

VOGTLE ELECTRIC GENERATING PLANT (VEGP) UNIT 2 CYCLE 6

CORE OPERATING LIMITS REPORT

REVISION 1

January 1997

## COLR for VEGP UNIT 2 CYCLE 6

### 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP UNIT 2 CYCLE 6 has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The Technical Requirement affected by this report is listed below:

13.1.1 SHUTDOWN MARGIN - MODES 1 and 2

The Technical Specifications affected by this report are listed below:

3.1.1 SHUTDOWN MARGIN - MODES 3, 4 and 5

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 -  $F_Q(Z)$

3.2.2 Nuclear Enthalpy Rise Hot Channel Factor -  $F_{AH}^N$

3.2.3 Axial Flux Difference

3.9.1 Boron Concentration

## 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 Technical Specification 5.6.5.

### 2.1 SHUTDOWN MARGIN - MODES 1 AND 2 (Technical Requirement 13.1.1)

2.1.1 The SHUTDOWN MARGIN shall be greater than or equal to  $1.3\% \Delta k/k$ .

### 2.2 SHUTDOWN MARGIN - MODES 3, 4 AND 5 (Specification 3.1.1)

2.2.1 The SHUTDOWN MARGIN shall be greater than or equal to the limits shown in Figures 1 and 2.

### 2.3 Moderator Temperature Coefficient (Specification 3.1.3)

2.3.1 The Moderator Temperature Coefficient (MTC) limits are:

The BOL/ARO/HZP - MTC shall be less positive than  $+0.7 \times 10^{-4} \Delta k/k/^{\circ}F$  for power levels up to 70% RTP with a linear ramp to  $0 \Delta k/k/^{\circ}F$  at 100% RTP.

The EOL/ARO/RTP-MTC shall be less negative than  $-5.5 \times 10^{-4} \Delta k/k/^{\circ}F$ .\*

2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to  $-4.75 \times 10^{-4} \Delta k/k/^{\circ}F$ .\*

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to  $-5.35 \times 10^{-4} \Delta k/k/^{\circ}F$ .\*

where: 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

### 2.4 Shutdown Bank Insertion Limits (Specification 3.1.5)

2.4.1 The shutdown banks shall be withdrawn to a position greater than or equal to 225 steps.

### 2.5 Control Bank Insertion Limits (Specification 3.1.6)

2.5.1 The control banks shall be limited in physical insertion as shown in Figure 3.

\* Applicable for full-power T-average of 586.4°F.

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2.6 Heat Flux Hot Channel Factor -  $F_o(Z)$  (Specification 3.2.1)

$$2.6.1 \quad F_o(Z) \leq \frac{F_o^{RTP}}{P} * K(Z) \quad \text{for } P > 0.5$$

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

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

$$2.6.2 \quad F_o^{RTP} = 2.50$$

2.6.3  $K(Z)$  is provided in Figure 5.

$$2.6.4 \quad F_o(Z) \leq \frac{F_o^{RTP} * K(Z)}{P * W(Z)} \quad \text{for } P > 0.5$$

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

2.6.5  $W(Z)$  values are provided in Figures 6 through 9.

2.6.6 The  $F_o(Z)$  penalty factors are provided in Table 1.

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

$$2.7.1 \quad F_{\Delta H}^N \leq F_{\Delta H}^{RTP} * (1 + PF_{\Delta H} * (1-P))$$

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

$$2.7.2a \quad F_{\Delta H}^{RTP} = 1.53 \text{ for LOPAR fuel, and}$$

$$2.7.2b \quad F_{\Delta H}^{RTP} = 1.65 \text{ for VANTAGE 5 fuel}$$

$$2.7.3 \quad PF_{\Delta H} = 0.3 \text{ for LOPAR and VANTAGE 5 fuel}$$

2.8 Axial Flux Difference (Specification 3.2.3)

2.8.1 The Axial Flux Difference (AFD) Acceptable Operation Limits are provided in Figure 4.

2.9 Boron Concentration (Specification 3.9.1)

2.9.1 The boron concentration shall be greater than or equal to 2008 ppm.\*

# This concentration bounds the conditions of  $k_{eff} \leq 0.95$  (all rods in less the most reactive rod) and subcriticality (all rods out) over the entire cycle. This concentration includes additional boron to address uncertainties and  $B^{10}$  depletion.

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TABLE 1

 $F_0(Z)$  PENALTY FACTOR

Cycle Burnup (MWD/MTU)	$F_0(Z)$ Penalty Factor
30	1.028
150	1.028
574	1.039
997	1.043
1633	1.041
1844	1.033
2268	1.026
2692	1.025
3115	1.025
3539	1.023
3963	1.021
4174	1.020

## Notes:

1. The Penalty Factor, to be applied to  $F_0(Z)$  in accordance with SR 3.2.1.2, is the maximum factor by which  $F_0(Z)$  is expected to increase over a 39 EFPD interval (surveillance interval of 31 EFPD plus the maximum allowable extension not to exceed 25% of the surveillance interval per SR 3.0.2) starting from the burnup at which the  $F_0(Z)$  was determined.
2. Linear interpolation is adequate for intermediate cycle burnups.
3. For all cycle burnups outside the range of the table, a penalty factor of 1.0200 shall be used.

COLR FOR VEGP UNIT 2 CYCLE 6

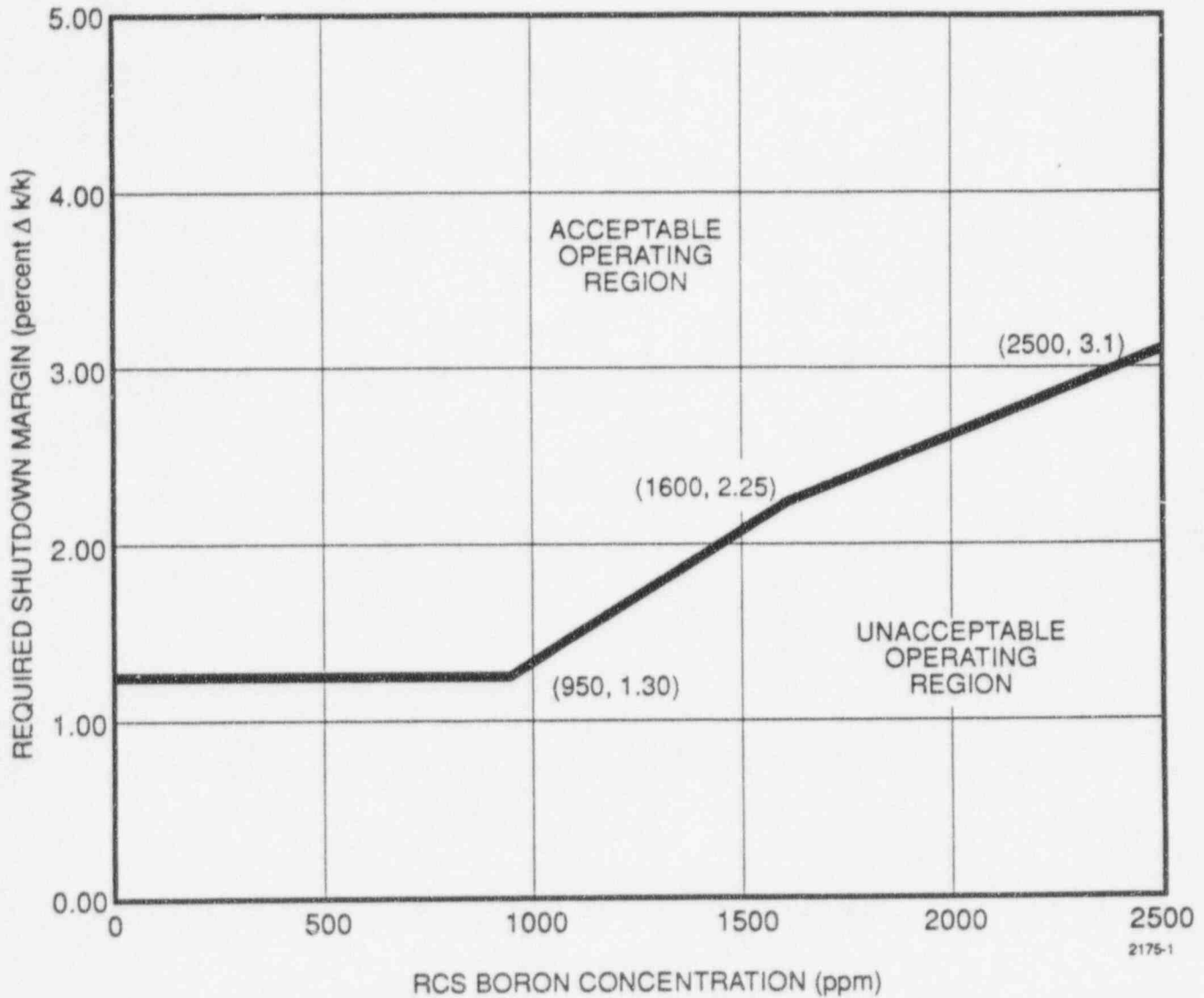


FIGURE 1

REQUIRED SHUTDOWN MARGIN FOR MODES 3 AND 4 (MODE 4 WITH AT LEAST ONE REACTOR COOLANT PUMP RUNNING)

# COLR FOR VEGP UNIT 2 CYCLE 6

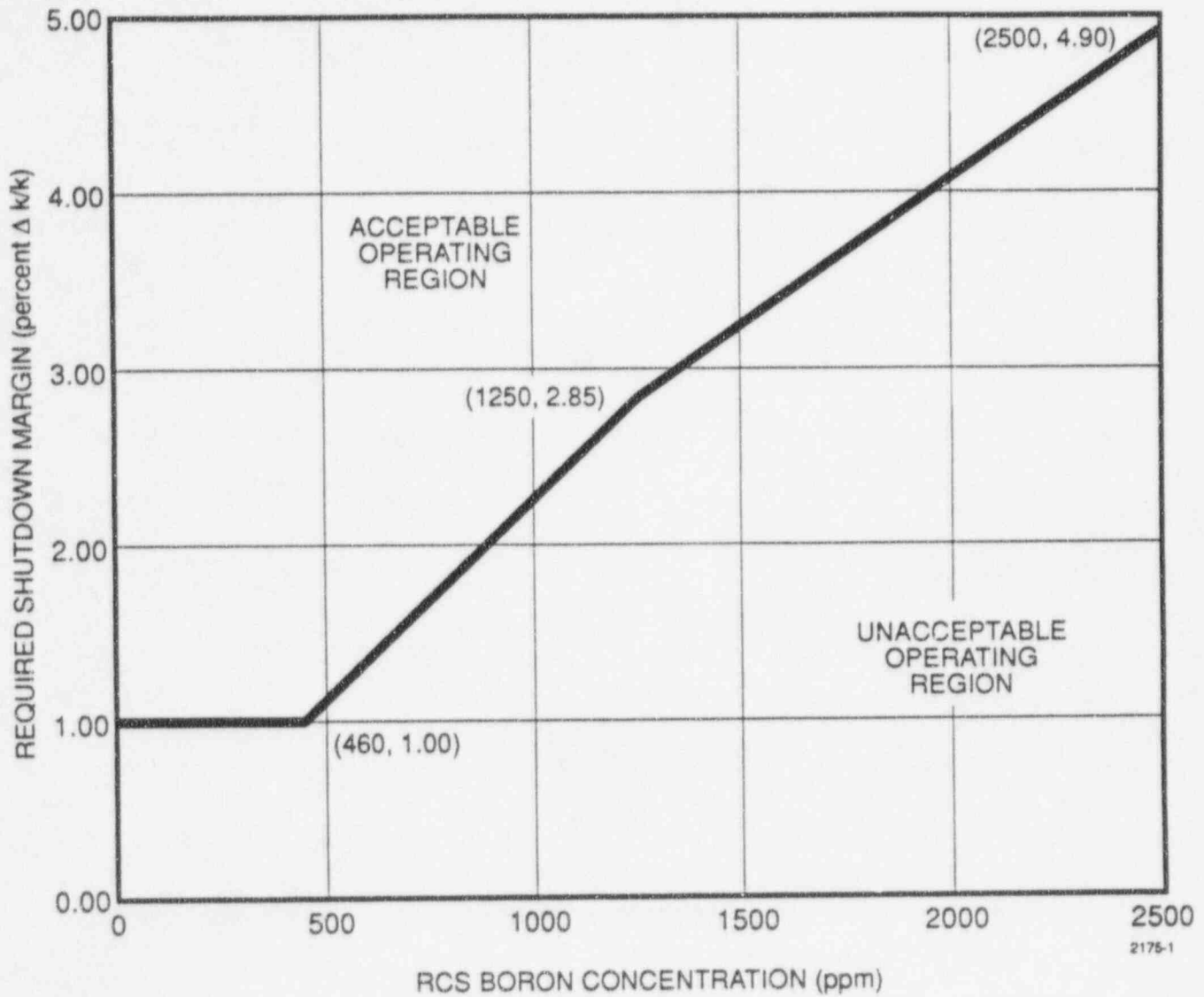
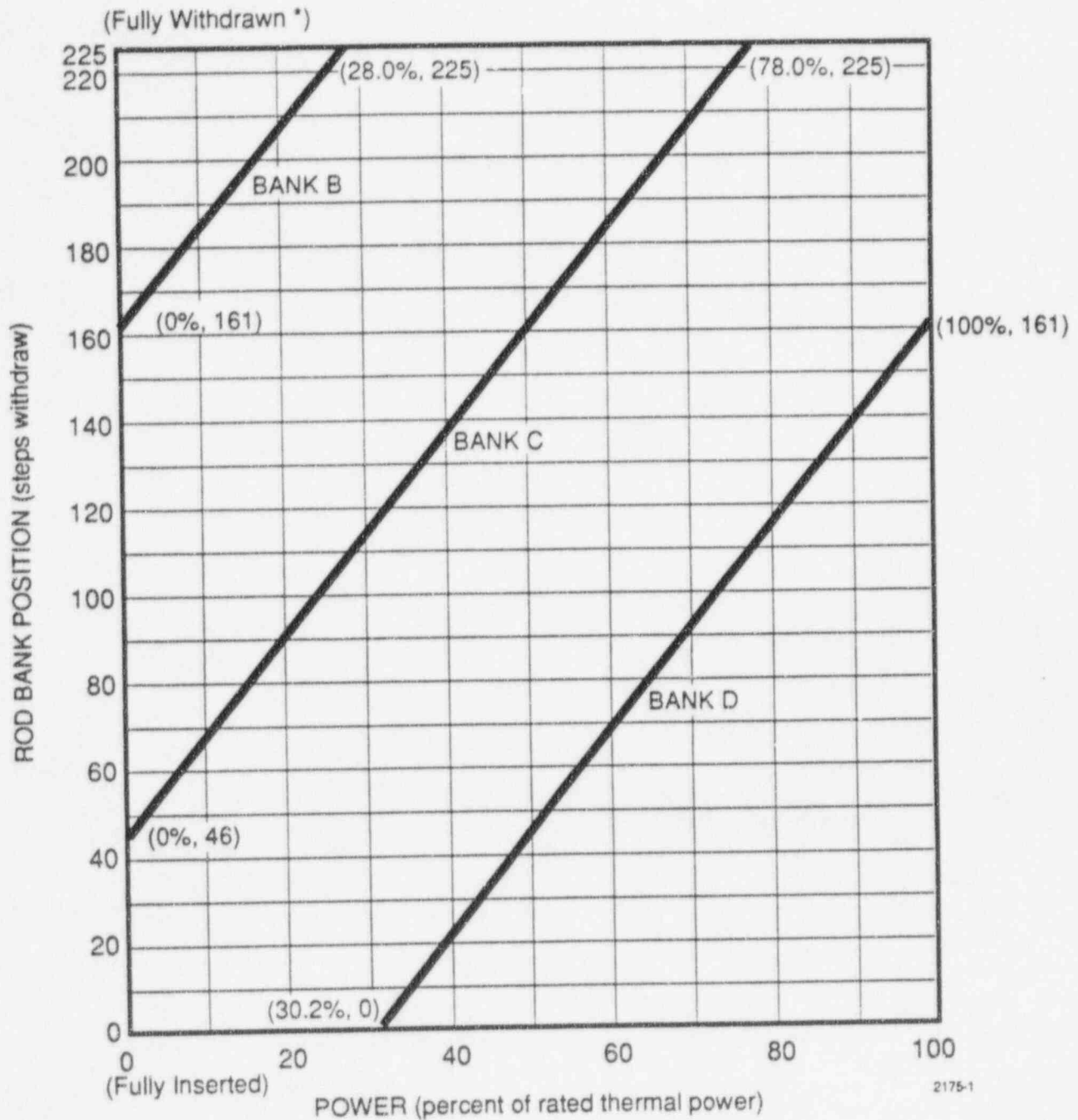


FIGURE 2

REQUIRED SHUTDOWN MARGIN FOR MODES 4 AND 5 (MODE 4 WITH NO REACTOR COOLANT PUMPS RUNNING)



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\* Fully withdrawn shall be the condition where control rods are at a position within the interval  $\geq 225$  and  $\leq 231$  steps withdrawn.

Note: The Rod Bank Insertion Limits are based on the control bank withdrawal sequence A, B, C, D and a control bank tip-to-tip distance of 115 steps.

FIGURE 3  
ROD BANK INSERTION LIMITS VERSUS THERMAL POWER

COLR FOR VEGP UNIT 2 CYCLE 6

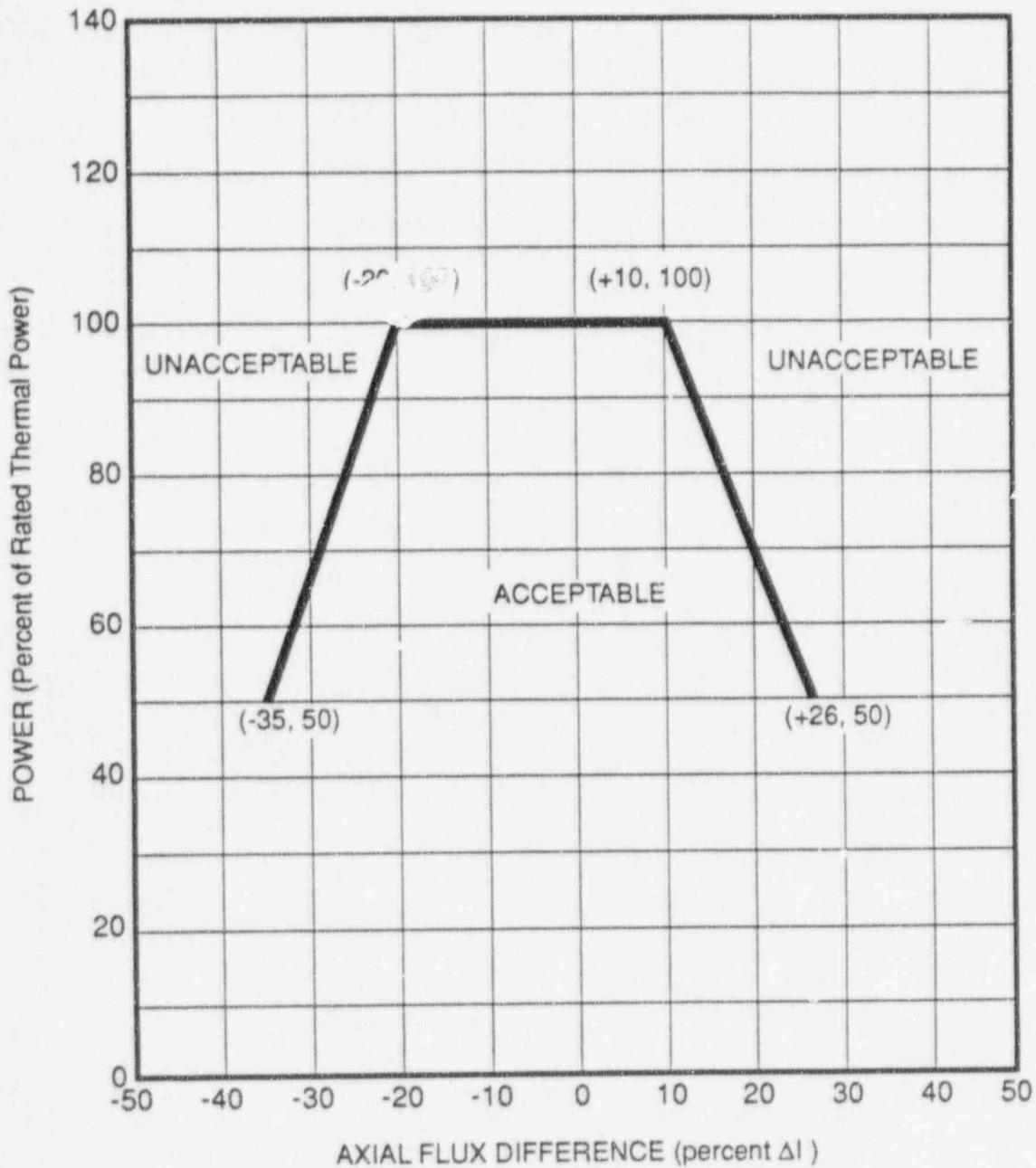


FIGURE 4

AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF RATED THERMAL POWER  
FOR RAOC

# COLR FOR VEGP UNIT 2 CYCLE 6

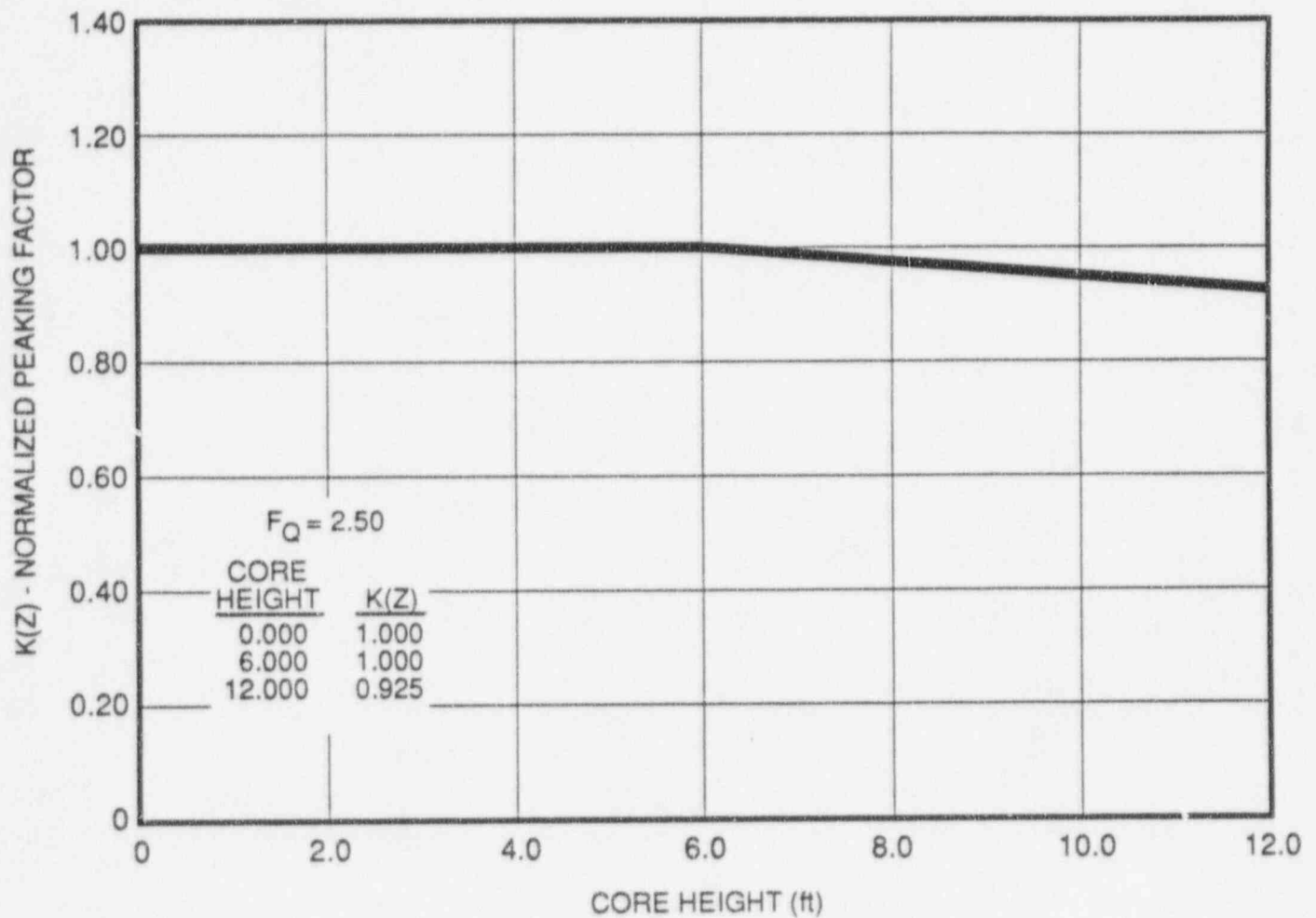
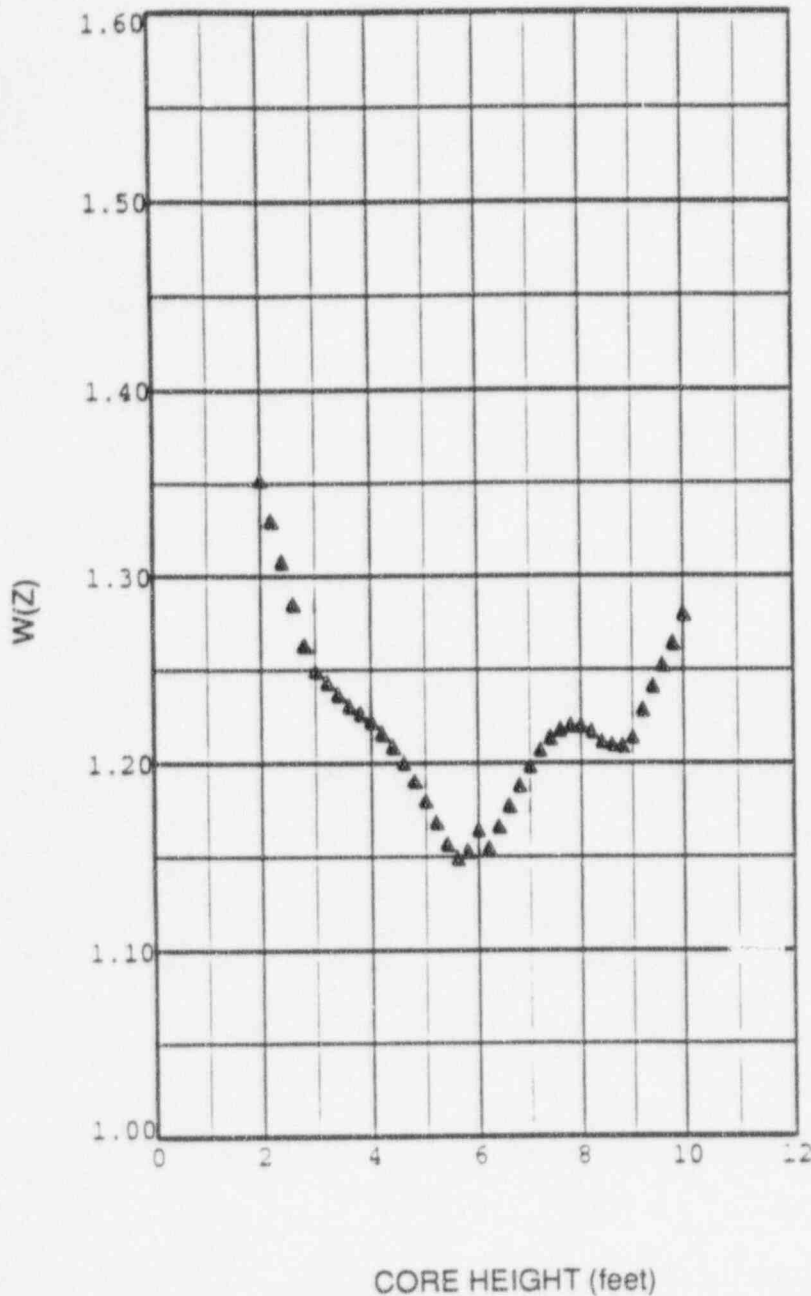


FIGURE 5

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

# COLR FOR VEGP UNIT 2 CYCLE 6



This figure is referred to by Technical Specification B3.2.1

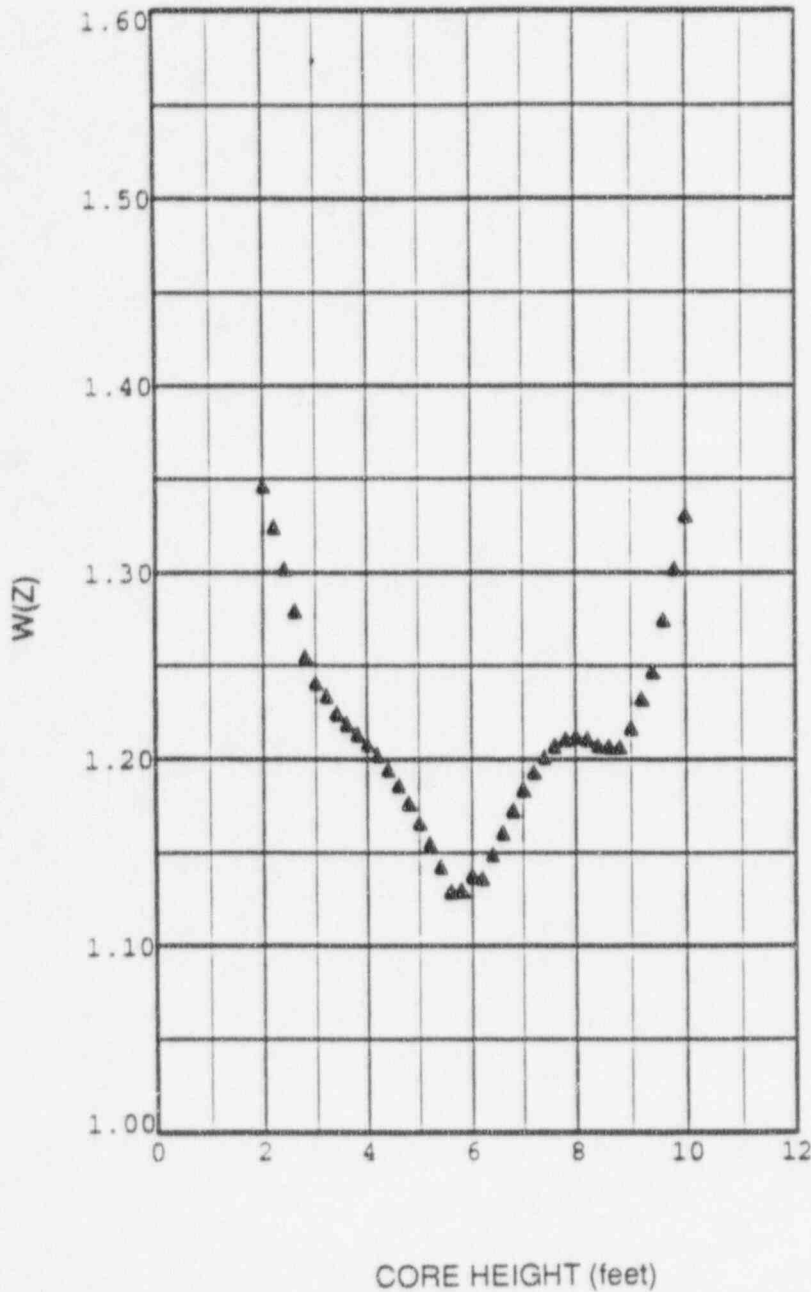
Axial Point	Elevation (feet)	BOL W(z)
* 1	12.00	1.0000
* 2	11.80	1.0000
* 3	11.60	1.0000
* 4	11.40	1.0000
* 5	11.20	1.0000
* 6	11.00	1.0000
* 7	10.80	1.0000
* 8	10.60	1.0000
* 9	10.40	1.0000
* 10	10.20	1.0000
11	10.00	1.2793
12	9.80	1.2637
13	9.60	1.2522
14	9.40	1.2408
15	9.20	1.2282
16	9.00	1.2140
17	8.80	1.2089
18	8.60	1.2097
19	8.40	1.2114
20	8.20	1.2166
21	8.00	1.2200
22	7.80	1.2200
23	7.60	1.2178
24	7.40	1.2132
25	7.20	1.2065
26	7.00	1.1981
27	6.80	1.1880
28	6.60	1.1770
29	6.40	1.1660
30	6.20	1.1545
31	6.00	1.1642
32	5.80	1.1526
33	5.60	1.1488
34	5.40	1.1562
35	5.20	1.1680
36	5.00	1.1797
37	4.80	1.1902
38	4.60	1.1999
39	4.40	1.2085
40	4.20	1.2157
41	4.00	1.2220
42	3.80	1.2263
43	3.60	1.2302
44	3.40	1.2363
45	3.20	1.2428
46	3.00	1.2491
47	2.80	1.2625
48	2.60	1.2847
49	2.40	1.3073
50	2.20	1.3296
51	2.00	1.3515
* 52	1.80	1.0000
* 53	1.60	1.0000
* 54	1.40	1.0000
* 55	1.20	1.0000
* 56	1.00	1.0000
* 57	0.80	1.0000
* 58	0.60	1.0000
* 59	0.40	1.0000
* 60	0.20	1.0000
* 61	0.00	1.0000

\* Top and Bottom 15% Excluded per Technical Specification B3.2.1

FIGURE 6

RAOC W(Z) AT 150 MWD/MTU

# COLR FOR VEGP UNIT 2 CYCLE 6



This figure is referred to by Technical  
Specification B3.2.1

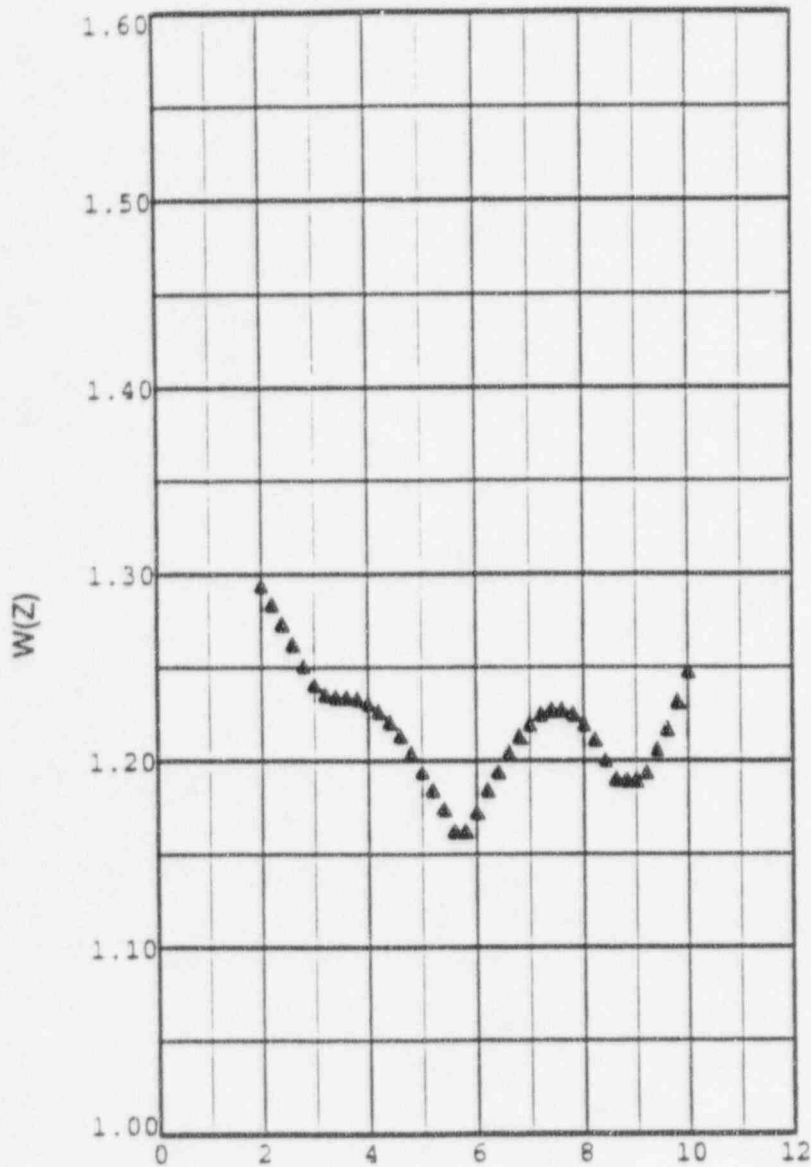
Axial Point	Elevation (feet)	MOL-1 W(z)
* 1	12.00	1.0000
* 2	11.80	1.0000
* 3	11.60	1.0000
* 4	11.40	1.0000
* 5	11.20	1.0000
* 6	11.00	1.0000
* 7	10.80	1.0000
* 8	10.60	1.0000
* 9	10.40	1.0000
* 10	10.20	1.0000
11	10.00	1.3303
12	9.80	1.3018
13	9.60	1.2744
14	9.40	1.2468
15	9.20	1.2322
16	9.00	1.2165
17	8.80	1.2064
18	8.60	1.2063
19	8.40	1.2069
20	8.20	1.2104
21	8.00	1.2120
22	7.80	1.2104
23	7.60	1.2067
24	7.40	1.2008
25	7.20	1.1929
26	7.00	1.1834
27	6.80	1.1723
28	6.60	1.1604
29	6.40	1.1487
30	6.20	1.1359
31	6.00	1.1373
32	5.80	1.1295
33	5.60	1.1289
34	5.40	1.1423
35	5.20	1.1547
36	5.00	1.1657
37	4.80	1.1763
38	4.60	1.1859
39	4.40	1.1945
40	4.20	1.2019
41	4.00	1.2079
42	3.80	1.2132
43	3.60	1.2186
44	3.40	1.2244
45	3.20	1.2334
46	3.00	1.2406
47	2.80	1.2546
48	2.60	1.2792
49	2.40	1.3017
50	2.20	1.3239
51	2.00	1.3460
* 52	1.80	1.0000
* 53	1.60	1.0000
* 54	1.40	1.0000
* 55	1.20	1.0000
* 56	1.00	1.0000
* 57	0.80	1.0000
* 58	0.60	1.0000
* 59	0.40	1.0000
* 60	0.20	1.0000
* 61	0.00	1.0000

\* Top and Bottom 15% Excluded per  
Technical Specification B3.2.1

FIGURE 7

RAOC W(Z) AT 4000 MWD/MTU

# COLR FOR VEGP UNIT 2 CYCLE 6



CORE HEIGHT (feet)

This figure is referred to by Technical Specification B3.2.1

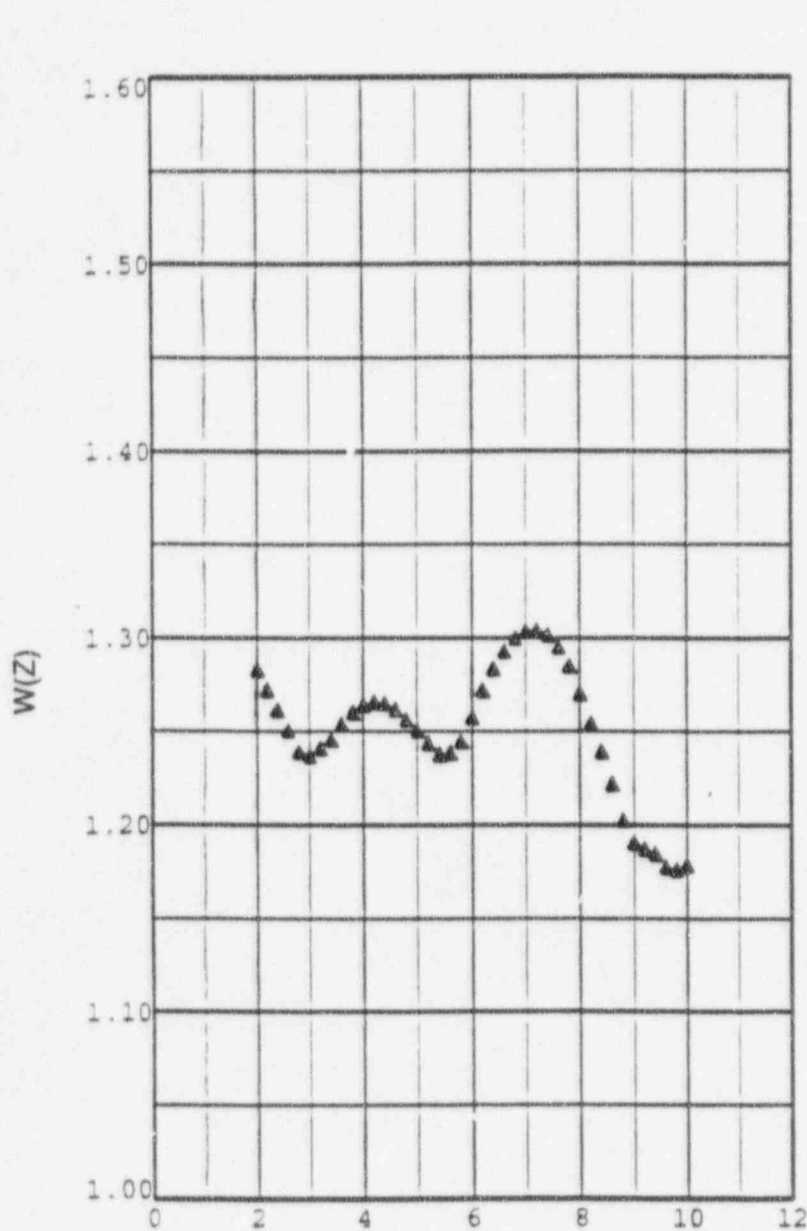
Axial Point	Elevation (feet)	MOL-2 W(z)
* 1	12.00	1.0000
* 2	11.80	1.0000
* 3	11.60	1.0000
* 4	11.40	1.0000
* 5	11.20	1.0000
* 6	11.00	1.0000
* 7	10.80	1.0000
* 8	10.60	1.0000
* 9	10.40	1.0000
* 10	10.20	1.0000
11	10.00	1.2476
12	9.80	1.2311
13	9.60	1.2166
14	9.40	1.2056
15	9.20	1.1937
16	9.00	1.1894
17	8.80	1.1892
18	8.60	1.1899
19	8.40	1.2000
20	8.20	1.2109
21	8.00	1.2192
22	7.80	1.2244
23	7.60	1.2270
24	7.40	1.2268
25	7.20	1.2243
26	7.00	1.2194
27	6.80	1.2125
28	6.60	1.2038
29	6.40	1.1939
30	6.20	1.1840
31	6.00	1.1721
32	5.80	1.1620
33	5.60	1.1618
34	5.40	1.1738
35	5.20	1.1841
36	5.00	1.1939
37	4.80	1.2040
38	4.60	1.2130
39	4.40	1.2204
40	4.20	1.2262
41	4.00	1.2304
42	3.80	1.2330
43	3.60	1.2339
44	3.40	1.2337
45	3.20	1.2351
46	3.00	1.2407
47	2.80	1.2506
48	2.60	1.2623
49	2.40	1.2732
50	2.20	1.2837
51	2.00	1.2941
* 52	1.80	1.0000
* 53	1.60	1.0000
* 54	1.40	1.0000
* 55	1.20	1.0000
* 56	1.00	1.0000
* 57	0.80	1.0000
* 58	0.60	1.0000
* 59	0.40	1.0000
* 60	0.20	1.0000
* 61	0.00	1.0000

\* Top and Bottom 15% Excluded per Technical Specification B3.2.1

FIGURE 8

RAOC W(Z) AT 11000 MWD/MTU

# COLR FOR VEGP UNIT 2 CYCLE 6



CORE HEIGHT (feet)

This figure is referred to by Technical  
Specification B3.2.1

Axial Point	Elevation (feet)	EOL W(z)
* 1	12.00	1.0000
* 2	11.80	1.0000
* 3	11.60	1.0000
* 4	11.40	1.0000
* 5	11.20	1.0000
* 6	11.00	1.0000
* 7	10.80	1.0000
* 8	10.60	1.0000
* 9	10.40	1.0000
* 10	10.20	1.0000
11	10.00	1.1783
12	9.80	1.1757
13	9.60	1.1772
14	9.40	1.1842
15	9.20	1.1869
16	9.00	1.1902
17	8.80	1.2023
18	8.60	1.2216
19	8.40	1.2391
20	8.20	1.2540
21	8.00	1.2701
22	7.80	1.2848
23	7.60	1.2948
24	7.40	1.3012
25	7.20	1.3039
26	7.00	1.3032
27	6.80	1.2994
28	6.60	1.2927
29	6.40	1.2834
30	6.20	1.2719
31	6.00	1.2571
32	5.80	1.2443
33	5.60	1.2383
34	5.40	1.2374
35	5.20	1.2435
36	5.00	1.2502
37	4.80	1.2560
38	4.60	1.2617
39	4.40	1.2648
40	4.20	1.2655
41	4.00	1.2638
42	3.80	1.2599
43	3.60	1.2536
44	3.40	1.2454
45	3.20	1.2407
46	3.00	1.2365
47	2.80	1.2390
48	2.60	1.2504
49	2.40	1.2613
50	2.20	1.2720
51	2.00	1.2828
* 52	1.80	1.0000
* 53	1.60	1.0000
* 54	1.40	1.0000
* 55	1.20	1.0000
* 56	1.00	1.0000
* 57	0.80	1.0000
* 58	0.60	1.0000
* 59	0.40	1.0000
* 60	0.20	1.0000
* 61	0.00	1.0000

\* Top and Bottom 15% Excluded per  
Technical Specification B3.2.1

FIGURE 9

RAOC W(Z) AT 19000 MWD/MTU