Callaway Cycle 6

Core Operating Limits Report

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1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Callaway Plant Cycle 6 has been prepared in accordance with the requirements of Technical Specification 6.9.1.9.

The Core Operating Limits affecting the following Technical Specifications are included in this report.

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	Nuclear Enthalpy Rise Hot Channel Factor
3.9.1	Refueling Boron Concentration

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 6.9.1.9.

2.1 Moderator Temperature Coefficient
(Specification 3.1.1.3)

2.1.1 The Moderator Temperature Coefficient shall be less positive than the limits shown in Figure 1. These limits shall be referred to as the Beginning of Cycle Life (BOL) Limit.

The Moderator Temperature Coefficient shall be less negative than -41 pcm/°F. This limit shall be referred to as the End of Cycle Life (EOL) Limit.

2.1.2 The MTC 300 ppm surveillance limit is -32 pcm/°F (all rods withdrawn, Rated Thermal Power condition).

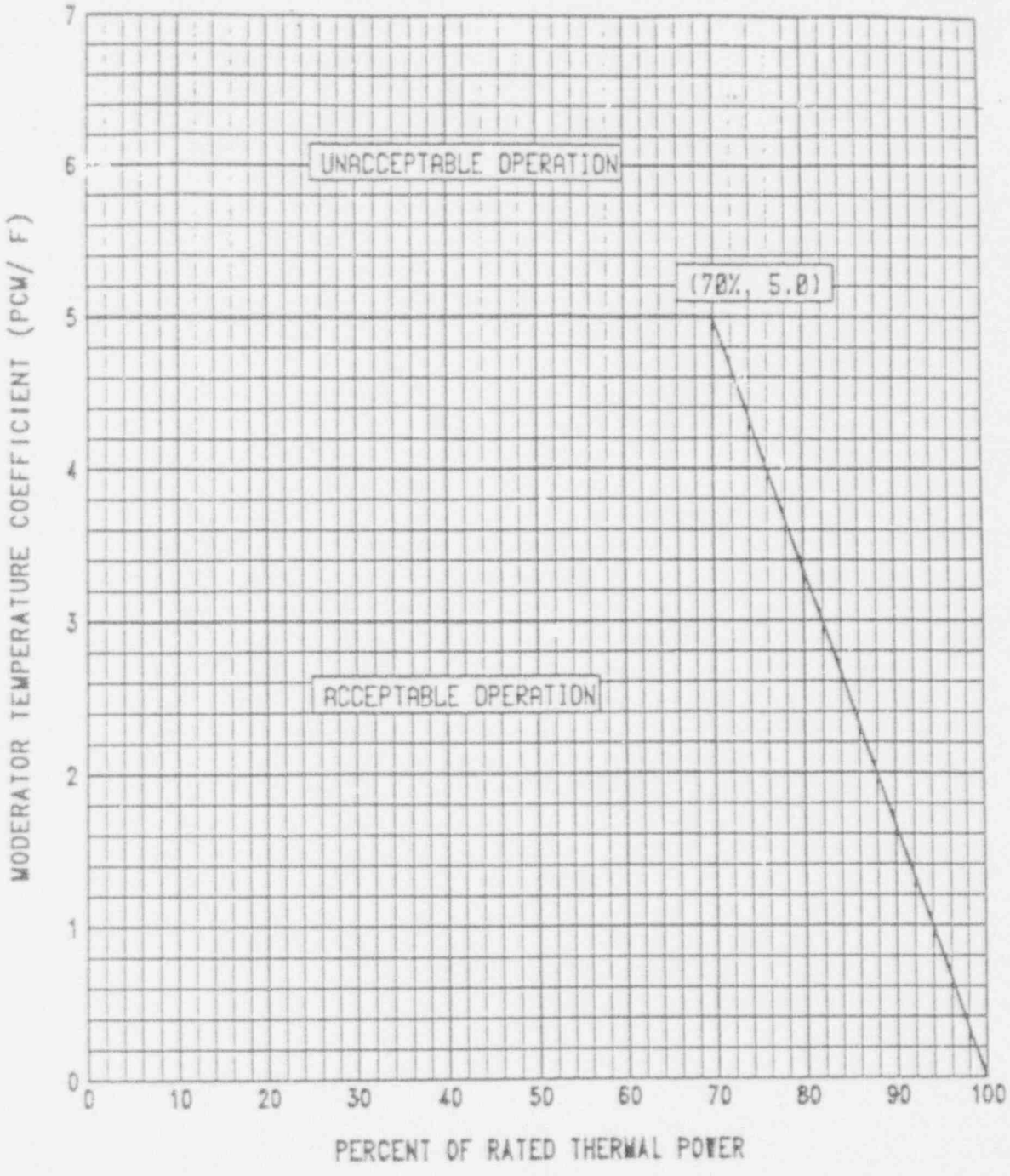

FIGURE 1

CALLAWAY UNIT 1 CYCLE 6

MODERATOR TEMPERATURE COEFFICIENT VS POWER LEVEL

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The shutdown rods shall be withdrawn to at least 225 steps.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

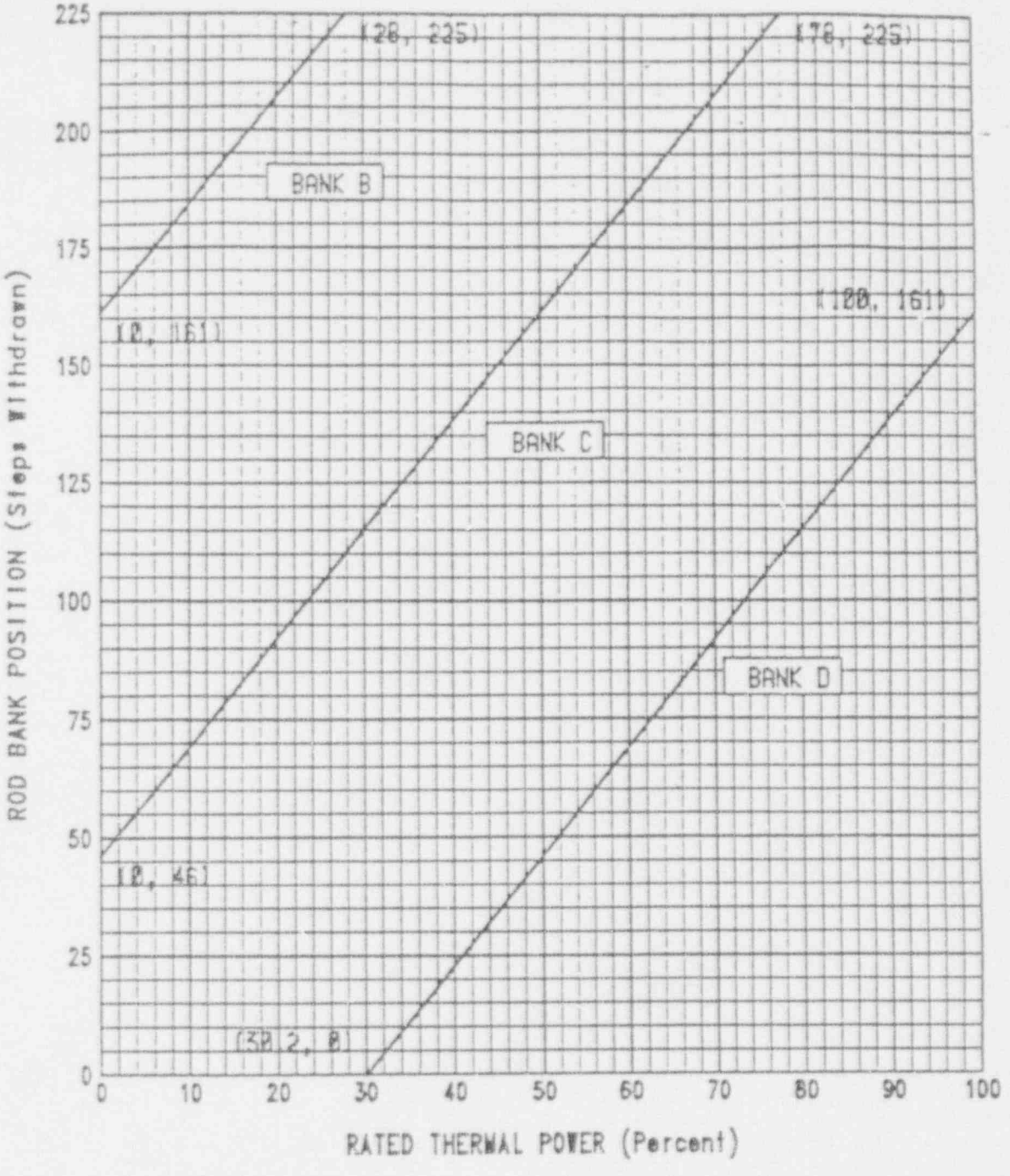

FIGURE 2

CALLAWAY UNIT 1 CYCLE 6

ROD BANK INSERTION LIMITS VERSUS

RATED THERMAL POWER - FOUR LOOP OPERATION

2.4 Axial Flux Difference (Specification 3.2.1)

2.4.1 The Axial Flux Difference (AFD) Limits are provided in Figure 3.

2.4.2 The target band during Restricted AFD Operation is $\pm 3\%$. The AFD limits provided in Figure 3 also remain applicable during Restricted AFD Operation.

2.4.3 The minimum allowable power level for Restricted AFD Operation, APL^{ND}, is 90% of RATED THERMAL POWER.

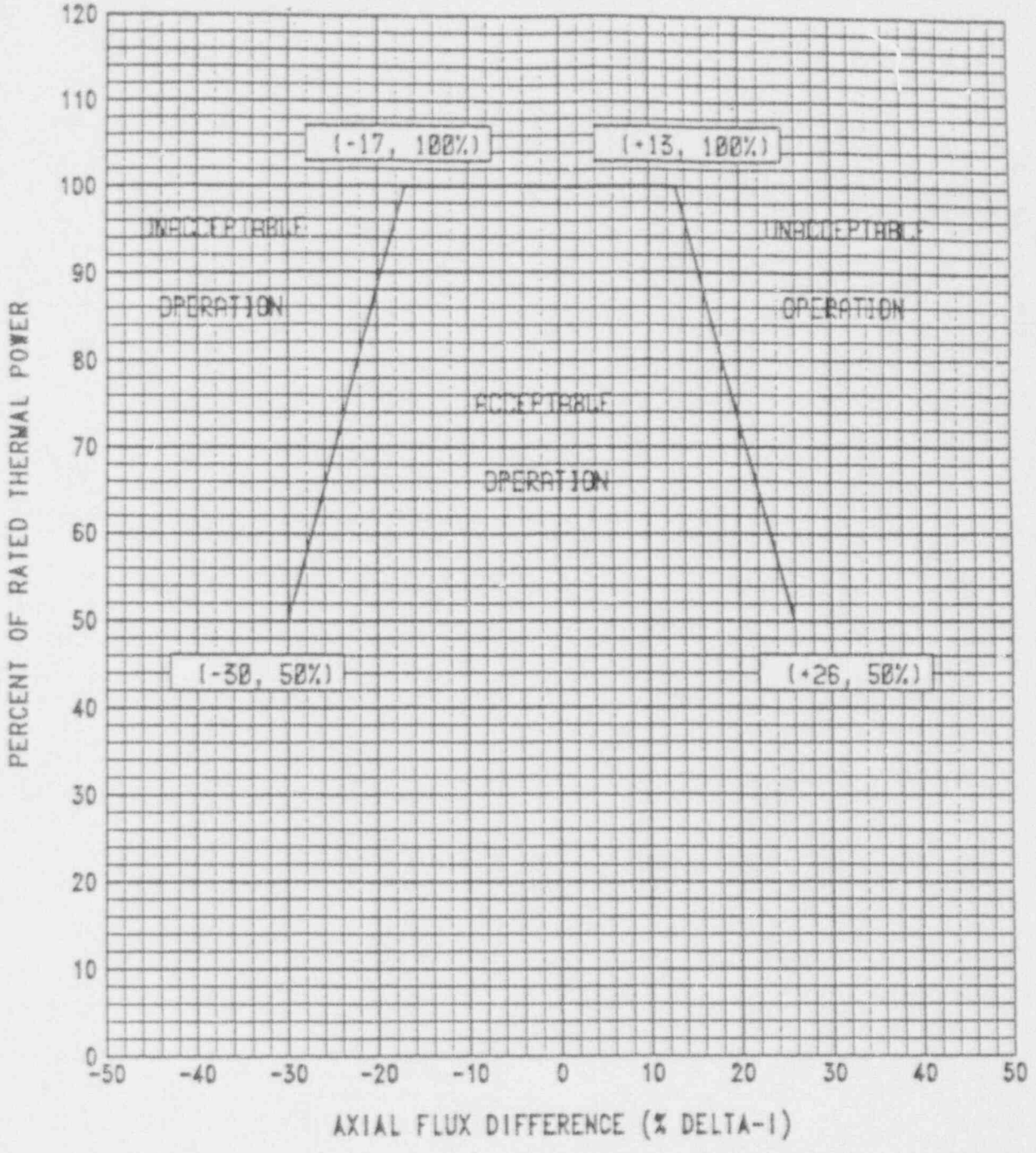

FIGURE 3

CALLAWAY UNIT 1 CYCLE 6

AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF

RATED THERMAL POWER FOR RAOC

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

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

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

where: $$P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

2.5.1 $F_Q^{RTP} = 2.50$

2.5.2 K(Z) is provided in Figure 4.

2.5.3 The W(z) functions that are to be used in Technical Specifications 4.2.2.2, 4.2.2.3, and 4.2.2.4 for F_Q surveillance are shown in Figures 5 through 13.

The Normal Operation W(z) values have been determined for several burnups up to 16000 MWD/MTU in Cycle 6. This permits determination of W(z) at any cycle burnup up to 16000 MWD/MTU through the use of three point interpolation. For cycle burnups greater than 16000 MWD/MTU, use of the 16000 MWD/MTU W(z) values without interpolation or extrapolation is conservative. The $W(z)_{NO}$ values were determined assuming Cycle 6 operates with the RAOC strategy. Also included is a $W(z)_{NO}$ function that bounds the $W(z)_{NO}$ curve for all Cycle 6 burnups. Use of the bounding $W(z)_{NO}$ curve will be conservative for any Cycle 6 burnup; however, additional margin may be gained by using the burnup dependent $W(z)_{NO}$ values. The $W(z)_{NO}$ values may be optionally adjusted using the multipliers provided in Tables 1 through 3.

The Restricted AFD Operation W(z) values, $W(z)_{RAFDO}$, have been determined for several burnups up to 18000 MWD/MTU in Cycle 6. This permits determination of W(z) at any cycle burnup up to 18000 MWD/MTU through the use of 3 point interpolation. For cycle burnups greater than 18000 MWD/MTU, use of the 18000 MWD/MTU W(z) values without interpolation or extrapolation is conservative.

The W(z) values are provided for 73 axial points assuming the core height boundaries of 0 and 12 feet and intervals of .167 feet between the core boundaries.

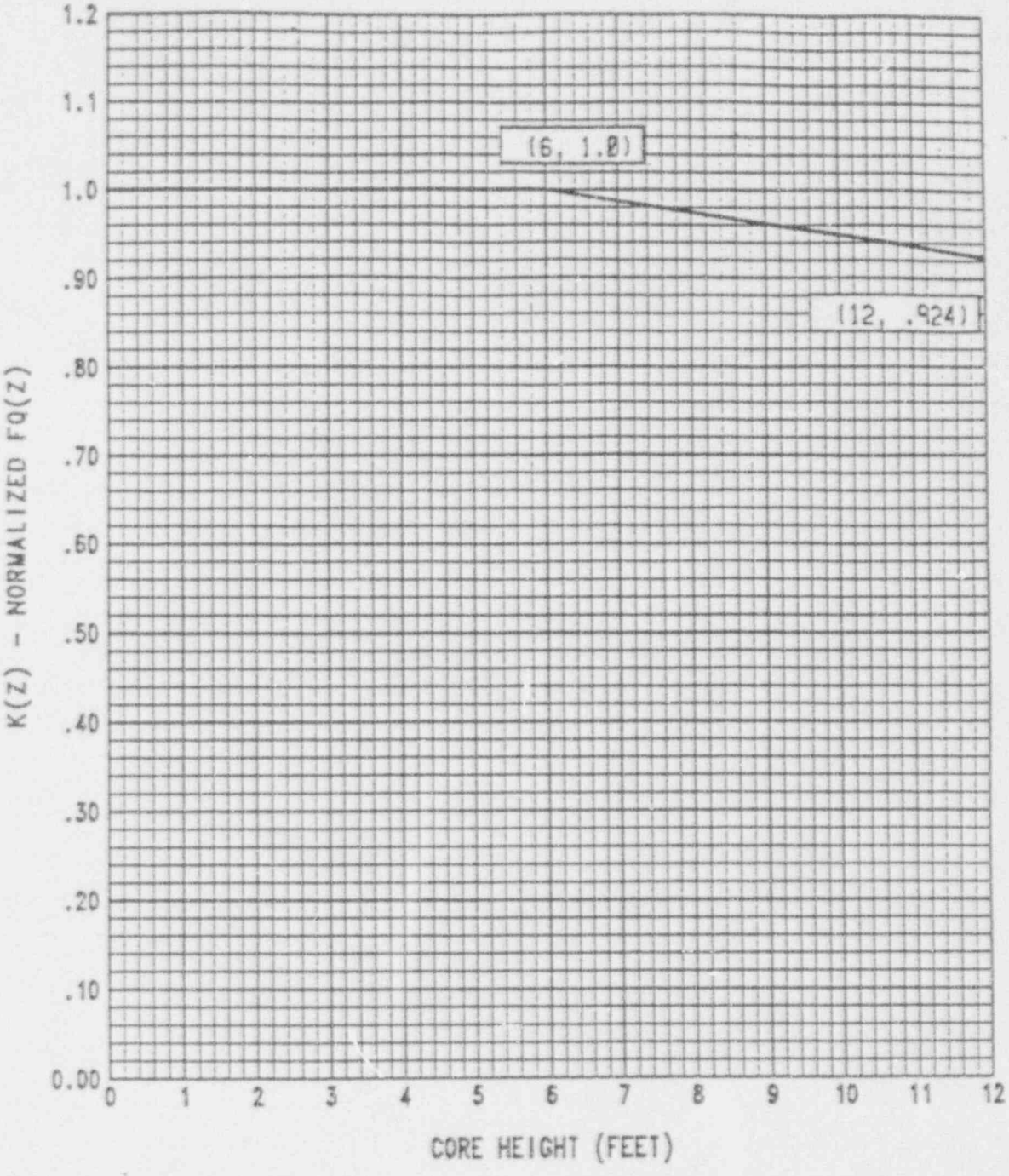

FIGURE 4

CALLAWAY UNIT 1 CYCLE 6

K(Z) - NORMALIZED FQ(Z) AS A FUNCTION OF CORE HEIGHT

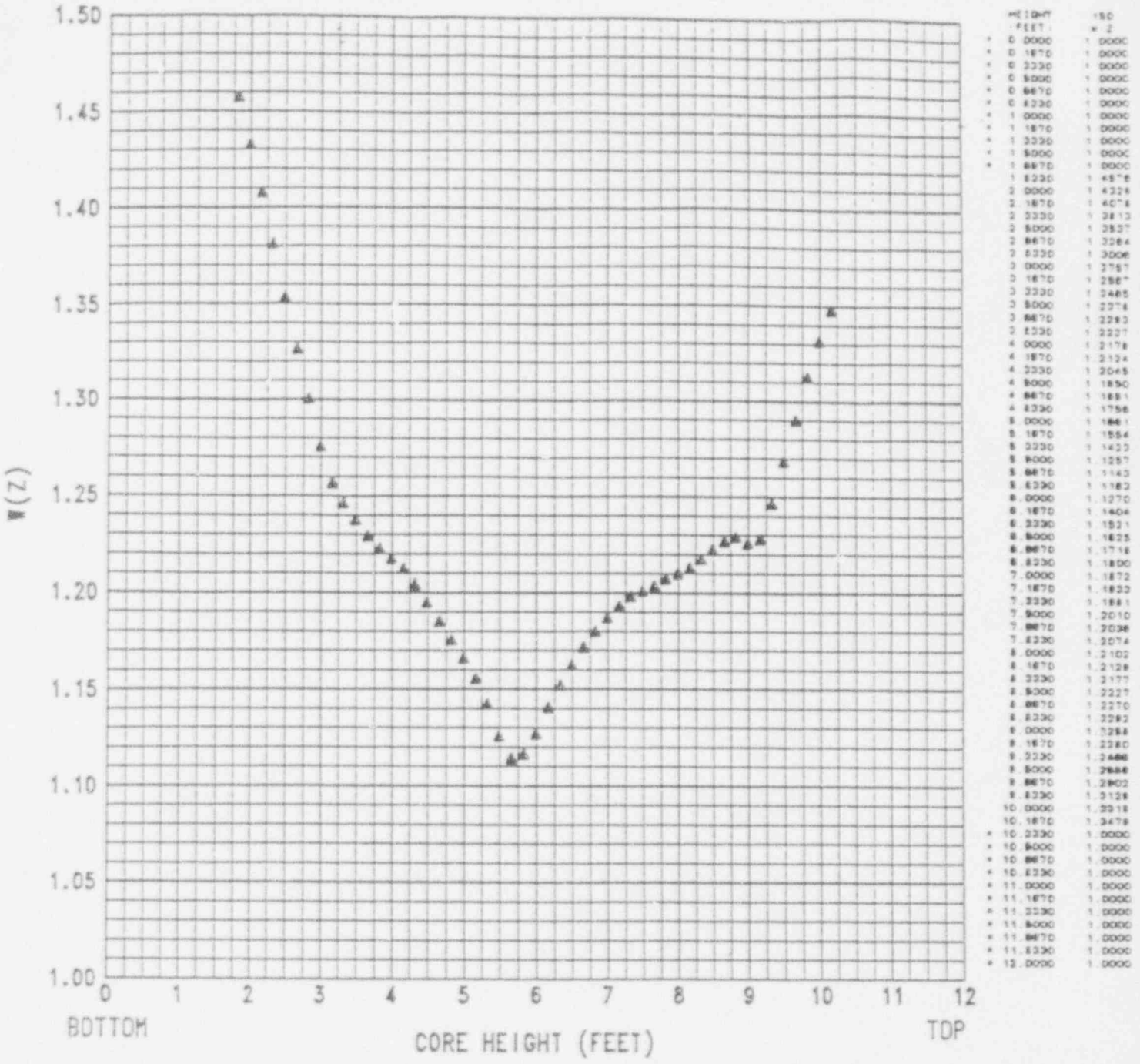

FIGURE 5

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{NO}$ AT 150 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

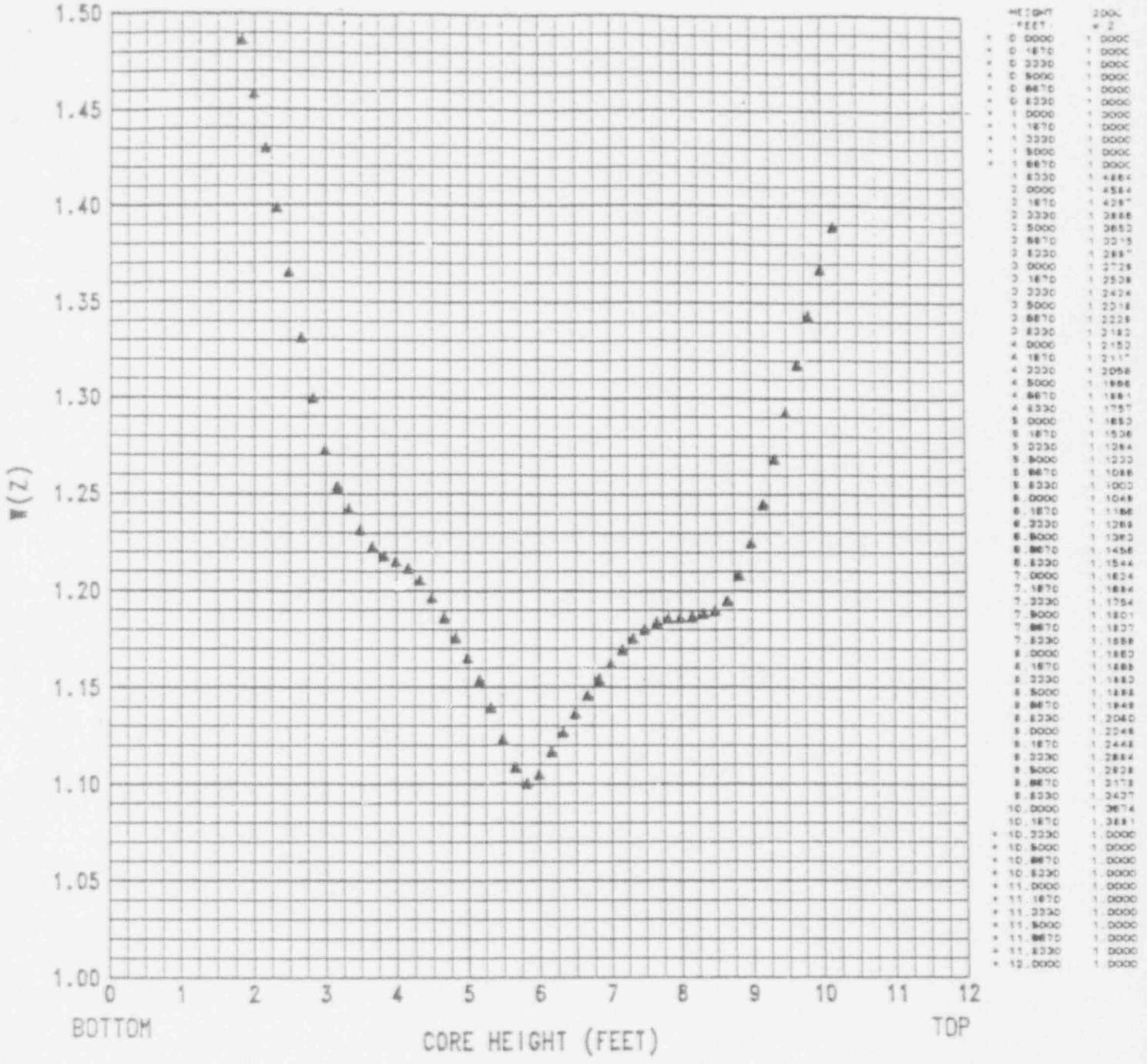

FIGURE 6

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{NO}$ AT 2000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

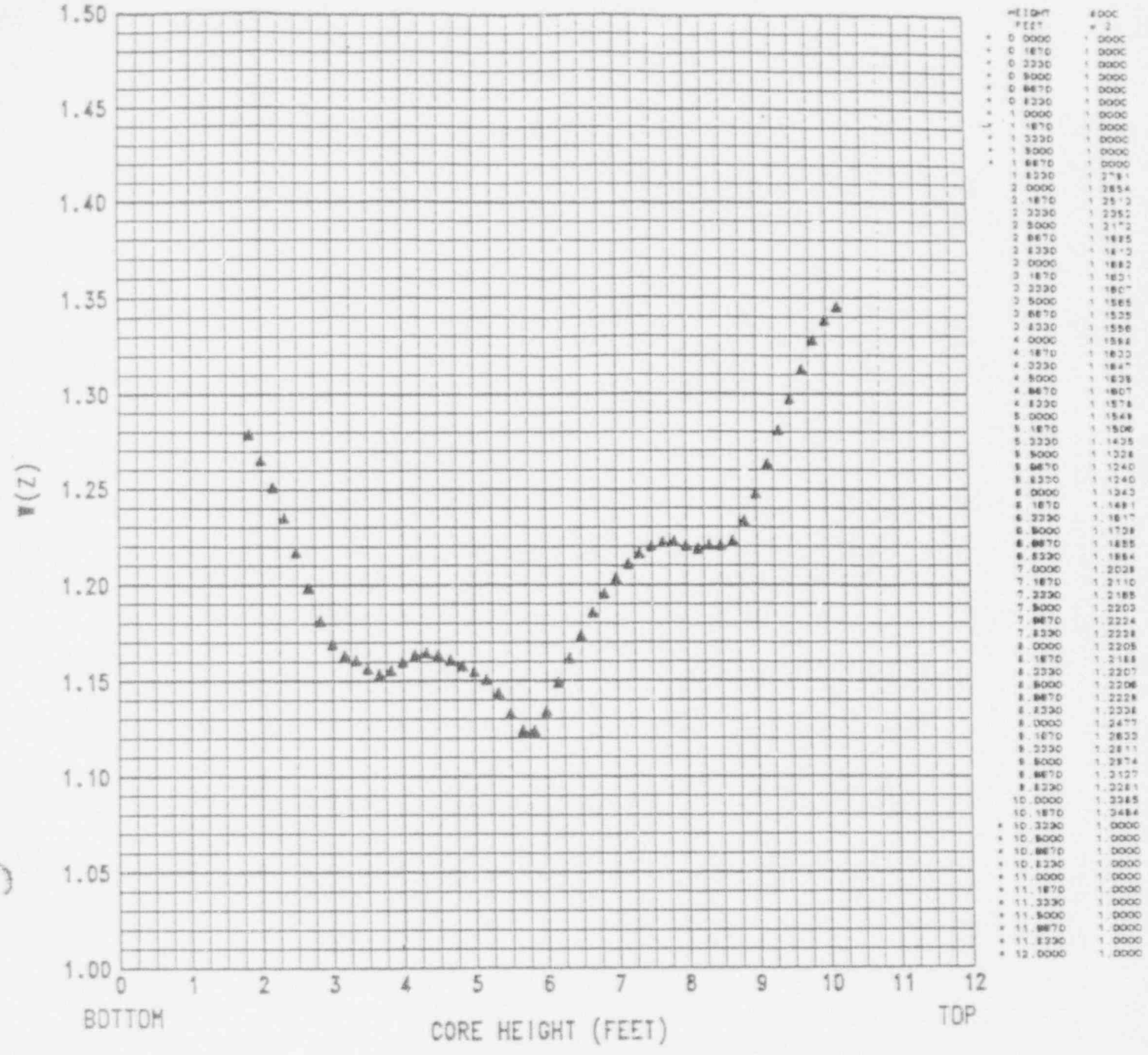

FIGURE 7

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{NO}$ AT 8000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

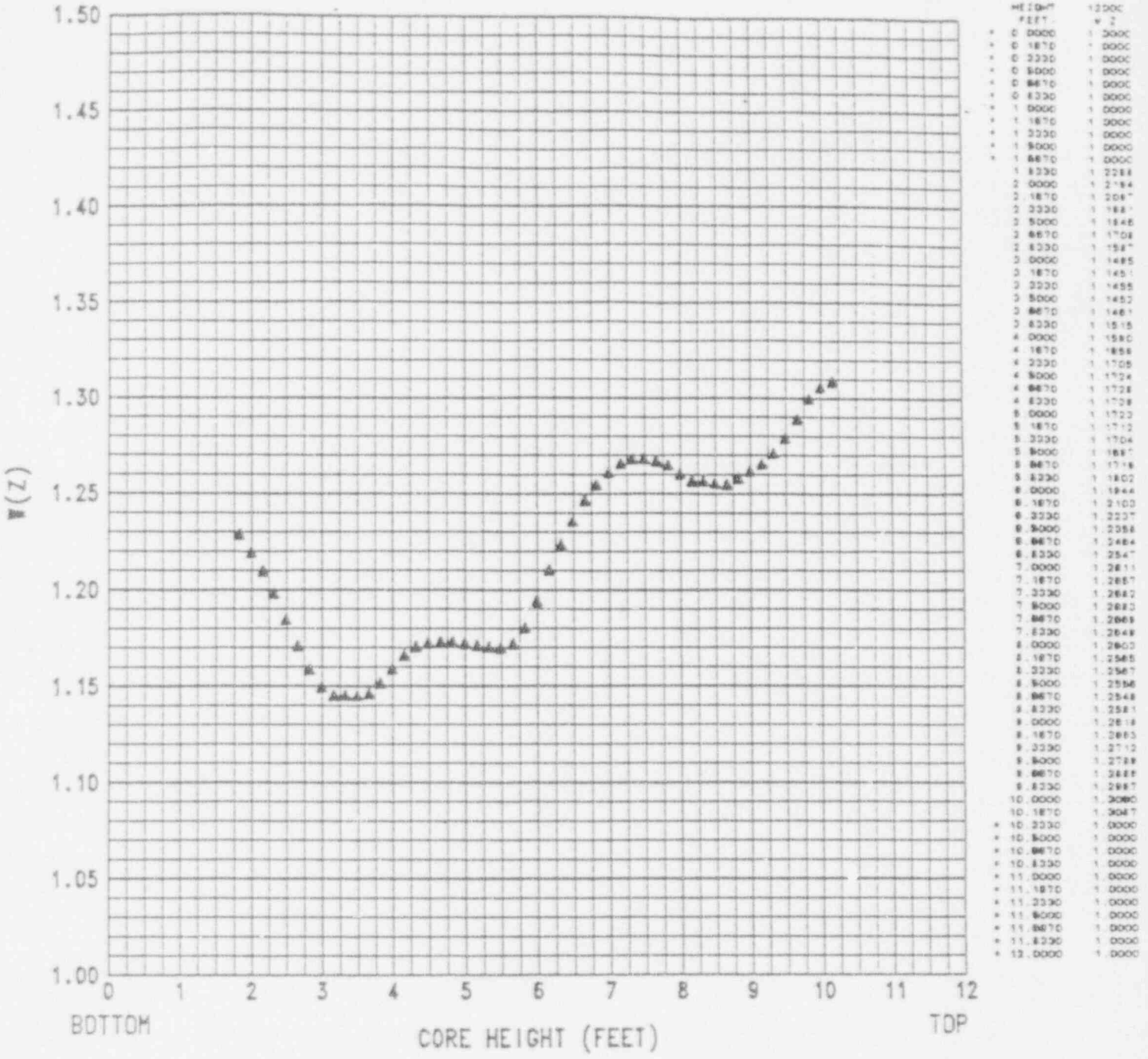

FIGURE 8

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{NO}$ AT 12000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

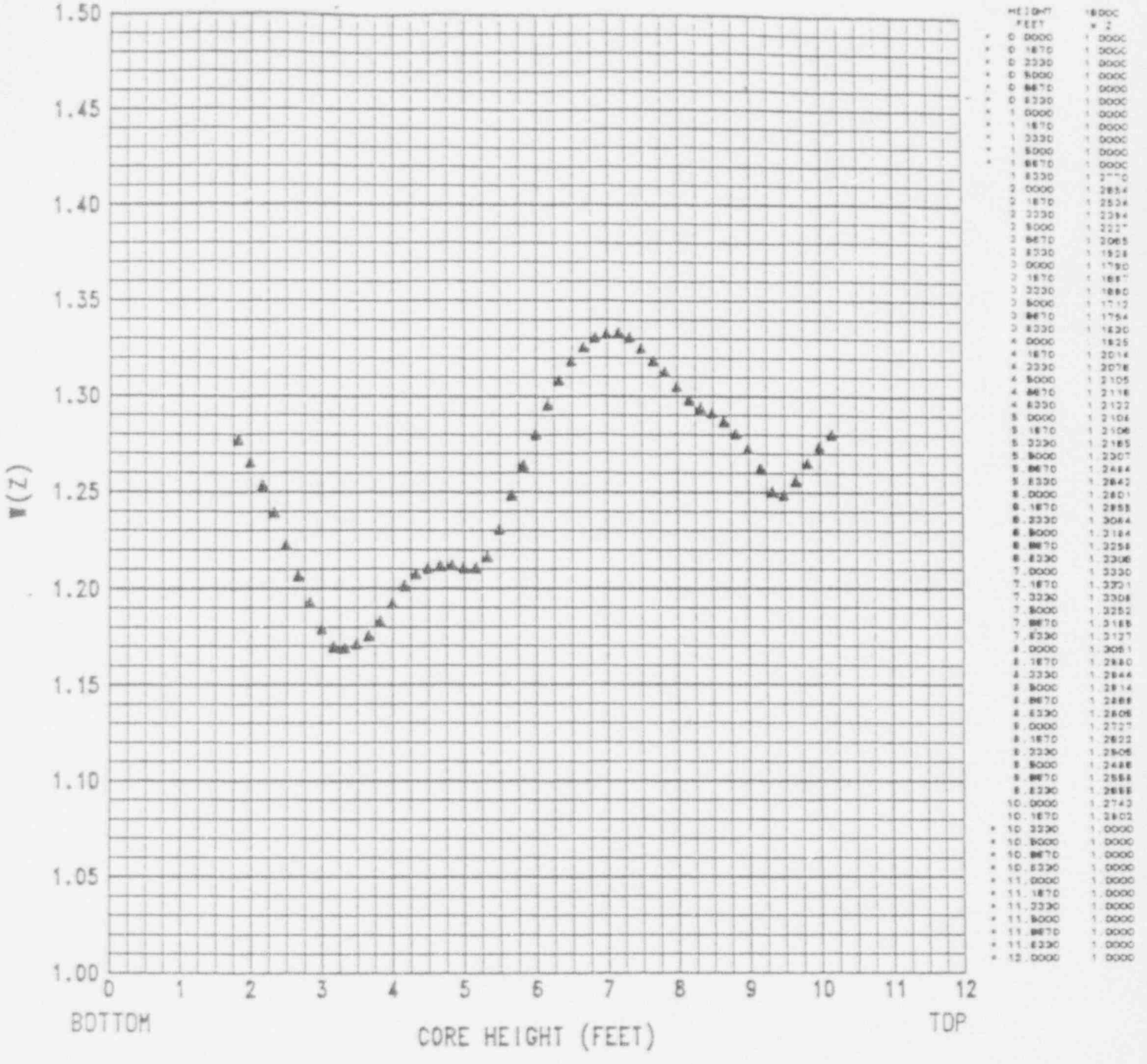

FIGURE 9

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{NO}$ AT 16000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

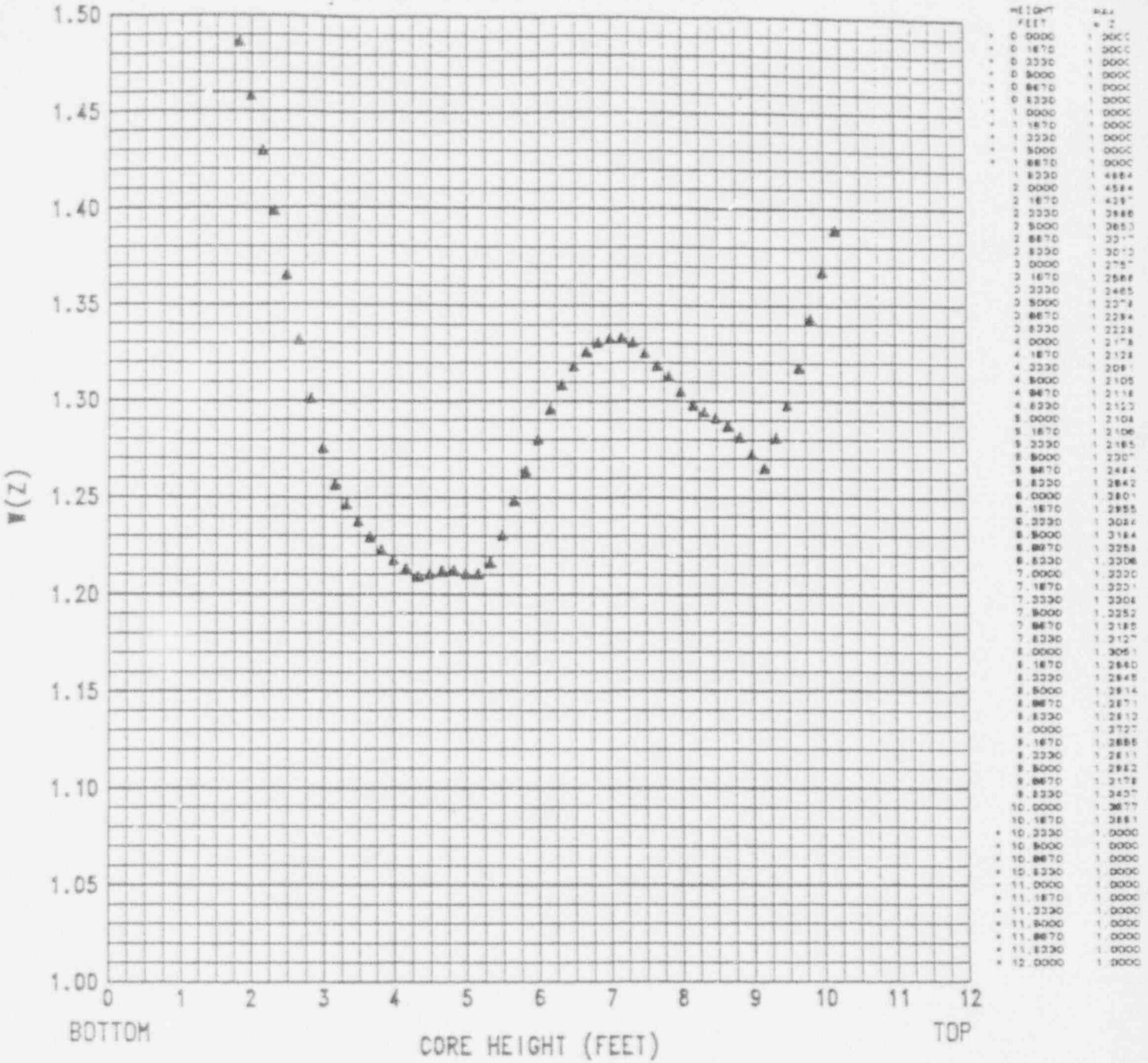

FIGURE 10

CALLAWAY UNIT 1 CYCLE 6

BOUNDING $W(Z)_{NO}$ FOR CYCLE 6

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

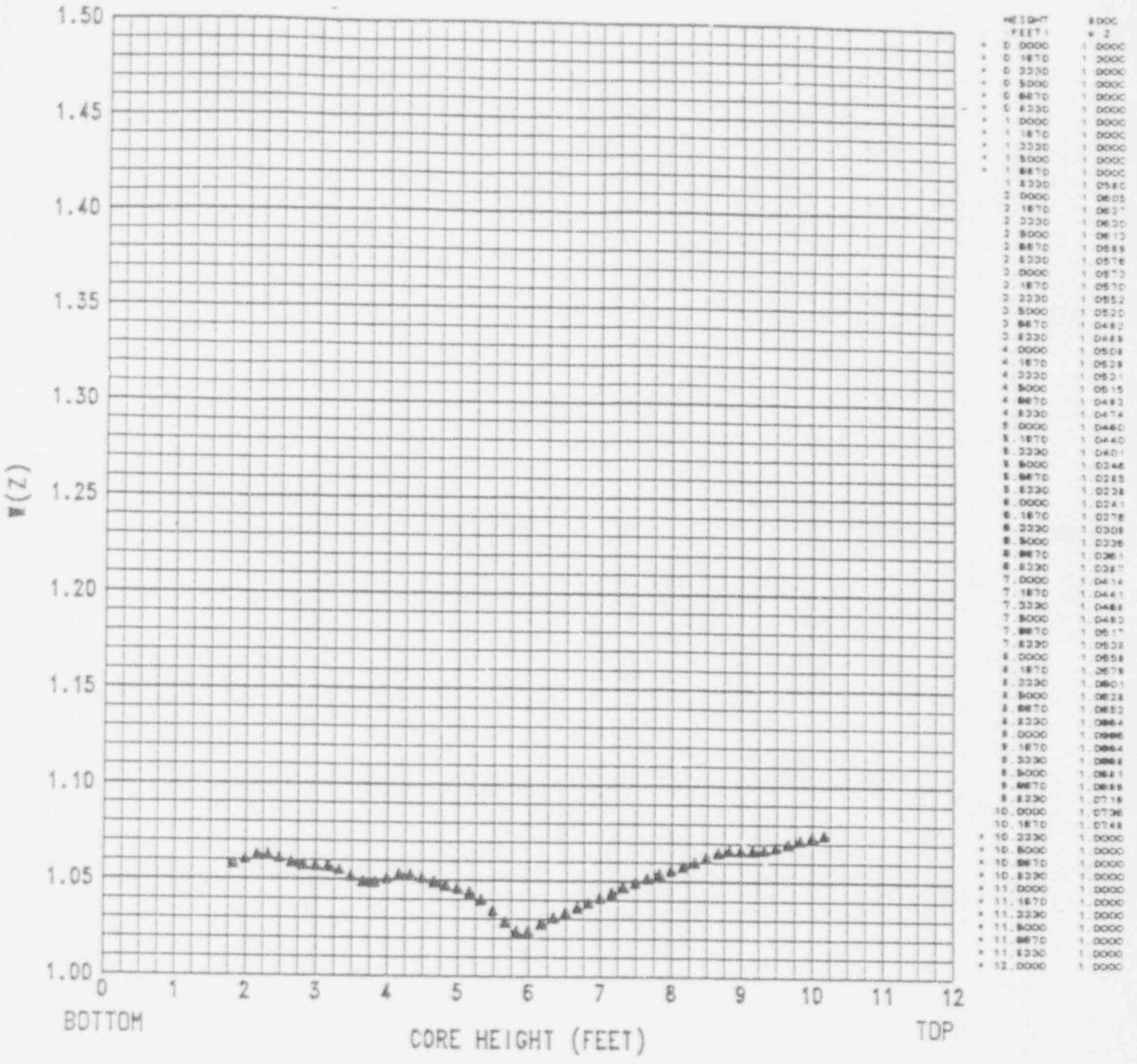

FIGURE 11

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{RAFDO}$ AT 8000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

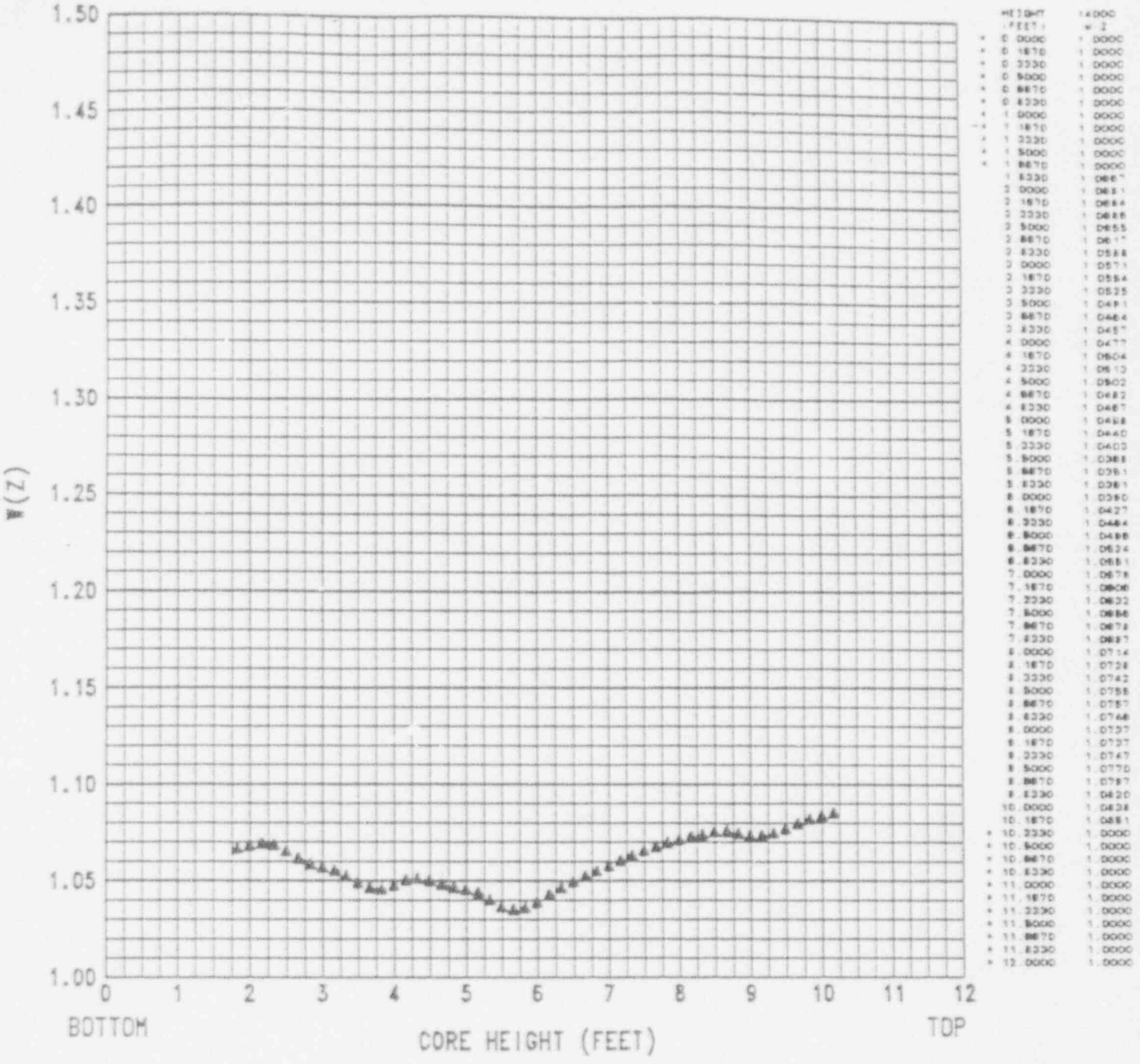

FIGURE 12

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{RAFDC}$ AT 14000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

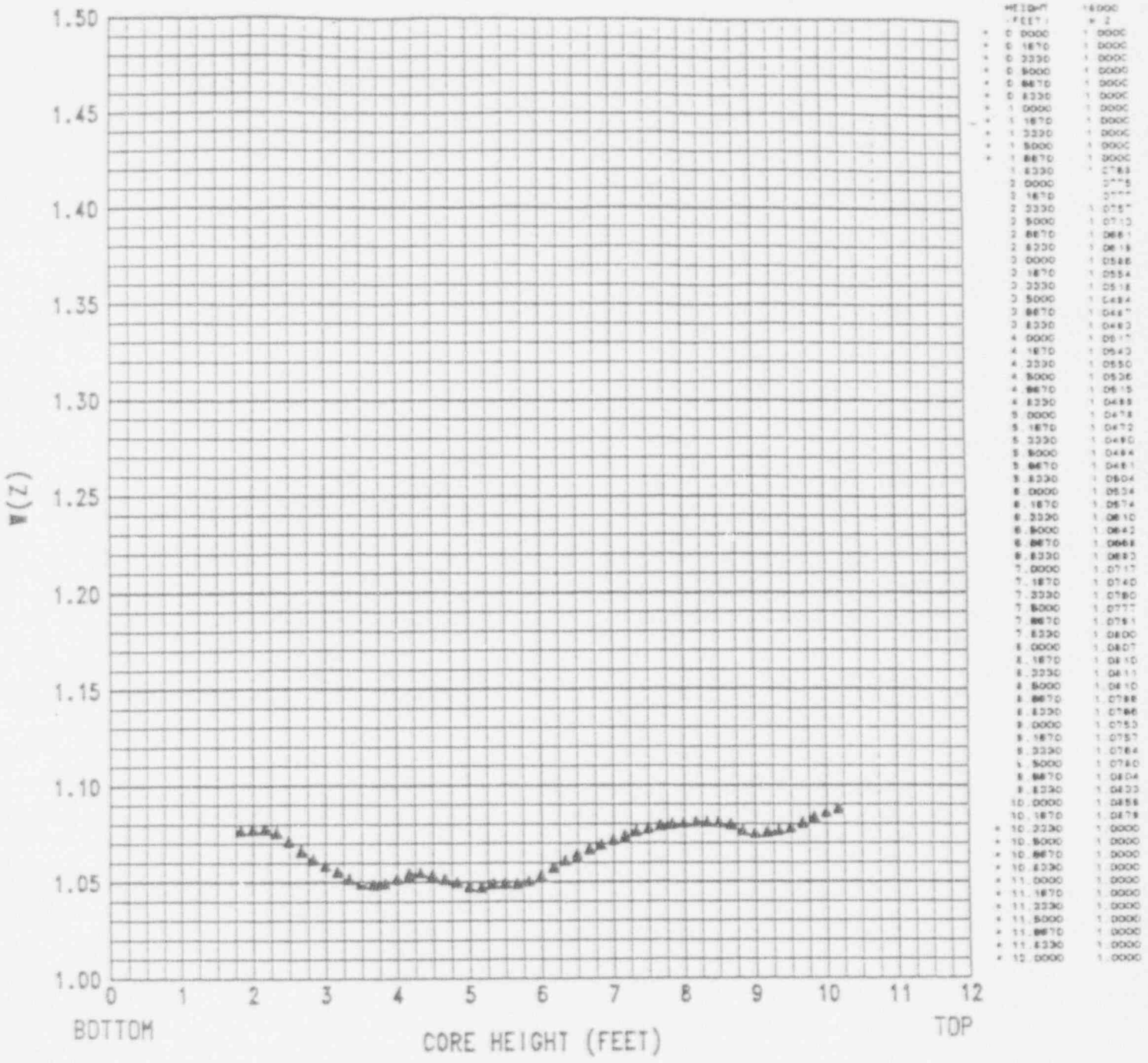

FIGURE 13

CALLAWAY UNIT 1 CYCLE 6

$W(Z)_{RAJPDO}$ AT 18000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}^{N}$
(Specification 3.2.3)

$$F_{\Delta H}^{N} \leq F_{\Delta H}^{RTP} [1 + PF_{\Delta H}(1-P)]$$

where: $$P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

2.6.1 $F_{\Delta H}^{RTP} = 1.59$

2.6.2 $PF_{\Delta H} = 0.3$

2.7 Refueling Boron Concentration
(Specification 3.9.1)

2.7.1 The refueling boron concentration to maintain $K_{eff} \leq 0.95$ shall be $\geq$ 2000 ppm.

TABLE 1

Height (Feet)	8000 BU (Mult)	Height (Feet)	8000 BU (Mult)
0.000	1.0000	6.167	0.9889
0.167	1.0000	6.333	0.9970
0.333	1.0000	6.500	1.0057
0.500	1.0000	6.667	1.0150
0.667	1.0000	6.833	1.0247
0.833	1.0000	7.000	1.0347
1.000	1.0000	7.167	1.0448
1.167	1.0000	7.333	1.0550
1.333	1.0000	7.500	1.0650
1.500	1.0000	7.667	1.0746
1.667	1.0000	7.833	1.0836
1.833	0.9103	8.000	1.0919
2.000	0.9109	8.167	1.0994
2.167	0.9117	8.333	1.1058
2.333	0.9127	8.500	1.1113
2.500	0.9139	8.667	1.1158
2.667	0.9153	8.833	1.1196
2.833	0.9170	9.000	1.1228
3.000	0.9188	9.167	1.1256
3.167	0.9208	9.333	1.1282
3.333	0.9229	9.500	1.1309
3.500	0.9250	9.667	1.1336
3.667	0.9273	9.833	1.1363
3.833	0.9295	10.000	1.1389
4.000	0.9318	10.167	1.1411
4.167	0.9342	10.333	1.0000
4.333	0.9367	10.500	1.0000
4.500	0.9393	10.667	1.0000
4.667	0.9422	10.833	1.0000
4.833	0.9454	11.000	1.0000
5.000	0.9490	11.167	1.0000
5.167	0.9530	11.333	1.0000
5.333	0.9574	11.500	1.0000
5.500	0.9625	11.667	1.0000
5.667	0.9682	11.833	1.0000
5.833	0.9744	12.000	1.0000
6.000	0.9813		

Note: The above multipliers are only applicable to $W(z)_{NO}$ for indicated core **AXIAL OFFSET** in the range of -10 to -14 percent.

TABLE 2

Height (Feet)	12000 BU (Mult)	Height (Feet)	12000 BU (Mult)
0.000	1.0000	6.167	0.9666
0.167	1.0000	6.333	0.9770
0.333	1.0000	6.500	0.9884
0.500	1.0000	6.667	1.0007
0.667	1.0000	6.833	1.0136
0.833	1.0000	7.000	1.0273
1.000	1.0000	7.167	1.0416
1.167	1.0000	7.333	1.0561
1.333	1.0000	7.500	1.0707
1.500	1.0000	7.667	1.0852
1.667	1.0000	7.833	1.0989
1.833	0.9055	8.000	1.1117
2.000	0.9052	8.167	1.1230
2.167	0.9051	8.333	1.1324
2.333	0.9055	8.500	1.1400
2.500	0.9064	8.667	1.1455
2.667	0.9079	8.833	1.1492
2.833	0.9097	9.000	1.1516
3.000	0.9118	9.167	1.1532
3.167	0.9139	9.333	1.1546
3.333	0.9158	9.500	1.1566
3.500	0.9174	9.667	1.1596
3.667	0.9186	9.833	1.1637
3.833	0.9194	10.000	1.1687
4.000	0.9198	10.167	1.1737
4.167	0.9199	10.333	1.0000
4.333	0.9199	10.500	1.0000
4.500	0.9200	10.667	1.0000
4.667	0.9205	10.833	1.0000
4.833	0.9216	11.000	1.0000
5.000	0.9235	11.167	1.0000
5.167	0.9263	11.333	1.0000
5.333	0.9301	11.500	1.0000
5.500	0.9352	11.667	1.0000
5.667	0.9414	11.833	1.0000
5.833	0.9487	12.000	1.0000
6.000	0.9571		

Note: The above multipliers are only applicable to $W(z)_{NO}$ for indicated core **AXIAL OFFSET** in the range of -10 to -14 percent.

TABLE 3

Height (Feet)	16000 BU (Mult)	Height (Feet)	16000 BU (Mult)
0.000	1.0000	6.167	0.9529
0.167	1.0000	6.333	0.9637
0.333	1.0000	6.500	0.9758
0.500	1.0000	6.667	0.9890
0.667	1.0000	6.833	1.0032
0.833	1.0000	7.000	1.0185
1.000	1.0000	7.167	1.0347
1.167	1.0000	7.333	1.0514
1.333	1.0000	7.500	1.0686
1.500	1.0000	7.667	1.0856
1.667	1.0000	7.833	1.1018
1.833	0.9158	8.000	1.1167
2.000	0.9143	8.167	1.1296
2.167	0.9132	8.333	1.1398
2.333	0.9127	8.500	1.1472
2.500	0.9129	8.667	1.1517
2.667	0.9139	8.833	1.1534
2.833	0.9154	9.000	1.1531
3.000	0.9173	9.167	1.1518
3.167	0.9191	9.333	1.1506
3.333	0.9207	9.500	1.1506
3.500	0.9218	9.667	1 1526
3.667	0.9222	9.833	1.1569
3.833	0.9219	10.000	1.1632
4.000	0.9209	10.167	1.1703
4.167	0.9193	10.333	1.0000
4.333	0.9175	10.500	1.0000
4.500	0.9158	10.667	1.0000
4.667	0.9143	10.833	1.0000
4.833	0.9136	11.000	1.0000
5.000	0.9138	11.167	1.0000
5.167	0.9152	11.333	1.0000
5.333	0.9180	11.500	1.0000
5.500	0.9221	11.667	1.0000
5.667	0.9278	11.833	1.0000
5.833	0.9348	12.000	1.0000
6.000	0.9432		

Note: The above multipliers are only applicable to $W(z)_{NO}$ for indicated core **AXIAL OFFSET** in the range of -10 to -14 percent.