

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402-2801

October 19, 2009

10 CFR 50.4

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

> Watts Bar Nuclear Plant, Unit 1 Facility Operating License No. NPF-90 NRC Docket No. 50-390

Subject: Revisions 2 and 3 of the Cycle 10 Core Operating Limits Report

The purpose of this letter is to provide Revisions 2 and 3 of the Cycle 10 Core Operating Limits Report (COLR) in accordance with Watts Bar Nuclear Plant Technical Specification 5.9.5.d. Revisions 0 and 1 of the COLR were never issued for use during Cycle 10. Revision 2 provided the boron concentrations required for reloading the core and entry into Mode 6 and Mode 5. Revision 3 defines the core operating limits for Cycle 10 operation.

There are no regulatory commitments contained in this letter or its enclosures. Please direct any questions concerning this matter to Kevin Casey at (423) 751-8523.

Respectfully,

R. M. Krich

Vice President Nuclear Licensing

Enclosures

Revision 2 of the Cycle 10 COLR
Revision 3 of the Cycle 10 COLR



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Enclosures cc (Enclosures):

NRC Regional Administrator - Region II

NRC Senior Resident Inspector - Watts Bar Nuclear Plant

Cycle 10 Core Operating Limits Report

Revision 2

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E1-1 of 3

COLR for Watts Bar Unit 1, Cycle 10

QA Record L36 091001 802

WATTS BAR NUCLEAR PLANT, UNIT 1, CYCLE 10

MODE 6 AND RESTRICTED MODE 5 CORE OPERATING LIMITS REPORT

Revision 2

October 2009

Prepared by: 10/6/09 te 10/6/09 10 n **Nuclear Fuel** Date Reviewed by: Manager, Nuclear Fyrel Engineering Date for CDG 10 01 Date **Reactor Engineering Supervisor** Approved by: PORC Chairman Date Var 60 10/6

Plant Manager

Date

Revision	Date of PORC Approval	PORC Meeting Number	Affected Pages	Reason for Revision
0	n/a	n/a	n/a	not issued
1	n/a	n/a	n/a	not issued
2	10/6/05	4273	all	initial issue

Mode 6 and Restricted Mode 5 COLR for Watts Bar Unit 1, Cycle 10

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Watts Bar Unit 1 Cycle 10 has been prepared in accordance with the requirements of the Technical Specifications 5.9.5.

The Technical Specifications affected by this report are listed below:

- 3.1.4 Moderator Temperature Coefficient (MTC)
- 3.1.6 Shutdown Bank Insertion Limits
- 3.1.7 Control Bank Insertion Limits
- 3.2.1 Heat Flux Hot Channel Factor (F_Q(Z))
- 3.2.2 Nuclear Enthalpy Rise Hot Channel Factor $(F_{\Delta H}^{N})$
- 3.2.3 Axial Flux Difference (AFD)
- 3.5.1 Accumulators
- 3.5.4 Refueling Water Storage Tank (RWST)
- 3.9.1 Boron Concentration

2.0 OPERATING LIMITS

This COLR is only valid for mode 6 and restricted mode 5. The mode 5 restriction does not allow the control rod drive system to withdraw any RCCA. The COLR must be revised before the withdrawal of the RCCAs by the control rod drive system is enabled. The cycle-specific parameter limits for specifications 3.1.4, 3.1.6, 3.1.7, 3.2.1, 3.2.2, and 3.2.3 are not applicable in mode 6 or restricted mode 5 and are not provided. The parameter limits for the specifications 3.5.1, 3.5.4, and 3.9.1 are provided in the following subsections. These limits have been developed using the NRC approved methodologies specified in the Technical Specifications Section 5.9.5.

- 2.1 REFUELING BORON CONCENTRATION (LCO 3.9.1)
 - 2.1.1 The refueling boron concentration shall be \geq 2000 ppm.
- 2.2 ACCUMULATORS (LCO 3.5.1)
 - 2.2.1 There are 240 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 10.
- 2.3 REFUELING WATER STORAGE TANK RWST (LCO 3.5.4)
 - 2.3.1 There are 240 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 10.

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Cycle 10 Core Operating Limits Report

Revision 3

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COLR for Watts Bar Unit 1, Cycle 10

QA Record L36 091009 807

WATTS BAR NUCLEAR PLANT, UNIT 1, CYCLE 10

CORE OPERATING LIMITS REPORT

Revision 3

October 2009

Prepared by: John Strange 09 Nuclear Fuel Daté Reviewed by: Manager, Nuclear Fuel Engineering Date 10/9/09 for CDG Date **Reactor Engineering Supervisor** Approved by: 10 19/04 PORC Chairman Date For 60 101 Plant Manager Date

Revision	PORC Approval	PORC Meeting Number	Affected Pages	Reason for Revision	
0	n/a	n/a	n/a	not issued	
1	n/a	n/a	n/a	not issued	
2	10/6/09	4273	ail	initial issue	
3	10/9/09	4274	all	revised to remove mode restriction	

Unit 1 Watts Bar

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Cycle 10 Revision 3

1.0 CORE OPERATING LIMITS REPORT

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The Technical Specifications affected by this report are listed below:

- 3.1.4 Moderator Temperature Coefficient (MTC)
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- 3.2.1 Heat Flux Hot Channel Factor $(F_Q(Z))$
- 3.2.2 Nuclear Enthalpy Rise Hot Channel Factor $(F_{\Delta H}^{N})$
- 3.2.3 Axial Flux Difference (AFD)
- 3.5.1 Accumulators
- 3.5.4 Refueling Water Storage Tank (RWST)
- 3.9.1 Boron Concentration

2.0 **OPERATING LIMITS**

The cycle-specific parameter limits for the specifications listed in section 1.0 are presented in the following subsections. These limits have been developed using the NRC approved methodologies specified in the Technical Specifications Section 5,9.5.

The following abbreviations are used in this section:

BOL--Beginning of Cycle LifeARO--All Rods OutHZP--Hot Zero Thermal PowerEOL--End of Cycle LifeRTP--Rated Thermal Power

2.1 MODERATOR TEMPERATURE COEFFICIENT - MTC (LCO 3.1.4)

2.1.1 The MTC limits are:

The ARO/HZP · MTC shall be less positive than or equal to $0 \Delta k/k^{\circ}F$ (upper limit). With the measured BOL/ARO/HZP · MTC more positive than $-0.60 \times 10^{-5} \Delta k/k^{\circ}F$ (as measured MTC limit), establish control rod withdrawal limits to ensure the MTC remains less positive than or equal to $0 \Delta k/k^{\circ}F$ (upper limit) for all times in core life.

The EOL/ARO/RTP · MTC shall be less negative than or equal to $-4.5 \times 10^{-4} \Delta k/k/^{\circ}$ F (lower limit).

2.1.2 The 300 ppm surveillance limit is:

The measured 300 ppm /ARO/RTP-MTC should be less negative than or equal to -3.75 x 10⁻⁴ $\Delta k/k/^{\circ}F$.

2.1.3 The 60 ppm surveillance limit is:

The measured 60 ppm /ARO/RTP-MTC should be less negative than or equal to -4.28 x 10 4 $\Delta k/k/^{\circ}F$.

2.2 SHUTDOWN BANK INSERTION LIMITS (LCO 3.1.6)

2.2.1 The shutdown banks shall be withdrawn to a position greater than or equal to 225 steps withdrawn.

2.3 CONTROL BANK INSERTION LIMITS (LCO 3.1.7)

- 2.3.1 The control banks are fully withdrawn or shall be limited in physical insertion as shown in Figure 1.
- 2.3.2 Each control bank shall be considered fully withdrawn from the core at greater than or equal to 225 steps.
- 2.3.3 The control banks shall be operated in sequence by withdrawal of Bank A, Bank B, Bank C, and Bank D. The control banks shall be sequenced in reverse order upon insertion.

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Park Position (steps)	Bank Overlap (steps)	Bank Difference(steps)
225	109	116
226	110	116
227	111	116
228	112	116
229	113	116
230	114	116
231	115	116

2.3.4 Each control bank not fully withdrawn from the core shall be operated with the following overlap as a function of park position.

2.4 HEAT FLUX HOT CHANNEL FACTOR - $F_Q(Z)$ (LCO 3.2.1)

 $F_Q(Z) \leq [CFQ / P] * K(Z)$ for P > 0.5

 $F_Q(Z) \leq [CFQ \, / \, 0.5]$ * K(Z)~ for $P \leq 0.5~$

Where P = Thermal Power / Rated Thermal Power

 $2.4.1 \, \mathrm{CFQ} = 2.50$

2.4.2 K(Z) is provided in Figure 2.

2.4.3 $F_Q^w(Z) = F_Q^c(Z) * W(Z)/P$ for P > 0.5 $F_Q^w(Z) = F_Q^c(Z) * W(Z)/0.5$ for $P \le 0.5$ where: W(Z) values are provided in Table A.1. The table provides sufficient information to determine W(Z) versus core height for all cycle burnups.

2.4.4 $F_Q^w(Z)$ Penalty Factor The $F_Q^w(Z)$ penalty factor is provided in Table A.2.

2.5 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR – $F_{\Delta H}^{N}$ (LCO 3.2.2)

 $\mathbf{F}_{\Delta H}^{N} \leq \mathbf{F}_{\Delta H}^{RTP} * (1 + PF * (1 - P))$

where **P** = Thermal Power / Rated Thermal Power

 $F_{\Delta H}^{RTP} = 1.65$ for RFA-2 fuel, and

PF = 0.3

2.6 AXIAL FLUX DIFFERENCE · AFD (LCO 3.2.3)

2.6.1 The AFD limits for Cycle 10 are provided in Figure 3.

2.7 **REFUELING BORON CONCENTRATION (LCO 3.9.1)**

2.7.1 The refueling boron concentration shall be ≥ 2000 ppm.

2.8 ACCUMULATORS (LCO 3.5.1)

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2.8.1 There are 240 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 10.

2.9 REFUELING WATER STORAGE TANK – RWST (LCO 3.5.4)

2.9.1 There are 240 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 10.

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Figure 1 Control Bank Insertion Limits Versus Thermal Power Four Loop Operation

* Fully withdrawn region shall be the condition where shutdown and control banks are at a position within the interval of ≥ 225 and ≤ 231 steps withdrawn.

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Figure 2 K(Z) - Normalized F_Q(Z) as a Function of Core Height

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Figure 3 Axial Flux Difference Acceptable Operation Limits as a function of Rated Thermal Power (RAOC)

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Table A.1 $F_Q^w(Z) = F_Q^c(Z) * W(Z)$

	Max W(z) at 150	Max W(z) at 150	Max W(z) at 150		Max W(z) at	Max W(z) at
Height (ft)	(30% Power)	MWD/MTU (75% Power)	MWD/MTU (100% Power)	Max W(z) at 3000	10000 MM/D/MTU	16000
12.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.8000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11,6000	1.0000	1.0000	1.0000	1.0000	1,0000	1.0000
11.4000	1.0000	1.0000	1,0000	1,0000	1,0000	1.0000
11,2000	1.0000	1,0000	1.0000	1.0000	1,0000	1.0000
11.0000	1,0000	1.0000	1.0000	.1.0000	1.0000	1.0000
10,8000	1,2811	1,3035	1,1893	1,1903	1.2164	1.2015
10.6000	1.2651	1.2796	1,1864	1,1869	1,2167	1,2033
10 4000	1 2458	1 2508	1 1812	1 1814	1 2157	1 2055
10 2000	1 2262	1 2218	1 1746	1 1745	1 2122	1 1986
10.0000	1.2058	1,1915	1.1672	1.1668	1 2071	1 1848
9 8000	1 1833	1 1622	1 1585	1 1585	1 2007	1 1817
9 6000	1 1615	1 1386	1 1512	1 1606	1 1933	1 1827
9 4000	1 1466	1 1243	1 1515	1 1702	1.1846	1.1826
9,2000	1 1416	1 1225	1 1606	1 1693	1 1754	1 1814
9,0000	1 1316	1 1182	1 1647	1 1666	1 1727	1 1902
8 8000	1 1249	1 1198	1 1727	1 1689	1 1747	1 2049
8.6000	1,1238	1 1295	1 1882	1 1790	1 1857	1 2229
8 4000	1 1230	1 1421	1 2052	1 1929	1.1001	1 2426
8,2000	1,1193	1 1520	1 2186	1 2033	1 2127	1 2588
8.0000	1 1135	1 1597	1.2100	1 2114	1 2222	1.2000
7 8000	1 1062	1 1658	1 2370	1 2173	1 2293	1.2830
7 6000	1 1013	1 1701	1.2070	1 2208	1 2340	1.2000
7.4000	1.0967	1.1728	1.2447	1 2221	1 2363	1.2000
7,2000	1 0922	1 1733	1 2448	1 2212	1 2363	1.2002
7 0000	1.0873	1 1712	1 2425	1 2186	1 2340	1 2057
6 8000	1.0876	1 1670	1 2380	1.2100	1,2300	1.2017
6,6000	1.0774	1 1621	1 2312	1 2087	1 2245	1.2852
6 4000	1.0727	1 1564	1 2227	1,2009	1 2171	1.2002
6 2000	1.0692	1 1512	1 2141	1 1914	1 2079	1.2646
6,0000	1.0660	1.1012	1.2.141	1.1314	1 1071	1.2040
5,8000	1.0622	1 1419	1.2000	1.1746	1.1840	1.2349
5 6000	1.0596	1,1413	1,1370	1 1677	1.1040	1 2173
5 4000	1.0603	1.1344	1.1000	1 1630	1 1640	1.2773
5 2000	1.0633	1.1332	1.1020	1,1603	1.1591	1.1992
5.0000	1.0675	1.1336	1 1735	1.1574	1 1535	1.1000
4 8000	1.0725	1.1347	1 1702	1.1658	1.1487	1.1770
4 6000	1.0728	1 1363	1.1132	1.1550	1.1407	1.1752
4 4000	1 0874	1 1392	1 1670	1 1533	1 1402	1 1639
4 2000	1 0964	1 1415	1 1661	1.1531	1.1378	1.1603
4 0000	1 1047	1 1437	1 1645	1 1532	1 1353	1.1490
3 8000	1 1150	1 1482	1 1650	1 1558	1 1322	1 1430
3.6000	1.1277	1.1550	1,1676	1.1620	1,1311	1.1415
3.4000	1.1405	1 1611	1 1693	1 1698	1 1330	1 1417
3 2000	1 1558	1 1692	1 1727	1 1771	1 1344	1 1414
3 0000	1 1780	1 1842	1 1830	1 1848	1 1418	1 1436
2 8000	1 2044	1 2034	1 1977	1 1990	1 1567	1 1472
2 6000	1 2351	1 2266	1 2163	1 2187	1 1753	1 1531
2 4000	1 2722	1 2556	1 2412	1 2376	1 1934	1 1662
2 2000	1 3089	1 2835	1.2412	1.2611	1.1004	1.1812
2.000	1.3426	1 3007	1 2881	1 2849	1 2200	1 1060
1.8000	1 3765	1 3405	1 3140	1 3079	1 2450	1 2102
1 6000	1 4144	1.3780	1 3456	1 3345	1 2619	1 2236
1 4000	1 4594	1 4165	1.3786	1.3664	1 2760	1 2356
1 2000	1 5070	1 4601	1 4087	1 3053	1.2700	1.2300
1,2000	1,000	1.4321	1.4007	1.0900	1.20/4	1.2400
0.8000	1,000	1.0000	1,0000	1,0000	1,0000	1.0000
0.000	1,0000	1.0000	1.0000	1.0000	1,0000	1.0000
0.0000	1,000	1.0000	1.0000	1,0000	1,0000	1.0000
0.4000	1,0000	1,0000	1,0000	1.0000	1,0000	1.0000
0.2000	1,0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.0000	1.0000	1,0000	1.0000	1.0000	1.0000	1.0000

Unit 1 WATTS BAR

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Cycle 10 Revision 3

$\begin{array}{c} Table \ A.2 \\ F_Q{}^w(Z) \ Penalty \ Factor \end{array}$

Core	F _Q ^W (Z)
Burnup	Penalty
(MWD/MTU)	Factor
All Burnups	1.0200

Note:

1. The Penalty Factor, which is applied to $F_Q^{W}(Z)$ for compliance with Surveillance Requirement 3.2.1.2.a, is the maximum factor by which $F_Q^{W}(Z)$ is expected to increase per 31 Effective Full Power Days (EFPD) starting from the burnup at which the $F_Q^{W}(Z)$ was determined.

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