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PG&E Letter DCL-22-089

U.S. Nuclear Regulatory Commission
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Docket No. 50-323, OL-DPR-82
Diablo Canyon Power Plant Unit 2
Core Operating Limits Report for Unit 2 Cycle 24

Dear Commissioners and Staff:

In accordance with Diablo Canyon Power Plant Technical Specification 5.6.5.d, enclosed is the Core Operating Limits Report (COLR) for DCPP Unit 2, Cycle 24.

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 me at (805) 545-6182.

Sincerely,

Dallas L. Adams

12/20/22
Date

kjse/50943730-08
Enclosure
cc: Diablo Distribution
cc/enc: Scott A. Morris, NRC Region IV Administrator
Mahdi O. Hayes, NRC Acting Senior Resident Inspector
Samson S. Lee, NRC Project Manager

PACIFIC GAS AND ELECTRIC COMPANY
NUCLEAR POWER GENERATION
DIABLO CANYON POWER PLANT
CORE OPERATING LIMITS REPORT
UNIT 2 CYCLE 24
EFFECTIVE DATE OCTOBER 31, 2022

TITLE: COLR for Diablo Canyon Unit 2

10/31/22
EFFECTIVE DATE

CLASSIFICATION: QUALITY RELATED

1. CORE OPERATING LIMITS REPORT

1.1 This Core Operating Limits Report (COLR) for Diablo Canyon Unit 2 Cycle 24 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 1.6% Δk/k. This limit addresses the concerns of NSAL-02-014 (Reference 6.3) and the boron dilution analysis for RCS filled conditions.

In order to address RCS drained conditions for the boron dilution analysis, a minimum boron concentration of 1800 ppm shall be maintained whenever the RCS level is at or below the reactor vessel flange elevation (114 feet).

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.

2.4.2 The control banks shall be withdrawn and inserted in the prescribed sequence in accordance with plant operating procedures. For withdrawal, the sequence is control bank A, control bank B, control bank C, and control bank D. The insertion sequence is the reverse of the withdrawal sequence.

2.4.3 A 128 step tip-to-tip relationship between each sequential control bank shall be maintained.

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

2.5.1 $$F_Q(Z) \leq \frac{CFQ}{P} * K(Z) \text{ for } P > 0.5$$

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

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

CFQ = 2.58

K(Z) = 1.0

2.5.2 The T(Z) data for Relaxed Axial Offset Control (RAOC) operation are provided in Tables 2A and 2B for RAOC Operating Spaces (ROS) ROS1 and ROS2, respectively, and are sufficient to determine the RAOC T(Z) versus core height for burnups through the end of full power reactivity plus a power coast down of up to 1200 MWD/MTU.

For T(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 T(Z) data to the desired burnup with a polynomial type fit that uses the T(Z) data for the nearest three burnup steps.

For T(Z) data at a desired burnup outside of the listed burnup steps, a linear extrapolation of the T(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 T(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 T(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.

Rj penalty factors account for the potential decrease in transient F_Q margin between surveillances. The Rj factors for ROS1 and ROS2 are provided in Tables 1A and 1B, respectively. These values shall be used to increase $F_Q^{W}(Z)$ per SR 3.2.1.2.

Either ROS1 or ROS2 may be implemented at any time during operation.

If ROS1 is implemented and entering LCO 3.2.1 Condition B for $F_Q^W(Z)$ not within limits, EITHER take Action B.1.1 and implement ROS2, OR take Action B.2.1 by using Table 3 to determine required THERMAL POWER and AFD limits based on Required $F_Q^W(Z)$ margin improvement.

If ROS2 is implemented and entering LCO 3.2.1 Condition B for $F_Q^W(Z)$ not within limits, take Action B.2.1 by using Table 3 to determine required THERMAL POWER and AFD limits based on Required $F_Q^W(Z)$ margin improvement.

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:

$$F_Q^C(Z) = 1.03 * F_Q^M(Z) * \left(1.0 + \frac{U_Q}{100.0}\right)$$

where 1.03 is the fuel manufacturing tolerance,

$F_Q^M(Z)$ is the measured value of $F_Q(Z)$ and

U_Q is the measurement uncertainty ($U_Q \geq 5$)

$F_Q^W(Z)$ equations are:

$$F_Q^W(Z) = 1.03 * \frac{[T(Z)]^{COLR}}{P} * A_{XY}(Z) * F_{XY}^M(Z) * Rj * \left(1.0 + \frac{U_Q}{100.0}\right) \text{ for } P > 0.5$$

$$F_Q^W(Z) = 1.03 * \frac{[T(Z)]^{COLR}}{0.5} * A_{XY}(Z) * F_{XY}^M(Z) * Rj * \left(1.0 + \frac{U_Q}{100.0}\right) \text{ for } P \leq 0.5$$

where $F_{XY}^M(Z)$ is the measured planar radial peaking factor

$A_{XY}(Z)$ factors adjust the surveillance to the reference conditions assumed in generating the $[T(Z)]^{COLR}$ factors. $A_{XY}(Z)$ may be assumed to be equal to 1.0 or may be determined for specific surveillance conditions using the approved methods listed in TS 5.6.5 (COLR).[Ref 7.5]

Table 3 provides the required limits on THERMAL POWER and the required AFD reductions for each ROS in the event that additional margin is required.

T(Z) and Rj are specified in step 2.5.2.

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

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

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. However, if the uncertainty is less than 5.0, the uncertainty should be set equal to 5.0.

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 AFD Limits are provided in Figures 2 and 3.

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, Temperature and Flow 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.

2.10.3 RCS total flow rate is greater than or equal to 362,500 gpm.

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 1A, "Rj Margin Decrease Factors for ROS1"

3.2 Table 1B, "Rj Margin Decrease Factors for ROS2"

3.3 Table 2A, "T(Z) Factors versus Burnup as a Function of Core Height for ROS1"

3.4 Table 2B, "T(Z) Factors versus Burnup as a Function of Core Height for ROS2"

3.5 Table 3, "Required Thermal Power Limits and AFD Reductions"

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 for Normal Operation"

4.3 Figure 3, "AFD Limits as a Function of Rated Thermal Power for F_Q Improvement"

5. RECORDS

None

6. REFERENCES

6.1 NF-PGE-22-038, "Diablo Canyon Power Plant Unit 2 Cycle 24 Final Reload Evaluation and Core Operating Limits Report," October 2022

6.2 WCAP-12472-P-A, Addendum 4, "BEACON Core Monitoring and Operation Support System, Addendum 4," September 2012

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

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-16996-P-A, Revision 1,"Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM LOCA Methodology)," November 2016.

7.5 WCAP-17661-P-A, Revision 1, "Improved RAOC and CAOC F_Q Surveillance Technical Specifications," February 2019.

7.6 Not used.

7.7 Not used.

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

7.9 WCAP-16045-P-A, "Qualification of the Two-Dimensional Transport Code PARAGON," August 2004.

7.10 WCAP-16045-P-A, Addendum 1-A, "Qualification of the NEXUS Nuclear Data Methodology," August 2007.

Table 1A: Rj Margin Decrease Factors for ROS1

Cycle Burnup (MWD/MTU)	Rj Penalty Multiplier	Cycle Burnup (MWD/MTU)	Rj Penalty Multiplier	Cycle Burnup (MWD/MTU)	Rj Penalty Multiplier
≤150	1.0000	8324	1.0191	16498	1.0076
354	1.0138	8528	1.0171	16702	1.0072
559	1.0247	8733	1.0149	16907	1.0068
763	1.0302	8937	1.0125	17111	1.0064
967	1.0298	9141	1.0083	17315	1.0060
1172	1.0260	9346	1.0061	17520	1.0056
1376	1.0214	9550	1.0042	17724	1.0052
1580	1.0177	9754	1.0027	17929	1.0047
1785	1.0144	9959	1.0015	18133	1.0044
1989	1.0120	10163	1.0007	18337	1.0043
2194	1.0130	10368	1.0002	18542	1.0043
2398	1.0151	10572	1.0000	18746	1.0047
2602	1.0188	10776	1.0000	18950	1.0052
2807	1.0202	10981	1.0000	19155	1.0056
3011	1.0215	11185	1.0000	19359	1.0060
3215	1.0193	11389	1.0000	19563	1.0064
3420	1.0163	11594	1.0000	19768	1.0068
3624	1.0131	11798	1.0000	≥19972	1.0071
3828	1.0096	12002	1.0000		
4033	1.0065	12207	1.0003		
4237	1.0041	12411	1.0014		
4441	1.0024	12615	1.0026		
4646	1.0000	12820	1.0038		
4850	1.0000	13024	1.0055		
5054	1.0000	13228	1.0066		
5259	1.0000	13433	1.0069		
5463	1.0000	13637	1.0080		
5667	1.0000	13841	1.0088		
5872	1.0043	14046	1.0094		
6076	1.0098	14250	1.0098		
6281	1.0140	14455	1.0099		
6485	1.0149	14659	1.0099		
6689	1.0159	14863	1.0097		
6894	1.0198	15068	1.0100		
7098	1.0202	15272	1.0097		
7302	1.0236	15476	1.0092		
7507	1.0246	15681	1.0088		
7711	1.0236	15885	1.0084		
7915	1.0223	16089	1.0081		
8120	1.0209	16294	1.0079		

NOTE: Linear interpolation is adequate for intermediate cycle burnups.

Table 1B: Rj Margin Decrease Factors for ROS2

Cycle Burnup (MWD/MTU)	Rj Penalty Multiplier	Cycle Burnup (MWD/MTU)	Rj Penalty Multiplier	Cycle Burnup (MWD/MTU)	Rj Penalty Multiplier
≤150	1.0069	8324	1.0000	16498	1.0021
354	1.0168	8528	1.0000	16702	1.0015
559	1.0235	8733	1.0000	16907	1.0011
763	1.0271	8937	1.0000	17111	1.0007
967	1.0263	9141	1.0054	17315	1.0004
1172	1.0227	9346	1.0084	17520	1.0002
1376	1.0177	9550	1.0064	17724	1.0002
1580	1.0111	9754	1.0043	17929	1.0002
1785	1.0075	9959	1.0026	18133	1.0001
1989	1.0063	10163	1.0013	18337	1.0001
2194	1.0077	10368	1.0005	18542	1.0000
2398	1.0103	10572	1.0001	18746	1.0000
2602	1.0151	10776	1.0000	18950	1.0000
2807	1.0172	10981	1.0000	19155	1.0000
3011	1.0191	11185	1.0000	19359	1.0000
3215	1.0174	11389	1.0000	19563	1.0005
3420	1.0149	11594	1.0000	19768	1.0009
3624	1.0121	11798	1.0000	≥19972	1.0013
3828	1.0089	12002	1.0000		
4033	1.0061	12207	1.0000		
4237	1.0038	12411	1.0000		
4441	1.0022	12615	1.0000		
4646	1.0000	12820	1.0005		
4850	1.0000	13024	1.0037		
5054	1.0000	13228	1.0052		
5259	1.0000	13433	1.0078		
5463	1.0000	13637	1.0093		
5667	1.0000	13841	1.0106		
5872	1.0000	14046	1.0116		
6076	1.0000	14250	1.0123		
6281	1.0000	14455	1.0127		
6485	1.0000	14659	1.0124		
6689	1.0014	14863	1.0116		
6894	1.0033	15068	1.0094		
7098	1.0000	15272	1.0083		
7302	1.0000	15476	1.0071		
7507	1.0000	15681	1.0059		
7711	1.0000	15885	1.0048		
7915	1.0000	16089	1.0038		
8120	1.0000	16294	1.0028		

NOTE: Linear interpolation is adequate for intermediate cycle burnups.

Table 2A: T(Z) Factors versus Burnup as a Function of Core Height for ROS1

Height (ft)	Burnup (MWD/MTU) 150	1000	2000	3000	4000	5000	6000	8000	10000	12000	14000	16000	18000
*0.0000	0.5679	0.5093	0.4738	0.4317	0.4124	0.4200	0.4094	0.4191	0.4372	0.4574	0.4527	0.4810	0.5145
*0.2012	0.5912	0.5333	0.4993	0.4575	0.4390	0.4488	0.4392	0.4527	0.4755	0.5009	0.5320	0.5667	0.6082
*0.4024	0.7862	0.7124	0.6695	0.6151	0.5910	0.6040	0.5910	0.6068	0.6335	0.6624	0.6929	0.7313	0.7770
*0.6036	1.2350	1.1270	1.0656	0.9840	0.9480	0.9688	0.9482	0.9693	1.0044	1.0400	1.0759	1.1217	1.1767
*0.8048	1.3609	1.2588	1.2064	1.1248	1.0920	1.1212	1.1026	1.1314	1.1725	1.2105	1.2461	1.2903	1.3428
1.0060	1.3343	1.2618	1.2332	1.1709	1.1518	1.1933	1.1838	1.2269	1.2774	1.3194	1.3544	1.3948	1.4413
1.2072	1.3585	1.2986	1.2811	1.2263	1.2127	1.2588	1.2520	1.2964	1.3451	1.3816	1.4096	1.4411	1.4786
1.4084	1.3643	1.3180	1.3119	1.2658	1.2578	1.3073	1.3031	1.3466	1.3919	1.4220	1.4425	1.4650	1.4941
1.6096	1.3695	1.3361	1.3402	1.3023	1.2991	1.3504	1.3481	1.3880	1.4283	1.4507	1.4636	1.4770	1.4983
1.8108	1.3605	1.3381	1.3496	1.3192	1.3197	1.3705	1.3697	1.4036	1.4381	1.4529	1.4590	1.4643	1.4795
2.0120	1.2993	1.2876	1.3048	1.2827	1.2866	1.3348	1.3362	1.3641	1.3942	1.4039	1.4065	1.4069	1.4192
2.2132	1.2573	1.2496	1.2717	1.2566	1.2637	1.3085	1.3110	1.3311	1.3605	1.3647	1.3638	1.3612	1.3696
2.4144	1.2908	1.2919	1.3173	1.3072	1.3182	1.3563	1.3580	1.3678	1.3862	1.3823	1.3755	1.3677	1.3681
2.6156	1.3102	1.3179	1.3410	1.3416	1.3533	1.3812	1.3824	1.3852	1.3951	1.3845	1.3735	1.3623	1.3603
2.8168	1.2876	1.3042	1.3229	1.3338	1.3457	1.3627	1.3645	1.3656	1.3653	1.3501	1.3381	1.3259	1.3218
3.0180	1.2721	1.2875	1.3099	1.3266	1.3383	1.3460	1.3438	1.3429	1.3329	1.3223	1.3038	1.2938	1.2832
3.2192	1.2755	1.2898	1.3158	1.3355	1.3465	1.3489	1.3468	1.3403	1.3213	1.3189	1.2900	1.2845	1.2695
3.4204	1.2867	1.3118	1.3426	1.3578	1.3679	1.3720	1.3699	1.3535	1.3242	1.3184	1.2878	1.2839	1.2753
3.6216	1.2686	1.3038	1.3374	1.3497	1.3591	1.3668	1.3618	1.3385	1.3043	1.2963	1.2766	1.2677	1.2634
3.8228	1.2110	1.2540	1.2895	1.3013	1.3108	1.3196	1.3139	1.2867	1.2522	1.2427	1.2339	1.2293	1.2267
4.0240	1.2197	1.2687	1.3065	1.3159	1.3246	1.3334	1.3246	1.2890	1.2493	1.2392	1.2342	1.2302	1.2274
4.2252	1.2744	1.3275	1.3677	1.3759	1.3821	1.3900	1.3773	1.3314	1.2848	1.2748	1.2696	1.2650	1.2646
4.4264	1.2768	1.3319	1.3734	1.3844	1.3902	1.3943	1.3800	1.3291	1.2844	1.2738	1.2717	1.2693	1.2745
4.6276	1.2759	1.3319	1.3740	1.3870	1.3918	1.3917	1.3756	1.3196	1.2762	1.2645	1.2642	1.2630	1.2724
4.8288	1.2744	1.3308	1.3730	1.3880	1.3920	1.3879	1.3704	1.3102	1.2686	1.2555	1.2567	1.2561	1.2689
5.0300	1.2719	1.3282	1.3702	1.3877	1.3911	1.3834	1.3652	1.3026	1.2639	1.2508	1.2537	1.2543	1.2712
5.2312	1.2831	1.3278	1.3694	1.3886	1.3914	1.3799	1.3610	1.2959	1.2598	1.2475	1.2495	1.2526	1.2702
5.4324	1.2778	1.3015	1.3452	1.3630	1.3654	1.3533	1.3319	1.2692	1.2335	1.2218	1.2228	1.2290	1.2454
5.6336	1.2309	1.2575	1.2875	1.3108	1.3084	1.2972	1.2770	1.2369	1.2030	1.1891	1.1855	1.2027	1.2236
5.8348	1.2866	1.3171	1.3522	1.3704	1.3710	1.3589	1.3342	1.2894	1.2502	1.2334	1.2279	1.2449	1.2678
6.0360	1.3519	1.3847	1.4211	1.4379	1.4373	1.4244	1.3957	1.3482	1.3030	1.2829	1.2756	1.2907	1.3151
6.2372	1.3458	1.3803	1.4178	1.4337	1.4339	1.4227	1.3934	1.3487	1.3023	1.2828	1.2765	1.2911	1.3184
6.4384	1.3027	1.3384	1.3764	1.3919	1.3937	1.3856	1.3575	1.3188	1.2786	1.2564	1.2521	1.2668	1.2970
6.6396	1.3341	1.3712	1.4096	1.4235	1.4252	1.4179	1.3881	1.3504	1.3076	1.2831	1.2776	1.2897	1.3207
6.8408	1.3908	1.4295	1.4680	1.4798	1.4807	1.4738	1.4415	1.4036	1.3611	1.3283	1.3203	1.3316	1.3593
7.0420	1.3812	1.4203	1.4583	1.4688	1.4706	1.4661	1.4346	1.4013	1.3634	1.3263	1.3182	1.3304	1.3555
7.2432	1.3253	1.3614	1.3981	1.4080	1.4117	1.4109	1.3825	1.3571	1.3264	1.2887	1.2823	1.2964	1.3194
7.4444	1.3111	1.3452	1.3802	1.3890	1.3937	1.3952	1.3687	1.3485	1.3217	1.2830	1.2767	1.2894	1.3097
7.6456	1.3683	1.4031	1.4358	1.4431	1.4473	1.4487	1.4223	1.4021	1.3741	1.3313	1.3221	1.3300	1.3467
7.8468	1.3963	1.4312	1.4610	1.4673	1.4715	1.4733	1.4483	1.4303	1.4024	1.3583	1.3473	1.3505	1.3644
8.0480	1.3502	1.3853	1.4121	1.4184	1.4241	1.4276	1.4073	1.3954	1.3710	1.3313	1.3216	1.3210	1.3350
8.2492	1.2919	1.3273	1.3511	1.3574	1.3646	1.3700	1.3550	1.3496	1.3287	1.2938	1.2861	1.2857	1.2976
8.4504	1.3277	1.3631	1.3830	1.3879	1.3947	1.3996	1.3875	1.3838	1.3600	1.3292	1.3186	1.3146	1.3201
8.6516	1.3339	1.3675	1.3832	1.3889	1.3951	1.4010	1.3906	1.3906	1.3627	1.3411	1.3372	1.3287	1.3254
8.8528	1.2802	1.3078	1.3213	1.3275	1.3361	1.3377	1.3389	1.3433	1.3246	1.3140	1.3147	1.3054	1.2880
9.0540	1.2240	1.2414	1.2446	1.2648	1.2750	1.2636	1.2764	1.2863	1.2839	1.2779	1.2782	1.2731	1.2542
9.2552	1.2460	1.2569	1.2520	1.2783	1.2883	1.2753	1.2889	1.2959	1.3065	1.3012	1.2995	1.2948	1.2763
9.4564	1.2913	1.3038	1.2883	1.3210	1.3291	1.3095	1.3277	1.3271	1.3473	1.3502	1.3369	1.3349	1.3120
9.6576	1.2890	1.2993	1.2817	1.3089	1.3155	1.3006	1.3174	1.3237	1.3445	1.3559	1.3424	1.3430	1.3293
9.8588	1.2248	1.2326	1.2115	1.2380	1.2445	1.2396	1.2510	1.2721	1.2952	1.3095	1.3033	1.3074	1.3058
10.0600	1.2206	1.2118	1.1878	1.2113	1.2162	1.2199	1.2234	1.2589	1.2857	1.3061	1.3058	1.3161	1.3137
10.2612	1.2686	1.2484	1.2146	1.2312	1.2289	1.2428	1.2428	1.2854	1.3138	1.3388	1.3435	1.3588	1.3563
10.4624	1.2520	1.2229	1.1784	1.1911	1.1844	1.2041	1.1973	1.2506	1.2810	1.3121	1.3254	1.3479	1.3584
10.6636	1.1716	1.1357	1.0833	1.0918	1.0841	1.1063	1.0971	1.1552	1.1882	1.2238	1.2473	1.2781	1.2865
10.8648	1.1334	1.0874	1.0308	1.0230	1.0159	1.0391	1.0250	1.0866	1.1235	1.1619	1.1906	1.2302	1.2418
11.0660	1.1487	1.0899	1.0218	1.0044	0.9962	1.0157	0.9977	1.0596	1.0975	1.1387	1.1709	1.2139	1.2403
*11.2672	1.1530	1.0743	0.9876	0.9584	0.9399	0.9509	0.9279	0.9781	1.0097	1.0470	1.0778	1.1222	1.1558
*11.4684	1.0880	0.9986	0.9060	0.8714	0.8488	0.8548	0.8311	0.8738	0.9020	0.9388	0.9760	1.0167	1.0537
*11.6696	0.8885	0.8096	0.7297	0.6986	0.6784	0.6821	0.6624	0.6970	0.7208	0.7548	0.7863	0.8243	0.8571
*11.8708	0.4705	0.4278	0.3871	0.3689	0.3588	0.3617	0.3520	0.3735	0.3891	0.4163	0.4340	0.4612	0.4795
*12.0720	0.1235	0.1086	0.0985	0.0900	0.0875	0.0892	0.0876	0.0976	0.1061	0.1282	0.1355	0.1537	0.1608

* Top and Bottom 8% Excluded

Table 2B: T(Z) Factors versus Burnup as a Function of Core Height for ROS2

	Burnup (MWD/MTU)												
Height (ft)	150	1000	2000	3000	4000	5000	6000	8000	10000	12000	14000	16000	18000
*0.0000	0.5192	0.4740	0.4415	0.4012	0.3831	0.3702	0.3776	0.3842	0.4053	0.4260	0.4207	0.4480	0.4763
*0.2012	0.5408	0.4966	0.4655	0.4253	0.4080	0.3959	0.4052	0.4153	0.4410	0.4667	0.4947	0.5284	0.5634
*0.4024	0.7199	0.6639	0.6248	0.5724	0.5499	0.5338	0.5457	0.5573	0.5882	0.6176	0.6448	0.6822	0.7204
*0.6036	1.1324	1.0517	0.9957	0.9170	0.8833	0.8583	0.8767	0.8915	0.9339	0.9708	1.0022	1.0475	1.0923
*0.8048	1.2498	1.1764	1.1288	1.0499	1.0191	0.9961	1.0209	1.0423	1.0918	1.1314	1.1621	1.2062	1.2479
1.0060	1.2273	1.1810	1.1556	1.0947	1.0767	1.0634	1.0976	1.1323	1.1914	1.2346	1.2645	1.3052	1.3411
1.2072	1.2521	1.2175	1.2025	1.1487	1.1358	1.1255	1.1626	1.1988	1.2568	1.2945	1.3175	1.3502	1.3776
1.4084	1.2603	1.2382	1.2338	1.1879	1.1803	1.1731	1.2119	1.2483	1.3031	1.3340	1.3499	1.3747	1.3942
1.6096	1.2687	1.2581	1.2632	1.2248	1.2217	1.2167	1.2559	1.2904	1.3402	1.3629	1.3714	1.3885	1.4005
1.8108	1.2646	1.2632	1.2753	1.2434	1.2438	1.2403	1.2781	1.3093	1.3529	1.3672	1.3698	1.3798	1.3858
2.0120	1.2127	1.2191	1.2364	1.2123	1.2162	1.2144	1.2492	1.2775	1.3155	1.3244	1.3240	1.3293	1.3324
2.2132	1.1735	1.1869	1.2087	1.1920	1.1983	1.1978	1.2289	1.2522	1.2839	1.2910	1.2876	1.2885	1.2892
2.4144	1.2128	1.2307	1.2556	1.2432	1.2505	1.2524	1.2768	1.2922	1.3164	1.3113	1.3027	1.2970	1.2933
2.6156	1.2370	1.2550	1.2823	1.2740	1.2819	1.2910	1.3032	1.3135	1.3292	1.3174	1.3050	1.2944	1.2878
2.8168	1.2273	1.2435	1.2677	1.2668	1.2752	1.2901	1.2929	1.3036	1.3052	1.2890	1.2769	1.2623	1.2552
3.0180	1.2153	1.2404	1.2585	1.2662	1.2751	1.2862	1.2883	1.2896	1.2800	1.2612	1.2504	1.2323	1.2247
3.2192	1.2181	1.2467	1.2712	1.2831	1.2940	1.2931	1.2944	1.2901	1.2738	1.2548	1.2407	1.2252	1.2169
3.4204	1.2360	1.2656	1.2958	1.3068	1.3165	1.3174	1.3155	1.3022	1.2817	1.2628	1.2440	1.2289	1.2250
3.6216	1.2277	1.2546	1.2903	1.3051	1.3125	1.3112	1.3077	1.2883	1.2664	1.2506	1.2307	1.2185	1.2150
3.8228	1.1797	1.2033	1.2429	1.2657	1.2727	1.2669	1.2619	1.2401	1.2190	1.2082	1.1896	1.1861	1.1849
4.0240	1.1937	1.2170	1.2616	1.2875	1.2932	1.2843	1.2736	1.2441	1.2196	1.2107	1.1900	1.1915	1.1945
4.2252	1.2505	1.2753	1.3259	1.3523	1.3560	1.3434	1.3257	1.2868	1.2572	1.2489	1.2277	1.2297	1.2349
4.4264	1.2557	1.2814	1.3367	1.3638	1.3668	1.3526	1.3300	1.2878	1.2588	1.2517	1.2342	1.2386	1.2485
4.6276	1.2578	1.2855	1.3428	1.3698	1.3715	1.3555	1.3275	1.2846	1.2542	1.2464	1.2318	1.2372	1.2504
4.8288	1.2590	1.2897	1.3475	1.3743	1.3750	1.3574	1.3262	1.2817	1.2502	1.2415	1.2294	1.2355	1.2510
5.0300	1.2652	1.2927	1.3506	1.3772	1.3772	1.3590	1.3273	1.2808	1.2492	1.2405	1.2316	1.2385	1.2575
5.2312	1.2827	1.2982	1.3558	1.3817	1.3808	1.3616	1.3295	1.2808	1.2488	1.2394	1.2329	1.2410	1.2607
5.4324	1.2774	1.2916	1.3347	1.3603	1.3587	1.3390	1.3117	1.2658	1.2293	1.2159	1.2118	1.2230	1.2393
5.6336	1.2305	1.2567	1.2875	1.2975	1.2992	1.2879	1.2754	1.2332	1.2024	1.1886	1.1810	1.1933	1.2230
5.8348	1.2863	1.3166	1.3479	1.3595	1.3579	1.3457	1.3272	1.2820	1.2496	1.2333	1.2218	1.2356	1.2678
6.0360	1.3516	1.3842	1.4169	1.4265	1.4225	1.4095	1.3878	1.3400	1.3024	1.2830	1.2679	1.2820	1.3151
6.2372	1.3456	1.3800	1.4138	1.4229	1.4197	1.4086	1.3858	1.3410	1.3020	1.2828	1.2701	1.2838	1.3183
6.4384	1.3027	1.3382	1.3729	1.3819	1.3806	1.3725	1.3506	1.3116	1.2738	1.2564	1.2473	1.2656	1.2970
6.6396	1.3341	1.3712	1.4064	1.4140	1.4126	1.4054	1.3817	1.3437	1.3025	1.2831	1.2736	1.2893	1.3207
6.8408	1.3908	1.4295	1.4651	1.4707	1.4687	1.4618	1.4354	1.3972	1.3512	1.3283	1.3166	1.3316	1.3593
7.0420	1.3810	1.4203	1.4559	1.4608	1.4599	1.4554	1.4293	1.3957	1.3511	1.3263	1.3146	1.3304	1.3555
7.2432	1.3225	1.3614	1.3963	1.4012	1.4026	1.4018	1.3781	1.3525	1.3136	1.2887	1.2789	1.2964	1.3194
7.4444	1.3068	1.3452	1.3789	1.3834	1.3861	1.3876	1.3652	1.3447	1.3084	1.2830	1.2714	1.2894	1.3097
7.6456	1.3647	1.4031	1.4350	1.4386	1.4410	1.4422	1.4195	1.3991	1.3599	1.3313	1.3138	1.3300	1.3467
7.8468	1.3934	1.4312	1.4608	1.4639	1.4666	1.4683	1.4464	1.4281	1.3876	1.3583	1.3354	1.3505	1.3644
8.0480	1.3483	1.3853	1.4121	1.4164	1.4209	1.4244	1.4063	1.3941	1.3564	1.3313	1.3056	1.3210	1.3350
8.2492	1.2909	1.3273	1.3511	1.3567	1.3633	1.3686	1.3549	1.3493	1.3154	1.2938	1.2668	1.2857	1.2976
8.4504	1.3279	1.3630	1.3830	1.3879	1.3945	1.3994	1.3874	1.3838	1.3507	1.3292	1.2923	1.3146	1.3201
8.6516	1.3339	1.3677	1.3832	1.3890	1.3953	1.4010	1.3907	1.3906	1.3600	1.3411	1.3110	1.3289	1.3255
8.8528	1.2798	1.3068	1.3213	1.3265	1.3350	1.3379	1.3382	1.3428	1.3242	1.3140	1.2901	1.3036	1.2874
9.0540	1.2233	1.2403	1.2447	1.2633	1.2734	1.2625	1.2751	1.2843	1.2831	1.2778	1.2554	1.2699	1.2528
9.2552	1.2453	1.2560	1.2511	1.2769	1.2868	1.2740	1.2876	1.2923	1.3058	1.3011	1.2790	1.2899	1.2740
9.4564	1.2906	1.3031	1.2872	1.3196	1.3277	1.3082	1.3265	1.3220	1.3466	1.3413	1.3202	1.3346	1.3109
9.6576	1.2883	1.2987	1.2808	1.3077	1.3143	1.3002	1.3167	1.3233	1.3439	1.3486	1.3354	1.3430	1.3293
9.8588	1.2243	1.2322	1.2108	1.2371	1.2435	1.2394	1.2505	1.2718	1.2949	1.3096	1.3034	1.3074	1.3058
10.0600	1.2203	1.2114	1.1873	1.2106	1.2147	1.2197	1.2231	1.2587	1.2854	1.3060	1.3058	1.3161	1.3137
10.2612	1.2683	1.2482	1.2145	1.2310	1.2222	1.2428	1.2427	1.2852	1.3136	1.3388	1.3435	1.3588	1.3563
10.4624	1.2518	1.2227	1.1784	1.1911	1.1764	1.2041	1.1973	1.2506	1.2808	1.3121	1.3254	1.3479	1.3585
10.6636	1.1714	1.1356	1.0833	1.0918	1.0806	1.1063	1.0971	1.1552	1.1867	1.2238	1.2473	1.2781	1.2860
10.8648	1.1332	1.0873	1.0308	1.0230	1.0161	1.0391	1.0250	1.0866	1.1210	1.1613	1.1906	1.2302	1.2395
11.0660	1.1485	1.0899	1.0218	1.0044	0.9961	1.0157	0.9977	1.0596	1.0940	1.1362	1.1707	1.2138	1.2406
*11.2672	1.1528	1.0743	0.9876	0.9584	0.9399	0.9509	0.9279	0.9781	1.0051	1.0438	1.0780	1.1223	1.1558
*11.4684	1.0879	0.9986	0.9060	0.8714	0.8488	0.8548	0.8311	0.8738	0.8929	0.9383	0.9697	1.0156	1.0538
*11.6696	0.8883	0.8096	0.7297	0.6986	0.6784	0.6821	0.6624	0.6970	0.7070	0.7532	0.7826	0.8249	0.8560
*11.8708	0.4705	0.4278	0.3871	0.3689	0.3588	0.3617	0.3520	0.3735	0.3826	0.4166	0.4322	0.4612	0.4756
*12.0720	0.1235	0.1086	0.0985	0.0900	0.0875	0.0892	0.0876	0.0976	0.1032	0.1295	0.1347	0.1537	0.1545

* Top and Bottom 8% Excluded

Table 3: Required Thermal Power Limits and AFD Reductions

RAOC Operating Space	Required Action Space	Required $F_Q^W(z)$ Margin Improvement (%)	Required THERMAL POWER Limit (%RTP)	Required AFD Reduction
ROS1	RA1	≤1.23	≤95	See Figure 3
		>1.23	<50	N/A
ROS2	RA2	≤1.27	≤95	See Figure 3
		>1.27	<50	N/A

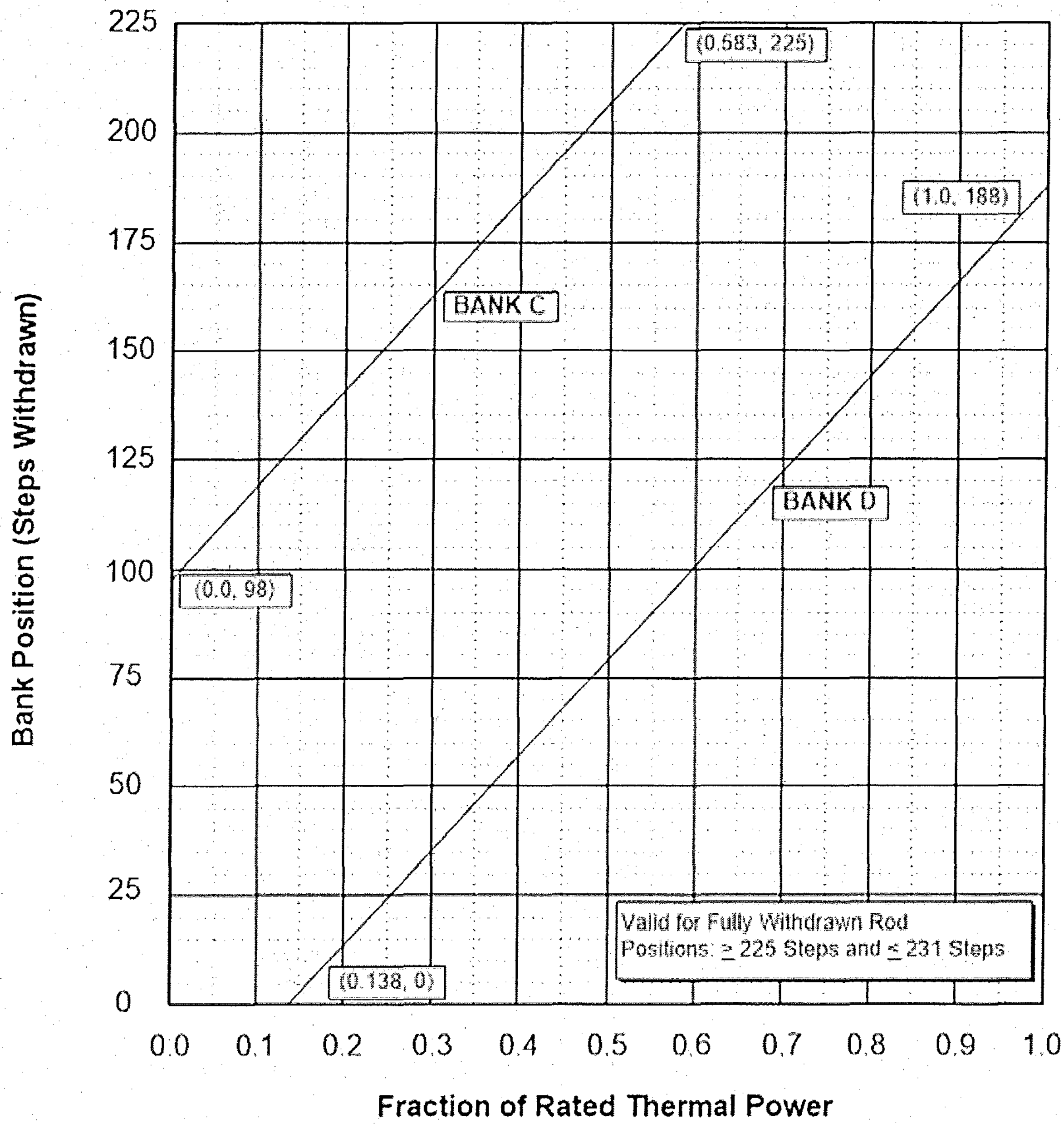

Figure 1: Control Bank Insertion Limits Versus Rated Thermal Power

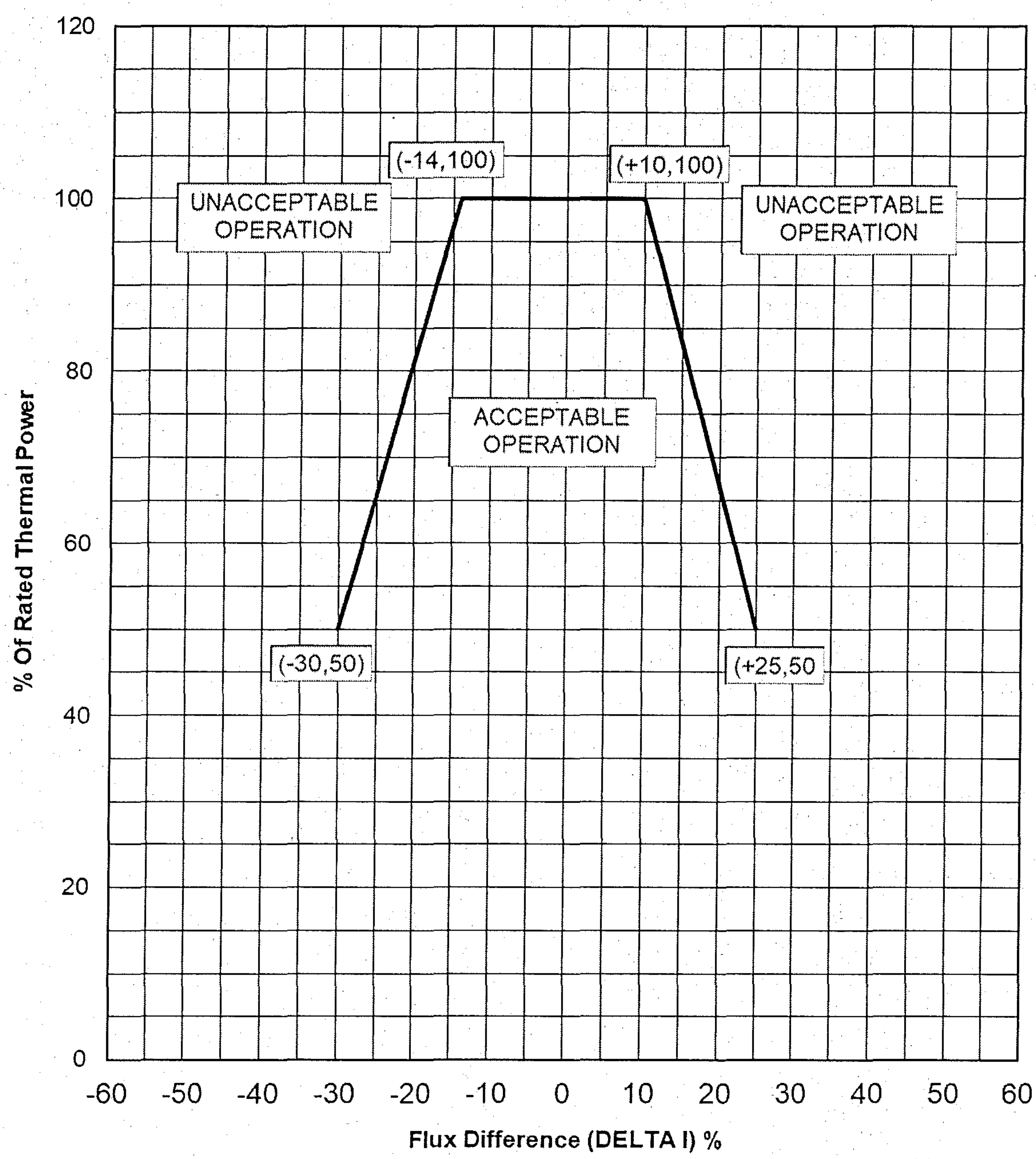

Figure 2: AFD Limits as a Function of Rated Thermal Power for Normal Operation

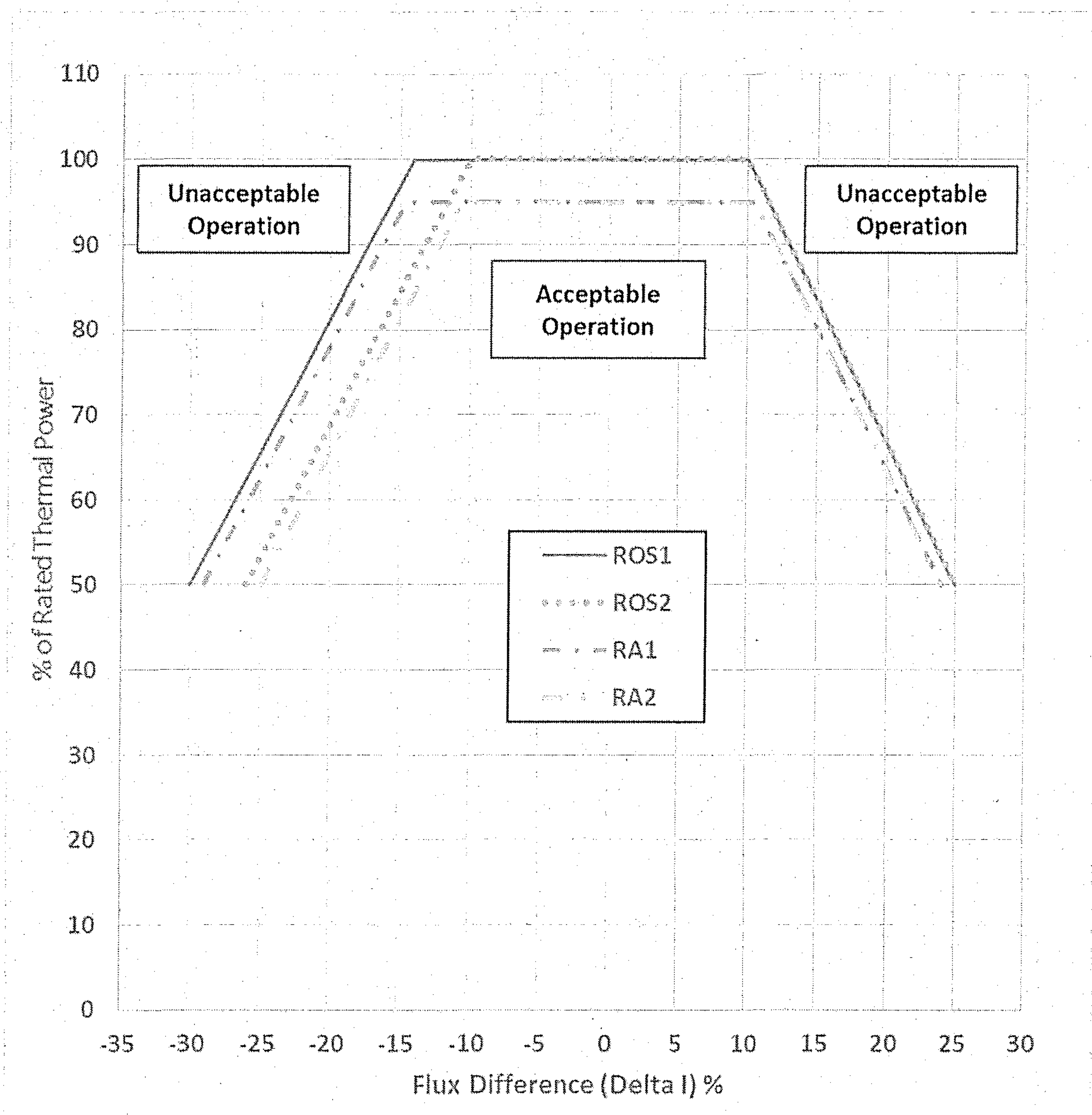

Figure 3: AFD Limits as a Function of Rated Thermal Power for F_Q Improvement

Power (% RTP)	ROS1 AFD Limit (%)	ROS2 AFD Limit (%)
50	-30	-26
100	-14	-10
100	10	10
50	25	25

Power (% RTP)	RA1 AFD Limit (%)	RA2 AFD Limit (%)
50	-29	-25
95	-14.6	-10.6
95	10.5	10.5
50	24	24