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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 29 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 29 Version 1.

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

Respectfully submitted,

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Regulatory Affairs Director
CAG/was/cbg

Enclosure: Core Operating Limits Report for FNP Unit 2 Cycle 29 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 29 Core Operating Limits Report

Enclosure

Core Operating Limits Report for FNP Unit 2 Cycle 29 Version 1

SOUTHERN COMPANY

Energy to Serve Your World®

Joseph M. Farley Nuclear Plant

Core Operating Limits Report

Unit 2 - Cycle 29

Version 1

January 2022

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 2 CYCLE 29 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 as 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 $F_{\Delta H}^{N} \leq F_{\Delta H}^{RTP} * \left(1 + PF_{\Delta H} * (1 - P)\right)$

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
566	1.0200
773	1.0264
981	1.0324
1189	1.0346
1397	1.0337
1605	1.0309
1812	1.0273
2020	1.0237
2228	1.0210
2436	1.0200
3267	1.0200
3475	1.0262
3683	1.0286
3890	1.0292
4098	1.0282
4306	1.0270
4514	1.0255
4722	1.0237
4929	1.0216
5137	1.0200
10332	1.0200
10540	1.0211
10748	1.0209
10956	1.0207
11164	1.0203
11371	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	1.1328	1.1634	1.2030	1.2429	1.2165	1.2644
	7	10.80	1.1326	1.1606	1.2007	1.2400	1.2162	1.2542
	8	10.60	1.1368	1.1563	1.1963	1.2343	1.2072	1.2348
	9	10.40	1.1416	1.1507	1.1912	1.2332	1.2028	1.2122
	10	10.20	1.1445	1.1543	1.1856	1.2314	1.1994	1.1886
	11	10.00	1.1433	1.1532	1.1792	1.2282	1.1960	1.1775
	12	9.80	1.1482	1.1538	1.1738	1.2239	1.1961	1.1750
	13	9.60	1.1512	1.1525	1.1785	1.2274	1.2031	1.1741
	14	9.40	1.1520	1.1492	1.1800	1.2313	1.2046	1.1728
	15	9.20	1.1510	1.1444	1.1771	1.2304	1.2168	1.1728
	16	9.00	1.1490	1.1386	1.1785	1.2376	1.2254	1.1837
	17	8.80	1.1443	1.1299	1.1838	1.2388	1.2289	1.1905
	18	8.60	1.1438	1.1256	1.1969	1.2436	1.2311	1.1944
	19	8.40	1.1530	1.1330	1.2057	1.2564	1.2410	1.2054
	20	8.20	1.1620	1.1412	1.2127	1.2654	1.2567	1.2266
	21	8.00	1.1691	1.1475	1.2172	1.2713	1.2685	1.2437
	22	7.80	1.1745	1.1522	1.2196	1.2747	1.2776	1.2580
	23	7.60	1.1772	1.1549	1.2194	1.2749	1.2837	1.2695
	24	7.40	1.1786	1.1564	1.2177	1.2733	1.2881	1.2793
	25	7.20	1.1780	1.1560	1.2132	1.2676	1.2880	1.2845
	26	7.00	1.1769	1.1550	1.2078	1.2593	1.2853	1.2862
	27	6.80	1.1747	1.1532	1.2012	1.2496	1.2819	1.2875
	28	6.60	1.1706	1.1499	1.1929	1.2379	1.2763	1.2868
	29	6.40	1.1658	1.1458	1.1833	1.2244	1.2684	1.2837
	30	6.20	1.1602	1.1411	1.1727	1.2094	1.2583	1.2782
	31	6.00	1.1536	1.1354	1.1611	1.1934	1.2466	1.2709
	32	5.80	1.1461	1.1290	1.1488	1.1767	1.2336	1.2622
	33	5.60	1.1377	1.1233	1.1358	1.1618	1.2187	1.2515
	34	5.40	1.1305	1.1329	1.1272	1.1580	1.2041	1.2374
	35	5.20	1.1370	1.1415	1.1306	1.1579	1.2039	1.2353
	36	5.00	1.1452	1.1496	1.1367	1.1567	1.2017	1.2336
	37	4.80	1.1536	1.1572	1.1423	1.1555	1.1986	1.2302
	38	4.60	1.1614	1.1641	1.1474	1.1552	1.1939	1.2249
	39	4.40	1.1686	1.1704	1.1519	1.1539	1.1877	1.2178
	40	4.20	1.1747	1.1758	1.1557	1.1517	1.1803	1.2091
	41	4.00	1.1799	1.1802	1.1588	1.1486	1.1717	1.1990
	42	3.80	1.1844	1.1851	1.1615	1.1440	1.1610	1.1860
	43	3.60	1.1881	1.1907	1.1646	1.1380	1.1481	1.1701
	44	3.40	1.1910	1.1948	1.1676	1.1316	1.1375	1.1567
	45	3.20	1.1922	1.2014	1.1694	1.1248	1.1302	1.1473
	46	3.00	1.1986	1.2130	1.1769	1.1211	1.1291	1.1384
	47	2.80	1.2213	1.2260	1.1857	1.1287	1.1377	1.1471
	48	2.60	1.2485	1.2369	1.2050	1.1421	1.1509	1.1633
	49	2.40	1.2746	1.2604	1.2282	1.1549	1.1637	1.1790
	50	2.20	1.3013	1.2880	1.2512	1.1680	1.1767	1.1948
	51	2.00	1.3279	1.3147	1.2738	1.1803	1.1884	1.2090
	52	1.80	1.3542	1.3412	1.2960	1.1923	1.1996	1.2224
	53	1.60	1.3791	1.3664	1.3172	1.2043	1.2110	1.2361
	54	1.40	1.4029	1.3902	1.3374	1.2161	1.2226	1.2501
	55	1.20	1.4252	1.4124	1.3562	1.2274	1.2339	1.2639
	56	1.00	1.4456	1.4325	1.3735	1.2382	1.2451	1.2777
*	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.**

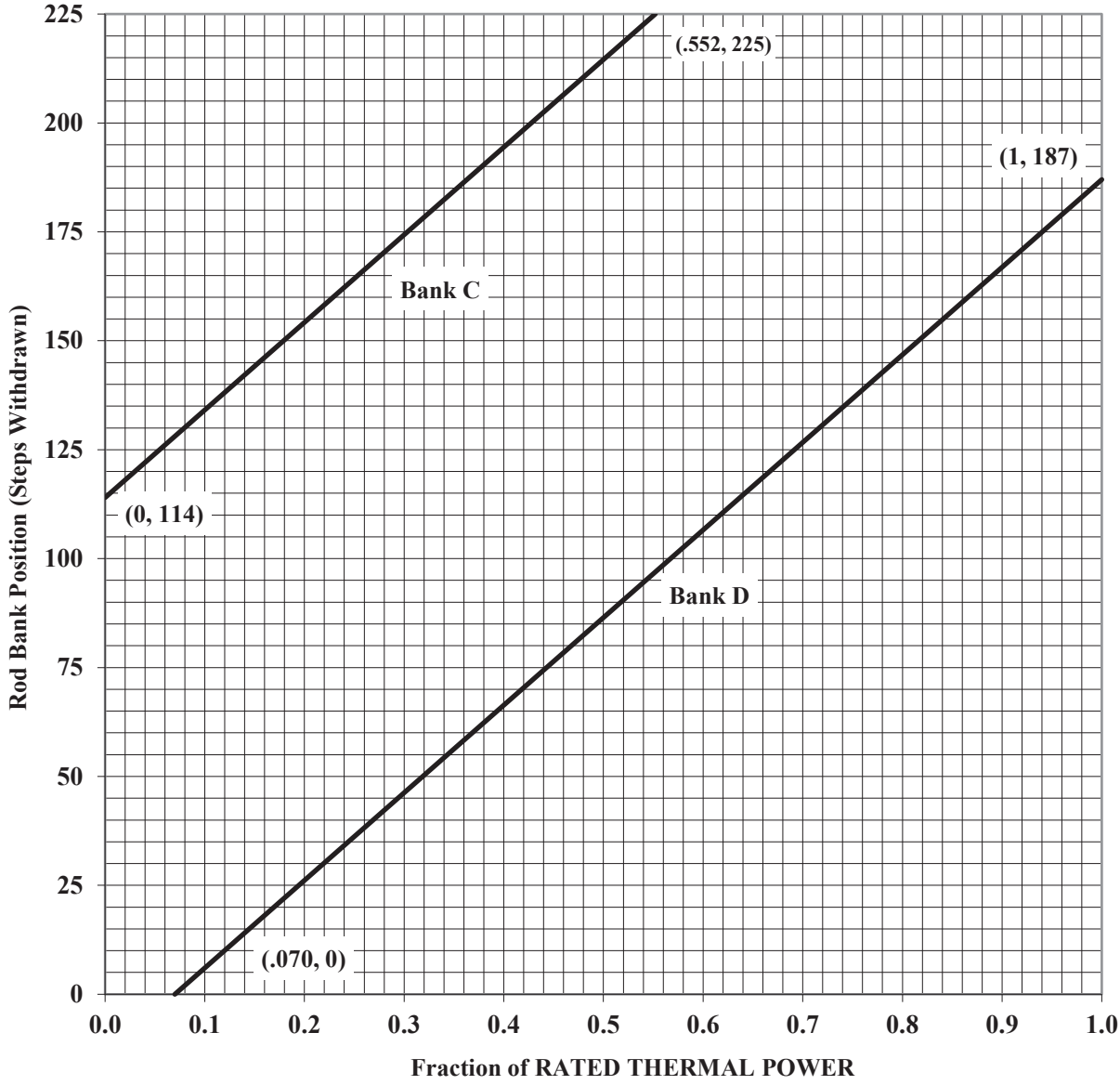
Table 5
Part Power (48%) RAOC W(Z)

	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	1.1630
	7	10.80	1.1602
	8	10.60	1.1580
	9	10.40	1.1547
	10	10.20	1.1475
	11	10.00	1.1360
	12	9.80	1.1286
	13	9.60	1.1182
	14	9.40	1.1056
	15	9.20	1.0929
	16	9.00	1.0799
	17	8.80	1.0652
	18	8.60	1.0572
	19	8.40	1.0588
	20	8.20	1.0619
	21	8.00	1.0650
	22	7.80	1.0676
	23	7.60	1.0679
	24	7.40	1.0670
	25	7.20	1.0676
	26	7.00	1.0688
	27	6.80	1.0676
	28	6.60	1.0665
	29	6.40	1.0656
	30	6.20	1.0619
	31	6.00	1.0592
	32	5.80	1.0562
	33	5.60	1.0532
	34	5.40	1.0525
	35	5.20	1.0644
	36	5.00	1.0781
	37	4.80	1.0924
	38	4.60	1.1066
	39	4.40	1.1195
	40	4.20	1.1315
	41	4.00	1.1428
	42	3.80	1.1551
	43	3.60	1.1671
	44	3.40	1.1777
	45	3.20	1.1867
	46	3.00	1.2004
	47	2.80	1.2306
	48	2.60	1.2651
	49	2.40	1.2989
	50	2.20	1.3338
	51	2.00	1.3699
	52	1.80	1.4057
	53	1.60	1.4406
	54	1.40	1.4742
	55	1.20	1.5057
	56	1.00	1.5342
*	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

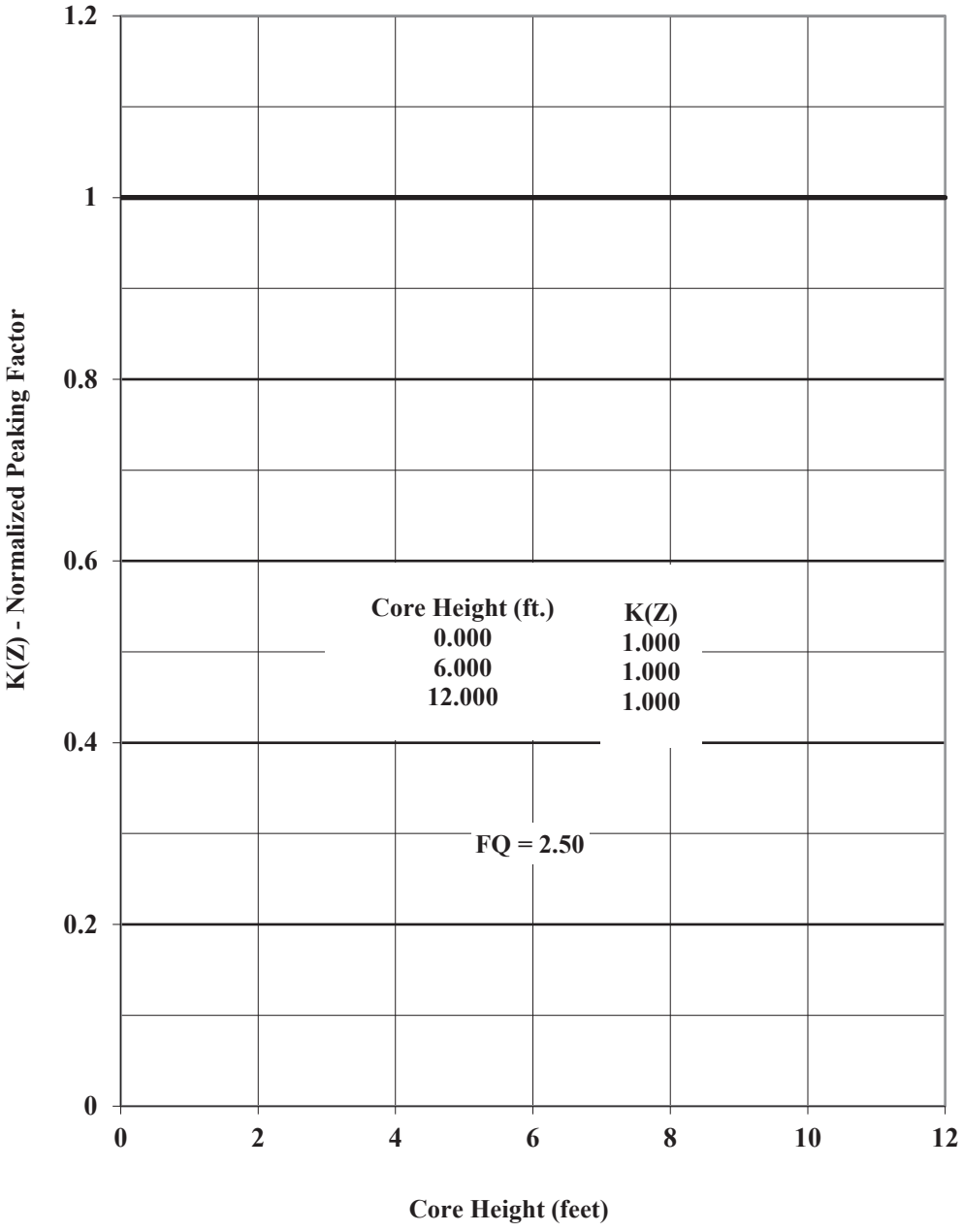


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

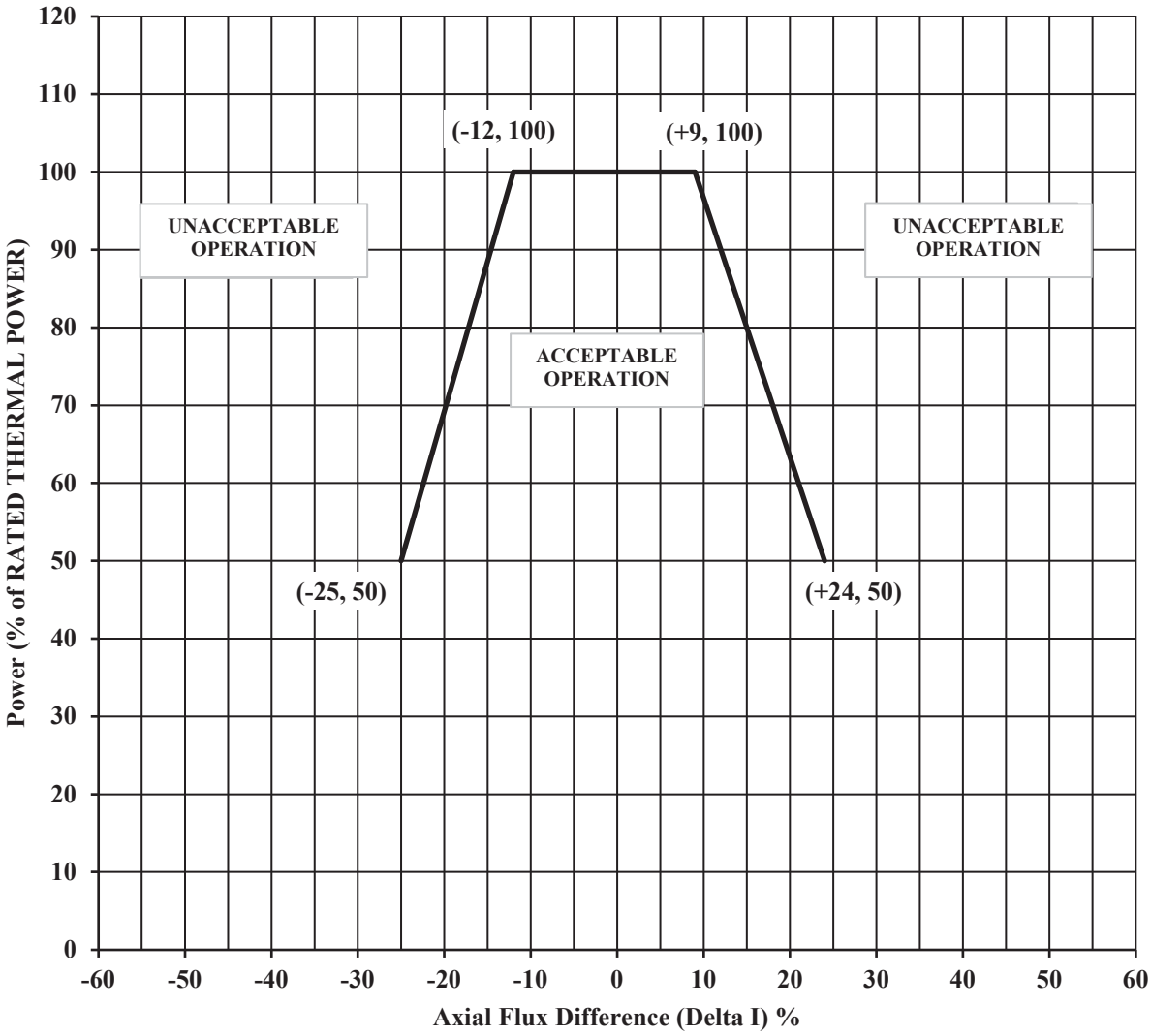


Figure 4
Reactor Core Safety Limits

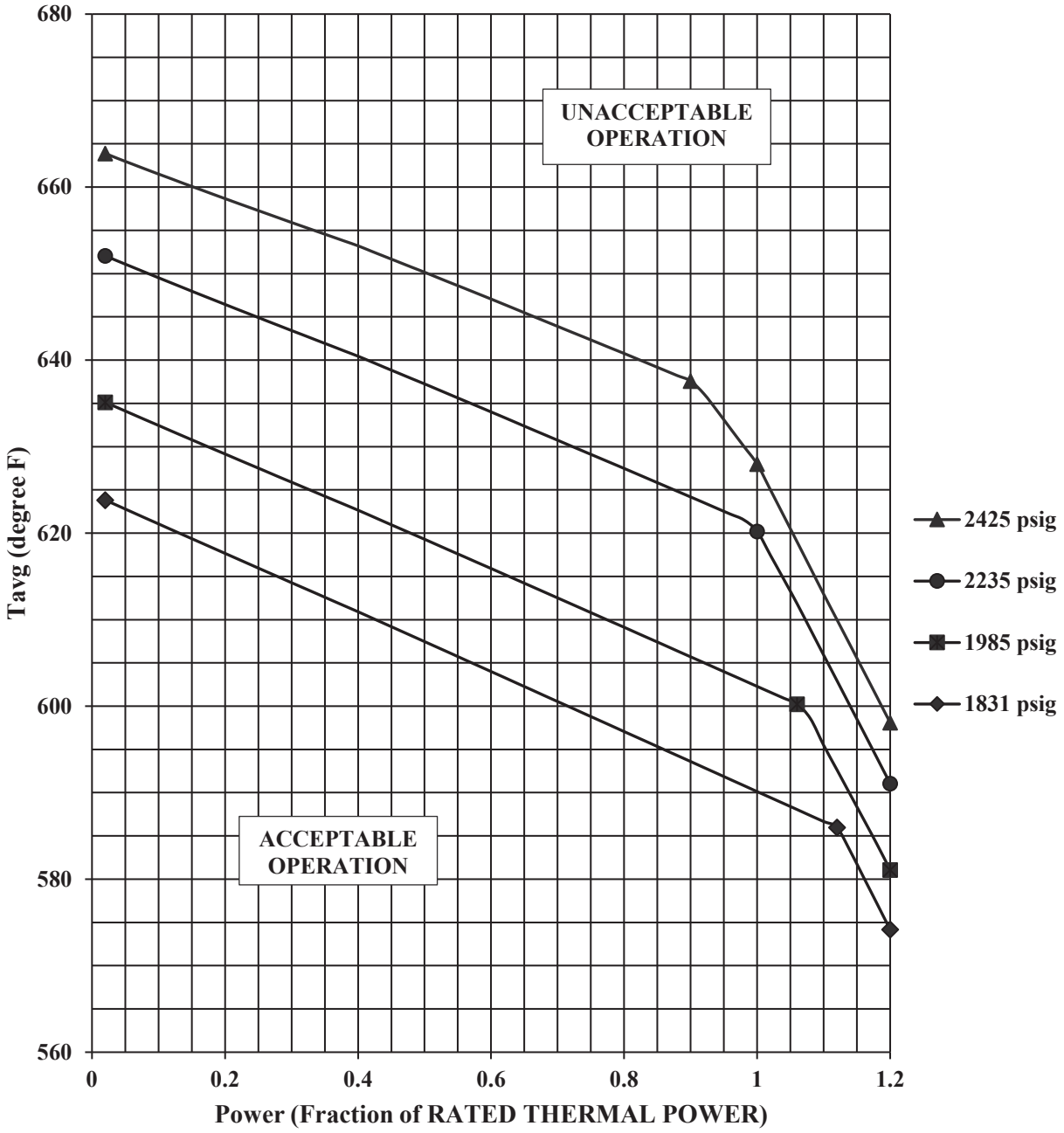
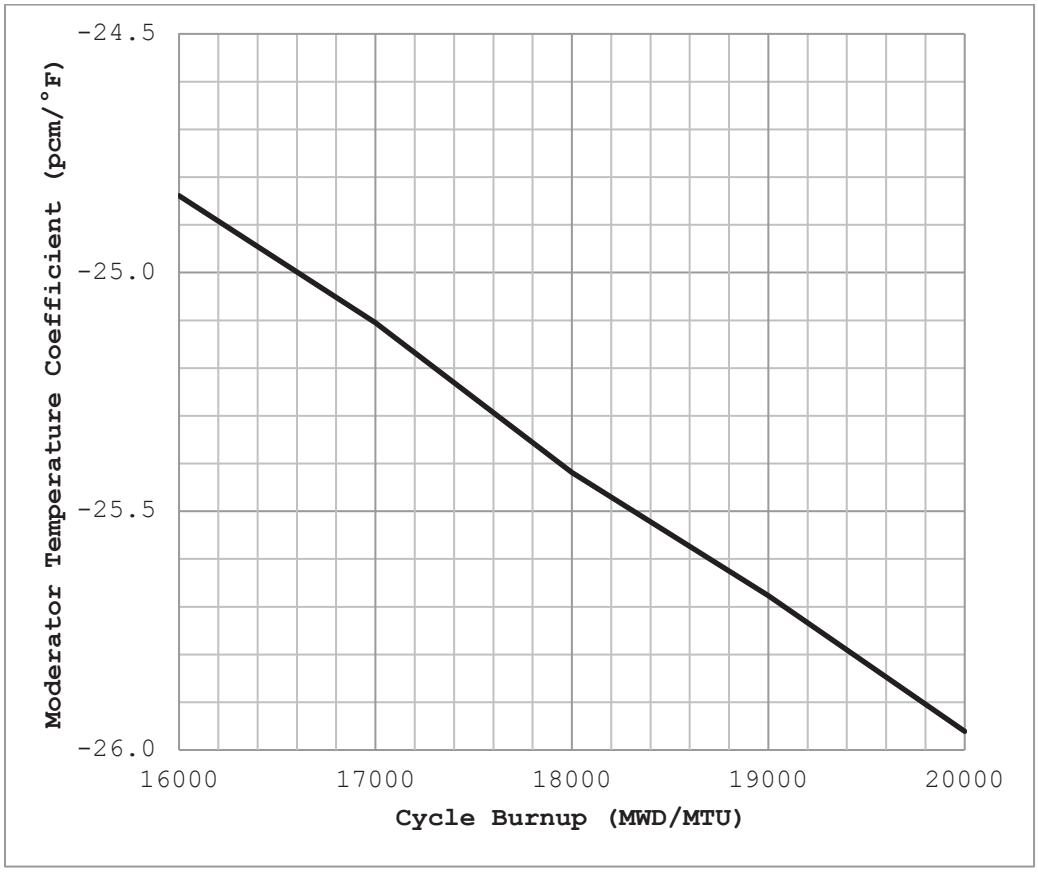


Figure 5
Predicted HFP 300 ppm MTC versus Cycle Burnup



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
16000	-24.84
17000	-25.11
18000	-25.42
19000	-25.68
20000	-25.96