

SEQUOYAH NUCLEAR PLANT UNIT 2, CYCLE 7

CORE OPERATING LIMITS REPORT

REVISION 1

November 17, 1995

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PORC Chairman Date

Revision 1

Pages affected 4, 9 - 16

Reason for Revision To: (1) allow the use of an updated calculational method to perform Heat Flux Hot Channel Factor surveillance, (2) to provide revised W(z) information to allow implementation of Technical Specification change 95-03, and (3) to delete W(z) information which is no longer applicable.

## COLR FOR SEQUOYAH UNIT 2 CYCLE 7

### 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Sequoyah Unit 2 Cycle 7 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 ( $F_{N\Delta H}$ )

### 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  $-1.9 \times 10^{-5} \Delta k/k/^\circ F$  (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  $-4.5 \times 10^{-4} \Delta k/k/^\circ F$ .

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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2.2.1 The shutdown rods shall be withdrawn to a position as defined below: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>
$\leq 4,000$	$\geq 226$ to $\leq 231$
$> 4,000$ to $< 14,000$	$\geq 222$ to $\leq 231$
$\geq 14,000$	$\geq 226$ 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)

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

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

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

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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 9. 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 Table A.1 shows  $F_Q$  margin decreases that are greater than 2% per 31 Effective Full Power Days (EFPD). These values shall be used to increase  $F_Q^M(z)$  as per Surveillance Requirement 4.2.2.2.e. A 2% penalty factor shall be used at all cycle burnups that are outside the range of Table A.1.

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  $PF_{\Delta H} = 0.3$

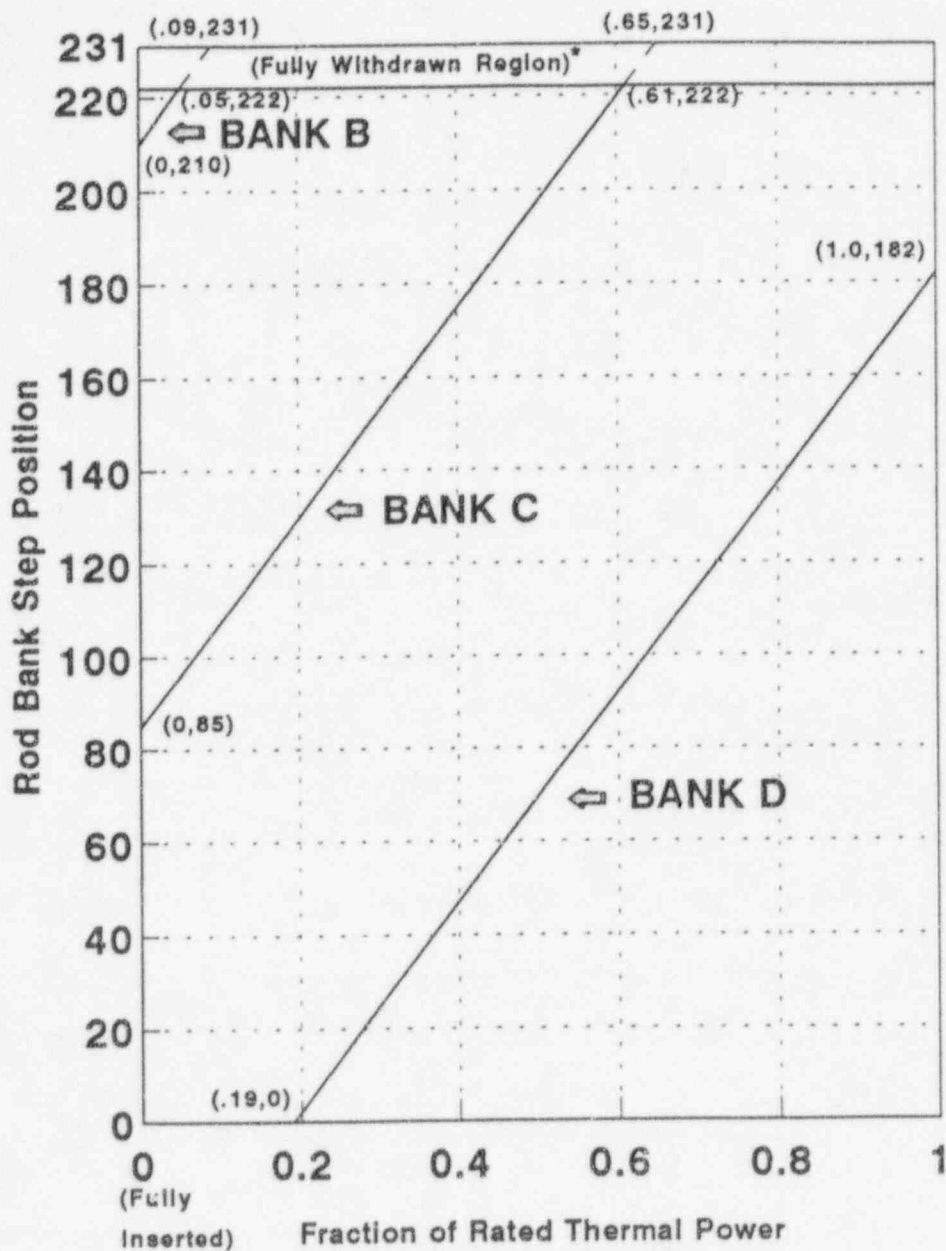
TABLE A.1

$F_Q$  Margin Decreases In Excess of 2% Per 31 EFPD

Burnup (MWD/MTU)	Max % decrease in $F_Q$ Margin
889	2.40
1037	2.63
1185	2.68
1333	2.54
1481	2.30

Note: All cycle burnups outside the range of the table shall use a 2% decrease in  $F_Q$  margin for compliance with the 4.2.2.2.e Surveillance Requirements. Linear interpolation is adequate for intermediate cycle burnups.

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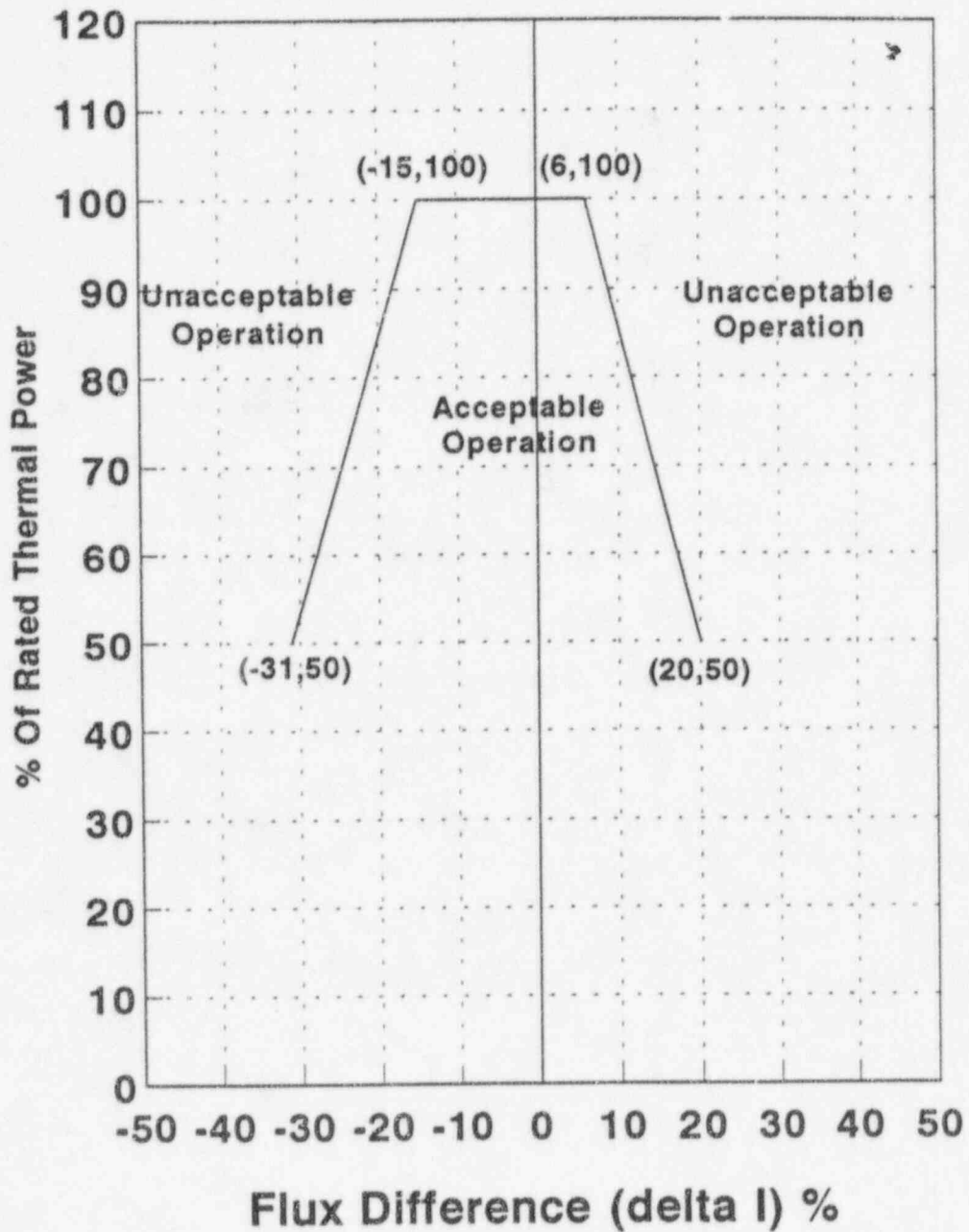
**FIGURE 1**  
**Rod Bank Insertion Limits Versus Thermal Power Four Loop Operation**

\* 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,

<u>Cycle Burnup (MWd/MTU)</u>	<u>Step Withdrawn</u>
$\leq 4000$	$\geq 226$ to $\leq 231$
$> 4000$ to $< 14,000$	$\geq 222$ to $\leq 231$
$\geq 14,000$	$\geq 226$ to $\leq 231$

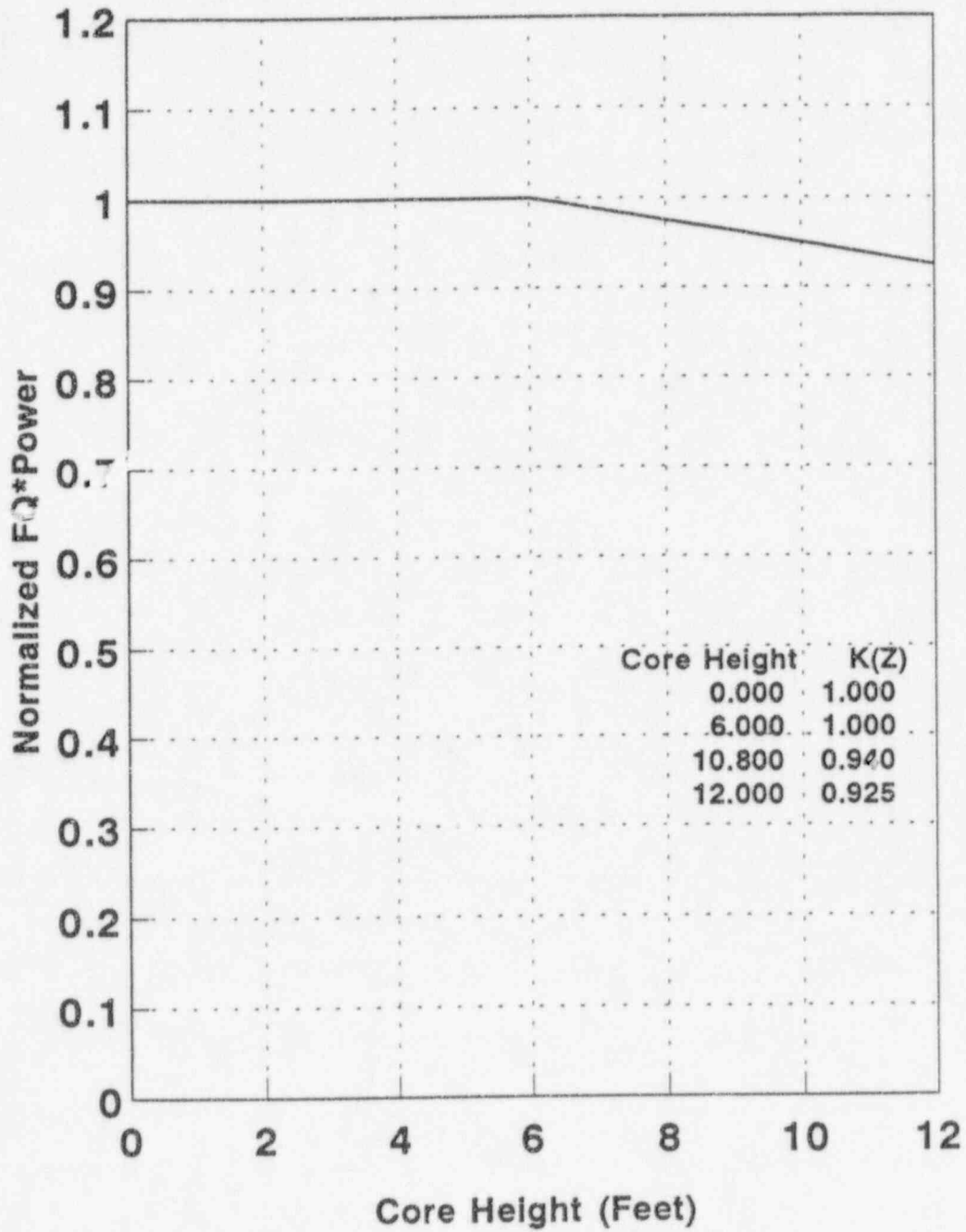
# COLR For Sequoyah Unit 2 Cycle 7



## FIGURE 2

Axial Flux Difference Limits As  
A Function Of Rated Thermal Power

# COLR For Sequoyah Unit 2 Cycle 7



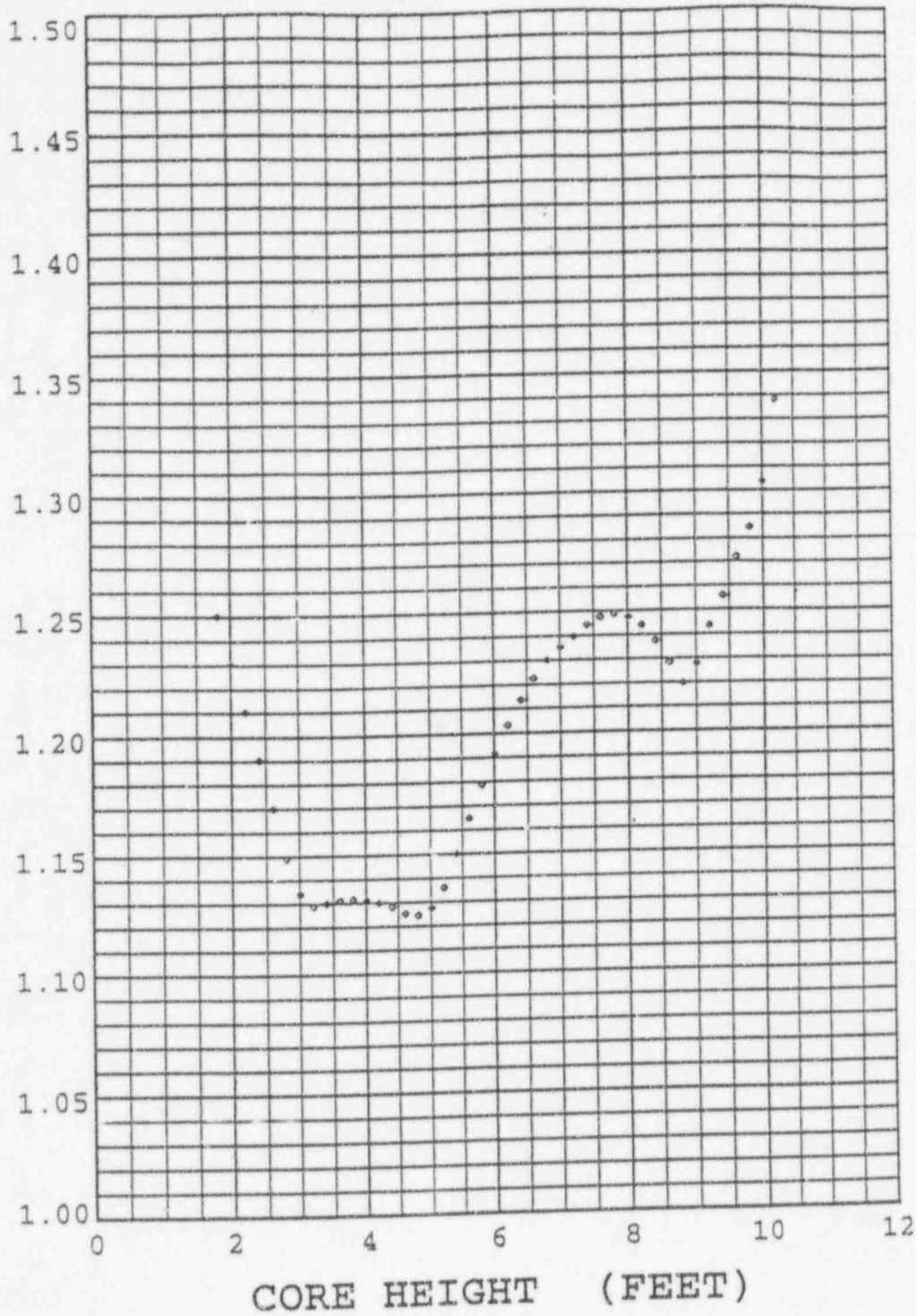
**FIGURE 3**

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



# COLR FOR SEQUOYAH UNIT 2 CYCLE 7

SUMMARY OF MAX 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	1.2504
2.0000	1.2305
2.2000	1.2103
2.4000	1.1901
2.6000	1.1699
2.8000	1.1489
3.0000	1.1339
3.2000	1.1288
3.4000	1.1300
3.6000	1.1311
3.8000	1.1315
4.0000	1.1311
4.2000	1.1300
4.4000	1.1281
4.6000	1.1253
4.8000	1.1245
5.0000	1.1274
5.2000	1.1359
5.4000	1.1499
5.6000	1.1648
5.8000	1.1787
6.0000	1.1915
6.2000	1.2032
6.4000	1.2135
6.6000	1.2225
6.8000	1.2299
7.0000	1.2352
7.2000	1.2395
7.4000	1.2443
7.6000	1.2477
7.8000	1.2488
8.0000	1.2475
8.2000	1.2438
8.4000	1.2374
8.6000	1.2282
8.8000	1.2197
9.0000	1.2276
9.2000	1.2435
9.4000	1.2558
9.6000	1.2722
9.8000	1.2845
10.0000	1.3037
10.2000	1.3381
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

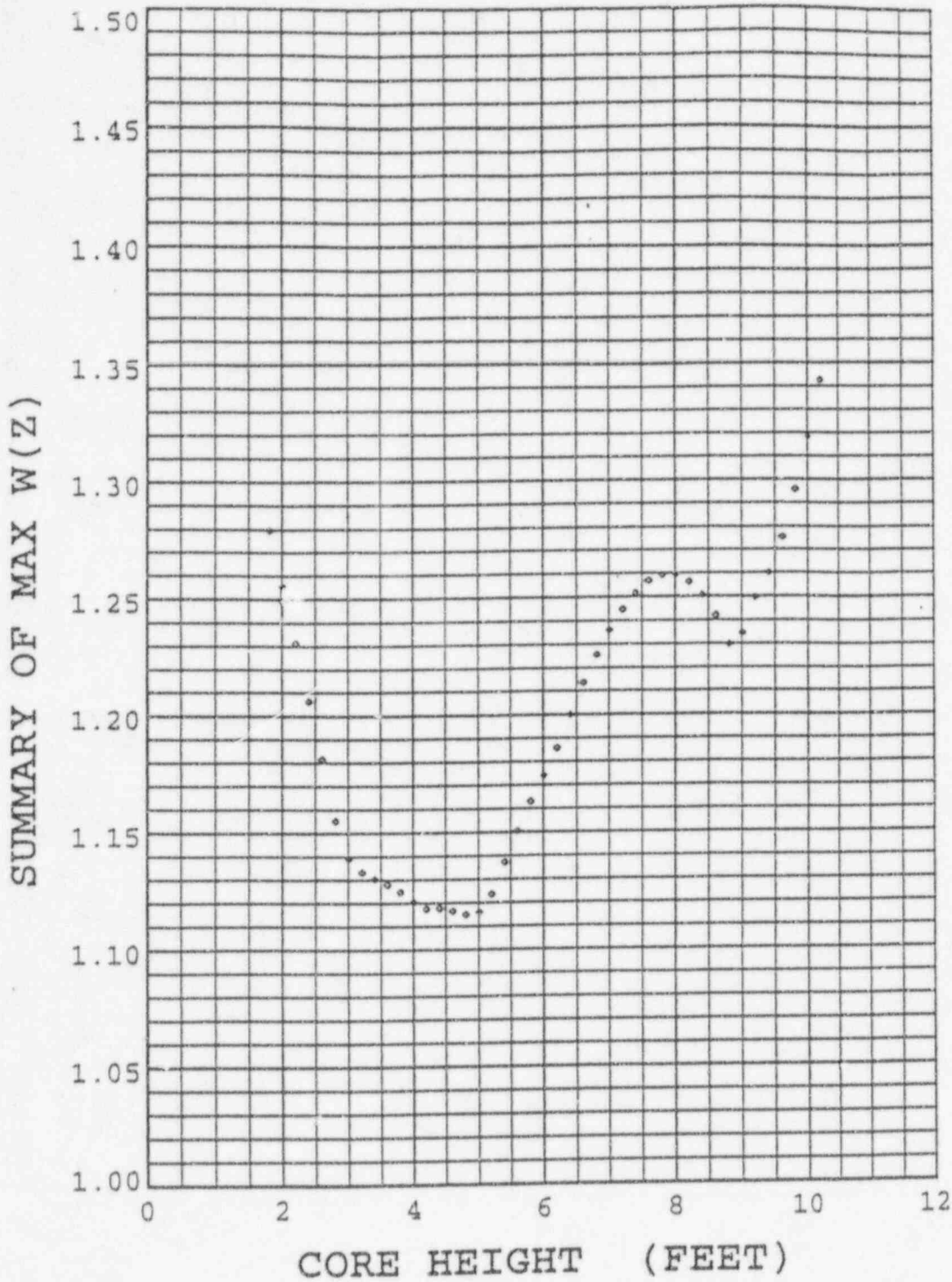
**Figure 4**

SEQUOYAH UNIT 2 CYCLE 7  
 RAOC SUMMARY OF MAX W(Z) AT 150 MWD/MTU

TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.1.1.1.G

COLR FOR SEQUOYAH UNIT 2 CYCLE 7

HEIGHT  
(FEET) MAX  
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	1.2795
2.0000	1.2557
2.2000	1.2311
2.4000	1.2064
2.6000	1.1815
2.8000	1.1552
3.0000	1.1389
3.2000	1.1331
3.4000	1.1303
3.6000	1.1279
3.8000	1.1248
4.0000	1.1204
4.2000	1.1175
4.4000	1.1176
4.6000	1.1165
4.8000	1.1149
5.0000	1.1159
5.2000	1.1234
5.4000	1.1372
5.6000	1.1505
5.8000	1.1629
6.0000	1.1738
6.2000	1.1856
6.4000	1.2000
6.6000	1.2135
6.8000	1.2255
7.0000	1.2359
7.2000	1.2446
7.4000	1.2517
7.6000	1.2568
7.8000	1.2593
8.0000	1.2573
8.2000	1.2564
8.4000	1.2506
8.6000	1.2419
8.8000	1.2296
9.0000	1.2344
9.2000	1.2496
9.4000	1.2601
9.6000	1.2753
9.8000	1.2958
10.0000	1.3184
10.2000	1.3425
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

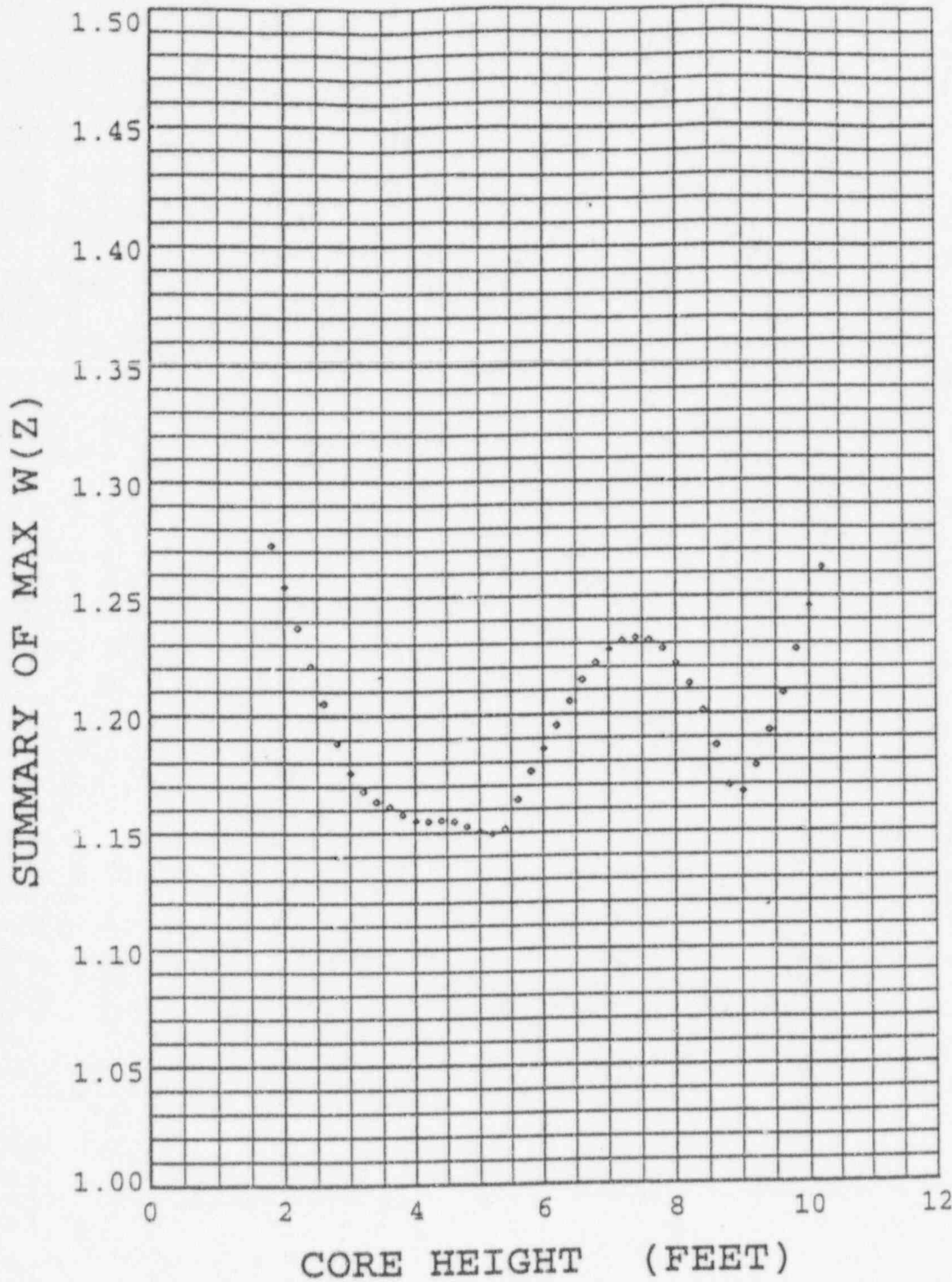
Figure 5

SEQUOYAH UNIT 2 CYCLE 7  
 RAOC SUMMARY OF MAX W(Z) AT 3000 MWD/MTU

TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.2.2.2.G

COLR FOR SEQUOYAH UNIT 2 CYCLE 7

HEIGHT MAX  
(FEET) 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	1.2729
2.0000	1.2549
2.2000	1.2372
2.4000	1.2210
2.6000	1.2051
2.8000	1.1884
3.0000	1.1756
3.2000	1.1679
3.4000	1.1634
3.6000	1.1613
3.8000	1.1578
4.0000	1.1552
4.2000	1.1549
4.4000	1.1554
4.6000	1.1547
4.8000	1.1525
5.0000	1.1508
5.2000	1.1494
5.4000	1.1515
5.6000	1.1640
5.8000	1.1759
6.0000	1.1855
6.2000	1.1952
6.4000	1.2054
6.6000	1.2144
6.8000	1.2217
7.0000	1.2273
7.2000	1.2309
7.4000	1.2322
7.6000	1.2311
7.8000	1.2275
8.0000	1.2214
8.2000	1.2127
8.4000	1.2012
8.6000	1.1865
8.8000	1.1694
9.0000	1.1666
9.2000	1.1776
9.4000	1.1927
9.6000	1.2085
9.8000	1.2271
10.0000	1.2457
10.2000	1.2624
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 2 CYCLE 7  
RAOC SUMMARY OF MAX W(Z) AT 7000 MWD/MTU

TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.1.2.1.G

COLR FOR SEQUOYAH UNIT 2 CYCLE 7

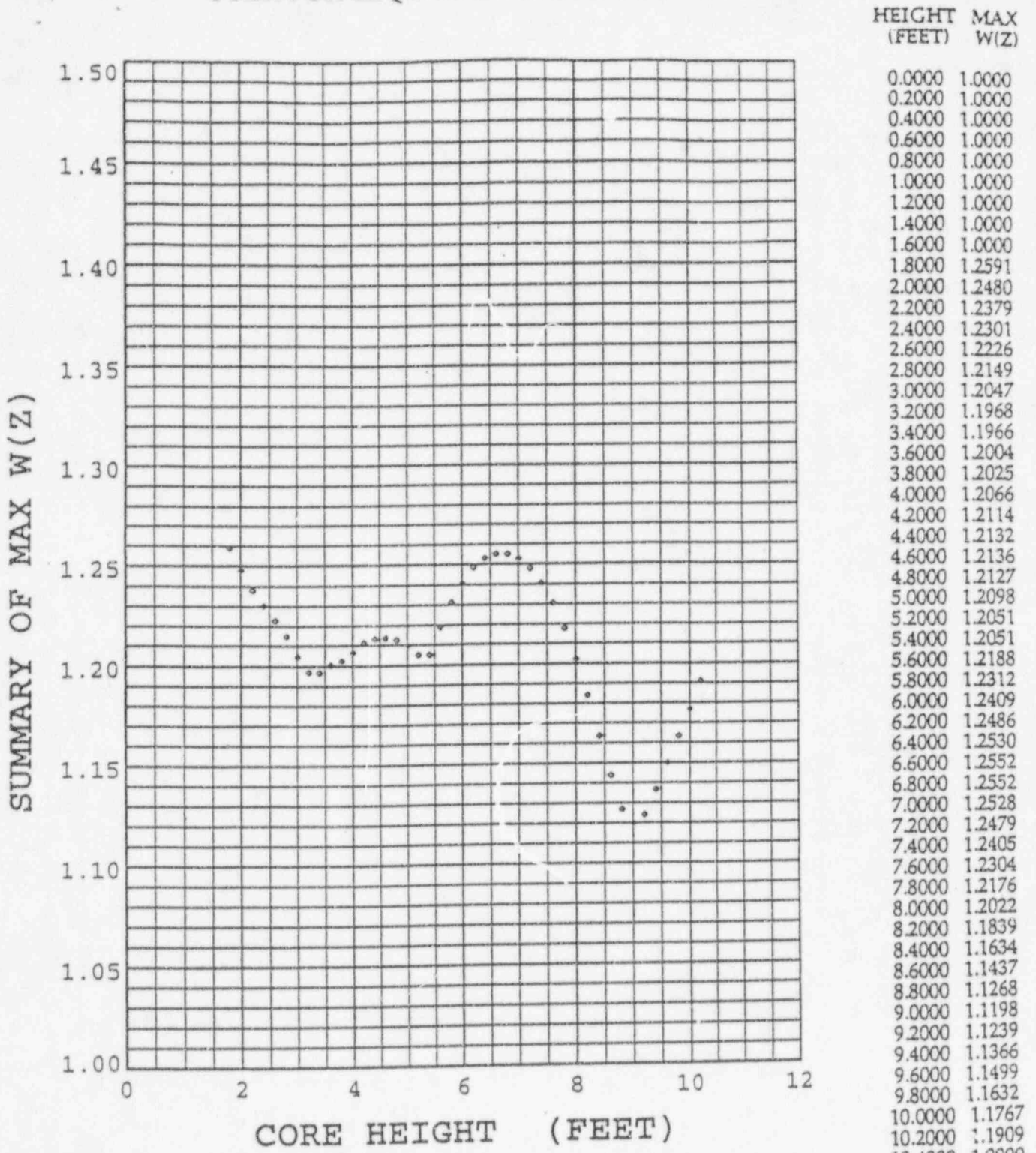


Figure 7

SEQUOYAH UNIT 2 CYCLE 7  
 RAOC SUMMARY OF MAX W(Z) AT 12000 MWD/MTU

TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.2.2.0

COLR FOR SEQUOYAH UNIT 2 CYCLE 7

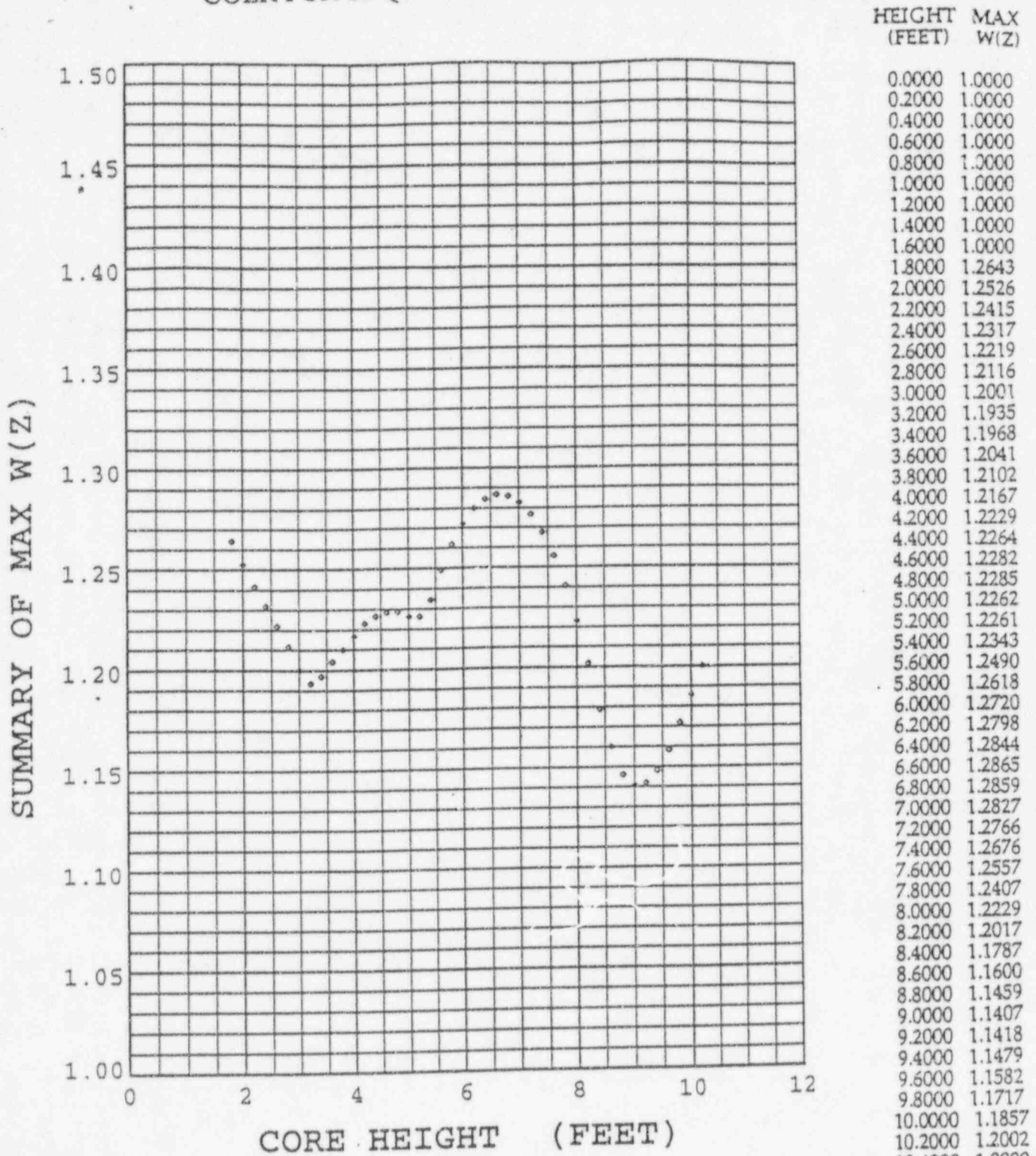


Figure 8

SEQUOYAH UNIT 2 CYCLE 7  
 RAOC SUMMARY OF MAX W(Z) AT 14000 MWD/MTU

TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.1.1.2.G

COLR FOR SEQUOYAH UNIT 2 CYCLE 7

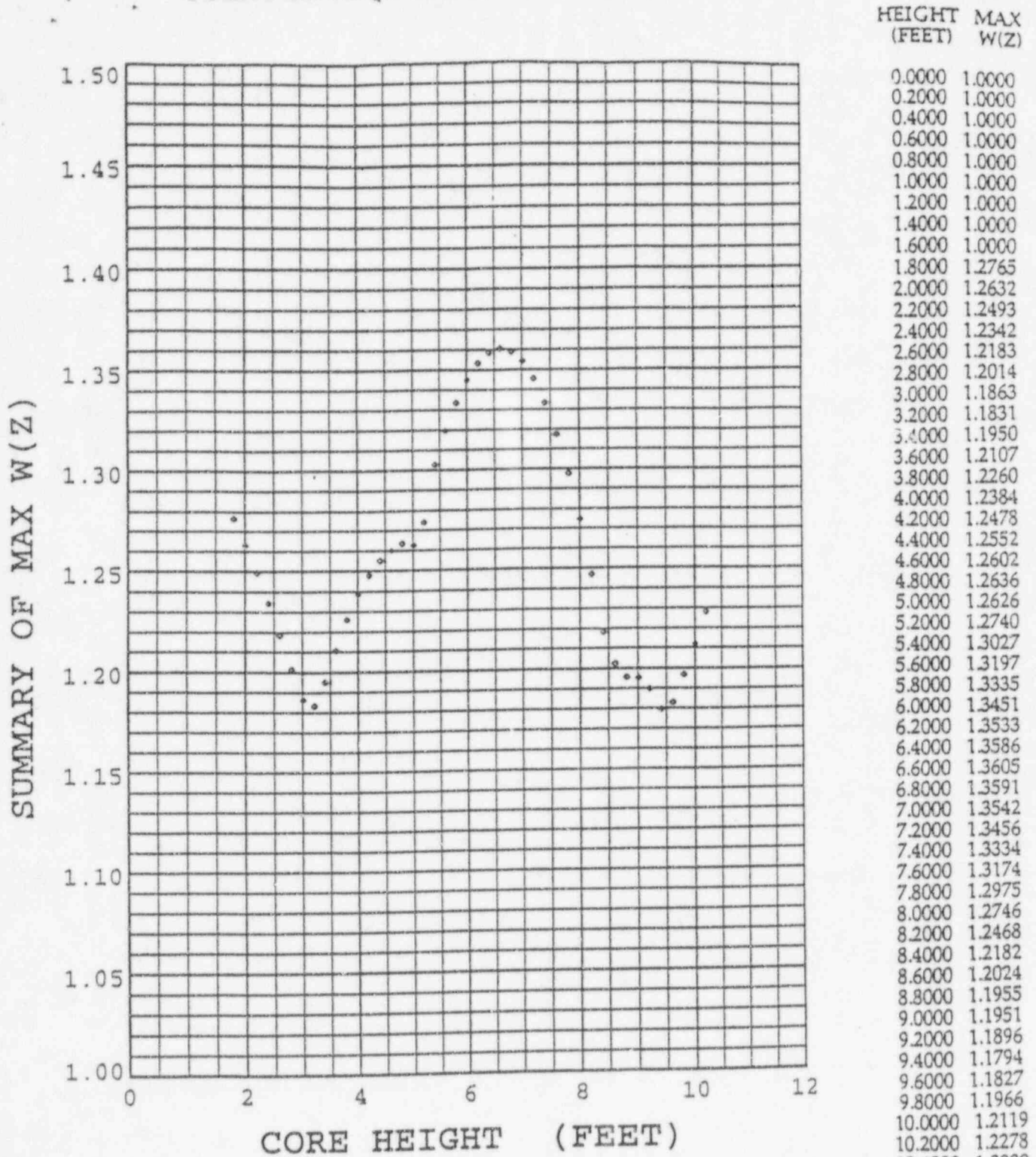


Figure 9

SEQUOYAH UNIT 2 CYCLE 7  
 RAOC SUMMARY OF MAX W(Z) AT 18400 MWD/MTU

TOP AND BOTTOM 1.5% EXCLUDED AS PER TECH SPEC 4.1.1.1.G