TITLE: COLR FOR DIABLO CANYON UNIT 1 CYCLE 9

1

APPROVED: _____ 09/12/97 DATE 09/16/97 EFFECTIVE DATE

PROCEDURE CLASSIFICATION: QUALITY RELATED

1. CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Diablo Canyon Unit 1 Cycle 9 has been prepared in accordance with the requirements of Technical Specification (TS) 6.9.1.8.

The Technical Specifications affected by this report are listed below:

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 - RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor

2. OPERATING LIMITS

The cycle-specific parameter limits for the TS listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC-approved methodologies specified in TS 6.9.1.8.

2.1 Shutdown Rod Insertion Limit (TS 3/4.1.3.5)

2.1.1 The shutdown rods shall be withdrawn to at least 225 steps.

2.2 Control Rod Insertion Limits (TS 3/4.1.3.6)

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

2.3 Axial Flux Difference (TS 3/4.2.1)

2.3.1 The Axial Flux Difference (AFD) Limits are provided in Figure 2.

2.4 Heat Flux Hot Channel Factor - $F_Q(Z)$ (TS 3/4.2.2)

2.4.1 $$F_Q(Z) < \frac{F_Q^{RTP}}{P} * K(Z) \quad \text{for } P > 0.5$$

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

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

$F_Q^{RTP} = 2.45$

K(Z) is provided in Figure 7.

2.4.2 The W(Z) curves for TS 4.2.2.2c. Relaxed Axial Offset Control (RAOC) operation, provided in Figures 3 through 6, and Tables 2A and 2B are sufficient to determine the RAOC W(Z) versus core height for Cycle 9 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 $F_Q^M(Z)$ as per TS 4.2.2.2e. A 2% penalty factor shall be used at all cycle burnups that are outside the range of Table 1.

2.5 RCS Flow Rate and Nuclear Enthalpy Rise Hot Channel Factor (TS 3/4.2.3)

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

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

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

$PF_{\Delta H} = 0.3$

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 3,000 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, "Rod Bank Insertion Limits Versus Rated Thermal Power."

4.2 Figure 2, "AFD Limits as a Function of Rated Thermal Power."

4.3 Figure 3, "Load Follow W(Z) at 150 MWD/MTU as a Function of Core Height."

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

4.5 Figure 5, "Load Follow W(Z) at 12,000 MWD/MTU as a Function of Core Height."

4.6 Figure 6, "Load Follow W(Z) at 22,000 MWD/MTU as a Function of Core Height."

4.7 Figure 7, "K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height."

5. RECORDS

None

6. REFERENCES

Westinghouse Reload Safety Evaluation for Diablo Canyon Power Plant Unit 1 Cycle 9, Revision 0, dated March 1997 (Westinghouse Letter 97PGE-G-0017, dated March 11, 1997).

Westinghouse letter on Cycle 9 COLR Revision 1 and W(z) Factors to Address Potential Negative Axial Offset Deviation Near BOL, dated April 18, 1997 (Westinghouse Letter 97PGE-G-0030).

Westinghouse Letter on Cycle 9 COLR Revision 2 and W(z) Factors to Address Expected Axial Offset Deviation Through EOL, dated August 29, 1997 (Westinghouse Letter 97PGE-G-0053).

Table 1

F_Q Margin Decreases in Excess of 2% Per 31 EFPD

Cycle Burnup (MWD/MTU)	Max % Decrease In F_Q Margin
0	3.63
150	3.63
312	3.49
474	3.33
637	3.19
799	2.99
961	2.75
1123	2.48
1286	2.19
1448	2.00
6477	2.00
6639	2.34
6801	2.30
6963	2.23
7125	2.10
7288	2.00

NOTE: All cycle burnups outside the range of this table shall use a 2% decrease in F_Q margin for compliance with Specification 4.2.2.2.e. Linear interpolation is adequate for intermediate cycle burnups.

Table 2A Load Follow W(Z) Factors at 150 and 3000 MWD/MTU
as a Function of Core Height

HEIGHT (FEET)	150 MWD/MTU W(Z)	HEIGHT (FEET)	3000 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	1.2145	2.0000	1.2856
2.2000	1.1947	2.2000	1.2589
2.4000	1.1754	2.4000	1.2323
2.6000	1.1591	2.6000	1.2059
2.8000	1.1448	2.8000	1.1787
3.0000	1.1366	3.0000	1.1599
3.2000	1.1352	3.2000	1.1491
3.4000	1.1363	3.4000	1.1422
3.6000	1.1364	3.6000	1.1412
3.8000	1.1358	3.8000	1.1401
4.0000	1.1345	4.0000	1.1385
4.2000	1.1323	4.2000	1.1367
4.4000	1.1295	4.4000	1.1339
4.6000	1.1258	4.6000	1.1305
4.8000	1.1216	4.8000	1.1263
5.0000	1.1188	5.0000	1.1215
5.2000	1.1185	5.2000	1.1160
5.4000	1.1221	5.4000	1.1100
5.6000	1.1320	5.6000	1.1050
5.8000	1.1460	5.8000	1.1061

NOTE: W(Z) values given above for 150 and 3000 MWD/MTU are plotted in COLR Figures 3 and 4, respectively.

* Top and Bottom 15% Excluded as Per Tech Spec 4.2.2.2.g

Table 2A Load Follow W(Z) Factors at 150 and 3000 MWD/MTU
as a Function of Core Height (Continued)

HEIGHT (FEET)	150 MWD/MTU W(Z)	HEIGHT (FEET)	3000 MWD/MTU W(Z)
6.0000	1.1622	6.0000	1.1140
6.2000	1.1787	6.2000	1.1292
6.4000	1.1938	6.4000	1.1424
6.6000	1.2079	6.6000	1.1550
6.8000	1.2207	6.8000	1.1667
7.0000	1.2320	7.0000	1.1772
7.2000	1.2417	7.2000	1.1865
7.4000	1.2496	7.4000	1.1956
7.6000	1.2555	7.6000	1.2056
7.8000	1.2590	7.8000	1.2142
8.0000	1.2601	8.0000	1.2210
8.2000	1.2587	8.2000	1.2261
8.4000	1.2543	8.4000	1.2294
8.6000	1.2468	8.6000	1.2308
8.8000	1.2418	8.8000	1.2309
9.0000	1.2434	9.0000	1.2432
9.2000	1.2560	9.2000	1.2629
9.4000	1.2786	9.4000	1.2814
9.6000	1.3020	9.6000	1.3110
9.8000	1.3247	9.8000	1.3403
10.0000	1.3434	10.0000	1.3725
*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 3000 MWD/MTU are plotted in COLR Figures 3 and 4, respectively.

* Top and Bottom 15% Excluded as Per Tech Spec 4.2.2.2.g

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	1.2397	2.0000	1.2342
2.2000	1.2289	2.2000	1.2188
2.4000	1.2178	2.4000	1.2031
2.6000	1.2064	2.6000	1.1869
2.8000	1.1951	2.8000	1.1695
3.0000	1.1819	3.0000	1.1569
3.2000	1.1748	3.2000	1.1549
3.4000	1.1743	3.4000	1.1642
3.6000	1.1761	3.6000	1.1804
3.8000	1.1773	3.8000	1.1957
4.0000	1.1777	4.0000	1.2091
4.2000	1.1773	4.2000	1.2211
4.4000	1.1760	4.4000	1.2310
4.6000	1.1736	4.6000	1.2390
4.8000	1.1701	4.8000	1.2451
5.0000	1.1662	5.0000	1.2477
5.2000	1.1596	5.2000	1.2528
5.4000	1.1548	5.4000	1.2663
5.6000	1.1637	5.6000	1.2823
5.8000	1.1781	5.8000	1.2959

NOTE: W(Z) values given above for 12000 and 22000 MWD/MTU are plotted in COLR Figures 5 and 6, respectively.

* Top and Bottom 15% Excluded as Per Tech Spec 4.2.2.2.g

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	1.1919	6.0000	1.3068
6.2000	1.2039	6.2000	1.3152
6.4000	1.2143	6.4000	1.3209
6.6000	1.2228	6.6000	1.3237
6.8000	1.2294	6.8000	1.3232
7.0000	1.2340	7.0000	1.3217
7.2000	1.2364	7.2000	1.3201
7.4000	1.2365	7.4000	1.3171
7.6000	1.2341	7.6000	1.3107
7.8000	1.2291	7.8000	1.3010
8.0000	1.2216	8.0000	1.2885
8.2000	1.2115	8.2000	1.2723
8.4000	1.1987	8.4000	1.2541
8.6000	1.1831	8.6000	1.2386
8.8000	1.1716	8.8000	1.2228
9.0000	1.1723	9.0000	1.2097
9.2000	1.1874	9.2000	1.2056
9.4000	1.2099	9.4000	1.2069
9.6000	1.2300	9.6000	1.2060
9.8000	1.2498	9.8000	1.2127
10.0000	1.2696	10.0000	1.2234
*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 5 and 6, respectively.

* Top and Bottom 15% Excluded as Per Tech Spec 4.2.2.2.g

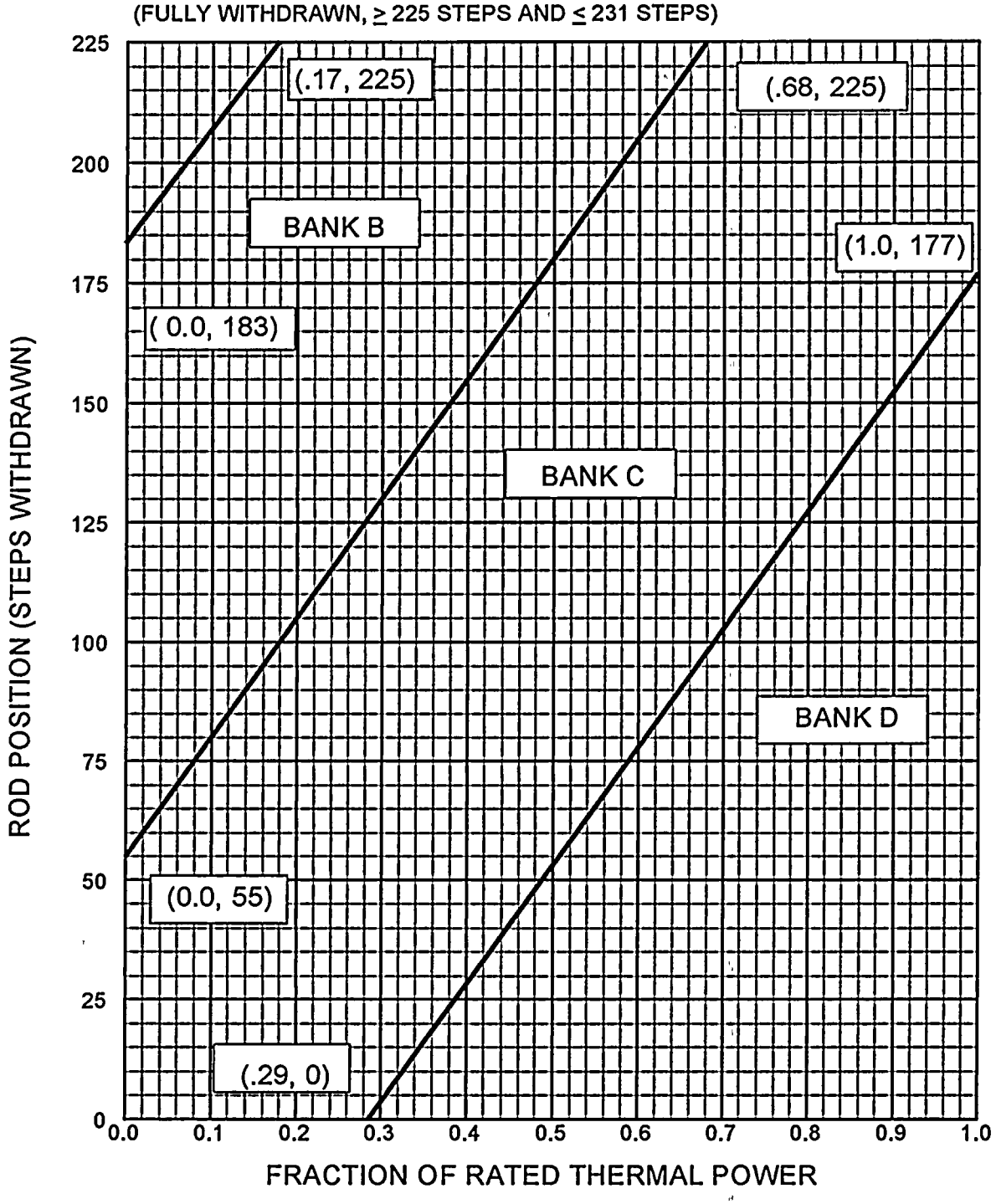

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Figure 1
Rod Bank Insertion Limits Versus Rated Thermal Power

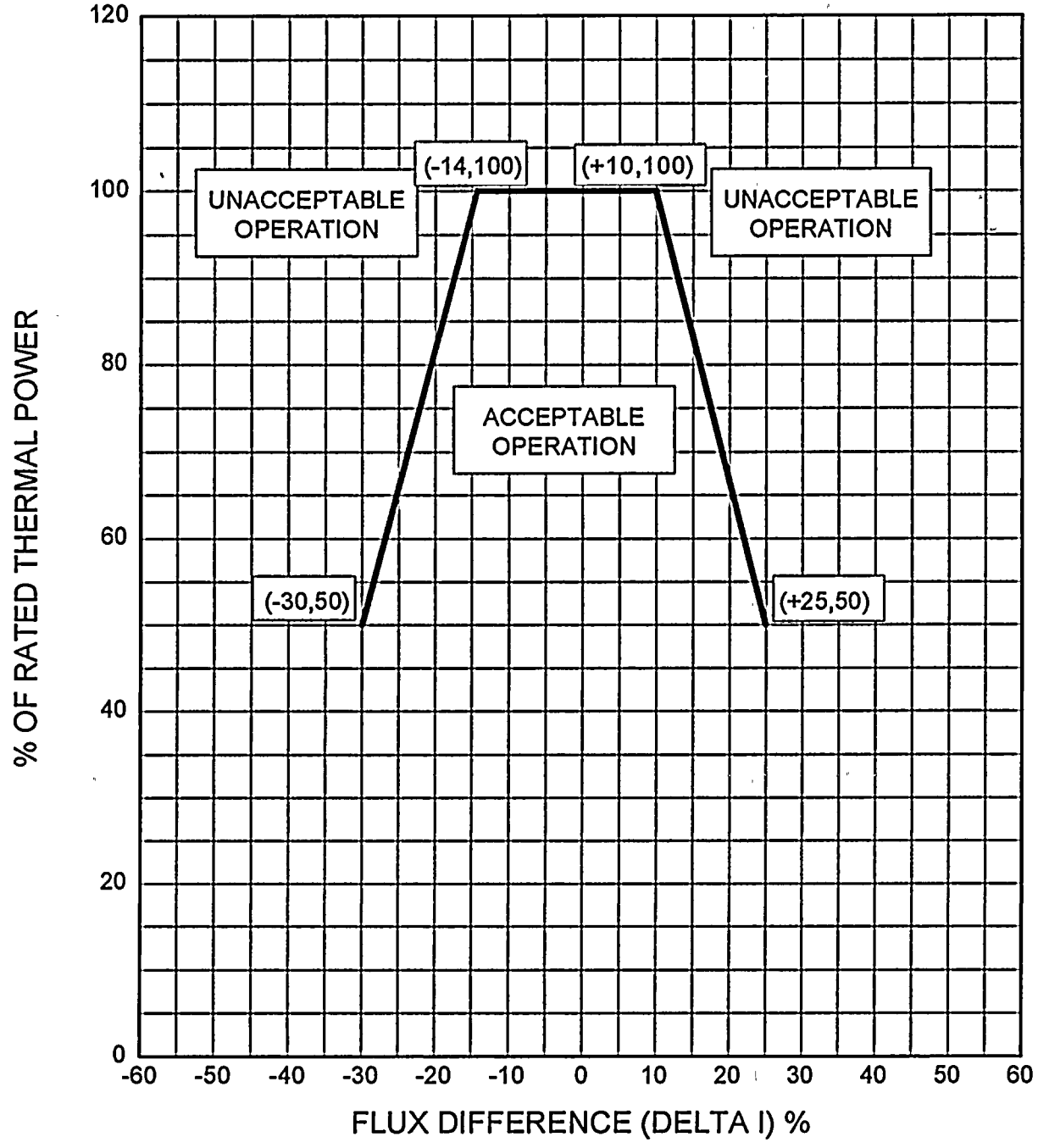

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Figure 2
AFD Limits as a Function of Rated Thermal Power

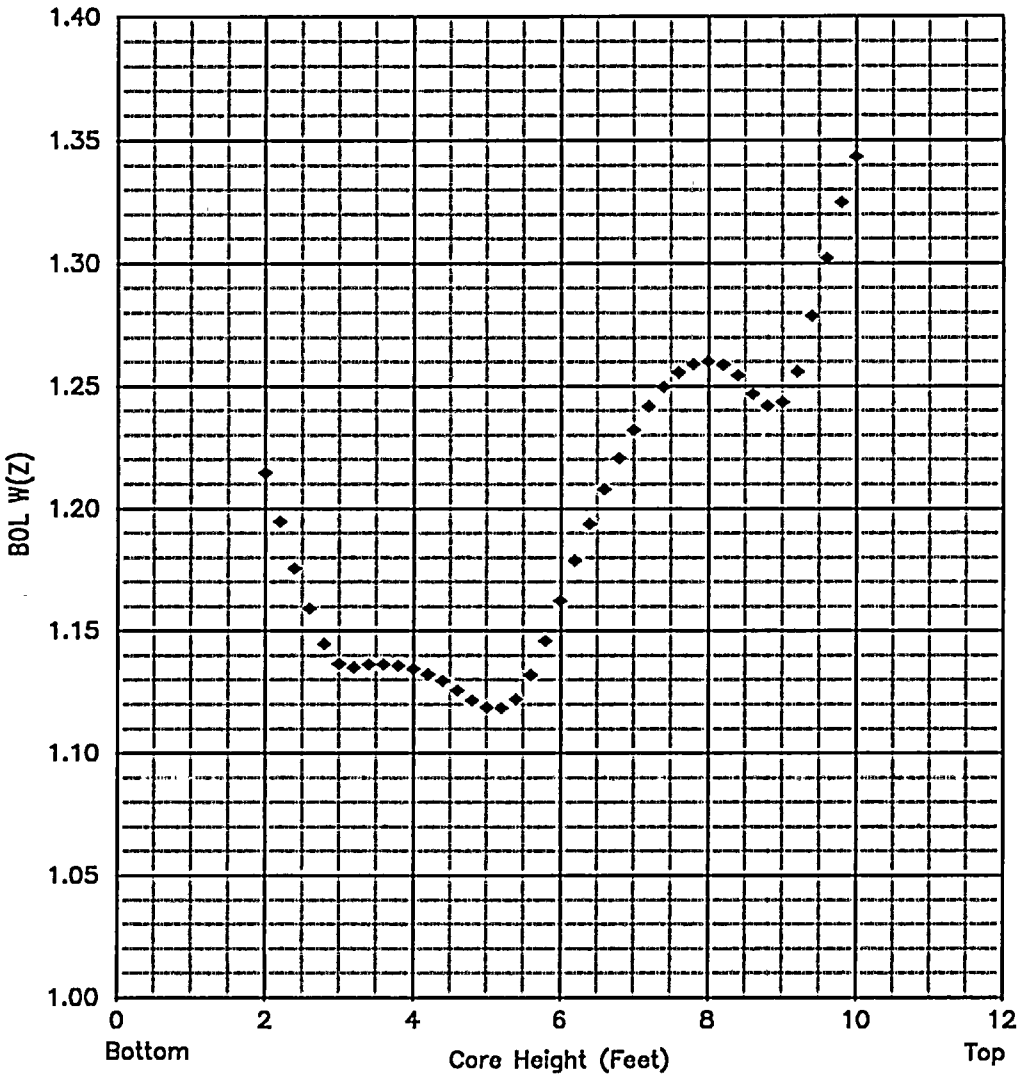

Figure 3

Load Follow W(z) at 150 MWD/MTU as a Function of Core Height

* TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.2.2.2.G

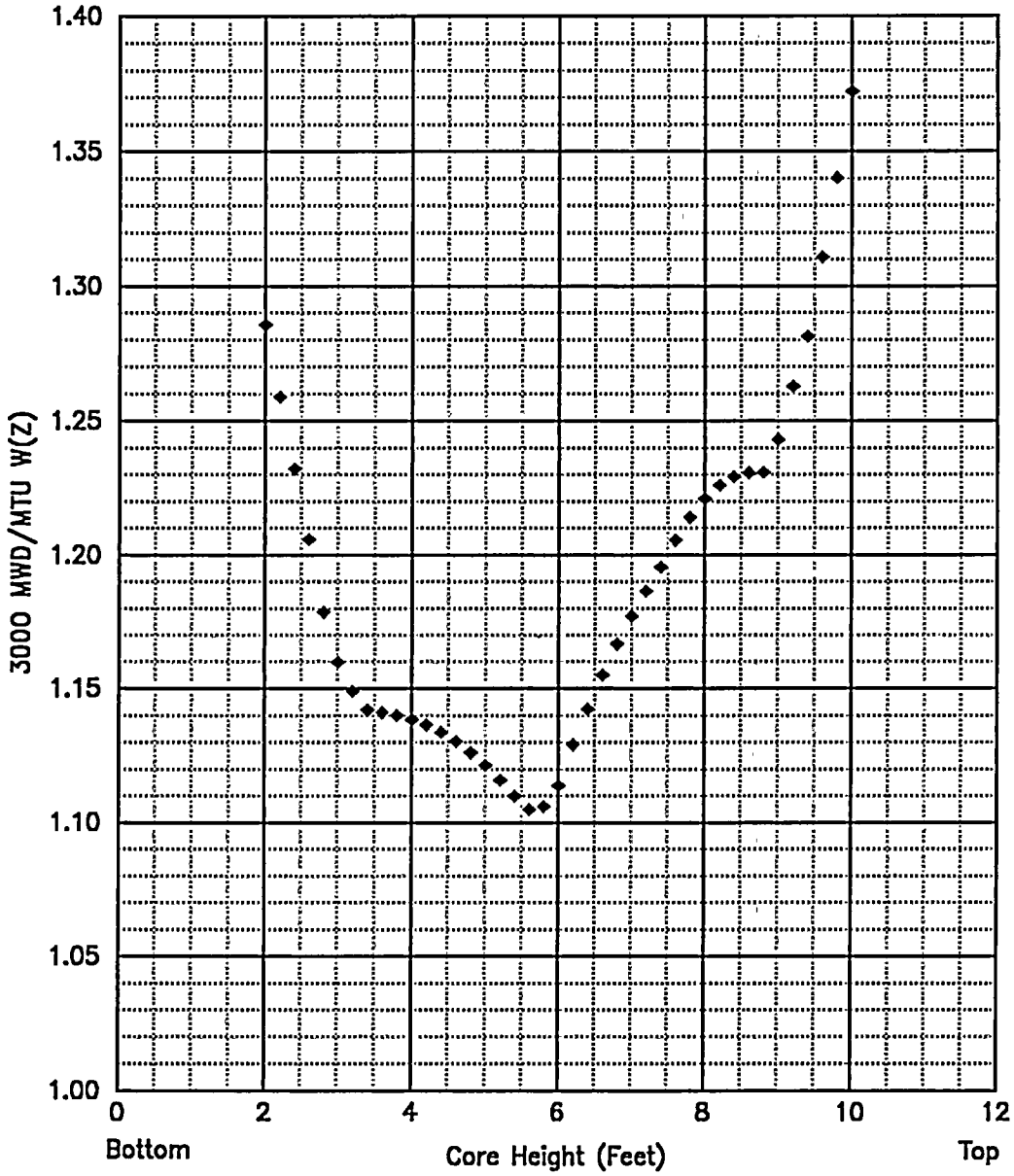

Figure 4

Load Follow W(z) at 3000 MWD/MTU as a Function of Core Height

* TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.2.2.2.G

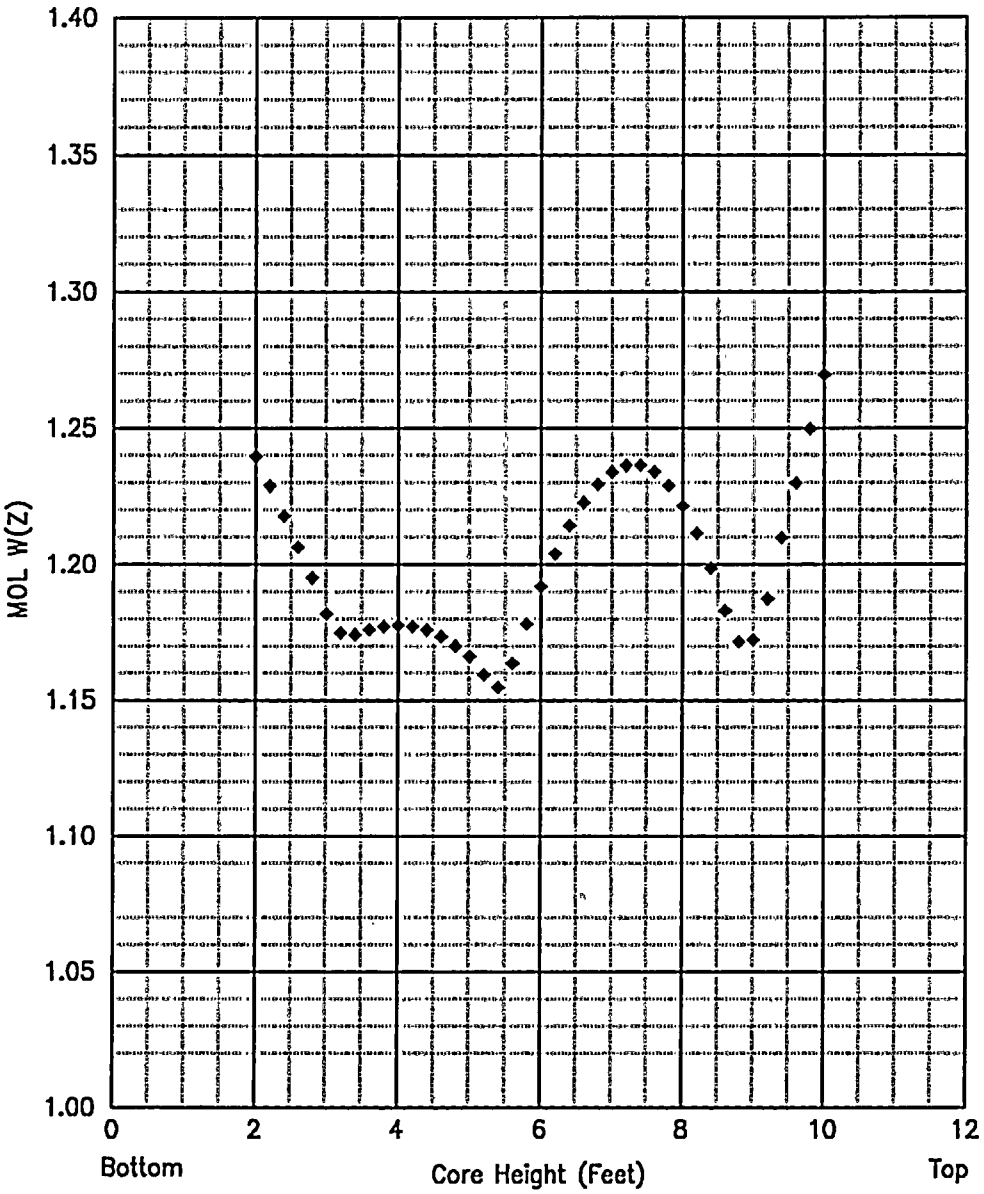

Figure 5

Load Follow W(z) at 12000 MWD/MTU as a Function of Core Height

* TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.2.2.2.G

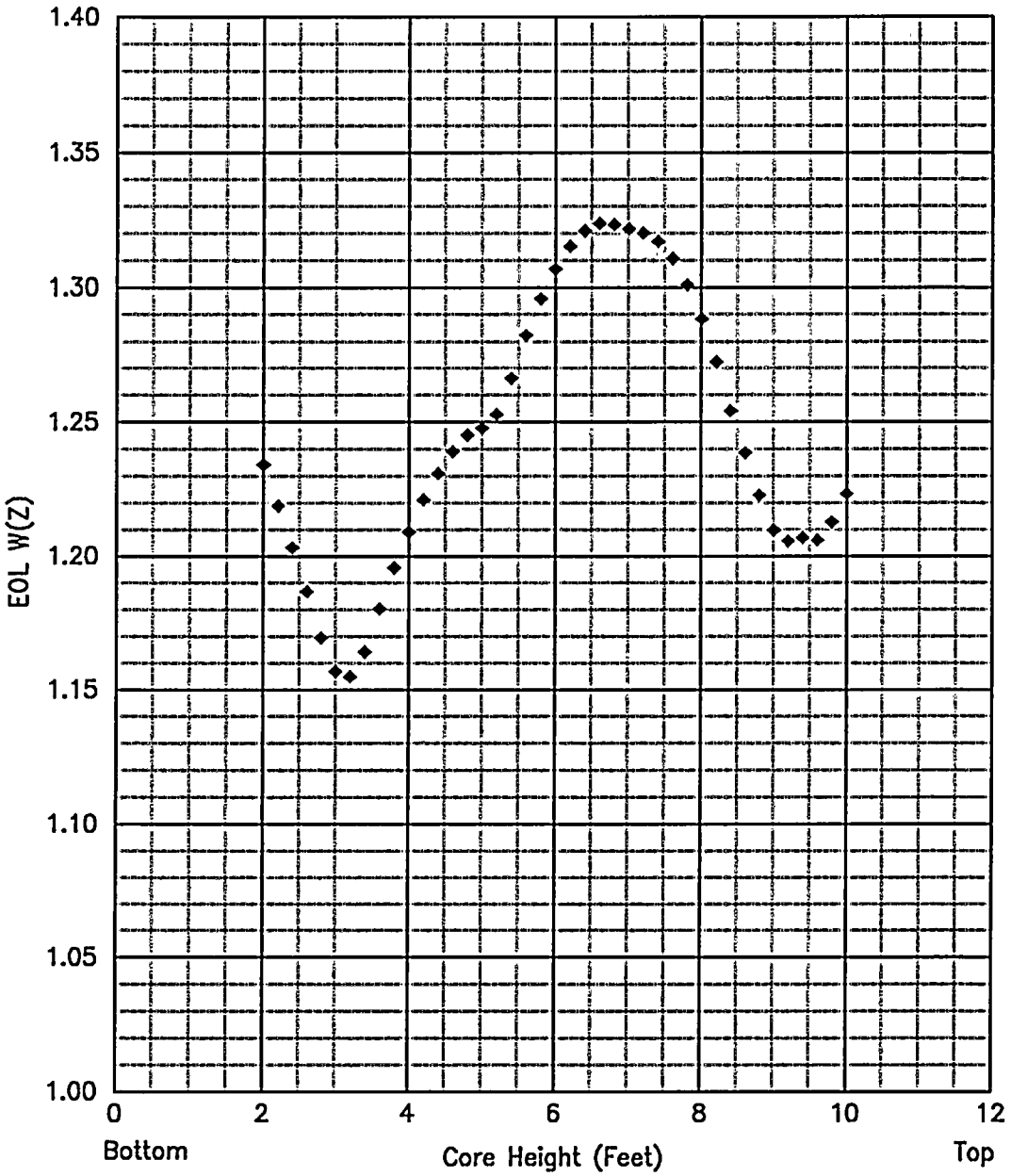

Figure 6

Load Follow W(z) at 22000 MWD/MTU as a Function of Core Height

* TOP AND BOTTOM 15% EXCLUDED AS PER TECH SPEC 4.2.2.2.G

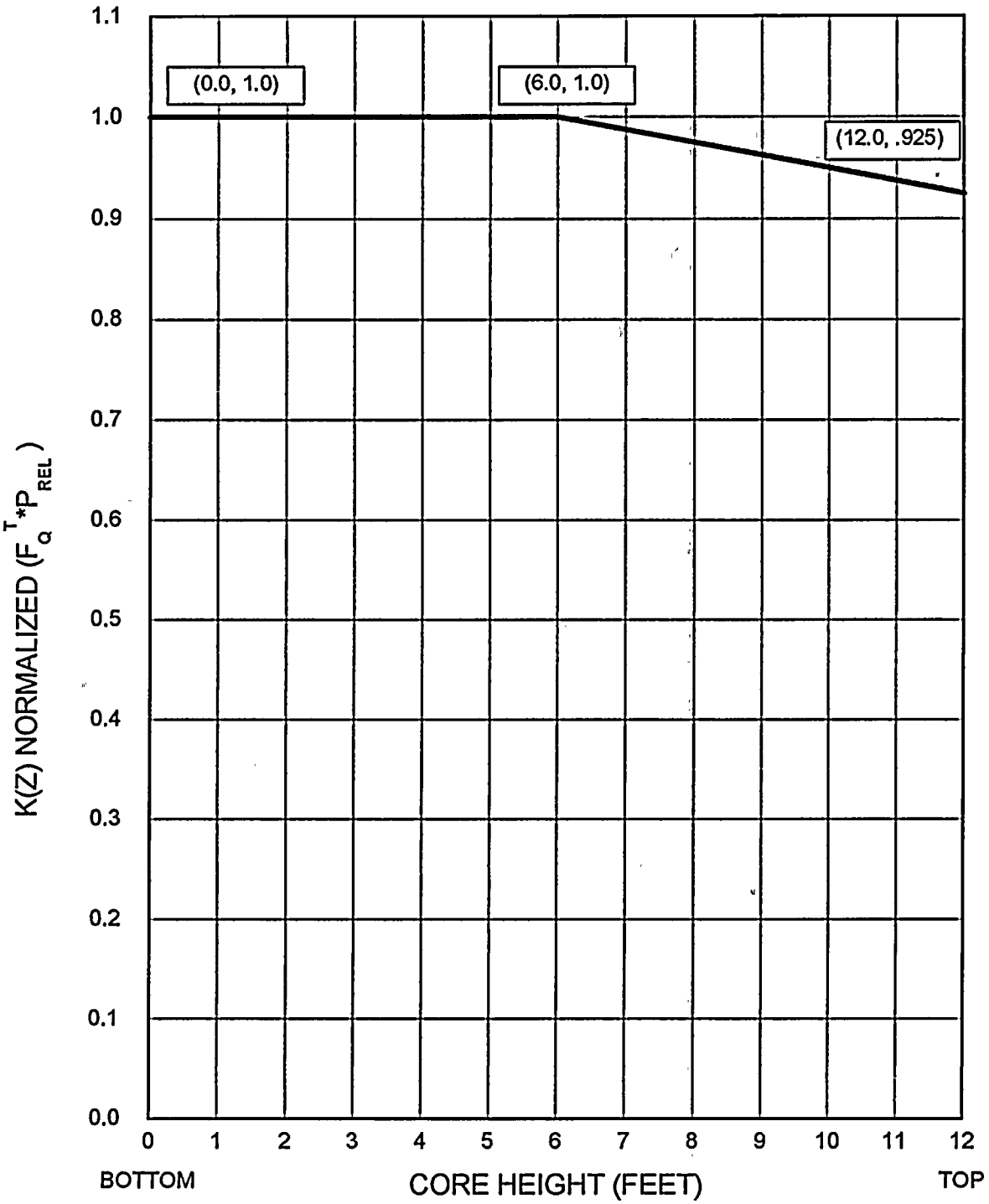

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Figure 7
K(Z) - Normalized F_Q (Z) as a Function of Core Height