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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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Joseph M. Farley Nuclear Plant – Unit 2
Cycle 25 Core Operating Limits Report

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 Joseph M. Farley Nuclear Plant (FNP) – Unit 2 Cycle 25 Version 1.

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

Sincerely,

C. R. Pierce

C.R. Pierce
Regulatory Affairs Director

CRP/RMJ

Enclosure: Core Operating Limits Report for FNP Unit 2 Cycle 25 Version 1

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Joseph M. Farley Nuclear Plant – Unit 2
Cycle 25 Core Operating Limits Report

Enclosure

Core Operating Limits Report for FNP Unit 2 Cycle 25 Version 1

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 2 CYCLE 25 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 - $F_{\Delta H}^N$
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 $+0.7 \times 10^{-4}$ $\Delta k/k/°F$ for power levels up to 70 percent RTP with a linear ramp to 0 $\Delta k/k/°F$ at 100 percent RTP.

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

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} $\Delta k/k/°F$.

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} $\Delta k/k/°F$.

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

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

$F_Q(Z) \le \frac{F_Q^{RTP} * K(Z)}{0.5 * W(Z)}$ 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.

[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	1.0206
150	1.0206
354	1.0200
5668	1.0200
5872	1.0254
6077	1.0290
6281	1.0276
6485	1.0255
6690	1.0238
6894	1.0257
7098	1.0218

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	4000 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	1.1307	1.1469	1.2528	1.2222	1.2204
	7	10.80	1.1283	1.1481	1.2496	1.2174	1.2166
	8	10.60	1.1244	1.1441	1.2440	1.2055	1.2117
	9	10.40	1.1229	1.1521	1.2375	1.1992	1.2061
	10	10.20	1.1229	1.1609	1.2306	1.1984	1.2010
	11	10.00	1.1214	1.1672	1.2230	1.1976	1.1960
	12	9.80	1.1195	1.1699	1.2179	1.1960	1.1905
	13	9.60	1.1172	1.1689	1.2199	1.1934	1.1884
	14	9.40	1.1144	1.1658	1.2163	1.1901	1.1883
	15	9.20	1.1234	1.1586	1.2232	1.1898	1.1914
	16	9.00	1.1354	1.1588	1.2262	1.2000	1.2155
	17	8.80	1.1433	1.1541	1.2261	1.2037	1.2321
	18	8.60	1.1519	1.1549	1.2296	1.2087	1.2461
	19	8.40	1.1638	1.1658	1.2402	1.2213	1.2606
	20	8.20	1.1739	1.1738	1.2471	1.2348	1.2798
	21	8.00	1.1821	1.1800	1.2514	1.2453	1.2957
	22	7.80	1.1882	1.1842	1.2535	1.2533	1.3084
	23	7.60	1.1914	1.1858	1.2528	1.2585	1.3176
	24	7.40	1.1931	1.1860	1.2505	1.2621	1.3248
	25	7.20	1.1924	1.1837	1.2444	1.2616	1.3267
	26	7.00	1.1902	1.1797	1.2371	1.2588	1.3250
	27	6.80	1.1865	1.1745	1.2292	1.2555	1.3211
	28	6.60	1.1808	1.1676	1.2194	1.2502	1.3148
	29	6.40	1.1743	1.1599	1.2080	1.2430	1.3058
	30	6.20	1.1671	1.1513	1.1954	1.2339	1.2942
	31	6.00	1.1588	1.1419	1.1819	1.2234	1.2808
	32	5.80	1.1495	1.1338	1.1739	1.2118	1.2660
	33	5.60	1.1393	1.1300	1.1651	1.1994	1.2490
	34	5.40	1.1298	1.1275	1.1542	1.1955	1.2308
	35	5.20	1.1395	1.1362	1.1487	1.1933	1.2297
	36	5.00	1.1481	1.1451	1.1473	1.1896	1.2252
	37	4.80	1.1574	1.1537	1.1474	1.1855	1.2203
	38	4.60	1.1661	1.1617	1.1465	1.1823	1.2156
	39	4.40	1.1743	1.1692	1.1448	1.1777	1.2096
	40	4.20	1.1814	1.1758	1.1422	1.1720	1.2021
	41	4.00	1.1876	1.1816	1.1390	1.1652	1.1933
	42	3.80	1.1933	1.1865	1.1343	1.1563	1.1816
	43	3.60	1.1981	1.1906	1.1283	1.1459	1.1676
	44	3.40	1.2020	1.1933	1.1218	1.1347	1.1529
	45	3.20	1.2056	1.1988	1.1167	1.1256	1.1395
	46	3.00	1.2157	1.2073	1.1144	1.1188	1.1251
	47	2.80	1.2277	1.2281	1.1187	1.1184	1.1281
	48	2.60	1.2429	1.2563	1.1296	1.1276	1.1390
	49	2.40	1.2657	1.2844	1.1411	1.1389	1.1518
	50	2.20	1.2904	1.3130	1.1527	1.1499	1.1654
	51	2.00	1.3148	1.3413	1.1635	1.1598	1.1774
	52	1.80	1.3389	1.3693	1.1741	1.1694	1.1887
	53	1.60	1.3616	1.3956	1.1847	1.1792	1.2005
	54	1.40	1.3830	1.4204	1.1951	1.1893	1.2127
	55	1.20	1.4029	1.4433	1.2051	1.1992	1.2247
	56	1.00	1.4210	1.4638	1.2147	1.2090	1.2368
*	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.**

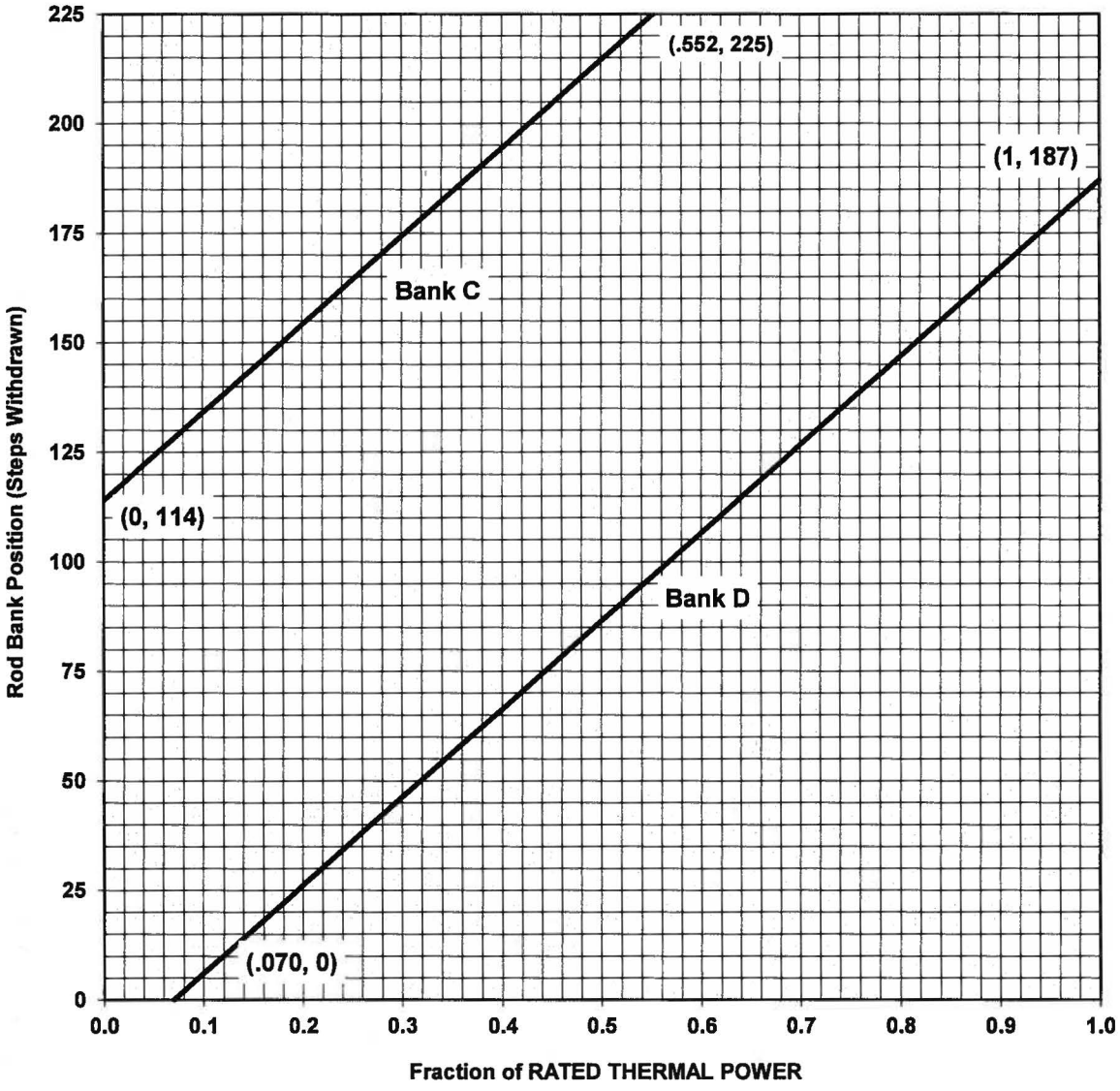
Table 5
Part Power (48%) RAOC W(Z)

	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	1.2226
	7	10.80	1.2079
	8	10.60	1.1916
	9	10.40	1.1774
	10	10.20	1.1626
	11	10.00	1.1454
	12	9.80	1.1240
	13	9.60	1.1027
	14	9.40	1.0837
	15	9.20	1.0787
	16	9.00	1.0773
	17	8.80	1.0741
	18	8.60	1.0740
	19	8.40	1.0774
	20	8.20	1.0874
	21	8.00	1.0855
	22	7.80	1.0878
	23	7.60	1.0881
	24	7.40	1.0884
	25	7.20	1.0862
	26	7.00	1.0834
	27	6.80	1.0817
	28	6.60	1.0789
	29	6.40	1.0764
	30	6.20	1.0729
	31	6.00	1.0689
	32	5.80	1.0644
	33	5.60	1.0598
	34	5.40	1.0566
	35	5.20	1.0713
	36	5.00	1.0852
	37	4.80	1.0999
	38	4.60	1.1143
	39	4.40	1.1282
	40	4.20	1.1413
	41	4.00	1.1532
	42	3.80	1.1656
	43	3.60	1.1774
	44	3.40	1.1888
	45	3.20	1.1999
	46	3.00	1.2175
	47	2.80	1.2370
	48	2.60	1.2585
	49	2.40	1.2884
	50	2.20	1.3214
	51	2.00	1.3541
	52	1.80	1.3862
	53	1.60	1.4173
	54	1.40	1.4472
	55	1.20	1.4755
	56	1.00	1.5016
*	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

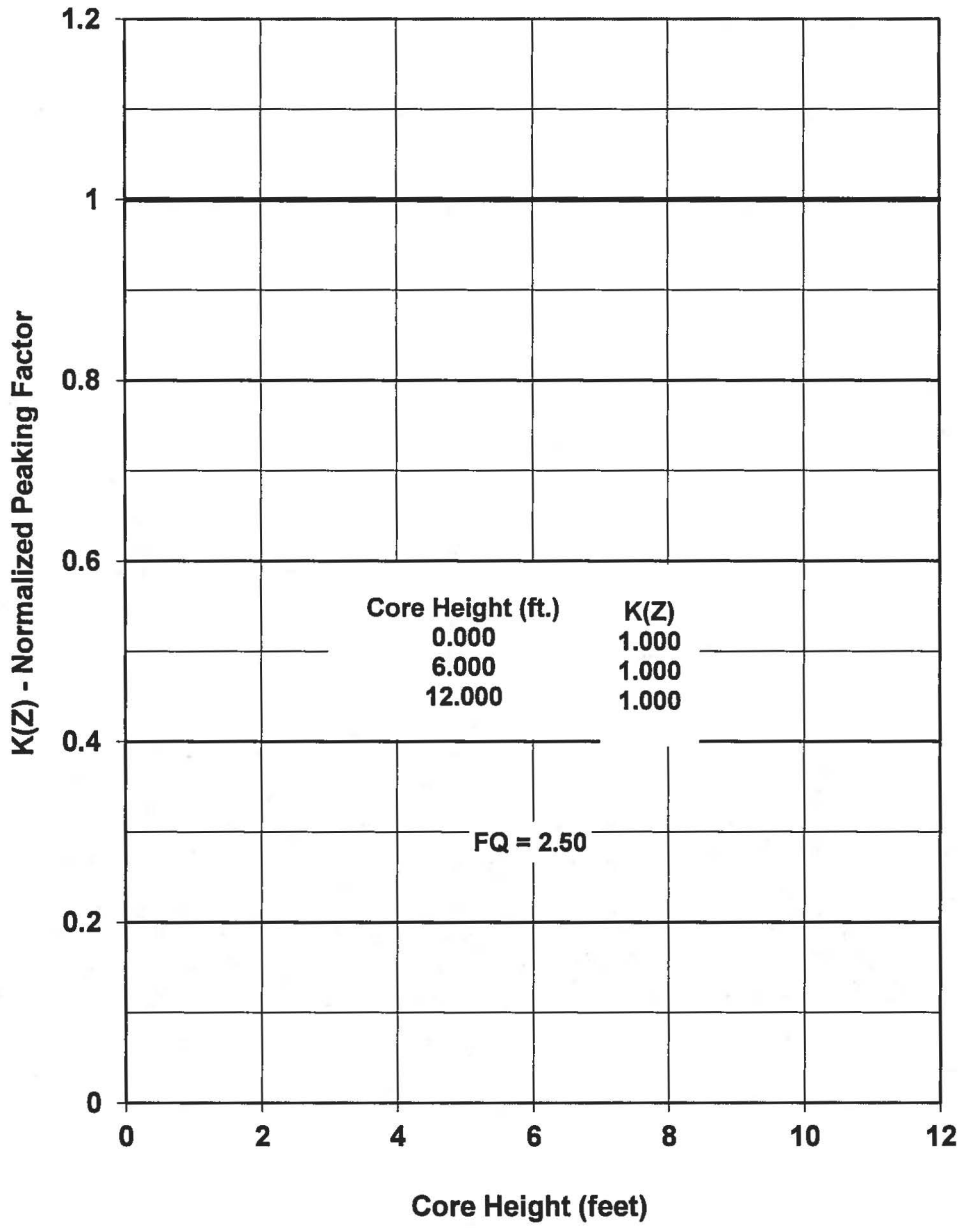


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

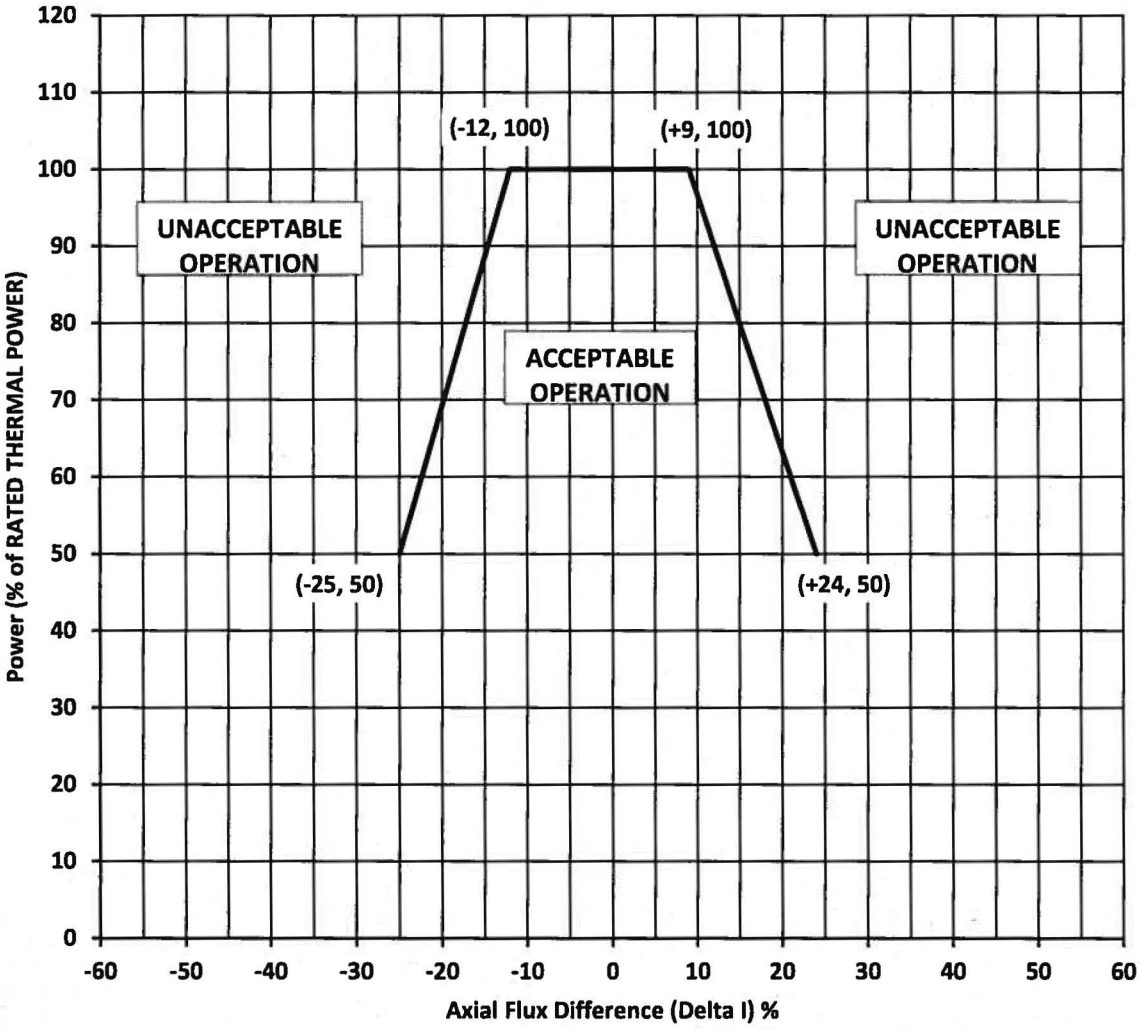


Figure 4
Reactor Core Safety Limits

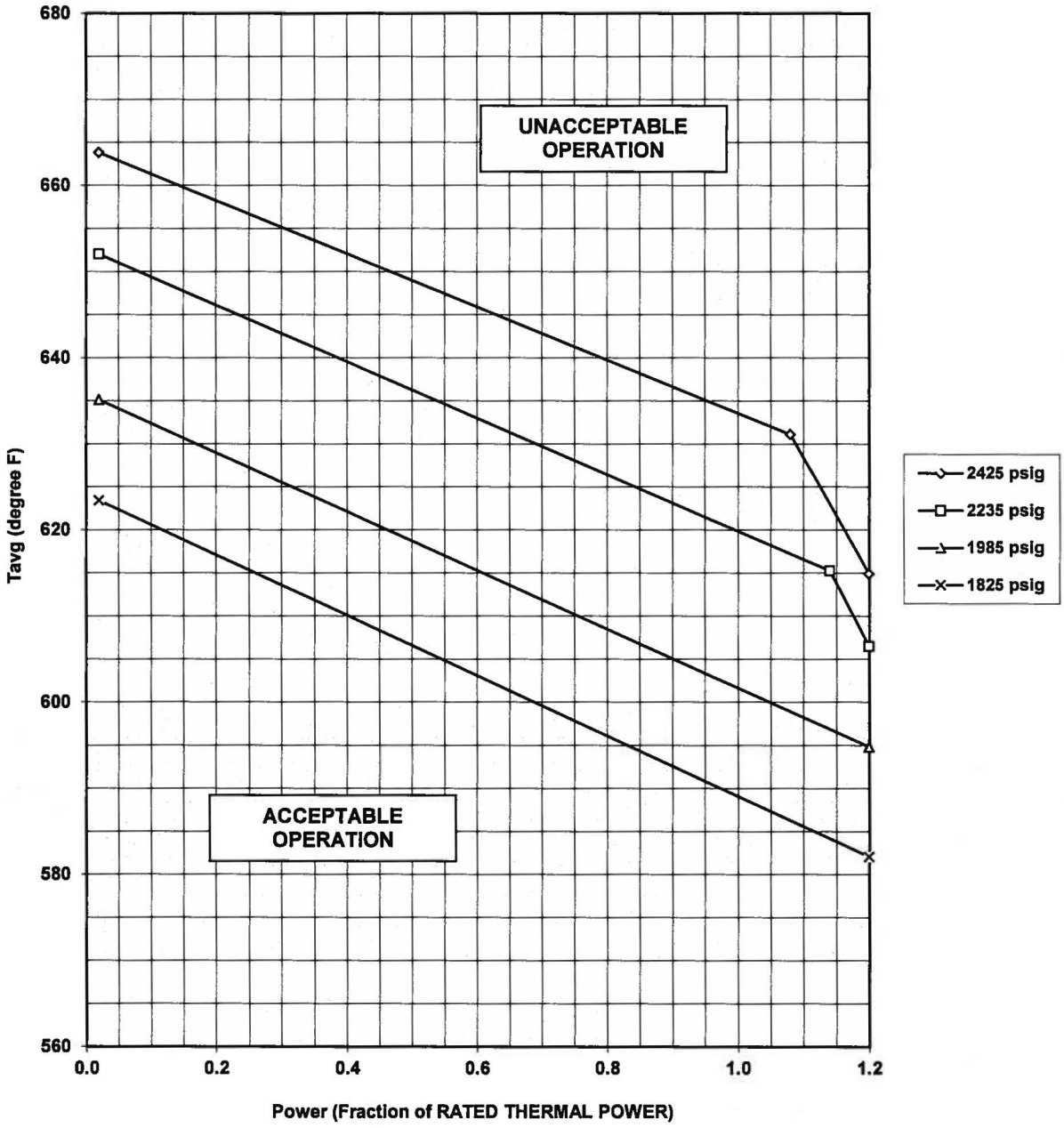
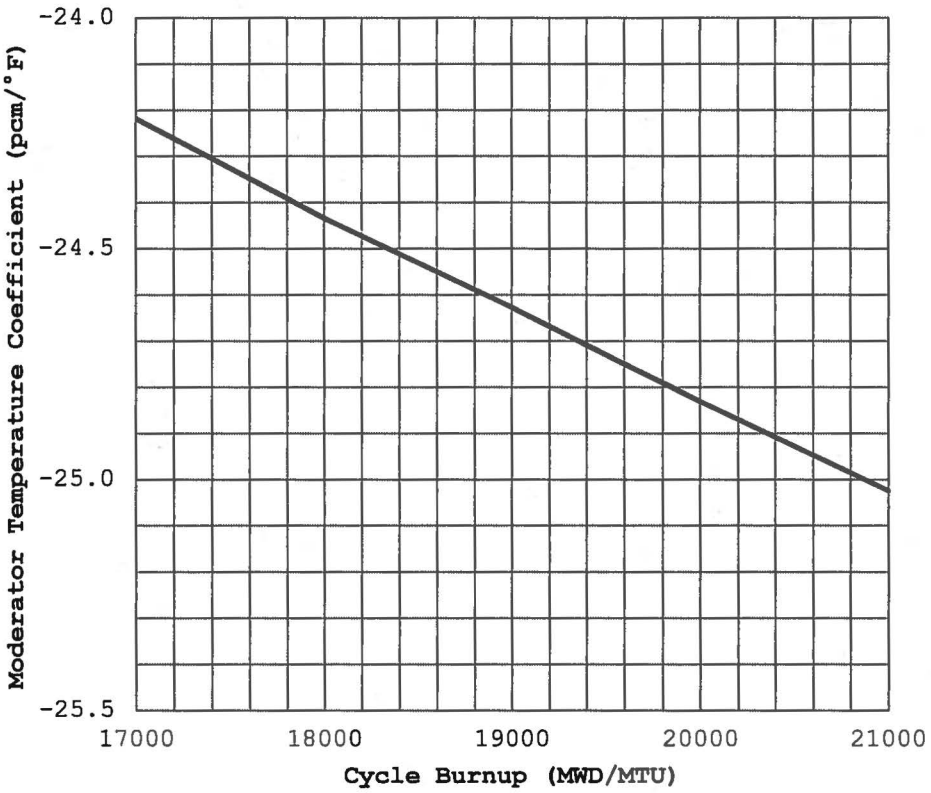


Figure 5
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
17000	-24.22
18000	-24.43
19000	-24.63
20000	-24.83
21000	-25.02