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DOMINION ENERGY NUCLEAR CONNECTICUT, INC
VIRGINIA ELECTRIC AND POWER COMPANY
DOMINION ENERGY SOUTH CAROLINA, INC
MILLSTONE POWER STATION UNITS 2 AND 3
NORTH ANNA POWER STATION UNITS 1 AND 2
SURRY POWER STATION UNITS 1 AND 2
VIRGIL C. SUMMER NUCLEAR STATION UNIT 1
2021 ANNUAL REPORT OF EMERGENCY CORE COOLING SYSTEM (ECCS) MODEL CHANGES PURSUANT TO THE REQUIREMENT OF 10 CFR 50.46

Pursuant to the provisions of 10 CFR 50.46(a)(3)(ii), Dominion Energy Nuclear Connecticut, Inc. (DENC), Virginia Electric and Power Company (Dominion Energy Virginia), and Dominion Energy South Carolina, Inc. (DESC) hereby submit the annual summary of permanent changes to the emergency core cooling system (ECCS) evaluation models (EMs) for Millstone Power Station (MPS) Units 2 and 3, North Anna Power Station (NAPS) Units 1 and 2, Surry Power Station (SPS) Units 1 and 2, and Virgil C. Summer Nuclear Station (VCSNS) Unit 1, respectively.

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

Information regarding the effect of the ECCS EM changes upon the reported SBLOCA and LBLOCA analysis of record results is provided for MPS 2 and 3, NAPS 1 and 2, SPS 1 and 2, and VCSNS 1 in Attachment 2, 3, 4 and 5, respectively. The calculated peak cladding temperature (PCT) for the SBLOCA and LBLOCA analysis for MPS 2 and 3, NAPS 1 and 2, SPS 1 and 2, and VCSNS 1 are summarized below:

Millstone Unit 2	Small break – Framatome EM:	1714°F
Millstone Unit 2	Large break – Framatome EM (Zr4 fuel):	1845°F
Millstone Unit 2	Large break – Framatome EM (M5 fuel):	1615°F
Millstone Unit 3	Small break – Westinghouse EM:	1193°F

Millstone Unit 3	Large break – Westinghouse EM:	1933°F
North Anna Units 1 and 2	Small break – Westinghouse EM:	1834.1°F
North Anna Units 1 and 2	FVI Small break – Framatome EM:	1801°F
North Anna Units 1 and 2	Large break – Westinghouse EM:	1982°F
Surry Units 1 and 2	Small break – Westinghouse EM:	2012°F
Surry Units 1 and 2	FVI Small break – Framatome EM:	1673°F
Surry Units 1 and 2	Large break – Westinghouse EM:	2071°F
Virgil C. Summer Unit 1	Small break – Westinghouse EM:	1923°F
Virgil C. Summer Unit 1	Westinghouse Full Spectrum LOCA EM Region I Small break:	1108°F
Virgil C. Summer Unit 1	Large break – Westinghouse EM:	
	Blowdown:	1814°F
	Reflood 1:	1814°F
	Reflood 2:	1961°F
	Composite:	1961°F
Virgil C. Summer Unit 1	Westinghouse FSLOCA EM Region II large break:	1879°F

The LOCA results for MPS 2 and 3, NAPS 1 and 2, SPS 1 and 2, and VCSNS 1 are confirmed to have sufficient 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 2021 annual reporting requirements of 10 CFR 50.46(a)(3)(ii).

Should you have any questions regarding this submittal, please contact Yan Gao at (804) 273-2768.

Respectfully,

Wayne M. Adams
Director – Nuclear Engineering and Fuel
Dominion Energy Nuclear Connecticut, Inc.
Virginia Electric and Power Company
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Commitments made in this letter: None.

Attachments:

1. Report of Changes in Framatome and Westinghouse ECCS Evaluation Models
2. 2021 Annual Reporting of 10 CFR 50.46 Margin Utilization – Millstone Power Station Units 2 and 3
3. 2021 Annual Reporting of 10 CFR 50.46 Margin Utilization – North Anna Power Station Units 1 and 2
4. 2021 Annual Reporting of 10 CFR 50.46 Margin Utilization – Surry Power Station Units 1 and 2
5. 2021 Annual Reporting of 10 CFR 50.46 Margin Utilization – Virgil C. Summer Nuclear Station Unit 1

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Electronically Distributed

Attachment 1

REPORT OF CHANGES IN FRAMATOME AND WESTINGHOUSE ECCS EVALUATION MODELS

Millstone Power Station Units 2 and 3
North Anna Power Station Units 1 and 2
Surry Power Station Units 1 and 2
Virgil C. Summer Nuclear Station Unit 1
Dominion Energy Nuclear Connecticut, Inc.
Virginia Electric and Power Company
Dominion Energy South Carolina, Inc.

REPORT OF CHANGES IN FRAMATOME AND WESTINGHOUSE ECCS EVALUATION MODELS

MILLSTONE POWER STATION UNIT 2

1. Framatome identified no changes or errors applicable to the EMF-2328(P)(A) Revision 0, with Supplement 1 evaluation model for Small Break LOCA (SBLOCA) for Millstone Unit 2 during 2021.
2. Framatome identified no changes or errors applicable to the SEM/PWR-98 evaluation model for Large Break LOCA (LBLOCA) for Millstone Unit 2 during 2021. This evaluation model is applicable to the Millstone Unit 2 fuel with Zr-4 cladding.
3. 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 (RLBLOCA) Methodology for Pressurized Water Reactors." The new analysis is applicable to the AREVA Standard CE14 HTP fuel product with the M5™ fuel rod cladding only. The analysis predicted a PCT of 1615°F.

   Framatome identified no changes or errors applicable to the EMF-2103(P)(A), Revision 3, evaluation model for RLBLOCA for Millstone Unit 2 during 2021.

MILLSTONE POWER STATION UNIT 3

1. Westinghouse identified the following changes applicable to the 1985 Westinghouse SBLOCA Evaluation Model with NOTRUMP for Millstone Unit 3 during 2021:

- **Reduction in Flow Area to the Bottom of the Barrel/Baffle Region**

  For plants without holes in the edge of the lower core plate, the flow area from the bottom of the core to the barrel/baffle region has historically been modeled as the gap between the baffle plate and the lower core plate, and this flow area did not consider the reduced flow area due to the presence of the bottom nozzle flow skirt. The impact of reducing the flow area between the core and barrel baffle region due to including the bottom nozzle flow skirt has been qualitatively evaluated. The evaluation determined that considering a reduced flow area from the bottom of the core to the barrel/baffle region when considering the bottom nozzle flow skirt has a negligible effect on the SBLOCA analysis results, leading to an estimated peak cladding temperature (PCT) impact of 0°F.

- **Measurement Uncertainty Recapture (MUR) Uprate**

  The Analysis of Record was examined for the impact of a planned MUR which will be implemented in Cycle 22. It was determined that the MUR would have a 0° impact on the SBLOCA PCT.

2. Westinghouse identified the following change applicable to the 2004 Westinghouse Best Estimate (BE) LBLOCA Evaluation Model (EM) using the Automated Statistical Treatment of Uncertainty Method (ASTRUM) for Millstone Unit 3 during 2021:

- **Measurement Uncertainty Recapture (MUR) Uprate**

  The Analysis of Record was examined for the impact of a planned MUR which will be implemented in Cycle 22. As discussed in the MUR LAR, a reduction in peaking factors fully offsets the impact of the MUR power increase on the MPS3 ASTRUM BE LBLOCA AOR. Therefore, the MUR would have a 0°F impact on the BE LBLOCA PCT.

NORTH ANNA POWER STATION UNITS 1 AND 2

1. Westinghouse identified the following change applicable to the 1985 Westinghouse SBLOCA Evaluation Model with NOTRUMP for North Anna Units 1 and 2 during 2021:

- **Reduction in Flow Area to the Bottom of the Barrel/Baffle Region**

  For plants without holes in the edge of the lower core plate, the flow area from the bottom of the core to the barrel/baffle region has historically been modeled as the gap between the baffle plate and the lower core plate, and this flow area did not consider the reduced flow area due to the presence of the bottom nozzle flow skirt. The impact of reducing the flow area between the core and barrel baffle region due to including the bottom nozzle flow skirt has been qualitatively evaluated. The evaluation determined that considering a reduced flow area from the bottom of the core to the barrel/baffle region when considering the bottom nozzle flow skirt has a negligible effect on the SBLOCA analysis results, leading to an estimated peak cladding temperature (PCT) impact of 0°F.

2. On March 19, 2021, a new Fuel Vendor Independent (FVI) SBLOCA analysis was approved by the NRC based upon the Framatome Topical Report EMF-2328(P)(A), Revision 0, PWR [pressurized water reactor] Small Break LOCA [loss-of-coolant accident] Evaluation Model, S-RELAP5 Based. The analysis predicted a PCT of 1801°F. This analysis became the Analysis of Record during 2021.

   Framatome identified no changes or errors applicable to the EMF-2328(P)(A), Revision 0, PWR Small Break LOCA EM using S-RELAP5 for North Anna Units 1 and 2 during 2021.

3. Westinghouse identified no changes or errors applicable to the 2004 Westinghouse BE LBLOCA EM using ASTRUM for North Anna Units 1 and 2 during 2021.

SURRY POWER STATION UNITS 1 AND 2

1. Westinghouse identified the following change applicable to the 1985 Westinghouse SBLOCA Evaluation Model with NOTRUMP for Surry Units 1 and 2 during 2021:

- **Reduction in Flow Area to the Bottom of the Barrel/Baffle Region**

  For plants without holes in the edge of the lower core plate, the flow area from the bottom of the core to the barrel/baffle region has historically been modeled as the gap between the baffle plate and the lower core plate, and this flow area did not consider the reduced flow area due to the presence of the bottom nozzle flow skirt. The impact of reducing the flow area between the core and barrel baffle region due to including the bottom nozzle flow skirt has been qualitatively evaluated. The evaluation determined that considering a reduced flow area from the bottom of the core to the barrel/baffle region when considering the bottom nozzle flow skirt has a negligible effect on the SBLOCA analysis results, leading to an estimated peak cladding temperature (PCT) impact of 0°F.

2. On March 19, 2021, a new Fuel Vendor Independent (FVI) SBLOCA analysis was approved by the NRC based upon the Framatome Topical Report EMF-2328(P)(A), Revision 0, PWR [pressurized water reactor] Small Break LOCA [loss-of-coolant accident] Evaluation Model, S-RELAP5 Based. The analysis predicted a PCT of 1673°F. This analysis became the Analysis of Record during 2021.

   Framatome identified the following error applicable to the EMF-2328(P)(A), Revision 0, PWR Small Break LOCA EM using S-RELAP5 for Surry Units 1 and 2 during 2021:

- **SBLOCA Rod History Truncation (FVI-SBLOCA downflow baffle)**

  Framatome topical EMF-2328(P)(A), for W&CE SBLOCA methods, specifies that the end of first cycle rod conditions are to be used. This is done by running RODEX2-2A with the identified power history and then truncating it to a point which exceeds the targeted end of-cycle (EOC) rod average burnup. The SBLOCA analysis guidelines were not explicitly followed in preparing the RODEX2-2A initialization for the Surry FVI-SBLOCA analysis of record (downflow baffle). The result was that the RODEX2-2A initialization was truncated prior to reaching the desired target rod average burnup.

  Properties such as pin pressure and gap conductance would differ depending on the truncation. However, the difference is <3000 MWd/MTU and the SBLOCA event itself has a strong impact on the evolution of the properties and significance of the difference. The differences in fuel rod properties between the RODEX initialization time-in-cycle point used in the analysis and that prescribed by the guidance is negligible in consideration of the SBLOCA event. The ΔPCT for the Surry Units 1 and 2 FVI-SBLOCA analysis (downflow baffle) is 0°F.

3. Westinghouse identified no changes or errors applicable to the 2004 Westinghouse BE LBLOCA EM using ASTRUM for Surry Units 1 and 2 during 2021.

VIRGIL C. SUMMER NUCLEAR STATION UNIT 1

1. Westinghouse identified the following change applicable to the 1985 Westinghouse SBLOCA Evaluation Model with NOTRUMP for Virgil C. Summer during 2021:

- **Reduction in Flow Area to the Bottom of the Barrel/Baffle Region**

  For plants without holes in the edge of the lower core plate, the flow area from the bottom of the core to the barrel/baffle region has historically been modeled as the gap between the baffle plate and the lower core plate, and this flow area did not consider the reduced flow area due to the presence of the bottom nozzle flow skirt. The impact of reducing the flow area between the core and barrel baffle region due to including the bottom nozzle flow skirt has been qualitatively evaluated. The evaluation determined that considering a reduced flow area from the bottom of the core to the barrel/baffle region when considering the bottom nozzle flow skirt has a negligible effect on the SBLOCA analysis results, leading to an estimated peak cladding temperature (PCT) impact of 0°F.

2. On June 20, 2021, a new analysis was approved by the NRC based upon the Westinghouse Topical Report WCAP-16996-P-A, Revision 1, "Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FSLOCA)." The new SBLOCA AOR analysis is defined as the Region I spectrum. The analysis predicted a PCT of 1108°F which includes a 12°F correction to account for gamma energy redistribution. This analysis became the Analysis of Record during 2021.

   Westinghouse identified no changes or errors applicable to the WCAP-16996-P-A Region I EM for VCSNS during 2021.

3. Westinghouse identified no changes or errors applicable to the 1996 Westinghouse Best Estimate Large Break LOCA Evaluation Model for Virgil C. Summer during 2021.

4. On June 20, 2021, a new analysis was approved by the NRC based upon the Westinghouse Topical Report WCAP-16996-P-A, Revision 1, "Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FSLOCA)." The new LBLOCA AOR analysis is defined as the Region II spectrum. The analysis predicted a PCT of 1879°F which includes a 31°F correction to account for gamma energy redistribution. This analysis became the Analysis of Record during 2021.

   Westinghouse identified no changes or errors applicable to the WCAP-16996-P-A Region II EM for VCSNS during 2021.

CONCLUSION

The LOCA results for Millstone Units 2 and 3, North Anna Units 1 and 2, Surry Units 1 and 2 and Virgil C. Summer Unit 1 are confirmed in the PCT rackup tables, Attachments 2 through 5, 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 2021.

Attachment 2

2021 ANNUAL REPORTING OF 10 CFR 50.46 MARGIN UTILIZATION – 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 Energy 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		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT	1707
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	Zirc-4 Product Penalty	4
2.	M5 LOCA Swelling and Rupture	0
3.	S-RELAP5 Oxidation Calculations	3
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	None	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =**	**1714**

10 CFR 50.46 MARGIN UTILIZATION - LARGE BREAK LOCA

Plant Name:	Millstone Power Station, Unit 2		
Utility Name:	Dominion Energy Nuclear Connecticut, Inc.		
Analysis Information			
EM:	SEM/PWR-98	**Limiting Break Size:**	1.0 DECLG
Analysis Date:	November 1998		
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.	**2021 ECCS Model Assessments**	
1. None		0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =**	**1845**

10 CFR 50.46 MARGIN UTILIZATION - LARGE BREAK LOCA

Plant Name:	Millstone Power Station, Unit 2 (M5 Fuel)		
Utility Name:	Dominion Energy Nuclear Connecticut, Inc.		
Analysis Information			
EM:	EMF-2103	Limiting Break Size:	1.0 DEGB
Analysis Date:	January 2017		
Vendor:	AREVA		
Peak Linear Power:	15.1 kW/ft		
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT	1615
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	Placement of Hot Leg Piping Form Loss Coefficient	0
2.	M5 LOCA Swelling and Rupture	0
3.	S-RELAP5 Oxidation Calculations	0
4.	Cathcart-Pawel correlation implementation	0
5.	Rod pressure not reset after rupture in S-RELAP5 LOCA calculations	0
6.	Radiation enclosure input error	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	None	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =**	**1615**

10 CFR 50.46 MARGIN UTILIZATION - SMALL BREAK LOCA

Plant Name:	Millstone Power Station, Unit 3		
Utility Name:	Dominion Energy Nuclear Connecticut, Inc.		
Analysis Information			
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		

		Clad Temp (°F)
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.	SBLOCTA 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
13.	Insertion of AXIOM™ Cladding LTAs	0
14.	Vessel Average Temperature Uncertainty	0
15.	Error in the Upper Plenum Fluid Volume Calculation	0
16.	UO_2 Fuel Pellet Heat Capacity	0
17.	Small Break LOCA PAD5 Implementation	0
B.	**Planned Plant Modification Evaluations**	
1.	Measurement Uncertainty Recapture Uprate	0
C.	**2021 ECCS Model Assessments**	
1.	Reduction in Flow Area to the Bottom of the Barrel/Baffle Region	0
D.	**Other**	
1.	None	0
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 Energy Nuclear Connecticut, Inc.		
Analysis Information			
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
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	0

		Unheated Conductor	
	33.	Error in Oxidation Calculations	0
	34.	Error in use of ASME Steam Tables	0
	35.	Insertion of AXIOM™ Cladding LTAs	0
	36.	Vessel Average Temperature Uncertainty	0
	37.	Inconsistent Application of Numerical Ramp Applied to the Entrained Liquid / Vapor Interfacial Drag Coefficient	0
	38.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	39.	Steady-State Fuel Temperature Calibration Method	0
	40.	Millstone Unit 3 Cycle 20 PBOT/PMID Violations	0
	41.	Vapor Temperature Resetting	0
	42.	Core Barrel Heat Slab Error	0
	43.	Cold Leg Volume Error	0
	44.	Core Barrel Wetted Perimeter Error	0
	45.	Removal of the Vessel Interfacial Heat Transfer Limit	0
	46.	Cycle 21 PBOT/PMID Envelope Violations	0
B.	**Planned Plant Modification Evaluations**		
	1.	Measurement Uncertainty Recapture Uprate	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**1933**

Attachment 3

2021 ANNUAL REPORTING OF 10 CFR 50.46 MARGIN UTILIZATION – NORTH ANNA POWER STATION UNITS 1 AND 2

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		
Analysis Information			
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		

		Clad Temp (°F)
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.	SBLOCA 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
6.	Error in the Upper Plenum Fluid Volume Calculation	0
7.	UO_2 Fuel Pellet Heat Capacity	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	Reduction in Flow Area to the Bottom of the Barrel/Baffle Region	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT = 1834.1**

10 CFR 50.46 MARGIN UTILIZATION – FRAMATOME FVI SMALL BREAK LOCA

Plant Name:	North Anna Power Station, Unit 1		
Utility Name:	Virginia Electric and Power Company		
Analysis Information			
EM:	W&CE SBLOCA EMF-2328	**Limiting Break Size:**	6.5 inches
Analysis Date:	May 2018		
Vendor:	Framatome		
FQ:	2.5	**FΔH:**	1.65
Fuel:	Representative 17x17 Non-M5	**SGTP (%):**	7
Notes:	None		

	Clad Temp (°F)
LICENSING BASIS	
Analysis of Record PCT	1801
PCT ASSESSMENTS (Delta PCT)	
A. Prior ECCS Model Assessments	
1. None	0
B. Planned Plant Modification Evaluations	
1. None	0
C. 2021 ECCS Model Assessments	
1. None	0
D. Other	
1. None	0
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT = 1801**

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		
Analysis Information			
EM:	ASTRUM (2004)	**Limiting Break Size:**	DEGB
Analysis Date:	8/25/2010		
Vendor:	Westinghouse		
FQ:	2.32	**FΔH:**	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

		Clad Temp (°F)
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
26.	Error in Oxidation Calculations	0
27.	Error in use of ASME Steam Tables	0
28.	Support Column Core Barrel Unheated Conductor Errors	0

	29.	Inconsistent Application of Numerical Ramp Applied to the Entrained Liquid / Vapor Interfacial Drag Coefficient	0
	30.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	31.	Steady-State Fuel Temperature Calibration Method	0
	32.	Correction to Fuel Pellet TCD Assessment	0
	33.	Vapor Temperature Resetting	0
	34.	Removal of the Vessel Interfacial Heat Transfer Limit	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**1982**

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		
Analysis Information			
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		

		Clad Temp (°F)
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
6.	Error in the Upper Plenum Fluid Volume Calculation	0
7.	UO_2 Fuel Pellet Heat Capacity	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	Reduction in Flow Area to the Bottom of the Barrel/Baffle Region	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT = 1834.1**

10 CFR 50.46 MARGIN UTILIZATION – FRAMATOME FVI SMALL BREAK LOCA

Plant Name:	North Anna Power Station, Unit 2		
Utility Name:	Virginia Electric and Power Company		
Analysis Information			
EM:	W&CE SBLOCA EMF-2328	**Limiting Break Size:**	6.5 inches
Analysis Date:	May 2018		
Vendor:	Framatome		
FQ:	2.5	**FΔH:**	1.65
Fuel:	Representative 17x17 Non-M5	**SGTP (%):**	7
Notes:	None		

		Clad Temp (°F)
LICENSING BASIS		
	Analysis of Record PCT	1801
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	None	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	None	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =** 1801

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		
Analysis Information			
EM:	ASTRUM (2004)	**Limiting Break Size:**	DEGB
Analysis Date:	8/25/2010		
Vendor:	Westinghouse		
FQ:	2.32	**FΔH:**	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

		Clad Temp (°F)
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
27.	Error in Oxidation Calculations	0
28.	Error in use of ASME Steam Tables	0

	29.	Support Column Core Barrel Unheated Conductor Errors	0
	30.	Inconsistent Application of Numerical Ramp Applied to the Entrained Liquid / Vapor Interfacial Drag Coefficient	0
	31.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	32.	Steady-State Fuel Temperature Calibration Method	0
	33.	Correction to Fuel Pellet TCD Assessment	0
	34.	Vapor Temperature Resetting	0
	35.	Removal of the Vessel Interfacial Heat Transfer Limit	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	

LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =**	**1982**

Attachment 4

2021 ANNUAL REPORTING OF 10 CFR 50.46 MARGIN UTILIZATION – SURRY POWER STATION UNITS 1 AND 2

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		
Analysis Information			
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		

			Clad Temp (°F)
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
	12.	Error in the Upper Plenum Fluid Volume Calculation	0
	13.	UO_2 Fuel Pellet Heat Capacity	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	Reduction in Flow Area to the Bottom of the Barrel/Baffle Region	0
D.	**Other**		
	1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**2012**

10 CFR 50.46 MARGIN UTILIZATION – FRAMATOME FVI SMALL BREAK LOCA

Plant Name:	Surry Power Station, Unit 1		
Utility Name:	Virginia Electric and Power Company		
Analysis Information			
EM:	W&CE SBLOCA EMF-2328	**Limiting Break Size:**	2.6 inches
Analysis Date:	July 2018		
Vendor:	Framatome		
FQ:	2.5	**FΔH:**	1.70
Fuel:	Representative 15x15 Non-M5	**SGTP (%):**	7
Notes:	None		

		Clad Temp (°F)
LICENSING BASIS		
	Analysis of Record PCT	1673
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	None	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	SBLOCA Rod History Truncation (FVI-SBLOCA downflow baffle)	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		PCT = 1673

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	**FΔH:**	1.7
Fuel:	Upgrade	**SGTP (%):**	7
Notes:	None		

		Clad Temp (°F)
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
27.	Evaluation of Additional Containment Metal	0
28.	Error in Oxidation Calculations	0
29.	Error in use of ASME Steam Tables	0
30.	Core Barrel Unheated Conductor Errors	0

	31.	Discrepancy in Wetted Perimeter Inputs	0
	32.	Inconsistent Application of Numerical Ramp Applied to the Entrained Liquid / Vapor Interfacial Drag Coefficient	0
	33.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	34.	Steady-State Fuel Temperature Calibration Method	0
	35.	Vapor Temperature Resetting	0
	36.	Removal of the Vessel Interfacial Heat Transfer Limit	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**2071**

10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE SMALL BREAK LOCA

Plant Name:	Surry Power Station, Unit 2		
Utility Name:	Virginia Electric and Power Company		
Analysis Information			
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		

		Clad Temp (°F)
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
12.	Error in the Upper Plenum Fluid Volume Calculation	0
13.	UO2 Fuel Pellet Heat Capacity	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	Reduction in Flow Area to the Bottom of the Barrel/Baffle Region	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT = 2012**

10 CFR 50.46 MARGIN UTILIZATION – FRAMATOME FVI SMALL BREAK LOCA

Plant Name:	Surry Power Station, Unit 2		
Utility Name:	Virginia Electric and Power Company		
Analysis Information			
EM:	W&CE SBLOCA EMF-2328	**Limiting Break Size:**	2.6 inches
Analysis Date:	July 2018		
Vendor:	Framatome		
FQ:	2.5	**FΔH:**	1.70
Fuel:	Representative 15x15 Non-M5	**SGTP (%):**	7
Notes:	None		

		Clad Temp (°F)
LICENSING BASIS		
	Analysis of Record PCT	1673
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	None	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	SBLOCA Rod History Truncation (FVI-SBLOCA downflow baffle)	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		PCT = 1673

10 CFR 50.46 MARGIN UTILIZATION - WESTINGHOUSE LARGE BREAK LOCA

Plant Name:	Surry Power Station, Unit 2		
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	**FΔH:** 1.7	
Fuel:	Upgrade	**SGTP (%):** 7	
Notes:	None		

		Clad Temp (°F)
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
27.	Evaluation of Additional Containment Metal	0
28.	Error in Oxidation Calculations	0
29.	Error in use of ASME Steam Tables	0
30.	Core Barrel Unheated Conductor Errors	0
31.	Discrepancy in Wetted Perimeter Inputs	0

	32.	Inconsistent Application of Numerical Ramp Applied to the Entrained Liquid / Vapor Interfacial Drag Coefficient	0
	33.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	34.	Steady-State Fuel Temperature Calibration Method	0
	35.	Vapor Temperature Resetting	0
	36.	Removal of the Vessel Interfacial Heat Transfer Limit	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**2071**

Attachment 5

2021 ANNUAL REPORTING OF 10 CFR 50.46 MARGIN UTILIZATION – VIRGIL C. SUMMER NUCLEAR STATION

10 CFR 50.46 Margin Utilization – Appendix K Small Break

Plant Name:	V. C. Summer		
Utility Name:	Dominion Energy South Carolina		
Analysis Information			
EM:	**NOTRUMP**	**Limiting Break Size:**	**3 Inch**
Analysis Date:	February 2003		
Vendor:	Westinghouse		
FQ:	**2.45**	**FdH:**	**1.62**
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT	1775
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	NOTRUMP-EM Refined Break Spectrum	0
2.	Errors in Reactor Vessel Nozzle Data Collections	0
3.	Pump Weir Resistance Modeling	0
4	Errors in Reactor Vessel Lower Plenum Surface Area Calculations	0
5.	Modeling of Annular Pellets	0
6.	Discrepancy in Metal Masses Used From Drawings	0
7.	V. C. Summer Upflow Conversion	148
8.	Treatment of Vessel Average Temperature Uncertainty	0
9.	Urania-Gadolinia Pellet Thermal Conductivity Calculation	0
10.	Pellet Crack and Dish Volume Calculation	0
11.	Radiation Heat Transfer Logic	0
12.	Maximum Fuel Rod Time Step Logic	0
13.	NOTRUMP-EM Evaluation of Fuel Pellet Thermal Conductivity Degradation	0
14.	SBLOCTA Cladding Strain Requirement for Fuel Rod Burst	0
15.	Fuel Rod Gap Conductance Error	0
16.	Radiation Heat Transfer Model Error	0
17.	SBLOCTA Pre-DNB Cladding Surface Heat Transfer Coefficient Calculation	0
18.	Control Rod Drop Time Technical Specification Change	0
19.	Vessel Average Temperature Uncertainty	0
20.	Error in the Upper Plenum Fluid Volume Calculation	0
21.	UO2 Fuel Pellet Heat Capacity	0
22.	Increased Vessel Average Temperature Uncertainty	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	Reduction in Flow Area to the Bottom of the Barrel/Baffle Region	0

D.	**Other**		
	1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**1923**

10 CFR 50.46 Margin Utilization – FSLOCA Region I - Small Break

Plant Name:	V. C. Summer		
Utility Name:	Dominion Energy South Carolina		
Analysis Information			
EM:	**FSLOCA**	**Limiting Break Size:**	**2.6 Inch**
Analysis Date:	January 2019		
Vendor:	Westinghouse		
FQ:	**2.5**	**FdH:**	**1.70**
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT (Including gamma energy redistribution)	1108
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	None	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	None	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT = 1108**

10 CFR 50.46 Margin Utilization – Best Estimate Large Break, BLOWDOWN

Plant Name:	V. C. Summer		
Utility Name:	Dominion Energy South Carolina		
Analysis Information			
EM:	**CQD (1996)**	**Limiting Break Size:**	**DEGB**
Analysis Date:	February 2003		
Vendor:	Westinghouse		
FQ:	**2.5**	**FdH:**	**1.7**
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT	1860
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	Fan Cooler Performance Increase	0
2.	Improved Automation of End of Blowdown Time	0
3.	Implementation of ASTRUM Capability in HOTSPOT	0
4	Revised Blowdown Heatup Uncertainty Distribution	49
5.	Revised Iteration Algorithm for Calculating The Average Fuel Temperature	0
6.	Improved Automation of End of Blowdown Time	0
7.	Thermodynamic Properties from Thermo	0
8.	Pressurizer Fluid Volumes	0
9.	Vessel Unheated Conductor Noding	0
10.	Containment Relative Humidity Assumption	0
11.	HOTSPOT Fuel Relocation	0
12.	Steam Generator Nozzle Volume Accounting Error	0
13.	Cold Leg Volume Discrepancy	0
14.	Errors in Reactor Vessel Nozzle Data Collection	0
15.	HOTSPOT Burst Temperature Logic Errors	0
16.	V. C. Summer Upflow Conversion	-7
17.	Zero Cross-Flow Boundary Condition Error	0
18.	Discrepancy in Metal Masses Used From Drawings	0
19.	HOTSPOT Gap Heat Transfer Logic	0
20.	HOTSPOT Statistical Output Logic	0
21.	Treatment of Vessel Average Temperature Uncertainty	0
22.	Additional Heat Sinks and Maximum Spray Flow	0
23.	Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	0
24.	PAD 4.0 Implementation	-83
25.	Zero Cross-Flow Boundary Condition Error	0
26.	HOTSPOT Burst Temperature Calculation For ZIRLO Cladding	0
27.	HOTSPOT Iteration Algorithm for Calculating The Initial Fuel Pellet Average Temperature	0
28.	WCOBRA/TRAC Automated Restart Process Logic Error	0
29.	Rod Internal Pressure Calculation	0
30.	WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER	0
31.	Burst Elevation Selection	0
32.	Elevation for Heat Slab Temperature Initialization	0

	33.	Heat Transfer Logic for Rod Burst Calculation	0
	34.	WCOBRA/TRAC U19 File Dimension Error Correction	0
	35.	Heat Transfer Model Error Corrections	0
	36.	Correction to Heat Transfer Node Initialization	0
	37.	Mass Conservation Error Fix	0
	38.	Correction to Split Channel Momentum Equation	0
	39.	Changes to Vessel Superheated Steam Properties	0
	40.	Update to Metal Density Reference Temperatures	0
	41	Decay Heat Model Error Correction	0
	42.	Correction to the Pipe Exit Pressure Drop Error	0
	43.	Vessel Section 7 Mid-Level Elevation Modeling	0
	44.	Grid Heat Transfer Enhancement Calculation	0
	45.	Revised Heat Transfer Multiplier Distributions	-5
	46.	Changes to Grid Blockage Ratio and Porosity	0
	47.	Error in Burst Strain Application	0
	48.	Code Uncertainty in BE LBLOCA Monte Carlo Simulations	0
	49.	Error in Oxidation Calculations	0
	50.	Support Column Unheated Conductor Error	0
	51.	Vessel Average Temperature Uncertainty	0
	52.	Numerical Ramp Entrained Liquid/Vapor Interfacial Drag	0
	53.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	54.	Vapor Temperature Resetting	0
	55.	Removal of the Vessel Interfacial Heat Transfer Limit	0
	56.	Increased Vessel Average Temperature Uncertainty	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**1814**

10 CFR 50.46 Margin Utilization – Best Estimate Large Break, REFLOOD 1

Plant Name:	V. C. Summer		
Utility Name:	Dominion Energy South Carolina		
Analysis Information			
EM:	**CQD (1996)**	**Limiting Break Size:**	**DEGB**
Analysis Date:	February 2003		
Vendor:	Westinghouse		
FQ:	**2.5**	**FdH:**	**1.7**
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT	1808
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	Fan Cooler Performance Increase	1
2.	Improved Automation of End of Blowdown Time	0
3.	Implementation of ASTRUM Capability in HOTSPOT	0
4	Revised Blowdown Heatup Uncertainty Distribution	5
5.	Revised Iteration Algorithm for Calculating The Average Fuel Temperature	0
6.	Improved Automation of End of Blowdown Time	0
7.	Thermodynamic Properties from Thermo	0
8.	Pressurizer Fluid Volumes	0
9.	Vessel Unheated Conductor Noding	0
10.	Containment Relative Humidity Assumption	0
11.	HOTSPOT Fuel Relocation	0
12.	Steam Generator Nozzle Volume Accounting Error	0
13.	Cold Leg Volume Discrepancy	0
14.	Errors in Reactor Vessel Nozzle Data Collection	0
15.	HOTSPOT Burst Temperature Logic Errors	0
16.	V. C. Summer Upflow Conversion	-44
17.	Zero Cross-Flow Boundary Condition Error	0
18.	Discrepancy in Metal Masses Used From Drawings	0
19.	HOTSPOT Gap Heat Transfer Logic	0
20.	HOTSPOT Statistical Output Logic	0
21.	Treatment of Vessel Average Temperature Uncertainty	0
22.	Additional Heat Sinks and Maximum Spray Flow	0
23.	Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	113
24.	PAD 4.0 Implementation	-118
25.	Zero Cross-Flow Boundary Condition Error	0
26.	HOTSPOT Burst Temperature Calculation For ZIRLO Cladding	0
27.	HOTSPOT Iteration Algorithm for Calculating The Initial Fuel Pellet Average Temperature	0
28.	WCOBRA/TRAC Automated Restart Process Logic Error	0
29.	Rod Internal Pressure Calculation	0
30.	WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER	0
31.	Burst Elevation Selection	0
32.	Elevation for Heat Slab Temperature Initialization	0

	33.	Heat Transfer Logic for Rod Burst Calculation	0
	34.	WCOBRA/TRAC U19 File Dimension Error Correction	0
	35.	Heat Transfer Model Error Corrections	0
	36.	Correction to Heat Transfer Node Initialization	0
	37.	Mass Conservation Error Fix	0
	38.	Correction to Split Channel Momentum Equation	0
	39.	Changes to Vessel Superheated Steam Properties	0
	40.	Update to Metal Density Reference Temperatures	0
	41.	Decay Heat Model Error Correction	0
	42.	Correction to the Pipe Exit Pressure Drop Error	0
	43.	Vessel Section 7 Mid-Level Elevation Modeling	0
	44.	Grid Heat Transfer Enhancement Calculation	0
	45.	Revised Heat Transfer Multiplier Distributions	5
	46.	Changes to Grid Blockage Ratio and Porosity	24
	47.	Error in Burst Strain Application	20
	48.	Code Uncertainty in BE LBLOCA Monte Carlo Simulations	0
	49.	Error in Oxidation Calculations	0
	50.	Support Column Unheated Conductor Error	0
	51.	Vessel Average Temperature Uncertainty	0
	52.	Numerical Ramp Entrained Liquid/Vapor Interfacial Drag	0
	53.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	54.	Vapor Temperature Resetting	0
	55.	Removal of the Vessel Interfacial Heat Transfer Limit	0
	56.	Increased Vessel Average Temperature Uncertainty	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	0

LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =**	**1814**

10 CFR 50.46 Margin Utilization – Best Estimate Large Break, REFLOOD 2

Plant Name:	V. C. Summer		
Utility Name:	Dominion Energy South Carolina		
Analysis Information			
EM:	**CQD (1996)**	**Limiting Break Size:**	**DEGB**
Analysis Date:	February 2003		
Vendor:	Westinghouse		
FQ:	**2.5**	**FdH:**	**1.7**
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT	1988
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	Fan Cooler Performance Increase	2
2.	Improved Automation of End of Blowdown Time	0
3.	Implementation of ASTRUM Capability in HOTSPOT	0
4	Revised Blowdown Heatup Uncertainty Distribution	5
5.	Revised Iteration Algorithm for Calculating The Average Fuel Temperature	0
6.	Improved Automation of End of Blowdown Time	0
7.	Thermodynamic Properties from Thermo	0
8.	Pressurizer Fluid Volumes	0
9.	Vessel Unheated Conductor Noding	0
10.	Containment Relative Humidity Assumption	0
11.	HOTSPOT Fuel Relocation	0
12.	Steam Generator Nozzle Volume Accounting Error	0
13.	Cold Leg Volume Discrepancy	0
14.	Errors in Reactor Vessel Nozzle Data Collection	0
15.	HOTSPOT Burst Temperature Logic Errors	0
16.	V. C. Summer Upflow Conversion	-29
17.	Zero Cross-Flow Boundary Condition Error	0
18.	Discrepancy in Metal Masses Used From Drawings	0
19.	HOTSPOT Gap Heat Transfer Logic	0
20.	HOTSPOT Statistical Output Logic	0
21.	Treatment of Vessel Average Temperature Uncertainty	0
22.	Additional Heat Sinks and Maximum Spray Flow	1
23.	Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	123
24.	PAD 4.0 Implementation	-118
25.	Zero Cross-Flow Boundary Condition Error	0
26.	HOTSPOT Burst Temperature Calculation For ZIRLO Cladding	0
27.	HOTSPOT Iteration Algorithm for Calculating The Initial Fuel Pellet Average Temperature	0
28.	WCOBRA/TRAC Automated Restart Process Logic Error	0
29.	Rod Internal Pressure Calculation	0
30.	WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER	0
31.	Burst Elevation Selection	0
32.	Elevation for Heat Slab Temperature Initialization	0

	33.	Heat Transfer Logic for Rod Burst Calculation	0
	34.	WCOBRA/TRAC U19 File Dimension Error Correction	0
	35.	Heat Transfer Model Error Corrections	0
	36.	Correction to Heat Transfer Node Initialization	0
	37.	Mass Conservation Error Fix	0
	38.	Correction to Split Channel Momentum Equation	0
	39.	Changes to Vessel Superheated Steam Properties	0
	40.	Update to Metal Density Reference Temperatures	0
	41.	Decay Heat Model Error Corrections	0
	42.	Correction to the Pipe Exit Pressure Drop Error	0
	43.	Vessel Section 7 Mid-Level Elevation Modeling	0
	44.	Grid Heat Transfer Enhancement Calculation	0
	45.	Revised Heat Transfer Multiplier Distributions	-35
	46.	Changes to Grid Blockage Ratio and Porosity	24
	47.	Error in Burst Strain Application	0
	48.	Code Uncertainty in BE LBLOCA Monte Carlo Simulations	0
	49.	Error in Oxidation Calculations	0
	50.	Support Column Unheated Conductor Error	0
	51.	Vessel Average Temperature Uncertainty	0
	52.	Numerical Ramp Entrained Liquid/Vapor Interfacial Drag	0
	53.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	54.	Vapor Temperature Resetting	0
	55.	Removal of the Vessel Interfacial Heat Transfer Limit	0
	56.	Increased Vessel Average Temperature Uncertainty	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	0

LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =**	**1961**

10 CFR 50.46 Margin Utilization – Best Estimate Large Break, COMPOSITE

Plant Name:	V. C. Summer		
Utility Name:	Dominion Energy South Carolina		
Analysis Information			
EM:	**CQD (1996)**	**Limiting Break Size:**	**DEGB**
Analysis Date:	February 2003		
Vendor:	Westinghouse		
FQ:	**2.5**	**FdH:**	**1.7**
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT	1988
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	Fan Cooler Performance Increase	2
2.	Improved Automation of End of Blowdown Time	0
3.	Implementation of ASTRUM Capability in HOTSPOT	0
4	Revised Blowdown Heatup Uncertainty Distribution	5
5.	Revised Iteration Algorithm for Calculating The Average Fuel Temperature	0
6.	Improved Automation of End of Blowdown Time	0
7.	Thermodynamic Properties from Thermo	0
8.	Pressurizer Fluid Volumes	0
9.	Vessel Unheated Conductor Noding	0
10.	Containment Relative Humidity Assumption	0
11.	HOTSPOT Fuel Relocation	0
12.	Steam Generator Nozzle Volume Accounting Error	0
13.	Cold Leg Volume Discrepancy	0
14.	Errors in Reactor Vessel Nozzle Data Collection	0
15.	HOTSPOT Burst Temperature Logic Errors	0
16.	V. C. Summer Upflow Conversion	-29
17.	Zero Cross-Flow Boundary Condition Error	0
18.	Discrepancy in Metal Masses Used From Drawings	0
19.	HOTSPOT Gap Heat Transfer Logic	0
20.	HOTSPOT Statistical Output Logic	0
21.	Treatment of Vessel Average Temperature Uncertainty	0
22.	Additional Heat Sinks and Maximum Spray Flow	1
23.	Fuel Pellet Thermal Conductivity Degradation and Peaking Factor Burndown	123
24.	PAD 4.0 Implementation	-118
25.	Zero Cross-Flow Boundary Condition Error	0
26.	HOTSPOT Burst Temperature Calculation For ZIRLO Cladding	0
27.	HOTSPOT Iteration Algorithm for Calculating The Initial Fuel Pellet Average Temperature	0
28.	WCOBRA/TRAC Automated Restart Process Logic Error	0
29.	Rod Internal Pressure Calculation	0
30.	WCOBRA/TRAC Thermal-Hydraulic History File Dimension used in HSDRIVER	0
31.	Burst Elevation Selection	0
32.	Elevation for Heat Slab Temperature Initialization	0

	33.	Heat Transfer Logic for Rod Burst Calculation	0
	34.	WCOBRA/TRAC U19 File Dimension Error Correction	0
	35.	Heat Transfer Model Error Corrections	0
	36.	Correction to Heat Transfer Node Initialization	0
	37.	Mass Conservation Error Fix	0
	38.	Correction to Split Channel Momentum Equation	0
	39.	Changes to Vessel Superheated Steam Properties	0
	40.	Update to Metal Density Reference Temperatures	0
	41.	Decay Heat Model Error Correction	0
	41.	Correction to the Pipe Exit Pressure Drop Error	0
	42.	Vessel Section 7 Mid-Level Elevation Modeling	0
	43.	Grid Heat Transfer Enhancement Calculation	0
	44.	Revised Heat Transfer Multiplier Distributions	-35
	45.	Changes to Grid Blockage Ratio and Porosity	24
	46.	Error in Burst Strain Application	0
	47.	Code Uncertainty in BE LBLOCA Monte Carlo Simulations	0
	48.	Error in Oxidation Calculations	0
	49.	Support Column Unheated Conductor Error	0
	50.	Vessel Average Temperature Uncertainty	0
	51.	Numerical Ramp Entrained Liquid/Vapor Interfacial Drag	0
	52.	Inappropriate Resetting of Transverse Liquid Mass Flow	0
	53.	Vapor Temperature Resetting	0
	54.	Removal of the Vessel Interfacial Heat Transfer Limit	0
	55.	Increased Vessel Average Temperature Uncertainty	0
B.	**Planned Plant Modification Evaluations**		
	1.	None	0
C.	**2021 ECCS Model Assessments**		
	1.	None	0
D.	**Other**		
	1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS		**PCT =**	**1961**

10 CFR 50.46 Margin Utilization – FSLOCA Region II - Large Break

Plant Name:	V. C. Summer		
Utility Name:	Dominion Energy South Carolina		
Analysis Information			
EM:	**FSLOCA**	**Limiting Break Size:**	**DEGB**
Analysis Date:	January 2019		
Vendor:	Westinghouse		
FQ:	**2.5**	**FdH:**	**1.70**
Notes:	None		

		Clad Temp(°F)
LICENSING BASIS		
	Analysis of Record PCT (Including gamma energy redistribution)	1879
PCT ASSESSMENTS (Delta PCT)		
A.	**Prior ECCS Model Assessments**	
1.	None	0
B.	**Planned Plant Modification Evaluations**	
1.	None	0
C.	**2021 ECCS Model Assessments**	
1.	None	0
D.	**Other**	
1.	None	0
LICENSING BASIS PCT + PCT ASSESSMENTS	**PCT =**	**1879**