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SOUTHERN COMPANY

August 17, 2010

Docket Nos.: 50-348

NL-10-1486

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

Joseph M. Farley Nuclear Plant-Unit 1
Cycle 23 Revision 1 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-Unit 1 Cycle 23 Revision 1.

This letter contains no NRC commitments. If there are any questions, please contact Mr. N. J. Stringfellow at 205-992-7037.

Sincerely,

Paula M. Marino

Paula M. Marino
Vice President Engineering

PMM/PAH/lac

Enclosure: Core Operating Limits Report FNP Unit 1 Cycle 23 Revision 1

cc: Southern Nuclear Operating Company
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Joseph M. Farley Nuclear Plant - Unit 1
Cycle 23 Core Operating Limits Report

Enclosure

Core Operating Limits Report Unit 1 Cycle 23, Revision 1

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Joseph M. Farley Nuclear Plant

Core Operating Limits Report

Unit 1 - Cycle 23

Revision 1

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 1 CYCLE 23, Revision 1 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 $F_Q(Z) \le \frac{F_Q^{RTP}}{P} * K(Z)$ 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 W(Z) values are provided in Table 4.

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.[2]

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 ≥ 263,400 GPM when using the precision heat balance method and ≥ 264,200 GPM when using the elbow tap method.

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[2] 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	1.027
150	1.027
354	1.033
558	1.036
763	1.037
967	1.034
1171	1.029
1375	1.023
1580	1.020

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 1.020 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

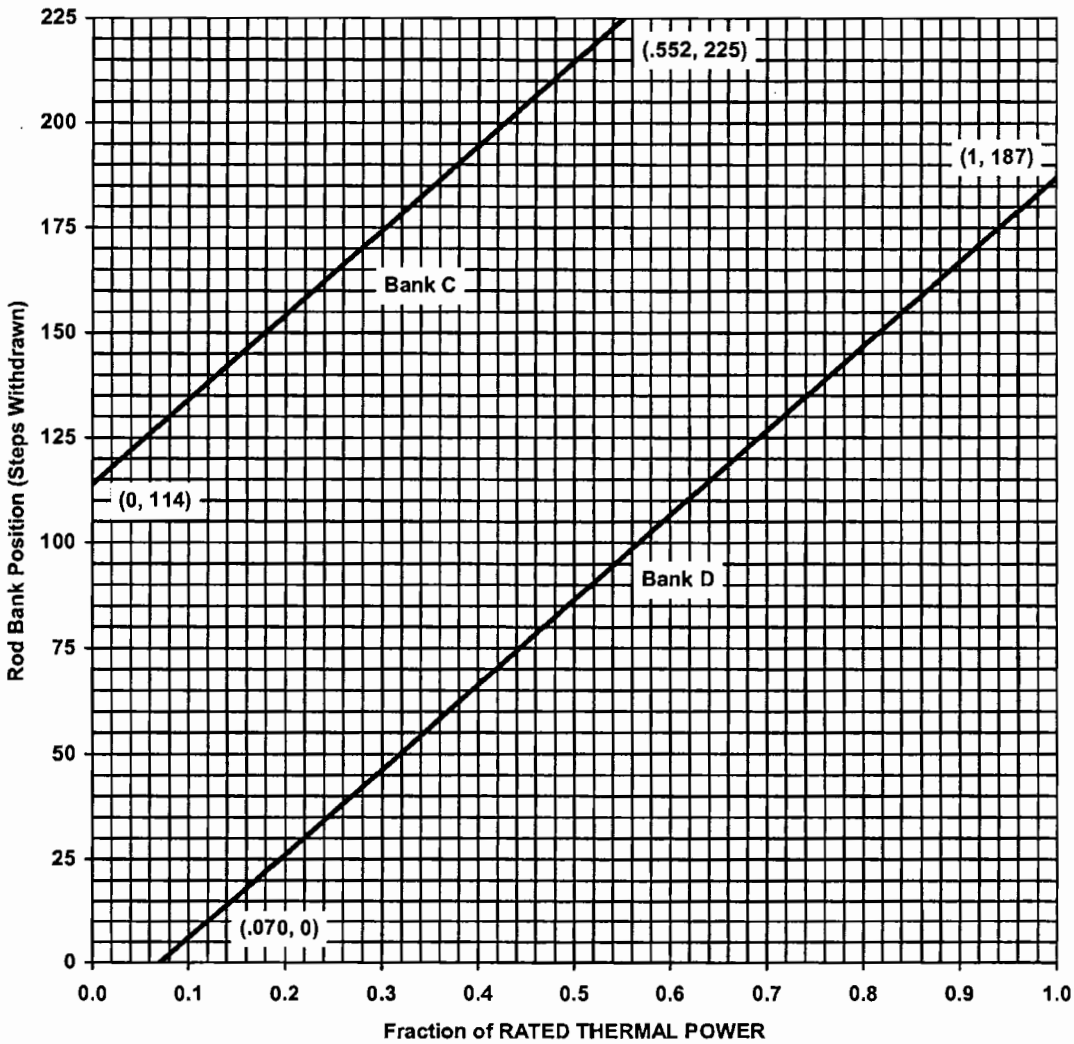
Table 4
RAOC W(Z)

	Axial Point	Elevation (feet)	150 MWD/MTU	3000 MWD/MTU	10000 MWD/MTU	18000 MWD/MTU
*	1	12.00	1.0000	1.0000	1.0000	1.0000
*	2	11.80	1.0000	1.0000	1.0000	1.0000
*	3	11.60	1.0000	1.0000	1.0000	1.0000
*	4	11.40	1.0000	1.0000	1.0000	1.0000
*	5	11.20	1.0000	1.0000	1.0000	1.0000
	6	11.00	1.2003	1.2659	1.2557	1.2569
	7	10.80	1.1959	1.2591	1.2533	1.2430
	8	10.60	1.1889	1.2497	1.2511	1.2290
	9	10.40	1.1819	1.2395	1.2489	1.2243
	10	10.20	1.1741	1.2283	1.2416	1.2175
	11	10.00	1.1652	1.2164	1.2295	1.2103
	12	9.80	1.1640	1.2038	1.2274	1.2033
	13	9.60	1.1657	1.1930	1.2287	1.2070
	14	9.40	1.1641	1.1871	1.2264	1.2165
	15	9.20	1.1611	1.1781	1.2227	1.2238
	16	9.00	1.1559	1.1688	1.2229	1.2331
	17	8.80	1.1550	1.1709	1.2331	1.2452
	18	8.60	1.1624	1.1812	1.2477	1.2642
	19	8.40	1.1741	1.1907	1.2593	1.2854
	20	8.20	1.1824	1.1976	1.2680	1.3055
	21	8.00	1.1885	1.2020	1.2736	1.3224
	22	7.80	1.1925	1.2041	1.2763	1.3354
	23	7.60	1.1942	1.2040	1.2761	1.3448
	24	7.40	1.1942	1.2019	1.2731	1.3504
	25	7.20	1.1934	1.1979	1.2676	1.3526
	26	7.00	1.1911	1.1922	1.2598	1.3514
	27	6.80	1.1871	1.1849	1.2498	1.3470
	28	6.60	1.1817	1.1763	1.2380	1.3397
	29	6.40	1.1751	1.1665	1.2244	1.3296
	30	6.20	1.1674	1.1555	1.2094	1.3169
	31	6.00	1.1588	1.1443	1.1955	1.3017
	32	5.80	1.1487	1.1331	1.1833	1.2847
	33	5.60	1.1396	1.1246	1.1707	1.2641
	34	5.40	1.1430	1.1320	1.1609	1.2434
	35	5.20	1.1508	1.1384	1.1565	1.2344
	36	5.00	1.1579	1.1439	1.1547	1.2267
	37	4.80	1.1644	1.1491	1.1526	1.2190
	38	4.60	1.1701	1.1533	1.1491	1.2116
	39	4.40	1.1748	1.1567	1.1446	1.2017
	40	4.20	1.1786	1.1592	1.1391	1.1900
	41	4.00	1.1814	1.1608	1.1325	1.1765
	42	3.80	1.1833	1.1612	1.1248	1.1613
	43	3.60	1.1840	1.1615	1.1170	1.1448
	44	3.40	1.1843	1.1629	1.1111	1.1273
	45	3.20	1.1897	1.1651	1.1068	1.1104
	46	3.00	1.1991	1.1755	1.1032	1.1053
	47	2.80	1.2149	1.1925	1.1036	1.1148
	48	2.60	1.2368	1.2108	1.1090	1.1280
	49	2.40	1.2602	1.2288	1.1159	1.1404
	50	2.20	1.2833	1.2466	1.1229	1.1529
	51	2.00	1.3059	1.2640	1.1307	1.1653
	52	1.80	1.3278	1.2809	1.1391	1.1777
	53	1.60	1.3489	1.2971	1.1476	1.1902
	54	1.40	1.3688	1.3123	1.1561	1.2026
	55	1.20	1.3874	1.3265	1.1646	1.2150
	56	1.00	1.4042	1.3392	1.1726	1.2269
*	57	0.80	1.0000	1.0000	1.0000	1.0000
*	58	0.60	1.0000	1.0000	1.0000	1.0000
*	59	0.40	1.0000	1.0000	1.0000	1.0000
*	60	0.20	1.0000	1.0000	1.0000	1.0000
*	61	0.00	1.0000	1.0000	1.0000	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

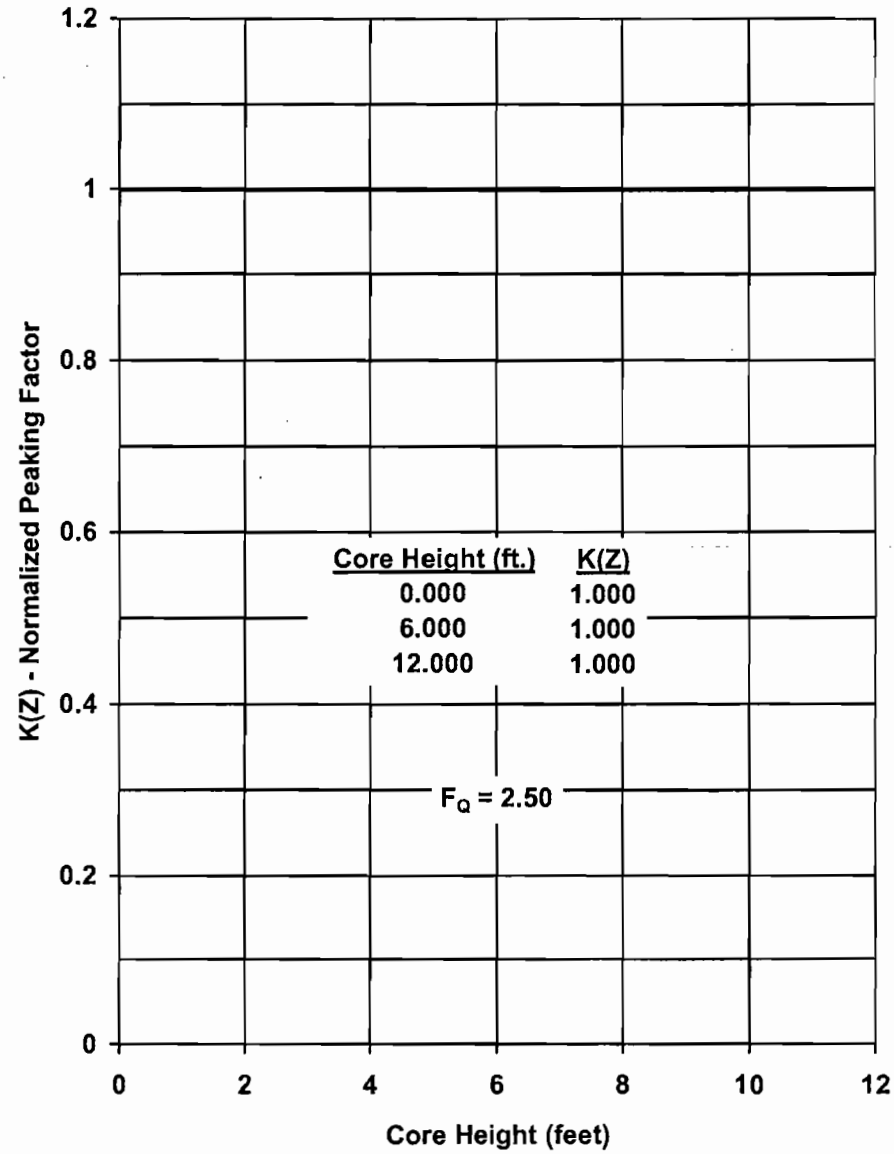


Figure 3
Axial Flux Difference Limits as a Function of
Rated Thermal Power for RAOC

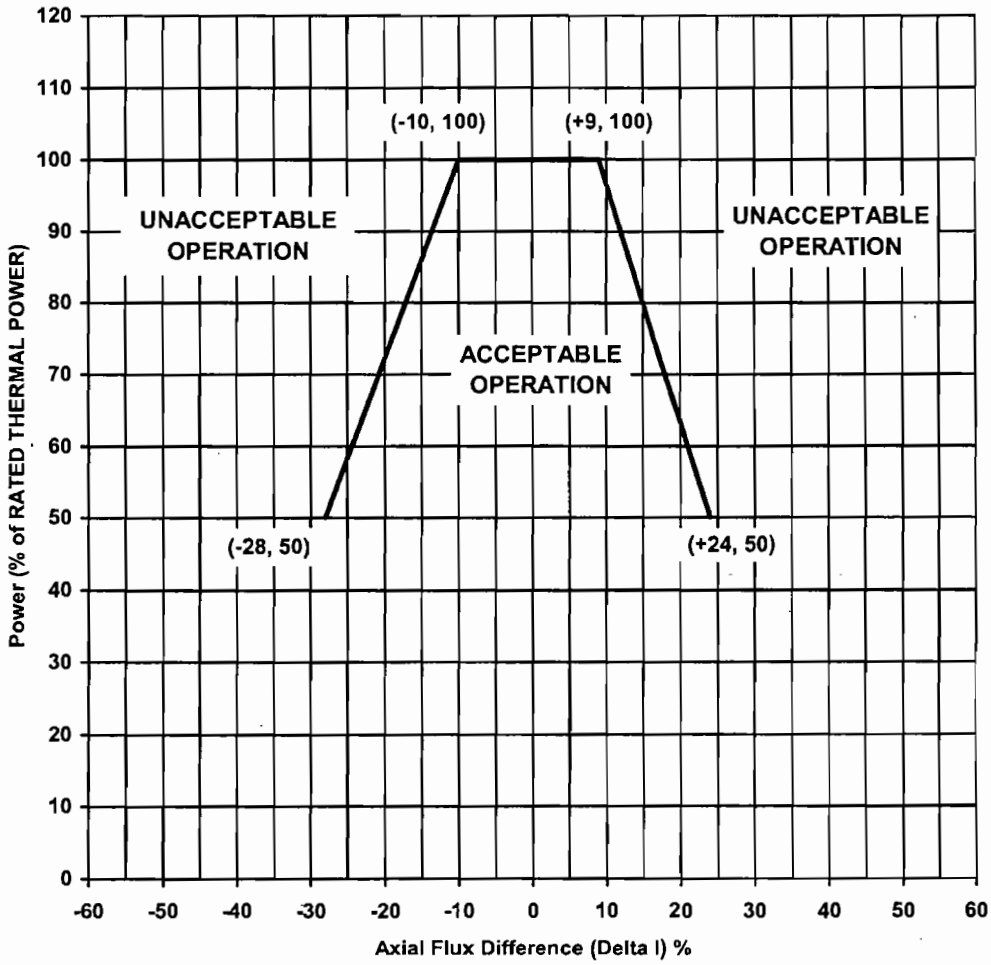


Figure 4
Reactor Core Safety Limits