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PG&E Letter DCL-13-030

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

Docket No. 50-323, OL-DPR-82
Diablo Canyon Power Plant Unit 2
Core Operating Limits Report for Unit 2 Cycle 18

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 2. This document was revised for DCPP Unit 2, Cycle 18.

Pacific Gas and Electric (PG&E) 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
Enclosure
cc: Diablo Distribution
cc/enc: Elmo E. Collins, NRC Region IV
Thomas R. Hipschman. NRC Senior Resident Inspector
James T. Polickoski, NRR Project Manager

CORE OPERATING LIMITS REPORTS (COLR)
DIABLO CANYON POWER PLANT UNIT 2, CYCLE 18
EFFECTIVE DATE March 14, 2013

TITLE: COLR for Diablo Canyon Unit 2

03/14/13
EFFECTIVE DATE

CLASSIFICATION: QUALITY RELATED

1. CORE OPERATING LIMITS REPORT

1.1 This Core Operating Limits Report (COLR) for Diablo Canyon Unit 2 Cycle 18 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 - $F_{\Delta H}^{N}$
- 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

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 (Reference 6.3).

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} $\Delta k/k/°F$ 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} $\Delta k/k/°F$ (all rods withdrawn, RATED THERMAL POWER condition).

2.2.3 The MTC 60 ppm surveillance limit is -3.72×10^{-4} $\Delta k/k/°F$ (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 $F_Q(Z) < \frac{F_Q^{RTP}}{P} * K(Z)$ for $P > 0.5$

$F_Q(Z) < \frac{F_Q^{RTP}}{0.5} * K(Z)$ 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 $\leq$ 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:

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

$F^N_{\Delta H}$ = 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 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 NF-PGE-13-17,"Diablo Canyon Unit 2 Cycle 18 Reload Evaluation and Core Operating Limits Report, Revision 1," March 4, 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, Revision 2, "Steam Line Break During Mode 3 for Westinghouse NSSS Plants," August 4, 2005.

6.4 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
312	2.01
475	2.98
637	3.75
799	4.27
961	4.48
1124	4.40
1286	4.08
1448	3.59
1611	3.02
1773	2.43
1935	2.00
5668	2.00
5830	2.57
5993	2.99
6155	2.86
6317	2.72
6480	2.62
6642	2.52
6804	2.41
6967	2.29
7129	2.17
7291	2.05
7453	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 (INCHES)	150 MWD/MTU W(Z)	HEIGHT (INCHES	4000 MWD/MTU W(Z)
*0.0	1.5137	*0.0	1.4970
*2.4	1.4961	*2.4	1.4781
*4.8	1.4777	*4.8	1.4611
*7.2	1.4590	*7.2	1.4462
*9.7	1.4402	*9.7	1.4340
12.1	1.4187	12.1	1.4193
14.5	1.3947	14.5	1.4020
16.9	1.3704	16.9	1.3828
19.3	1.3517	19.3	1.3618
21.7	1.3321	21.7	1.3394
24.1	1.3107	24.1	1.3161
26.6	1.2902	26.6	1.2916
29.0	1.2722	29.0	1.2675
31.4	1.2551	31.4	1.2458
33.8	1.2390	33.8	1.2250
36.2	1.2261	36.2	1.2070
38.6	1.2156	38.6	1.1944
41.0	1.2074	41.0	1.1873
43.5	1.2052	43.5	1.1846
45.9	1.2023	45.9	1.1816
48.3	1.1982	48.3	1.1777
50.7	1.1930	50.7	1.1727
53.1	1.1869	53.1	1.1671
55.5	1.1800	55.5	1.1606
57.9	1.1722	57.9	1.1533
60.4	1.1638	60.4	1.1452
62.8	1.1543	62.8	1.1370
65.2	1.1449	65.2	1.1284
67.6	1.1425	67.6	1.1204
70.0	1.1524	70.0	1.1273

* Top and Bottom 8% Excluded

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

HEIGHT (INCHES)	150 MWD/MTU W(Z)	HEIGHT (INCHES)	4000 MWD/MTU W(Z)
72.4	1.1650	72.4	1.1390
74.9	1.1751	74.9	1.1494
77.3	1.1847	77.3	1.1592
79.7	1.1931	79.7	1.1680
82.1	1.2001	82.1	1.1757
84.5	1.2057	84.5	1.1821
86.9	1.2096	86.9	1.1870
89.3	1.2118	89.3	1.1905
91.8	1.2129	91.8	1.1931
94.2	1.2118	94.2	1.1938
96.6	1.2084	96.6	1.1923
99.0	1.2026	99.0	1.1892
101.4	1.1943	101.4	1.1833
103.8	1.1836	103.8	1.1752
106.2	1.1737	106.2	1.1760
108.7	1.1736	108.7	1.1870
111.1	1.1767	111.1	1.2017
113.5	1.1767	113.5	1.2131
115.9	1.1808	115.9	1.2230
118.3	1.1824	118.3	1.2303
120.7	1.1860	120.7	1.2383
123.1	1.1910	123.1	1.2458
125.6	1.1940	125.6	1.2511
128.0	1.1980	128.0	1.2589
130.4	1.2007	130.4	1.2758
132.8	1.1998	132.8	1.2865
*135.2	1.2065	*135.2	1.2949
*137.6	1.2170	*137.6	1.2988
*140.0	1.2160	*140.0	1.2936
*142.5	1.2044	*142.5	1.2838
*144.9	1.1959	*144.9	1.2754

* 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	1.2703	*0.0	1.3120
*2.4	1.2689	*2.4	1.3146
*4.8	1.2674	*4.8	1.3127
*7.2	1.2660	*7.2	1.3080
*9.7	1.2615	*9.7	1.3003
12.1	1.2538	12.1	1.2890
14.5	1.2446	14.5	1.2764
16.9	1.2346	16.9	1.2631
19.3	1.2240	19.3	1.2495
21.7	1.2131	21.7	1.2357
24.1	1.2019	24.1	1.2216
26.6	1.1904	26.6	1.2073
29.0	1.1787	29.0	1.1928
31.4	1.1662	31.4	1.1773
33.8	1.1558	33.8	1.1606
36.2	1.1529	36.2	1.1564
38.6	1.1527	38.6	1.1598
41.0	1.1536	41.0	1.1716
43.5	1.1557	43.5	1.1839
45.9	1.1570	45.9	1.1950
48.3	1.1567	48.3	1.2046
50.7	1.1573	50.7	1.2129
53.1	1.1595	53.1	1.2189
55.5	1.1604	55.5	1.2231
57.9	1.1601	57.9	1.2254
60.4	1.1595	60.4	1.2256
62.8	1.1559	62.8	1.2253
65.2	1.1549	65.2	1.2322
67.6	1.1686	67.6	1.2533
70.0	1.1868	70.0	1.2733

* 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	1.2028	72.4	1.2893
74.9	1.2175	74.9	1.3035
77.3	1.2306	77.3	1.3152
79.7	1.2421	79.7	1.3245
82.1	1.2517	82.1	1.3311
84.5	1.2592	84.5	1.3347
86.9	1.2648	86.9	1.3358
89.3	1.2688	89.3	1.3346
91.8	1.2706	91.8	1.3298
94.2	1.2696	94.2	1.3218
96.6	1.2660	96.6	1.3105
99.0	1.2598	99.0	1.2959
101.4	1.2507	101.4	1.2780
103.8	1.2388	103.8	1.2586
106.2	1.2312	106.2	1.2449
108.7	1.2295	108.7	1.2322
111.1	1.2279	111.1	1.2183
113.5	1.2233	113.5	1.2078
115.9	1.2217	115.9	1.1998
118.3	1.2252	118.3	1.1950
120.7	1.2300	120.7	1.2015
123.1	1.2334	123.1	1.2206
125.6	1.2357	125.6	1.2398
128.0	1.2399	128.0	1.2633
130.4	1.2562	130.4	1.2847
132.8	1.2667	132.8	1.2968
*135.2	1.2720	*135.2	1.3096
*137.6	1.2712	*137.6	1.3183
*140.0	1.2598	*140.0	1.3124
*142.5	1.2410	*142.5	1.2929
*144.9	1.2244	*144.9	1.2774

* Top and Bottom 8% Excluded

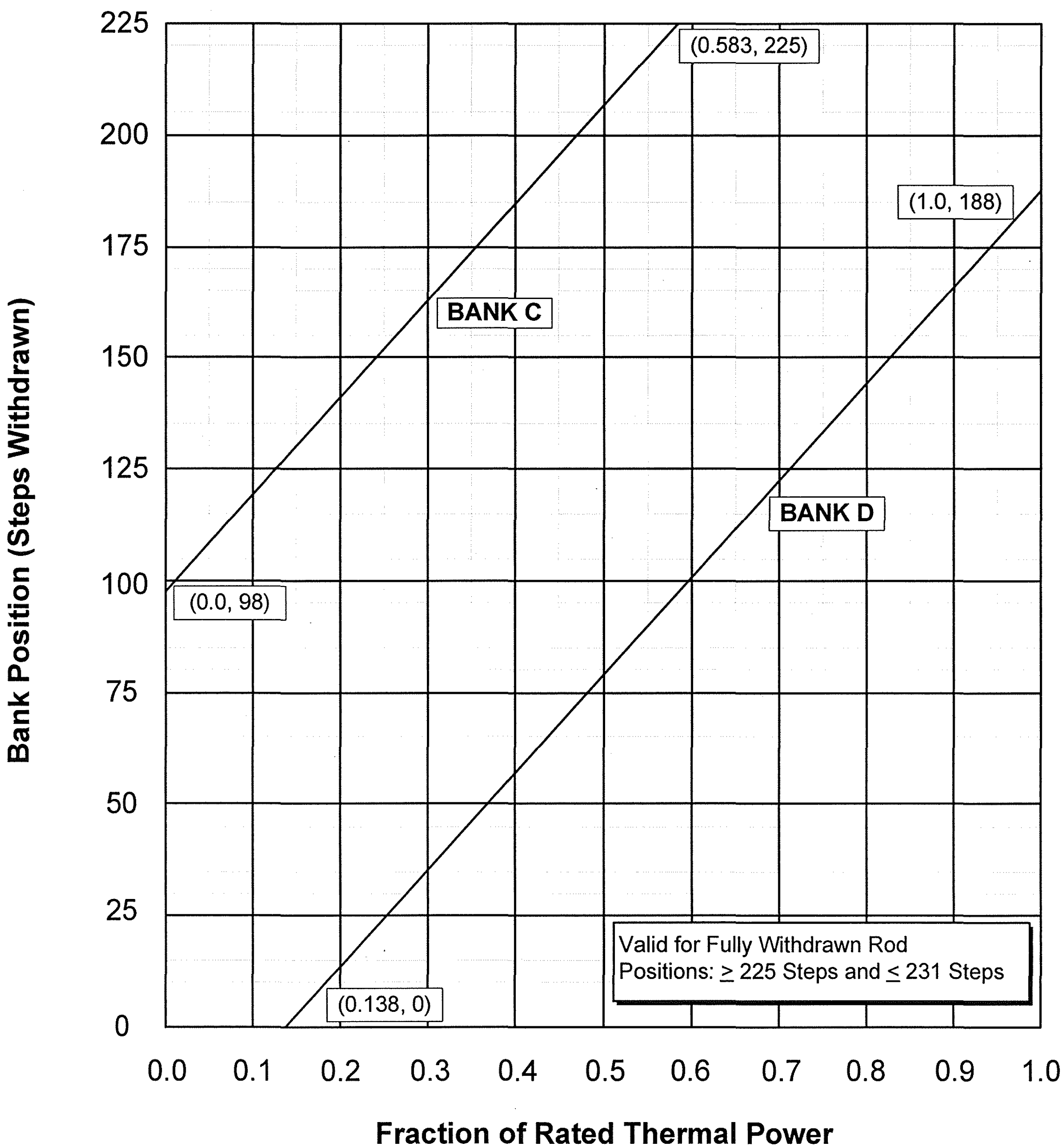

Figure 1: Control Bank Insertion Limits Versus Rated Thermal Power

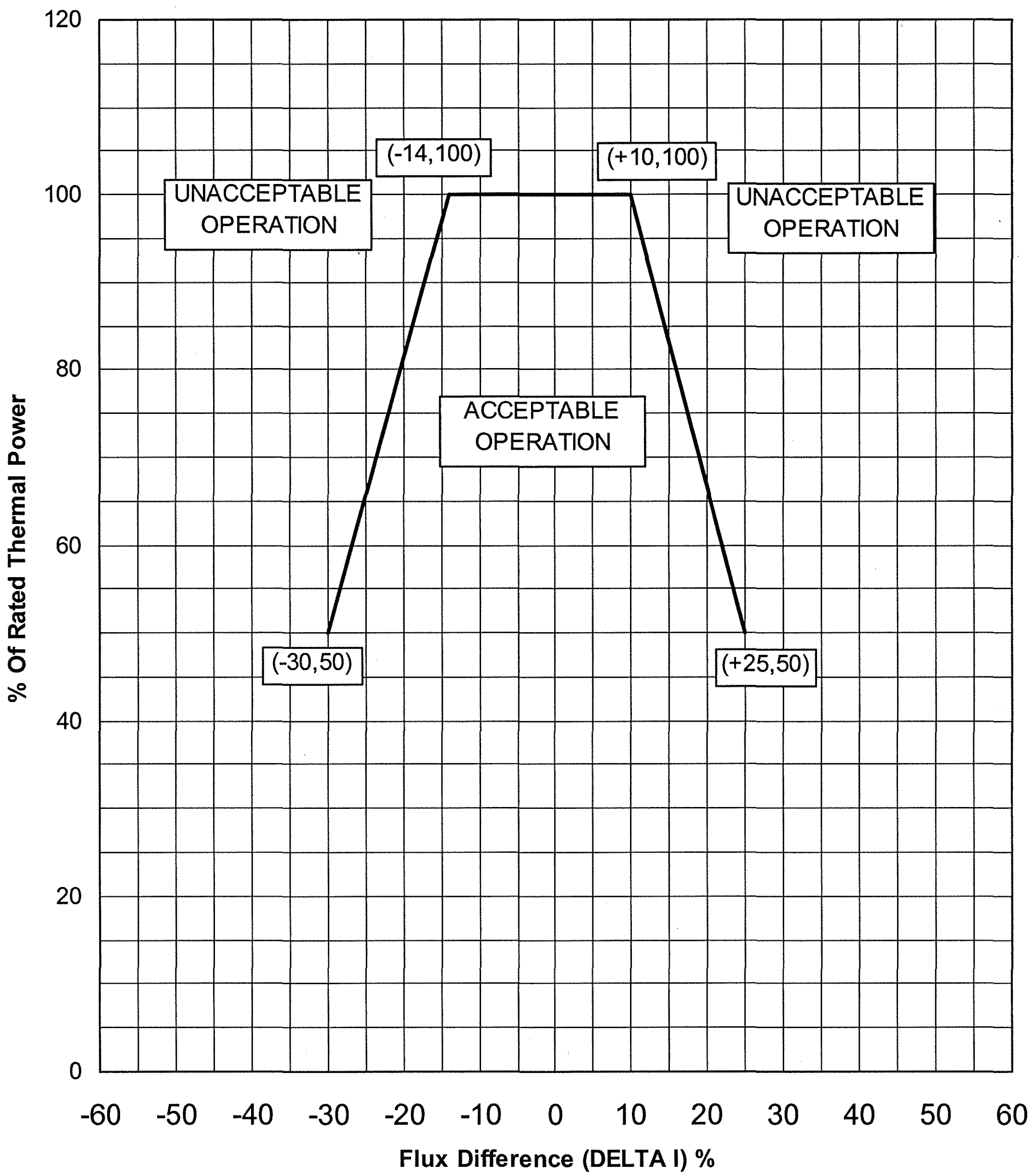

Figure 2: AFD Limits as a Function of Rated Thermal Power