



June 27, 2017

U.S. Nuclear Regulatory Commission
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Washington, DC 20555

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DPR-32/37

DOMINION NUCLEAR CONNECTICUT, INC.
VIRGINIA ELECTRIC AND POWER COMPANY
MILLSTONE POWER STATION UNITS 2 AND 3
NORTH ANNA POWER STATION UNITS 1 AND 2
SURRY POWER STATION UNITS 1 AND 2
2016 ANNUAL REPORT OF EMERGENCY CORE COOLING SYSTEM (ECCS) MODEL
CHANGES PURSUANT TO THE REQUIREMENTS OF 10 CFR 50.46

In accordance with 10 CFR 50.46(a)(3)(ii), Dominion Nuclear Connecticut, Inc. and Virginia Electric and Power Company hereby submit the annual summary of permanent changes to the emergency core cooling system (ECCS) evaluation models for Millstone Power Station (MPS) Units 2 and 3, North Anna Power Station (NAPS) Units 1 and 2, and Surry Power Station (SPS) Units 1 and 2, respectively.

Attachment 1 of this letter provides a report describing plant-specific evaluation model changes associated with the Westinghouse and AREVA Small Break Loss of Coolant Accident (SBLOCA) and Large Break Loss of Coolant Accident (LBLOCA) ECCS evaluation models for MPS 2 and 3, NAPS 1 and 2, and SPS 1 and 2, as applicable.

Information regarding the effect of the ECCS evaluation model changes upon the reported SBLOCA and LBLOCA analyses of record results is provided for MPS 2 and 3, NAPS 1 and 2, and SPS 1 and 2 in Attachments 2, 3 and 4, respectively. The calculated peak cladding temperatures (PCT) for the SBLOCA and LBLOCA analyses for MPS 2 and 3, NAPS 1 and 2, and SPS 1 and 2 are summarized below:

Millstone Unit 2	Small break - AREVA Evaluation Model:	1711°F
Millstone Unit 2	Large break - AREVA Evaluation Model:	1845°F
Millstone Unit 3	Small break - Westinghouse Evaluation Model:	1193°F
Millstone Unit 3	Large break - Westinghouse Evaluation Model:	1933°F
North Anna Unit 1	Small break - Westinghouse Evaluation Model:	1834.1°F
North Anna Unit 1	Large break - Westinghouse Evaluation Model:	1982°F
North Anna Unit 2	Small break - Westinghouse Evaluation Model:	1834.1°F
North Anna Unit 2	Large break - Westinghouse Evaluation Model:	1982°F
Surry Units 1 and 2	Small break - Westinghouse Evaluation Model:	2012°F
Surry Units 1 and 2	Large break - Westinghouse Evaluation Model:	2071°F

ADDZ
NRR

The LOCA results for MPS 2 and 3, NAPS 1 and 2, and SPS 1 and 2 are confirmed to have margin to the 2200°F limit for PCT specified in 10 CFR 50.46. Based on the evaluation of this information and the resulting changes in the applicable licensing basis PCT results, no further action is required to demonstrate compliance with the 10 CFR 50.46 requirements.

The information contained herein satisfies the 2016 annual reporting requirements of 10 CFR 50.46(a)(3)(ii).

If you have any questions regarding this submittal, please contact Mr. Gary D. Miller at (804) 273-2771.

Respectfully,



Mark D. Sartain
Vice President - Nuclear Engineering and Fleet Support
Dominion Nuclear Connecticut, Inc.
Virginia Electric and Power Company

Commitments made in this letter: None

Attachments:

1. Report of Changes in AREVA and Westinghouse ECCS Evaluation Models
2. 2016 Annual Reporting of 10 CFR 50.46 Margin Utilization - Millstone Power Station Units 2 and 3
3. 2016 Annual Reporting of 10 CFR 50.46 Margin Utilization – North Anna Power Station Units 1 and 2
4. 2016 Annual Reporting of 10 CFR 50.46 Margin Utilization – Surry Power Station Units 1 and 2

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Attachment 1

**2016 ANNUAL REPORT OF EMERGENCY CORE
COOLING SYSTEM (ECCS) MODEL CHANGES
PURSUANT TO THE REQUIREMENTS OF 10 CFR 50.46**

**REPORT OF CHANGES IN
AREVA AND WESTINGHOUSE ECCS EVALUATION MODELS**

**DOMINION NUCLEAR CONNECTICUT, INC.
VIRGINIA ELECTRIC AND POWER COMPANY
MILLSTONE POWER STATION UNITS 2 AND 3
NORTH ANNA POWER STATION UNITS 1 AND 2
SURRY POWER STATION UNITS 1 AND 2**

**REPORT OF CHANGES IN
AREVA AND WESTINGHOUSE ECCS EVALUATION MODELS**

Millstone Power Station Unit 2

1. AREVA identified no changes or errors applicable to the 2002 S-RELAP5 based Small Break LOCA (SBLOCA) Evaluation Model for Millstone Unit 2 during 2016. This was the analysis of record in 2016 until the implementation of License Amendment 329 with the new SBLOCA analysis described in Item #2 below.
2. On September 30, 2016, a new SBLOCA analysis was approved by the NRC based upon EMF-2328(P)(A), Revision 0 with Supplement 1. That analysis was performed in support of introduction of the AREVA Standard CE14 HTP fuel product with M5™ fuel rod cladding. The new limiting break size resulted in a peak clad temperature (PCT) of 1707°F. Additionally, results were presented for the current fuel product with Zircaloy-4 (Zr-4) cladding. The Zr-4 necessitated a 4°F PCT penalty.
3. AREVA identified no changes or errors applicable to the SEM/PWR-98 evaluation model for Large Break LOCA (LBLOCA) for Millstone Unit 2 during 2016.
4. On January 24, 2017, a new LBLOCA analysis was approved by the NRC based upon the EMF-2103(P)(A), Revision 3, Realistic Large Break LOCA Methodology for Pressurized Water Reactors. The new analysis was applicable to the AREVA Standard CE14 HTP fuel product with M5™ fuel rod cladding only. The analysis predicted a PCT of 1615°F. As this fuel type will not be included in the Millstone 2 core until the spring of 2017, the margin utilization table for the realistic LBLOCA analysis is not included in this 2016 annual report.

Millstone Power Station (Millstone) Unit 3

1. Westinghouse identified no changes or errors to the 1985 Westinghouse SBLOCA Evaluation Model with NOTRUMP for Millstone Unit 3 during 2016.
2. Westinghouse identified the following changes and errors applicable to the 2004 Westinghouse Best Estimate (BE) LBLOCA Evaluation Model using the Automated Statistical Treatment of Uncertainty Method (ASTRUM) for Millstone Unit 3 during 2016:
 - **General Code Maintenance.** 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. The nature of these changes leads to an estimated PCT impact of 0°F.

- **Error in Oxidation Calculations.** A closely-related group of errors were discovered in the WCOBRA/TRAC software program. The errors are related to the calculation of high temperature oxidation within a realistic LBLOCA calculation. This issue has been evaluated to estimate the impact on the ASTRUM and the BE LBLOCA licensing basis analysis results. It was determined that correcting the high temperature oxidation calculation in WCOBRA/TRAC is estimated to have a negligible impact on the BE LBLOCA PCT analysis results, leading to an estimated PCT impact of 0°F.
 - **Error in use of ASME Steam Tables.** The American Society of Mechanical Engineers (ASME) steam tables are used to calculate the steady state upper head liquid temperature as a function of the pressure and specific enthalpy in the ASTRUM software program. The steam table applicable to steam/gas is used to determine the upper head fluid temperature. However, the water in the upper head is in the subcooled liquid state during normal operation (and the steady-state calculation). Therefore, the steam table applicable to liquid should be used to determine the upper head fluid temperature. This issue has been evaluated to estimate the impact on ASTRUM BE LBLOCA analysis results. It was determined that the temperatures calculated by the ASME steam tables applicable to the steam/gas side and the liquid side are very similar within the typical upper head pressure and liquid specific enthalpy ranges. Therefore, this error was evaluated to have a negligible impact on the ASTRUM BE LBLOCA analysis results, leading to an estimated PCT impact of 0°F.
3. A future plant change, the insertion of up to eight (8) AXIOM™ lead test assemblies (LTAs) into fuel cycle 19 was evaluated. The AXIOM™ cladding LTAs at Millstone Unit 3 will be non-limiting with respect to the Millstone Unit 3 LOCA analyses, leading to an estimated PCT impact of 0°F on the LBLOCA and SBLOCA analyses.

North Anna Power Station (North Anna) Units 1 and 2

1. For consistency with the completion of the fuel transition to Westinghouse fuel assemblies and Dominion's plans not to re-insert AREVA fuel assemblies into the North Anna cores, the PCT utilization tables for AREVA Evaluation Models have been deleted as stated in the Virginia Electric and Power Company letter to the NRC dated May 6, 2016 (ADAMS Accession No. ML16134A071) and as indicated below:

North Anna Unit 1 - Small break - AREVA Evaluation Model:	deleted
North Anna Unit 1 - Large break - AREVA Evaluation Model:	deleted
North Anna Unit 2 - Small break - AREVA Evaluation Model:	deleted
North Anna Unit 2 - Large break - AREVA Evaluation Model:	deleted

2. Westinghouse identified no changes or errors applicable to the 1985 Westinghouse SBLOCA Evaluation Model with NOTRUMP for North Anna Units 1 and 2 during 2016.

3. A design change (reactor vessel barrel/baffle upflow conversion) was completed for North Anna Unit 2 during the spring 2016 refueling outage. Westinghouse performed an evaluation and concluded the SBLOCA analysis of record performed with the NOTRUMP Evaluation Model continues to remain applicable to North Anna Unit 2 after the implementation of the upflow conversion. Therefore, no changes were made to the SBLOCA rack-up table for North Anna Unit 2 presented in Attachment 3. This information, regarding changes to the North Anna Unit 2 Evaluation Model in 2016, was transmitted to the NRC in the Virginia Electric and Power Company letter to the NRC dated May 6, 2016 (ADAMS Accession No. ML16134A071).
4. A design change (reactor vessel barrel/baffle upflow conversion) was completed for North Anna Unit 2 during the spring 2016 refueling outage. Westinghouse performed an evaluation to ensure the LBLOCA model for North Anna Unit 1, which has an upflow baffle/barrel configuration, is representative of Unit 2 subsequent to the upflow conversion. Westinghouse concluded that the LBLOCA analysis results for North Anna Unit 1 are also applicable to North Anna Unit 2. Therefore, the LBLOCA rackup table for North Anna Unit 2 presented in Attachment 3 is updated to reflect this change. This information, regarding changes to the North Anna Unit 2 Evaluation Model in 2016, was transmitted to the NRC in the Virginia Electric and Power Company letter to the NRC dated May 6, 2016 (ADAMS Accession No. ML16134A071).
5. Westinghouse identified the following changes or errors applicable to the 2004 Westinghouse BE LBLOCA Evaluation Model using ASTRUM for North Anna Units 1 and 2 during 2016:
 - **General Code Maintenance.** 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. The nature of these changes leads to an estimated PCT impact of 0°F.
 - **Error in Oxidation Calculations.** A closely-related group of errors were discovered in the WCOBRA/TRAC software program. The errors are related to the calculation of high temperature oxidation within a realistic LBLOCA calculation. This issue has been evaluated to estimate the impact on the ASTRUM and the BE LBLOCA licensing basis analysis results. It was determined that correcting the high temperature oxidation calculation in WCOBRA/TRAC is estimated to have a negligible impact on the BE LBLOCA peak cladding temperature (PCT) analysis results, leading to an estimated PCT impact of 0°F.

- **Error in use of ASME Steam Tables.** The ASME steam tables are used to calculate the steady state upper head liquid temperature as a function of the pressure and specific enthalpy in the ASTRUM software program. The steam table applicable to steam/gas is used to determine the upper head fluid temperature. However, the water in the upper head is in the subcooled liquid state during normal operation (and the steady-state calculation). Therefore, the steam table applicable to liquid should be used to determine the upper head fluid temperature. This issue has been evaluated to estimate the impact on ASTRUM BE LBLOCA analysis results. It was determined that the temperatures calculated by the ASME steam tables applicable to the steam/gas side and the liquid side are very similar within the typical upper head pressure and liquid specific enthalpy ranges. Therefore, this error was evaluated to have a negligible impact on the ASTRUM BE LBLOCA analysis results, leading to an estimated PCT impact of 0°F.
- **Support Column Unheated Conductor Error.** A modeling error was discovered in the support column unheated conductor in several BE LBLOCA analyses of record in which the metal thickness of the support columns in the upper plenum was underestimated. The heat transferred to the fluid from the support columns is small relative to the heat release from the core due to high fuel stored energy, decay heat, and since the upper plenum rapidly becomes a steam environment in a LBLOCA. Therefore, it does not significantly contribute to the transient response. The support column unheated conductor modeling error has been generically evaluated to have a negligible impact on the existing analyses, leading to an estimated PCT impact of 0°F.

Surry Power Station (Surry) Units 1 and 2

1. Westinghouse identified no changes or errors applicable to the 1985 Westinghouse SBLOCA Evaluation Model with NOTRUMP for Surry Units 1 and 2 during 2016.
2. Westinghouse identified the following changes or errors applicable to the 2004 Westinghouse BE LBLOCA Evaluation Model using ASTRUM for Surry Units 1 and 2 during 2016.
 - **General Code Maintenance.** 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. The nature of these changes leads to an estimated PCT impact of 0°F.
 - **Error in Oxidation Calculations.** A closely-related group of errors were discovered in the WCOBRA/TRAC software program. The errors are related to the calculation of high temperature oxidation within a realistic LBLOCA

calculation. This issue has been evaluated to estimate the impact on the ASTRUM and the BE LBLOCA licensing basis analysis results. It was determined that correcting the high temperature oxidation calculation in WCOBRA/TRAC is estimated to have a negligible impact on the BE LBLOCA PCT analysis results, leading to an estimated PCT impact of 0°F.

- **Error in use of ASME Steam Tables.** The ASME steam tables are used to calculate the steady state upper head liquid temperature as a function of the pressure and specific enthalpy in the ASTRUM software program. The steam table applicable to steam/gas is used to determine the upper head fluid temperature. However, the water in the upper head is in the subcooled liquid state during normal operation (and the steady-state calculation). Therefore, the steam table applicable to liquid should be used to determine the upper head fluid temperature. This issue has been evaluated to estimate the impact on ASTRUM BE LBLOCA analysis results. It was determined that the temperatures calculated by the ASME steam tables applicable to the steam/gas side and the liquid side are very similar within the typical upper head pressure and liquid specific enthalpy ranges. Therefore, this error was evaluated to have a negligible impact on the ASTRUM BE LBLOCA analysis results, leading to an estimated PCT impact of 0°F.
- **Core Barrel Unheated Conductor Errors.** Errors were discovered in modeling the core barrel in the vessel lower plenum within the BE LBLOCA analysis of record. An evaluation was performed to estimate the impact on the Surry Units 1 and 2 BE LBLOCA analysis. The modeling errors impacted the thermal resistance and stored energy of the core barrel. A qualitative evaluation concluded that the material modeled for the core barrel unheated conductor is adequate; therefore, this error was evaluated to have a negligible impact on the BE LBLOCA analysis results, leading to an estimated PCT impact of 0°F.
- **Discrepancy in Wetted Perimeter Inputs.** Inconsistencies were discovered in the wetted perimeter inputs in the upper plenum and upper head of the vessel model for the BE LBLOCA analysis of record. An evaluation was performed to estimate the impact on the Surry Units 1 and 2 BE LBLOCA analysis. A qualitative evaluation of the wetted perimeter at the bottom of the upper head concluded a negligible impact on the BE LBLOCA analysis results, leading to an estimated PCT impact of 0°F.

Conclusion

The LOCA results for Millstone Units 2 and 3, North Anna Units 1 and 2, and Surry Units 1 and 2 are confirmed in the PCT rack-up tables, Attachments 2 through 4, respectively, to have margin to the 2200°F limit for PCT specified in 10 CFR 50.46. Based on the evaluation of this information and the resulting changes in the applicable licensing basis PCT results, no further action is required to demonstrate compliance

with the 10 CFR 50.46 requirements. Reporting of this information is required per 10 CFR 50.46(a)(3)(ii), which obligates each licensee to report the effect upon calculated temperature of any change or error in evaluation models or their application on an annual basis.

This information satisfies the annual reporting requirements of 10 CFR 50.46(a)(3)(ii) for calendar year 2016.

Attachment 2

**2016 ANNUAL REPORT OF EMERGENCY CORE
COOLING SYSTEM (ECCS) MODEL CHANGES
PURSUANT TO THE REQUIREMENTS OF 10 CFR 50.46**

2016 ANNUAL REPORTING OF 10 CFR 50.46 MARGIN UTILIZATION

**DOMINION NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNITS 2 AND 3**

10 CFR 50.46 MARGIN UTILIZATION - SMALL BREAK LOCA

Plant Name: Millstone Power Station, Unit 2
Utility Name: Dominion Nuclear Connecticut, Inc.

Analysis Information

EM: 2015, Supp. 1, SBLOCA, S-RELAP5 Based **Limiting Break Size:** 3.78 Inches
Analysis Date: April 2015
Vendor: AREVA
Peak Linear Power: 15.1 kW/ft
Notes: None

	<u>Clad Temp(°F)</u>
LICENSING BASIS	
Analysis of Record PCT	1707
PCT ASSESSMENTS (Delta PCT)	
A. Prior ECCS Model Assessments	
1. Zirc-4 Product Penalty	4
B. Planned Plant Modification Evaluations	
1. None	0
C. 2016 ECCS Model Assessments	
1. None	0
D. Other	
1. None	0
LICENSING BASIS PCT + PCT ASSESSMENTS	PCT = 1711

10 CFR 50.46 MARGIN UTILIZATION - LARGE BREAK LOCA

Plant Name: Millstone Power Station, Unit 2
Utility Name: Dominion Nuclear Connecticut, Inc.

Analysis Information

EM: SEM/PWR-98 **Limiting Break Size:** 1.0 DECLG
Analysis Date: 11/98
Vendor: AREVA
Peak Linear Power: 15.1 kW/ft
Notes: None

Clad Temp (°F)

LICENSING BASIS

Analysis of Record PCT

1814

PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments

- | | | |
|-----|--|----|
| 1. | Corrected Corrosion Enhancement Factor | -1 |
| 2. | ICECON Coding Errors | 0 |
| 3. | Setting RFPAC Fuel Temperatures at Start of Reflood | -2 |
| 4. | SISPUNCH/ujun98 Code Error | 0 |
| 5. | Error in Flow Blockage Model in TOODEE2 | 0 |
| 6. | Change in TOODEE2-Calculation of QMAX | 0 |
| 7. | Change in Gadolinia Modeling | 0 |
| 8. | PWR LBLOCA Split Break Modeling | 0 |
| 9. | TEOBY Calculation Error | 0 |
| 10. | Inappropriate Heat Transfer in TOODEE2 | 0 |
| 11. | End-of-Bypass Prediction by TEOBY | 0 |
| 12. | R4SS Overwrite of Junction Inertia | 0 |
| 13. | Incorrect Junction Inertia Multipliers | 1 |
| 14. | Errors Discovered During RODEX2 V&V | 0 |
| 15. | Error in Broken Loop SG Tube Exit Junction Inertia | 0 |
| 16. | RFPAC Refill and Reflood Calculation Code Errors | 16 |
| 17. | Incorrect Pump Junction Area Used in RELAP4 | 0 |
| 18. | Error in TOODEE2 Clad Thermal Expansion | -1 |
| 19. | Accumulator Line Loss Error | -1 |
| 20. | Inconsistent Loss Coefficients Used for Robinson LBLOCA | 0 |
| 21. | Pump Head Adjustment for Pressure Balance Initialization | -3 |
| 22. | ICECON Code Errors | 0 |
| 23. | Containment Sump Modification and Replacement PZR | 2 |
| 24. | Non-Conservative RODEX Fuel Pellet Temperature | 20 |
| 25. | Array Index Issues in the RELAP4 Code | 0 |

B. Planned Plant Modification Evaluations

- | | | |
|----|------|---|
| 1. | None | 0 |
|----|------|---|

C. 2016 ECCS Model Assessments

- | | | |
|----|------|---|
| 1. | None | 0 |
|----|------|---|

D. Other

1. None

0

LICENSING BASIS PCT + PCT ASSESSMENTS

PCT = 1845

10 CFR 50.46 MARGIN UTILIZATION - SMALL BREAK LOCA

Plant Name:	Millstone Power Station, Unit 3		
Utility Name:	Dominion Nuclear Connecticut, Inc.		
<u>Analysis Information</u>			
EM:	NOTRUMP	Limiting Break Size:	4 inches
Analysis Date:	02/07/07		
Vendor:	Westinghouse		
FQ:	2.6	FdH:	1.65
Fuel:	RFA-2	SGTP (%):	10
Notes:	None		

	<u>Clad Temp (°F)</u>
LICENSING BASIS	
Analysis of Record PCT	1193
PCT ASSESSMENTS (Delta PCT)	
A. Prior ECCS Model Assessments	
1. Errors in Reactor Vessel Lower Plenum Surface Area Calculations	0
2. Discrepancy in Metal Masses Used From Drawings	0
3. Urania-Gadolinia Pellet Thermal Conductivity Calculation	0
4. Pellet Crack and Dish Volume Calculation	0
5. Treatment of Vessel Average Temperature Uncertainty	0
6. Maximum Fuel Rod Time Step Logic	0
7. Radiation Heat Transfer Logic	0
8. NOTRUMP-EM Evaluation of Fuel Pellet Thermal Conductivity Degradation	0
9. SBLOCA Cladding Strain Requirement for Fuel Rod Burst	0
10. Fuel Rod Gap Conductance Error	0
11. Radiation Heat Transfer Model Error	0
12. SBLOCTA Pre-DNB Cladding Heat Transfer Coefficient Calculation	0
B. Planned Plant Modification Evaluations	
1. Insertion of AXIOM™ Cladding LTAs	0
C. 2016 ECCS Model Assessments	
1. None	0
D. Other	
1. None	0
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LICENSING BASIS PCT + PCT ASSESSMENTS	PCT = 1193

10 CFR 50.46 MARGIN UTILIZATION - LARGE BREAK LOCA

Plant Name:	Millstone Power Station, Unit 3		
Utility Name:	Dominion Nuclear Connecticut, Inc.		
<u>Analysis Information</u>			
EM:	ASTRUM (2004)	Limiting Break Size:	Guillotine
Analysis Date:	04/17/07		
Vendor:	Westinghouse		
FQ:	2.6	FdH:	1.65
Fuel:	RFA-2	SGTP (%):	10
Notes:	None		

Clad Temp (°F)

LICENSING BASIS

Analysis of Record PCT	1781
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PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments

- | | | |
|-----|---|-----|
| 1. | HOTSPOT Burst Temperature Logic Errors | 0 |
| 2. | CCFL Global Volume Error | 0 |
| 3. | HOTSPOT Gap Heat Transfer Logic | 0 |
| 4. | Discrepancy in Metal Masses Used From Drawings | 0 |
| 5. | Error in ASTRUM Processing of Average Rod Burnup and Rod Internal Pressure | 0 |
| 6. | Treatment of Vessel Average Temperature Uncertainty | 0 |
| 7. | PBOT and PMID Evaluation | 0 |
| 8. | Evaluation of Fuel Pellet Thermal Conductivity Degradation | 222 |
| 9. | HOTSPOT Burst Temperature Calculation for ZIRLO Cladding | 0 |
| 10. | Rod Internal Pressure Calculation | 0 |
| 11. | HOTSPOT Iteration Algorithm for Calculating the Initial Fuel Pellet Average Temperature | 0 |
| 12. | WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER Background | 0 |
| 13. | WCOBRA/TRAC Automated Restart Process Logic Error | 0 |
| 14. | Initial Fuel Pellet Average Temperature Uncertainty Calculation | 0 |
| 15. | Elevations for Heat Slab Temperature Initialization | 0 |
| 16. | Heat Transfer Model Error Corrections | 0 |
| 17. | Correction to Heat Transfer Node Initialization | 0 |
| 18. | Mass Conservation Error Fix | 0 |
| 19. | Correction to Split Channel Momentum Equation | 0 |
| 20. | Heat Transfer Logic Correction for Rod Burst Calculation | 0 |
| 21. | Changes to Vessel Superheated Steam Properties | 0 |
| 22. | Update to Metal Density Reference Temperatures | 0 |
| 23. | Decay Heat Model Error Corrections | 0 |
| 24. | Correction to the Pipe Exit Pressure Drop Error | 0 |

25.	WCOBRA/TRAC U19 File Dimension Error Correction	0
26.	Revised Heat Transfer Multiplier Distributions	-91
27.	HOTSPOT Burst Strain Error Correction	21
28.	Changes to Grid Blockage Ratio and Porosity	0
29.	Grid Heat Transfer Enhancement Calculation	0
30.	Burst Elevation Selection	0
31.	Errors in Decay Group Uncertainty Factors	0
32.	Errors in Support Plate, Core Barrel, and Vessel Wall Unheated Conductor	0
B.	Planned Plant Modification Evaluations	
1.	Insertion of AXIOM™ Cladding LTAs	0
C.	2016 ECCS Model Assessments	
1.	Error in Oxidation Calculations	0
2.	Error in use of ASME Steam Tables	0
D.	Other	
1.	None	0

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1933
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Attachment 3

**2016 ANNUAL REPORT OF EMERGENCY CORE
COOLING SYSTEM (ECCS) MODEL CHANGES
PURSUANT TO THE REQUIREMENTS OF 10 CFR 50.46**

2016 ANNUAL REPORTING OF 10 CFR 50.46 MARGIN UTILIZATION

**VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2**

10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE SMALL BREAK LOCA

Plant Name:	North Anna Power Station, Unit 1		
Utility Name:	Virginia Electric and Power Company		
<u>Analysis Information</u>			
EM:	NOTRUMP	Limiting Break Size:	2.75 inches
Analysis Date:	12/20/2010		
Vendor:	Westinghouse		
FQ:	2.32	FΔH:	1.65
Fuel:	RFA-2	SGTP (%):	7
Notes:	None		

	<u>Clad Temp (°F)</u>
LICENSING BASIS	
Analysis of Record PCT	1834.1

PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments		
1. NOTRUMP-EM Evaluation of Fuel Pellet Thermal Conductivity Degradation	0	
2. SBLOCTA Cladding Strain Requirement for Fuel Rod Burst	0	
3. Fuel Rod Gap Conductance Error	0	
4. Radiation Heat Transfer Model Error	0	
5. SBLOCTA Pre-DNB Cladding Heat Transfer Coefficient Calculation	0	
B. Planned Plant Modification Evaluations		
1. None	0	
C. 2016 ECCS Model Assessments		
1. None	0	
D. Other		
1. None	0	

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1834.1
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10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE LARGE BREAK LOCA

Plant Name:	North Anna Power Station, Unit 1		
Utility Name:	Virginia Electric and Power Company		
<u>Analysis Information</u>			
EM:	ASTRUM (2004)	Limiting Break Size:	DEGB
Analysis Date:	8/25/2010		
Vendor:	Westinghouse		
FQ:	2.32	FAH:	1.65
Fuel:	RFA-2	SGTP (%):	7
Notes:	Core Power ≤ 100% of 2951 MWt; SG Model 54F; 17x17 RFA-2 Fuel with ZIRLO® or Optimized ZIRLO™ cladding, Non-IFBA or IFBA, IFMs		

	<u>Clad Temp (°F)</u>
LICENSING BASIS	
Analysis of Record PCT	1852

PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments	
1. Evaluation of Fuel Pellet Thermal Conductivity Degradation	135
2. HOTSPOT Burst Temperature Calculation for ZIRLO Cladding	0
3. Rod Internal Pressure Calculation	0
4. HOTSPOT Iteration Algorithm for Calculating the Initial Fuel Pellet Average Temperature	0
5. WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER Background	0
6. WCOBRA/TRAC Automated Restart Process Logic Error	0
7. Initial Fuel Pellet Average Temperature Uncertainty Calculation	1
8. Elevations for Heat Slab Temperature Initialization	0
9. Heat Transfer Model Error Corrections	0
10. Correction to Heat Transfer Node Initialization	0
11. Mass Conservation Error Fix	0
12. Correction to Split Channel Momentum Equation	0
13. Heat Transfer Logic Correction for Rod Burst Calculation	0
14. Changes to Vessel Superheated Steam Properties	0
15. Update to Metal Density Reference Temperatures	0
16. Decay Heat Model Error Corrections	0
17. Correction to the Pipe Exit Pressure Drop Error	0
18. WCOBRA/TRAC U19 File Dimension Error Correction	0
19. Revised Heat Transfer Multiplier Distributions	-27
20. HOTSPOT Burst Strain Error Correction	21
21. Changes to Grid Blockage Ratio and Porosity	0
22. Grid Heat Transfer Enhancement Calculation	0

23.	Vessel Section 7 Mid-Level Elevation Modeling	0
24.	Burst Elevation Selection	0
25.	Errors in Decay Group Uncertainty Factors	0
B.	Planned Plant Modification Evaluations	
1.	None	0
C.	2016 ECCS Model Assessments	
1.	Error in Oxidation Calculations	0
2.	Error in use of ASME Steam Tables	0
3.	Support Column Core Barrel Unheated Conductor Errors	0
D.	Other	
1.	Transition Core	0

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1982
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10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE SMALL BREAK LOCA

Plant Name:	North Anna Power Station, Unit 2		
Utility Name:	Virginia Electric and Power Company		
<u>Analysis Information</u>			
EM:	NOTRUMP	Limiting Break Size:	2.75 inches
Analysis Date:	12/20/2010		
Vendor:	Westinghouse		
FQ:	2.32	FAH:	1.65
Fuel:	RFA-2	SGTP (%):	7
Notes:	None		

	<u>Clad Temp (°F)</u>
LICENSING BASIS	
Analysis of Record PCT	1834.1

PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments		
1. NOTRUMP-EM Evaluation of Fuel Pellet Thermal Conductivity Degradation	0	
2. SBLOCTA Cladding Strain Requirement for Fuel Rod Burst	0	
3. Fuel Rod Gap Conductance Error	0	
4. Radiation Heat Transfer Model Error	0	
5. SBLOCTA Pre-DNB Cladding Heat Transfer Coefficient Calculation	0	
B. Planned Plant Modification Evaluations		
1. None	0	
C. 2016 ECCS Model Assessments		
1. None	0	
D. Other		
1. None	0	

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1834.1
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10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE LARGE BREAK LOCA

Plant Name:	North Anna Power Station, Unit 2		
Utility Name:	Virginia Electric and Power Company		
<u>Analysis Information</u>			
EM:	ASTRUM (2004)	Limiting Break Size:	DEGB
Analysis Date:	8/25/2010		
Vendor:	Westinghouse		
FQ:	2.32	FAH:	1.65
Fuel:	RFA-2	SGTP (%):	7
Notes:	Core Power \leq 100% of 2951 MWt; SG Model 54F; 17x17 RFA-2 Fuel with ZIRLO® or Optimized ZIRLO™ cladding, Non-IFBA or IFBA, IFMs		

Clad Temp (°F)

LICENSING BASIS

Analysis of Record PCT	1852
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PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments

1.	Evaluation of Fuel Pellet Thermal Conductivity Degradation	135
2.	HOTSPOT Burst Temperature Calculation for ZIRLO Cladding	0
3.	Rod Internal Pressure Calculation	0
4.	HOTSPOT Iteration Algorithm for Calculating the Initial Fuel Pellet Average Temperature	0
5.	WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER Background	0
6.	WCOBRA/TRAC Automated Restart Process Logic Error	0
7.	Initial Fuel Pellet Average Temperature Uncertainty Calculation	1
8.	Elevations for Heat Slab Temperature Initialization	0
9.	Heat Transfer Model Error Corrections	0
10.	Correction to Heat Transfer Node Initialization	0
11.	Mass Conservation Error Fix	0
12.	Correction to Split Channel Momentum Equation	0
13.	Heat Transfer Logic Correction for Rod Burst Calculation	0
14.	Changes to Vessel Superheated Steam Properties	0
15.	Update to Metal Density Reference Temperatures	0
16.	Decay Heat Model Error Corrections	0
17.	Correction to the Pipe Exit Pressure Drop Error	0
18.	WCOBRA/TRAC U19 File Dimension Error Correction	0
19.	Revised Heat Transfer Multiplier Distributions	-27
20.	HOTSPOT Burst Strain Error Correction	21
21.	Changes to Grid Blockage Ratio and Porosity	0

22.	Grid Heat Transfer Enhancement Calculation	0
23.	Vessel Section 7 Mid-Level Elevation Modeling	0
24.	Burst Elevation Selection	0
25.	Errors in Decay Group Uncertainty Factors	0
B.	Planned Plant Modification Evaluations	
1.	None	0
C.	2016 ECCS Model Assessments	
1.	Error in Oxidation Calculations	0
2.	Error in use of ASME Steam Tables	0
3.	Support Column Core Barrel Unheated Conductor Errors	0
D.	Other	
1.	Transition Core	0

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	1982
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Attachment 4

**2016 ANNUAL REPORT OF EMERGENCY CORE
COOLING SYSTEM (ECCS) MODEL CHANGES
PURSUANT TO THE REQUIREMENTS OF 10 CFR 50.46**

2016 ANNUAL REPORTING OF 10 CFR 50.46 MARGIN UTILIZATION

**VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2**

10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE SMALL BREAK LOCA

Plant Name:	Surry Power Station, Unit 1		
Utility Name:	Virginia Electric and Power Company		
<u>Analysis Information</u>			
EM:	NOTRUMP	Limiting Break Size:	2.75 inches
Analysis Date:	5/7/2009		
Vendor:	Westinghouse		
FQ:	2.5	FΔH:	1.7
Fuel:	Upgrade	SGTP (%):	7
Notes:	None		

	<u>Clad Temp (°F)</u>
LICENSING BASIS	
Analysis of Record PCT	2012
PCT ASSESSMENTS (Delta PCT)	
A. Prior ECCS Model Assessments	
1. Urania-Gadolinia Pellet Thermal Conductivity Calculation.	0
2. Pellet Crack and Dish Volume Calculation.	0
3. Treatment of Vessel Average Temperature Uncertainty	0
4. 15X15 Upgrade Fuel	0
5. Maximum Fuel Rod Time Step Logic	0
6. Radiation Heat Transfer Logic	0
7. NOTRUMP-EM Evaluation of Fuel Pellet Thermal Conductivity Degradation	0
8. SBLOCTA Cladding Strain Requirement for Fuel Rod Burst	0
9. Fuel Rod Gap Conductance Error	0
10. Radiation Heat Transfer Model Error	0
11. SBLOCTA Pre-DNB Cladding Heat Transfer Coefficient Calculation	0
B. Planned Plant Modification Evaluations	
1. None	0
C. 2016 ECCS Model Assessments	
1. None	0
D. Other	
1. None	0
LICENSING BASIS PCT + PCT ASSESSMENTS	
PCT =	2012

10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE LARGE BREAK LOCA

Plant Name:	Surry Power Station, Unit 1		
Utility Name:	Virginia Electric and Power Company		
Analysis Information			
EM:	ASTRUM (2004)	Limiting Break Size:	DEG
Analysis Date:	10/6/2010		
Vendor:	Westinghouse		
FQ:	2.5	FAH:	1.7
Fuel:	Upgrade	SGTP (%):	7
Notes:	None		

	<u>Clad Temp (°F)</u>
LICENSING BASIS	
Analysis of Record PCT	1853

PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments

1.	Evaluation of Fuel Pellet Thermal Conductivity Degradation	183
2.	Pellet Radial Profile Option	-13
3.	HOTSPOT Burst Temperature Calculation for ZIRLO Cladding	0
4.	Rod Internal Pressure Calculation	0
5.	HOTSPOT Iteration Algorithm for Calculating the Initial Fuel Pellet Average Temperature	0
6.	WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER Background	0
7.	WCOBRA/TRAC Automated Restart Process Logic Error	0
8.	Initial Fuel Pellet Average Temperature Uncertainty Calculation	0
9.	Elevations for Heat Slab Temperature Initialization	0
10.	Heat Transfer Model Error Corrections	0
11.	Correction to Heat Transfer Node Initialization	0
12.	Mass Conservation Error Fix	0
13.	Correction to Split Channel Momentum Equation	0
14.	Heat Transfer Logic Correction for Rod Burst Calculation	0
15.	Changes to Vessel Superheated Steam Properties	0
16.	Update to Metal Density Reference Temperatures	0
17.	Decay Heat Model Error Corrections	0
18.	Correction to the Pipe Exit Pressure Drop Error	0
19.	WCOBRA/TRAC U19 File Dimension Error Correction	0
20.	Revised Heat Transfer Multiplier Distributions	-7
21.	HOTSPOT Burst Strain Error Correction	51
22.	Changes to Grid Blockage Ratio and Porosity	0
23.	Grid Heat Transfer Enhancement Calculation	0

24.	Vessel Section 7 Mid-Level Elevation Modeling	0
25.	Burst Elevation Selection	0
26.	Errors in Decay Group Uncertainty Factors	4
B.	Planned Plant Modification Evaluations	
1.	Evaluation of Additional Containment Metal	0
C.	2016 ECCS Model Assessments	
1.	Error in Oxidation Calculations	0
2.	Error in use of ASME Steam Tables	0
3.	Core Barrel Unheated Conductor Errors	0
4.	Discrepancy in Wetted Perimeter Inputs	0
D.	Other	
1.	None	0

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	2071
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10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE SMALL BREAK LOCA

Plant Name:	Surry Power Station, Unit 2		
Utility Name:	Virginia Electric and Power Company		
<u>Analysis Information</u>			
EM:	NOTRUMP	Limiting Break Size:	2.75 inches
Analysis Date:	5/7/2009		
Vendor:	Westinghouse		
FQ:	2.5	FAH:	1.7
Fuel:	Upgrade	SGTP (%):	7
Notes:	None		

LICENSING BASIS	<u>Clad Temp (°F)</u>
Analysis of Record PCT	2012

PCT ASSESSMENTS (Delta PCT)

A.	Prior ECCS Model Assessments	
	1. Urania-Gadolinia Pellet Thermal Conductivity Calculation	0
	2. Pellet Crack and Dish Volume Calculation	0
	3. Treatment of Vessel Average Temperature Uncertainty	0
	4. 15X15 Upgrade Fuel	0
	5. Maximum Fuel Rod Time Step Logic	0
	6. Radiation Heat Transfer Logic	0
	7. NOTRUMP-EM Evaluation of Fuel Pellet Thermal Conductivity Degradation	0
	8. SBLOCTA Cladding Strain Requirement for Fuel Rod Burst	0
	9. Fuel Rod Gap Conductance Error	0
	10. Radiation Heat Transfer Model Error	0
	11. SBLOCTA Pre-DNB Cladding Heat Transfer Coefficient Calculation	0
B.	Planned Plant Modification Evaluations	
	1. None	0
C.	2016 ECCS Model Assessments	
	1. None	0
D.	Other	
	1. None	0

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	2012
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10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE LARGE BREAK LOCA

Plant Name:	Surry Power Station, Unit 2		
Utility Name:	Virginia Electric and Power Company		
<u>Analysis Information</u>			
EM:	ASTRUM (2004)	Limiting Break Size:	DEG
Analysis Date:	10/6/2010		
Vendor:	Westinghouse		
FQ:	2.5	FΔH:	1.7
Fuel:	Upgrade	SGTP (%):	7
Notes:	None		

Clad Temp (°F)

LICENSING BASIS

Analysis of Record PCT	1853
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PCT ASSESSMENTS (Delta PCT)

A. Prior ECCS Model Assessments

1.	Evaluation of Fuel Pellet Thermal Conductivity Degradation	183
2.	Pellet Radial Profile Option	-13
3.	HOTSPOT Burst Temperature Calculation for ZIRLO Cladding	0
4.	Rod Internal Pressure Calculation	0
5.	HOTSPOT Iteration Algorithm for Calculating the Initial Fuel Pellet Average Temperature	0
6.	WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER Background	0
7.	WCOBRA/TRAC Automated Restart Process Logic Error	0
8.	Initial Fuel Pellet Average Temperature Uncertainty Calculation	0
9.	Elevations for Heat Slab Temperature Initialization	0
10.	Heat Transfer Model Error Corrections	0
11.	Correction to Heat Transfer Node Initialization	0
12.	Mass Conservation Error Fix	0
13.	Correction to Split Channel Momentum Equation	0
14.	Heat Transfer Logic Correction for Rod Burst Calculation	0
15.	Changes to Vessel Superheated Steam Properties	0
16.	Update to Metal Density Reference Temperatures	0
17.	Decay Heat Model Error Corrections	0
18.	Correction to the Pipe Exit Pressure Drop Error	0
19.	WCOBRA/TRAC U19 File Dimension Error Correction	0
20.	Revised Heat Transfer Multiplier Distributions	-7
21.	HOTSPOT Burst Strain Error Correction	51
22.	Changes to Grid Blockage Ratio and Porosity	0
23.	Grid Heat Transfer Enhancement Calculation	0

24.	Vessel Section 7 Mid-Level Elevation Modeling	0
25.	Burst Elevation Selection	0
26.	Errors in Decay Group Uncertainty Factors	4
B.	Planned Plant Modification Evaluations	
1.	Evaluation of Additional Containment Metal	0
C.	2016 ECCS Model Assessments	
1.	Error in Oxidation Calculations	0
2.	Error in use of ASME Steam Tables	0
3.	Core Barrel Unheated Conductor Errors	0
4.	Discrepancy in Wetted Perimeter Inputs	0
D.	Other	
1.	None	0

LICENSING BASIS PCT + PCT ASSESSMENTS	PCT =	2071
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