



Tennessee Valley Authority, 1101 Market Street, Chattanooga, TN 37402

WBL-20-007

March 5, 2020

10 CFR 50.4  
10 CFR 50.46

ATTN: Document Control Desk  
U.S. Nuclear Regulatory Commission  
Washington, D.C. 20555-0001

Watts Bar Nuclear Plant, Units 1 and 2  
Facility Operating License NPF-90 and NPF-96  
NRC Docket Nos. 50-390 and 50-391

Subject: **10 CFR 50.46 - 30-Day and Annual Report for Watts Bar Nuclear Plant Units 1 and 2**

Reference: TVA Letter to NRC, WBL-19-019, "10 CFR 50.46 - 30-Day and Annual Report for Watts Bar Nuclear Plant Units 1 and 2," dated March 7, 2019 (ML19066A046)

The purpose of this letter is to provide the annual report of changes and errors to the calculated peak cladding temperature (PCT) for the Watts Bar Nuclear Plant (WBN) Units 1 and 2, Emergency Core Cooling System (ECCS) evaluation model. This report is required in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors," paragraph (a)(3)(ii).

Tennessee Valley Authority (TVA) submitted the last 10 CFR 50.46 annual report for WBN Units 1 and 2 to the Nuclear Regulatory Commission (NRC) in the referenced letter. As indicated in the enclosure, there are no changes to the current updated (net) licensing basis PCT for the WBN Unit 1 large break loss of coolant accident (LBLOCA) and the updated (net) licensing basis PCT for the WBN Unit 1 small break loss of coolant accident (SBLOCA). Similarly, there are no changes to the current updated (net) licensing basis PCT for the WBN Unit 2 LBLOCA and the updated (net) licensing basis PCT for the WBN Unit 2 SBLOCA.

The enclosure also serves as the 30-day report in accordance with 10 CFR 50.46(a)(3)(ii), which states that a holder of an operating license or construction permit is required to report changes and errors affecting an ECCS evaluation model to the NRC within 30 days when the cumulative sum of the absolute magnitudes of resulting PCT changes exceeds 50°F. The licensee is also required to include with the report, a proposed schedule for providing a

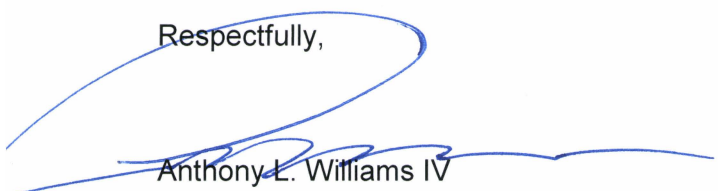
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reanalysis or taking other action as may be needed to show compliance with the 10 CFR 50.46 requirements. Westinghouse performs the LOCA analysis for WBN and Westinghouse submitted a list of changes and errors to the LOCA analysis to TVA on February 11, 2020. All the submitted changes and errors result in a 0°F change in PCT, but because the accumulated changes and errors from previous years are more than 50°F (with the exception of the WBN Units 1 and 2 SBLOCA analysis), a 30-day report is required.

As presented in this report, compliance with 10 CFR 50.46 requirements is demonstrated by the calculated PCT for both WBN units remaining below the 2200°F limit. Therefore, TVA has concluded that no proposed schedule for providing a reanalysis or other action is required. No further actions are needed to show compliance with 10 CFR 50.46 requirements.

There are no regulatory commitments in this letter. Please address any questions regarding this response to Michael A. Brown at (423) 365-7720.

Respectfully,



Anthony L. Williams IV  
Site Vice President  
Watts Bar Nuclear Plant

Enclosure: Watts Bar Nuclear Plant, 10 CFR 50.46 30-Day and Annual Report for 2019

cc (Enclosure):

NRC Regional Administrator - Region II  
NRC Senior Resident Inspector - Watts Bar Nuclear Plant  
Division of Radiological Health - State of Tennessee

## ENCLOSURE

### Watts Bar Nuclear Plant, 10 CFR 50.46 30-Day and Annual Report for 2019

In accordance with the reporting requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.46(a)(3)(ii), the Tennessee Valley Authority (TVA) is providing the following summary of the limiting design basis loss of coolant accident (LOCA) analysis results established using the current Watts Bar Nuclear Plant (WBN) Emergency Core Cooling System (ECCS) evaluation models for WBN Units 1 and 2. This report describes the changes and errors affecting the calculated peak cladding temperatures (PCTs) since the last analysis of record (AOR) was submitted to the Nuclear Regulatory Commission (NRC).

TVA submitted the last 10 CFR 50.46 annual report for WBN Units 1 and 2 to the NRC in Reference 1.

Table 1 lists the changes and errors in the large break LOCA (LBLOCA) analysis for WBN Unit 1 since the analysis of record (AOR) and the associated effect on PCT. Table 2 lists the changes and errors in the small break LOCA (SBLOCA) analyses for WBN Unit 1 since the AOR and the associated effect on PCT. The changes that were not previously identified in Reference 1 are described in the notes to Tables 1 and 2.

Table 3 lists the changes and errors in the LBLOCA analysis for WBN Unit 2 since the AOR and the associated effect on PCT. Table 4 lists the changes and errors in the SBLOCA analyses for WBN Unit 2 since the AOR and the associated effect on PCT. The changes that were not previously identified in Reference 1 are described in the notes to Tables 3 and 4.

The updated (net) licensing basis PCT for the LBLOCA and SBLOCA remain unchanged for WBN Units 1 and 2 from the last annual report.

This report also serves as the 30-day report in accordance with 10 CFR 50.46(a)(3)(ii), which states that a holder of an operating license or construction permit is required to report changes and errors affecting an ECCS evaluation model to the NRC within 30 days when the cumulative sum of the absolute magnitudes of resulting PCT changes exceeds 50°F. The licensee is also required to include with the report, a proposed schedule for providing a reanalysis or taking other action as may be needed to show compliance with the 10 CFR 50.46 requirements. Westinghouse performs the LOCA analysis for WBN; Westinghouse submitted a list of changes and errors to the LOCA analysis to TVA on February 11, 2020. All the submitted changes and errors result in a 0°F change in PCT, but because the accumulated changes and errors from previous years are more than 50°F, a 30-day report is required.

As presented in this report, compliance with 10 CFR 50.46 requirements is demonstrated by the calculated PCT for both WBN units remaining below the 2200°F limit. Therefore, TVA has concluded that no proposed schedule for providing a reanalysis or other action is required.

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**Table 1**  
**Watts Bar Unit 1 LBLOCA**

Year	Description	Reflood 1		Reflood 2		Note	Reference
		$\Delta$ PCT (°F)	$\Delta$ PCT  (°F)	$\Delta$ PCT (°F)	$\Delta$ PCT  (°F)		
1998	BE LBLOCA AOR PCT	1656	---	1892	---	---	3
1998	Vessel Channel DX Error	56	56	-4	4	---	4
1999	Accumulator Line/Pressurizer Surge Line Data Evaluation	-37	37	-131	131	---	4
2000	Increased Accumulator Room Temperature Evaluation	4	4	4	4	---	4
2000	1.4% Uprate Evaluation	12	12	12	12	---	4
2000	MONTECF Decay Heat Uncertainty Error	4	4	4	4	---	5
2001	WBN Specific LBLOCA Vessel Geometry Input Errors	0	0	0	0	---	6
2003	Input Error Resulting in Incomplete Solution Matrix	60	60	0	0	---	7
2003	Tavg Bias Error	8	8	8	8	---	7
2004	Increased Stroke Time for ECCS Valves	0	0	0	0	---	8
2004	Revised Blowdown Heatup Uncertainty Distribution	5	5	5	5	---	8
2006	Replacement Steam Generators (D3 to 68AXP)	-50	50	-10	10	---	9
2006	HOTSPOT™ Fuel Relocation Error	0	0	65	65	---	9
2012	PMID/PBOT Violation Evaluation	20	20	20	20	---	10, 11
2012	TCD and Peaking Factor Burndown	114	114	15	15	---	10, 11

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**Table 1**  
**Watts Bar Unit 1 LBLOCA**

Year	Description	Reflood 1		Reflood 2		Note	Reference
		$\Delta$ PCT (°F)	$\Delta$ PCT  (°F)	$\Delta$ PCT (°F)	$\Delta$ PCT  (°F)		
2013	WCOBRA/TRAC™ History File Dimension Error	0	0	0	0	---	12
2013	General Code Maintenance	0	0	0	0	---	13
2013	HOTSPOT™ Burst Temperature Calculation for ZIRLO™ Cladding	0	0	0	0	---	13
2013	HOTSPOT™ Iteration Algorithm for Calculation Initial Fuel Pellet Average Temperature	0	0	0	0	---	13
2013	WCOBRA/TRAC™ Automated Restart Process Logic Error	0	0	0	0	---	13
2013	Rod Internal Pressure Calculation Error	0	0	0	0	---	13
2013	Elevations for Heat Slab Temperature Initialization	0	0	0	0	---	14
2013	Heat Transfer Model Error Corrections	0	0	0	0	---	14
2013	Correction to Heat Transfer Node Initialization	0	0	0	0	---	14
2013	Mass Conservation Error Fix	0	0	0	0	---	14
2013	Correction to Split Channel Momentum Equation	0	0	0	0	---	14
2013	Heat Transfer Logic Correction for Rod Burst Calculation	0	0	0	0	---	14
2013	Changes to Vessel Superheated Steam Properties	0	0	0	0	---	14

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**Table 1**  
**Watts Bar Unit 1 LBLOCA**

Year	Description	Reflood 1		Reflood 2		Note	Reference
		$\Delta$ PCT (°F)	$\Delta$ PCT  (°F)	$\Delta$ PCT (°F)	$\Delta$ PCT  (°F)		
2013	Update to Metal Density Reference Temperatures	0	0	0	0	---	14
2013	Decay Heat Model Error Corrections	0	0	0	0	---	14
2013	Correction to the Pipe Exit Pressure Drop Error	0	0	0	0	---	14
2013	WCOBRA/TRAC File Dimension Error Correction	0	0	0	0	---	14
2013	Revised Heat Transfer Multiplier Distributions	-40	40	-85	85	---	14
2013	HOTSPOT Burst Strain Error	20	20	70	70	---	15
2014	General Computer Code Maintenance	0	0	0	0	---	20
2014	Revised Uncertainty in LBLOCA Monte Carl Simulations	0	0	0	0	---	20
2016	General Code Maintenance	0	0	0	0	---	22
2016	Clad Oxidation Calculation	0	0	0	0	---	22
2016	LOTIC2 Net Free Volume Direction of Conservatism and Ice Melt Condition	0	0	0	0	---	22
2016	LOTIC2 Calculation of the Thermodynamic Properties of Air	0	0	0	0	---	22
2016	Increased Safety Injection Time Delay with Offsite Power Available	0	0	0	0	---	22
2017	Increase in ECCS pump injection delay time	0	0	0	0	---	23
2017	General Code Maintenance	0	0	0	0	---	24
2017	Entrained Liquid / Vapor Interfacial Drag Coefficient Calculation Inconsistency	0	0	0	0	---	24

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**Table 1**  
**Watts Bar Unit 1 LBLOCA**

Year	Description	Reflow 1		Reflow 2		Note	Reference
		$\Delta PCT$ (°F)	$ \Delta PCT $ (°F)	$\Delta PCT$ (°F)	$ \Delta PCT $ (°F)		
2017	Resetting of the Transverse Liquid Mass Flow	0	0	0	0	---	24
2018	Vapor Temperature Resetting	0	0	0	0	---	1
2019	General Code Maintenance	0	0	0	0	1	---
2019	Removal of the Vessel Interfacial Heat Transfer Limit	0	0	0	0	2	---
---	<b>Updated (net) licensing basis PCT</b> AOR PCT + $\sum \Delta PCT$	<b>1832</b>	--	<b>1865</b>	---	---	---
---	<b>Cumulative sum of PCT changes</b> $\sum  \Delta PCT $	---	<b>430</b>	---	<b>433</b>	---	---

Notes:

1. Various changes have been made to enhance the usability of codes and to streamline future analyses. Examples of these changes include 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 peak cladding temperature impact of 0°F.
2. The WCOBRA/TRAC code included a limit on the vessel interfacial heat transfer to prevent extreme conditions, which are detrimental to the robustness of the numerical method. An error was found in the implementation of the limit, which effectively negates the application of the limit. The error was corrected by removing the limit from the WCOBRA/TRAC code. Removal of the limit was found to have a negligible impact of the code validation results, resulting in a peak cladding temperature impact of 0°F.

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**Table 2**  
**Watts Bar Unit 1 SBLOCA**

<b>Year</b>	<b>Description</b>	<b>SBLOCA <math>\Delta</math>PCT (°F)</b>	<b>SBLOCA   <math>\Delta</math>PCT   (°F)</b>	<b>Note</b>	<b>Reference</b>
2006	SBLOCA AOR PCT	1132	---	---	16
2013	NOTRUMP-EM™ Evaluation of Fuel Pellet TCD	0	0	---	13
2014	General Computer Code Maintenance	0	0	---	20
2014	Fuel Rod Gap Conductance Error	0	0	---	20
2014	Radiation Heat Transfer Model Error	0	0	---	20
2014	SBLOCTA Pre-DNB Cladding Surface Heat Transfer Coefficient Calculation	0	0	---	20
2014	Evaluation of 8-inch Axial Blankets	0	0	---	20
2015	General Computer Code Maintenance	0	0	---	21
2015	Auxiliary Feedwater (AFW) Temperature Increase During Cold Leg Recirculation	0	0	---	21
2016	Plant-Specific Upper Head Geometric Data	0	0	---	22
2016	Increased Containment Spray Flow Rate and Reduced RWST Useable Volume	0	0	---	22
2017	General Code Maintenance	0	0	---	24
2017	Upper Plenum Fluid Volume Reduction	0	0	---	24



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**Table 2**  
**Watts Bar Unit 1 SBLOCA**

<b>Year</b>	<b>Description</b>	<b>SBLOCA <math>\Delta</math>PCT (°F)</b>	<b>SBLOCA <math> \Delta</math>PCT  (°F)</b>	<b>Note</b>	<b>Reference</b>
2018	UO <sub>2</sub> Fuel Pellet Heat Capacity	0	0	---	1
---	<b>Updated (net) licensing basis PCT</b> AOR PCT + $\sum \Delta$ PCT	<b>1132</b>	---	---	---
---	<b>Cumulative sum of PCT changes</b> $\sum  \Delta$ PCT	---	<b>0</b>	---	---

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**Table 3**  
**Watts Bar Unit 2 LBLOCA**

<b>Year</b>	<b>Description</b>	<b>LBLOCA <math>\Delta</math>PCT (°F)</b>	<b>LBLOCA <math> \Delta</math>PCT  (°F)</b>	<b>Note</b>	<b>Reference</b>
2013	<b>LBLOCA AOR PCT</b>	<b>1766</b>	---	---	17
2013	Elevations for Heat Slab Temperature Initialization	0	0	---	19
2013	Heat Transfer Model Error Corrections	0	0	---	19
2013	Correction to Heat Transfer Node Initialization	0	0	---	19
2013	Mass Conservation Error Fix	0	0	---	19
2013	Correction to Split Channel Momentum Equation	0	0	---	19
2013	Heat Transfer Logic Correction for Rod Burst Calculation	0	0	---	19
2013	Changes to Vessel Superheated Steam Properties	0	0	---	19
2013	Update to Metal Density Reference Temperatures	0	0	---	19
2013	Decay Heat Model Error Corrections	0	0	---	19
2013	Correction to the Pipe Exit Pressure Drop Error	0	0	---	19
2013	WCOBRA/TRAC File Dimension Error Correction	0	0	---	19
2013	Revised Heat Transfer Multiplier Distributions	-55	55	---	19
2013	Initial Fuel Pellet Average Temperature Uncertainty Calculation	0	0	---	19
2013	HOTSPOT Burst Strain Error	0	0	---	15
2014	Cold Leg Accumulator Injection Lines Hydraulic Resistance Changes	0	0	---	2
2014	General Computer Code Maintenance	0	0	---	20
2014	Errors in Decay Group Uncertainty Factors	0	0	---	20

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**Table 3**  
**Watts Bar Unit 2 LBLOCA**

<b>Year</b>	<b>Description</b>	<b>LBLOCA <math>\Delta</math>PCT (°F)</b>	<b>LBLOCA <math> \Delta</math>PCT  (°F)</b>	<b>Note</b>	<b>Reference</b>
2014	Treatment of Burnup Effects on Thermal Conductivity Degradation	0	0	---	20
2016	General Code Maintenance	0	0	---	22
2016	Clad Oxidation Calculation	0	0	---	22
2016	Use of Steam Tables in Upper Head Fluid Temperature Calculations	0	0	---	22
2016	Lower Support Plate Heat Conductor Surface Area	0	0	---	22
2016	LOTIC2 Net Free Volume Direction of Conservatism and Ice Melt Condition	0	0	---	22
2016	LOTIC2 Calculation of the Thermodynamic Properties of Air	0	0	---	22
2017	General Code Maintenance	0	0	---	24
2017	Entrained Liquid / Vapor Interfacial Drag Coefficient Calculation Inconsistency	0	0	---	24
2017	Resetting of Transverse Liquid Mass Flow	0	0	---	24
2017	Steady State Fuel Temperature Calibration non-Conservatisms	0	0	---	24
2018	Vapor Temperature Resetting	0	0	---	1
2019	Core Barrel Heat Slab Error	0	0	1	---
2019	General Code Maintenance	0	0	2	---
2019	Removal of the Vessel Interfacial Heat Transfer Limit	0	0	3	---
---	<b>Updated (net) licensing basis PCT</b> (AOR PCT + $\sum \Delta$ PCT)	<b>1711</b>	---	---	---
---	<b>Cumulative sum of PCT changes</b> $\sum  \Delta$ PCT	---	<b>55</b>	---	---

**Notes:**

1. In the LBLOCA analysis, a modeling error was discovered in heat slab connection inputs, which resulted in erroneous wetted perimeters in the vessel component. An evaluation of the impact determined the difference in the wetted perimeter due to the error is very small and

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would be expected to produce a negligible effect on the large break LOCA analysis results, leading to an estimated PCT impact of 0°F.

2. Various changes have been made to enhance the usability of codes and to streamline future analyses. Examples of these changes include 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 peak cladding temperature impact of 0°F.
3. The WCOBRA/TRAC code included a limit on the vessel interfacial heat transfer to prevent extreme conditions, which are detrimental to the robustness of the numerical method. An error was found in the implementation of the limit, which effectively negates the application of the limit. The error was corrected by removing the limit from the WCOBRA/TRAC code. Removal of the limit was found to have a negligible impact of the code validation results, resulting in a peak cladding temperature impact of 0°F.

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**Table 4**  
**Watts Bar Unit 2 SBLOCA**

Year	Description	SBLOCA $\Delta$ PCT (°F)	SBLOCA $ \Delta$ PCT  (°F)	Note	Reference
2010	<b>SBLOCA AOR PCT</b>	<b>1184</b>	---	---	18
2014	Cold Leg Accumulator Injection Lines Hydraulic Resistance Changes	0	0	---	2
2014	General Computer Code Maintenance	0	0	---	20
2014	Fuel Rod Gap Conductance Error	0	0	---	20
2014	Radiation Heat Transfer Model Error	0	0	---	20
2014	SBLOCTA Pre-DNB Cladding Surface Heat Transfer Coefficient Calculation	0	0	---	20
2015	General Computer Code Maintenance	0	0	---	21
2015	AFW Temperature Increase During Cold Leg Recirculation	0	0	---	21
2016	Plant-Specific Upper Head Geometric Data	0	0	---	22
2016	Reduced RWST Useable Volume	0	0	---	22
2017	Increased SI injection time delay	0	0	---	24
2017	General Code Maintenance	0	0	---	24
2017	Upper Plenum Fluid Volume Reduction	0	0	---	24
2018	UO <sub>2</sub> Fuel Pellet Heat Capacity	0	0	---	1
---	<b>Updated (net) licensing basis PCT</b> (AOR PCT + $\sum \Delta$ PCT)	<b>1184</b>	---	---	---
---	<b>Cumulative sum of PCT changes</b> $\sum  \Delta$ PCT	---	<b>0</b>	---	---

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### References:

1. TVA Letter to NRC, WBL-19-019, "10 CFR 50.46 - 30-Day and Annual Report for Watts Bar Nuclear Plant Units 1 and 2," dated March 7, 2019 (ML19066A046)
2. TVA letter to NRC, CNL-15-034, "10 CFR 50.46 - 30-Day Report for Watts Bar, Unit 2" dated February 6, 2015 (ML15037A725)
3. WCAP-14839, Revision 1, "Best Estimate Analysis of the Large Break Loss of Coolant Accident for the Watts Bar Nuclear Plant," September 1998
4. TVA letter to NRC, "Watts Bar Nuclear Plant (WBN) Unit 1 - Emergency Core Cooling System (ECCS) Evaluation Model Changes - 30-Day Report and Annual Notification and Reporting for 2000," dated October 26, 2000 (ML003764646)
5. TVA letter to NRC, "Watts Bar Nuclear Plant (WBN) Unit 1 - Emergency Core Cooling System (ECCS) Evaluation Model Changes - 30-Day Report and Revised Annual Notification Report for 2000," dated September 7, 2001 (ML012570290)
6. TVA letter to NRC, "Watts Bar Nuclear Plant (WBN) Unit 1 - Emergency Core Cooling System (ECCS) Evaluation Model Changes - Annual Notification and Reporting for 2001," dated April 3, 2002 (ML021070404)
7. TVA letter to NRC, "Watts Bar Nuclear Plant (WBN) Unit 1 - Emergency Core Cooling System (ECCS) Evaluation Model Changes - 30-Day Report and Revised Annual Notification and Reporting for 2003," dated April 19, 2004 (ML041130196)
8. TVA letter to NRC, "Watts Bar Nuclear Plant (WBN) Unit 1 - Emergency Core Cooling System (ECCS) Evaluation Model Changes - Annual Notification and Reporting for 2004," dated April 19, 2005 (ML051120164)
9. TVA letter to NRC, "Watts Bar Nuclear Plant (WBN) Unit 1 - Emergency Core Cooling System (ECCS) Evaluation Model Changes - 30-Day Report and Annual Notification and Reporting for 2006," dated July 3, 2007 (ML071860388)
10. TVA letter to NRC, "Supplement to 10 CFR 50.46 - 30-Day Special Report," dated February 13, 2013 (ML13046A002)
11. TVA letter to NRC, "10 CFR 50.46 - 30-Day Special Report," dated October 18, 2012 (ML12296A254)
12. TVA letter to NRC, "10 CFR 50.46 - 30-Day Report for Watts Bar Unit 1," dated March 19, 2013 (ML13080A405)
13. TVA letter to NRC, "10 CFR 50.46 - 30-Day and Annual Report for 2012," dated April 25, 2013 (ML13120A005)
14. TVA letter to NRC, "10 CFR 50.46 - 30 day Report for Watts Bar, Unit 1," dated August 28, 2013 (ML13267A034)
15. TVA letter to NRC, CNL-14-035, "10 CFR 50.46 - 30 day Report for Watts Bar, Units 1 and 2," dated February 28, 2014 (ML14064A431)
16. WTV-RSG-06-015, "LOCA & Non-LOCA Analysis Summary for Replacement Steam Generator," February 2006
17. WCAP-17093-P, Revision 1, "Best Estimate Analysis of the Large Break Loss of Coolant Accident for the Watts Bar Unit 2 Nuclear Plant Using the ASTRUM Methodology," June 2013
18. WBT-D-1460, "Final Small Break LOCA Summary Report for WBN Unit 2," January 2010

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19. TVA letter to NRC, "Watts Bar Nuclear Plant, Unit 2 - Emergency Core Cooling System Evaluation Model Changes - 30 Day Report - 10 CFR 50.46 Notification," dated August 28, 2013 (ML13246A076)
20. TVA letter to NRC, CNL-15-053, "10 CFR 50.46 - 30-Day and Annual Report for Watts Bar, Units 1 and 2," dated March 30, 2015 (ML15098A124)
21. TVA letter to NRC, CNL-16-057, "10 CFR 50.46 - Annual Report for Watts Bar, Units 1 and 2," dated March 18, 2016 (ML16081A248)
22. TVA Letter to NRC, "10 CFR 50.46 - 30-Day and Annual Report for Watts Bar, Units 1 and 2," dated March 8, 2017 (ML17067A079)
23. TVA letter to NRC, 10 CFR 50.46 - 30-Day Report for Watts Bar Nuclear Plant Unit 1," dated August 21, 2017 (ML17235A905)
24. TVA Letter to NRC, CNL-18-040, "10 CFR 50.46 - 30-Day and Annual Report for Watts Bar, Units 1 and 2," dated March 7, 2018 (ML18066A730)