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

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January 29, 2019

10 CFR 50.4

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

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

Subject: **UNIT 1 REVISION 1 OF THE CYCLE 16 CORE OPERATING LIMITS REPORT (COLR)**

Pursuant to Watts Bar Nuclear Plant Technical Specifications (Tech Spec) Section 5.9.5.d, Tennessee Valley Authority (TVA) has enclosed Revision 1 of the Unit 1 Cycle 16 COLR. This revision updates the W(z) values on Table A.1.

There are no regulatory commitments contained in this letter or the enclosure. Should you have questions regarding this submittal, please contact Kim Hulvey at (423) 365-7720.

Respectfully,

Paul Simmons
Site Vice President
Watts Bar Nuclear Plant

Enclosure: Watts Bar Nuclear Plant, Unit 1, Cycle 16 Core Operating Limits Report, Revision 1, January 2019

cc (Enclosure):

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

ENCLOSURE 1

Watts Bar Nuclear Plant, Unit 1, Cycle 16
Core Operating Limits Report
Revision 1
January 2019

QA Record
L36 190118 802

WATTS BAR NUCLEAR PLANT, UNIT 1, CYCLE 16

CORE OPERATING LIMITS REPORT

Revision 1

January 2019

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J.M. Casner, PORC Chairman / 1/24/19 Date

T.B. Marshall, Plant Manager Lee Sanders / 1/24/2019 Date

Revision	Date of PORC Approval	Affected Pages	Reason for Revision
0	08/27/2018	All	Initial Issue
1	See Above	1, 8	Revised W(z) values due to DAO > 3%

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Watts Bar Unit 1 Cycle 16 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 -3.277×10^{-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 -4.5×10^{-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% Δk/k in MODE 1 and MODE 2.

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

2.2.3 For TS 3.1.7, SDM shall be $\geq$ 1.6% Δk/k in MODE 1 and MODE 2 with keff $\geq$ 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. The table provides sufficient information to determine W(Z) versus core height for all cycle burnups.

2.5.4 Part power W(Z) values are only required to be used when the part power surveillance is performed using the moveable 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 16 are provided in Figure 3.

2.8 REFUELING BORON CONCENTRATION (LCO 3.9.1)

2.8.1 The refueling boron concentration shall be ≥ 2000 ppm.

3.0 NUMBER OF TPBARS IN REACTOR CORE (TS 4.2.1)

3.0.1 There are 1584 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 16.

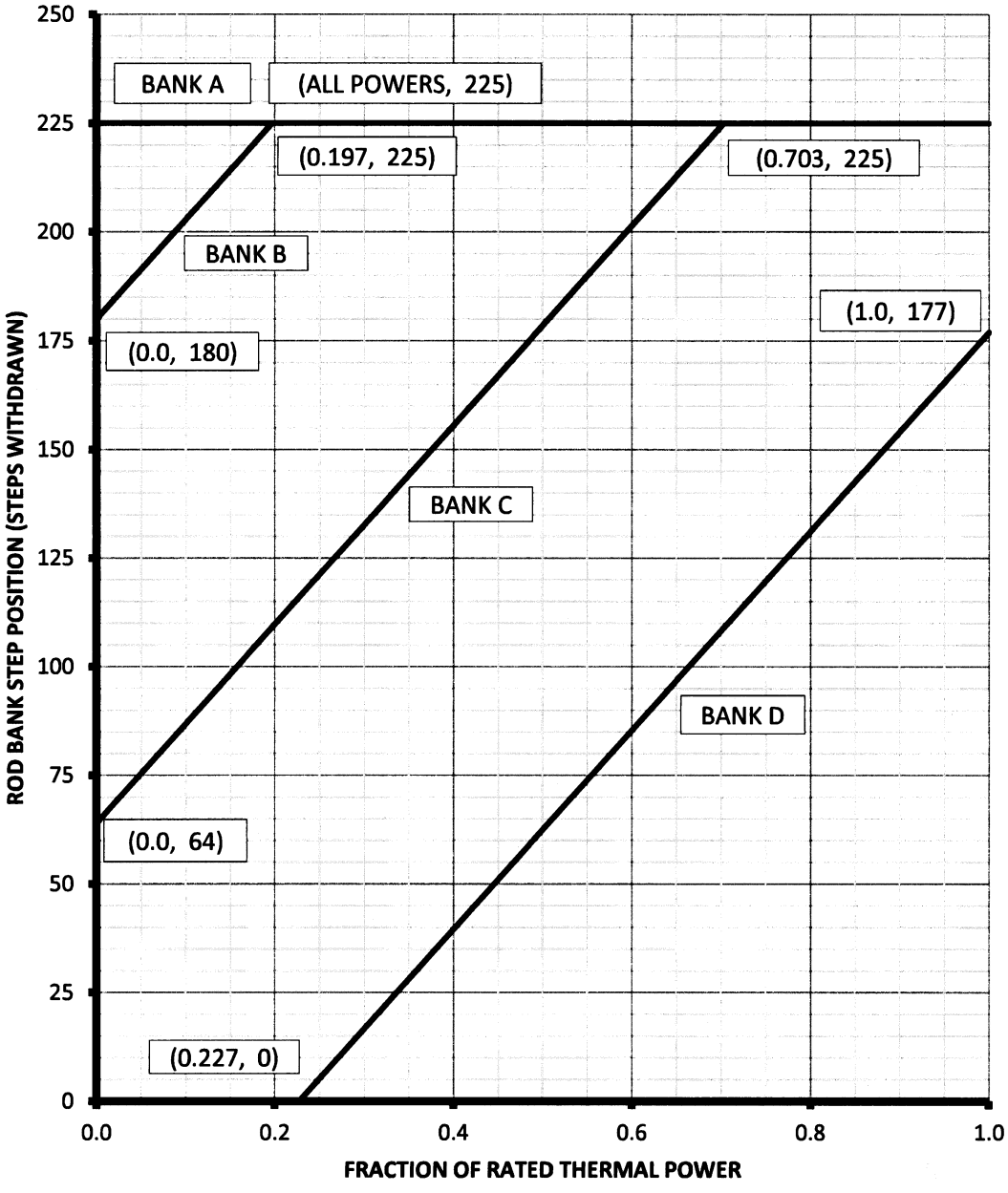

Figure 1
Control Bank Insertion Limits Versus Thermal Power
Four Loop Operation

Note: 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.

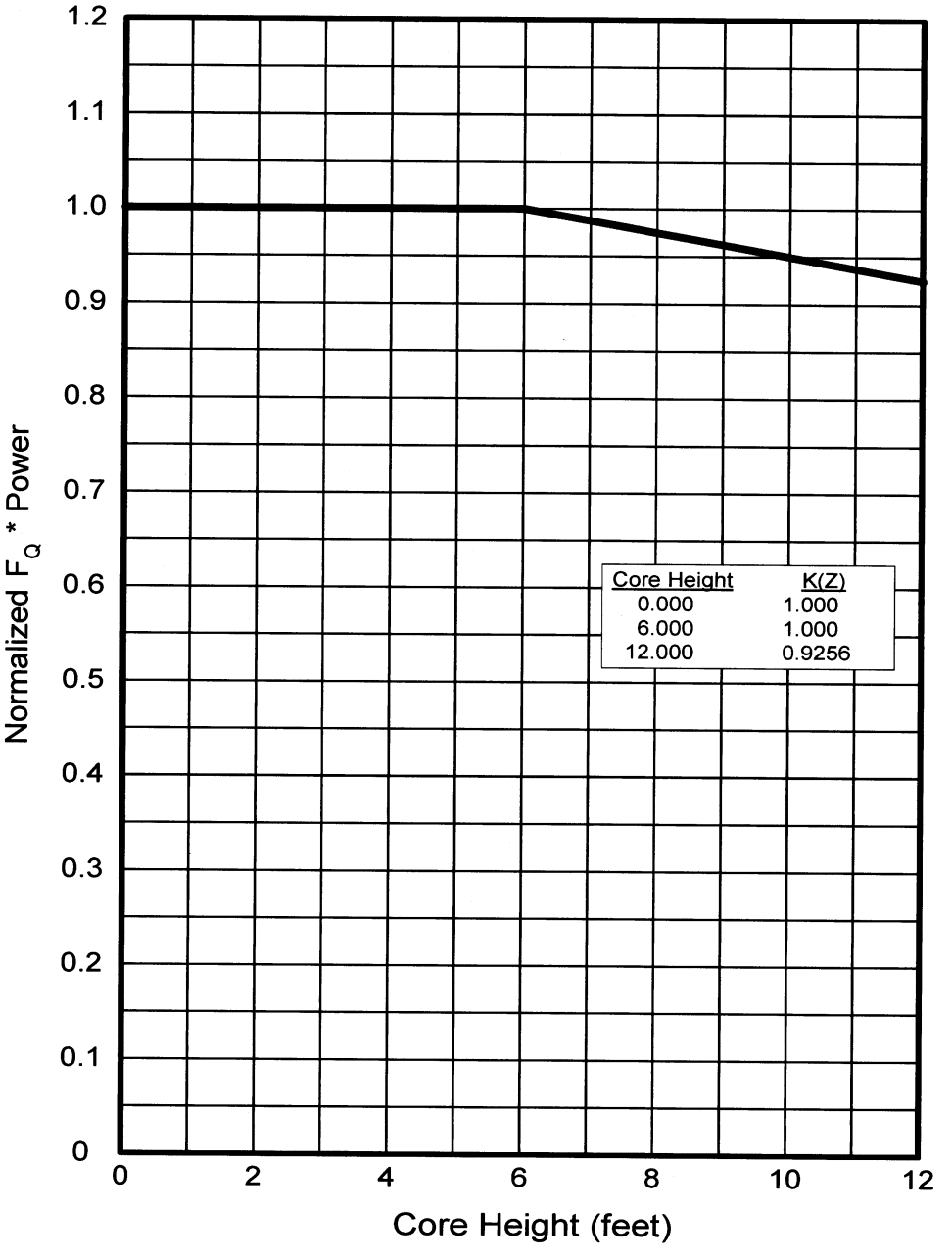

Figure 2
K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height

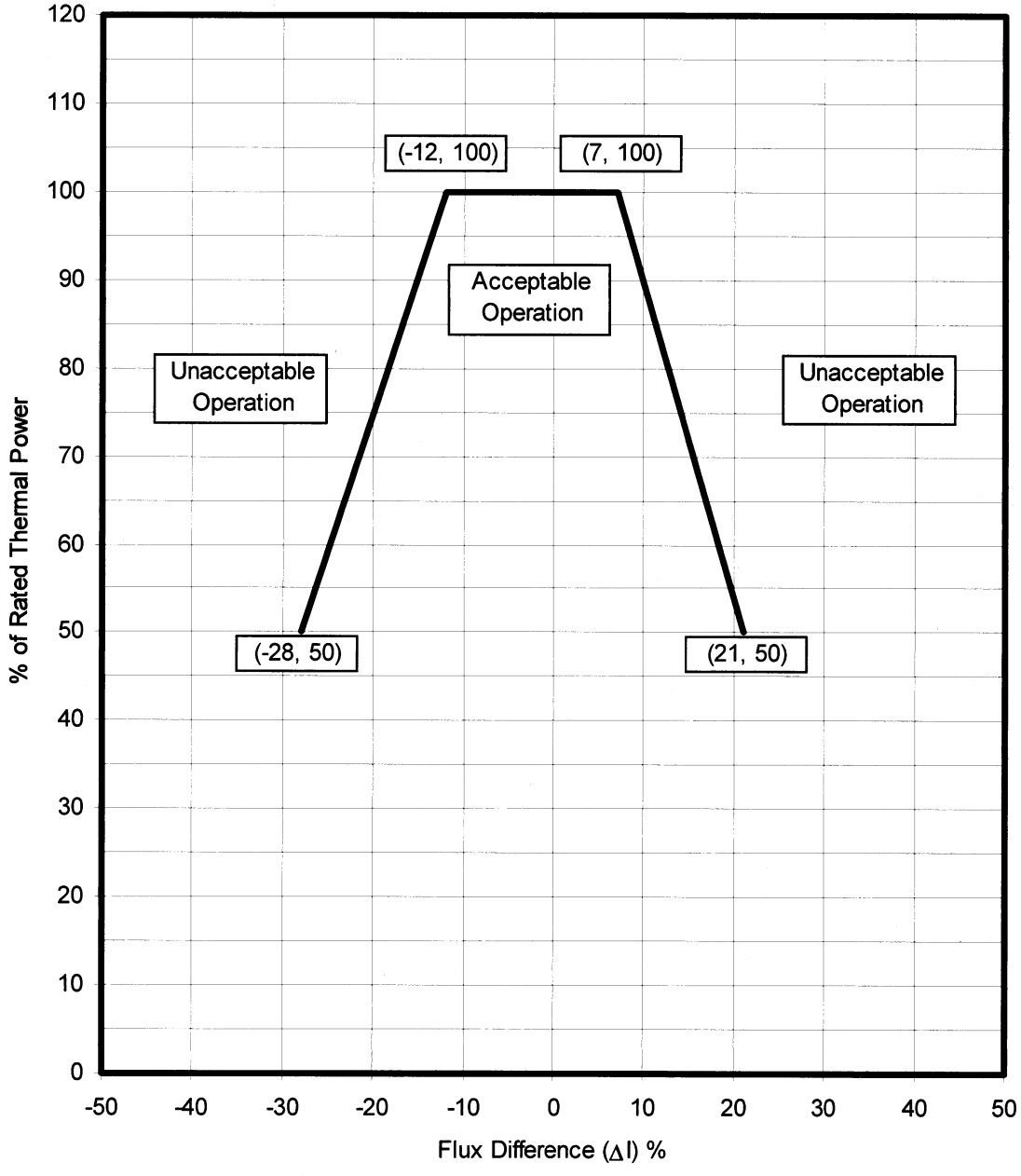

Figure 3
Axial Flux Difference Acceptable Operation Limits as a function of Rated Thermal Power (RAOC)

Table A.1
RAOC W(Z) Surveillance Factors

Height (ft)	Max W(z) at 150 MWD/MTU (100% Power)	Max W(z) at 3000 MWD/MTU (100% Power)	Max W(z) at 6000 MWD/MTU (100% Power)	Max W(z) at 8000 MWD/MTU (100% Power)	Max W(z) at 12000 MWD/MTU (100% Power)	Max W(z) at 16000 MWD/MTU (100% Power)	Max W(z) at 18000 MWD/MTU (100% Power)
12.0742	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.8730	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.6717	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.4705	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.2693	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11.0680	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10.8668	1.1622	1.2701	1.2488	1.2143	1.1449	1.1530	1.1705
10.6655	1.1598	1.2670	1.2453	1.2113	1.1438	1.1510	1.1679
10.4643	1.1549	1.2612	1.2391	1.2057	1.1403	1.1465	1.1638
10.2631	1.1491	1.2538	1.2312	1.1983	1.1355	1.1405	1.1580
10.0618	1.1438	1.2445	1.2216	1.1900	1.1288	1.1326	1.1514
9.8606	1.1390	1.2362	1.2128	1.1799	1.1255	1.1273	1.1435
9.6594	1.1364	1.2301	1.2052	1.1715	1.1253	1.1270	1.1363
9.4581	1.1377	1.2223	1.1978	1.1702	1.1247	1.1264	1.1338
9.2569	1.1370	1.2123	1.1997	1.1714	1.1266	1.1236	1.1367
9.0557	1.1388	1.2042	1.2014	1.1723	1.1273	1.1248	1.1434
8.8544	1.1465	1.1996	1.1978	1.1713	1.1281	1.1304	1.1486
8.6532	1.1579	1.1959	1.1948	1.1712	1.1341	1.1402	1.1558
8.4519	1.1687	1.1914	1.1970	1.1766	1.1443	1.1571	1.1736
8.2507	1.1769	1.1906	1.1973	1.1798	1.1525	1.1720	1.1892
8.0495	1.1828	1.1908	1.1953	1.1807	1.1587	1.1843	1.2020
7.8482	1.1866	1.1906	1.1918	1.1802	1.1633	1.1950	1.2131
7.6470	1.1881	1.1887	1.1867	1.1779	1.1663	1.2034	1.2218
7.4458	1.1878	1.1853	1.1800	1.1741	1.1675	1.2096	1.2282
7.2445	1.1888	1.1806	1.1719	1.1688	1.1666	1.2137	1.2322
7.0433	1.1904	1.1737	1.1628	1.1617	1.1679	1.2157	1.2340
6.8420	1.1909	1.1681	1.1573	1.1585	1.1701	1.2156	1.2335
6.6408	1.1898	1.1648	1.1559	1.1587	1.1701	1.2135	1.2309
6.4396	1.1876	1.1599	1.1526	1.1579	1.1692	1.2102	1.2266
6.2383	1.1835	1.1553	1.1475	1.1557	1.1669	1.2050	1.2205
6.0371	1.1799	1.1515	1.1439	1.1523	1.1626	1.1978	1.2123
5.8359	1.1771	1.1472	1.1410	1.1471	1.1584	1.1889	1.2022
5.6346	1.1738	1.1418	1.1373	1.1420	1.1559	1.1782	1.1903
5.4334	1.1700	1.1378	1.1355	1.1404	1.1540	1.1684	1.1782
5.2322	1.1680	1.1363	1.1357	1.1427	1.1537	1.1683	1.1716
5.0309	1.1690	1.1346	1.1357	1.1454	1.1535	1.1698	1.1708
4.8297	1.1711	1.1318	1.1346	1.1469	1.1542	1.1711	1.1717
4.6284	1.1717	1.1286	1.1330	1.1479	1.1582	1.1715	1.1709
4.4272	1.1719	1.1249	1.1309	1.1482	1.1625	1.1710	1.1694
4.2260	1.1734	1.1206	1.1282	1.1480	1.1664	1.1715	1.1672
4.0247	1.1749	1.1162	1.1252	1.1475	1.1700	1.1732	1.1640
3.8235	1.1755	1.1111	1.1219	1.1463	1.1734	1.1743	1.1623
3.6223	1.1761	1.1069	1.1211	1.1454	1.1766	1.1762	1.1629
3.4210	1.1788	1.1065	1.1259	1.1472	1.1797	1.1829	1.1684
3.2198	1.1886	1.1090	1.1301	1.1518	1.1853	1.1912	1.1734
3.0186	1.1996	1.1108	1.1351	1.1600	1.1938	1.1978	1.1791
2.8173	1.2095	1.1172	1.1444	1.1751	1.2093	1.2110	1.1926
2.6161	1.2210	1.1323	1.1588	1.1962	1.2320	1.2337	1.2138
2.4148	1.2356	1.1497	1.1761	1.2166	1.2534	1.2546	1.2336
2.2136	1.2493	1.1671	1.1944	1.2365	1.2742	1.2747	1.2527
2.0124	1.2620	1.1839	1.2124	1.2559	1.2942	1.2940	1.2711
1.8111	1.2737	1.2001	1.2294	1.2742	1.3131	1.3121	1.2884
1.6099	1.2842	1.2151	1.2452	1.2910	1.3304	1.3286	1.3043
1.4087	1.2939	1.2279	1.2587	1.3053	1.3450	1.3425	1.3177
1.2074	1.3025	1.2372	1.2684	1.3157	1.3554	1.3520	1.3268
1.0062	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.8049	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.6037	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
0.4025	1.0000	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	1.0000
0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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

Core Burnup (MWD/MTU)	$F_Q^W(Z)$ Penalty 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, 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.