Southern Nuclear

Regulatory Affairs

3535 Colonnade Parkway
Birmingham, AL 35243

205 992 5000 tel
205 992 7795 fax

NOV 19 2019

Docket No.: 50-348

NL-19-1384

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

Joseph M. Farley Nuclear Plant – Unit 1
Cycle 30 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 1 Cycle 30 Version 1.

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

Respectfully submitted,

Cheryl A. Gayheart
Regulatory Affairs Director
CAG/was/scm

Enclosure: Core Operating Limits Report for FNP Unit 1 Cycle 30 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 1
Cycle 30 Core Operating Limits Report

Enclosure

Core Operating Limits Report for FNP Unit 1 Cycle 30 Version 1

SOUTHERN COMPANY

Energy to Serve Your World®

Joseph M. Farley Nuclear Plant

Core Operating Limits Report

Unit 1 - Cycle 30

Version 1

June 2019

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 1 CYCLE 30 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 ($OT\Delta T$) and Overpower ΔT ($OP\Delta T$) 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 $$F_Q(Z) \le \frac{F_Q^{RTP}}{P} * K(Z) \qquad \text{for P} > 0.5$$

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

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

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

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
0	1.0422
150	1.0422
354	1.0506
559	1.0560
763	1.0581
968	1.0567
1172	1.0520
1377	1.0449
1581	1.0367
1786	1.0283
1990	1.0205
2195	1.0200
7306	1.0200
7510	1.0248
7715	1.0261
7919	1.0274
8124	1.0233
8328	1.0216
8532	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 4
RAOC W(Z)

	Axial Point	Elevation (feet)	150 MWD/MTU	3000 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	1.1992	1.1842	1.2322	1.2369	1.2118	1.2384
	7	10.80	1.2003	1.1842	1.2303	1.2358	1.2112	1.2304
	8	10.60	1.1955	1.1781	1.2228	1.2294	1.2039	1.2121
	9	10.40	1.1933	1.1754	1.2190	1.2228	1.1971	1.1976
	10	10.20	1.1899	1.1716	1.2178	1.2161	1.1905	1.1904
	11	10.00	1.1848	1.1661	1.2111	1.2089	1.1856	1.1837
	12	9.80	1.1790	1.1600	1.2100	1.2014	1.1883	1.1765
	13	9.60	1.1727	1.1534	1.2070	1.1937	1.1945	1.1714
	14	9.40	1.1654	1.1469	1.2018	1.1857	1.2015	1.1703
	15	9.20	1.1588	1.1457	1.1948	1.1802	1.2044	1.1737
	16	9.00	1.1539	1.1599	1.1897	1.1813	1.2167	1.1861
	17	8.80	1.1460	1.1687	1.1972	1.1787	1.2221	1.1924
	18	8.60	1.1432	1.1772	1.2039	1.1814	1.2329	1.1955
	19	8.40	1.1524	1.1863	1.2127	1.1946	1.2513	1.2046
	20	8.20	1.1606	1.1940	1.2190	1.2051	1.2659	1.2251
	21	8.00	1.1673	1.1994	1.2230	1.2134	1.2775	1.2422
	22	7.80	1.1721	1.2028	1.2249	1.2194	1.2865	1.2565
	23	7.60	1.1746	1.2035	1.2241	1.2230	1.2925	1.2679
	24	7.40	1.1758	1.2028	1.2220	1.2251	1.2966	1.2777
	25	7.20	1.1748	1.1993	1.2167	1.2237	1.2961	1.2828
	26	7.00	1.1731	1.1941	1.2105	1.2204	1.2930	1.2845
	27	6.80	1.1708	1.1877	1.2036	1.2169	1.2891	1.2857
	28	6.60	1.1668	1.1795	1.1948	1.2117	1.2830	1.2851
	29	6.40	1.1621	1.1703	1.1848	1.2050	1.2745	1.2821
	30	6.20	1.1568	1.1603	1.1738	1.1970	1.2637	1.2766
	31	6.00	1.1505	1.1493	1.1619	1.1878	1.2513	1.2696
	32	5.80	1.1434	1.1376	1.1494	1.1777	1.2376	1.2611
	33	5.60	1.1357	1.1252	1.1391	1.1666	1.2220	1.2509
	34	5.40	1.1286	1.1176	1.1298	1.1584	1.2073	1.2413
	35	5.20	1.1265	1.1276	1.1226	1.1590	1.2070	1.2400
	36	5.00	1.1336	1.1354	1.1231	1.1598	1.2045	1.2390
	37	4.80	1.1408	1.1432	1.1290	1.1610	1.2011	1.2363
	38	4.60	1.1475	1.1503	1.1339	1.1609	1.1960	1.2317
	39	4.40	1.1536	1.1568	1.1384	1.1599	1.1895	1.2251
	40	4.20	1.1587	1.1623	1.1421	1.1578	1.1816	1.2168
	41	4.00	1.1631	1.1671	1.1452	1.1548	1.1725	1.2071
	42	3.80	1.1664	1.1710	1.1471	1.1501	1.1612	1.1942
	43	3.60	1.1707	1.1740	1.1497	1.1440	1.1474	1.1786
	44	3.40	1.1765	1.1756	1.1540	1.1373	1.1388	1.1631
	45	3.20	1.1818	1.1797	1.1572	1.1306	1.1331	1.1452
	46	3.00	1.1854	1.1881	1.1633	1.1288	1.1291	1.1468
	47	2.80	1.1949	1.2123	1.1751	1.1373	1.1369	1.1613
	48	2.60	1.2183	1.2422	1.1883	1.1511	1.1512	1.1777
	49	2.40	1.2446	1.2713	1.2003	1.1642	1.1647	1.1949
	50	2.20	1.2707	1.3012	1.2189	1.1777	1.1785	1.2120
	51	2.00	1.2969	1.3310	1.2385	1.1904	1.1909	1.2274
	52	1.80	1.3228	1.3604	1.2576	1.2026	1.2028	1.2420
	53	1.60	1.3475	1.3885	1.2761	1.2149	1.2150	1.2569
	54	1.40	1.3711	1.4151	1.2938	1.2270	1.2272	1.2719
	55	1.20	1.3933	1.4400	1.3104	1.2386	1.2391	1.2868
	56	1.00	1.4137	1.4626	1.3258	1.2497	1.2509	1.3016
*	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.**

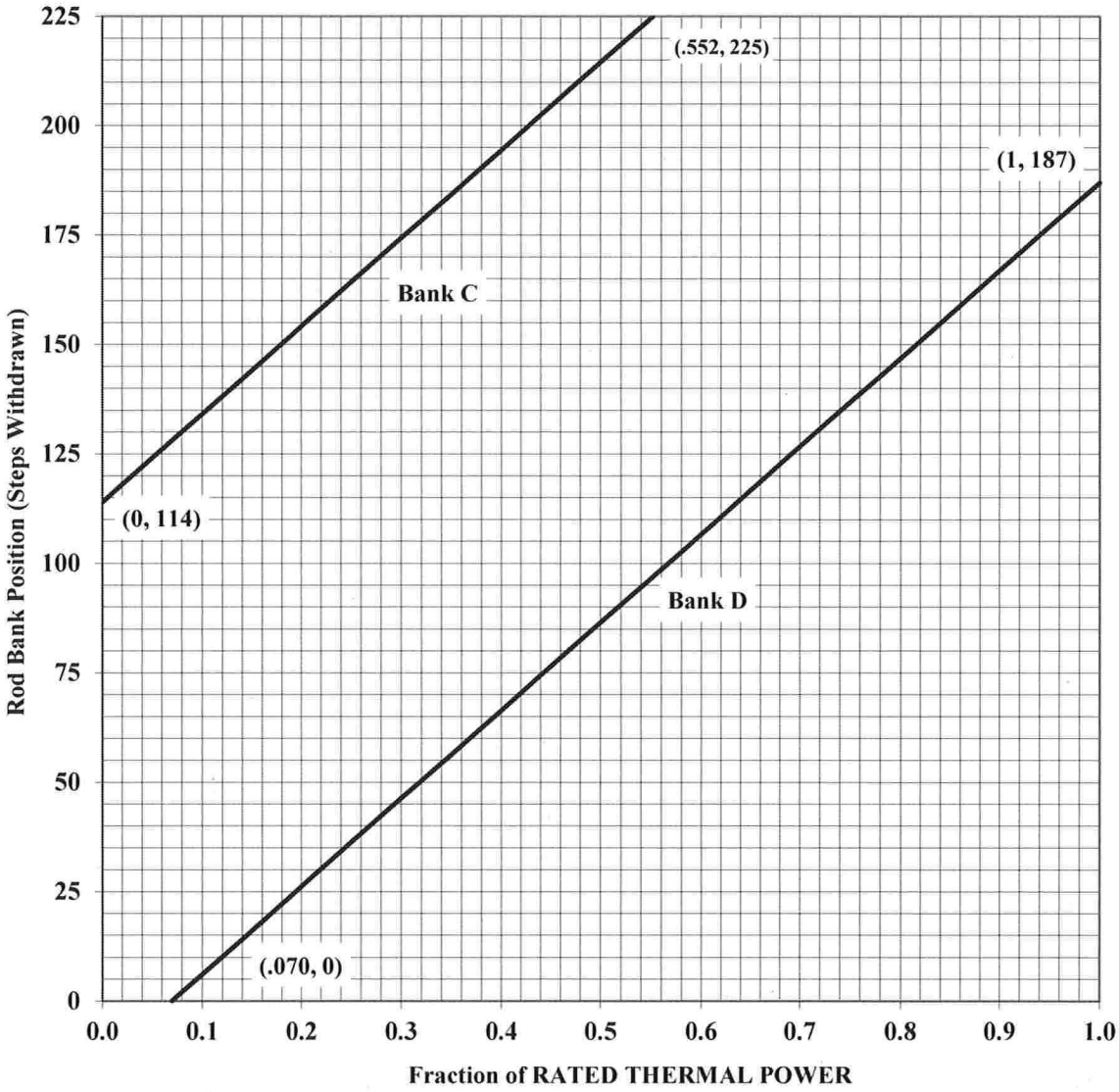
Table 5
Part Power (48%) RAOC W(Z)

	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	1.2722
	7	10.80	1.2648
	8	10.60	1.2525
	9	10.40	1.2396
	10	10.20	1.2194
	11	10.00	1.2072
	12	9.80	1.1872
	13	9.60	1.1598
	14	9.40	1.1389
	15	9.20	1.1194
	16	9.00	1.1021
	17	8.80	1.0854
	18	8.60	1.0750
	19	8.40	1.0761
	20	8.20	1.0762
	21	8.00	1.0792
	22	7.80	1.0803
	23	7.60	1.0794
	24	7.40	1.0801
	25	7.20	1.0788
	26	7.00	1.0775
	27	6.80	1.0776
	28	6.60	1.0759
	29	6.40	1.0740
	30	6.20	1.0724
	31	6.00	1.0700
	32	5.80	1.0667
	33	5.60	1.0632
	34	5.40	1.0622
	35	5.20	1.0661
	36	5.00	1.0790
	37	4.80	1.0914
	38	4.60	1.1033
	39	4.40	1.1148
	40	4.20	1.1254
	41	4.00	1.1347
	42	3.80	1.1445
	43	3.60	1.1560
	44	3.40	1.1697
	45	3.20	1.1829
	46	3.00	1.1938
	47	2.80	1.2102
	48	2.60	1.2385
	49	2.40	1.2701
	50	2.20	1.3023
	51	2.00	1.3369
	52	1.80	1.3713
	53	1.60	1.4050
	54	1.40	1.4372
	55	1.20	1.4672
	56	1.00	1.4953
*	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

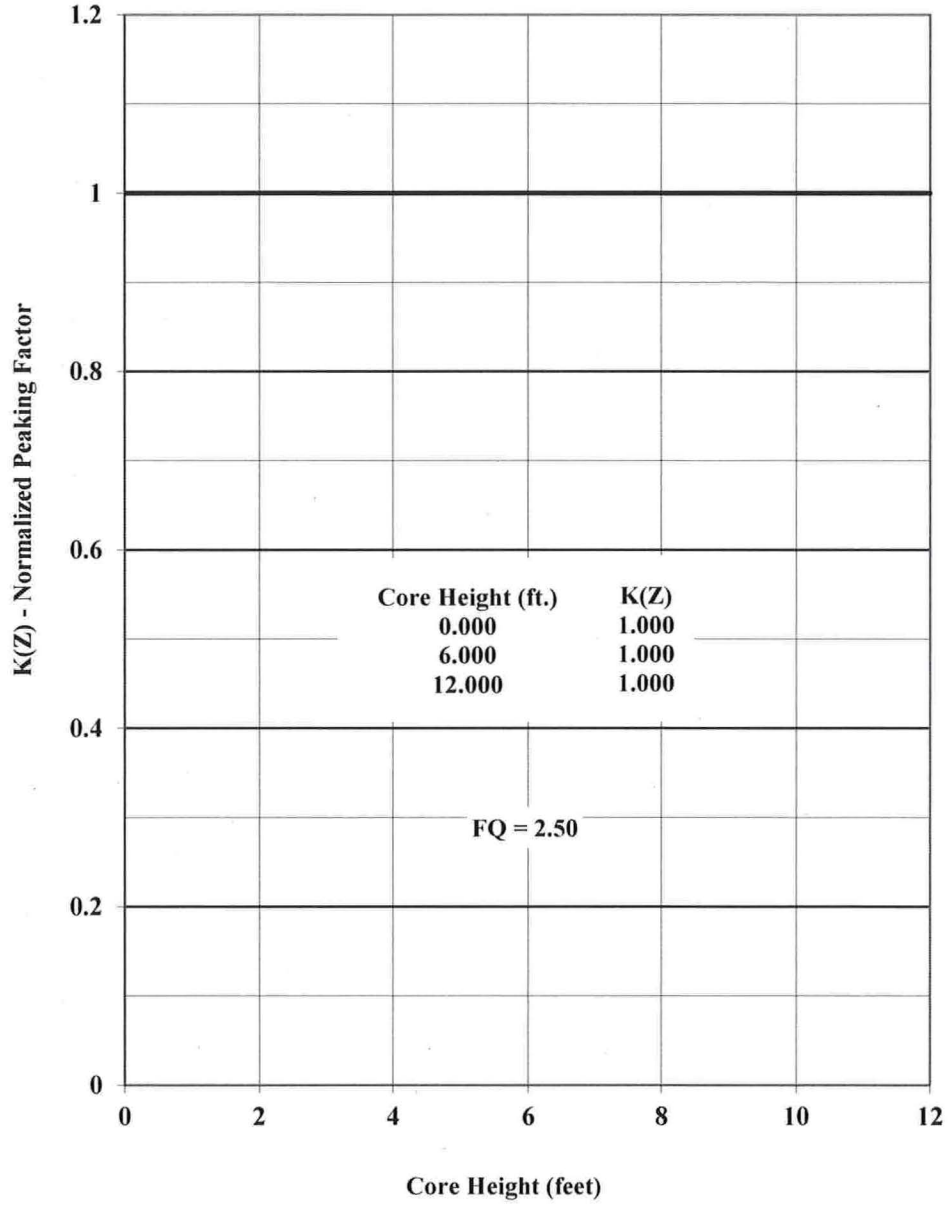


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

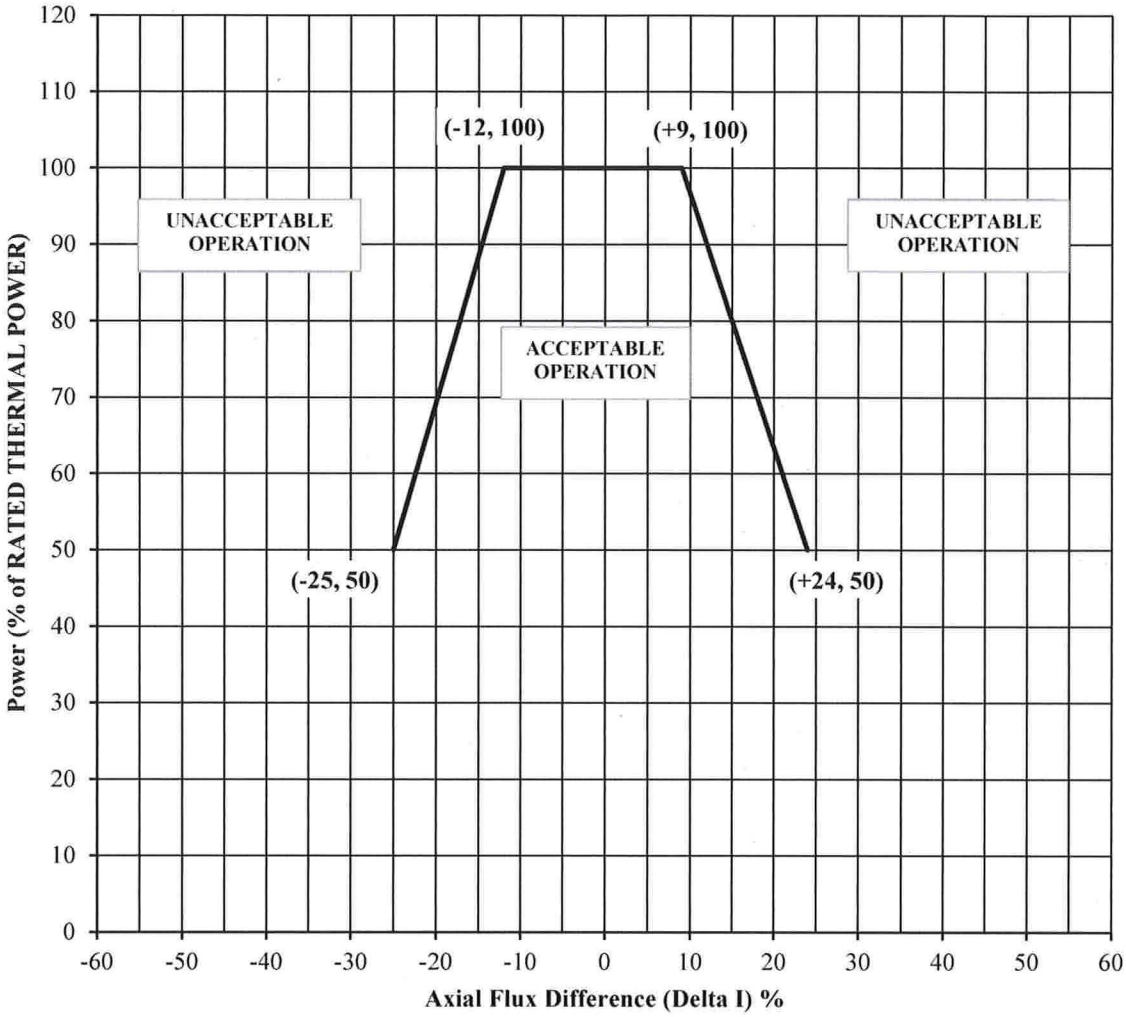


Figure 4
Reactor Core Safety Limits

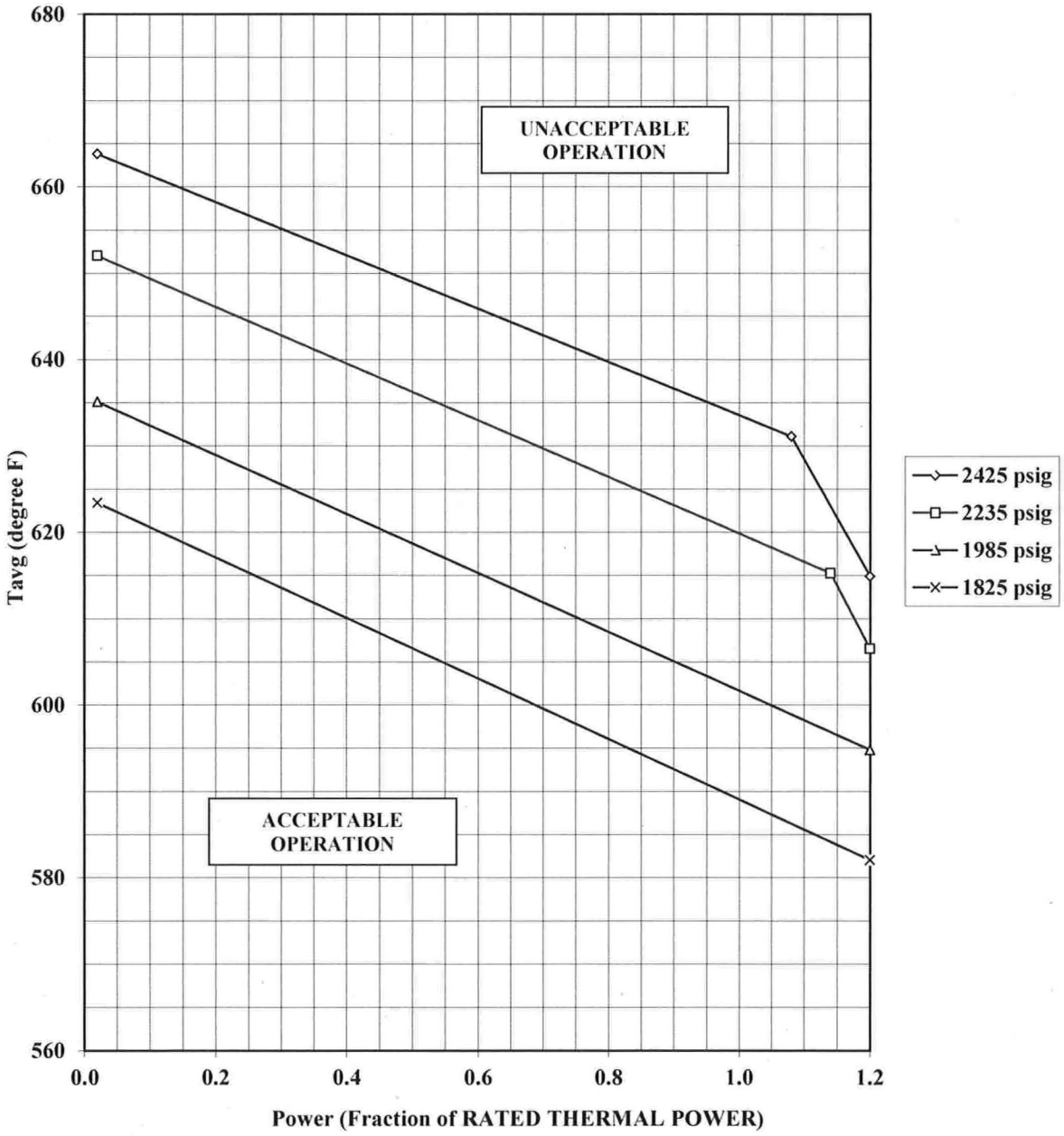
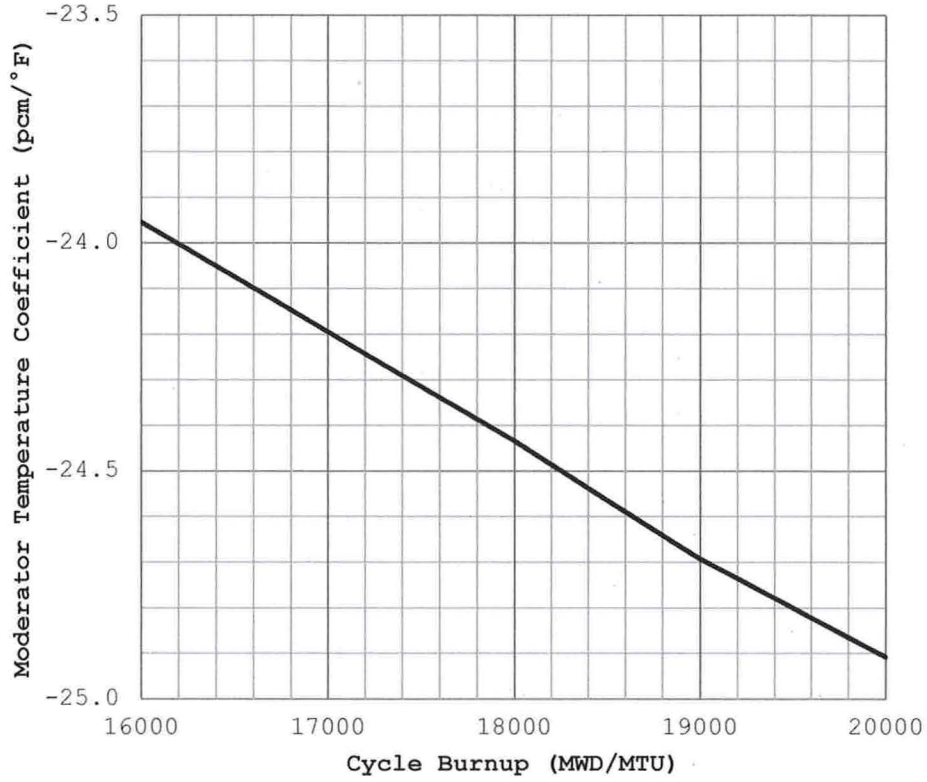


Figure 5
PREDICTED HFP 300 PPM MTC VS CYCLE BURNUP



Cycle Burnup (MWD/MTU)	Moderator Temperature Coefficient (pcm/°F)
16000	-23.95
17000	-24.20
18000	-24.43
19000	-24.69
20000	-24.91