

April 13, 2020

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NL-20-0415

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 23, Version 3

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 23, Version 3.

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/kgj/sm

Enclosure: VEGP Unit 1 COLR, Cycle 23, Version 3

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 23, Version 3**

**ENCLOSURE to NL-20-0415**

Vogtle Electric Generating Plant (VEGP) Unit 1 Cycle 23  
Core Operating Limits Report  
Version 3

VOGTLE ELECTRIC GENERATING PLANT (VEGP) UNIT 1 CYCLE 23

CORE OPERATING LIMITS REPORT

Version 3

March 2020

## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP Unit 1 Cycle 23 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 as 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  $-5.35 \times 10^{-4} \Delta k/k/^\circ F$ .<sup>1</sup>

#### 2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to  $-4.60 \times 10^{-4} \Delta k/k/^\circ F$ .<sup>1</sup>

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:

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

where:  $\Delta AFD$  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  $-5.20 \times 10^{-4} \Delta k/k/^\circ F$ .<sup>1</sup>

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

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<sup>1</sup> 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)

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

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

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

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

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)

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

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.<sup>2</sup>

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<sup>2</sup> This concentration bounds the condition of  $k_{\text{eff}} \leq 0.95$  (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<sup>10</sup> depletion.



**Table 1**  
**F<sub>Q</sub>(Z) PENALTY FACTOR**

<b>Burnup (MWD/MTU)</b>	<b>Penalty Factor</b>
9941	1.0200
10158	1.0215
10376	1.0215
10593	1.0209
10811	1.0200

Notes:

1. The Penalty Factor, to be applied to F<sub>Q</sub>(Z) in accordance with SR 3.2.1.2, is the maximum factor by which F<sub>Q</sub>(Z) is expected to increase over a 39 EFPD interval (nominal 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<sub>Q</sub>(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)**

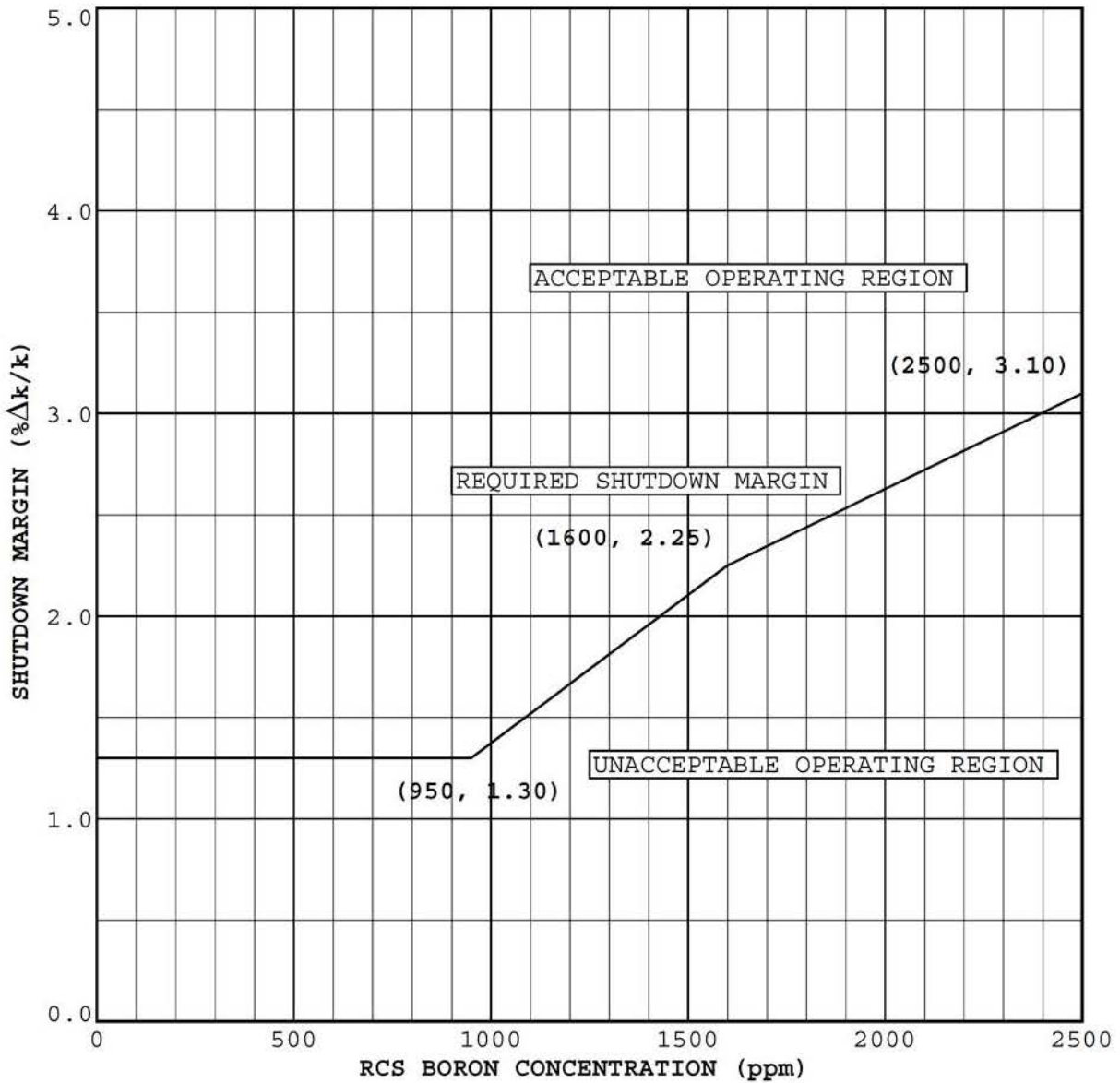
Axial Point	Elevation (feet)	150 MWD/MTU	3000 MWD/MTU	8000 MWD/MTU	12000 MWD/MTU	16000 MWD/MTU	20000 MWD/MTU
* 1-5	12.072 – 11.267	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	11.066	1.2988	1.3597	1.3361	1.2485	1.1876	1.2011
7	10.865	1.2874	1.3574	1.3320	1.2433	1.1904	1.1965
8	10.664	1.2702	1.3457	1.3164	1.2324	1.1905	1.1939
9	10.462	1.2536	1.3264	1.2964	1.2191	1.1883	1.1949
10	10.261	1.2460	1.3067	1.2777	1.2051	1.1862	1.1907
11	10.060	1.2363	1.2917	1.2581	1.1916	1.1895	1.1916
12	9.859	1.2398	1.2676	1.2350	1.1808	1.1989	1.1912
13	9.658	1.2505	1.2622	1.2109	1.1774	1.1979	1.1900
14	9.456	1.2459	1.2594	1.2113	1.1783	1.2016	1.1945
15	9.255	1.2330	1.2578	1.2124	1.1770	1.1948	1.2068
16	9.054	1.2251	1.2506	1.2104	1.1825	1.1931	1.2161
17	8.853	1.2216	1.2370	1.2046	1.1858	1.1963	1.2251
18	8.652	1.2185	1.2239	1.2014	1.1891	1.1976	1.2314
19	8.450	1.2200	1.2152	1.2011	1.1969	1.2048	1.2345
20	8.249	1.2219	1.2102	1.2012	1.2038	1.2160	1.2426
21	8.048	1.2229	1.2027	1.2004	1.2081	1.2259	1.2517
22	7.847	1.2260	1.1967	1.1996	1.2106	1.2336	1.2603
23	7.646	1.2251	1.1951	1.2021	1.2109	1.2390	1.2730
24	7.444	1.2225	1.1907	1.2017	1.2100	1.2431	1.2826
25	7.243	1.2169	1.1835	1.1980	1.2056	1.2431	1.2871
26	7.042	1.2095	1.1744	1.1919	1.1990	1.2403	1.2876
27	6.841	1.2006	1.1642	1.1844	1.1914	1.2361	1.2861
28	6.640	1.1898	1.1556	1.1751	1.1832	1.2302	1.2820
29	6.438	1.1779	1.1473	1.1644	1.1759	1.2252	1.2751
30	6.237	1.1663	1.1395	1.1526	1.1684	1.2189	1.2655
31	6.036	1.1562	1.1327	1.1398	1.1603	1.2117	1.2540
32	5.835	1.1483	1.1283	1.1278	1.1512	1.2031	1.2429
33	5.634	1.1434	1.1235	1.1215	1.1481	1.1939	1.2354
34	5.432	1.1391	1.1204	1.1212	1.1556	1.1929	1.2269
35	5.231	1.1370	1.1215	1.1266	1.1627	1.1964	1.2275
36	5.030	1.1377	1.1301	1.1362	1.1689	1.1989	1.2284
37	4.829	1.1433	1.1375	1.1450	1.1741	1.2020	1.2295
38	4.628	1.1490	1.1446	1.1534	1.1783	1.2039	1.2297
39	4.426	1.1540	1.1512	1.1612	1.1814	1.2043	1.2278
40	4.225	1.1580	1.1570	1.1678	1.1834	1.2033	1.2243
41	4.024	1.1611	1.1619	1.1755	1.1840	1.2012	1.2193
42	3.823	1.1635	1.1673	1.1850	1.1863	1.1968	1.2115
43	3.622	1.1650	1.1738	1.1935	1.1911	1.1907	1.2012
44	3.420	1.1670	1.1800	1.2010	1.1949	1.1838	1.1902
45	3.219	1.1711	1.1840	1.2074	1.1977	1.1803	1.1796
46	3.018	1.1743	1.1947	1.2131	1.2008	1.1860	1.1755
47	2.817	1.1871	1.2104	1.2179	1.2079	1.1982	1.1828
48	2.616	1.2041	1.2288	1.2355	1.2214	1.2098	1.1960
49	2.414	1.2202	1.2481	1.2571	1.2361	1.2215	1.2086
50	2.213	1.2365	1.2676	1.2782	1.2505	1.2331	1.2214
51	2.012	1.2529	1.2882	1.2988	1.2639	1.2434	1.2324
52	1.811	1.2691	1.3109	1.3190	1.2768	1.2531	1.2427
53	1.610	1.2845	1.3326	1.3382	1.2893	1.2631	1.2536
54	1.408	1.2993	1.3532	1.3564	1.3014	1.2733	1.2649
55	1.207	1.3134	1.3724	1.3733	1.3129	1.2833	1.2762
56	1.006	1.3267	1.3898	1.3888	1.3238	1.2932	1.2877
* 57-61	0.805 – 0.000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

\*

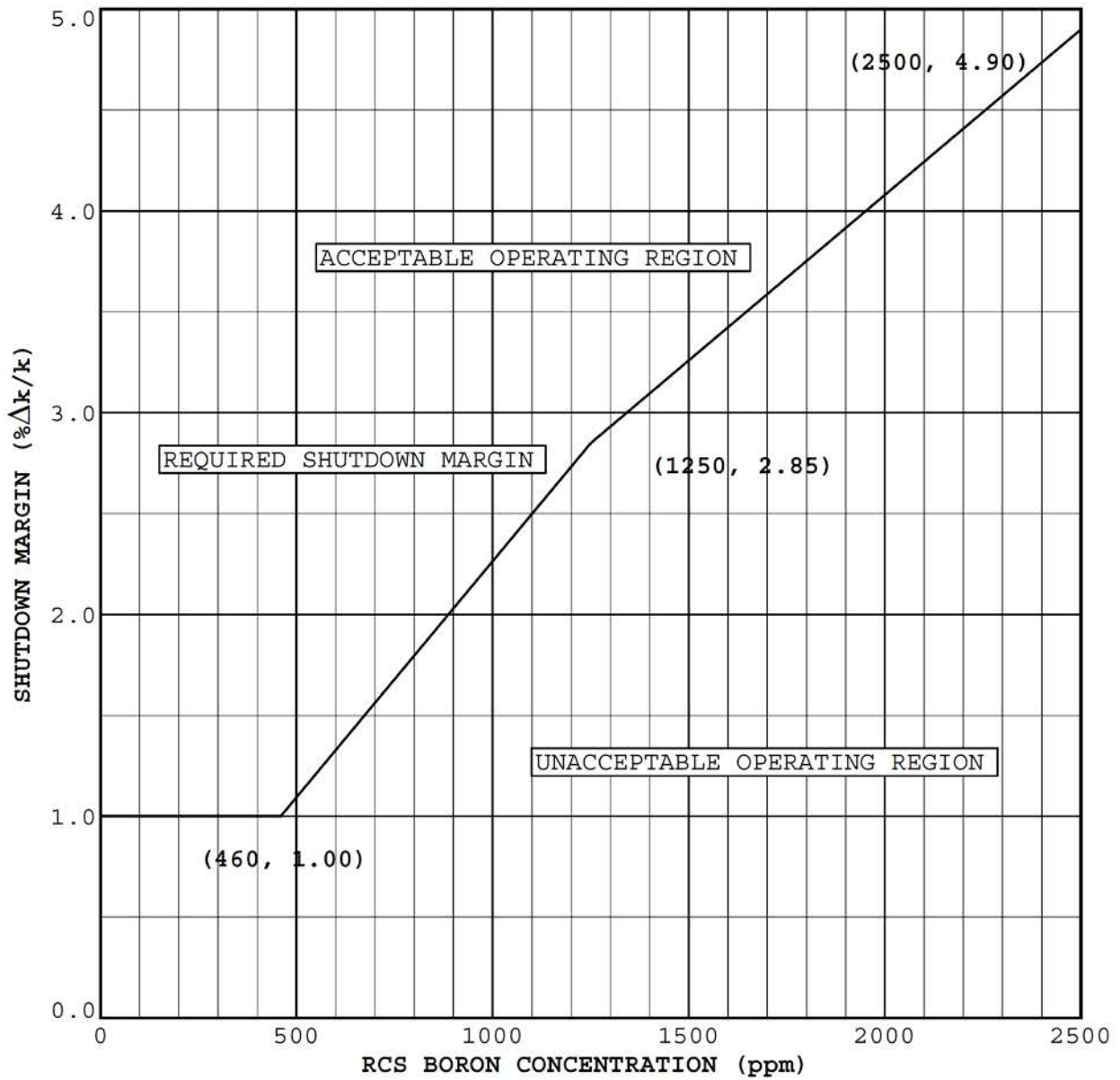
**Top and Bottom 5 Points Excluded per Technical Specification B3.2.1.**

These W(Z) values are consistent with Figure 5, and are valid over the HFP T<sub>avg</sub> 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)**

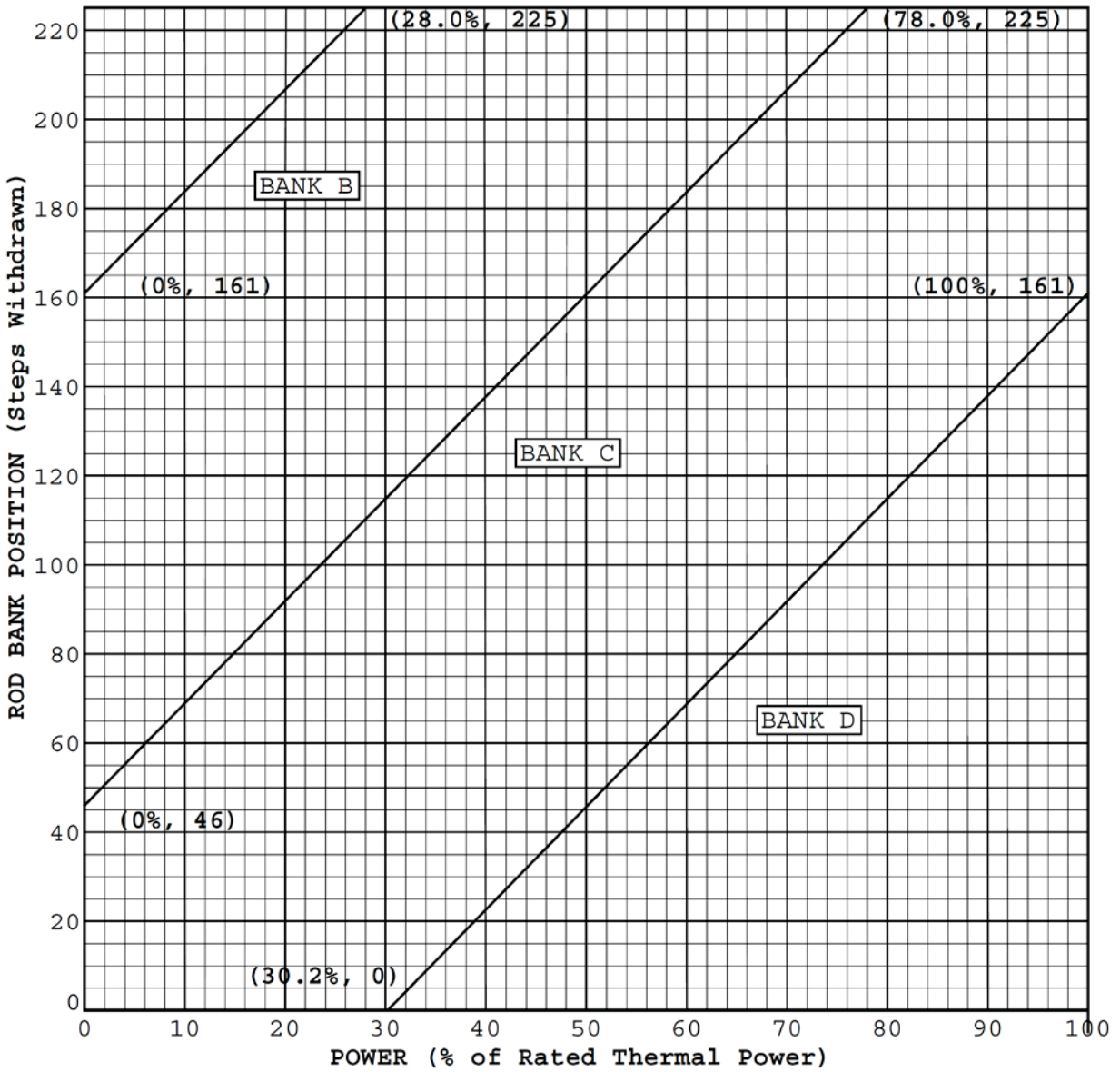


**FIGURE 2**  
**REQUIRED SHUTDOWN MARGIN FOR MODES 4 AND 5 (MODE 4 WHEN FIGURE 1 NOT APPLICABLE)**



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

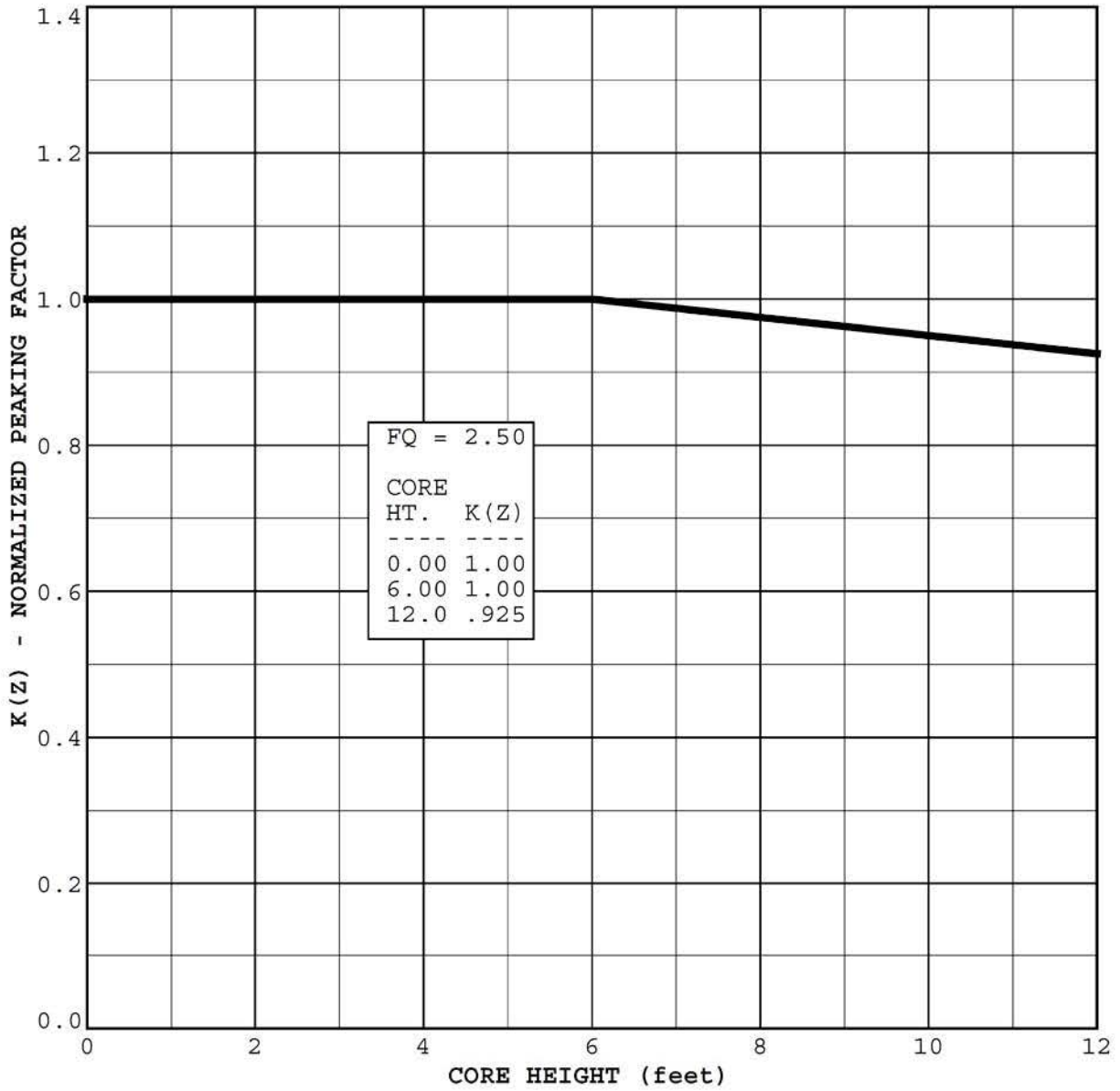
(Fully Withdrawn\*)



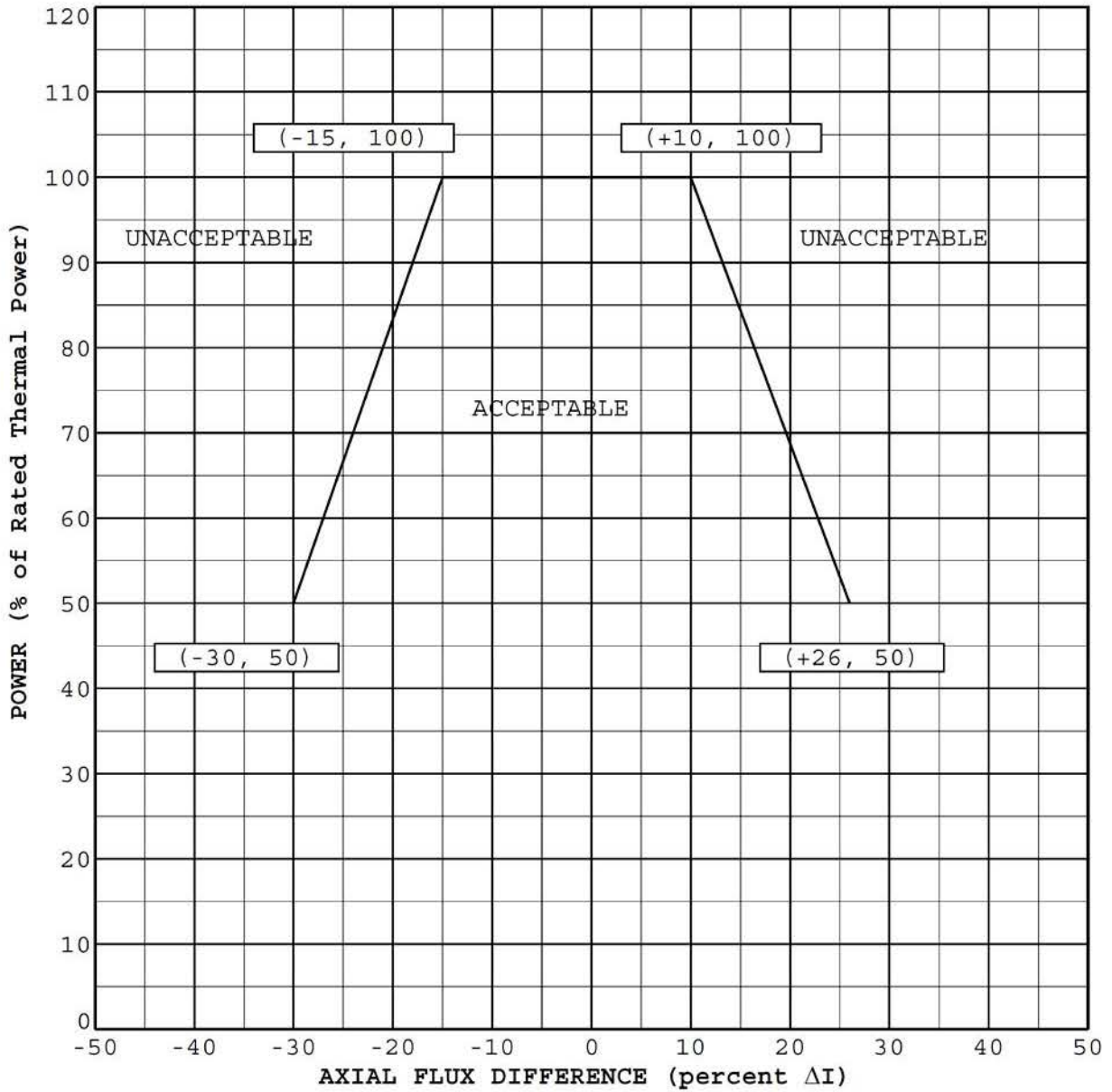
\*Fully withdrawn shall be the condition where control rods are at a position within the interval  $\geq 225$  and  $\leq 231$  steps withdrawn.

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.

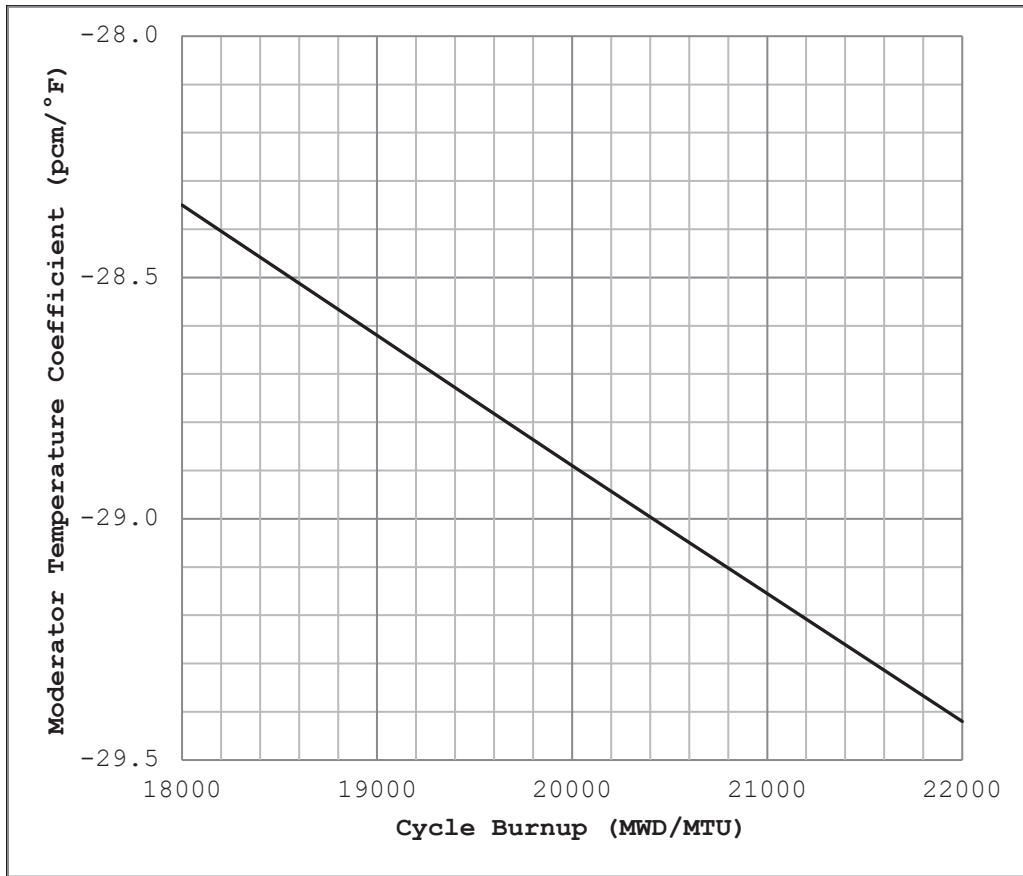
**FIGURE 4**  
**K(Z) – NORMALIZED F<sub>Q</sub>(Z) AS A FUNCTION OF CORE HEIGHT**



**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**



<u>Cycle Burnup (MWD/MTU)</u>	<u>Moderator Temperature Coefficient (pcm/°F)</u>
18000	-28.35
19000	-28.62
20000	-28.89
21000	-29.16
22000	-29.42