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SEQUOYAH NUCLEAR PLANT UNIT 1, CYCLE 8

CORE OPERATING LIMITS REPORT

REVISION 0

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Prepared:

James F. Lomas / 9-20-95  
Nuclear Fuel / Date

Reviewed:

MSK / 9-28-95  
Reactor Engineering Supervisor / Date

[Signature] / 9/28/95  
Technical Support Manager / Date

[Signature] / 9/28/95  
PORC Chairman / Date

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## COLR FOR SEQUOYAH UNIT 1 CYCLE 8

### 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Sequoyah Unit 1 Cycle 8 has been prepared in accordance with the requirements of Technical Specification (TS) 6.9.1.14.

The TSs affected by this report are listed below:

- 3/4.1.1.3 Moderator Temperature Coefficient (MTC)
- 3/4.1.3.5 Shutdown Rod Insertion Limit
- 3/4.1.3.6 Control Rod Insertion Limits
- 3/4.2.1 Axial Flux Difference (AFD)
- 3/4.2.2 Heat Flux Hot Channel Factor ( $F_Q(z)$ )
- 3/4.2.3 Nuclear Enthalpy Hot Channel Factor ( $F_{N\Delta H}^N$ )

### 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 TS 6.9.1.14.

The following abbreviations are used in this section:

- BOL stands for Beginning of Cycle Life
- ARO stands for All Rods Out
- HZP stands for Hot Zero THERMAL POWER
- EOL stands for End of Cycle Life
- RTP stands for RATED THERMAL POWER

#### 2.1 Moderator Temperature Coefficient - MTC (Specification 3/4.1.1.3)

##### 2.1.1 The MTC limits are:

The BOL/ARO/HZP-MTC shall be less positive than 0  $\Delta k/k/^\circ F$  (BOL limit). With the measured BOL/ARO/HZP-MTC more positive than  $-0.8 \times 10^{-5}$   $\Delta k/k/^\circ F$  (as-measured MTC limit), establish control rod withdrawal limits to ensure the MTC remains less positive than 0  $\Delta k/k/^\circ F$  for all times in core life.

The EOL/ARO/RTP-MTC shall be less negative than or equal to  $-4.5 \times 10^{-4}$   $\Delta k/k/^\circ F$ .

COLR FOR SEQUOYAH UNIT 1 CYCLE 8

2.1.2 The 300 ppm surveillance limit is:

The measured 300 ppm/ARO/RTP-MTC should be less negative than or equal to  $-3.75 \times 10^{-4} \Delta k/k/^\circ F$ .

2.2 Shutdown Rod Insertion Limit (Specification 3/4.1.3.5)

2.2.1 The shutdown rods shall be withdrawn to a position as defined below:

<u>Cycle Burnup (MWD/MTU)</u>	<u>Steps Withdrawn</u>
$\leq 8,000$	$\geq 225$ to $\leq 231$
$> 8,000$ to $< 14,000$	$\geq 222$ to $\leq 231$
$\geq 14,000$	$\geq 225$ to $\leq 231$

2.3 Control Rod Insertion Limits (Specification 3/4.1.3.6)

2.3.1 The control rod banks shall be limited in physical insertion as shown in Figure 1.

2.4 Axial Flux Difference - AFD (Specification 3/4.2.1)

2.4.1 The axial flux difference (AFD) limits are provided in Figure 2.

2.5 Heat Flux Hot Channel Factor -  $F_Q(z)$  (Specification 3/4.2.2)

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

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

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

COLR FOR SEQUOYAH UNIT 1 CYCLE 8

2.5.1  $F_Q^{RTP} = 2.40$

2.5.2  $K(z)$  is provided in Figure 3.

2.5.3 The  $W(z)$  values required by TS SR 4.2.2.2 are provided in Figures 4 through 8. These figures provide a complete set of conservative  $W(z)$  values and provide sufficient information to determine  $W(z)$  versus core height for all cycle burnups.

2.5.4 All cycle burnups shall use a 2% decrease in  $F_Q$  margin for compliance with the 4.2.2.2.e Surveillance Requirements.

2.6 Nuclear Enthalpy Rise Hot Channel Factor -  $F_{\Delta H}^N$   
(Specification 3/4.2.3)

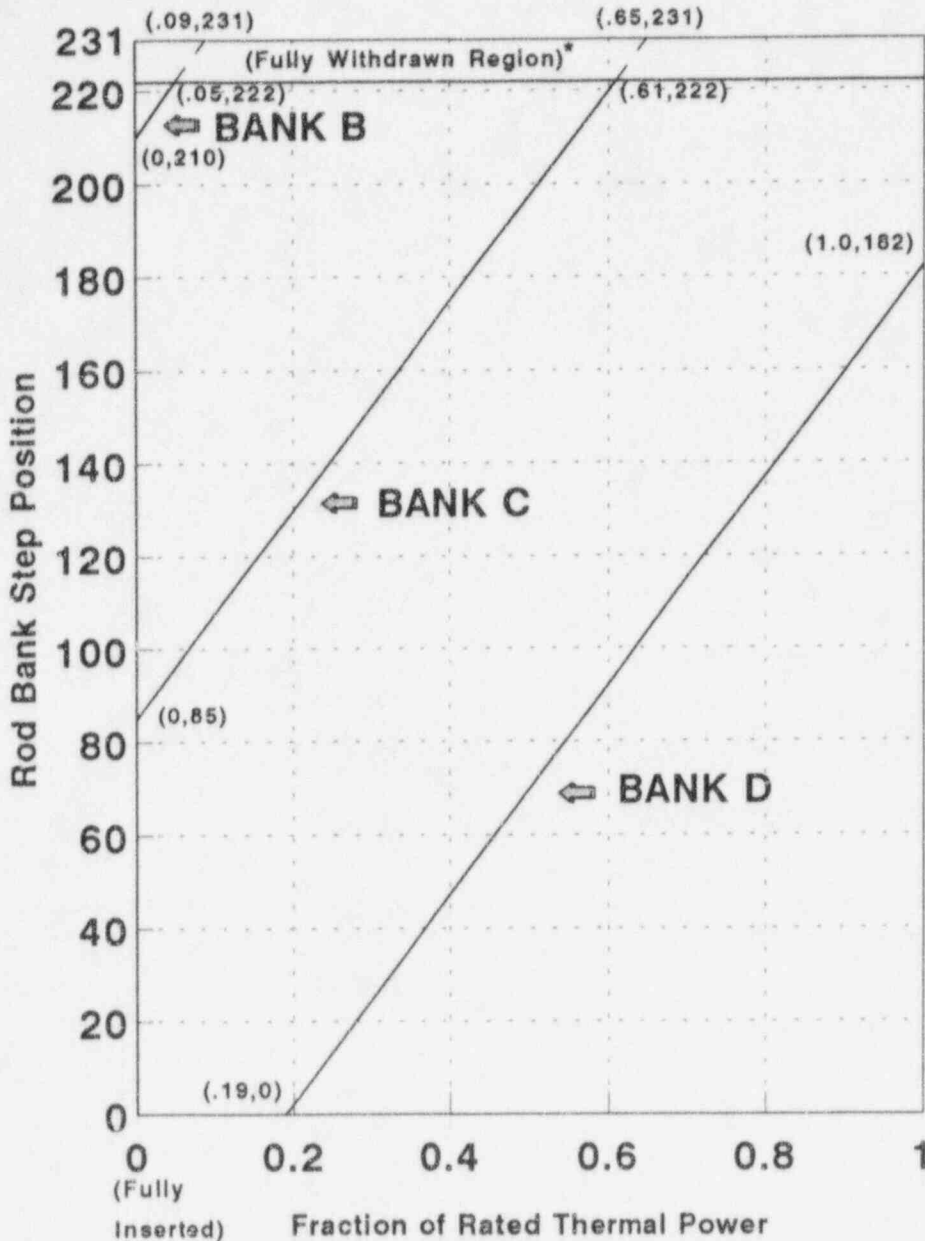
$$F_{\Delta H}^N \leq F_{\Delta H}^{RTP} * (1 + PF_{\Delta H} * [1 - P])$$

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

2.6.1  $F_{\Delta H}^{RTP} = 1.62$

2.6.2  $PF_{\Delta H} = 0.3$

# COLR For Sequoyah Unit 1 Cycle 8



## FIGURE 1

### Rod 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  $\geq 222$  and  $\leq 231$  steps withdrawn, inclusive.

Fully withdrawn shall be the position as defined below,

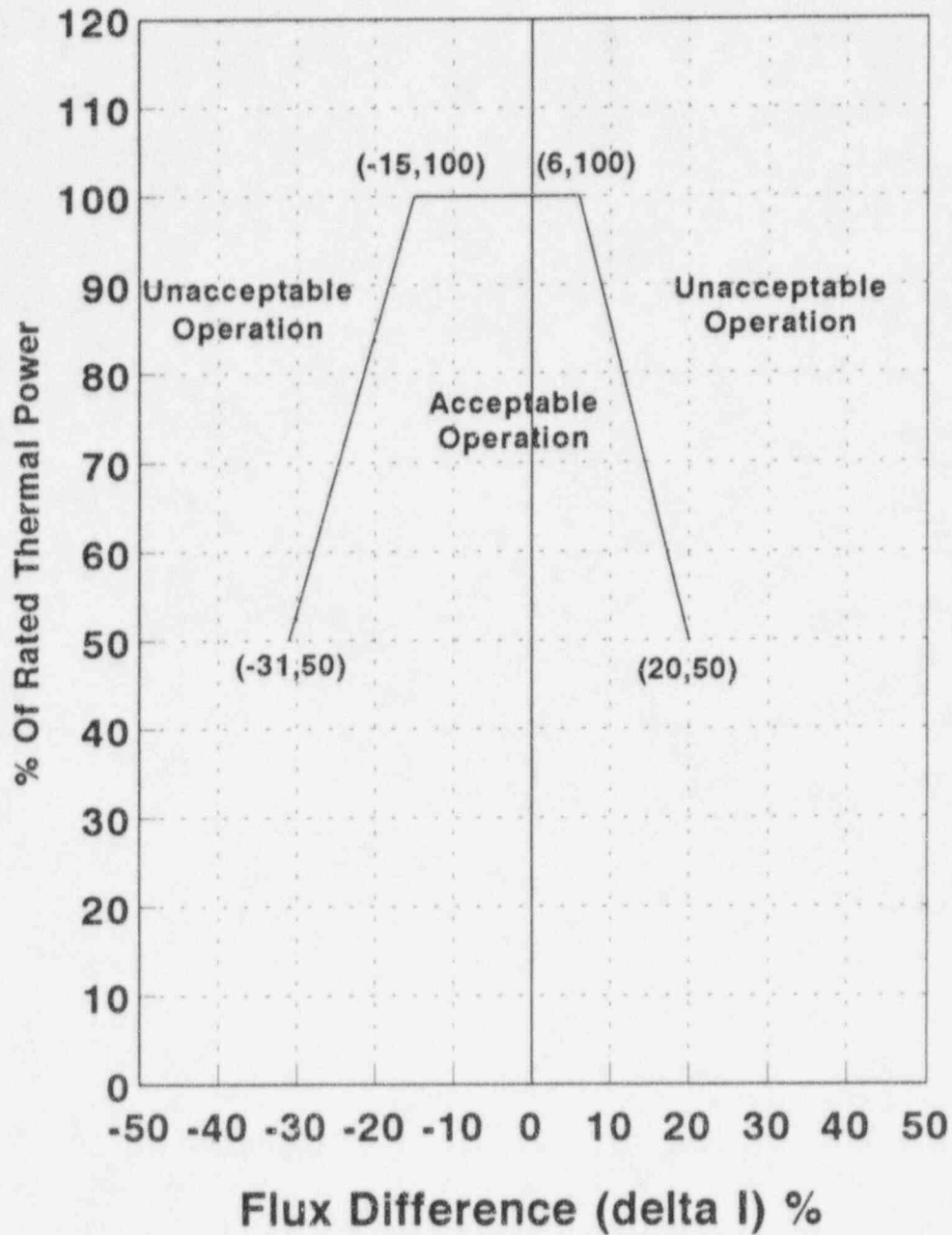
Cycle Burnup (MWd/MTU)

$\leq 8000$   
 $> 8000$  to  $< 14,000$   
 $\geq 14,000$

Step Withdrawn

$\geq 225$  to  $\leq 231$   
 $\geq 222$  to  $\leq 231$   
 $\geq 225$  to  $\leq 231$

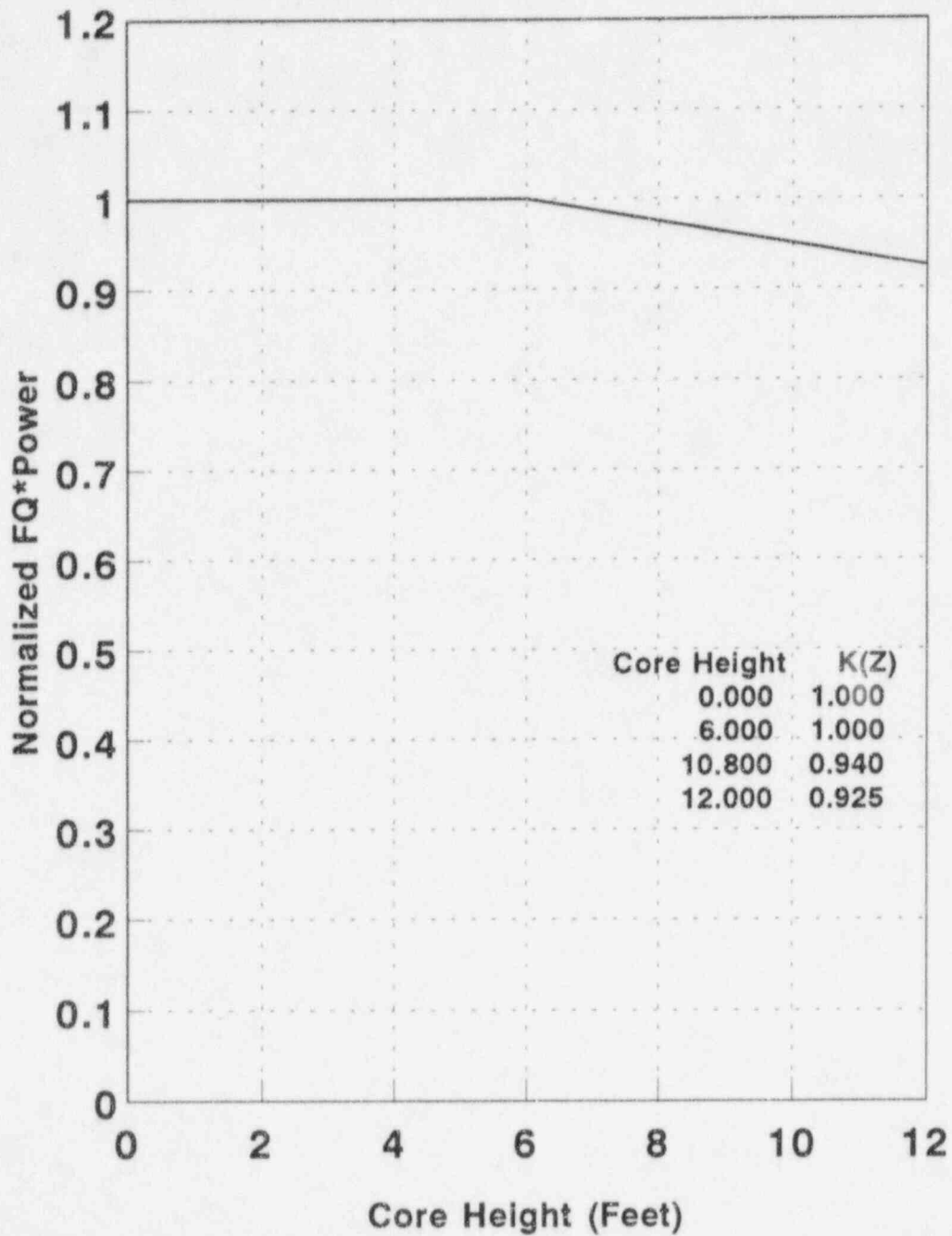
# COLR For Sequoyah Unit 1 Cycle 8



## FIGURE 2

Axial Flux Difference Limits As  
A Function Of Rated Thermal Power

## COLR For Sequoyah Unit 1 Cycle 8



**FIGURE 3**

**K(Z) - Normalized Fq(Z) as a Function of Core Height**

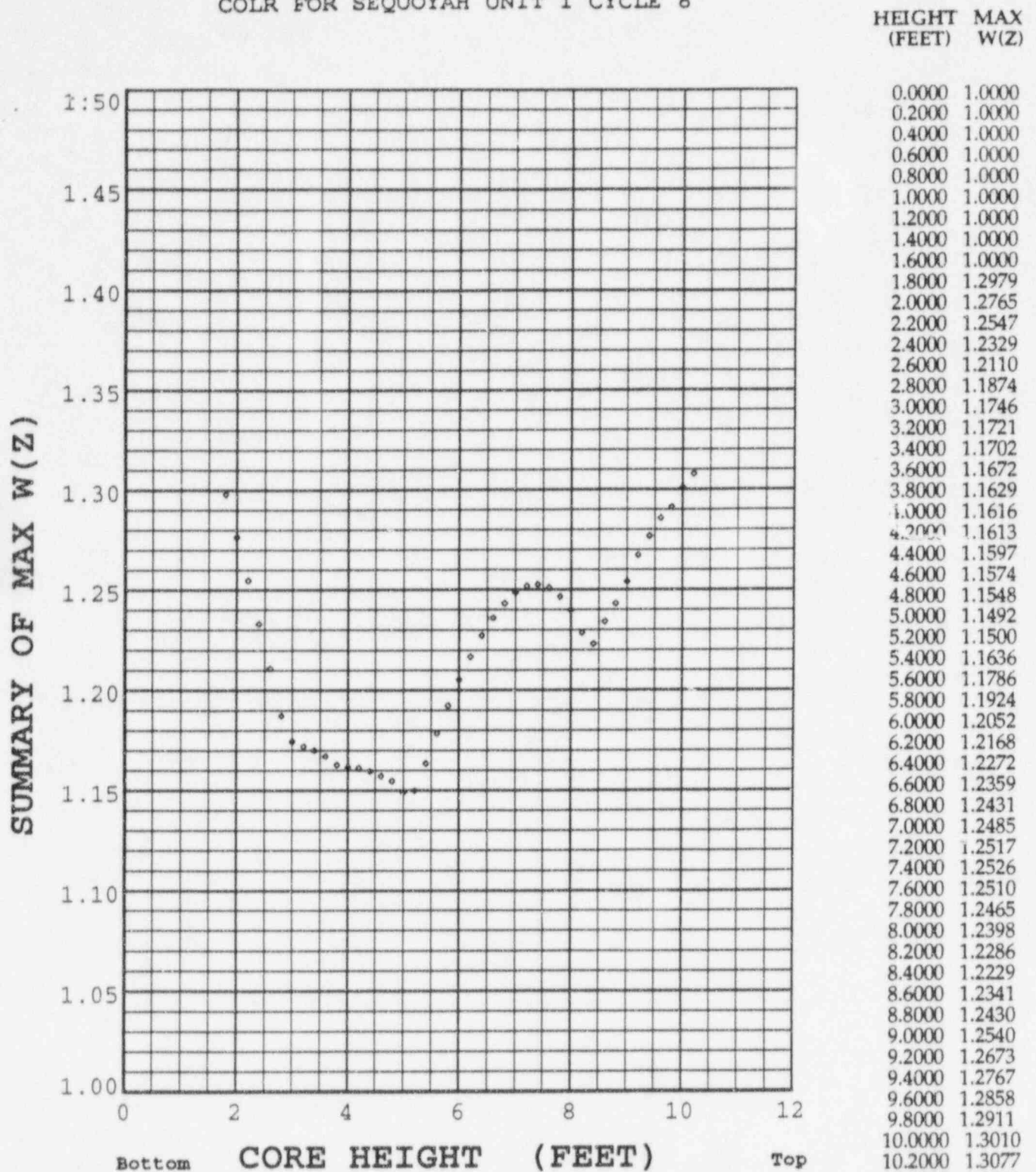


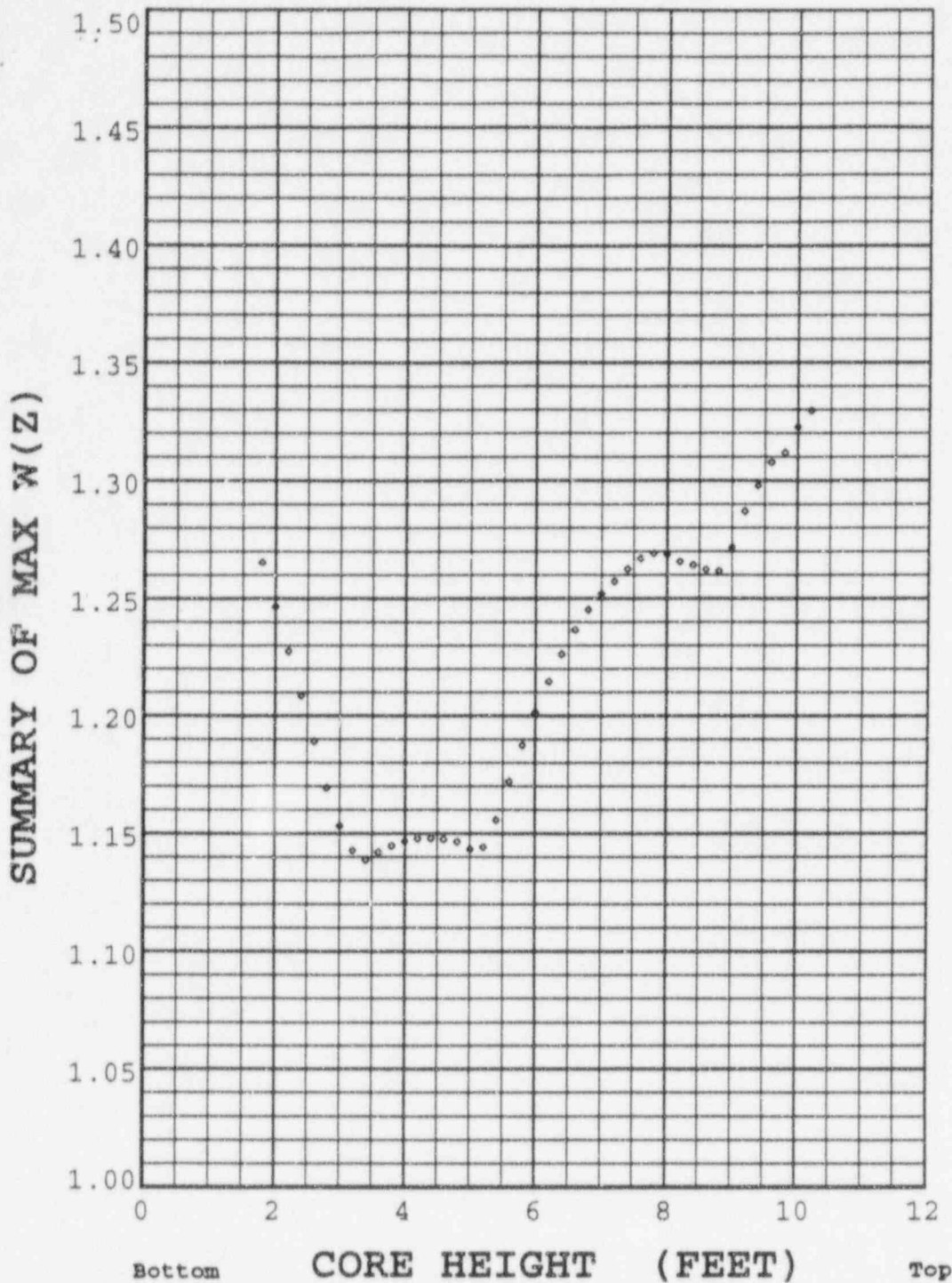
Figure 4

SEQUOYAH UNIT 1 CYCLE 8  
 RAOC SUMMARY OF MAX W(Z) AT 150 MWD/MTU

(Top and Bottom 15% Excluded per Tech Spec 4.2.2.2 G)

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	1.0000
1.4000	1.0000
1.6000	1.0000
1.8000	1.2979
2.0000	1.2765
2.2000	1.2547
2.4000	1.2329
2.6000	1.2110
2.8000	1.1874
3.0000	1.1746
3.2000	1.1721
3.4000	1.1702
3.6000	1.1672
3.8000	1.1629
4.0000	1.1616
4.2000	1.1613
4.4000	1.1597
4.6000	1.1574
4.8000	1.1548
5.0000	1.1492
5.2000	1.1500
5.4000	1.1636
5.6000	1.1786
5.8000	1.1924
6.0000	1.2052
6.2000	1.2168
6.4000	1.2272
6.6000	1.2359
6.8000	1.2431
7.0000	1.2485
7.2000	1.2517
7.4000	1.2526
7.6000	1.2510
7.8000	1.2465
8.0000	1.2398
8.2000	1.2286
8.4000	1.2229
8.6000	1.2341
8.8000	1.2430
9.0000	1.2540
9.2000	1.2673
9.4000	1.2767
9.6000	1.2858
9.8000	1.2911
10.0000	1.3010
10.2000	1.3077
10.4000	1.0000
10.6000	1.0000
10.8000	1.0000
11.0000	1.0000
11.2000	1.0000
11.4000	1.0000
11.6000	1.0000
11.8000	1.0000
12.0000	1.0000



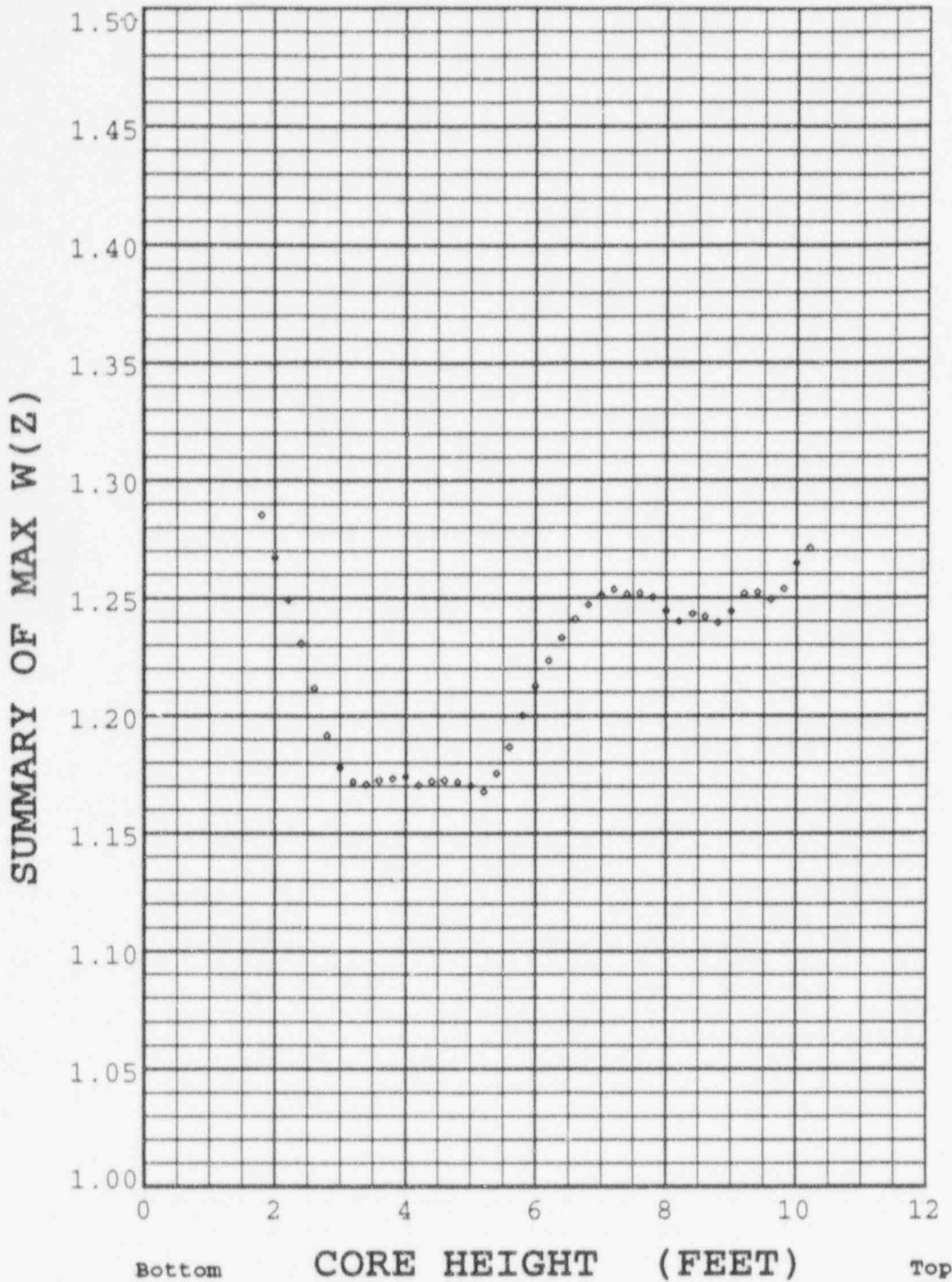


HEIGHT (FEET)	MAX W(Z)
0.0000	1.0000
0.2000	1.0000
0.4000	1.0000
0.6000	1.0000
0.8000	1.0000
1.0000	1.0000
1.2000	1.0000
1.4000	1.0000
1.6000	1.0000
1.8000	1.2653
2.0000	1.2466
2.2000	1.2276
2.4000	1.2084
2.6000	1.1891
2.8000	1.1692
3.0000	1.1532
3.2000	1.1428
3.4000	1.1388
3.6000	1.1421
3.8000	1.1449
4.0000	1.1467
4.2000	1.1478
4.4000	1.1481
4.6000	1.1475
4.8000	1.1466
5.0000	1.1433
5.2000	1.1442
5.4000	1.1558
5.6000	1.1720
5.8000	1.1875
6.0000	1.2015
6.2000	1.2146
6.4000	1.2263
6.6000	1.2366
6.8000	1.2453
7.0000	1.2519
7.2000	1.2572
7.4000	1.2625
7.6000	1.2669
7.8000	1.2691
8.0000	1.2686
8.2000	1.2656
8.4000	1.2642
8.6000	1.2622
8.8000	1.2616
9.0000	1.2717
9.2000	1.2870
9.4000	1.2978
9.6000	1.3076
9.8000	1.3117
10.0000	1.3225
10.2000	1.3294
10.4000	1.0000
10.6000	1.0000
10.8000	1.0000
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

SEQUOYAH UNIT 1 CYCLE 8  
 RAOC SUMMARY OF MAX W(Z) AT 2000 MWD/MTU

(Top and Bottom 15% Excluded per Tech Spec 4.2.2.2 G)



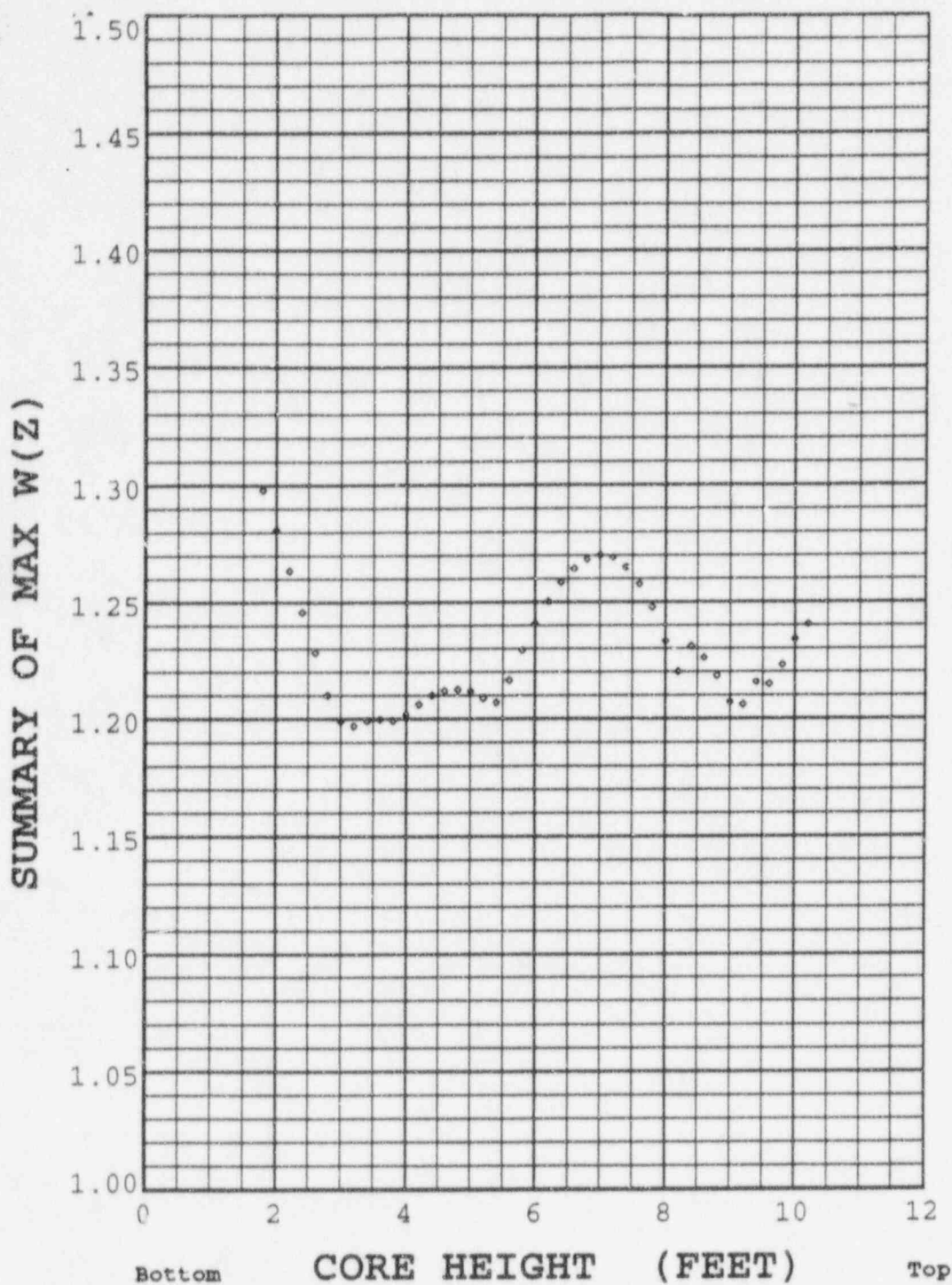
HEIGHT (FEET)	MAX W(Z)
0.0000	1.0000
0.2000	1.0000
0.4000	1.0000
0.6000	1.0000
0.8000	1.0000
1.0000	1.0000
1.2000	1.0000
1.4000	1.0000
1.6000	1.0000
1.8000	1.2853
2.0000	1.2674
2.2000	1.2492
2.4000	1.2307
2.6000	1.2119
2.8000	1.1918
3.0000	1.1780
3.2000	1.1721
3.4000	1.1708
3.6000	1.1726
3.8000	1.1732
4.0000	1.1742
4.2000	1.1705
4.4000	1.1721
4.6000	1.1725
4.8000	1.1719
5.0000	1.1703
5.2000	1.1678
5.4000	1.1756
5.6000	1.1868
5.8000	1.2002
6.0000	1.2125
6.2000	1.2235
6.4000	1.2331
6.6000	1.2410
6.8000	1.2471
7.0000	1.2513
7.2000	1.2535
7.4000	1.2516
7.6000	1.2520
7.8000	1.2503
8.0000	1.2445
8.2000	1.2401
8.4000	1.2432
8.6000	1.2420
8.8000	1.2395
9.0000	1.2443
9.2000	1.2518
9.4000	1.2522
9.6000	1.2492
9.8000	1.2538
10.0000	1.2647
10.2000	1.2713
10.4000	1.0000
10.6000	1.0000
10.8000	1.0000
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

SEQUOYAH UNIT 1 CYCLE 8  
RAOC SUMMARY OF MAX W(Z) AT 6000 MWD/MTU

(Top and Bottom 15% Excluded per Tech Spec 4.2.2.2 G)

HEIGHT MAX  
(FEET) W(Z)



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	1.0000
1.4000	1.0000
1.6000	1.0000
1.8000	1.2979
2.0000	1.2810
2.2000	1.2635
2.4000	1.2458
2.6000	1.2282
2.8000	1.2101
3.0000	1.1990
3.2000	1.1971
3.4000	1.1992
3.6000	1.1998
3.8000	1.1994
4.0000	1.2018
4.2000	1.2063
4.4000	1.2100
4.6000	1.2120
4.8000	1.2125
5.0000	1.2119
5.2000	1.2088
5.4000	1.2071
5.6000	1.2165
5.8000	1.2293
6.0000	1.2407
6.2000	1.2504
6.4000	1.2584
6.6000	1.2644
6.8000	1.2683
7.0000	1.2700
7.2000	1.2691
7.4000	1.2649
7.6000	1.2577
7.8000	1.2478
8.0000	1.2332
8.2000	1.2201
8.4000	1.2311
8.6000	1.2261
8.8000	1.2183
9.0000	1.2072
9.2000	1.2060
9.4000	1.2157
9.6000	1.2148
9.8000	1.2230
10.0000	1.2340
10.2000	1.2404
10.4000	1.0000
10.6000	1.0000
10.8000	1.0000
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

SEQUOYAH UNIT 1 CYCLE 8  
RAOC SUMMARY OF MAX W(Z) AT 10000 MWD/MTU

(Top and Bottom 15% Excluded per Tech Spec 4.2.2.2 G)

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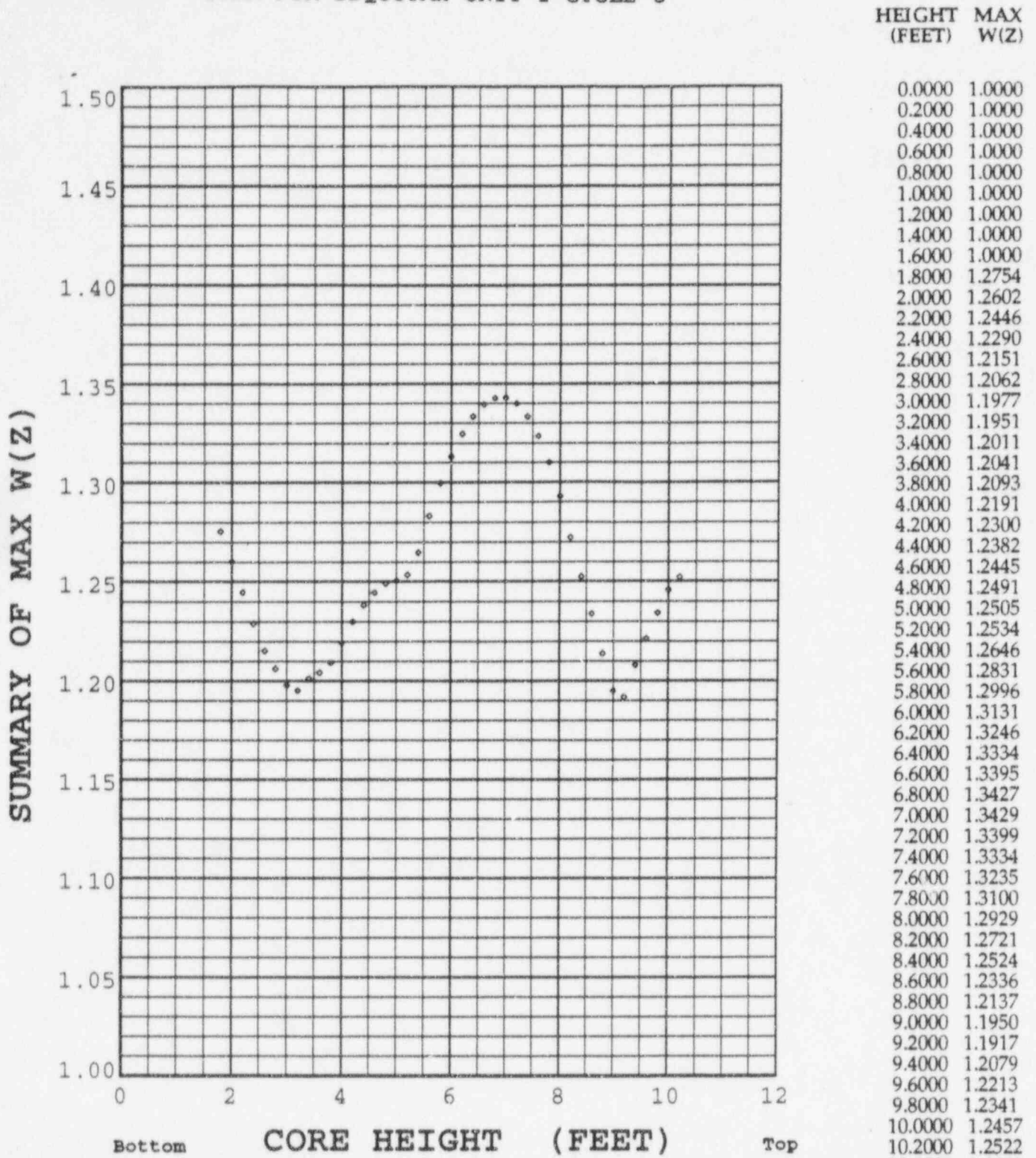


Figure 8

SEQUOYAH UNIT 1 CYCLE 8  
 RAOC SUMMARY OF MAX W(Z) AT 14000 MWD/MTU

(Top and Bottom 15% Excluded per Tech Spec 4.2.2.2 G)

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	1.0000
1.4000	1.0000
1.6000	1.0000
1.8000	1.2754
2.0000	1.2602
2.2000	1.2446
2.4000	1.2290
2.6000	1.2151
2.8000	1.2062
3.0000	1.1977
3.2000	1.1951
3.4000	1.2011
3.6000	1.2041
3.8000	1.2093
4.0000	1.2191
4.2000	1.2300
4.4000	1.2382
4.6000	1.2445
4.8000	1.2491
5.0000	1.2505
5.2000	1.2534
5.4000	1.2646
5.6000	1.2831
5.8000	1.2996
6.0000	1.3131
6.2000	1.3246
6.4000	1.3334
6.6000	1.3395
6.8000	1.3427
7.0000	1.3429
7.2000	1.3399
7.4000	1.3334
7.6000	1.3235
7.8000	1.3100
8.0000	1.2929
8.2000	1.2721
8.4000	1.2524
8.6000	1.2336
8.8000	1.2137
9.0000	1.1950
9.2000	1.1917
9.4000	1.2079
9.6000	1.2213
9.8000	1.2341
10.0000	1.2457
10.2000	1.2522
10.4000	1.0000
10.6000	1.0000
10.8000	1.0000
11.0000	1.0000
11.2000	1.0000
11.4000	1.0000
11.6000	1.0000
11.8000	1.0000
12.0000	1.0000