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PG&E Letter DCL-10-143

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 50-275, OL-DPR-80
Diablo Canyon Power Plant Unit 1
Core Operating Limits Report for Unit 1 Cycle 17

Dear Commissioners and Staff:

In accordance with Diablo Canyon Power Plant (DCPP) Technical Specification 5.6.5.d, enclosed is the Core Operating Limits Report (COLR) for Unit 1. This document was revised for DCPP Unit 1, Cycle 17.

There are no new or revised regulatory commitments in this submittal.

If there are any questions regarding the COLR, please contact Mr. Mark Mayer at (805) 545-4674.

Sincerely,

James R. Becker

swh/3449/60023340

Enclosure

cc: Diablo Distribution
cc/enc: Elmo E. Collins, NRC Region IV
Michael S. Peck, NRC Senior Resident Inspector
Alan B. Wang, NRR Project Manager

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**CORE OPERATING LIMITS REPORTS (COLR)
DIABLO CANYON POWER PLANT UNIT 1, CYCLE 17
EFFECTIVE DATE OCTOBER 23, 2010**

*** ISSUED FOR USE BY: _____ DATE: _____ EXPIRES: _____ ***
PACIFIC GAS AND ELECTRIC COMPANY NUMBER COLR 1
NUCLEAR POWER GENERATION REVISION 4
DIABLO CANYON POWER PLANT PAGE 1 OF 13
CORE OPERATING LIMITS REPORT UNIT

TITLE: COLR for Diablo Canyon Unit 1

1

10/23/10

EFFECTIVE DATE

PROCEDURE CLASSIFICATION: QUALITY RELATED

1. CORE OPERATING LIMITS REPORT

- 1.1 This Core Operating Limits Report (COLR) for Diablo Canyon Unit 1 Cycle 17 has been prepared in accordance with the requirements of Technical Specification (TS) 5.6.5.
- 1.2 The Technical Specifications affected by this report are listed below:
- 3.1.1 - Shutdown Margin (MODE 2 with $k_{\text{eff}} < 1.0$, MODES 3, 4, and 5)
 - 3.1.3 - Moderator Temperature Coefficient
 - 3.1.4 - Rod Group Alignment Limits
 - 3.1.5 - Shutdown Bank Insertion Limits
 - 3.1.6 - Control Bank Insertion Limits
 - 3.1.8 - PHYSICS TESTING Exceptions – MODE 2
 - 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)
 - 3.4.1 - RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits
 - 3.9.1 - Boron Concentration

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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, 3.1.4, 3.1.5, 3.1.6, 3.1.8)

The SDM limit for MODE 1, MODE 2, MODE 3 and MODE 4 is:

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

2.1.2 In Modes 3 or 4 the shutdown margin with Safety Injection blocked shall be greater than or equal to 1.6% $\Delta k/k$ 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% $\Delta k/k$. However, an administrative value of 1.6 % $\Delta k/k$ will be used to address concerns of NSAL-02-014.

2.2 Moderator Temperature Coefficient (MTC) (TS 3.1.3)

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

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

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

2.2.3 The MTC 60 ppm surveillance limit is $-3.72 \times 10^{-4} \Delta k/k/^\circ F$ (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.

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

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

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

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

$$F_Q^{RTP} = 2.58$$

$$K(Z) = 1.0$$

NOTE: The $W(Z)$ data is appropriate for use only if the predicted axial offset is within $\pm 3\%$ of the measured value.

2.5.2 The $W(Z)$ data for Relaxed Axial Offset Control (RAOC) operation, provided in Tables 2A and 2B are sufficient to determine the RAOC $W(Z)$ versus core height for Cycle 16 burnups through the end of full power reactivity plus a power coast down of up to 1000 MWD/MTU.

For $W(Z)$ data at a desired burnup not listed in the table, but less than the maximum listed burnup, values at 3 or more burnup steps should be used to interpolate the $W(Z)$ data to the desired burnup with a polynomial type fit that uses the $W(Z)$ data for the nearest three burnup steps.

For $W(Z)$ data at a desired burnup outside of the listed burnup steps, a linear extrapolation of the $W(Z)$ data for the nearest two burnup steps can be used. If data are listed for only 2 burnup steps, a linear fit can be used for both interpolation and extrapolation.

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.

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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:

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

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

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

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

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

$F_Q^W(Z)$ 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.

$W(z)$ 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.

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2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}^N$ (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.

$F_{\Delta H}^{RTP}$ = 1.586 (prior to including 4% uncertainty)

$PF_{\Delta H}$ = 0.3 = Power Factor Multiplier

2.7 Power Distribution Measurement Uncertainty (TS 3.2.1. and TS 3.2.2):

If the Power Distribution Monitoring System (PDMS) is OPERABLE, the uncertainty, $U_{F\Delta H}$, to be applied to the Nuclear Enthalpy Rise Hot Channel Factor, $F_{\Delta H}^N$, shall be calculated by the following formula:

$$U_{F\Delta H} = 1.0 + \frac{U_{\Delta H}}{100.0}$$

where: $U_{\Delta H}$ = Uncertainty for enthalpy rise as defined in equation (5-19) in Reference 6.2 and $F_{\Delta H}^{RTP} = 1.65$ for PDMS (in the above Section 2.6 equation).

If the PDMS is OPERABLE, the uncertainty, U_{FQ} , to be applied to the Heat Flux Hot Channel Factor, $F_Q(z)$, shall be calculated by the following formula:

$$U_{FQ} = \left(1.0 + \frac{U_Q}{100.0} \right) * U_e$$

where: U_Q = Uncertainty for power peaking factor as defined in equation (5-19) in Reference 6.2.

U_e = Engineering uncertainty factor
= 1.03

If the PDMS is inoperable, the Nuclear Enthalpy Rise Hot Channel Factor, $F_{\Delta H}^N$, shall be calculated as specified in Section 2.6.

If the PDMS is inoperable, the Heat Flux Hot Channel Factor, $F_Q(Z)$, shall be calculated as specified in Section 2.5.

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2.8 Axial Flux Difference (TS 3.2.3)

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

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.

2.10 RCS Pressure and Temperature Departure from Nucleate Boiling (DNB) Limit (TS 3.4.1)

2.10.1 Pressurizer pressure is greater than or equal to 2175 psig.

2.10.2 RCS average temperature is less than or equal to 581.7°F.

NOTE: The DNBR RCS T_{AVG} limit is based on the slightly lower and bounding value associated with Unit 1 in order to have the same surveillance limits for both Unit 1 and Unit 2.

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, "AFD Limits as a Function of Rated Thermal Power"

5. RECORDS

None

6. REFERENCES

6.1 "Diablo Canyon Unit 1 Cycle 17 Final Reload Evaluation Revision 1," October, 2010

6.2 WCAP-12473-A (Non-Proprietary), "BEACON Core Monitoring and Operations Support System," August, 1994

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

Cycle Burnup (MWD/MTU)	Max. % Decrease in F _Q Margin
313	2.00
475	2.71
638	3.53
800	4.07
963	4.28
1126	4.17
1288	3.79
1451	3.25
1613	2.62
1776	2.00
5353	2.00
5516	2.31
5678	2.96
5841	3.21
6004	3.18
6166	3.14
6329	3.08
6491	2.97
6654	2.81
6817	2.65
6979	2.52
7142	2.38
7304	2.23
7467	2.07
7630	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.

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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	1.4777	*0.0000	1.4873
*0.2000	1.4732	*0.2000	1.4834
*0.4000	1.4653	*0.4000	1.4758
*0.6000	1.4554	*0.6000	1.4658
*0.8000	1.4433	*0.8000	1.4532
1.0000	1.4285	1.0000	1.4378
1.2000	1.4114	1.2000	1.4196
1.4000	1.3925	1.4000	1.3992
1.6000	1.3723	1.6000	1.3771
1.8000	1.3511	1.8000	1.3535
2.0000	1.3290	2.0000	1.3289
2.2000	1.3064	2.2000	1.3035
2.4000	1.2831	2.4000	1.2776
2.6000	1.2593	2.6000	1.2516
2.8000	1.2393	2.8000	1.2253
3.0000	1.2226	3.0000	1.2034
3.2000	1.2085	3.2000	1.1914
3.4000	1.1988	3.4000	1.1889
3.6000	1.1953	3.6000	1.1879
3.8000	1.1938	3.8000	1.1860
4.0000	1.1917	4.0000	1.1831
4.2000	1.1883	4.2000	1.1792
4.4000	1.1840	4.4000	1.1744
4.6000	1.1788	4.6000	1.1686
4.8000	1.1726	4.8000	1.1620
5.0000	1.1656	5.0000	1.1545
5.2000	1.1581	5.2000	1.1465
5.4000	1.1497	5.4000	1.1377
5.6000	1.1416	5.6000	1.1268
5.8000	1.1484	5.8000	1.1280

* Top and Bottom 8% Excluded

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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	1.1617	6.0000	1.1387
6.2000	1.1715	6.2000	1.1504
6.4000	1.1809	6.4000	1.1613
6.6000	1.1890	6.6000	1.1712
6.8000	1.1958	6.8000	1.1799
7.0000	1.2011	7.0000	1.1871
7.2000	1.2048	7.2000	1.1929
7.4000	1.2071	7.4000	1.1975
7.6000	1.2073	7.6000	1.2001
7.8000	1.2052	7.8000	1.2006
8.0000	1.2006	8.0000	1.1989
8.2000	1.1936	8.2000	1.1947
8.4000	1.1839	8.4000	1.1880
8.6000	1.1721	8.6000	1.1796
8.8000	1.1649	8.8000	1.1762
9.0000	1.1652	9.0000	1.1780
9.2000	1.1724	9.2000	1.1919
9.4000	1.2064	9.4000	1.2134
9.6000	1.2441	9.6000	1.2366
9.8000	1.2777	9.8000	1.2596
10.0000	1.3083	10.0000	1.2772
10.2000	1.3360	10.2000	1.2870
10.4000	1.3589	10.4000	1.2959
10.6000	1.3780	10.6000	1.3033
10.8000	1.3975	10.8000	1.3127
11.0000	1.4133	11.0000	1.3269
*11.2000	1.4216	*11.2000	1.3393
*11.4000	1.4291	*11.4000	1.3362
*11.6000	1.4241	*11.6000	1.3216
*11.8000	1.4050	*11.8000	1.2976
*12.0000	1.3893	*12.0000	1.2757

* Top and Bottom 8% Excluded

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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	1.3197	*0.0000	1.3571
*0.2000	1.3099	*0.2000	1.3478
*0.4000	1.2991	*0.4000	1.3379
*0.6000	1.2876	*0.6000	1.3282
*0.8000	1.2751	*0.8000	1.3189
1.0000	1.2626	1.0000	1.3075
1.2000	1.2515	1.2000	1.2938
1.4000	1.2418	1.4000	1.2796
1.6000	1.2314	1.6000	1.2651
1.8000	1.2207	1.8000	1.2504
2.0000	1.2098	2.0000	1.2355
2.2000	1.1988	2.2000	1.2204
2.4000	1.1876	2.4000	1.2050
2.6000	1.1762	2.6000	1.1893
2.8000	1.1653	2.8000	1.1734
3.0000	1.1515	3.0000	1.1570
3.2000	1.1445	3.2000	1.1546
3.4000	1.1523	3.4000	1.1737
3.6000	1.1594	3.6000	1.1897
3.8000	1.1655	3.8000	1.2039
4.0000	1.1711	4.0000	1.2172
4.2000	1.1754	4.2000	1.2284
4.4000	1.1787	4.4000	1.2376
4.6000	1.1807	4.6000	1.2446
4.8000	1.1814	4.8000	1.2503
5.0000	1.1813	5.0000	1.2523
5.2000	1.1799	5.2000	1.2563
5.4000	1.1804	5.4000	1.2770
5.6000	1.2011	5.6000	1.2999
5.8000	1.2237	5.8000	1.3204

* Top and Bottom 8% Excluded

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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	1.2424	6.0000	1.3382
6.2000	1.2601	6.2000	1.3532
6.4000	1.2756	6.4000	1.3653
6.6000	1.2889	6.6000	1.3743
6.8000	1.2997	6.8000	1.3800
7.0000	1.3080	7.0000	1.3825
7.2000	1.3133	7.2000	1.3818
7.4000	1.3157	7.4000	1.3774
7.6000	1.3148	7.6000	1.3690
7.8000	1.3106	7.8000	1.3565
8.0000	1.3027	8.0000	1.3398
8.2000	1.2916	8.2000	1.3190
8.4000	1.2770	8.4000	1.2941
8.6000	1.2565	8.6000	1.2679
8.8000	1.2493	8.8000	1.2511
9.0000	1.2488	9.0000	1.2406
9.2000	1.2582	9.2000	1.2323
9.4000	1.2858	9.4000	1.2353
9.6000	1.3159	9.6000	1.2539
9.8000	1.3436	9.8000	1.2773
10.0000	1.3675	10.0000	1.2973
10.2000	1.3882	10.2000	1.3167
10.4000	1.4100	10.4000	1.3349
10.6000	1.4291	10.6000	1.3522
10.8000	1.4400	10.8000	1.3688
11.0000	1.4477	11.0000	1.3860
*11.2000	1.4543	*11.2000	1.4010
*11.4000	1.4454	*11.4000	1.4035
*11.6000	1.4252	*11.6000	1.3929
*11.8000	1.3960	*11.8000	1.3703
*12.0000	1.3687	*12.0000	1.3505

* Top and Bottom 8% Excluded

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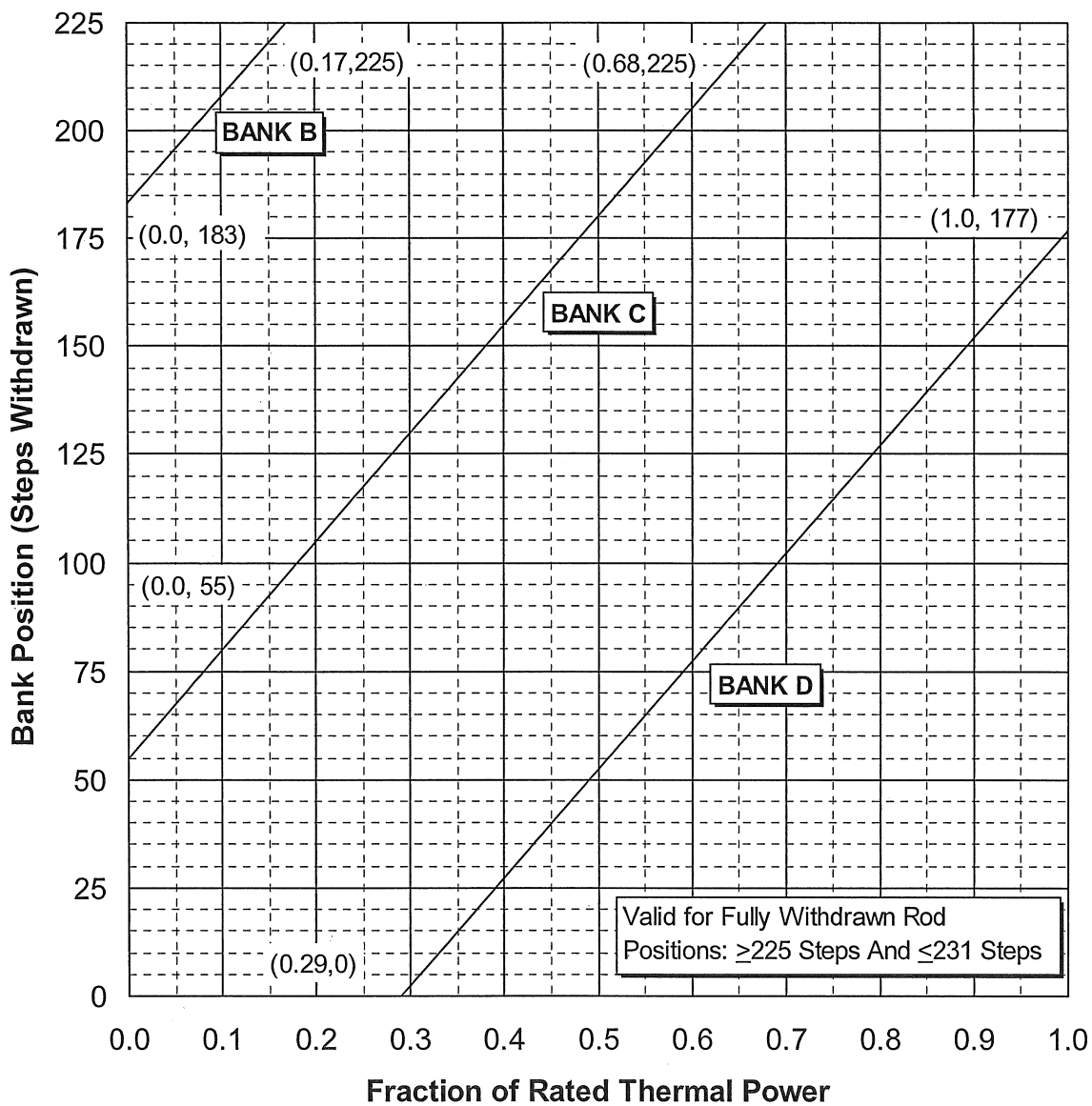


Figure 1: Control Bank Insertion Limits Versus Rated Thermal Power

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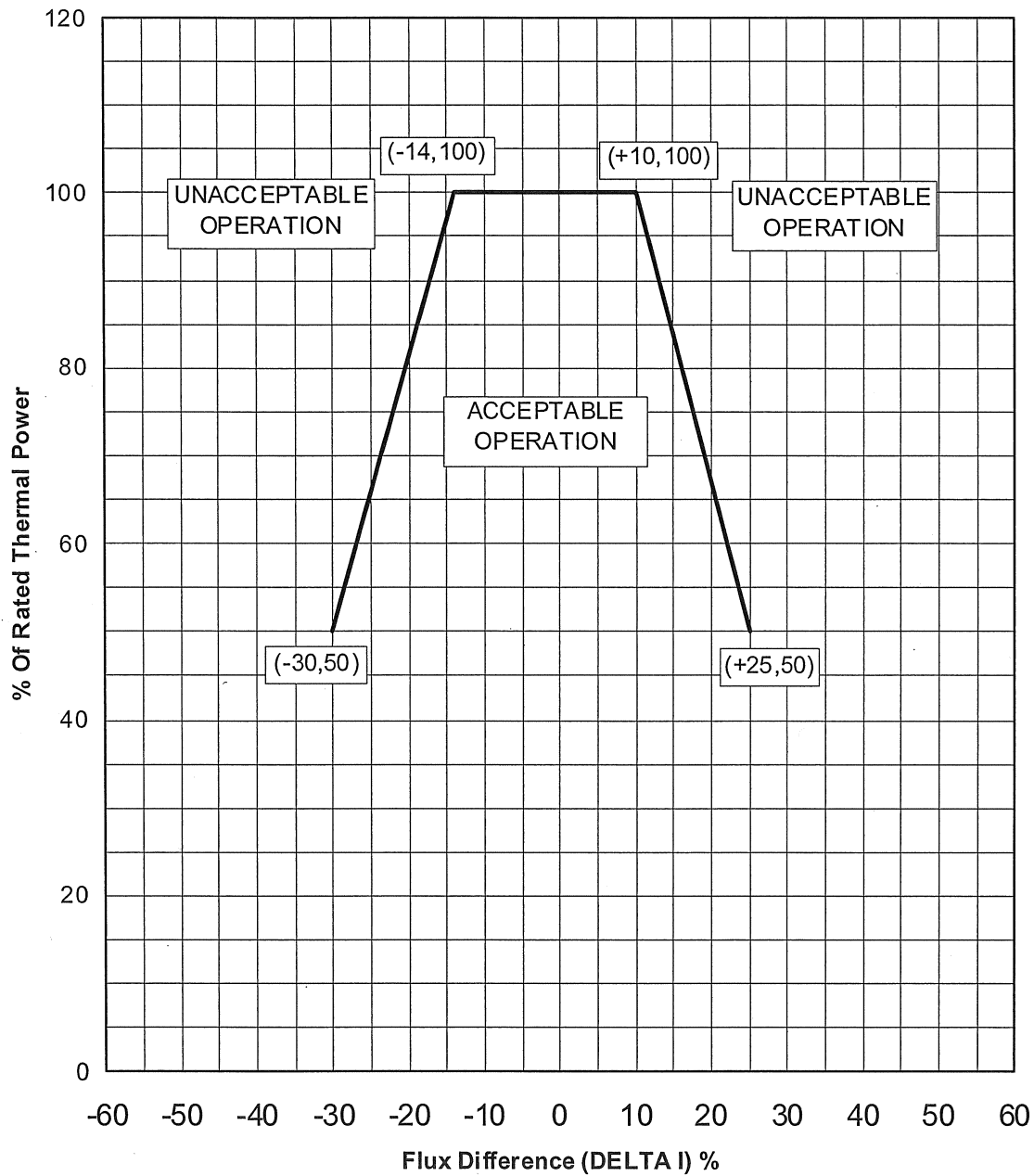


Figure 2: AFD Limits as a Function of Rated Thermal Power