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Docket Nos.: 50-348

NL-12-0810

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

**Joseph M. Farley Nuclear Plant – Unit 1  
Cycle 25 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 25 Version 1.

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

Sincerely,

A handwritten signature in black ink that reads "Mark J. Ajluni". The signature is written in a cursive, flowing style.

M. J. Ajluni  
Nuclear Licensing Director

MJA/RMJ/lac

Enclosure: Core Operating Limits Report for FNP Unit 1 Cycle 25 Version 1

cc: Southern Nuclear Operating Company  
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Mr. D. G. Bost, Executive Vice President & Chief Nuclear Officer  
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U. S. Nuclear Regulatory Commission  
Mr. V. M. McCree, Regional Administrator  
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Mr. E. L. Crowe, Senior Resident Inspector – Farley

Joseph M. Farley Nuclear Plant – Unit 1  
Cycle 25 Core Operating Limits Report Version 1

Enclosure

Core Operating Limits Report for FNP Unit 1 Cycle 25 Version 1



# **Joseph M. Farley Nuclear Plant**

## **Core Operating Limits Report**

**Unit 1 - Cycle 25**

**Version 1**

## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for FNP UNIT 1 CYCLE 25 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  $k_{\text{eff}} \geq 1$ )

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  $k_{\text{eff}} < 1$ ), 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 Channel Factor -  $F_{\Delta H}^N$
- 3.2.3 Axial Flux Difference
- 3.3.1 Reactor Trip System Instrumentation Overtemperature  $\Delta T$  (OT $\Delta T$ ) and Overpower  $\Delta T$  (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  $+0.7 \times 10^{-4} \Delta k/k/^{\circ}F$  for power levels up to 70 percent RTP with a linear ramp to 0  $\Delta k/k/^{\circ}F$  at 100 percent RTP.

The EOL/ARO/RTP-MTC shall be less negative than  $-4.3 \times 10^{-4} \Delta k/k/^{\circ}F$ .

2.3.2 The MTC Surveillance limits are:

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

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

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)

$$2.6.1 \quad F_Q(Z) \leq \frac{F_Q^{RTP}}{P} * K(Z) \quad \text{for } P > 0.5$$

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

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

$$2.6.2 \quad F_Q^{RTP} = 2.50$$

2.6.3  $K(Z)$  is provided in Figure 2.

$$2.6.4 \quad F_Q(Z) \leq \frac{F_Q^{RTP} * K(Z)}{P * W(Z)} \quad \text{for } P > 0.5$$

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

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)

$$2.7.1 \quad F_{\Delta H}^N \leq F_{\Delta H}^{RTP} * (1 + PF_{\Delta H} * (1 - P))$$

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

$$2.7.2 \quad F_{\Delta H}^{RTP} = 1.70$$

$$2.7.3 \quad PF_{\Delta H} = 0.3$$

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.<sup>1</sup>

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  $\Delta T$  (OT $\Delta T$ ) and Overpower  $\Delta T$  (OP $\Delta T$ ) Setpoint Parameter Values for Table 3.3.1-1 (Specification 3.3.1)

2.11.1 The Reactor Trip System Instrumentation Overtemperature  $\Delta T$  (OT $\Delta T$ ) and Overpower  $\Delta T$  (OP $\Delta T$ ) 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  $\geq 2209$  psig;
- b. RCS average temperature  $\leq 580.3^\circ\text{F}$ ; and
- c. The minimum RCS total flow rate shall be  $\geq 263,400$  GPM when using the precision heat balance method and  $\geq 264,200$  GPM when using the elbow tap method.

<sup>1</sup> This concentration bounds the condition of  $k_{\text{eff}} \leq 0.95$  (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<sup>10</sup> depletion.

Table 1

**F<sub>Q</sub>(Z) Penalty Factor**

| <b>Cycle Burnup<br/>(MWD/MTU)</b> | <b>F<sub>Q</sub>(Z) Penalty<br/>Factor</b> |
|-----------------------------------|--------------------------------------------|
| 559                               | 1.0200                                     |
| 763                               | 1.0203                                     |
| 967                               | 1.0219                                     |
| 1171                              | 1.0203                                     |
| 1376                              | 1.0200                                     |
| 4031                              | 1.0200                                     |
| 4235                              | 1.0238                                     |
| 4439                              | 1.0287                                     |
| 4644                              | 1.0331                                     |
| 4848                              | 1.0374                                     |
| 5052                              | 1.0415                                     |
| 5256                              | 1.0389                                     |
| 5461                              | 1.0356                                     |
| 5665                              | 1.0325                                     |
| 5869                              | 1.0293                                     |
| 6073                              | 1.0258                                     |
| 6278                              | 1.0218                                     |
| 6482                              | 1.0200                                     |

## Notes:

1. The Penalty Factor, to be applied to F<sub>Q</sub>(Z) in accordance with SR 3.2.1.2, is the maximum factor by which F<sub>Q</sub>(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<sub>Q</sub>(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  $\Delta T$  (OT $\Delta T$ )  
Setpoint Parameter Values**

|                                 |                                                                          |                                                                                                                                                    |
|---------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| $T' \leq 577.2^{\circ}\text{F}$ | $P' = 2235 \text{ psig}$                                                 |                                                                                                                                                    |
| $K_1 = 1.17$                    | $K_2 = 0.017/^{\circ}\text{F}$                                           | $K_3 = 0.000825/\text{psi}$                                                                                                                        |
| $\tau_1 \geq 30 \text{ sec}$    | $\tau_2 \leq 4 \text{ sec}$                                              |                                                                                                                                                    |
| $\tau_4 = 0 \text{ sec}$        | $\tau_5 \leq 6 \text{ sec}$                                              | $\tau_6 \leq 6 \text{ sec}$                                                                                                                        |
| $f_1(\Delta I) =$               | $-2.48 \{23 + (q_t - q_b)\}$<br>0% of RTP<br>$2.05 \{(q_t - q_b) - 15\}$ | when $(q_t - q_b) \leq -23\% \text{ RTP}$<br>when $-23\% \text{ RTP} < (q_t - q_b) \leq 15\% \text{ RTP}$<br>when $(q_t - q_b) > 15\% \text{ RTP}$ |

Table 3

**Reactor Trip System Instrumentation - Overpower  $\Delta T$  (OP $\Delta T$ )  
Setpoint Parameter Values**

$$T'' \leq 577.2^{\circ}\text{F}$$

$$K_4 = 1.10$$

$$K_5 = 0.02/^{\circ}\text{F for increasing } T_{\text{avg}}$$

$$K_5 = 0/^{\circ}\text{F for decreasing } T_{\text{avg}}$$

$$K_6 = 0.00109/^{\circ}\text{F when } T > T''$$

$$K_6 = 0/^{\circ}\text{F when } T \leq T''$$

$$\tau_3 \geq 10 \text{ sec}$$

$$\tau_4 = 0 \text{ sec}$$

$$\tau_5 \leq 6 \text{ sec}$$

$$\tau_6 \leq 6 \text{ sec}$$

$$f_2(\Delta I) = 0\% \text{ RTP for all } \Delta I$$

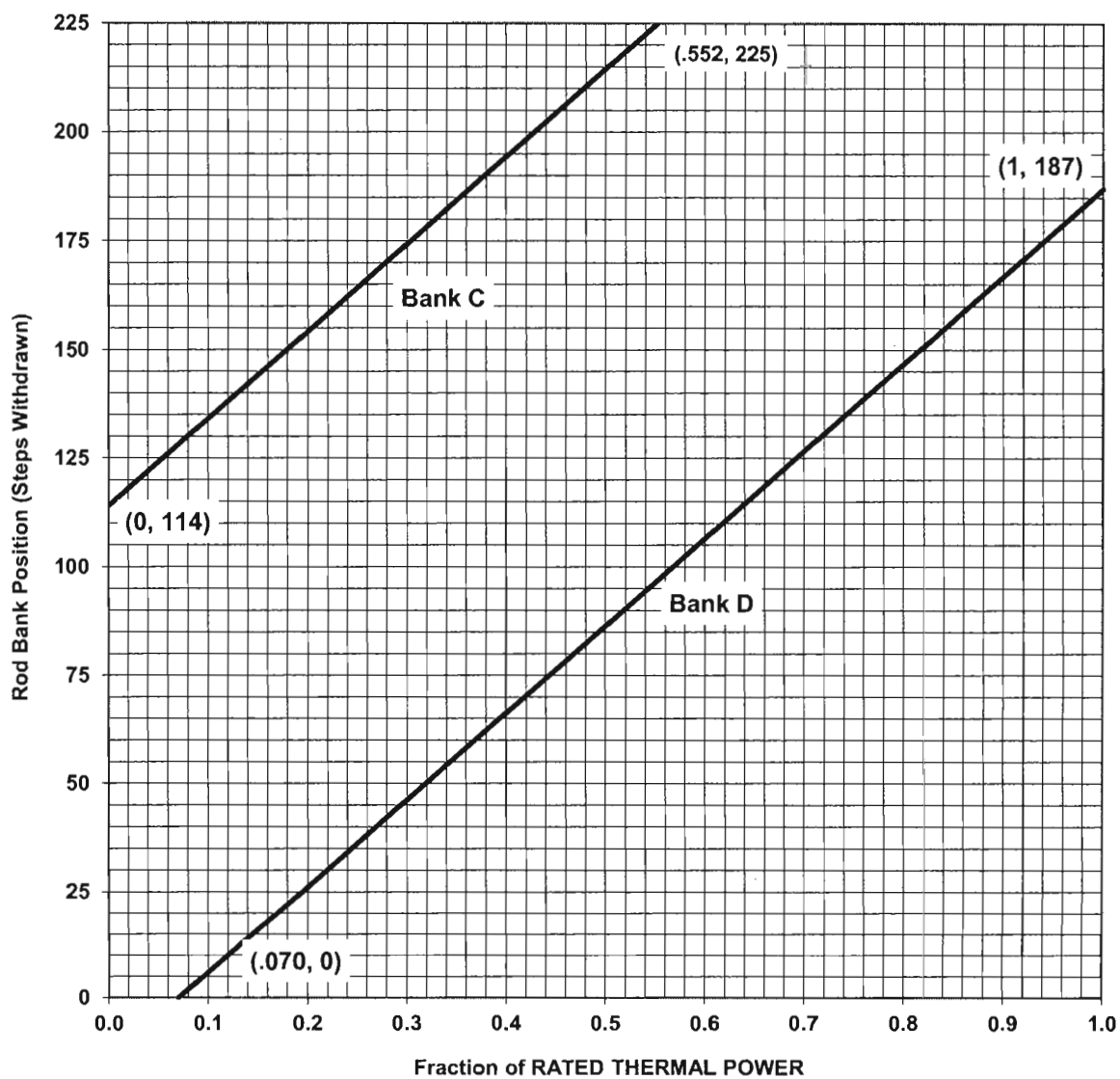
**Table 4**  
**RAOC W(Z)**

|   | 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            | 1.1531      | 1.1843       | 1.2451        | 1.2313        | 1.2345        |
|   | 7           | 10.80            | 1.1489      | 1.1847       | 1.2450        | 1.2249        | 1.2281        |
|   | 8           | 10.60            | 1.1432      | 1.1828       | 1.2395        | 1.2176        | 1.2220        |
|   | 9           | 10.40            | 1.1368      | 1.1789       | 1.2242        | 1.2132        | 1.2158        |
|   | 10          | 10.20            | 1.1299      | 1.1740       | 1.2088        | 1.2114        | 1.2088        |
|   | 11          | 10.00            | 1.1257      | 1.1676       | 1.2209        | 1.2094        | 1.2015        |
|   | 12          | 9.80             | 1.1258      | 1.1595       | 1.2291        | 1.2072        | 1.1921        |
|   | 13          | 9.60             | 1.1261      | 1.1528       | 1.2304        | 1.2024        | 1.1950        |
|   | 14          | 9.40             | 1.1255      | 1.1480       | 1.2339        | 1.2008        | 1.2109        |
|   | 15          | 9.20             | 1.1266      | 1.1416       | 1.2341        | 1.2106        | 1.2218        |
|   | 16          | 9.00             | 1.1266      | 1.1334       | 1.2368        | 1.2177        | 1.2361        |
|   | 17          | 8.80             | 1.1329      | 1.1304       | 1.2454        | 1.2217        | 1.2464        |
|   | 18          | 8.60             | 1.1471      | 1.1333       | 1.2582        | 1.2327        | 1.2588        |
|   | 19          | 8.40             | 1.1602      | 1.1451       | 1.2710        | 1.2512        | 1.2797        |
|   | 20          | 8.20             | 1.1706      | 1.1533       | 1.2801        | 1.2651        | 1.3007        |
|   | 21          | 8.00             | 1.1787      | 1.1595       | 1.2860        | 1.2760        | 1.3181        |
|   | 22          | 7.80             | 1.1845      | 1.1639       | 1.2888        | 1.2840        | 1.3316        |
|   | 23          | 7.60             | 1.1881      | 1.1663       | 1.2884        | 1.2889        | 1.3414        |
|   | 24          | 7.40             | 1.1896      | 1.1671       | 1.2852        | 1.2908        | 1.3476        |
|   | 25          | 7.20             | 1.1891      | 1.1675       | 1.2793        | 1.2899        | 1.3503        |
|   | 26          | 7.00             | 1.1870      | 1.1664       | 1.2709        | 1.2877        | 1.3495        |
|   | 27          | 6.80             | 1.1832      | 1.1639       | 1.2603        | 1.2836        | 1.3456        |
|   | 28          | 6.60             | 1.1781      | 1.1601       | 1.2476        | 1.2769        | 1.3387        |
|   | 29          | 6.40             | 1.1718      | 1.1552       | 1.2332        | 1.2681        | 1.3291        |
|   | 30          | 6.20             | 1.1644      | 1.1494       | 1.2173        | 1.2573        | 1.3170        |
|   | 31          | 6.00             | 1.1556      | 1.1421       | 1.1995        | 1.2448        | 1.3023        |
|   | 32          | 5.80             | 1.1487      | 1.1391       | 1.1832        | 1.2299        | 1.2858        |
|   | 33          | 5.60             | 1.1500      | 1.1411       | 1.1700        | 1.2150        | 1.2658        |
|   | 34          | 5.40             | 1.1594      | 1.1517       | 1.1613        | 1.2052        | 1.2456        |
|   | 35          | 5.20             | 1.1671      | 1.1609       | 1.1604        | 1.2027        | 1.2362        |
|   | 36          | 5.00             | 1.1757      | 1.1692       | 1.1599        | 1.1993        | 1.2328        |
|   | 37          | 4.80             | 1.1846      | 1.1769       | 1.1583        | 1.1956        | 1.2290        |
|   | 38          | 4.60             | 1.1926      | 1.1836       | 1.1557        | 1.1923        | 1.2226        |
|   | 39          | 4.40             | 1.1996      | 1.1894       | 1.1520        | 1.1870        | 1.2144        |
|   | 40          | 4.20             | 1.2056      | 1.1942       | 1.1473        | 1.1802        | 1.2042        |
|   | 41          | 4.00             | 1.2102      | 1.1979       | 1.1414        | 1.1721        | 1.1921        |
|   | 42          | 3.80             | 1.2149      | 1.2005       | 1.1347        | 1.1623        | 1.1785        |
|   | 43          | 3.60             | 1.2209      | 1.2020       | 1.1268        | 1.1519        | 1.1655        |
|   | 44          | 3.40             | 1.2282      | 1.2026       | 1.1186        | 1.1401        | 1.1533        |
|   | 45          | 3.20             | 1.2367      | 1.2039       | 1.1157        | 1.1256        | 1.1382        |
|   | 46          | 3.00             | 1.2465      | 1.2152       | 1.1214        | 1.1306        | 1.1385        |
|   | 47          | 2.80             | 1.2561      | 1.2353       | 1.1329        | 1.1453        | 1.1501        |
|   | 48          | 2.60             | 1.2645      | 1.2570       | 1.1426        | 1.1568        | 1.1623        |
|   | 49          | 2.40             | 1.2724      | 1.2836       | 1.1525        | 1.1687        | 1.1742        |
|   | 50          | 2.20             | 1.2847      | 1.3095       | 1.1622        | 1.1803        | 1.1860        |
|   | 51          | 2.00             | 1.3082      | 1.3347       | 1.1719        | 1.1917        | 1.1977        |
|   | 52          | 1.80             | 1.3371      | 1.3591       | 1.1816        | 1.2029        | 1.2095        |
|   | 53          | 1.60             | 1.3641      | 1.3824       | 1.1911        | 1.2141        | 1.2214        |
|   | 54          | 1.40             | 1.3890      | 1.4043       | 1.2005        | 1.2251        | 1.2334        |
|   | 55          | 1.20             | 1.4114      | 1.4245       | 1.2096        | 1.2358        | 1.2455        |
|   | 56          | 1.00             | 1.4310      | 1.4425       | 1.2180        | 1.2460        | 1.2572        |
| * | 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  $\geq 225$  and  $\leq 231$  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**

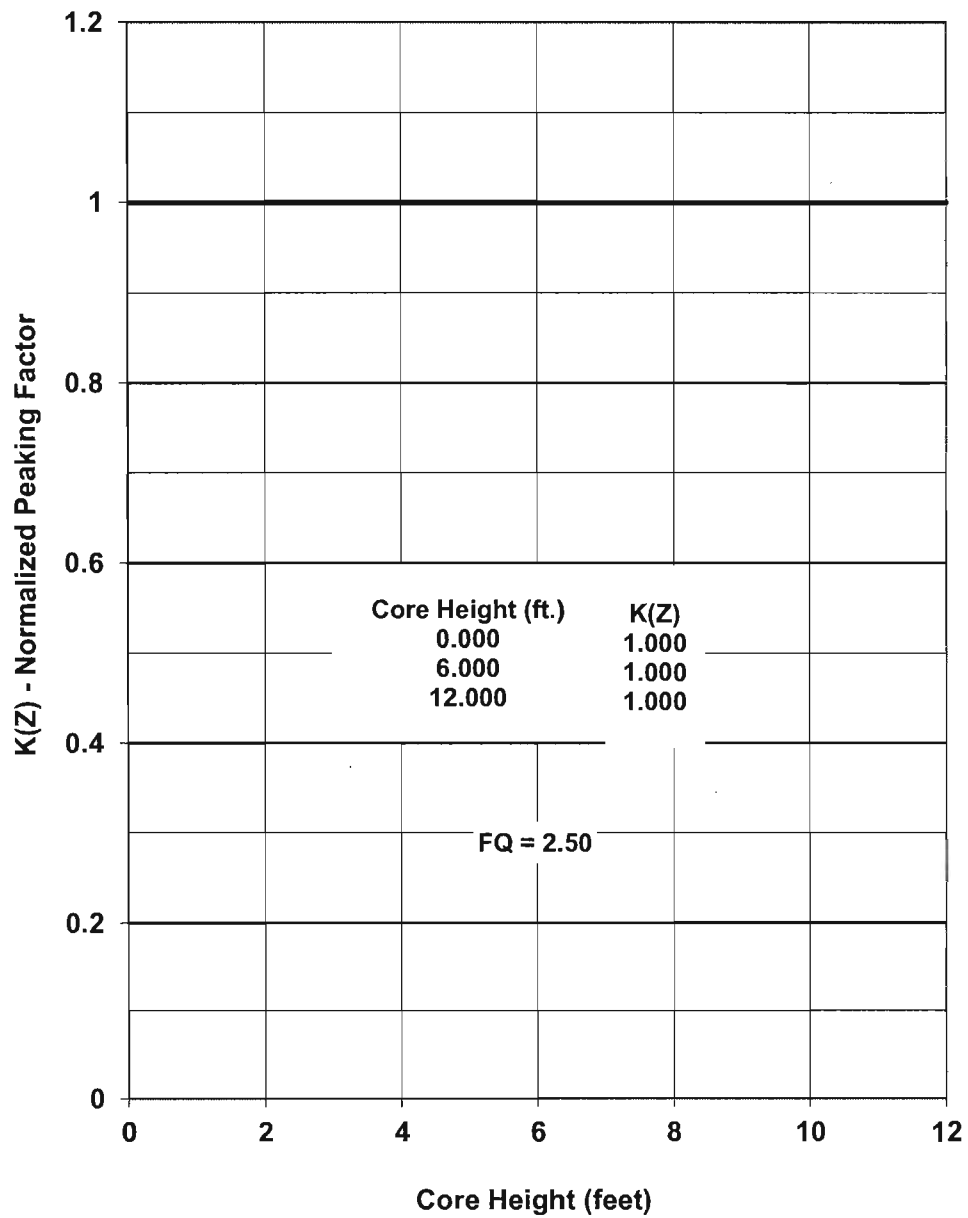


Figure 3  
Axial Flux Difference Limits as a Function of  
Rated Thermal Power for RAOC

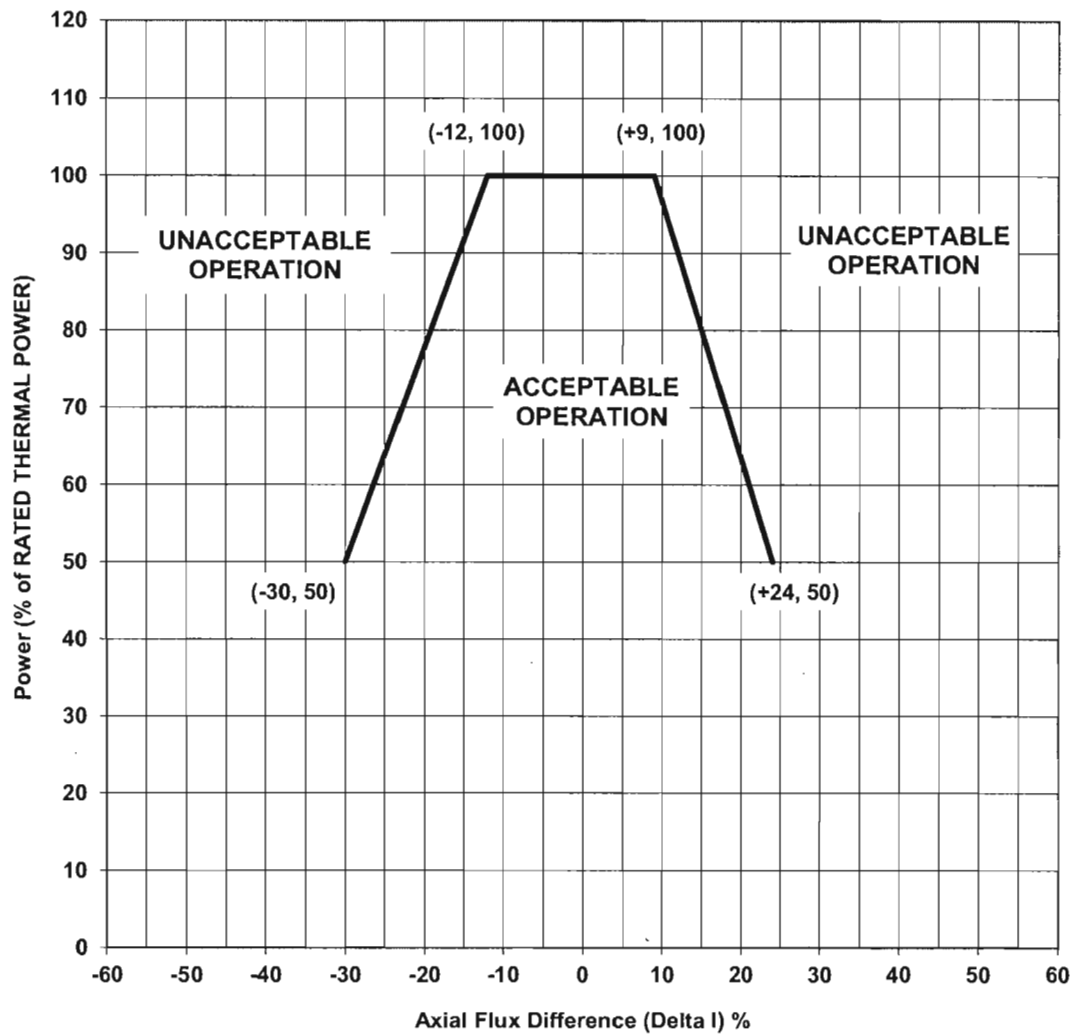


Figure 4  
Reactor Core Safety Limits

