TRM 2.1

Kewaunee Nuclear Power Plant

CORE OPERATING LIMITS REPORT (COLR)

CYCLE 25

REVISION 0

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Kewaunee Nuclear Power Plant (KNPP) has been prepared in accordance with the requirements of Technical Specification (TS) 6.9.4.

A cross-reference between the COLR sections and the KNPP Technical Specifications affected by this report is given below:

COLR Section	KNPP TS	Description
2.1	2.1	Reactor Core Safety Limits
2.2	3.10.a	Shutdown Margin
2.3	3.1.f.3	Moderator Temperature Coefficient
2.4	3.10.d.1	Shutdown Bank Insertion Limit
2.5	3.10.d.2	Control Bank Insertion Limits
2.6	3.10.b.1.A 3.10.b.4 3.10.b.5.C.i	Heat Flux Hot Channel Factor ($F_Q(Z)$)
2.7	3.10.b.1.B	Nuclear Enthalpy Rise Hot Channel Factor ($F^N H$)
2.8	3.10.b.9 3.10.b.11.A	Axial Flux Difference (AFD)
2.9	2.3.a.3.A	Overtemperature ΔT Setpoint
2.10	2.3.a.3.B	Overpower ΔT Setpoint
2.11	3.10.k 3.10.l 3.10.m.1	RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits
2.12	3.8.a.5	Refueling Boron Concentration
Figure 1		Safety Limits-Reactor Core
Figure 2		Required Shutdown Margin
Figure 3		K(Z) Normalized Operating Envelope
Figure 4		Control Bank Insertion Limits
Figure 5		V(Z) as a Function of Core Height

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 6.9.a.4

2.1 Reactor Core Safety Limits

The combination of rated power level, coolant pressure, and coolant temperature shall not exceed the limits shown in COLR Figure 1. The safety limit is exceeded if the point defined by the combination of Reactor Coolant System average temperature and power level is at any time above the appropriate pressure line

2.2 Shutdown Margin

2.2.1 When the reactor is subcritical prior to reactor startup, the SHUTDOWN margin shall be at least that shown in COLR Figure 2.

2.3 Moderator Temperature Coefficient

2.3.1 When the reactor is critical and ≤ 60% RATED POWER, the moderator temperature coefficient shall be ≤ 5.0 pcm/°F, except during LOW POWER PHYSICS TESTING. When the reactor is > 60% RATED POWER, the moderator temperature coefficient shall be zero or negative.

2.3.2 The reactor will have a moderator temperature coefficient no less negative than -8 pcm/°F for 95% of the cycle time at full power.

2.4 Shutdown Bank Insertion Limit

2.4.1 The shutdown rods shall be fully withdrawn when the reactor is critical or approaching criticality

2.5 Control Bank Insertion Limit

2.5.1 The control banks shall be limited in physical insertion; insertion limits are shown in COLR Figure 4

2.6 Nuclear Heat Flux Hot Channel Factor ($F_Q^N(Z)$)

2.6.1 $F_Q^N(Z)$ Limits for FRA-ANP Fuel

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.35)/P \times K(Z)$ for $P > 0.5$ **[Hvy]**

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (4.70) \times K(Z)$ for $P \leq 0.5$ **[Hvy]**

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.28)/P \times K(Z)$ for $P > 0.5$ **[Std]**

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (4.56) \times K(Z)$ for $P \leq 0.5$ **[Std]**

where:

P is the fraction of full power at which the core is OPERATING

K(Z) is the function given in Figure 3

Z is the core height location for the F_Q of interest

2.6.2 The measured $F_Q^{EQ}(Z)$ hot channel factors under equilibrium conditions shall satisfy the following relationship for the central axial 80% of the core for FRA-ANP fuel:

$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times V(Z) \leq (2.35)/P \times K(Z)$ **[Hvy]**

$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times V(Z) \leq (2.28)/P \times K(Z)$ **[Std]**

where:

P is the fraction of full power at which the core is OPERATING

V(Z) is defined in COLR Figure 5

$F_Q^{EQ}(Z)$ is a measured F_Q distribution obtained during the target flux determination

2.6.3 The penalty factor for TS 3.10.b.5.C.i shall be 2%.

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

2.7.1 $F_{\Delta H}^{N}$ Limits for FRA-ANP Fuel

$F_{\Delta H}^{N} \times 1.04 \leq 1.70\ [1 + 0.2(1-P)]$ **[Hvy]**

$F_{\Delta H}^{N} \times 1.04 \leq 1.55\ [1 + 0.2(1-P)]$ **[Std]**

where:

P is the fraction of full power at which the core is OPERATING

2.8 Axial Flux Difference (AFD)

2.8.1 The indicated axial flux target band shall be the area maintained within ± 5% about the target flux difference.

2.8.2 The envelope is an area whose outer limits are described by -10% and +10% from the target axial flux difference at 90% rated power and increasing by -1% and +1% from the target axial flux difference for each 2.7% decrease in rated power < 90% and > 50%.

2.9 Overtemperature ΔT Setpoint

Overtemperature ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, %
T	=	Average temperature, °F
T'	=	567.3 °F
P	=	Pressurizer Pressure, psig
P′	=	2235 psig
K_1	=	1.11
K_2	=	0.0090
K_3	=	0.000566
τ_1	=	30 seconds
τ_2	=	4 seconds
f(ΔI)	=	An even function of the indicated difference between top and bottom detectors of the power range nuclear ion chambers. Selected gains are based on measured instrument response during plant startup tests, where q_t and q_b are the percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of RATED POWER, such that

(a) For $q_t - q_b$ within -12, +9 %, f(ΔI) = 0

(b) For each percent that the magnitude of $q_t - q_b$ exceeds +9 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 2.5 % of RATED POWER.

(c) For each percent that the magnitude of $q_t - q_b$ exceed -12 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 1.5 % of RATED POWER.

2.10 Overpower ΔT Setpoint

Overpower ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, %
T	=	Average temperature, °F
T'	=	567.3 °F
K_4	≤	1.10
K_5	≥	0.0275 for increasing T; 0 for decreasing T
K_6	≥	0.002 for T > T′ ; 0 for T < T′
τ_3	=	10 seconds
f(ΔI)	=	Same as in 2.9

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

2.11.1 During steady state power operation, Tavg shall be < 568.8°F.

2.11.2 During steady state power operation, Pressurizer Pressure shall be > 2205 psig

2.11.3 During steady state power operation, reactor coolant flow rate shall be ≥ 93,000 gpm per loop.

2.12 Refueling Boron Concentration

2.12.1 When there is fuel in the reactor, a minimum boron concentration of 2200 ppm and a shutdown margin of ≥ 5% Δ k/k shall be maintained in the Reactor Coolant System during reactor vessel head removal or while loading and unloading fuel from the reactor.

Figure 1

Safety Limits-Reactor Core

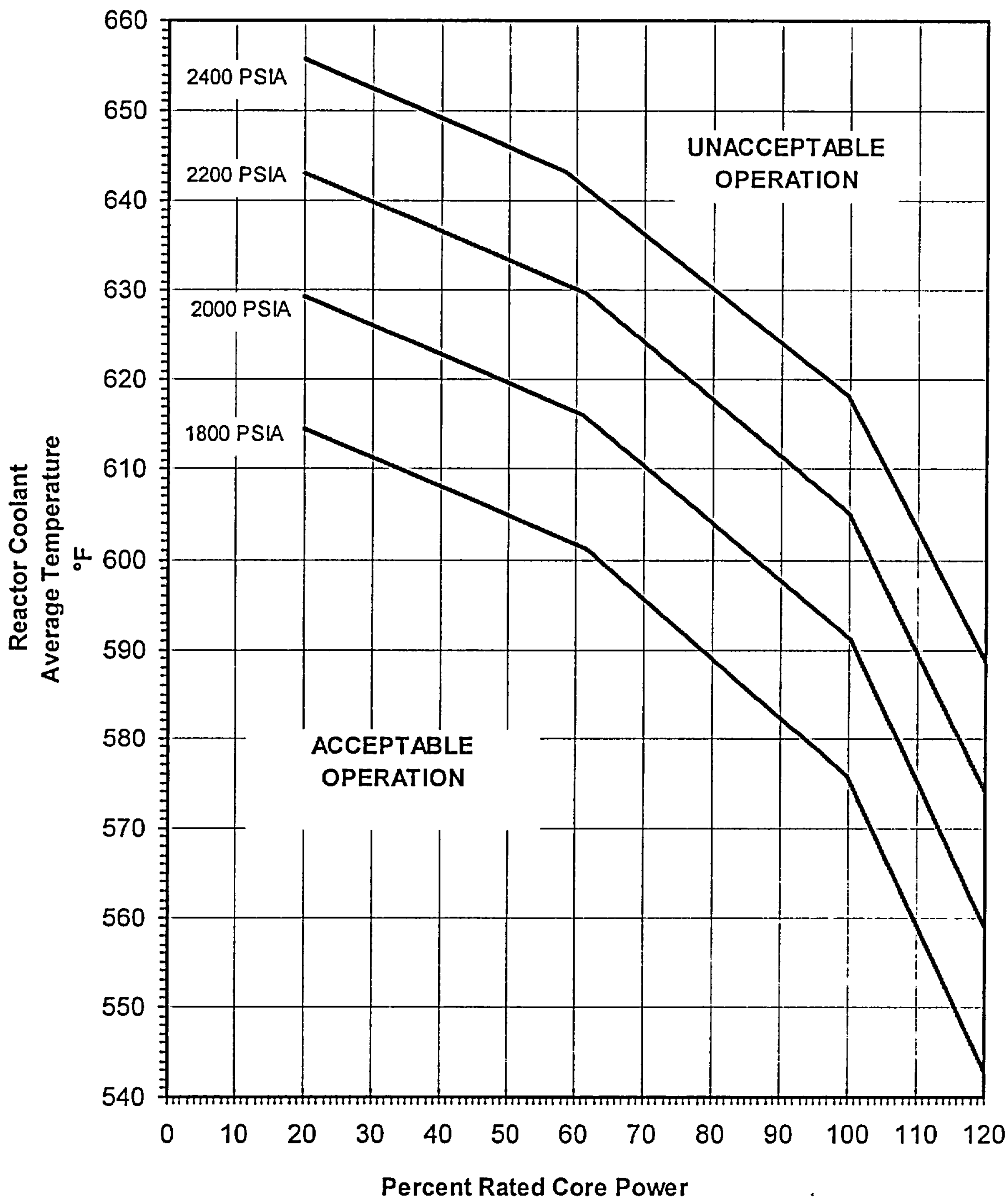

Figure 2

Required Shutdown Reactivity vs Boron Concentration

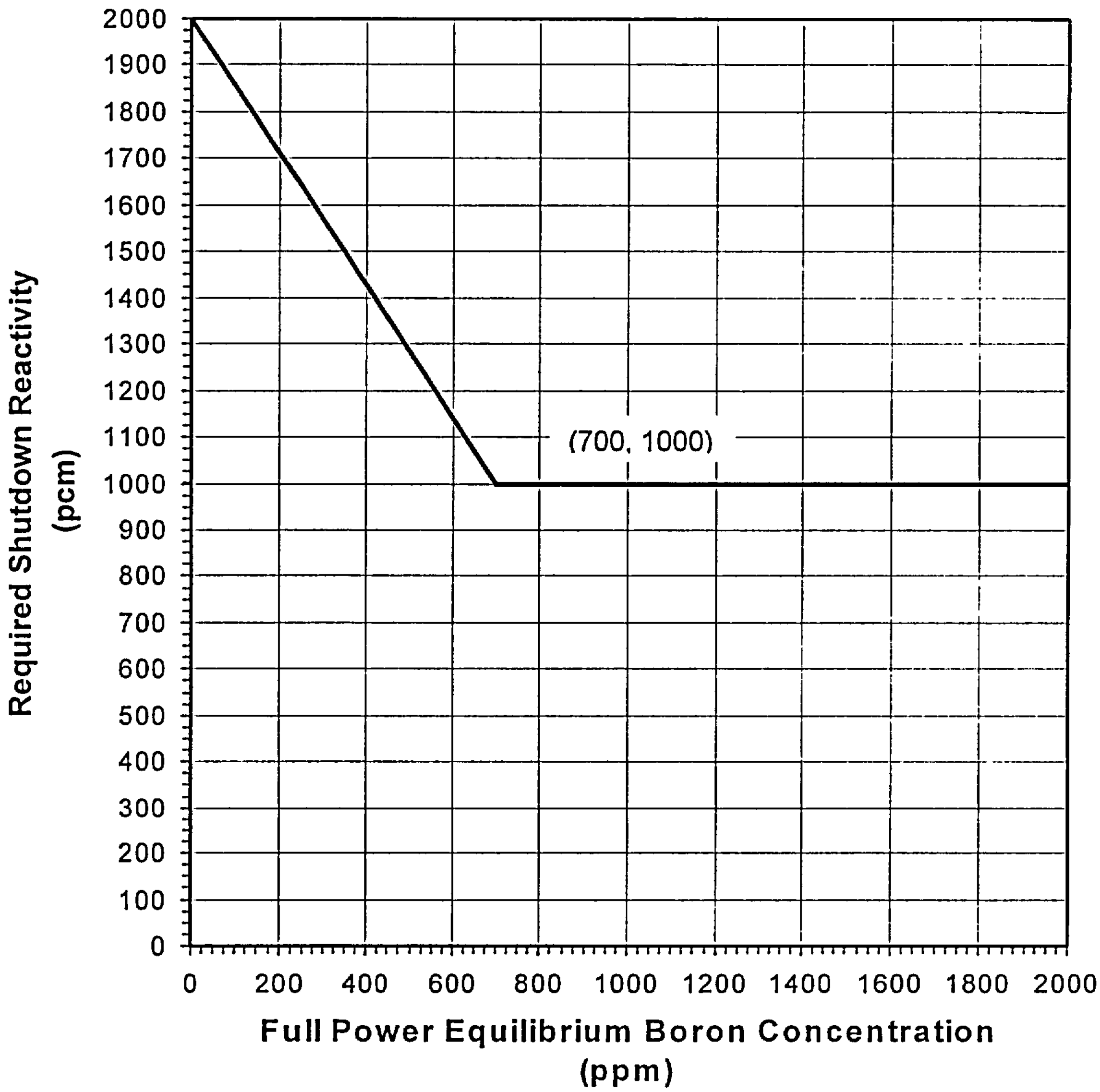

Figure 3

Hot Channel Factor Normalized Operating Envelope

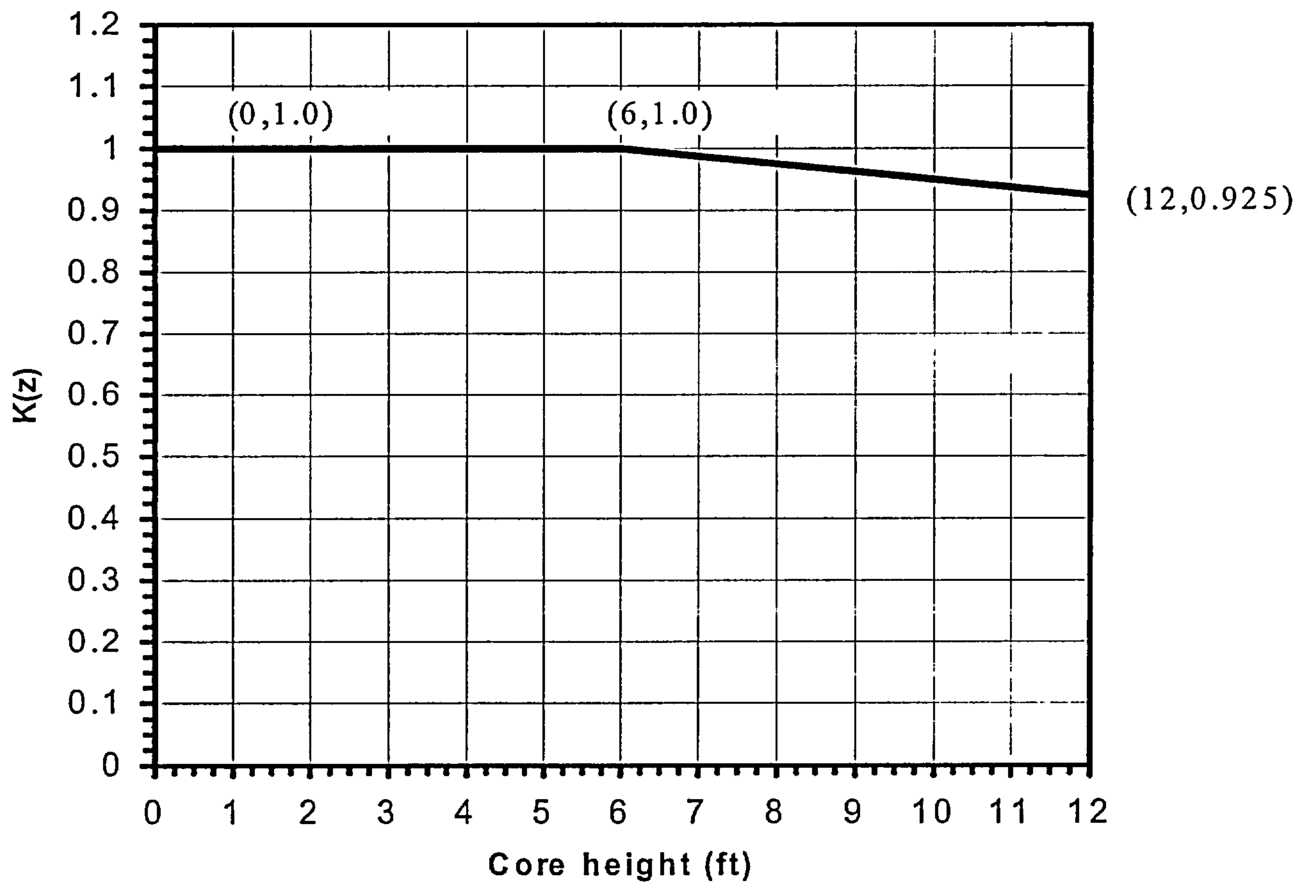

Figure 4

Control Bank Insertion Limits

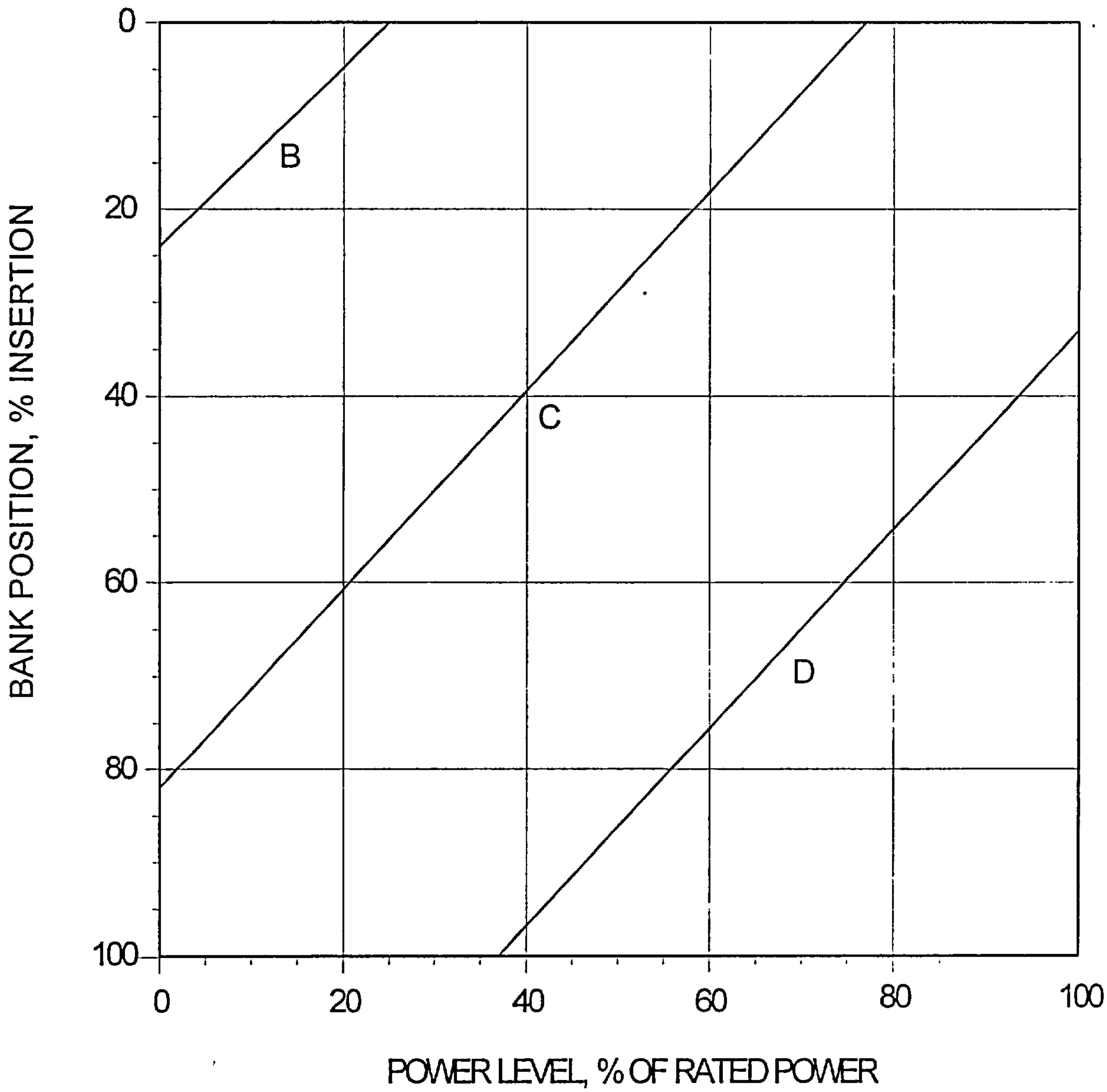

Figure 5

V(Z) as a Function of Core Height