VOGTLE ELECTRIC GENERATING PLANT (VEGP) UNIT 1 CYCLE 7

CORE OPERATING LIMITS REPORT

REVISION 1

JANUARY 1997

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 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 - $F^N_{\Delta H}$
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 percent $\Delta k/k$.

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 $+0.7 \times 10^{-4}$ $\Delta k/k/°F$ for power levels up to 70 percent RTP with a linear ramp to 0 $\Delta k/k/°F$ at 100 percent RTP.

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

2.3.2 The MTC Surveillance limits are:

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

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

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2.4.1 The shutdown banks shall be withdrawn to a position greater than or equal to 225 steps.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

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

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

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

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

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

2.6.2 $$F_Q^{RTP} = 2.50$$

2.6.3 K(Z) is provided in figure 5.

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

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

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

2.6.6 The $F_Q(Z)$ penalty factors are provided in table 1.

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

2.7.1 $F^N_{\Delta H} \leq F^{RTP}_{\Delta H} * (1 + PF_{\Delta H} * (1-P))$

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

2.7.2a $F^{RTP}_{\Delta H}$ = 1.53 for LOPAR fuel and

2.7.2b $F^{RTP}_{\Delta H}$ = 1.65 for VANTAGE 5 fuel

2.7.3 $PF_{\Delta H}$ = 0.3 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 2096 ppm.#

#This concentration bounds the condition 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.

COLR for VEGP UNIT 1 CYCLE 7

TABLE 1

$F_Q(Z)$ PENALTY FACTOR

Cycle Burnup (MWD/MTU)	$F_Q(Z)$ 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 $F_Q(Z)$ in accordance with SR 3.2.1.2, is the maximum factor by which $F_Q(Z)$ 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 $F_Q(Z)$ was determined.

2. Linear interpolation is adequate for intermediate cycle burnups.

3. For <u>all</u> cycle burnups outside the range of the table, a penalty factor of 1.0200 shall be used.

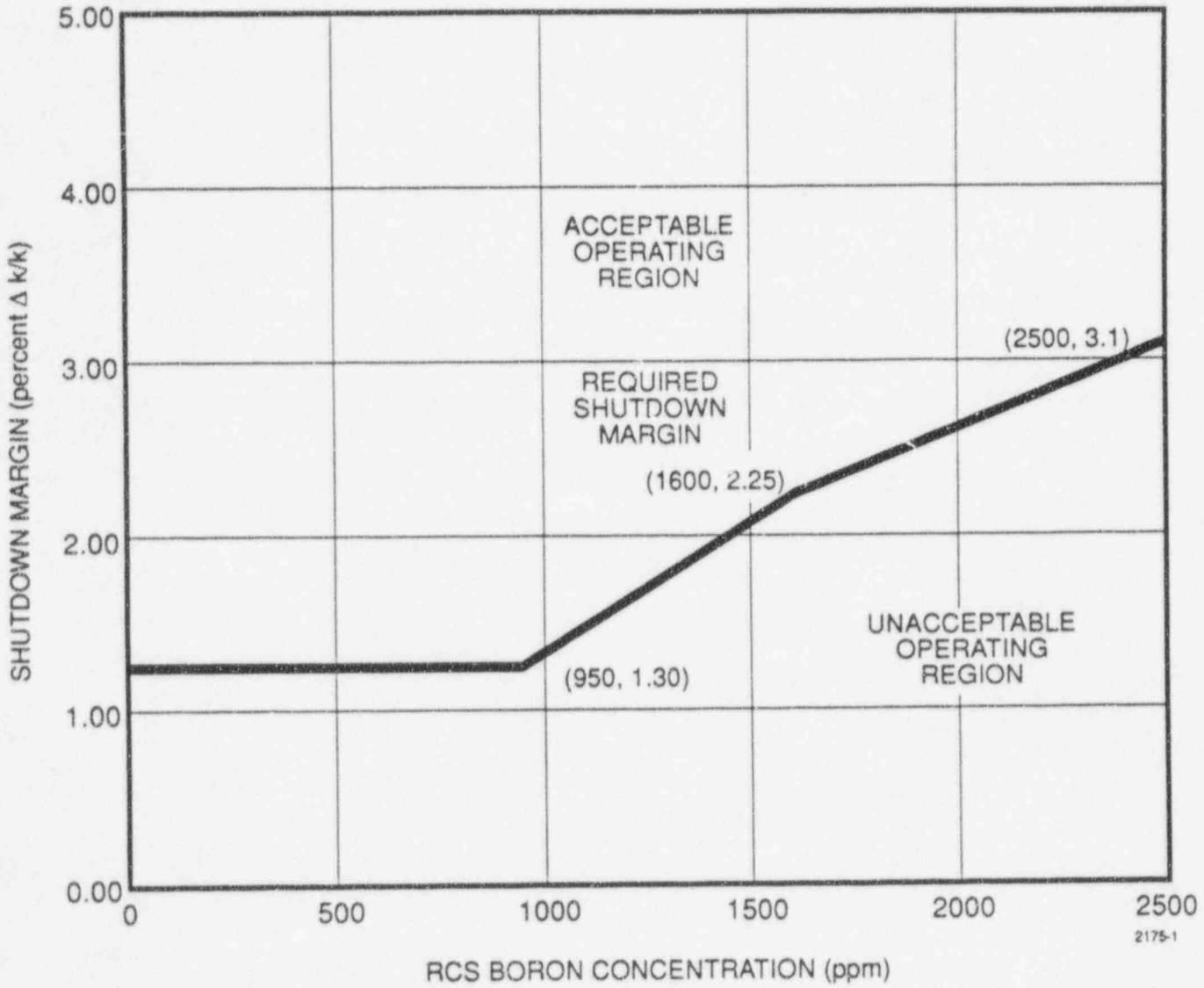


FIGURE 1

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

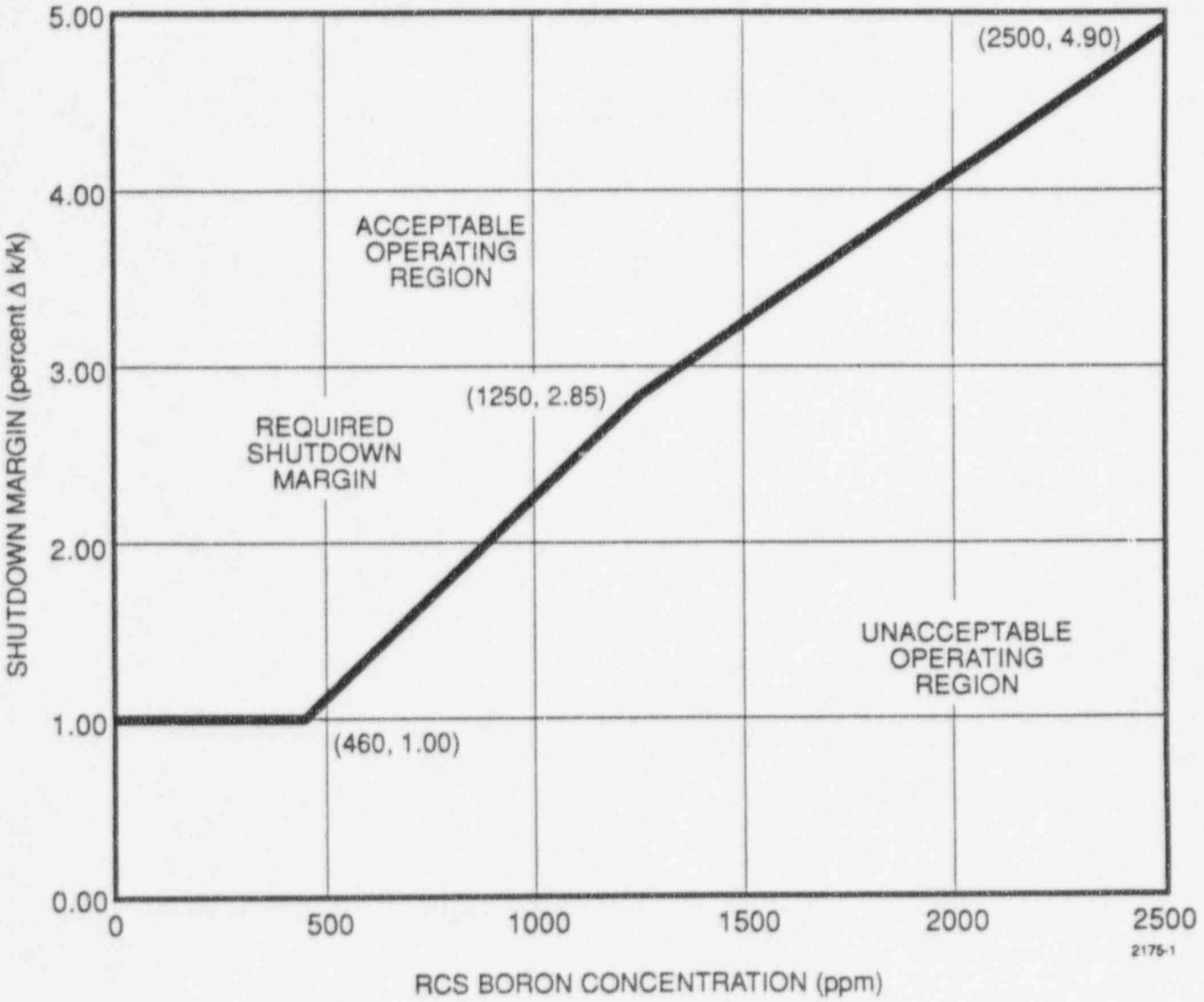
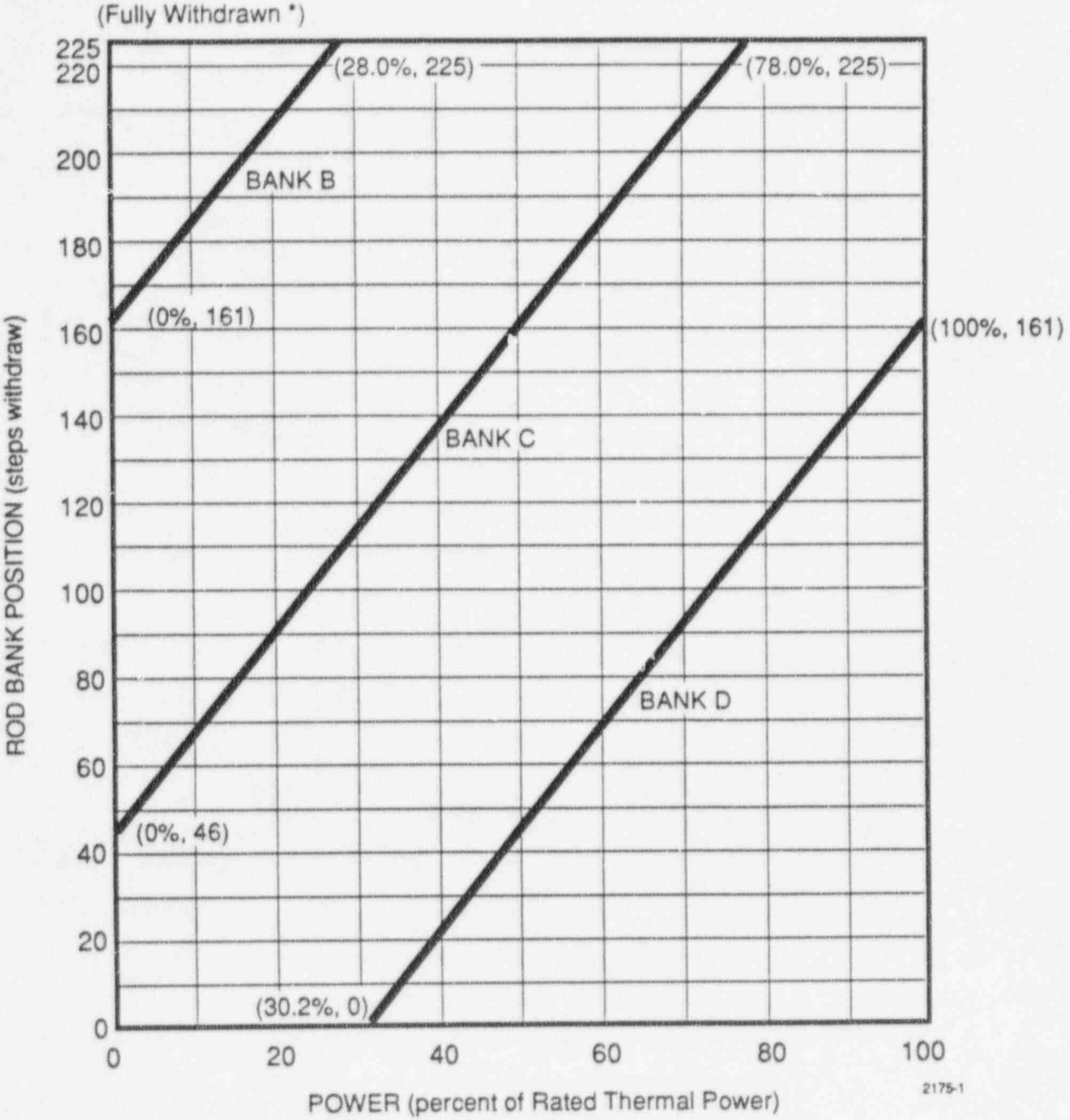


FIGURE 2

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



* 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

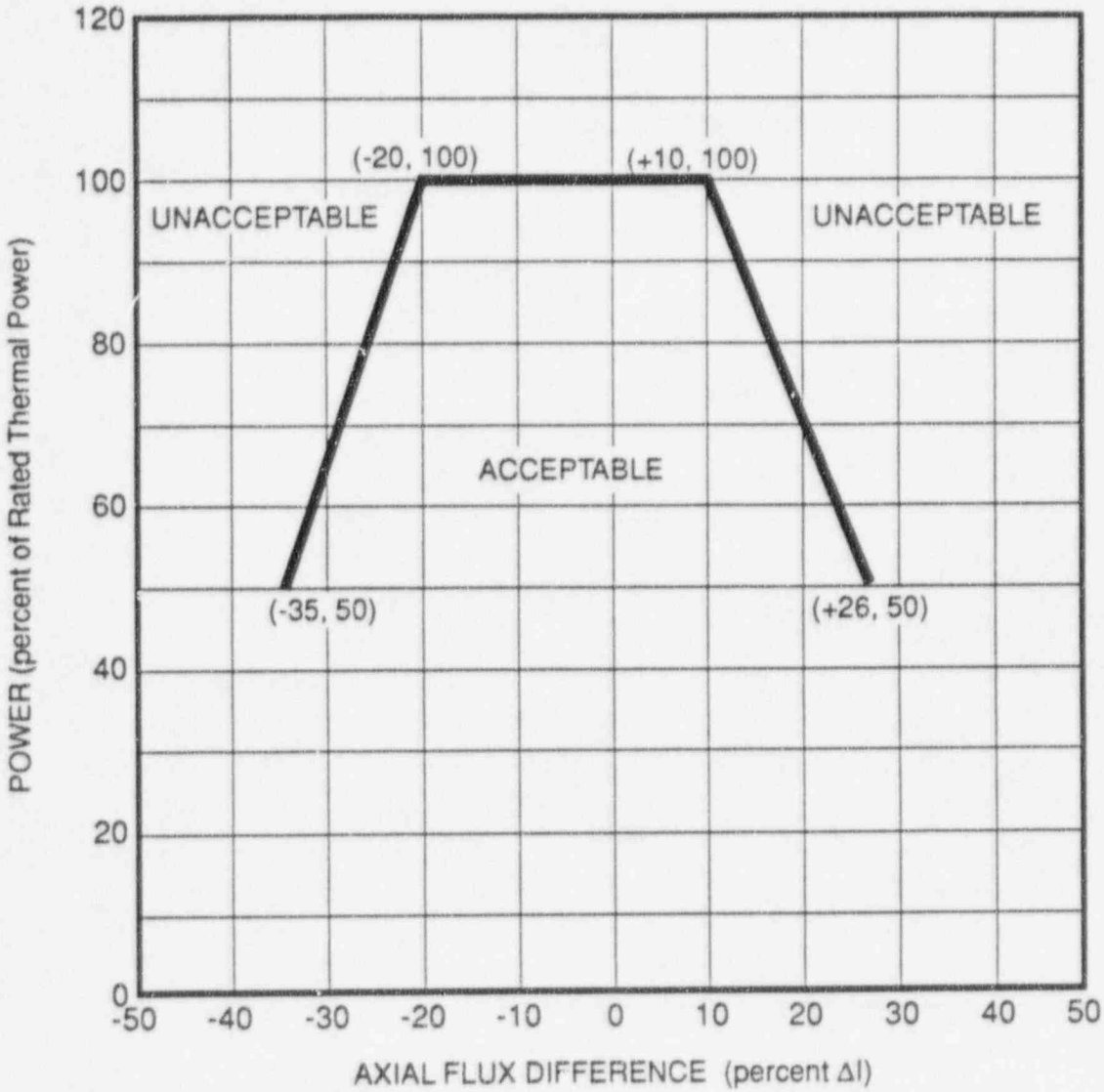


FIGURE 4

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

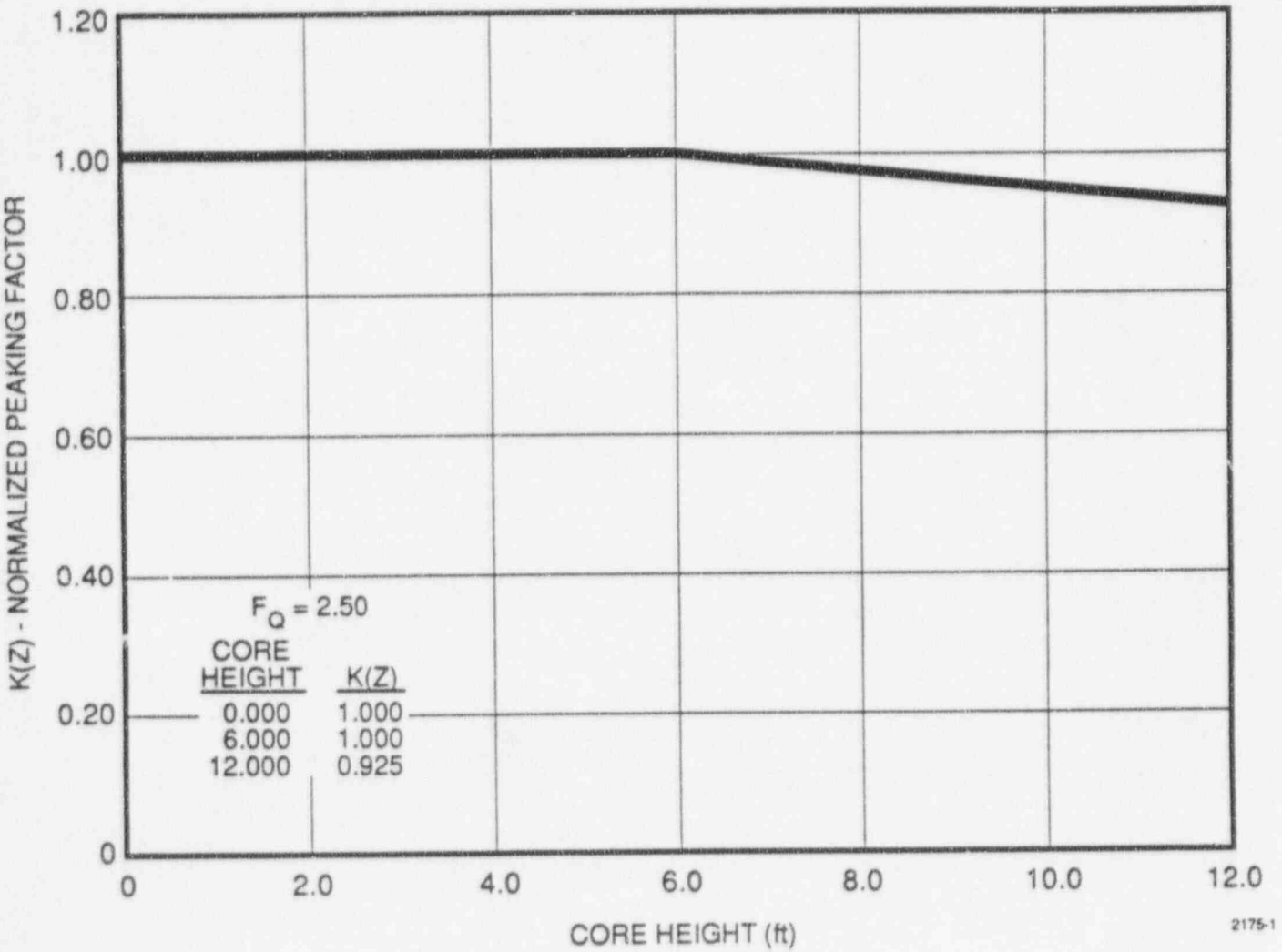


FIGURE 5

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

COLR FOR VEGP UNIT 1 CYCLE 7

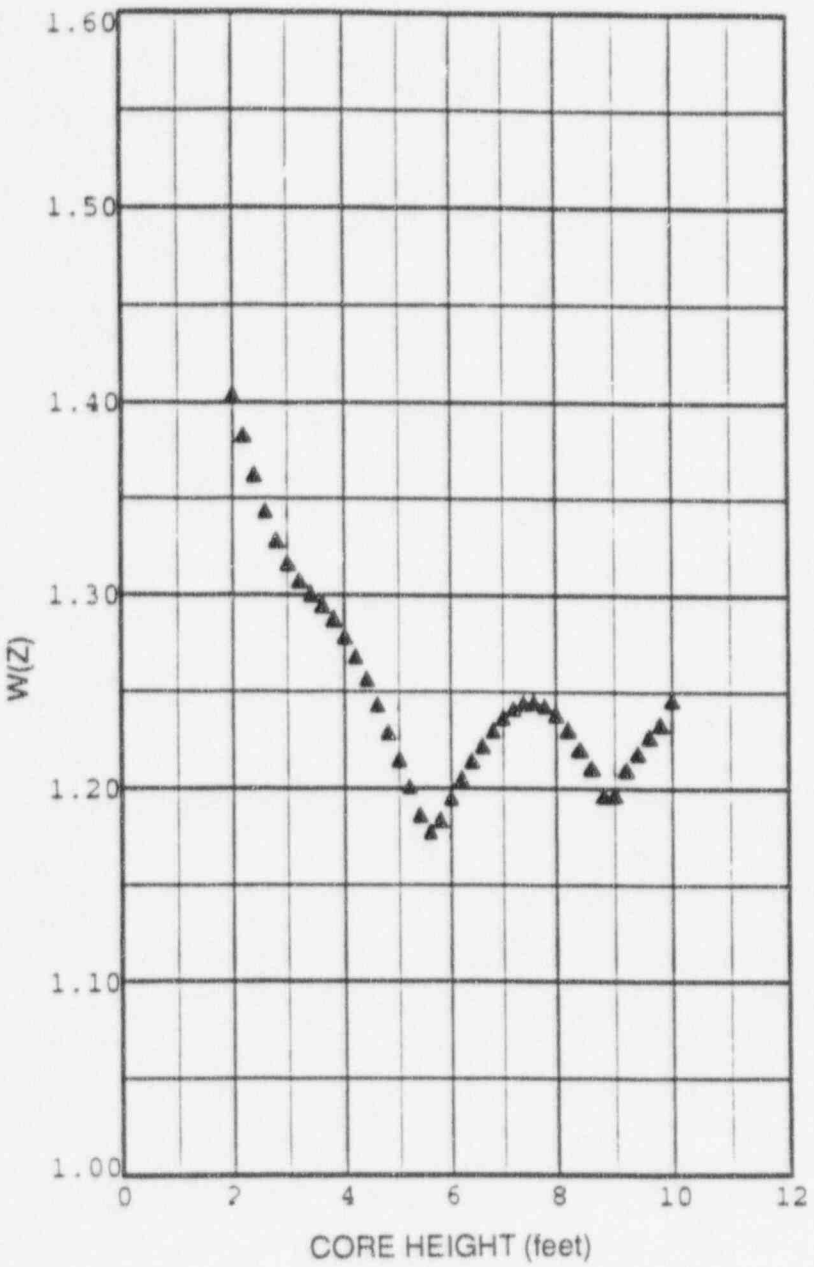


FIGURE 6

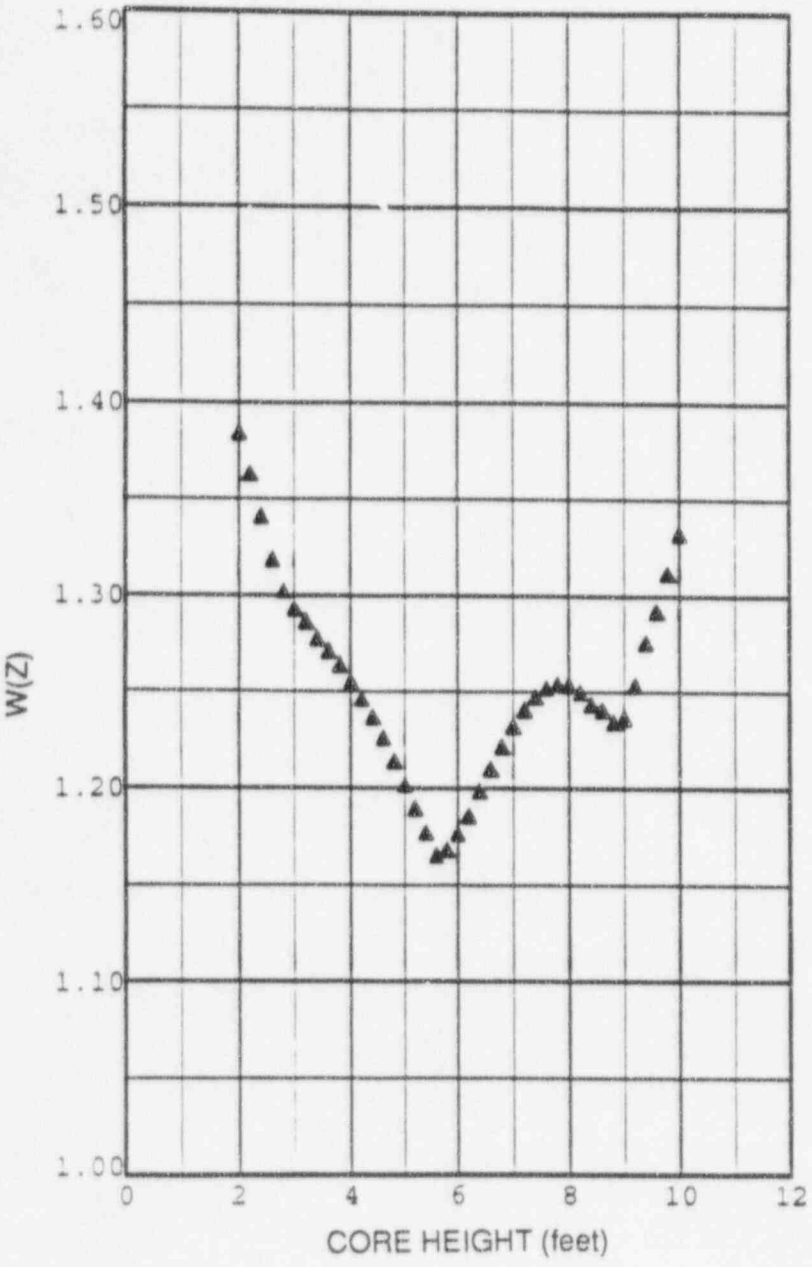
RAOC W(Z) AT 150 MWD/MTU

	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 B3.2.1

This figure is referred to by Technical Specification B3.2.1

COLR FOR VEGP UNIT 1 CYCLE 7



	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

FIGURE 7

RAOC W(Z) AT 4000 MWD/MTU

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

This figure is referred to by Technical Specification B3.2.1

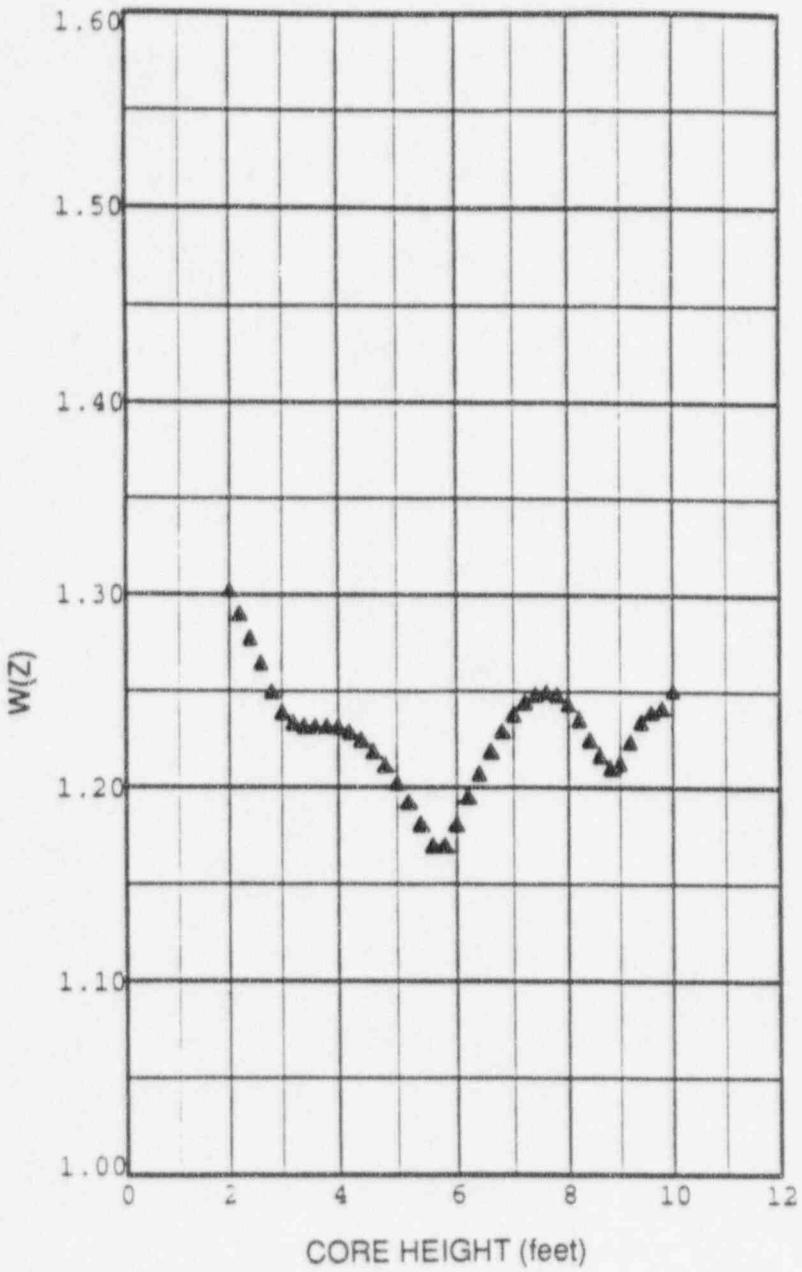


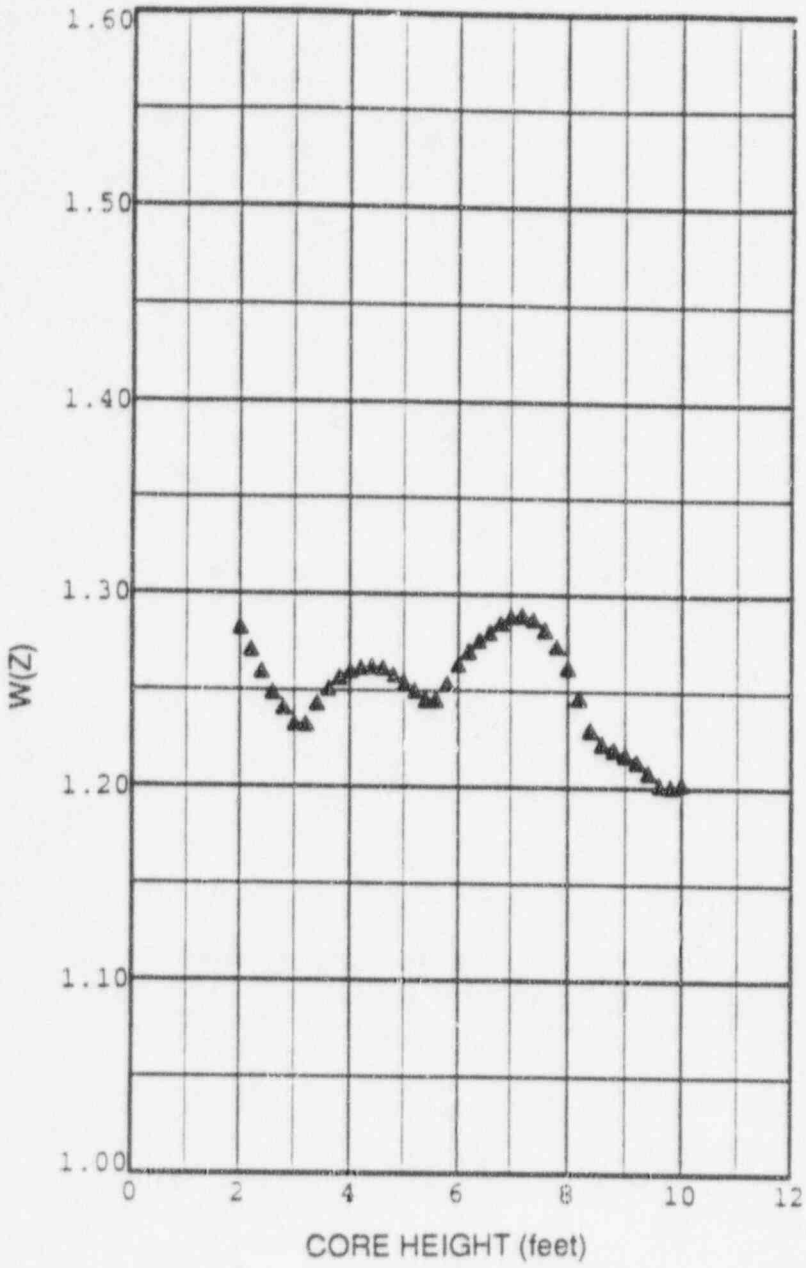
FIGURE 8

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 B3.2.1

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	1.2023
	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

FIGURE 9

RAOC W(Z) AT 19000 MWD/MTU

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

This figure is referred to by Technical Specification B3.2.1