Southern Nuclear

Regulatory Affairs

3535 Colonnade Parkway
Birmingham, AL 35243

205 992 5000 tel
205 992 7795 fax

MAY 3 1 2019

Docket No.: 50-364

NL-19-0565

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

Joseph M. Farley Nuclear Plant - Unit 2
Cycle 27 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 27 Version 1.

This letter contains no NRC commitments. If you have any questions, please contact Jamie Coleman at 205.992.6611.

Respectfully submitted,

Justin T. Wheat
Licensing Manager
JTW/was/scm

Enclosure: Core Operating Limits Report for FNP Unit 2 Cycle 27 Version 1

cc: Regional Administrator, Region II
NRR Project Manager – Farley Nuclear Plant
Senior Resident Inspector – Farley Nuclear Plant
RTYPE: CFA04.054

Joseph M. Farley Nuclear Plant - Unit 2
Cycle 27 Core Operating Limits Report

Enclosure

Core Operating Limits Report for FNP Unit 2 Cycle 27 Version 1

SOUTHERN COMPANY

Energy to Serve Your World®

Joseph M. Farley Nuclear Plant

Core Operating Limits Report

Unit 2 - Cycle 27

Version 1

January 2019

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 2 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 - $F_{\Delta H}^N$
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 $F_Q(Z) \leq \frac{F_Q^{RTP}}{P} * K(Z)$ 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: $P = \frac{THERMAL\ POWER}{RATED\ THERMAL\ POWER}$

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
150	1.0220
354	1.0297
559	1.0346
763	1.0366
968	1.0357
1172	1.0321
1377	1.0268
1581	1.0209
1785	1.0200
10780	1.0200
10985	1.0203
11189	1.0212
11394	1.0222
11598	1.0233
11803	1.0245
12007	1.0258
12212	1.0266
12416	1.0265
12620	1.0240
12825	1.0213
13029	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	4000 MWD/MTU	6000 MWD/MTU	10000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
*	1	12.00	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	2	11.80	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	3	11.60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	4	11.40	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	5	11.20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	6	11.00	1.1638	1.1694	1.2048	1.2140	1.2294	1.1996
	7	10.80	1.1676	1.1713	1.2064	1.2139	1.2286	1.1933
	8	10.60	1.1667	1.1668	1.2015	1.2109	1.2234	1.1807
	9	10.40	1.1667	1.1650	1.1991	1.2112	1.2180	1.1736
	10	10.20	1.1652	1.1619	1.1956	1.2144	1.2126	1.1672
	11	10.00	1.1619	1.1572	1.1905	1.2117	1.2071	1.1650
	12	9.80	1.1581	1.1518	1.1847	1.2165	1.2011	1.1674
	13	9.60	1.1537	1.1458	1.1866	1.2191	1.1948	1.1758
	14	9.40	1.1487	1.1475	1.1808	1.2195	1.1963	1.1826
	15	9.20	1.1507	1.1497	1.1817	1.2189	1.2086	1.1885
	16	9.00	1.1627	1.1583	1.1799	1.2238	1.2176	1.2014
	17	8.80	1.1696	1.1622	1.1749	1.2305	1.2216	1.2255
	18	8.60	1.1774	1.1674	1.1774	1.2370	1.2241	1.2452
	19	8.40	1.1883	1.1772	1.1887	1.2471	1.2330	1.2633
	20	8.20	1.1974	1.1857	1.1964	1.2556	1.2475	1.2824
	21	8.00	1.2045	1.1920	1.2021	1.2611	1.2583	1.2987
	22	7.80	1.2094	1.1963	1.2058	1.2643	1.2664	1.3118
	23	7.60	1.2113	1.1979	1.2069	1.2645	1.2718	1.3214
	24	7.40	1.2116	1.1981	1.2066	1.2632	1.2754	1.3290
	25	7.20	1.2093	1.1956	1.2034	1.2578	1.2747	1.3312
	26	7.00	1.2054	1.1913	1.1994	1.2509	1.2715	1.3296
	27	6.80	1.2000	1.1857	1.1945	1.2433	1.2678	1.3260
	28	6.60	1.1927	1.1785	1.1879	1.2338	1.2621	1.3198
	29	6.40	1.1843	1.1702	1.1800	1.2226	1.2543	1.3109
	30	6.20	1.1752	1.1610	1.1712	1.2098	1.2445	1.2993
	31	6.00	1.1650	1.1508	1.1614	1.1960	1.2333	1.2860
	32	5.80	1.1538	1.1400	1.1509	1.1812	1.2208	1.2713
	33	5.60	1.1431	1.1284	1.1395	1.1654	1.2072	1.2542
	34	5.40	1.1350	1.1215	1.1261	1.1520	1.2005	1.2341
	35	5.20	1.1288	1.1298	1.1205	1.1498	1.2014	1.2315
	36	5.00	1.1319	1.1377	1.1267	1.1492	1.2005	1.2282
	37	4.80	1.1397	1.1459	1.1312	1.1490	1.1986	1.2260
	38	4.60	1.1466	1.1535	1.1356	1.1477	1.1951	1.2215
	39	4.40	1.1531	1.1605	1.1394	1.1455	1.1901	1.2153
	40	4.20	1.1588	1.1666	1.1426	1.1426	1.1839	1.2074
	41	4.00	1.1631	1.1720	1.1451	1.1414	1.1766	1.1982
	42	3.80	1.1697	1.1764	1.1480	1.1405	1.1672	1.1859
	43	3.60	1.1782	1.1801	1.1510	1.1378	1.1552	1.1713
	44	3.40	1.1852	1.1824	1.1533	1.1346	1.1475	1.1555
	45	3.20	1.1908	1.1873	1.1542	1.1309	1.1428	1.1440
	46	3.00	1.1985	1.1940	1.1627	1.1292	1.1416	1.1430
	47	2.80	1.2062	1.2147	1.1825	1.1365	1.1509	1.1556
	48	2.60	1.2291	1.2434	1.2046	1.1487	1.1653	1.1715
	49	2.40	1.2575	1.2722	1.2266	1.1605	1.1790	1.1871
	50	2.20	1.2855	1.3016	1.2490	1.1726	1.1929	1.2029
	51	2.00	1.3138	1.3309	1.2711	1.1840	1.2055	1.2171
	52	1.80	1.3418	1.3598	1.2929	1.1951	1.2176	1.2306
	53	1.60	1.3684	1.3874	1.3138	1.2064	1.2299	1.2446
	54	1.40	1.3938	1.4136	1.3337	1.2175	1.2422	1.2588
	55	1.20	1.4177	1.4381	1.3525	1.2283	1.2542	1.2729
	56	1.00	1.4397	1.4603	1.3697	1.2387	1.2660	1.2870
*	57	0.80	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	58	0.60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	59	0.40	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	60	0.20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
*	61	0.00	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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

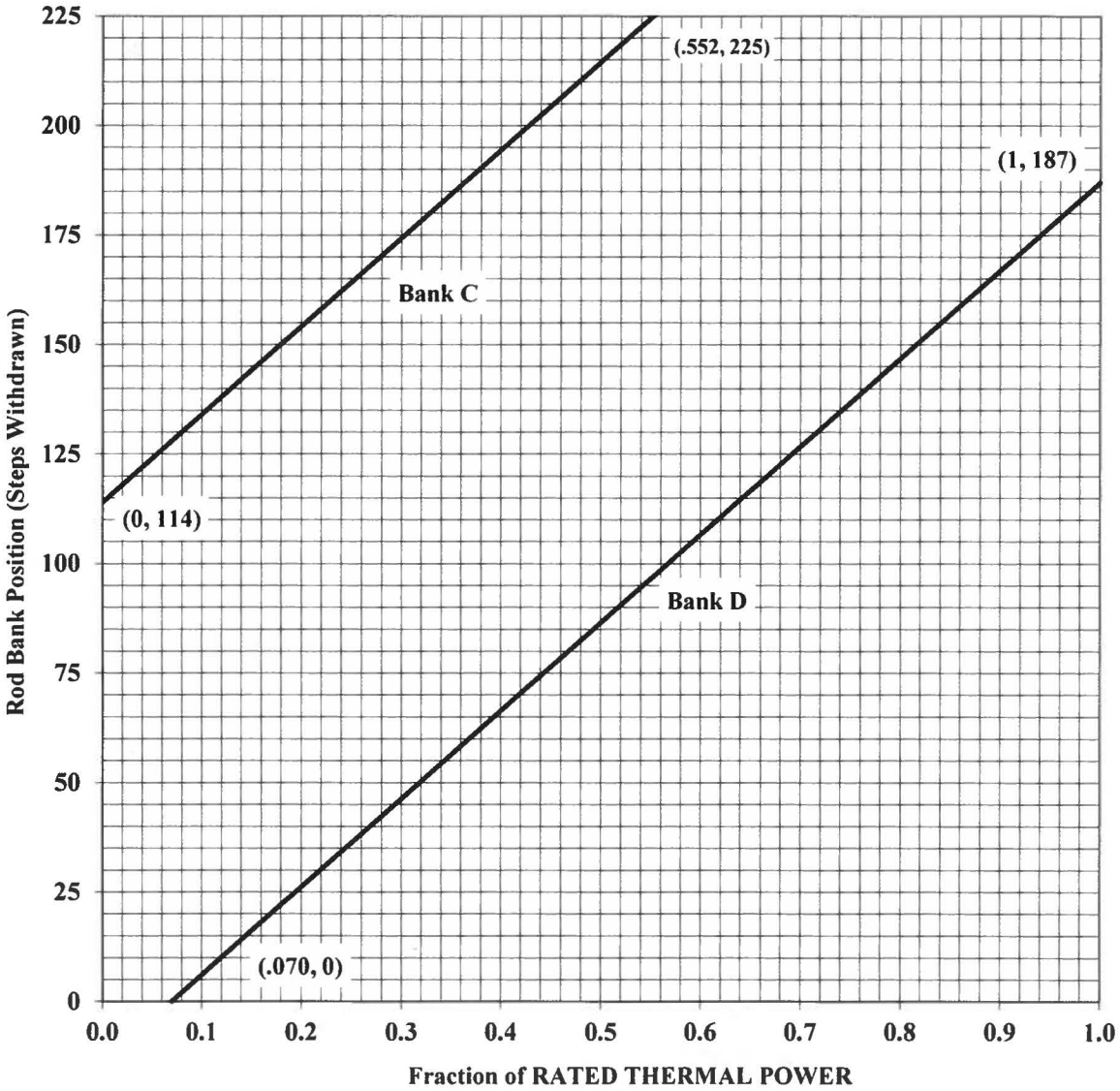
Table 5
Part Power (48%) RAOC W(Z)

	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	1.2728
	7	10.80	1.2681
	8	10.60	1.2550
	9	10.40	1.2415
	10	10.20	1.2245
	11	10.00	1.2039
	12	9.80	1.1794
	13	9.60	1.1544
	14	9.40	1.1302
	15	9.20	1.1154
	16	9.00	1.1117
	17	8.80	1.1072
	18	8.60	1.1061
	19	8.40	1.1085
	20	8.20	1.1118
	21	8.00	1.1137
	22	7.80	1.1150
	23	7.60	1.1137
	24	7.40	1.1128
	25	7.20	1.1113
	26	7.00	1.1091
	27	6.80	1.1045
	28	6.60	1.1004
	29	6.40	1.0941
	30	6.20	1.0828
	31	6.00	1.0761
	32	5.80	1.0721
	33	5.60	1.0719
	34	5.40	1.0632
	35	5.20	1.0611
	36	5.00	1.0699
	37	4.80	1.0831
	38	4.60	1.0955
	39	4.40	1.1074
	40	4.20	1.1188
	41	4.00	1.1287
	42	3.80	1.1421
	43	3.60	1.1576
	44	3.40	1.1716
	45	3.20	1.1844
	46	3.00	1.1991
	47	2.80	1.2139
	48	2.60	1.2436
	49	2.40	1.2792
	50	2.20	1.3148
	51	2.00	1.3518
	52	1.80	1.3883
	53	1.60	1.4238
	54	1.40	1.4588
	55	1.20	1.4934
	56	1.00	1.5247
*	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

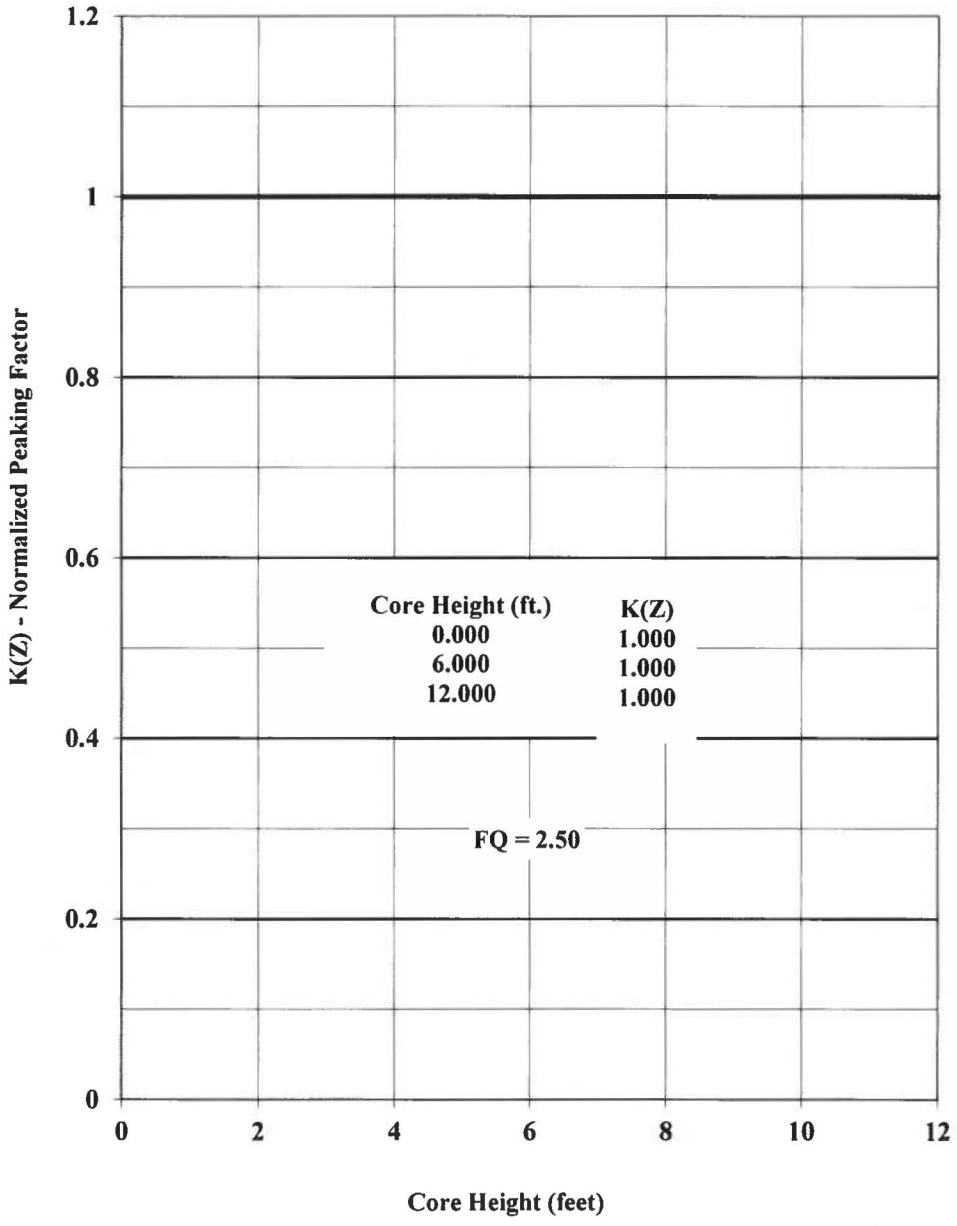


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

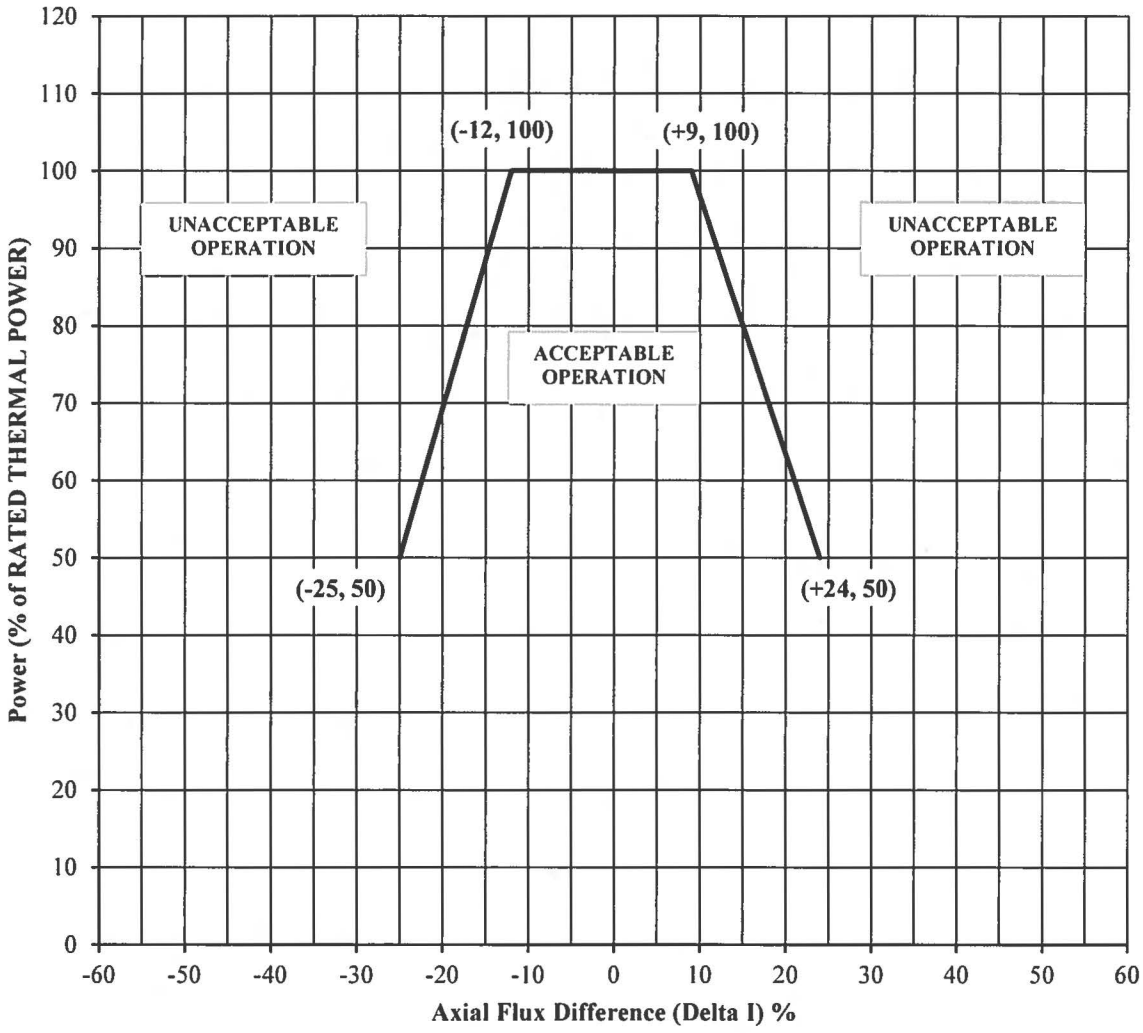


Figure 4
Reactor Core Safety Limits

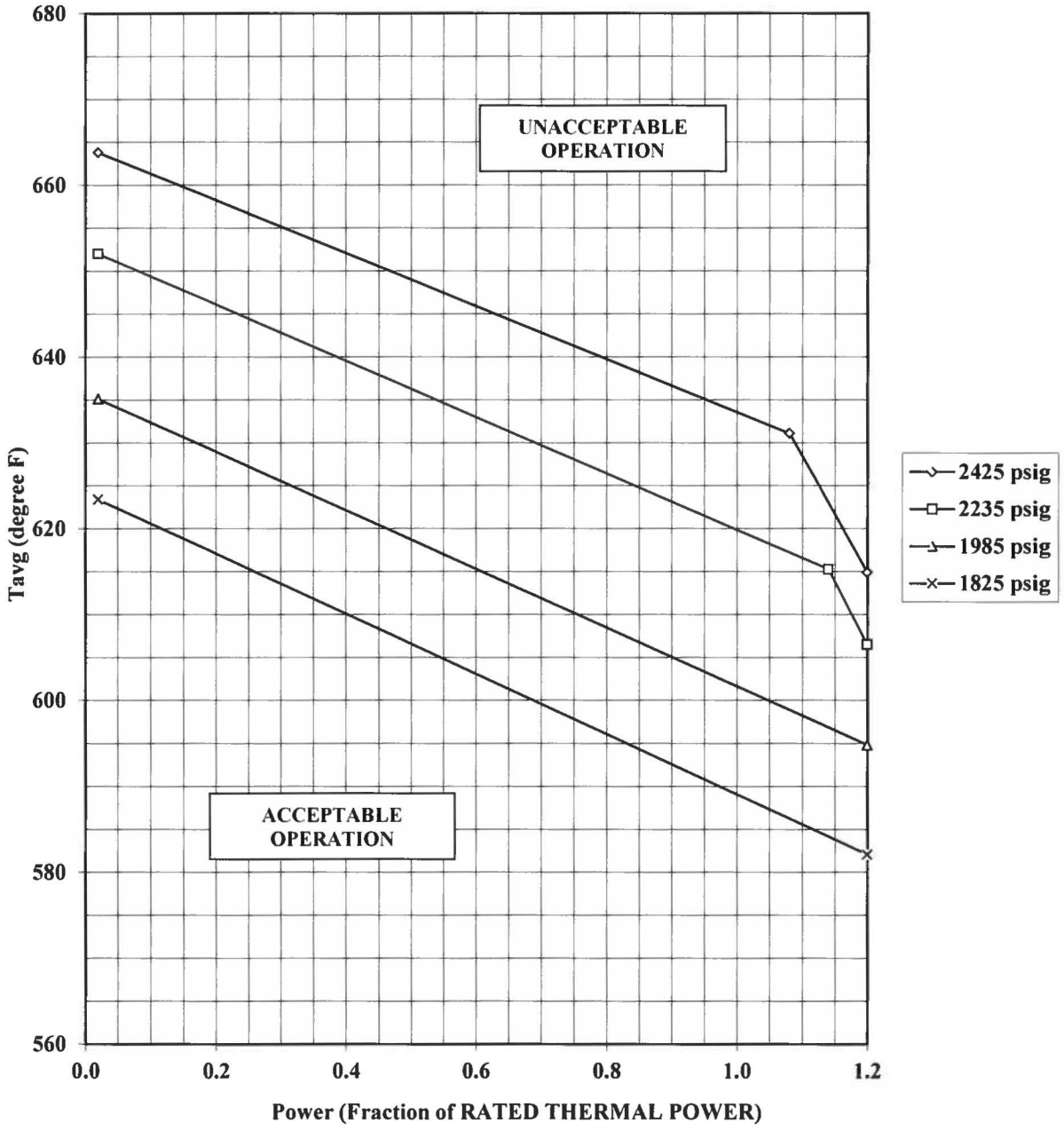
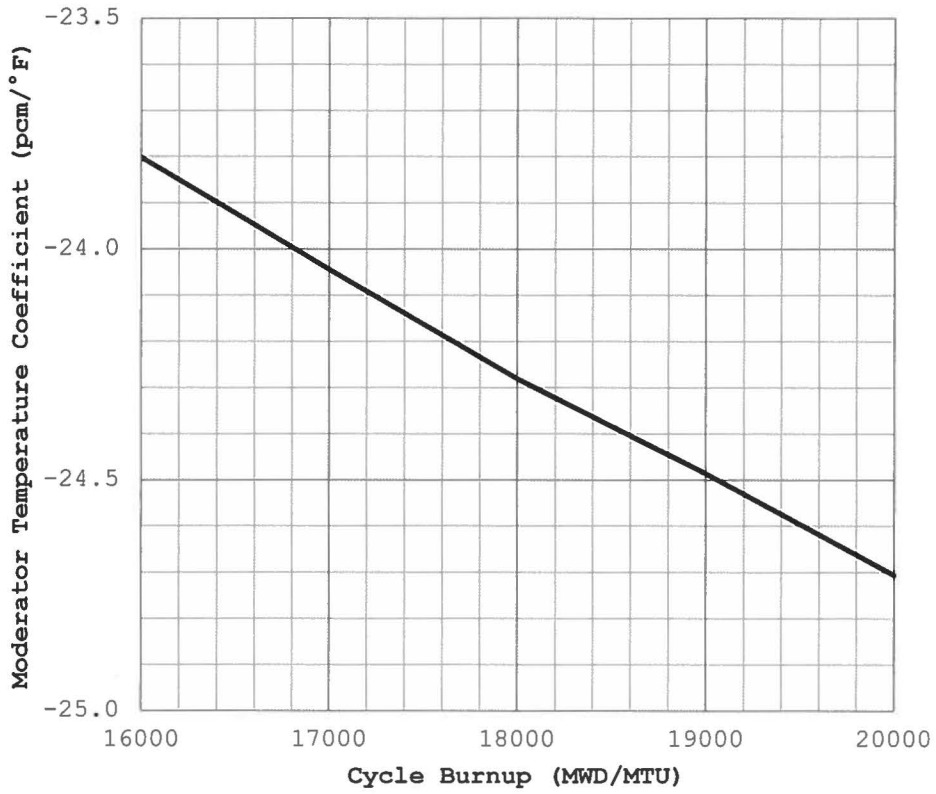


Figure 5
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
16000	-23.80
17000	-24.04
18000	-24.28
19000	-24.49
20000	-24.71