



**Nuclear Management Company, LLC**

**Prairie Island Nuclear Generating Plant**  
1717 Wakonade Dr. East • Welch MN 55089

March 18, 2002

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

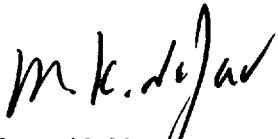
**PRAIRIE ISLAND NUCLEAR GENERATING PLANT**  
Docket No. 50-306 License No. DPR-60

**Core Operating Limits Report for Prairie Island Unit 2 Cycle 21, Revision 0**

The attached revision to the Core Operating Limits Report for Prairie Island Unit 2 Cycle 21, Revision 0, is being provided in accordance with the requirements of Technical Specification Section 6.6.E.4. The limits specified in the attached Core Operating Limits Report have been established using NRC approved methodology.

The Unit 2 Core Operating Limits Report has been revised to support refueling activities associated with Unit 2 Cycle 21.

We have made no new Nuclear Regulatory Commission commitments in this letter or the attachment. Please contact Gene Eckholt (651-388-1121) if you have any questions related to this report.

  
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Site Vice President  
Prairie Island Nuclear Generating Plant

c: Regional Administrator - Region III, NRC  
Senior Resident Inspector, NRC  
NRR Project Manager, NRC  
State of Minnesota - James Bernstein  
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A001

Attachment: Core Operating Limits Report - Unit 2 Cycle 21, Revision 0

**PRAIRIE ISLAND NUCLEAR GENERATING PLANT**

**CORE OPERATING LIMITS REPORT**

**UNIT 2 – CYCLE 21**

**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 2- CYCLE 21**  
**REVISION 0**

This report provides the values of the limits for Unit 2 Cycle 21 as required by Technical Specification Section 6.6.E. 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 Limits

$$F_Q^{RTP} = 2.40$$

K(z) values are provided in Figure 1.

V(z) values are provided in Figures 2a through 2f and Table 1 and Table 2.

Reference Technical Specification sections: 3.10.B.1 and 3.10.B.2

Nuclear Enthalpy Rise Hot Channel Factor Limits

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

$$PFDH = 0.3$$

If the nuclear enthalpy rise hot channel factor exceeds its limit in Technical Specification 3.10.B.1, reduce reactor power and the high neutron flux trip setpoint by 3.33% for each percent that the measured nuclear enthalpy rise hot channel factor exceeds the 3.10.B.1 limit.

Reference Technical Specification sections: 3.10.B.1, 3.10.B.2, and 3.10.B.3

### Linear Heat Generation Rate

The 95% probability level ECCS analysis calculation utilized a peak linear heat generation rate of 14.788 kW/ft.

The Appendix K ECCS analysis calculation utilized a peak linear heat generation rate of 15.167 kW/ft for the  $F_Q$  limit of 2.40.

Reference Technical Specification section: 3.10.B

### 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 2e 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 2f and Table 2.

Reference Technical Specification sections: 3.10.B.4 through 3.10.B.9

### Shutdown Rod Insertion Limits

The shutdown rods shall be fully withdrawn.

Reference Technical Specification section: 3.10.D

### Control Rod Insertion Limits

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

Reference Technical Specification sections: 3.10.D and 3.10.G

### Reactor Coolant Flow Limit

The reactor coolant system flow shall be  $\geq 178,000$  gpm.

Reference Technical Specification section: 3.10.J

## Shutdown Margin Requirements

Minimum Shutdown Margin requirements are shown in Table 3.

Reference Technical Specification Sections: Table TS.1-1 and Specifications 3.10.A and 3.10.D.3.

### 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 3.10.B,  $K(z)$  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 2, cycle 21 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 – 2e.

An alternate two tier  $V(z)$  curve is presented in Table 2 and figure 2f. 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 - 2.000 GWd/MTU	0.20	1.000	6.30	1.060
Eq AO range: -3% to +8%	0.39	1.000	6.49	1.056
Operating band: $\pm 5\%$ $\Delta I$	0.59	1.000	6.69	1.052
(Startup)	0.79	1.000	6.89	1.050
	0.98	1.000	7.08	1.049
	1.18	1.100	7.28	1.048
	1.38	1.095	7.48	1.048
	1.57	1.089	7.67	1.049
	1.77	1.084	7.87	1.051
	1.97	1.079	8.07	1.055
	2.16	1.075	8.26	1.059
	2.36	1.072	8.46	1.061
	2.56	1.069	8.66	1.063
	2.75	1.067	8.85	1.065
	2.95	1.065	9.05	1.067
	3.15	1.064	9.25	1.069
	3.34	1.063	9.44	1.070
	3.54	1.062	9.64	1.072
	3.74	1.061	9.84	1.074
	3.93	1.061	10.03	1.076
	4.13	1.061	10.23	1.079
	4.33	1.062	10.43	1.081
	4.52	1.064	10.62	1.083
	4.72	1.066	10.82	1.086
	4.92	1.067	11.02	1.000
	5.11	1.067	11.21	1.000
	5.31	1.067	11.41	1.000
	5.51	1.067	11.61	1.000
	5.70	1.066	11.80	1.000
	5.90	1.065	12.00	1.000
	6.10	1.063		

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

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
2.000 - 4.000 GWd/MTU	0.20	1.000	6.30	1.060
Eq AO range: -3% to +6%	0.39	1.000	6.49	1.056
Operating band: $\pm 5\%$ $\Delta I$	0.59	1.000	6.69	1.052
	0.79	1.000	6.89	1.050
	0.98	1.000	7.08	1.049
	1.18	1.100	7.28	1.048
	1.38	1.095	7.48	1.050
	1.57	1.089	7.67	1.052
	1.77	1.084	7.87	1.055
	1.97	1.079	8.07	1.059
	2.16	1.075	8.26	1.062
	2.36	1.072	8.46	1.064
	2.56	1.069	8.66	1.066
	2.75	1.067	8.85	1.068
	2.95	1.065	9.05	1.069
	3.15	1.064	9.25	1.071
	3.34	1.063	9.44	1.072
	3.54	1.062	9.64	1.073
	3.74	1.061	9.84	1.075
	3.93	1.061	10.03	1.077
	4.13	1.061	10.23	1.079
	4.33	1.062	10.43	1.081
	4.52	1.064	10.62	1.083
	4.72	1.066	10.82	1.086
	4.92	1.067	11.02	1.000
	5.11	1.067	11.21	1.000
	5.31	1.067	11.41	1.000
	5.51	1.067	11.61	1.000
	5.70	1.066	11.80	1.000
	5.90	1.065	12.00	1.000
	6.10	1.063		

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

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
4.000 - 8.000 GWd/MTU	0.20	1.000	6.30	1.061
Eq AO range: -4% to +4%	0.39	1.000	6.49	1.058
Operating band: $\pm 5\%$ $\Delta I$	0.59	1.000	6.69	1.055
	0.79	1.000	6.89	1.056
	0.98	1.000	7.08	1.057
	1.18	1.100	7.28	1.059
	1.38	1.095	7.48	1.062
	1.57	1.089	7.67	1.065
	1.77	1.084	7.87	1.067
	1.97	1.080	8.07	1.070
	2.16	1.077	8.26	1.072
	2.36	1.074	8.46	1.073
	2.56	1.071	8.66	1.074
	2.75	1.068	8.85	1.075
	2.95	1.066	9.05	1.075
	3.15	1.064	9.25	1.075
	3.34	1.063	9.44	1.076
	3.54	1.062	9.64	1.076
	3.74	1.061	9.84	1.077
	3.93	1.061	10.03	1.079
	4.13	1.061	10.23	1.080
	4.33	1.062	10.43	1.082
	4.52	1.064	10.62	1.083
	4.72	1.066	10.82	1.086
	4.92	1.067	11.02	1.000
	5.11	1.067	11.21	1.000
	5.31	1.067	11.41	1.000
	5.51	1.067	11.61	1.000
	5.70	1.066	11.80	1.000
	5.90	1.065	12.00	1.000
	6.10	1.063		



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

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
8.000 - 13.000 GWd/MTU	0.20	1.000	6.30	1.065
Eq AO range: -6% to +2%	0.39	1.000	6.49	1.069
Operating band: $\pm 5\%$ $\Delta I$	0.59	1.000	6.69	1.074
	0.79	1.000	6.89	1.077
	0.98	1.000	7.08	1.080
	1.18	1.109	7.28	1.083
	1.38	1.106	7.48	1.085
	1.57	1.102	7.67	1.087
	1.77	1.099	7.87	1.087
	1.97	1.097	8.07	1.087
	2.16	1.095	8.26	1.087
	2.36	1.091	8.46	1.086
	2.56	1.088	8.66	1.084
	2.75	1.084	8.85	1.083
	2.95	1.079	9.05	1.083
	3.15	1.074	9.25	1.083
	3.34	1.070	9.44	1.083
	3.54	1.066	9.64	1.082
	3.74	1.062	9.84	1.084
	3.93	1.061	10.03	1.086
	4.13	1.061	10.23	1.089
	4.33	1.062	10.43	1.091
	4.52	1.064	10.62	1.093
	4.72	1.066	10.82	1.095
	4.92	1.067	11.02	1.000
	5.11	1.067	11.21	1.000
	5.31	1.067	11.41	1.000
	5.51	1.067	11.61	1.000
	5.70	1.067	11.80	1.000
	5.90	1.066	12.00	1.000
	6.10	1.065		

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

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
13.000 - EOC GWd/MTU	0.20	1.000	6.30	1.091
Eq AO range: -6% to +4%	0.39	1.000	6.49	1.094
Operating band: $\pm 5\%$ $\Delta I$	0.59	1.000	6.69	1.096
	0.79	1.000	6.89	1.096
	0.98	1.000	7.08	1.095
	1.18	1.150	7.28	1.095
	1.38	1.148	7.48	1.096
	1.57	1.148	7.67	1.097
	1.77	1.146	7.87	1.097
	1.97	1.140	8.07	1.095
	2.16	1.134	8.26	1.094
	2.36	1.126	8.46	1.090
	2.56	1.119	8.66	1.087
	2.75	1.111	8.85	1.085
	2.95	1.105	9.05	1.084
	3.15	1.098	9.25	1.083
	3.34	1.092	9.44	1.087
	3.54	1.084	9.64	1.091
	3.74	1.076	9.84	1.094
	3.93	1.073	10.03	1.098
	4.13	1.070	10.23	1.101
	4.33	1.069	10.43	1.102
	4.52	1.071	10.62	1.102
	4.72	1.073	10.82	1.104
	4.92	1.074	11.02	1.000
	5.11	1.076	11.21	1.000
	5.31	1.077	11.41	1.000
	5.51	1.079	11.61	1.000
	5.70	1.081	11.80	1.000
	5.90	1.085	12.00	1.000
	6.10	1.088		

**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	1.164
Eq AO range: -6% to +4%	0.39	1.000	6.49	1.167
Operating Band	0.59	1.000	6.69	1.170
±5% ΔI at and above 90% power	0.79	1.000	6.89	1.169
±10% ΔI below 90% power	0.98	1.000	7.08	1.167
	1.18	1.282	7.28	1.164
	1.38	1.279	7.48	1.157
	1.57	1.277	7.67	1.150
	1.77	1.275	7.87	1.141
	1.97	1.264	8.07	1.131
	2.16	1.253	8.26	1.122
	2.36	1.240	8.46	1.124
	2.56	1.226	8.66	1.127
	2.75	1.212	8.85	1.130
	2.95	1.201	9.05	1.135
	3.15	1.190	9.25	1.140
	3.34	1.179	9.44	1.144
	3.54	1.166	9.64	1.148
	3.74	1.154	9.84	1.152
	3.93	1.141	10.03	1.155
	4.13	1.127	10.23	1.159
	4.33	1.120	10.43	1.160
	4.52	1.126	10.62	1.160
	4.72	1.131	10.82	1.163
	4.92	1.135	11.02	1.000
	5.11	1.138	11.21	1.000
	5.31	1.143	11.41	1.000
	5.51	1.147	11.61	1.000
	5.70	1.152	11.80	1.000
	5.90	1.156	12.00	1.000
	6.10	1.160		

**Table 3**

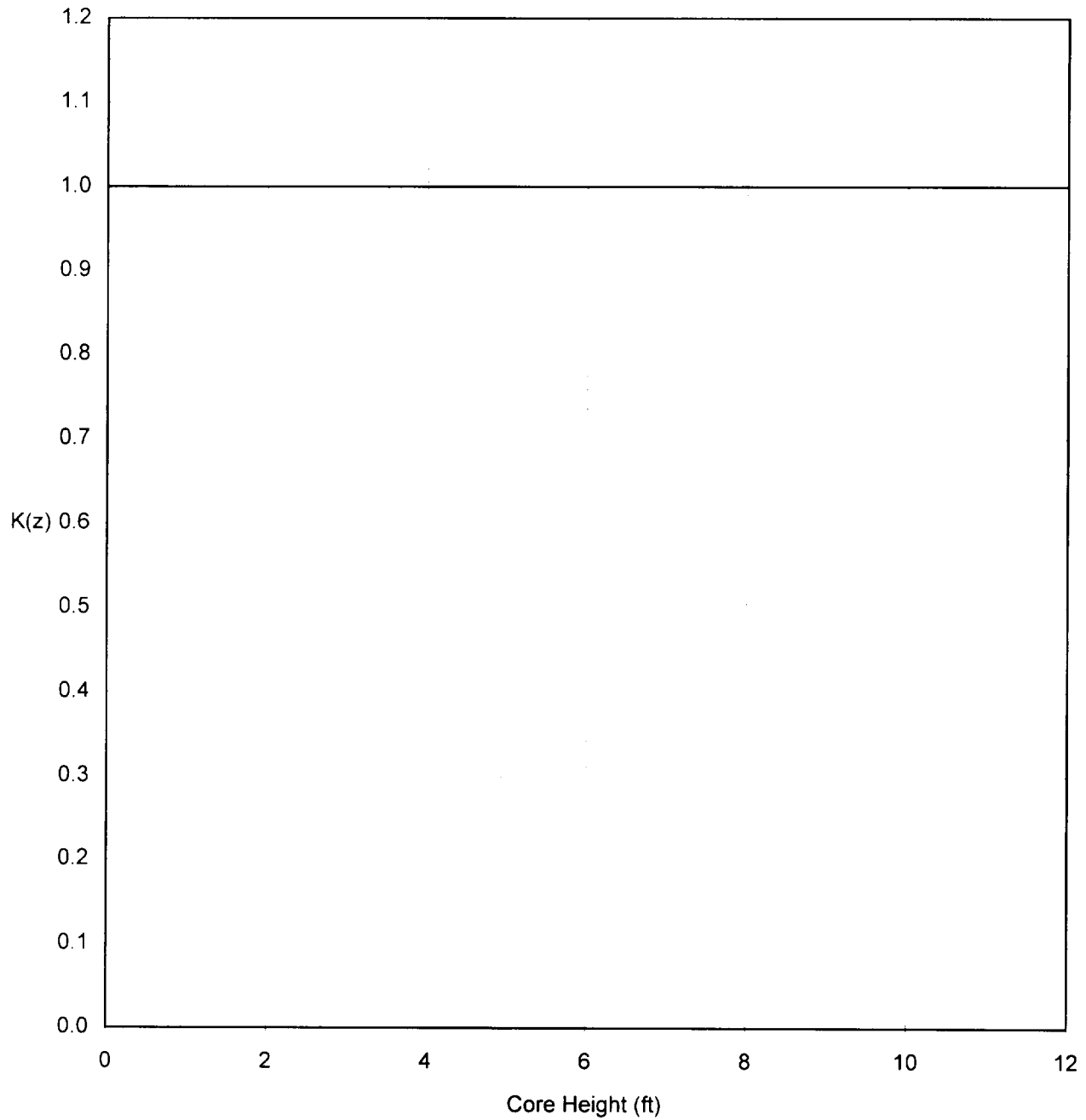
**Minimum Required Shutdown Margin**

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%	2.0%
Mode 4	2.0%	4.0%	6.0%
Mode 5***	2.0%	5.26%	7.0%
Mode 6, ARI***	5.26%	5.26%	7.0%
Mode 6, ARO***	5.26%	6.0%	9.0%

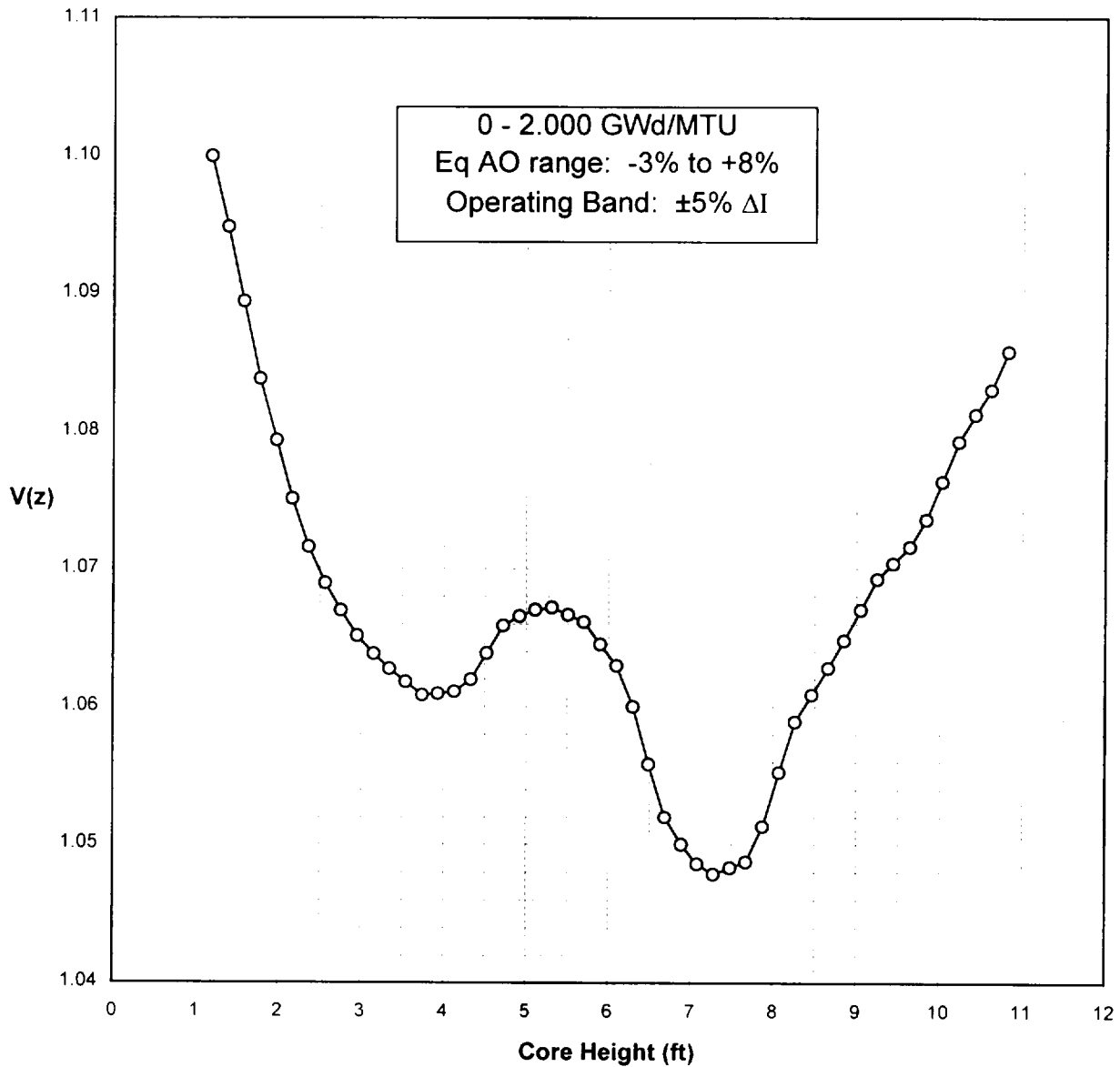
\* For Modes 1 and 2, minimum shutdown margin requirements are provided by the Rod Insertion Limits.

\*\* 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.

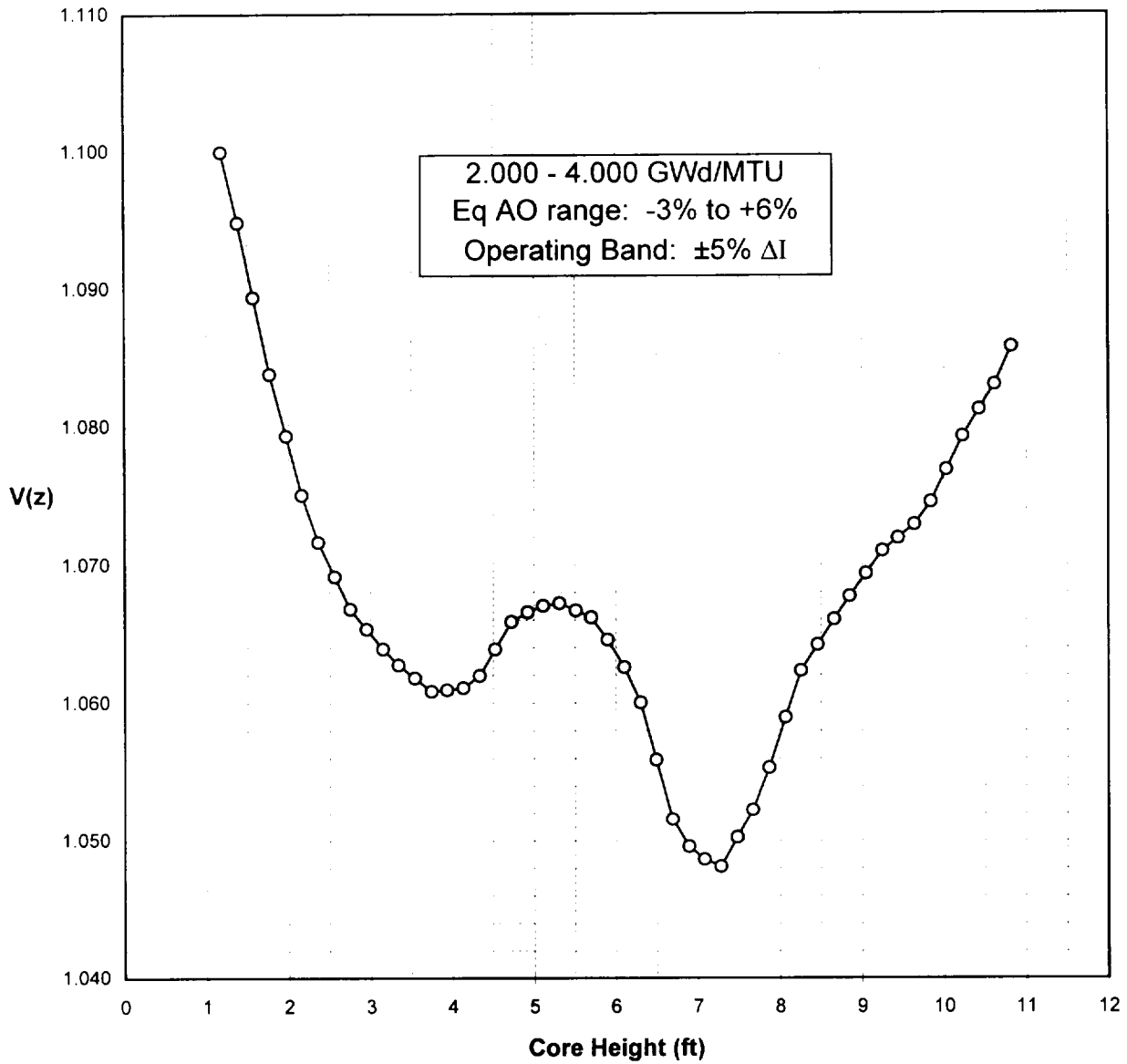
\*\*\* Values for modes 5 and 6 are also applicable for the Unit 2 Cycle 20 end of cycle.



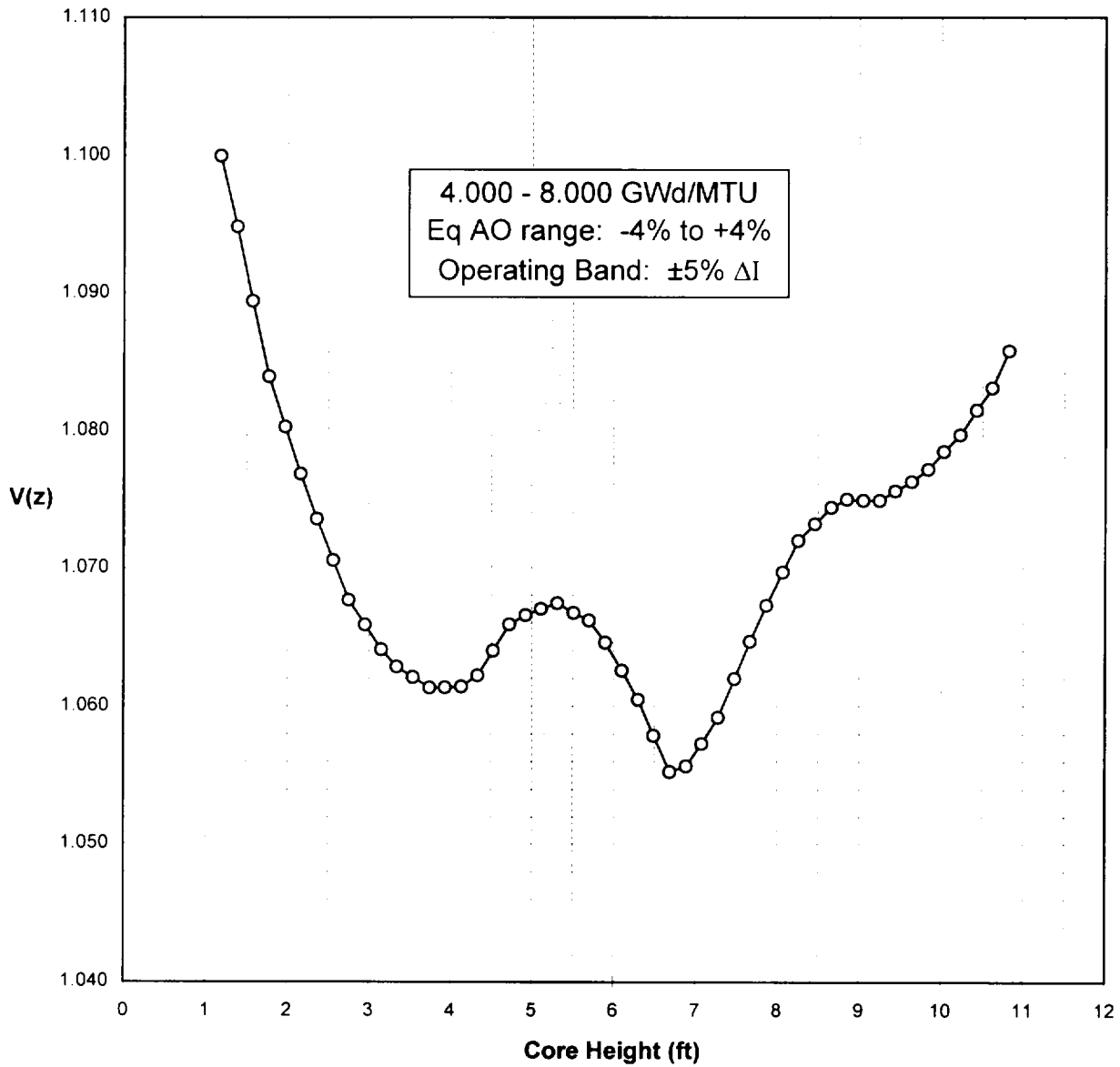
**Figure 1: Hot Channel Factor  
Normalized Operating Envelope**



**Figure 2a: Bounding V(z) Values  
From 0 - 2.000 GWd/MTU  
(Startup)**

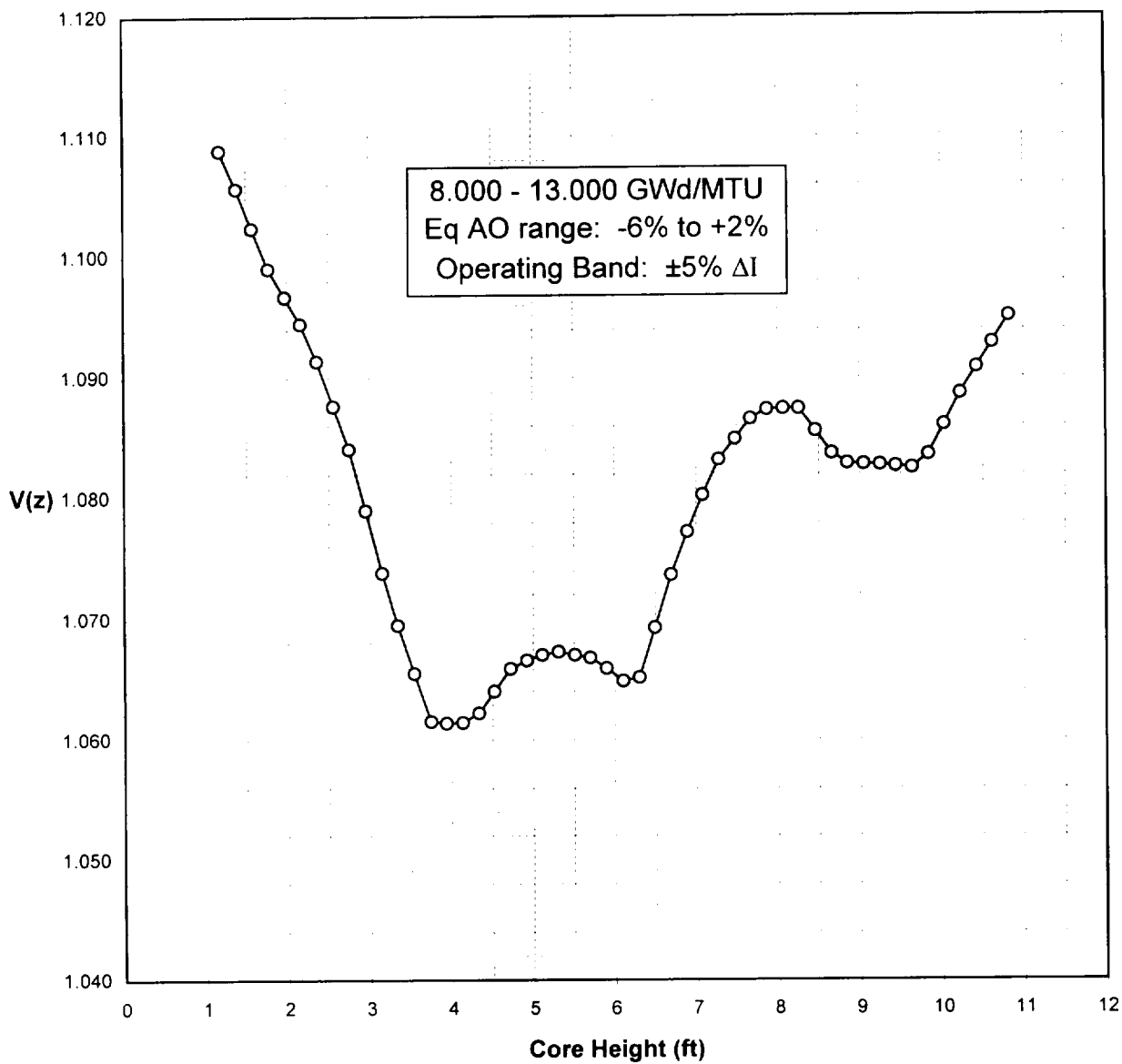


**Figure 2b: Bounding V(z) Values  
From 2.000 - 4.000 GWd/MTU**

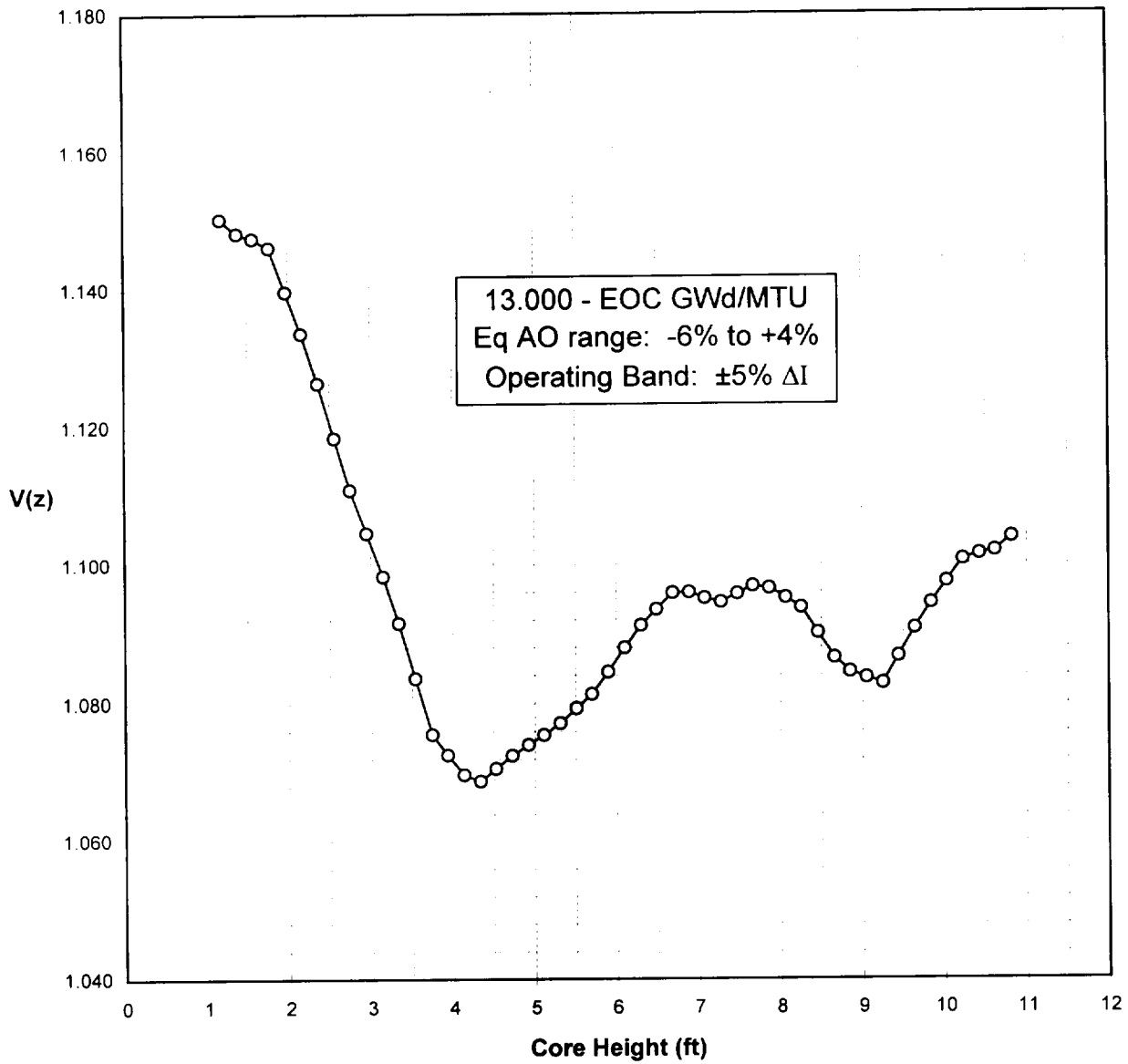


**Figure 2c: Bounding V(z) Values  
From 4.000 - 8.000 GWd/MTU**

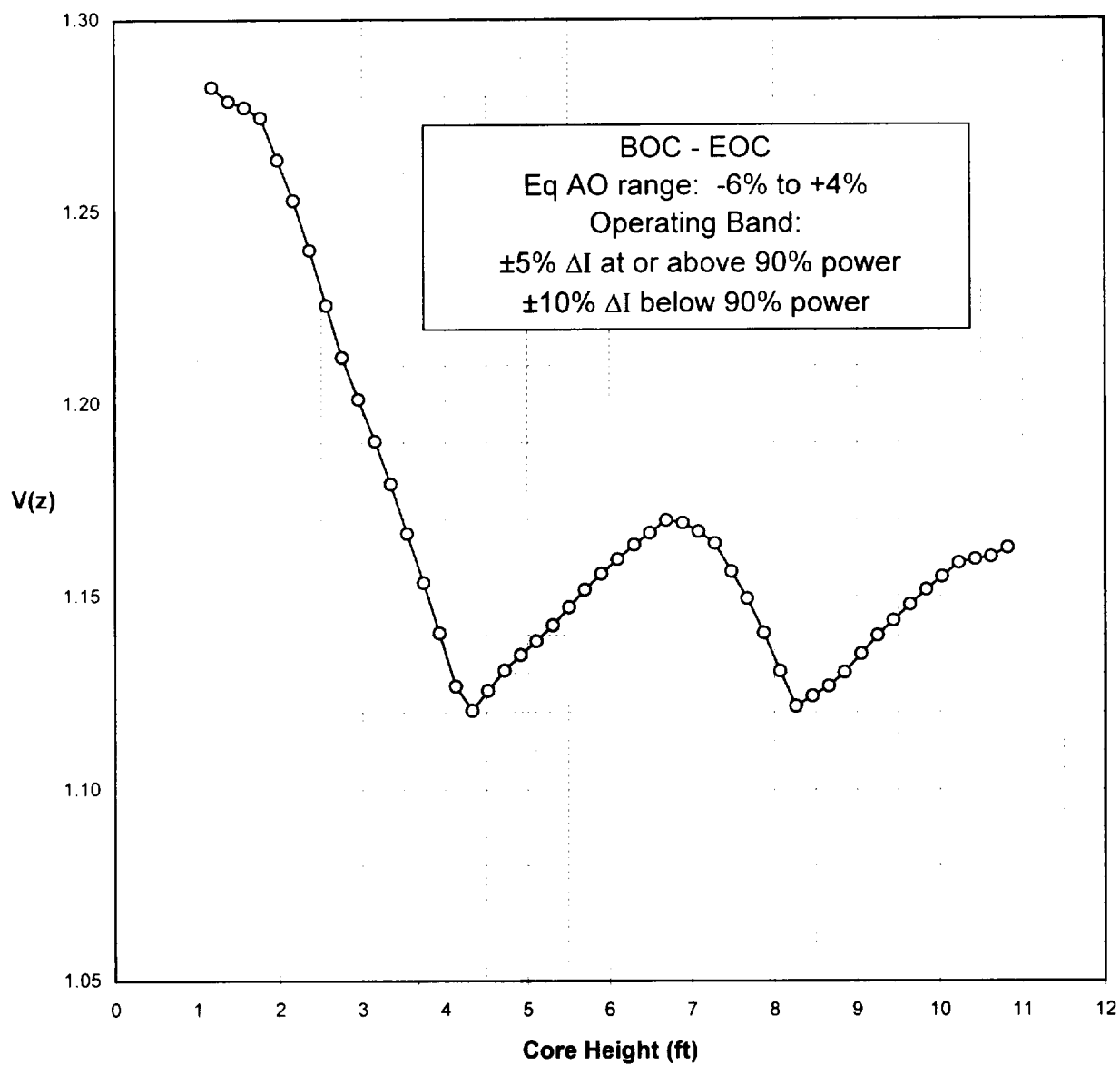




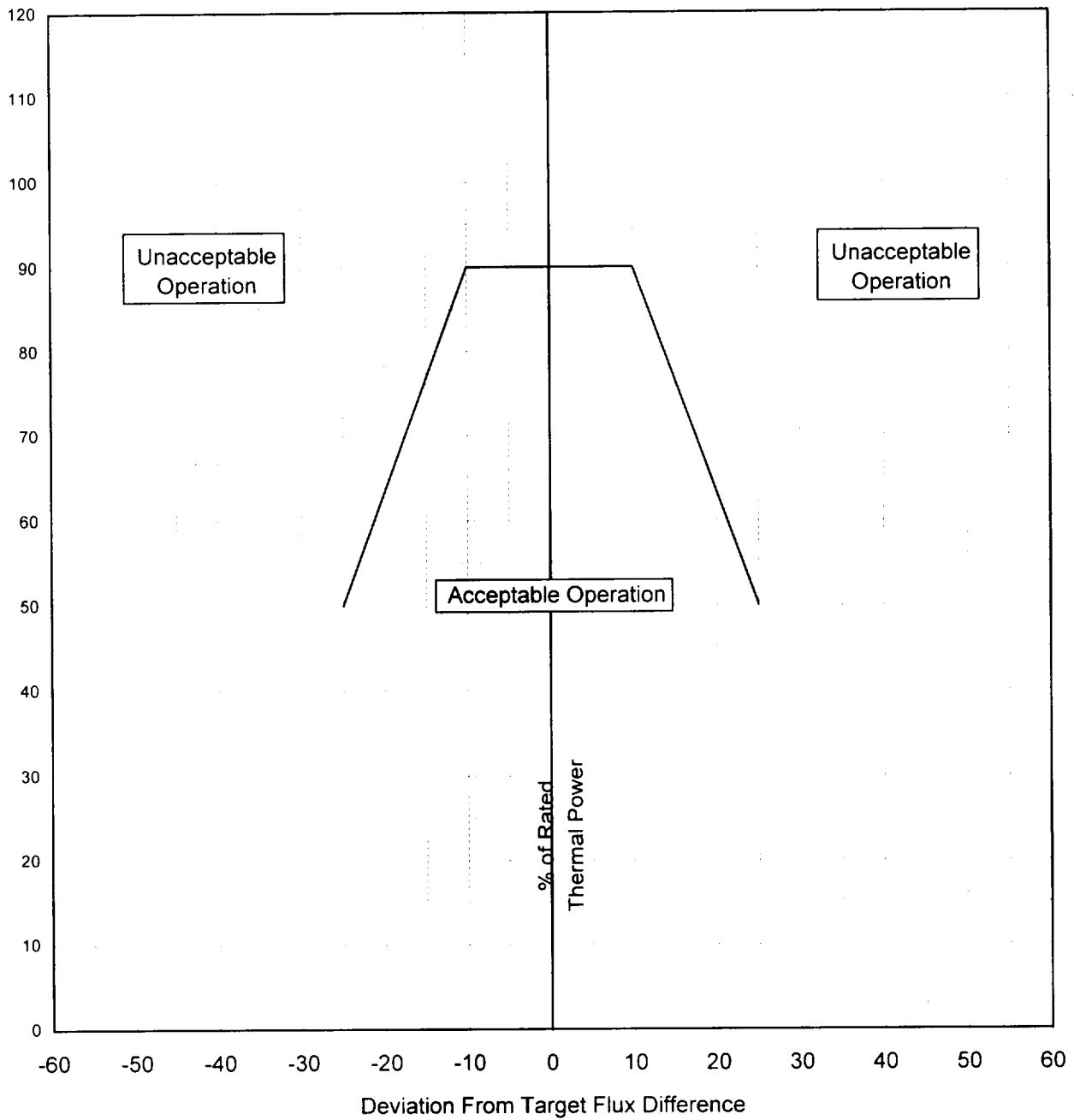
**Figure 2d: Bounding V(z) Values  
From 8.000 - 13.000 GWd/MTU**



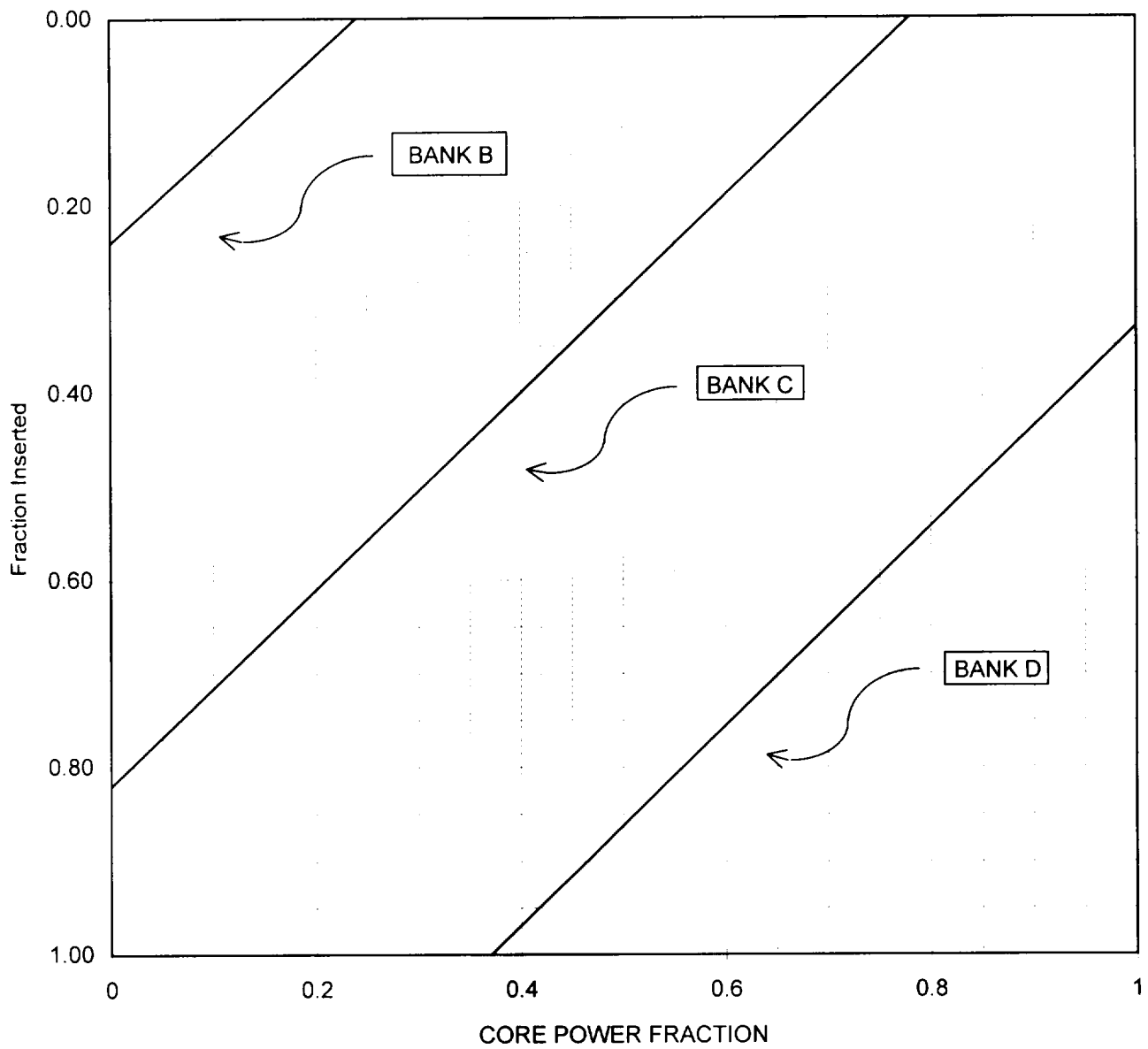
**Figure 2e: Bounding V(z) Values  
From 13.000 - EOC GWd/MTU**



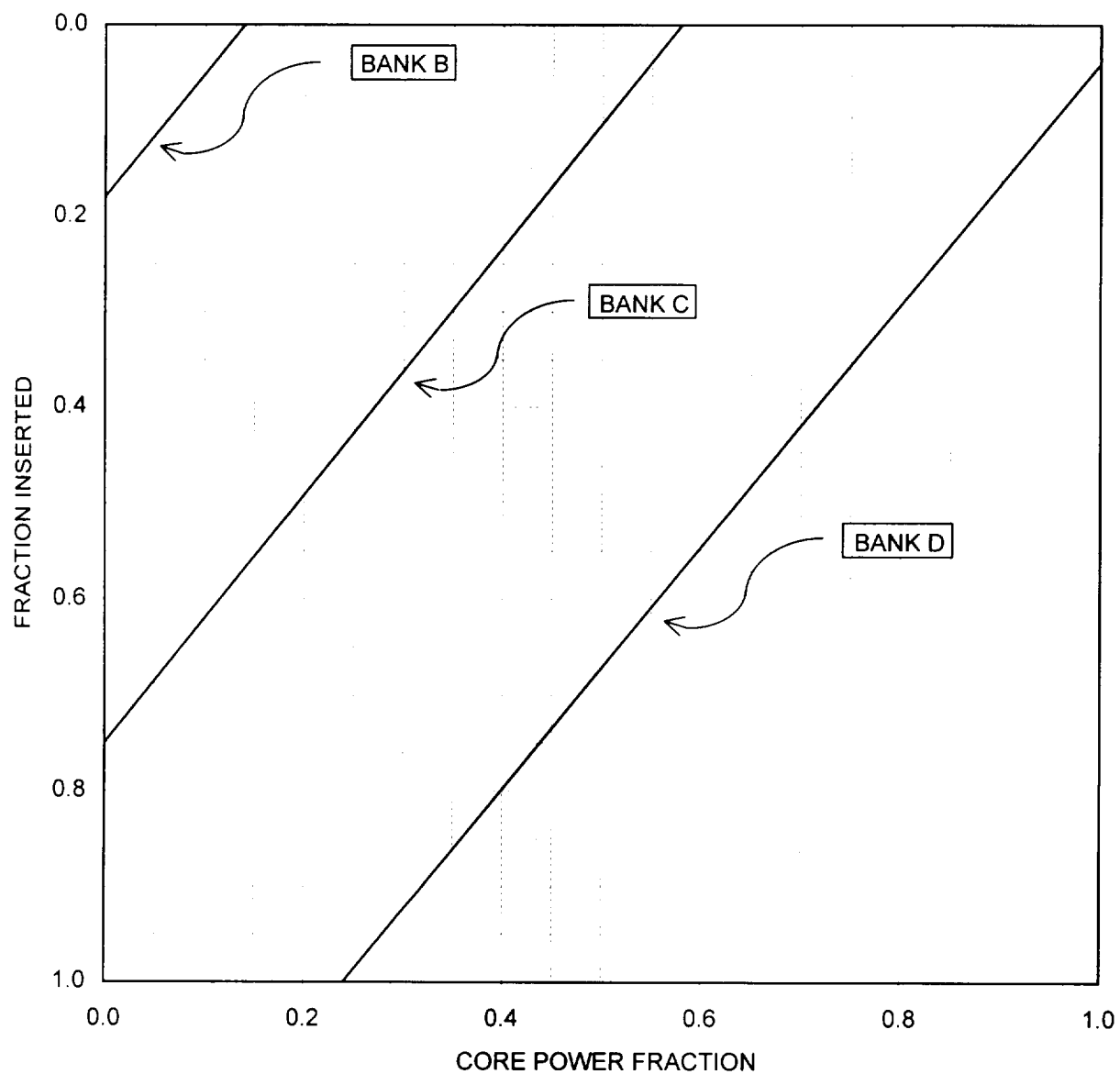
**Figure 2f: Bounding V(z) Values  
2 Tier band  
BOC - EOC**



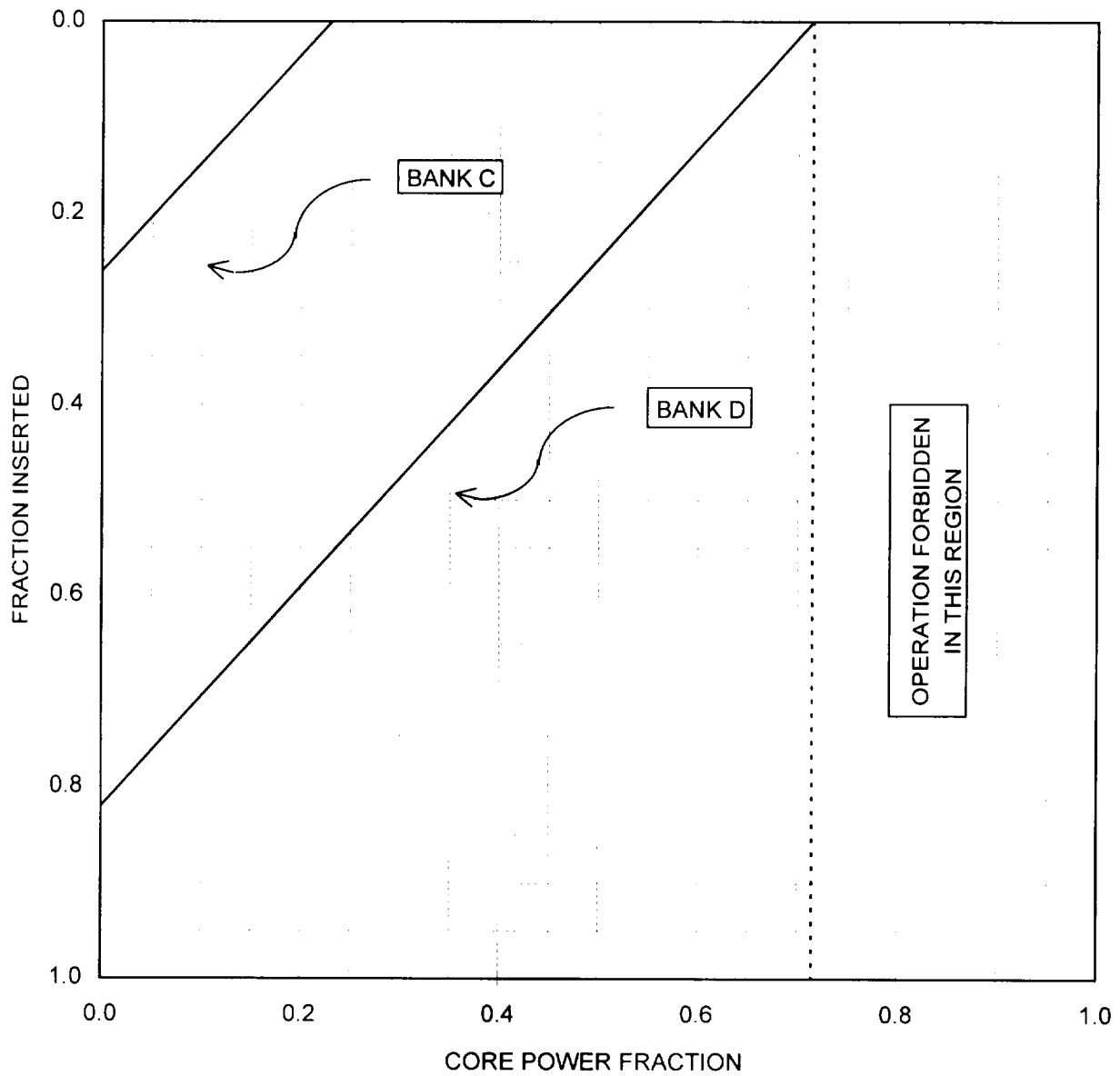
**Figure 3: Deviation From Target Flux Difference as a Function of Thermal Power**



**Figure 4: Control Bank Insertion Limits**



**Figure 5: Insertion Limits**  
**100 Step Overlap With One Bottomed Rod**  
(Technical Specification 3.10.G.3)



**Figure 6: Insertion Limits**  
**100 Step Overlap With One Inoperable Rod**  
(Technical Specification 3.10.G.4)

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