



April 14, 2011

Docket No. 50-443

SBK-L-11077

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

Seabrook Station  
Core Operating Limits Report for Cycle 15

Pursuant to Technical Specification 6.8.1.6.c, NextEra Energy Seabrook, LLC has enclosed the latest revision of the Seabrook Station Core Operating Limits Report (COLR) for cycle 15.

If you have any questions regarding this information, please contact me at (603) 773-7745.

Sincerely,

NextEra Energy Seabrook, LLC

  
Michael O'Keefe  
Licensing Manager

cc: NRC Region I Administrator  
G. E. Miller, NRC Project Manager  
W. J. Raymond, NRC Senior Resident Inspector

A001  
NRC

**ENCLOSURE TO SBK-L-11077**

## 1.0 Core Operating Limits Report (COLR)

This Core Operating Limits Report for Seabrook Station Unit 1, Cycle 15 has been prepared in accordance with the requirements of Technical Specification 6.8.1.6.

The Technical Specifications affected by this report are:

- 1) 2.2.1 Limiting Safety System Settings
- 2) 2.1 Safety Limits
- 3) 3.1.1.1 Shutdown Margin Limit for MODES 1, 2, 3, 4
- 4) 3.1.1.2 Shutdown Margin Limit for MODE 5
- 5) 3.1.1.3 Moderator Temperature Coefficient
- 6) 3.1.2.7 Minimum Boron Concentration for MODES 4, 5, 6
- 7) 3.1.3.5 Shutdown Rod Insertion Limit
- 8) 3.1.3.6 Control Rod Insertion Limits
- 9) 3.2.1 Axial Flux Difference
- 10) 3.2.2 Heat Flux Hot Channel Factor
- 11) 3.2.3 Nuclear Enthalpy Rise Hot Channel Factor
- 12) 3.2.5 DNB Parameters
- 13) 3.5.1.1 Boron Concentration Limits for MODES 1, 2, 3
- 14) 3.5.4 Boron Concentration Limits for MODES 1, 2, 3, 4
- 15) 3.9.1 Boron Concentration Limits for MODE 6

## 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 the NRC-approved methodologies specified in Technical Specification 6.8.1.6.

### 2.1 Limiting Safety System Settings: (Specification 2.2.1)

#### 2.1.1 Cycle Dependent Overtemperature $\Delta T$ Trip Setpoint Parameters and Function Modifier:

$$2.1.1.1 \quad K_1 = 1.210$$

$$2.1.1.2 \quad K_2 = 0.021 / ^\circ\text{F}$$

$$2.1.1.3 \quad K_3 = 0.0011 / \text{psig}$$

$$T = \text{Measured RCS } T_{\text{avg}} (^\circ\text{F}), \text{ and}$$

$$T^1 = \text{Indicated RCS } T_{\text{avg}} \text{ at RATED THERMAL POWER (Calibration temperature for } \Delta T \text{ instrumentation, } \leq 589.1^\circ\text{F}).$$

$$P^1 = \text{Nominal RCS operating pressure, 2235 psig}$$

- 2.1.1.4 Channel Total Allowance (TA) = N.A.
- 2.1.1.5 Channel Z = N.A.
- 2.1.1.6 Channel Sensor Error (S) = N.A.
- 2.1.1.7 Allowable Value – The channel’s maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 0.5% of  $\Delta T$  span. Note that 0.5% of  $\Delta T$  span is applicable to OT $\Delta T$  input channels  $\Delta T$ , Tavg and Pressurizer Pressure; 0.25% of  $\Delta T$  span is applicable to  $\Delta I$ .
- 2.1.1.8  $f_1(\Delta I)$  is a function of the indicated difference between top and bottom detectors of the power-range neutron ion chambers; with nominal gains to be selected based on measured instrument response during plant startup tests calibrations such that:
  - (1) For  $q_t - q_b$  between  $-20\%$  and  $+8\%$ ,  $f_1(\Delta I) \geq 0$ ; where  $q_t$  and  $q_b$  are percent RATED THERMAL POWER in the upper and lower halves of the core, respectively, and  $q_t + q_b$  is the total THERMAL POWER in percent RATED THERMAL POWER;
  - (2) For each percent that the magnitude of  $q_t - q_b$  exceeds  $-20\%$ , the  $\Delta T$  Trip Setpoint shall be automatically reduced by  $\geq 2.87\%$  of its value at RATED THERMAL POWER.
  - (3) For each percent that the magnitude of  $q_t - q_b$  exceeds  $+8\%$ , the  $\Delta T$  Trip Setpoint shall be automatically reduced by  $\geq 1.71\%$  of its value at RATED THERMAL POWER.

See Figure 5.

- 2.1.1.9  $\tau_1 = 0$  seconds
- 2.1.1.10  $\tau_2 = 0$  seconds
- 2.1.1.11  $\tau_3 \leq 2$  seconds
- 2.1.1.12  $\tau_4 \geq 28$  seconds
- 2.1.1.13  $\tau_5 \leq 4$  seconds
- 2.1.1.14  $\tau_6 \leq 2$  seconds

2.1.2 Cycle Dependent Overpower  $\Delta T$  Trip Setpoint Parameters and Function Modifier:

2.1.2.1  $K_4 = 1.116$

2.1.2.2  $K_5 = 0.020 / ^\circ\text{F}$  for increasing average temperature and  $K_5 = 0.0$  for decreasing average temperature.

2.1.2.3  $K_6 = 0.00175 / ^\circ\text{F}$  for  $T > T^{11}$  and  $K_6 = 0.0$  for  $T \leq T^{11}$ ,

where:

$T$  = Measured  $T_{\text{avg}}$  ( $^\circ\text{F}$ ), and

$T^{11}$  = Indicated  $T_{\text{avg}}$  at RATED THERMAL POWER (Calibration temperature for  $\Delta T$  instrumentation,  $\leq 589.1$   $^\circ\text{F}$ ).

2.1.2.4 Channel Total Allowance (TA) = N.A.

2.1.2.5 Channel Z = N.A.

2.1.2.6 Channel Sensor Error (S) = N.A.

2.1.2.7 Allowable Value – The channel’s maximum Trip Setpoint shall not exceed its computed Trip Setpoint by more than 0.5% of  $\Delta T$  span. Note that 0.5% of  $\Delta T$  span is applicable to OP $\Delta T$  input channels  $\Delta T$  and  $T_{\text{avg}}$ .

2.1.2.8  $f_2(\Delta I)$  is disabled.

2.1.2.9  $\tau_1$  as defined in 2.1.1.9, above.

2.1.2.10  $\tau_2$  as defined in 2.1.1.10, above.

2.1.2.11  $\tau_3$  as defined in 2.1.1.11, above.

2.1.2.12  $\tau_6$  as defined in 2.1.1.14, above.

2.1.2.13  $\tau_7 \geq 10$  seconds. It is recognized that exactly equal values cannot always be dialed into the numerator and denominator in the protection system hardware, even if the nominal values are the same (10 seconds). Thus given the inequality sign in the COLR (greater than or equal to) the intent of the definition of this time constant applies primarily to the rate time constant (i.e. the Tau value in the numerator). The lag time constant (denominator Tau value) may be less than 10 seconds or less than the value of the numerator Tau value (e.g., if the numerator is set at 10.5, the denominator may be set to 10 or 9.5) and still satisfy the intent of the anticipatory protective feature.

## 2.2 Safety Limits: (Specification 2.1.1)

2.2.1 In Modes 1 and 2, the combination of Thermal Power, reactor coolant system highest loop average temperature and pressurizer pressure shall not exceed the limits in Figure 6.

## 2.3 Shutdown Margin Limit for MODES 1, 2, 3, and 4: (Specification 3.1.1.1)

2.3.1 The Shutdown Margin shall be greater than or equal to

1.3%  $\Delta K/K$ , in MODES 1, 2 and 3.

2.3.2 The Shutdown Margin shall be greater than or equal to

2.3%  $\Delta K/K$ , in MODE 4.

2.3.3 The Boric Acid Storage System boron concentration

shall be greater than or equal to 7000 ppm.

## 2.4 Shutdown Margin Limit for MODE 5: (Specification 3.1.1.2)

2.4.1 The Shutdown Margin shall be greater than or equal to 2.3%  $\Delta K/K$ .

2.4.2 The RCS boron concentration shall be greater than or equal to 2000 ppm when the reactor coolant loops are in a drained condition.

2.4.3 The Boric Acid Storage System boron concentration shall be greater than or equal to 7000 ppm.

## 2.5 Moderator Temperature Coefficient: (Specification 3.1.1.3)

2.5.1 The Moderator Temperature Coefficient (MTC) shall be less positive than  $+4.089 \times 10^{-5} \Delta K/K/^\circ F$  for Beginning of Cycle Life (BOL), All Rods Out (ARO), Hot Zero Thermal Power conditions.

2.5.2 MTC shall be less negative than  $-5.5 \times 10^{-4} \Delta K/K/^\circ F$  for End of Cycle Life (EOL), ARO, Rated Thermal Power conditions.

2.5.3 The 300 ppm ARO, Rated Thermal Power MTC shall be less negative than  $-4.6 \times 10^{-4} \Delta K/K/^\circ F$  (300 ppm Surveillance Limit).

2.5.4 The Revised Predicted near-EOL 300 ppm MTC shall be calculated using the algorithm contained in WCAP 13749-P-A:

$$\text{Revised Predicted MTC} = \text{Predicted MTC} + \text{AFD Correction} - 3 \text{ PCM/degree F}$$

If the Revised Predicted MTC is less negative than the SR 4.1.1.3.b 300 ppm surveillance limit and all the benchmark data contained in the surveillance procedure are met, then an MTC measurement in accordance with SR 4.1.1.3.b is not required to be performed.

**2.6 Minimum Boron Concentration for MODES 4, 5, 6 (Specification 3.1.2.7)**

2.6.1 The Boric Acid Storage System boron concentration shall be greater than or equal to 7000 ppm.

**2.7 Shutdown Rod Insertion Limit: (Specification 3.1.3.5)**

2.7.1 The shutdown rods shall be fully withdrawn. The fully withdrawn position is defined as the interval within 225 steps withdrawn to the mechanical fully withdrawn position inclusive.

**2.8 Control Rod Insertion Limits: (Specification 3.1.3.6)**

2.8.1 The control rod banks shall be limited in physical insertion as specified in Figure 1. Control Bank A shall be at least 225 steps withdrawn.

**2.9 Axial Flux Difference: (Specification 3.2.1)**

2.9.1 The indicated AFD must be within the Acceptable Operation Limits specified in Figure 2.

**2.10 Heat Flux Hot Channel Factor: (Specification 3.2.2)**

2.10.1  $F^{RTP}_Q = 2.50$

2.10.2  $K(Z)$  is specified in Figure 3.

2.10.3  $W(Z)$  is specified in Table 1.

The  $W(Z)$  data is applied over the cycle as follows:

$BU < 150$ MWD/MTU,	linear extrapolation of 150 and 3000 MWD/MTU $W(Z)$ data
$150 \leq BU < 6500$ MWD/MTU,	quadratic interpolation of 150, 3000, and 10000 MWD/MTU data
$6500 \leq BU < 18000$ MWD/MTU,	quadratic interpolation of 3000, 10000, and 18000 MWD/MTU $W(Z)$ data
$BU \geq 18000$ MWD/MTU,	linear extrapolation of 10000 and 18000 MWD/MTU $W(Z)$ data

**Note: The  $FQ(Z)$  surveillance exclusion zone is specified by Technical Specification 4.2.2.2.g**

2.10.4 The  $F^M_{Q(Z)}$  penalty factor is applied over the cycle as follows:

$BU \geq 0$  MWD/MTU,  $F^M_{Q(Z)}$  penalty factor is 1.020

## 2.11 Nuclear Enthalpy Rise Hot Channel Factor: (Specification 3.2.3)

2.11.1  $F^N_{\Delta H} \leq F^N_{\Delta H(RTP)} \times (1 + PF \times (1 - P))$

where  $P = \text{THERMAL POWER} / \text{RATED THERMAL POWER}$ .

2.11.2.a For  $F^N_{\Delta H}$  measured by the fixed incore detectors:

$$F^N_{\Delta H(RTP)} = 1.584.$$

2.11.2.b For  $F^N_{\Delta H}$  measured by the movable incore detectors:

$$F^N_{\Delta H(RTP)} = 1.584.$$

2.11.3 Power Factor Multiplier for  $F^N_{\Delta H} = PF = 0.3$ .

## 2.12 DNB Parameters (Specification 3.2.5)

2.12.1 The Reactor Coolant System  $T_{avg}$  shall be less than or equal to 595.1 degrees F.

2.12.2 The Pressurizer Pressure shall be greater than or equal to 2185 PSIG.

**Note:** Technical Specification Bases 3/4.2.5, "DNB Parameters" indicates that the limits on DNB-related parameters assure consistency with the normal steady-state envelope of operation assumed in the transient and accident analyses. Operating procedures include allowances for measurement and indication uncertainty so that the limits in the COLR for  $T_{avg}$  and pressurizer pressure are not exceeded. Consistent with the Bases, the values of these DNB parameters are the limiting  $T_{avg}$  and pressurizer pressure assumed in the transient and accident analyses.

## 2.13 Accumulator Boron Concentration Limits for MODES 1,2,3 (Specification 3.5.1.1)

2.13.1 Each Accumulator shall have a boron concentration between 2300 and 2600 ppm.



**2.14 Refueling Water Storage Tank Boron Concentration Limits for MODES 1, 2, 3, 4 (Specification 3.5.4)**

2.14.1 The RWST shall have a boron concentration between 2400 and 2600 ppm.

**2.15 Refueling Boron Concentration Limits for MODE 6 (Specification 3.9.1)**

2.15.1 The Refueling Boron Concentration during Cycle 15 shall be greater than or equal to 2195 ppm.

2.15.2 The Boric Acid Storage System boron concentration shall be greater than or equal to 7000 ppm.

Figure 1: Control Bank Insertion Limits Versus Thermal Power

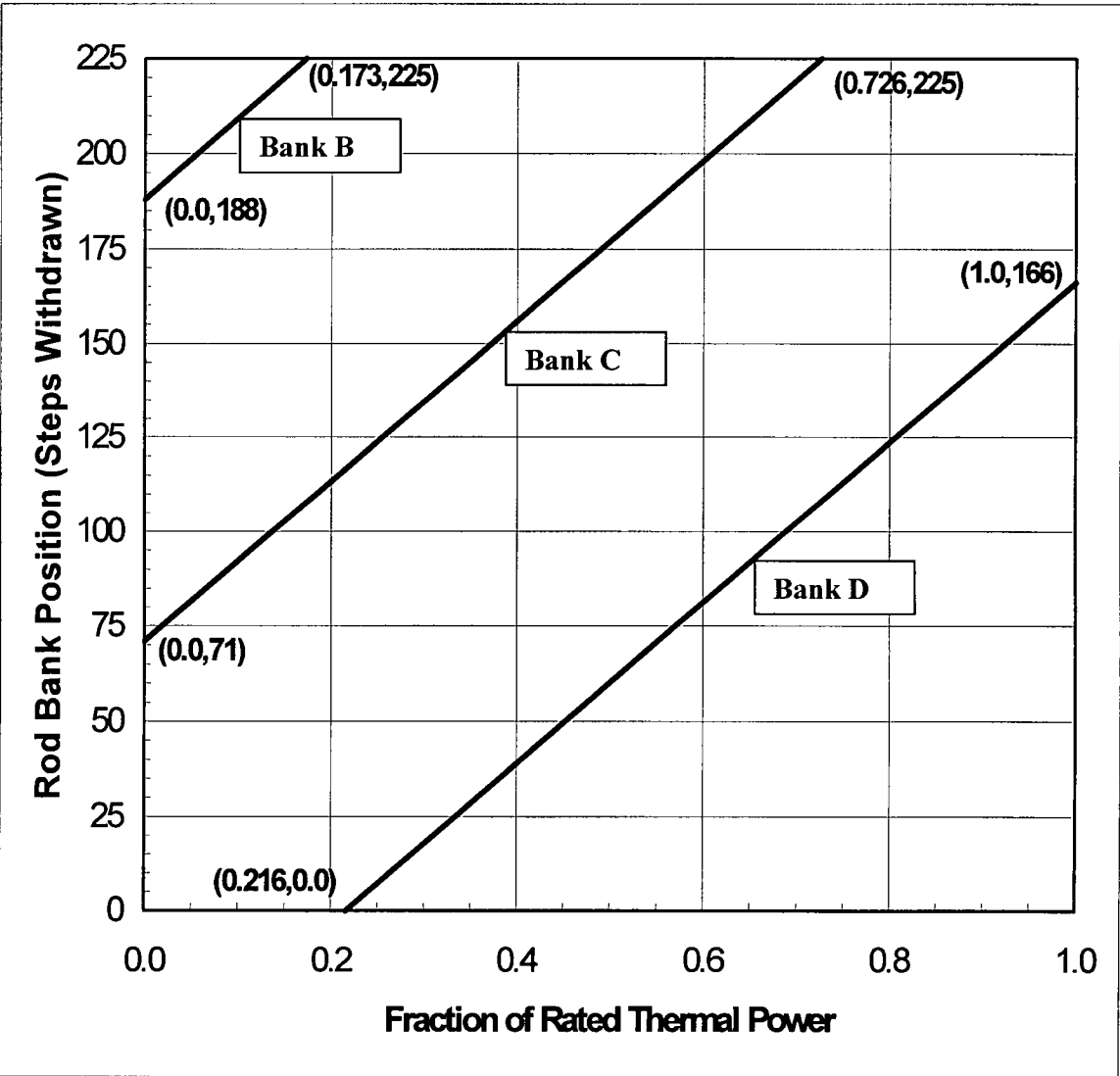
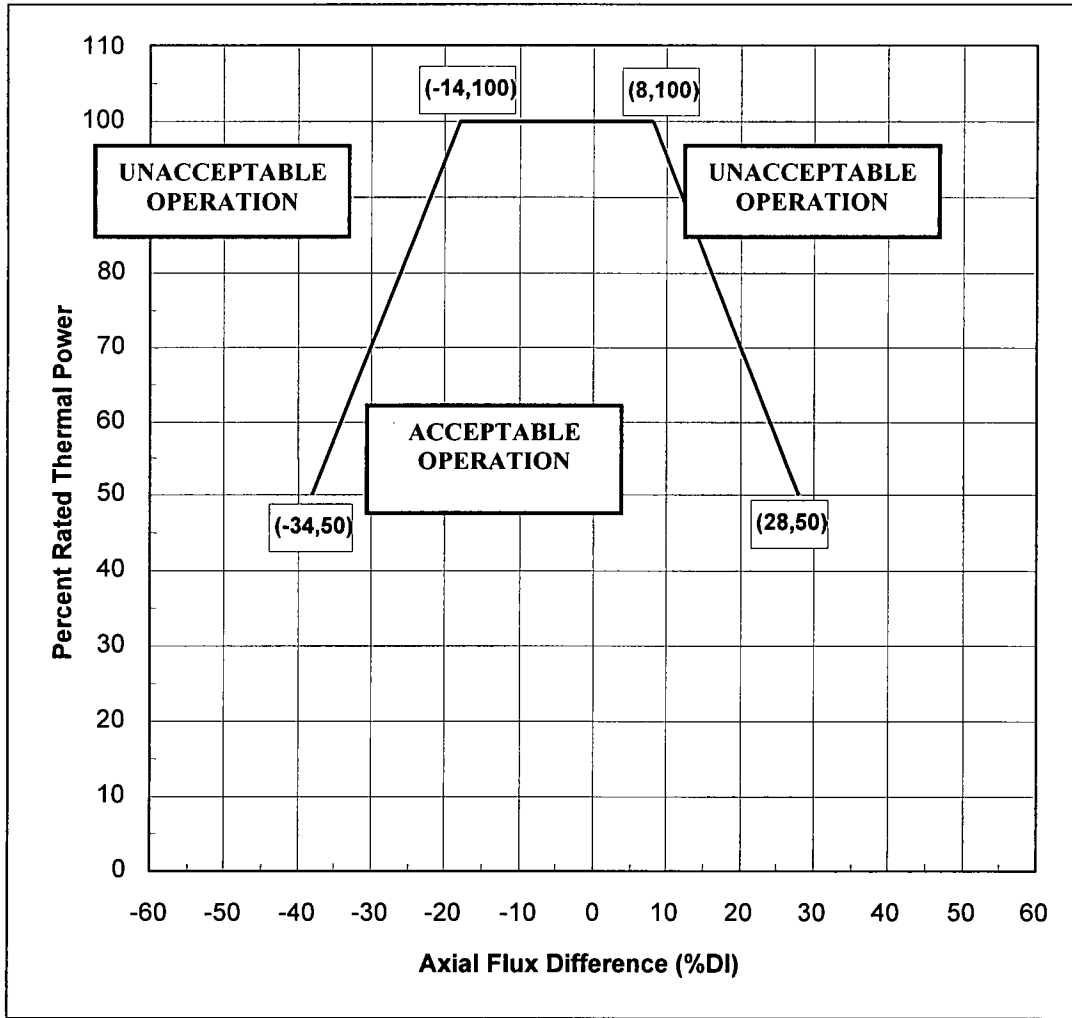
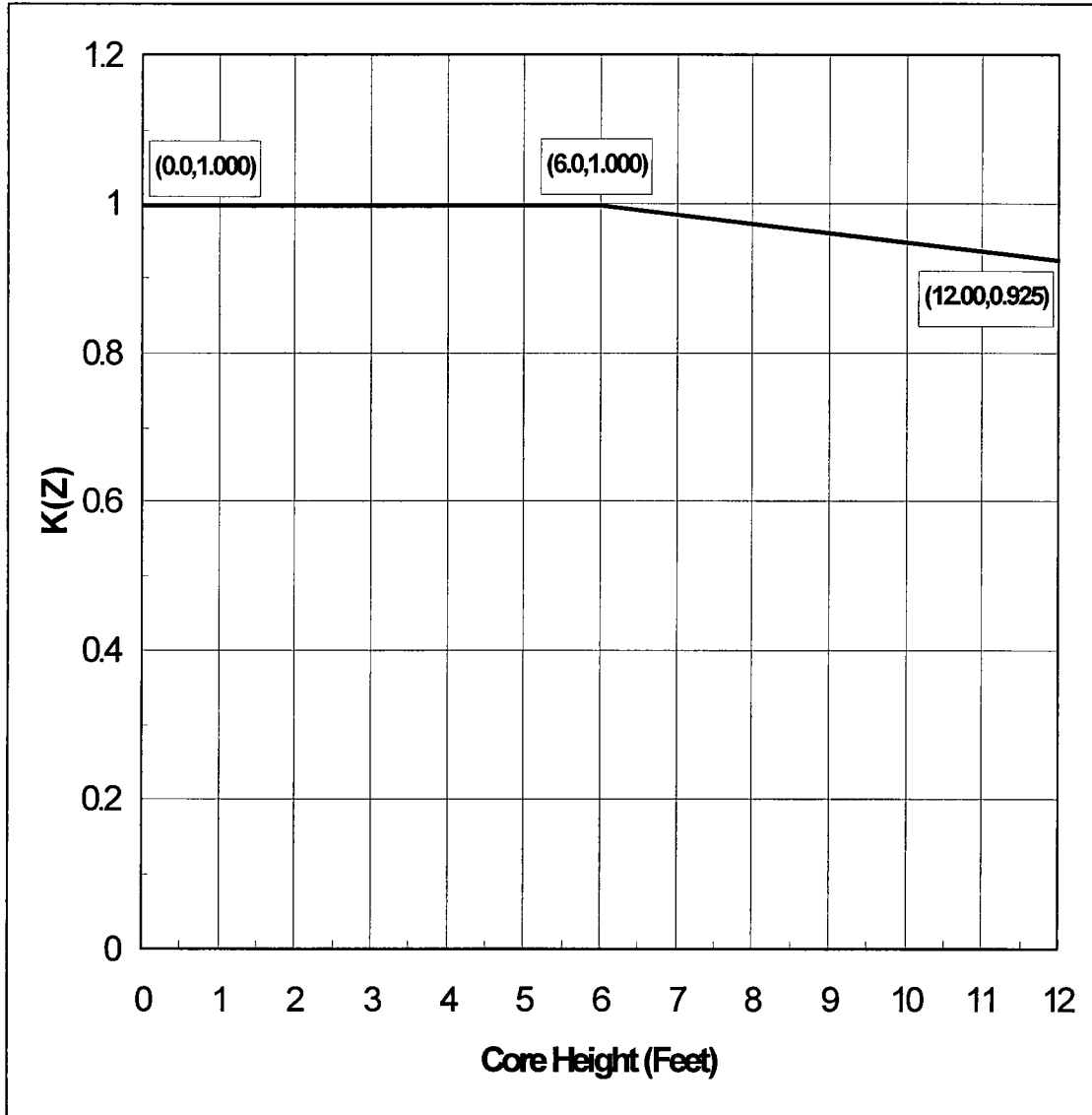


Figure 2: Axial Flux Difference Operating Limits Versus Thermal Power



Note: %DI = %ΔI

Figure 3:  $K(Z)$  Versus Core Height



**FIGURE 4 DELETED**

Figure 5:  $f_1(\Delta I)$  Function

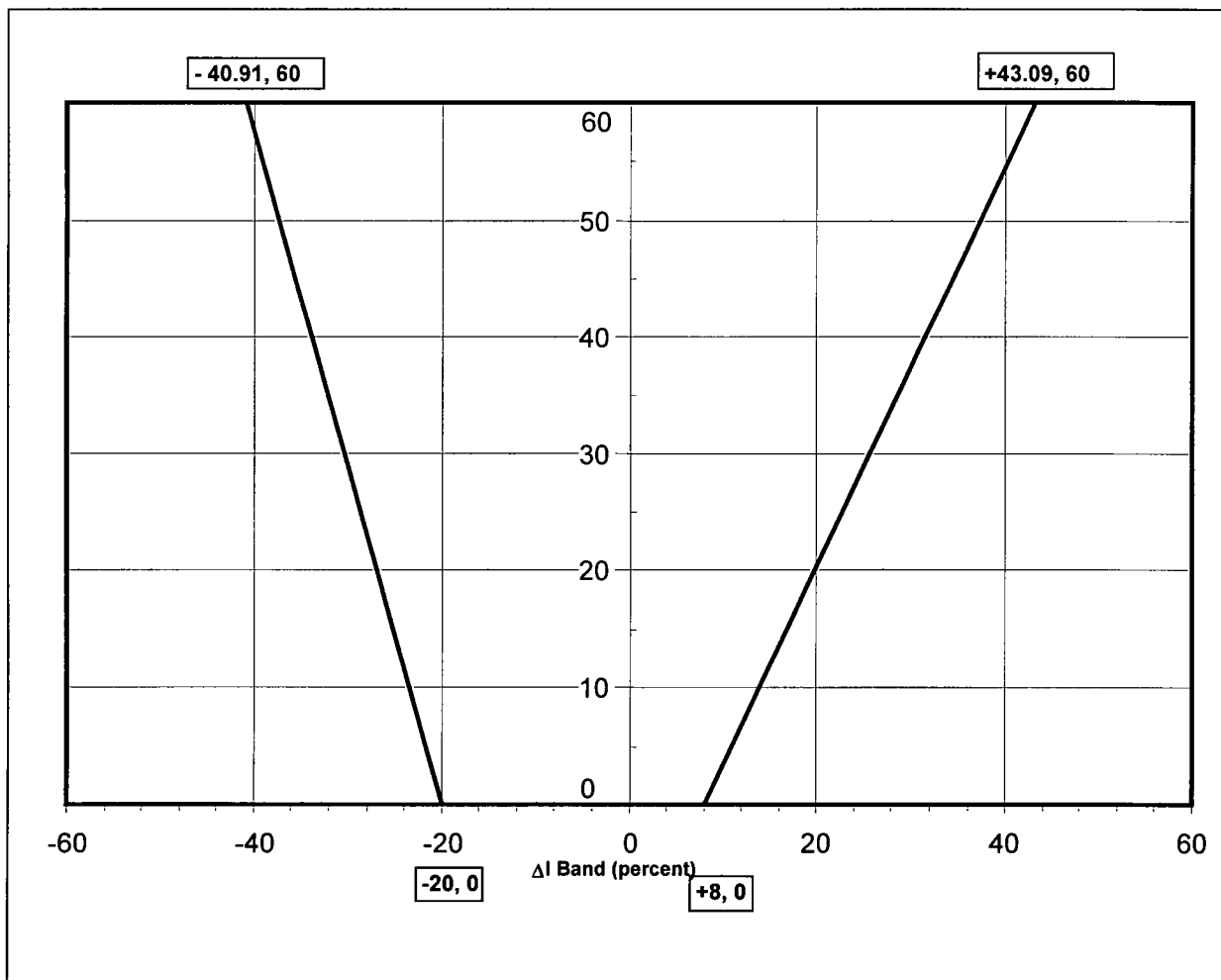
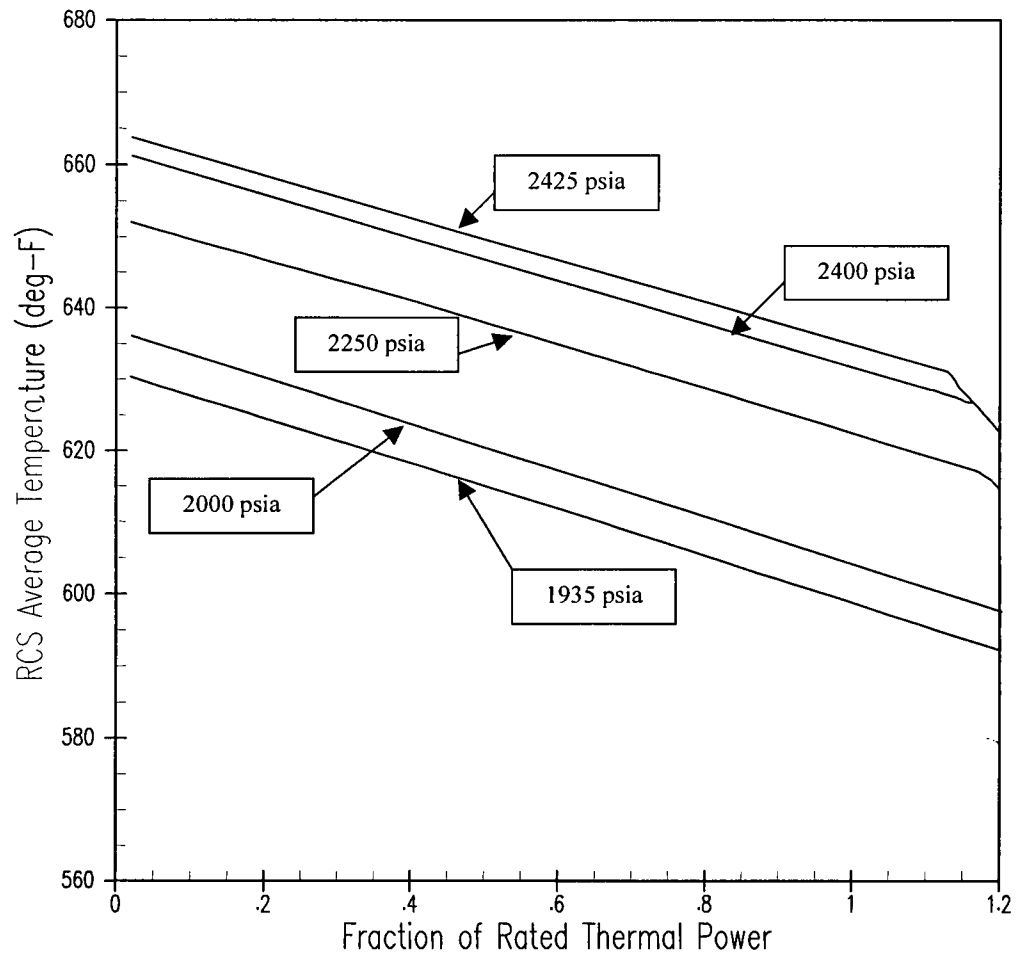


Figure 6: Safety Limits



**Table 1: W(Z,BU) versus Axial Height**

(Sheet 1 of 2)

<b>HEIGHT (Z) (Feet)</b>	<b>W(Z,BU) 150 MWD/MTU</b>	<b>W(Z,BU) 3000 MWD/MTU</b>	<b>W(Z,BU) 10000 MWD/MTU</b>	<b>W(Z,BU) 18000 MWD/MTU</b>
≤1.0	1.0000	1.0000	1.0000	1.0000
1.2	1.4142	1.4334	1.2712	1.2701
1.4	1.3996	1.4165	1.2634	1.2619
1.6	1.3822	1.3968	1.2536	1.2515
1.8	1.3628	1.3751	1.2422	1.2396
2.0	1.3419	1.3518	1.2298	1.2269
2.2	1.3203	1.3276	1.2168	1.2134
2.4	1.2976	1.3026	1.2030	1.1995
2.6	1.2798	1.2785	1.1919	1.1854
2.8	1.2650	1.2612	1.1826	1.1694
3.0	1.2480	1.2472	1.1747	1.1643
3.2	1.2362	1.2365	1.1695	1.1650
3.4	1.2273	1.2248	1.1636	1.1651
3.6	1.2213	1.2127	1.1574	1.1649
3.8	1.2145	1.2048	1.1527	1.1653
4.0	1.2071	1.1971	1.1484	1.1656
4.2	1.1989	1.1889	1.1433	1.1648
4.4	1.1900	1.1798	1.1378	1.1633
4.6	1.1803	1.1701	1.1318	1.1607
4.8	1.1700	1.1597	1.1253	1.1573
5.0	1.1590	1.1487	1.1183	1.1528
5.2	1.1476	1.1372	1.1109	1.1474
5.4	1.1355	1.1251	1.1029	1.1411
5.6	1.1221	1.1138	1.0938	1.1348
5.8	1.1151	1.1034	1.0933	1.1395
6.0	1.1155	1.1008	1.1024	1.1496
6.2	1.1179	1.1038	1.1141	1.1568
6.4	1.1189	1.1049	1.1249	1.1628
6.6	1.1207	1.1089	1.1347	1.1679
6.8	1.1232	1.1133	1.1434	1.1732
7.0	1.1245	1.1164	1.1508	1.1777
7.2	1.1257	1.1186	1.1571	1.1807
7.4	1.1278	1.1197	1.1620	1.1823
7.6	1.1288	1.1196	1.1654	1.1824
7.8	1.1287	1.1183	1.1677	1.1810
8.0	1.1275	1.1156	1.1677	1.1781
8.2	1.1252	1.1128	1.1674	1.1740
8.4	1.1217	1.1122	1.1707	1.1685
8.6	1.1169	1.1116	1.1730	1.1601
8.8	1.1107	1.1114	1.1752	1.1619



**Table 1: W(Z,BU) versus Axial Height**

(Sheet 2 of 2)

<b>HEIGHT (Z) (Feet)</b>	<b>W(Z,BU) 150 MWD/MTU</b>	<b>W(Z,BU) 3000 MWD/MTU</b>	<b>W(Z,BU) 10000 MWD/MTU</b>	<b>W(Z,BU) 18000 MWD/MTU</b>
9.0	1.1088	1.1177	1.1817	1.1710
9.2	1.1117	1.1331	1.1943	1.1802
9.4	1.1177	1.1509	1.2096	1.1995
9.6	1.1223	1.1714	1.2232	1.2199
9.8	1.1476	1.1969	1.2437	1.2399
10.0	1.1731	1.2229	1.2694	1.2579
10.2	1.1960	1.2453	1.2916	1.2818
10.4	1.2176	1.2690	1.3133	1.3092
10.6	1.2399	1.2904	1.3342	1.3271
10.8	1.2623	1.3072	1.3524	1.3415
≥11.0	1.0000	1.0000	1.0000	1.0000

**Note: The FQ(Z) surveillance exclusion zone is specified by Technical Specification 4.2.2.2.g**