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January 10, 2003

L-PI-03-003

U S Nuclear Regulatory Commission  
Attn: Document Control Desk  
Washington, DC 20555

**PRAIRIE ISLAND NUCLEAR GENERATING PLANT**  
Docket No. 50-282 License No. DPR-42

**Core Operating Limits Report (COLR) for Prairie Island Unit 1 Cycle 22, Revision 0**

The attached COLR revision for Prairie Island Unit 1 Cycle 22 is provided in accordance with the requirements of Technical Specification Section 5.6.5.d. The limits specified in the attached COLR have been established using NRC approved methodologies.

The Unit 1 COLR has been revised for Cycle 22 to incorporate the following changes:

- Tables 1 and 2 have been updated to incorporate revised bounding V(z) values.
- Table 3 has been updated to incorporate revised minimum shutdown margin limits.
- Figures 2a through 2f have been updated to incorporate revised bounding V(z) values.
- New Figure 2g has been included with additional bounding V(z) values.
- Text has been deleted or revised to eliminate duplication with the Technical Specifications and Bases.

The Nuclear Management Company has not made new or revised existing Nuclear Regulatory Commission commitments in this letter or the attachment. Please contact Dale Vincent (651-388-1121) if you have any questions related to this report.

Mano K. Nazar  
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(Copies and Attachment listed on page 2)

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USNRC  
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**NUCLEAR MANAGEMENT COMPANY**

c: Regional Administrator - Region III, NRC  
Senior Resident Inspector, NRC  
NRR Project Manager, NRC  
James Bernstein, State of Minnesota

Attachment: Core Operating Limits Report - Unit 1 Cycle 22, Revision 0

**PRAIRIE ISLAND NUCLEAR GENERATING PLANT**

**CORE OPERATING LIMITS REPORT**

**UNIT 1 – CYCLE 22**

**REVISION 0**

Note: This report is not part of the Technical Specifications  
This report is referenced in the Technical Specifications

**PRAIRIE ISLAND NUCLEAR GENERATING PLANT**  
**CORE OPERATING LIMITS REPORT**  
**UNIT 1 - CYCLE 22**  
**REVISION 0**

This report provides the values of the limits for Unit 1 Cycle 22 as required by Technical Specification Section 5.6.5. These values have been established using NRC approved methodology and are established such that all applicable limits of the plant safety analysis are met.

Heat Flux Hot Channel Factor ( $F_Q(Z)$ ) Limits

The Heat Flux Hot Channel Factor,  $F_Q(Z)$ , shall be limited by the relationships in Technical Bases 3.2.1.

Where:

$CFQ = 2.40$ ,  
 $K(z)$  values are provided in Figure 1.

$$F_Q^c(Z) = F_Q^m(Z) * (1.0815)$$

Where:

$F_Q^m(Z)$  is the measured value from the incore flux map

$$F_Q^w(Z) = F_Q^c(Z) * V(Z)$$

Where:

$V(Z)$  values are provided in Figures 2a through 2g and Table 1 and Table 2.

For SR 3.2.1.2 the appropriate factor to meet the  $F_Q(Z)$  limit,  $F_Q^A$ , is applied to the  $F_Q^w(Z)$  when the measured  $F_Q$  increases, specified in Table 4.

Reference Technical Specification section: 3.2.1

Nuclear Enthalpy Rise Hot Channel Factor ( $F_{\Delta H}^N$ ) Limits

$$F_{\Delta H}^N * 1.04 \leq F_{\Delta H}^{RTP} * [1 + PFDH * (1 - P)]$$

Where:

$$F_{\Delta H}^{RTP} = 1.77$$

$$PFDH = 0.3$$

$$P = \text{Thermal Power} / \text{RTP}$$

Reference Technical Specification section: 3.2.2

### Isothermal Temperature Coefficient (ITC)

ITC Upper limit:

- a.  $< 5$  pcm/°F for power levels  $\leq 70\%$  RTP; and
- b.  $< 0$  pcm/°F for power levels  $> 70\%$  RTP

ITC Lower limit:

- a.  $-32.7$  pcm/°F

Reference Technical Specification section: 3.1.3.

### RCS Pressure, Temperature, and Flow – Departure from Nucleate Boiling (DNB) Limits

Pressurizer pressure limit = 2205 psig  
RCS average temperature limit = 564°F  
RCS total flow rate limit = 178,000 gpm

Reference Technical Specification section: 3.4.1.

### Axial Flux Difference Limits

The axial flux difference limits are provided in Figure 3.

The axial flux difference target band is  $\pm 5\%$  when using figures 2a through 2f and Table 1. The axial flux difference target band is  $\pm 5\%$  when equal to or above 90% power and  $\pm 10\%$  below 90% power when using figure 2g and Table 2.

Reference Technical Specification sections: 3.2.3.

### Shutdown Rod Insertion Limits

The shutdown rods shall be fully withdrawn.

Reference Technical Specification section: 3.1.5.

### Control Rod Insertion Limits

The control rod banks shall be limited in physical insertion as shown in Figures 4, 5, and 6.

The control rod banks withdrawal sequence shall be Bank A, Bank B, Bank C, and finally Bank D.

The control rod banks shall be withdrawn in 100 step overlap.

Reference Technical Specification sections: 3.1.6.

### Shutdown Margin Requirements

Minimum Shutdown Margin requirements are shown in Table 3.

Reference Technical Specification sections: 3.1.1 and 3.1.8.

### Refueling Boron Concentrations

The boron concentration of the reactor coolant system and the refueling cavity shall be sufficient to ensure that the more restrictive of the following conditions is met:

- a)  $K_{\text{eff}} \leq 0.95$
- b) 2000 ppm
- c) The Shutdown Margin specified in Table 3

Reference Technical Specification sections: 3.9.1.

### Penalty on $F_Q$ for Small Break LOCA – $K(z)$

The small and large break LOCA analyses performed for this cycle are valid for  $F_Q \leq 2.80$  and  $F_Q \leq 2.40$ , respectively. The  $F_Q$  limit for the large break LOCA analysis is more limiting than the  $F_Q$  limit for the small break LOCA analysis. The small break LOCA analysis incorporates the  $K(z)$  methodology. However, since the small break LOCA is less limiting than the large break LOCA, no  $K(z)$  penalty needs to be applied to calculations of most limiting  $F_Q$  values. Thus for the equation in Technical Specification Bases B3.2.1,  $K(z)$  is equal to 1.  $K(z)$  is shown graphically in Figure 1.

### Transient Power Distribution Penalty for $F_Q$ – $V(z)$

Table 1 summarizes the bounding  $V(z)$  values for the middle 80% of the core for Prairie Island unit 1, cycle 22 with an operating band of  $\pm 5\% \Delta I$ . The  $V(z)$  penalty takes the form of straight lines connecting data points determined as a function of core height. A particular  $V(z)$  curve is valid over a given exposure range and equilibrium axial offset range as noted in Table 1. The  $V(z)$  penalty for each exposure and axial offset range is shown graphically in Figures 2a – 2f.

An alternate two tier  $V(z)$  curve is presented in Table 2 and figure 2g. The operating band is  $\pm 5\% \Delta I$  at or above 90% power, and  $\pm 10\% \Delta I$  below 90% power. This figure is valid over all exposure ranges.

**Table 1**  
**Bounding V(z) Values**

<b>Exposure Range</b>	<b>z(ft)</b>	<b>V(z)</b>	<b>z(ft)</b>	<b>V(z)</b>
0.0 - 4.000 GWd/MTU	0.20	1.000	6.30	1.059
Eq AO range: -3% to +8%	0.39	1.000	6.49	1.055
Operating band: $\pm 5\% \Delta I$	0.59	1.000	6.69	1.052
(Startup)	0.79	1.000	6.89	1.049
	0.98	1.000	7.08	1.047
	1.18	1.107	7.28	1.046
	1.38	1.102	7.48	1.049
	1.57	1.098	7.67	1.052
	1.77	1.093	7.87	1.054
	1.97	1.087	8.07	1.056
	2.16	1.082	8.26	1.058
	2.36	1.076	8.46	1.059
	2.56	1.071	8.66	1.060
	2.75	1.066	8.85	1.061
	2.95	1.064	9.05	1.063
	3.15	1.063	9.25	1.064
	3.34	1.062	9.44	1.068
	3.54	1.063	9.64	1.071
	3.74	1.063	9.84	1.074
	3.93	1.063	10.03	1.077
	4.13	1.063	10.23	1.080
	4.33	1.064	10.43	1.083
	4.52	1.065	10.62	1.087
	4.72	1.067	10.82	1.091
	4.92	1.066	11.02	1.000
	5.11	1.066	11.21	1.000
	5.31	1.065	11.41	1.000
	5.51	1.064	11.61	1.000
	5.70	1.064	11.80	1.000
	5.90	1.062	12.00	1.000
	6.10	1.061		

**Table 1**  
**Bounding V(z) Values**

<b>Exposure Range</b>	<b>z(ft)</b>	<b>V(z)</b>	<b>z(ft)</b>	<b>V(z)</b>
4.000 - 7.000 GWd/MTU	0.20	1.000	6.30	1.062
Eq AO range: -4% to +6%	0.39	1.000	6.49	1.058
Operating band: $\pm 5\% \Delta I$	0.59	1.000	6.69	1.053
	0.79	1.000	6.89	1.051
	0.98	1.000	7.08	1.050
	1.18	1.101	7.28	1.050
	1.38	1.097	7.48	1.053
	1.57	1.094	7.67	1.056
	1.77	1.089	7.87	1.058
	1.97	1.084	8.07	1.060
	2.16	1.079	8.26	1.061
	2.36	1.074	8.46	1.062
	2.56	1.069	8.66	1.063
	2.75	1.065	8.85	1.064
	2.95	1.064	9.05	1.066
	3.15	1.062	9.25	1.067
	3.34	1.062	9.44	1.070
	3.54	1.063	9.64	1.073
	3.74	1.064	9.84	1.077
	3.93	1.064	10.03	1.080
	4.13	1.064	10.23	1.083
	4.33	1.065	10.43	1.086
	4.52	1.067	10.62	1.090
	4.72	1.069	10.82	1.093
	4.92	1.069	11.02	1.000
	5.11	1.069	11.21	1.000
	5.31	1.068	11.41	1.000
	5.51	1.068	11.61	1.000
	5.70	1.067	11.80	1.000
	5.90	1.065	12.00	1.000
	6.10	1.064		



**Table 1**  
**Bounding V(z) Values**

<b>Exposure Range</b>	<b>z(ft)</b>	<b>V(z)</b>	<b>z(ft)</b>	<b>V(z)</b>
7.000 - 10.000 GWd/MTU Eq AO range: -6% to +4% Operating band: $\pm 5\%$ $\Delta I$	0.20	1.000	6.30	1.065
	0.39	1.000	6.49	1.060
	0.59	1.000	6.69	1.056
	0.79	1.000	6.89	1.053
	0.98	1.000	7.08	1.052
	1.18	1.100	7.28	1.051
	1.38	1.095	7.48	1.054
	1.57	1.090	7.67	1.056
	1.77	1.085	7.87	1.058
	1.97	1.080	8.07	1.059
	2.16	1.074	8.26	1.060
	2.36	1.071	8.46	1.062
	2.56	1.068	8.66	1.064
	2.75	1.066	8.85	1.066
	2.95	1.064	9.05	1.068
	3.15	1.063	9.25	1.069
	3.34	1.062	9.44	1.072
	3.54	1.064	9.64	1.074
	3.74	1.065	9.84	1.077
	3.93	1.065	10.03	1.080
4.13	1.066	10.23	1.084	
4.33	1.067	10.43	1.086	
4.52	1.069	10.62	1.088	
4.72	1.072	10.82	1.091	
4.92	1.072	11.02	1.000	
5.11	1.072	11.21	1.000	
5.31	1.072	11.41	1.000	
5.51	1.071	11.61	1.000	
5.70	1.071	11.80	1.000	
5.90	1.069	12.00	1.000	
6.10	1.067			

**Table 1**  
**Bounding V(z) Values**

<b>Exposure Range</b>	<b>z(ft)</b>	<b>V(z)</b>	<b>z(ft)</b>	<b>V(z)</b>
10.000 - 15.000 GWd/MTU	0.20	1.000	6.30	1.073
Eq AO range: -6% to +2%	0.39	1.000	6.49	1.078
Operating band: $\pm 5\% \Delta I$	0.59	1.000	6.69	1.083
	0.79	1.000	6.89	1.085
	0.98	1.000	7.08	1.086
	1.18	1.093	7.28	1.086
	1.38	1.091	7.48	1.086
	1.57	1.088	7.67	1.086
	1.77	1.086	7.87	1.084
	1.97	1.085	8.07	1.082
	2.16	1.084	8.26	1.080
	2.36	1.082	8.46	1.078
	2.56	1.079	8.66	1.075
	2.75	1.076	8.85	1.075
	2.95	1.072	9.05	1.078
	3.15	1.068	9.25	1.080
	3.34	1.064	9.44	1.081
	3.54	1.061	9.64	1.082
	3.74	1.058	9.84	1.083
	3.93	1.057	10.03	1.084
	4.13	1.057	10.23	1.084
	4.33	1.058	10.43	1.088
	4.52	1.061	10.62	1.091
	4.72	1.065	10.82	1.095
	4.92	1.067	11.02	1.000
	5.11	1.069	11.21	1.000
	5.31	1.070	11.41	1.000
	5.51	1.071	11.61	1.000
	5.70	1.072	11.80	1.000
	5.90	1.072	12.00	1.000
	6.10	1.072		

**Table 1**  
**Bounding V(z) Values**

<b>Exposure Range</b>	<b>z(ft)</b>	<b>V(z)</b>	<b>z(ft)</b>	<b>V(z)</b>
15.000 - 18.000 GWd/MTU	0.20	1.000	6.30	1.104
Eq AO range: -6% to +4%	0.39	1.000	6.49	1.107
Operating band: $\pm 5\% \Delta I$	0.59	1.000	6.69	1.110
	0.79	1.000	6.89	1.110
	0.98	1.000	7.08	1.109
	1.18	1.121	7.28	1.108
	1.38	1.120	7.48	1.105
	1.57	1.119	7.67	1.102
	1.77	1.118	7.87	1.099
	1.97	1.114	8.07	1.095
	2.16	1.110	8.26	1.092
	2.36	1.105	8.46	1.087
	2.56	1.099	8.66	1.082
	2.75	1.094	8.85	1.080
	2.95	1.087	9.05	1.081
	3.15	1.081	9.25	1.082
	3.34	1.077	9.44	1.085
	3.54	1.075	9.64	1.088
	3.74	1.074	9.84	1.092
	3.93	1.074	10.03	1.096
	4.13	1.074	10.23	1.101
	4.33	1.077	10.43	1.102
	4.52	1.082	10.62	1.103
	4.72	1.088	10.82	1.105
	4.92	1.090	11.02	1.000
	5.11	1.092	11.21	1.000
	5.31	1.092	11.41	1.000
	5.51	1.090	11.61	1.000
	5.70	1.089	11.80	1.000
	5.90	1.093	12.00	1.000
	6.10	1.099		

**Table 1**  
**Bounding V(z) Values**

<u>Exposure Range</u>	<u>z(ft)</u>	<u>V(z)</u>	<u>z(ft)</u>	<u>V(z)</u>
18.000 - EOC GWd/MTU	0.20	1.000	6.30	1.122
Eq AO range: -6% to +4%	0.39	1.000	6.49	1.123
Operating band: $\pm 5\% \Delta I$	0.59	1.000	6.69	1.124
	0.79	1.000	6.89	1.123
	0.98	1.000	7.08	1.122
	1.18	1.158	7.28	1.119
	1.38	1.156	7.48	1.115
	1.57	1.153	7.67	1.110
	1.77	1.151	7.87	1.105
	1.97	1.145	8.07	1.100
	2.16	1.141	8.26	1.095
	2.36	1.134	8.46	1.089
	2.56	1.127	8.66	1.083
	2.75	1.120	8.85	1.081
	2.95	1.112	9.05	1.084
	3.15	1.103	9.25	1.087
	3.34	1.096	9.44	1.090
	3.54	1.088	9.64	1.093
	3.74	1.080	9.84	1.097
	3.93	1.078	10.03	1.101
	4.13	1.076	10.23	1.105
	4.33	1.077	10.43	1.105
	4.52	1.082	10.62	1.105
	4.72	1.088	10.82	1.107
	4.92	1.090	11.02	1.000
	5.11	1.092	11.21	1.000
	5.31	1.094	11.41	1.000
	5.51	1.099	11.61	1.000
	5.70	1.104	11.80	1.000
	5.90	1.110	12.00	1.000
	6.10	1.117		

**Table 2**  
**Bounding V(z) Values**

<b>Exposure Range</b>	<b>z(ft)</b>	<b>V(z)</b>	<b>z(ft)</b>	<b>V(z)</b>
<u>BOC to EOC</u>	0.20	1.000	6.30	1.243
Eq AO range: -6% to +4%	0.39	1.000	6.49	1.242
Operating Band	0.59	1.000	6.69	1.241
±5% ΔI at and above 90% power	0.79	1.000	6.89	1.238
±10% ΔI below 90% power	0.98	1.000	7.08	1.234
	1.18	1.279	7.28	1.228
	1.38	1.274	7.48	1.215
	1.57	1.268	7.67	1.202
	1.77	1.262	7.87	1.188
	1.97	1.253	8.07	1.172
	2.16	1.244	8.26	1.157
	2.36	1.236	8.46	1.137
	2.56	1.230	8.66	1.117
	2.75	1.223	8.85	1.104
	2.95	1.215	9.05	1.096
	3.15	1.207	9.25	1.087
	3.34	1.198	9.44	1.090
	3.54	1.188	9.64	1.094
	3.74	1.177	9.84	1.098
	3.93	1.166	10.03	1.102
	4.13	1.153	10.23	1.107
	4.33	1.146	10.43	1.107
	4.52	1.145	10.62	1.107
	4.72	1.145	10.82	1.109
	4.92	1.158	11.02	1.000
	5.11	1.172	11.21	1.000
	5.31	1.187	11.41	1.000
	5.51	1.202	11.61	1.000
	5.70	1.216	11.80	1.000
	5.90	1.226	12.00	1.000
	6.10	1.236		

**Table 3**

**Minimum Required Shutdown Margin**

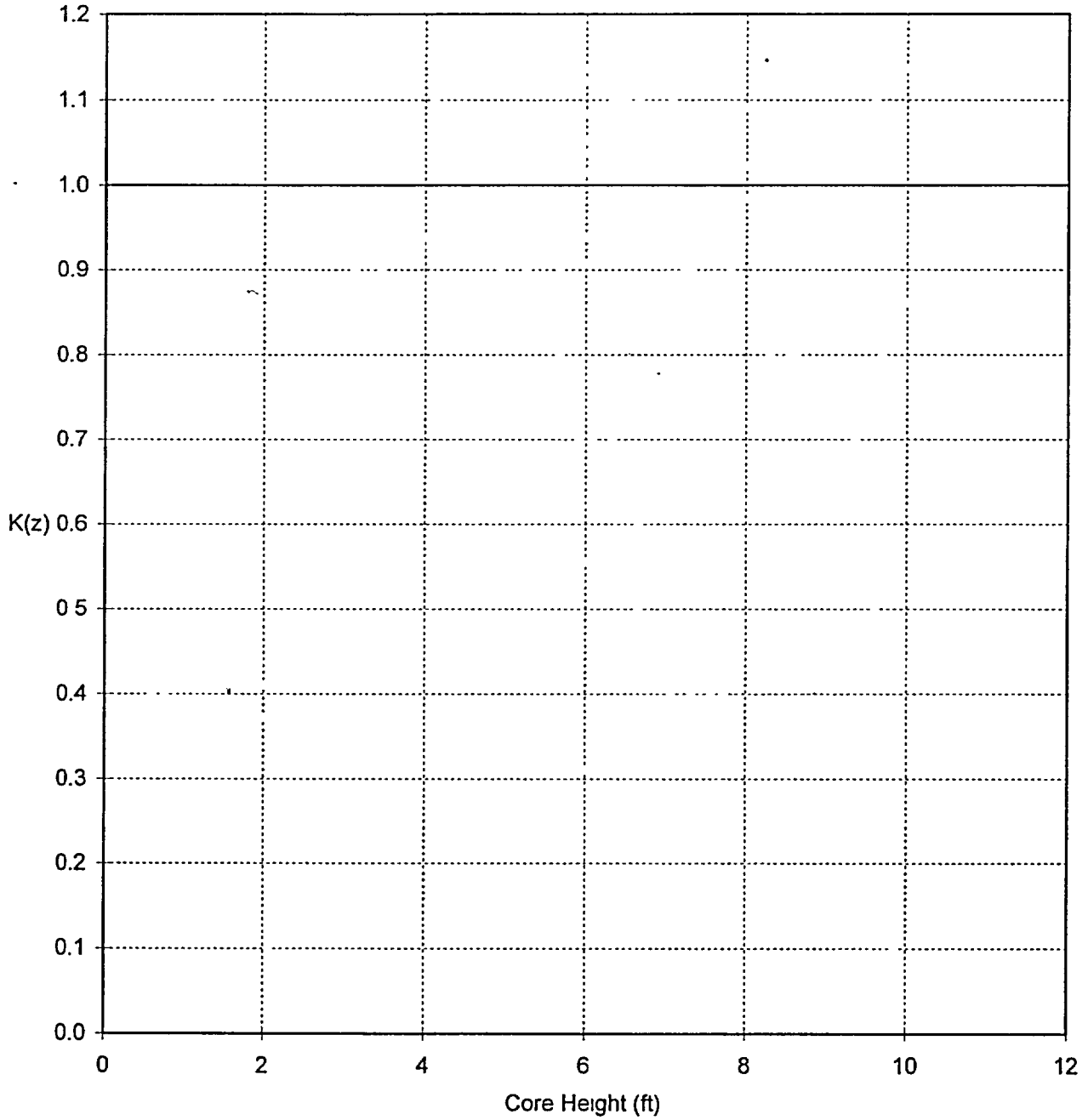
Plant Conditions	Number of Charging Pumps Running**		
	0-1 Pump	2 Pumps	3 Pumps
Mode 1*	2.0%	2.0%	2.0%
Mode 2*	2.0%	2.0%	2.0%
Mode 3, $T_{ave} \geq 520^{\circ}\text{F}$	2.0%	2.0%	2.0%
Mode 3, $350^{\circ}\text{F} \leq T_{ave} < 520^{\circ}\text{F}$	2.0%	2.0%	2.5%
Mode 4	2.0%	4.5%	7.0%
Mode 5***	2.5%	4.5%	7.0%
Mode 6, ARI***	5.26%	5.26%	7.0%
Mode 6, ARO***	5.26%	5.5%	9.0%
Physics Testing in Mode 2	0.5%	0.5%	0.5%

Operational Mode Definitions, as per TS Table 1.1-1.

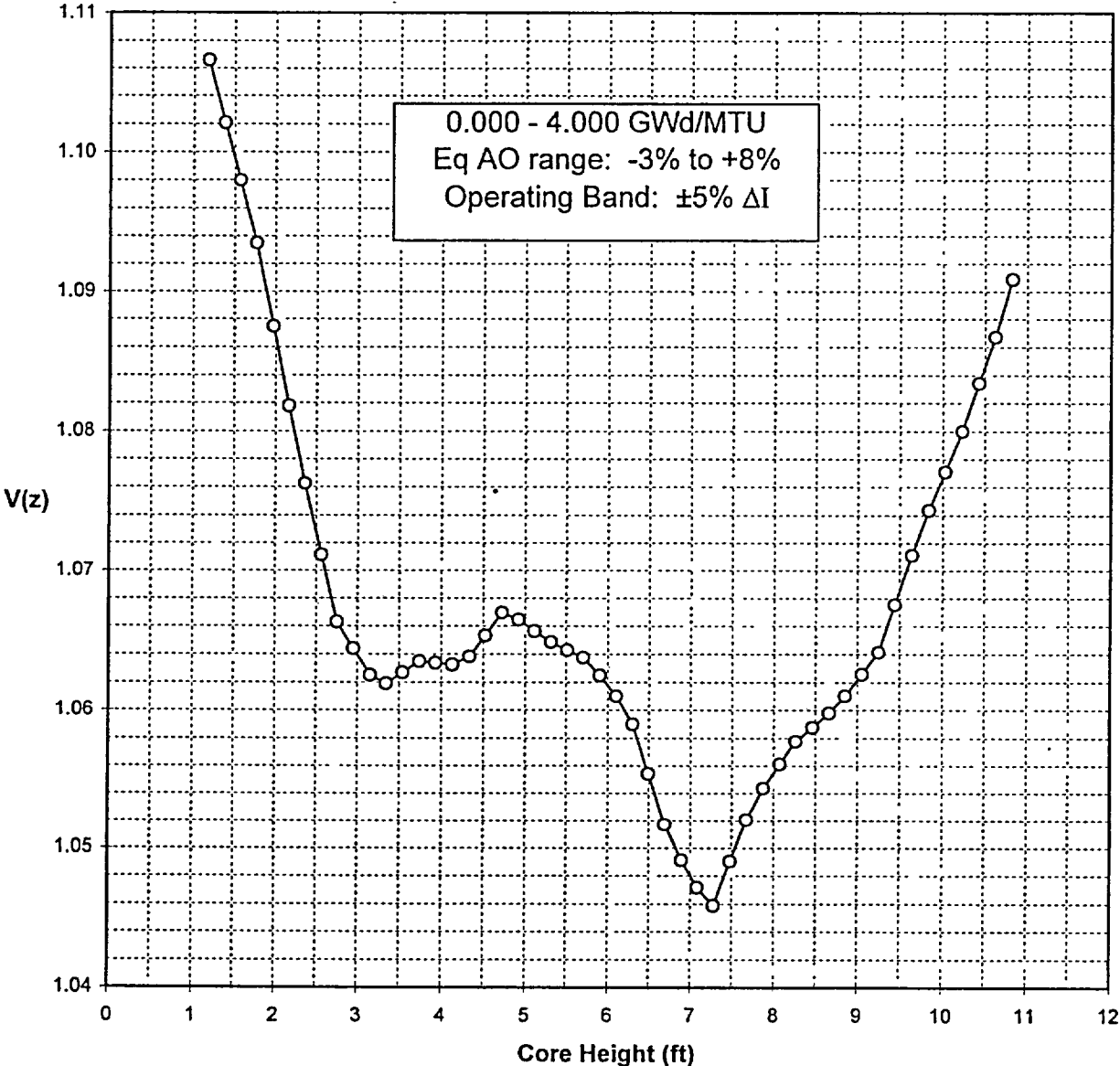
- \* For Modes 1 and 2, minimum shutdown margin requirements are provided by the Rod Insertion Limits.
- \*\* Charging pump(s) in service only pertains to steady state operations. It does not include transitory operations. For example, operations such as starting a second charging pump in order to secure the operating pump would fall under the one pump in service column.
- \*\*\* These values are also applicable for the Unit 1 Cycle 21 end of cycle.

**Table 4**  
 $F_Q^A$  Factor

Exposure Range	$F_Q^A$ Factor
BOC – EOC	1.027

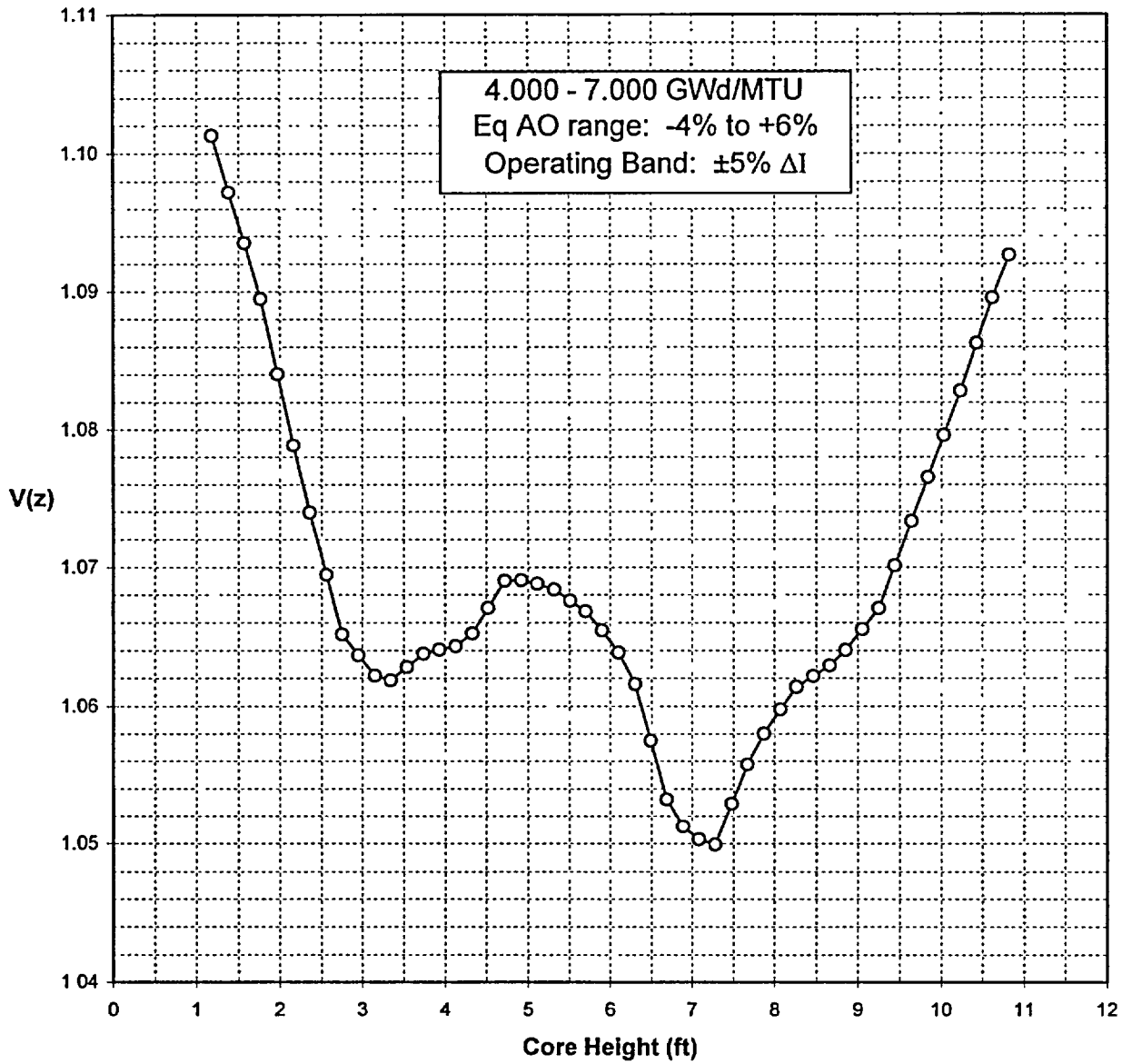


**Figure 1: Hot Channel Factor  
Normalized Operating Envelope**

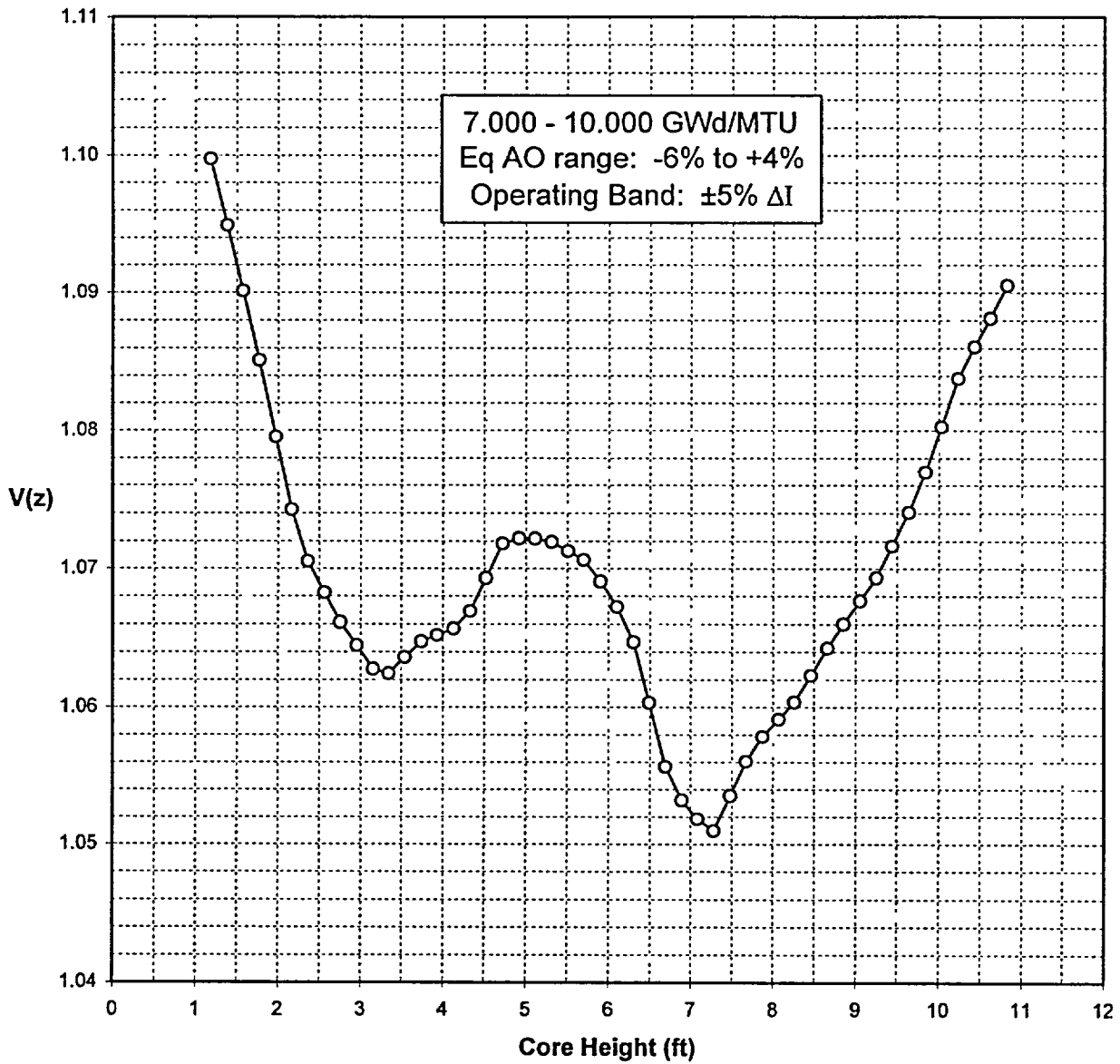


**Figure 2a: Bounding V(z) Values  
From 0 - 4.000 GWd/MTU  
(Startup)**

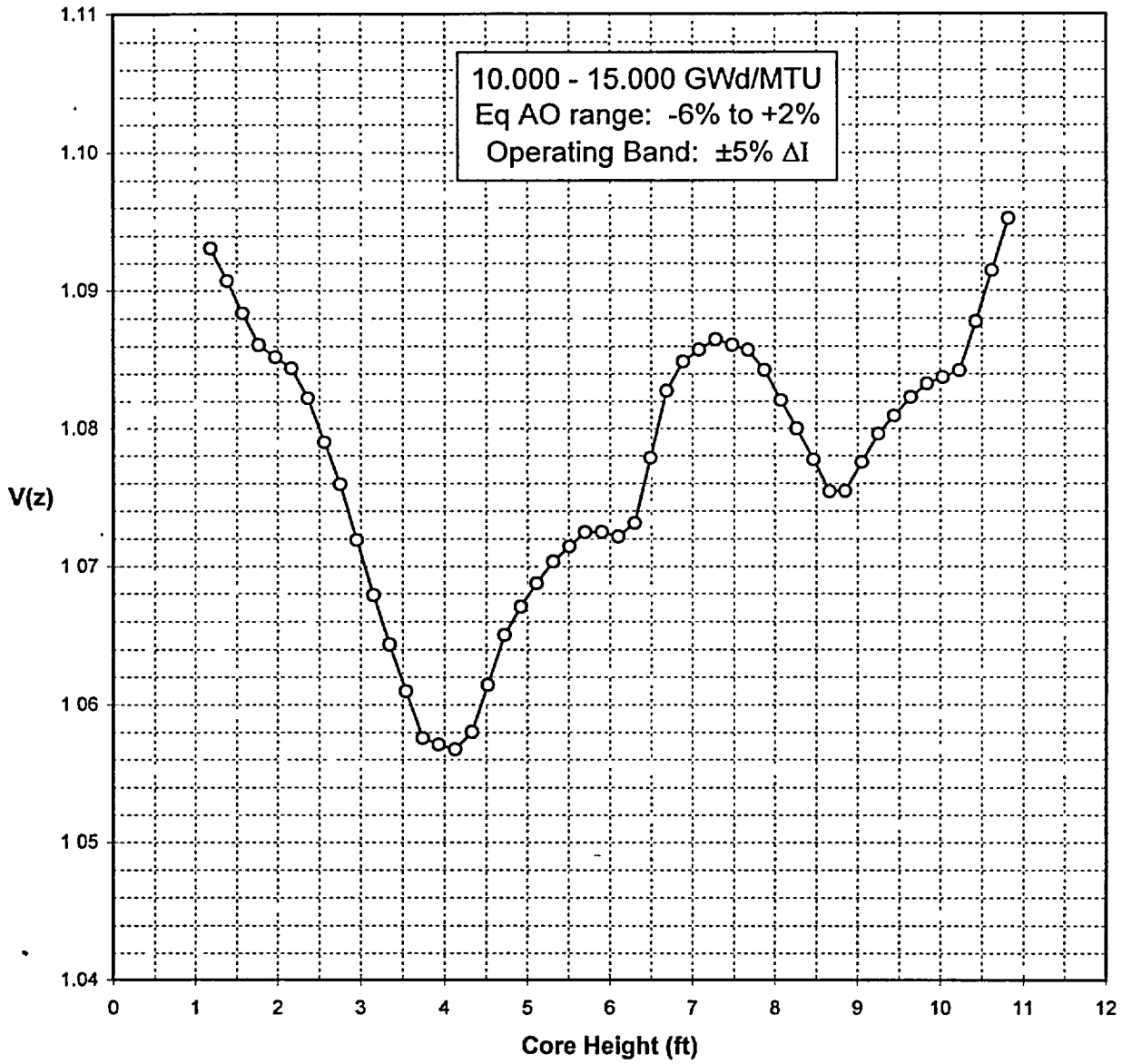




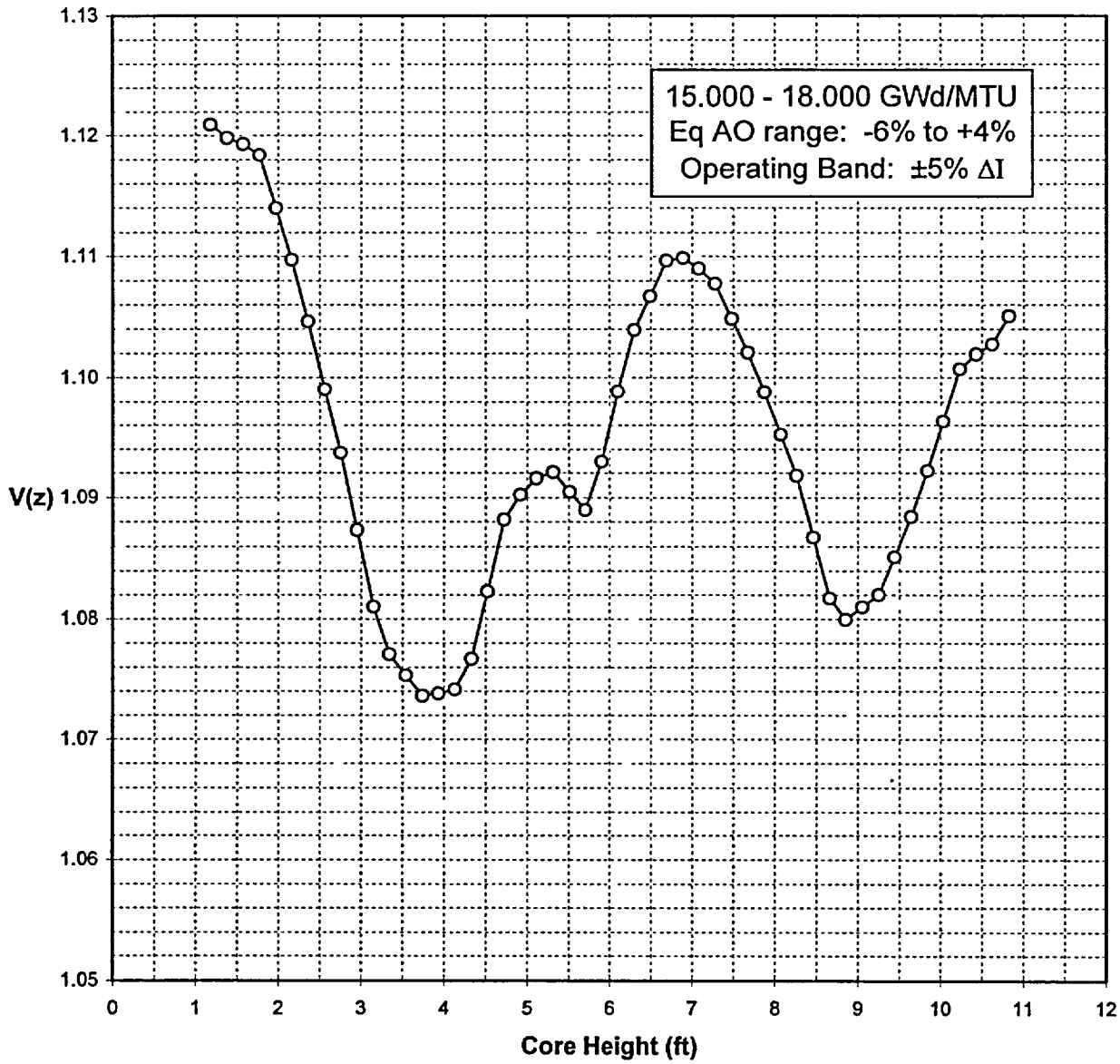
**Figure 2b: Bounding V(z) Values  
From 4.0000 - 7.000 GWd/MTU**



**Figure 2c: Bounding V(z) Values  
From 7.000 - 10.000 GWd/MTU**



**Figure 2d: Bounding V(z) Values  
From 10.000 - 15.000 GWd/MTU**



**Figure 2e: Bounding V(z) Values  
From 15.000 - 18.000 GWd/MTU**

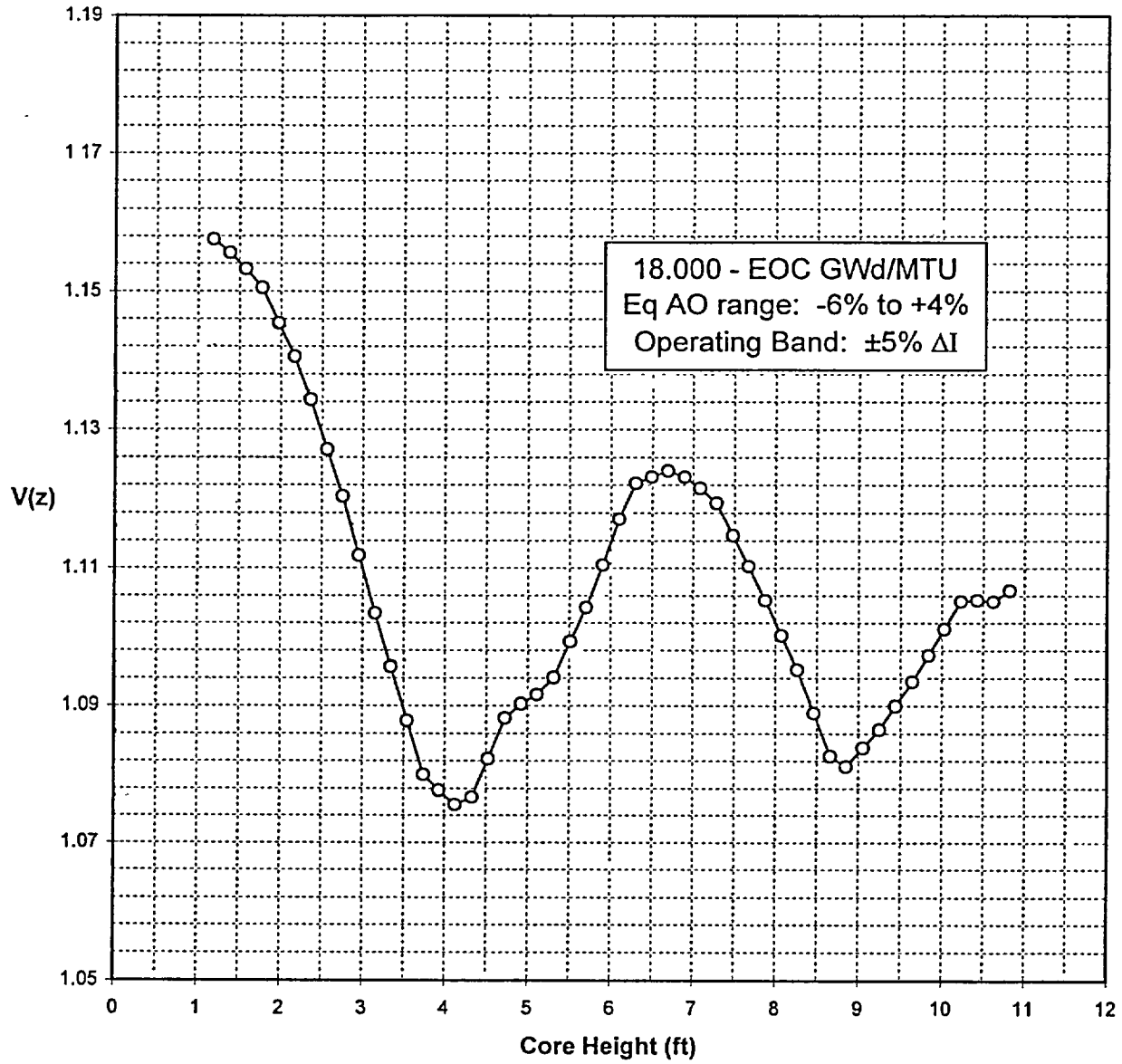
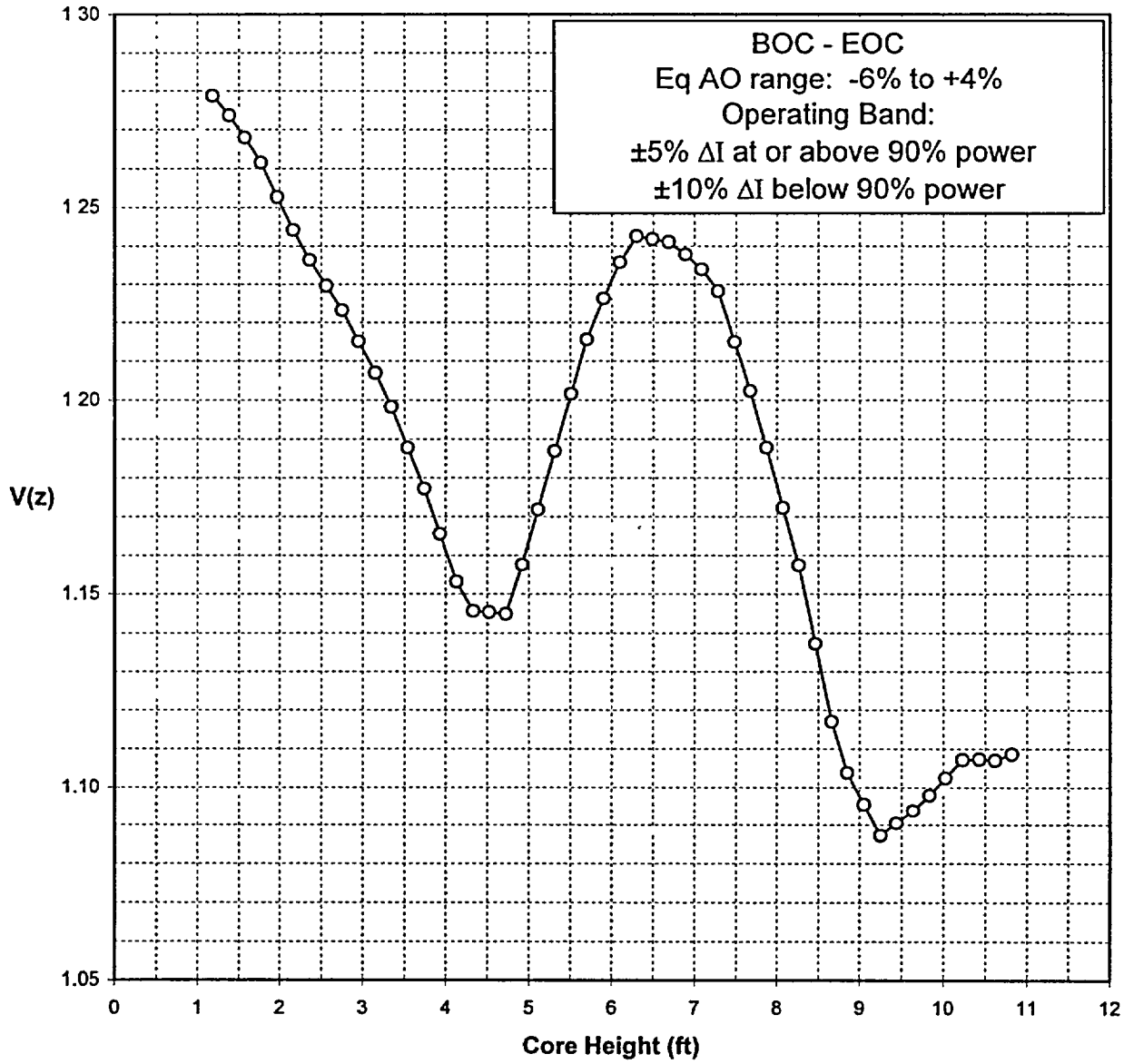
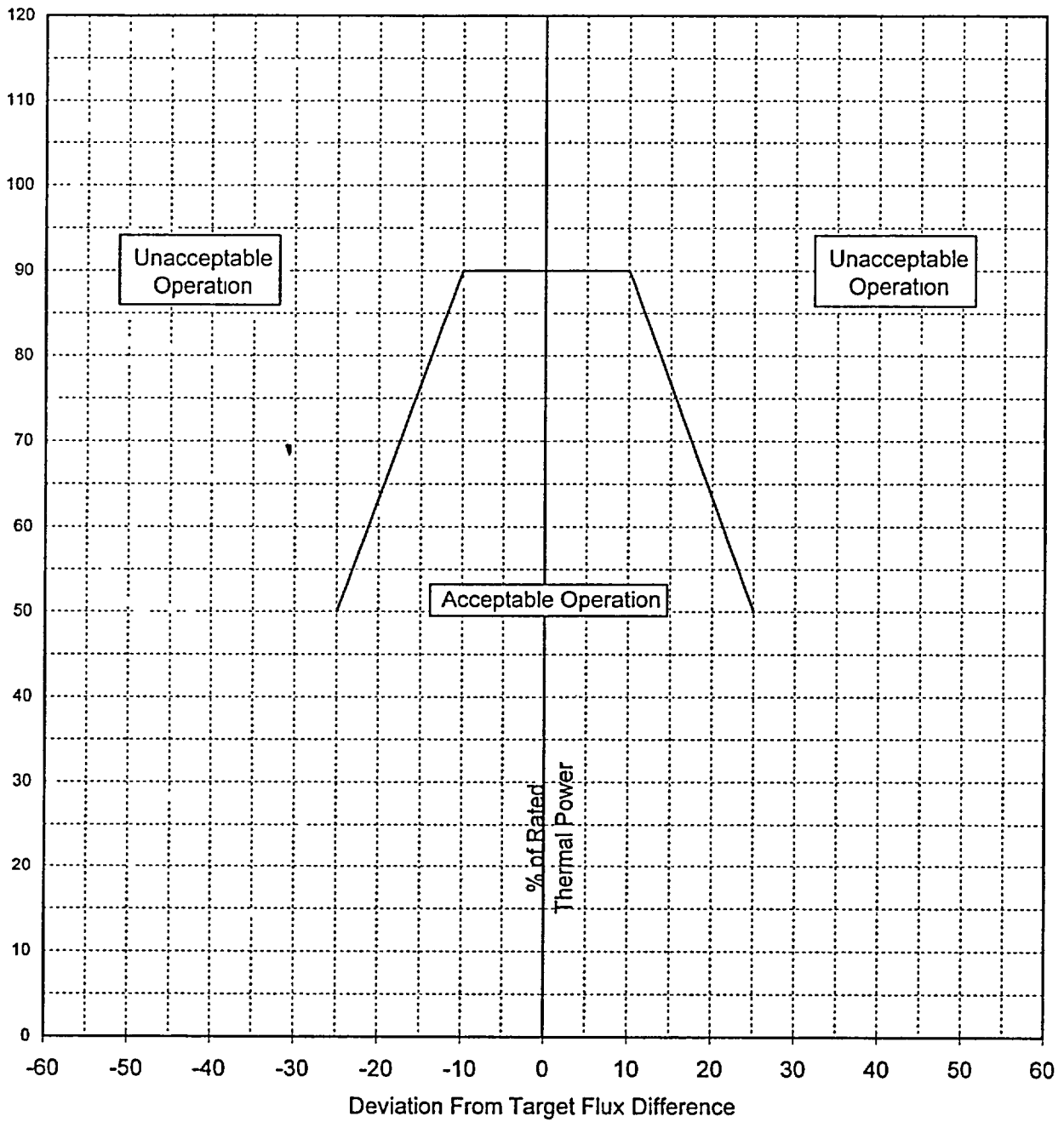


Figure 2f: Bounding V(z) Values  
From 18.000 - EOC GWd/MTU



**Figure 2g: Bounding V(z) Values  
2 Tier band  
BOC - EOC**



**Figure 3: Deviation From Target Flux Difference as a Function of Thermal Power**

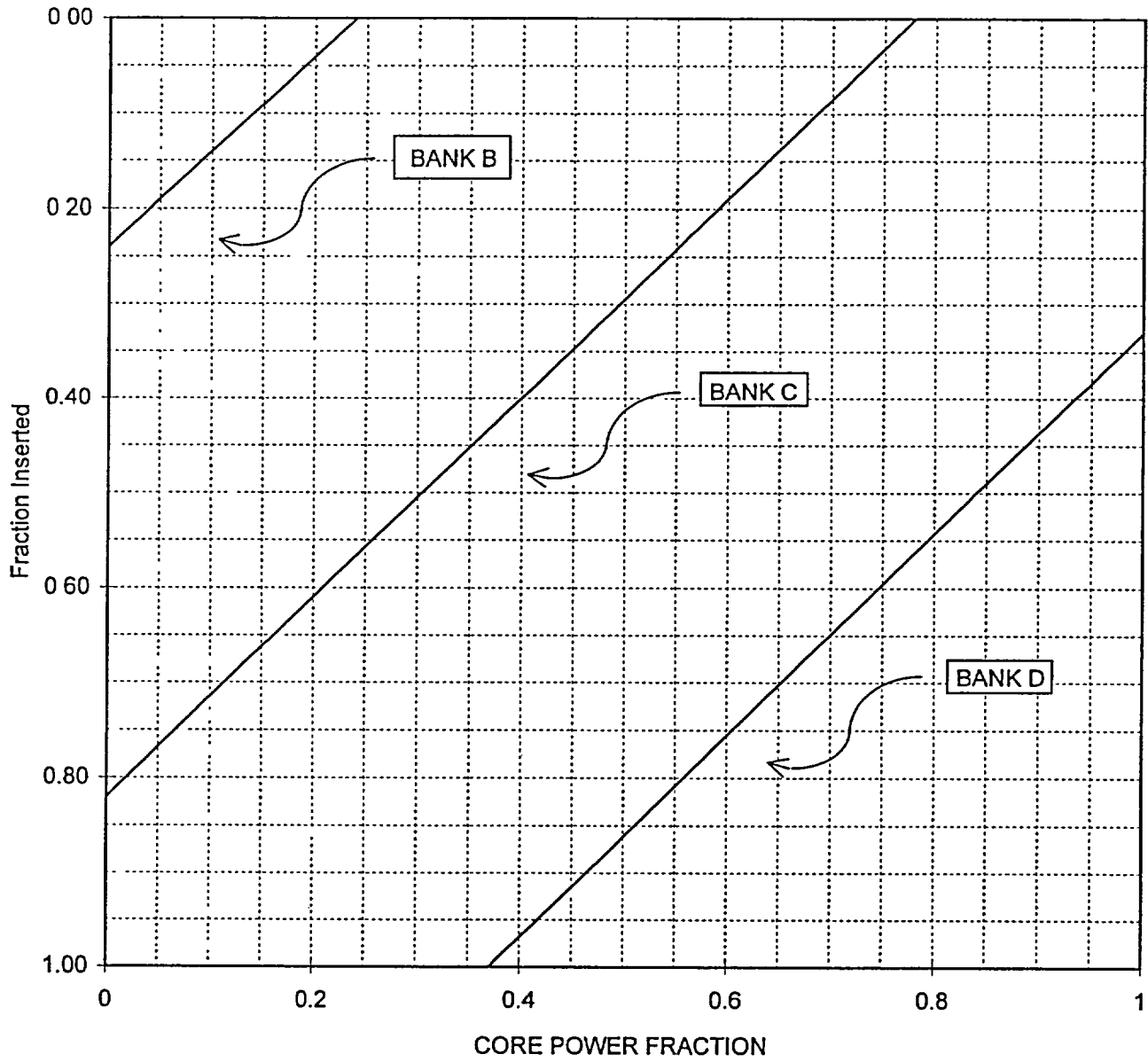
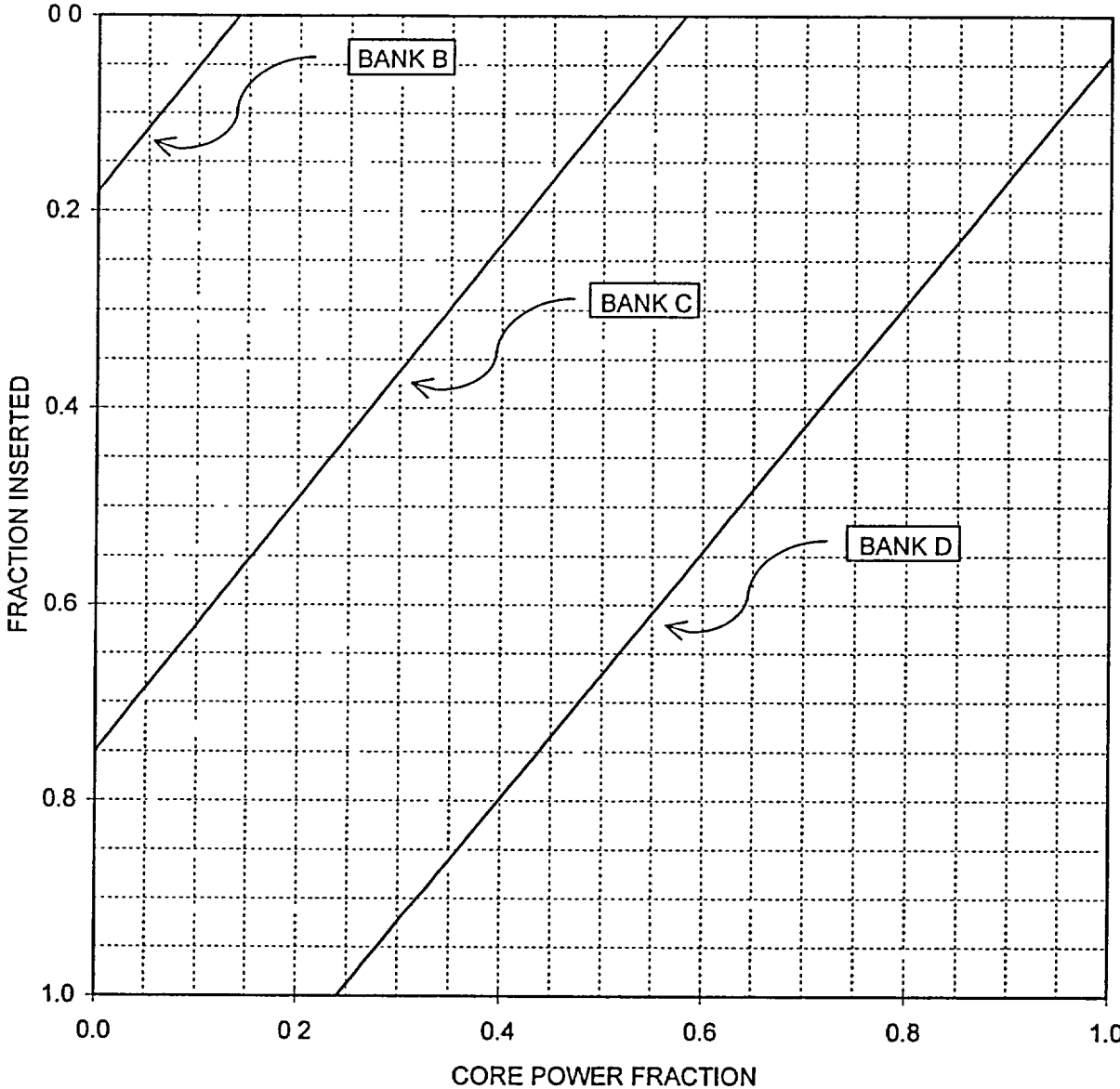
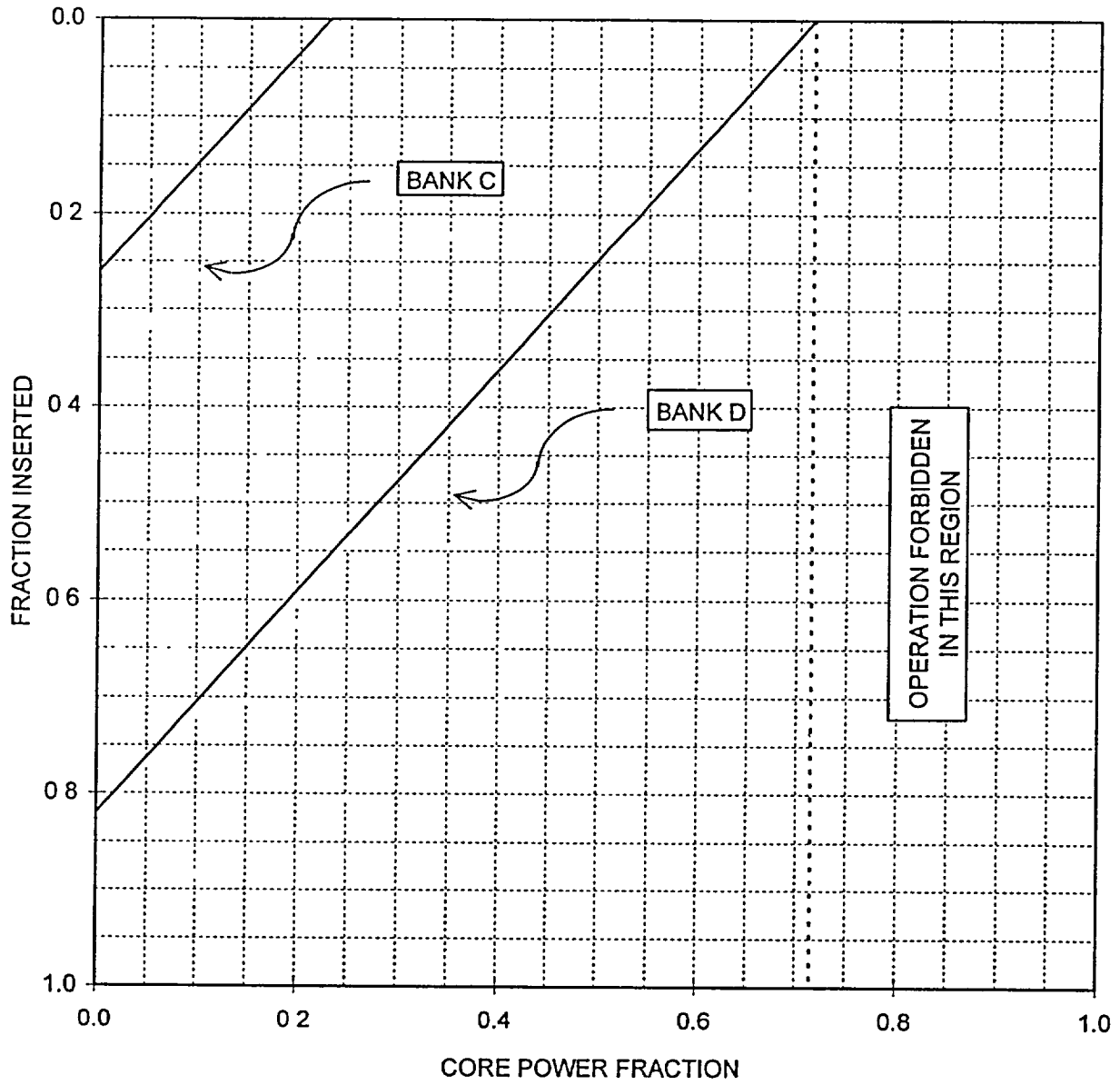


Figure 4: Control Bank Insertion Limits






**Figure 5: Insertion Limits**  
**100 Step Overlap With One Bottomed Rod**  
(Technical Specification 3.1.4)

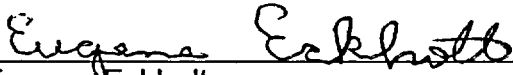



**Figure 6: Insertion Limits**  
**100 Step Overlap With One Inoperable Rod**  
(Technical Specification 3.1.4)

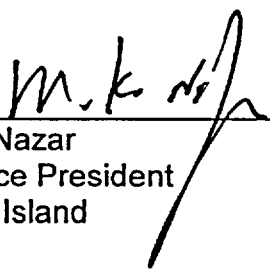
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