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SOUTHERN COMPANY

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Docket Nos.: 50-348 NL-13-2294

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

Joseph M. Farley Nuclear Plant – Unit 1
Cycle 26 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 1 Cycle 26 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

C.R. Pierce
Regulatory Affairs Director

CRP/RMJ/lac

Enclosure: Core Operating Limits Report for FNP Unit 1 Cycle 26 Version 1

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Joseph M. Farley Nuclear Plant – Unit 1
Cycle 26 Core Operating Limits Report Version 1

Enclosure

Core Operating Limits Report for FNP Unit 1 Cycle 26 Version 1

SOUTHERN COMPANY

*Energy to Serve Your World®*

# Joseph M. Farley Nuclear Plant

# Core Operating Limits Report

## Unit 1 - Cycle 26

## Version 1

## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 1 CYCLE 26 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 $-4.3 \times 10^{-4}$ $\Delta k/k/°F$.

2.3.2 The MTC Surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to $-3.65 \times 10^{-4}$ $\Delta k/k/°F$.

The 100 ppm/ARO/RTP-MTC should be less negative than $-4.0 \times 10^{-4}$ $\Delta k/k/°F$.

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

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 |
|---|---|
| All Burn Up Steps | 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.

## Table 2

### Reactor Trip System Instrumentation - Overtemperature ΔT (OTΔT)
**Setpoint Parameter Values**

| | | |
|---|---|---|
| $T' \leq 577.2°F$ | $P' = 2235$ psig | |
| $K_1 = 1.17$ | $K_2 = 0.017/°F$ | $K_3 = 0.000825/\text{psi}$ |
| $\tau_1 \geq 30$ 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 $\Delta I$

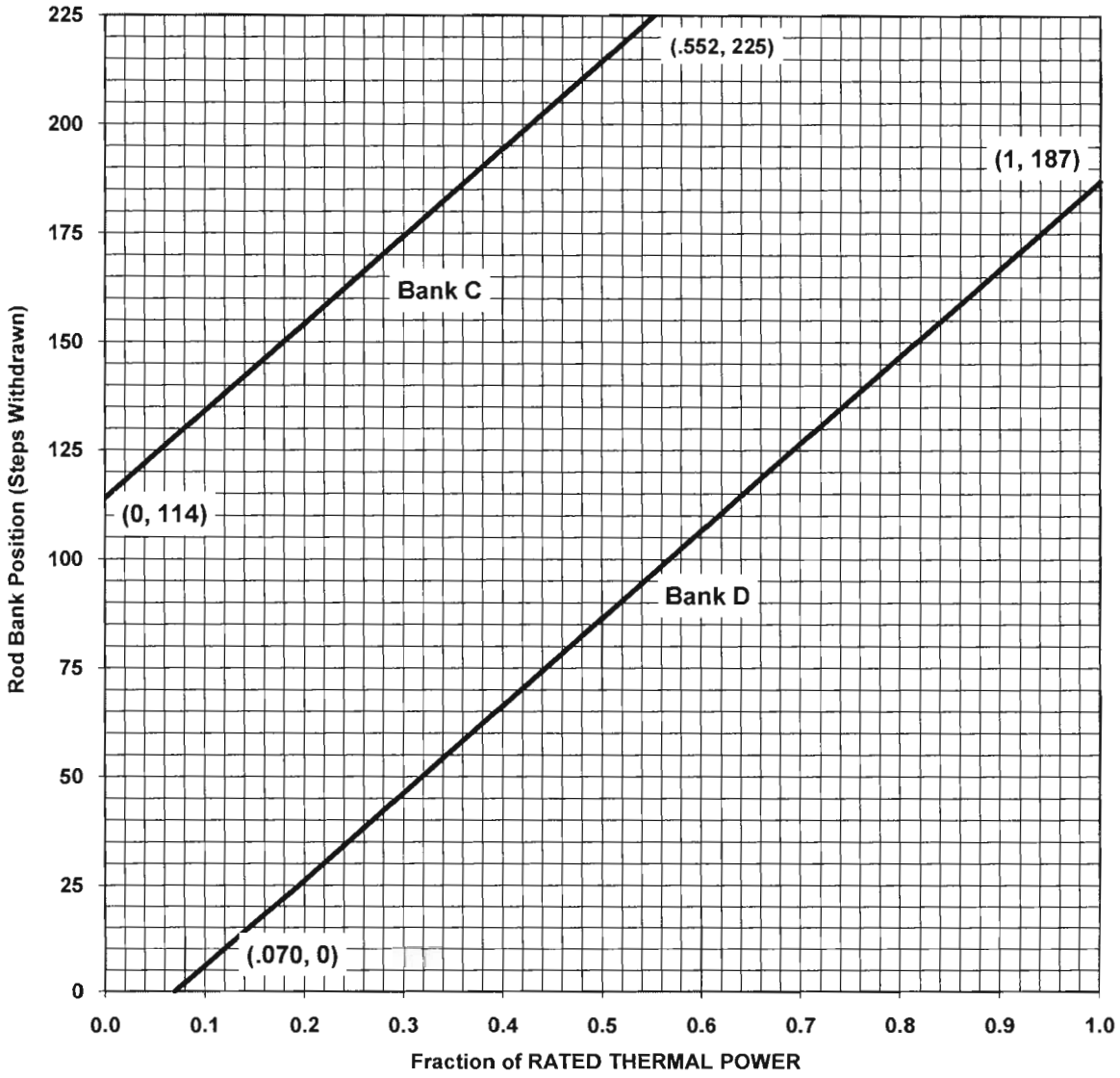
## Table 4
## RAOC W(Z)

| | 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 | 1.1632 | 1.2116 | 1.2928 | 1.2696 | 1.2628 |
| | 7 | 10.80 | 1.1604 | 1.2099 | 1.2746 | 1.2522 | 1.2473 |
| | 8 | 10.60 | 1.1539 | 1.2024 | 1.2484 | 1.2271 | 1.2253 |
| | 9 | 10.40 | 1.1472 | 1.1946 | 1.2292 | 1.2221 | 1.2111 |
| | 10 | 10.20 | 1.1410 | 1.1920 | 1.2149 | 1.2163 | 1.2036 |
| | 11 | 10.00 | 1.1427 | 1.1894 | 1.2174 | 1.2080 | 1.1951 |
| | 12 | 9.80 | 1.1477 | 1.1859 | 1.2268 | 1.2017 | 1.1923 |
| | 13 | 9.60 | 1.1479 | 1.1828 | 1.2303 | 1.1984 | 1.1969 |
| | 14 | 9.40 | 1.1454 | 1.1775 | 1.2341 | 1.1980 | 1.2077 |
| | 15 | 9.20 | 1.1457 | 1.1705 | 1.2342 | 1.2067 | 1.2156 |
| | 16 | 9.00 | 1.1427 | 1.1618 | 1.2357 | 1.2159 | 1.2247 |
| | 17 | 8.80 | 1.1427 | 1.1529 | 1.2420 | 1.2200 | 1.2369 |
| | 18 | 8.60 | 1.1530 | 1.1517 | 1.2528 | 1.2273 | 1.2533 |
| | 19 | 8.40 | 1.1661 | 1.1637 | 1.2671 | 1.2451 | 1.2763 |
| | 20 | 8.20 | 1.1768 | 1.1735 | 1.2782 | 1.2600 | 1.2960 |
| | 21 | 8.00 | 1.1850 | 1.1800 | 1.2856 | 1.2712 | 1.3118 |
| | 22 | 7.80 | 1.1910 | 1.1848 | 1.2899 | 1.2796 | 1.3242 |
| | 23 | 7.60 | 1.1947 | 1.1873 | 1.2910 | 1.2848 | 1.3330 |
| | 24 | 7.40 | 1.1962 | 1.1878 | 1.2891 | 1.2872 | 1.3383 |
| | 25 | 7.20 | 1.1970 | 1.1875 | 1.2844 | 1.2865 | 1.3399 |
| | 26 | 7.00 | 1.1963 | 1.1858 | 1.2770 | 1.2842 | 1.3394 |
| | 27 | 6.80 | 1.1938 | 1.1825 | 1.2672 | 1.2803 | 1.3368 |
| | 28 | 6.60 | 1.1898 | 1.1777 | 1.2553 | 1.2740 | 1.3312 |
| | 29 | 6.40 | 1.1844 | 1.1715 | 1.2415 | 1.2655 | 1.3228 |
| | 30 | 6.20 | 1.1778 | 1.1641 | 1.2260 | 1.2550 | 1.3119 |
| | 31 | 6.00 | 1.1699 | 1.1564 | 1.2090 | 1.2430 | 1.2985 |
| | 32 | 5.80 | 1.1617 | 1.1457 | 1.1906 | 1.2283 | 1.2835 |
| | 33 | 5.60 | 1.1570 | 1.1381 | 1.1735 | 1.2137 | 1.2652 |
| | 34 | 5.40 | 1.1583 | 1.1464 | 1.1631 | 1.2061 | 1.2448 |
| | 35 | 5.20 | 1.1659 | 1.1546 | 1.1613 | 1.2035 | 1.2414 |
| | 36 | 5.00 | 1.1738 | 1.1612 | 1.1605 | 1.2000 | 1.2398 |
| | 37 | 4.80 | 1.1804 | 1.1676 | 1.1590 | 1.1961 | 1.2361 |
| | 38 | 4.60 | 1.1863 | 1.1730 | 1.1565 | 1.1930 | 1.2308 |
| | 39 | 4.40 | 1.1911 | 1.1774 | 1.1528 | 1.1880 | 1.2234 |
| | 40 | 4.20 | 1.1950 | 1.1810 | 1.1478 | 1.1814 | 1.2139 |
| | 41 | 4.00 | 1.1975 | 1.1834 | 1.1431 | 1.1733 | 1.2025 |
| | 42 | 3.80 | 1.2009 | 1.1851 | 1.1403 | 1.1638 | 1.1891 |
| | 43 | 3.60 | 1.2054 | 1.1853 | 1.1385 | 1.1531 | 1.1744 |
| | 44 | 3.40 | 1.2083 | 1.1849 | 1.1354 | 1.1415 | 1.1583 |
| | 45 | 3.20 | 1.2143 | 1.1900 | 1.1317 | 1.1303 | 1.1408 |
| | 46 | 3.00 | 1.2210 | 1.2004 | 1.1257 | 1.1296 | 1.1374 |
| | 47 | 2.80 | 1.2363 | 1.2159 | 1.1252 | 1.1354 | 1.1429 |
| | 48 | 2.60 | 1.2627 | 1.2362 | 1.1343 | 1.1480 | 1.1454 |
| | 49 | 2.40 | 1.2870 | 1.2578 | 1.1438 | 1.1596 | 1.1484 |
| | 50 | 2.20 | 1.3109 | 1.2791 | 1.1532 | 1.1709 | 1.1521 |
| | 51 | 2.00 | 1.3345 | 1.3000 | 1.1627 | 1.1823 | 1.1618 |
| | 52 | 1.80 | 1.3571 | 1.3201 | 1.1720 | 1.1934 | 1.1750 |
| | 53 | 1.60 | 1.3788 | 1.3394 | 1.1812 | 1.2044 | 1.1870 |
| | 54 | 1.40 | 1.3992 | 1.3576 | 1.1903 | 1.2153 | 1.1993 |
| | 55 | 1.20 | 1.4183 | 1.3746 | 1.1992 | 1.2260 | 1.2116 |
| | 56 | 1.00 | 1.4355 | 1.3897 | 1.2075 | 1.2361 | 1.2234 |
| * | 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.**

**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**

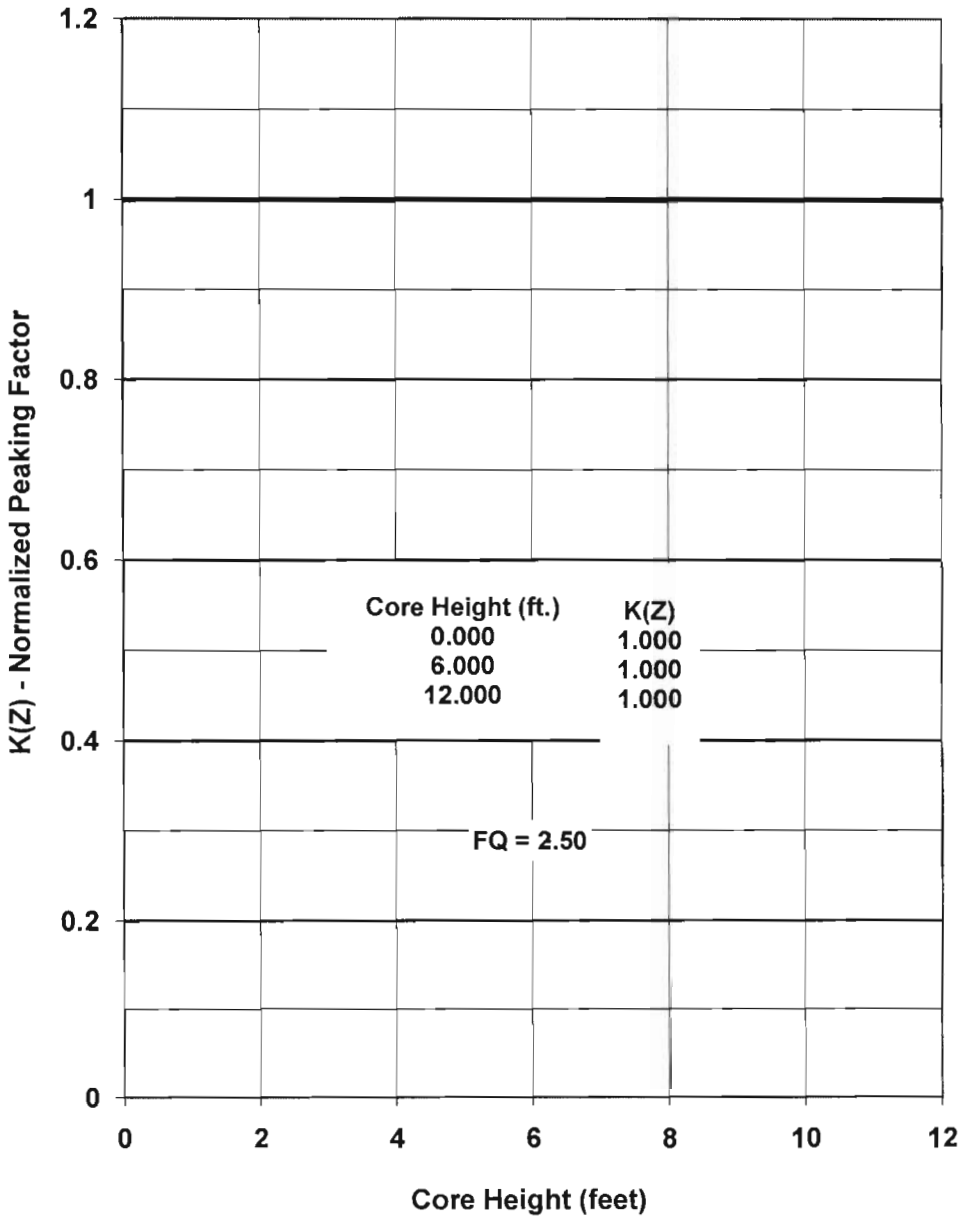


**Figure 3**
**Axial Flux Difference Limits as a Function of**
**Rated Thermal Power for RAOC**

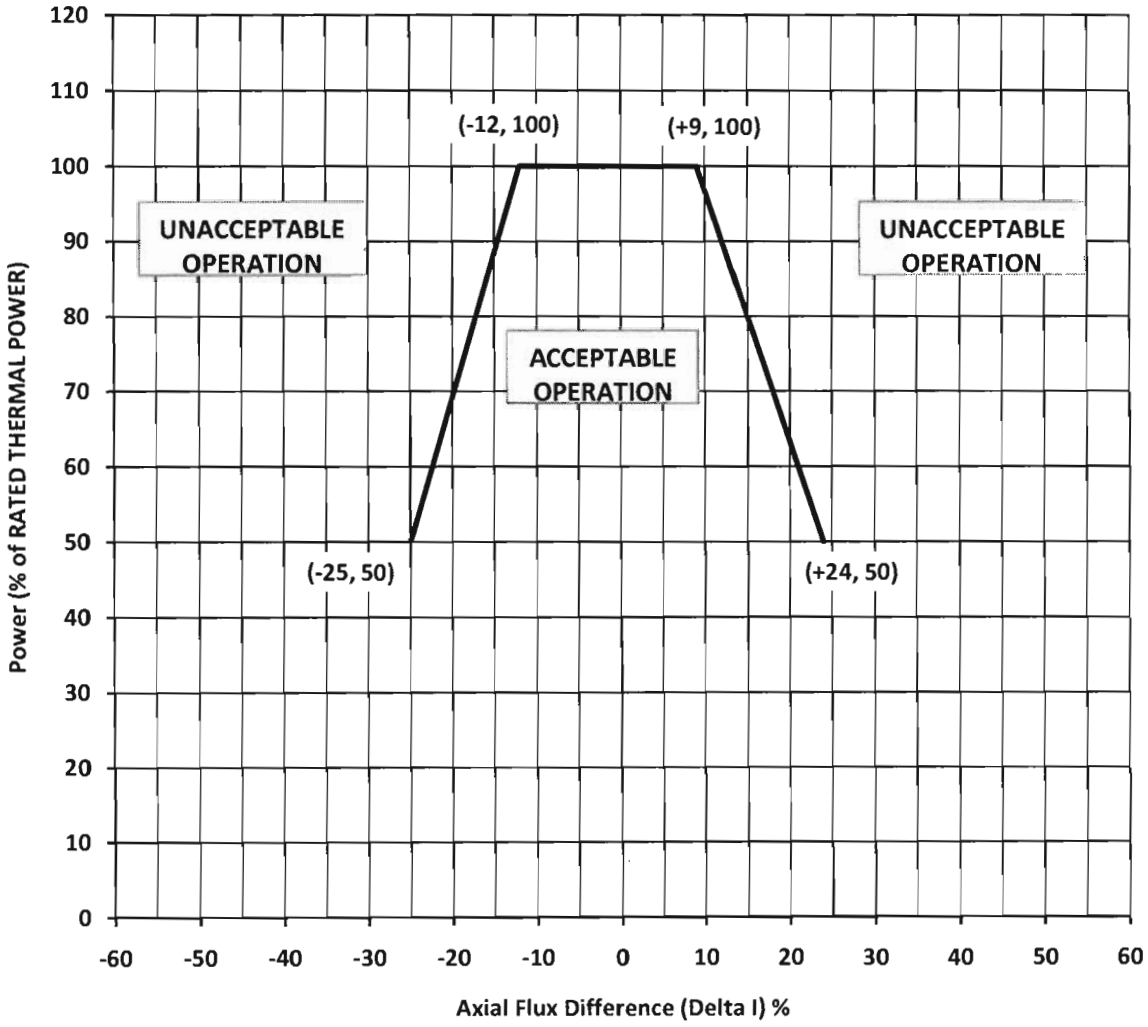


**Figure 4**
**Reactor Core Safety Limits**