SOUTH CAROLINA ELECTRIC & GAS COMPANY

VIRGIL C. SUMMER NUCLEAR STATION

CORE OPERATING LIMITS REPORT

FOR

CYCLE 10

REVISION 0

MAY 7, 1996

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1.0 Core Operating Limits Report

This Core Operating Limits Report (COLR) for V. C. Summer Station Cycle 10 has been prepared in accordance with the requirements of Technical Specification 6.9.1.11.

The Technical Specifications affected by this report are listed below:

3.1.1.3	Moderator Temperature Coefficient
3.1.3.5	Shutdown Rod Insertion Limit
3.1.3.6	Control Rod Insertion Limits
3.2.1	Axial Flux Difference
3.2.2	Heat Flux Hot Channel Factor
3.2.3	RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor

2.0 Operating Limits

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the subsections which follow. These limits have been developed using the NRC-approved methodologies specified in Technical Specification 6.9.1.11.

2.1 Moderator Temperature Coefficient (Specification 3.1.1.3):

2.1.1 The Moderator Temperature Coefficient (MTC) limits are:

The BOL/ARO-MTC shall be less positive than the limits shown in Figure 1.
The EOL/ARO/RTP-MTC shall be less negative than -5×10^{-4} $\Delta k/k/°F$.

2.1.2 The MTC Surveillance limit is:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -4.1×10^{-4} $\Delta k/k/°F$.

where: BOL stands for Beginning-of-Cycle-Life
ARO stands for All-Rods-Out
RTP stands for RATED THERMAL POWER
EOL stands for End-of-Cycle-Life

2.2 Shutdown Rod Insertion Limits (Specification 3.1.3.5):

The shutdown rods shall be withdrawn to at least 225 steps.

2.3 Control Rod Insertion Limits (Specification 3.1.3.6):

The Control Bank Insertion Limits are specified by Figure 2.

Figure 1
Moderator Temperature Coefficient vs. Power Level
V. C. Summer - Cycle 10

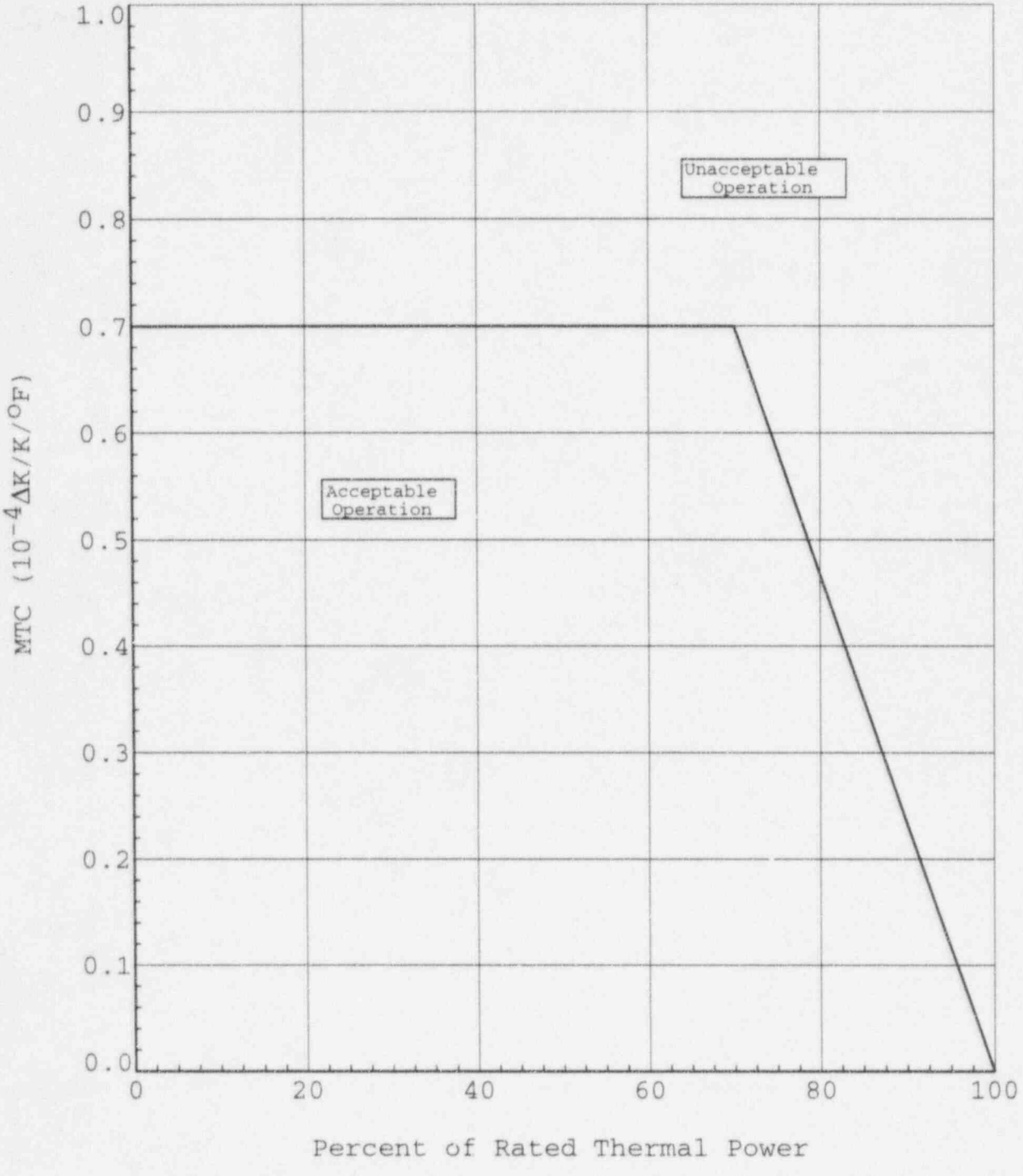
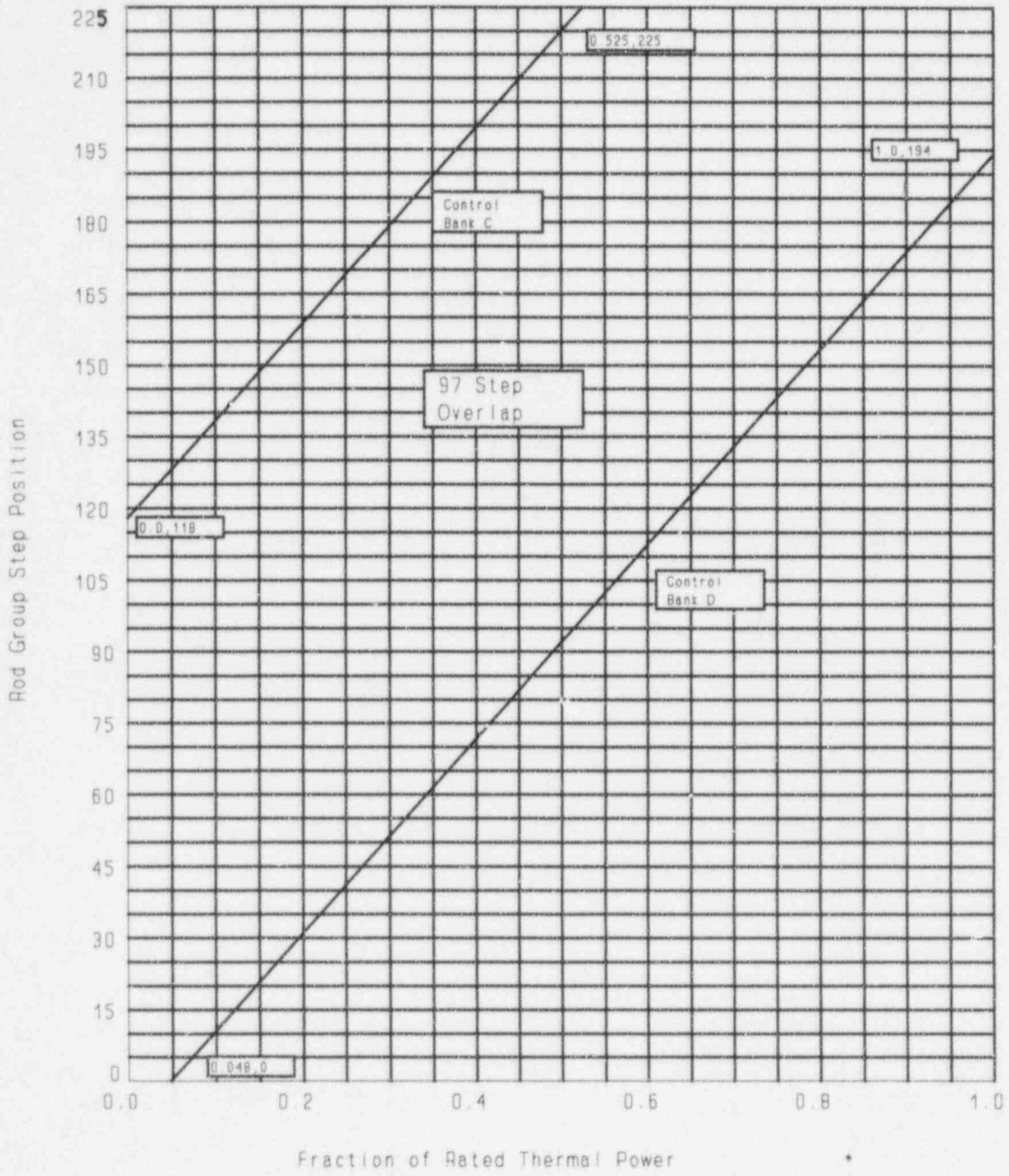


Figure 2
Rod Group Insertion Limits vs. Thermal Power
for Three Loop Operation
V. C. Summer - Cycle 10



2.4 Axial Flux Difference (Specification 3.2.1):

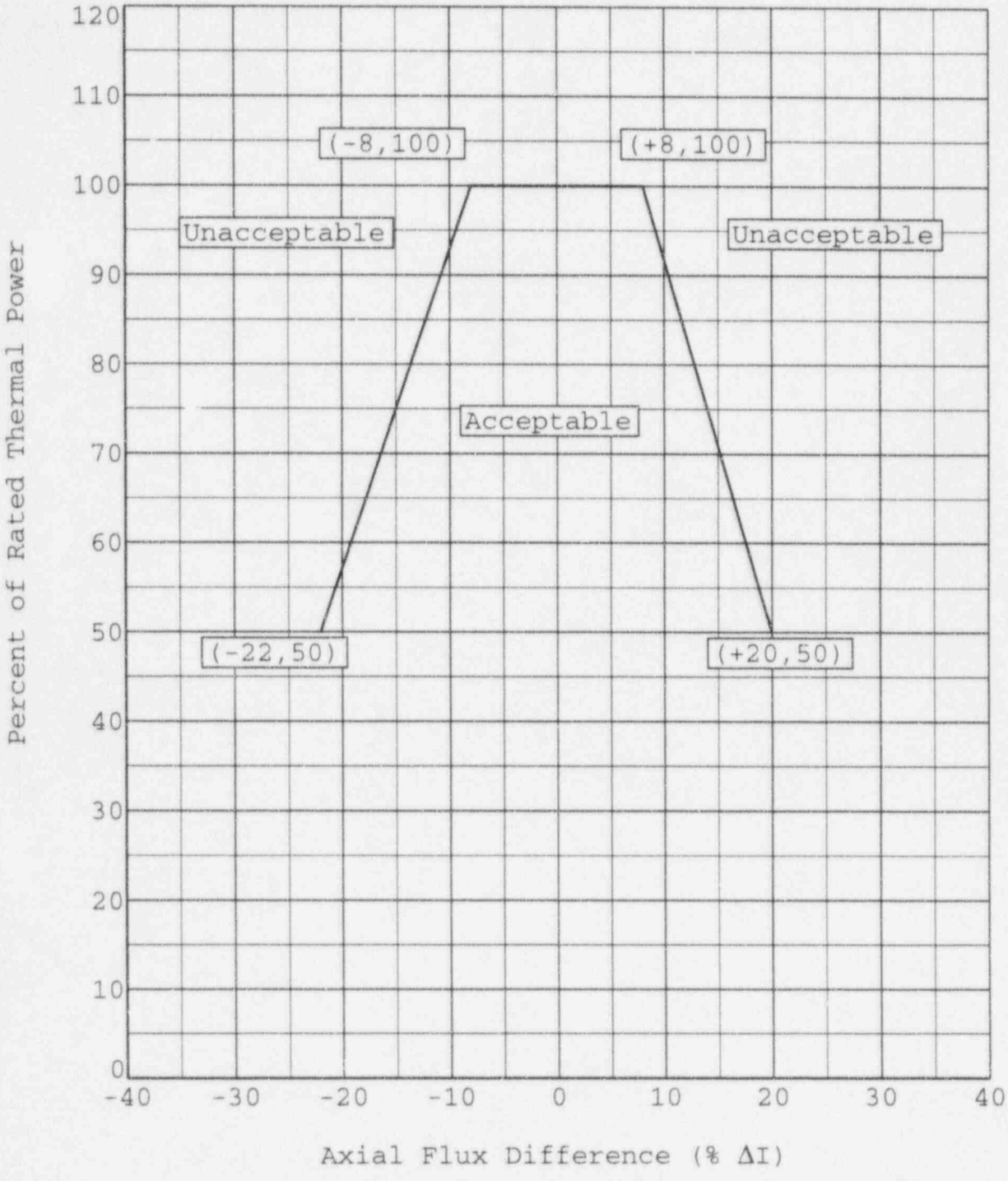
2.4.1 The Axial Flux Difference (AFD) Limits for RAOC operation for Cycle 10 are shown in Figure 3.

2.4.2 The Axial Flux Difference (AFD) target band during base load operations for Cycle 10 is:

BOL - EOL (0 - 22,180 MWD/MTU): ± 5% about a measured target value.

2.4.3 The minimum allowable power level for base load operation, APL^{ND}, is 85% of RATED THERMAL POWER.

Figure 3
Axial Flux Difference Limits as a Function of Rated Thermal Power
V. C. Summer - Cycle 10



2.5 Heat Flux Hot Channel Factor - $F_Q(Z)$ (Specification 3.2.2):

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{P} * K(Z) \quad for\ P > 0.5$$

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} * K(Z) \quad for\ P \leq 0.5$$

$$where:\ P = \frac{Thermal\ Power}{Rated\ Thermal\ Power}$$

2.5.1 $F_Q^{RTP} = 2.45$

2.5.2 K(Z) is provided in Figure 4

2.5.3 Elevation dependent W(Z) values for RAOC operation at 150, 4,000, 10,000, and 18,000 MWD/MTU are shown in Figures 5 through 8, respectively. This information is sufficient to determine W(Z) versus core height in the range of 0 MWD/MTU to EOL burnup through the use of three point interpolation.

2.5.4 Elevation dependent $W(Z)_{BL}$ values for base load operation between 85 and 100% of rated thermal power with the item 2.4.2 specified target band about a measured target value at 150, 4,000, 10,000, and 18,000 MWD/MTU are shown in Figures 9 through 12, respectively. This information is sufficient to determine $W(Z)_{BL}$ versus core height for burnups in the range of 0 MWD/MTU to EOL burnup through the use of three point interpolation.

Figure 4
K(z) - Normalized $F_Q(Z)$ as a Function of Core Height
V. C. Summer - Cycle 10

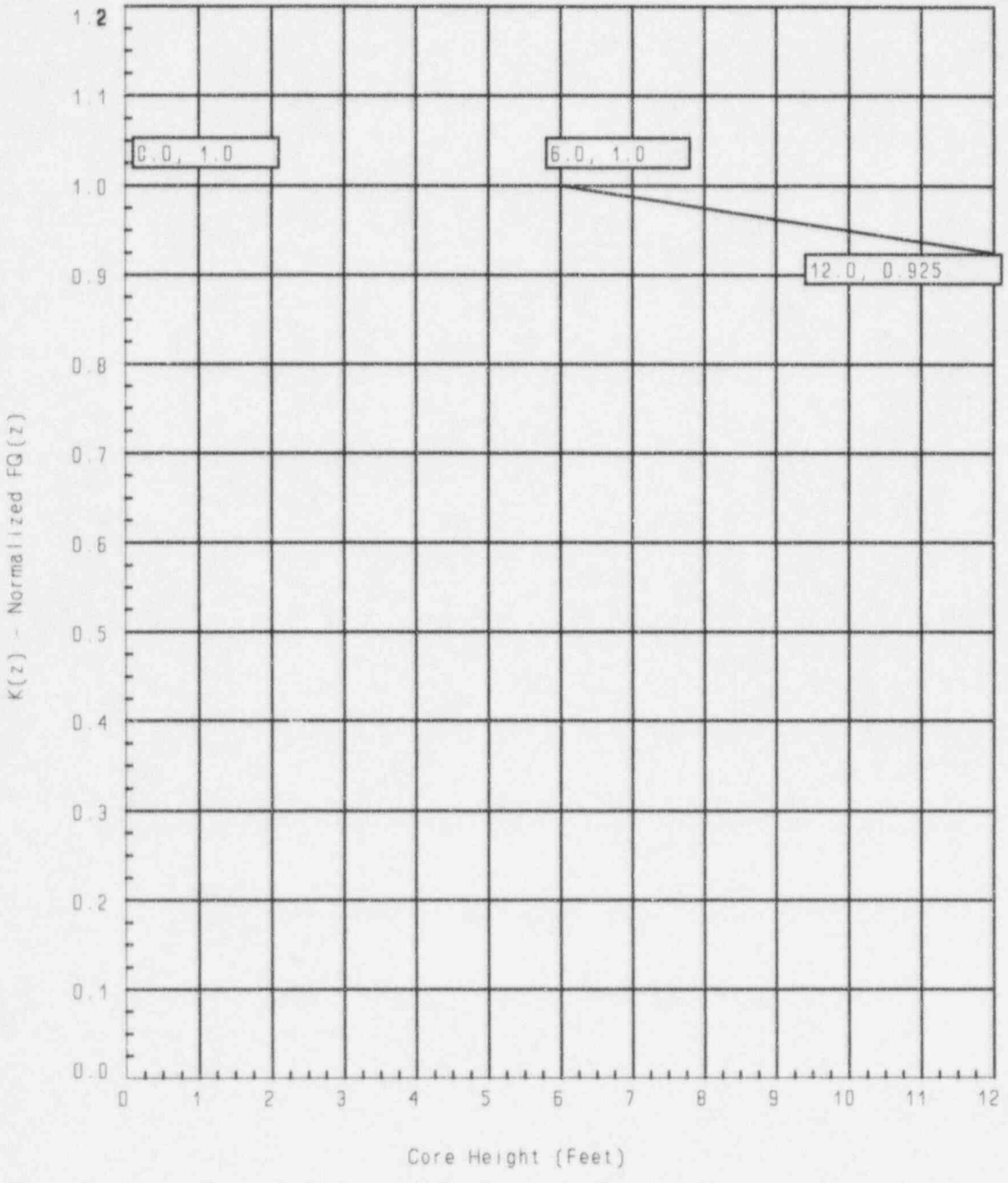


Figure 5

RAOC W(Z) at 150 MWD/MTU

V. C. Summer - Cycle 10

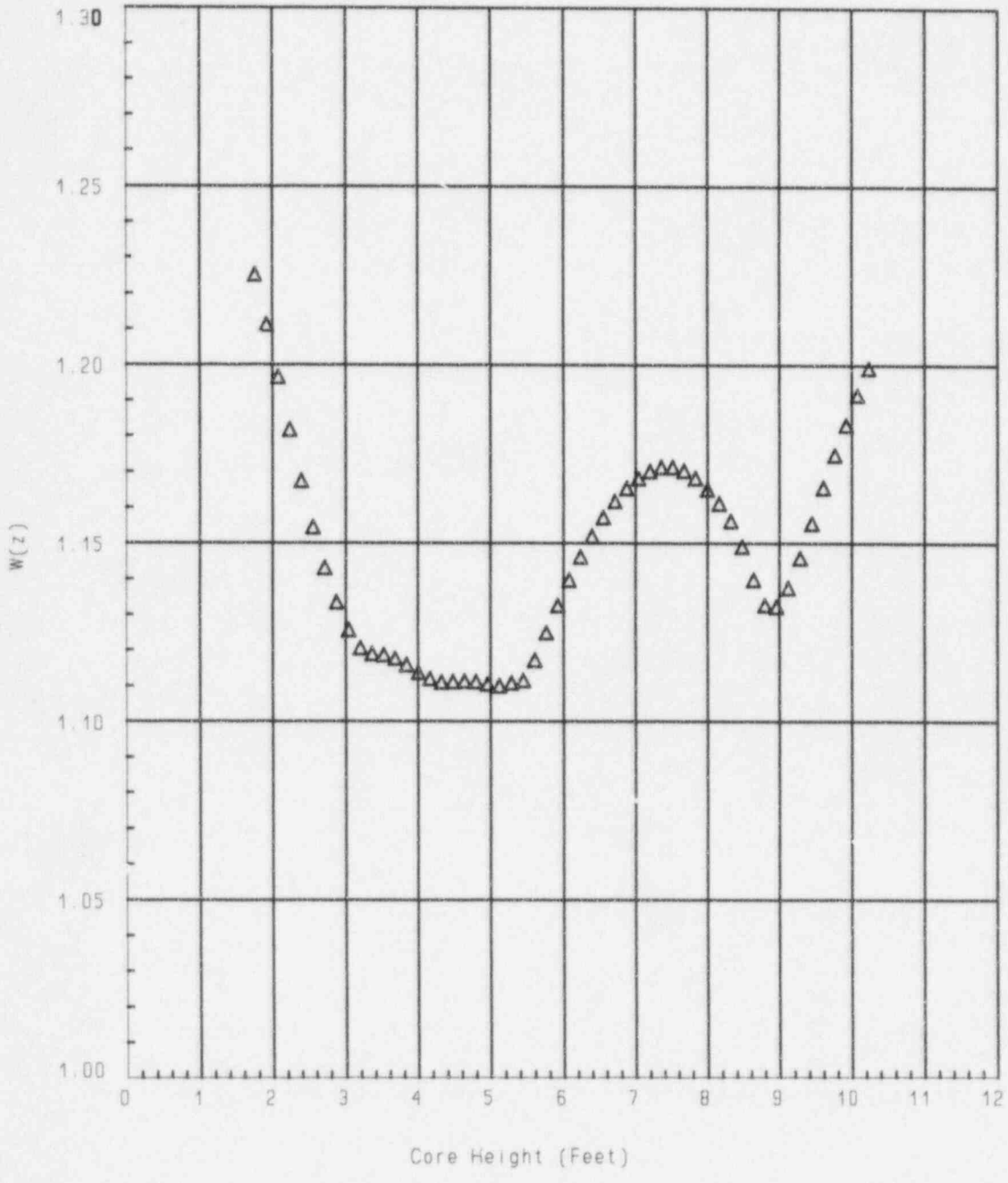


Table 1

RAOC W(Z) at 150 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.1397
0.16	1.0000	6.24	1.1462
0.32	1.0000	6.40	1.1520
0.48	1.0000	6.56	1.1572
0.64	1.0000	6.72	1.1617
0.80	1.0000	6.88	1.1654
0.96	1.0000	7.04	1.1682
1.12	1.0000	7.20	1.1701
1.28	1.0000	7.36	1.1712
1.44	1.0000	7.52	1.1712
1.60	1.0000	7.68	1.1703
1.76	1.2252	7.84	1.1681
1.92	1.2111	8.00	1.1650
2.08	1.1965	8.16	1.1612
2.24	1.1817	8.32	1.1563
2.40	1.1673	8.48	1.1491
2.56	1.1544	8.64	1.1398
2.72	1.1431	8.80	1.1327
2.88	1.1334	8.96	1.1323
3.04	1.1256	9.12	1.1375
3.20	1.1206	9.28	1.1458
3.36	1.1189	9.44	1.1556
3.52	1.1186	9.60	1.1655
3.68	1.1176	9.76	1.1746
3.84	1.1158	9.92	1.1832
4.00	1.1137	10.08	1.1915
4.16	1.1120	10.24	1.1990
4.32	1.1110	10.40	1.0000
4.48	1.1111	10.56	1.0000
4.64	1.1113	10.72	1.0000
4.80	1.1111	10.88	1.0000
4.96	1.1104	11.04	1.0000
5.12	1.1100	11.20	1.0000
5.28	1.1108	11.36	1.0000
5.44	1.1115	11.52	1.0000
5.60	1.1171	11.68	1.0000
5.76	1.1249	11.84	1.0000
5.92	1.1326	12.00	1.0000

Figure 6

RAOC W(Z) at 4,000 MWD/MTU

V. C. Summer - Cycle 10

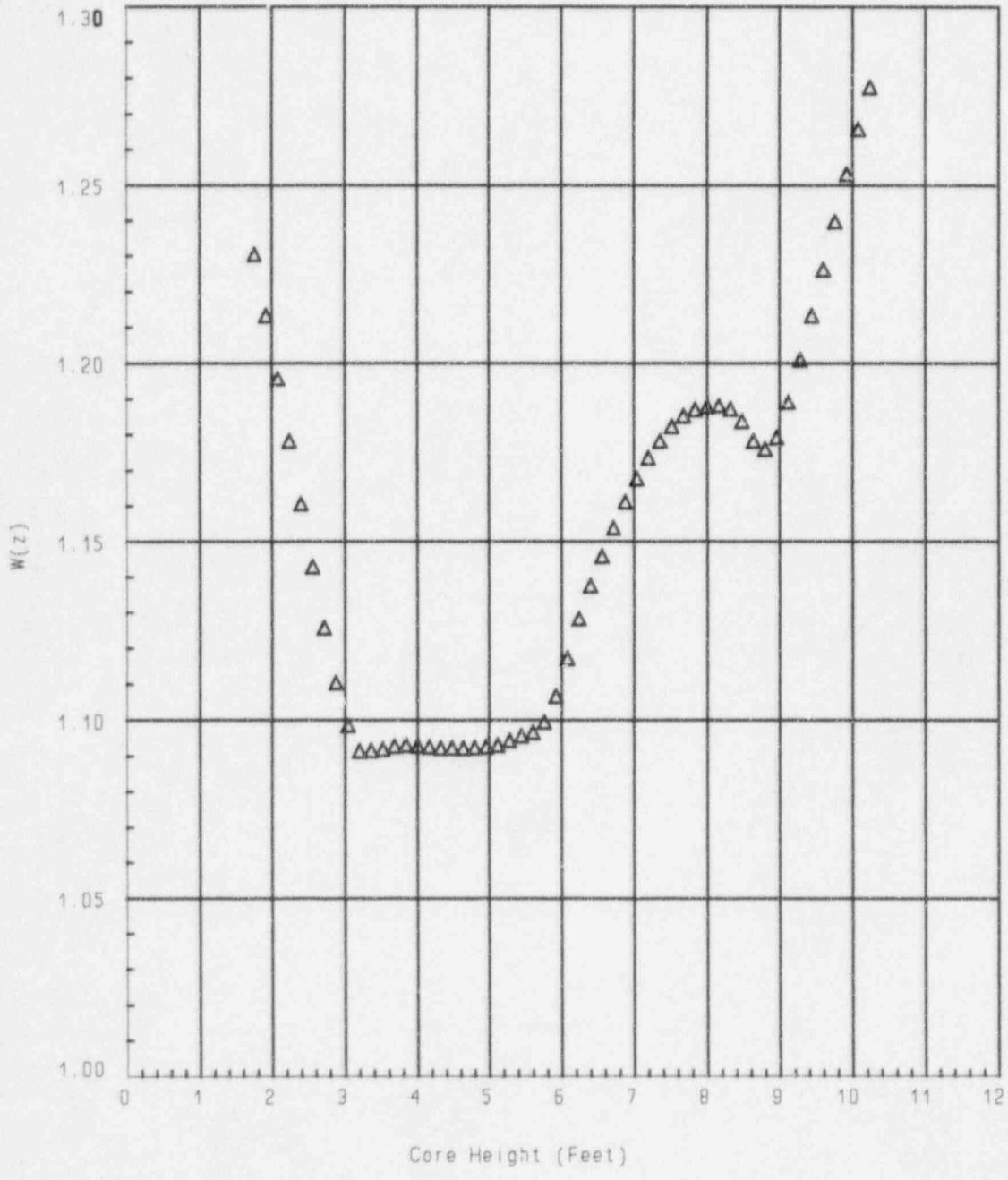


Table 2

RAOC W(Z) at 4,000 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.1174
0.16	1.0000	6.24	1.1283
0.32	1.0000	6.40	1.1376
0.48	1.0000	6.56	1.1459
0.64	1.0000	6.72	1.1538
0.80	1.0000	6.88	1.1612
0.96	1.0000	7.04	1.1677
1.12	1.0000	7.20	1.1735
1.28	1.0000	7.36	1.1783
1.44	1.0000	7.52	1.1823
1.60	1.0000	7.68	1.1852
1.76	1.2303	7.84	1.1870
1.92	1.2132	8.00	1.1879
2.08	1.1956	8.16	1.1881
2.24	1.1782	8.32	1.1872
2.40	1.1606	8.48	1.1838
2.56	1.1430	8.64	1.1783
2.72	1.1258	8.80	1.1759
2.88	1.1105	8.96	1.1793
3.04	1.0985	9.12	1.1891
3.20	1.0914	9.28	1.2009
3.36	1.0916	9.44	1.2132
3.52	1.0919	9.60	1.2261
3.68	1.0928	9.76	1.2396
3.84	1.0931	9.92	1.2530
4.00	1.0929	10.08	1.2658
4.16	1.0925	10.24	1.2775
4.32	1.0922	10.40	1.0000
4.48	1.0922	10.56	1.0000
4.64	1.0923	10.72	1.0000
4.80	1.0924	10.88	1.0000
4.96	1.0925	11.04	1.0000
5.12	1.0931	11.20	1.0000
5.28	1.0944	11.36	1.0000
5.44	1.0956	11.52	1.0000
5.60	1.0967	11.68	1.0000
5.76	1.0995	11.84	1.0000
5.92	1.1067	12.00	1.0000

Figure 7

RAOC W(Z) at 10,000 MWD/MTU

V. C. Summer - Cycle 10

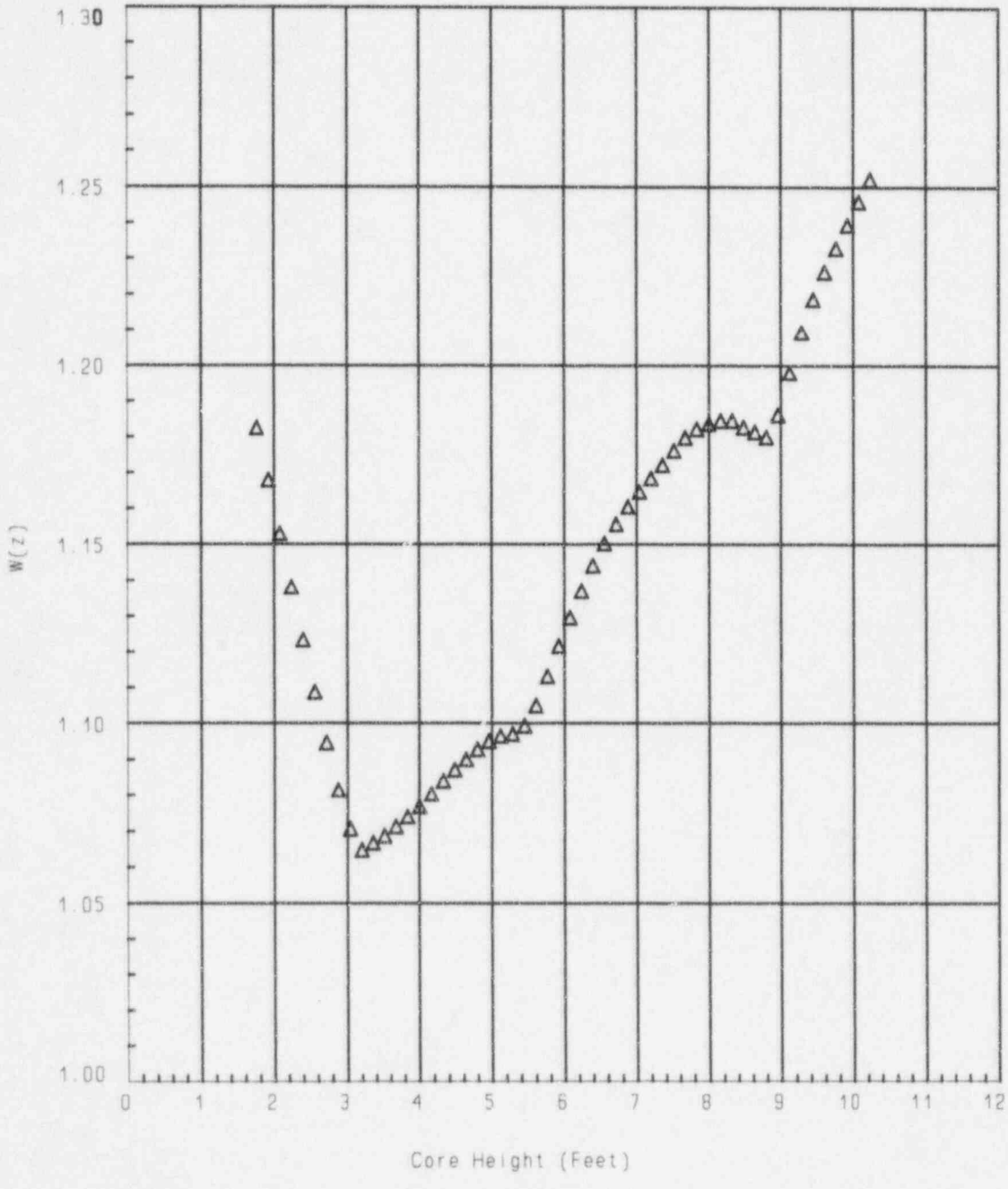


Table 3

RAOC W(Z) at 10,000 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.1295
0.16	1.0000	6.24	1.1371
0.32	1.0000	6.40	1.1440
0.48	1.0000	6.56	1.1502
0.64	1.0000	6.72	1.1556
0.80	1.0000	6.88	1.1604
0.96	1.0000	7.04	1.1645
1.12	1.0000	7.20	1.1683
1.28	1.0000	7.36	1.1721
1.44	1.0000	7.52	1.1762
1.60	1.0000	7.68	1.1797
1.76	1.1825	7.84	1.1821
1.92	1.1678	8.00	1.1836
2.08	1.1529	8.16	1.1844
2.24	1.1381	8.32	1.1844
2.40	1.1233	8.48	1.1826
2.56	1.1087	8.64	1.1813
2.72	1.0945	8.80	1.1799
2.88	1.0814	8.96	1.1861
3.04	1.0706	9.12	1.1979
3.20	1.0647	9.28	1.2093
3.36	1.0667	9.44	1.2184
3.52	1.0686	9.60	1.2261
3.68	1.0713	9.76	1.2329
3.84	1.0739	9.92	1.2393
4.00	1.0768	10.08	1.2458
4.16	1.0803	10.24	1.2521
4.32	1.0840	10.40	1.0000
4.48	1.0871	10.56	1.0000
4.64	1.0899	10.72	1.0000
4.80	1.0927	10.88	1.0000
4.96	1.0950	11.04	1.0000
5.12	1.0964	11.20	1.0000
5.28	1.0970	11.36	1.0000
5.44	1.0992	11.52	1.0000
5.60	1.1050	11.68	1.0000
5.76	1.1131	11.84	1.0000
5.92	1.1215	12.00	1.0000

Figure 8

RAOC W(Z) at 18,000 MWD/MTU

V. C. Summer - Cycle 10

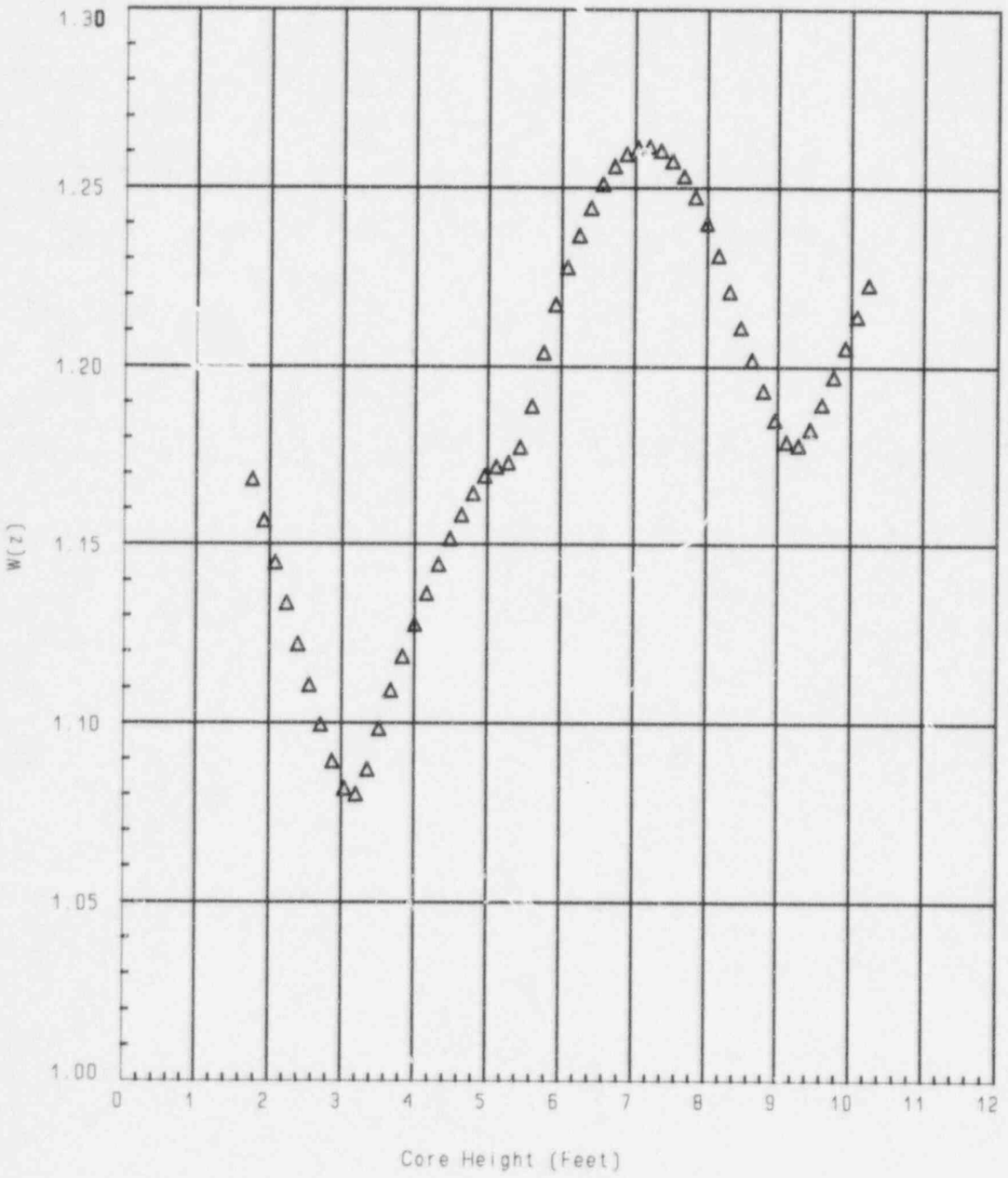


Table 4

RAOC W(Z) at 18,000 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.2276
0.16	1.0000	6.24	1.2365
0.32	1.0000	6.40	1.2443
0.48	1.0000	6.56	1.2509
0.64	1.0000	6.72	1.2559
0.80	1.0000	6.88	1.2593
0.96	1.0000	7.04	1.2612
1.12	1.0000	7.20	1.2615
1.28	1.0000	7.36	1.2603
1.44	1.0000	7.52	1.2574
1.60	1.0000	7.68	1.2531
1.76	1.1681	7.84	1.2473
1.92	1.1565	8.00	1.2400
2.08	1.1448	8.16	1.2310
2.24	1.1334	8.32	1.2209
2.40	1.1220	8.48	1.2109
2.56	1.1106	8.64	1.2019
2.72	1.0995	8.80	1.1933
2.88	1.0893	8.96	1.1850
3.04	1.0817	9.12	1.1789
3.20	1.0800	9.28	1.1780
3.36	1.0871	9.44	1.1825
3.52	1.0984	9.60	1.1894
3.68	1.1092	9.76	1.1971
3.84	1.1186	9.92	1.2053
4.00	1.1275	10.08	1.2140
4.16	1.1362	10.24	1.2228
4.32	1.1444	10.40	1.0000
4.48	1.1516	10.56	1.0000
4.64	1.1582	10.72	1.0000
4.80	1.1642	10.88	1.0000
4.96	1.1691	11.04	1.0000
5.12	1.1718	11.20	1.0000
5.28	1.1729	11.36	1.0000
5.44	1.1773	11.52	1.0000
5.60	1.1888	11.68	1.0000
5.76	1.2038	11.84	1.0000
5.92	1.2172	12.00	1.0000

Figure 9

Baseload W(Z) at 150 MWD/MTU

V. C. Summer - Cycle 10

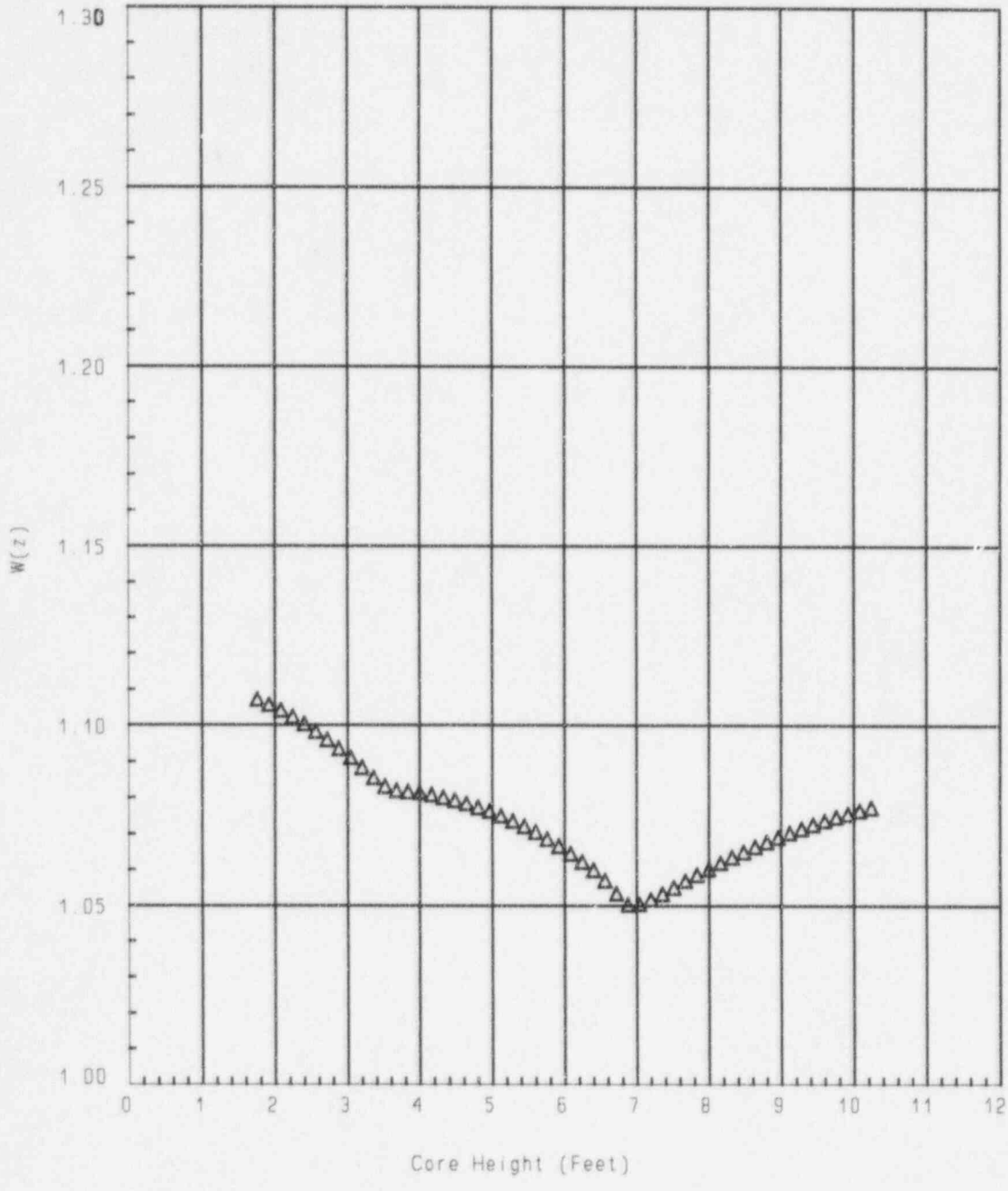


Table 5

Baseload W(Z) at 150 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.0644
0.16	1.0000	6.24	1.0621
0.32	1.0000	6.40	1.0598
0.48	1.0000	6.56	1.0569
0.64	1.0000	6.72	1.0533
0.80	1.0000	6.88	1.0502
0.96	1.0000	7.04	1.0503
1.12	1.0000	7.20	1.0516
1.28	1.0000	7.36	1.0531
1.44	1.0000	7.52	1.0550
1.60	1.0000	7.68	1.0568
1.76	1.1072	7.84	1.0585
1.92	1.1057	8.00	1.0602
2.08	1.1042	8.16	1.0619
2.24	1.1024	8.32	1.0634
2.40	1.1004	8.48	1.0649
2.56	1.0983	8.64	1.0663
2.72	1.0960	8.80	1.0677
2.88	1.0936	8.96	1.0690
3.04	1.0910	9.12	1.0702
3.20	1.0883	9.28	1.0714
3.36	1.0855	9.44	1.0725
3.52	1.0832	9.60	1.0736
3.68	1.0820	9.76	1.0746
3.84	1.0817	9.92	1.0755
4.00	1.0814	10.08	1.0764
4.16	1.0808	10.24	1.0773
4.32	1.0800	10.40	1.0000
4.48	1.0792	10.56	1.0000
4.64	1.0783	10.72	1.0000
4.80	1.0773	10.88	1.0000
4.96	1.0762	11.04	1.0000
5.12	1.0749	11.20	1.0000
5.28	1.0735	11.36	1.0000
5.44	1.0720	11.52	1.0000
5.60	1.0704	11.68	1.0000
5.76	1.0685	11.84	1.0000
5.92	1.0665	12.00	1.0000

Figure 10

Baseload W(Z) at 4,000 MWD/MTU

V. C. Summer - Cycle 10

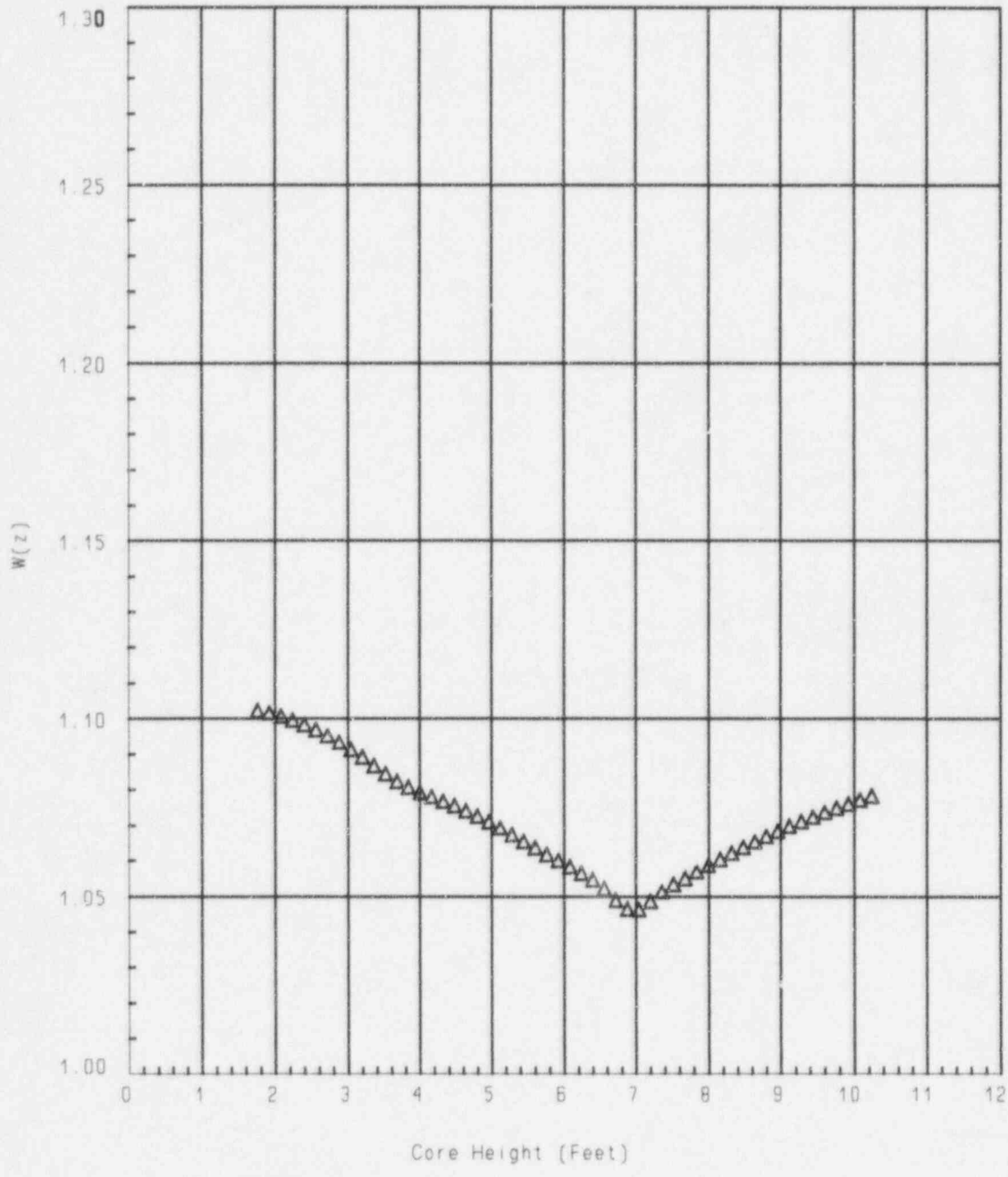


Table 6

Baseload W(Z) at 4,000 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.0582
0.16	1.0000	6.24	1.0564
0.32	1.0000	6.40	1.0546
0.48	1.0000	6.56	1.0522
0.64	1.0000	6.72	1.0490
0.80	1.0000	6.88	1.0464
0.96	1.0000	7.04	1.0463
1.12	1.0000	7.20	1.0486
1.28	1.0000	7.36	1.0513
1.44	1.0000	7.52	1.0533
1.60	1.0000	7.68	1.0550
1.76	1.1024	7.84	1.0568
1.92	1.1016	8.00	1.0587
2.08	1.1007	8.16	1.0604
2.24	1.0996	8.32	1.0621
2.40	1.0983	8.48	1.0637
2.56	1.0968	8.64	1.0653
2.72	1.0951	8.80	1.0668
2.88	1.0933	8.96	1.0683
3.04	1.0913	9.12	1.0697
3.20	1.0891	9.28	1.0710
3.36	1.0867	9.44	1.0723
3.52	1.0844	9.60	1.0736
3.68	1.0823	9.76	1.0748
3.84	1.0807	9.92	1.0760
4.00	1.0792	10.08	1.0771
4.16	1.0780	10.24	1.0782
4.32	1.0767	10.40	1.0000
4.48	1.0754	10.56	1.0000
4.64	1.0740	10.72	1.0000
4.80	1.0725	10.88	1.0000
4.96	1.0709	11.04	1.0000
5.12	1.0692	11.20	1.0000
5.28	1.0673	11.36	1.0000
5.44	1.0654	11.52	1.0000
5.60	1.0635	11.68	1.0000
5.76	1.0617	11.84	1.0000
5.92	1.0599	12.00	1.0000

Figure 11

Baseload W(Z) at 10,000 MWD/MTU

V. C. Summer - Cycle 10

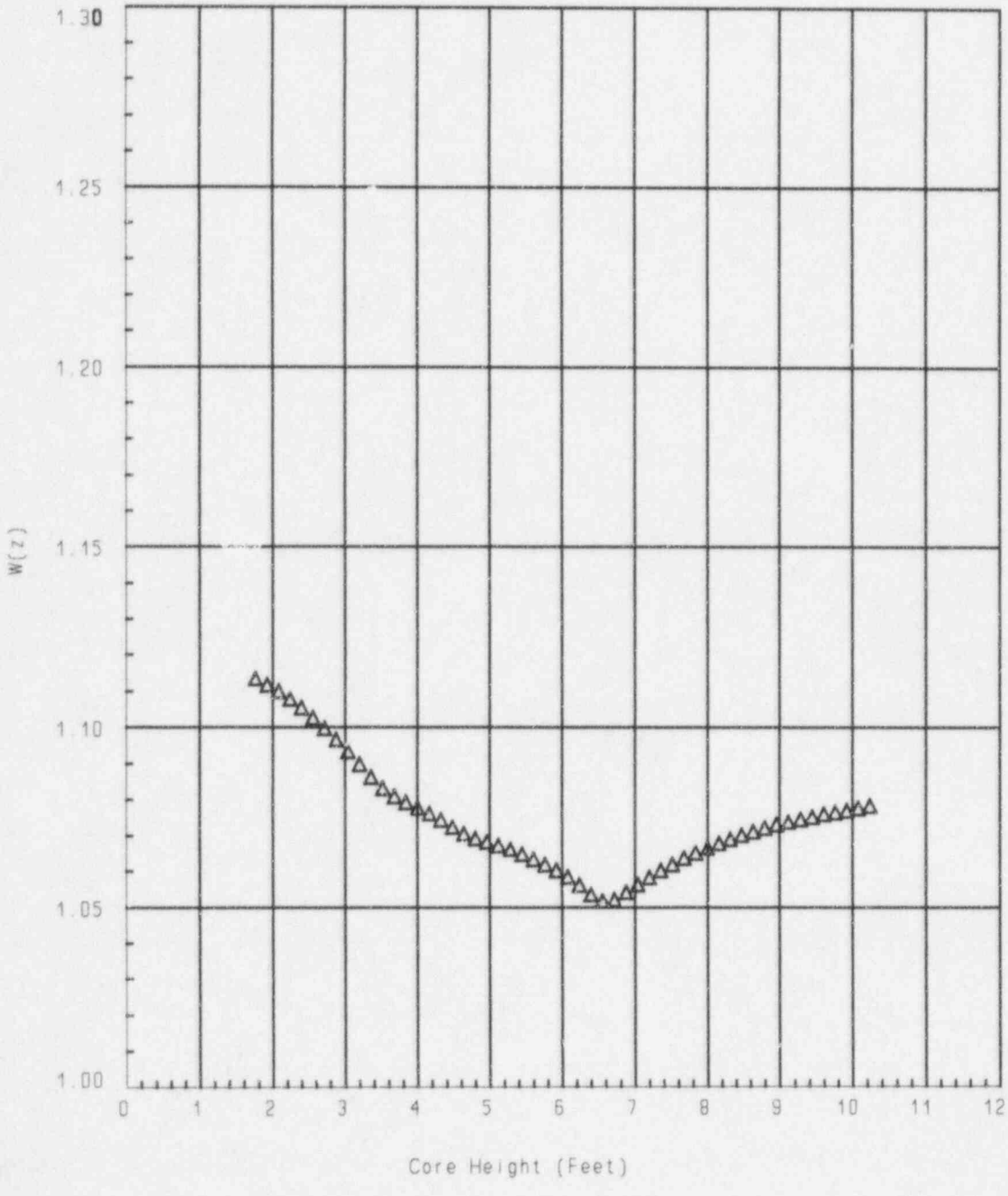


Table 7

Baseload W(Z) at 10,000 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.0584
0.16	1.0000	6.24	1.0561
0.32	1.0000	6.40	1.0534
0.48	1.0000	6.56	1.0516
0.64	1.0000	6.72	1.0521
0.80	1.0000	6.88	1.0541
0.96	1.0000	7.04	1.0562
1.12	1.0000	7.20	1.0582
1.28	1.0000	7.36	1.0601
1.44	1.0000	7.52	1.0618
1.60	1.0000	7.68	1.0635
1.76	1.1135	7.84	1.0650
1.92	1.1118	8.00	1.0664
2.08	1.1100	8.16	1.0678
2.24	1.1078	8.32	1.0690
2.40	1.1054	8.48	1.0701
2.56	1.1027	8.64	1.0711
2.72	1.0998	8.80	1.0721
2.88	1.0967	8.96	1.0730
3.04	1.0933	9.12	1.0738
3.20	1.0898	9.28	1.0745
3.36	1.0863	9.44	1.0752
3.52	1.0832	9.60	1.0759
3.68	1.0809	9.76	1.0764
3.84	1.0792	9.92	1.0770
4.00	1.0777	10.08	1.0776
4.16	1.0761	10.24	1.0782
4.32	1.0743	10.40	1.0000
4.48	1.0723	10.56	1.0000
4.64	1.0704	10.72	1.0000
4.80	1.0691	10.88	1.0000
4.96	1.0682	11.04	1.0000
5.12	1.0672	11.20	1.0000
5.28	1.0661	11.36	1.0000
5.44	1.0648	11.52	1.0000
5.60	1.0633	11.68	1.0000
5.76	1.0618	11.84	1.0000
5.92	1.0602	12.00	1.0000

Figure 12

Baseload W(Z) at 18,000 MWD/MTU

V. C. Summer - Cycle 10

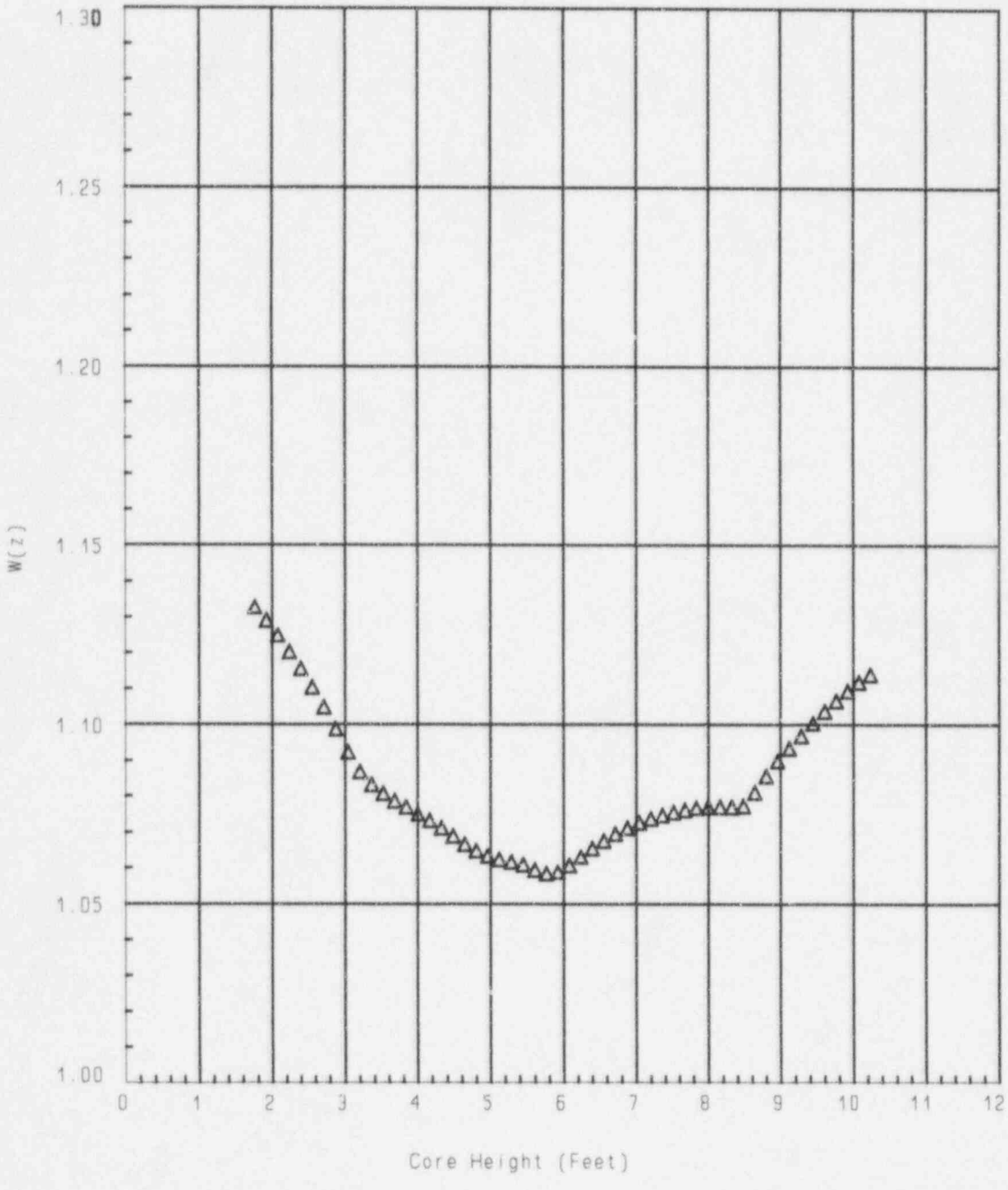


Table 8

Baseload W(Z) at 18,000 MWD/MTU

V. C. Summer - Cycle 10

Core Height (ft)	W(Z)	Core Height (ft)	W(Z)
0.00	1.0000	6.08	1.0607
0.16	1.0000	6.24	1.0630
0.32	1.0000	6.40	1.0654
0.48	1.0000	6.56	1.0675
0.64	1.0000	6.72	1.0694
0.80	1.0000	6.88	1.0710
0.96	1.0000	7.04	1.0725
1.12	1.0000	7.20	1.0737
1.28	1.0000	7.36	1.0747
1.44	1.0000	7.52	1.0754
1.60	1.0000	7.68	1.0761
1.76	1.1327	7.84	1.0767
1.92	1.1290	8.00	1.0770
2.08	1.1249	8.16	1.0769
2.24	1.1203	8.32	1.0769
2.40	1.1155	8.48	1.0773
2.56	1.1103	8.64	1.0810
2.72	1.1048	8.80	1.0856
2.88	1.0987	8.96	1.0898
3.04	1.0922	9.12	1.0934
3.20	1.0867	9.28	1.0969
3.36	1.0831	9.44	1.1003
3.52	1.0806	9.60	1.1036
3.68	1.0786	9.76	1.1066
3.84	1.0769	9.92	1.1093
4.00	1.0750	10.08	1.1118
4.16	1.0731	10.24	1.1140
4.32	1.0710	10.40	1.0000
4.48	1.0687	10.56	1.0000
4.64	1.0665	10.72	1.0000
4.80	1.0647	10.88	1.0000
4.96	1.0632	11.04	1.0000
5.12	1.0623	11.20	1.0000
5.28	1.0617	11.36	1.0000
5.44	1.0608	11.52	1.0000
5.60	1.0594	11.68	1.0000
5.76	1.0583	11.84	1.0000
5.92	1.0588	12.00	1.0000

2.6 RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor - $F^{N}_{\Delta H}$ (Specification 3.2.3):

$$R = \frac{F^{N}_{\Delta H}}{F^{RTP}_{\Delta H} * (1 + PF_{\Delta H} * (1-P))}$$

$$Where: P = \frac{Thermal\ Power}{Rated\ Thermal\ Power}$$

2.6.1 $F_{\Delta H}^{RTP} = 1.56$

2.6.2 $PF_{\Delta H} = 0.3$

2.6.3 The Acceptable Operation Region from the combination of Reactor Coolant System total flow and R is provided in Figure 13.

Figure 13

RCS Total Flow Rate vs. Three Loop Operation

V. C. Summer - Cycle 10

Measurement Uncertainties of 2.1% for Flow (includes 0.1% for feedwater venturi fouling) and 4.0% for Incore Measurement of $F^N_{\Delta H}$ are included in this figure.