

**FARLEY NUCLEAR PLANT (FNP) UNIT 2 CYCLE 14**

**CORE OPERATING LIMITS REPORT REVISION 1**

**DECEMBER 1999**



## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Joseph M. Farley Unit 2 Cycle 14 has been prepared in accordance with the requirements of Technical Specification 6.9.1.11.

The Technical Specifications affected by this report are listed below:

3/4.1.1.1	SHUTDOWN MARGIN - MODES 1, 2, 3 and 4
3/4.1.1.2	SHUTDOWN MARGIN - MODE 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 - $F_Q(Z)$
3/4.2.3	Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}^N$



## 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 Technical Specifications 6.9.1.11.

### 2.1 SHUTDOWN MARGIN - MODES 1, 2, 3 and 4 (Specification 3/4.1.1.1)

2.1.1 The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent  $\Delta k/k$ .

### 2.2 SHUTDOWN MARGIN - MODE 5 (Specification 3/4.1.1.2)

2.2.1 The SHUTDOWN MARGIN shall be greater than or equal to 1.0 percent  $\Delta k/k$ .

### 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 than or equal to  $+0.7 \times 10^{-4} \Delta k/k/^\circ F$  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  $-4.3 \times 10^{-4} \Delta k/k/^\circ F$ .

2.3.2 The MTC Surveillance limit is:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to  $-3.65 \times 10^{-4} \Delta k/k/^\circ F$ .

The 100 ppm/ARO/RTP-MTC should be less negative than  $-4.0 \times 10^{-4} \Delta k/k/^\circ F$ .

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2.4.1 The shutdown rods shall be withdrawn to a position greater than or equal to 225 steps.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 1.

## 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 2.

## 2.7 Heat Flux Hot Channel Factor - $F_Q(Z)$ (Specification 3/4.2.2)

[ $F_Q$  Methodology]

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

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

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

$$2.7.2 \quad F_Q^{RTP} = 2.50$$

2.7.3  $K(Z)$  is provided in Figure 3.

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

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

2.7.5  $W(Z)$  values are provided in Figures 4 through 7.

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)

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

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

$$2.8.2 \quad F_{\Delta H}^{RTP} = 1.70$$

$$2.8.3 \quad PF_{\Delta H} = 0.3$$

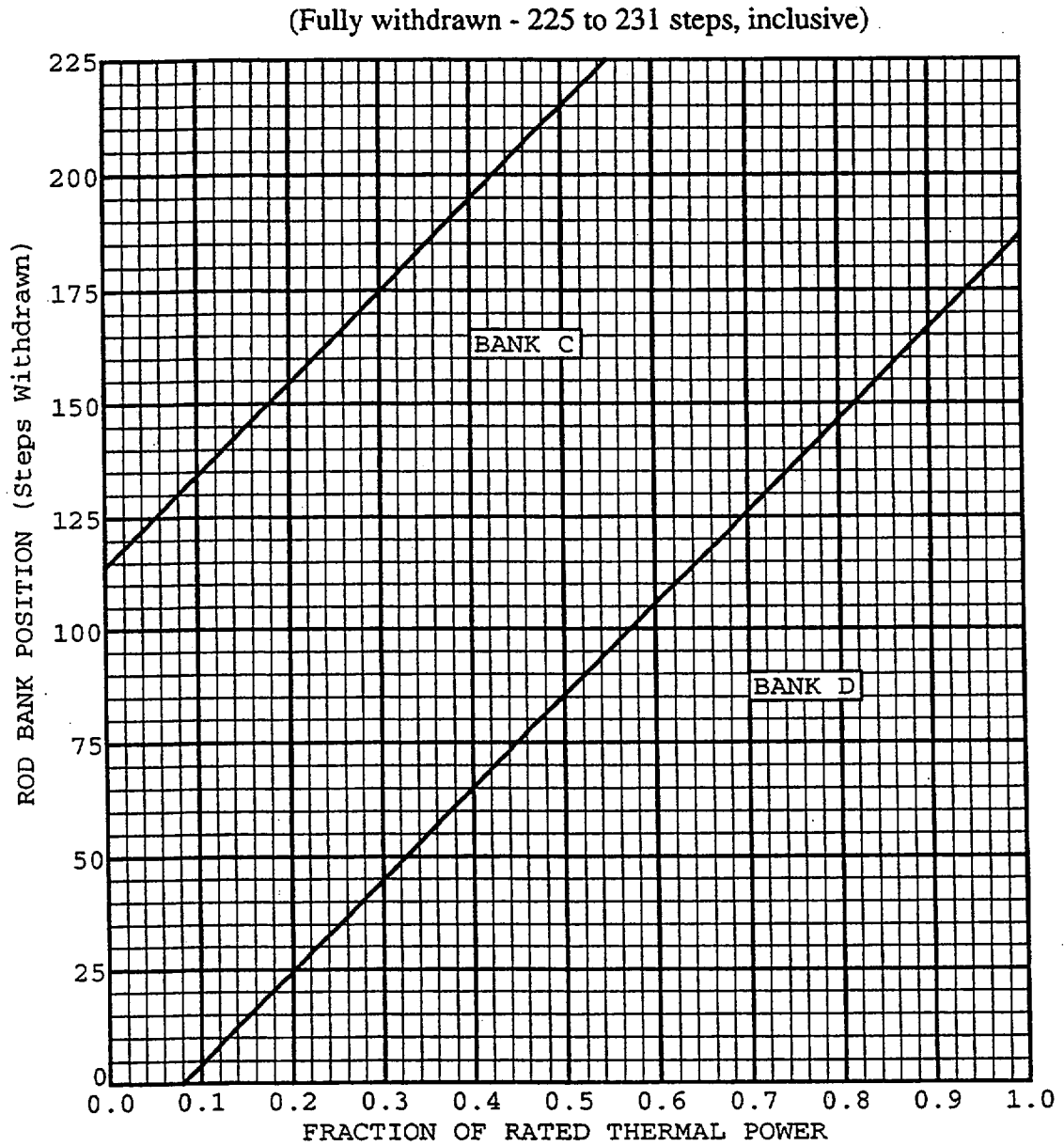


**Table 1**  
 **$F_Q^C(Z)$  PENALTY FACTOR**

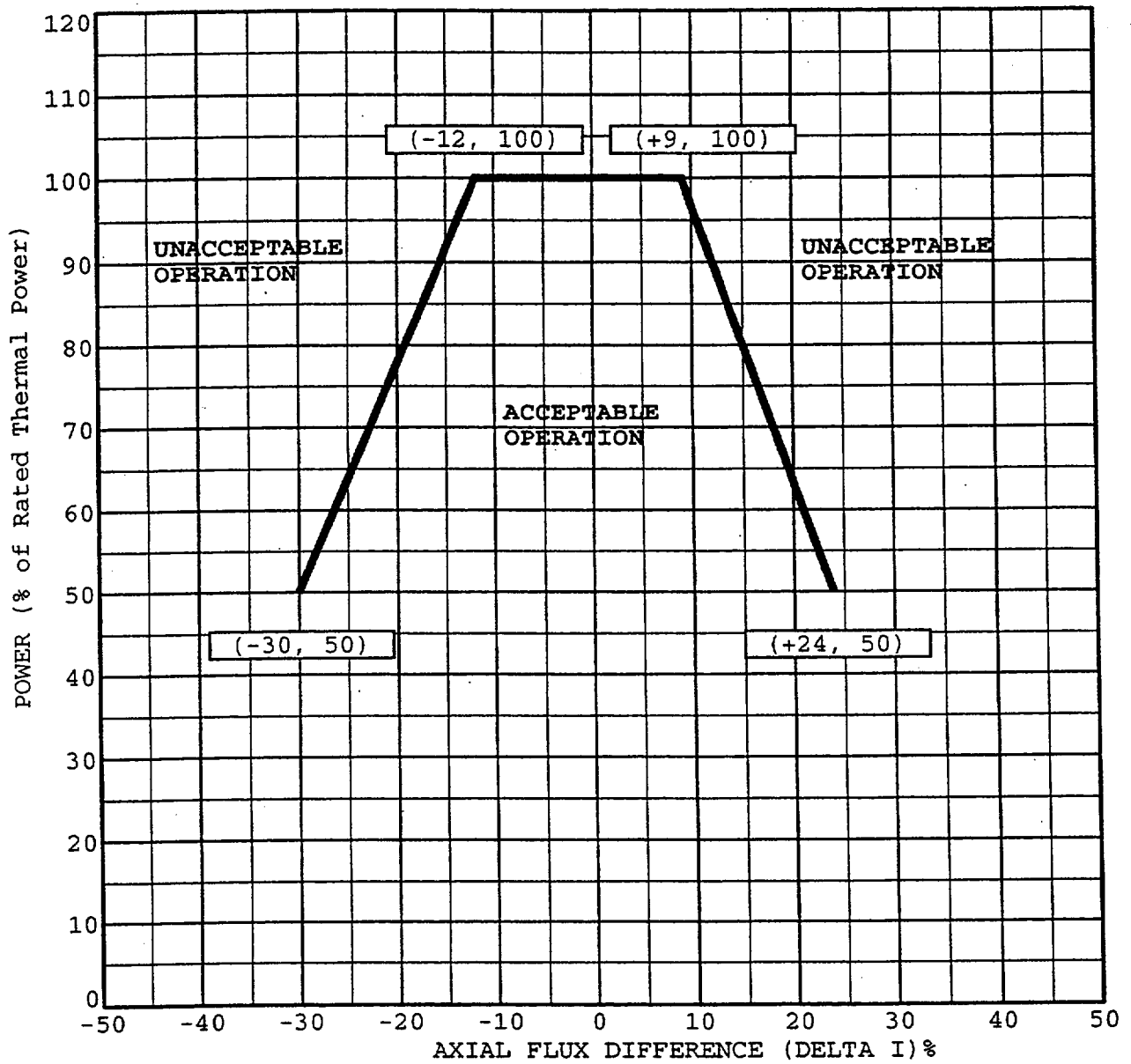
Cycle Burnup (MWD/MTU)	$F_Q^C(Z)$ Penalty Factor
All Burnups	1.0200

Notes:

1. The Penalty Factor, to be applied to  $F_Q^C(Z)$  in accordance with surveillance requirement 4.2.2.2.f, is the maximum factor by which  $F_Q^C(Z)$  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  $F_Q^C(Z)$  was determined.

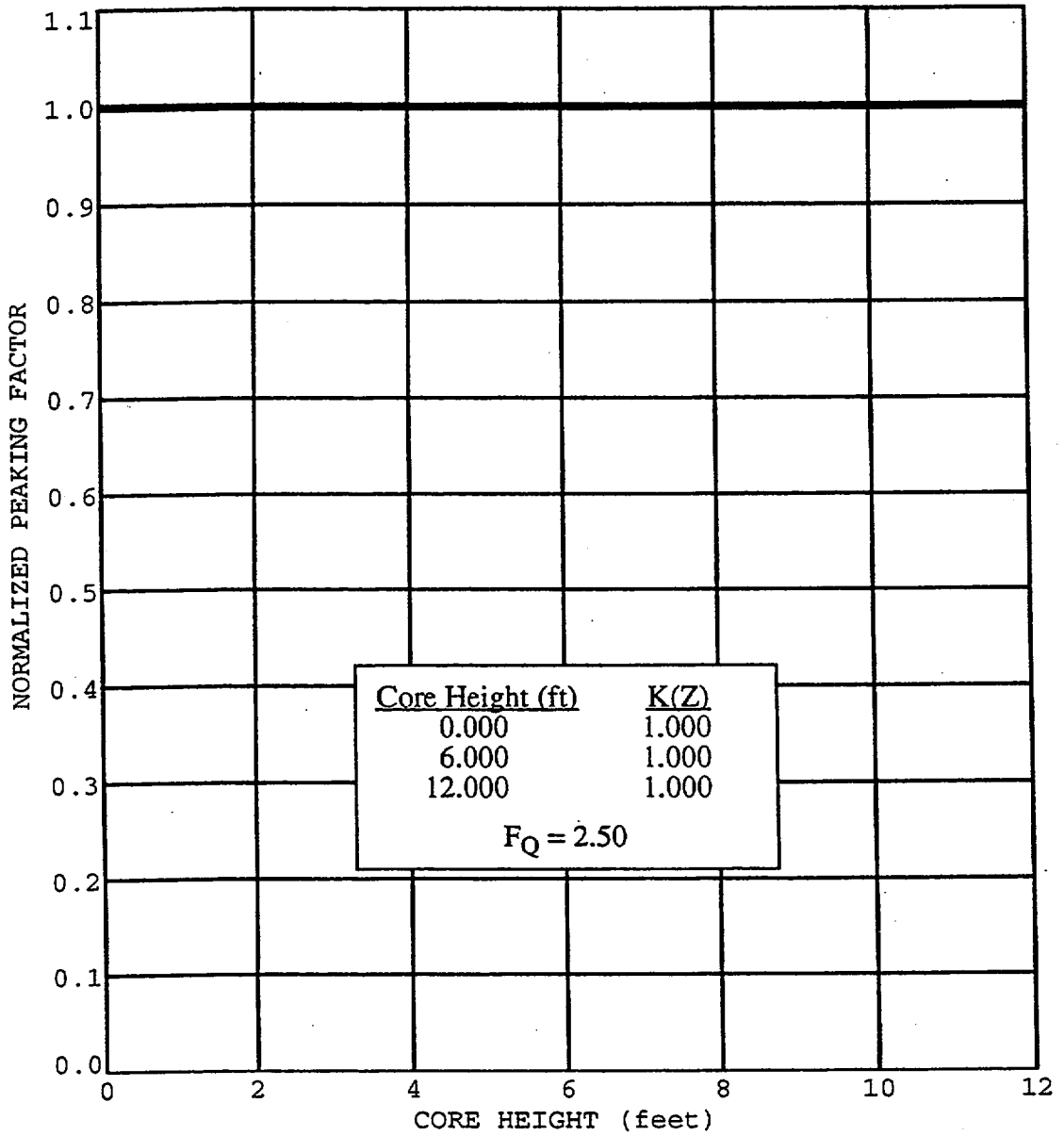


**Figure 1**  
**Rod Bank Insertion Limits versus Rated Thermal Power**

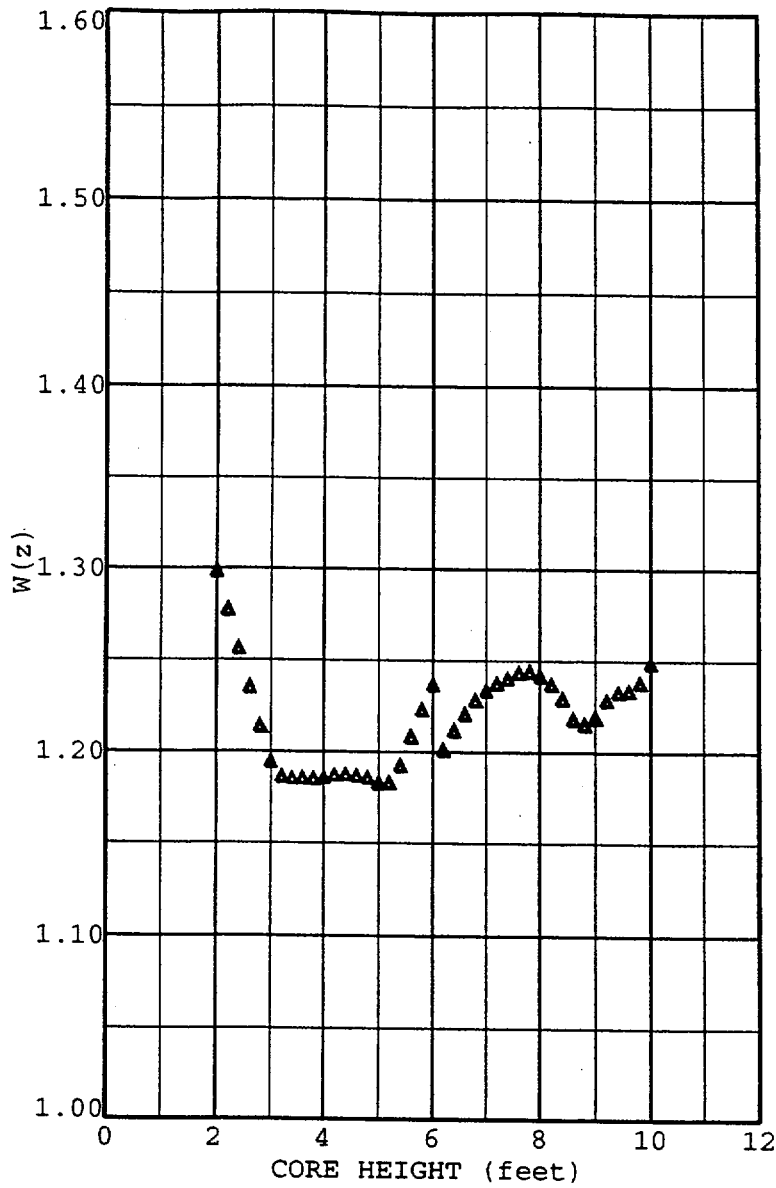


**Figure 2**  
**Axial Flux Difference Limits as a Function of**  
**Rated Thermal Power for RAOC**





**Figure 3**  
**K(Z)**  
**Normalized  $F_Q(Z)$  as a Function of Core Height**

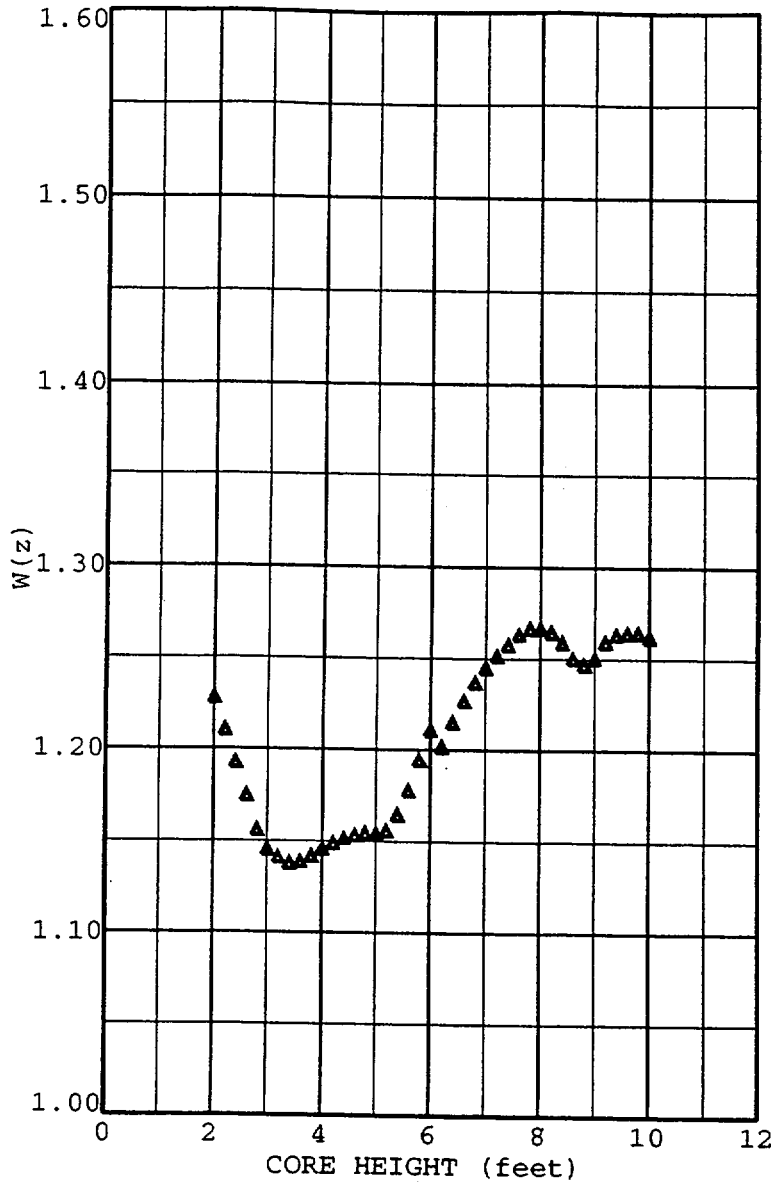


This figure is referred to by Technical Specifications 4.2.2.2d, B3/4.2.2.

**Figure 4**  
**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	1.2487
12	9.80	1.2380
13	9.60	1.2335
14	9.40	1.2328
15	9.20	1.2283
16	9.00	1.2188
17	8.80	1.2151
18	8.60	1.2182
19	8.40	1.2292
20	8.20	1.2370
21	8.00	1.2417
22	7.80	1.2439
23	7.60	1.2433
24	7.40	1.2403
25	7.20	1.2374
26	7.00	1.2336
27	6.80	1.2281
28	6.60	1.2206
29	6.40	1.2115
30	6.20	1.2009
31	6.00	1.2365
32	5.80	1.2230
33	5.60	1.2081
34	5.40	1.1923
35	5.20	1.1828
36	5.00	1.1827
37	4.80	1.1857
38	4.60	1.1867
39	4.40	1.1873
40	4.20	1.1870
41	4.00	1.1857
42	3.80	1.1851
43	3.60	1.1854
44	3.40	1.1853
45	3.20	1.1861
46	3.00	1.1944
47	2.80	1.2136
48	2.60	1.2350
49	2.40	1.2561
50	2.20	1.2773
51	2.00	1.2983
* 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

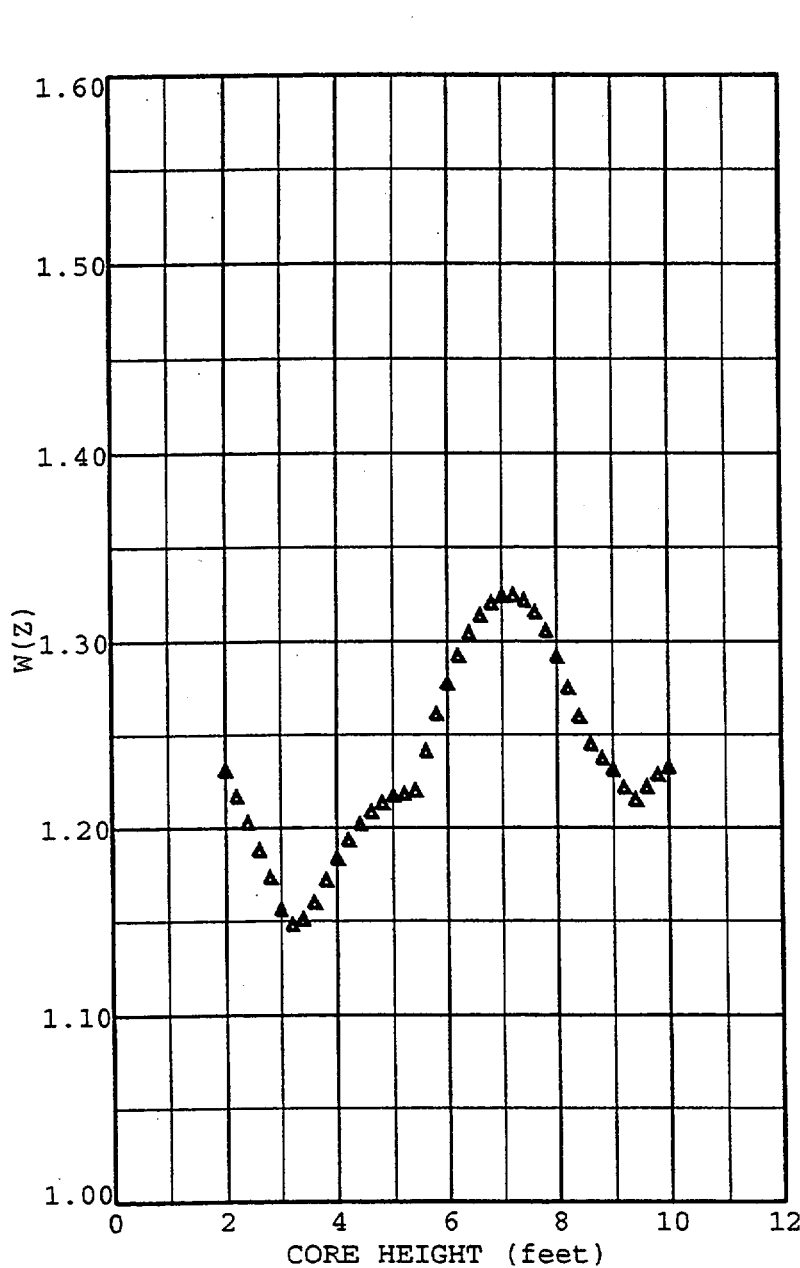


Axial Point	Elevation (feet)	MOL-1 W(Z)	
*	1	12.00	1.0000
*	2	11.80	1.0000
*	3	11.60	1.0000
*	4	11.40	1.0000
*	5	11.20	1.0000
*	6	11.00	1.0000
*	7	10.80	1.0000
*	8	10.60	1.0000
*	9	10.40	1.0000
*	10	10.20	1.0000
*	11	10.00	1.2618
	12	9.80	1.2641
	13	9.60	1.2638
	14	9.40	1.2633
	15	9.20	1.2592
	16	9.00	1.2500
	17	8.80	1.2467
	18	8.60	1.2499
	19	8.40	1.2587
	20	8.20	1.2642
	21	8.00	1.2665
	22	7.80	1.2662
	23	7.60	1.2630
	24	7.40	1.2574
	25	7.20	1.2512
	26	7.00	1.2446
	27	6.80	1.2366
	28	6.60	1.2264
	29	6.40	1.2146
	30	6.20	1.2012
	31	6.00	1.2104
	32	5.80	1.1941
	33	5.60	1.1776
	34	5.40	1.1643
	35	5.20	1.1556
	36	5.00	1.1541
	37	4.80	1.1542
	38	4.60	1.1531
	39	4.40	1.1514
	40	4.20	1.1488
	41	4.00	1.1456
	42	3.80	1.1418
	43	3.60	1.1387
	44	3.40	1.1378
	45	3.20	1.1411
	46	3.00	1.1454
	47	2.80	1.1560
	48	2.60	1.1748
	49	2.40	1.1924
	50	2.20	1.2100
	51	2.00	1.2278
*	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

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

**Figure 5**  
RAOC W(Z) at 4000 MWD/MTU

\* Top and Bottom 15% Excluded per Technical Specification 4.2.2.2

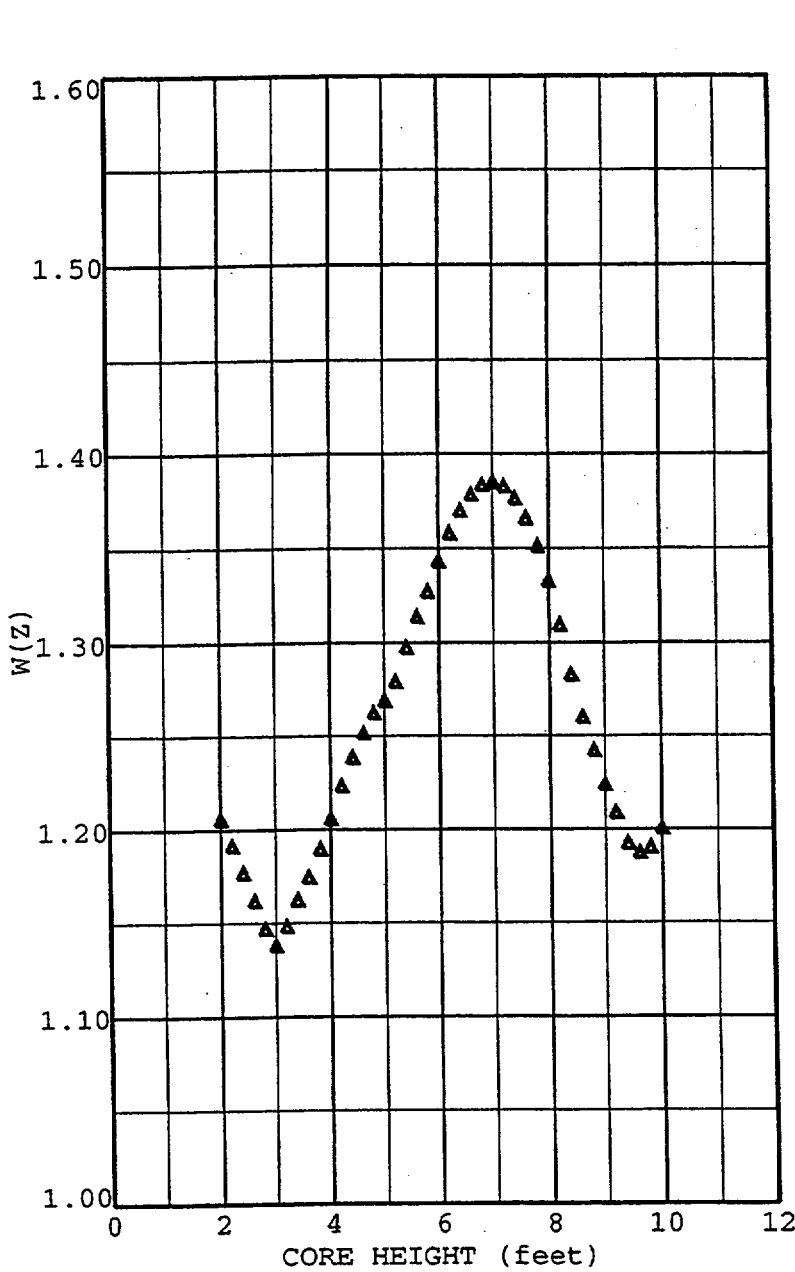


This figure is referred to by Technical Specifications 4.2.2.2d, B3/4.2.2.

**Figure 6**  
RAOC W(Z) at 10000 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	1.2324
12	9.80	1.2281
13	9.60	1.2215
14	9.40	1.2148
15	9.20	1.2214
16	9.00	1.2312
17	8.80	1.2371
18	8.60	1.2447
19	8.40	1.2596
20	8.20	1.2749
21	8.00	1.2917
22	7.80	1.3053
23	7.60	1.3151
24	7.40	1.3215
25	7.20	1.3243
26	7.00	1.3238
27	6.80	1.3201
28	6.60	1.3135
29	6.40	1.3040
30	6.20	1.2920
31	6.00	1.2773
32	5.80	1.2610
33	5.60	1.2411
34	5.40	1.2198
35	5.20	1.2180
36	5.00	1.2170
37	4.80	1.2131
38	4.60	1.2083
39	4.40	1.2016
40	4.20	1.1931
41	4.00	1.1833
42	3.80	1.1717
43	3.60	1.1597
44	3.40	1.1508
45	3.20	1.1480
46	3.00	1.1559
47	2.80	1.1733
48	2.60	1.1878
49	2.40	1.2024
50	2.20	1.2167
51	2.00	1.2308
* 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



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	1.2002
	12	9.80	1.1902
	13	9.60	1.1873
	14	9.40	1.1922
	15	9.20	1.2087
	16	9.00	1.2238
	17	8.80	1.2418
	18	8.60	1.2598
	19	8.40	1.2827
	20	8.20	1.3092
	21	8.00	1.3326
	22	7.80	1.3513
	23	7.60	1.3659
	24	7.40	1.3763
	25	7.20	1.3826
	26	7.00	1.3849
	27	6.80	1.3834
	28	6.60	1.3783
	29	6.40	1.3697
	30	6.20	1.3580
	31	6.00	1.3431
	32	5.80	1.3269
	33	5.60	1.3135
	34	5.40	1.2973
	35	5.20	1.2790
	36	5.00	1.2689
	37	4.80	1.2623
	38	4.60	1.2513
	39	4.40	1.2383
	40	4.20	1.2231
	41	4.00	1.2055
	42	3.80	1.1895
	43	3.60	1.1744
	44	3.40	1.1622
	45	3.20	1.1482
	46	3.00	1.1381
	47	2.80	1.1468
	48	2.60	1.1620
	49	2.40	1.1768
	50	2.20	1.1913
	51	2.00	1.2056
*	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

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

\* Top and Bottom 15% Excluded per Technical Specification 4.2.2.2

**Figure 7**  
**RAOC W(Z) at 16000 MWD/MTU**