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SOUTHERN COMPANY
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April 10, 2001

Docket No.: 50-364

NEL-01-0080

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Joseph M. Farley Nuclear Plant - Unit 2
Cycle 15 Core Operating Limits Report

Ladies and Gentlemen:

In accordance with Technical Specification 5.6.5.d, Southern Nuclear Operating Company submits the enclosed Core Operating Limits Report for Farley Nuclear Plant Unit 2, Cycle 15.

If there are any questions, please advise.

Respectfully submitted,

Dave Morey

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Enclosure:
Core Operating Limits Report - Unit 2 - Cycle 15

A001

cc: Southern Nuclear Operating Company
Mr. L. M. Stinson, General Manager - Farley

U. S. Nuclear Regulatory Commission, Washington, D. C.
Mr. F. Rinaldi, Licensing Project Manager – Farley

U. S. Nuclear Regulatory Commission, Region II
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ENCLOSURE

Core Operating Limits Report

Joseph M. Farley Nuclear Plant

Unit 2 - Cycle 15

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 2 CYCLE 15 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 (with $k_{eff} \geq 1$)

The Technical Specifications affected by this report are listed below:

3.1.1 SHUTDOWN MARGIN - MODES 2 (with $k_{eff} < 1$), 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 - $F_{\Delta H}^N$
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 NRC-approved methodologies, including those specified in Technical Specification 5.6.5.

2.1 SHUTDOWN MARGIN - MODES 1 AND 2 (with $k_{eff} \geq 1.0$) (Technical Requirement 13.1.1)

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

2.2 SHUTDOWN MARGIN - MODES 2 (with $k_{eff} < 1.0$), 3, 4 and 5 (Specification 3.1.1)

2.2.1 Modes 2 ($k_{eff} < 1.0$), 3 and 4 - The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent $\Delta k/k$.

2.2.2 Mode 5 - The SHUTDOWN MARGIN shall be greater than or equal to 1.0 percent $\Delta k/k$.

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 than or equal to $+0.7 \times 10^{-4}$ $\Delta k/k/°F$ 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 -4.3×10^{-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 -3.65×10^{-4} $\Delta k/k/°F$.

The 100 ppm/ARO/RTP-MTC should be less negative than -4.0×10^{-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 rod banks shall be limited in physical insertion as shown in Figure 1.

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

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

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

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

2.6.2 $F_Q^{RTP} = 2.50$

2.6.3 K(Z) is provided in Figure 2.

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

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

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

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

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

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

where: $P = \dfrac{THERMAL\ POWER}{RATED\ THERMAL\ POWER}$

2.7.2 $F_{\Delta H}^{RTP} = 1.70$

2.7.3 $PF_{\Delta H} = 0.3$

2.8 Axial Flux Difference (Specification 3.2.3)

2.8.1 The Axial Flux Difference (AFD) acceptable operation limits are provided in Figure 3.

2.9 Boron Concentration (Specification 3.9.1)

2.9.1 The boron concentration shall be greater than or equal to 2000 ppm.[1]

[1] 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.

Table 1

$F_Q(Z)$ PENALTY FACTOR

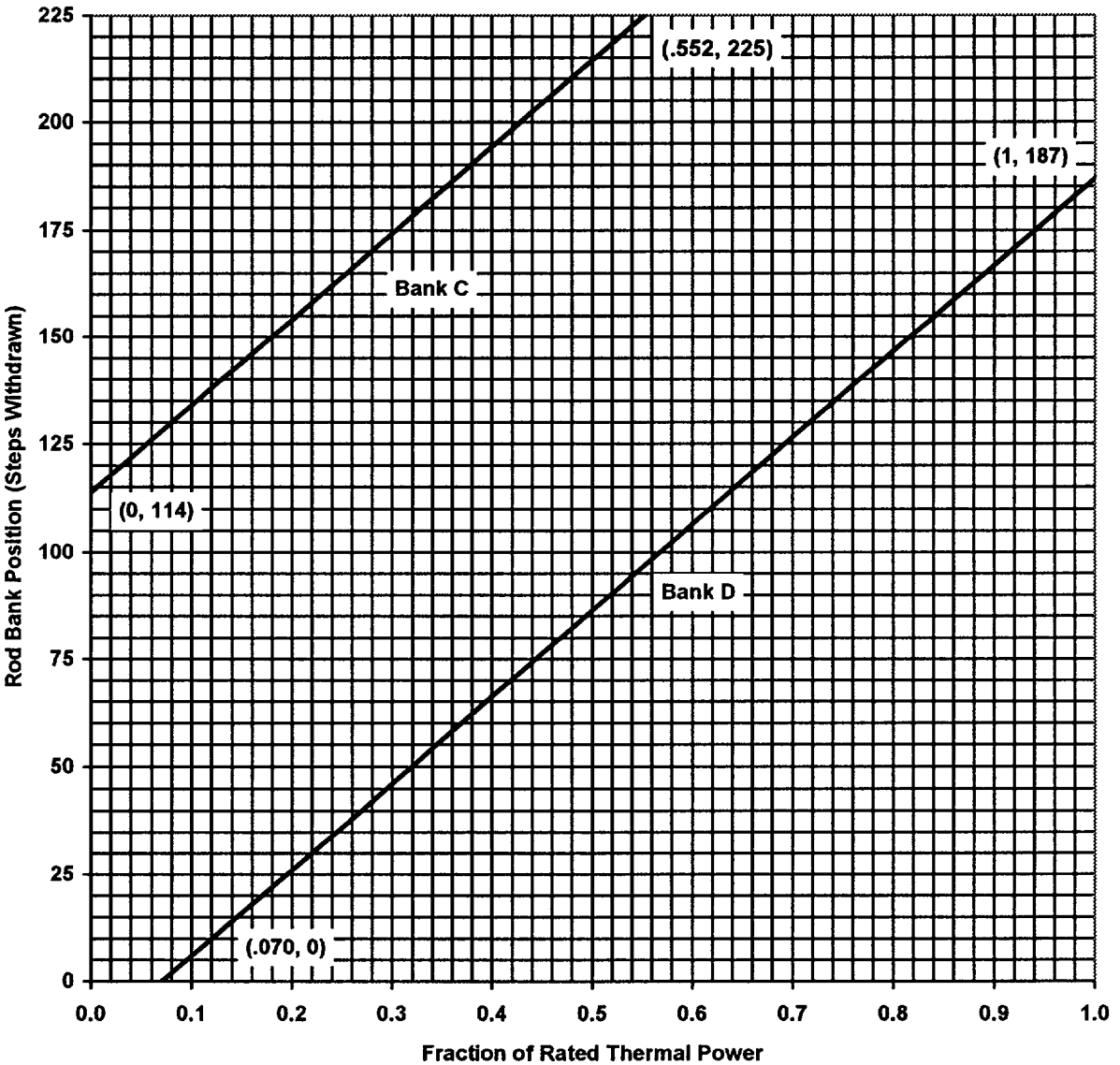
Cycle Burnup (MWD/MTU)	$F_Q(Z)$ Penalty Factor
30	1.029
354	1.031
557	1.031
761	1.029
965	1.026
1372	1.020
4428	1.020
4632	1.021
4836	1.029
5040	1.038
5243	1.036
6262	1.020

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 all cycle burnups outside the range of the table, a penalty factor of 1.020 shall be used.

Figure 1
Rod Bank Insertion Limits versus Rated Thermal Power

Fully Withdrawn – 225 to 231 steps, inclusive



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 128 steps.

Figure 2
K(Z) – Normalized $F_Q(Z)$ as a Function of Core Height

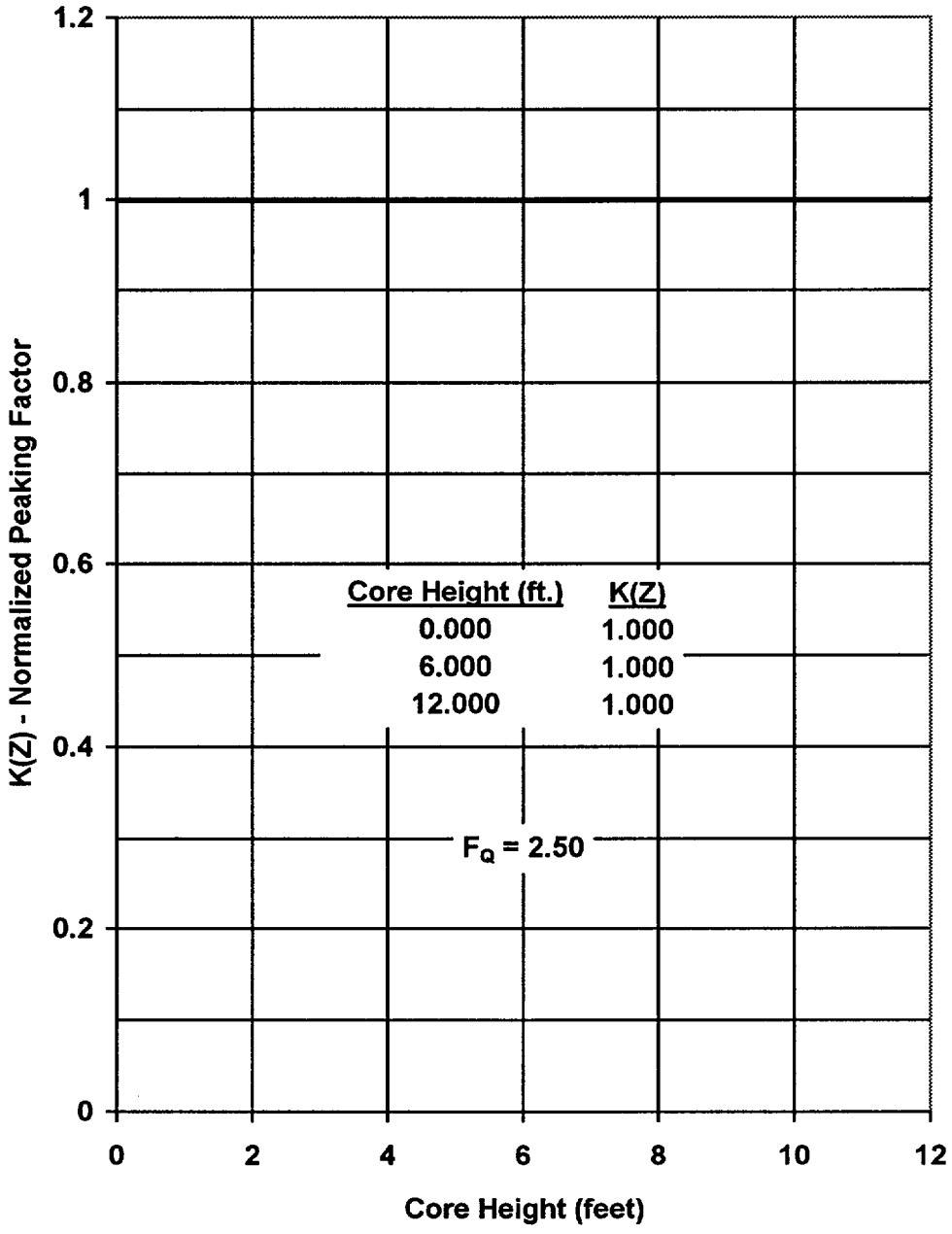


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

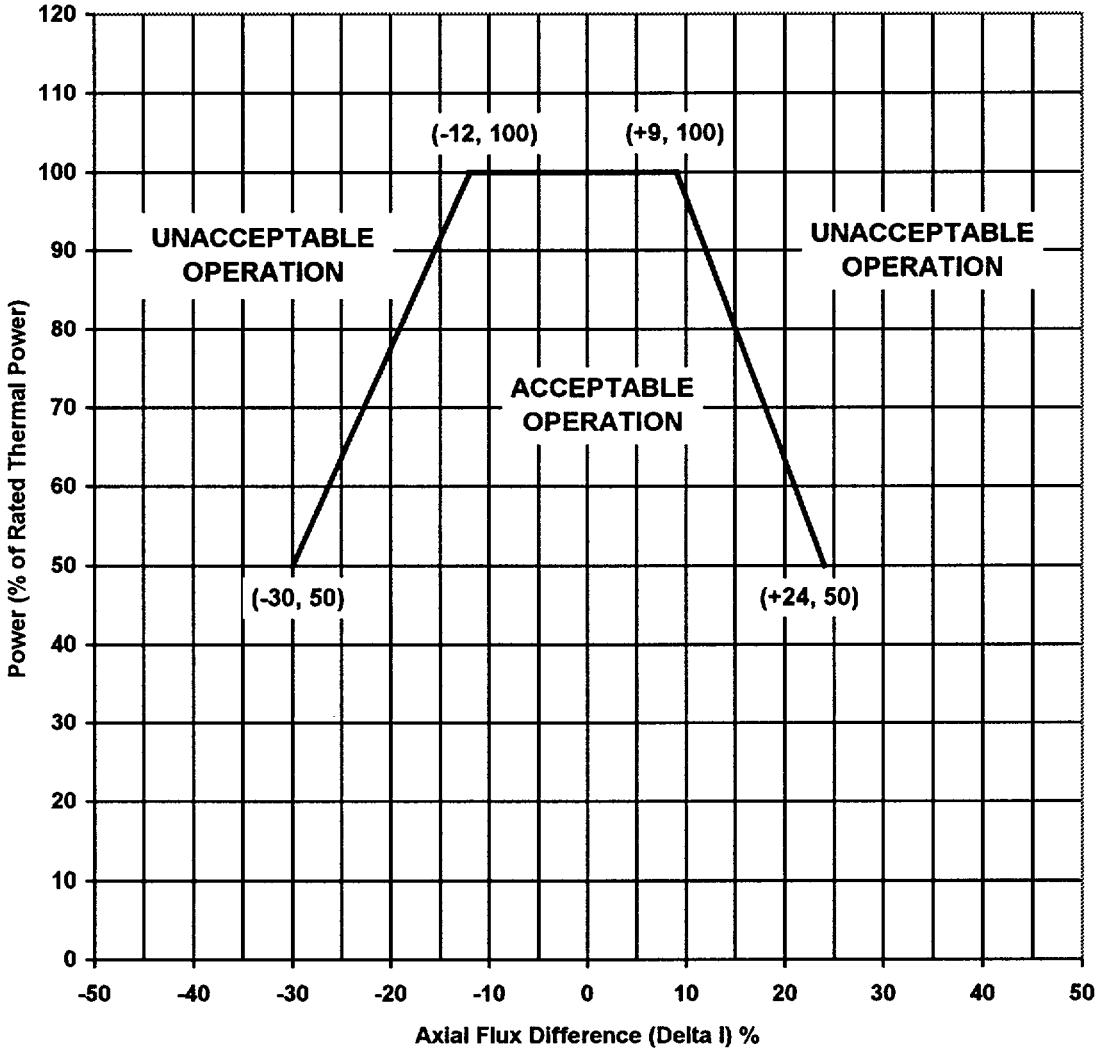
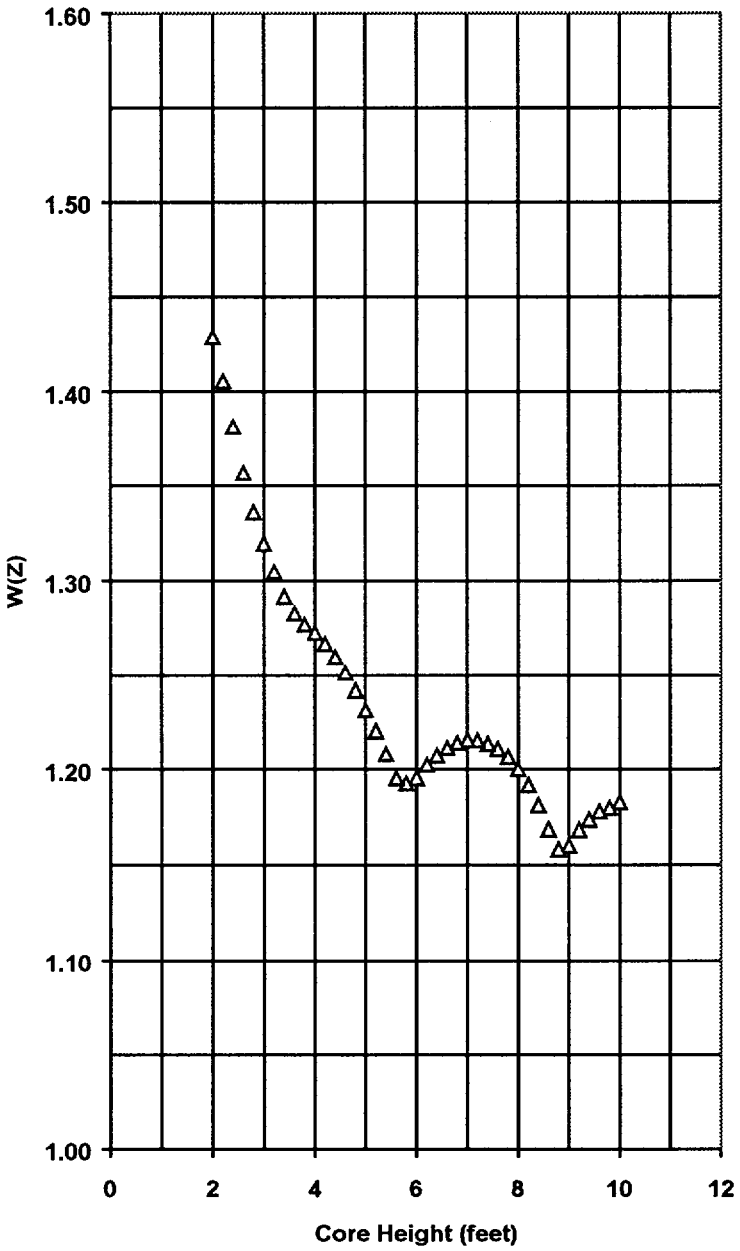


Figure 4
RAOC W(Z) at 150 MWD/MTU

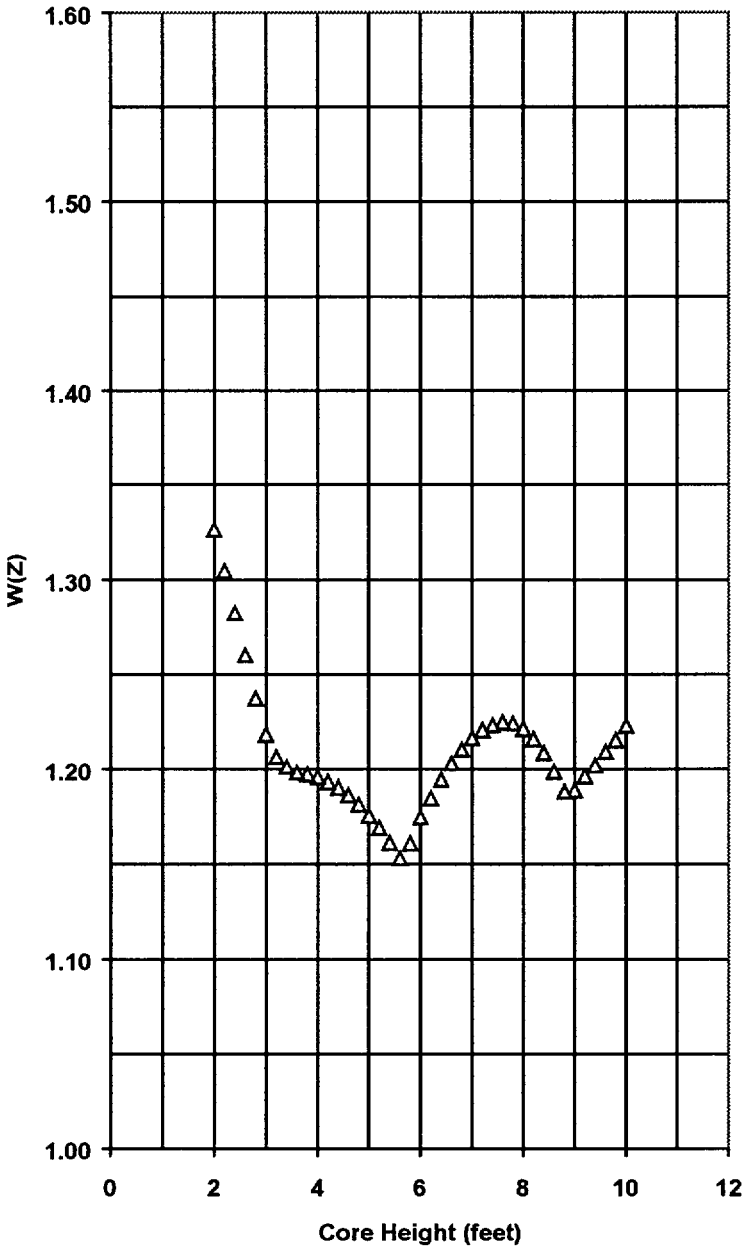


	Axial Point	Elevation (feet)	BOL W(Z)
*	1	12.00	1.0000
*	2	11.80	1.0000
*	3	11.60	1.0000
*	4	11.40	1.0000
*	5	11.20	1.0000
*	6	11.00	1.0000
*	7	10.80	1.0000
*	8	10.60	1.0000
*	9	10.40	1.0000
*	10	10.20	1.0000
	11	10.00	1.1830
	12	9.80	1.1798
	13	9.60	1.1780
	14	9.40	1.1736
	15	9.20	1.1682
	16	9.00	1.1600
	17	8.80	1.1582
	18	8.60	1.1686
	19	8.40	1.1813
	20	8.20	1.1919
	21	8.00	1.2003
	22	7.80	1.2067
	23	7.60	1.2112
	24	7.40	1.2138
	25	7.20	1.2156
	26	7.00	1.2158
	27	6.80	1.2143
	28	6.60	1.2116
	29	6.40	1.2075
	30	6.20	1.2026
	31	6.00	1.1957
	32	5.80	1.1929
	33	5.60	1.1955
	34	5.40	1.2082
	35	5.20	1.2205
	36	5.00	1.2318
	37	4.80	1.2423
	38	4.60	1.2516
	39	4.40	1.2600
	40	4.20	1.2669
	41	4.00	1.2726
	42	3.80	1.2770
	43	3.60	1.2830
	44	3.40	1.2920
	45	3.20	1.3049
	46	3.00	1.3197
	47	2.80	1.3362
	48	2.60	1.3568
	49	2.40	1.3813
	50	2.20	1.4056
	51	2.00	1.4290
*	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.

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

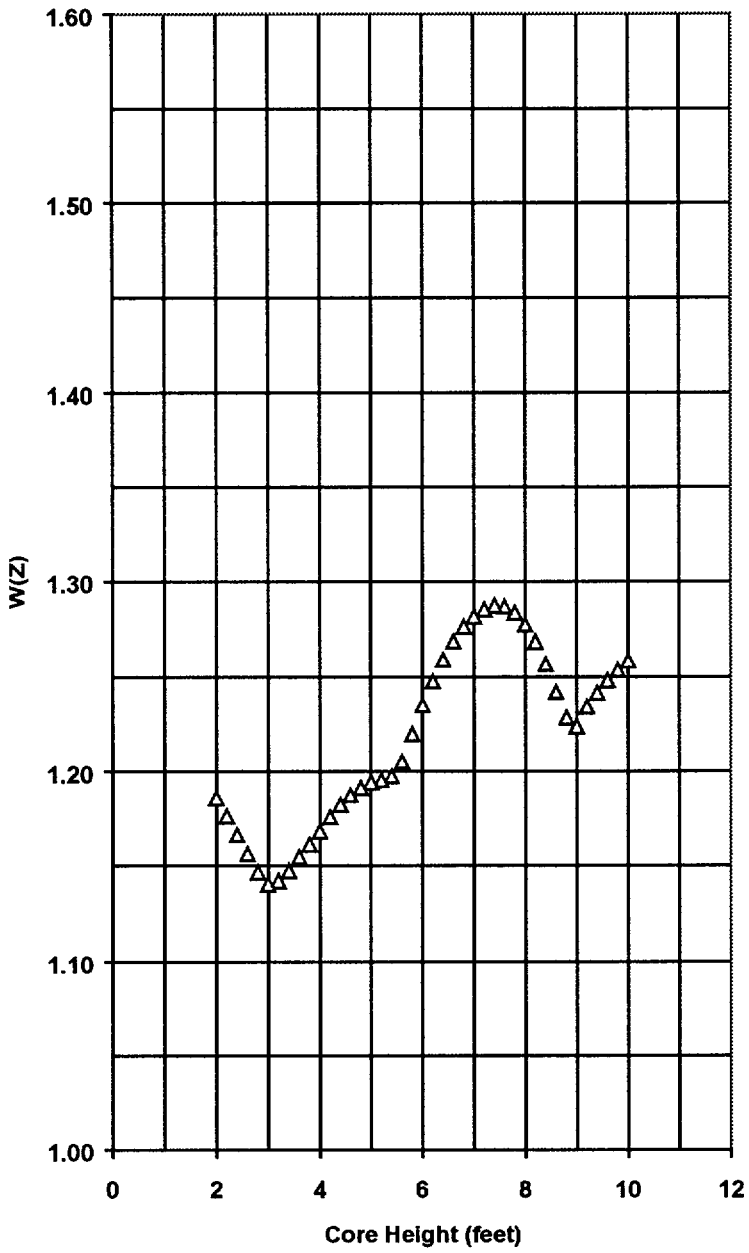


	Axial Point	Elevation (feet)	MOL-1 W(Z)
*	1	12.00	1.0000
*	2	11.80	1.0000
*	3	11.60	1.0000
*	4	11.40	1.0000
*	5	11.20	1.0000
*	6	11.00	1.0000
*	7	10.80	1.0000
*	8	10.60	1.0000
*	9	10.40	1.0000
*	10	10.20	1.0000
	11	10.00	1.2231
	12	9.80	1.2155
	13	9.60	1.2093
	14	9.40	1.2020
	15	9.20	1.1964
	16	9.00	1.1890
	17	8.80	1.1881
	18	8.60	1.1987
	19	8.40	1.2087
	20	8.20	1.2162
	21	8.00	1.2215
	22	7.80	1.2243
	23	7.60	1.2249
	24	7.40	1.2234
	25	7.20	1.2208
	26	7.00	1.2166
	27	6.80	1.2106
	28	6.60	1.2033
	29	6.40	1.1946
	30	6.20	1.1846
	31	6.00	1.1744
	32	5.80	1.1608
	33	5.60	1.1530
	34	5.40	1.1611
	35	5.20	1.1690
	36	5.00	1.1752
	37	4.80	1.1813
	38	4.60	1.1863
	39	4.40	1.1903
	40	4.20	1.1934
	41	4.00	1.1958
	42	3.80	1.1973
	43	3.60	1.1982
	44	3.40	1.2012
	45	3.20	1.2066
	46	3.00	1.2185
	47	2.80	1.2377
	48	2.60	1.2606
	49	2.40	1.2828
	50	2.20	1.3048
	51	2.00	1.3263
*	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.

Figure 6
RAOC W(Z) at 10000 MWD/MTU

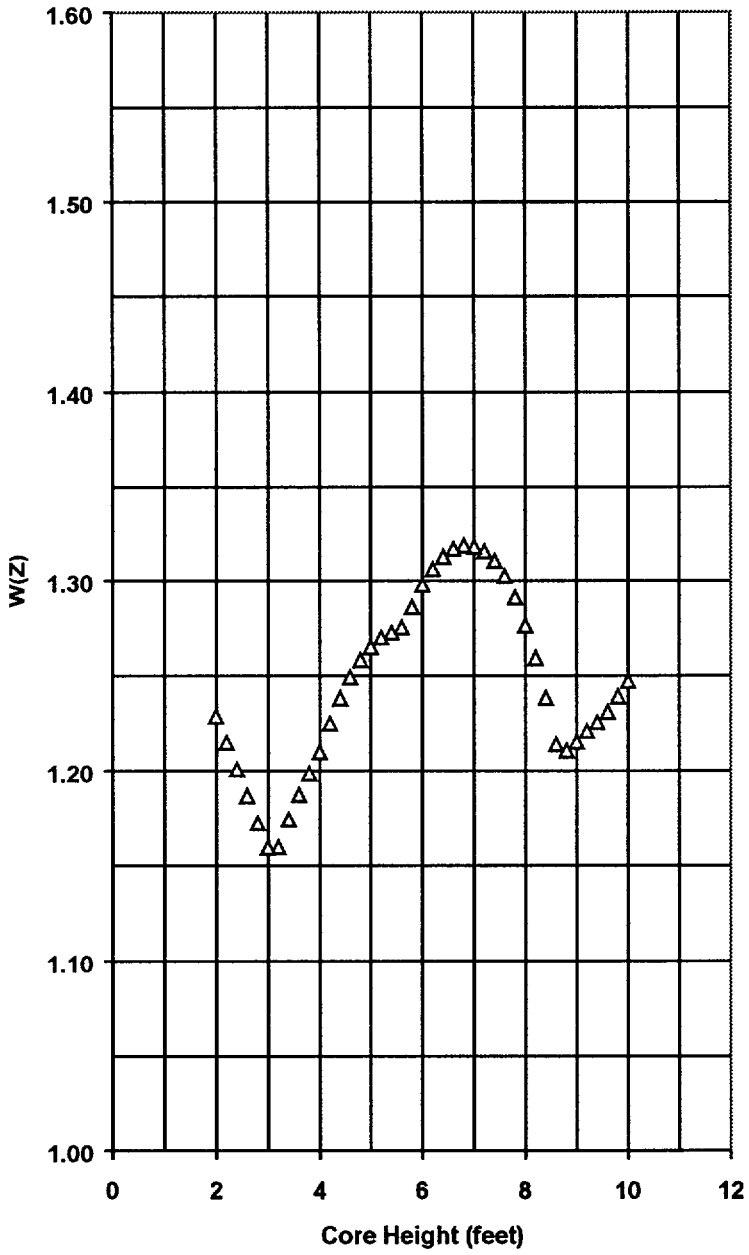


	Axial Point	Elevation (feet)	MOL-2 W(Z)
*	1	12.00	1.0000
*	2	11.80	1.0000
*	3	11.60	1.0000
*	4	11.40	1.0000
*	5	11.20	1.0000
*	6	11.00	1.0000
*	7	10.80	1.0000
*	8	10.60	1.0000
*	9	10.40	1.0000
*	10	10.20	1.0000
	11	10.00	1.2585
	12	9.80	1.2537
	13	9.60	1.2482
	14	9.40	1.2415
	15	9.20	1.2342
	16	9.00	1.2238
	17	8.80	1.2283
	18	8.60	1.2420
	19	8.40	1.2567
	20	8.20	1.2687
	21	8.00	1.2776
	22	7.80	1.2837
	23	7.60	1.2869
	24	7.40	1.2874
	25	7.20	1.2854
	26	7.00	1.2818
	27	6.80	1.2764
	28	6.60	1.2688
	29	6.40	1.2591
	30	6.20	1.2477
	31	6.00	1.2349
	32	5.80	1.2199
	33	5.60	1.2052
	34	5.40	1.1974
	35	5.20	1.1955
	36	5.00	1.1942
	37	4.80	1.1913
	38	4.60	1.1873
	39	4.40	1.1821
	40	4.20	1.1756
	41	4.00	1.1681
	42	3.80	1.1611
	43	3.60	1.1545
	44	3.40	1.1473
	45	3.20	1.1422
	46	3.00	1.1404
	47	2.80	1.1467
	48	2.60	1.1562
	49	2.40	1.1662
	50	2.20	1.1761
	51	2.00	1.1859
*	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.

Figure 7
RAOC W(Z) at 17000 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	1.2470
	12	9.80	1.2392
	13	9.60	1.2311
	14	9.40	1.2256
	15	9.20	1.2210
	16	9.00	1.2152
	17	8.80	1.2107
	18	8.60	1.2139
	19	8.40	1.2383
	20	8.20	1.2593
	21	8.00	1.2764
	22	7.80	1.2910
	23	7.60	1.3022
	24	7.40	1.3103
	25	7.20	1.3153
	26	7.00	1.3178
	27	6.80	1.3184
	28	6.60	1.3166
	29	6.40	1.3124
	30	6.20	1.3059
	31	6.00	1.2976
	32	5.80	1.2861
	33	5.60	1.2753
	34	5.40	1.2725
	35	5.20	1.2698
	36	5.00	1.2650
	37	4.80	1.2582
	38	4.60	1.2493
	39	4.40	1.2382
	40	4.20	1.2250
	41	4.00	1.2100
	42	3.80	1.1988
	43	3.60	1.1875
	44	3.40	1.1745
	45	3.20	1.1598
	46	3.00	1.1596
	47	2.80	1.1724
	48	2.60	1.1870
	49	2.40	1.2009
	50	2.20	1.2149
	51	2.00	1.2288
*	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.