

VOGTLE ELECTRIC GENERATING PLANT (VEGP) UNIT 1 CYCLE 7

CORE OPERATING LIMITS REPORT

MARCH 1996

COLR for VEGP UNIT 1 CYCLE 7

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP UNIT 1 CYCLE 7 has been prepared in accordance with the requirements of Technical Specification 6.8.1.6.

The Technical Specifications affected by this report are listed below:

3/4.1.1.1	SHUTDOWN MARGIN - MODES 1 and 2
3/4.1.1.2	SHUTDOWN MARGIN - MODES 3, 4 and 5
3/4.1.1.3	Moderator Temperature Coefficient
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
3/4.2.2	Heat Flux Hot Channel Factor - $F_o(Z)$
3/4.2.3	Nuclear Enthalpy Rise Hot Channel Factor - F_{AH}^N

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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 6.8.1.6

2.1 SHUTDOWN MARGIN - MODES 1 AND 2 (Specification 3/4.1.1.1)

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

2.2 SHUTDOWN MARGIN - MODES 3, 4 AND 5 (Specification 3/4.1.1.2)

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 3/4.1.1.3)

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 percent RTP with a linear ramp to $0 \Delta k/k/^{\circ}F$ at 100 percent RTP.

The EOL/ARO/RTP-MTC shall be less negative than $-5.50 \times 10^{-4} \Delta k/k/^{\circ}F$.*

2.3.2 The MTC Surveillance limit is:

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

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 Rod Insertion Limit (Specification 3/4.1.3.5)

2.4.1 The shutdown rods shall be withdrawn to a position greater than or equal to 225 steps.

2.5 Control Rod Insertion Limits (Specification 3/4.1.3.6)

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

*Based on full-power T-average of 586.4.

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2.6 Axial Flux Difference (Specification 3/4.2.1)
{relaxed axial offset control (RAOC) methodology}

2.6.1 The Axial Flux Difference (AFD) acceptable operation limits are provided in figure 4.

2.7 Heat Flux Hot Channel Factor - $F_q(Z)$ (Specification 3/4.2.2)
{ F_q methodology}

$$2.7.1 \quad F_q(Z) \leq \frac{F_q^{\text{RTP}}}{P} * K(Z) \quad \text{for } P > 0.5$$

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

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

$$2.7.2 \quad F_q^{\text{RTP}} = 2.50$$

2.7.3 $K(Z)$ is provided in figure 5.

$$2.7.4 \quad F_q^C(Z) \leq \frac{F_q^{\text{RTP}}}{P * W(Z)} * K(Z) \quad \text{for } P > 0.5$$

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

2.7.5 $W(Z)$ values are provided in figures 6 through 9.

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2.7.6 The $F_Q^C(Z)$ penalty factors are provided in table 1.

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

$$2.8.1 \quad F_{\Delta H}^N \leq F_{\Delta H}^{RTP} * (1 + PF_{\Delta H} * (1-P))$$

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

$$2.8.2a \quad F_{\Delta H}^{RTP} = 1.53 \text{ for LOPAR fuel and}$$

$$2.8.2b \quad F_{\Delta H}^{RTP} = 1.65 \text{ for VANTAGE 5 fuel}$$

$$2.8.3 \quad PF_{\Delta H} = 0.3 \text{ for LOPAR and VANTAGE 5 fuel}$$

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TABLE 1

 $F_0^c(Z)$ PENALTY FACTOR

Cycle Burnup (MWD/MTU)	$F_0^c(Z)$ Penalty Factor
360	1.021
1408	1.021
3085	1.024
3295	1.030
3924	1.033
4344	1.031
4973	1.026
5392	1.024
6021	1.023
6650	1.022
7069	1.021

Notes:

1. The Penalty Factor, to be applied to $F_0^c(Z)$ in accordance with surveillance requirement 4.2.2.2.f, is the maximum factor by which $F_0^c(Z)$ 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 Technical Specification 4.0.2) starting from the burnup at which the $F_0^c(Z)$ 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.

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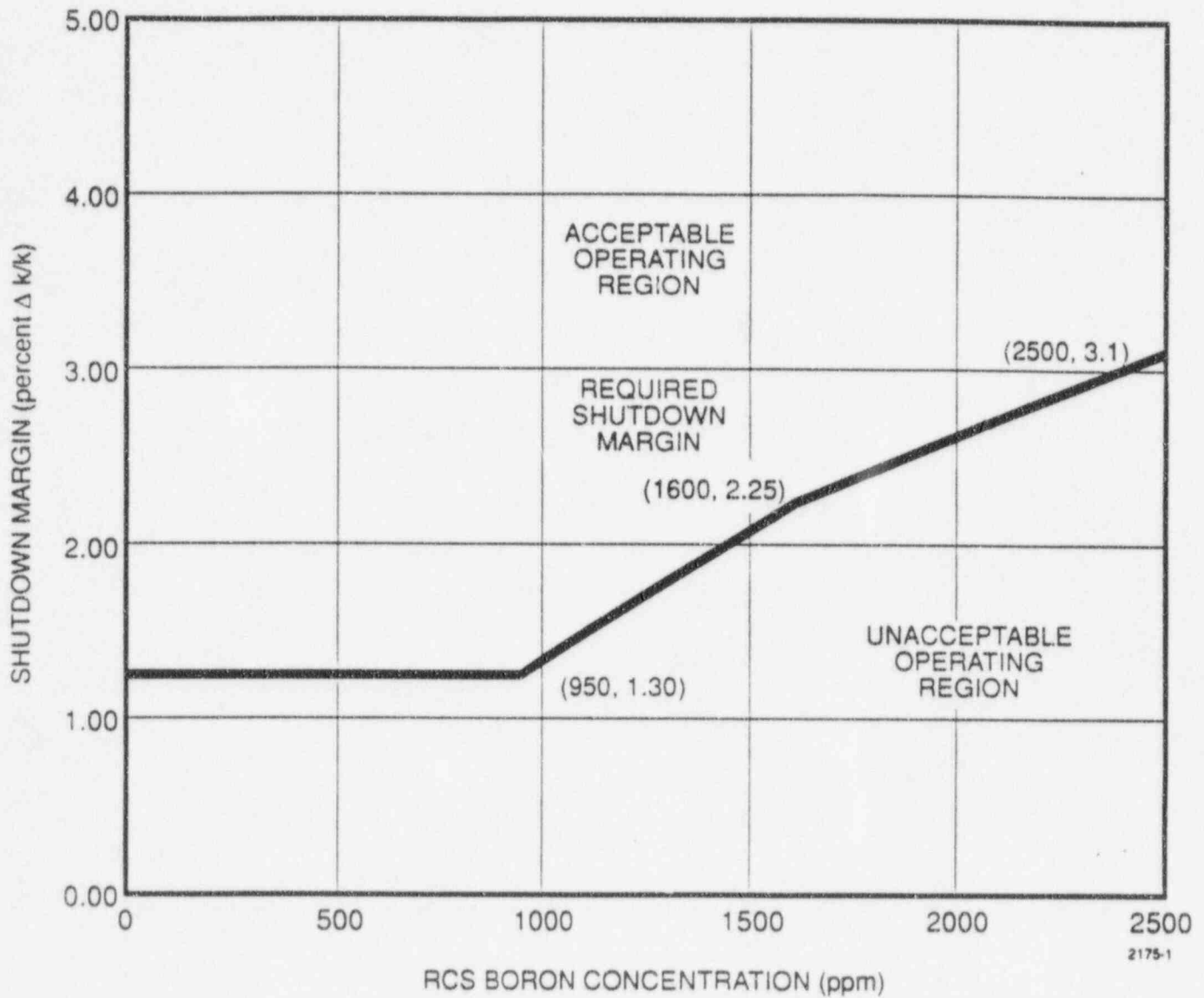


FIGURE 1

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

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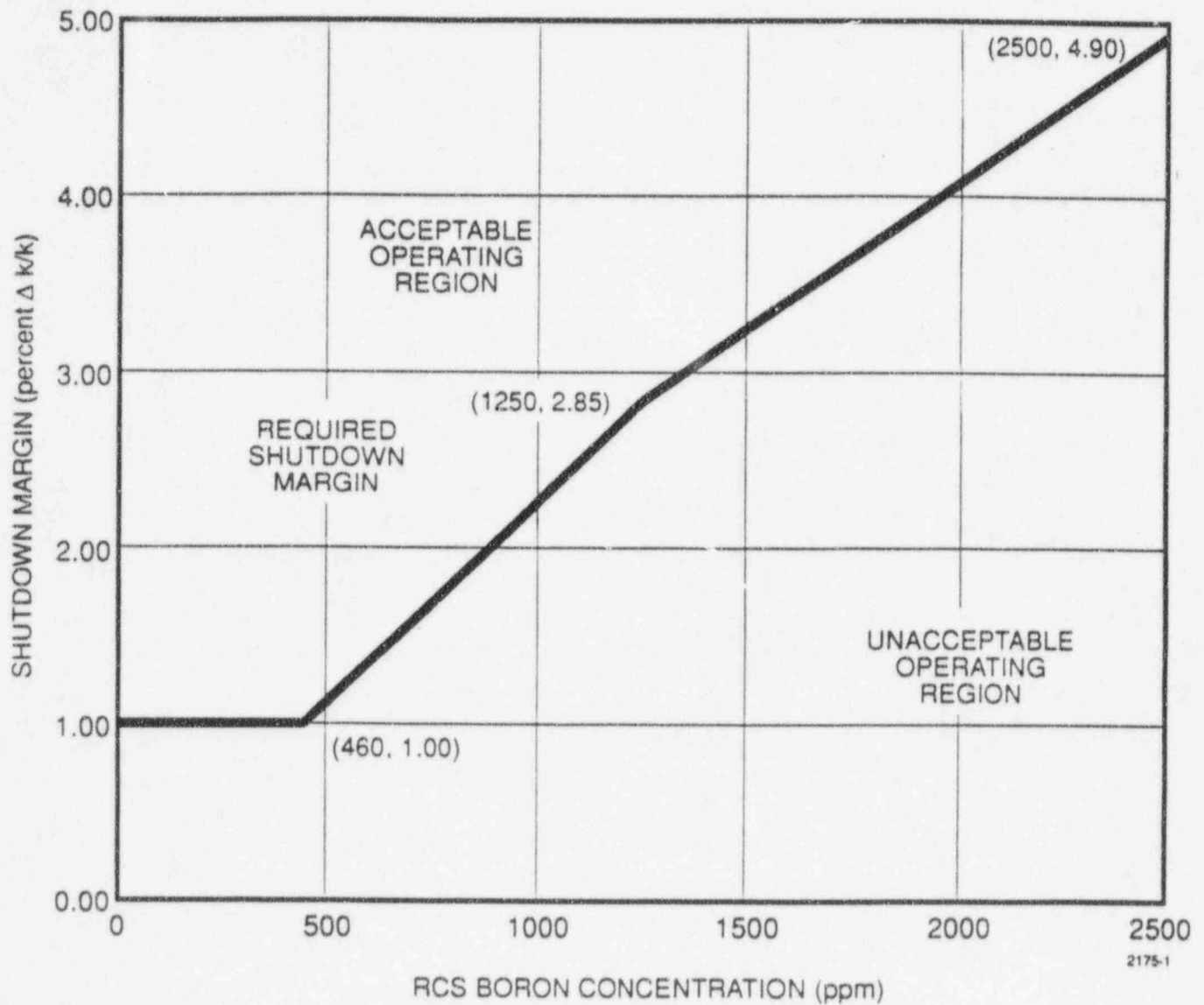
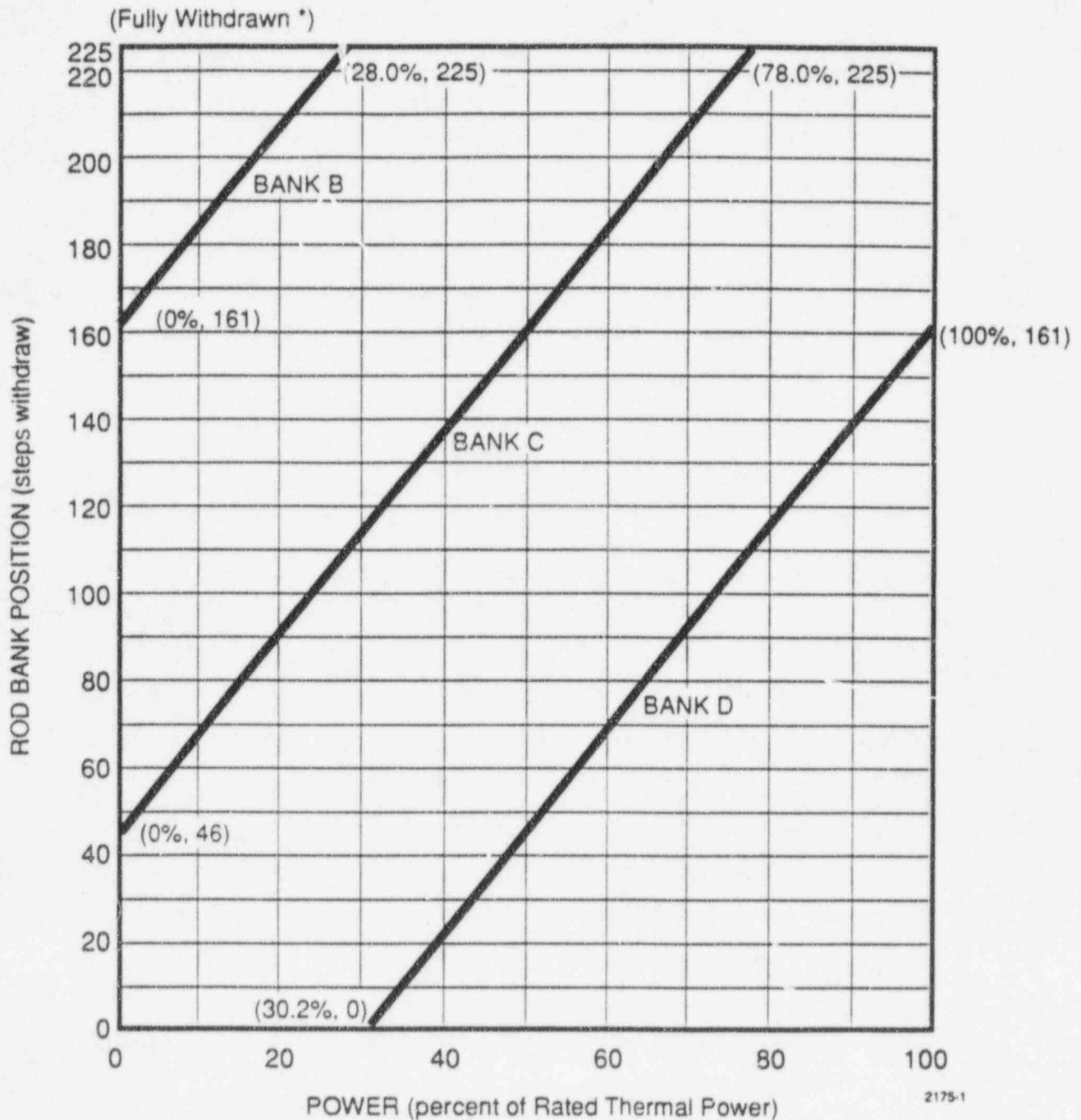


FIGURE 2

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 ≥ 225 and ≤ 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 RATED THERMAL POWER

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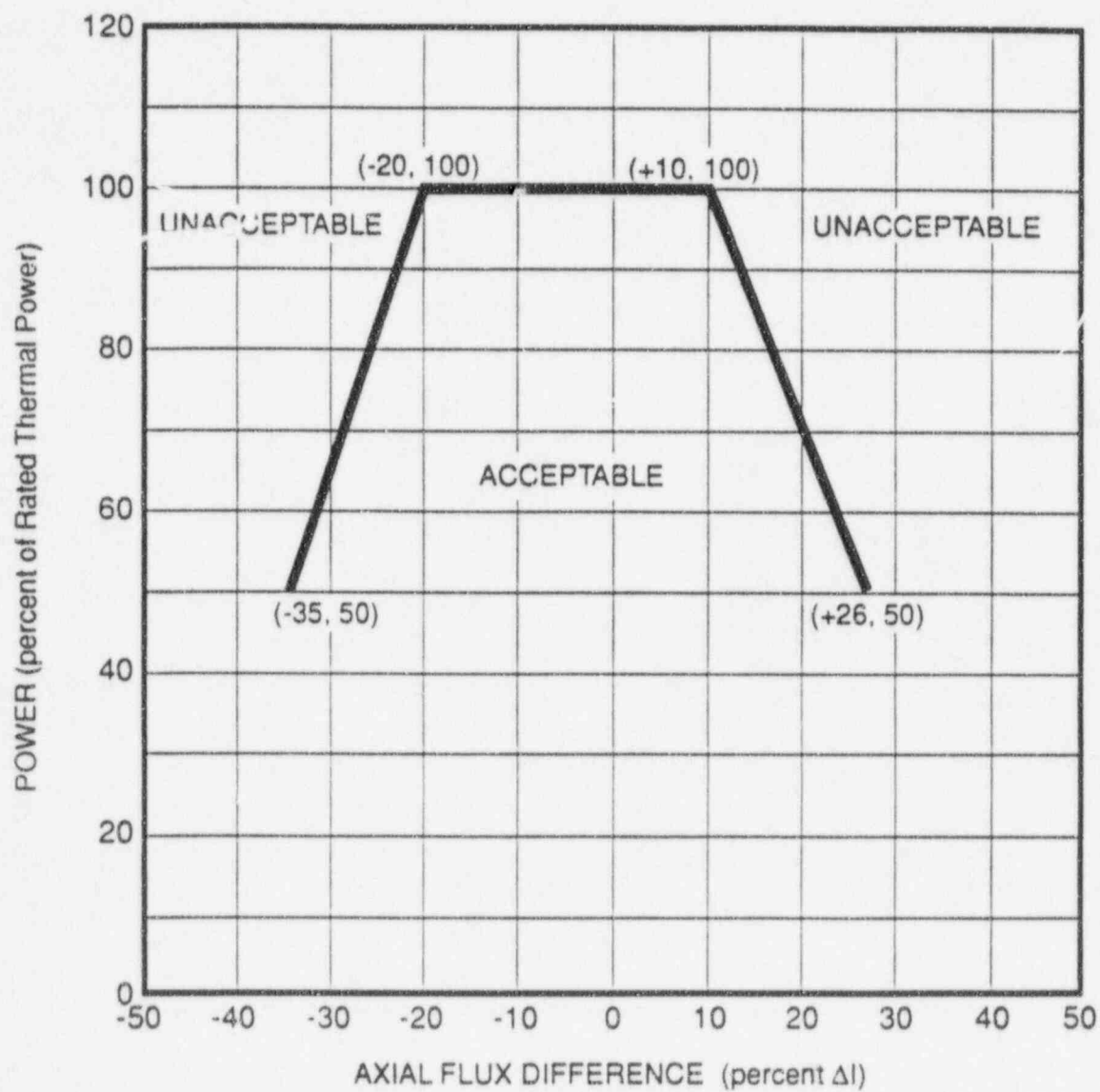


FIGURE 4

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

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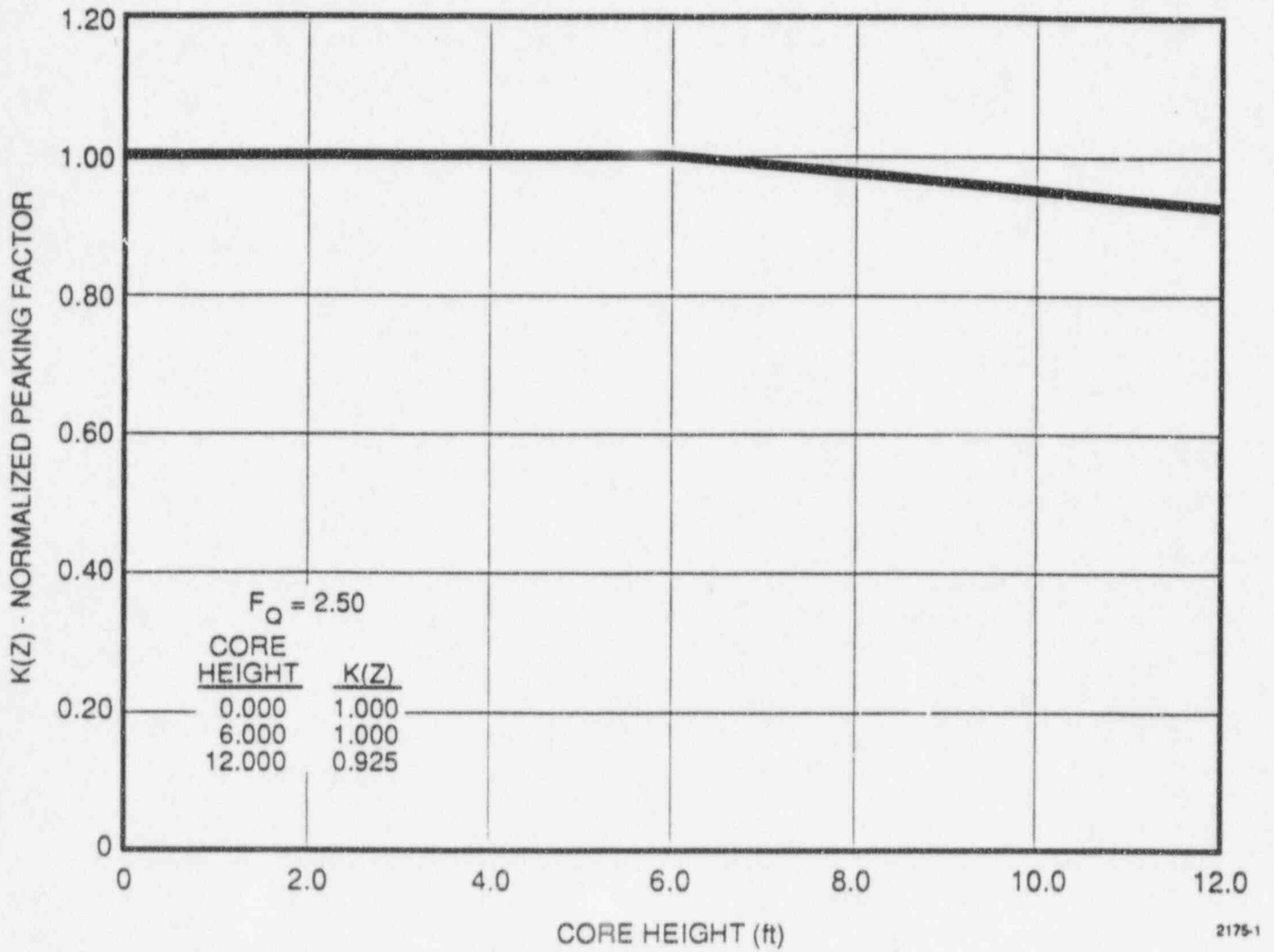


FIGURE 5

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

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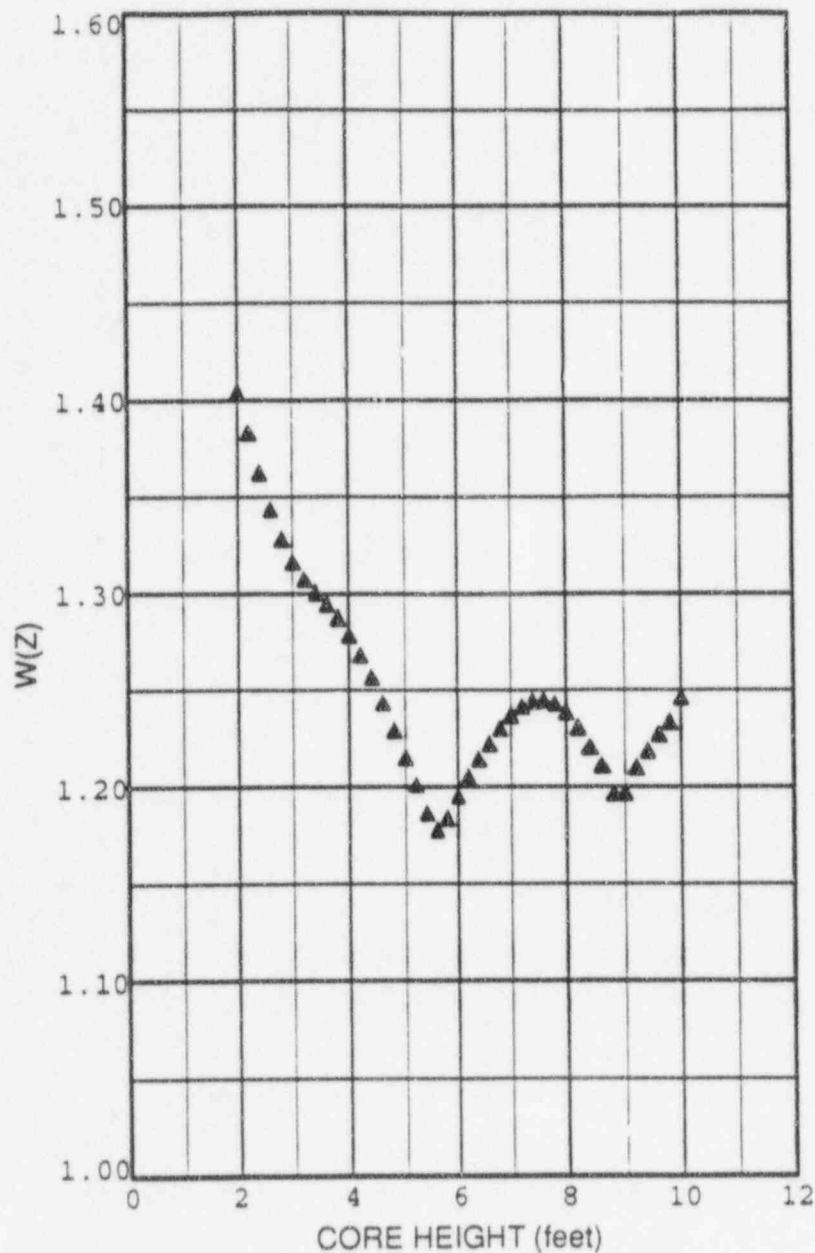


FIGURE 6
RAOC W(Z) AT 150 MWD/MTU

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	1.2462
12	9.80	1.2334
13	9.60	1.2269
14	9.40	1.2183
15	9.20	1.2096
16	9.00	1.1967
17	8.80	1.1963
18	8.60	1.2108
19	8.40	1.2202
20	8.20	1.2303
21	8.00	1.2383
22	7.80	1.2427
23	7.60	1.2448
24	7.40	1.2442
25	7.20	1.2414
26	7.00	1.2366
27	6.80	1.2298
28	6.60	1.2219
29	6.40	1.2141
30	6.20	1.2050
31	6.00	1.1950
32	5.80	1.1835
33	5.60	1.1774
34	5.40	1.1861
35	5.20	1.2007
36	5.00	1.2148
37	4.80	1.2289
38	4.60	1.2433
39	4.40	1.2564
40	4.20	1.2680
41	4.00	1.2783
42	3.80	1.2872
43	3.60	1.2944
44	3.40	1.3001
45	3.20	1.3072
46	3.00	1.3163
47	2.80	1.3280
48	2.60	1.3432
49	2.40	1.3620
50	2.20	1.3829
51	2.00	1.4038
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 4.2.2.2

This figure is referred to by Technical Specifications 4.2.2.2d, B3/4.2.2

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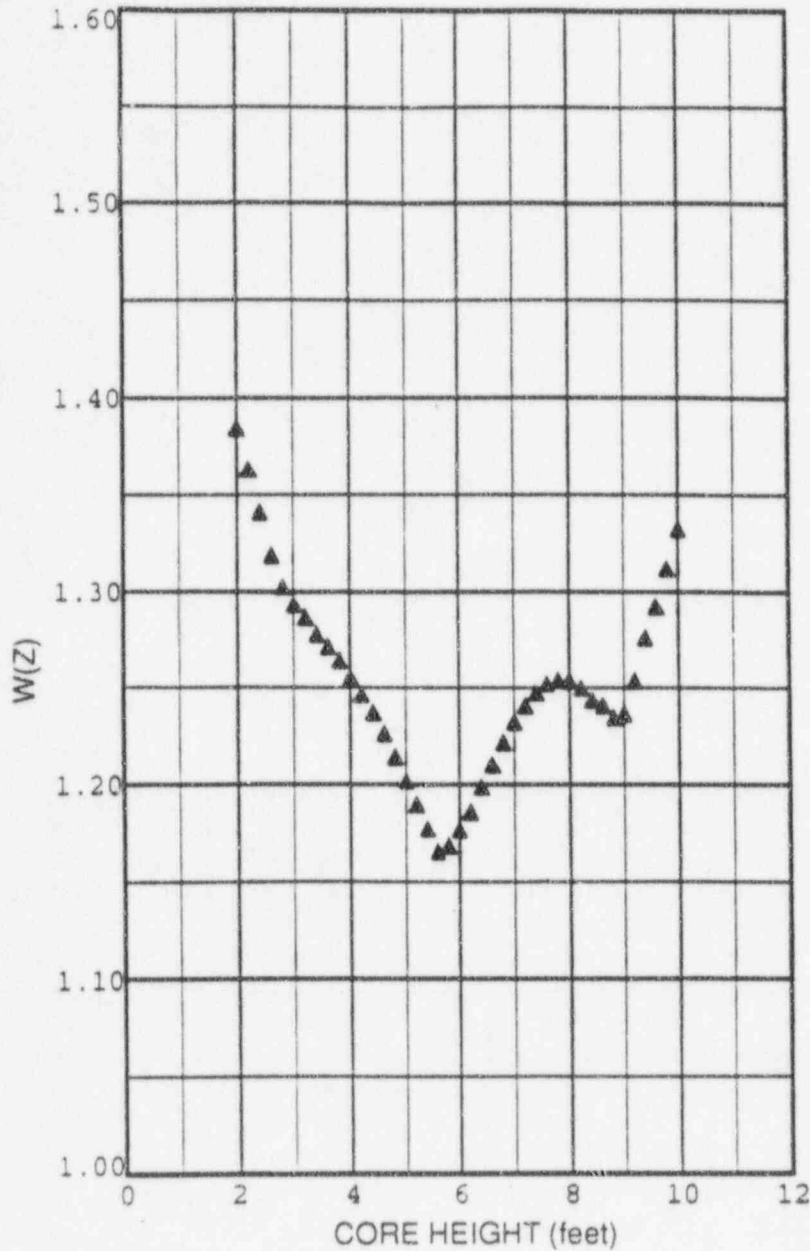


FIGURE 7
RAOC W(Z) AT 4000 MWD/MTU

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	1.3323
12	9.80	1.3115
13	9.60	1.2919
14	9.40	1.2756
15	9.20	1.2534
16	9.00	1.2364
17	8.80	1.2341
18	8.60	1.2404
19	8.40	1.2434
20	8.20	1.2494
21	8.00	1.2534
22	7.80	1.2538
23	7.60	1.2518
24	7.40	1.2472
25	7.20	1.2404
26	7.00	1.2318
27	6.80	1.2213
28	6.60	1.2097
29	6.40	1.1985
30	6.20	1.1856
31	6.00	1.1763
32	5.80	1.1681
33	5.60	1.1652
34	5.40	1.1769
35	5.20	1.1894
36	5.00	1.2014
37	4.80	1.2139
38	4.60	1.2258
39	4.40	1.2366
40	4.20	1.2460
41	4.00	1.2552
42	3.80	1.2637
43	3.60	1.2708
44	3.40	1.2773
45	3.20	1.2861
46	3.00	1.2930
47	2.80	1.3020
48	2.60	1.3185
49	2.40	1.3409
50	2.20	1.3627
51	2.00	1.3839
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 4.2.2.2

This figure is referred to by Technical Specifications 4.2.2.2d, B3/4.2.2

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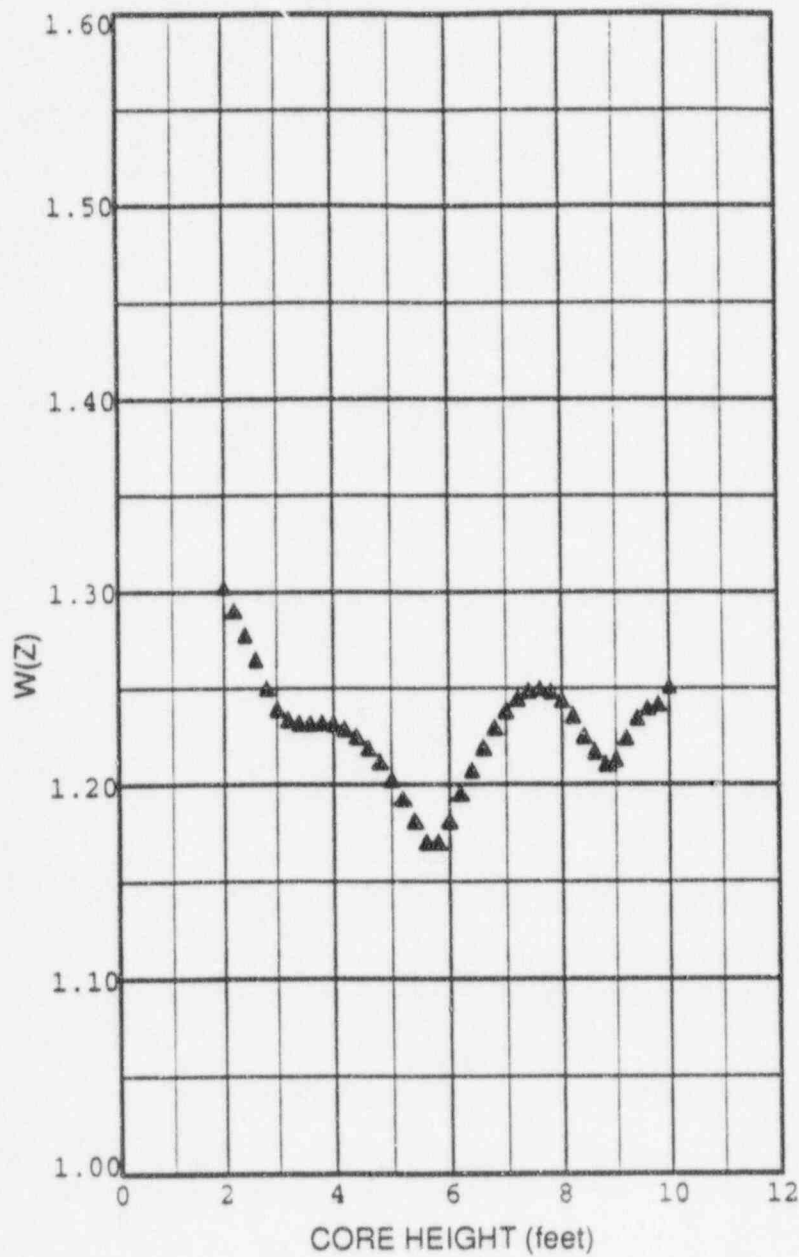


FIGURE 8
RAOC W(Z) AT 11000 MWD/MTU

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	1.2506
12	9.80	1.2416
13	9.60	1.2393
14	9.40	1.2343
15	9.20	1.2239
16	9.00	1.2129
17	8.80	1.2103
18	8.60	1.2166
19	8.40	1.2249
20	8.20	1.2354
21	8.00	1.2435
22	7.80	1.2480
23	7.60	1.2496
24	7.40	1.2483
25	7.20	1.2443
26	7.00	1.2379
27	6.80	1.2292
28	6.60	1.2187
29	6.40	1.2071
30	6.20	1.1952
31	6.00	1.1810
32	5.80	1.1699
33	5.60	1.1699
34	5.40	1.1808
35	5.20	1.1923
36	5.00	1.2024
37	4.80	1.2113
38	4.60	1.2186
39	4.40	1.2245
40	4.20	1.2286
41	4.00	1.2312
42	3.80	1.2318
43	3.60	1.2316
44	3.40	1.2316
45	3.20	1.2333
46	3.00	1.2389
47	2.80	1.2499
48	2.60	1.2644
49	2.40	1.2775
50	2.20	1.2902
51	2.00	1.3025
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 4.2.2.2

This figure is referred to by Technical Specifications 4.2.2.2d, B3/4.2.2

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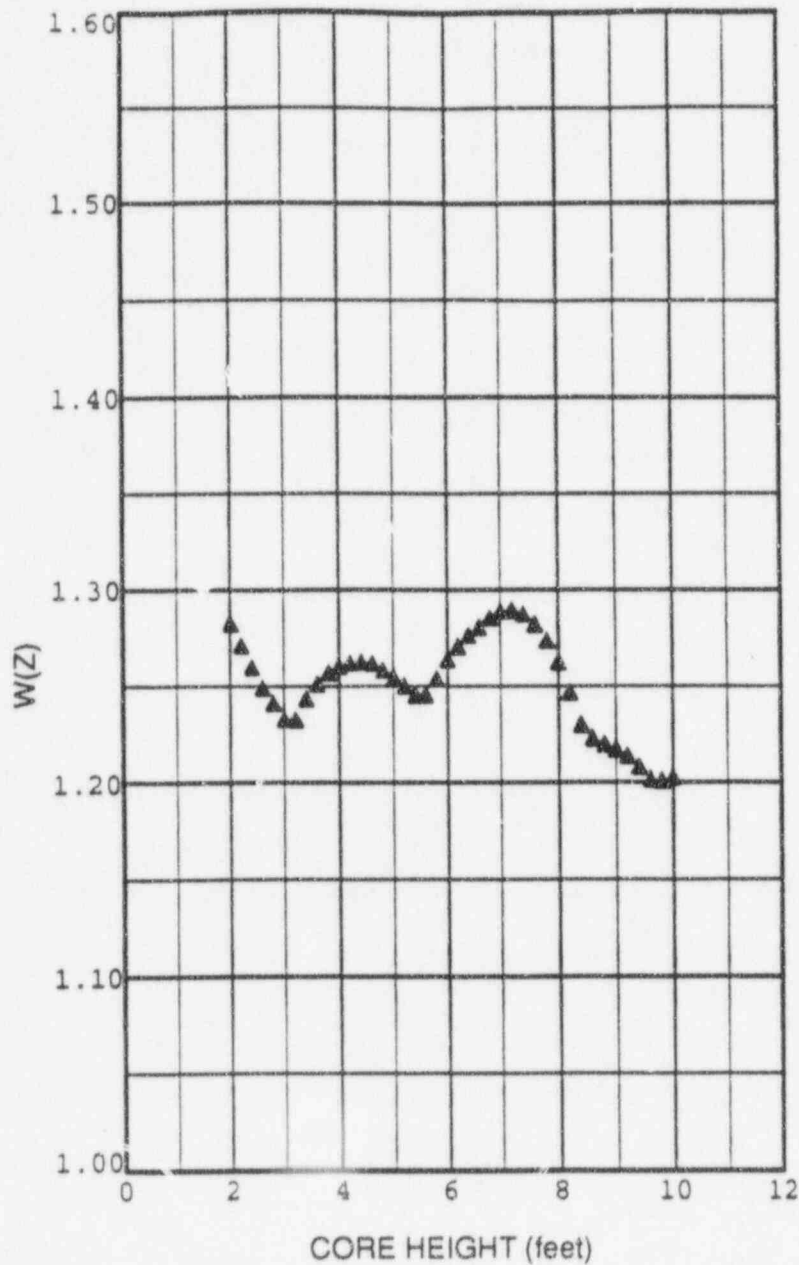


FIGURE 9

RAOC W(Z) AT 19000 MWD/MTU

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	1.2023
12	9.80	1.2005
13	9.60	1.2013
14	9.40	1.2077
15	9.20	1.2133
16	9.00	1.2167
17	8.80	1.2193
18	8.60	1.2226
19	8.40	1.2297
20	8.20	1.2464
21	8.00	1.2620
22	7.80	1.2732
23	7.60	1.2816
24	7.40	1.2869
25	7.20	1.2891
26	7.00	1.2886
27	6.80	1.2851
28	6.60	1.2802
29	6.40	1.2759
30	6.20	1.2703
31	6.00	1.2635
32	5.80	1.2534
33	5.60	1.2450
34	5.40	1.2450
35	5.20	1.2497
36	5.00	1.2541
37	4.80	1.2579
38	4.60	1.2614
39	4.40	1.2623
40	4.20	1.2616
41	4.00	1.2600
42	3.80	1.2565
43	3.60	1.2509
44	3.40	1.2433
45	3.20	1.2322
46	3.00	1.2325
47	2.80	1.2408
48	2.60	1.2487
49	2.40	1.2595
50	2.20	1.2708
51	2.00	1.2821
* 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 4.2.2.2

This figure is referred to by Technical Specifications 4.2.2.2d, B3/4.2.2