TENNESSEE VALLEY AUTHORITY

Post Office Box 2000, Spring City, Tennessee 37381

WBL-21-013

March 18, 2021

10 CFR 50.4

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

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

Subject: **REVISION 1 OF THE WATTS BAR UNIT 2 CYCLE 4 CORE OPERATING LIMITS REPORT (COLR)**

In accordance with Watts Bar Nuclear Plant (WBN) Technical Specifications Section 5.9.5.d, Tennessee Valley Authority (TVA) is submitting Revision 1 of the WBN Unit 2, Cycle 4 Core Operating Limits Report (COLR).

There are no new regulatory commitments contained in this letter or the enclosure. Should you have questions regarding this submittal, please contact Tony Brown, WBN Site Licensing Manager, at (423) 365-7720.

Respectfully,

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

Enclosure: Watts Bar Nuclear Plant, Unit 2, Cycle 4 Core Operating Limits Report Revision 1
March 2021

cc (Enclosure):

NRC Regional Administrator - Region II
NRR Project Manager
NRC Senior Resident Inspector

ENCLOSURE

Watts Bar Nuclear Plant, Unit 2, Cycle 4
Core Operating Limits Report
Revision 1
March 2021

QA Record
L36 210302 800

WATTS BAR NUCLEAR PLANT, UNIT 2, CYCLE 4

CORE OPERATING LIMITS REPORT

Revision 1

March 2021

Prepared by:

Digitally signed by Bell, Jamel C
DN: dc=gov, dc=tva, dc=main, ou=Main, ou=Corporate, ou=Users, cn=Bell, Jamel C, email=jcbell@tva.gov
Reason: I am the author of this document
Location: TVA CDC - WP4
Date: 2021.03.03 16:11:34 -05'00'

Jamel C. Bell, PWR Fuel Engineering / Date

Verified by:

Porter, Mark Donald
Digitally signed by Porter, Mark Donald
DN: dc=gov, dc=tva, dc=main, ou=Main, ou=Corporate, ou=Users, cn=Porter, Mark Donald, email=mdporter@tva.gov
Reason: I have reviewed this document
Date: 2021.03.03 16:15:53 -05'00'

Mark D. Porter, PWR Fuel Engineering / Date

Reviewed by:

Ritchie, John A
Digitally signed by Ritchie, John A
DN: dc=gov, dc=tva, dc=main, ou=Main, ou=Corporate, ou=Users, cn=Ritchie, John A, email=jaritchie0@tva.gov
Reason: I have reviewed this document
Date: 2021.03.04 08:35:27 -05'00'

John A. Ritchie, Manager, PWR Fuel Engineering / Date

Mack, Bryan Thomas
Digitally signed by Mack, Bryan Thomas
Date: 2021.03.04 11:41:28 -05'00'

Bryan T. Mack, Manager, Reactor Engineering / Date

Approved by:

PORC Chairman / 3/11/2021 Date

Plant Manager / 3/11/2021 Date

Revision	Date of PORC Approval	Affected Pages	Reason for Revision
0	10/23/2020	All	Initial issue
1	See Above	1, 4, 9, 10	Updated W(z) values on Table A.1 and removed Table A.3

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Watts Bar Unit 2 Cycle 4 has been prepared in accordance with the requirements of the Technical Specifications (TS) 5.9.5.

The Technical Specifications affected by this report are listed below:

3.1.4 Moderator Temperature Coefficient (MTC)
3.1.5 Rod Group Alignment Limits
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)
3.9.1 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 Life
ARO	--	All Rods Out
HZP	--	Hot Zero Thermal Power
EOL	--	End of Cycle Life
RTP	--	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 $\Delta k/k/°F$ (upper limit). With the measured BOL/ARO/HZP - MTC more positive than -2.12×10^{-5} $\Delta k/k/°F$ (as-measured MTC limit), establish control rod withdrawal limits to ensure the MTC remains less positive than or equal to 0 $\Delta k/k/°F$ (upper limit) for all times in core life.

The EOL/ARO/RTP - MTC shall be less negative than or equal to -4.50×10^{-4} $\Delta k/k/°F$ (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 -3.75×10^{-4} $\Delta k/k/°F$.

2.1.3 The 60 ppm surveillance limit is:

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

2.2 SHUTDOWN MARGIN – SDM (LCO 3.1.5, 3.1.6, 3.1.7)

2.2.1 For TS 3.1.5, SDM shall be $\geq$ 1.6% $\Delta k/k$ in MODE 1 and MODE 2.

2.2.2 For TS 3.1.6, SDM shall be $\geq$ 1.6% $\Delta k/k$ in MODE 1 and MODE 2.

2.2.3 For TS 3.1.7, SDM shall be $\geq$ 1.6% $\Delta k/k$ in MODE 1 and MODE 2 with $k_{eff} \geq 1.0$.

2.3 SHUTDOWN BANK INSERTION LIMITS (LCO 3.1.6)

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

2.4 CONTROL BANK INSERTION LIMITS (LCO 3.1.7)

2.4.1 The control banks are fully withdrawn or shall be limited in physical insertion as shown in Figure 1.

2.4.2 Each control bank shall be considered fully withdrawn from the core at greater than or equal to 225 steps.

2.4.3 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.

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

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

2.5 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

2.5.1 CFQ = 2.50

2.5.2 K(Z) is provided in Figure 2.

2.5.3 $F_Q^W(Z) = F_Q^c(Z) * W(Z)/P$ for $P > 0.5$
$F_Q^W(Z) = F_Q^c(Z) * W(Z)/0.5$ for $P \leq 0.5$

where: W(Z) values are provided in Table A.1.

This table provides sufficient information to determine W(Z) versus core height for all cycle burnups.

2.5.4 The W(Z) values provided by Table A.1 may be used when the part power surveillance is performed using the fixed incore detector system.

2.5.5 $F_Q^W(Z)$ Penalty Factor
The $F_Q^W(Z)$ penalty factor is provided in Table A.2.

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

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

where P = Thermal Power / Rated Thermal Power

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

PF = 0.3

2.7 AXIAL FLUX DIFFERENCE - AFD (LCO 3.2.3)

2.7.1 The AFD limits for Cycle 4 are provided in Figure 3.

2.8 REFUELING BORON CONCENTRATION (LCO 3.9.1)

2.8.1 The refueling boron concentration shall be ≥ 2300 ppm.

3.0 NUMBER OF TPBARS IN REACTOR CORE (TS 4.2.1)

3.0.1 There are 544 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 4.

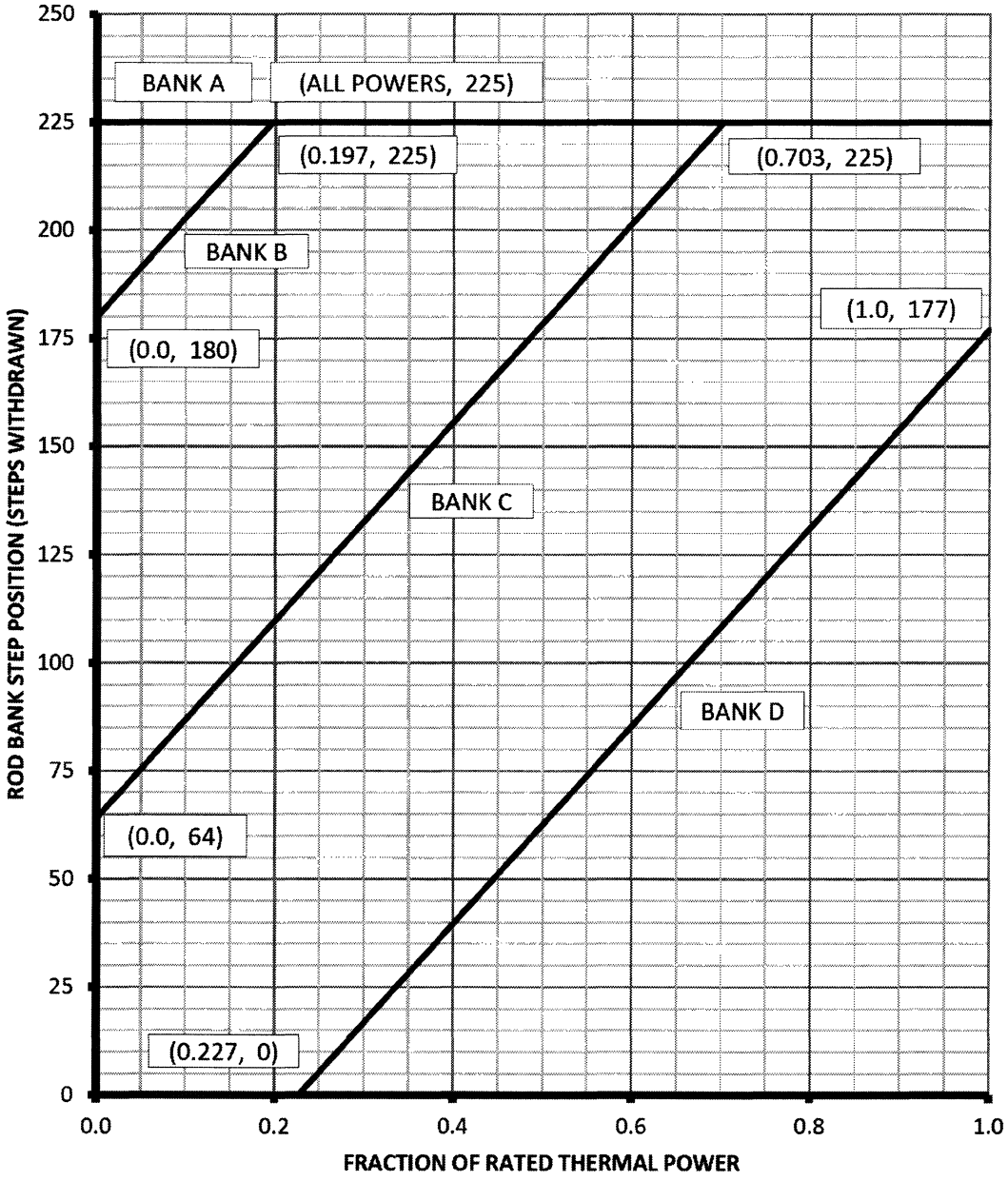

Figure 1
Control Bank Insertion Limits Versus Thermal Power
Four Loop Operation

* 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.

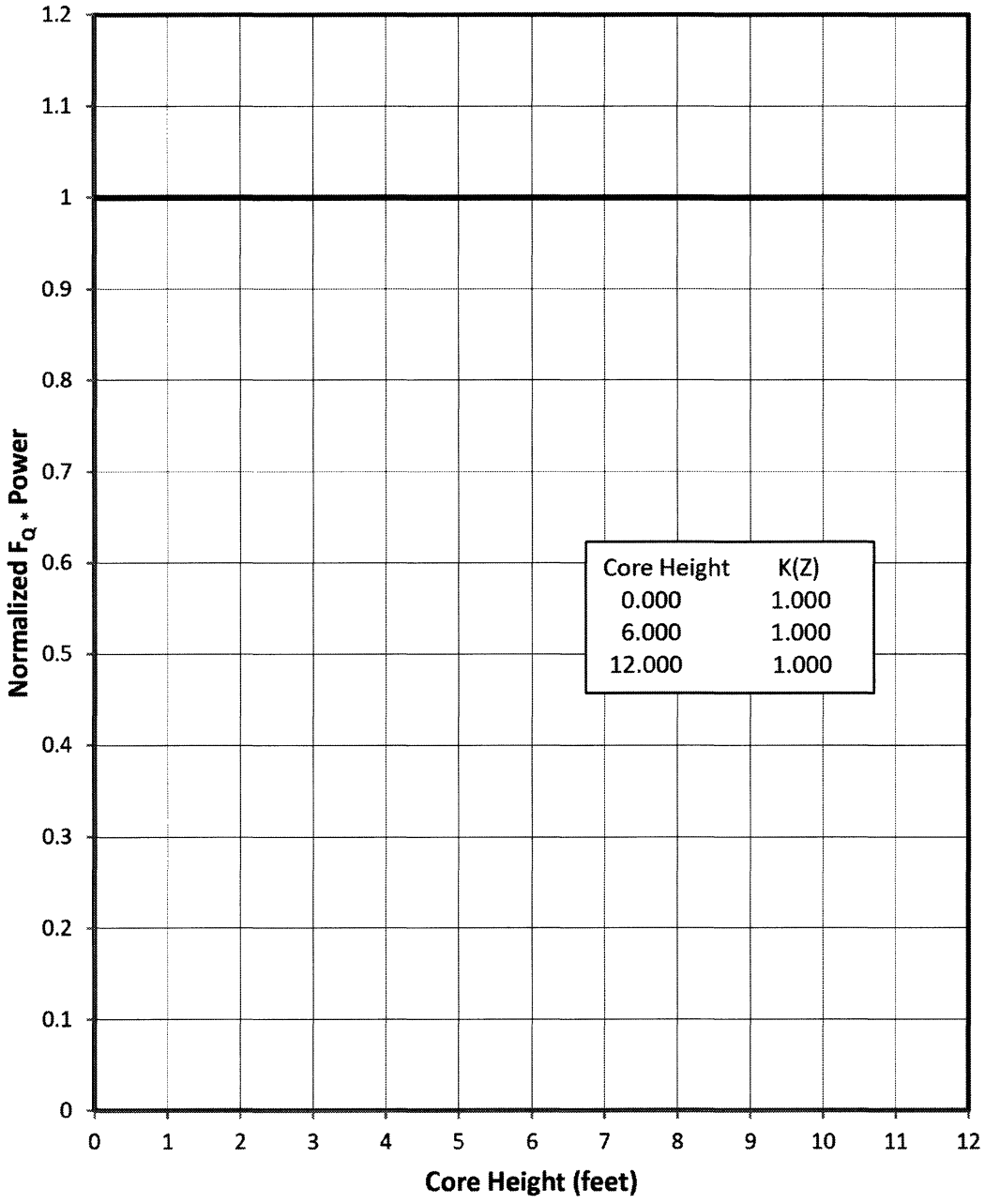

Figure 2
K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height

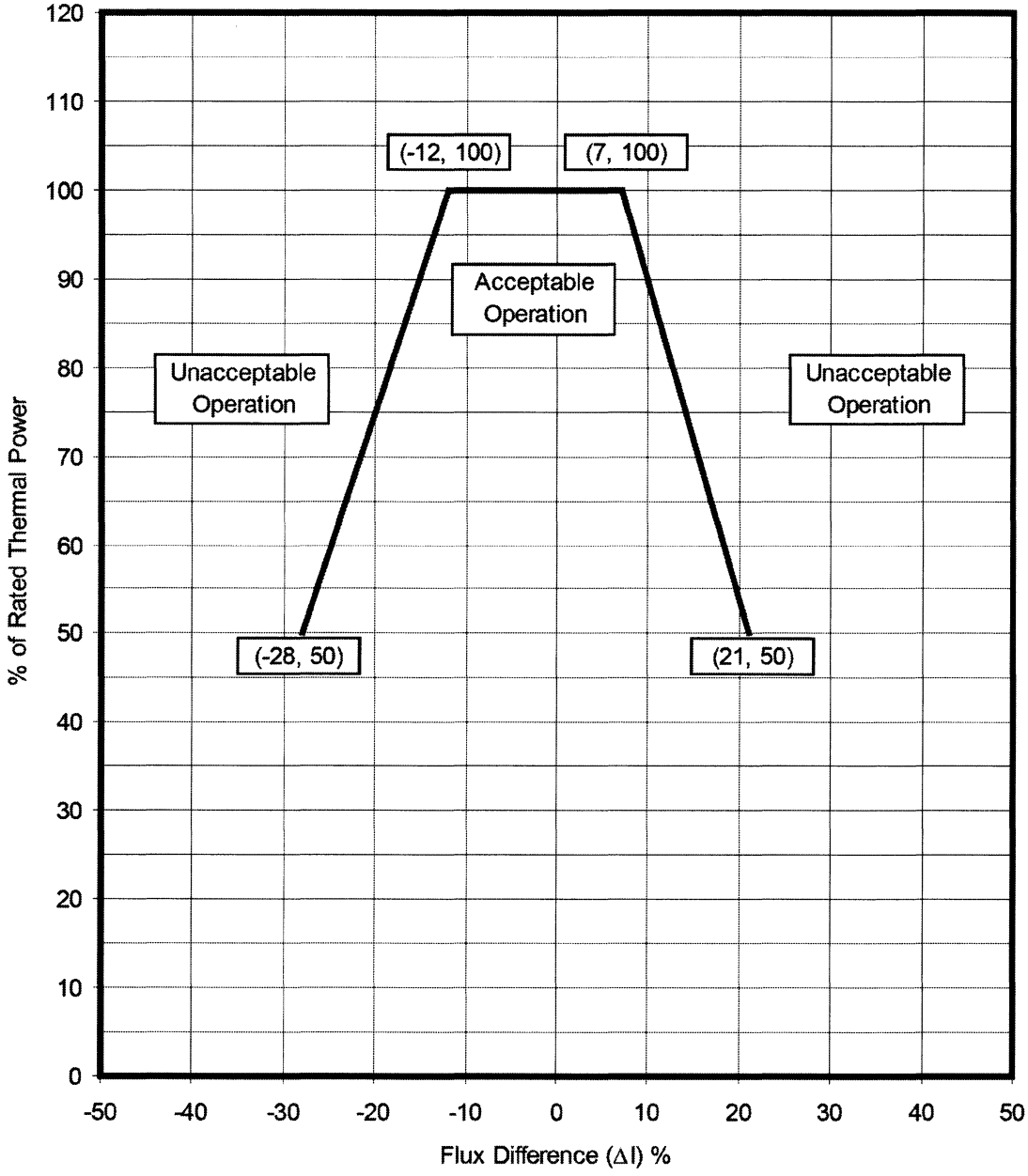

Figure 3
Axial Flux Difference Acceptable Operation Limits as a function of Rated Thermal Power (RAOC)

Table A.1
RAOC W(Z) Surveillance Factors

Height (Ft)	150 (MWD/MTU)	2000 (MWD/MTU)	8000 (MWD/MTU)	12000 (MWD/MTU)	14000 (MWD/MTU)	16000 (MWD/MTU)
12.0720	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.8708	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.6696	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.4684	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.2672	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.0660	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10.8648	1.2448	1.2607	1.2818	1.2400	1.2528	1.2621
10.6636	1.2318	1.2401	1.2398	1.2212	1.2258	1.2348
10.4624	1.2230	1.2278	1.2261	1.2082	1.2194	1.2242
10.2612	1.2102	1.2077	1.2134	1.1938	1.2005	1.2116
10.0600	1.1982	1.1919	1.1974	1.1802	1.1829	1.1949
9.8588	1.1869	1.1775	1.1834	1.1710	1.1759	1.1825
9.6576	1.1854	1.1780	1.1760	1.1676	1.1760	1.1857
9.4564	1.1850	1.1753	1.1731	1.1807	1.1764	1.1877
9.2552	1.1843	1.1738	1.1752	1.1800	1.1756	1.1893
9.0540	1.1820	1.1761	1.1781	1.1816	1.1809	1.1946
8.8528	1.1871	1.1808	1.1795	1.1855	1.1815	1.1956
8.6516	1.1941	1.1818	1.1814	1.1978	1.1833	1.1979
8.4504	1.2016	1.1851	1.1905	1.2133	1.1944	1.2086
8.2492	1.2059	1.1882	1.2036	1.2262	1.2124	1.2272
8.0480	1.2077	1.1913	1.2116	1.2365	1.2273	1.2425
7.8468	1.2145	1.1944	1.2186	1.2443	1.2381	1.2560
7.6456	1.2182	1.1975	1.2221	1.2489	1.2470	1.2651
7.4444	1.2198	1.1988	1.2253	1.2515	1.2538	1.2728
7.2432	1.2192	1.1979	1.2234	1.2509	1.2575	1.2770
7.0420	1.2172	1.1954	1.2213	1.2481	1.2579	1.2775
6.8408	1.2132	1.1916	1.2164	1.2431	1.2574	1.2762
6.6396	1.2070	1.1856	1.2109	1.2364	1.2533	1.2720
6.4384	1.1998	1.1786	1.2033	1.2314	1.2477	1.2673
6.2372	1.1918	1.1768	1.1943	1.2244	1.2402	1.2594
6.0360	1.1827	1.1770	1.1829	1.2151	1.2314	1.2490
5.8348	1.1787	1.1741	1.1707	1.2046	1.2184	1.2364
5.6336	1.1734	1.1714	1.1632	1.1920	1.2060	1.2223
5.4324	1.1705	1.1700	1.1605	1.1785	1.1914	1.2054
5.2312	1.1696	1.1672	1.1587	1.1777	1.1856	1.1946
5.0300	1.1694	1.1635	1.1590	1.1752	1.1840	1.1910
4.8288	1.1692	1.1580	1.1595	1.1726	1.1807	1.1871
4.6276	1.1689	1.1564	1.1605	1.1682	1.1756	1.1822
4.4264	1.1678	1.1561	1.1596	1.1638	1.1705	1.1762
4.2252	1.1649	1.1550	1.1585	1.1585	1.1666	1.1712
4.0240	1.1624	1.1533	1.1565	1.1542	1.1629	1.1661
3.8228	1.1589	1.1514	1.1544	1.1511	1.1582	1.1599
3.6216	1.1580	1.1495	1.1512	1.1509	1.1525	1.1525
3.4204	1.1626	1.1529	1.1515	1.1543	1.1477	1.1465
3.2192	1.1672	1.1578	1.1559	1.1580	1.1478	1.1454
3.0180	1.1766	1.1722	1.1665	1.1605	1.1507	1.1515
2.8168	1.1963	1.1958	1.1846	1.1727	1.1622	1.1691
2.6156	1.2172	1.2184	1.2056	1.1910	1.1796	1.1881
2.4144	1.2374	1.2422	1.2242	1.2080	1.1956	1.2067
2.2132	1.2578	1.2643	1.2437	1.2254	1.2129	1.2248
2.0120	1.2773	1.2874	1.2627	1.2418	1.2289	1.2420
1.8108	1.2973	1.3082	1.2804	1.2574	1.2434	1.2582
1.6096	1.3143	1.3290	1.2973	1.2715	1.2578	1.2736
1.4084	1.3287	1.3458	1.3130	1.2838	1.2701	1.2877
1.2072	1.3428	1.3601	1.3270	1.2946	1.2812	1.2988
1.0060	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.8048	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.6036	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.4024	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.2012	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

Table A.2
$F_Q^W(Z)$ Penalty Factor

Cycle Burnup (MWD/MTU)	$F_Q^W(Z)$ Penalty Factor
8296	1.0200
8485	1.0215
8675	1.0231
8864	1.0247
9054	1.0261
9243	1.0250
9433	1.0234
9622	1.0218
9812	1.0202
10001	1.0200

Note:

1. The Penalty Factor, which is applied to $F_Q^W(Z)$ for compliance with Surveillance Requirement 3.2.1.2, 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. This Penalty Factor is applicable for the set of W(Z) Surveillance Factors provided in Table A.1.