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SOUTHERN COMPANY

November 11, 2014

Docket Nos.: 50-364

NL-14-1791

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

Joseph M. Farley Nuclear Plant – Unit 2
Cycle 24 Core Operating Limits Report Version 1

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 24 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

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Regulatory Affairs Director

CRP/RMJ/lac

Enclosure: Core Operating Limits Report for FNP Unit 2 Cycle 24 Version 1

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Joseph M. Farley Nuclear Plant – Unit 2
Cycle 24 Core Operating Limits Report Version 1

Enclosure

Core Operating Limits Report for FNP Unit 2 Cycle 24 Version 1

SOUTHERN COMPANY

Energy to Serve Your World®

Joseph M. Farley Nuclear Plant

Core Operating Limits Report

Unit 2 - Cycle 24

Version 1

September 2014

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

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
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.**

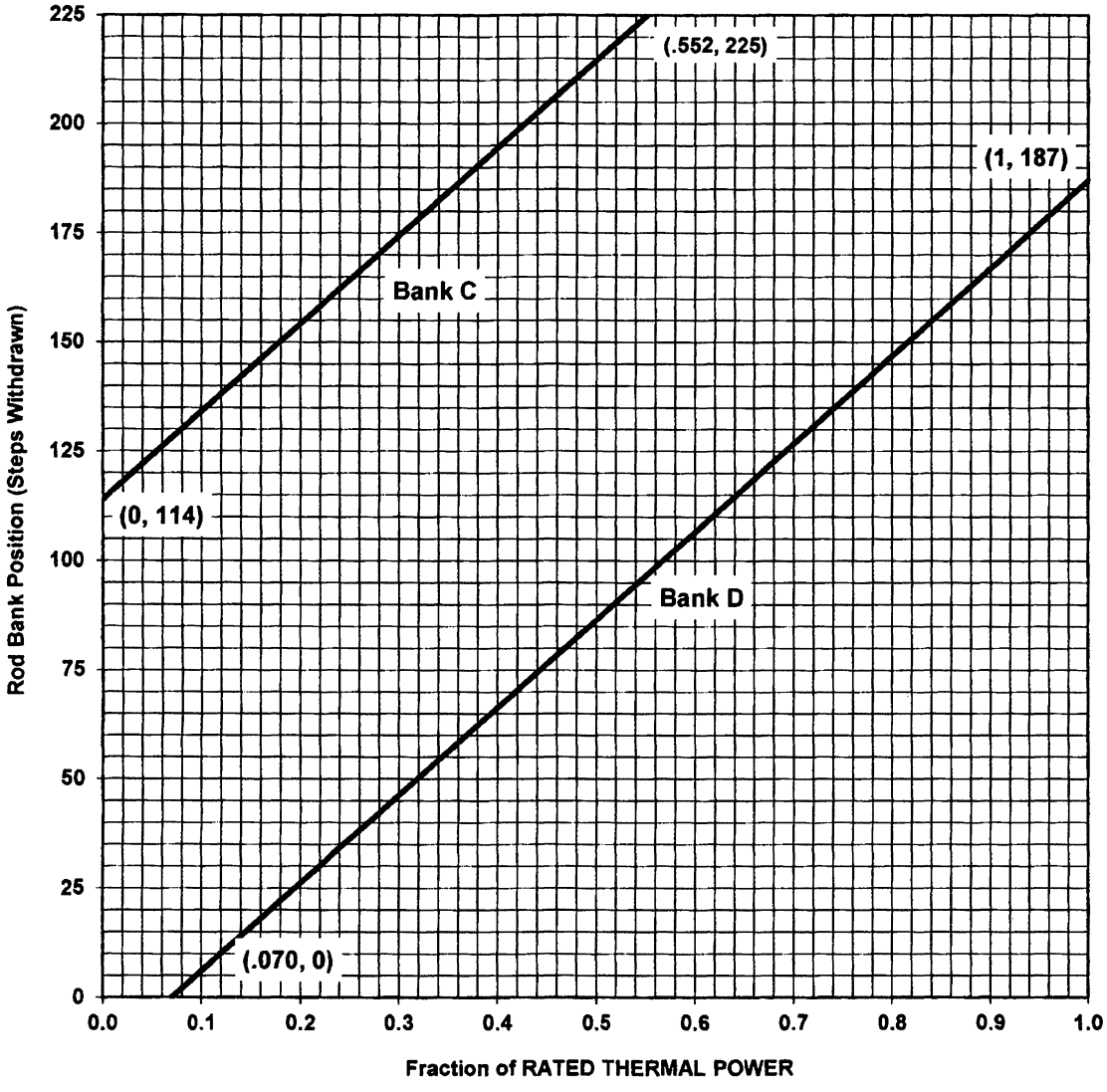
Table 5
Part Power (48%) RAOC W(Z)

	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

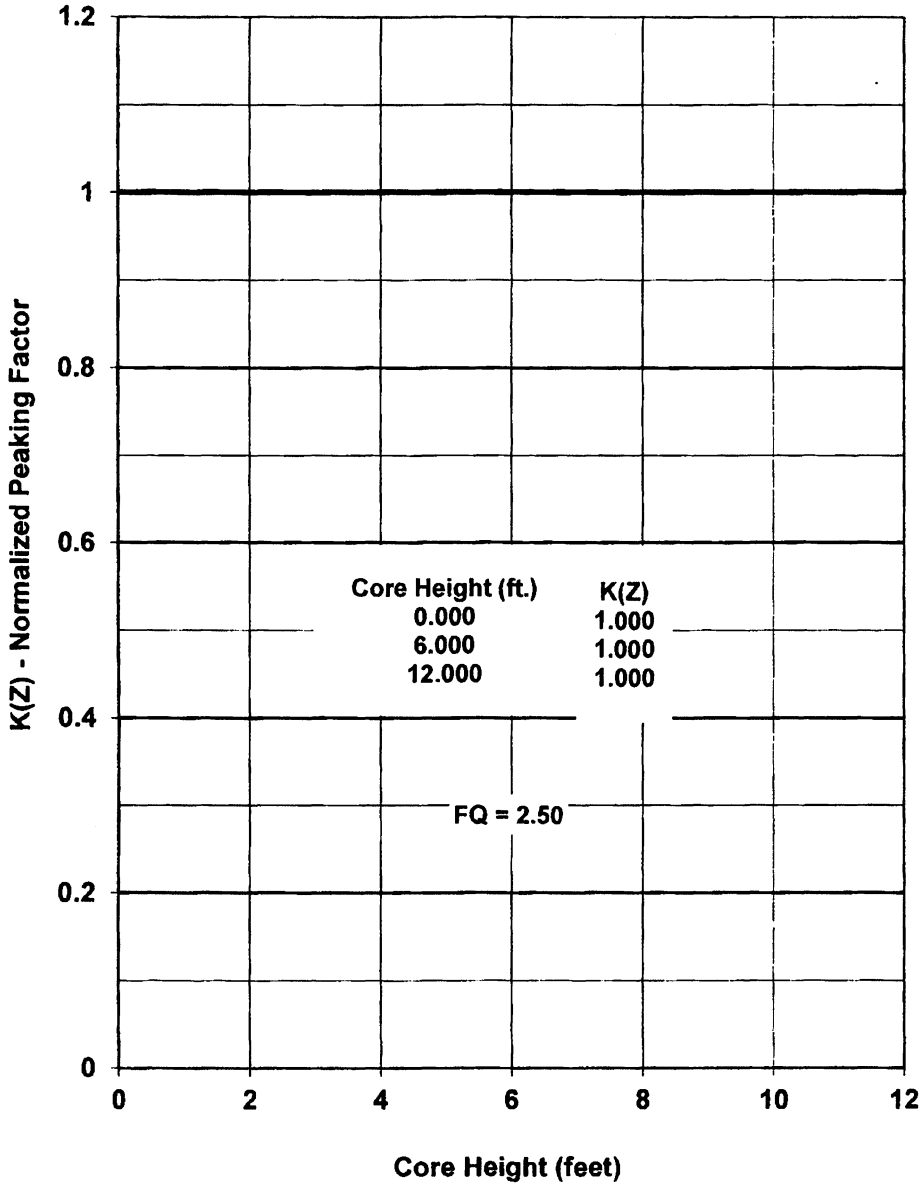


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

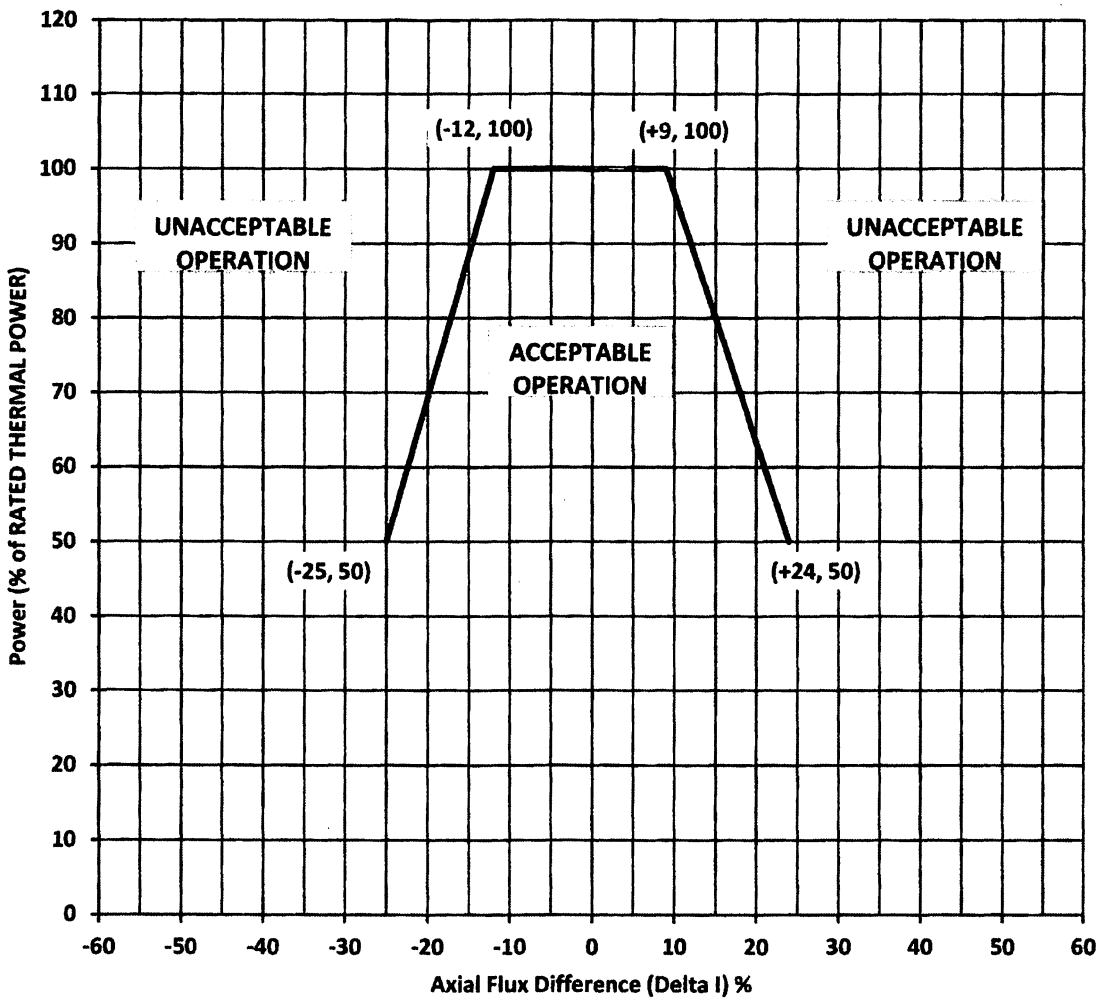


Figure 4
Reactor Core Safety Limits