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NL-18-1356

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

Vogtle Electric Generating Plant – Unit 1
Core Operating Limits Report, Cycle 22, Version 1

Ladies and Gentlemen:

In accordance with Technical Specifications (TS) 5.6.5.d for Vogtle Electric Generating Plant (VEGP), Southern Nuclear Operating Company (SNC) submits the VEGP Core Operating Limits Report (COLR) for Unit 1, Cycle 22, Version 1.

This letter contains no NRC commitments. If you have any questions, please contact Jamie Coleman at 205.992.6611.

Respectfully submitted,

Cheryl A. Gayheart
Regulatory Affairs Director

CAG/kgf/sm

Enclosure: VEGP Unit 1 COLR, Cycle 22, Version 1

Cc: Regional Administrator
NRR Project Manager – Vogtle 1 & 2
Senior Resident Inspector – Vogtle 1 & 2
RType: CVC7000

**Vogtle Electric Generating Plant – Unit 1
Core Operating Limits Report, Cycle 22, Version 1**

ENCLOSURE to NL-18-1356

Vogtle Electric Generating Plant (VEGP) Unit 1 Cycle 22
Core Operating Limits Report
Version 1

VOGTLE ELECTRIC GENERATING PLANT (VEGP) UNIT 1 CYCLE 22

CORE OPERATING LIMITS REPORT

Version 1

June 2018

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP Unit 1 Cycle 22 has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The Technical Requirement affected by this report is listed below:

13.1.1 SHUTDOWN MARGIN - MODES 1 and 2

The Technical Specifications affected by this report are listed below:

3.1.1 SHUTDOWN MARGIN - MODES 3, 4 and 5
3.1.3 Moderator Temperature Coefficient
3.1.5 Shutdown Bank Insertion Limits
3.1.6 Control Bank Insertion Limits
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
3.9.1 Boron Concentration

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using NRC-approved methodologies including those specified in Technical Specification 5.6.5.

2.1 SHUTDOWN MARGIN - MODES 1 and 2 (Technical Requirement 13.1.1)

2.1.1 The SHUTDOWN MARGIN shall be greater than or equal to 1.30 percent $\Delta k/k$.

2.2 SHUTDOWN MARGIN - MODES 3, 4 and 5 (Specification 3.1.1)

2.2.1 The SHUTDOWN MARGIN shall be greater than or equal to the limits shown in Figures 1 and 2.

2.3 Moderator Temperature Coefficient (Specification 3.1.3)

2.3.1 The Moderator Temperature Coefficient (MTC) limits are:

The BOL/ARO/HZP-MTC shall be less positive than $+0.7 \times 10^{-4} \Delta k/k/^{\circ}F$ for power levels up to 70% RTP with a linear ramp to $0 \Delta k/k/^{\circ}F$ at 100% RTP.

The EOL/ARO/RTP-MTC shall be less negative than $-5.50 \times 10^{-4} \Delta k/k/^{\circ}F$.¹

2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to $-4.75 \times 10^{-4} \Delta k/k/^{\circ}F$.¹

The revised predicted near-EOL 300 ppm MTC shall be calculated using Figure 6 and the following algorithm:

Revised Predicted MTC = Predicted MTC* + AFD Correction** + Predictive Correction***

where,

* Predicted MTC is calculated from Figure 6 at the burnup corresponding to the measurement of 300 ppm at RTP conditions,

** AFD Correction is the more negative value of:

{ $0 \text{ pcm}/^{\circ}F$ or $(\Delta AFD * AFD \text{ Sensitivity})$ }

where: ΔAFD is the measured AFD minus the predicted AFD from an incore flux map taken at or near the burnup corresponding to 300 ppm,

$AFD \text{ Sensitivity} = 0.08 \text{ pcm}/^{\circ}F / \Delta AFD$

***Predictive Correction is $-3 \text{ pcm}/^{\circ}F$.

The 60 ppm/ARO/RTP-MTC should be less negative than $-5.35 \times 10^{-4} \Delta k/k/^{\circ}F$.¹

where: BOL stands for Beginning of Cycle Life

ARO stands for All Rods Out

HZP stands for Hot Zero THERMAL POWER

EOL stands for End of Cycle Life

RTP stands for RATED THERMAL POWER

¹ Applicable for full-power T-average of 584.1 to 587.1 °F.

2.4 Shutdown Bank Insertion Limits (Specification 3.1.5)

2.4.1 The shutdown banks shall be withdrawn to a position greater than or equal to 225 steps.

2.5 Control Bank Insertion Limits (Specification 3.1.6)

2.5.1 The control rod banks shall be limited in physical insertion as shown in Figure 3.

2.6 Heat Flux Hot Channel Factor – $F_Q(Z)$ (Specification 3.2.1)

$$2.6.1 \quad F_Q(Z) \leq \frac{F_Q^{RTP}}{P} \cdot K(Z) \quad \text{for } P > 0.5$$

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

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

$$2.6.2 \quad F_Q^{RTP} = 2.50$$

2.6.3 $K(Z)$ is provided in Figure 4.

$$2.6.4 \quad F_Q(Z) \leq \frac{F_Q^{RTP} \cdot K(Z)}{P \cdot W(Z)} \quad \text{for } P > 0.5$$

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

2.6.5 $W(Z)$ values are provided in Table 2.2.6.6 The $F_Q(Z)$ penalty factors are provided in Table 1.

2.7 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}^N$ (Specification 3.2.2)

$$2.7.1 \quad F_{\Delta H}^N \leq F_{\Delta H}^{RTP} \cdot (1 + PF_{\Delta H} \cdot (1 - P))$$

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

$$2.7.2 \quad F_{\Delta H}^{RTP} = 1.65$$

$$2.7.3 \quad PF_{\Delta H} = 0.3$$

2.8 Axial Flux Difference (Specification 3.2.3)

2.8.1 The Axial Flux Difference (AFD) Acceptable Operation Limits are provided in Figure 5.

2.9 Boron Concentration (Specification 3.9.1)

2.9.1 The boron concentration shall be greater than or equal to 2000 ppm.²

² This concentration bounds the condition of $k_{eff} \leq 0.95$ (all rods in less the most reactive rod) and subcriticality (all rods out) over the entire cycle. This concentration includes additional boron to address uncertainties and B¹⁰ depletion.

Table 1
F_Q(Z) PENALTY FACTOR

Burnup (MWD/MTU)	Penalty Factor
0	1.0421
150	1.0421
368	1.0562
585	1.0601
803	1.0613
1020	1.0592
1238	1.0516
1456	1.0433
1673	1.0347
1891	1.0264
2108	1.0200
8419	1.0200
8636	1.0203
8854	1.0222
9071	1.0221
9289	1.0209
9507	1.0200

Notes:

1. The Penalty Factor, to be applied to F_Q(Z) in accordance with SR 3.2.1.2, is the maximum factor by which F_Q(Z) is expected to increase over a 39 EFPD interval (surveillance interval of 31 EFPD plus the maximum allowable extension not to exceed 25% of the surveillance interval per SR 3.0.2) starting from the burnup at which the F_Q(Z) was determined.
2. Linear interpolation is adequate for intermediate cycle burnups.
3. For all cycle burnups outside the range of the table, a penalty factor of 1.020 shall be used.

Table 2
RAOC W(Z)

Axial Point	Elevation (feet)	150 MWD/MTU	4000 MWD/MTU	8000 MWD/MTU	12000 MWD/MTU	16000 MWD/MTU	20000 MWD/MTU
* 1-5	12.072 – 11.267	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	11.066	1.2888	1.3603	1.2629	1.2570	1.2289	1.2306
7	10.865	1.2776	1.3455	1.2633	1.2595	1.2317	1.2313
8	10.664	1.2611	1.3226	1.2582	1.2522	1.2131	1.2169
9	10.462	1.2433	1.3015	1.2579	1.2410	1.1900	1.1981
10	10.261	1.2239	1.2780	1.2496	1.2319	1.1885	1.1861
11	10.060	1.2036	1.2552	1.2446	1.2309	1.1876	1.1885
12	9.859	1.1931	1.2299	1.2361	1.2312	1.1894	1.1909
13	9.658	1.1915	1.2006	1.2260	1.2239	1.1866	1.1943
14	9.456	1.1871	1.1782	1.2131	1.2168	1.1876	1.1975
15	9.255	1.1843	1.1737	1.2015	1.2161	1.1926	1.1996
16	9.054	1.1853	1.1702	1.1916	1.2118	1.1979	1.2020
17	8.853	1.1910	1.1666	1.1806	1.1977	1.2035	1.2059
18	8.652	1.1962	1.1648	1.1778	1.1911	1.2087	1.2243
19	8.450	1.2001	1.1691	1.1842	1.1941	1.2167	1.2375
20	8.249	1.2030	1.1723	1.1871	1.1969	1.2274	1.2511
21	8.048	1.2040	1.1735	1.1882	1.2048	1.2369	1.2628
22	7.847	1.2052	1.1733	1.1876	1.2103	1.2443	1.2730
23	7.646	1.2053	1.1708	1.1849	1.2136	1.2493	1.2846
24	7.444	1.2033	1.1673	1.1811	1.2153	1.2531	1.2935
25	7.243	1.1986	1.1613	1.1745	1.2133	1.2525	1.2969
26	7.042	1.1921	1.1540	1.1662	1.2088	1.2491	1.2962
27	6.841	1.1843	1.1460	1.1571	1.2030	1.2443	1.2935
28	6.640	1.1746	1.1393	1.1489	1.1954	1.2379	1.2883
29	6.438	1.1648	1.1326	1.1409	1.1862	1.2320	1.2802
30	6.237	1.1598	1.1261	1.1333	1.1767	1.2248	1.2691
31	6.036	1.1547	1.1219	1.1251	1.1664	1.2166	1.2563
32	5.835	1.1485	1.1192	1.1220	1.1584	1.2070	1.2445
33	5.634	1.1427	1.1169	1.1187	1.1556	1.1992	1.2359
34	5.432	1.1409	1.1249	1.1193	1.1571	1.1949	1.2303
35	5.231	1.1407	1.1366	1.1299	1.1619	1.1969	1.2299
36	5.030	1.1427	1.1474	1.1391	1.1660	1.1980	1.2292
37	4.829	1.1511	1.1578	1.1480	1.1712	1.2000	1.2288
38	4.628	1.1584	1.1677	1.1564	1.1751	1.2004	1.2270
39	4.426	1.1652	1.1769	1.1641	1.1781	1.1993	1.2231
40	4.225	1.1710	1.1852	1.1709	1.1797	1.1972	1.2185
41	4.024	1.1758	1.1927	1.1771	1.1812	1.1953	1.2142
42	3.823	1.1801	1.1995	1.1822	1.1822	1.1918	1.2069
43	3.622	1.1833	1.2048	1.1885	1.1816	1.1862	1.1970
44	3.420	1.1873	1.2123	1.1952	1.1807	1.1803	1.1869
45	3.219	1.1929	1.2216	1.2003	1.1785	1.1735	1.1754
46	3.018	1.1976	1.2356	1.2062	1.1839	1.1780	1.1773
47	2.817	1.2132	1.2532	1.2125	1.1968	1.1892	1.1892
48	2.616	1.2331	1.2761	1.2281	1.2094	1.2000	1.2012
49	2.414	1.2518	1.3015	1.2466	1.2219	1.2108	1.2133
50	2.213	1.2707	1.3273	1.2655	1.2344	1.2217	1.2254
51	2.012	1.2896	1.3530	1.2845	1.2459	1.2311	1.2357
52	1.811	1.3081	1.3783	1.3032	1.2568	1.2400	1.2454
53	1.610	1.3256	1.4022	1.3209	1.2676	1.2494	1.2558
54	1.408	1.3422	1.4247	1.3378	1.2782	1.2589	1.2666
55	1.207	1.3579	1.4456	1.3534	1.2883	1.2684	1.2776
56	1.006	1.3724	1.4644	1.3677	1.2980	1.2779	1.2890
* 57-61	0.805 – 0.000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* Top and Bottom 5 Points Excluded per Technical Specification B3.2.1.

These W(Z) values are consistent with Figure 5, and are valid over the HFP T_{avg} temperature range from 584.1 to 587.1°F.

FIGURE 1
REQUIRED SHUTDOWN MARGIN FOR MODES 3 AND 4 (FOUR LOOPS FILLED AND VENTED AND AT LEAST ONE REACTOR COOLANT PUMP RUNNING)

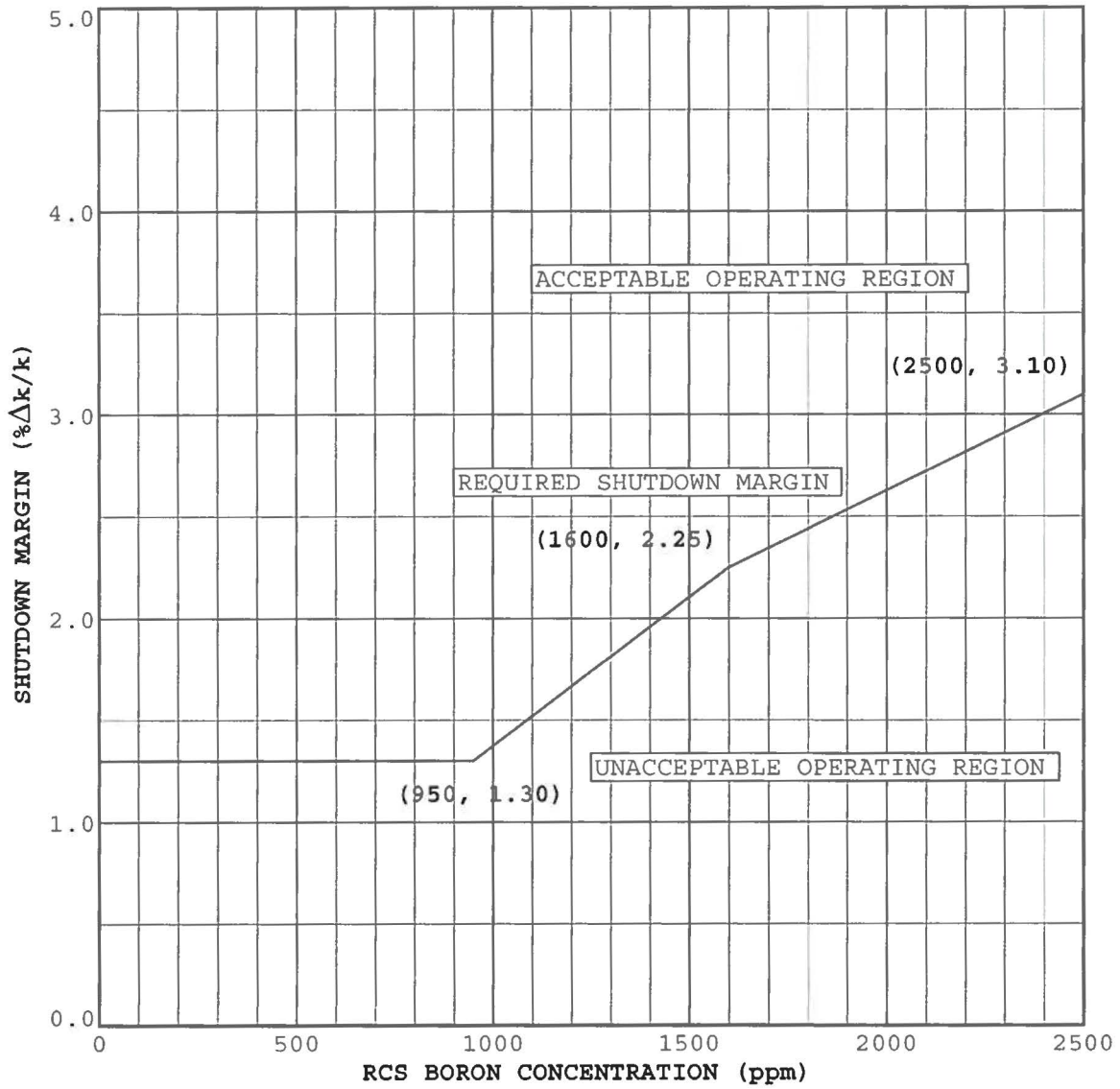
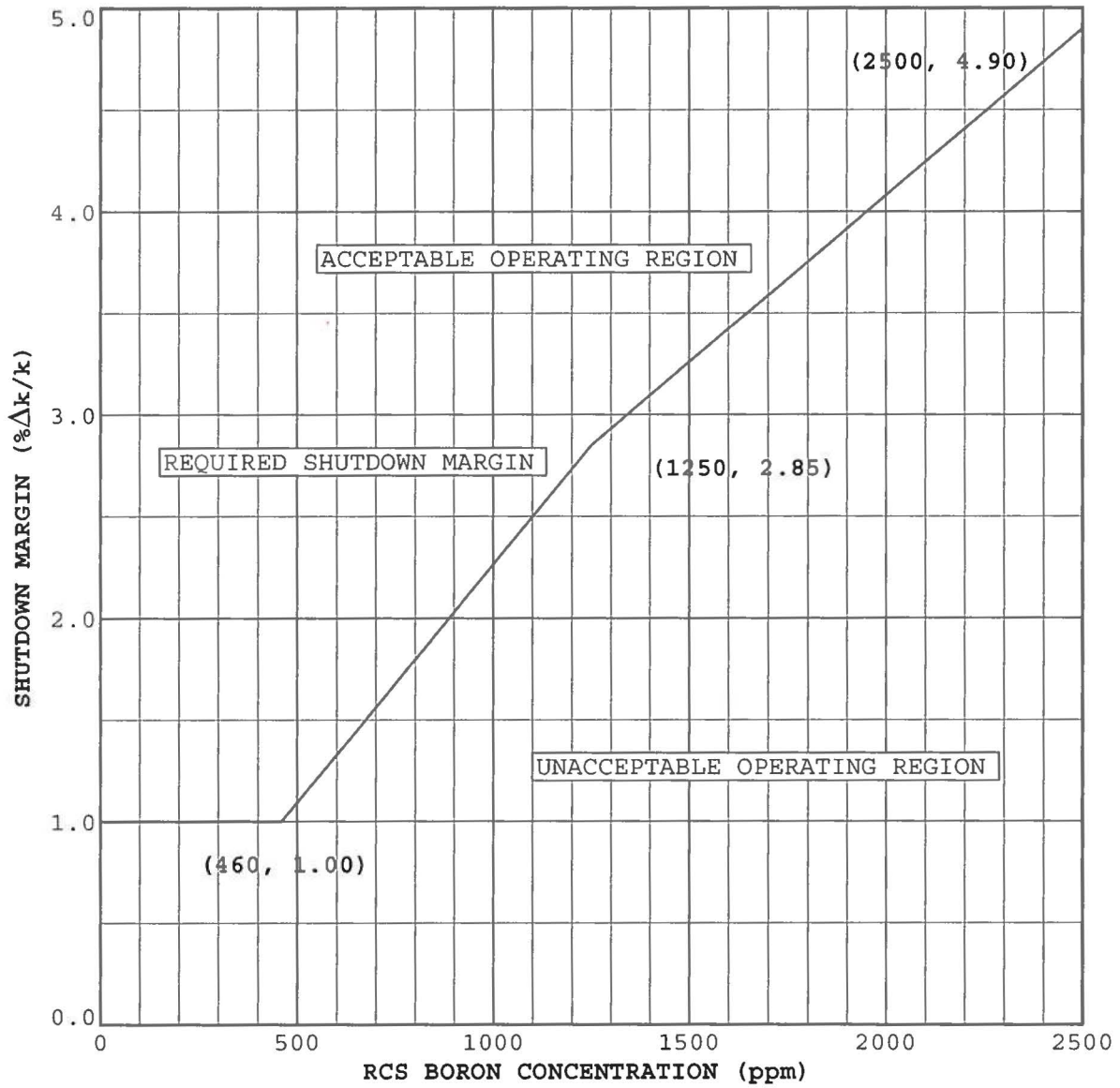
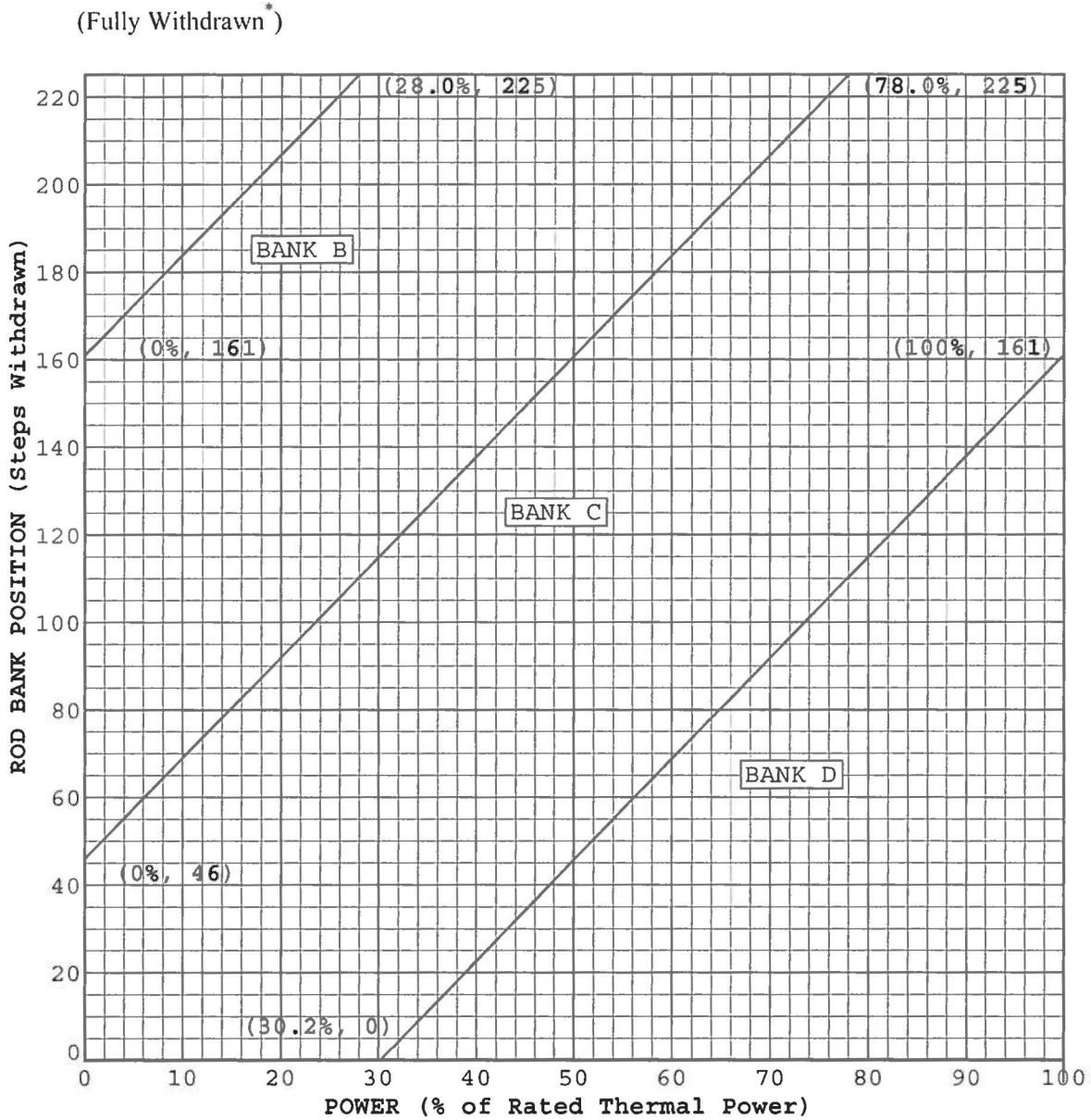


FIGURE 2
REQUIRED SHUTDOWN MARGIN FOR MODES 4 AND 5 (MODE 4 WHEN FIGURE 1 NOT APPLICABLE)



**FIGURE 3
ROD BANK INSERTION LIMITS VERSUS % OF RATED THERMAL POWER**



*Fully withdrawn shall be the condition where control rods are at a position within the interval ≥ 225 and ≤ 231 steps withdrawn.

NOTE: The Rod Bank Insertion Limits are based on the control bank withdrawal sequence A, B, C, D and a control bank tip-to-tip distance of 115 steps.

FIGURE 4
K(Z) – NORMALIZED F_Q(Z) AS A FUNCTION OF CORE HEIGHT

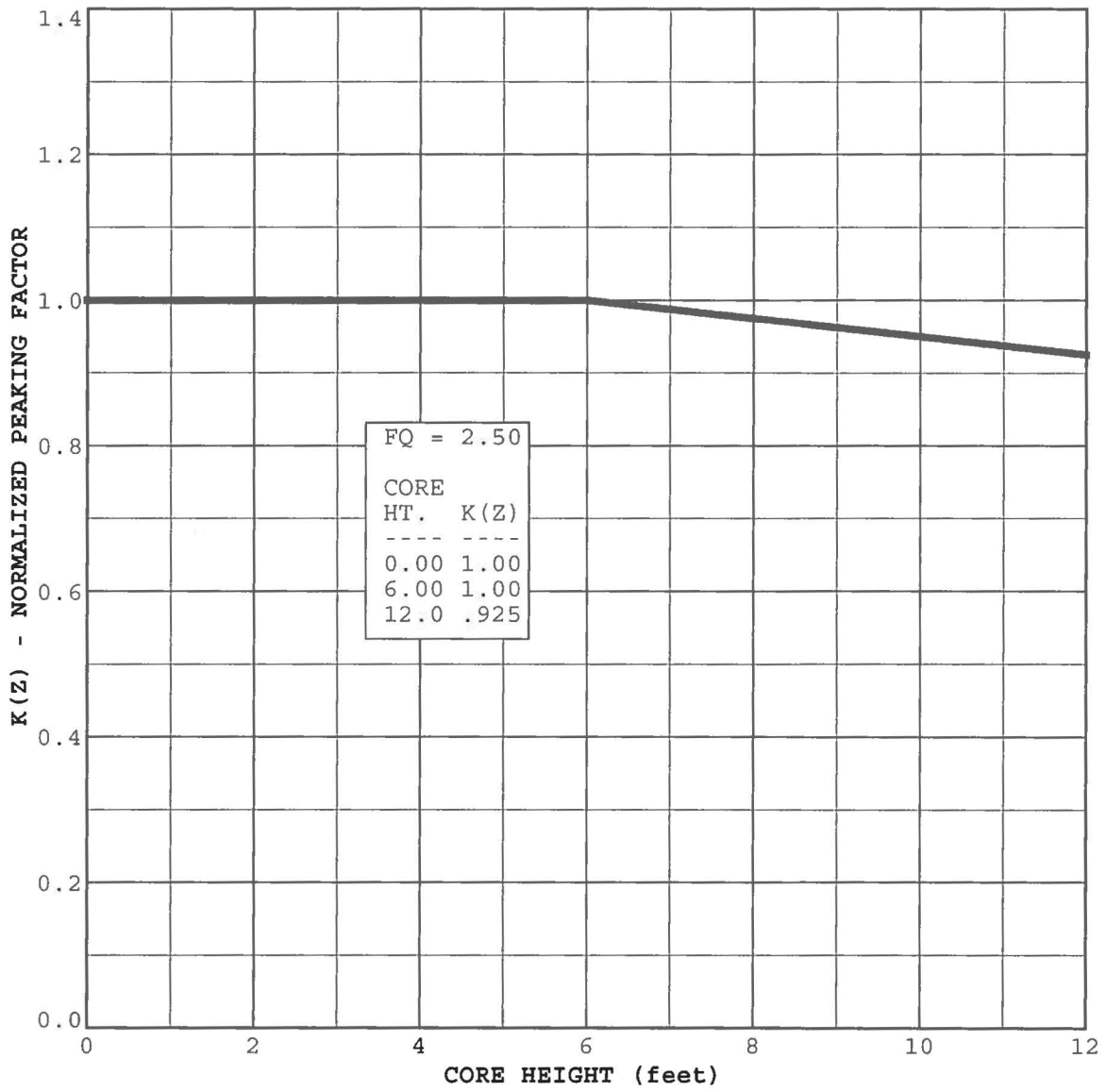
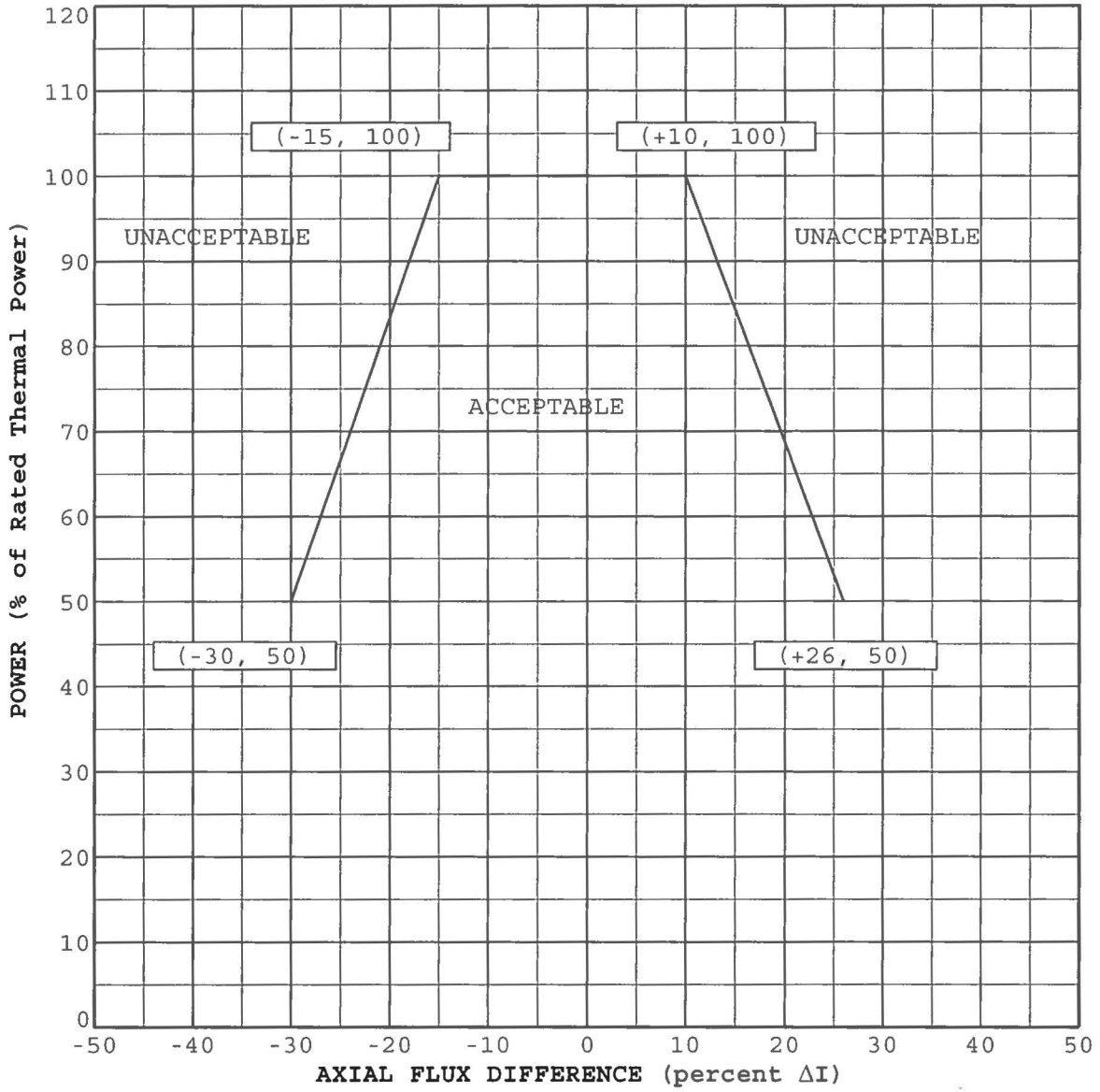
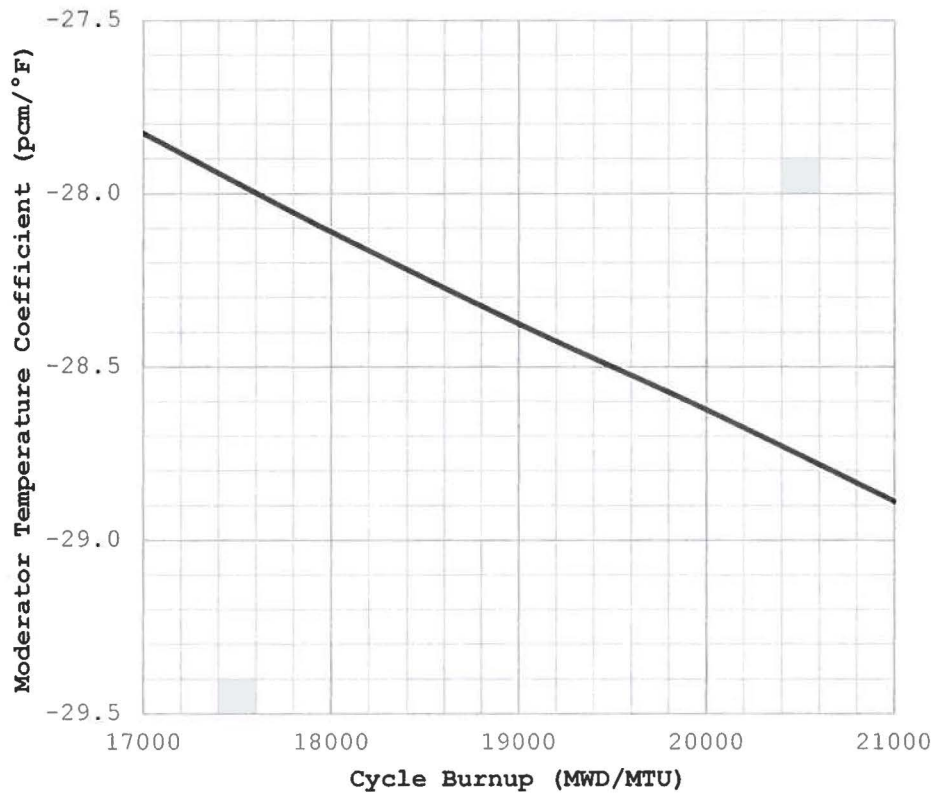


FIGURE 5
AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF % RATED THERMAL POWER FOR RAOC



**FIGURE 6
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP**



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
17000	-27.83
18000	-28.11
19000	-28.38
20000	-28.62
21000	-28.89