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Prairie Island Nuclear Generating Plant
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February 21, 2001

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 for Prairie Island Unit 1 Cycle 21, Revision 1

The attached revision to the Core Operating Limits Report for Prairie Island Unit 1 Cycle 21 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.

Revision 0 of the Unit 1 Core Operating Limits Report was issued to support refueling activities associated with Unit 1 Cycle 21. Revision 0 had to be issued prior to confirming the applicability of the LOCA analysis. Therefore, Revision 0 did not contain all of the operating limits necessary to support operation of Unit 1 Cycle 21. The Unit 1 Core Operating Limits Report has been revised to incorporate the operating limits associated with 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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A001

Attachment: Core Operating Limits Report - Unit 1 Cycle 21, Revision 1

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 1 – CYCLE 21

REVISION 1

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 21

REVISION 1

This report provides the values of the limits for Unit 1 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 ±5% when using figures 2a through 2e and Table 1. The axial flux difference target band is ±5% when equal to or above 90% power and ± 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 ≥ 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 1, cycle 21 with an operating band of $\pm$ 5% ΔI. 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% ΔI at or above 90% power, and $\pm$ 10% ΔI below 90% power. This figure is valid over all exposure ranges.

Table 1

Bounding V(z) Values

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
0.0 - 1.464 GWd/MTU	0.20	1.000	6.30	1.072
Eq AO range: -3% to +8%	0.39	1.000	6.49	1.070
Operating band: ±5% ΔI	0.59	1.000	6.69	1.067
(Startup)	0.79	1.000	6.89	1.064
	0.98	1.000	7.08	1.060
	1.18	1.113	7.28	1.057
	1.38	1.109	7.48	1.058
	1.57	1.105	7.67	1.059
	1.77	1.102	7.87	1.062
	1.97	1.098	8.07	1.065
	2.16	1.094	8.26	1.068
	2.36	1.091	8.46	1.071
	2.56	1.087	8.66	1.073
	2.75	1.083	8.85	1.076
	2.95	1.082	9.05	1.080
	3.15	1.082	9.25	1.084
	3.34	1.081	9.44	1.087
	3.54	1.082	9.64	1.091
	3.74	1.082	9.84	1.095
	3.93	1.082	10.03	1.098
	4.13	1.082	10.23	1.101
	4.33	1.081	10.43	1.104
	4.52	1.081	10.62	1.107
	4.72	1.080	10.82	1.110
	4.92	1.079	11.02	1.000
	5.11	1.078	11.21	1.000
	5.31	1.078	11.41	1.000
	5.51	1.077	11.61	1.000
	5.70	1.077	11.80	1.000
	5.90	1.075	12.00	1.000
	6.10	1.074		

Table 1

Bounding V(z) Values

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
1.464 - 4.064 GWd/MTU	0.20	1.000	6.30	1.078
Eq AO range: -6% to +6%	0.39	1.000	6.49	1.076
Operating band: ±5% ΔI	0.59	1.000	6.69	1.073
	0.79	1.000	6.89	1.071
	0.98	1.000	7.08	1.069
	1.18	1.108	7.28	1.067
	1.38	1.105	7.48	1.071
	1.57	1.101	7.67	1.074
	1.77	1.098	7.87	1.077
	1.97	1.095	8.07	1.079
	2.16	1.091	8.26	1.082
	2.36	1.089	8.46	1.084
	2.56	1.088	8.66	1.085
	2.75	1.087	8.85	1.087
	2.95	1.085	9.05	1.090
	3.15	1.084	9.25	1.092
	3.34	1.083	9.44	1.094
	3.54	1.083	9.64	1.096
	3.74	1.082	9.84	1.098
	3.93	1.082	10.03	1.100
	4.13	1.081	10.23	1.102
	4.33	1.081	10.43	1.106
	4.52	1.082	10.62	1.108
	4.72	1.083	10.82	1.111
	4.92	1.083	11.02	1.000
	5.11	1.084	11.21	1.000
	5.31	1.084	11.41	1.000
	5.51	1.084	11.61	1.000
	5.70	1.083	11.80	1.000
	5.90	1.082	12.00	1.000
	6.10	1.080		

Table 1

Bounding V(z) Values

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
4.064 - 8.064 GWd/MTU	0.20	1.000	6.30	1.078
Eq AO range: -6% to +4%	0.39	1.000	6.49	1.075
Operating band: ±5% ΔI	0.59	1.000	6.69	1.072
	0.79	1.000	6.89	1.072
	0.98	1.000	7.08	1.074
	1.18	1.107	7.28	1.075
	1.38	1.104	7.48	1.078
	1.57	1.101	7.67	1.081
	1.77	1.098	7.87	1.084
	1.97	1.095	8.07	1.086
	2.16	1.092	8.26	1.088
	2.36	1.090	8.46	1.089
	2.56	1.089	8.66	1.091
	2.75	1.088	8.85	1.092
	2.95	1.087	9.05	1.094
	3.15	1.086	9.25	1.096
	3.34	1.085	9.44	1.097
	3.54	1.084	9.64	1.098
	3.74	1.083	9.84	1.100
	3.93	1.083	10.03	1.102
	4.13	1.083	10.23	1.104
	4.33	1.083	10.43	1.108
	4.52	1.083	10.62	1.111
	4.72	1.083	10.82	1.114
	4.92	1.083	11.02	1.000
	5.11	1.083	11.21	1.000
	5.31	1.083	11.41	1.000
	5.51	1.082	11.61	1.000
	5.70	1.082	11.80	1.000
	5.90	1.081	12.00	1.000
	6.10	1.079		

Table 1

Bounding V(z) Values

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
8.064 - 12.064 GWd/MTU	0.20	1.000	6.30	1.074
Eq AO range: -6% to +2%	0.39	1.000	6.49	1.072
Operating band: ±5% ΔI	0.59	1.000	6.69	1.069
	0.79	1.000	6.89	1.071
	0.98	1.000	7.08	1.075
	1.18	1.102	7.28	1.079
	1.38	1.099	7.48	1.082
	1.57	1.097	7.67	1.086
	1.77	1.095	7.87	1.088
	1.97	1.093	8.07	1.091
	2.16	1.092	8.26	1.093
	2.36	1.091	8.46	1.094
	2.56	1.090	8.66	1.095
	2.75	1.089	8.85	1.096
	2.95	1.088	9.05	1.097
	3.15	1.086	9.25	1.099
	3.34	1.084	9.44	1.099
	3.54	1.082	9.64	1.100
	3.74	1.081	9.84	1.101
	3.93	1.081	10.03	1.104
	4.13	1.082	10.23	1.107
	4.33	1.082	10.43	1.110
	4.52	1.082	10.62	1.114
	4.72	1.082	10.82	1.117
	4.92	1.082	11.02	1.000
	5.11	1.082	11.21	1.000
	5.31	1.082	11.41	1.000
	5.51	1.081	11.61	1.000
	5.70	1.080	11.80	1.000
	5.90	1.078	12.00	1.000
	6.10	1.077		

Table 1

Bounding V(z) Values

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
12.064 - EOC GWd/MTU	0.20	1.000	6.30	1.190
Eq AO range: -6% to +5%	0.39	1.000	6.49	1.189
Operating band: ±5% ΔI	0.59	1.000	6.69	1.188
	0.79	1.000	6.89	1.183
	0.98	1.000	7.08	1.178
	1.18	1.126	7.28	1.171
	1.38	1.123	7.48	1.162
	1.57	1.120	7.67	1.153
	1.77	1.117	7.87	1.142
	1.97	1.110	8.07	1.131
	2.16	1.103	8.26	1.120
	2.36	1.096	8.46	1.109
	2.56	1.089	8.66	1.099
	2.75	1.083	8.85	1.095
	2.95	1.085	9.05	1.096
	3.15	1.087	9.25	1.098
	3.34	1.093	9.44	1.102
	3.54	1.104	9.64	1.106
	3.74	1.114	9.84	1.113
	3.93	1.124	10.03	1.122
	4.13	1.134	10.23	1.133
	4.33	1.143	10.43	1.133
	4.52	1.151	10.62	1.133
	4.72	1.159	10.82	1.134
	4.92	1.164	11.02	1.000
	5.11	1.168	11.21	1.000
	5.31	1.172	11.41	1.000
	5.51	1.175	11.61	1.000
	5.70	1.178	11.80	1.000
	5.90	1.182	12.00	1.000
	6.10	1.187		

Table 2

Bounding V(z) Values

Exposure Range	z(ft)	V(z)	z(ft)	V(z)
BOC to EOC	0.20	1.000	6.30	1.253
Eq AO range: -6% to +5%	0.39	1.000	6.49	1.251
Operating Band	0.59	1.000	6.69	1.248
±5% ΔI at and above 90% power	0.79	1.000	6.89	1.240
±10% ΔI below 90% power	0.98	1.000	7.08	1.232
	1.18	1.133	7.28	1.222
	1.38	1.130	7.48	1.208
	1.57	1.126	7.67	1.194
	1.77	1.122	7.87	1.178
	1.97	1.115	8.07	1.161
	2.16	1.109	8.26	1.145
	2.36	1.101	8.46	1.132
	2.56	1.093	8.66	1.118
	2.75	1.086	8.85	1.110
	2.95	1.089	9.05	1.107
	3.15	1.092	9.25	1.104
	3.34	1.099	9.44	1.103
	3.54	1.112	9.64	1.103
	3.74	1.125	9.84	1.107
	3.93	1.137	10.03	1.115
	4.13	1.150	10.23	1.124
	4.33	1.162	10.43	1.124
	4.52	1.172	10.62	1.124
	4.72	1.182	10.82	1.125
	4.92	1.193	11.02	1.000
	5.11	1.204	11.21	1.000
	5.31	1.216	11.41	1.000
	5.51	1.228	11.61	1.000
	5.70	1.239	11.80	1.000
	5.90	1.246	12.00	1.000
	6.10	1.250		

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, $T_{ave} \geq 520°F$	2.0%	2.0%	2.0%
Mode 3, $350°F \leq T_{ave} < 520°F$	2.0%	2.0%	2.5%
Mode 4	2.5%	5.0%	8.0%
Mode 5***	2.5%	5.0%	8.0%
Mode 6, ARI***	5.26%	5.26%	8.0%
Mode 6, ARO***	5.26%	6.0%	9.5%

* 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 20 end of cycle.

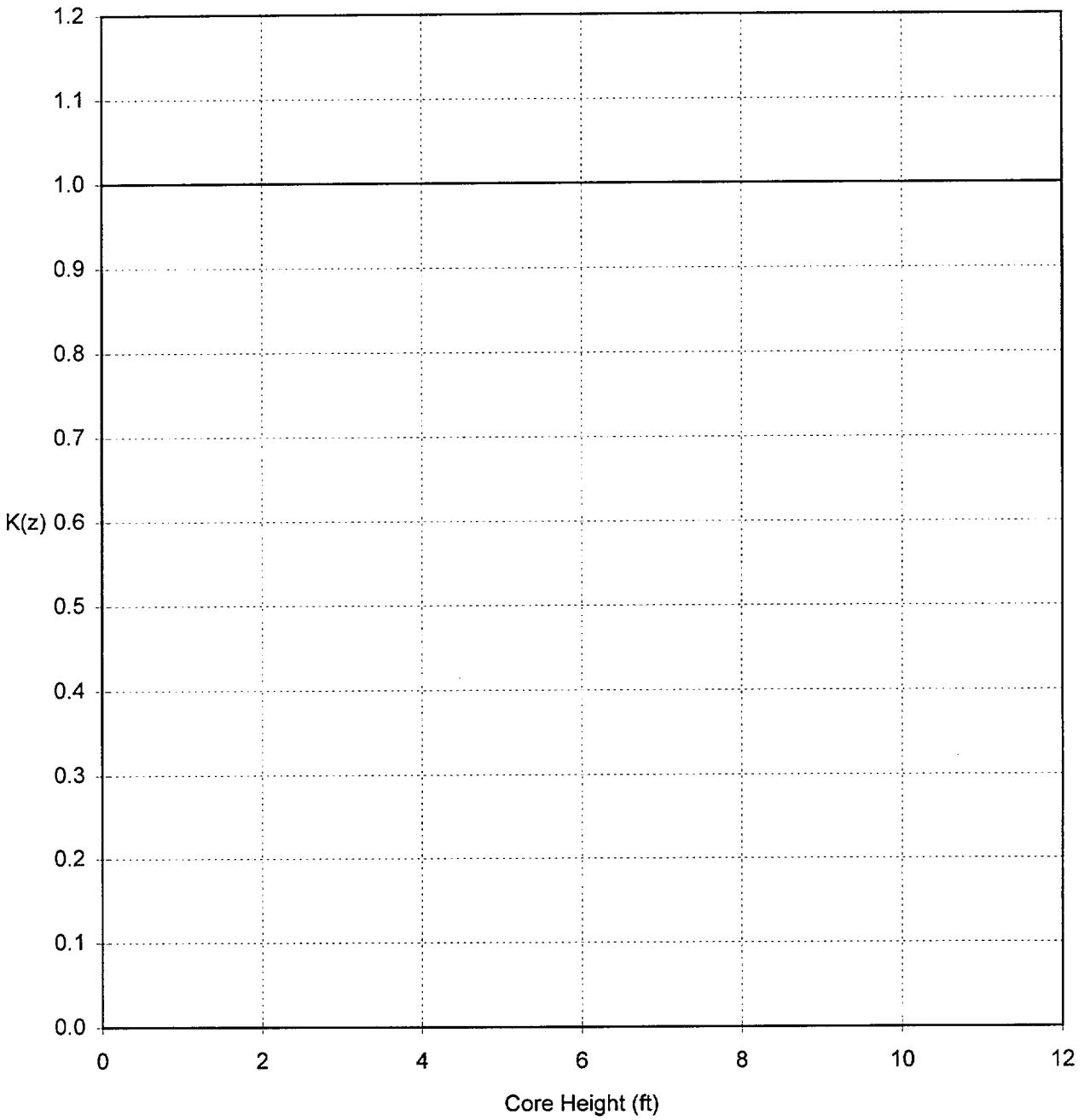

Figure 1: Hot Channel Factor
Normalized Operating Envelope

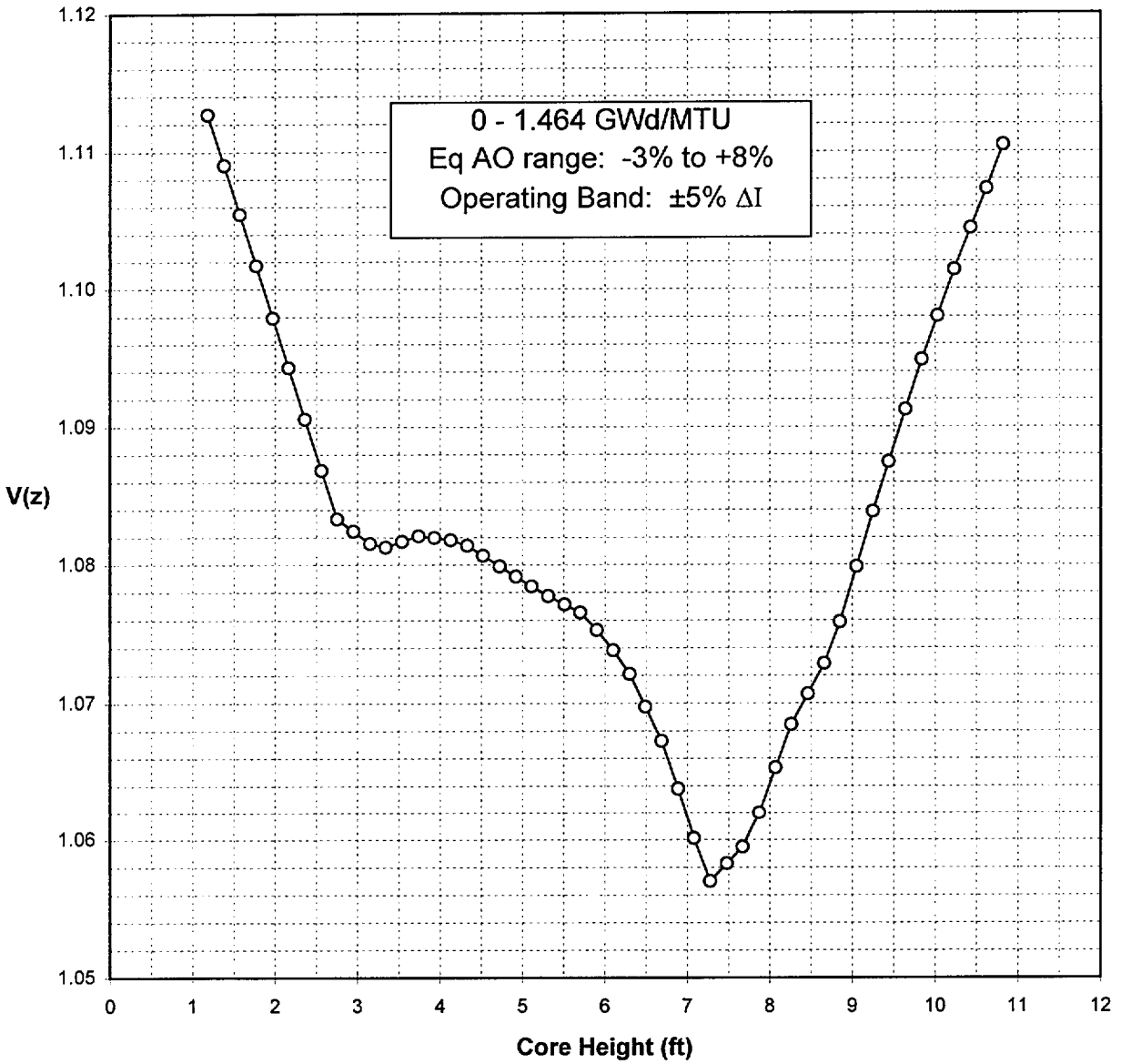

Figure 2a: Bounding V(z) Values From 0 - 1.464 GWd/MTU (Startup)

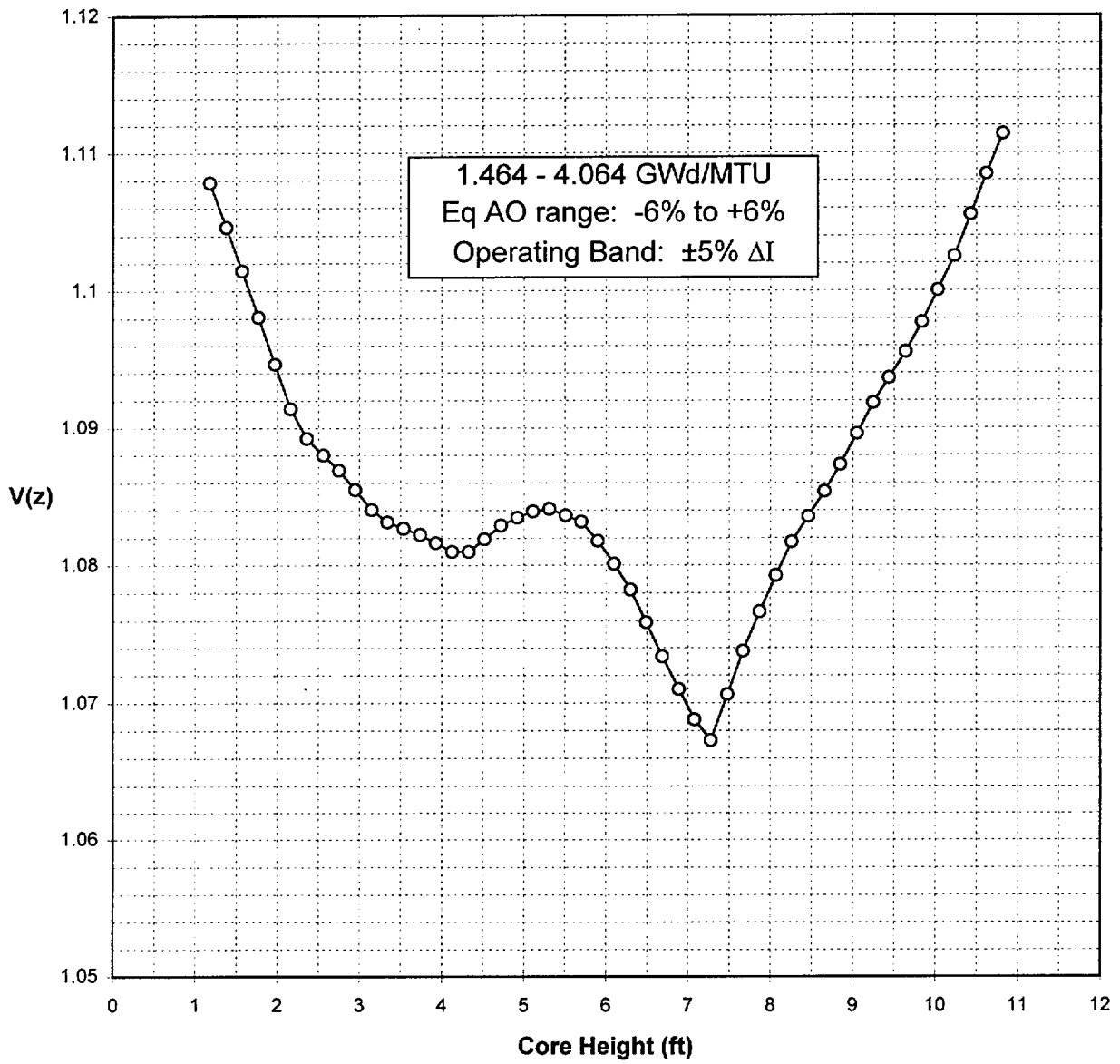

Figure 2b: Bounding V(z) Values From 1.464 - 4.064 GWd/MTU

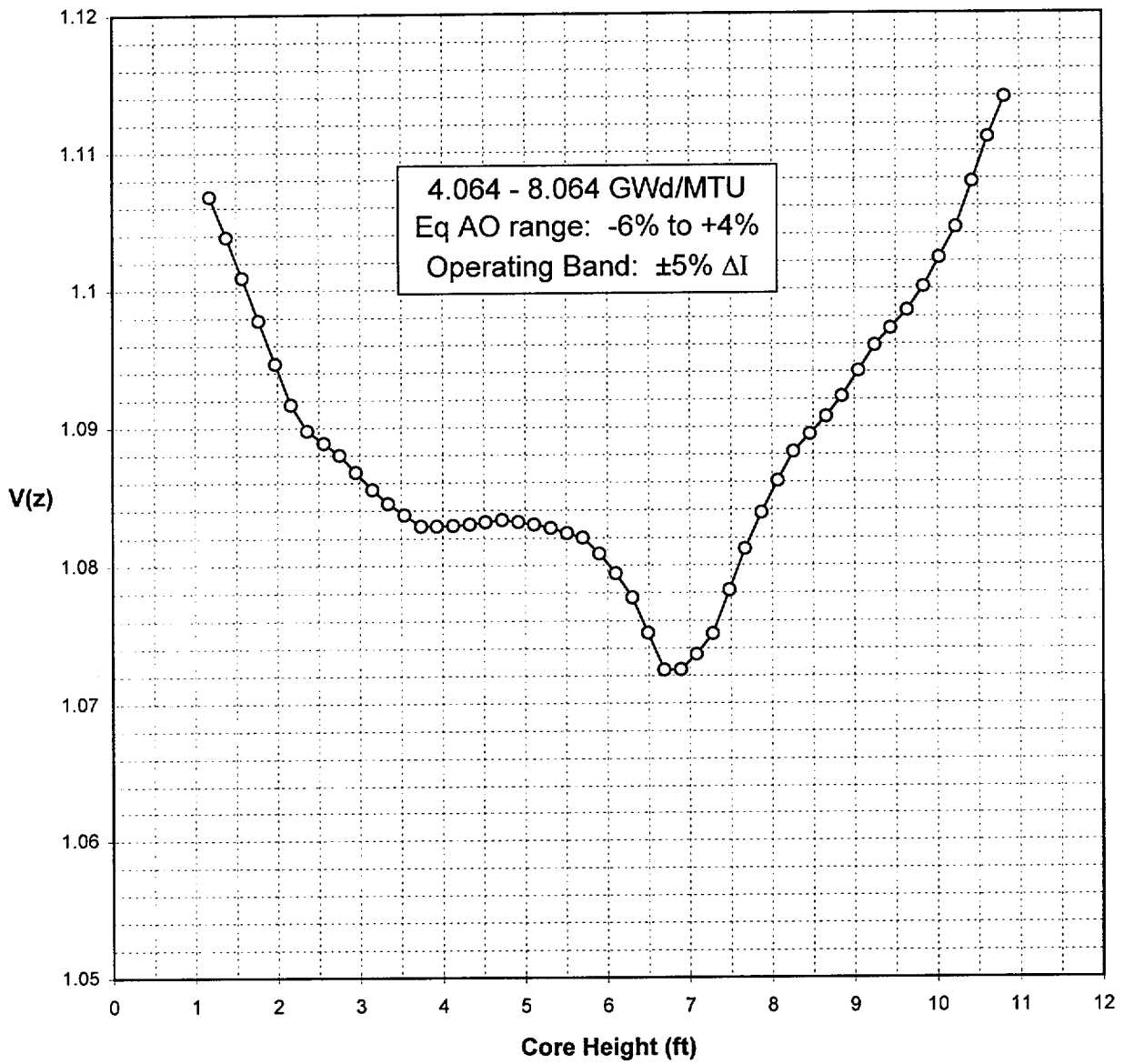

Figure 2c: Bounding V(z) Values From 4.064 - 8.064 GWd/MTU

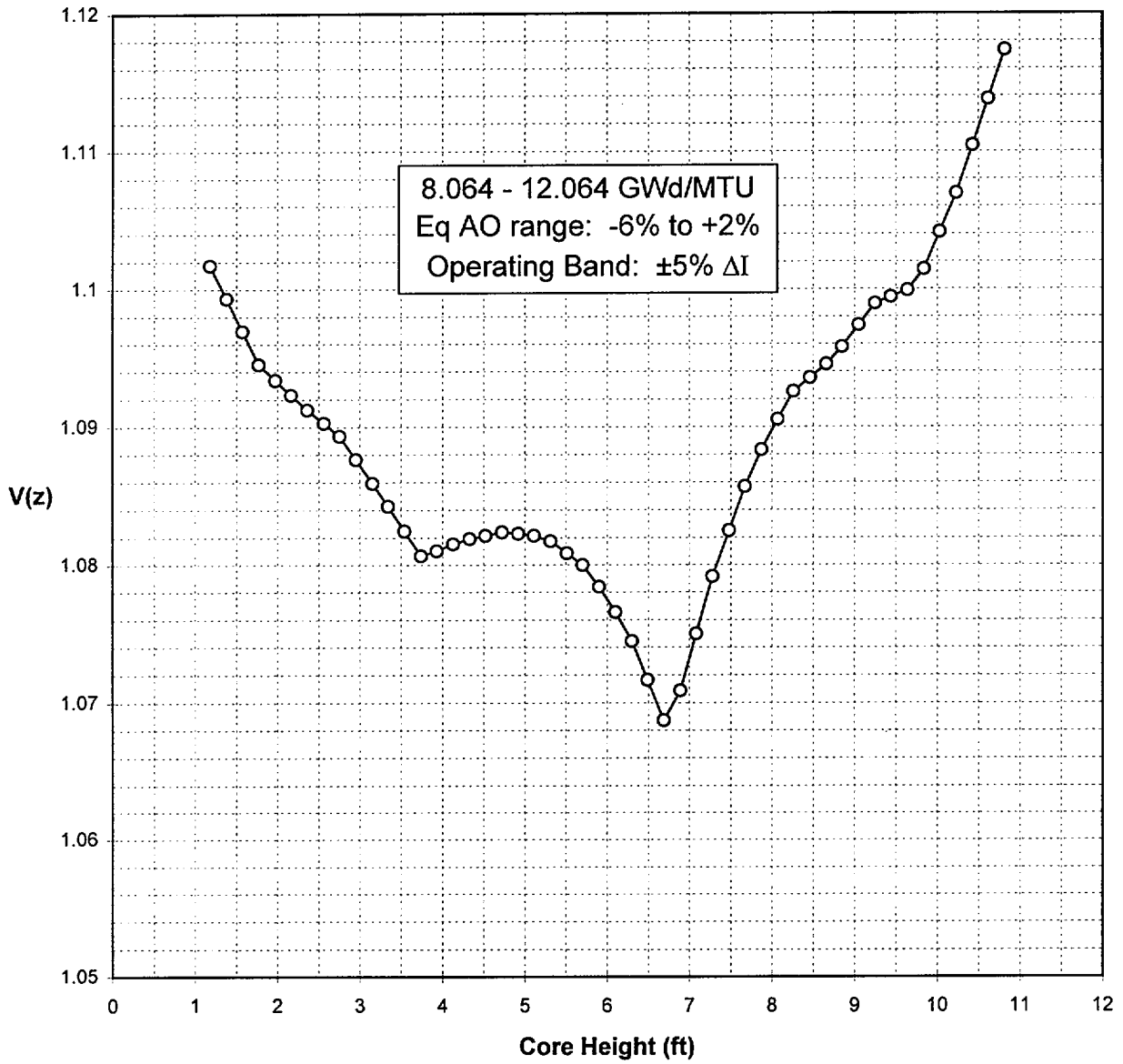

Figure 2d: Bounding V(z) Values From 8.064 - 12.064 GWd/MTU

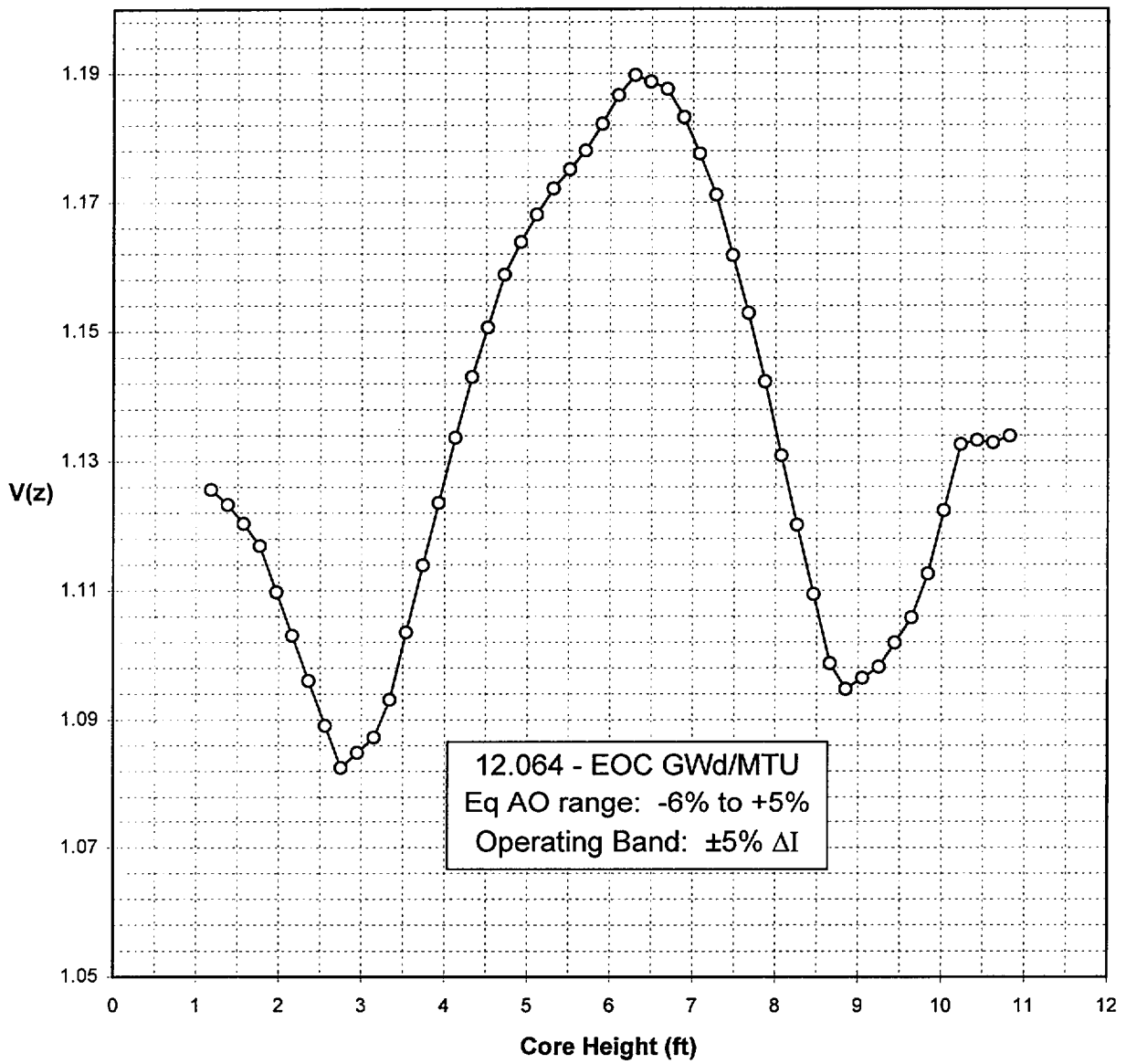

Figure 2e: Bounding V(z) Values From 12.064 - EOC GWd/MTU

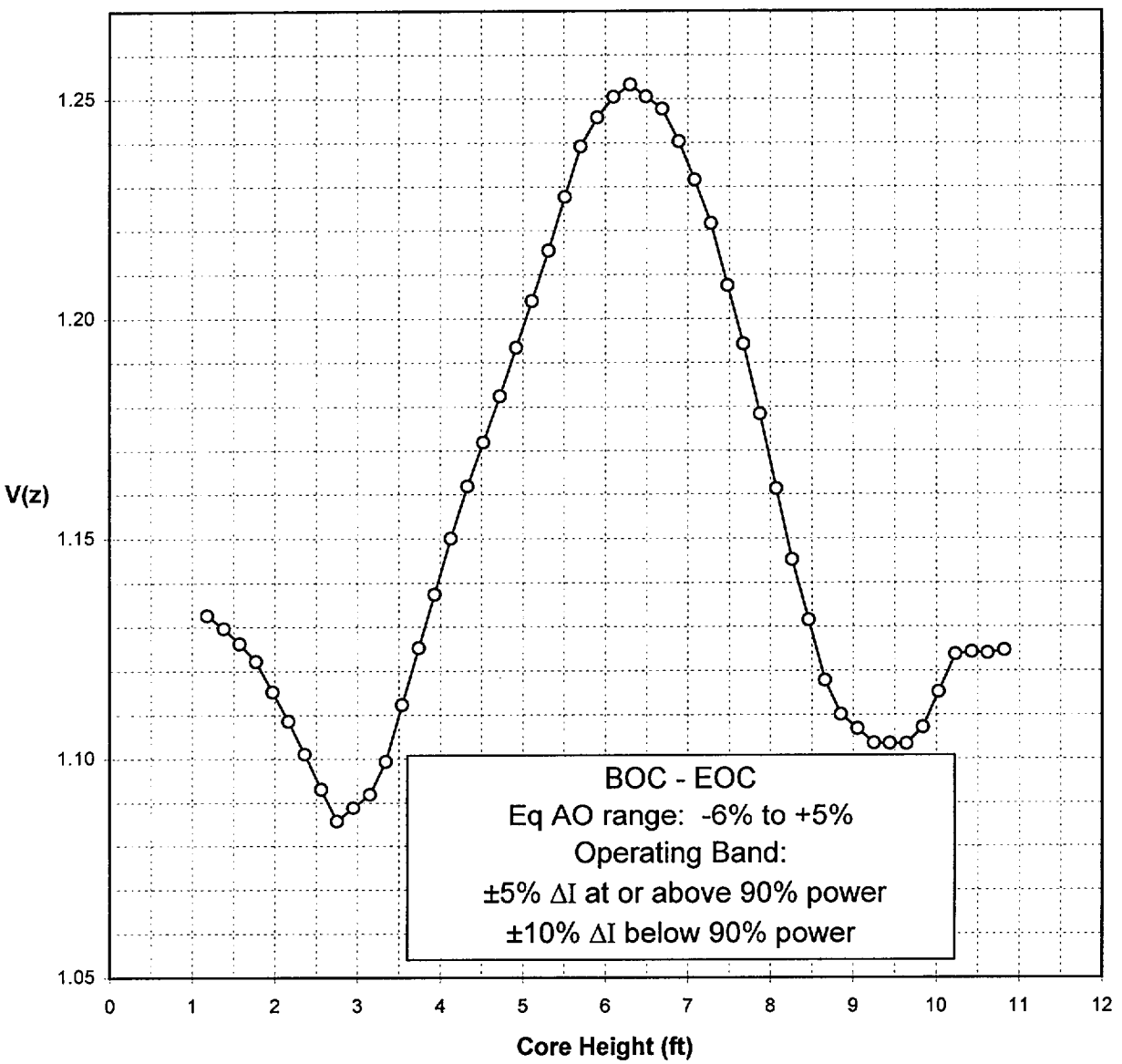

Figure 2f: Bounding V(z) Values
2 Tier band
BOC - EOC

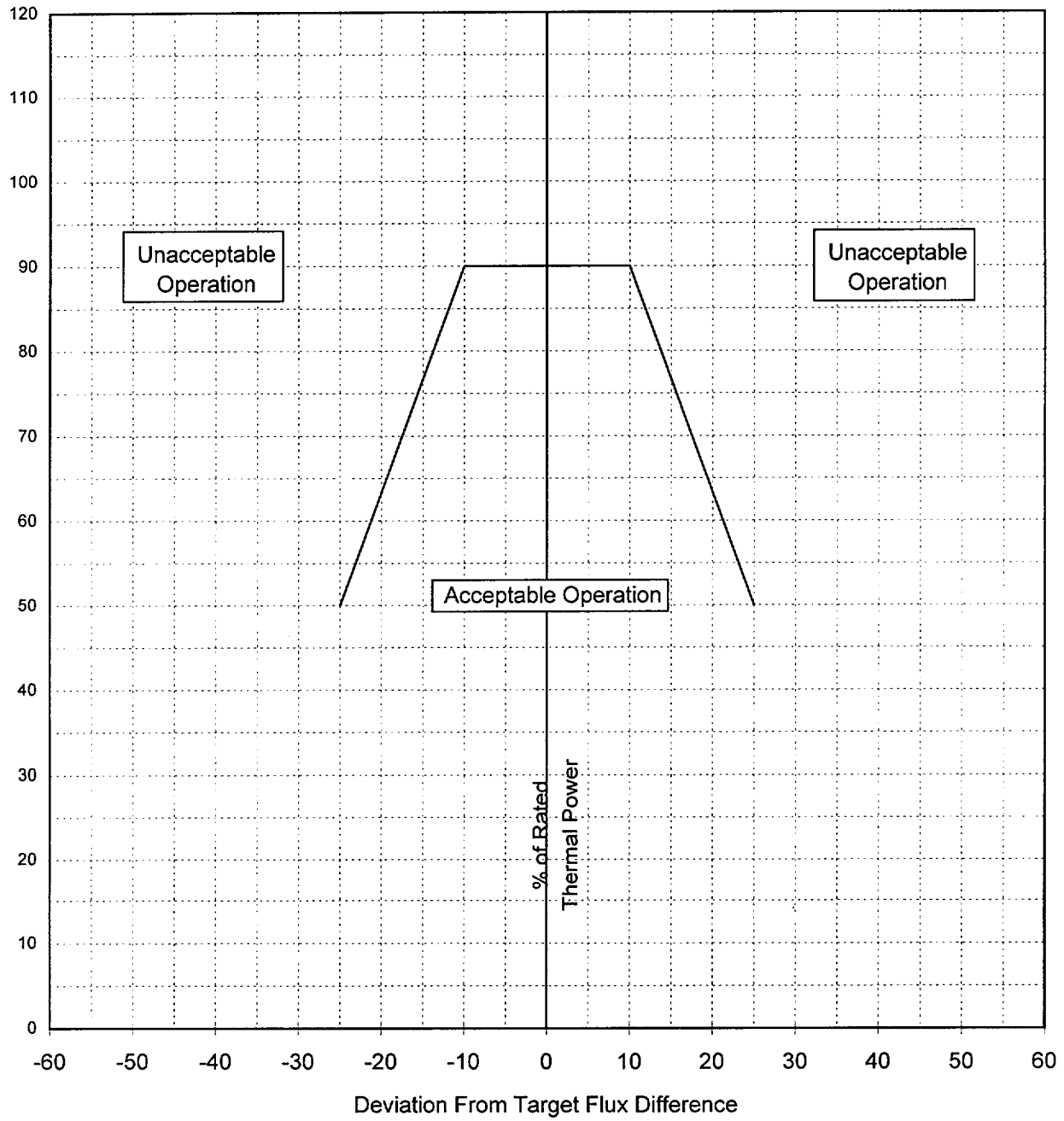

Figure 3: Deviation From Target Flux Difference as a Function of Thermal Power

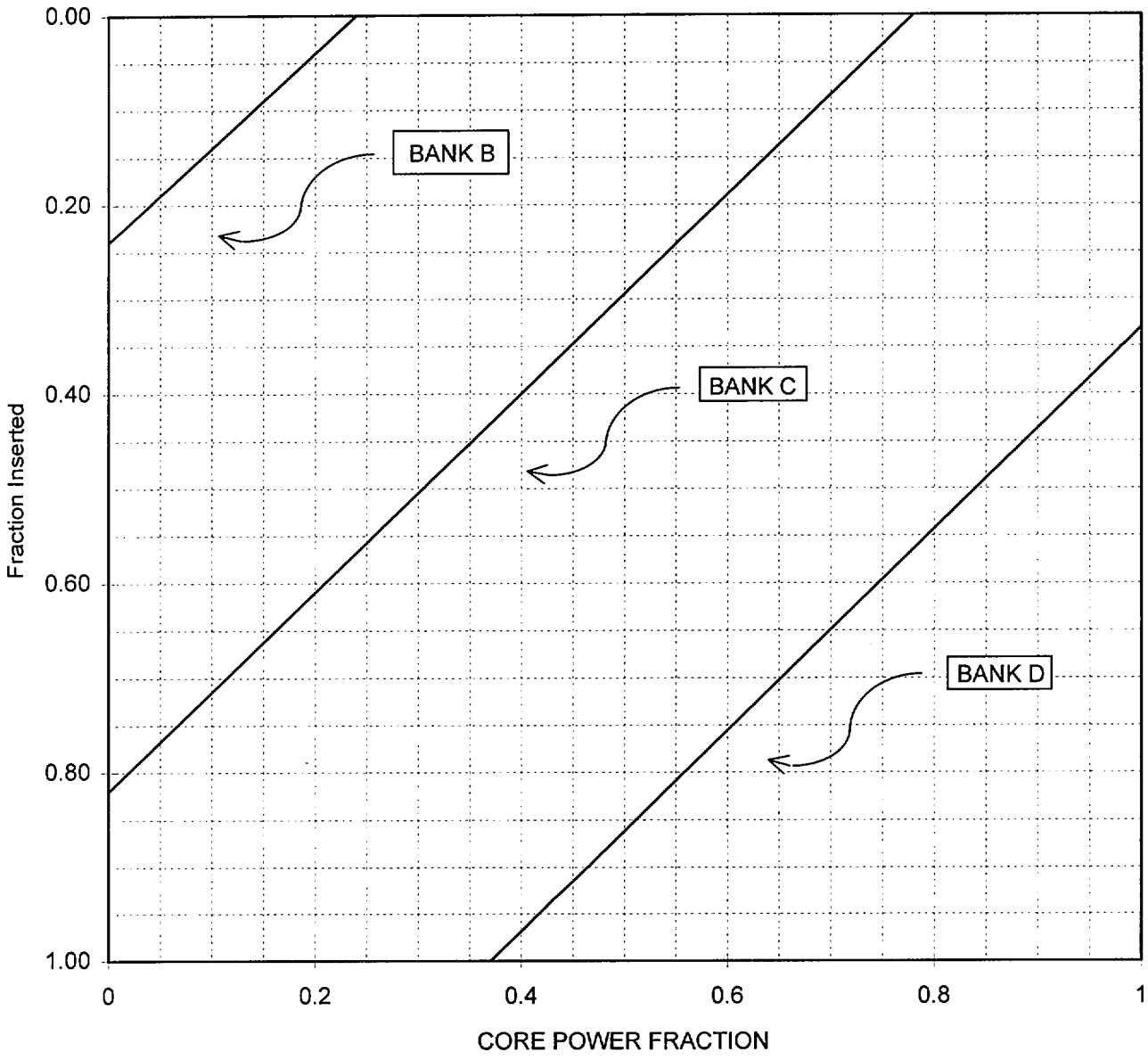

Figure 4: Control Bank Insertion Limits

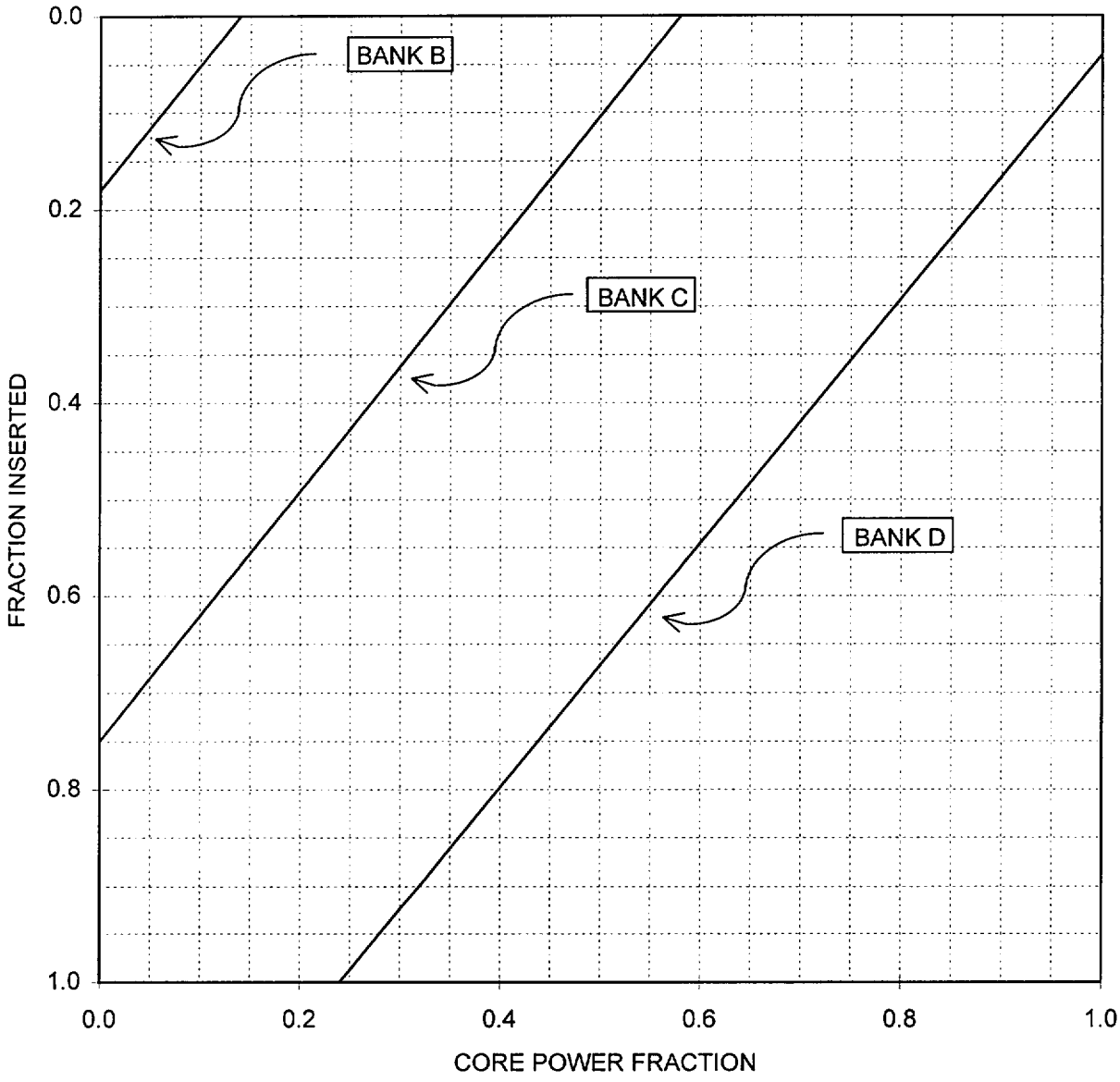

Figure 5: Insertion Limits
100 Step Overlap With One Bottomed Rod
(Technical Specification 3.10.G.3)

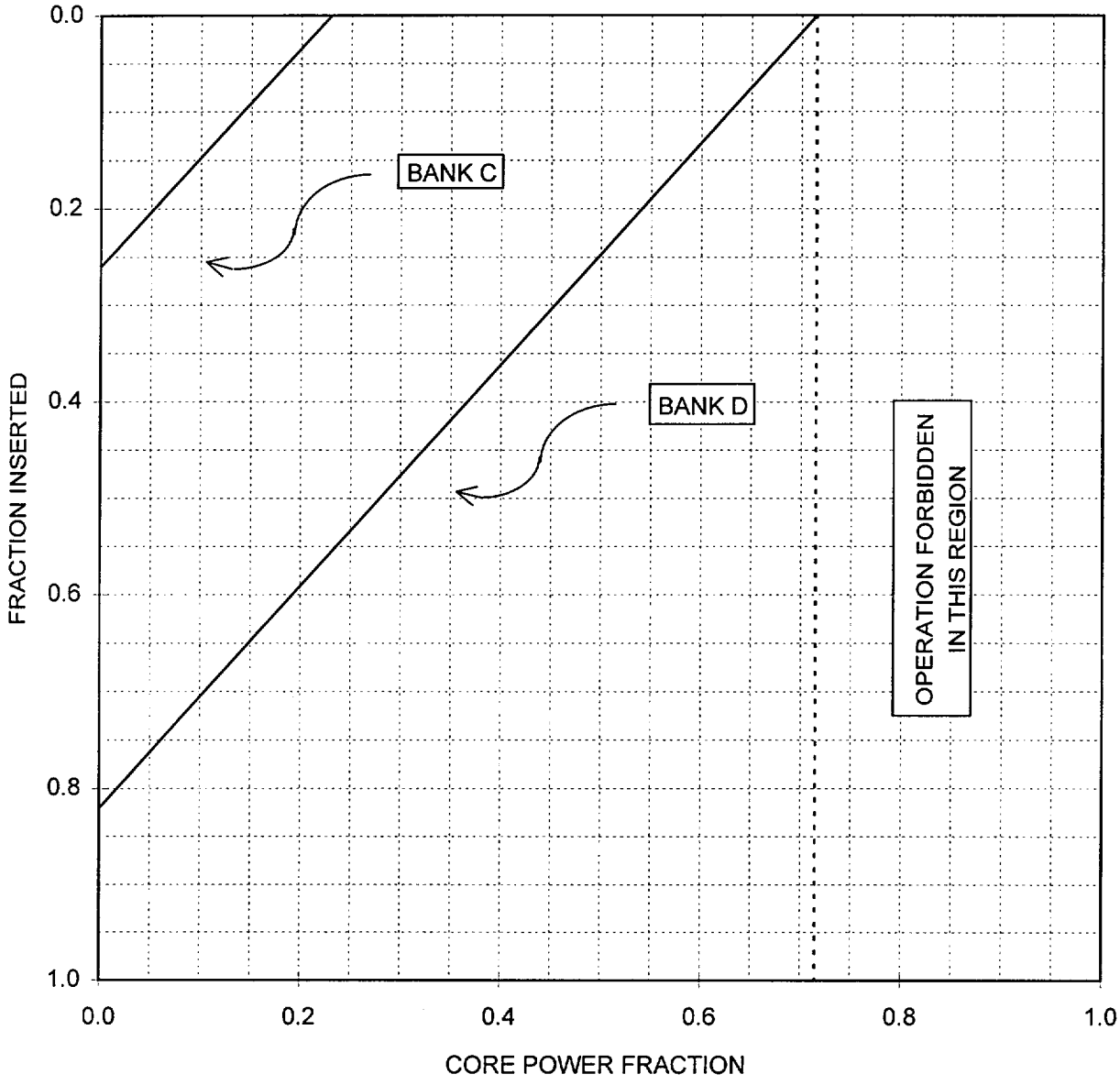

Figure 6: Insertion Limits
100 Step Overlap With One Inoperable Rod
(Technical Specification 3.10.G.4)

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