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PG&E Letter DCL-14-024

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 19

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 19.

Pacific Gas and Electric Company makes no new or revised regulatory commitments (as defined by NEI 99-04) in this letter.

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

Sincerely,

James M. Welsch

J8L3/4486/60052827-360
Enclosure
cc: Diablo Distribution
cc/enc: Peter J. Bamford, NRC Project Manager
Marc L. Dapas, NRC Region IV
Thomas R. Hipschman, NRC Senior Resident Inspector

CORE OPERATING LIMITS REPORTS (COLR)
DIABLO CANYON POWER PLANT UNIT 1, CYCLE 19
EFFECTIVE DATE March 9, 2014

TITLE: COLR for Diablo Canyon Unit 1

03/09/14

EFFECTIVE DATE

CLASSIFICATION: QUALITY RELATED

1. CORE OPERATING LIMITS REPORT

1.1 This Core Operating Limits Report (COLR) for Diablo Canyon Unit 1 Cycle 19 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 $k_{eff} < 1.0$, 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 - $F^N_{\Delta H}$
- 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

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 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 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 -3.9×10^{-4} Δk/k/°F for all rods withdrawn, end of cycle life (EOL), RATED THERMAL POWER condition.

2.2.2 The MTC 300 ppm surveillance limit is -3.0×10^{-4} Δk/k/°F (all rods withdrawn, RATED THERMAL POWER condition).

2.2.3 The MTC 60 ppm surveillance limit is -3.72×10^{-4} Δk/k/°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.

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

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

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

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

$F_Q^{RTP} = 2.58$

$K(Z) = 1.0$

NOTE: The W(Z) data is appropriate for use only if the predicted axial offset is within ±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 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.

The W(Z) values are generated assuming that they will be used for full power surveillance. When using a flux map instead of the Power Distribution Monitoring System (PDMS) for part power surveillance, the W(Z) values must be increased by the factor 1/P (P > 0.5) or 1/0.5 (P ≤ 0.5), where P is the core relative power during the surveillance, to account for the increase in the $F_Q(Z)$ limit at reduced power levels.

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:

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

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

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

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

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

$F_Q^W(Z)$ 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.

2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F^N_{\Delta H}$ (TS 3.2.2)

$F^N_{\Delta H} \leq F^{RTP}_{\Delta H}$ *[1 + $PF_{\Delta H}$ * (1-*P*)]

where:

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

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

$F^{RTP}_{\Delta H}$ = 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 PDMS is OPERABLE, the uncertainty, $U_{F\Delta H}$, to be applied to the Nuclear Enthalpy Rise Hot Channel Factor, $F^N_{\Delta H}$, 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. However, if the uncertainty is less than 4.0, the uncertainty should be set equal to 4.0. $F^{RTP}_{\Delta H}$ = 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, $F^N_{\Delta H}$, 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.

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 DNB 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 3,000 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 NF-PGE-13-87, "Diablo Canyon Unit 1 Cycle 19 Reload Evaluation and Core Operating Limits Report," November 2013

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

6.3 Westinghouse Nuclear Safety Advisory Letter NSAL-02-14, "Steam Line Break During Mode 3 for Westinghouse NSSS Plants," Revision 2, August 4, 2005

7. ANALYTICAL METHODS

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

7.1 WCAP-10216-P-A, Revision 1A, "Relaxation of Constant Axial Offset Control F_Q Surveillance Technical Specification," February 1994.

7.2 WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.

7.3 WCAP-8385, "Power Distribution Control and Load Following Procedures," September 1974. Approved by NRC Safety Evaluation dated January 31, 1978.

7.4 WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code," August 1985.

7.5 WCAP-10054-P-A, Addendum 2, Revision 1, "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code: Safety Injection Into the Broken Loop and COSI Condensation Model," July 1997.

7.6 WCAP-12945-P-A, Volume 1 (Revision 2) and Volumes 2 - 5 (Revision 1), "Code Qualification Document for Best-Estimate LOCA Analysis," March 1998.

7.7 WCAP-12945-P-A, Addendum 1-A, Revision 0, "Method for Satisfying 10 CFR 50.46 Reanalysis Requirements for Best Estimate LOCA Evaluation Models," December 2004.

7.8 WCAP-8567-P-A, "Improved Thermal Design Procedure," February 1989.

7.9 WCAP-11596-P-A, "Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores," June 1988.

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	2.09
638	2.56
800	2.82
963	2.84
1126	2.63
1288	2.25
1451	2.00
5028	2.00
5191	2.03
5353	2.37
5516	2.70
5678	3.03
5841	3.21
6004	3.02
6166	2.84
6329	2.67
6491	2.49
6654	2.33
6817	2.18
6979	2.03
7142	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 3000 MWD/MTU as a Function of Core Height

HEIGHT (INCHES)	150 MWD/MTU W(Z)	HEIGHT (INCHES)	3000 MWD/MTU W(Z)
*0.0	1.5121	*0.0	1.5315
*2.4	1.5086	*2.4	1.5275
*4.8	1.5016	*4.8	1.5197
*7.2	1.4924	*7.2	1.5094
*9.7	1.4809	*9.7	1.4966
12.1	1.4660	12.1	1.4799
14.5	1.4492	14.5	1.4612
16.9	1.4305	16.9	1.4402
19.3	1.4105	19.3	1.4173
21.7	1.3892	21.7	1.3929
24.1	1.3670	24.1	1.3675
26.6	1.3440	26.6	1.3411
29.0	1.3204	29.0	1.3143
31.4	1.2952	31.4	1.2860
33.8	1.2699	33.8	1.2579
36.2	1.2505	36.2	1.2375
38.6	1.2382	38.6	1.2250
41.0	1.2286	41.0	1.2168
43.5	1.2185	43.5	1.2133
45.9	1.2106	45.9	1.2094
48.3	1.2053	48.3	1.2042
50.7	1.2003	50.7	1.1978
53.1	1.1940	53.1	1.1906
55.5	1.1869	55.5	1.1825
58.0	1.1790	58.0	1.1735
60.4	1.1701	60.4	1.1638
62.8	1.1611	62.8	1.1533
65.2	1.1505	65.2	1.1423
67.6	1.1394	67.6	1.1324
70.0	1.1454	70.0	1.1291

* Top and Bottom 8% Excluded

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

HEIGHT (INCHES)	150 MWD/MTU W(Z)	HEIGHT (INCHES)	3000 MWD/MTU W(Z)
72.4	1.1571	72.4	1.1340
74.9	1.1672	74.9	1.1457
77.3	1.1766	77.3	1.1553
79.7	1.1847	79.7	1.1642
82.1	1.1915	82.1	1.1719
84.5	1.1967	84.5	1.1781
86.9	1.2003	86.9	1.1830
89.3	1.2019	89.3	1.1866
91.8	1.2014	91.8	1.1884
94.2	1.1985	94.2	1.1881
96.6	1.1931	96.6	1.1856
99.0	1.1855	99.0	1.1804
101.4	1.1744	101.4	1.1735
103.8	1.1606	103.8	1.1672
106.2	1.1580	106.2	1.1647
108.7	1.1604	108.7	1.1719
111.1	1.1705	111.1	1.1946
113.5	1.1828	113.5	1.2186
115.9	1.1953	115.9	1.2433
118.3	1.2218	118.3	1.2665
120.7	1.2523	120.7	1.2858
123.1	1.2780	123.1	1.2967
125.6	1.3000	125.6	1.3008
128.0	1.3218	128.0	1.3050
130.4	1.3431	130.4	1.3053
132.8	1.3557	132.8	1.3021
*135.2	1.3601	*135.2	1.2883
*137.6	1.3493	*137.6	1.2749
*140.0	1.3078	*140.0	1.2906
*142.5	1.2456	*142.5	1.3062
*144.9	1.1955	*144.9	1.3219

* Top and Bottom 8% Excluded

Table 2B: Load Follow W(Z) Factors at 12000 and 20000 MWD/MTU as a Function of Core Height

HEIGHT (INCHES)	12000 MWD/MTU W(Z)	HEIGHT (INCHES)	20000 MWD/MTU W(Z)
*0.0	1.3047	*0.0	1.3314
*2.4	1.2967	*2.4	1.3332
*4.8	1.2869	*4.8	1.3309
*7.2	1.2763	*7.2	1.3257
*9.7	1.2648	*9.7	1.3176
12.1	1.2505	12.1	1.3061
14.5	1.2357	14.5	1.2932
16.9	1.2233	16.9	1.2795
19.3	1.2147	19.3	1.2655
21.7	1.2059	21.7	1.2512
24.1	1.1967	24.1	1.2367
26.6	1.1876	26.6	1.2218
29.0	1.1783	29.0	1.2067
31.4	1.1684	31.4	1.1904
33.8	1.1591	33.8	1.1742
36.2	1.1479	36.2	1.1602
38.6	1.1435	38.6	1.1614
41.0	1.1456	41.0	1.1779
43.5	1.1502	43.5	1.1909
45.9	1.1540	45.9	1.2027
48.3	1.1569	48.3	1.2133
50.7	1.1591	50.7	1.2224
53.1	1.1616	53.1	1.2292
55.5	1.1652	55.5	1.2340
58.0	1.1676	58.0	1.2375
60.4	1.1694	60.4	1.2376
62.8	1.1691	62.8	1.2433
65.2	1.1693	65.2	1.2669
67.6	1.1841	67.6	1.2870
70.0	1.2037	70.0	1.3055

* Top and Bottom 8% Excluded

Table 2B: Load Follow W(Z) Factors at 12000 and 20000 MWD/MTU as a Function of Core Height (continued)

HEIGHT (INCHES)	12000 MWD/MTU W(Z)	HEIGHT (INCHES)	20000 MWD/MTU W(Z)
72.4	1.2211	72.4	1.3209
74.9	1.2368	74.9	1.3335
77.3	1.2509	77.3	1.3434
79.7	1.2629	79.7	1.3504
82.1	1.2727	82.1	1.3543
84.5	1.2805	84.5	1.3554
86.9	1.2861	86.9	1.3535
89.3	1.2893	89.3	1.3480
91.8	1.2894	91.8	1.3382
94.2	1.2864	94.2	1.3250
96.6	1.2801	96.6	1.3078
99.0	1.2710	99.0	1.2871
101.4	1.2580	101.4	1.2621
103.8	1.2416	103.8	1.2371
106.2	1.2347	106.2	1.2354
108.7	1.2369	108.7	1.2345
111.1	1.2473	111.1	1.2319
113.5	1.2672	113.5	1.2321
115.9	1.2954	115.9	1.2364
118.3	1.3211	118.3	1.2569
120.7	1.3417	120.7	1.2818
123.1	1.3613	123.1	1.3035
125.6	1.3823	125.6	1.3258
128.0	1.3996	128.0	1.3470
130.4	1.4022	130.4	1.3618
132.8	1.4007	132.8	1.3702
*135.2	1.3983	*135.2	1.3755
*137.6	1.3814	*137.6	1.3654
*140.0	1.3345	*140.0	1.3176
*142.5	1.2676	*142.5	1.2447
*144.9	1.2124	*144.9	1.1864

* Top and Bottom 8% Excluded

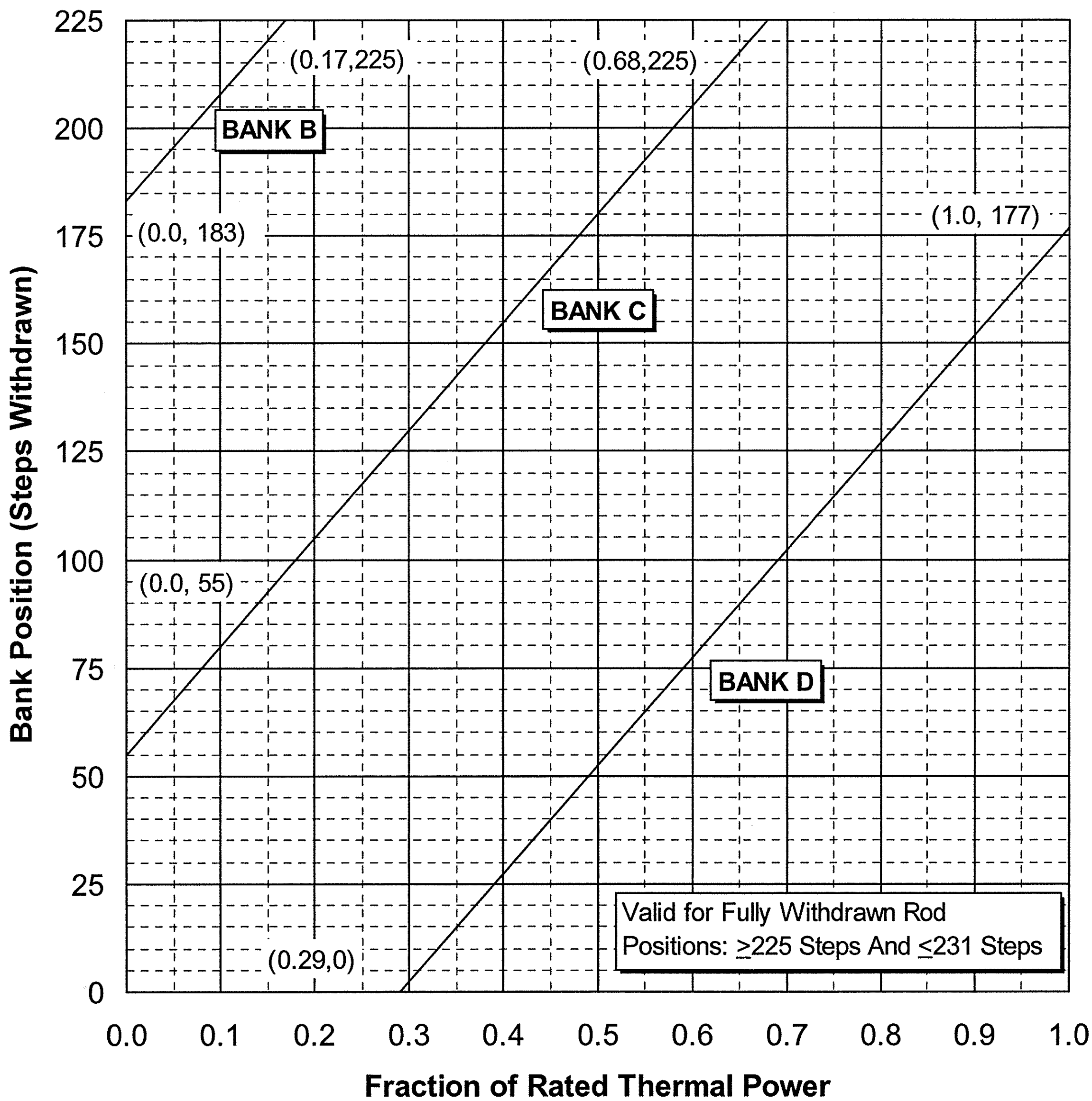

Figure 1: Control Bank Insertion Limits Versus Rated Thermal Power

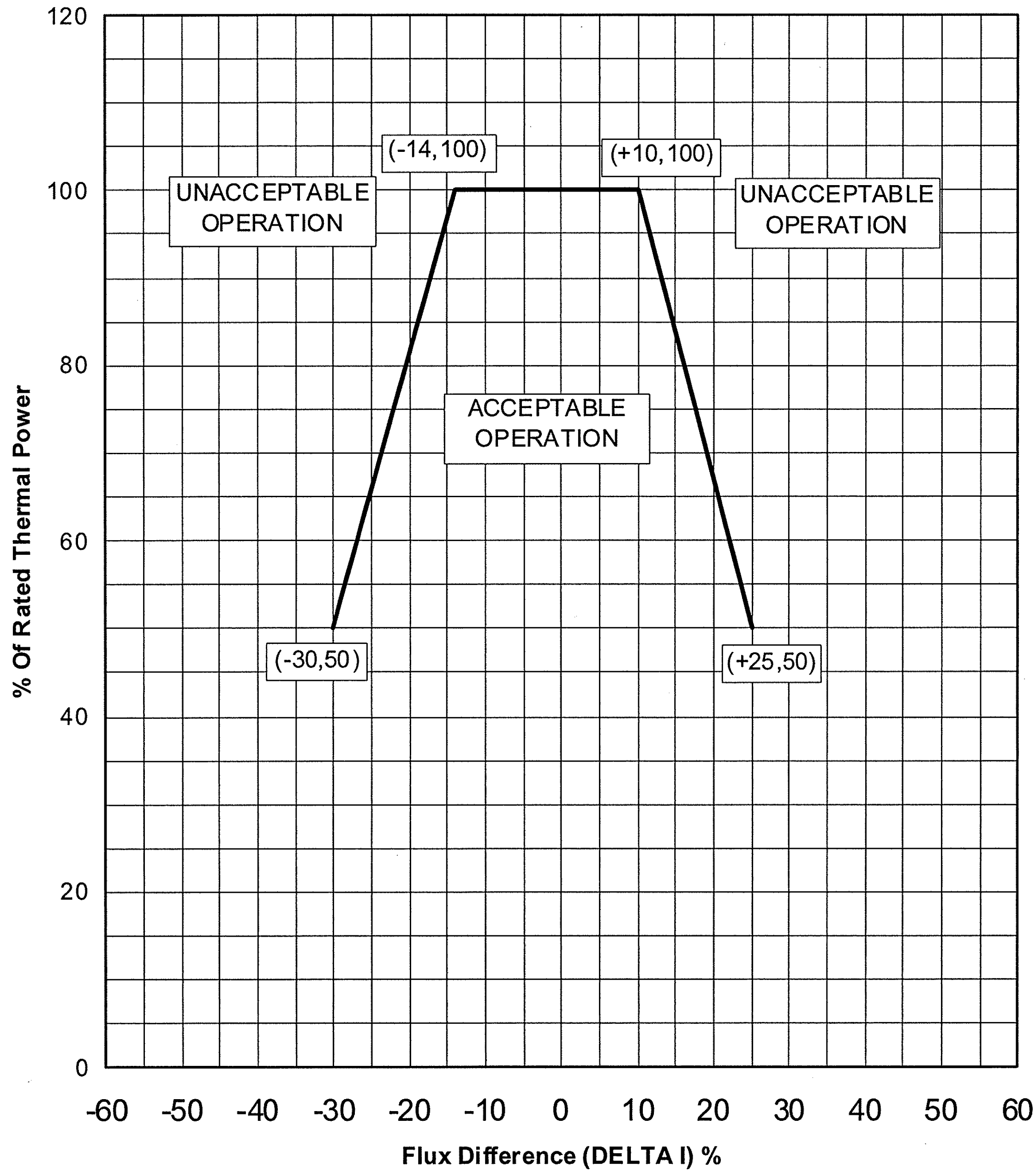

Figure 2: AFD Limits as a Function of Rated Thermal Power