Charles R. Pierce
Regulatory Affairs Director

Southern Nuclear
Operating Company, Inc.
40 Inverness Center Parkway
Post Office Box 1295
Birmingham, AL 35242

Tel 205.992.7872
Fax 205.992.7601

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U. S. Nuclear Regulatory Commission
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Vogtle Electric Generating Plant, Unit 1
Cycle 19 Core Operating Limits Report Version 2

Ladies and Gentlemen:

In accordance with Technical Specification 5.6.5.d, Southern Nuclear Operating Company (SNC) submits the enclosed Core Operating Limits Report (COLR) for the Vogtle Electric Generating Plant (VEGP) - Unit 1, Cycle 19, Version 2. Version 2 includes an algorithm and figure for calculating the revised predicted near End of Life (EOL) moderator temperature coefficient (MTC). The Nuclear Regulatory Commission approved the use of this methodology with the issuance of Technical Specification amendment number 174 (Unit 1).

This letter contains no NRC commitments. If you have any questions, please contact Ken McElroy at (205) 992-7369.

Respectfully submitted,

C. R. Pierce

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Regulatory Affairs Director

CRP/RMJ

Enclosure: Unit 1 Cycle 19 Core Operating Limits Report Version 2

cc: Southern Nuclear Operating Company
Mr. S. E. Kuczynski, Chairman, President & CEO
Mr. D. G. Bost, Executive Vice President & Chief Nuclear Officer
Mr. D. R. Madison, Vice President – Fleet Operations
Mr. M. D. Meier, Vice President – Regulatory Affairs
Mr. B. K. Taber, Vice President – Vogtle 1 & 2
Mr. B. J. Adams, Vice President – Engineering
Mr. G.W. Gunn, Regulatory Affairs Manager – Vogtle 1 & 2
RType: CVC7000

U. S. Nuclear Regulatory Commission
Mr. V. M. McCree, Regional Administrator
Mr. R. E. Martin, NRR Senior Project Manager – Vogtle 1 & 2
Mr. L. M. Cain, Senior Resident Inspector – Vogtle 1 & 2

Vogtle Electric Generating Plant, Unit 1
Cycle 19 Core Operating Limits Report Version 2

Enclosure

Unit 1 Cycle 19 Core Operating Limits Report Version 2

VOGTLE ELECTRIC GENERATING PLANT (VEGP) UNIT 1 CYCLE 19

CORE OPERATING LIMITS REPORT

Version 2

June 2015

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP Unit 1 Cycle 19 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 Channnel Factor - $F^N_{\Delta H}$
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 $+0.7 \times 10^{-4}$ Δk/k/°F for power levels up to 70% RTP with a linear ramp to 0 Δk/k/°F at 100% RTP.

The EOL/ARO/RTP-MTC shall be less negative than -5.50×10^{-4} Δk/k/°F.[1]

2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -4.75×10^{-4} Δk/k/°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 pcm/°F or (ΔAFD * AFD 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 Sensitivity = 0.08 pcm/°F / ΔAFD
***Predictive Correction is -3 pcm/°F.

The 60 ppm/ARO/RTP-MTC should be less negative than -5.35×10^{-4} Δk/k/°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 $$F_Q(Z) \le \frac{F_Q^{RTP}}{P} \cdot K(Z) \quad \text{for P} > 0.5$$

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

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

2.6.2 $F_Q^{RTP} = 2.50$

2.6.3 K(Z) is provided in Figure 4.

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

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

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 - $F^N_{\Delta H}$ (Specification 3.2.2)

2.7.1 $F^N_{\Delta H} \leq F^{RTP}_{\Delta H} \cdot (1 + PF_{\Delta H} \cdot (1 - P))$

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

2.7.2 $F^{RTP}_{\Delta H} = 1.65$

2.7.3 $PF_{\Delta H} = 0.3$

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 1880 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 B^{10} depletion.

Table 1
$F_Q(Z)$ PENALTY FACTOR

Cycle Burnup (MWD/MTU)	$F_Q(Z)$ Penalty Factor
30	1.0348
150	1.0348
368	1.0391
585	1.0417
803	1.0423
1020	1.0410
1238	1.0366
1456	1.0308
1673	1.0248
1891	1.0200
6242	1.0200
6460	1.0204
6678	1.0260
6895	1.0262
7113	1.0261
7330	1.0244
7548	1.0214
7765	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	3000 MWD/MTU	12000 MWD/MTU	20000 MWD/MTU
*	1-5	12.072 – 11.267	1.0000	1.0000	1.0000	1.0000
	6	11.066	1.3172	1.3495	1.3279	1.2728
	7	10.865	1.3162	1.3440	1.3244	1.2665
	8	10.664	1.3018	1.3350	1.3164	1.2561
	9	10.462	1.2808	1.3167	1.3051	1.2430
	10	10.261	1.2615	1.2912	1.2919	1.2294
	11	10.060	1.2467	1.2683	1.2775	1.2189
	12	9.859	1.2503	1.2431	1.2614	1.2150
	13	9.658	1.2444	1.2130	1.2438	1.2096
	14	9.456	1.2373	1.1979	1.2384	1.2144
	15	9.255	1.2278	1.1893	1.2286	1.2272
	16	9.054	1.2168	1.1763	1.2165	1.2359
	17	8.853	1.2020	1.1662	1.2092	1.2397
	18	8.652	1.1893	1.1670	1.2141	1.2426
	19	8.450	1.1900	1.1724	1.2230	1.2438
	20	8.249	1.1889	1.1761	1.2290	1.2500
	21	8.048	1.1918	1.1783	1.2332	1.2591
	22	7.847	1.1940	1.1780	1.2344	1.2670
	23	7.646	1.1935	1.1761	1.2336	1.2800
	24	7.444	1.1914	1.1728	1.2315	1.2895
	25	7.243	1.1867	1.1674	1.2259	1.2944
	26	7.042	1.1802	1.1604	1.2178	1.2950
	27	6.841	1.1724	1.1523	1.2083	1.2931
	28	6.640	1.1633	1.1459	1.1988	1.2890
	29	6.438	1.1529	1.1393	1.1896	1.2819
	30	6.237	1.1452	1.1326	1.1801	1.2719
	31	6.036	1.1401	1.1279	1.1696	1.2596
	32	5.835	1.1344	1.1252	1.1608	1.2478
	33	5.634	1.1321	1.1225	1.1560	1.2400
	34	5.432	1.1309	1.1258	1.1590	1.2349
	35	5.231	1.1317	1.1378	1.1648	1.2349
	36	5.030	1.1386	1.1484	1.1706	1.2348
	37	4.829	1.1477	1.1587	1.1753	1.2344
	38	4.628	1.1561	1.1683	1.1790	1.2333
	39	4.426	1.1640	1.1775	1.1815	1.2302
	40	4.225	1.1710	1.1856	1.1829	1.2254
	41	4.024	1.1770	1.1930	1.1833	1.2191
	42	3.823	1.1826	1.1994	1.1822	1.2100
	43	3.622	1.1872	1.2065	1.1795	1.1985
	44	3.420	1.1925	1.2159	1.1763	1.1861
	45	3.219	1.1985	1.2241	1.1722	1.1765
	46	3.018	1.2057	1.2377	1.1765	1.1776
	47	2.817	1.2190	1.2562	1.1889	1.1890
	48	2.616	1.2337	1.2794	1.2020	1.2019
	49	2.414	1.2476	1.3058	1.2149	1.2147
	50	2.213	1.2616	1.3328	1.2279	1.2275
	51	2.012	1.2755	1.3595	1.2399	1.2386
	52	1.811	1.2893	1.3858	1.2514	1.2491
	53	1.610	1.3024	1.4105	1.2627	1.2601
	54	1.408	1.3149	1.4336	1.2737	1.2714
	55	1.207	1.3269	1.4550	1.2843	1.2828
	56	1.006	1.3380	1.4742	1.2943	1.2945
*	57-61	0.805 – 0.000	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)

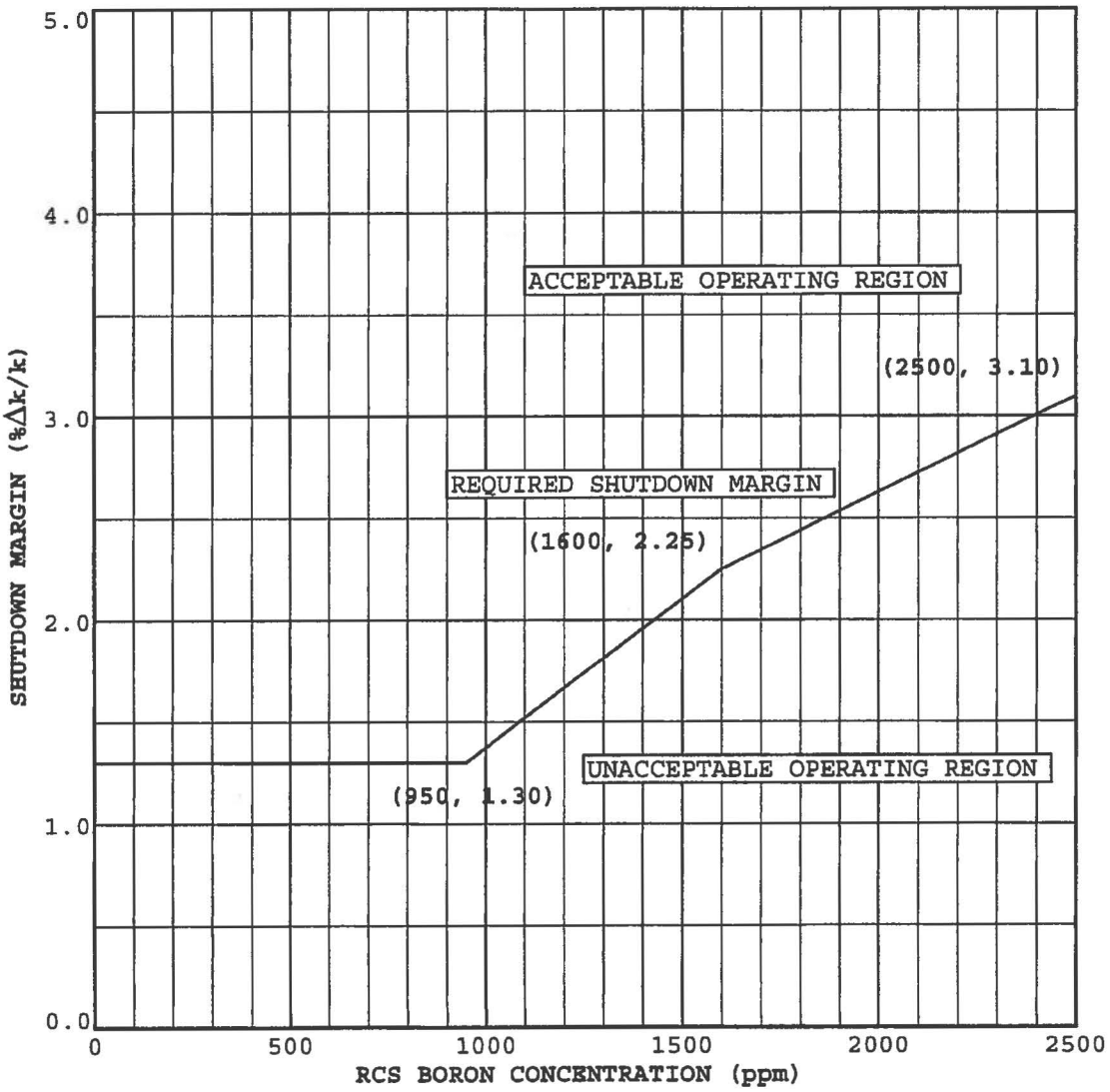


FIGURE 2
REQUIRED SHUTDOWN MARGIN FOR MODES 4 AND 5 (MODE 4 WHEN FIGURE 1 NOT APPLICABLE)

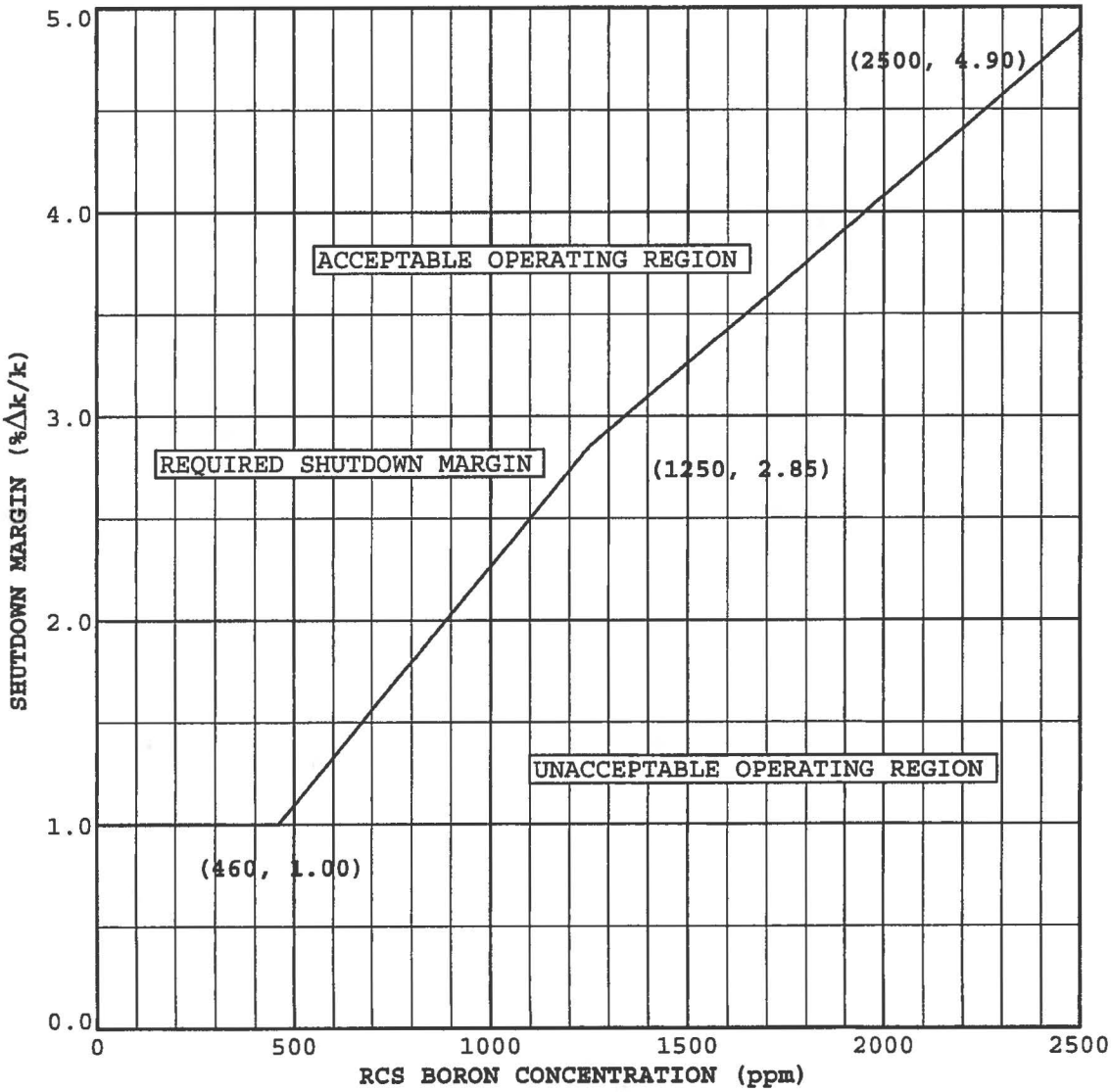
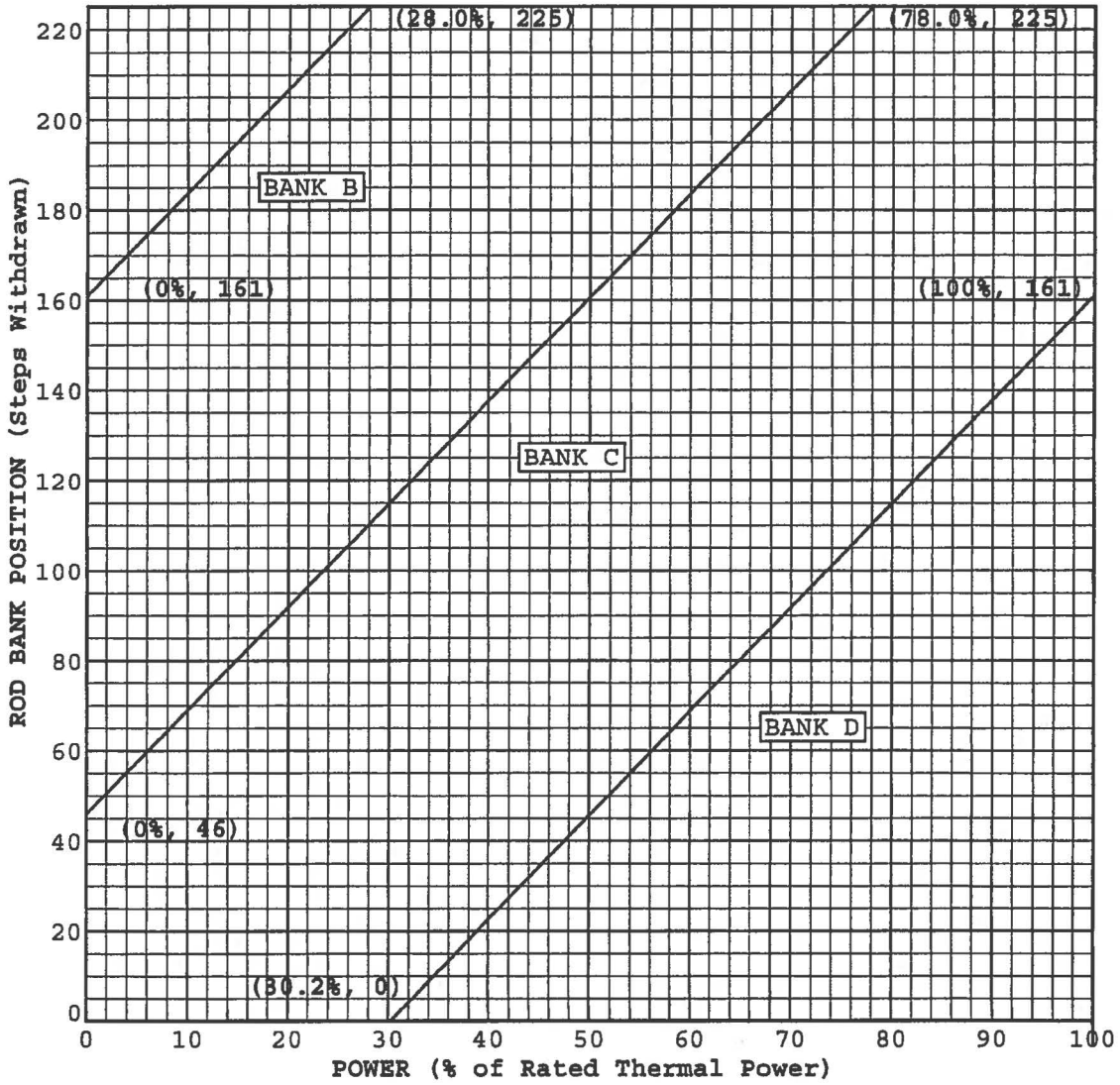


FIGURE 3
ROD BANK INSERTION LIMITS VERSUS % OF RATED THERMAL POWER

(Fully Withdrawn*)



*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

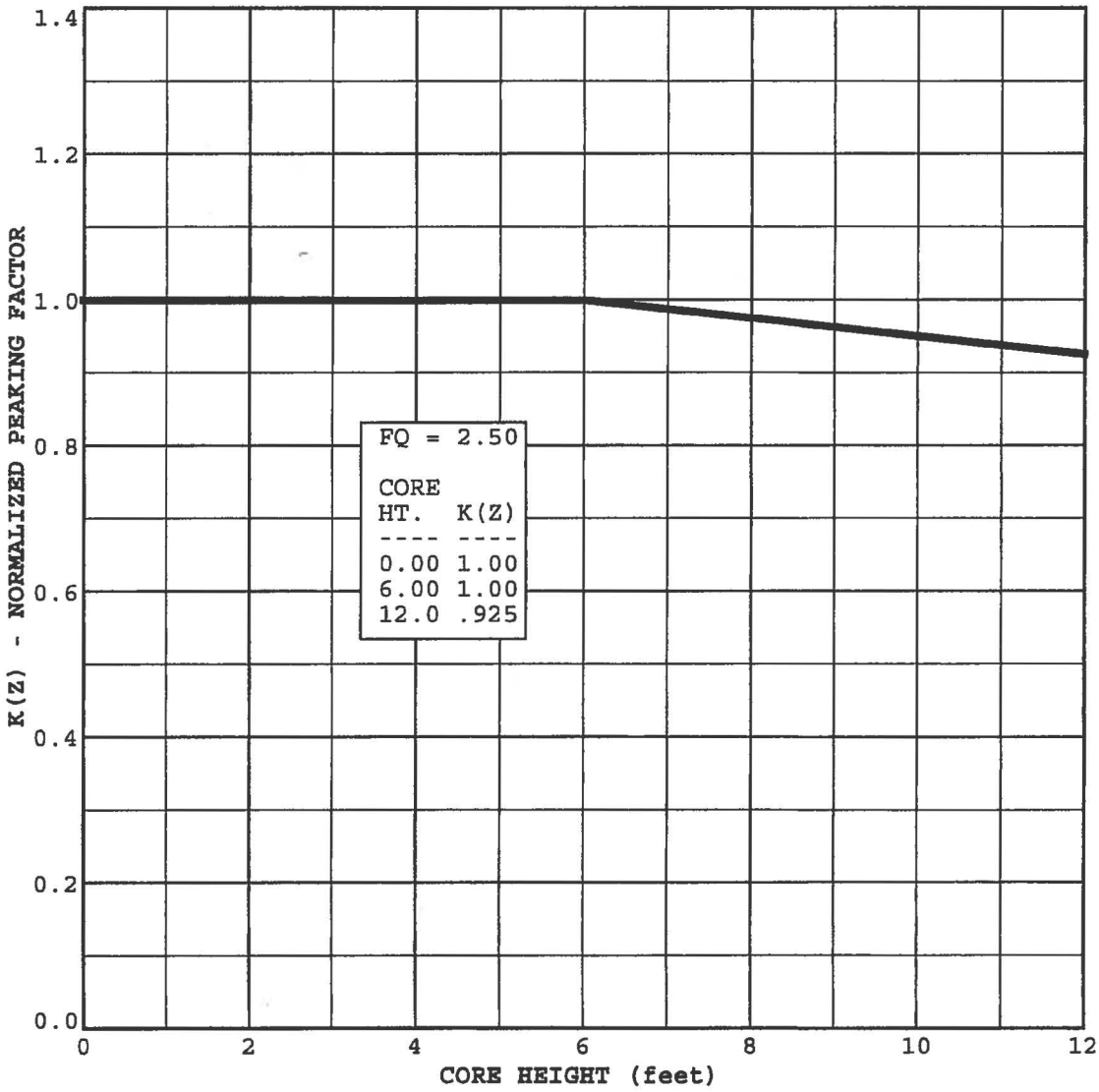


FIGURE 5
AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF % RATED THERMAL POWER FOR RAOC

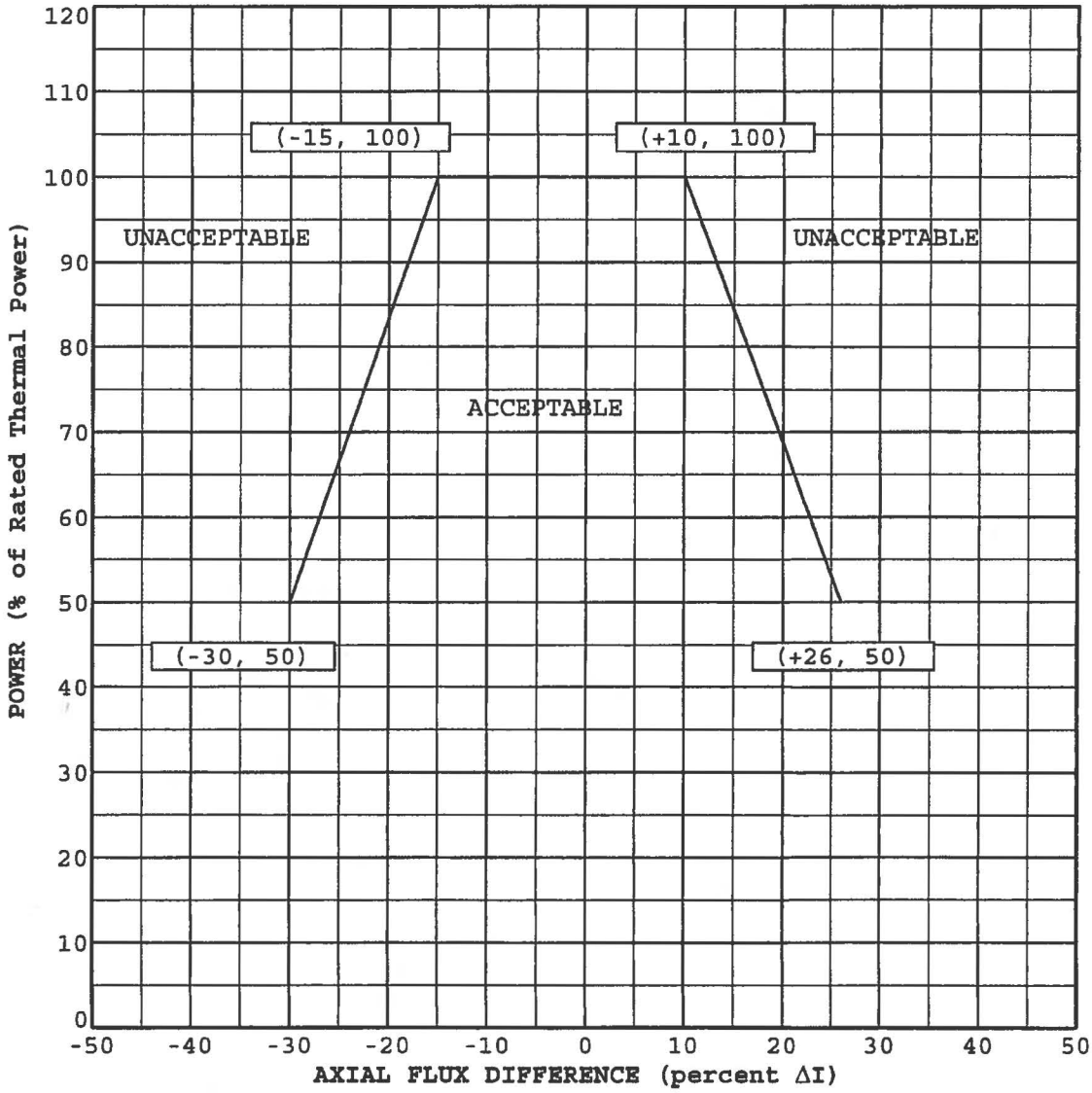
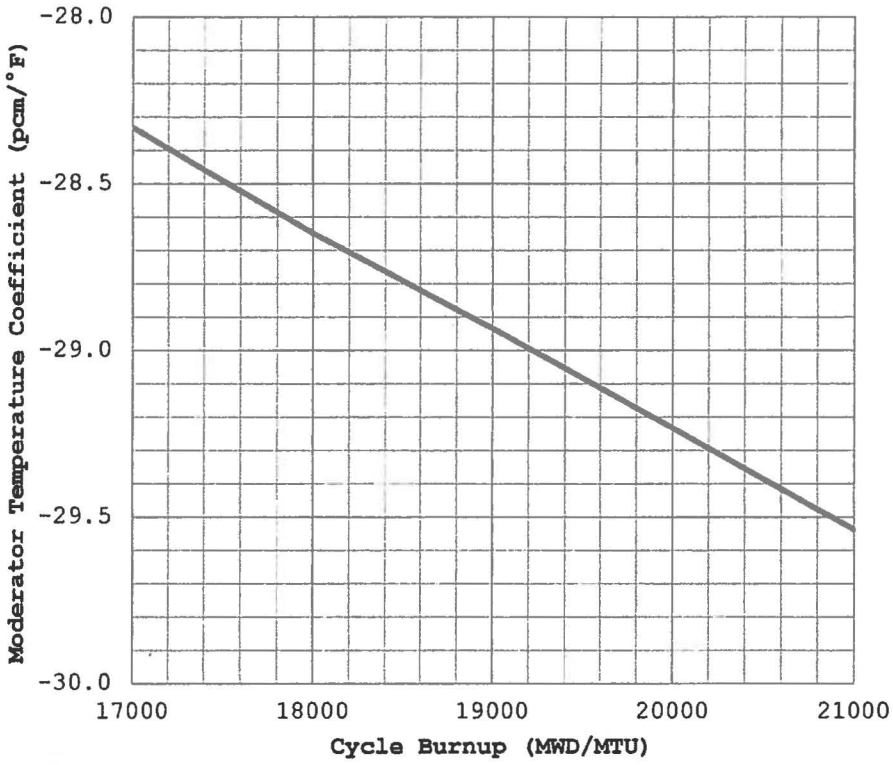


FIGURE 6
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
17000	-28.33
18000	-28.65
19000	-28.93
20000	-29.23
21000	-29.54