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

OCT 2 7 2003

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

Gentlemen:

In the Matter of ) Docket No.50-390
Tennessee Valley Authority )

WATTS BAR NUCLEAR PLANT (WBN) UNIT 1- CORE OPERATING LIMITS REPORT FOR CYCLE 6, REVISIONS 3 AND 4

The purpose of this letter is to provide the Cycle 6 Core Operating Limits Report (COLR) in accordance with WBN Technical Specification 5.9.5.d. Enclosed are Revisions 3 and 4 of the COLR. Revision 3, which was effective on September 29, 2003, was limited to Modes 6 and 5 of the Cycle 5 Refueling Outage in order to permit core load and reactor assembly to proceed in advance of NRC's approval of the License Amendment Requests for Robust Fuel Assemblies and Boron Concentration Reductions in the refueling water storage tank and the cold leg accumulators. Revision 4 of the COLR was effective October 13, 2003, and removed the restrictions identified in Revision 3 following NRC's approval of the above License Amendment Requests in Amendments 46 and 48, respectively.

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If you have any questions about these reports, please contact me at (423) 365-1824.

Sincerely,

P. L. Pace
Manager, Site Licensing
and Industry Affairs

Enclosures
Core Operating Limits Report, Unit 1 Cycle 6, Revision 3
Core Operating Limits Report, Unit 1 Cycle 6, Revision 4

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QA Record

# WATTS BAR NUCLEAR PLANT, UNIT 1, CYCLE 6

# CORE OPERATING LIMITS REPORT

October 2003

Prepared:

John Strange, 10/10/03

Nuclear Fuel — Date

Reviewed:

Thomas F. Hutch for CSF, 10/10/03

Reactor Engineering Supervisor — Date

Approved:

John B Roden for TDW, 10/10/03

Operations Manager — Date

[illegible], 10/10/03

PORC Chairman — Date

| Revision | Date of PORC Approval | PORC Meeting Number | Affected Pages | Reason for Revision |
|---|---|---|---|---|
| 0 | n/a | n/a | All | Initial issue |
| 1 | n/a | n/a | All | Early shutdown of cycle 5 |
| 2 | n/a | n/a | 1 and 9 | Add missing data to Figure 4 |
| 3 | 9/26/03 | 3989 | 1,3-4,13-18 | consistency with TS nomenclature |
| 4 | 10/10/03 | 3993 | All | Redesign due to damage to assembly G20 |

**COLR for Watts Bar Unit 1, Cycle 6 - TPC Redesign**

## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Watts Bar Unit 1 Cycle 6 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

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

## COLR for Watts Bar Unit 1, Cycle 6 – TPC Redesign

### 2.1 MODERATOR TEMPERATURE COEFFICIENT - MTC (LCO 3.1.4)

2.1.1 The MTC limits are:

The BOL/ARO/HZP - MTC shall be less positive than or equal to 0 Δk/k/°F (upper limit). With the measured BOL/ARO/HZP - MTC more positive than $-0.70 \times 10^{-5}$ Δk/k/°F (as-measured MTC limit), establish control rod withdrawal limits to ensure the MTC remains less positive than or equal to 0 Δk/k/°F (upper limit) for all times in core life.

The EOL/ARO/RTP - MTC shall be less negative than or equal to $-4.5 \times 10^{-4}$ Δk/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
$-3.75 \times 10^{-4}$ Δk/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
$-4.28 \times 10^{-4}$ Δk/k/°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 shall be limited in physical insertion as shown in Figure 1.

2.3.2 Table 1 shows the control rod overlap positions.

## 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 CFQ = 2.50

2.4.2 K(Z) is provided in Figure 2.

2.4.3 $F_Q^C(Z) = F_Q^M(Z) * 1.0815$

where: $F_Q^M(Z)$ is the measured value of $F_Q(Z)$ obtained from incore flux map results and 1.0815 is a factor that accounts for fuel manufacturing tolerances and flux map measurement uncertainty.

2.4.4 $F_Q^W(Z) = F_Q^C(Z) * W(Z)$

where: W(Z) values are provided in Figures 4 through 7. The figures provide sufficient information to determine W(Z) versus core height for all cycle burnups.

2.4.5 $F_Q^W(Z)$ Penalty Factor

The $F_Q^W(Z)$ penalty factor is provided in Table A.1.

## 2.5 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
$F_{\Delta H}^{RTP}$ = 1.62 for VANTAGE+/PERFORMANCE+ fuel
PF = 0.3

## 2.6 AXIAL FLUX DIFFERENCE - AFD (LCO 3.2.3)

2.6.1 The AFD limits for Cycle 6 are provided in Figure 3.

## 2.7 REFUELING BORON CONCENTRATION (LCO 3.9.1)

2.7.1 The refueling boron concentration shall be ≥ 2103 ppm.

## 2.8 ACCUMULATORS (LCO 3.5.1)

2.8.1 There are 240 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 6.

## 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 6.

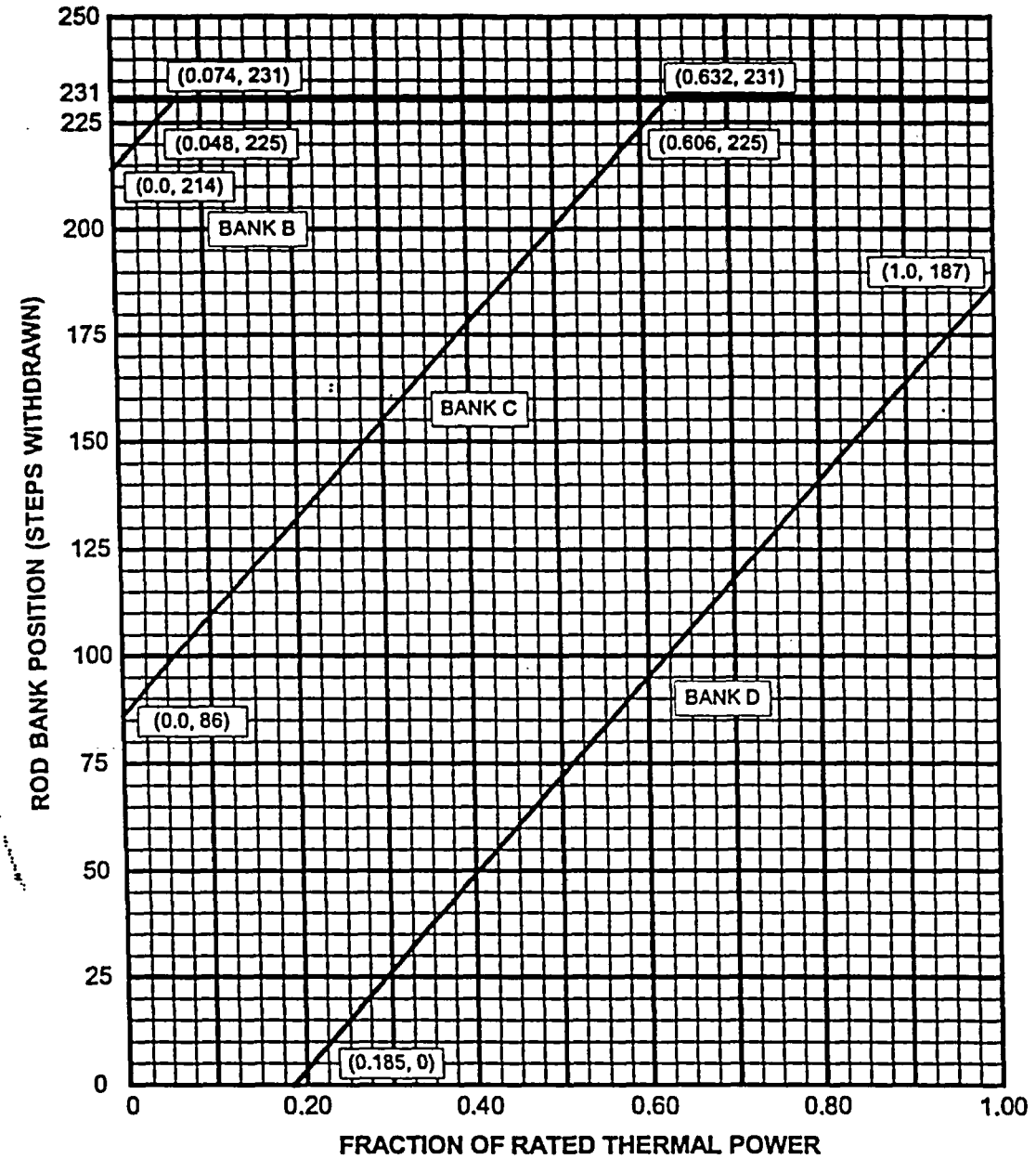



**Figure 1**
**Control Bank Insertion Limits Versus Thermal Power**
**Four Loop Operation**

* 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.

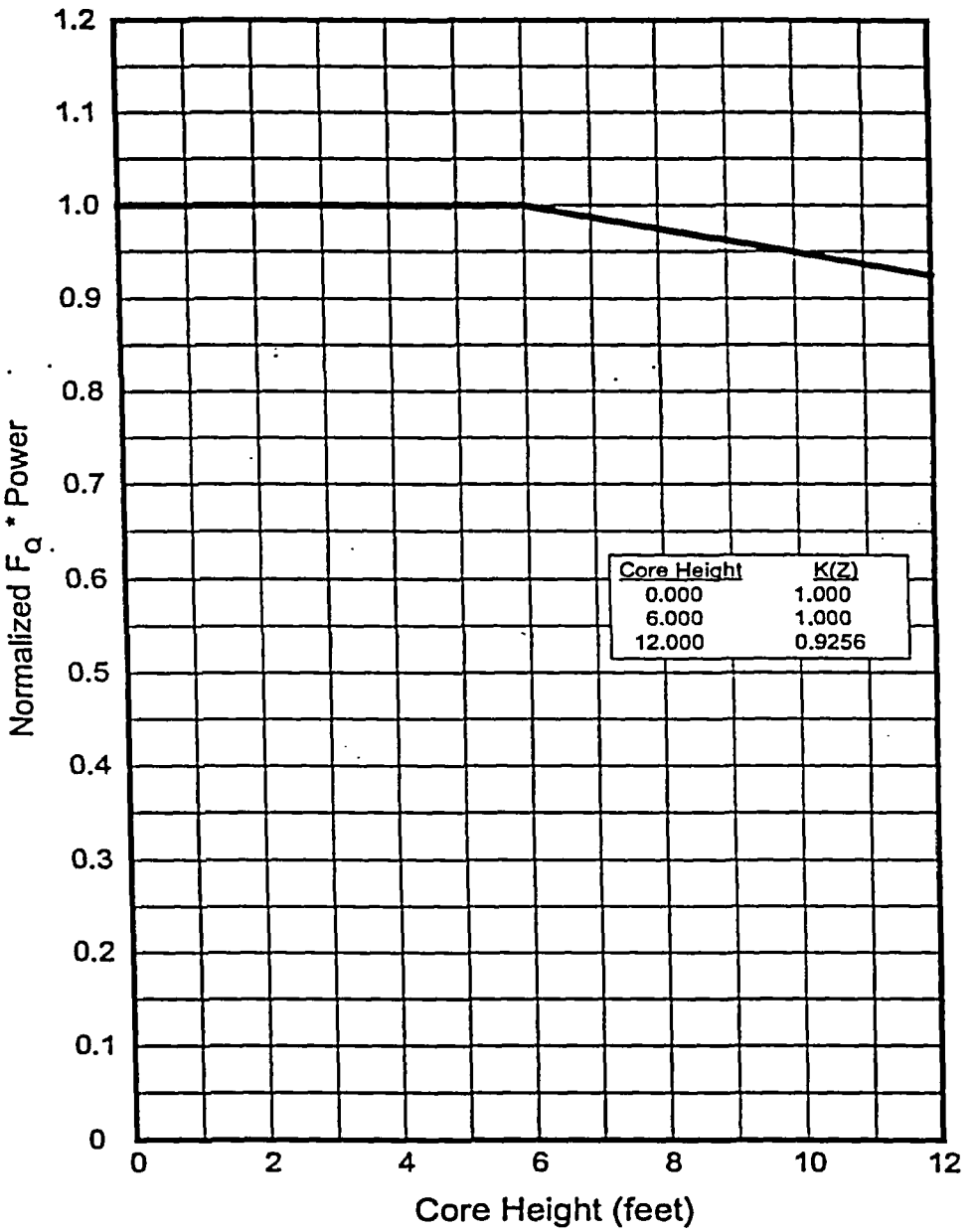



**Figure 2**
**K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height**

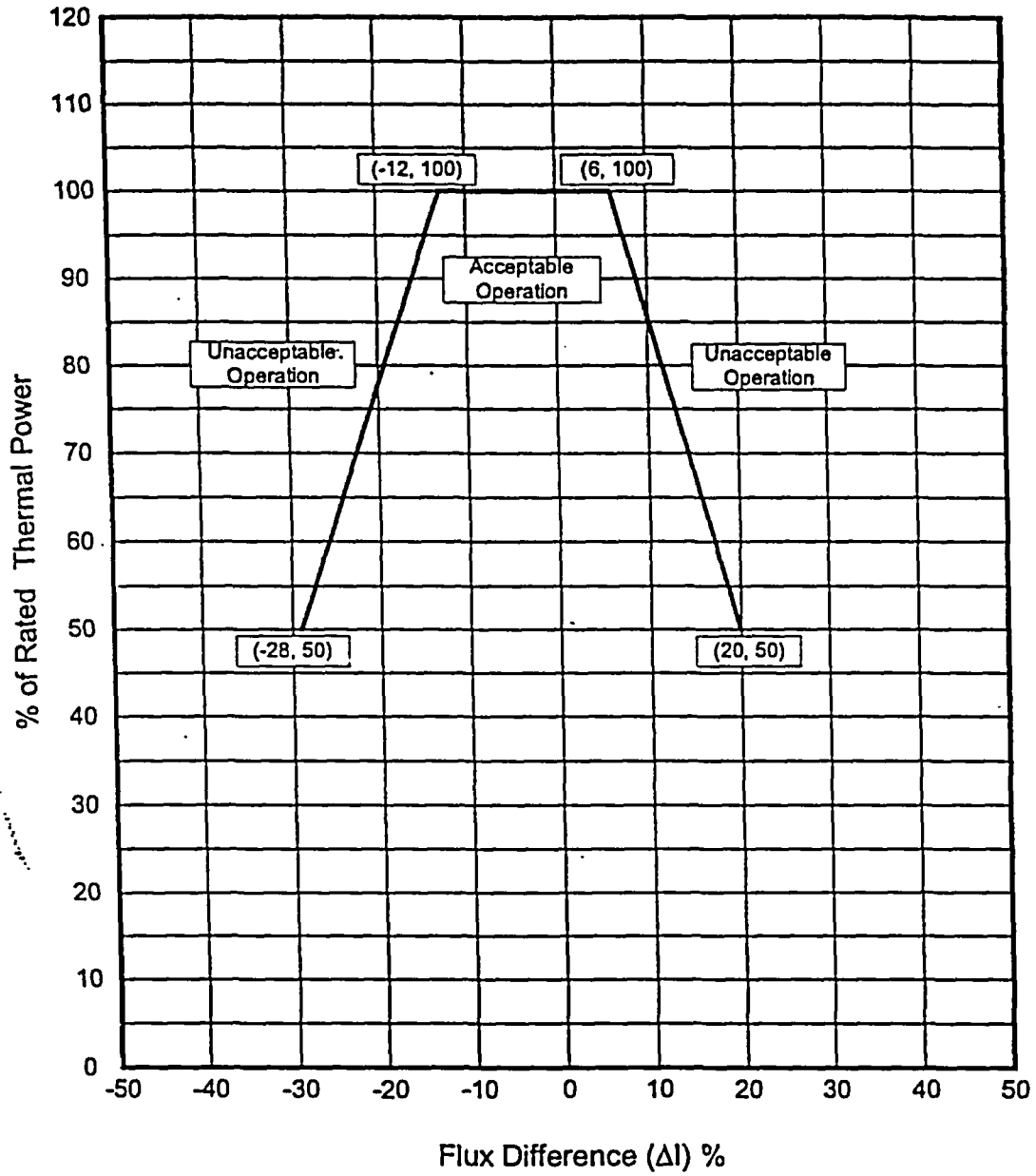
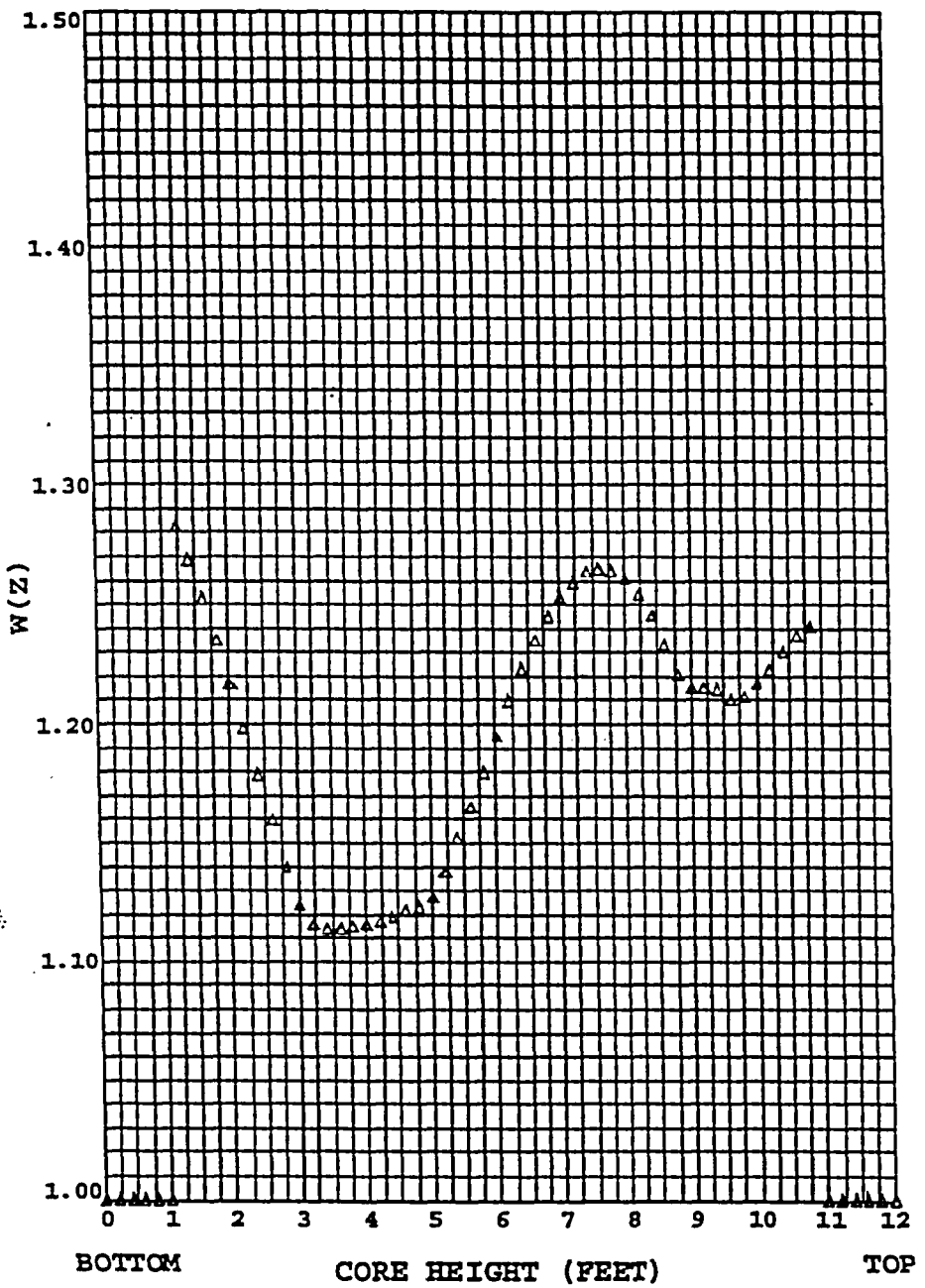
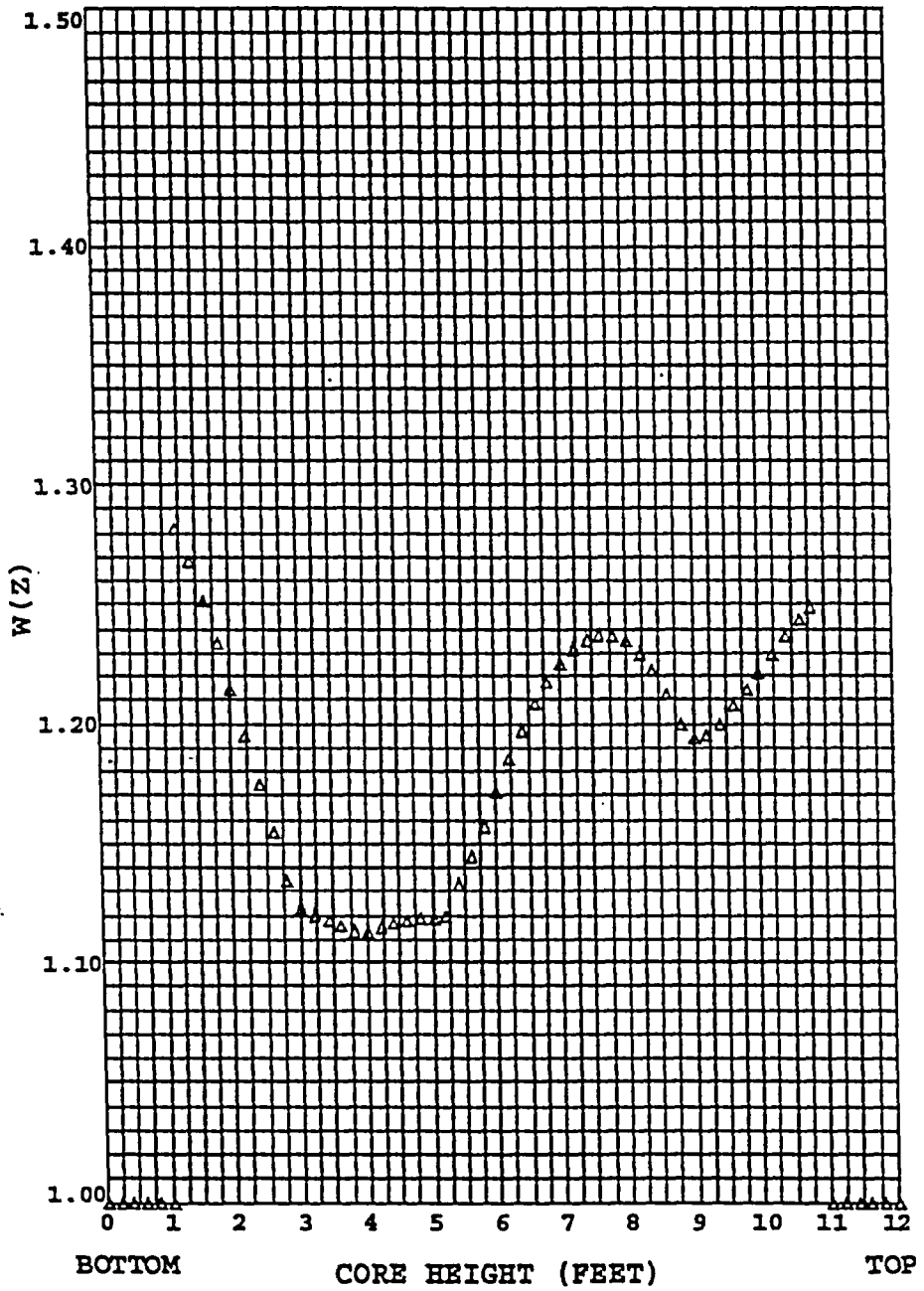



**Figure 3**
**Axial Flux Difference Acceptable Operation Limits as a Function of Rated Thermal Power (RAOC)**



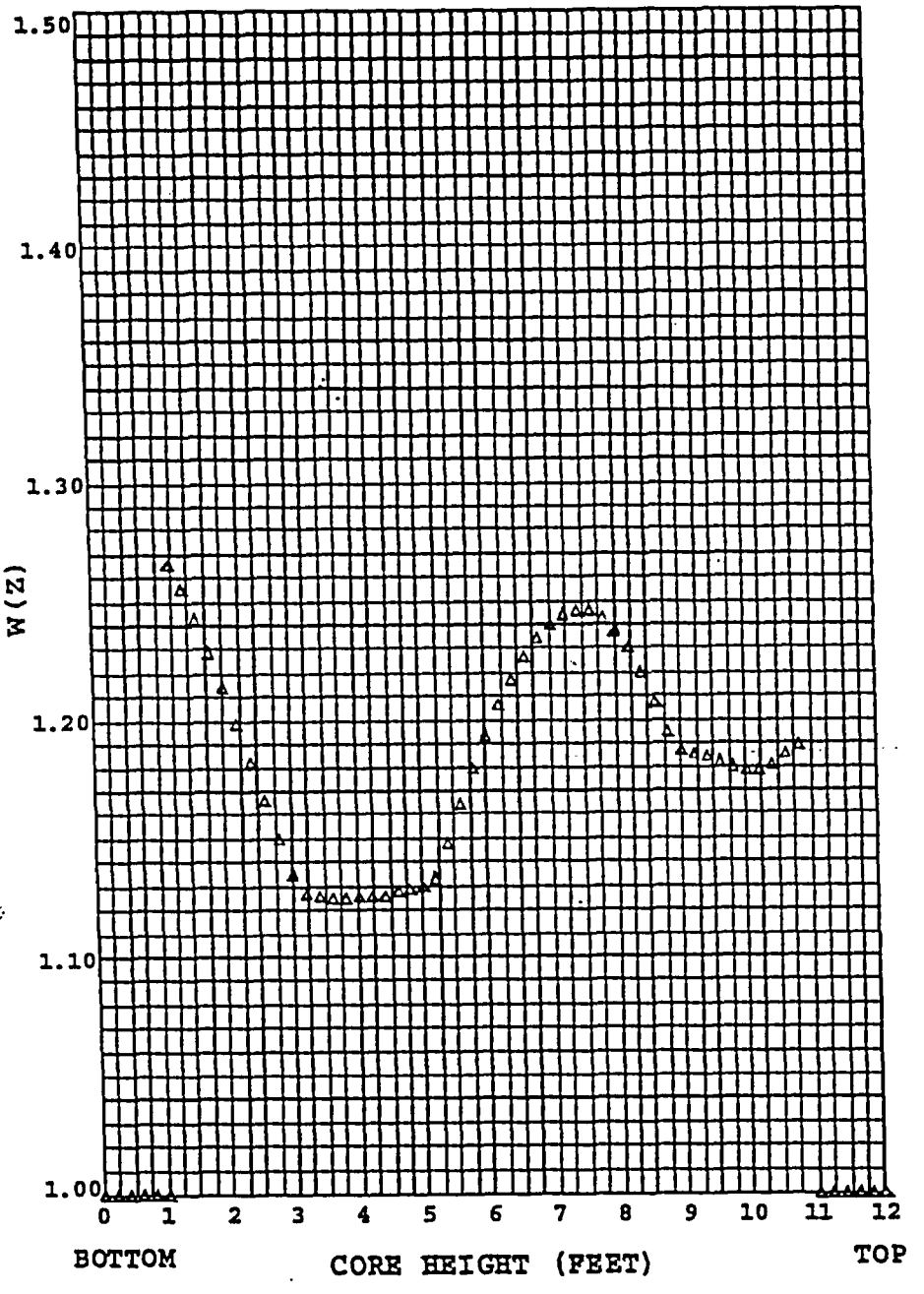

| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2820 |
| 1.4000 | 1.2685 |
| 1.6000 | 1.2526 |
| 1.8000 | 1.2352 |
| 2.0000 | 1.2169 |
| 2.2000 | 1.1980 |
| 2.4000 | 1.1787 |
| 2.6000 | 1.1594 |
| 2.8000 | 1.1394 |
| 3.0000 | 1.1236 |
| 3.2000 | 1.1158 |
| 3.4000 | 1.1142 |
| 3.6000 | 1.1141 |
| 3.8000 | 1.1149 |
| 4.0000 | 1.1160 |
| 4.2000 | 1.1170 |
| 4.4000 | 1.1190 |
| 4.6000 | 1.1215 |
| 4.8000 | 1.1229 |
| 5.0000 | 1.1270 |
| 5.2000 | 1.1374 |
| 5.4000 | 1.1521 |
| 5.6000 | 1.1653 |
| 5.8000 | 1.1796 |
| 6.0000 | 1.1951 |
| 6.2000 | 1.2099 |
| 6.4000 | 1.2232 |
| 6.6000 | 1.2349 |
| 6.8000 | 1.2449 |
| 7.0000 | 1.2530 |
| 7.2000 | 1.2591 |
| 7.4000 | 1.2631 |
| 7.6000 | 1.2646 |
| 7.8000 | 1.2637 |
| 8.0000 | 1.2602 |
| 8.2000 | 1.2541 |
| 8.4000 | 1.2452 |
| 8.6000 | 1.2330 |
| 8.8000 | 1.2206 |
| 9.0000 | 1.2152 |
| 9.2000 | 1.2149 |
| 9.4000 | 1.2146 |
| 9.6000 | 1.2102 |
| 9.8000 | 1.2111 |
| 10.0000 | 1.2176 |
| 10.2000 | 1.2229 |
| 10.4000 | 1.2303 |
| 10.6000 | 1.2366 |
| 10.8000 | 1.2409 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

**Figure 4**
**RAOC Summary of Max W(z) at 150 MWD/MTU**
**with HFP AFD Band of -12/+6 %**
**(Top and Bottom 10% Excluded)**



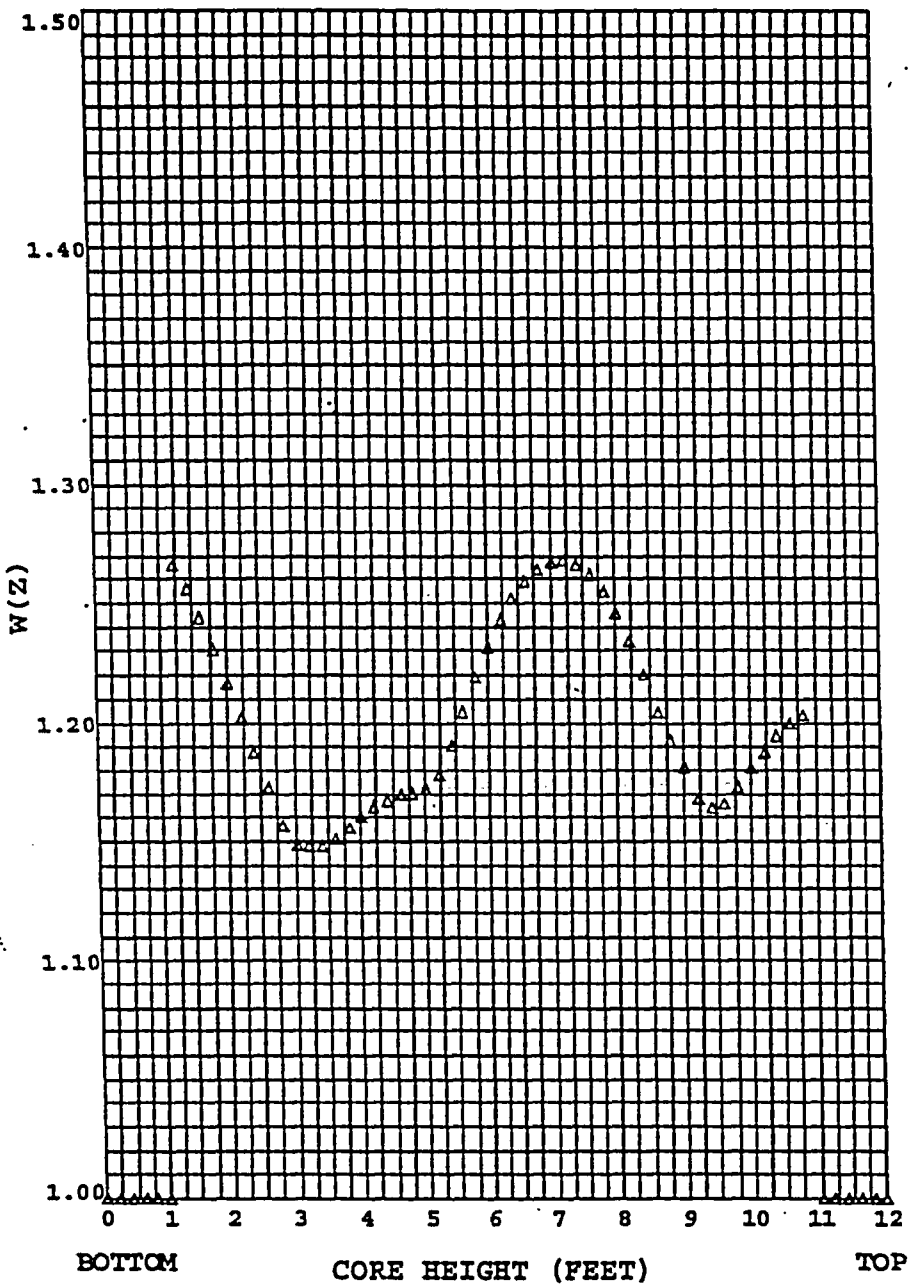

| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2818 |
| 1.4000 | 1.2679 |
| 1.6000 | 1.2515 |
| 1.8000 | 1.2335 |
| 2.0000 | 1.2144 |
| 2.2000 | 1.1947 |
| 2.4000 | 1.1746 |
| 2.6000 | 1.1546 |
| 2.8000 | 1.1344 |
| 3.0000 | 1.1231 |
| 3.2000 | 1.1201 |
| 3.4000 | 1.1174 |
| 3.6000 | 1.1156 |
| 3.8000 | 1.1132 |
| 4.0000 | 1.1131 |
| 4.2000 | 1.1153 |
| 4.4000 | 1.1166 |
| 4.6000 | 1.1176 |
| 4.8000 | 1.1187 |
| 5.0000 | 1.1185 |
| 5.2000 | 1.1200 |
| 5.4000 | 1.1329 |
| 5.6000 | 1.1445 |
| 5.8000 | 1.1572 |
| 6.0000 | 1.1714 |
| 6.2000 | 1.1850 |
| 6.4000 | 1.1972 |
| 6.6000 | 1.2082 |
| 6.8000 | 1.2176 |
| 7.0000 | 1.2253 |
| 7.2000 | 1.2313 |
| 7.4000 | 1.2353 |
| 7.6000 | 1.2372 |
| 7.8000 | 1.2370 |
| 8.0000 | 1.2344 |
| 8.2000 | 1.2294 |
| 8.4000 | 1.2220 |
| 8.6000 | 1.2120 |
| 8.8000 | 1.1995 |
| 9.0000 | 1.1937 |
| 9.2000 | 1.1948 |
| 9.4000 | 1.1999 |
| 9.6000 | 1.2075 |
| 9.8000 | 1.2145 |
| 10.0000 | 1.2209 |
| 10.2000 | 1.2287 |
| 10.4000 | 1.2369 |
| 10.6000 | 1.2439 |
| 10.8000 | 1.2489 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

**Figure 5**
**RAOC Summary of Max W(z) at 3000 MWD/MTU**
**with HFP AFD Band of -12/+6 %**
**(Top and Bottom 10% Excluded)**




| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2660 |
| 1.4000 | 1.2557 |
| 1.6000 | 1.2431 |
| 1.8000 | 1.2290 |
| 2.0000 | 1.2141 |
| 2.2000 | 1.1985 |
| 2.4000 | 1.1826 |
| 2.6000 | 1.1663 |
| 2.8000 | 1.1498 |
| 3.0000 | 1.1350 |
| 3.2000 | 1.1268 |
| 3.4000 | 1.1257 |
| 3.6000 | 1.1248 |
| 3.8000 | 1.1250 |
| 4.0000 | 1.1258 |
| 4.2000 | 1.1261 |
| 4.4000 | 1.1261 |
| 4.6000 | 1.1274 |
| 4.8000 | 1.1289 |
| 5.0000 | 1.1298 |
| 5.2000 | 1.1330 |
| 5.4000 | 1.1481 |
| 5.6000 | 1.1644 |
| 5.8000 | 1.1796 |
| 6.0000 | 1.1936 |
| 6.2000 | 1.2061 |
| 6.4000 | 1.2172 |
| 6.6000 | 1.2267 |
| 6.8000 | 1.2344 |
| 7.0000 | 1.2403 |
| 7.2000 | 1.2442 |
| 7.4000 | 1.2459 |
| 7.6000 | 1.2455 |
| 7.8000 | 1.2428 |
| 8.0000 | 1.2376 |
| 8.2000 | 1.2301 |
| 8.4000 | 1.2201 |
| 8.6000 | 1.2071 |
| 8.8000 | 1.1946 |
| 9.0000 | 1.1872 |
| 9.2000 | 1.1855 |
| 9.4000 | 1.1840 |
| 9.6000 | 1.1820 |
| 9.8000 | 1.1800 |
| 10.0000 | 1.1787 |
| 10.2000 | 1.1786 |
| 10.4000 | 1.1804 |
| 10.6000 | 1.1850 |
| 10.8000 | 1.1889 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

**Figure 6**
**RAOC Summary of Max W(z) at 10000 MWD/MTU**
**with HFP AFD Band of -12/+6 %**
**(Top and Bottom 10% Excluded)**




| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2660 |
| 1.4000 | 1.2561 |
| 1.6000 | 1.2441 |
| 1.8000 | 1.2308 |
| 2.0000 | 1.2168 |
| 2.2000 | 1.2023 |
| 2.4000 | 1.1875 |
| 2.6000 | 1.1725 |
| 2.8000 | 1.1567 |
| 3.0000 | 1.1487 |
| 3.2000 | 1.1481 |
| 3.4000 | 1.1481 |
| 3.6000 | 1.1507 |
| 3.8000 | 1.1556 |
| 4.0000 | 1.1605 |
| 4.2000 | 1.1643 |
| 4.4000 | 1.1674 |
| 4.6000 | 1.1696 |
| 4.8000 | 1.1703 |
| 5.0000 | 1.1719 |
| 5.2000 | 1.1781 |
| 5.4000 | 1.1902 |
| 5.6000 | 1.2046 |
| 5.8000 | 1.2190 |
| 6.0000 | 1.2319 |
| 6.2000 | 1.2430 |
| 6.4000 | 1.2521 |
| 6.6000 | 1.2592 |
| 6.8000 | 1.2643 |
| 7.0000 | 1.2671 |
| 7.2000 | 1.2677 |
| 7.4000 | 1.2659 |
| 7.6000 | 1.2618 |
| 7.8000 | 1.2551 |
| 8.0000 | 1.2460 |
| 8.2000 | 1.2344 |
| 8.4000 | 1.2203 |
| 8.6000 | 1.2044 |
| 8.8000 | 1.1926 |
| 9.0000 | 1.1812 |
| 9.2000 | 1.1678 |
| 9.4000 | 1.1639 |
| 9.6000 | 1.1660 |
| 9.8000 | 1.1730 |
| 10.0000 | 1.1810 |
| 10.2000 | 1.1880 |
| 10.4000 | 1.1944 |
| 10.6000 | 1.1997 |
| 10.8000 | 1.2032 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

**Figure 7**
**RAOC Summary of Max W(z) at 16000 MWD/MTU**
**with HFP AFD Band of -12/+6 %**
**(Top and Bottom 10% Excluded)**

## Table A.1

## $F_Q^W(Z)$ 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.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.

## COLR for Watts Bar Unit 1, Cycle 6 – TPC Redesign

### Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 0 | 0 | | | |
| 2 | 2 | | | |
| 4 | 4 | | | |
| 6 | 6 | | | |
| 8 | 8 | | | |
| 10 | 10 | | | |
| 12 | 12 | | | |
| 14 | 14 | | | |
| 16 | 16 | | | |
| 18 | 18 | | | |
| 20 | 20 | | | |
| 22 | 22 | | | |
| 24 | 24 | | | |
| 26 | 26 | | | |
| 28 | 28 | | | |
| 30 | 30 | | | |
| 32 | 32 | | | |
| 34 | 34 | | | |
| 36 | 36 | | | |
| 38 | 38 | | | |
| 40 | 40 | | | |
| 42 | 42 | | | |
| 44 | 44 | | | |
| 46 | 46 | | | |
| 48 | 48 | | | |
| 50 | 50 | | | |
| 52 | 52 | | | |
| 54 | 54 | | | |
| 56 | 56 | | | |
| 58 | 58 | | | |
| 60 | 60 | | | |
| 62 | 62 | | | |
| 64 | 64 | | | |
| 66 | 66 | | | |
| 68 | 68 | | | |
| 70 | 70 | | | |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 72 | 72 | | | |
| 74 | 74 | | | |
| 76 | 76 | | | |
| 78 | 78 | | | |
| 80 | 80 | | | |
| 82 | 82 | | | |
| 84 | 84 | | | |
| 86 | 86 | | | |
| 88 | 88 | | | |
| 90 | 90 | | | |
| 92 | 92 | | | |
| 94 | 94 | | | |
| 96 | 96 | | | |
| 98 | 98 | | | |
| 100 | 100 | | | |
| 102 | 102 | | | |
| 104 | 104 | | | |
| 106 | 106 | | | |
| 108 | 108 | | | |
| 110 | 110 | | | |
| 112 | 112 | | | |
| 114 | 114 | | | |
| 116 | 116 | | | |
| 118 | 118 | | | |
| 120 | 120 | | | |
| 122 | 122 | | | |
| 124 | 124 | | | |
| 126 | 126 | | | |
| 128 | 128 | 0 | | |
| 130 | 130 | 2 | | |
| 132 | 132 | 4 | | |
| 134 | 134 | 6 | | |
| 136 | 136 | 8 | | |
| 138 | 138 | 10 | | |
| 140 | 140 | 12 | | |
| 142 | 142 | 14 | | |

## COLR for Watts Bar Unit 1, Cycle 6 – TPC Redesign

### Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 144 | 144 | 16 | | |
| 146 | 146 | 18 | | |
| 148 | 148 | 20 | | |
| 150 | 150 | 22 | | |
| 152 | 152 | 24 | | |
| 154 | 154 | 26 | | |
| 156 | 156 | 28 | | |
| 158 | 158 | 30 | | |
| 160 | 160 | 32 | | |
| 162 | 162 | 34 | | |
| 164 | 164 | 36 | | |
| 166 | 166 | 38 | | |
| 168 | 168 | 40 | | |
| 170 | 170 | 42 | | |
| 172 | 172 | 44 | | |
| 174 | 174 | 46 | | |
| 176 | 176 | 48 | | |
| 178 | 178 | 50 | | |
| 180 | 180 | 52 | | |
| 182 | 182 | 54 | | |
| 184 | 184 | 56 | | |
| 186 | 186 | 58 | | |
| 188 | 188 | 60 | | |
| 190 | 190 | 62 | | |
| 192 | 192 | 64 | | |
| 194 | 194 | 66 | | |
| 196 | 196 | 68 | | |
| 198 | 198 | 70 | | |
| 200 | 200 | 72 | | |
| 202 | 202 | 74 | | |
| 204 | 204 | 76 | | |
| 206 | 206 | 78 | | |
| 208 | 208 | 80 | | |
| 210 | 210 | 82 | | |
| 212 | 212 | 84 | | |
| 214 | 214 | 86 | | |
| 216 | 216 | 88 | | |
| 218 | 218 | 90 | | |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 220 | 220 | 92 | | |
| 222 | 222 | 94 | | |
| 224 | 224 | 96 | | |
| 226 | 226 | 98 | | |
| 228 | 228 | 100 | | |
| 230 | 230 | 102 | | |
| 232 | 232 | 104 | | |
| 234 | | 106 | | |
| 236 | | 108 | | |
| 238 | | 110 | | |
| 240 | | 112 | | |
| 242 | | 114 | | |
| 244 | | 116 | | |
| 246 | | 118 | | |
| 248 | | 120 | | |
| 250 | | 122 | | |
| 252 | | 124 | | |
| 254 | | 126 | | |
| 256 | | 128 | 0 | |
| 258 | | 130 | 2 | |
| 260 | | 132 | 4 | |
| 262 | | 134 | 6 | |
| 264 | | 136 | 8 | |
| 266 | | 138 | 10 | |
| 268 | | 140 | 12 | |
| 270 | | 142 | 14 | |
| 272 | | 144 | 16 | |
| 274 | | 146 | 18 | |
| 276 | | 148 | 20 | |
| 278 | | 150 | 22 | |
| 280 | | 152 | 24 | |
| 282 | | 154 | 26 | |
| 284 | | 156 | 28 | |
| 286 | | 158 | 30 | |
| 288 | | 160 | 32 | |
| 290 | | 162 | 34 | |
| 292 | | 164 | 36 | |
| 294 | | 166 | 38 | |

## COLR for Watts Bar Unit 1, Cycle 6 - TPC Redesign

### Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 296 | | 168 | 40 | |
| 298 | | 170 | 42 | |
| 300 | | 172 | 44 | |
| 302 | | 174 | 46 | |
| 304 | | 176 | 48 | |
| 306 | | 178 | 50 | |
| 308 | | 180 | 52 | |
| 310 | | 182 | 54 | |
| 312 | | 184 | 56 | |
| 314 | | 186 | 58 | |
| 316 | | 188 | 60 | |
| 318 | | 190 | 62 | |
| 320 | | 192 | 64 | |
| 322 | | 194 | 66 | |
| 324 | | 196 | 68 | |
| 326 | | 198 | 70 | |
| 328 | | 200 | 72 | |
| 330 | | 202 | 74 | |
| 332 | | 204 | 76 | |
| 334 | | 206 | 78 | |
| 336 | | 208 | 80 | |
| 338 | | 210 | 82 | |
| 340 | | 212 | 84 | |
| 342 | | 214 | 86 | |
| 344 | | 216 | 88 | |
| 346 | | 218 | 90 | |
| 348 | | 220 | 92 | |
| 350 | | 222 | 94 | |
| 352 | | 224 | 96 | |
| 354 | | 226 | 98 | |
| 356 | | 228 | 100 | |
| 358 | | 230 | 102 | |
| 360 | | 232 | 104 | |
| 362 | | | 106 | |
| 364 | | | 108 | |
| 366 | | | 110 | |
| 368 | | | 112 | |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 370 | | | 114 | |
| 372 | | | 116 | |
| 374 | | | 118 | |
| 376 | | | 120 | |
| 378 | | | 122 | |
| 380 | | | 124 | |
| 382 | | | 126 | |
| 384 | | | 128 | 0 |
| 386 | | | 130 | 2 |
| 388 | | | 132 | 4 |
| 390 | | | 134 | 6 |
| 392 | | | 136 | 8 |
| 394 | | | 138 | 10 |
| 396 | | | 140 | 12 |
| 398 | | | 142 | 14 |
| 400 | | | 144 | 16 |
| 402 | | | 146 | 18 |
| 404 | | | 148 | 20 |
| 406 | | | 150 | 22 |
| 408 | | | 152 | 24 |
| 410 | | | 154 | 26 |
| 412 | | | 156 | 28 |
| 414 | | | 158 | 30 |
| 416 | | | 160 | 32 |
| 418 | | | 162 | 34 |
| 420 | | | 164 | 36 |
| 422 | | | 166 | 38 |
| 424 | | | 168 | 40 |
| 426 | | | 170 | 42 |
| 428 | | | 172 | 44 |
| 430 | | | 174 | 46 |
| 432 | | | 176 | 48 |
| 434 | | | 178 | 50 |
| 436 | | | 180 | 52 |
| 438 | | | 182 | 54 |
| 440 | | | 184 | 56 |
| 442 | | | 186 | 58 |

## COLR for Watts Bar Unit 1, Cycle 6 – TPC Redesign

### Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 444 | | | 188 | 60 |
| 446 | | | 190 | 62 |
| 448 | | | 192 | 64 |
| 450 | | | 194 | 66 |
| 452 | | | 196 | 68 |
| 454 | | | 198 | 70 |
| 456 | | | 200 | 72 |
| 458 | | | 202 | 74 |
| 460 | | | 204 | 76 |
| 462 | | | 206 | 78 |
| 464 | | | 208 | 80 |
| 466 | | | 210 | 82 |
| 468 | | | 212 | 84 |
| 470 | | | 214 | 86 |
| 472 | | | 216 | 88 |
| 474 | | | 218 | 90 |
| 476 | | | 220 | 92 |
| 478 | | | 222 | 94 |
| 480 | | | 224 | 96 |
| 482 | | | 226 | 98 |
| 484 | | | 228 | 100 |
| 486 | | | 230 | 102 |
| 488 | | | 232 | 104 |
| 490 | | | | 106 |
| 492 | | | | 108 |
| 494 | | | | 110 |
| 496 | | | | 112 |
| 498 | | | | 114 |
| 500 | | | | 116 |
| 502 | | | | 118 |
| 504 | | | | 120 |
| 506 | | | | 122 |
| 508 | | | | 124 |
| 510 | | | | 126 |
| 512 | | | | 128 |
| 514 | | | | 130 |
| 516 | | | | 132 |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 518 | | | | 134 |
| 520 | | | | 136 |
| 522 | | | | 138 |
| 524 | | | | 140 |
| 526 | | | | 142 |
| 528 | | | | 144 |
| 530 | | | | 146 |
| 532 | | | | 148 |
| 534 | | | | 150 |
| 536 | | | | 152 |
| 538 | | | | 154 |
| 540 | | | | 156 |
| 542 | | | | 158 |
| 544 | | | | 160 |
| 546 | | | | 162 |
| 548 | | | | 164 |
| 550 | | | | 166 |
| 552 | | | | 168 |
| 554 | | | | 170 |
| 556 | | | | 172 |
| 558 | | | | 174 |
| 560 | | | | 176 |
| 562 | | | | 178 |
| 564 | | | | 180 |
| 566 | | | | 182 |
| 568 | | | | 184 |
| 570 | | | | 186 |
| 572 | | | | 188 |
| 574 | | | | 190 |
| 576 | | | | 192 |
| 578 | | | | 194 |
| 580 | | | | 196 |
| 582 | | | | 198 |
| 584 | | | | 200 |
| 586 | | | | 202 |
| 588 | | | | 204 |
| 590 | | | | 206 |

**Table 1: Control Rod Overlap**

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 592 | | | | 208 |
| 594 | | | | 210 |
| 596 | | | | 212 |
| 598 | | | | 214 |
| 600 | | | | 216 |
| 602 | | | | 218 |
| 604 | | | | 220 |
| 606 | | | | 222 |
| 608 | | | | 224 |
| 610 | | | | 226 |
| 612 | | | | 228 |
| 614 | | | | 230 |
| 616 | | | | 232 |

**This information is provided in 2 step increments. One step increments can be derived by interpolation. 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. The Table indicates a maximum step of 232 to be consistent with 2 step increments.**

L36 030925 800

QA Record

# WATTS BAR NUCLEAR PLANT, UNIT 1, CYCLE 6

# CORE OPERATING LIMITS REPORT, REVISION ~~2~~ 3 CJS 9/26/03

## IMPLEMENTATION LIMITED TO MODE 6 AND MODE 5

September 2003

Prepared:

John Stange, 9/26/03

Nuclear Fuel — Date

Reviewed:

[illegible], 9/26/03

Reactor Engineering Supervisor — Date

Approved:

John B Corden for TDW, 9/26/03

Operations Manager — Date

[illegible], 9/26/03

PORC Chairman — Date

| Revision | Date of PORC Approval | PORC Meeting Number | Affected Pages | Reason for Revision |
|---|---|---|---|---|
| 0 | n/a | n/a | All | Initial issue |
| 1 | n/a | n/a | All | Early shutdown of cycle 5 |
| 2 | n/a | n/a | 1 and 9 | Add missing data to Figure 4 |
| 3 | 9/26/03 | 3989 | 1,3-4,13-18 CJS 9/26/03 | consistency with TS nomenclature |

## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Watts Bar Unit 1 Cycle 6 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

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 BOL/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 $-0.70 \times 10^{-5}$ $\Delta k/k/°F$ (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 $-4.5 \times 10^{-4}$ $\Delta k/k/°F$ (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
$-3.75 \times 10^{-4}$ $\Delta k/k/°F$.

2.1.3 The 60 ppm surveillance limit is:

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

## 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 shall be limited in physical insertion as shown in Figure 1.

2.3.2 Table 1 shows the control rod overlap positions.

## 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 CFQ = 2.50

2.4.2 K(Z) is provided in Figure 2.

2.4.3 $F_Q^C(Z) = F_Q^M(Z) * 1.0815$

where: $F_Q^M(Z)$ is the measured value of $F_Q(Z)$ obtained from incore flux map results and 1.0815 is a factor that accounts for fuel manufacturing tolerances and flux map measurement uncertainty.

2.4.4 $F_Q^W(Z) = F_Q^C(Z) * W(Z)$

where: W(Z) values are provided in Figures 4 through 7. The figures provide sufficient information to determine W(Z) versus core height for all cycle burnups.

2.4.5 $F_Q^W(Z)$ Penalty Factor

The $F_Q^W(Z)$ penalty factor is provided in Table A.1.

## 2.5 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
$F_{\Delta H}^{RTP}$ = 1.62 for VANTAGE+/PERFORMANCE+ fuel
PF = 0.3

## 2.6 AXIAL FLUX DIFFERENCE - AFD (LCO 3.2.3)

2.6.1 The AFD limits for Cycle 6 are provided in Figure 3.

## 2.7 REFUELING BORON CONCENTRATION (LCO 3.9.1)

2.7.1 The refueling boron concentration shall be ≥ 2103 ppm.

## 2.8 ACCUMULATORS (LCO 3.5.1)

2.8.1 There are 240 tritium producing burnable absorber rods (TPBARs) in the reactor core for Cycle 6.

## 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 6.

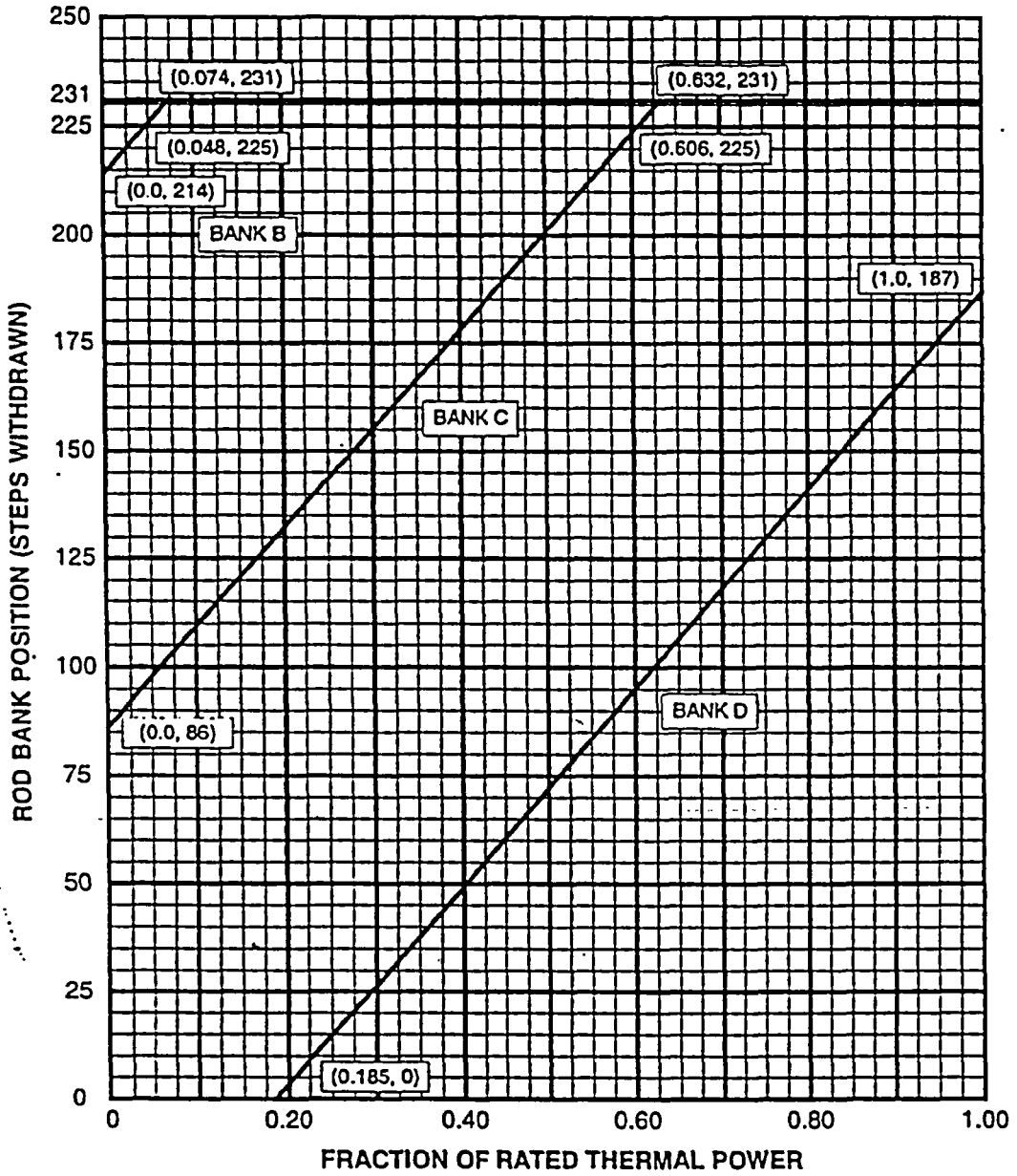



**Figure 1**
**Control Bank Insertion Limits Versus Thermal Power**
**Four Loop Operation**

* 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.

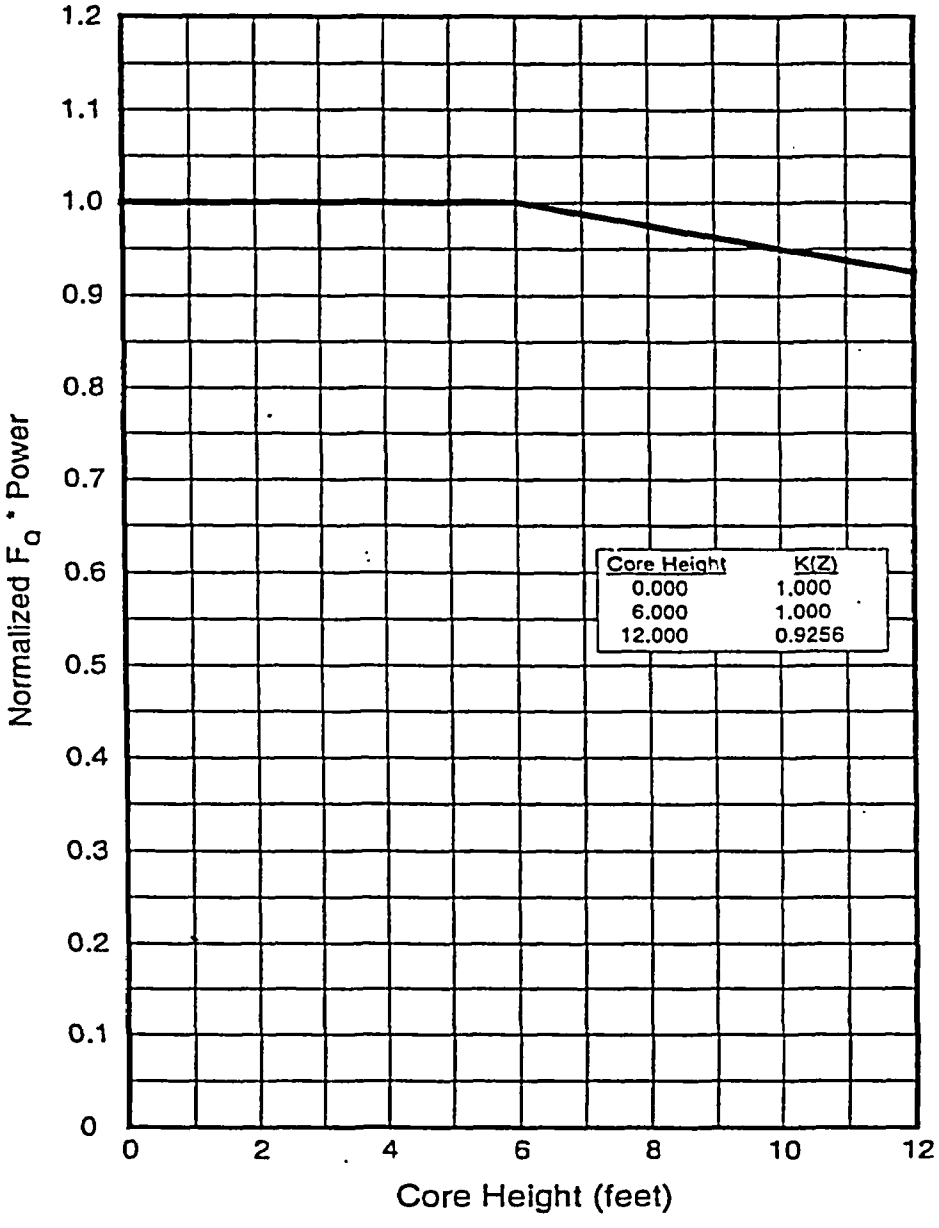



**Figure 2**
**K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height**

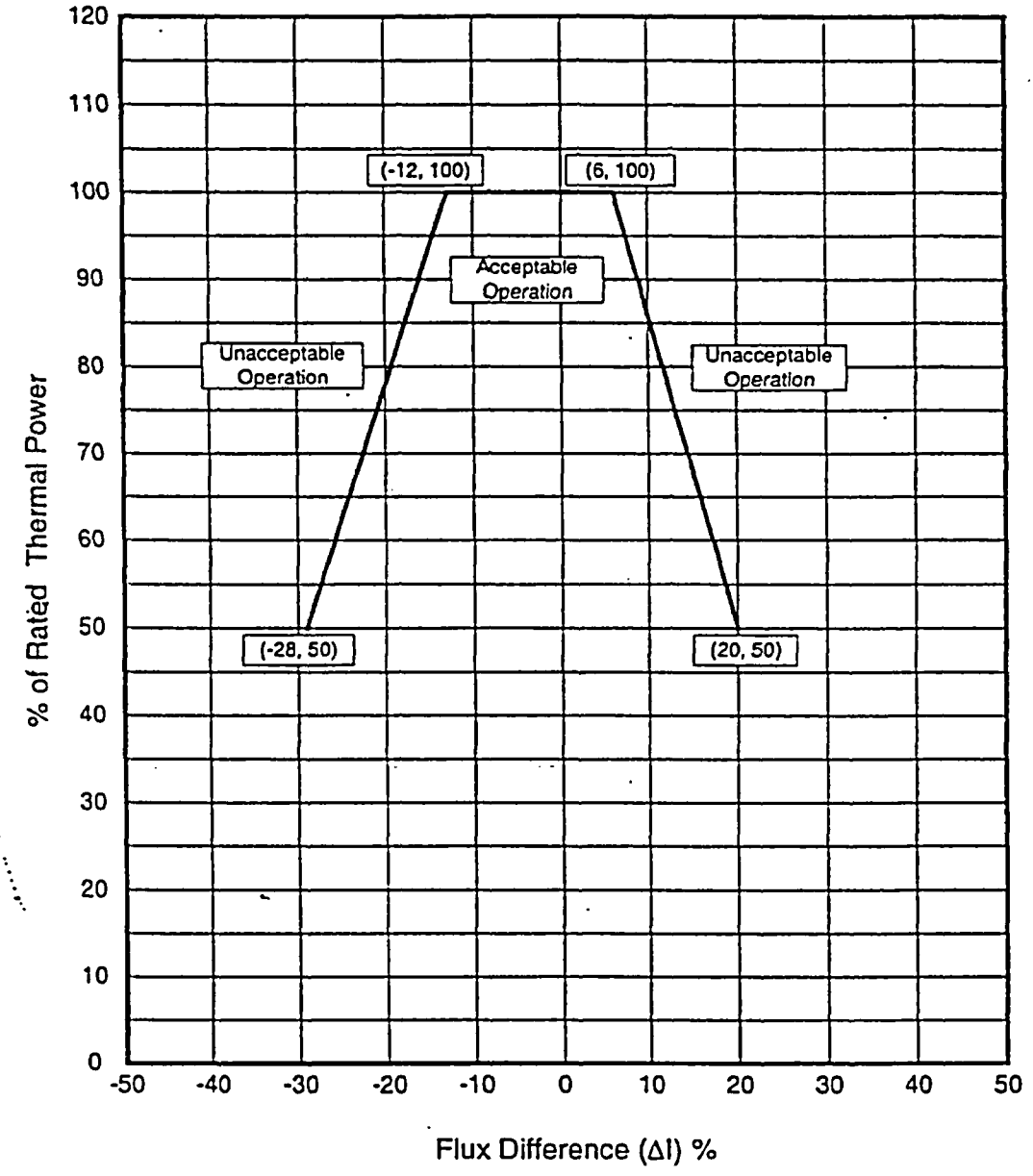
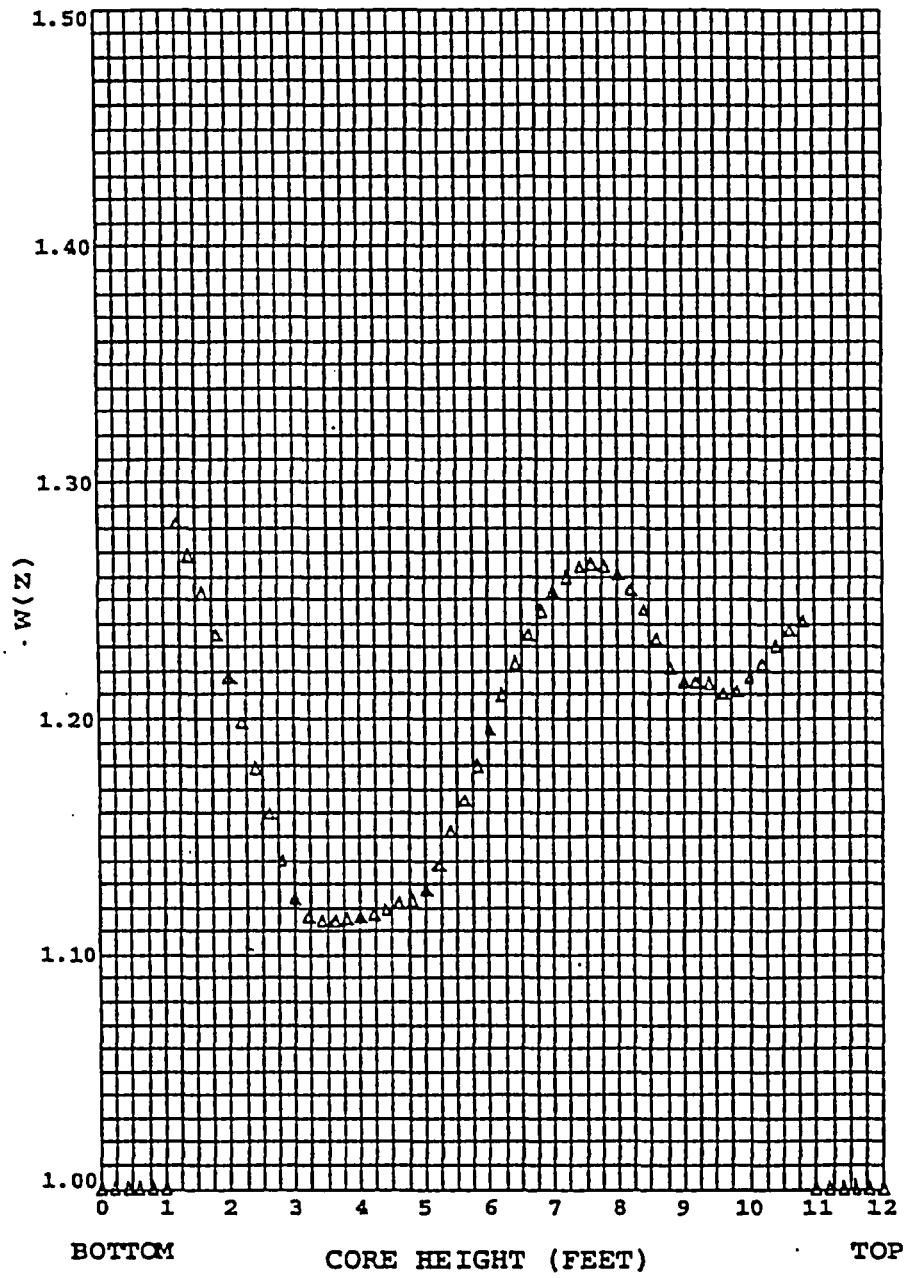
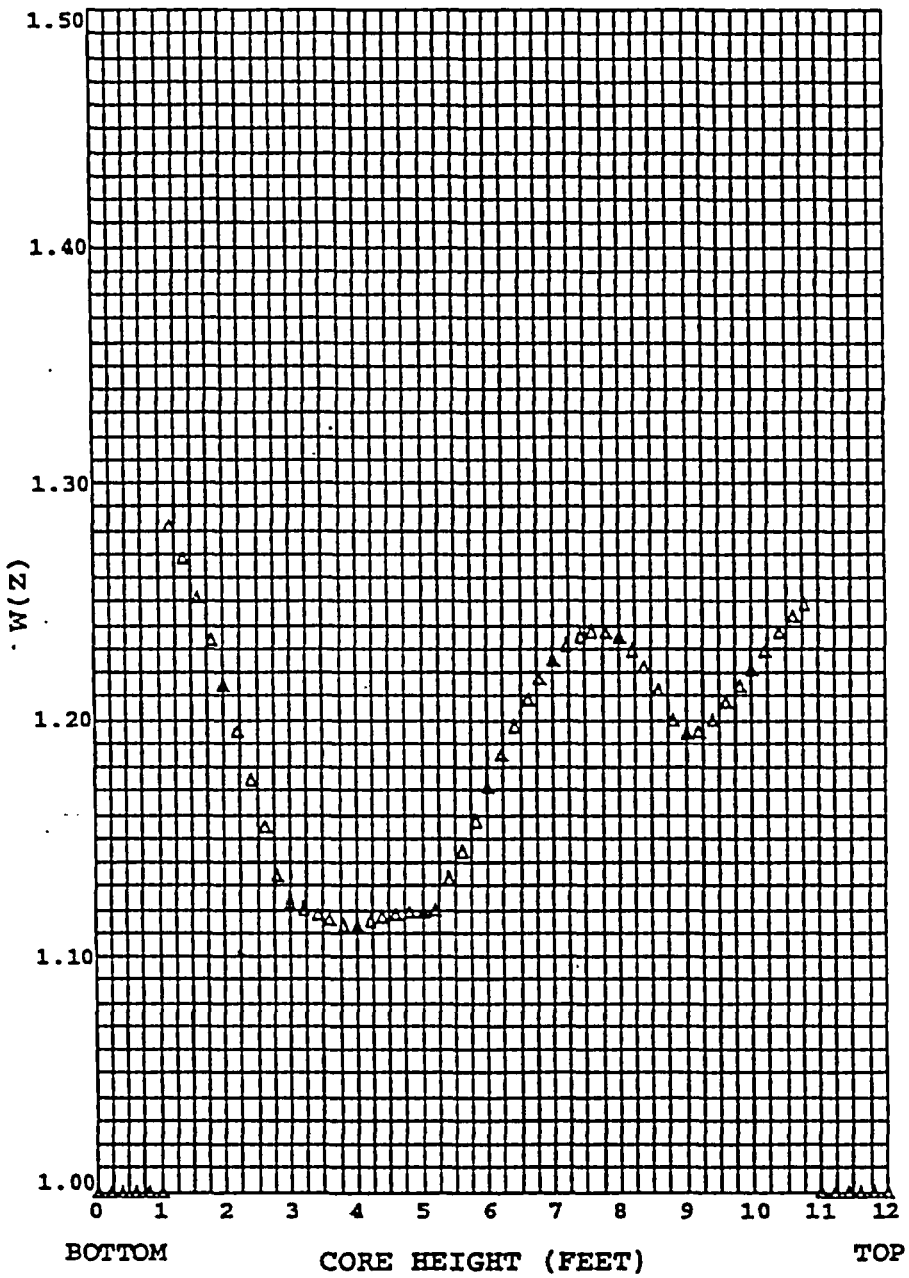



**Figure 3**
**Axial Flux Difference Acceptable Operation Limits as a Function of Rated Thermal Power (RAOC)**



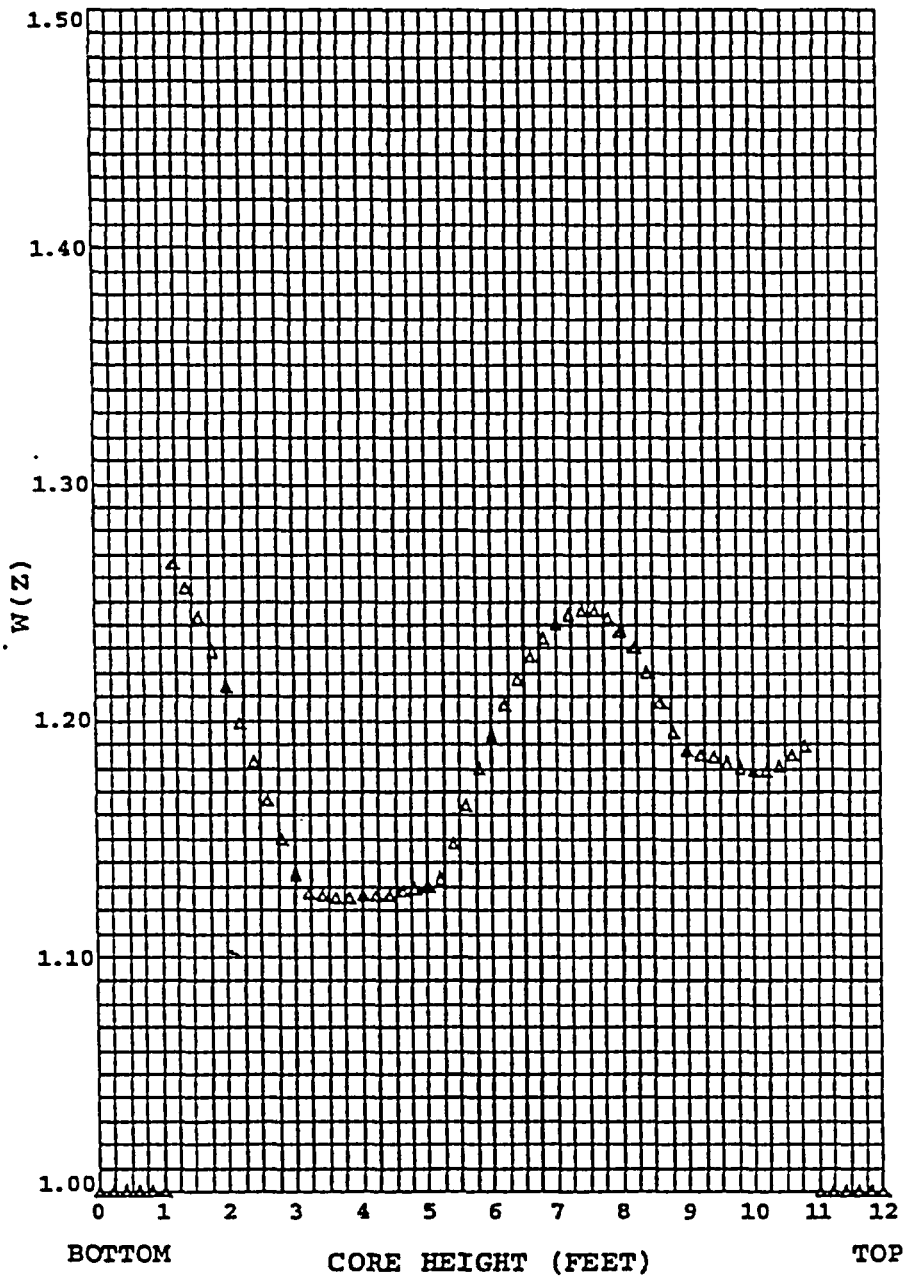

| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2820 |
| 1.4000 | 1.2685 |
| 1.6000 | 1.2526 |
| 1.8000 | 1.2352 |
| 2.0000 | 1.2169 |
| 2.2000 | 1.1980 |
| 2.4000 | 1.1787 |
| 2.6000 | 1.1594 |
| 2.8000 | 1.1394 |
| 3.0000 | 1.1236 |
| 3.2000 | 1.1158 |
| 3.4000 | 1.1142 |
| 3.6000 | 1.1141 |
| 3.8000 | 1.1149 |
| 4.0000 | 1.1160 |
| 4.2000 | 1.1170 |
| 4.4000 | 1.1190 |
| 4.6000 | 1.1215 |
| 4.8000 | 1.1229 |
| 5.0000 | 1.1270 |
| 5.2000 | 1.1374 |
| 5.4000 | 1.1521 |
| 5.6000 | 1.1653 |
| 5.8000 | 1.1796 |
| 6.0000 | 1.1951 |
| 6.2000 | 1.2099 |
| 6.4000 | 1.2232 |
| 6.6000 | 1.2349 |
| 6.8000 | 1.2449 |
| 7.0000 | 1.2530 |
| 7.2000 | 1.2591 |
| 7.4000 | 1.2631 |
| 7.6000 | 1.2646 |
| 7.8000 | 1.2637 |
| 8.0000 | 1.2602 |
| 8.2000 | 1.2541 |
| 8.4000 | 1.2452 |
| 8.6000 | 1.2330 |
| 8.8000 | 1.2206 |
| 9.0000 | 1.2152 |
| 9.2000 | 1.2149 |
| 9.4000 | 1.2146 |
| 9.6000 | 1.2102 |
| 9.8000 | 1.2111 |
| 10.0000 | 1.2176 |
| 10.2000 | 1.2229 |
| 10.4000 | 1.2303 |
| 10.6000 | 1.2366 |
| 10.8000 | 1.2409 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

Figure 4
RAOC Summary of Max W(z) at 150 MWD/MTU
with HFP AFD Band of -12/+6 %
(Top and Bottom 10% Excluded)



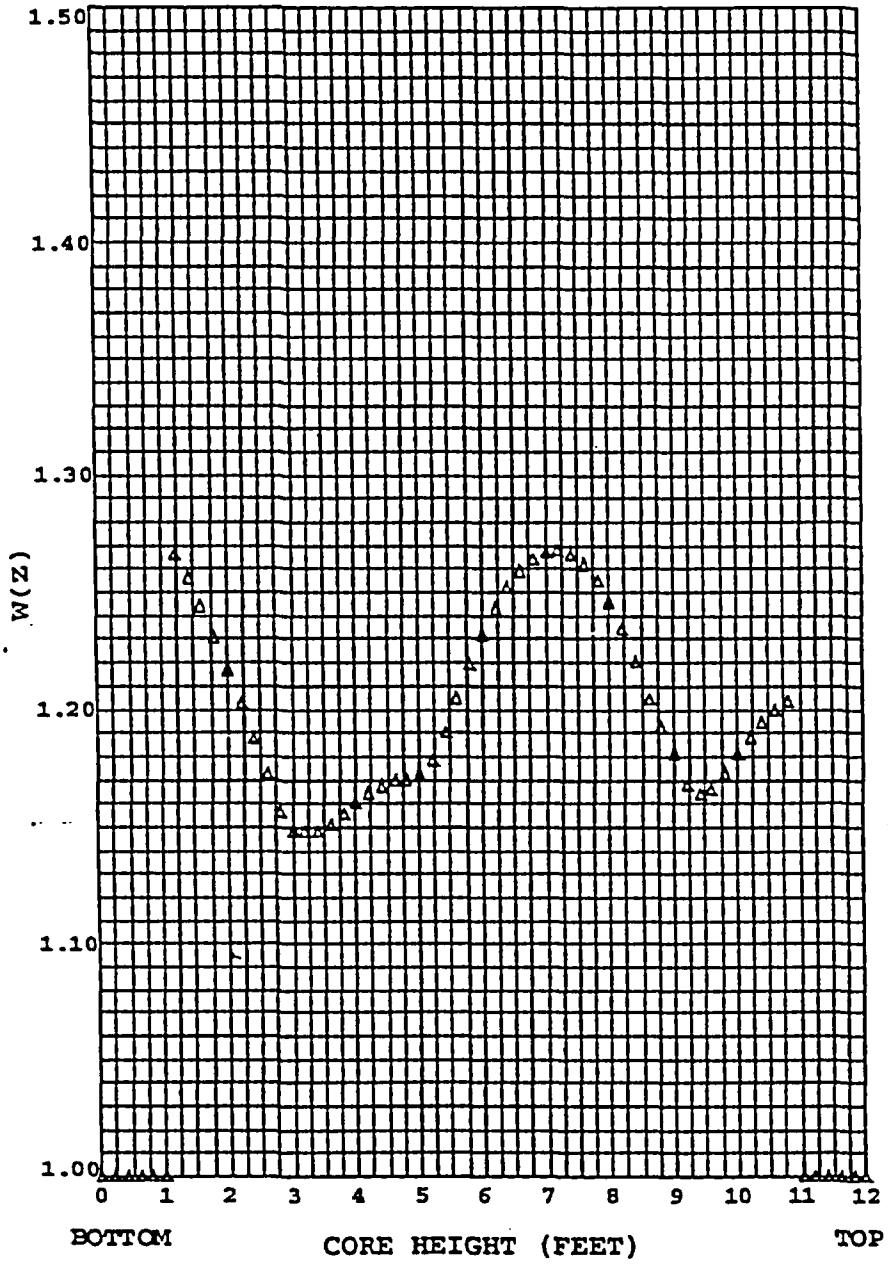

| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2818 |
| 1.4000 | 1.2679 |
| 1.6000 | 1.2515 |
| 1.8000 | 1.2335 |
| 2.0000 | 1.2144 |
| 2.2000 | 1.1947 |
| 2.4000 | 1.1746 |
| 2.6000 | 1.1546 |
| 2.8000 | 1.1344 |
| 3.0000 | 1.1231 |
| 3.2000 | 1.1201 |
| 3.4000 | 1.1174 |
| 3.6000 | 1.1156 |
| 3.8000 | 1.1132 |
| 4.0000 | 1.1131 |
| 4.2000 | 1.1153 |
| 4.4000 | 1.1166 |
| 4.6000 | 1.1176 |
| 4.8000 | 1.1187 |
| 5.0000 | 1.1185 |
| 5.2000 | 1.1200 |
| 5.4000 | 1.1329 |
| 5.6000 | 1.1445 |
| 5.8000 | 1.1572 |
| 6.0000 | 1.1714 |
| 6.2000 | 1.1850 |
| 6.4000 | 1.1972 |
| 6.6000 | 1.2082 |
| 6.8000 | 1.2176 |
| 7.0000 | 1.2253 |
| 7.2000 | 1.2313 |
| 7.4000 | 1.2353 |
| 7.6000 | 1.2372 |
| 7.8000 | 1.2370 |
| 8.0000 | 1.2344 |
| 8.2000 | 1.2294 |
| 8.4000 | 1.2220 |
| 8.6000 | 1.2120 |
| 8.8000 | 1.1995 |
| 9.0000 | 1.1937 |
| 9.2000 | 1.1948 |
| 9.4000 | 1.1999 |
| 9.6000 | 1.2075 |
| 9.8000 | 1.2145 |
| 10.0000 | 1.2209 |
| 10.2000 | 1.2287 |
| 10.4000 | 1.2369 |
| 10.6000 | 1.2439 |
| 10.8000 | 1.2489 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

**Figure 5**
**RAOC Summary of Max W(z) at 3000 MWD/MTU**
**with HFP AFD Band of -12/+6 %**
**(Top and Bottom 10% Excluded)**




| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2660 |
| 1.4000 | 1.2557 |
| 1.6000 | 1.2431 |
| 1.8000 | 1.2290 |
| 2.0000 | 1.2141 |
| 2.2000 | 1.1985 |
| 2.4000 | 1.1826 |
| 2.6000 | 1.1663 |
| 2.8000 | 1.1498 |
| 3.0000 | 1.1350 |
| 3.2000 | 1.1268 |
| 3.4000 | 1.1257 |
| 3.6000 | 1.1248 |
| 3.8000 | 1.1250 |
| 4.0000 | 1.1258 |
| 4.2000 | 1.1261 |
| 4.4000 | 1.1261 |
| 4.6000 | 1.1274 |
| 4.8000 | 1.1289 |
| 5.0000 | 1.1298 |
| 5.2000 | 1.1330 |
| 5.4000 | 1.1481 |
| 5.6000 | 1.1644 |
| 5.8000 | 1.1796 |
| 6.0000 | 1.1936 |
| 6.2000 | 1.2061 |
| 6.4000 | 1.2172 |
| 6.6000 | 1.2267 |
| 6.8000 | 1.2344 |
| 7.0000 | 1.2403 |
| 7.2000 | 1.2442 |
| 7.4000 | 1.2459 |
| 7.6000 | 1.2455 |
| 7.8000 | 1.2428 |
| 8.0000 | 1.2376 |
| 8.2000 | 1.2301 |
| 8.4000 | 1.2201 |
| 8.6000 | 1.2071 |
| 8.8000 | 1.1946 |
| 9.0000 | 1.1872 |
| 9.2000 | 1.1855 |
| 9.4000 | 1.1840 |
| 9.6000 | 1.1820 |
| 9.8000 | 1.1800 |
| 10.0000 | 1.1787 |
| 10.2000 | 1.1786 |
| 10.4000 | 1.1804 |
| 10.6000 | 1.1850 |
| 10.8000 | 1.1889 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

**Figure 6**
**RAOC Summary of Max W(z) at 10000 MWD/MTU**
**with HFP AFD Band of -12/+6 %**
**(Top and Bottom 10% Excluded)**




| Height (feet) | Max. W(z) |
|---|---|
| 0.0000 | 1.0000 |
| 0.2000 | 1.0000 |
| 0.4000 | 1.0000 |
| 0.6000 | 1.0000 |
| 0.8000 | 1.0000 |
| 1.0000 | 1.0000 |
| 1.2000 | 1.2660 |
| 1.4000 | 1.2561 |
| 1.6000 | 1.2441 |
| 1.8000 | 1.2308 |
| 2.0000 | 1.2168 |
| 2.2000 | 1.2023 |
| 2.4000 | 1.1875 |
| 2.6000 | 1.1725 |
| 2.8000 | 1.1567 |
| 3.0000 | 1.1487 |
| 3.2000 | 1.1481 |
| 3.4000 | 1.1481 |
| 3.6000 | 1.1507 |
| 3.8000 | 1.1556 |
| 4.0000 | 1.1605 |
| 4.2000 | 1.1643 |
| 4.4000 | 1.1674 |
| 4.6000 | 1.1696 |
| 4.8000 | 1.1703 |
| 5.0000 | 1.1719 |
| 5.2000 | 1.1781 |
| 5.4000 | 1.1902 |
| 5.6000 | 1.2046 |
| 5.8000 | 1.2190 |
| 6.0000 | 1.2319 |
| 6.2000 | 1.2430 |
| 6.4000 | 1.2521 |
| 6.6000 | 1.2592 |
| 6.8000 | 1.2643 |
| 7.0000 | 1.2671 |
| 7.2000 | 1.2677 |
| 7.4000 | 1.2659 |
| 7.6000 | 1.2618 |
| 7.8000 | 1.2551 |
| 8.0000 | 1.2460 |
| 8.2000 | 1.2344 |
| 8.4000 | 1.2203 |
| 8.6000 | 1.2044 |
| 8.8000 | 1.1926 |
| 9.0000 | 1.1812 |
| 9.2000 | 1.1678 |
| 9.4000 | 1.1639 |
| 9.6000 | 1.1660 |
| 9.8000 | 1.1730 |
| 10.0000 | 1.1810 |
| 10.2000 | 1.1880 |
| 10.4000 | 1.1944 |
| 10.6000 | 1.1997 |
| 10.8000 | 1.2032 |
| 11.0000 | 1.0000 |
| 11.2000 | 1.0000 |
| 11.4000 | 1.0000 |
| 11.6000 | 1.0000 |
| 11.8000 | 1.0000 |
| 12.0000 | 1.0000 |

**Figure 7**
**RAOC Summary of Max W(z) at 16000 MWD/MTU**
**with HFP AFD Band of -12/+6 %**
**(Top and Bottom 10% Excluded)**

## Table A.1

## $F_Q^W(Z)$ Penalty Factor

| Core Burnup (MWD/MTU) | $F_Q^W(Z)$ Penalty Factor |
|---|---|
| 8149 | 1.0200 |
| 8300 | 1.0208 |
| 8450 | 1.0212 |
| 8601 | 1.0203 |
| 8752 | 1.0200 |

Notes:

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.
2. Linear interpolation is adequate for intermediate cycle burnups.
3. For all cycle burnups outside the range of the table, a penalty factor of 1.020 shall be used for compliance with Surveillance Requirement 3.2.1.2.a.

## Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 0 | 0 | | | |
| 2 | 2 | | | |
| 4 | 4 | | | |
| 6 | 6 | | | |
| 8 | 8 | | | |
| 10 | 10 | | | |
| 12 | 12 | | | |
| 14 | 14 | | | |
| 16 | 16 | | | |
| 18 | 18 | | | |
| 20 | 20 | | | |
| 22 | 22 | | | |
| 24 | 24 | | | |
| 26 | 26 | | | |
| 28 | 28 | | | |
| 30 | 30 | | | |
| 32 | 32 | | | |
| 34 | 34 | | | |
| 36 | 36 | | | |
| 38 | 38 | | | |
| 40 | 40 | | | |
| 42 | 42 | | | |
| 44 | 44 | | | |
| 46 | 46 | | | |
| 48 | 48 | | | |
| 50 | 50 | | | |
| 52 | 52 | | | |
| 54 | 54 | | | |
| 56 | 56 | | | |
| 58 | 58 | | | |
| 60 | 60 | | | |
| 62 | 62 | | | |
| 64 | 64 | | | |
| 66 | 66 | | | |
| 68 | 68 | | | |
| 70 | 70 | | | |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 72 | 72 | | | |
| 74 | 74 | | | |
| 76 | 76 | | | |
| 78 | 78 | | | |
| 80 | 80 | | | |
| 82 | 82 | | | |
| 84 | 84 | | | |
| 86 | 86 | | | |
| 88 | 88 | | | |
| 90 | 90 | | | |
| 92 | 92 | | | |
| 94 | 94 | | | |
| 96 | 96 | | | |
| 98 | 98 | | | |
| 100 | 100 | | | |
| 102 | 102 | | | |
| 104 | 104 | | | |
| 106 | 106 | | | |
| 108 | 108 | | | |
| 110 | 110 | | | |
| 112 | 112 | | | |
| 114 | 114 | | | |
| 116 | 116 | | | |
| 118 | 118 | | | |
| 120 | 120 | | | |
| 122 | 122 | | | |
| 124 | 124 | | | |
| 126 | 126 | | | |
| 128 | 128 | 0 | | |
| 130 | 130 | 2 | | |
| 132 | 132 | 4 | | |
| 134 | 134 | 6 | | |
| 136 | 136 | 8 | | |
| 138 | 138 | 10 | | |
| 140 | 140 | 12 | | |
| 142 | 142 | 14 | | |

## Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 144 | 144 | 16 | | |
| 146 | 146 | 18 | | |
| 148 | 148 | 20 | | |
| 150 | 150 | 22 | | |
| 152 | 152 | 24 | | |
| 154 | 154 | 26 | | |
| 156 | 156 | 28 | | |
| 158 | 158 | 30 | | |
| 160 | 160 | 32 | | |
| 162 | 162 | 34 | | |
| 164 | 164 | 36 | | |
| 166 | 166 | 38 | | |
| 168 | 168 | 40 | | |
| 170 | 170 | 42 | | |
| 172 | 172 | 44 | | |
| 174 | 174 | 46 | | |
| 176 | 176 | 48 | | |
| 178 | 178 | 50 | | |
| 180 | 180 | 52 | | |
| 182 | 182 | 54 | | |
| 184 | 184 | 56 | | |
| 186 | 186 | 58 | | |
| 188 | 188 | 60 | | |
| 190 | 190 | 62 | | |
| 192 | 192 | 64 | | |
| 194 | 194 | 66 | | |
| 196 | 196 | 68 | | |
| 198 | 198 | 70 | | |
| 200 | 200 | 72 | | |
| 202 | 202 | 74 | | |
| 204 | 204 | 76 | | |
| 206 | 206 | 78 | | |
| 208 | 208 | 80 | | |
| 210 | 210 | 82 | | |
| 212 | 212 | 84 | | |
| 214 | 214 | 86 | | |
| 216 | 216 | 88 | | |
| 218 | 218 | 90 | | |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 220 | 220 | 92 | | |
| 222 | 222 | 94 | | |
| 224 | 224 | 96 | | |
| 226 | 226 | 98 | | |
| 228 | 228 | 100 | | |
| 230 | 230 | 102 | | |
| 232 | 232 | 104 | | |
| 234 | | 106 | | |
| 236 | | 108 | | |
| 238 | | 110 | | |
| 240 | | 112 | | |
| 242 | | 114 | | |
| 244 | | 116 | | |
| 246 | | 118 | | |
| 248 | | 120 | | |
| 250 | | 122 | | |
| 252 | | 124 | | |
| 254 | | 126 | | |
| 256 | | 128 | 0 | |
| 258 | | 130 | 2 | |
| 260 | | 132 | 4 | |
| 262 | | 134 | 6 | |
| 264 | | 136 | 8 | |
| 266 | | 138 | 10 | |
| 268 | | 140 | 12 | |
| 270 | | 142 | 14 | |
| 272 | | 144 | 16 | |
| 274 | | 146 | 18 | |
| 276 | | 148 | 20 | |
| 278 | | 150 | 22 | |
| 280 | | 152 | 24 | |
| 282 | | 154 | 26 | |
| 284 | | 156 | 28 | |
| 286 | | 158 | 30 | |
| 288 | | 160 | 32 | |
| 290 | | 162 | 34 | |
| 292 | | 164 | 36 | |
| 294 | | 166 | 38 | |

## Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 296 | | 168 | 40 | |
| 298 | | 170 | 42 | |
| 300 | | 172 | 44 | |
| 302 | | 174 | 46 | |
| 304 | | 176 | 48 | |
| 306 | | 178 | 50 | |
| 308 | | 180 | 52 | |
| 310 | | 182 | 54 | |
| 312 | | 184 | 56 | |
| 314 | | 186 | 58 | |
| 316 | | 188 | 60 | |
| 318 | | 190 | 62 | |
| 320 | | 192 | 64 | |
| 322 | | 194 | 66 | |
| 324 | | 196 | 68 | |
| 326 | | 198 | 70 | |
| 328 | | 200 | 72 | |
| 330 | | 202 | 74 | |
| 332 | | 204 | 76 | |
| 334 | | 206 | 78 | |
| 336 | | 208 | 80 | |
| 338 | | 210 | 82 | |
| 340 | | 212 | 84 | |
| 342 | | 214 | 86 | |
| 344 | | 216 | 88 | |
| 346 | | 218 | 90 | |
| 348 | | 220 | 92 | |
| 350 | | 222 | 94 | |
| 352 | | 224 | 96 | |
| 354 | | 226 | 98 | |
| 356 | | 228 | 100 | |
| 358 | | 230 | 102 | |
| 360 | | 232 | 104 | |
| 362 | | | 106 | |
| 364 | | | 108 | |
| 366 | | | 110 | |
| 368 | | | 112 | |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 370 | | | 114 | |
| 372 | | | 116 | |
| 374 | | | 118 | |
| 376 | | | 120 | |
| 378 | | | 122 | |
| 380 | | | 124 | |
| 382 | | | 126 | |
| 384 | | | 128 | 0 |
| 386 | | | 130 | 2 |
| 388 | | | 132 | 4 |
| 390 | | | 134 | 6 |
| 392 | | | 136 | 8 |
| 394 | | | 138 | 10 |
| 396 | | | 140 | 12 |
| 398 | | | 142 | 14 |
| 400 | | | 144 | 16 |
| 402 | | | 146 | 18 |
| 404 | | | 148 | 20 |
| 406 | | | 150 | 22 |
| 408 | | | 152 | 24 |
| 410 | | | 154 | 26 |
| 412 | | | 156 | 28 |
| 414 | | | 158 | 30 |
| 416 | | | 160 | 32 |
| 418 | | | 162 | 34 |
| 420 | | | 164 | 36 |
| 422 | | | 166 | 38 |
| 424 | | | 168 | 40 |
| 426 | | | 170 | 42 |
| 428 | | | 172 | 44 |
| 430 | | | 174 | 46 |
| 432 | | | 176 | 48 |
| 434 | | | 178 | 50 |
| 436 | | | 180 | 52 |
| 438 | | | 182 | 54 |
| 440 | | | 184 | 56 |
| 442 | | | 186 | 58 |

## Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 444 | | | 188 | 60 |
| 446 | | | 190 | 62 |
| 448 | | | 192 | 64 |
| 450 | | | 194 | 66 |
| 452 | | | 196 | 68 |
| 454 | | | 198 | 70 |
| 456 | | | 200 | 72 |
| 458 | | | 202 | 74 |
| 460 | | | 204 | 76 |
| 462 | | | 206 | 78 |
| 464 | | | 208 | 80 |
| 466 | | | 210 | 82 |
| 468 | | | 212 | 84 |
| 470 | | | 214 | 86 |
| 472 | | | 216 | 88 |
| 474 | | | 218 | 90 |
| 476 | | | 220 | 92 |
| 478 | | | 222 | 94 |
| 480 | | | 224 | 96 |
| 482 | | | 226 | 98 |
| 484 | | | 228 | 100 |
| 486 | | | 230 | 102 |
| 488 | | | 232 | 104 |
| 490 | | | | 106 |
| 492 | | | | 108 |
| 494 | | | | 110 |
| 496 | | | | 112 |
| 498 | | | | 114 |
| 500 | | | | 116 |
| 502 | | | | 118 |
| 504 | | | | 120 |
| 506 | | | | 122 |
| 508 | | | | 124 |
| 510 | | | | 126 |
| 512 | | | | 128 |
| 514 | | | | 130 |
| 516 | | | | 132 |

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 518 | | | | 134 |
| 520 | | | | 136 |
| 522 | | | | 138 |
| 524 | | | | 140 |
| 526 | | | | 142 |
| 528 | | | | 144 |
| 530 | | | | 146 |
| 532 | | | | 148 |
| 534 | | | | 150 |
| 536 | | | | 152 |
| 538 | | | | 154 |
| 540 | | | | 156 |
| 542 | | | | 158 |
| 544 | | | | 160 |
| 546 | | | | 162 |
| 548 | | | | 164 |
| 550 | | | | 166 |
| 552 | | | | 168 |
| 554 | | | | 170 |
| 556 | | | | 172 |
| 558 | | | | 174 |
| 560 | | | | 176 |
| 562 | | | | 178 |
| 564 | | | | 180 |
| 566 | | | | 182 |
| 568 | | | | 184 |
| 570 | | | | 186 |
| 572 | | | | 188 |
| 574 | | | | 190 |
| 576 | | | | 192 |
| 578 | | | | 194 |
| 580 | | | | 196 |
| 582 | | | | 198 |
| 584 | | | | 200 |
| 586 | | | | 202 |
| 588 | | | | 204 |
| 590 | | | | 206 |

## Table 1: Control Rod Overlap

| Band Overlap Counter (steps) | A Bank | B Bank | C Bank | D Bank |
|---|---|---|---|---|
| 592 | | | | 208 |
| 594 | | | | 210 |
| 596 | | | | 212 |
| 598 | | | | 214 |
| 600 | | | | 216 |
| 602 | | | | 218 |
| 604 | | | | 220 |
| 606 | | | | 222 |
| 608 | | | | 224 |
| 610 | | | | 226 |
| 612 | | | | 228 |
| 614 | | | | 230 |
| 616 | | | | 232 |

**This information is provided in 2 step increments. One step increments can be derived by interpolation. 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. The Table indicates a maximum step of 232 to be consistent with 2 step increments.**