Pacific Gas and Electric Company

David H. Oatley
Vice President–Diablo Canyon
Operations and Plant Manager

Diablo Canyon Power Plant
P.O. Box 56
Avila Beach, CA 93424

805.545.6000

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PG&E Letter DCL-00-133

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Docket No. 50-275, OL-DPR-80
Diablo Canyon Unit 1
Core Operating Limits Report Unit 1, Cycle 11

Dear Commissioners and Staff:

In accordance with Diablo Canyon Power Plant Technical Specification 5.6.5.d, enclosed is the Core Operating Limits Report for Unit 1, Cycle 11.

Sincerely,

David H. Oatley

cc: Edgar Bailey, DHS
Ellis W. Merschoff
David L. Proulx
Lakshminaras Raghavan
Linda J. Smith
Diablo Distribution

Enclosure

DDM/2254/A0479103

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CORE OPERATING LIMITS REPORT (COLR)
DIABLO CANYON POWER PLANT
UNIT 1, CYCLE 11, REVISION 0 (16 Pages)

TITLE: COLR For Diablo Canyon Unit 1 Cycle 11

1

10-20-00
EFFECTIVE DATE

PROCEDURE CLASSIFICATION: QUALITY RELATED

1. CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Diablo Canyon Unit 1 Cycle 11 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

This procedure was rewritten; therefore, revision bars are not included.

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 shall be greater than or equal to 1.6% $\Delta k/k$.

The SDM limit for MODE 5 is:

2.1.2 The shutdown margin shall be greater than or equal to 1.0% $\Delta k/k$.

2.2 Moderator Temperature Coefficient (MTC) (TS 3.1.3)

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

2.2.1 The MTC shall be less negative than -3.9×10^{-4} Δk/k/°F for all rods withdrawn, end of cycle life (EOL), RATED THERMAL POWER condition.

The 300 ppm Surveillance limit is:

2.2.2 The MTC shall be less negative than -3.0×10^{-4} Δk/k/°F (for all rods withdrawn, RATED THERMAL POWER condition).

The 60 ppm Surveillance limit is:

2.2.3 The MTC shall be less negative than -3.72×10^{-4} Δk/k/°F (for all rods withdrawn, RATED THERMAL POWER condition).

2.3 Shutdown Bank Insertion Limits (TS 3.1.5)

2.3.1 Each shutdown bank shall be withdrawn to at least 225 steps.

2.4 Control Bank Insertion Limits (TS 3.1.6)

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

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

2.5.1 $F_Q(Z) < \frac{F_Q^{RTP}}{P} * K(Z)$ for $P > 0.5$

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

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

$F_Q^{RTP} = 2.45$

$K(Z) = 1.0$

2.5.2 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 11 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.

2.5.3 $F_Q(Z)$ 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:

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

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

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

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

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 2.5.1 and W(Z) is specified in 2.5.2.

$F_Q^W(Z)$ 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.

2.6 Nuclear Enthalpy Rise Hot Channel Factor (TS 3.2.2)

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

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

2.7 Axial Flux Difference (TS 3.2.3)

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

2.8 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:

2.8.1 A k_{eff} of 0.95 or less, which includes a 1% $\Delta k/k$ conservative allowance for uncertainties, or

2.8.2 A boron concentration of greater than or equal to 2000 ppm, which includes a 50 ppm conservative allowance for uncertainties.

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 20,000 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 20,000 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 Safety Evaluation for Diablo Canyon Power Plant Unit 1 Cycle 11, Revision 2, dated October 2000.

7. SPONSOR

Jay Lesko

Table 1

F_Q Margin Decreases in Excess of 2% Per 31 EFPD

Cycle Burnup (MWD/MTU)	Max % Decrease In F_Q Margin
0	2.67
150	2.67
313	2.67
476	2.62
639	2.51
802	2.56
965	2.57
1128	2.55
1291	2.49
1454	2.40
1618	2.27
1781	2.13
1944	2.00
5694	2.00
5857	2.13
6020	2.52
6183	2.48
6346	2.64
6509	2.52
6672	2.40
6835	2.28
6999	2.12
7162	2.02
7325	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	1.3122	2.0000	1.2979
2.2000	1.2870	2.2000	1.2763
2.4000	1.2615	2.4000	1.2541
2.6000	1.2360	2.6000	1.2317
2.8000	1.2128	2.8000	1.2096
3.0000	1.1984	3.0000	1.1869
3.2000	1.1916	3.2000	1.1755
3.4000	1.1876	3.4000	1.1737
3.6000	1.1856	3.6000	1.1718
3.8000	1.1828	3.8000	1.1689
4.0000	1.1787	4.0000	1.1652
4.2000	1.1737	4.2000	1.1604
4.4000	1.1677	4.4000	1.1547
4.6000	1.1609	4.6000	1.1481
4.8000	1.1527	4.8000	1.1403
5.0000	1.1461	5.0000	1.1339
5.2000	1.1403	5.2000	1.1292
5.4000	1.1350	5.4000	1.1234
5.6000	1.1350	5.6000	1.1168
5.8000	1.1412	5.8000	1.1207

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	1.1513	6.0000	1.1324
6.2000	1.1611	6.2000	1.1456
6.4000	1.1697	6.4000	1.1579
6.6000	1.1773	6.6000	1.1692
6.8000	1.1836	6.8000	1.1793
7.0000	1.1882	7.0000	1.1879
7.2000	1.1921	7.2000	1.1951
7.4000	1.1966	7.4000	1.2006
7.6000	1.2010	7.6000	1.2041
7.8000	1.2035	7.8000	1.2054
8.0000	1.2040	8.0000	1.2044
8.2000	1.2025	8.2000	1.2007
8.4000	1.1987	8.4000	1.1945
8.6000	1.1925	8.6000	1.1872
8.8000	1.1904	8.8000	1.1864
9.0000	1.1944	9.0000	1.1926
9.2000	1.2034	9.2000	1.2107
9.4000	1.2099	9.4000	1.2345
9.6000	1.2230	9.6000	1.2581
9.8000	1.2418	9.8000	1.2792
10.0000	1.2690	10.0000	1.2949
*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 20000 MWD/MTU as a Function of Core Height

HEIGHT (FEET)	12000 MWD/MTU W(Z)	HEIGHT (FEET)	20000 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	1.2148	2.0000	1.2110
2.2000	1.2032	2.2000	1.1953
2.4000	1.1910	2.4000	1.1797
2.6000	1.1784	2.6000	1.1656
2.8000	1.1710	2.8000	1.1573
3.0000	1.1653	3.0000	1.1574
3.2000	1.1628	3.2000	1.1658
3.4000	1.1640	3.4000	1.1784
3.6000	1.1693	3.6000	1.1895
3.8000	1.1741	3.8000	1.2009
4.0000	1.1778	4.0000	1.2150
4.2000	1.1802	4.2000	1.2296
4.4000	1.1817	4.4000	1.2414
4.6000	1.1837	4.6000	1.2511
4.8000	1.1864	4.8000	1.2588
5.0000	1.1889	5.0000	1.2632
5.2000	1.1887	5.2000	1.2687
5.4000	1.1888	5.4000	1.2812
5.6000	1.2045	5.6000	1.2984
5.8000	1.2216	5.8000	1.3133

NOTE: W(Z) values given above for 12000 and 20000 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 20000 MWD/MTU as a Function of Core Height (Continued)

HEIGHT (FEET)	12000 MWD/MTU W(Z)	HEIGHT (FEET)	20000 MWD/MTU W(Z)
6.0000	1.2364	6.0000	1.3252
6.2000	1.2496	6.2000	1.3346
6.4000	1.2605	6.4000	1.3411
6.6000	1.2692	6.6000	1.3447
6.8000	1.2754	6.8000	1.3447
7.0000	1.2792	7.0000	1.3440
7.2000	1.2804	7.2000	1.3432
7.4000	1.2788	7.4000	1.3405
7.6000	1.2741	7.6000	1.3342
7.8000	1.2664	7.8000	1.3244
8.0000	1.2556	8.0000	1.3112
8.2000	1.2417	8.2000	1.2941
8.4000	1.2268	8.4000	1.2746
8.6000	1.2155	8.6000	1.2558
8.8000	1.2111	8.8000	1.2332
9.0000	1.2100	9.0000	1.2258
9.2000	1.2089	9.2000	1.2262
9.4000	1.2115	9.4000	1.2264
9.6000	1.2190	9.6000	1.2287
9.8000	1.2315	9.8000	1.2426
10.0000	1.2465	10.0000	1.2614
*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 20000 MWD/MTU are plotted in COLR Figures 4 and 5, respectively.

* Top and Bottom 15% Excluded

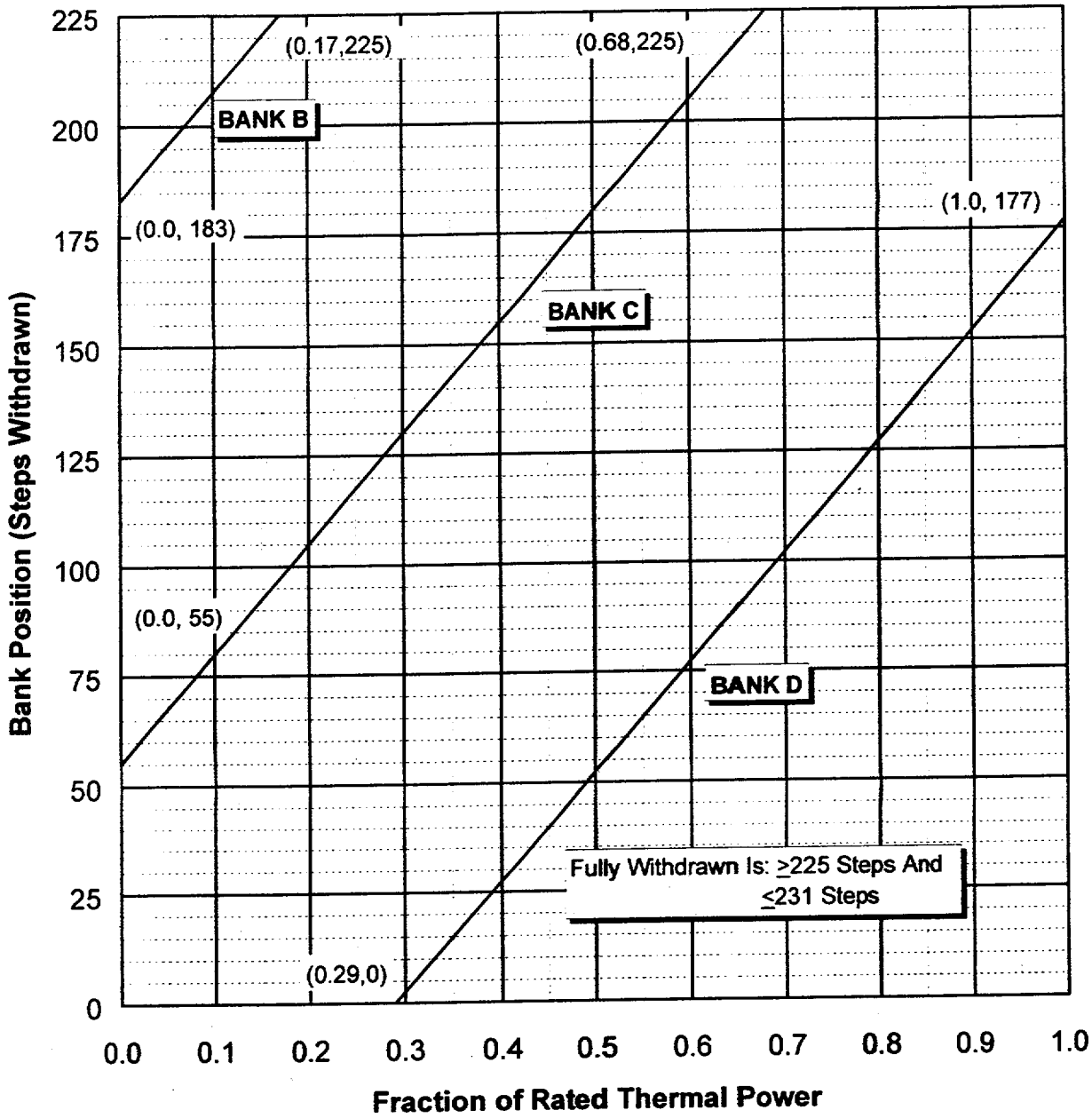

Figure 1
Control Bank Insertion Limits Versus Rated Thermal Power

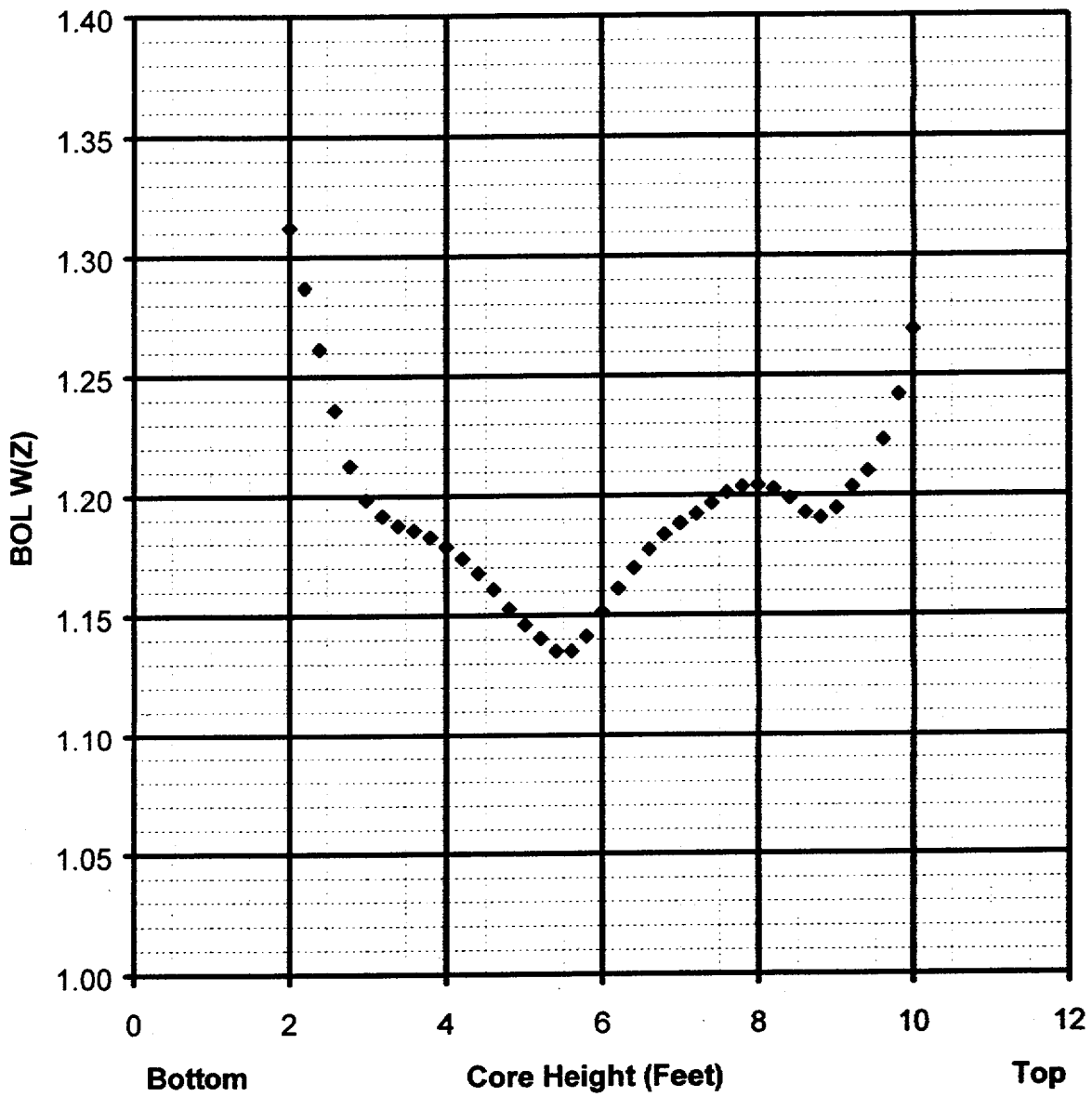

Figure 2
Load Follow W(Z) at 150 MWD/MTU as a Function of Core Height
* Top and Bottom 15% Excluded

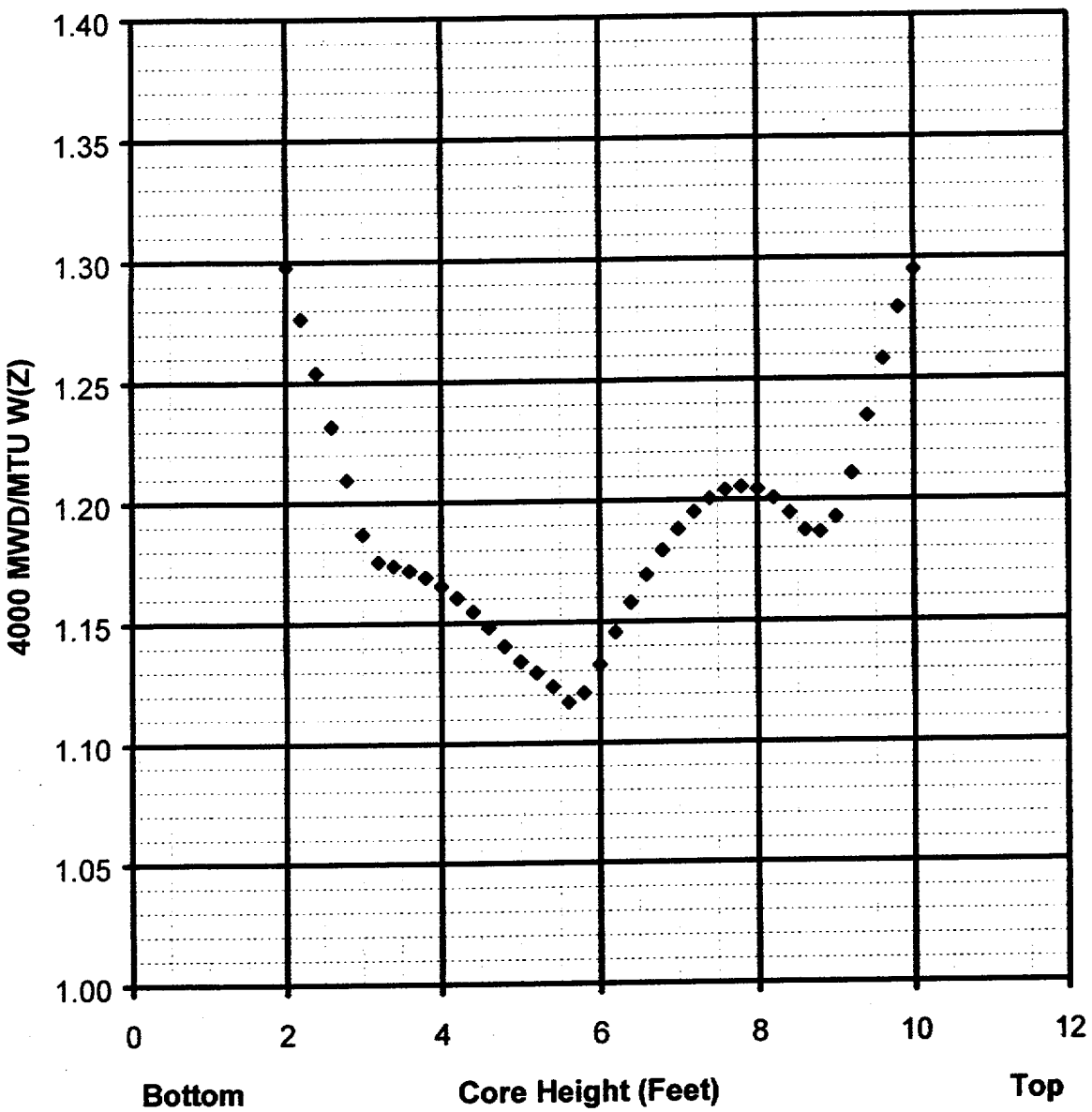

Figure 3
Load Follow W(Z) at 4000 MWD/MTU as a Function of Core Height
*Top and Bottom 15% Excluded

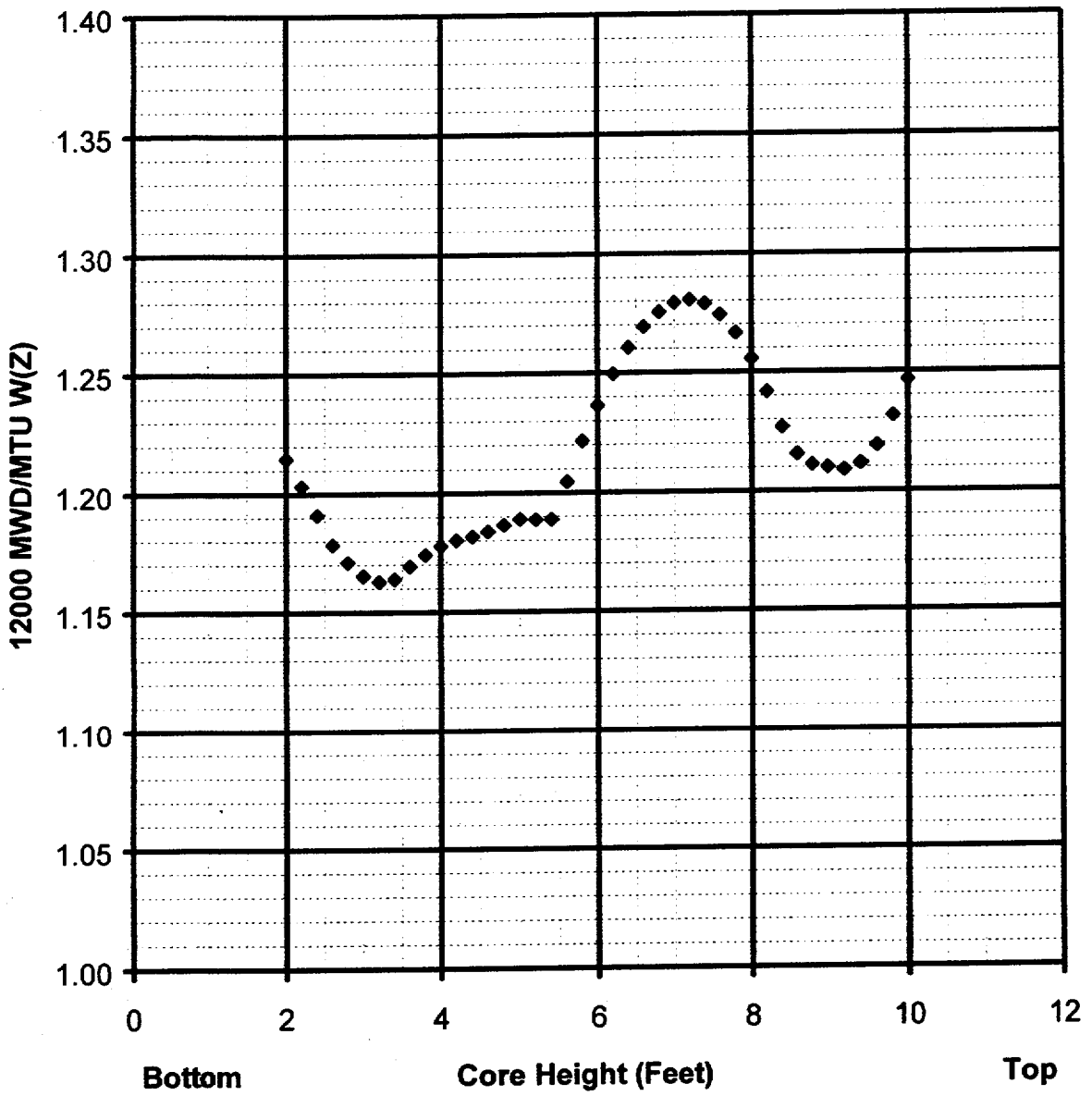

Figure 4
Load Follow W(Z) at 12000 MWD/MTU as a Function of Core Height
* Top and Bottom 15% Excluded

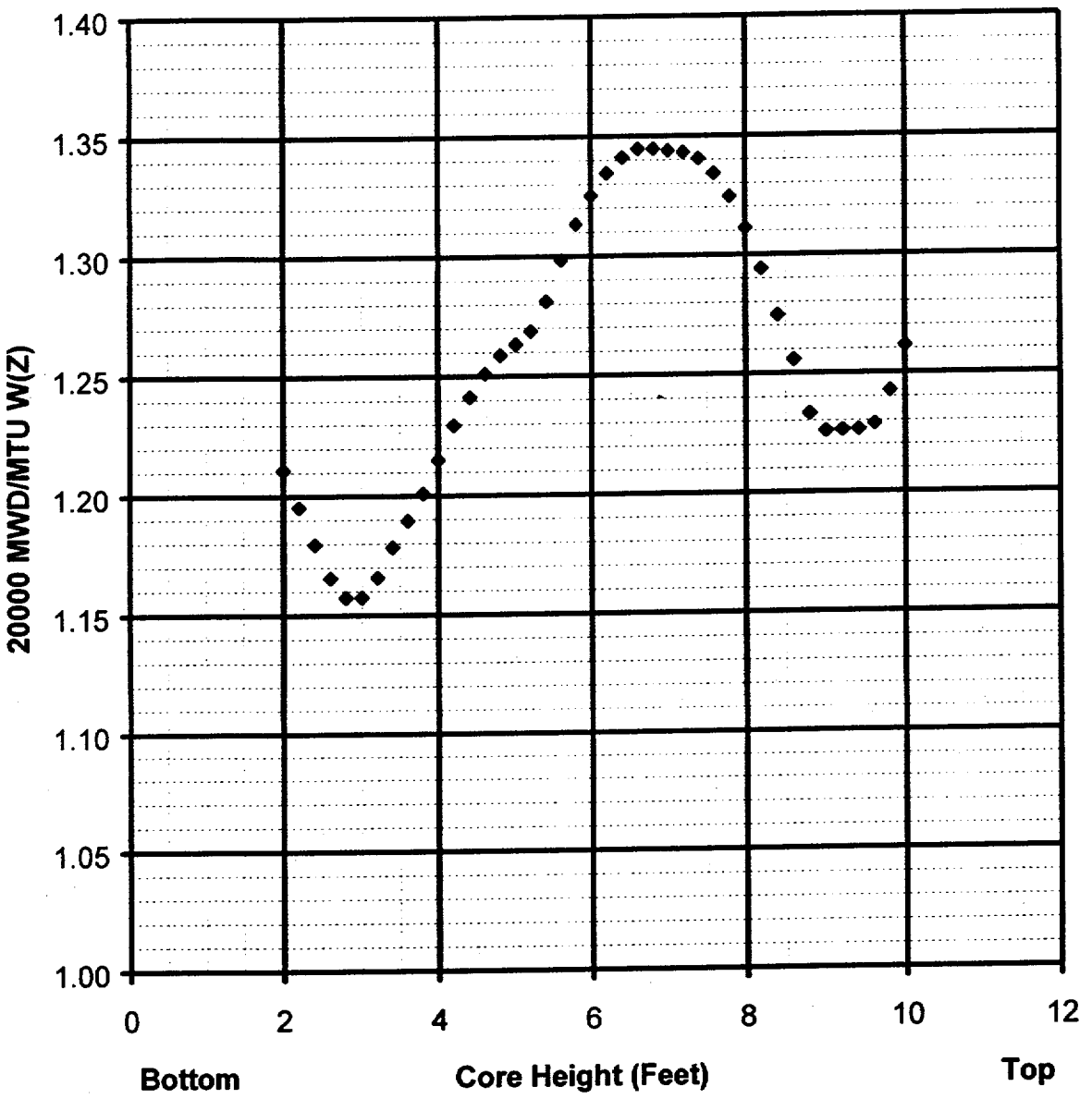

Figure 5
Load Follow W(Z) at 20000 MWD/MTU as a Function of Core Height
* Top and Bottom 15% Excluded

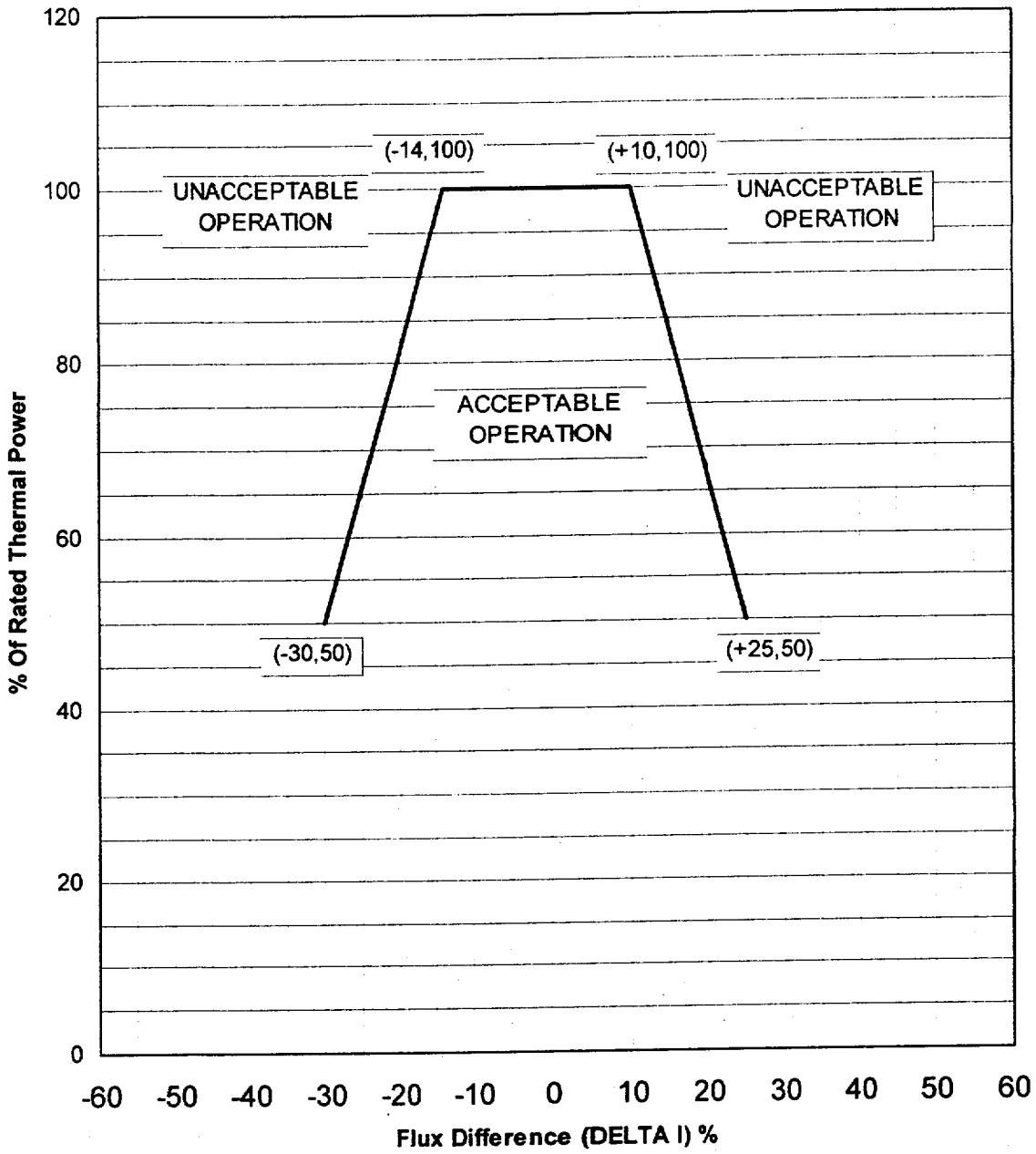

Figure 6
AFD Limits as a Function of Rated Thermal Power