AmerenUE
Callaway Plant

PO Box 620
Fulton, MO 65251

May 24, 2004

U.S. Nuclear Regulatory Commission
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Ladies and Gentlemen: ULNRC-05009

CALLAWAY PLANT
DOCKET NUMBER 50-483
CORE OPERATING LIMITS REPORT
Reference: ULNRC-05007, dated May 14, 2004

Attached is the Callaway Plant Cycle 14 Core Operating Limits Report (COLR), Revision 2. COLR, Revision 1, transmitted via the referenced letter, has been modified to accommodate NSAL-02-14. Changes are indicated by the use of revision bars. This report is provided to the NRC Staff for information. It has been prepared in accordance with the requirements of Technical Specification 5.6.5.

If you have any questions concerning this report, please contact us.

Sincerely,

Keith D. Young
Manager, Regulatory Affairs

DJW/jdg

Attachment: Callaway Cycle 14 Core Operating Limits Report, Rev. 2

A001

cc: U.S. Nuclear Regulatory Commission (Original and 1 copy)
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CALLAWAY CYCLE 14

CORE OPERATING LIMITS REPORT

(Revision 2)

May 2004

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Callaway Plant Cycle 14 has been prepared in accordance with the requirements of Technical Specification 5.6.5.

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

3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.1.8	Shutdown Margin
3.1.3	Moderator Temperature Coefficient
3.1.5	Shutdown Bank Insertion Limits
3.1.6	Control Bank Insertion Limits
3.2.1	Heat Flux Hot Channel Factor
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor
3.2.3	Axial Flux Difference

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 5.6.5.

2.1 Shutdown Margin
(Specifications 3.1.1, 3.1.4, 3.1.5, 3.1.6, and 3.1.8)

2.1.1 The Shutdown Margin in MODES 1-4 shall be greater than or equal to 1.3% Δk/k.

2.1.2 The Shutdown Margin prior to blocking Safety Injection below P-11 in MODES 3 and 4 shall be greater than 0% Δk/k as calculated at 200°F.

2.1.3 The Shutdown Margin in MODE 5 shall be greater than or equal to 1.0% Δk/k.

2.2 Moderator Temperature Coefficient
(Specification 3.1.3)

2.2.1 The Moderator Temperature Coefficient shall be less positive than the limits shown in Figure 1. These limits shall be referred to as upper limit.

The Moderator Temperature Coefficient shall be less negative than -47.9 pcm/°F. This limit shall be referred to as the lower limit.

2.2.2 The MTC 300 ppm surveillance limit is -40.4 pcm/°F (all rods withdrawn, Rated Thermal Power condition).

2.2.3 The MTC 60 ppm surveillance limit is -45.5 pcm/°F (all rods withdrawn, Rated Thermal Power condition).

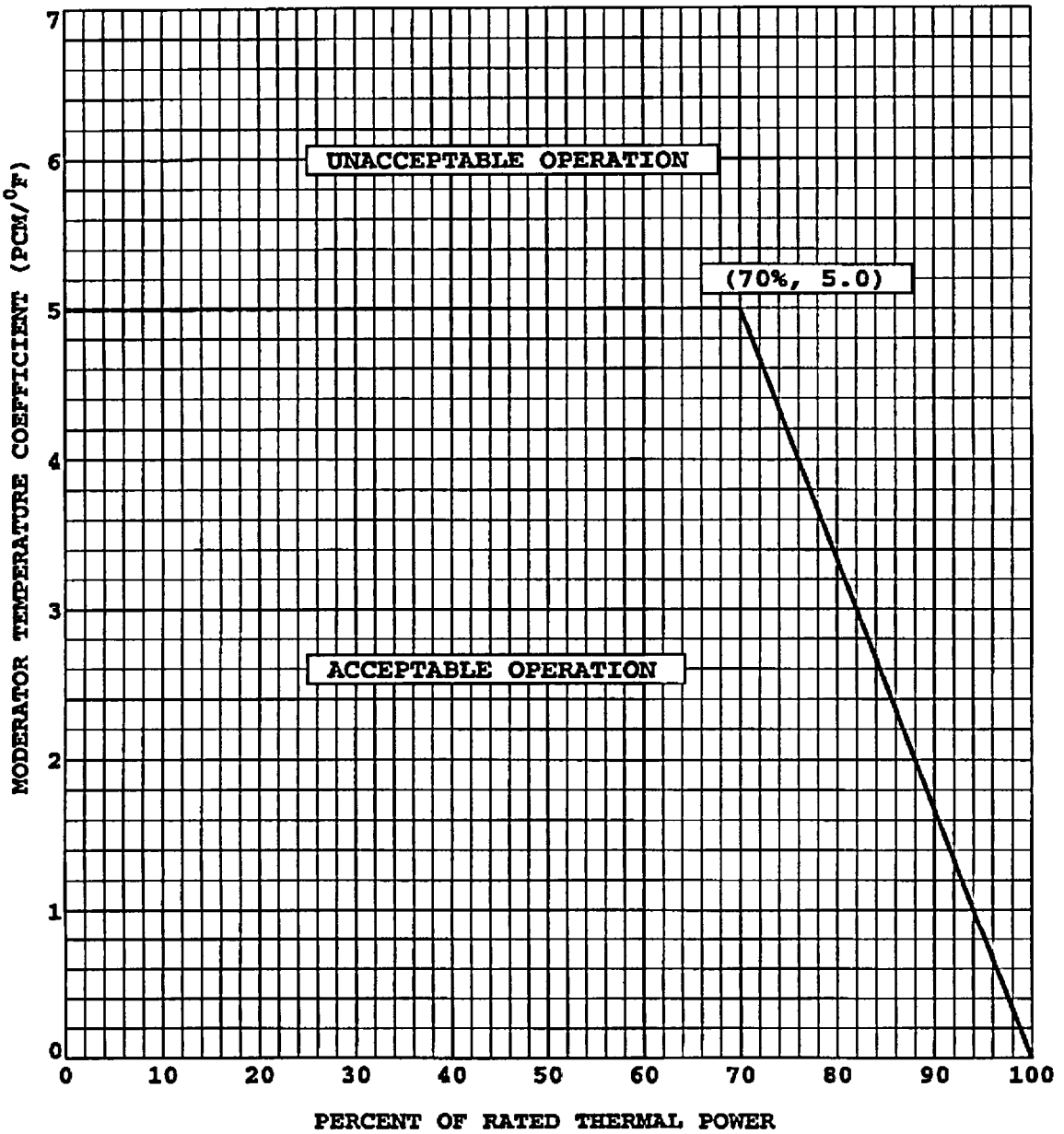


Figure 1

Callaway Cycle 14
Moderator Temperature Coefficient
Versus Power Level

2.3 Shutdown Bank Insertion Limits
(Specification 3.1.5)

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

2.4 Control Bank Insertion Limits
(Specification 3.1.6)

2.4.1 Control Bank insertion limits are specified by Figure 2.

2.4.2 Control Bank withdrawal sequence is A-B-C-D. The insertion sequence is the reverse of the withdrawal sequence.

2.4.3 The difference between each sequential Control Bank position is 115 steps when not fully inserted and not fully withdrawn.

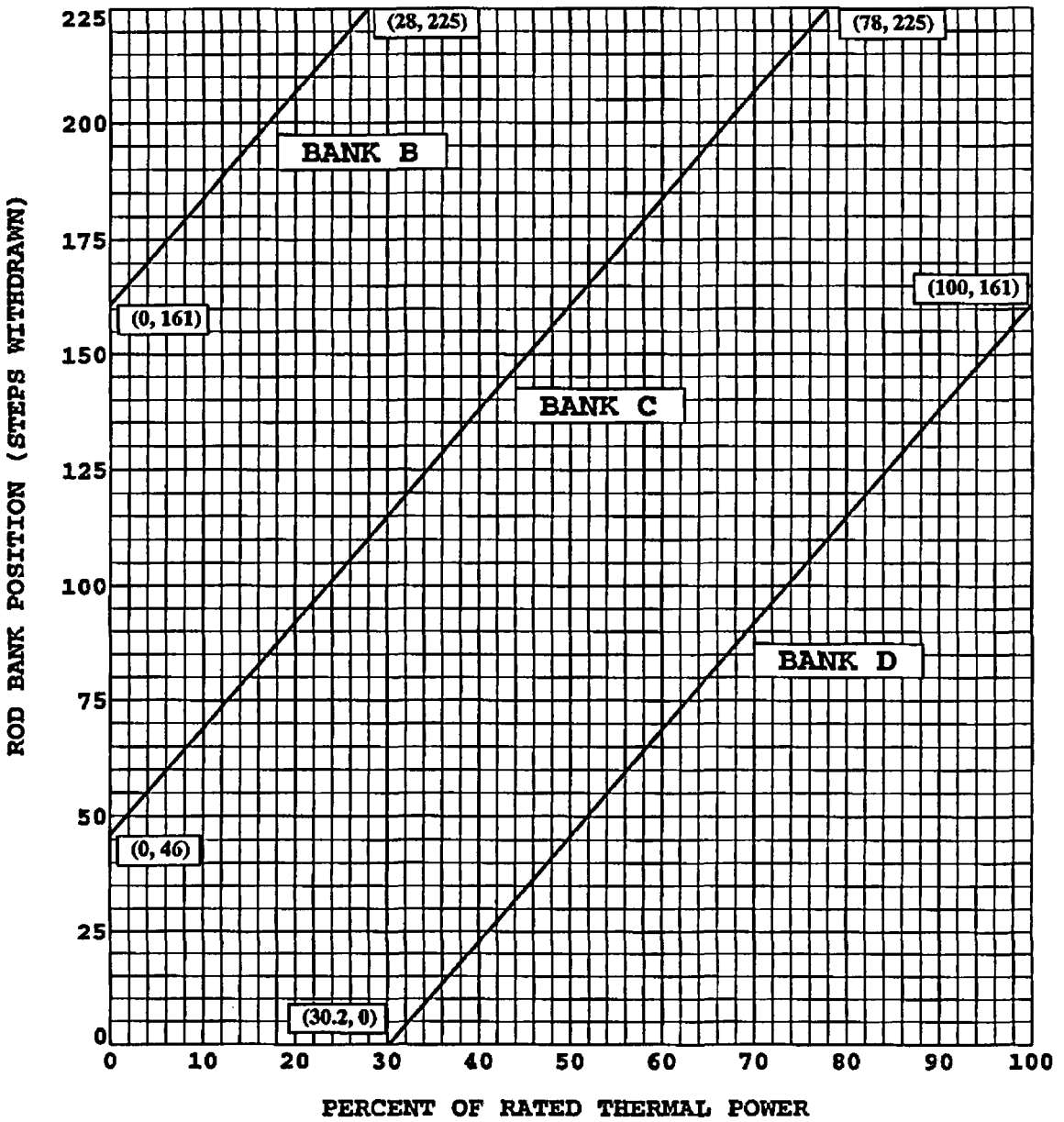


Figure 2

Callaway Cycle 14
Rod Bank Insertion Limits
Versus Rated Thermal Power - Four Loop Operation

2.5 Heat Flux Hot Channel Factor - $F_Q(Z)$
(Specification 3.2.1)

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

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

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

2.5.1 $F_Q^{RTP} = 2.45$ for all Cycle 14 burnups less than 8000 MWD/MTU, and $F_Q^{RTP} = 2.50$ for all Cycle 14 burnups greater than or equal to 8000 MWD/MTU.

2.5.2 K(Z) is provided in Figure 3.

2.5.3 The W(z) functions that are to be used in Technical Specification 3.2.1 and Surveillance Requirement 3.2.1.2 for determining $F_Q^W(z)$ are shown in Figures 4 through 8.

The W(z) values have been determined for several burnups up to 18000 MWD/MTU in Cycle 14. This permits determination of W(z) at any cycle burnup up to 18000 MWD/MTU through the use of three point interpolation. For cycle burnups greater than 18000 MWD/MTU, use of 18000 MWD/MTU W(z) values without interpolation or extrapolation is conservative. The W(z) values were determined assuming Cycle 14 operates with RAOC strategy. Also included is a W(z) function that bounds the W(z) Curve for all Cycle 14 burnups. Use of the bounding W(z) curve will be conservative for any Cycle 14 burnup; however, additional margin may be gained by using the burnup dependent W(z) values.

The W(z) values are provided for 73 axial points within the core height boundaries of 0 and 12 feet at intervals of 0.167 feet.

Table A.1 shows the burnup dependent F_Q penalty factors for Cycle 14. These values shall be used to increase $F_Q^W(z)$ when required by Technical Specification Surveillance Requirement 3.2.1.2. A 2% penalty factor should be used at all cycle burnups that are outside the range of Table A.1.

TABLE A.1

F_Q PENALTY FACTORS AS A FUNCTION OF CYCLE BURNUP

Cycle 14 Burnup	$F_Q^W(z)$ Penalty Factor (%)
All Cycle 14 Burnups	2.00

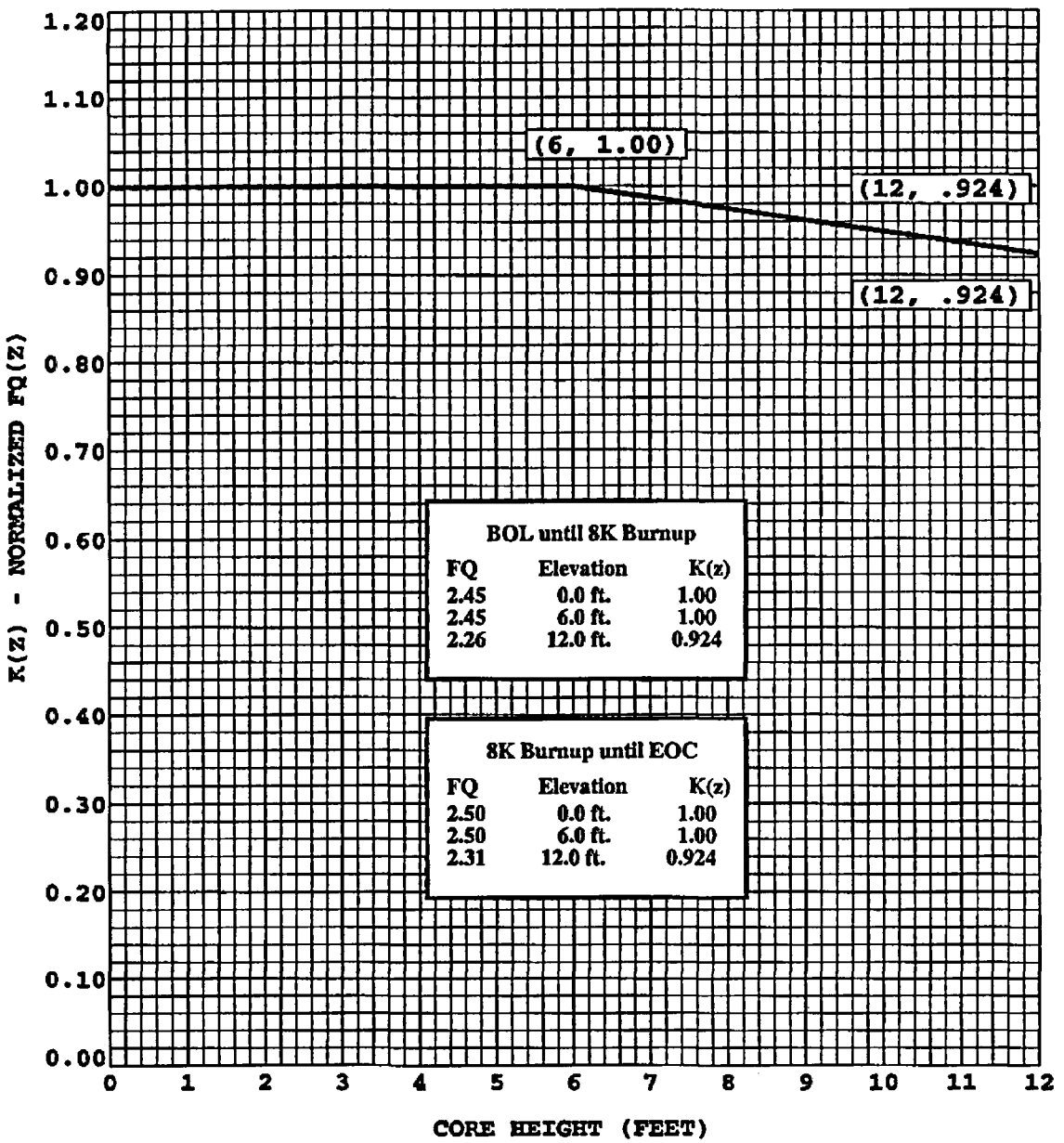
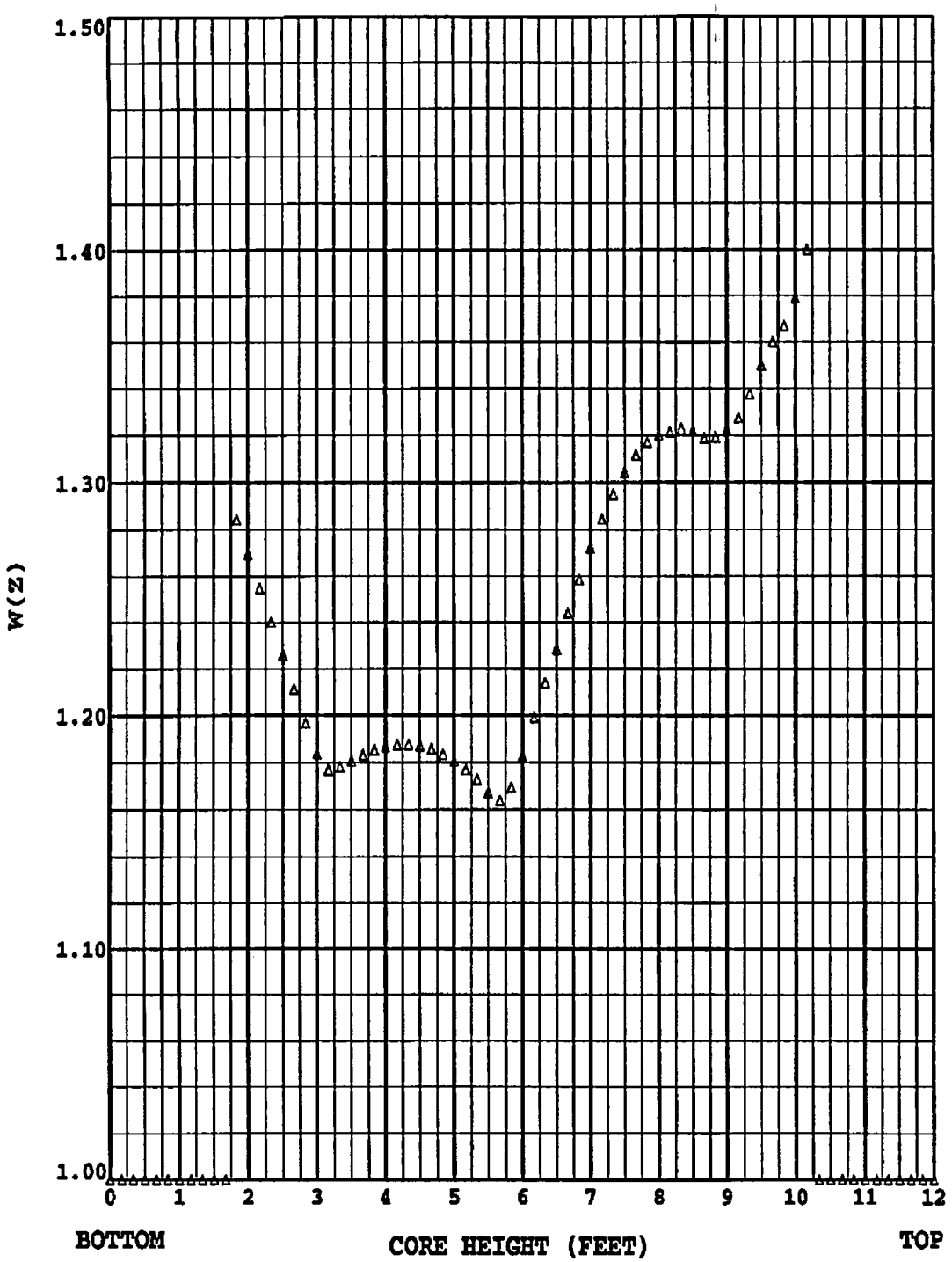


Figure 3

Callaway Cycle 14
K(z) - Normalized $F_Q(z)$
As a Function of Core Height

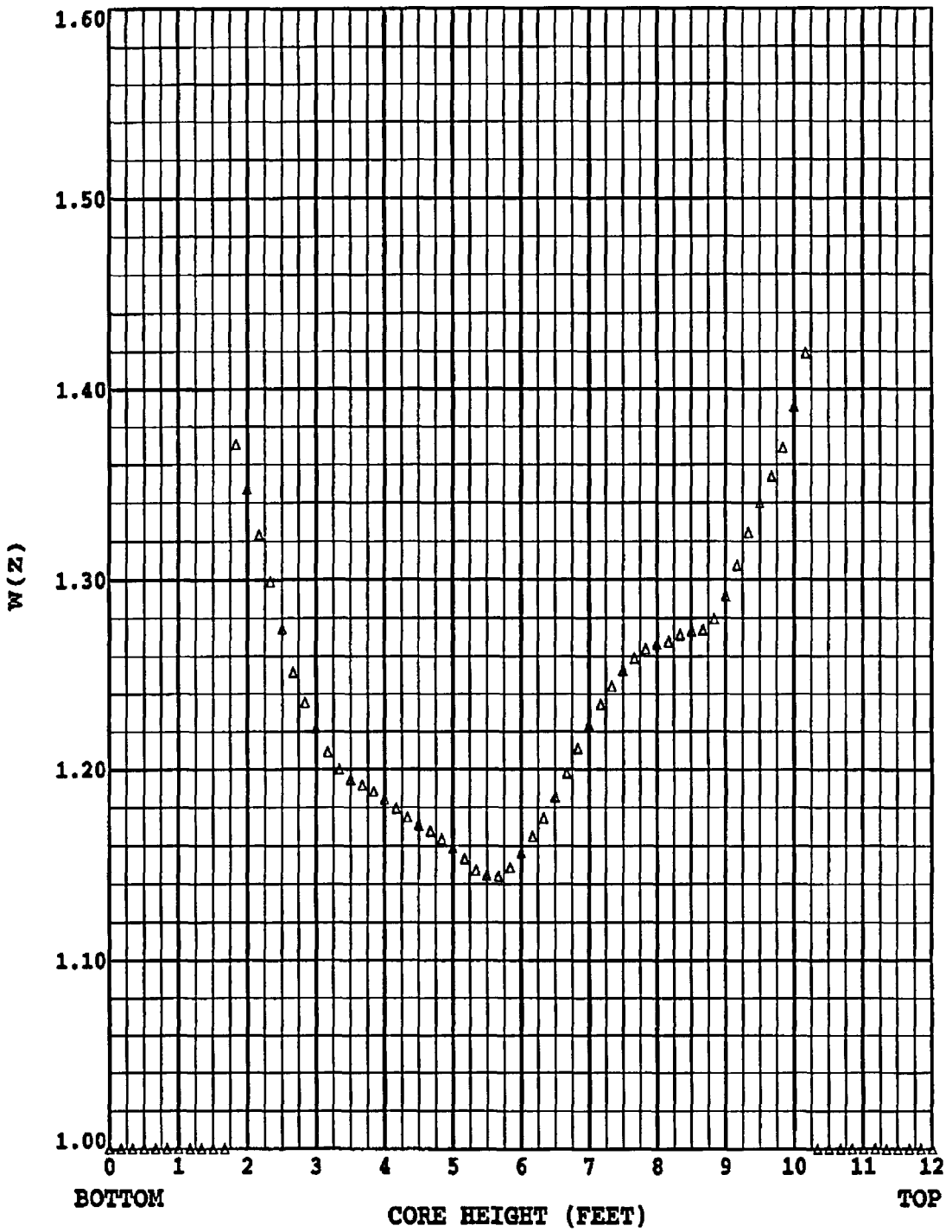


	HEIGHT (FEET)	150. W(Z)
*	0.000	1.0000
*	0.167	1.0000
*	0.333	1.0000
*	0.500	1.0000
*	0.667	1.0000
*	0.833	1.0000
*	1.000	1.0000
*	1.167	1.0000
*	1.333	1.0000
*	1.500	1.0000
*	1.667	1.0000
	1.833	1.2844
	2.000	1.2695
	2.167	1.2548
	2.333	1.2403
	2.500	1.2259
	2.667	1.2113
	2.833	1.1968
	3.000	1.1837
	3.167	1.1769
	3.333	1.1782
	3.500	1.1807
	3.667	1.1832
	3.833	1.1853
	4.000	1.1867
	4.167	1.1875
	4.333	1.1876
	4.500	1.1870
	4.667	1.1856
	4.833	1.1835
	5.000	1.1806
	5.167	1.1770
	5.333	1.1729
	5.500	1.1673
	5.667	1.1639
	5.833	1.1695
	6.000	1.1828
	6.167	1.1993
	6.333	1.2139
	6.500	1.2286
	6.667	1.2439
	6.833	1.2586
	7.000	1.2722
	7.167	1.2845
	7.333	1.2951
	7.500	1.3042
	7.667	1.3116
	7.833	1.3171
	8.000	1.3201
	8.167	1.3214
	8.333	1.3228
	8.500	1.3217
	8.667	1.3188
	8.833	1.3194
	9.000	1.3224
	9.167	1.3275
	9.333	1.3377
	9.500	1.3499
	9.667	1.3602
	9.833	1.3672
	10.000	1.3791
	10.167	1.4001
*	10.333	1.0000
*	10.500	1.0000
*	10.667	1.0000
*	10.833	1.0000
*	11.000	1.0000
*	11.167	1.0000
*	11.333	1.0000
*	11.500	1.0000
*	11.667	1.0000
*	11.833	1.0000
*	12.000	1.0000

Figure 4

Callaway Cycle 14
W(z) at 150 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec SR 3.2.1.2

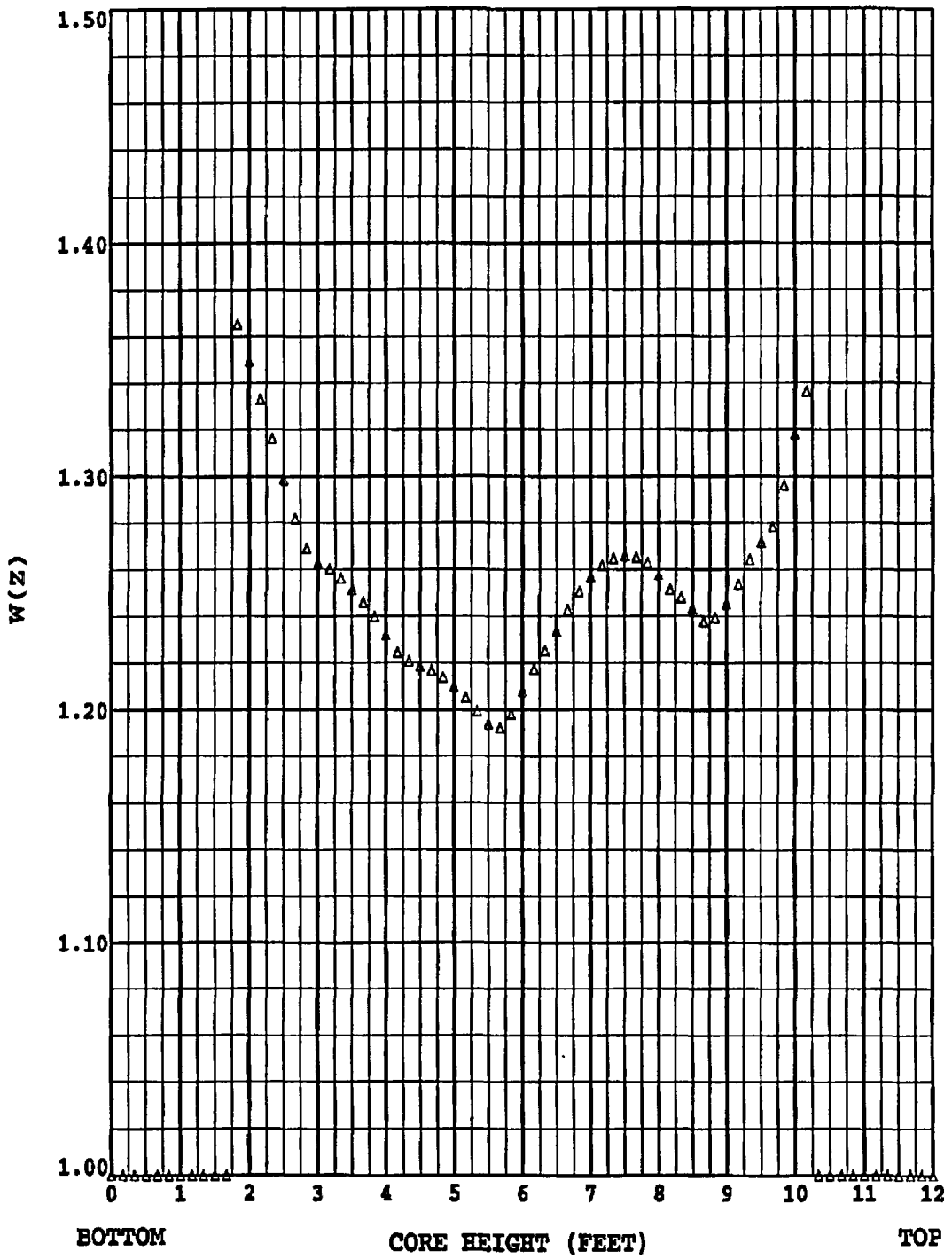


	HEIGHT (FEET)	4000. W(Z)
*	0.000	1.0000
*	0.167	1.0000
*	0.333	1.0000
*	0.500	1.0000
*	0.667	1.0000
*	0.833	1.0000
*	1.000	1.0000
*	1.167	1.0000
*	1.333	1.0000
*	1.500	1.0000
*	1.667	1.0000
	1.833	1.3706
	2.000	1.3471
	2.167	1.3232
	2.333	1.2992
	2.500	1.2741
	2.667	1.2515
	2.833	1.2354
	3.000	1.2216
	3.167	1.2092
	3.333	1.2000
	3.500	1.1947
	3.667	1.1916
	3.833	1.1883
	4.000	1.1842
	4.167	1.1795
	4.333	1.1748
	4.500	1.1710
	4.667	1.1677
	4.833	1.1635
	5.000	1.1588
	5.167	1.1533
	5.333	1.1472
	5.500	1.1446
	5.667	1.1440
	5.833	1.1487
	6.000	1.1562
	6.167	1.1649
	6.333	1.1743
	6.500	1.1853
	6.667	1.1979
	6.833	1.2110
	7.000	1.2234
	7.167	1.2344
	7.333	1.2441
	7.500	1.2523
	7.667	1.2589
	7.833	1.2639
	8.000	1.2664
	8.167	1.2677
	8.333	1.2712
	8.500	1.2731
	8.667	1.2736
	8.833	1.2794
	9.000	1.2915
	9.167	1.3076
	9.333	1.3245
	9.500	1.3399
	9.667	1.3536
	9.833	1.3687
	10.000	1.3906
	10.167	1.4190
*	10.333	1.0000
*	10.500	1.0000
*	10.667	1.0000
*	10.833	1.0000
*	11.000	1.0000
*	11.167	1.0000
*	11.333	1.0000
*	11.500	1.0000
*	11.667	1.0000
*	11.833	1.0000
*	12.000	1.0000

Figure 5

Callaway Cycle 14
W(z) at 4000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec SR 3.2.1.2

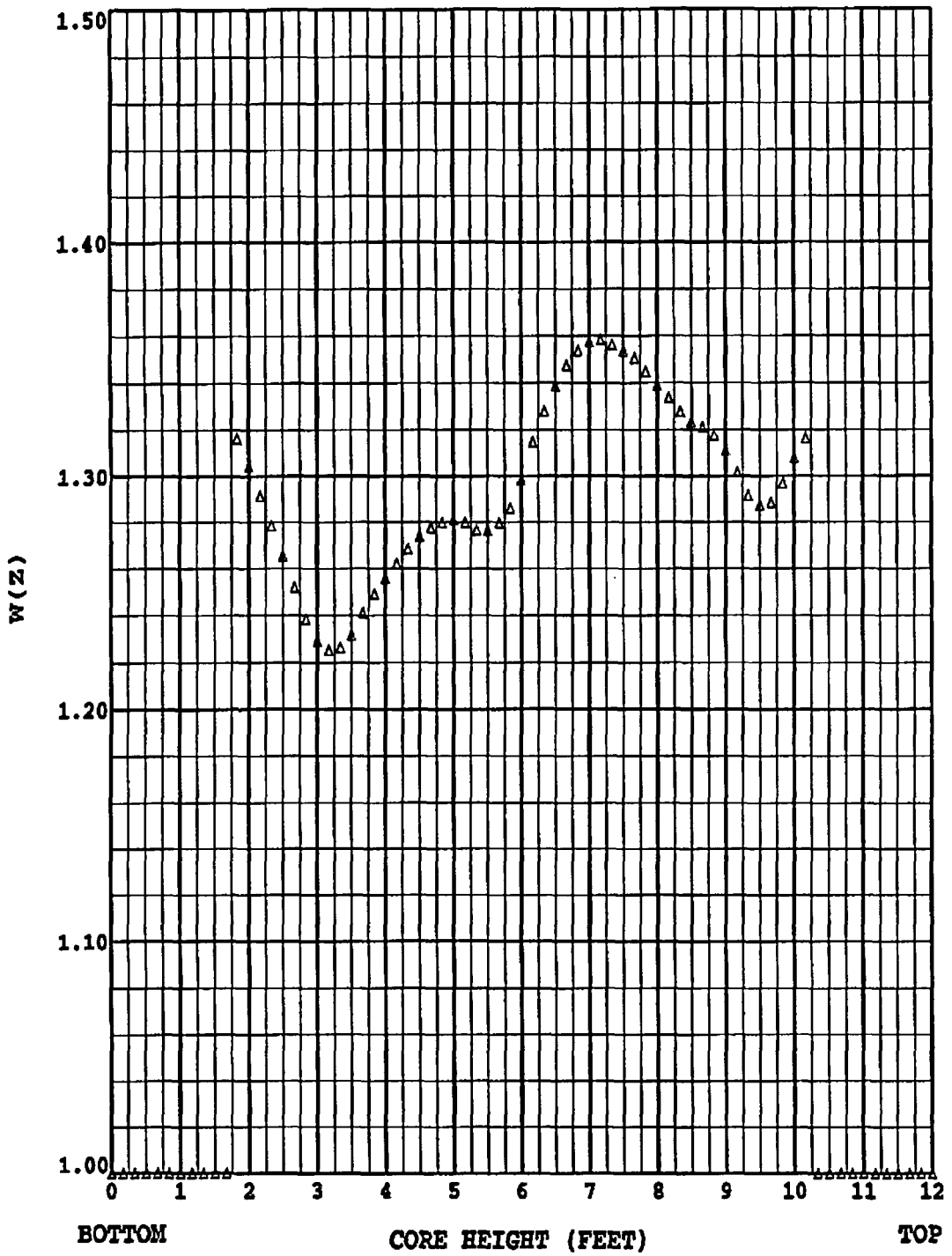


	HEIGHT (FEET)	10000. W(Z)
*	0.000	1.0000
*	0.167	1.0000
*	0.333	1.0000
*	0.500	1.0000
*	0.667	1.0000
*	0.833	1.0000
*	1.000	1.0000
*	1.167	1.0000
*	1.333	1.0000
*	1.500	1.0000
*	1.667	1.0000
	1.833	1.3654
	2.000	1.3494
	2.167	1.3329
	2.333	1.3162
	2.500	1.2987
	2.667	1.2820
	2.833	1.2691
	3.000	1.2628
	3.167	1.2602
	3.333	1.2563
	3.500	1.2514
	3.667	1.2460
	3.833	1.2399
	4.000	1.2320
	4.167	1.2246
	4.333	1.2207
	4.500	1.2186
	4.667	1.2168
	4.833	1.2138
	5.000	1.2099
	5.167	1.2052
	5.333	1.1994
	5.500	1.1939
	5.667	1.1922
	5.833	1.1981
	6.000	1.2078
	6.167	1.2175
	6.333	1.2253
	6.500	1.2337
	6.667	1.2429
	6.833	1.2507
	7.000	1.2569
	7.167	1.2617
	7.333	1.2647
	7.500	1.2658
	7.667	1.2652
	7.833	1.2629
	8.000	1.2577
	8.167	1.2515
	8.333	1.2462
	8.500	1.2434
	8.667	1.2379
	8.833	1.2395
	9.000	1.2455
	9.167	1.2537
	9.333	1.2643
	9.500	1.2718
	9.667	1.2783
	9.833	1.2963
	10.000	1.3182
	10.167	1.3364
*	10.333	1.0000
*	10.500	1.0000
*	10.667	1.0000
*	10.833	1.0000
*	11.000	1.0000
*	11.167	1.0000
*	11.333	1.0000
*	11.500	1.0000
*	11.667	1.0000
*	11.833	1.0000
*	12.000	1.0000

Figure 6

Callaway Cycle 14
W(z) at 10000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec SR 3.2.1.2

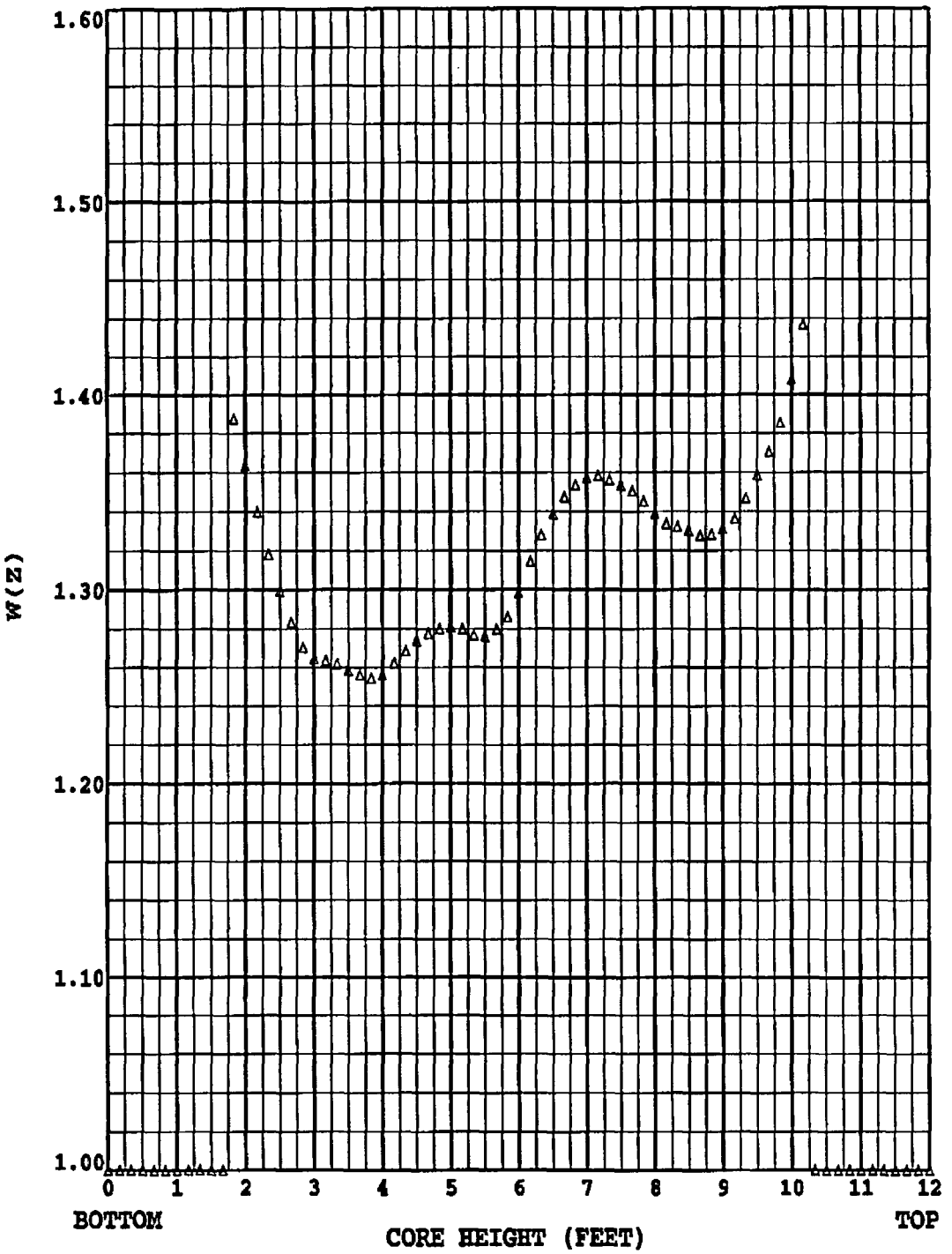


	HEIGHT (FEET)	18000. W(Z)
*	0.000	1.0000
*	0.167	1.0000
*	0.333	1.0000
*	0.500	1.0000
*	0.667	1.0000
*	0.833	1.0000
*	1.000	1.0000
*	1.167	1.0000
*	1.333	1.0000
*	1.500	1.0000
*	1.667	1.0000
	1.833	1.3164
	2.000	1.3041
	2.167	1.2914
	2.333	1.2785
	2.500	1.2654
	2.667	1.2519
	2.833	1.2385
	3.000	1.2292
	3.167	1.2254
	3.333	1.2265
	3.500	1.2316
	3.667	1.2412
	3.833	1.2491
	4.000	1.2558
	4.167	1.2621
	4.333	1.2684
	4.500	1.2737
	4.667	1.2776
	4.833	1.2799
	5.000	1.2809
	5.167	1.2799
	5.333	1.2767
	5.500	1.2762
	5.667	1.2798
	5.833	1.2861
	6.000	1.2984
	6.167	1.3147
	6.333	1.3280
	6.500	1.3388
	6.667	1.3475
	6.833	1.3537
	7.000	1.3575
	7.167	1.3584
	7.333	1.3562
	7.500	1.3534
	7.667	1.3505
	7.833	1.3449
	8.000	1.3391
	8.167	1.3339
	8.333	1.3278
	8.500	1.3233
	8.667	1.3211
	8.833	1.3177
	9.000	1.3111
	9.167	1.3016
	9.333	1.2915
	9.500	1.2874
	9.667	1.2884
	9.833	1.2969
	10.000	1.3077
	10.167	1.3164
*	10.333	1.0000
*	10.500	1.0000
*	10.667	1.0000
*	10.833	1.0000
*	11.000	1.0000
*	11.167	1.0000
*	11.333	1.0000
*	11.500	1.0000
*	11.667	1.0000
*	11.833	1.0000
*	12.000	1.0000

Figure 7

Callaway Cycle 14
W(z) at 18000 MWD/MTU

* Top and bottom 15% excluded as per Tech Spec SR 3.2.1.2



	HEIGHT (FEET)	MAX W(Z)
*	0.000	1.0000
*	0.167	1.0000
*	0.333	1.0000
*	0.500	1.0000
*	0.667	1.0000
*	0.833	1.0000
*	1.000	1.0000
*	1.167	1.0000
*	1.333	1.0000
*	1.500	1.0000
*	1.667	1.0000
	1.833	1.3877
	2.000	1.3636
	2.167	1.3398
	2.333	1.3183
	2.500	1.2995
	2.667	1.2832
	2.833	1.2703
	3.000	1.2643
	3.167	1.2635
	3.333	1.2617
	3.500	1.2585
	3.667	1.2560
	3.833	1.2544
	4.000	1.2558
	4.167	1.2622
	4.333	1.2684
	4.500	1.2737
	4.667	1.2776
	4.833	1.2799
	5.000	1.2809
	5.167	1.2799
	5.333	1.2767
	5.500	1.2762
	5.667	1.2798
	5.833	1.2861
	6.000	1.2984
	6.167	1.3147
	6.333	1.3280
	6.500	1.3388
	6.667	1.3475
	6.833	1.3537
	7.000	1.3575
	7.167	1.3584
	7.333	1.3562
	7.500	1.3534
	7.667	1.3505
	7.833	1.3451
	8.000	1.3391
	8.167	1.3339
	8.333	1.3322
	8.500	1.3303
	8.667	1.3276
	8.833	1.3283
	9.000	1.3311
	9.167	1.3363
	9.333	1.3467
	9.500	1.3587
	9.667	1.3705
	9.833	1.3855
	10.000	1.4079
	10.167	1.4366
*	10.333	1.0000
*	10.500	1.0000
*	10.667	1.0000
*	10.833	1.0000
*	11.000	1.0000
*	11.167	1.0000
*	11.333	1.0000
*	11.500	1.0000
*	11.667	1.0000
*	11.833	1.0000
*	12.000	1.0000

Figure 8

Callaway Cycle 14
Bounding W(z)

* Top and bottom 15% excluded as per Tech Spec SR 3.2.1.2

2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}^{N}$
(Specification 3.2.2)

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

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 Axial Flux Difference
(Specification 3.2.3)

The Axial Flux Difference (AFD) Limits are provided in Figure 9.

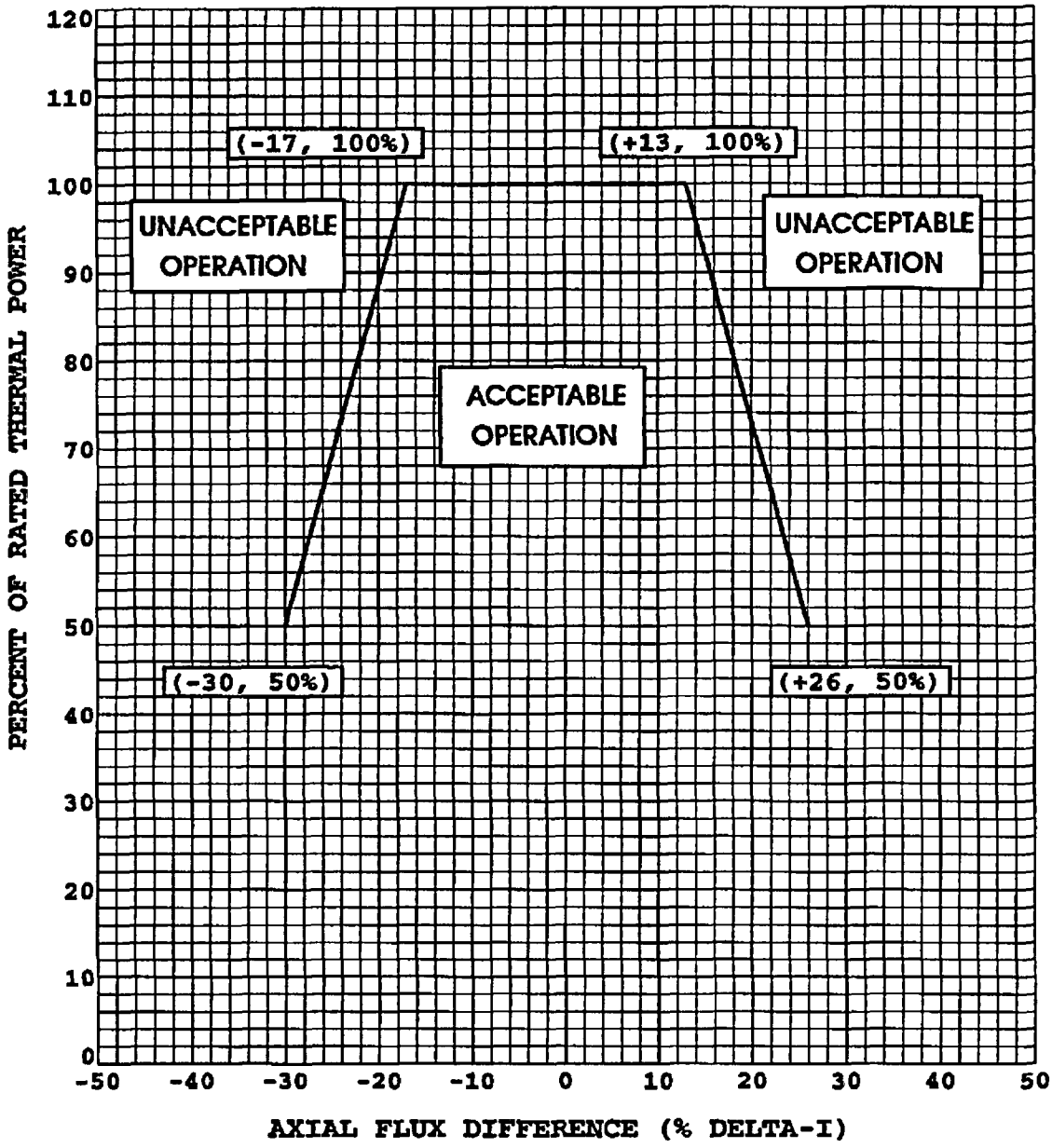


Figure 9

Callaway Cycle 14
Axial Flux Difference Limits as a Function of Rated Thermal Power for RAOC