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Your ref: Docket No. 52-006
Our ref: DCP_NRC_003242

March 27, 2013

Subject: 10 CFR 50.46 Annual Report for the AP1000®[1] Standard 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 annual report to document any emergency core cooling system (ECCS) evaluation model changes or errors for the 2012 model year that affect the peak cladding temperature (PCT) calculations for the AP1000 standard plant design.

On December 30, 2011, the U.S. Nuclear Regulatory Commission amended its regulations to certify an amendment to the Design Certification rule for the AP1000. As such, AP1000 Design Control Document (DCD) Revision 19 now documents the analyses of record.

Westinghouse provided a 30 day reporting letter in June, 2012, to the NRC (DCP_NRC_003214) which documented the results of its evaluation of the effect of fuel thermal conductivity degradation and peaking factor burndown on the AP1000 Large Break Loss-of-Coolant Accident Analysis of Record presented in the DCD. The conclusion of the evaluation was that the estimated PCT impact was +139°F. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451. Information on this change is included in Attachment 1. Information on additional discretionary and non-discretionary changes is included in Attachment 1. There are no additional ASTRUM or NOTRUMP evaluation model changes for the 2012 model year from those reported in the last 10 CFR 50.46 report documented in letter DCP_NRC_003207, dated March 15, 2012.

The information included in this letter is generic and is expected to apply to all COL Holders and COL Applicants referencing the amended Design Certification Rule for the AP1000. 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).

[1] AP1000® is a registered trademark of Westinghouse Electric Company LLC, its subsidiaries and/or affiliates 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.

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NRO

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 Design amended Certification Rule for the AP1000. A representative for each COL Holder and COL Applicant is included on the cc: list of this letter.

Very truly yours,

Paul A. Russ, Director
U.S. Licensing and Regulatory Support
Licensing and Regulatory Affairs

/Attachment

1. 10 CFR 50.46 Annual Report

cc:

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R. Joshi	-	U.S. NRC
D.L. McGovern	-	U.S. NRC
B.M. Bavol	-	U.S. NRC
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D. Stout	-	TVA
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M. Leslie	-	Westinghouse
A. Colussy	-	Westinghouse
A. Gagnon	-	Westinghouse

Internal Reference: LTR-LIS-13-123

Attachment 1

10 CFR 50.46 Annual Report

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 (Reference 1).

Affected Evaluation Model(s)
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model for Application to PWRs with Upper Plenum Injection
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.

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

EVALUATION OF FUEL PELLET THERMAL CONDUCTIVITY DEGRADATION AND PEAKING FACTOR BURNDOWN

Background

Fuel pellet thermal conductivity degradation (TCD) and peaking factor burndown were not explicitly considered in the AP1000 Large Break Loss-of-Coolant Accident (LBLOCA) Analysis of Record (AOR) presented in AP1000 Design Control Document Revision 19 (Reference 1). NRC Information Notice 2011-21 (Reference 2) notified addressees of recent information obtained concerning the impact of irradiation on fuel thermal conductivity and its potential to cause significantly higher predicted peak cladding temperature (PCT) results in realistic emergency core cooling system (ECCS) evaluation models. This evaluation provides an estimated effect of TCD on PCT for the ECCS in the AP1000 plant design. This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model

2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

A quantitative evaluation which utilized the methodology described in Reference 3 was performed to assess the PCT effect of TCD and peaking factor burndown with other considerations of burnup and concluded that the estimated PCT impact on the AP1000 LBLOCA analysis presented in DCD Revision 19 is +139°F for 10 CFR 50.46 reporting purposes.

References

1. DCP_NRC_003177, "Westinghouse Electric Company – Updated Application to Amend the AP1000® Nuclear Power Plant Design Certification Rule," June 13, 2011.
2. NRC Information Notice 2011-21, McGinty, T.J., and Dudes, L. A., "Realistic Emergency Core Cooling System Evaluation Model Effects Resulting From Nuclear Fuel Thermal Conductivity Degradation," December 13, 2011. (NRC ADAMS #ML 113430785).
3. DCP_NRC_003214, "10 CFR 50.46 Thirty (30) Day Report for the AP1000® Standard Plant Design," June 13, 2012.

HOTSPOT BURST TEMPERATURE CALCULATION FOR ZIRLO CLADDING

Background
A problem was identified in the calculation of the burst temperature for **ZIRLO®**[2] 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 in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)
1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model for Application to PWRs with Upper Plenum Injection
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect
The evaluation of existing analyses demonstrated no impact on the overall Peak Cladding Temperature (PCT) results, leading to an estimated effect of 0°F.

[2] 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.

HOTSPOT ITERATION ALGORITHM FOR CALCULATING THE INITIAL FUEL PELLET AVERAGE TEMPERATURE

Background

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 in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model for Application to PWRs with Upper Plenum Injection
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect

Sample calculations and engineering judgment lead to an estimated Peak Cladding Temperature (PCT) impact of 0°F.

WCOBRA/TRAC AUTOMATED RESTART PROCESS LOGIC ERROR

Background
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. 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
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model for Application to PWRs with Upper Plenum Injection
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect
These errors were evaluated to have a negligible impact on the Large Break LOCA analysis results, leading to an estimated Peak Cladding Temperature (PCT) impact of 0°F.

ROD INTERNAL PRESSURE CALCULATION

Background
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 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 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 Peak Cladding Temperature (PCT) impact of 0°F.

MODELING OF THE PELLET CENTER HOLE VOLUME

Background
Various void volumes within the fuel rods are modeled in Large Break Loss-of-Coolant Accident (LOCA) analyses to calculate the rod internal pressure during the Large Break LOCA transient. For fuel rod designs which include annular pellets, one of the volumes modeled is the center hole volume inside the annular pellets. This center hole volume was not modeled in certain Automated Statistical Treatment of Uncertainty Method (ASTRUM) Large Break LOCA analyses. This discrepancy has been evaluated for impact on existing Large Break LOCA analysis results, and its resolution represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)
2004 Westinghouse Realistic Large Break LOCA Evaluation Model Using ASTRUM

Estimated Effect
This issue was judged to have a negligible impact on existing Large Break LOCA analysis results, leading to an estimated Peak Cladding Temperature (PCT) impact of 0°F.

WCOBRA/TRAC THERMAL-HYDRAULIC HISTORY FILE DIMENSION USED IN HSDRIVER

Background

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 in accordance with Section 4.1.1 of WCAP-13451.

Affected Evaluation Model(s)

1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model
1999 Westinghouse Best Estimate Large Break LOCA Evaluation Model for Application to PWRs with Upper Plenum Injection
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 PCT calculation for prior LBLOCA analyses, which leads to a PCT impact of 0°F.

ERRORS IN VARIOUS COMPONENT ELEVATIONS AND METAL MASSES

Background
Several closely related errors associated with various component elevations and metal masses were discovered in the AP1000 plant calculations. These errors have been evaluated and will be corrected in the future. 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)
1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect
These errors were evaluated as having a negligible impact on existing analyses, leading to an estimated Peak Cladding Temperature (PCT) impact of 0°F.

NOTRUMP-AP EM EVALUATION OF FUEL PELLET THERMAL CONDUCTIVITY DEGRADATION

Background

An evaluation has been completed to estimate the effect of fuel pellet thermal conductivity degradation (TCD) on peak cladding temperature (PCT) for the AP1000 plant licensed under the Design Control Document (DCD) using the 1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP (NOTRUMP-AP EM). This change represents a Non-Discretionary Change in accordance with Section 4.1.2 of WCAP-13451.

Affected Evaluation Model(s)

1985 Westinghouse Advanced Plant Small Break LOCA Evaluation Model with NOTRUMP

Estimated Effect

Based on the phenomena and physics of the SBLOCA transient, it is concluded that TCD has a negligible effect on the transient results, leading to an estimated PCT impact of 0°F.

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

Plant Name: AP1000
Utility Name: Westinghouse Nuclear Power Plants
Revision Date: 3/4/2013

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 . None	0		
B. PLANNED PLANT MODIFICATION EVALUATIONS			
1 . None	0		
C. 2012 ECCS MODEL ASSESSMENTS			
1 . Evaluation of Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	139	2	
D. OTHER*			
1 . None	0		
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =** 1976		

* 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, Tier 2, Chapter 15, "Design Certification Document: Accident analysis," 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.

Notes:

None

Westinghouse LOCA Peak Clad Temperature Summary for Appendix K Small Break

Plant Name: AP1000
Utility Name: Westinghouse Nuclear Power Plants
Revision Date: 3/4/2013

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. 2012 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, Tier 2, Chapter 15, "Design Certification Document: Accident Analysis," 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.