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U.S. Nuclear Regulatory Commission
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Docket No. 50-323, OL-DPR-82
Diablo Canyon Unit 2
Core Operating Limits Report for Unit 2 Cycle 12

Dear Commissioners and Staff:

In accordance with Diablo Canyon Power Plant Technical Specification 5.6.5.d, enclosed is revision 2 of the Core Operating Limits Report for Diablo Canyon Unit 2 Cycle 12. These revisions incorporate changes made following the Unit 2 eleventh refueling outage and subsequent startup.

Sincerely,

D. H. Oatley

David H. Oatley

ddm/2254
cc/enc: Edgar Bailey, DHS
Thomas P. Gwynn
David H. Jaffe
William B. Jones
David L. Proulx
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A001

CORE OPERATING LIMITS REPORT (COLR)
DIABLO CANYON POWER PLANT
UNIT 2, CYCLE 12, REVISION 2 (15 Pages)
EFFECTIVE DATE MAY 21, 2003

TITLE: COLR for Diablo Canyon Unit 2 Cycle 12

05/21/03
EFFECTIVE DATE

1. CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Diablo Canyon Unit 2 Cycle 12 has been prepared in accordance with the requirements of Technical Specification (TS) 5.6.5.

The Technical Specifications affected by this report are listed below:

3.1.1 - Shutdown Margin (MODE 2 with $k_{eff} < 1.0$, 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 - $F_{\Delta H}^N$

3.2.3 - Axial Flux Difference - (AFD)

3.9.1 - Boron Concentration

2. OPERATING LIMITS

The cycle-specific parameter limits for the TS listed in Section 1. are presented in the following subsections. These limits have been developed using the NRC-approved methodologies specified in TS 5.6.5.

2.1 Shutdown Margin (SDM) (TS 3.1.1)

The SDM limit for MODE 2 with $k_{eff} < 1.0$, MODES 3 and 4 is:

2.1.1 The shutdown margin with Safety Injection enabled shall be greater than or equal to 1.6% Δk/k.

2.1.2 In Modes 3 or 4 the shutdown margin with Safety Injection blocked shall be greater than or equal to 1.6% Δk/k calculated at a temperature of 200 °F.

The SDM limit for MODE 5 is:

2.1.3 The shutdown margin shall be greater than or equal to 1.0% Δk/k. However, an administrative value of 1.6 % Δk/k will be used to address concerns of NSAL-02-014.

2.2 Shutdown Margin (SDM) for MODE 1 and MODE 2 with $k_{eff} \geq 1.0$ is:

2.2.1 The shutdown margin shall be greater than or equal to 1.6% Δk/k.

2.3 Moderator Temperature Coefficient (MTC) (TS 3.1.3)

The MTC limit for MODES 1, 2, and 3 is:

2.3.1 The MTC shall be less negative than -3.9×10^{-4} $\Delta k/k/°F$ for all rods withdrawn, end of cycle life (EOL), RATED THERMAL POWER condition.

The 300 ppm Surveillance limit is:

2.3.2 The MTC 300 ppm surveillance limit is -3.0×10^{-4} $\Delta k/k/°F$ (all rods withdrawn, RATED THERMAL POWER condition).

The 60 ppm Surveillance limit is:

2.3.3 The MTC 60 ppm surveillance limit is -3.72×10^{-4} $\Delta k/k/°F$ (all rods withdrawn, RATED THERMAL POWER condition).

2.4 Shutdown Bank Insertion Limits (TS 3.1.5)

2.4.1 Each shutdown bank shall be withdrawn to at least 225 steps.

2.5 Control Bank Insertion Limits (TS 3.1.6)

2.5.1 The control banks shall be limited in physical insertion as shown in Figure 1.

2.6 Heat Flux Hot Channel Factor – $F_Q(Z)$ (TS 3.2.1)

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

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

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

$F_Q^{RTP} = 2.45$

$K(Z) = 1.0$.

2.6.2 The W(Z) curves for Relaxed Axial Offset Control (RAOC) operation, provided in Figures 2 through 5, and Tables 2A and 2B are sufficient to determine the RAOC W(Z) versus core height for Cycle 12 burnups through the end of full power reactivity plus a power coastdown of up to 1000 MWD/MTU.

Table 1 shows F_Q margin decreases that are greater than 2% per 31 Effective Full Power Days (EFPD). These values shall be used to increase $F_Q^W(Z)$ per SR 3.2.1.2. A 2% penalty factor shall be used at all cycle burnups that are outside the range of Table 1.

<u>**NOTE:**</u> That the W(Z) data is appropriate for use if the predicted axial offset is within ±3% of the measured value.

2.6.3 $F_Q(Z)$ shall be evaluated to determine if it is within its limits by verifying that $F_Q^C(Z)$ and $F_Q^W(Z)$ satisfy the following:

a. Using the moveable incore detectors to obtain a power distribution map in MODE 1.

b. Increasing the measured $F_Q(Z)$ component of the power distribution map by 3% to account for manufacturing tolerances and further increasing the value by 5% to account for measurement uncertainties.

c. Satisfying the following relationship:

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

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

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

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

where:

$F_Q^C(Z)$ is the measured $F_Q(Z)$ increased by the allowances for manufacturing tolerances and measurement uncertainty.

F_Q^{RTP} is the F_Q limit

K(Z) is the normalized $F_Q(Z)$ as a function of core height

P is the relative THERMAL POWER, and

W(Z) is the cycle dependent function that accounts for power distribution transients encountered during normal operation.

F_Q^{RTP} and K(Z) are specified in 2.6.1 and W(Z) is specified in 2.6.2.

$F_Q^W(Z)$ is the total peaking factor, $F_Q^C(Z)$, multiplied by W(Z) which gives the maximum $F_Q(Z)$ calculated to occur in normal operation.

2.7 Nuclear Enthalpy Rise Hot Channel Factor (TS 3.2.2)

$$F_{\Delta H}^N \le F_{\Delta H}^{RTP} * [1 + PF_{\Delta H} * (1-P)]$$

where:

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

$F_{\Delta H}^N$ = Measured values of $F_{\Delta H}^N$ obtained by using the moveable incore detectors to obtain a power distribution map.

$F_{\Delta H}^{RTP} = 1.59$

$PF_{\Delta H} = 0.3$

2.8 Axial Flux Difference (TS 3.2.3)

2.8.1 The Axial Flux Difference (AFD) Limits are provided in Figure 6.

2.9 Boron Concentration (TS 3.9.1)

The refueling boron concentration of the Reactor Coolant System, the refueling canal, and the refueling cavity shall be maintained within the more restrictive of the following limits:

2.9.1 A k_{eff} of 0.95 or less, with the most reactive control rod assembly completely withdrawn, or

2.9.2 A boron concentration of greater than or equal to 2000 ppm.

3. TABLES

3.1 Table 1, "F_Q Margin Decreases in Excess of 2% Per 31 EFPD."

3.2 Table 2A, "Load Follow W(Z) Factors at 150 and 4,000 MWD/MTU as a Function of Core Height."

3.3 Table 2B, "Load Follow W(Z) Factors at 12,000 and 22,000 MWD/MTU as a Function of Core Height."

4. FIGURES

4.1 Figure 1, "Control Bank Insertion Limits Versus Rated Thermal Power."

4.2 Figure 2, "Load Follow W(Z) at 150 MWD/MTU as a Function of Core Height."

4.3 Figure 3, "Load Follow W(Z) at 4,000 MWD/MTU as a Function of Core Height."

4.4 Figure 4, "Load Follow W(Z) at 12,000 MWD/MTU as a Function of Core Height."

4.5 Figure 5, "Load Follow W(Z) at 22,000 MWD/MTU as a Function of Core Height."

4.6 Figure 6, "AFD Limits as a Function of Rated Thermal Power."

5. RECORDS

None

6. REFERENCES

6.1 Westinghouse Reload Evaluation for Diablo Canyon Power Plant Unit 2 Cycle 12, dated February 2003.

7. SPONSOR

Ken Kargol

TABLE 1: F_Q Margin Decreases in Excess of 2% Per 31 EFPD

Cycle Burnup (MWD/MTU)	Max % Decrease In F_Q Margin
150	2.00
313	2.31
475	2.59
638	2.83
801	2.98
964	3.00
1126	2.89
1289	2.69
1452	2.41
1615	2.10
1777	2.00

NOTE: All cycle burnups outside the range of this table shall use a 2% decrease in F_Q margin for compliance with SR 3.2.1.2. Linear interpolation is adequate for intermediate cycle burnups.

TABLE 2A: Load Follow W(Z) Factors at 150 and 4000 MWD/MTU as a Function of Core Height

HEIGHT (FEET)	150 MWD/MTU W(Z)	HEIGHT (FEET)	4000 MWD/MTU W(Z)
*0.0000	1.0000	*0.0000	1.0000
*0.2000	1.0000	*0.2000	1.0000
*0.4000	1.0000	*0.4000	1.0000
*0.6000	1.0000	*0.6000	1.0000
*0.8000	1.0000	*0.8000	1.0000
*1.0000	1.0000	*1.0000	1.0000
*1.2000	1.0000	*1.2000	1.0000
*1.4000	1.0000	*1.4000	1.0000
*1.6000	1.0000	*1.6000	1.0000
*1.8000	1.0000	*1.8000	1.0000
2.0000	1.2453	2.0000	1.2782
2.2000	1.2333	2.2000	1.2563
2.4000	1.2211	2.4000	1.2340
2.6000	1.2087	2.6000	1.2117
2.8000	1.1953	2.8000	1.1888
3.0000	1.1852	3.0000	1.1700
3.2000	1.1794	3.2000	1.1587
3.4000	1.1751	3.4000	1.1524
3.6000	1.1706	3.6000	1.1468
3.8000	1.1681	3.8000	1.1462
4.0000	1.1652	4.0000	1.1462
4.2000	1.1620	4.2000	1.1450
4.4000	1.1605	4.4000	1.1432
4.6000	1.1580	4.6000	1.1407
4.8000	1.1547	4.8000	1.1375
5.0000	1.1504	5.0000	1.1336
5.2000	1.1471	5.2000	1.1293
5.4000	1.1475	5.4000	1.1242
5.6000	1.1583	5.6000	1.1192
5.8000	1.1701	5.8000	1.1258

NOTE: W(Z) values given above for 150 and 4000 MWD/MTU are plotted in COLR Figures 2 and 3, respectively.

* Top and Bottom 15% Excluded

Table 2A: Load Follow W(Z) Factors at 150 and 4000 MWD/MTU as a Function of Core Height (Continued)

HEIGHT (FEET)	150 MWD/MTU W(Z)	HEIGHT (FEET)	4000 MWD/MTU W(Z)
6.0000	1.1823	6.0000	1.1412
6.2000	1.1969	6.2000	1.1531
6.4000	1.2114	6.4000	1.1648
6.6000	1.2246	6.6000	1.1756
6.8000	1.2362	6.8000	1.1851
7.0000	1.2461	7.0000	1.1935
7.2000	1.2540	7.2000	1.2003
7.4000	1.2599	7.4000	1.2055
7.6000	1.2633	7.6000	1.2096
7.8000	1.2641	7.8000	1.2121
8.0000	1.2622	8.0000	1.2123
8.2000	1.2575	8.2000	1.2105
8.4000	1.2498	8.4000	1.2064
8.6000	1.2382	8.6000	1.1988
8.8000	1.2283	8.8000	1.1980
9.0000	1.2183	9.0000	1.2040
9.2000	1.2089	9.2000	1.2193
9.4000	1.2096	9.4000	1.2320
9.6000	1.2181	9.6000	1.2455
9.8000	1.2286	9.8000	1.2596
10.0000	1.2369	10.0000	1.2730
*10.2000	1.0000	*10.2000	1.0000
*10.4000	1.0000	*10.4000	1.0000
*10.6000	1.0000	*10.6000	1.0000
*10.8000	1.0000	*10.8000	1.0000
*11.0000	1.0000	*11.0000	1.0000
*11.2000	1.0000	*11.2000	1.0000
*11.4000	1.0000	*11.4000	1.0000
*11.6000	1.0000	*11.6000	1.0000
*11.8000	1.0000	*11.8000	1.0000
*12.0000	1.0000	*12.0000	1.0000

NOTE: W(Z) values given above for 150 and 4000 MWD/MTU are plotted in COLR Figures 2 and 3, respectively.

* Top and Bottom 15% Excluded

TABLE 2B: Load Follow W(Z) Factors at 12000 and 22000 MWD/MTU as a Function of Core Height

HEIGHT (FEET)	12000 MWD/MTU W(Z)	HEIGHT (FEET)	22000 MWD/MTU W(Z)
*0.0000	1.0000	*0.0000	1.0000
*0.2000	1.0000	*0.2000	1.0000
*0.4000	1.0000	*0.4000	1.0000
*0.6000	1.0000	*0.6000	1.0000
*0.8000	1.0000	*0.8000	1.0000
*1.0000	1.0000	*1.0000	1.0000
*1.2000	1.0000	*1.2000	1.0000
*1.4000	1.0000	*1.4000	1.0000
*1.6000	1.0000	*1.6000	1.0000
*1.8000	1.0000	*1.8000	1.0000
2.0000	1.2382	2.0000	1.2133
2.2000	1.2256	2.2000	1.1982
2.4000	1.2128	2.4000	1.1827
2.6000	1.1999	2.6000	1.1669
2.8000	1.1854	2.8000	1.1549
3.0000	1.1774	3.0000	1.1566
3.2000	1.1761	3.2000	1.1673
3.4000	1.1740	3.4000	1.1747
3.6000	1.1707	3.6000	1.1810
3.8000	1.1706	3.8000	1.1891
4.0000	1.1713	4.0000	1.1985
4.2000	1.1706	4.2000	1.2073
4.4000	1.1690	4.4000	1.2139
4.6000	1.1663	4.6000	1.2186
4.8000	1.1626	4.8000	1.2220
5.0000	1.1577	5.0000	1.2222
5.2000	1.1523	5.2000	1.2241
5.4000	1.1505	5.4000	1.2411
5.6000	1.1580	5.6000	1.2625
5.8000	1.1686	5.8000	1.2822

NOTE: W(Z) values given above for 12000 and 22000 MWD/MTU are plotted in COLR Figures 4 and 5, respectively.

* Top and Bottom 15% Excluded

TABLE 2B: Load Follow W(Z) Factors at 12000 and 22000 MWD/MTU as a Function of Core Height (Continued)

HEIGHT (FEET)	12000 MWD/MTU W(Z)	HEIGHT (FEET)	22000 MWD/MTU W(Z)
6.0000	1.1795	6.0000	1.2994
6.2000	1.1905	6.2000	1.3143
6.4000	1.1999	6.4000	1.3269
6.6000	1.2079	6.6000	1.3369
6.8000	1.2145	6.8000	1.3442
7.0000	1.2193	7.0000	1.3486
7.2000	1.2225	7.2000	1.3500
7.4000	1.2246	7.4000	1.3481
7.6000	1.2247	7.6000	1.3429
7.8000	1.2228	7.8000	1.3341
8.0000	1.2185	8.0000	1.3218
8.2000	1.2121	8.2000	1.3059
8.4000	1.2035	8.4000	1.2866
8.6000	1.1918	8.6000	1.2661
8.8000	1.1880	8.8000	1.2419
9.0000	1.1890	9.0000	1.2258
9.2000	1.1936	9.2000	1.2210
9.4000	1.1961	9.4000	1.2108
9.6000	1.1974	9.6000	1.2129
9.8000	1.1954	9.8000	1.2184
10.0000	1.1961	10.0000	1.2210
*10.2000	1.0000	*10.2000	1.0000
*10.4000	1.0000	*10.4000	1.0000
*10.6000	1.0000	*10.6000	1.0000
*10.8000	1.0000	*10.8000	1.0000
*11.0000	1.0000	*11.0000	1.0000
*11.2000	1.0000	*11.2000	1.0000
*11.4000	1.0000	*11.4000	1.0000
*11.6000	1.0000	*11.6000	1.0000
*11.8000	1.0000	*11.8000	1.0000
*12.0000	1.0000	*12.0000	1.0000

NOTE: W(Z) values given above for 12000 and 22000 MWD/MTU are plotted in COLR Figures 4 and 5, respectively.

* Top and Bottom 15% Excluded

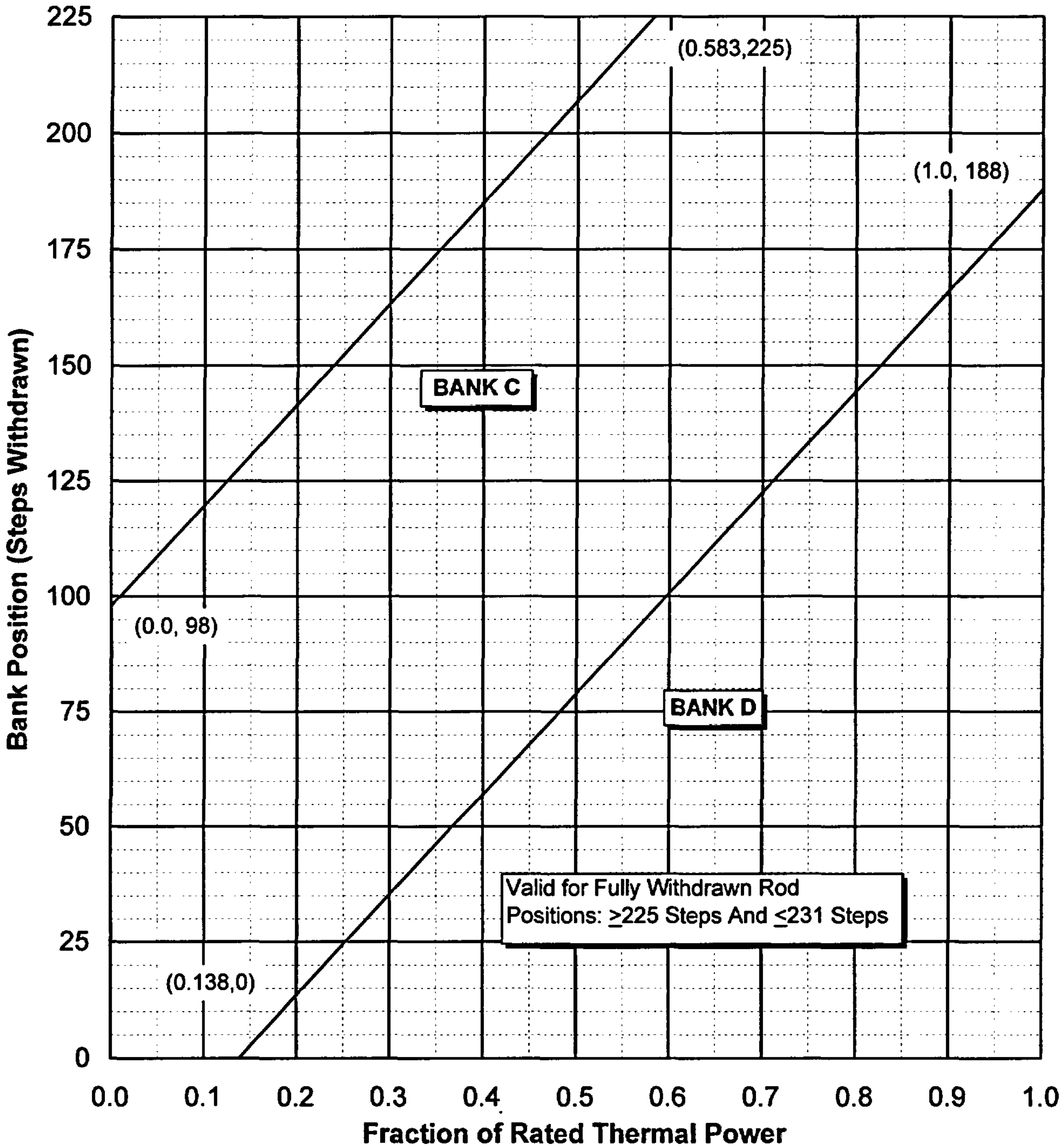

FIGURE 1: Control Bank Insertion Limits Versus Rated Thermal Power

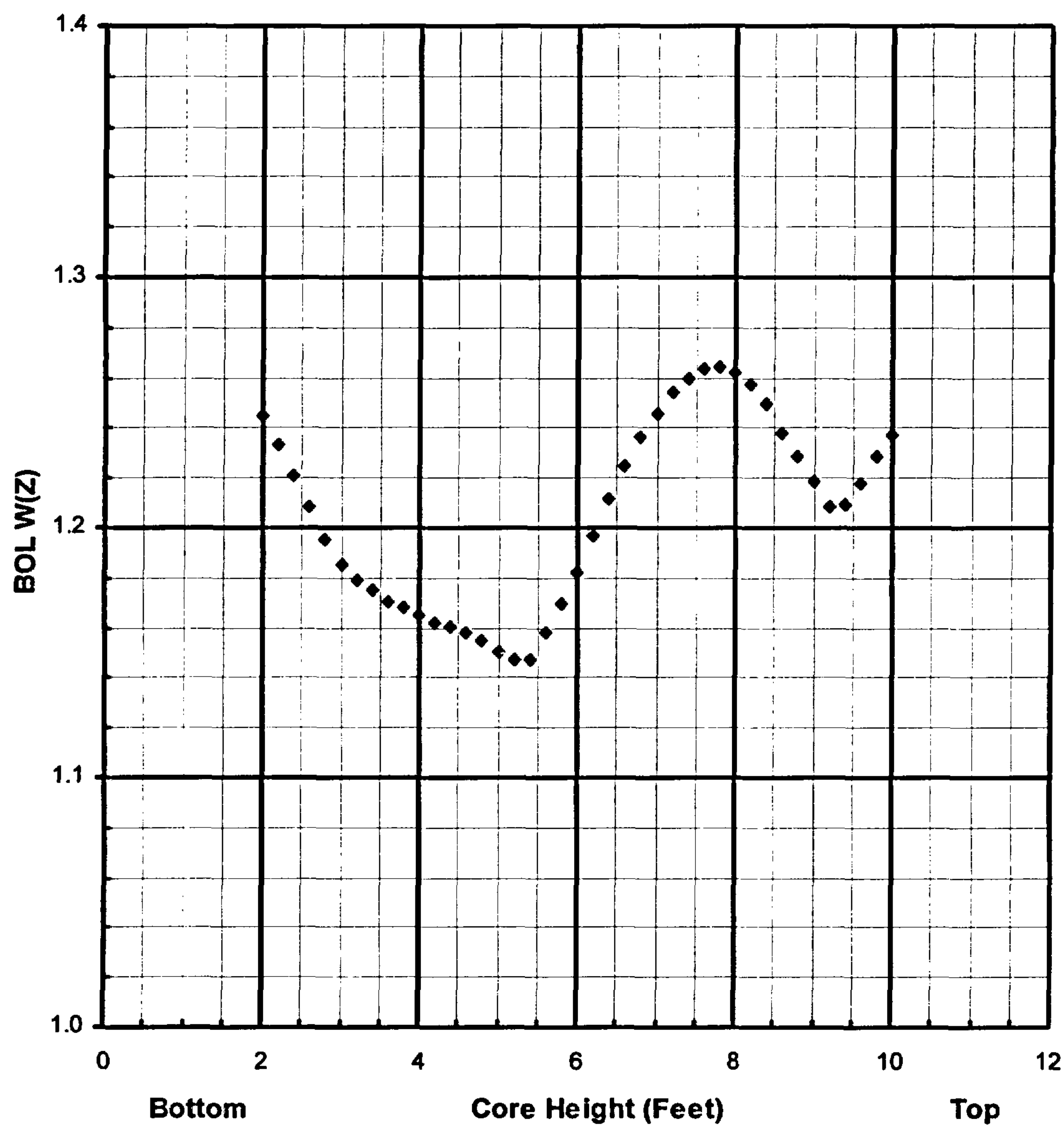

FIGURE 2: Load Follow W(Z) at 150 MWD/MTU as a Function of Core Height
* Top and Bottom 15% Excluded

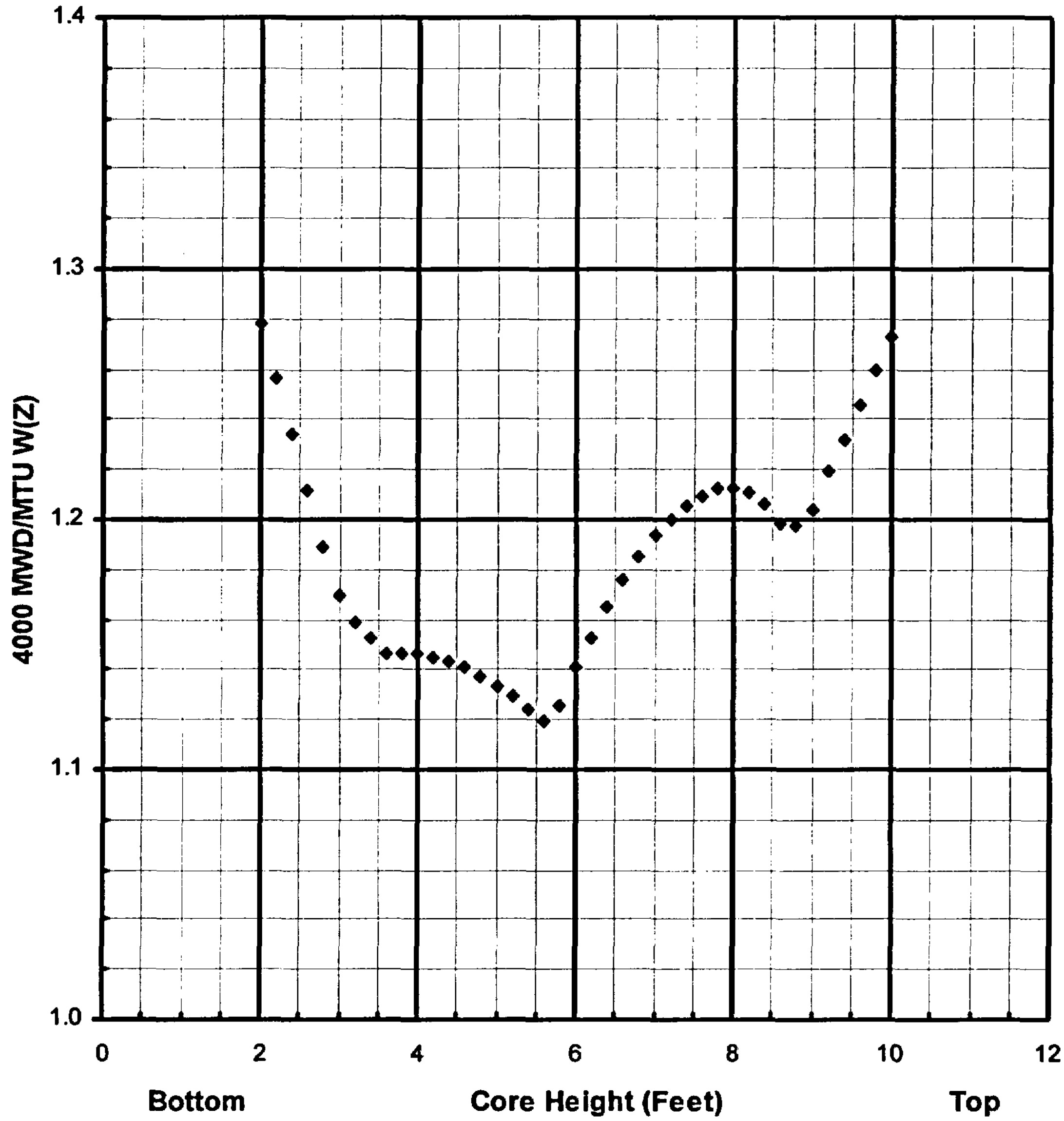

FIGURE 3: Load Follow W(Z) at 4000 MWD/MTU as a Function of Core Height
*Top and Bottom 15% Excluded

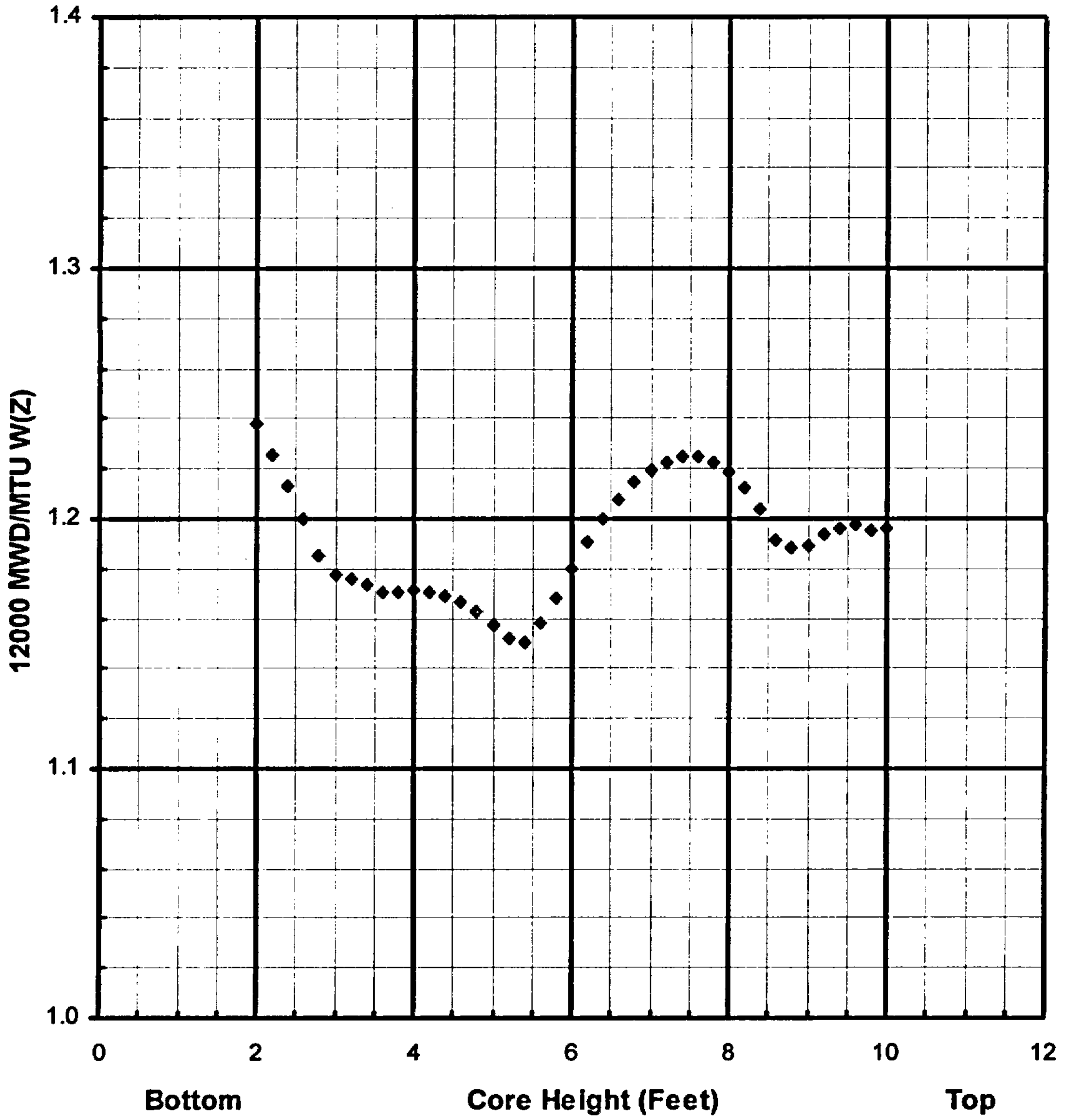

FIGURE 4: Load Follow W(Z) at 12000 MWD/MTU as a Function of Core Height
* Top and Bottom 15% Excluded

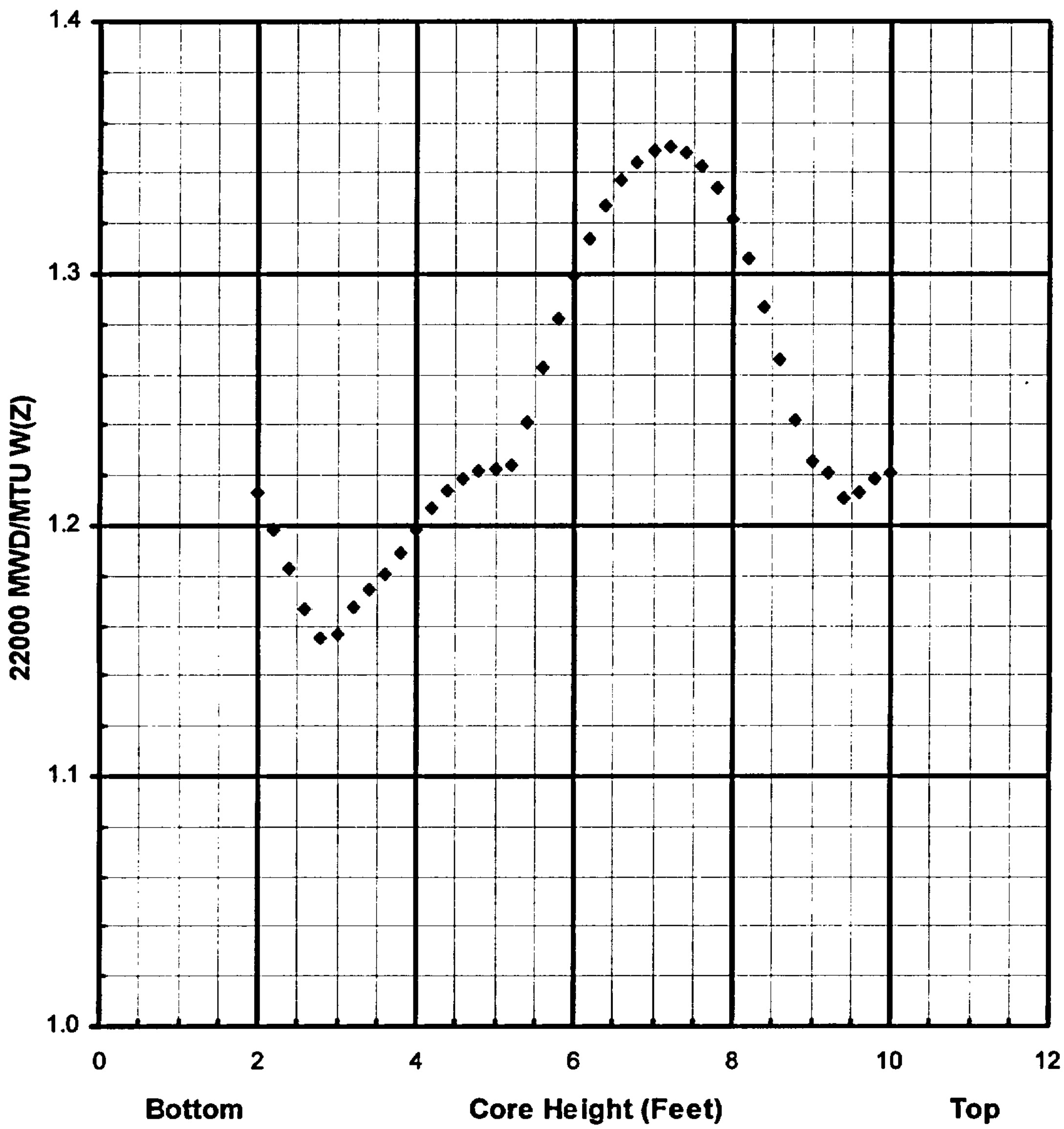

FIGURE 5: Load Follow W(Z) at 22000 MWD/MTU as a Function of Core Height
* Top and Bottom 15% Excluded

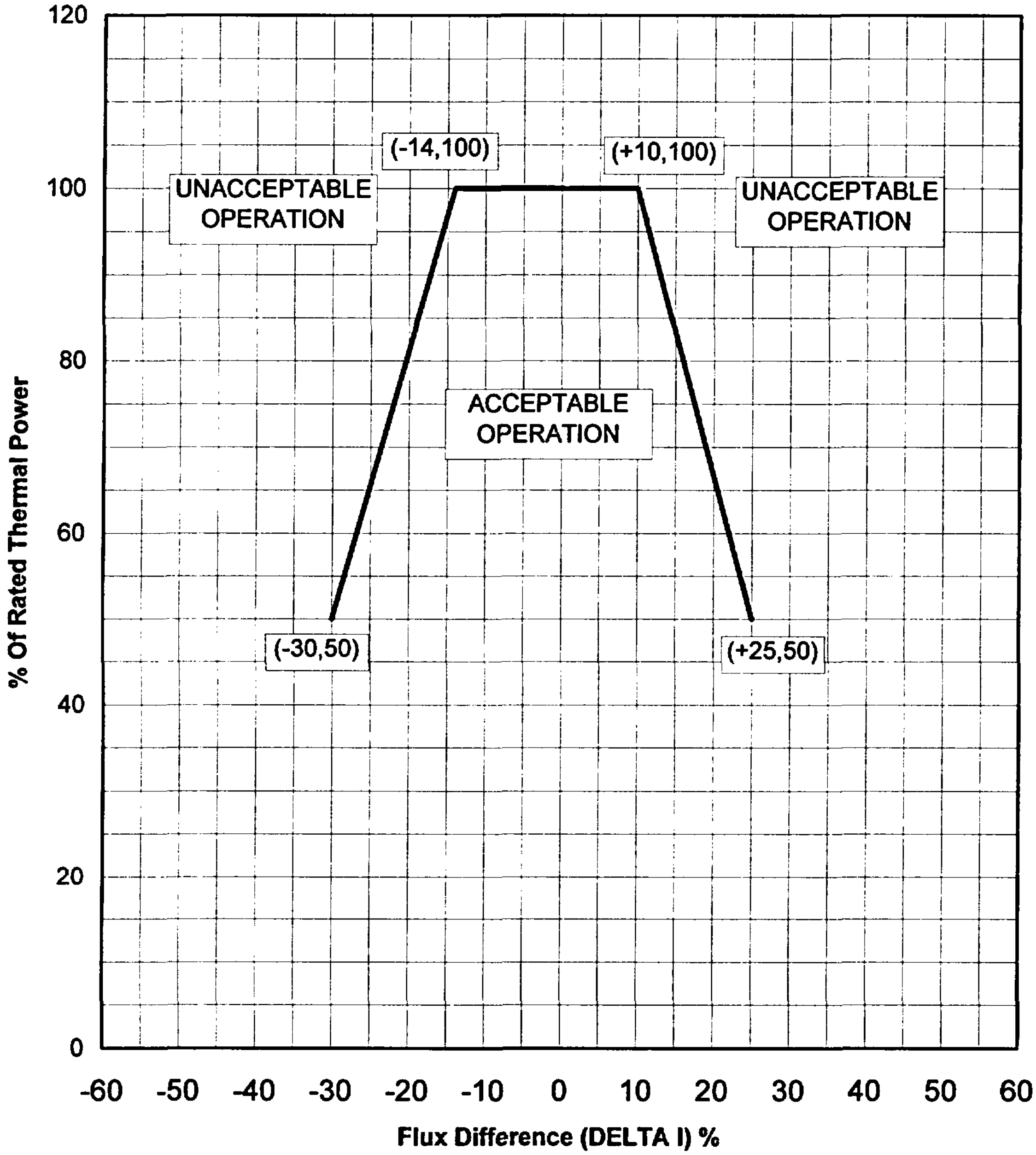

FIGURE 6: AFD Limits as a Function of Rated Thermal Power