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SOUTHERN NUCLEAR
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50-364 50-425

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

Joseph M. Farley Nuclear Plant (Farley), Units 1 & 2
Vogtle Electric Generating Plant (Vogtle), Units 1 & 2
Farley Unit 1 Cycle 27 Core Operating Limits Report Version 2
Farley Unit 2 Cycle 24 Core Operating Limits Report Version 2
Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1
Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

Ladies and Gentlemen:

In accordance with Technical Specification (TS) 5.6.5.d for Joseph M. Farley Nuclear Plant (Farley) and Vogtle Electric Generating Plant (Vogtle), Southern Nuclear Operating Company (SNC) submits the enclosed Core Operating Limits Reports (COLRs):

- Farley Unit 1 Cycle 27 Core Operating Limits Report Version 2
- Farley Unit 2 Cycle 24 Core Operating Limits Report Version 2
- Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1
- Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

The enclosed Version 2 COLRs were revised to include an algorithm and figure for calculating the revised predicted near End of Life (EOL) moderator temperature coefficient (MTC). The enclosed Vogtle Unit 1 Cycle 20 COLR Version 1 also includes this algorithm and figure.

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

Respectfully submitted,

C. R. Pierce

C. R. Pierce
Regulatory Affairs Director

CRP/RMJ

Enclosures:
1. Farley Unit 1 Cycle 27 Core Operating Limits Report Version 2
2. Farley Unit 2 Cycle 24 Core Operating Limits Report Version 2
3. Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1
4. Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

cc: Southern Nuclear Operating Company
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RType: Farley=CFA04.054; Vogtle=CVC7000

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Joseph M. Farley Nuclear Plant (Farley), Units 1 & 2
Vogtle Electric Generating Plant (Vogtle), Units 1 & 2
Farley Unit 1 Cycle 27 Core Operating Limits Report Version 2
Farley Unit 2 Cycle 24 Core Operating Limits Report Version 2
Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1
Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

Enclosure 1

Farley Unit 1 Cycle 27 Core Operating Limits Report Version 2

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 1 CYCLE 27 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 (with $k_{eff} \geq 1$)

The Technical Specifications affected by this report are listed below:

2.1.1 Reactor Core Safety Limits for THERMAL POWER
3.1.1 SHUTDOWN MARGIN - MODES 2 (with $k_{eff} < 1$), 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
3.3.1 Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) Setpoint Parameter Values for Table 3.3.1-1
3.4.1 RCS DNB Parameters for Pressurizer Pressure, RCS Average Temperature, and RCS Total Flow Rate
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 (with $k_{eff} \geq 1.0$) (Technical Requirement 13.1.1)

2.1.1 The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent $\Delta k/k$.

2.2 SHUTDOWN MARGIN - MODES 2 (with $k_{eff} < 1.0$), 3, 4 and 5 (Specification 3.1.1)

2.2.1 Modes 2 ($k_{eff} < 1.0$), 3 and 4 - The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent $\Delta k/k$.

2.2.2 Mode 5 - The SHUTDOWN MARGIN shall be greater than or equal to 1.0 percent $\Delta k/k$.

2.3 Moderator Temperature Coefficient (Specification 3.1.3)

2.3.1 The Moderator Temperature Coefficient (MTC) limits are:

The BOL/ARO-MTC shall be less than or equal to $+0.7 \times 10^{-4}$ Δk/k/°F for power levels up to 70 percent RTP with a linear ramp to 0 Δk/k/°F at 100 percent RTP.

The EOL/ARO/RTP-MTC shall be less negative than -4.3×10^{-4} Δk/k/°F.

2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -3.65×10^{-4} Δk/k/°F.

The revised predicted near-EOL 300 ppm MTC shall be calculated using Figure 5 and the following algorithm:

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

where,
* Predicted MTC is calculated from Figure 5 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 = 0.07 pcm/°F / ΔAFD
***Predictive Correction is -3 pcm/°F.

The 100 ppm/ARO/RTP-MTC should be less negative than -4.0×10^{-4} Δk/k/°F.

where: BOL stands for Beginning of Cycle Life
ARO stands for All Rods Out
EOL stands for End of Cycle Life
RTP stands for RATED THERMAL POWER

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 1.

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

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

$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} * K(Z)$ for P ≤ 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 2.

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

$F_Q(Z) \leq \frac{F_Q^{RTP} * K(Z)}{0.5 * W(Z)}$ for P ≤ 0.5

2.6.5 Full Power W(Z) values are provided in Table 4.
Part Power (48% RTP) W(Z) values are provided in Table 5.

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

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

2.7.2 $F_{\Delta H}^{RTP} = 1.70$

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 3.

2.9 Boron Concentration (Specification 3.9.1)

2.9.1 The boron concentration shall be greater than or equal to 2000 ppm.[1]

2.10 Reactor Core Safety Limits for THERMAL POWER (Specification 2.1.1)

2.10.1 In MODES 1 and 2, the combination of THERMAL POWER, Reactor Coolant System (RCS) highest loop average temperature, and pressurizer pressure shall not exceed the safety limits specified in Figure 4.

2.11 Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) Setpoint Parameter Values for Table 3.3.1-1 (Specification 3.3.1)

2.11.1 The Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) setpoint parameter values for TS Table 3.3.1-1 are listed in COLR Tables 2 and 3.

2.12 RCS DNB Parameters for Pressurizer Pressure, RCS Average Temperature, and RCS Total Flow Rate (Specification 3.4.1)

2.12.1 RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure ≥ 2209 psig;
b. RCS average temperature ≤ 580.3°F; and
c. The minimum RCS total flow rate shall be ≥ 273,900 GPM when using the precision heat balance method and ≥ 274,800 GPM when using the elbow tap method.

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[1] 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	1.0370
150	1.0370
354	1.0338
559	1.0302
763	1.0264
967	1.0238
1172	1.0222
1376	1.0201
1580	1.0200
4237	1.0200
4441	1.0204
4645	1.0244
4850	1.0245
5463	1.0248
5667	1.0246
6076	1.0338
6280	1.0304
6485	1.0265
6689	1.0208
6893	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

Reactor Trip System Instrumentation - Overtemperature ΔT (OTΔT)
Setpoint Parameter Values

$T' \leq 577.2°F$	$P' = 2235$ psig	
$K_1 = 1.17$	$K_2 = 0.017/°F$	$K_3 = 0.000825/psi$
$\tau_1 \geq 30$ sec	$\tau_2 \leq 4$ sec	
$\tau_4 = 0$ sec	$\tau_5 \leq 6$ sec	$\tau_6 \leq 6$ sec

$f_1(\Delta I) =$	$-2.48\ \{23 + (q_t - q_b)\}$	when $(q_t - q_b) \leq -23\%$ RTP
	0% of RTP	when -23% RTP $< (q_t - q_b) \leq 15\%$ RTP
	$2.05\ \{(q_t - q_b) - 15\}$	when $(q_t - q_b) > 15\%$ RTP

Table 3

Reactor Trip System Instrumentation - Overpower ΔT (OPΔT)
Setpoint Parameter Values

$T'' \leq 577.2°F$

$K_4 = 1.10$	$K_5 = 0.02/°F$ for increasing T_{avg}	$K_6 = 0.00109/°F$ when $T > T''$
	$K_5 = 0/°F$ for decreasing T_{avg}	$K_6 = 0/°F$ when $T \leq T''$

$\tau_3 \geq 10$ sec
$\tau_4 = 0$ sec
$\tau_5 \leq 6$ sec
$\tau_6 \leq 6$ sec

$f_2(\Delta I) = 0\%$ RTP for all ΔI

Table 4
RAOC W(Z)

	Axial Point	Elevation (feet)	150 MWD/MTU	3000 MWD/MTU	10000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
*	1	12.00	1.0000	1.0000	1.0000	1.0000	1.0000
*	2	11.80	1.0000	1.0000	1.0000	1.0000	1.0000
*	3	11.60	1.0000	1.0000	1.0000	1.0000	1.0000
*	4	11.40	1.0000	1.0000	1.0000	1.0000	1.0000
*	5	11.20	1.0000	1.0000	1.0000	1.0000	1.0000
	6	11.00	1.1135	1.1146	1.2697	1.2319	1.2220
	7	10.80	1.1112	1.1168	1.2666	1.2294	1.2196
	8	10.60	1.1076	1.1134	1.2611	1.2246	1.2149
	9	10.40	1.1060	1.1185	1.2546	1.2188	1.2094
	10	10.20	1.1060	1.1291	1.2476	1.2160	1.2042
	11	10.00	1.1141	1.1334	1.2396	1.2149	1.1992
	12	9.80	1.1167	1.1316	1.2314	1.2131	1.1941
	13	9.60	1.1206	1.1297	1.2251	1.2102	1.1884
	14	9.40	1.1173	1.1220	1.2270	1.2063	1.1989
	15	9.20	1.1203	1.1225	1.2343	1.2032	1.2104
	16	9.00	1.1230	1.1223	1.2390	1.2109	1.2295
	17	8.80	1.1319	1.1255	1.2382	1.2153	1.2419
	18	8.60	1.1414	1.1356	1.2403	1.2193	1.2508
	19	8.40	1.1526	1.1452	1.2505	1.2301	1.2618
	20	8.20	1.1629	1.1543	1.2583	1.2441	1.2811
	21	8.00	1.1715	1.1617	1.2633	1.2548	1.2978
	22	7.80	1.1781	1.1672	1.2660	1.2629	1.3112
	23	7.60	1.1817	1.1701	1.2656	1.2679	1.3209
	24	7.40	1.1840	1.1717	1.2636	1.2714	1.3286
	25	7.20	1.1841	1.1711	1.2578	1.2707	1.3311
	26	7.00	1.1827	1.1689	1.2505	1.2674	1.3298
	27	6.80	1.1797	1.1655	1.2424	1.2637	1.3264
	28	6.60	1.1748	1.1603	1.2322	1.2579	1.3202
	29	6.40	1.1692	1.1543	1.2205	1.2502	1.3115
	30	6.20	1.1630	1.1478	1.2074	1.2407	1.3003
	31	6.00	1.1555	1.1401	1.1931	1.2297	1.2871
	32	5.80	1.1471	1.1317	1.1806	1.2175	1.2726
	33	5.60	1.1380	1.1265	1.1712	1.2064	1.2557
	34	5.40	1.1327	1.1393	1.1595	1.2031	1.2360
	35	5.20	1.1433	1.1514	1.1540	1.2002	1.2337
	36	5.00	1.1517	1.1631	1.1535	1.1958	1.2298
	37	4.80	1.1612	1.1742	1.1525	1.1908	1.2245
	38	4.60	1.1713	1.1847	1.1506	1.1864	1.2173
	39	4.40	1.1808	1.1947	1.1478	1.1809	1.2083
	40	4.20	1.1891	1.2035	1.1441	1.1741	1.1979
	41	4.00	1.1973	1.2115	1.1397	1.1664	1.1860
	42	3.80	1.2082	1.2187	1.1337	1.1563	1.1714
	43	3.60	1.2201	1.2250	1.1300	1.1453	1.1539
	44	3.40	1.2304	1.2302	1.1281	1.1379	1.1395
	45	3.20	1.2393	1.2347	1.1250	1.1308	1.1283
	46	3.00	1.2475	1.2478	1.1219	1.1284	1.1241
	47	2.80	1.2549	1.2774	1.1175	1.1286	1.1304
	48	2.60	1.2790	1.3109	1.1215	1.1296	1.1416
	49	2.40	1.3079	1.3433	1.1320	1.1307	1.1533
	50	2.20	1.3359	1.3764	1.1429	1.1405	1.1673
	51	2.00	1.3639	1.4090	1.1530	1.1507	1.1799
	52	1.80	1.3913	1.4411	1.1629	1.1602	1.1919
	53	1.60	1.4170	1.4711	1.1728	1.1701	1.2043
	54	1.40	1.4411	1.4992	1.1827	1.1803	1.2170
	55	1.20	1.4634	1.5250	1.1923	1.1904	1.2297
	56	1.00	1.4835	1.5481	1.2015	1.2004	1.2425
*	57	0.80	1.0000	1.0000	1.0000	1.0000	1.0000
*	58	0.60	1.0000	1.0000	1.0000	1.0000	1.0000
*	59	0.40	1.0000	1.0000	1.0000	1.0000	1.0000
*	60	0.20	1.0000	1.0000	1.0000	1.0000	1.0000
*	61	0.00	1.0000	1.0000	1.0000	1.0000	1.0000

* **Top and bottom 5 axial points excluded per Technical Specification B3.2.1.**

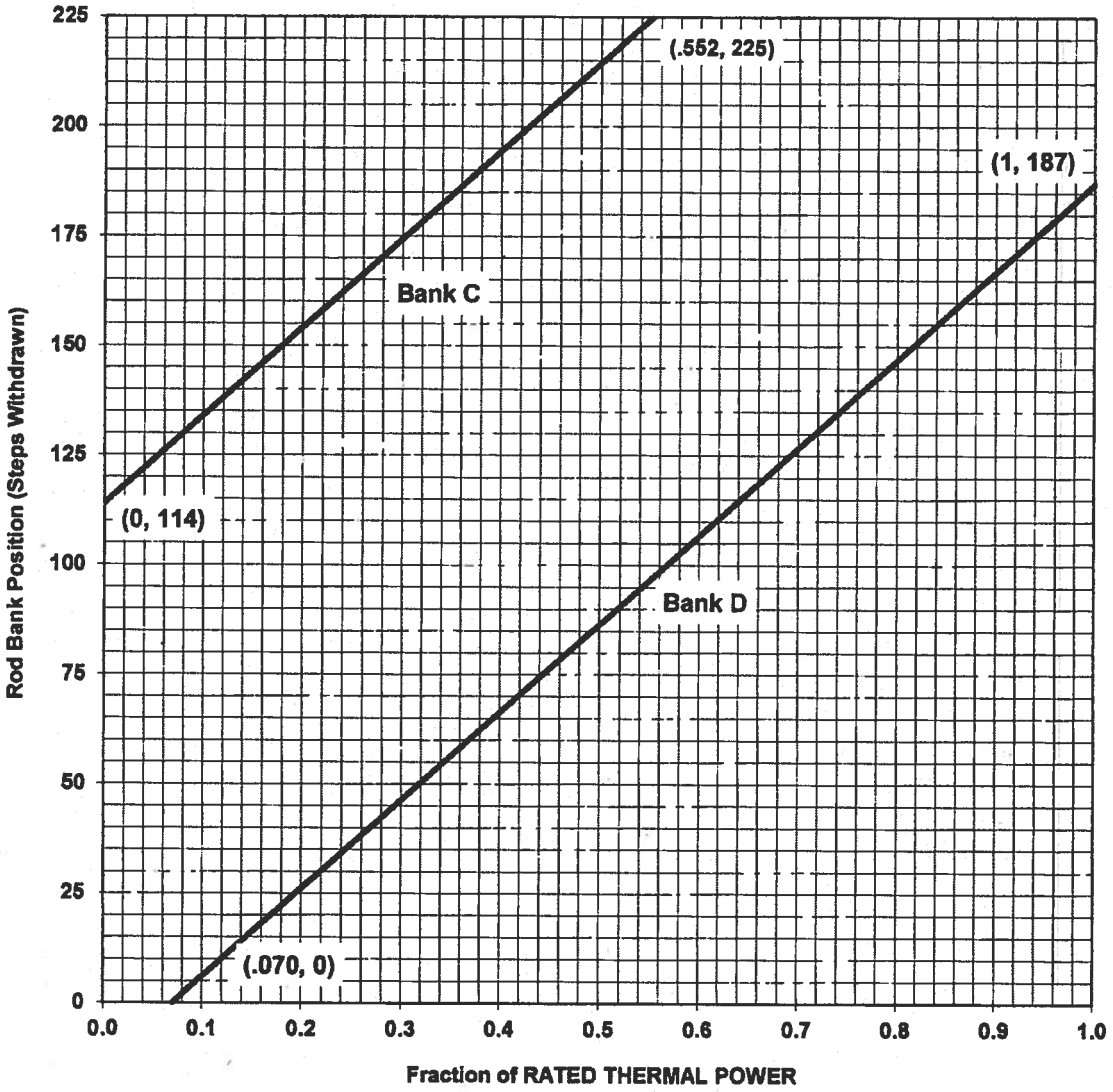
Table 5
Part Power (48%) RAOC W(Z)

	Axial Point	Elevation (feet)	150 MWD/MTU
*	1	12.00	1.0000
*	2	11.80	1.0000
*	3	11.60	1.0000
*	4	11.40	1.0000
*	5	11.20	1.0000
	6	11.00	1.1607
	7	10.80	1.1520
	8	10.60	1.1427
	9	10.40	1.1361
	10	10.20	1.1309
	11	10.00	1.1252
	12	9.80	1.1134
	13	9.60	1.1083
	14	9.40	1.0933
	15	9.20	1.0805
	16	9.00	1.0662
	17	8.80	1.0663
	18	8.60	1.0697
	19	8.40	1.0752
	20	8.20	1.0757
	21	8.00	1.0792
	22	7.80	1.0822
	23	7.60	1.0827
	24	7.40	1.0840
	25	7.20	1.0847
	26	7.00	1.0842
	27	6.80	1.0805
	28	6.60	1.0787
	29	6.40	1.0778
	30	6.20	1.0713
	31	6.00	1.0675
	32	5.80	1.0636
	33	5.60	1.0604
	34	5.40	1.0607
	35	5.20	1.0760
	36	5.00	1.0897
	37	4.80	1.1047
	38	4.60	1.1207
	39	4.40	1.1356
	40	4.20	1.1493
	41	4.00	1.1635
	42	3.80	1.1811
	43	3.60	1.1997
	44	3.40	1.2174
	45	3.20	1.2340
	46	3.00	1.2498
	47	2.80	1.2648
	48	2.60	1.2958
	49	2.40	1.3321
	50	2.20	1.3677
	51	2.00	1.4039
	52	1.80	1.4397
	53	1.60	1.4746
	54	1.40	1.5088
	55	1.20	1.5423
	56	1.00	1.5720
*	57	0.80	1.0000
*	58	0.60	1.0000
*	59	0.40	1.0000
*	60	0.20	1.0000
*	61	0.00	1.0000

* **Top and bottom 5 axial points excluded per Technical Specification B3.2.1.**

Figure 1
Rod Bank Insertion Limits versus Rated Thermal Power

Fully Withdrawn – 225 to 231 steps, inclusive



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 128 steps.

Figure 2
K(Z) – Normalized $F_Q(Z)$ as a Function of Core Height

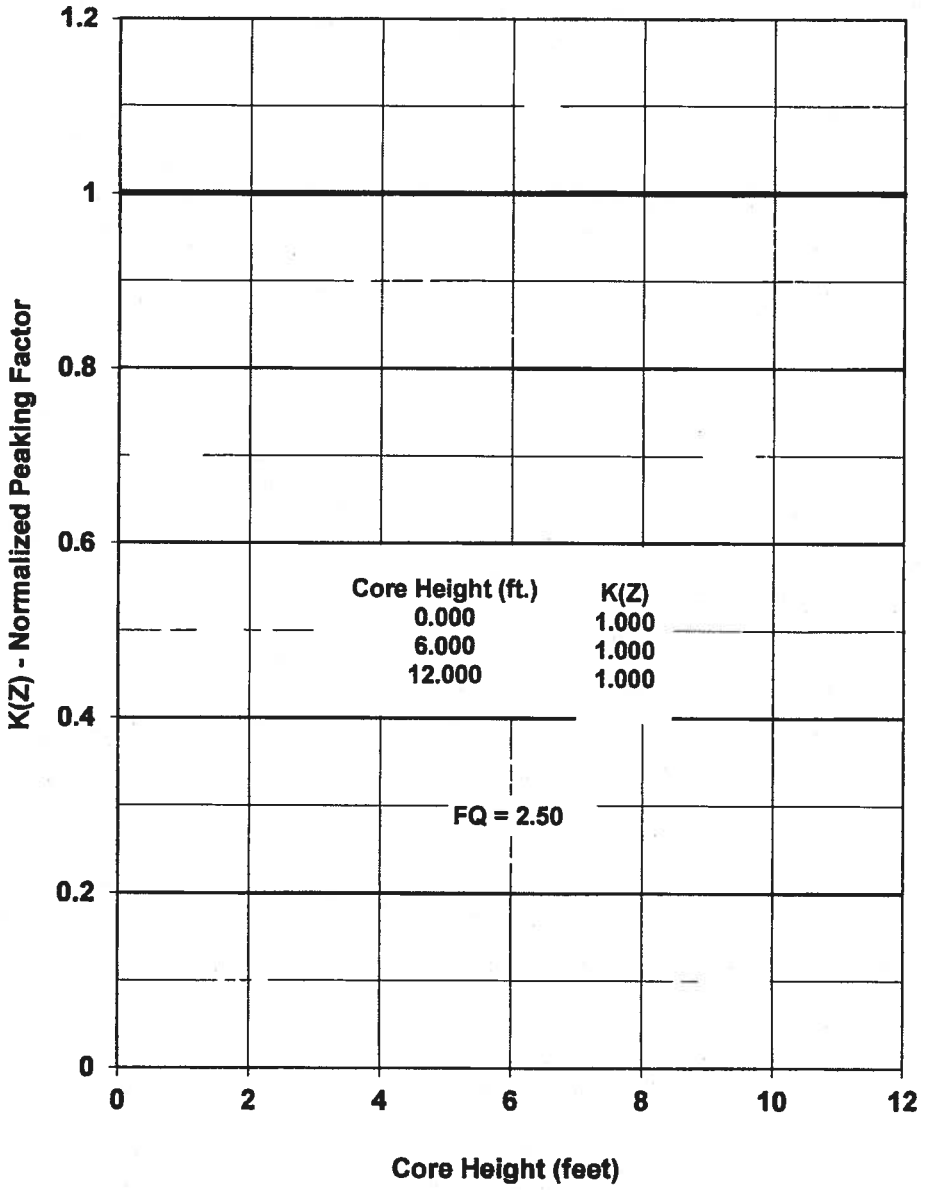


Figure 3
Axial Flux Difference Limits as a Function of Rated Thermal Power for RAOC

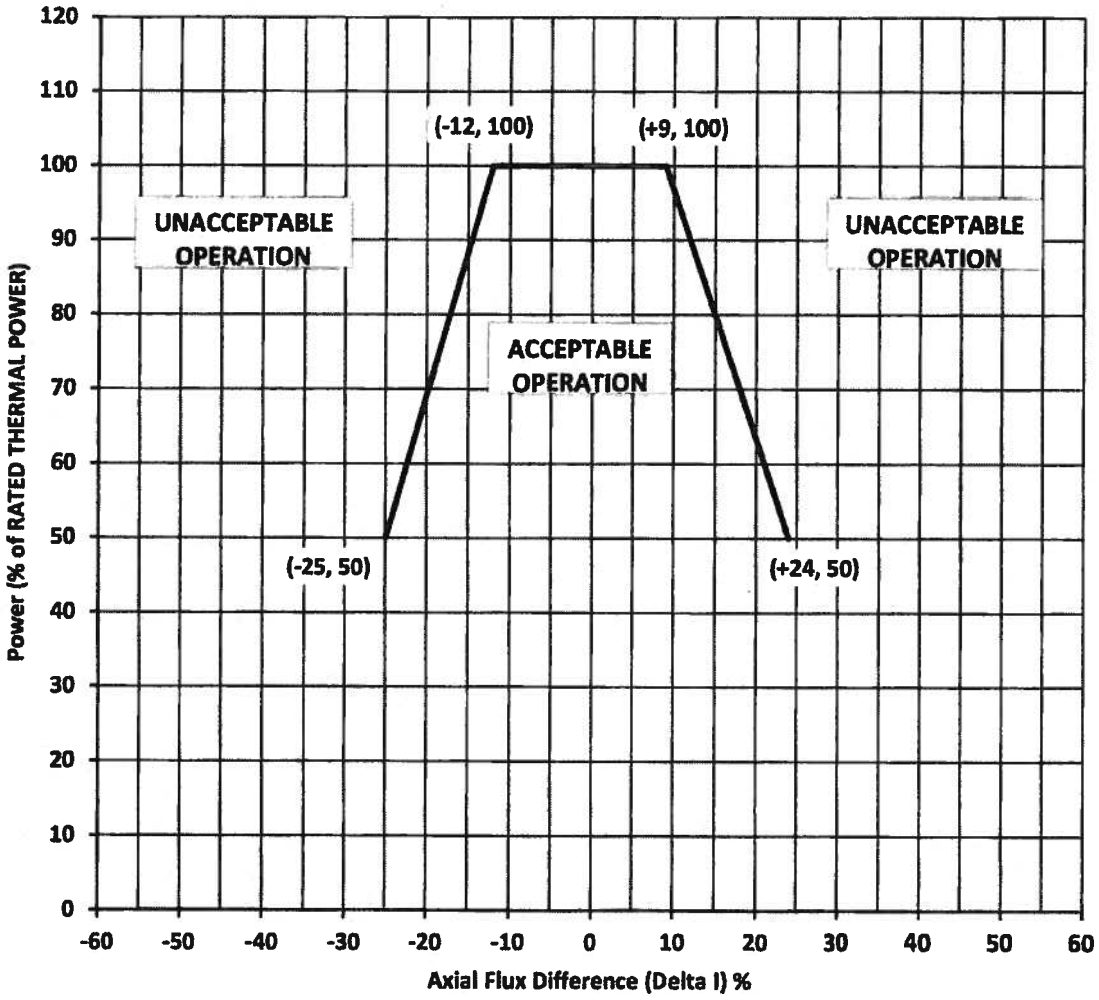


Figure 4
Reactor Core Safety Limits

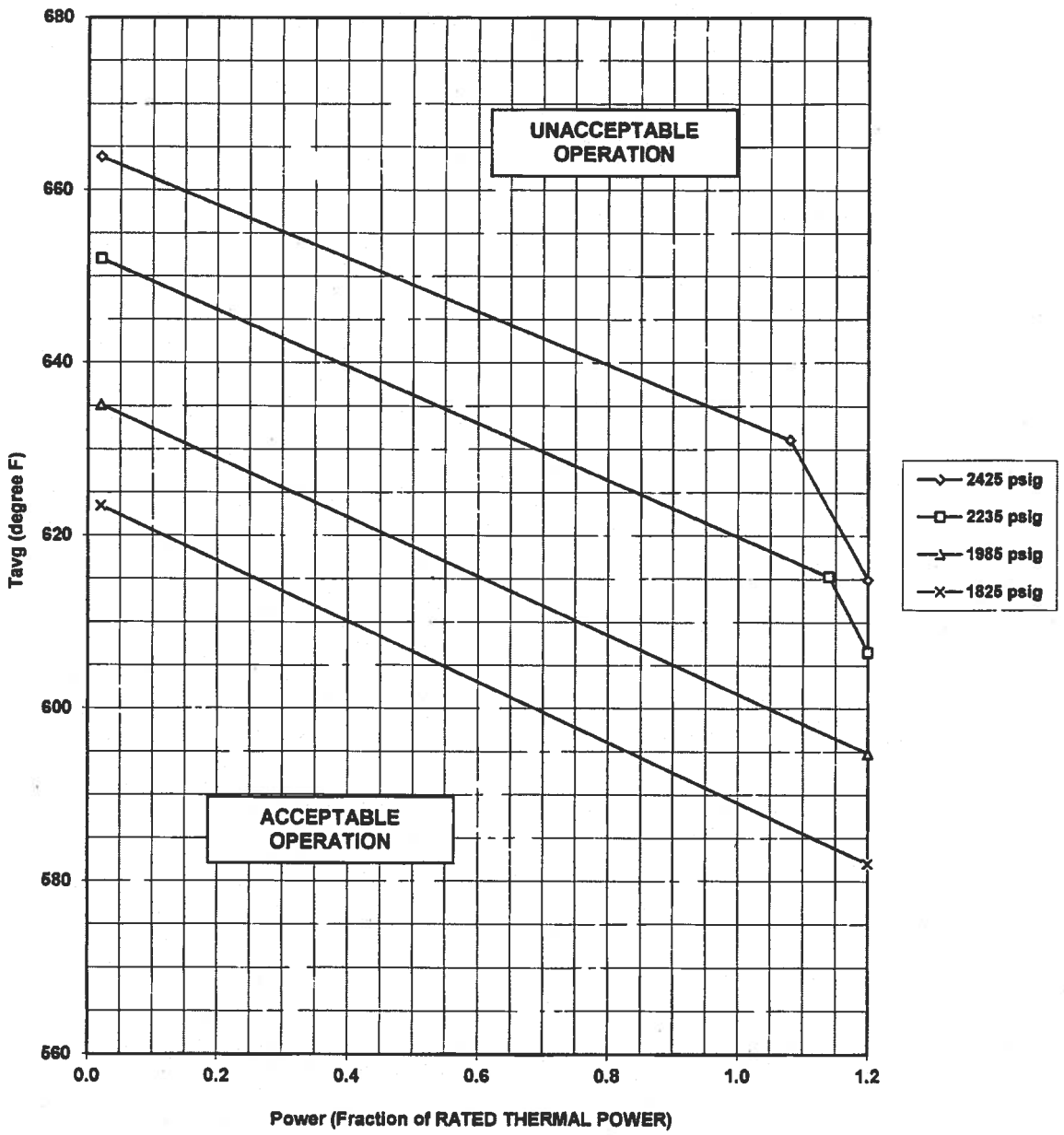
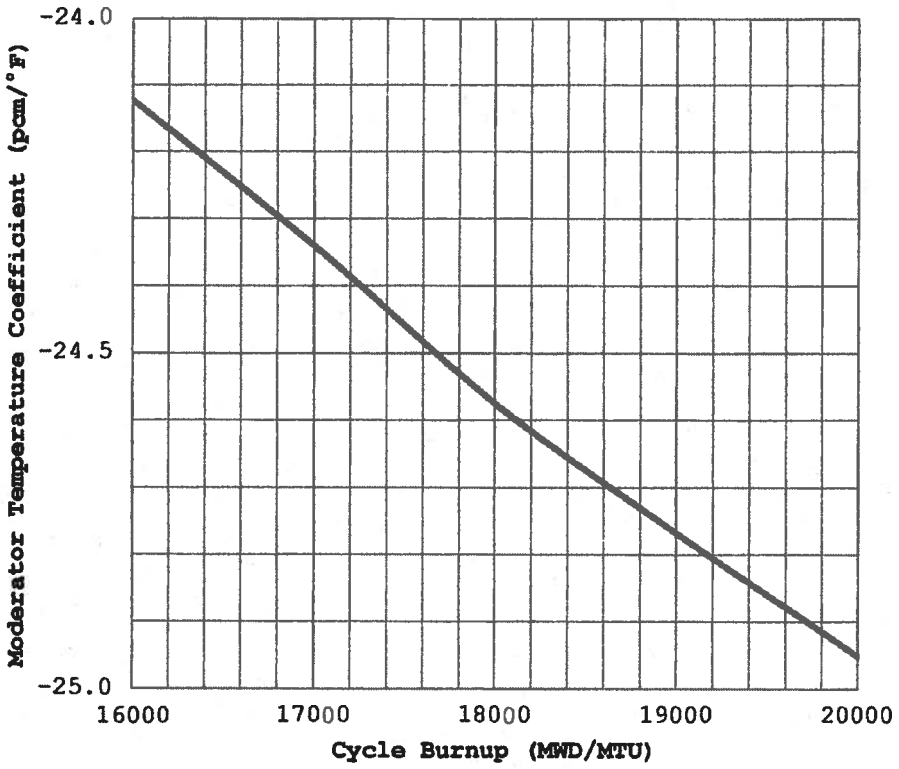


Figure 5
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
16000	-24.12
17000	-24.34
18000	-24.58
19000	-24.77
20000	-24.95

Joseph M. Farley Nuclear Plant (Farley), Units 1 & 2
Vogtle Electric Generating Plant (Vogtle), Units 1 & 2
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Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1
Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

Enclosure 2

Farley Unit 2 Cycle 24 Core Operating Limits Report Version 2

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 2 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 (with $k_{eff} \geq 1$)

The Technical Specifications affected by this report are listed below:

2.1.1 Reactor Core Safety Limits for THERMAL POWER
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3.3.1 Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) Setpoint Parameter Values for Table 3.3.1-1
3.4.1 RCS DNB Parameters for Pressurizer Pressure, RCS Average Temperature, and RCS Total Flow Rate
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 (with $k_{eff} \geq 1.0$) (Technical Requirement 13.1.1)

2.1.1 The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent $\Delta k/k$.

2.2 SHUTDOWN MARGIN - MODES 2 (with $k_{eff} < 1.0$), 3, 4 and 5 (Specification 3.1.1)

2.2.1 Modes 2 ($k_{eff} < 1.0$), 3 and 4 - The SHUTDOWN MARGIN shall be greater than or equal to 1.77 percent $\Delta k/k$.

2.2.2 Mode 5 - The SHUTDOWN MARGIN shall be greater than or equal to 1.0 percent $\Delta k/k$.

2.3 Moderator Temperature Coefficient (Specification 3.1.3)

2.3.1 The Moderator Temperature Coefficient (MTC) limits are:

The BOL/ARO-MTC shall be less than or equal to $+0.7 \times 10^{-4}$ Δk/k/°F for power levels up to 70 percent RTP with a linear ramp to 0 Δk/k/°F at 100 percent RTP.

The EOL/ARO/RTP-MTC shall be less negative than -4.3×10^{-4} Δk/k/°F.

2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -3.65×10^{-4} Δk/k/°F.

The revised predicted near-EOL 300 ppm MTC shall be calculated using Figure 5 and the following algorithm:

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

where,
* Predicted MTC is calculated from Figure 5 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 = 0.07 pcm/°F / ΔAFD
***Predictive Correction is -3 pcm/°F.

The 100 ppm/ARO/RTP-MTC should be less negative than -4.0×10^{-4} Δk/k/°F.

where: BOL stands for Beginning of Cycle Life
ARO stands for All Rods Out
EOL stands for End of Cycle Life
RTP stands for RATED THERMAL POWER

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 1.

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

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

$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} * K(Z)$ for P ≤ 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 2.

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

$F_Q(Z) \leq \frac{F_Q^{RTP} * K(Z)}{0.5 * W(Z)}$ for P ≤ 0.5

2.6.5 Full Power W(Z) values are provided in Table 4.
Part Power (48% RTP) W(Z) values are provided in Table 5.

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

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

2.7.2 $F_{\Delta H}^{RTP} = 1.70$

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 3.

2.9 Boron Concentration (Specification 3.9.1)

2.9.1 The boron concentration shall be greater than or equal to 2000 ppm.[1]

2.10 Reactor Core Safety Limits for THERMAL POWER (Specification 2.1.1)

2.10.1 In MODES 1 and 2, the combination of THERMAL POWER, Reactor Coolant System (RCS) highest loop average temperature, and pressurizer pressure shall not exceed the safety limits specified in Figure 4.

2.11 Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) Setpoint Parameter Values for Table 3.3.1-1 (Specification 3.3.1)

2.11.1 The Reactor Trip System Instrumentation Overtemperature ΔT (OTΔT) and Overpower ΔT (OPΔT) setpoint parameter values for TS Table 3.3.1-1 are listed in COLR Tables 2 and 3.

2.12 RCS DNB Parameters for Pressurizer Pressure, RCS Average Temperature, and RCS Total Flow Rate (Specification 3.4.1)

2.12.1 RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure ≥ 2209 psig;
b. RCS average temperature ≤ 580.3°F; and
c. The minimum RCS total flow rate shall be ≥ 273,900 GPM when using the precision heat balance method and ≥ 274,800 GPM when using the elbow tap method.

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[1] 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
5459	1.0200
5663	1.0214
5867	1.0236
6071	1.0260
6275	1.0264
6480	1.0250
6684	1.0232
6888	1.0210
7092	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

Reactor Trip System Instrumentation - Overtemperature ΔT (OTΔT)
Setpoint Parameter Values

$T' \leq 577.2°F$	$P' = 2235$ psig	
$K_1 = 1.17$	$K_2 = 0.017/°F$	$K_3 = 0.000825/psi$
$\tau_1 \geq 30$ sec	$\tau_2 \leq 4$ sec	
$\tau_4 = 0$ sec	$\tau_5 \leq 6$ sec	$\tau_6 \leq 6$ sec

$f_1(\Delta I) =$	$-2.48\ \{23 + (q_t - q_b)\}$	when $(q_t - q_b) \leq -23\%$ RTP
	0% of RTP	when -23% RTP $< (q_t - q_b) \leq 15\%$ RTP
	$2.05\ \{(q_t - q_b) - 15\}$	when $(q_t - q_b) > 15\%$ RTP

Table 3

Reactor Trip System Instrumentation - Overpower ΔT (OPΔT)
Setpoint Parameter Values

$T'' \leq 577.2°F$

$K_4 = 1.10$	$K_5 = 0.02/°F$ for increasing T_{avg}	$K_6 = 0.00109/°F$ when $T > T''$
	$K_5 = 0/°F$ for decreasing T_{avg}	$K_6 = 0/°F$ when $T \leq T''$

$\tau_3 \geq 10$ sec
$\tau_4 = 0$ sec
$\tau_5 \leq 6$ sec
$\tau_6 \leq 6$ sec

$f_2(\Delta I) = 0\%$ RTP for all ΔI

Table 4
RAOC W(Z)

	Axial Point	Elevation (feet)	150 MWD/MTU	3000 MWD/MTU	10000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
*	1	12.00	1.0000	1.0000	1.0000	1.0000	1.0000
*	2	11.80	1.0000	1.0000	1.0000	1.0000	1.0000
*	3	11.60	1.0000	1.0000	1.0000	1.0000	1.0000
*	4	11.40	1.0000	1.0000	1.0000	1.0000	1.0000
*	5	11.20	1.0000	1.0000	1.0000	1.0000	1.0000
	6	11.00	1.1235	1.1452	1.2675	1.2613	1.2533
	7	10.80	1.1213	1.1446	1.2602	1.2522	1.2426
	8	10.60	1.1162	1.1391	1.2390	1.2332	1.2206
	9	10.40	1.1110	1.1330	1.2244	1.2146	1.1961
	10	10.20	1.1051	1.1316	1.2219	1.1933	1.1846
	11	10.00	1.1110	1.1272	1.2198	1.1958	1.1779
	12	9.80	1.1143	1.1290	1.2244	1.2012	1.1708
	13	9.60	1.1167	1.1286	1.2251	1.2085	1.1631
	14	9.40	1.1155	1.1264	1.2275	1.2097	1.1611
	15	9.20	1.1186	1.1231	1.2253	1.2226	1.1712
	16	9.00	1.1183	1.1188	1.2342	1.2314	1.1981
	17	8.80	1.1208	1.1121	1.2365	1.2357	1.2280
	18	8.60	1.1374	1.1085	1.2403	1.2372	1.2543
	19	8.40	1.1502	1.1167	1.2535	1.2464	1.2779
	20	8.20	1.1611	1.1267	1.2642	1.2622	1.2979
	21	8.00	1.1702	1.1349	1.2726	1.2747	1.3151
	22	7.80	1.1767	1.1410	1.2772	1.2834	1.3277
	23	7.60	1.1810	1.1454	1.2791	1.2895	1.3370
	24	7.40	1.1838	1.1487	1.2790	1.2937	1.3441
	25	7.20	1.1843	1.1501	1.2750	1.2935	1.3460
	26	7.00	1.1832	1.1510	1.2682	1.2909	1.3437
	27	6.80	1.1805	1.1508	1.2594	1.2870	1.3389
	28	6.60	1.1766	1.1497	1.2491	1.2814	1.3320
	29	6.40	1.1713	1.1474	1.2366	1.2732	1.3221
	30	6.20	1.1649	1.1440	1.2223	1.2628	1.3094
	31	6.00	1.1575	1.1399	1.2067	1.2506	1.2947
	32	5.80	1.1495	1.1352	1.1904	1.2374	1.2789
	33	5.60	1.1416	1.1308	1.1753	1.2223	1.2607
	34	5.40	1.1443	1.1411	1.1689	1.2088	1.2412
	35	5.20	1.1576	1.1519	1.1682	1.2082	1.2378
	36	5.00	1.1693	1.1622	1.1680	1.2064	1.2339
	37	4.80	1.1807	1.1719	1.1668	1.2036	1.2306
	38	4.60	1.1915	1.1811	1.1645	1.1991	1.2251
	39	4.40	1.2016	1.1895	1.1611	1.1932	1.2177
	40	4.20	1.2105	1.1969	1.1569	1.1860	1.2088
	41	4.00	1.2184	1.2034	1.1519	1.1776	1.1984
	42	3.80	1.2256	1.2097	1.1453	1.1672	1.1849
	43	3.60	1.2316	1.2170	1.1370	1.1539	1.1687
	44	3.40	1.2383	1.2240	1.1300	1.1450	1.1523
	45	3.20	1.2455	1.2301	1.1245	1.1387	1.1344
	46	3.00	1.2607	1.2339	1.1219	1.1370	1.1390
	47	2.80	1.2833	1.2470	1.1276	1.1463	1.1556
	48	2.60	1.3061	1.2651	1.1376	1.1606	1.1709
	49	2.40	1.3283	1.2868	1.1473	1.1743	1.1868
	50	2.20	1.3499	1.3134	1.1574	1.1882	1.2027
	51	2.00	1.3771	1.3401	1.1667	1.2008	1.2170
	52	1.80	1.4053	1.3662	1.1758	1.2128	1.2306
	53	1.60	1.4316	1.3909	1.1851	1.2250	1.2446
	54	1.40	1.4563	1.4140	1.1945	1.2373	1.2591
	55	1.20	1.4791	1.4354	1.2038	1.2494	1.2735
	56	1.00	1.4995	1.4546	1.2129	1.2613	1.2879
*	57	0.80	1.0000	1.0000	1.0000	1.0000	1.0000
*	58	0.60	1.0000	1.0000	1.0000	1.0000	1.0000
*	59	0.40	1.0000	1.0000	1.0000	1.0000	1.0000
*	60	0.20	1.0000	1.0000	1.0000	1.0000	1.0000
*	61	0.00	1.0000	1.0000	1.0000	1.0000	1.0000

* **Top and bottom 5 axial points excluded per Technical Specification B3.2.1.**

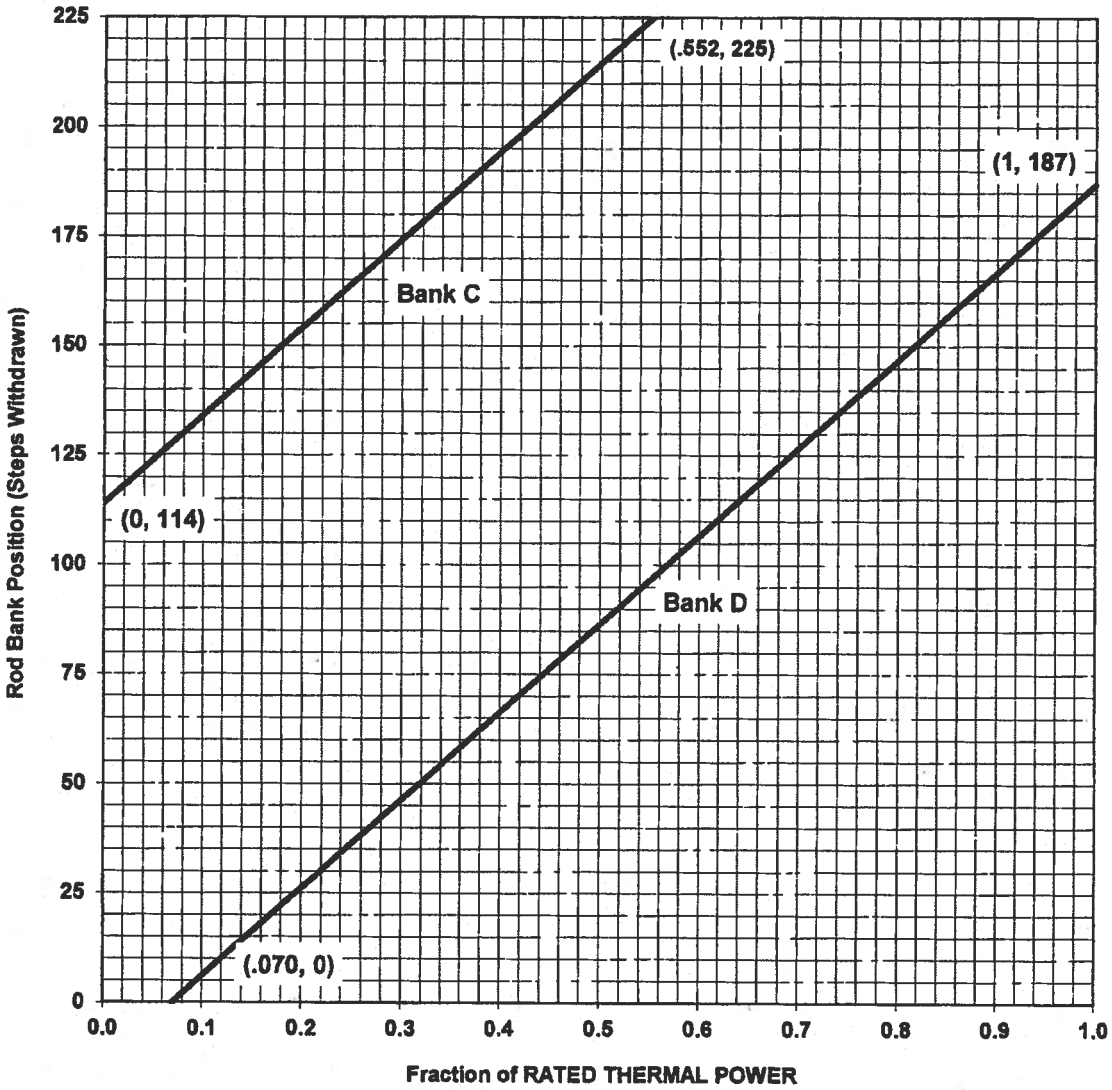
Table 5
Part Power (48%) RAOC W(Z)

	Axial Point	Elevation (feet)	150 MWD/MTU
*	1	12.00	1.0000
*	2	11.80	1.0000
*	3	11.60	1.0000
*	4	11.40	1.0000
*	5	11.20	1.0000
	6	11.00	1.2173
	7	10.80	1.2038
	8	10.60	1.1857
	9	10.40	1.1663
	10	10.20	1.1453
	11	10.00	1.1357
	12	9.80	1.1232
	13	9.60	1.1086
	14	9.40	1.0916
	15	9.20	1.0817
	16	9.00	1.0694
	17	8.80	1.0620
	18	8.60	1.0701
	19	8.40	1.0762
	20	8.20	1.0818
	21	8.00	1.0865
	22	7.80	1.0900
	23	7.60	1.0924
	24	7.40	1.0943
	25	7.20	1.0949
	26	7.00	1.0946
	27	6.80	1.0926
	28	6.60	1.0862
	29	6.40	1.0813
	30	6.20	1.0783
	31	6.00	1.0740
	32	5.80	1.0699
	33	5.60	1.0673
	34	5.40	1.0754
	35	5.20	1.0936
	36	5.00	1.1104
	37	4.80	1.1271
	38	4.60	1.1432
	39	4.40	1.1587
	40	4.20	1.1728
	41	4.00	1.1860
	42	3.80	1.2001
	43	3.60	1.2131
	44	3.40	1.2269
	45	3.20	1.2410
	46	3.00	1.2630
	47	2.80	1.2925
	48	2.60	1.3224
	49	2.40	1.3508
	50	2.20	1.3790
	51	2.00	1.4152
	52	1.80	1.4522
	53	1.60	1.4869
	54	1.40	1.5202
	55	1.20	1.5515
	56	1.00	1.5805
*	57	0.80	1.0000
*	58	0.60	1.0000
*	59	0.40	1.0000
*	60	0.20	1.0000
*	61	0.00	1.0000

* **Top and bottom 5 axial points excluded per Technical Specification B3.2.1.**

Figure 1
Rod Bank Insertion Limits versus Rated Thermal Power

Fully Withdrawn – 225 to 231 steps, inclusive



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 128 steps.

Figure 2
K(Z) – Normalized $F_Q(Z)$ as a Function of Core Height

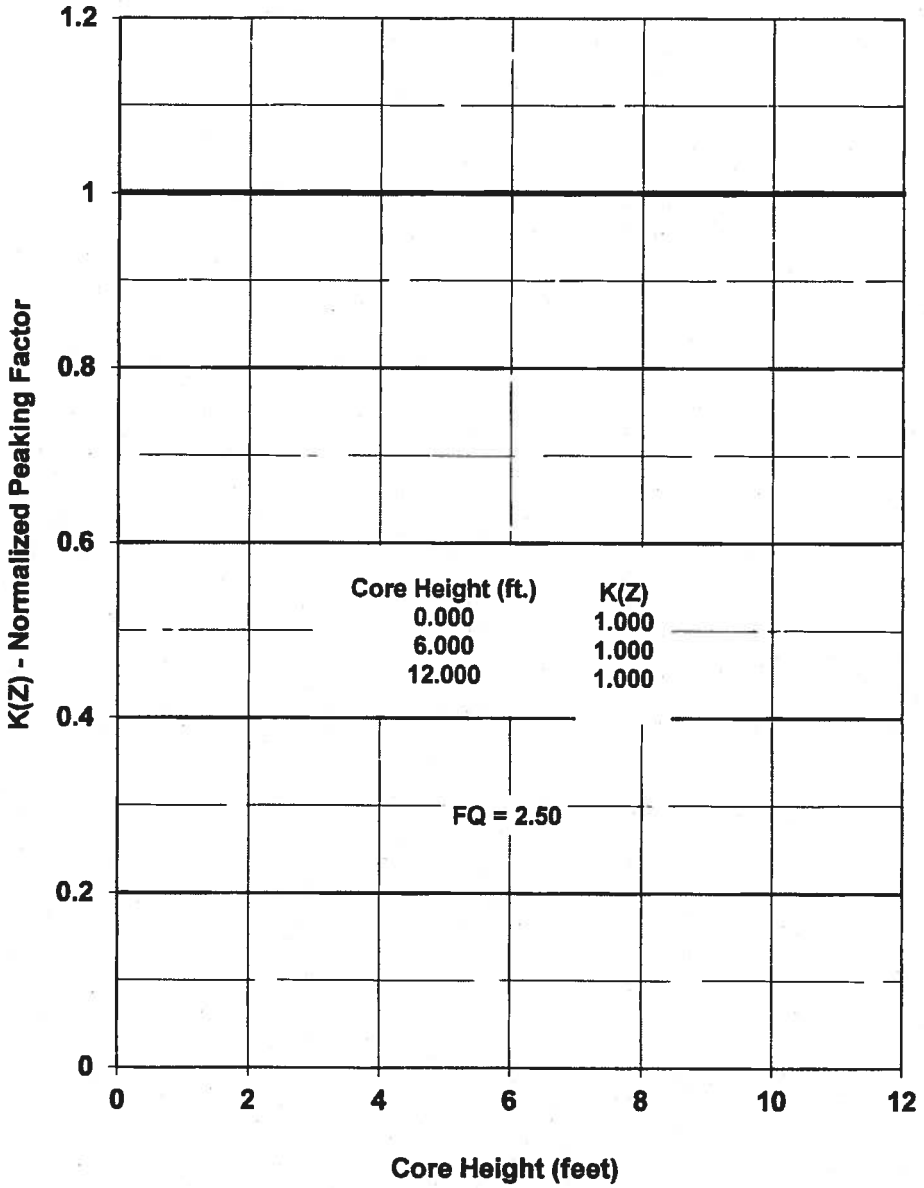


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

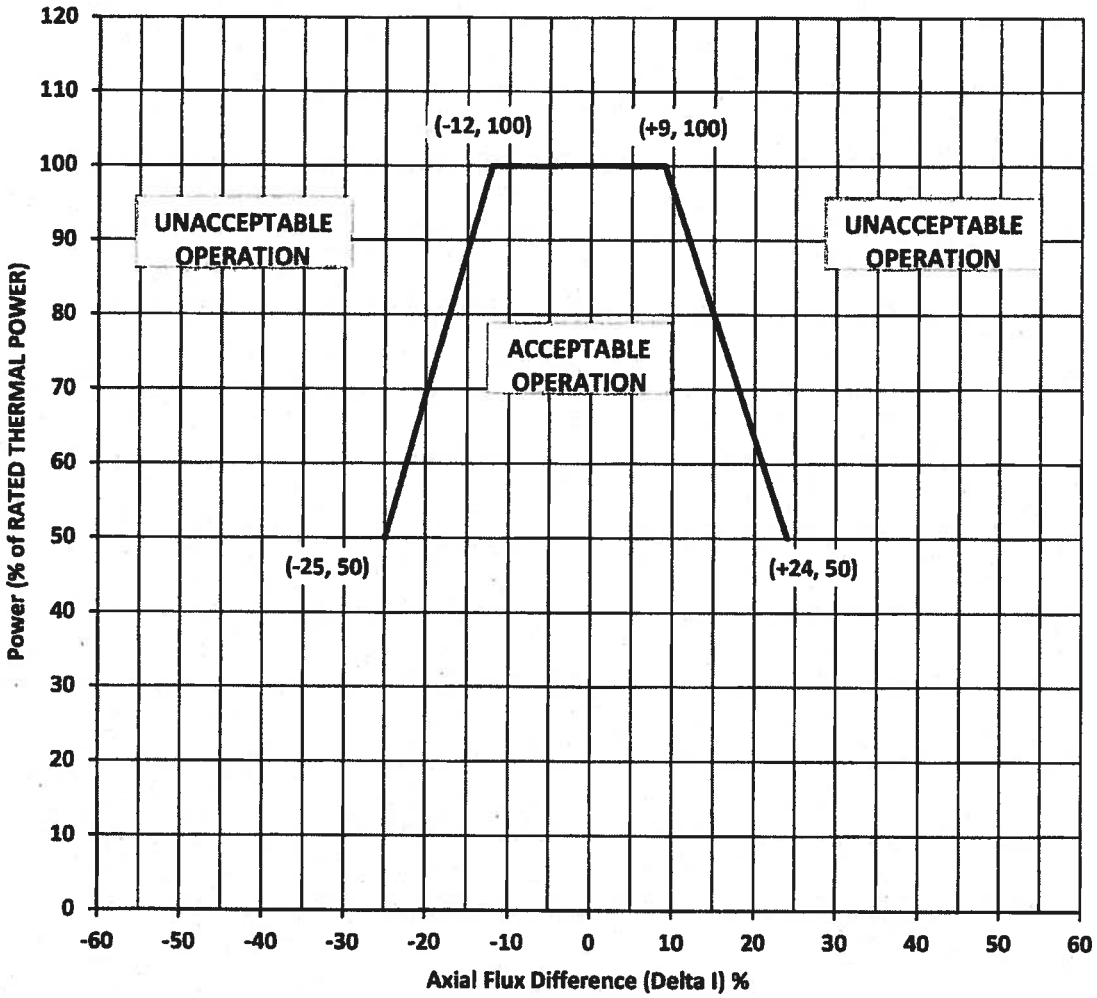


Figure 4
Reactor Core Safety Limits

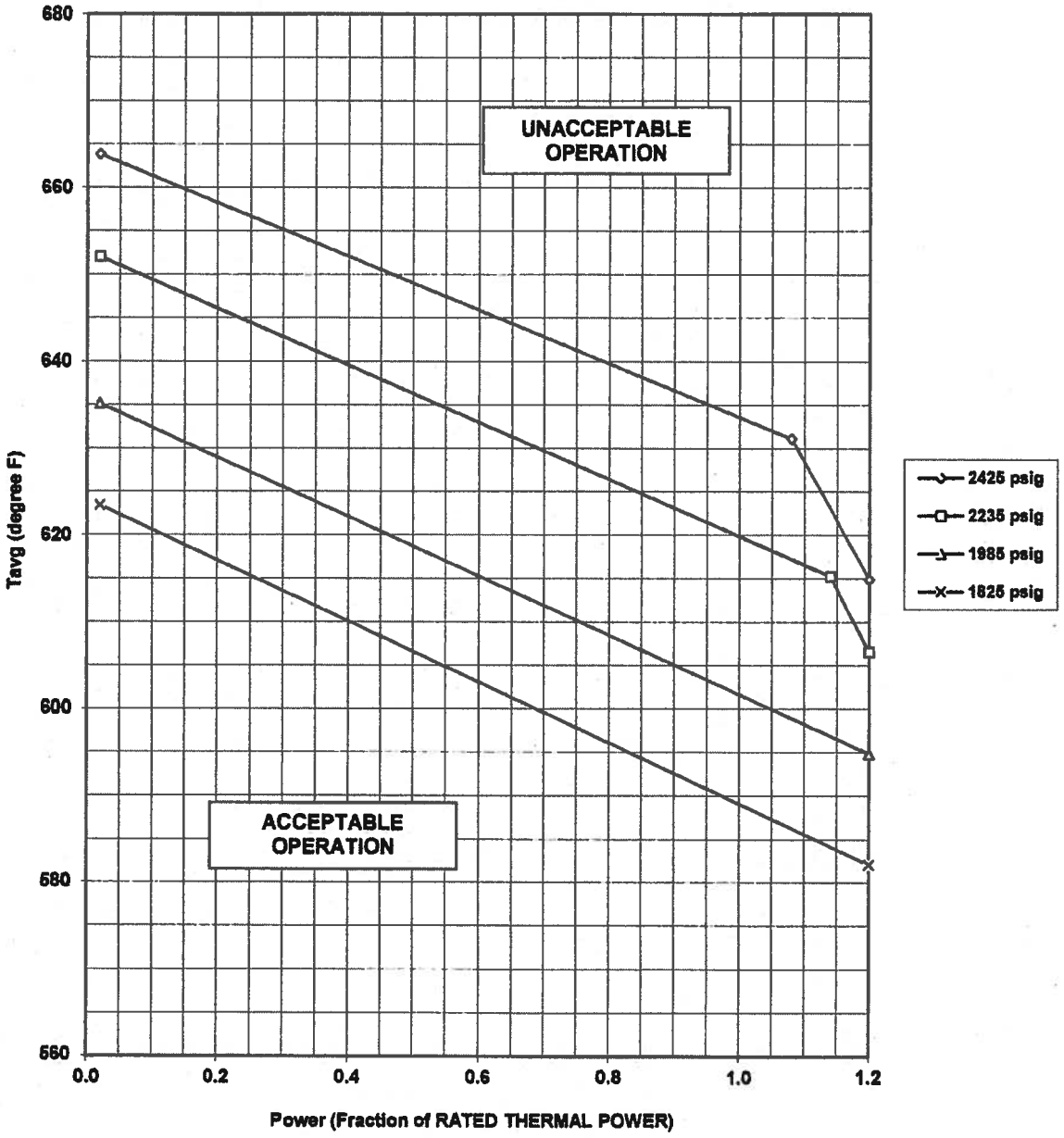
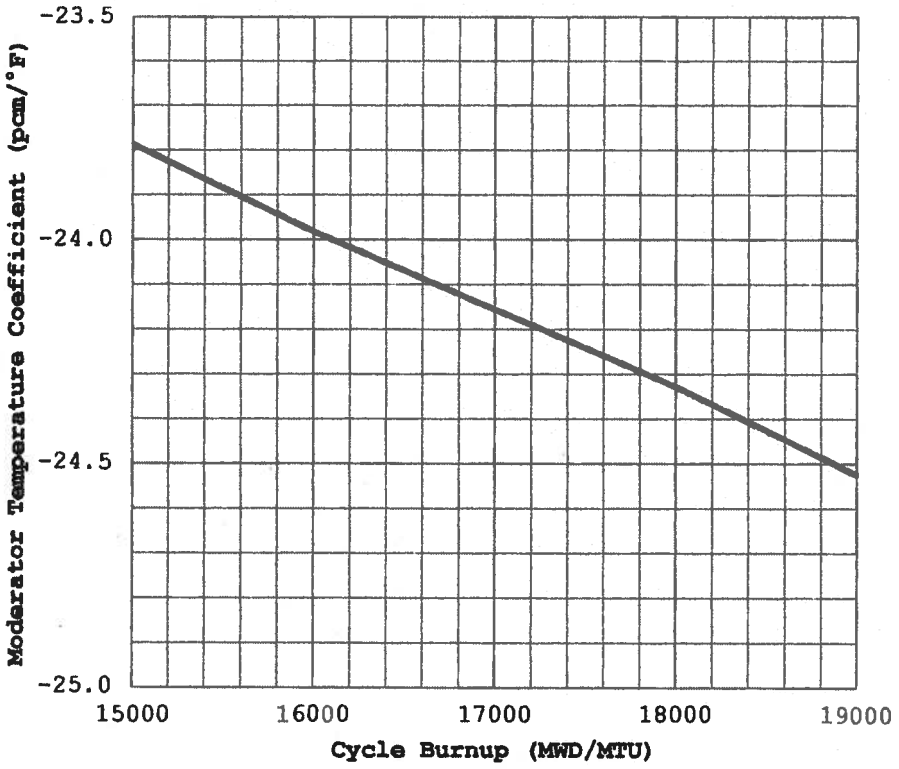


Figure 5
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
15000	-23.79
16000	-23.98
17000	-24.16
18000	-24.33
19000	-24.53

Joseph M. Farley Nuclear Plant (Farley), Units 1 & 2
Vogtle Electric Generating Plant (Vogtle), Units 1 & 2
Farley Unit 1 Cycle 27 Core Operating Limits Report Version 2
Farley Unit 2 Cycle 24 Core Operating Limits Report Version 2
Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1
Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

Enclosure 3

Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP Unit 1 Cycle 20 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 $F_Q(Z) \leq \frac{F_Q^{RTP}}{P} \cdot K(Z)$ for P > 0.5

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

$F_Q(Z) \leq \frac{F_Q^{RTP} \cdot K(Z)}{0.5 \cdot W(Z)}$ for P ≤ 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 1858 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
368	1.0200
585	1.0265
803	1.0362
1020	1.0391
1238	1.0397
1456	1.0390
1673	1.0373
1891	1.0325
2108	1.0265
2326	1.0204
2543	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	12000 MWD/MTU	20000 MWD/MTU
*	1-5	12.072 – 11.267	1.0000	1.0000	1.0000	1.0000
	6	11.066	1.2889	1.3865	1.2757	1.2190
	7	10.865	1.2870	1.3819	1.2725	1.2195
	8	10.664	1.2663	1.3741	1.2626	1.2031
	9	10.462	1.2531	1.3609	1.2494	1.1825
	10	10.261	1.2461	1.3382	1.2366	1.1728
	11	10.060	1.2291	1.3119	1.2220	1.1732
	12	9.859	1.2297	1.2875	1.2047	1.1759
	13	9.658	1.2289	1.2619	1.1871	1.1798
	14	9.456	1.2297	1.2497	1.1812	1.1834
	15	9.255	1.2208	1.2500	1.1786	1.1855
	16	9.054	1.2199	1.2453	1.1798	1.1904
	17	8.853	1.2305	1.2358	1.1797	1.2035
	18	8.652	1.2319	1.2267	1.1807	1.2172
	19	8.450	1.2325	1.2171	1.1880	1.2283
	20	8.249	1.2333	1.2096	1.1944	1.2408
	21	8.048	1.2390	1.2026	1.1987	1.2528
	22	7.847	1.2418	1.1962	1.2011	1.2634
	23	7.646	1.2411	1.1942	1.2014	1.2753
	24	7.444	1.2384	1.1893	1.2006	1.2846
	25	7.243	1.2327	1.1817	1.1966	1.2887
	26	7.042	1.2250	1.1721	1.1904	1.2889
	27	6.841	1.2157	1.1615	1.1833	1.2869
	28	6.640	1.2042	1.1491	1.1757	1.2822
	29	6.438	1.1916	1.1368	1.1689	1.2749
	30	6.237	1.1791	1.1330	1.1621	1.2648
	31	6.036	1.1681	1.1293	1.1546	1.2528
	32	5.835	1.1593	1.1247	1.1463	1.2414
	33	5.634	1.1498	1.1199	1.1459	1.2337
	34	5.432	1.1423	1.1193	1.1524	1.2291
	35	5.231	1.1443	1.1259	1.1602	1.2294
	36	5.030	1.1481	1.1348	1.1669	1.2294
	37	4.829	1.1511	1.1430	1.1728	1.2297
	38	4.628	1.1536	1.1509	1.1776	1.2288
	39	4.426	1.1565	1.1582	1.1814	1.2259
	40	4.225	1.1585	1.1646	1.1840	1.2214
	41	4.024	1.1597	1.1705	1.1859	1.2155
	42	3.823	1.1599	1.1756	1.1859	1.2069
	43	3.622	1.1607	1.1798	1.1881	1.1951
	44	3.420	1.1645	1.1837	1.1931	1.1874
	45	3.219	1.1686	1.1850	1.1957	1.1804
	46	3.018	1.1704	1.1968	1.2033	1.1837
	47	2.817	1.1807	1.2169	1.2177	1.1961
	48	2.616	1.1962	1.2373	1.2328	1.2086
	49	2.414	1.2113	1.2599	1.2476	1.2211
	50	2.213	1.2264	1.2835	1.2623	1.2336
	51	2.012	1.2416	1.3069	1.2759	1.2443
	52	1.811	1.2565	1.3301	1.2889	1.2543
	53	1.610	1.2706	1.3521	1.3015	1.2649
	54	1.408	1.2842	1.3729	1.3136	1.2760
	55	1.207	1.2971	1.3924	1.3251	1.2871
	56	1.006	1.3093	1.4100	1.3359	1.2985
*	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)

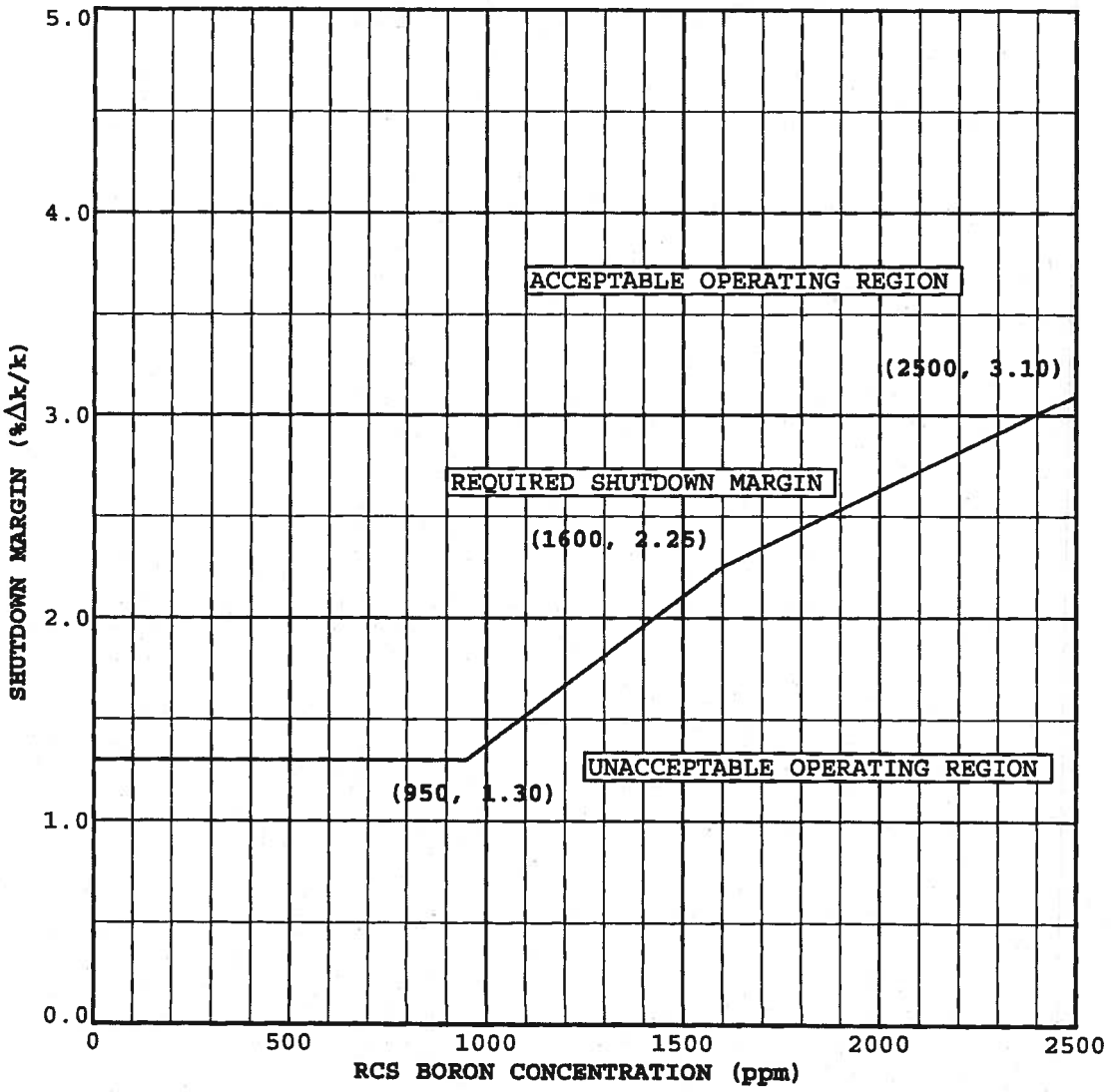


FIGURE 2
REQUIRED SHUTDOWN MARGIN FOR MODES 4 AND 5 (MODE 4 WHEN FIGURE 1 NOT APPLICABLE)

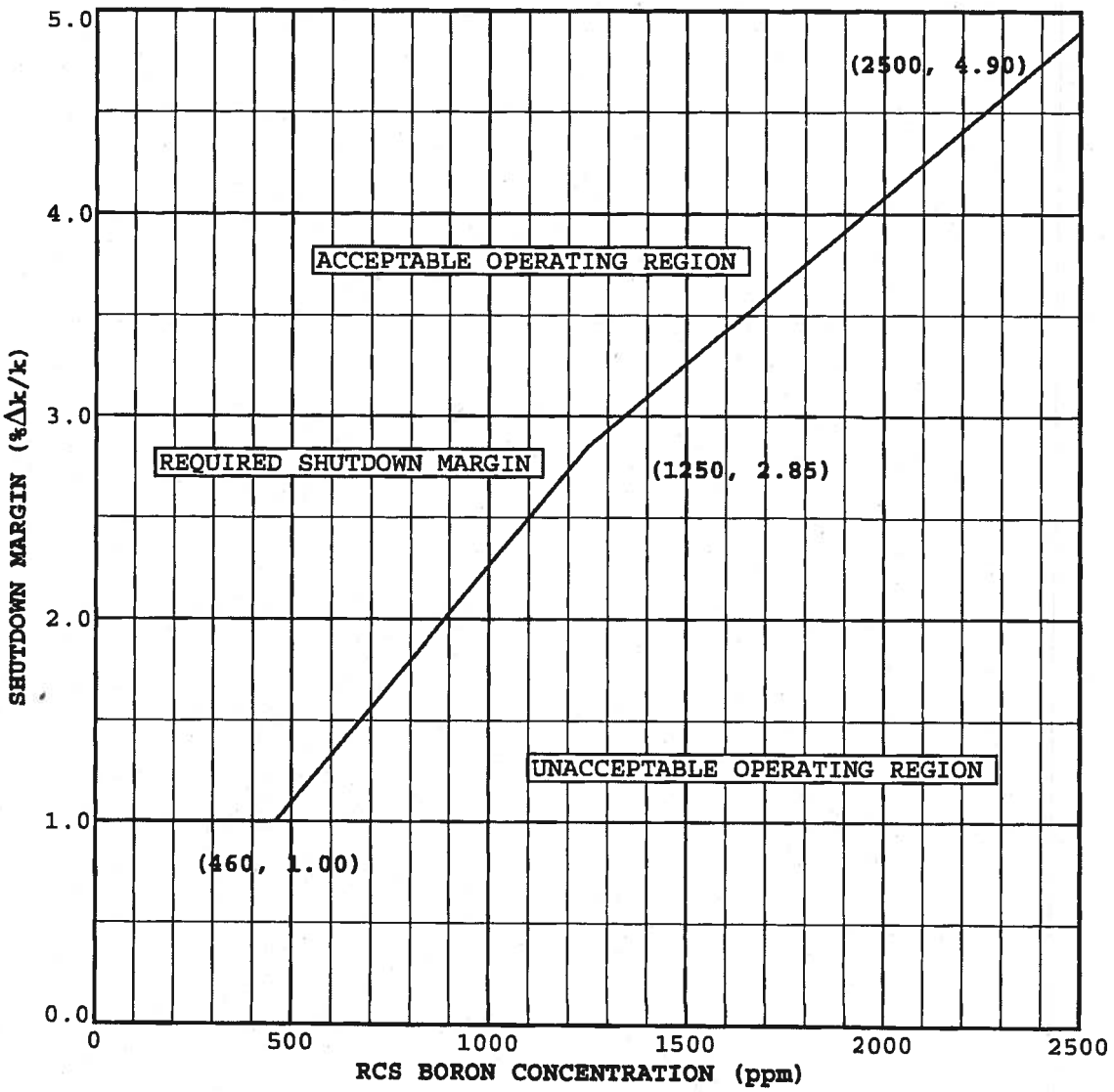
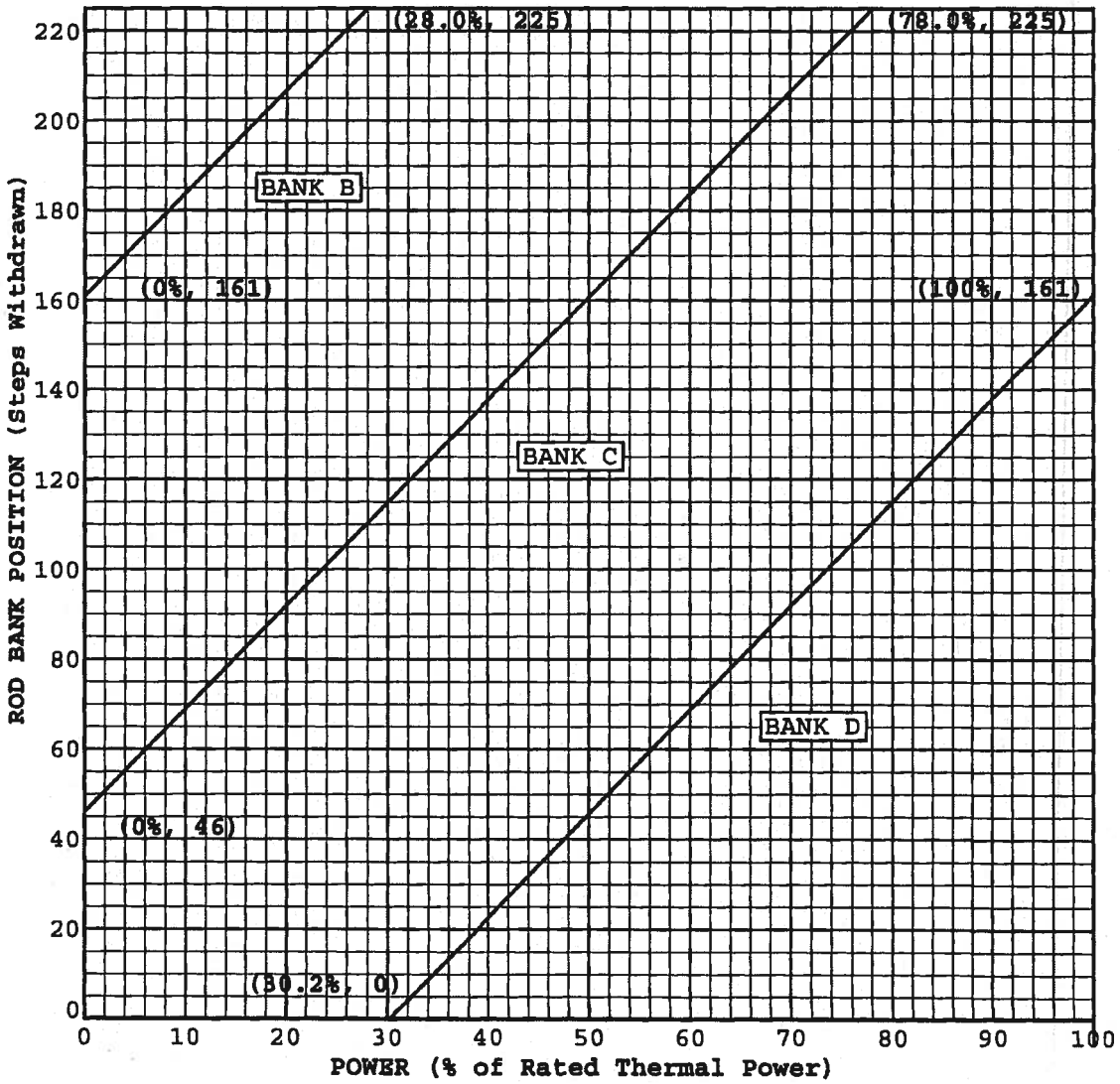


FIGURE 3
ROD BANK INSERTION LIMITS VERSUS % OF RATED THERMAL POWER

(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

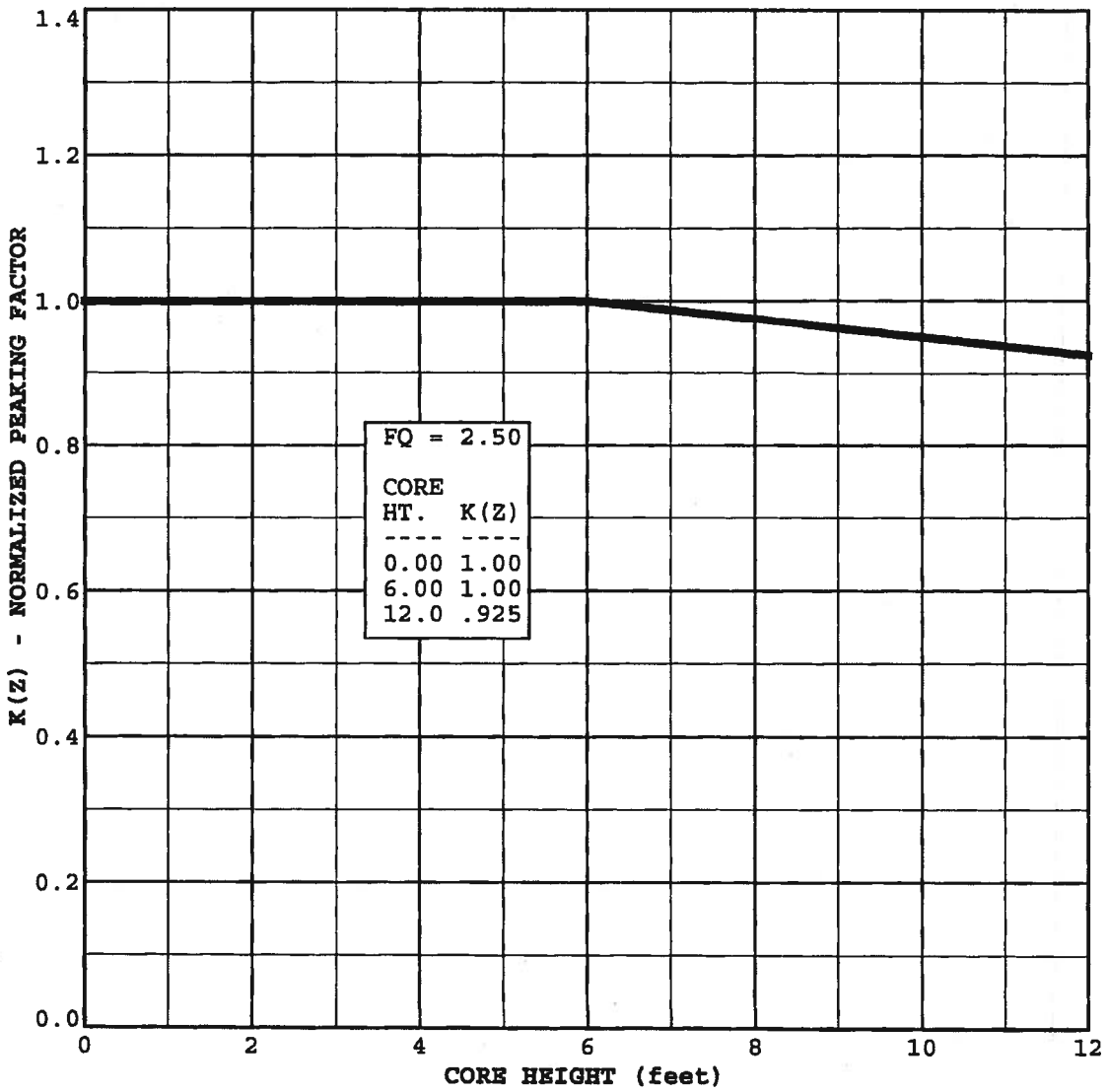


FIGURE 5
AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF % RATED THERMAL POWER FOR RAOC

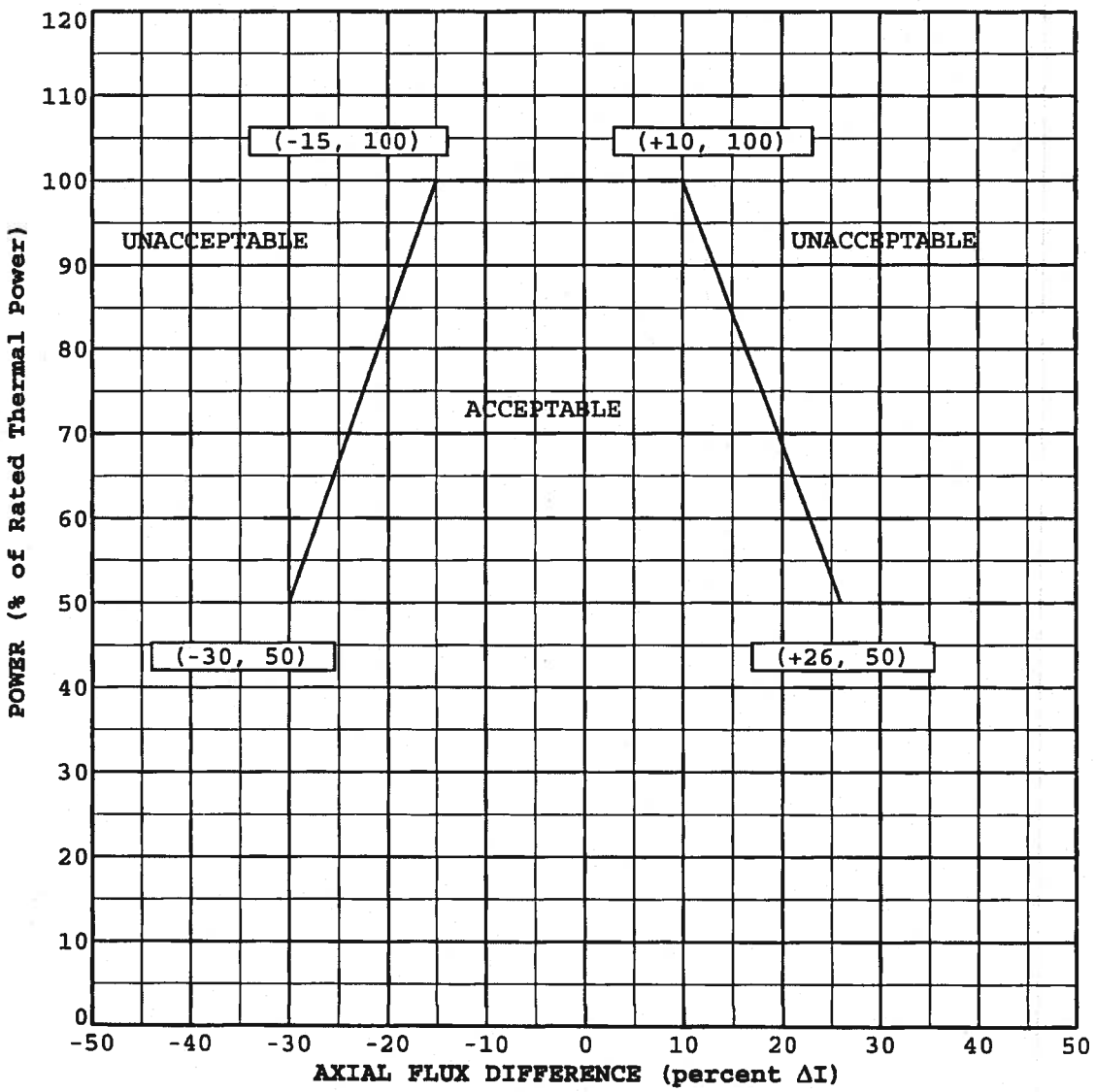
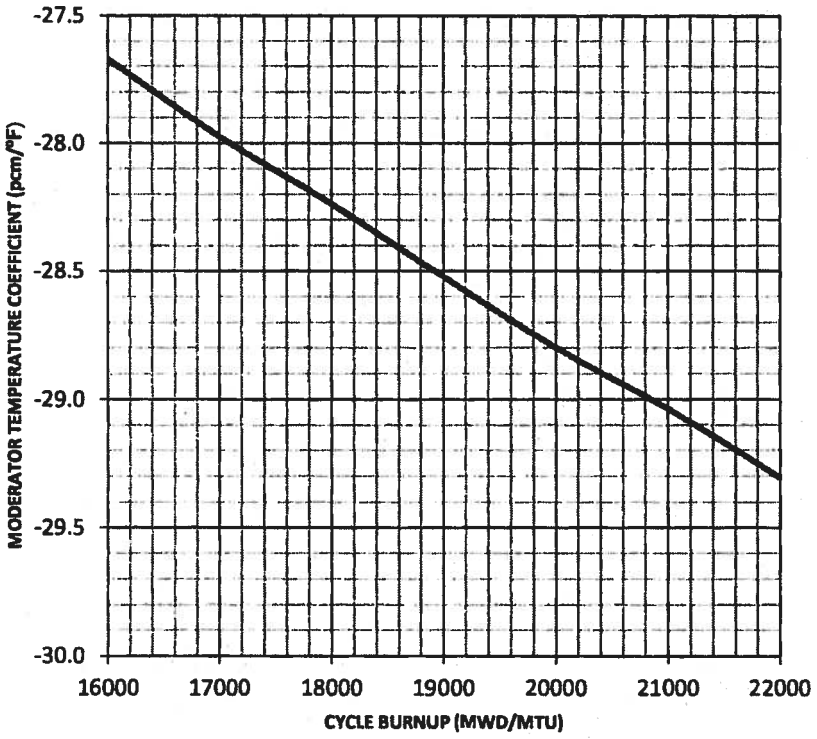


FIGURE 6
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
16000	-27.67
17000	-27.97
18000	-28.24
19000	-28.52
20000	-28.80
21000	-29.04
22000	-29.31

Joseph M. Farley Nuclear Plant (Farley), Units 1 & 2
Vogtle Electric Generating Plant (Vogtle), Units 1 & 2
Farley Unit 1 Cycle 27 Core Operating Limits Report Version 2
Farley Unit 2 Cycle 24 Core Operating Limits Report Version 2
Vogtle Unit 1 Cycle 20 Core Operating Limits Report Version 1
Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

Enclosure 4

Vogtle Unit 2 Cycle 18 Core Operating Limits Report Version 2

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for VEGP Unit 2 Cycle 18 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 583.8 to 586.8 °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 $F_Q(Z) \leq \frac{F_Q^{RTP}}{P} \cdot K(Z)$ for P > 0.5

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

$F_Q(Z) \leq \frac{F_Q^{RTP} \cdot K(Z)}{0.5 \cdot W(Z)}$ for P ≤ 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 1793 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. The boron concentration includes credit for Samarium.

Table 1
$F_Q(Z)$ PENALTY FACTOR

Cycle Burnup (MWD/MTU)	$F_Q(Z)$ Penalty Factor
0	1.0591
150	1.0591
368	1.0628
585	1.0652
803	1.0661
1020	1.0640
1455	1.0495
1890	1.0338
2325	1.0200
5806	1.0200

Cycle Burnup (MWD/MTU)	$F_Q(Z)$ Penalty Factor
6241	1.0259
6458	1.0265
6893	1.0241
7111	1.0243
7328	1.0244
7546	1.0243
7763	1.0241
8199	1.0236
8416	1.0233
8851	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	12000 MWD/MTU	20000 MWD/MTU
*	1-5	12.072 – 11.267	1.0000	1.0000	1.0000	1.0000
	6	11.066	1.3351	1.3680	1.2203	1.2465
	7	10.865	1.3271	1.3584	1.2230	1.2436
	8	10.664	1.3071	1.3490	1.2236	1.2326
	9	10.462	1.2854	1.3357	1.2229	1.2175
	10	10.261	1.2690	1.3157	1.2226	1.2050
	11	10.060	1.2510	1.2939	1.2232	1.1937
	12	9.859	1.2304	1.2708	1.2266	1.1974
	13	9.658	1.2306	1.2469	1.2197	1.2013
	14	9.456	1.2273	1.2308	1.2121	1.2046
	15	9.255	1.2252	1.2187	1.2096	1.2073
	16	9.054	1.2213	1.2042	1.2054	1.2108
	17	8.853	1.2197	1.1924	1.1938	1.2112
	18	8.652	1.2201	1.1927	1.1869	1.2104
	19	8.450	1.2238	1.1965	1.1904	1.2138
	20	8.249	1.2239	1.1984	1.1944	1.2237
	21	8.048	1.2287	1.1986	1.2037	1.2395
	22	7.847	1.2299	1.1962	1.2096	1.2518
	23	7.646	1.2288	1.1921	1.2136	1.2623
	24	7.444	1.2256	1.1867	1.2160	1.2712
	25	7.243	1.2196	1.1789	1.2149	1.2758
	26	7.042	1.2114	1.1695	1.2111	1.2768
	27	6.841	1.2018	1.1590	1.2056	1.2757
	28	6.640	1.1908	1.1506	1.1989	1.2728
	29	6.438	1.1783	1.1417	1.1902	1.2700
	30	6.237	1.1655	1.1326	1.1810	1.2654
	31	6.036	1.1548	1.1257	1.1711	1.2595
	32	5.835	1.1466	1.1209	1.1605	1.2521
	33	5.634	1.1383	1.1165	1.1607	1.2430
	34	5.432	1.1349	1.1188	1.1627	1.2376
	35	5.231	1.1362	1.1290	1.1700	1.2380
	36	5.030	1.1418	1.1378	1.1765	1.2409
	37	4.829	1.1465	1.1464	1.1821	1.2415
	38	4.628	1.1517	1.1544	1.1865	1.2401
	39	4.426	1.1569	1.1619	1.1898	1.2367
	40	4.225	1.1610	1.1685	1.1917	1.2315
	41	4.024	1.1642	1.1744	1.1929	1.2249
	42	3.823	1.1673	1.1795	1.1935	1.2154
	43	3.622	1.1729	1.1835	1.1930	1.2032
	44	3.420	1.1789	1.1882	1.1915	1.1906
	45	3.219	1.1835	1.1925	1.1899	1.1771
	46	3.018	1.1873	1.2046	1.1930	1.1743
	47	2.817	1.1934	1.2243	1.2051	1.1825
	48	2.616	1.2079	1.2478	1.2186	1.1945
	49	2.414	1.2243	1.2721	1.2317	1.2062
	50	2.213	1.2404	1.2968	1.2449	1.2181
	51	2.012	1.2567	1.3215	1.2571	1.2282
	52	1.811	1.2728	1.3459	1.2687	1.2378
	53	1.610	1.2883	1.3691	1.2801	1.2480
	54	1.408	1.3032	1.3911	1.2913	1.2588
	55	1.207	1.3175	1.4117	1.3020	1.2697
	56	1.006	1.3310	1.4303	1.3123	1.2811
*	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 583.8 to 586.8°F.

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

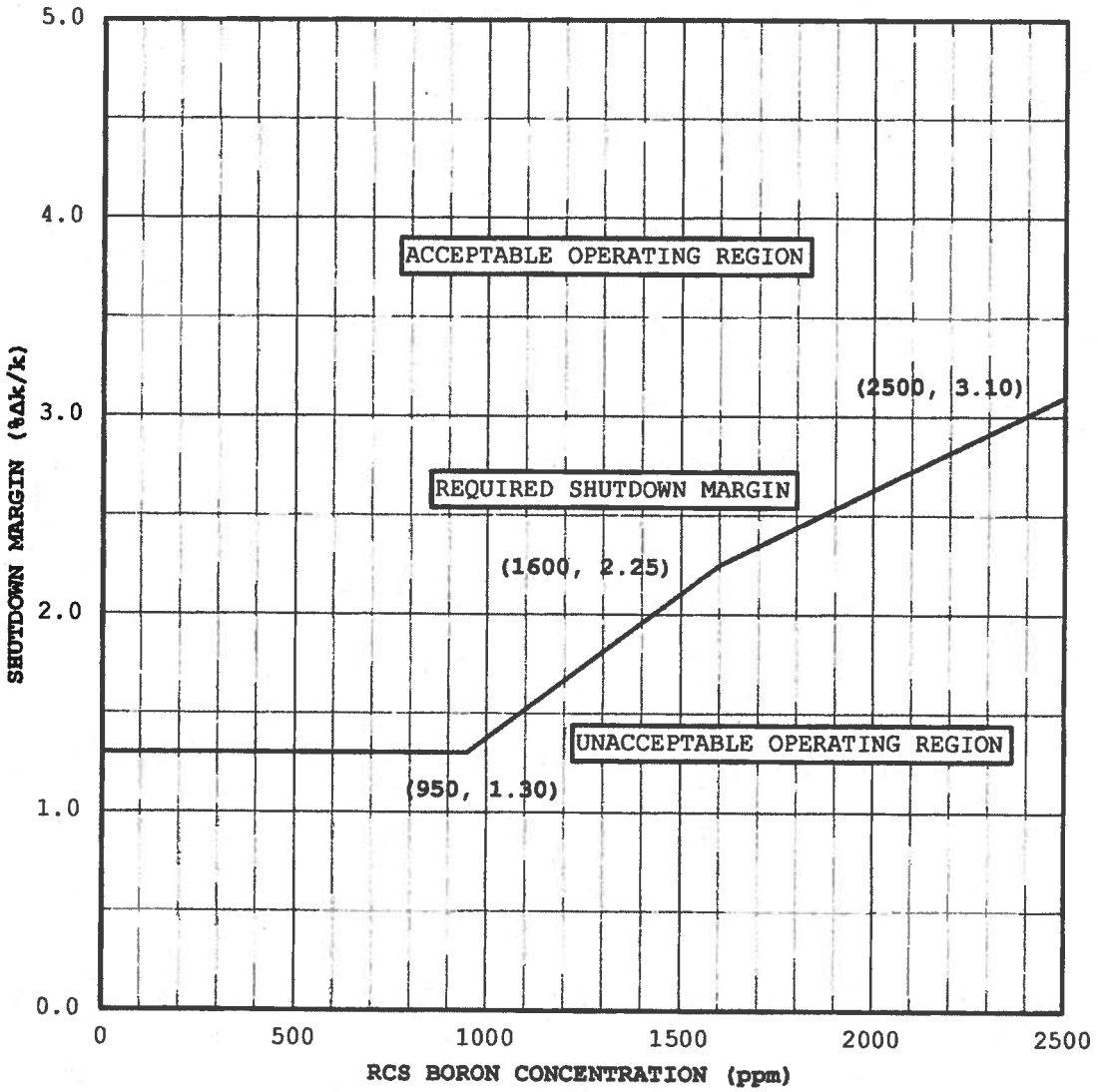


FIGURE 2
REQUIRED SHUTDOWN MARGIN FOR MODES 4 AND 5 (MODE 4 WHEN FIGURE 1 NOT APPLICABLE)

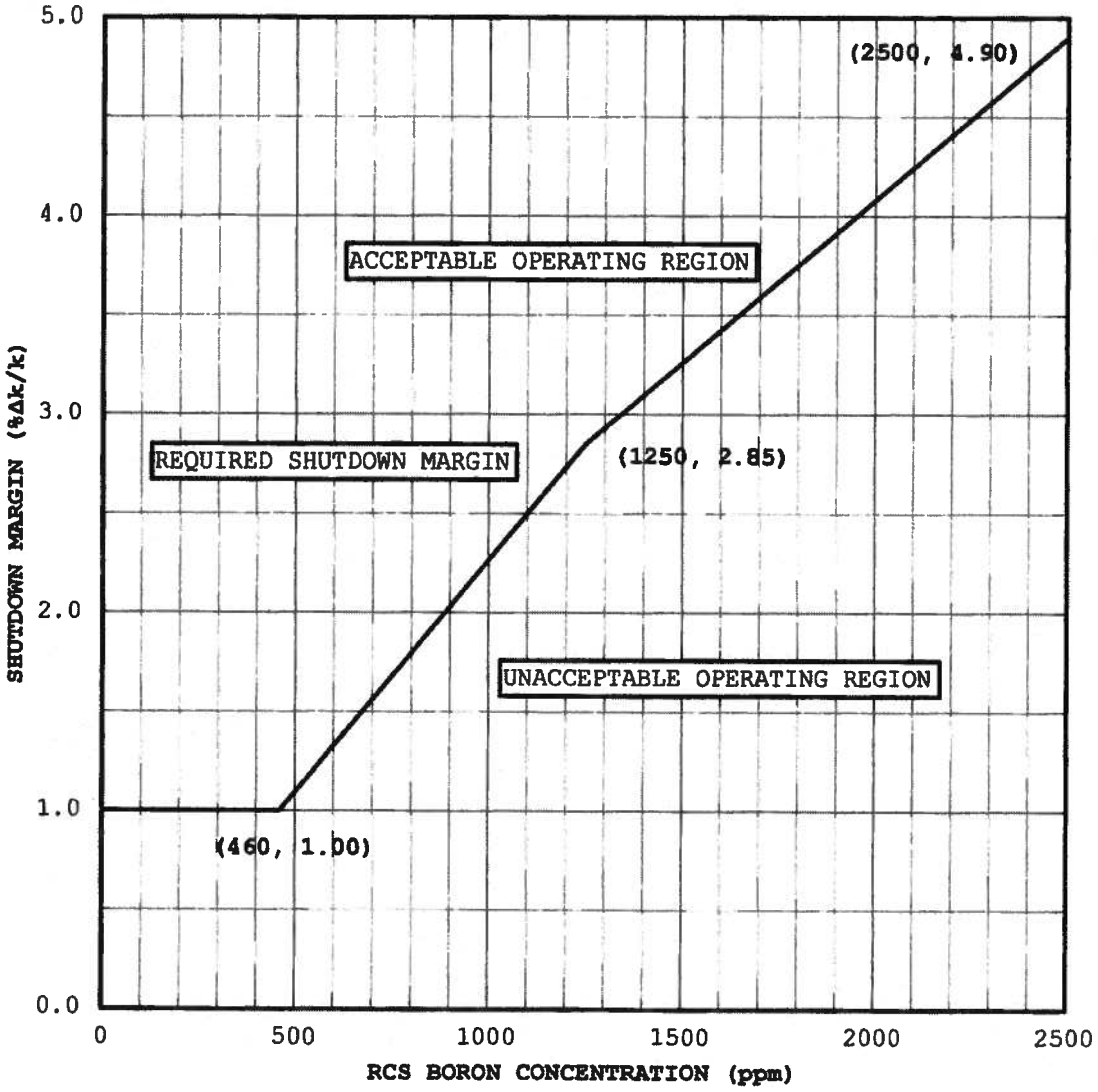
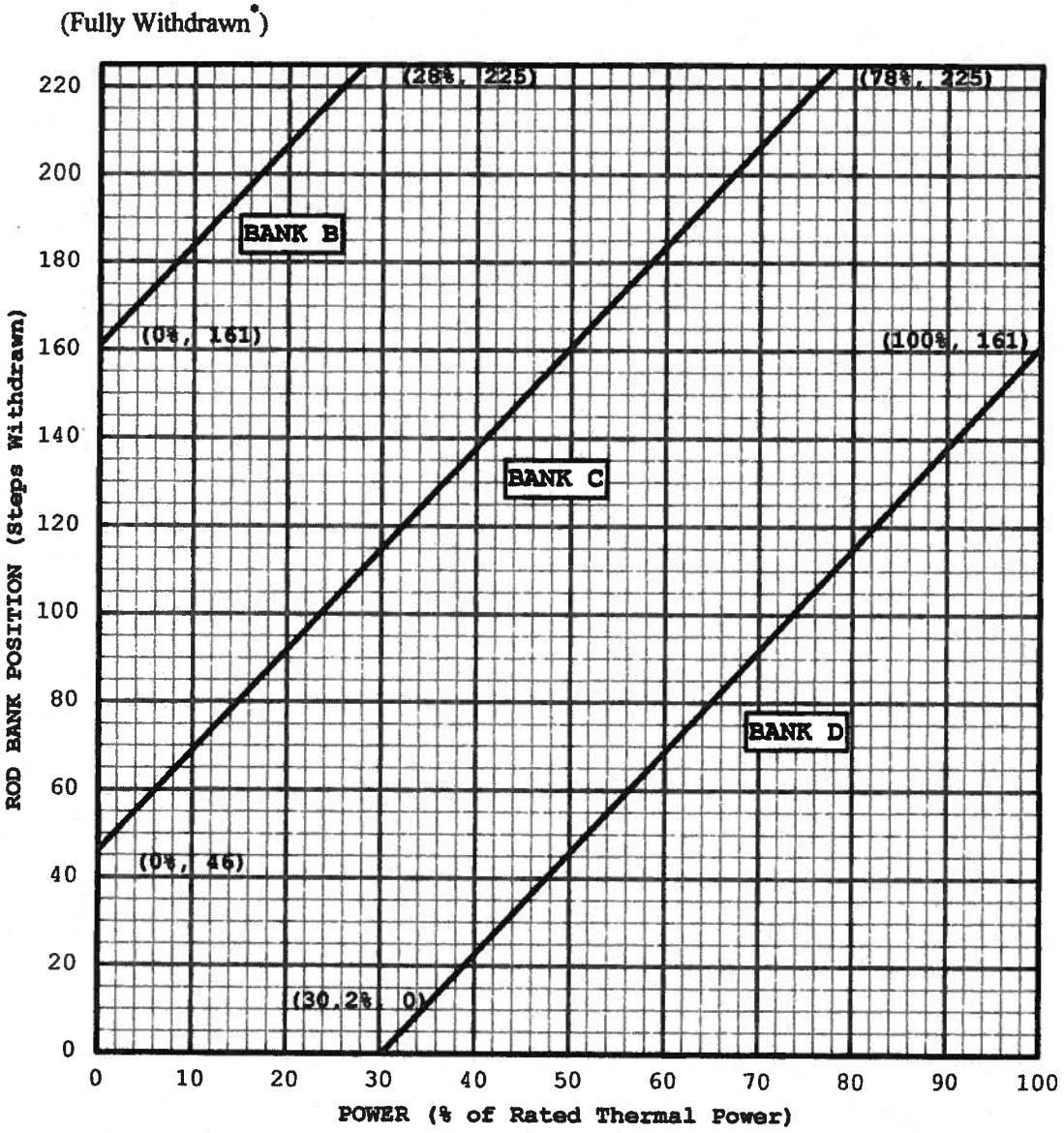


FIGURE 3
ROD BANK INSERTION LIMITS VERSUS % OF RATED THERMAL POWER



*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

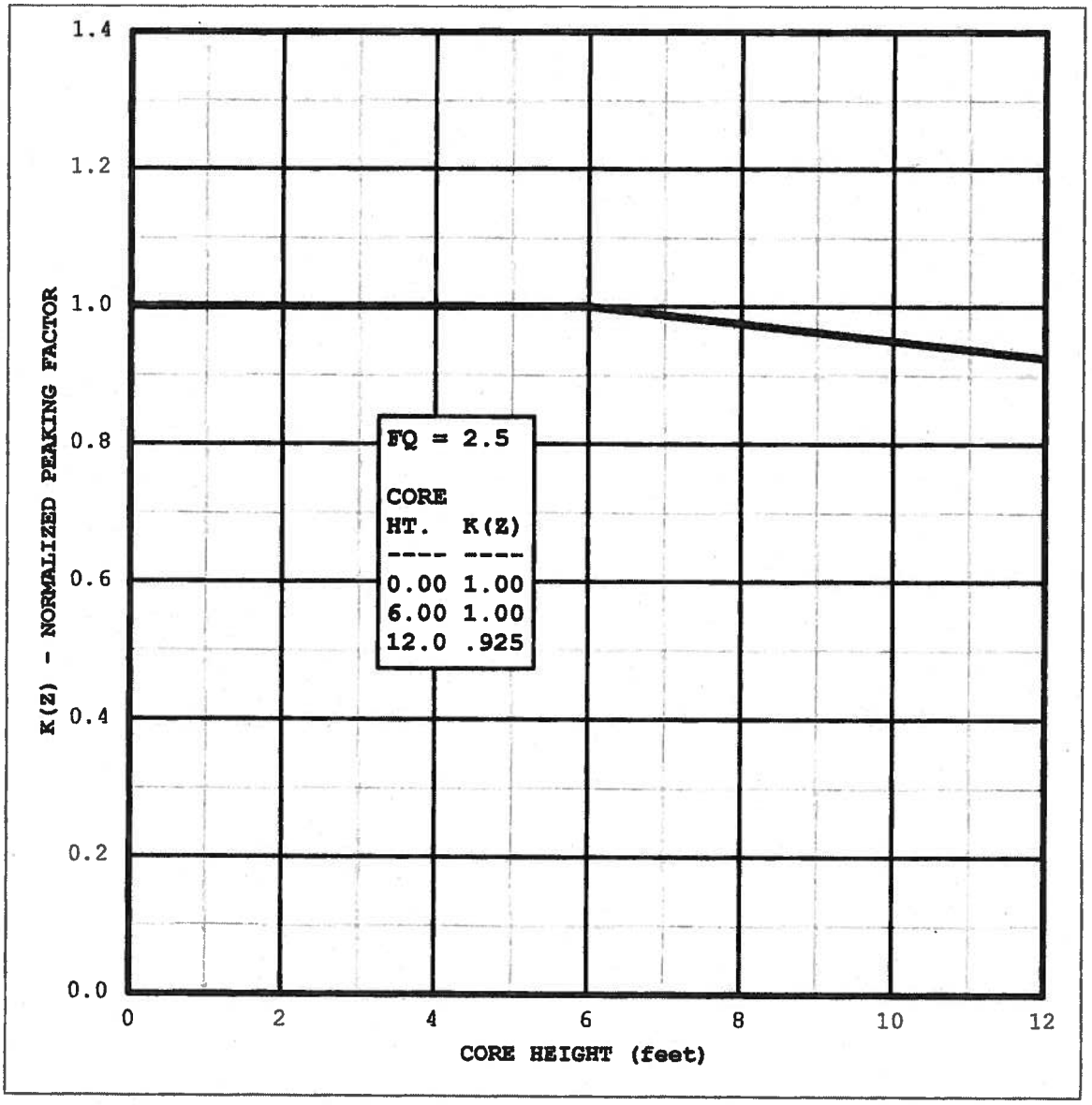


FIGURE 5
AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF % RATED THERMAL POWER FOR RAOC

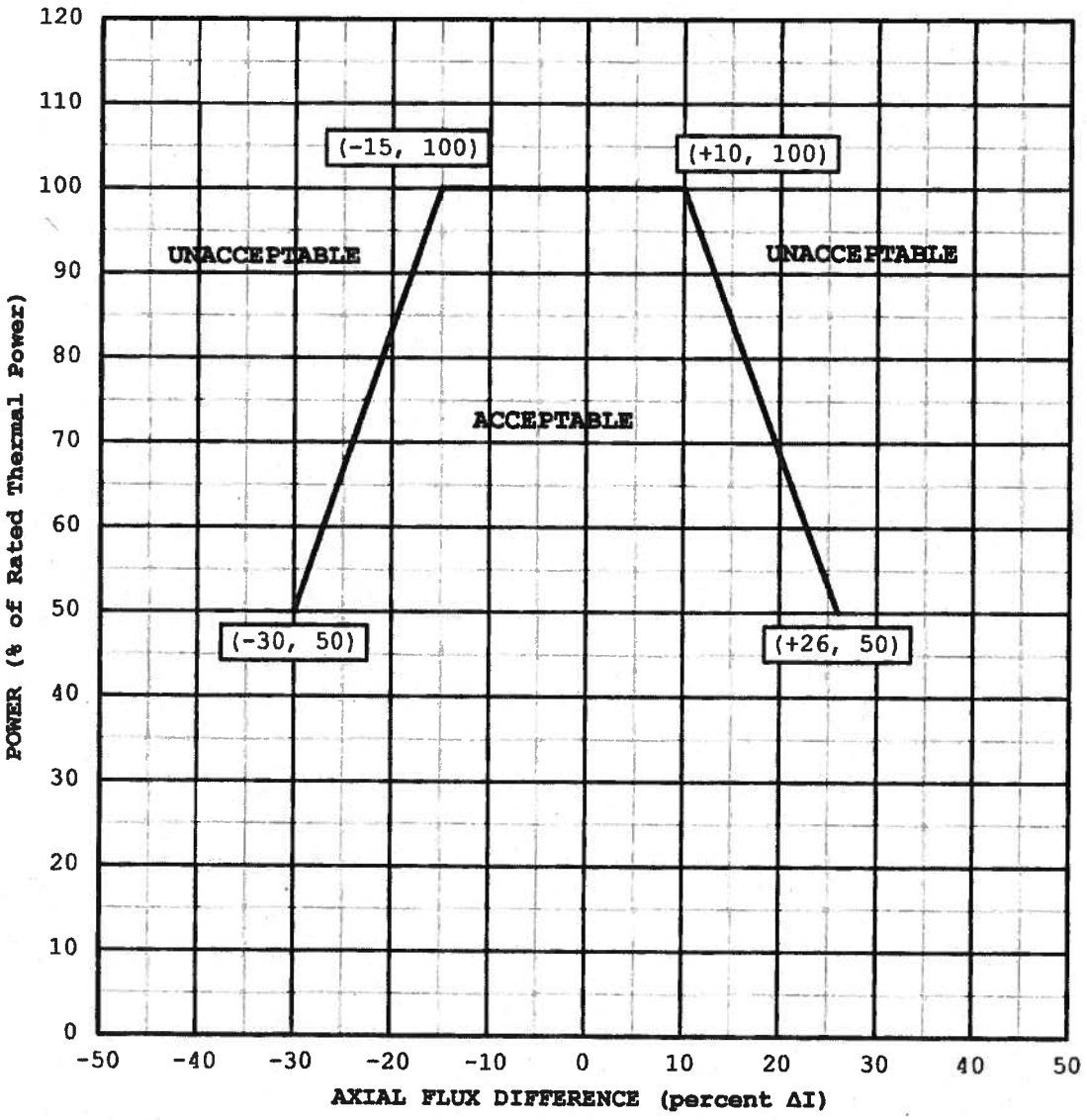
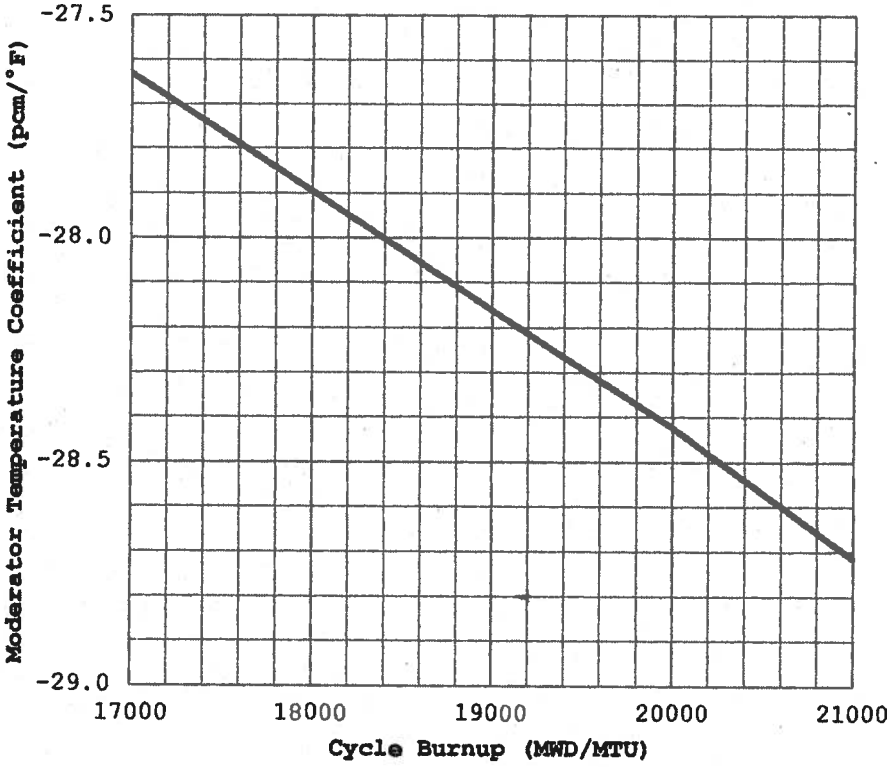


FIGURE 6
Predicted HFP 300 ppm MTC vs Cycle Burnup



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
17000	-27.63
18000	-27.90
19000	-28.16
20000	-28.42
21000	-28.72