LTR-LIS-13-357, "AP1000 Plant 10 CFR 50.46 Report for Revised Heat Transfer Multiplier Distributions," July 2013.

3 . LTR-LIS-14-41, "AP1000 Plant 10 CFR 50.46 Report for the HOTSPOT Burst Strain Error Correction," January 2014.

Notes:

(a) Value contains 2°F bias for PCT sensitivity to PRHR isolation, per Reference 1 response to CRR-008, Table 2 and Table 15.6.5-8.

Westinghouse LOCA Peak Clad Temperature Summary for Appendix K Small Break

Plant Name: AP1000 - Vogtle Units 3 & 4
Utility Name: Southern Nuclear Operating Company
Revision Date: 3/1/2018

Analysis Information

EM:	NOTRUMP-AP	**Analysis Date:**	8/26/2013	**Limiting Break Size:**	2 Inch
FQ:	2.6	**FdH:**	1.75		
Fuel:	RFA	**SGTP (%):**	10		
Notes:					

	Clad Temp (°F)	Ref.	Notes
LICENSING BASIS			
Analysis-Of-Record PCT	**663.5**	1	
PCT ASSESSMENTS (Delta PCT)			
A. PRIOR ECCS MODEL ASSESSMENTS			
1 . NOTRUMP Bubble Rise/Drift Flux Model Inconsistencies	32	2	
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1 . LAR-114 Evaluation	13	3, 4, 5	(a)
C. 2017 ECCS MODEL ASSESSMENTS			
1 . None	0		
D. OTHER*			
1 . None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =** 708.5		

* It is recommended that the licensee determine if these PCT allocations should be considered with respect to 10 CFR 50.46 reporting requirements.

References

1 . WCAP-17524-P-A, Revision 1, "AP1000 Core Reference Report," May 2015.

2 . LTR-LIS-15-5, "Updates to the AP1000 Plant SBLOCA 10 CFR 50.46 PCT Rackups," January 2015.

3 . LTR-LIS-16-144, "Update to the AP1000 Plant SBLOCA 10 CFR 50.46 PCT Rackups for LAR-114," January 2017.

4 . LTR-LIS-17-59, "AP1000 Plant 10 CFR 50.46 Annual Notification and Reporting for 2016," March 2017.

5 . ND-16-0984 (ML16207A340), "Automatic Depressurization System (ADS) Stage 2, 3 & 4 Valve Flow Area Changes and Clarifications (LAR-16-012)," July 2016. Approved by NRC December 29, 2016 as Amendment 62 (ML16357A640).

Notes:

(a) The LAR-114 evaluation assesses the impact of reduced automatic depressurization system (ADS) Stage 2, 3, and 4 flow areas described in design change proposals (DCPs) 5051 and 5054.