Tennessee Valley Authority, Post Office Box 2000 Spring City, Tennessee 37381

February 9, 2018

10 CFR 50.36

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

Watts Bar Nuclear Plant, Unit 2
Facility Operating License No. NPF-96
NRC Docket Nos. 50-391

Subject: **Watts Bar Nuclear Plant Unit 2 – Revised Pressure and Temperature Limits Report (PTLR)**

The purpose of this letter is to provide the enclosed copy of the Watts Bar Unit 2 Pressure and Temperature Limits Report (PTLR) Revision 5, in accordance with Technical Specification Section 5.9.6.c. Revision 5 of the PTLR updates the Surveillance Capsule Withdrawal Schedule for capsule "U" from the first refueling outage to the end of cycle 2 based on the revised lead factor and expected fluence values for this capsule.

There are no new regulatory commitments in this letter. Should you have questions regarding this submittal, please contact Kim Hulvey, Manager of Watts Bar Site Licensing, at (423) 365-7720.

Respectfully,

Paul Simmons
Site Vice President
Watts Bar Nuclear Plant

Enclosure:

Watts Bar Nuclear Plant, Unit 2 Pressure and Temperature Limits Report (PTLR), Revision 5.

cc (Enclosure):

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ENCLOSURE
Watts Bar Nuclear Plant, Unit 2
Pressure and Temperature Limits Report, Revision 5

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Watts Bar Unit 2 - RCS Pressure and Temperature Limits Report (PTLR) - Revision 5

APPENDIX "B" TO REC SYSTEM DESCRIPTION N3-68-4001 WATTS BAR UNIT 2 RCS PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR) REVISION 5	
Prepared by:	M. R. Smith
Checked by:	C. A. Boudreaux
Approved by:	D. S. Acselrod

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1.0 RCS PRESSURE AND TEMPERATURE LIMITS REPORT (PTLR)

This PTLR for Watts Bar Unit 2 has been prepared in accordance with the requirements of Technical Specification 5.9.6. Revisions to the PTLR shall be provided to the NRC within 30 days of issuance.

The Technical Specifications affected by this report are listed below:

LCO 3.4.3, RCS Pressure and Temperature (P/T) Limits

LCO 3.4.12, Cold Overpressure Mitigation System (COMS)

2.0 RCS PRESSURE AND TEMPERATURE LIMITS

The limits for LCO 3.4.3 are presented in the subsection which follows. These limits have been developed (Ref. 1) using the NRC-approved methodologies specified in Technical Specification 5.9.6.

2.1 RCS Pressure and Temperature (P/T) Limits (LCO 3.4.3)

2.1.1 The minimum boltup temperature is 60°F.

2.1.2 The RCS temperature rate-of-change limits are:

A. A maximum heatup rate of 100°F per hour.

B. A maximum cooldown rate of 100°F per hour.

C. A maximum temperature change of ≤ 10°F in any 1-hour period during inservice hydrostatic and leak testing operations above the heatup and cooldown limit curves.

2.1.3 RCS P/T Limits for Heatup, Cooldown, Inservice Hydrostatic and Leak Testing, and Criticality

The RCS P/T limits for heatup, cooldown, inservice hydrostatic and leak testing, and criticality are specified by Figures 2.1-1 and 2.1-2 (Ref. 1).

3.0 COLD OVERPRESSURE MITIGATION SYSTEM (LCO 3.4.12)

The lift setting limits for the pressurizer Power Operated Relief Valves (PORVs) are presented in the subsection that follows. These lift setting limits have been developed using the NRC-approved methodologies specified in Technical Specification 5.9.6.

3.1 Pressurizer PORV Lift Setting Limits

The pressurizer PORV lift setting limits are specified by Figure 3.1-1 and Table 3.1-1 (Ref. 2).

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3.1 Pressurizer PORV Lift Setting Limits (continued)

NOTE: These setpoints include allowance for pressure difference between the pressure transmitter and reactor midplane, and also includes a 71.8 psig pressure channel uncertainty, and a 16.3°F temperature uncertainty.

3.2 Arming Temperature

COMS shall be armed when any RCS cold leg temperature is ≤ 225°F for Unit 2.

4.0 REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM

The reactor vessel material irradiation surveillance specimens shall be removed and examined to determine changes in material properties. The results of these examinations shall be used to update Figures 2.1-1, 2.1-2, and 3.1-1.

The pressure vessel steel surveillance program (Ref. 3) is in compliance with Appendix H to 10 CFR 50 (Ref. 4), entitled "Reactor Vessel Material Surveillance Program Requirements." The material test requirements and the acceptance standard utilize the reference nil-ductility temperature, RT_{NDT}, which is determined in accordance with ASTM E208 (Ref. 5). The empirical relationship between RT_{NDT} and the fracture toughness of the reactor vessel steel is developed in accordance with Appendix G, "Fracture Toughness Criteria for Protection Against Failure," to Section XI of the ASME Boiler and Pressure Vessel Code (Ref. 6). The surveillance capsule removal schedule meets the requirements of ASTM E185-82 (Ref. 7). The removal schedule is provided in Table 4.0-1.

5.0 SUPPLEMENTAL DATA TABLES

- Table 5-1 contains a Summary of the Best Estimate Cu and Ni Weight Percent and Initial RT_{NDT} Values for the Watts Bar Unit 2 Reactor Vessel Materials.
- Table 5-2 shows a Summary of the Initial RT_{NDT} Values for the Watts Bar Unit 2 Closure Head and Vessel Flange.
- Table 5-3 provides the Summary of the Watts Bar Unit 2 Reactor Vessel Beltline Material Chemistry Factors.
- Table 5-4 provides Fluence Values for the Watts Bar Unit 2 Reactor Vessel Beltline Materials.
- Table 5-5 shows Adjusted Reference Temperature Evaluation for the Watts Bar Unit 2 Reactor Vessel Beltline materials through 7 EFPY at the 1/4T Location.
- Table 5-6 contains Adjusted Reference Temperature Evaluation for the Watts Bar Unit 2 Reactor Vessel Beltline Materials through 7 EFPY at the 3/4T Location.

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5.0 SUPPLEMENTAL DATA TABLES (continued)

- Table 5-7 provides a Summary of the Limiting ART Values Used in the Generation of the Watts Bar Unit 2 Heatup/Cooldown Curves.

- Table 5-8 shows RT_{PTS} Calculations for the Watts Bar Unit 2 Beltline Materials at 32 EFPY.

6.0 REFERENCES

1. WCAP-17035-NP, Revision 2, "Watts Bar Unit 2 Heatup and Cooldown Limit Curves for Normal Operation and PTLR Support Documentation," December 2009.

2. Westinghouse Letter WBT-D-5147, dated December 10, 2014, "PORV Analyses."

3. WCAP-9455, Revision 3, "Tennessee Valley Authority Watts Bar Unit No. 2 Reactor Vessel Radiation Surveillance Program," September 2009.

4. Code of Federal Regulations, 10 CFR 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," U.S. Nuclear Regulatory Commission, Federal Register, Volume 60, No. 243, December 19, 1995.

5. ASTM E208, "Standard Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels," American Society for Testing and Materials.

6. Appendix G to the 1998 through the 2000 Addenda Edition of the ASME Boiler and Pressure Vessel Code, Section XI, Division 1, "Fracture Toughness Criteria for Protection Against Failure."

7. ASTM E185-82, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," E706 (IF), ASTM 1982.

8. WCAP-13830, Revision 1, "Heat Up and Cool Down Limit Curves for Normal Operation for Watts Bar Unit 2," J. M. Chicots, et al, February 1995.

9. Westinghouse letter WAT-D-12366, Rev. 0, "Transmittal of Justification for the Surveillance Capsule Withdrawal Schedule Update for Watts Bar Unit 2" which references WCAP-18191-NP, Rev. 0, "Watts Bar Unit 2 Heatup and Cooldown Limit Curves for Normal Operation and Supplemental Reactor Vessel Integrity Evaluations" for TPBAR project.

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7.0 FIGURES AND TABLES

MATERIAL PROPERTY BASIS

LIMITING MATERIAL: Intermediate Shell Forging 05
INITIAL RT_{NDT}: 14°F
LIMITING ART VALUES AT 7 EFPY: 1/4T, 61°F
3/4T, 45°F

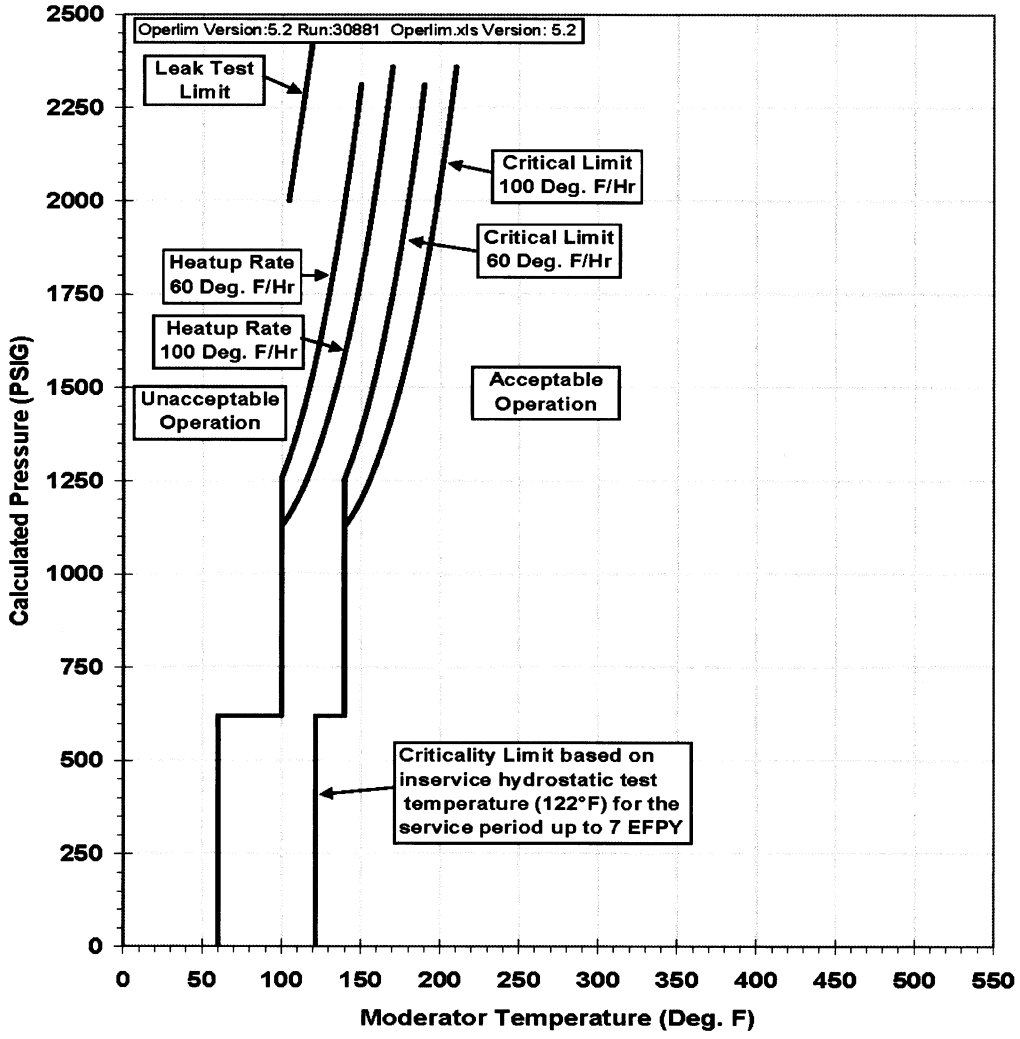

Figure 2.1-1
Watts Bar Unit 2 Reactor Coolant System Heatup Limitations (Heatup Rates of 60°F/hr and 100°F/hr) Applicable for 7 EFPY (without Margins for Instrumentation Errors) Using 1998 through 2000 Addenda App. G Methodology (w/K_{Ic})

(Plotted data (Ref. 1) provided in Table 2.1-1)

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7.0 FIGURES AND TABLES (continued)

TABLE 2.1-1
Watts Bar Unit 2 Heatup Limits
7 EFPY Heatup Curve Data Points Using 1998 through 2000 Addenda App. G Methodology
Data (Ref. 1) plotted on Figure 2.1-1

LEAK TEST LIMITS		HEATUP RATE (60°F/HR)		CRITICALITY LIMITS (60°F/HR)		HEATUP RATE (100°F/HR)		CRITICALITY LIMITS (100°F/HR)	
T (°F)	P (psig)	T (°F)	P (psig)	T (°F)	P (psig)	T (°F)	P (psig)	T (°F)	P (psig)
105	2000	60	0	122	0	60	0	122	0
105	2000	60	621	122	621	60	621	122	621
122	2485	65	621	122	621	65	621	122	621
122	2485	70	621	122	621	70	621	122	621
		75	621	122	621	75	621	122	621
		80	621	125	621	80	621	125	621
		85	621	130	621	85	621	130	621
		90	621	135	621	90	621	135	621
		95	621	140	621	95	621	140	621
		100	621	140	1256	100	621	140	1128
		100	621	145	1314	100	621	145	1160
		100	1256	150	1381	100	1128	150	1199
		105	1314	155	1458	105	1160	155	1245
		110	1381	160	1544	110	1199	160	1298
		115	1458	165	1640	115	1245	165	1358
		120	1544	170	1748	120	1298	170	1426
		125	1640	175	1868	125	1358	175	1503
		130	1748	180	2001	130	1426	180	1590
		135	1868	185	2149	135	1503	185	1687
		140	2001	190	2312	140	1590	190	1795
		145	2149			145	1687	195	1915
		150	2312			150	1795	200	2048
						155	1915	205	2196
						160	2048	210	2360
						165	2196		
						170	2360		

7.0 FIGURES AND TABLES (continued)

MATERIAL PROPERTY BASIS

LIMITING MATERIAL: Intermediate Shell Forging 05
INITIAL RT_{NDT}: 14°F
LIMITING ART VALUES AT 7 EFPY: 1/4T, 61°F
3/4T, 45°F

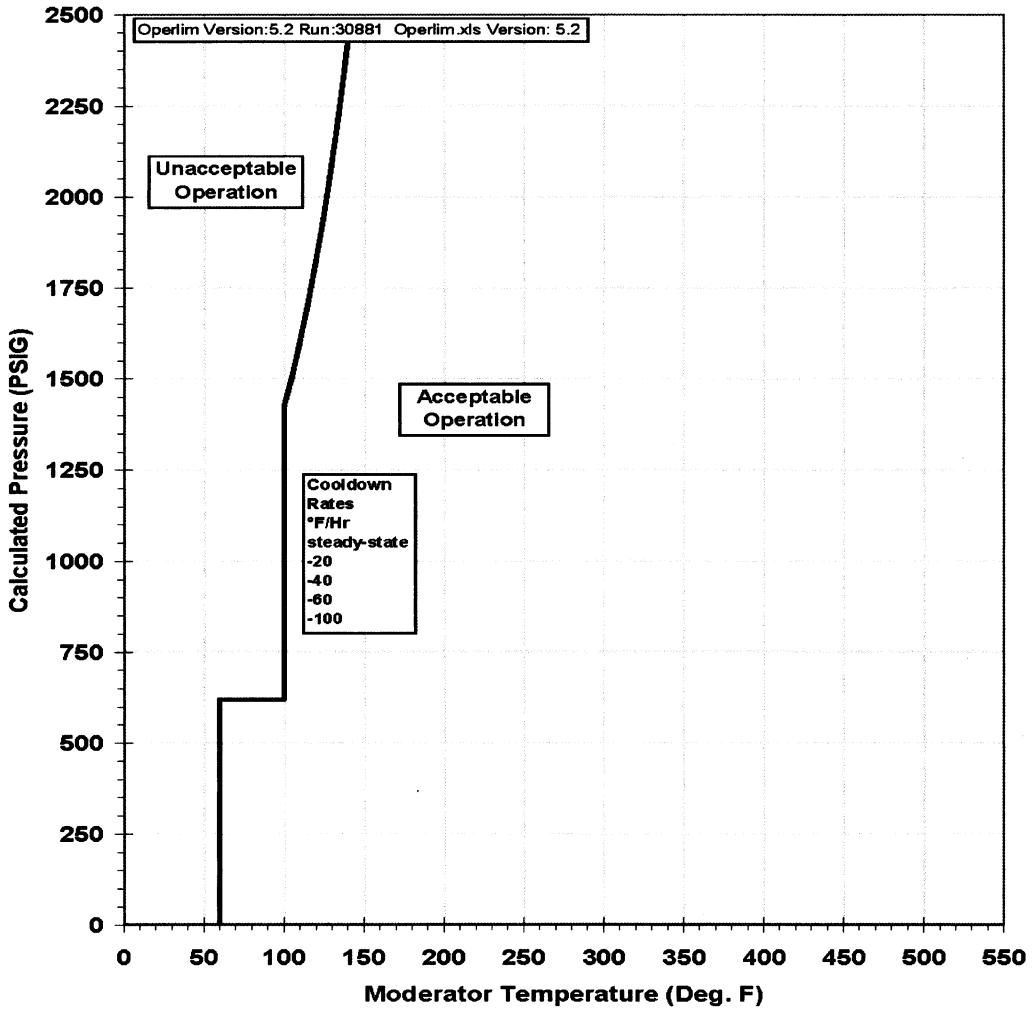

Figure 2.1-2
Watts Bar Unit 2 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 100°F/hr) Applicable for 7 EFPY (without Margins for Instrumentation Errors) Using 1998 through 2000 Addenda App. G Methodology (w/K_{Ic})

(Plotted data (Ref. 1) provided in Table 2.1-2)

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7.0 FIGURES AND TABLES (continued)

TABLE 2.1-2
Watts Bar Unit 2 Cooldown Limits
7 EFPY Heatup Curve Data Points Using 1998 through 2000 Addenda App. G Methodology
(Data (Ref. 1) plotted on Figure 2.1-2)

Steady State		20°F/HR		40°F/HR		60°F/HR		100°F/HR	
T (°F)	P (psig)	T (°F)	P (psig)	T (°F)	P (psig)	T (°F)	P (psig)	T (°F)	P (psig)
60	0	60	0	60	0	60	0	60	0
60	621	60	621	60	621	60	621	60	621
65	621	65	621	65	621	65	621	65	621
70	621	70	621	70	621	70	621	70	621
75	621	75	621	75	621	75	621	75	621
80	621	80	621	80	621	80	621	80	621
85	621	85	621	85	621	85	621	85	621
90	621	90	621	90	621	90	621	90	621
95	621	95	621	95	621	95	621	95	621
100	621	100	621	100	621	100	621	100	621
100	1422	100	1422	100	1422	100	1422	100	1422
105	1508	105	1508	105	1508	105	1508	105	1508
110	1603	110	1603	110	1603	110	1603	110	1603
115	1709	115	1709	115	1709	115	1709	115	1709
120	1825	120	1825	120	1825	120	1825	120	1825
125	1954	125	1954	125	1954	125	1954	125	1954
130	2096	130	2096	130	2096	130	2096	130	2096
135	2253	135	2253	135	2253	135	2253	135	2253
140	2427	140	2427	140	2427	140	2427	140	2427

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7.0 FIGURES AND TABLES (continued)

Setpoint Window

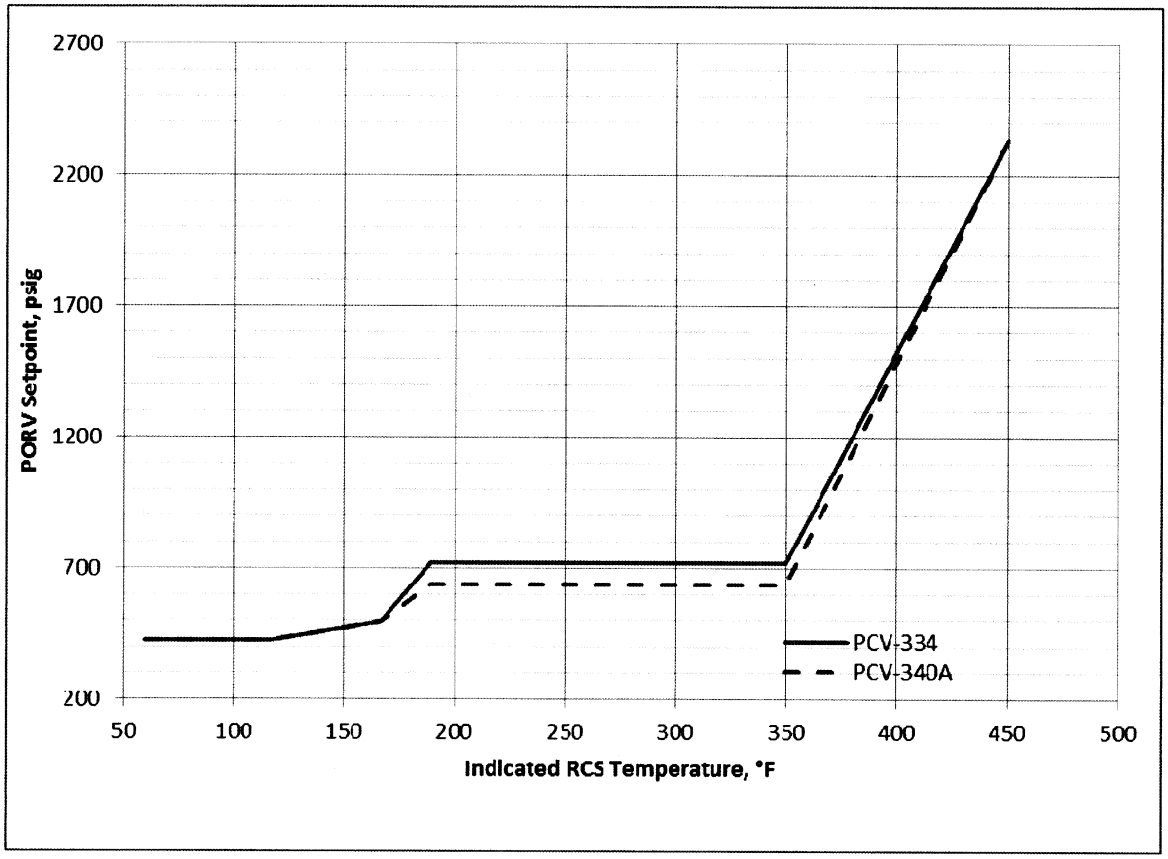

Figure 3.1-1

PORV Setpoint vs RCS Temperature

(Plotted data (Ref. 2) provided in Table 3.1-1)

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7.0 FIGURES AND TABLES (continued)

TABLE 3.1-1
Watts Bar Unit 2 PORV Setpoints vs Temperature
(Data (Ref. 2) Plotted on Figure 3.1-1)

Temperature (°F)	PCV-334 Setpoint (psig)	PCV-340A Setpoint (psig)
60	425	425
120	425	425
130	495	495
170	495	495
195	720	640
250	720	640
300	720	640
350	720	640
450	2335	2335

7.0 FIGURES AND TABLES (continued)

TABLE 4.0-1
Watts Bar Unit 2 Surveillance Capsule Removal Schedule [a]

Capsule	Orientation of Capsule	Lead Factor	Removal Time	Expected Capsule Fluence (n/cm^2,E > 1.0 MeV)
U	Dual 34°	4.8	2.61 EFPY (EOC 2)	0.77×10^{19}
W	Single 34°	5.18	6.1 EFPY	3.17×10^{19} [b]
X	Dual 34°	5.13	6.2 EFPY to 12.5 EFPY [c]	3.17×10^{19} to 6.34×10^{19} [c]
Z	Single 34°	5.18	Standby	-------
V	Dual 31.5°	4.40	Standby	-------
Y	Dual 31.5°	4.40	Standby	-------

Notes:

(a) This information is taken from the withdrawal schedule contained in WCAP-9455, Revision 3 (Ref. 3) and WCAP-18191-NP, Rev. 0 / letter WAT-D-12366 Rev. 0 (Ref. 9).

(b) Approximate Fluence at vessel inner wall at End-of-Life (32 EFPY).

(c) Capsule X should be withdrawn between 6.2 EFPY and 12.5 EFPY, which corresponds to a capsule fluence of not less than once (3.17×10^{19} n/cm^2 (E > 1.0 MeV)) or greater than twice (6.34×10^{19} n/cm^2 (E > 1.0 MeV)) the peak End-of-Life vessel fluence. This is consistent with the recommendations of ASTM E185-82.

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7.0 FIGURES AND TABLES (continued)

Table 5-1 Summary of the Best Estimate Cu and Ni Weight Percent and Initial RT_{NDT} Values for the Watts Bar Unit 2 Reactor Vessel Materials

Material Description	Chemical Composition		Initial RTNDT (a)
Reactor Vessel Beltline Region Location	Cu wt%	Ni wt%	
Intermediate Shell Forging 05	0.05	0.78	14°F
Lower Shell Forging 04	0.05	0.81	5°F
Intermediate to Lower Shell Circumferential Weld Seam W05	0.05	0.70	-50°F
Note: (a) The initial RT_{NDT} values are measured values, taken from WCAP-13830, Revision 1 [Reference 8]			

Table 5-2 Summary of the Initial RT_{NDT} Values for the Watts Bar Unit 2 Closure Head and Vessel Flange

Material Identification	Initial RTNDT (a)
Closure Head Flange	-40°F
Vessel Flange	-22°F
Note: (a) The initial RT_{NDT} values are measured values, taken from WCAP-13830, Revision 1 [Reference 8]	

Table 5-3 Summary of the Watts Bar Unit 2 Reactor Vessel Beltline Material Chemistry Factors

Beltline Materials	Chemistry Factor
Intermediate Shell Forging 05	31°F
Lower Shell Forging 04	31°F
Intermediate to Lower Shell Circumferential Weld Seam W05	68°F

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7.0 FIGURES AND TABLES (continued)

Table 5-4 Fluence Values for the Watts Bar Unit 2 Reactor Vessel Beltline Materials

Beltline Materials	7 EFPY Fluence (n/cm^2, E>1.0 MeV)		
	Inner Wetted Surface	1/4T Location (x=2.116 in.)	3/4T Location (x=6.349 in.)
Intermediate Shell Forging 05	6.93E+18	4.17E+18	1.51E+18
Lower Shell Forging 04	6.93E+18	4.17E+18	1.51E+18
Intermediate to Lower Shell Circumferential Weld Seam W05	6.93E+18	4.17E+18	1.51E+18

Table 5-5 Adjusted Reference Temperature Evaluation for the Watts Bar Unit 2 Reactor Vessel Beltline Materials through 7 EFPY at the 1/4T Location

Reactor Vessel Location	CF (°F)	1/4T f (n/cm^2, E>1.0 MeV)	1/4T FF	ΔRT_{NDT} (°F)	IRT_{NDT}[(a)] (°F)	σ_1[(a)] (°F)	σ_Δ (°F)	M (°F)	ART (°F)
Intermediate Shell Forging 05	31	4.17E+18	0.757	23.5	14	0	11.7	23.5	61
Lower Shell Forging 04	31	4.17E+18	0.757	23.5	5	0	11.7	23.5	52
Intermediate to Lower Shell Circumferential Weld Seam W05	68	4.17E+18	0.757	51.5	-50	0	25.7	51.5	53
Note: (a) The initial RT_{NDT} values are measured values; therefore, σ_i=0°F									

Table 5-6 Adjusted Reference Temperature Evaluation for the Watts Bar Unit 2 Reactor Vessel Beltline Materials through 7 EFPY at the 3/4T Location

Reactor Vessel Location	CF (°F)	3/4T f (n/cm^2, E>1.0 MeV)	3/4T FF	ΔRT_{NDT} (°F)	IRT_{NDT}[(a)] (°F)	σ_1[(a)] (°F)	σ_Δ (°F)	M (°F)	ART (°F)
Intermediate Shell Forging 05	31	1.51E+18	0.504	15.6	14	0	7.8	15.6	45
Lower Shell Forging 04	31	1.51E+18	0.504	15.6	5	0	7.8	15.6	36
Intermediate to Lower Shell Circumferential Weld Seam W05	68	1.51E+18	0.504	34.3	-50	0	17.1	34.3	19
Note: (a) The initial RT_{NDT} values are measured values; therefore, σ_i=0°F									

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7.0 FIGURES AND TABLES (continued)

Table 5-7 Summary of the Limiting ART Values Used in the Generation of the Watts Bar Unit 2 Heatup/Cooldown Curves

EFPY	Limiting ART (°F)	
	1/4T	3/4T
7	61	45

Table 5-8 RT_{PTS} Calculations for the Watts Bar Unit 2 Beltline Materials at 32 EFPY

Material	CF (°F)	32 EFPY Fluence (n/cm^2, E>1.0 MeV)	FF[(a)]	IRT_{NDT} (°F)	ΔRT_{NDT}[(b)] (°F)	σ_u[(c)] (°F)	σ_Δ[(d)] (°F)	M[(e)] (°F)	RT_{PTS}[(f)] (°F)
Intermediate Shell Forging 05	31	3.17E+19	1.30	14	40.4	0	17	34	88
Lower Shell Forging 04	31	3.17E+19	1.30	5	40.4	0	17	34	79
Intermediate to Lower Shell Circumferential Weld Seam W05	68	3.17E+19	1.30	-50	88.7	0	28	56	95

Note:
(a) FF = fluence factor = $f^{(0.28 - 0.1 \log (f))}$

(b) $\Delta RT_{NDT} = \Delta RT_{PTS} = CF * FF$

(c) As indicated in Table 5-1 of this report, the IRT_{NDT} values are measured; hence, according to 10 CFR 50.61, $\sigma_u = 0°F$

(d) Per the guidance of 10 CFR 50.61, the base metal $\sigma_\Delta = 17°F$ and the weld metal $\sigma_\Delta = 28°F$ when surveillance data is not utilized. However, σ_Δ need not exceed $0.5*\Delta RT_{NDT}$

(e) $M = \text{Margin} = 2 *(\sigma_u^2 + \sigma_\Delta^2)^{1/2}$

(f) $RT_{PTS} - IRT_{NDT} + \Delta RT_{PTS} + \text{Margin}$