Southern Nuclear

Cheryl A. Gayheart
Regulatory Affairs Director

3535 Colonnade Parkway
Birmingham, AL 35243
205 992 5316

cagayhea@southernco.com

October 26, 2021

Docket No.: 50-424 NL-21-0962

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 24, 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 24, Version 1.

All the methods described in the documents listed in TS 5.6.5.b were used to develop the core operating limits contained in the COLR as described in this TS section. There were no additional methods used to develop the core operating limits contained in the COLR other than those described in the documents listed in TS 5.6.5.b. All methods used to determine the core operating limits contained in the COLR have NRC approval via a safety evaluation.

This letter contains no NRC commitments. If you have any questions, please contact Ryan Joyce at 205.992.6468.

Respectfully submitted,

Cheryl A. Gayheart
Regulatory Affairs Director

CAG/kgl/cg

Enclosure: VEGP Unit 1 COLR, Cycle 24, 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 24, Version 1

ENCLOSURE to NL-21-0962

VEGP Unit 1 COLR, Cycle 24, Version 1

VOGTLE ELECTRIC GENERATING PLANT (VEGP) UNIT 1 CYCLE 24

CORE OPERATING LIMITS REPORT

Version 1

June 2021

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP Unit 1 Cycle 24 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 -5.35×10^{-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 -4.60×10^{-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 -5.20×10^{-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 580.0 to 587.0 °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 $$F^N_{\Delta H} \le F^{RTP}_{\Delta H} \cdot \left(1 + PF_{\Delta H} \cdot \left(1 - P\right)\right)$$

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

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 2000 ppm.[2]

[2] This concentration bounds the condition of $k_{eff} \le 0.95$ (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

Burnup (MWD/MTU)	Penalty Factor
0	1.0594
150	1.0594
368	1.0569
585	1.0538
803	1.0504
1020	1.0470
1238	1.0430
1456	1.0364
1673	1.0306
1891	1.0257
2108	1.0218
2326	1.0200
7766	1.0200
7983	1.0202
8201	1.0210
8418	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 1.0200 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	1.3733	1.4042	1.2807	1.2524	1.2279	1.2288
	7	10.865	1.3592	1.3892	1.2714	1.2511	1.2252	1.2237
	8	10.664	1.3419	1.3696	1.2569	1.2461	1.2119	1.2118
	9	10.462	1.3243	1.3477	1.2420	1.2392	1.1946	1.2012
	10	10.261	1.3032	1.3235	1.2331	1.2382	1.1967	1.1895
	11	10.060	1.2799	1.2969	1.2245	1.2395	1.2029	1.1869
	12	9.859	1.2544	1.2649	1.2132	1.2404	1.2071	1.1850
	13	9.658	1.2448	1.2309	1.2046	1.2287	1.2063	1.1876
	14	9.456	1.2433	1.2035	1.1971	1.2238	1.2078	1.1907
	15	9.255	1.2406	1.1870	1.1866	1.2224	1.2059	1.1962
	16	9.054	1.2314	1.1714	1.1819	1.2178	1.2049	1.2024
	17	8.853	1.2250	1.1656	1.1769	1.2031	1.2024	1.2048
	18	8.652	1.2208	1.1660	1.1767	1.1947	1.1963	1.2063
	19	8.450	1.2213	1.1704	1.1829	1.1974	1.1982	1.2120
	20	8.249	1.2174	1.1728	1.1860	1.2010	1.2074	1.2250
	21	8.048	1.2228	1.1734	1.1872	1.2093	1.2212	1.2399
	22	7.847	1.2252	1.1725	1.1868	1.2150	1.2324	1.2523
	23	7.646	1.2247	1.1694	1.1842	1.2185	1.2412	1.2623
	24	7.444	1.2221	1.1653	1.1805	1.2204	1.2483	1.2710
	25	7.243	1.2164	1.1589	1.1740	1.2184	1.2510	1.2747
	26	7.042	1.2087	1.1509	1.1659	1.2138	1.2505	1.2750
	27	6.841	1.1995	1.1434	1.1568	1.2080	1.2483	1.2738
	28	6.640	1.1883	1.1364	1.1493	1.2003	1.2439	1.2705
	29	6.438	1.1766	1.1299	1.1417	1.1910	1.2372	1.2676
	30	6.237	1.1653	1.1232	1.1343	1.1814	1.2294	1.2627
	31	6.036	1.1534	1.1207	1.1260	1.1709	1.2204	1.2567
	32	5.835	1.1452	1.1179	1.1215	1.1597	1.2100	1.2491
	33	5.634	1.1390	1.1197	1.1196	1.1583	1.2034	1.2398
	34	5.432	1.1386	1.1326	1.1259	1.1642	1.2035	1.2355
	35	5.231	1.1448	1.1440	1.1366	1.1686	1.2082	1.2367
	36	5.030	1.1521	1.1550	1.1463	1.1727	1.2118	1.2391
	37	4.829	1.1589	1.1653	1.1557	1.1777	1.2138	1.2395
	38	4.628	1.1651	1.1751	1.1643	1.1813	1.2141	1.2379
	39	4.426	1.1706	1.1842	1.1724	1.1839	1.2128	1.2342
	40	4.225	1.1750	1.1922	1.1794	1.1851	1.2100	1.2289
	41	4.024	1.1782	1.1994	1.1858	1.1863	1.2060	1.2220
	42	3.823	1.1823	1.2056	1.1910	1.1870	1.1995	1.2120
	43	3.622	1.1888	1.2108	1.1949	1.1857	1.1912	1.1995
	44	3.420	1.1950	1.2151	1.1982	1.1841	1.1822	1.1864
	45	3.219	1.1992	1.2187	1.2002	1.1816	1.1741	1.1738
	46	3.018	1.2056	1.2318	1.2057	1.1867	1.1750	1.1743
	47	2.817	1.2141	1.2489	1.2211	1.1969	1.1846	1.1842
	48	2.616	1.2276	1.2646	1.2408	1.2060	1.1952	1.1955
	49	2.414	1.2436	1.2847	1.2606	1.2150	1.2057	1.2074
	50	2.213	1.2608	1.3090	1.2806	1.2266	1.2162	1.2192
	51	2.012	1.2778	1.3332	1.2999	1.2377	1.2253	1.2293
	52	1.811	1.2946	1.3570	1.3186	1.2484	1.2340	1.2388
	53	1.610	1.3103	1.3795	1.3366	1.2589	1.2431	1.2490
	54	1.408	1.3253	1.4006	1.3535	1.2693	1.2525	1.2598
	55	1.207	1.3395	1.4202	1.3693	1.2792	1.2619	1.2708
	56	1.006	1.3526	1.4379	1.3837	1.2888	1.2714	1.2823
*	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 580.0 to 587.0°F.

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

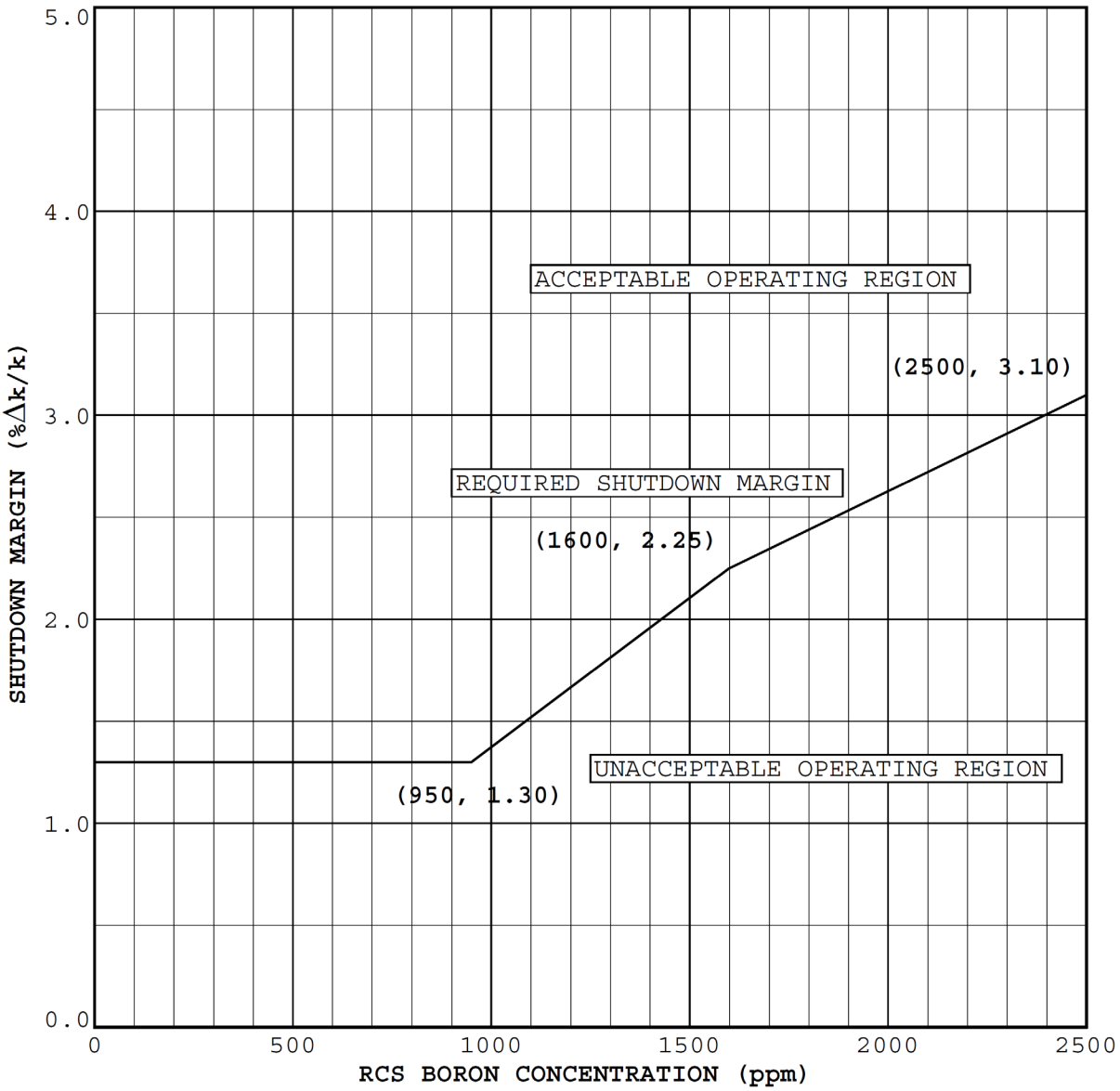


FIGURE 2
REQUIRED SHUTDOWN MARGIN FOR MODES 4 AND 5 (MODE 4 WHEN FIGURE 1 NOT APPLICABLE)

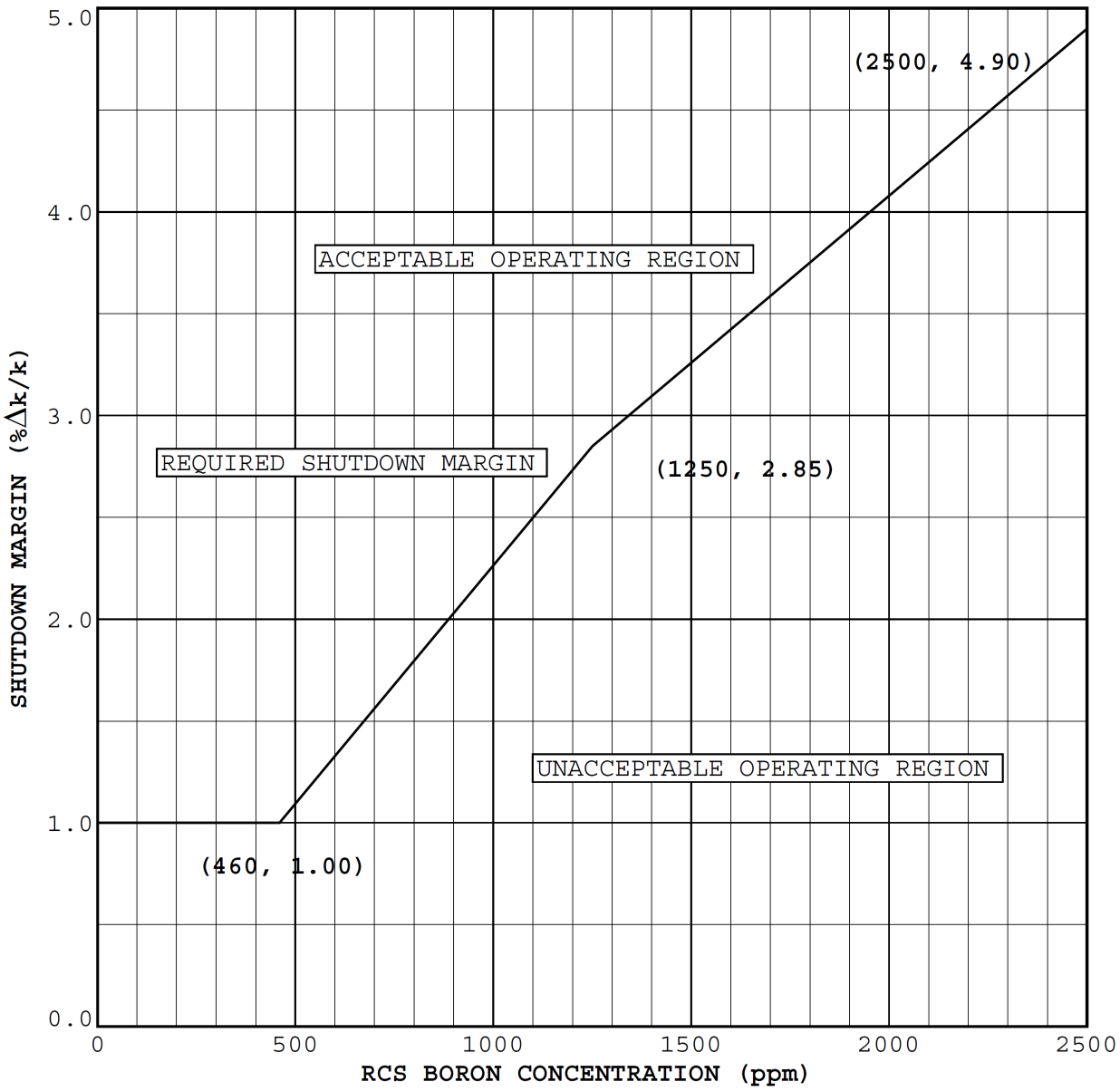
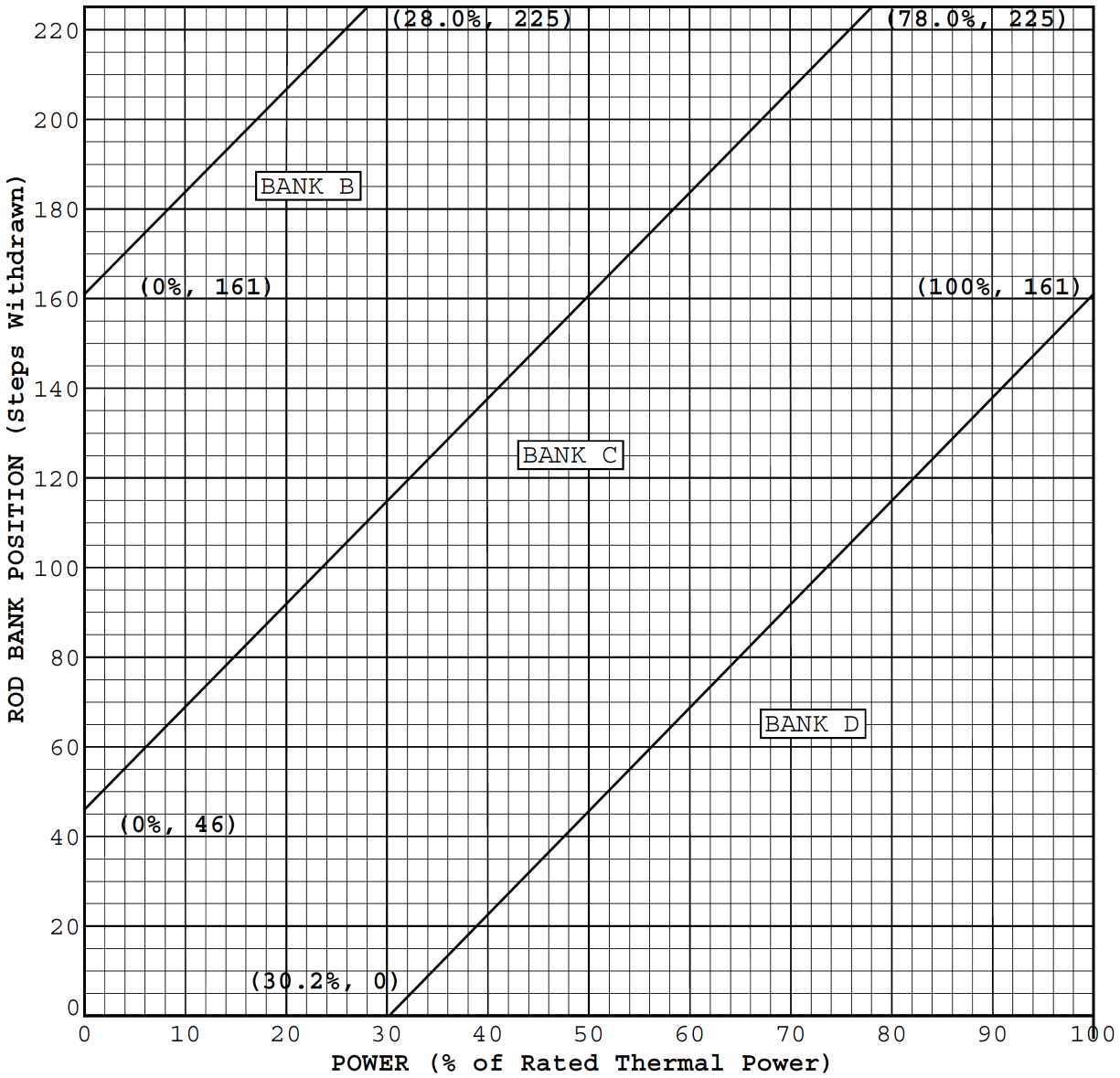


FIGURE 3
ROD BANK INSERTION LIMITS VERSUS % OF RATED THERMAL POWER

(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

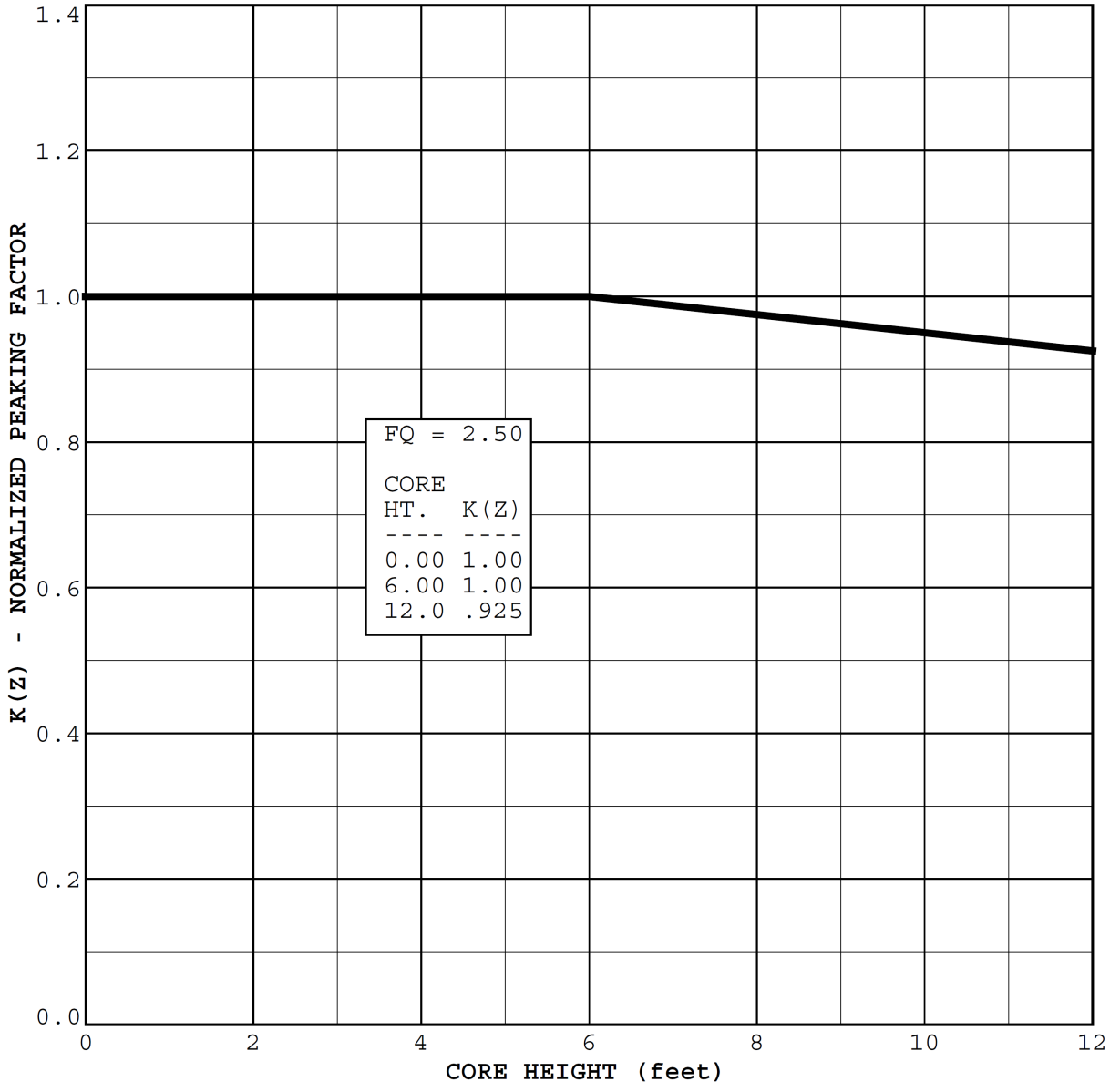


FIGURE 5
AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF % RATED THERMAL POWER FOR RAOC

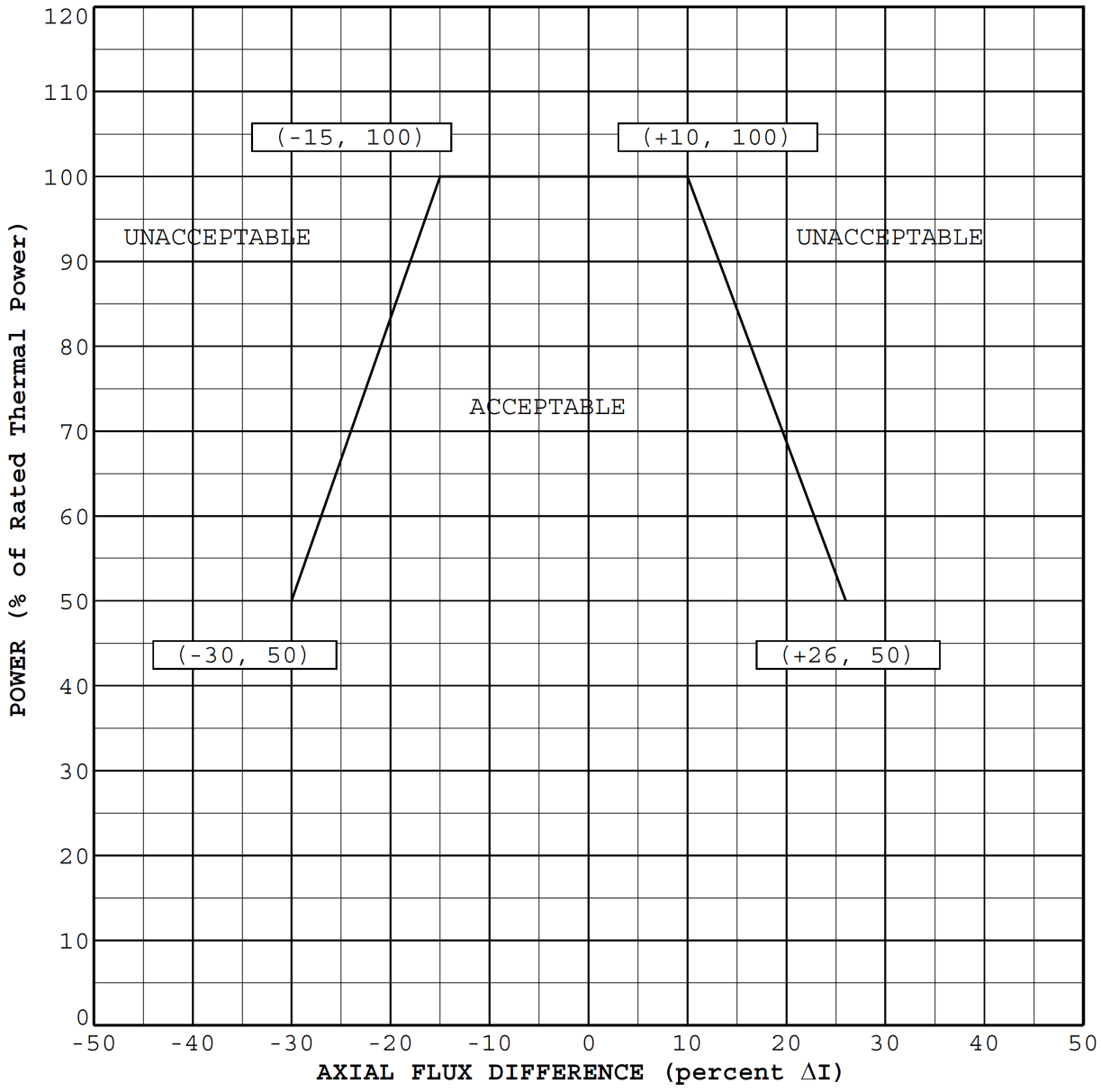
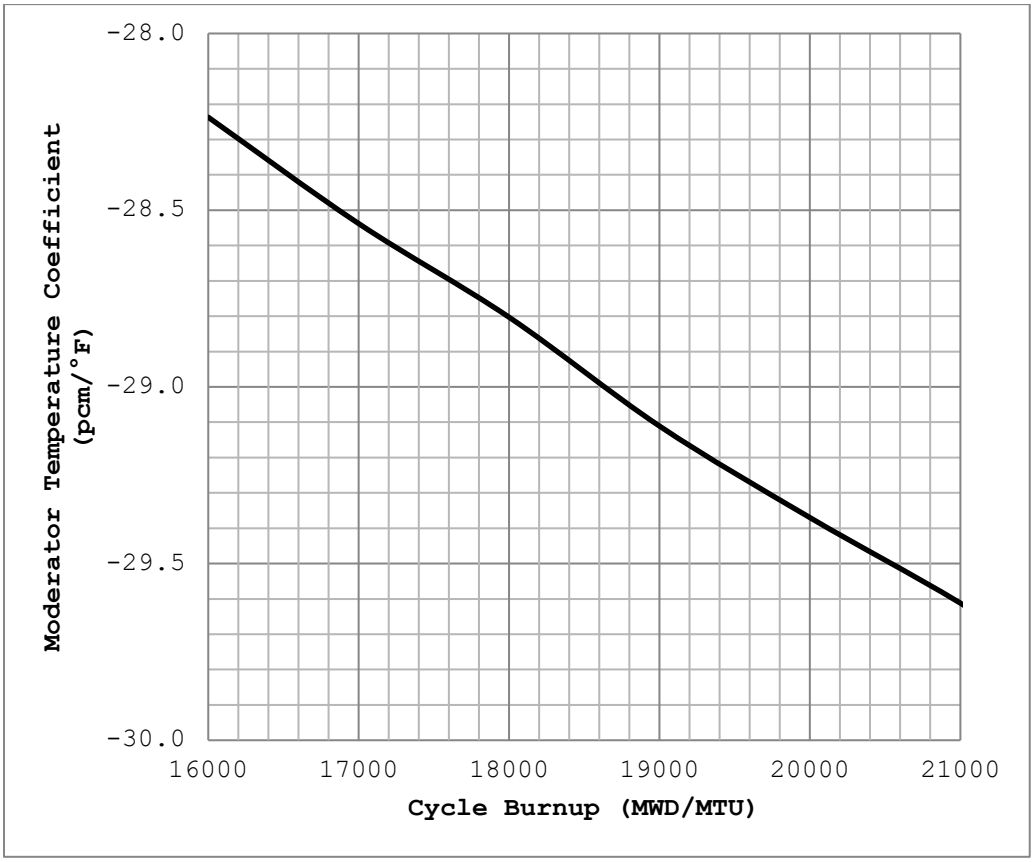


FIGURE 6
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
16000	-28.24
17000	-28.54
18000	-28.81
19000	-29.12
20000	-29.37
21000	-29.62