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KEWAUNEE NUCLEAR POWER PLANT
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KEWAUNEE NUCLEAR POWER PLANT - CORE OPERATING LIMITS REPORT (COLR), CYCLE 26, REVISION 0

In accordance with the requirements of Technical Specification 6.9.a.4, enclosed is Revision 0 of the Cycle 26, Core Operating Limits Report (COLR).

If you have any questions, please contact Mr. Gerald Riste at (920) 388-8424.

This letter contains no new commitments and no revisions to existing commitments.

KA Kaoza For

Thomas Coutu
Site Vice-President, Kewaunee Plant

GOR

cc US NRC, Region III
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Enclosure – KNPP Core Operating Limits Report

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TRM 2.1

Kewaunee Nuclear Power Plant

CORE OPERATING LIMITS REPORT (COLR)

CYCLE 26

REVISION 0

Approved	*[signature]*	4/16/03	03-062
	PORC Chariman	Date	Mtg.#

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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
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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 Figures 1a (1650 MWt) and 1b (1673 MWt). 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 (≥ 224 steps and ≤ 231 steps) 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 Fuel

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.35)/P \times K(Z)$ for $P > 0.5$	[FRA-ANP **Hvy]**
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (4.70) \times K(Z)$ for $P \leq 0.5$	[FRA-ANP **Hvy]**
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.28)/P \times K(Z)$ for $P > 0.5$	[FRA-ANP **Std]**
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (4.56) \times K(Z)$ for $P \leq 0.5$	[FRA-ANP **Std]**
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.50)/P \times K(Z)$ for $P > 0.5$	**[422 V+]**
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (5.00) \times K(Z)$ for $P \leq 0.5$	**[422 V+]**

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 fuel:

$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times W(Z) \leq (2.35)/P \times K(Z)$	[FRA-ANP **Hvy]**
$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times W(Z) \leq (2.28)/P \times K(Z)$	[FRA-ANP **Std]**
$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times W(Z) \leq (2.5)/ P \times K(Z)$	**[422 V +]**

where:

- P is the fraction of full power at which the core is OPERATING
- W(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.6.C.i provided in Figure 6 shall be used. The penalty factor for all burnups outside the range of Figure 6 shall be 2%.

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

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

$F_{\Delta H}^{N} \times 1.04 \leq 1.58\,[1+ 0.3(1-P)]$ [FRA-ANP **Hvy]**

$F_{\Delta H}^{N} \times 1.04 \leq 1.70\,[1 + 0.3(1-P)]$ **[422 V+]**

$F_{\Delta H}^{N} \times 1.04 \leq 1.55\,[1 + 0.3(1-P)]$ [FRA-ANP **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 Axial Flux Difference (AFD) acceptable operation limits are provided in Figure 7.

2.9 Overtemperature ΔT Setpoint

Overtemperature ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, %
T	=	Average temperature, °F
T'	$\leq$	573.0 °F
P	=	Pressurizer Pressure, psig
P'	=	2235 psig
K_1	=	1.20
K_2	=	0.015/°F
K_3	=	0.00072/psig
τ_1	=	30 seconds
τ_2	=	4 seconds
$f(\Delta I)$	=	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 -22, +12 %, $f(\Delta I) = 0$

(b) For each percent that the magnitude of $q_t - q_b$ exceeds +12 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 0.96 % of RATED POWER.

(c) For each percent that the magnitude of $q_t - q_b$ exceed -22 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 4.00% of RATED POWER.

2.10 <u>Overpower ΔT Setpoint</u>

Overpower ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, %
T	=	Average temperature, °F
T'	$\leq$	573.0 °F
K_4	$\leq$	1.095
K_5	$\geq$	0.0275/°F for increasing T; 0 for decreasing T
K_6	$\geq$	0.00103/°F for $T > T'$; 0 for $T < T'$
τ_3	=	10 seconds
$f(\Delta I)$	=	0 for all ΔI

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

2.11.1 During steady state power operation, Tavg shall be < 576.7°F for control board indication or < 576.5°F for computer indication .

2.11.2 During steady state power operation, Pressurizer Pressure shall be > 2217 psig for control board indication or > 2219 psig for computer indication

2.11.3 During steady state power operation, reactor coolant total flow rate shall be ≥ 186,000 gpm.

2.12 Refueling Boron Concentration

2.12.1 When there is fuel in the reactor, a minimum boron concentration of 2426 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 1a

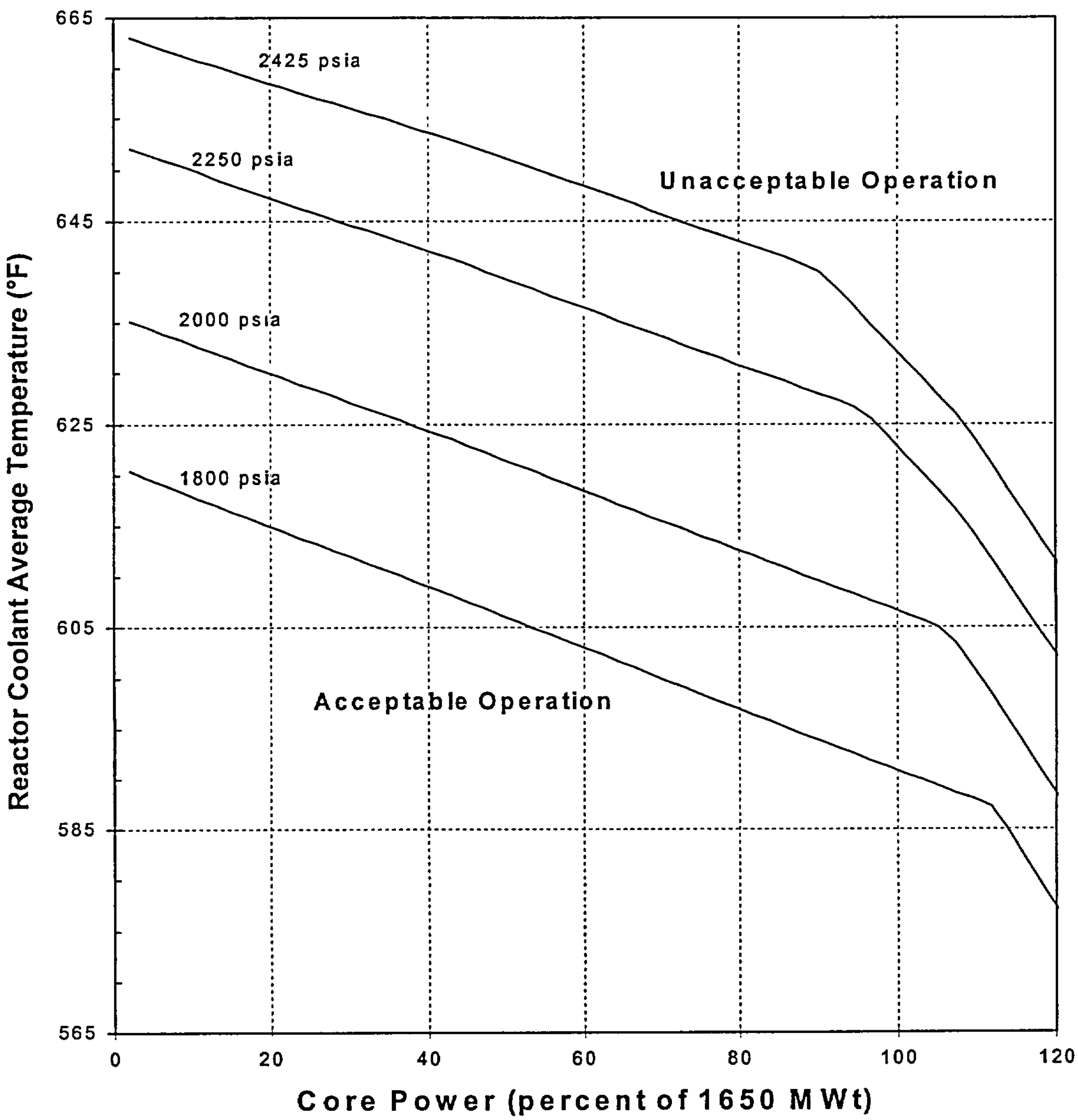

665
645
625
605
585
565
Reactor Coolant Average Temperature (°F)
2425 psia
2250 psia
2000 psia
1800 psia
Unacceptable Operation
Acceptable Operation
0
20
40
60
80
100
120
Core Power (percent of 1650 MWt)

Figure 1b

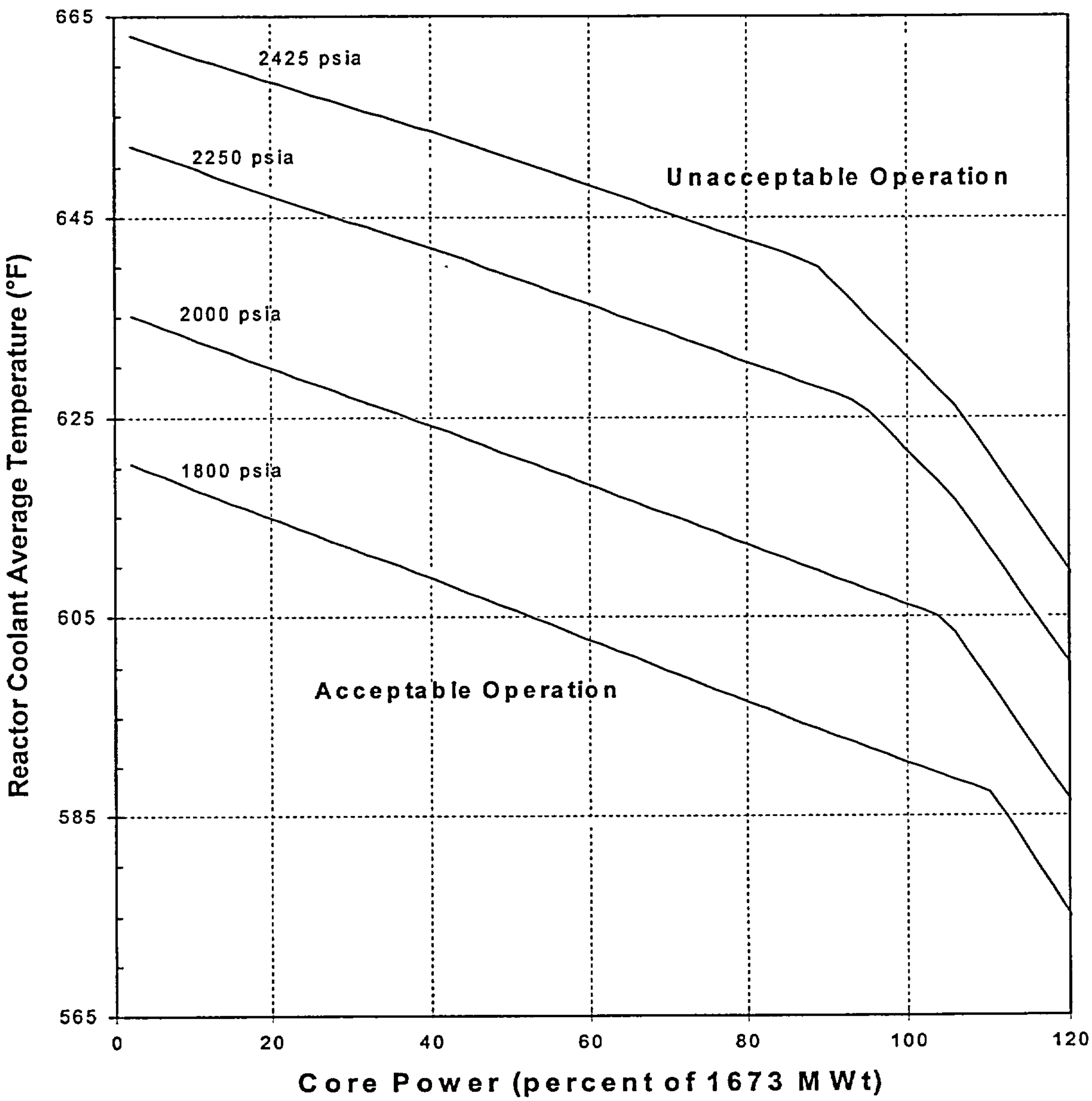

2425 psia
2250 psia
2000 psia
1800 psia
Unacceptable Operation
Acceptable Operation
665
645
625
605
585
565
0
20
40
60
80
100
120
Reactor Coolant Average Temperature (°F)
Core Power (percent of 1673 MWt)

Figure 2

Required Shutdown Reactivity vs. Boron Concentration

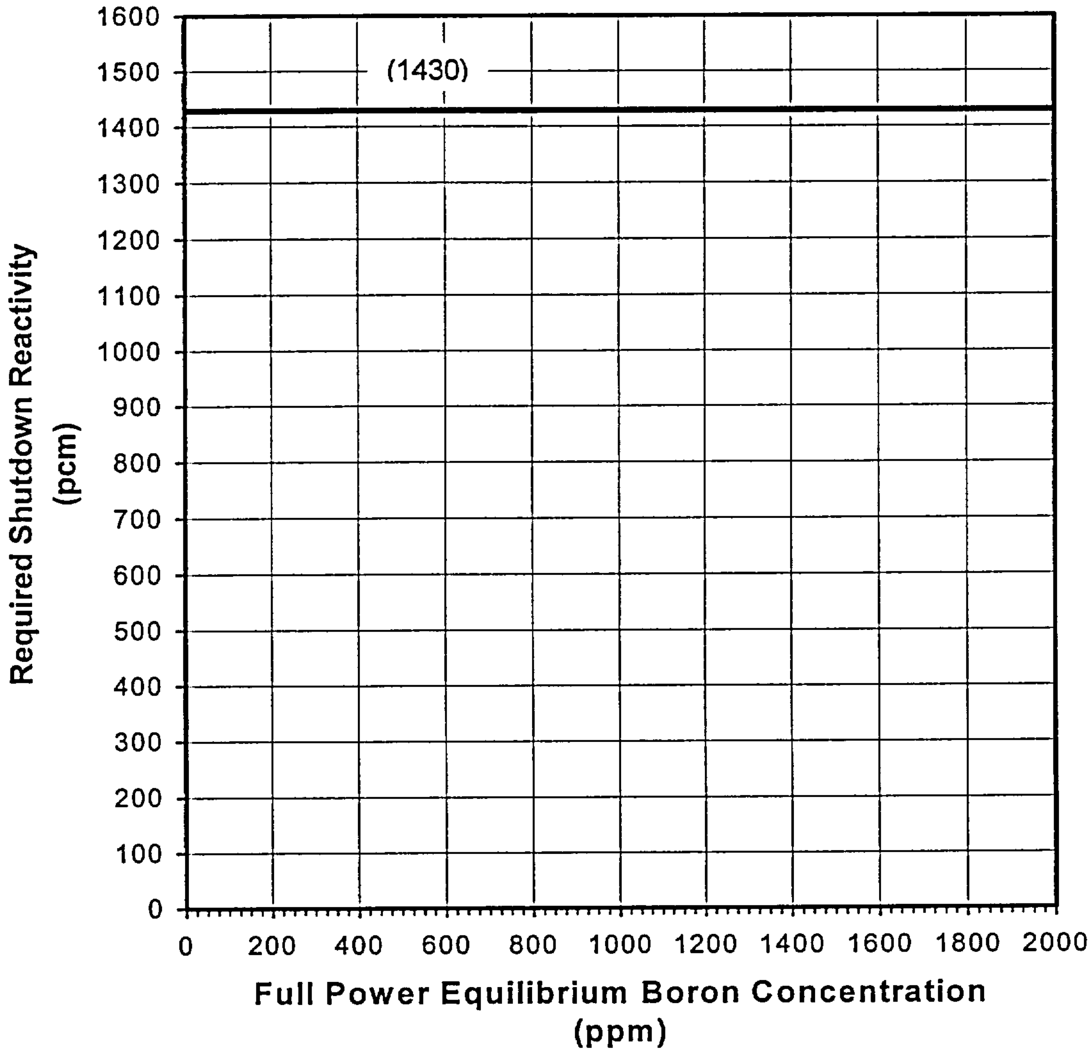


Figure 3

Hot Channel Factor Normalized Operating Envelope

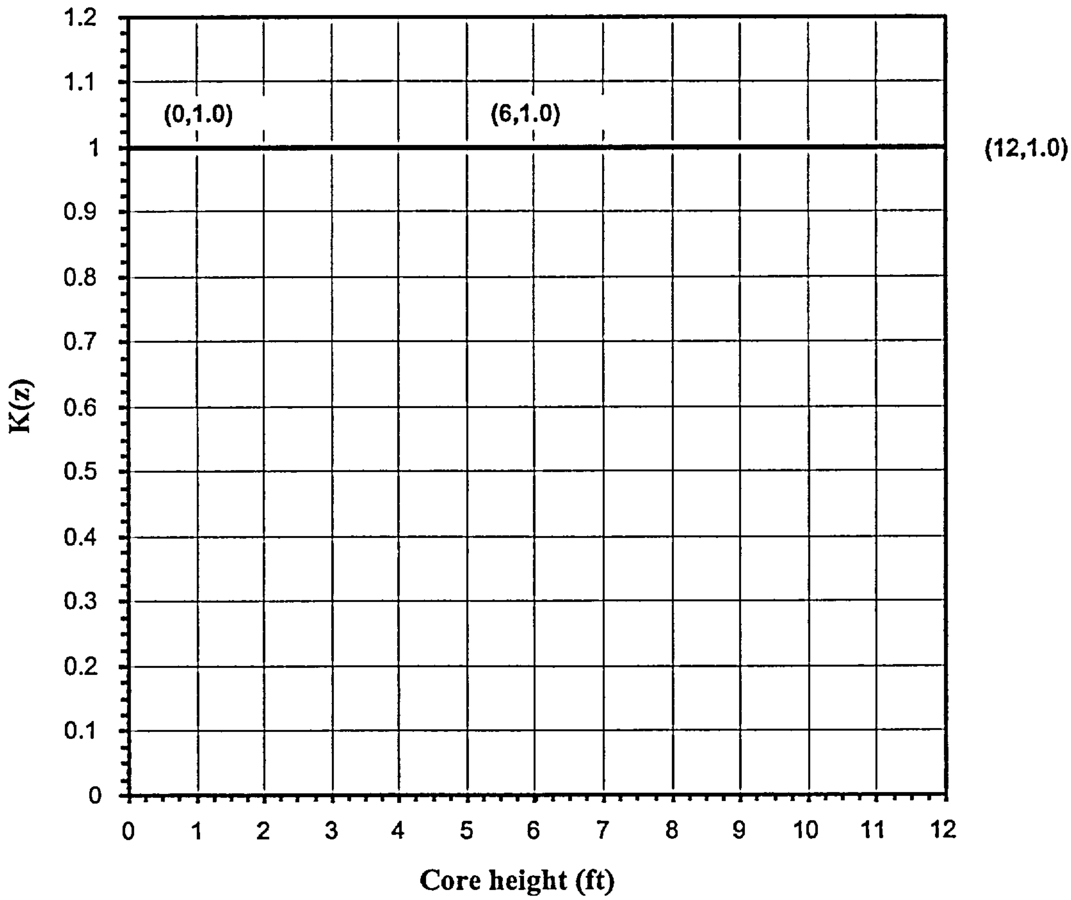
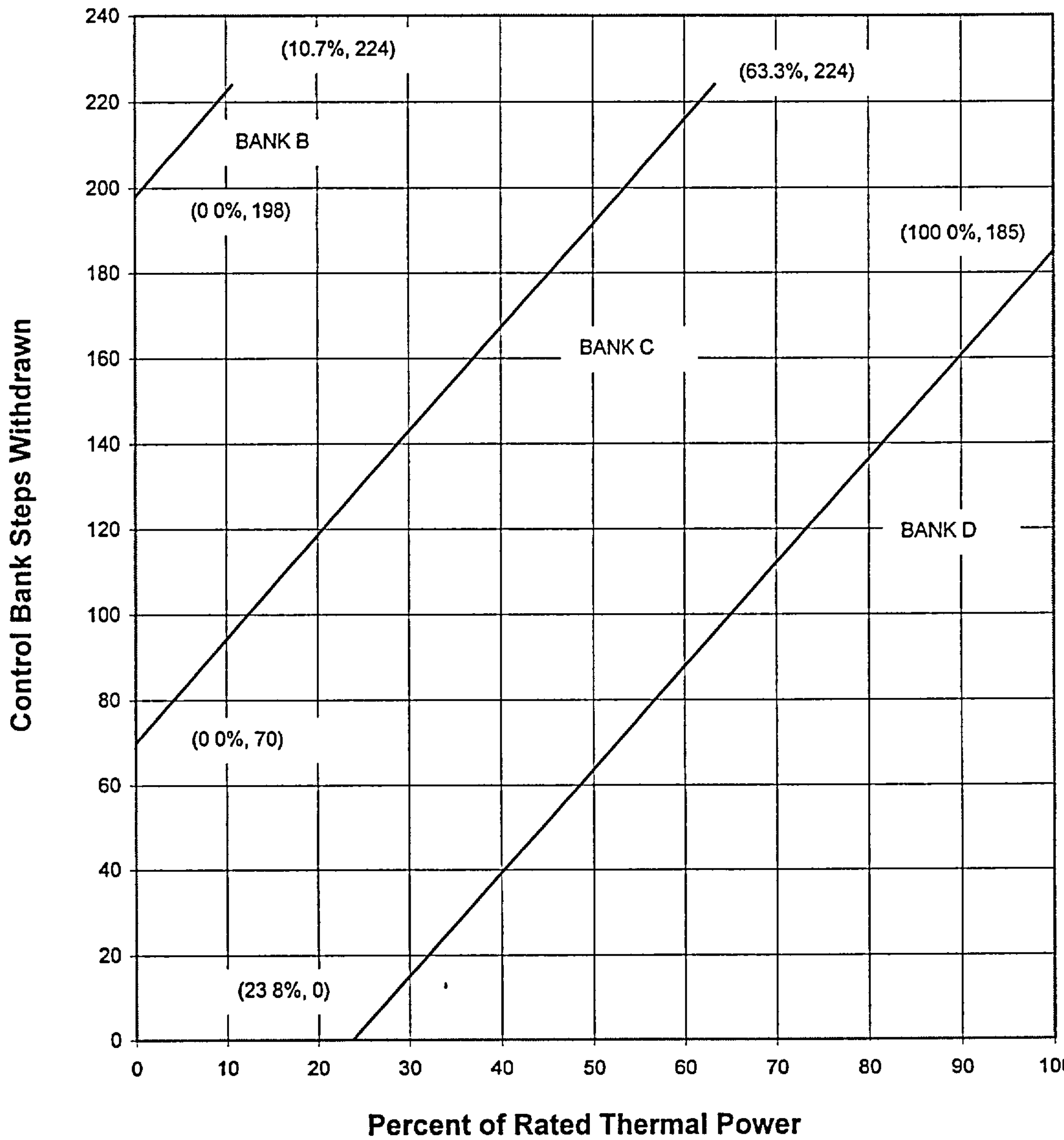


Figure 4

Control Bank Insertion Limits



Fully withdrawn shall be the condition where control rods are at a position within the interval ≥ 224 and ≤ 231 steps withdrawn.

Note: The Rod Bank Insertion Limits are based on a control bank tip-to-tip distance of 128 steps.

Figure 5a

RAOC Summary of W(Z) at 150 MWD/MTU

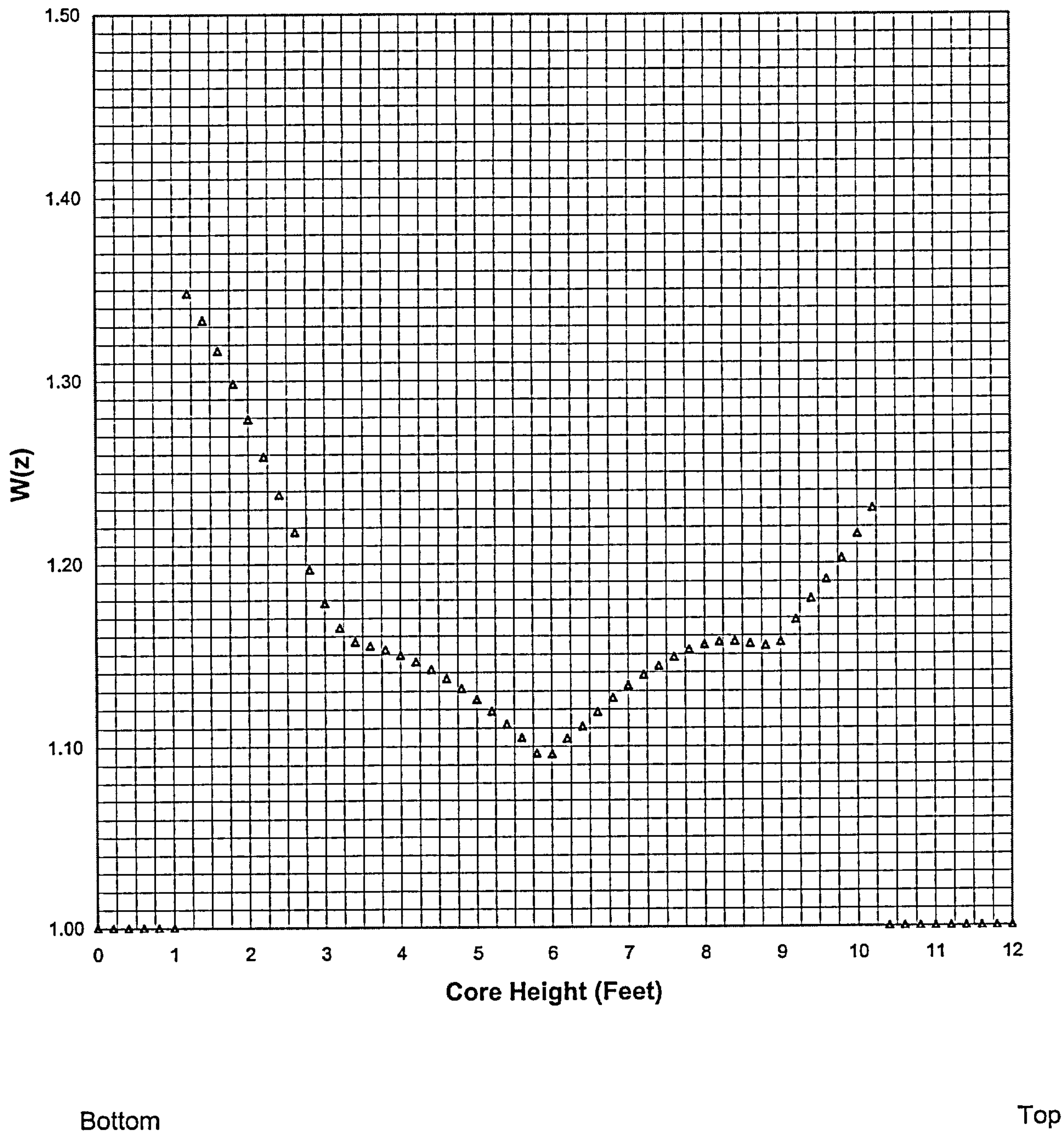


Figure 5b

RAOC Summary of W(Z) at 5000 MWD/MTU

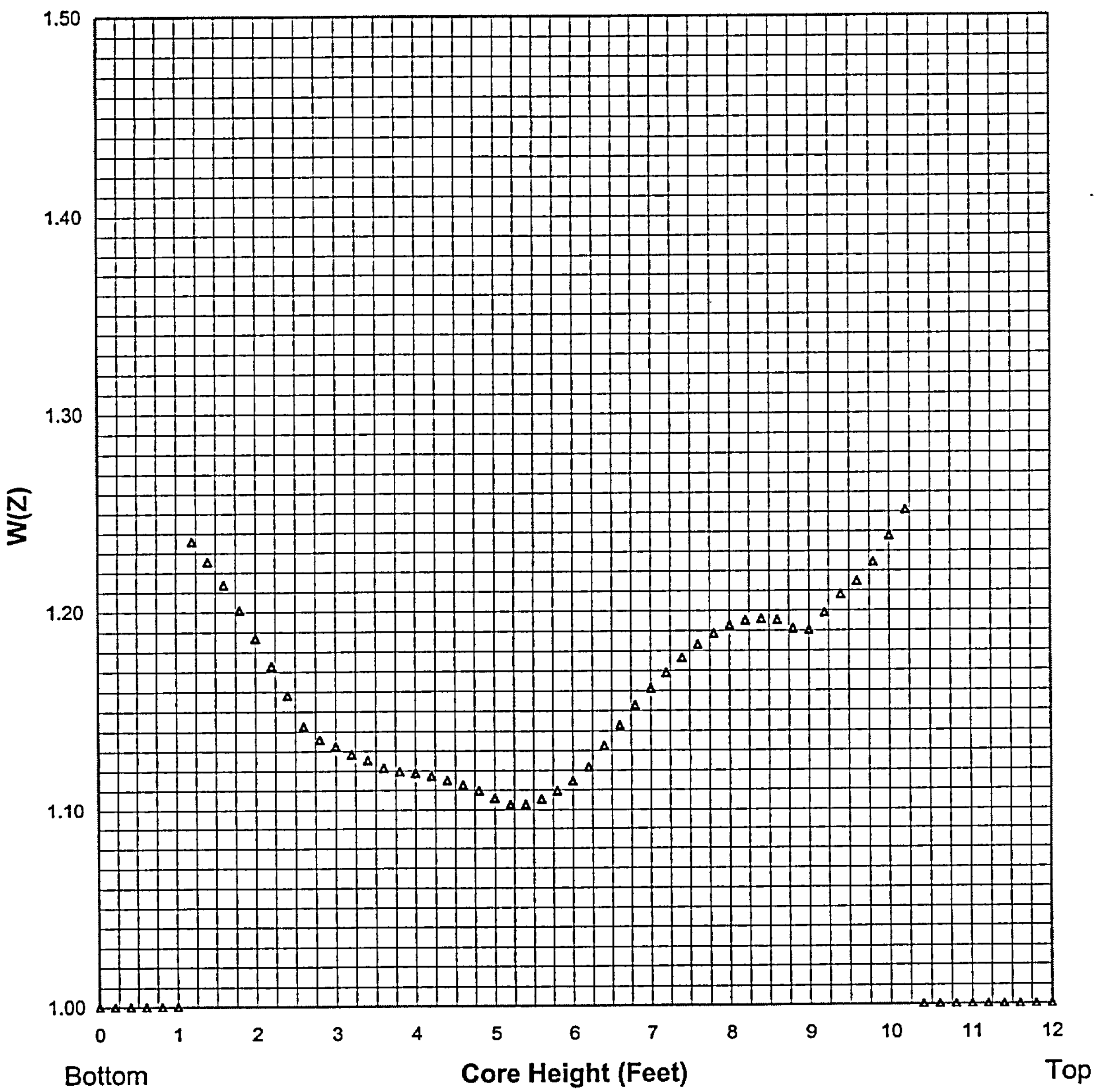


Figure 5c

RAOC Summary of W(Z) at 7000 MWD/MTU

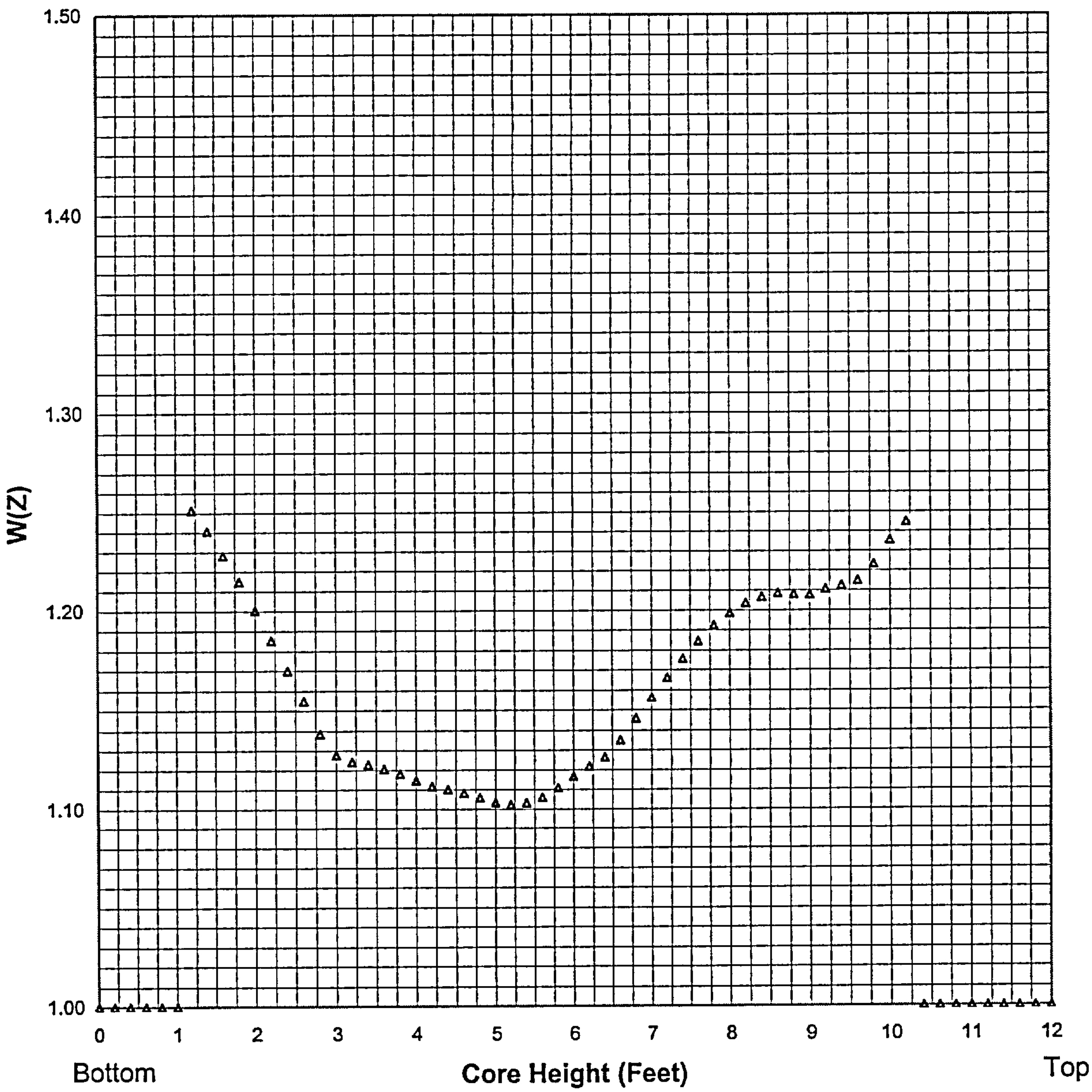


Figure 5d

RAOC Summary of W(Z) at 12000 MWD/MTU

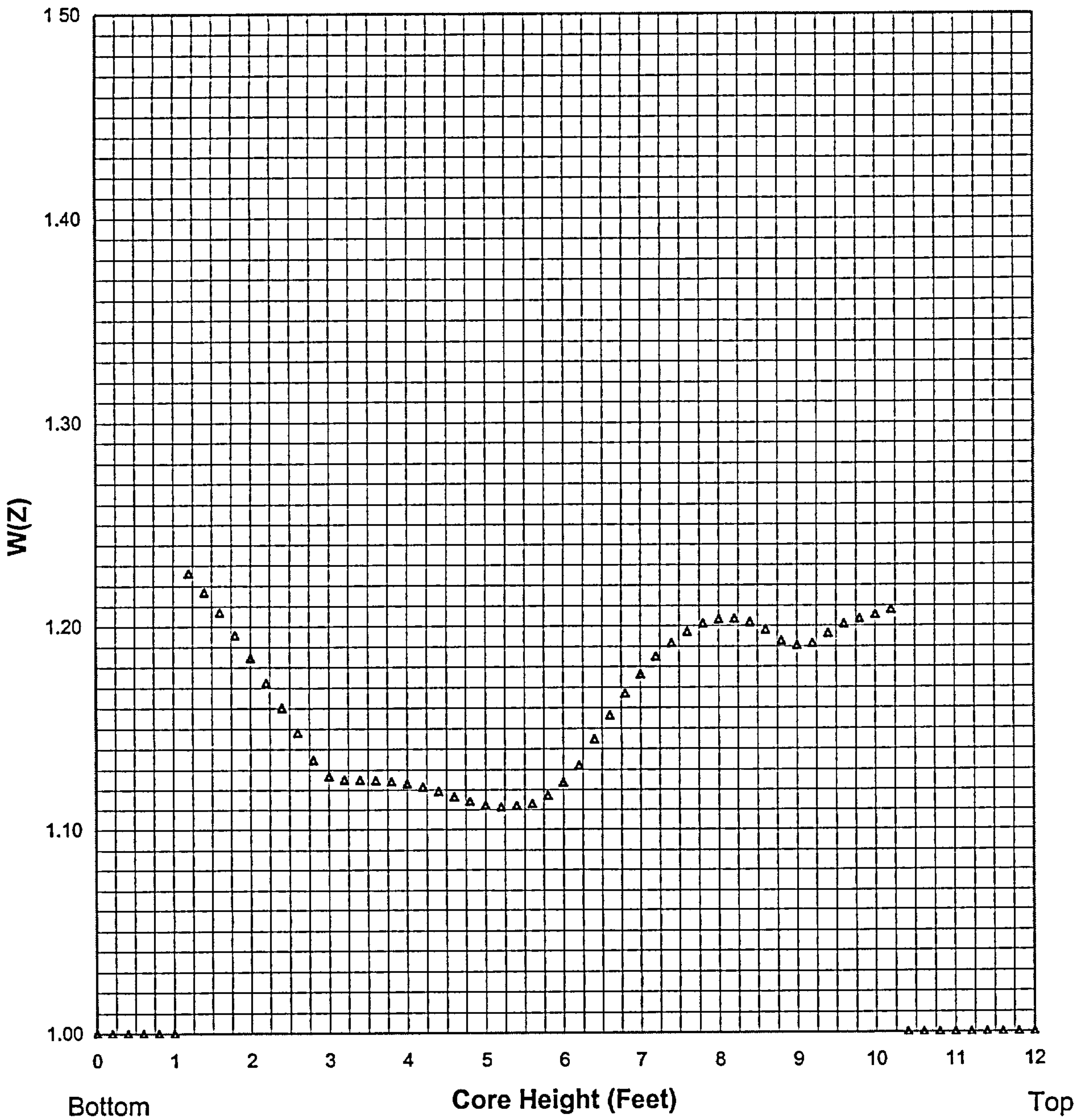


Figure 5e

RAOC Summary of W(Z) at 16000 MWD/MTU

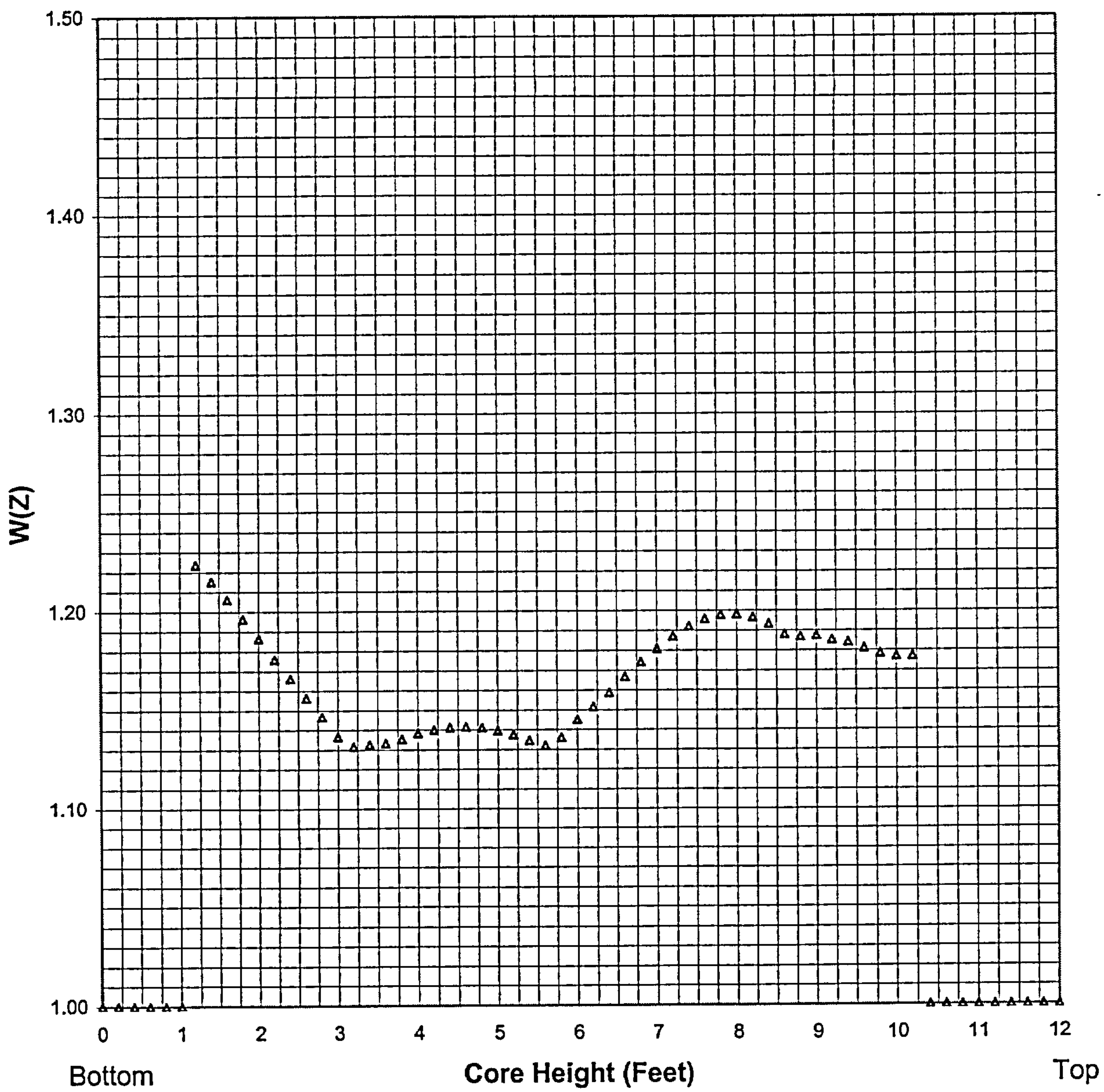


Figure 6

Penalty Factors in Excess of 2% per 31 EFPD

Cycle Burnup (MWD/MTU)	Penalty Factor
4742	2.00
4873	2.24
5004	2.44
5135	2.50
5266	2.62
5398	2.74
5529	2.82
5660	2.89
5791	2.94
5922	3.01
6053	3.01
6185	3.03
6316	2.95
6447	2.77
6578	2.57
6709	2.33
6841	2.06
6972	2.00

Note: Linear interpolation is adequate for intermediate cycle burnup.

All cycle burnups outside the range of the table shall use a 2% decrease in F_Q margin for compliance with the Surveillance.

Figure 7

Axial Flux Difference

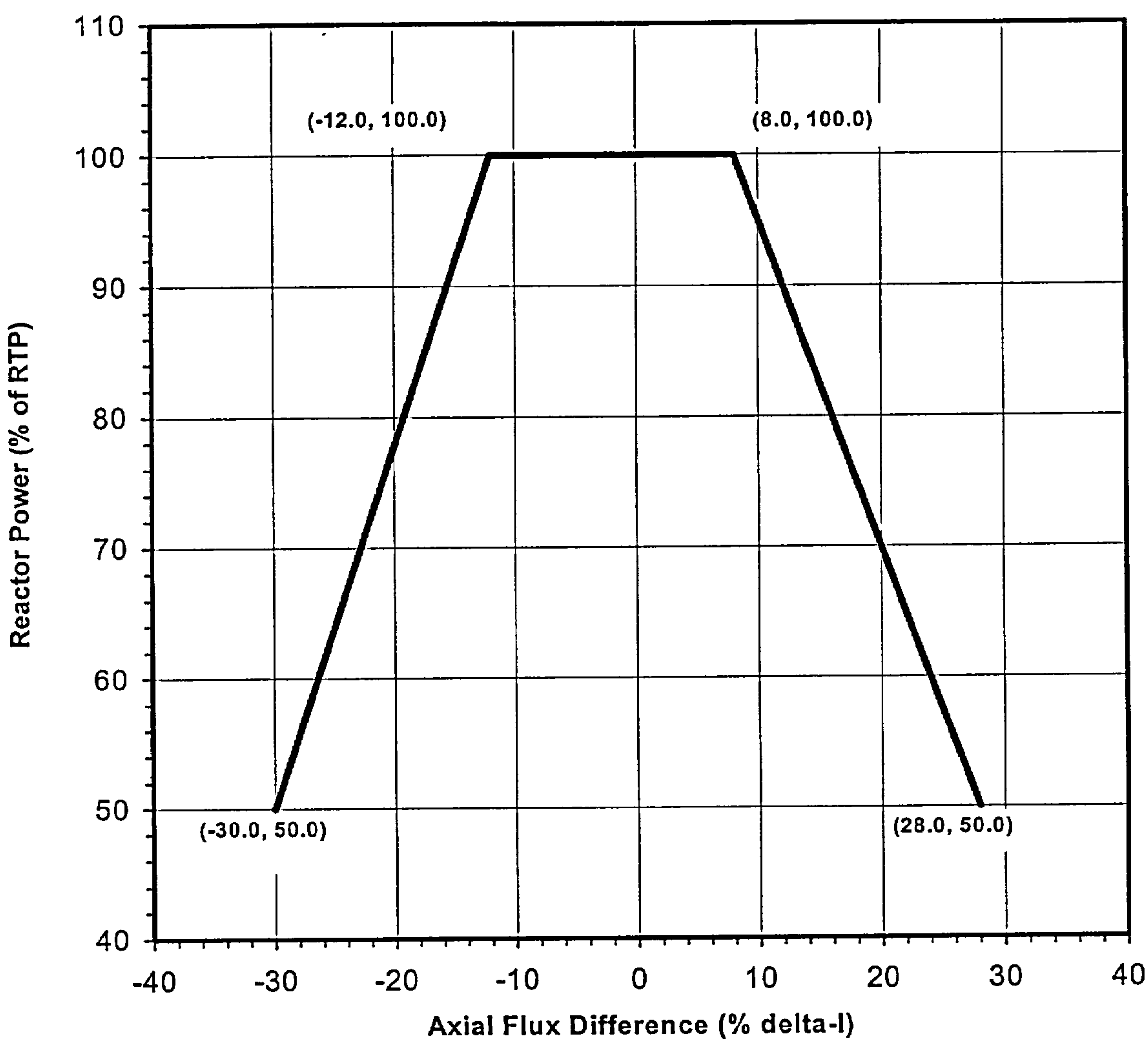


Table 1

NRC Approved Methodologies for COLR Parameters

COLR Section	Parameter	NRC Approved Methodology
2.1	Reactor Core Safety Limits	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.2	Shutdown Margin	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
2.3	Moderator Temperature Coefficient	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
2.4	Shutdown Bank Insertion Limit	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.

COLR Section	Parameter	NRC Approved Methodology
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.5	Control Bank Insertion Limits	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.6	Heat Flux Hot Channel Factor	WCAP-10216-P-A, Revision 1A, "Relaxation of Constant Axial Offset Control-F_Q Surveillance Technical Specification," February 1994.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		WCAP-12945-P-A (Proprietary), "Westinghouse Code Qualification Document for Best-Estimate Loss-of-Coolant Accident Analysis," Volume I, Rev.2, and Volumes II-V, Rev.1, and WCAP-14747 (Non-Proprietary), March 1998.
		ANF-88-133 (P)(A) and Supplement 1, "Qualification of Advanced Nuclear Fuels' PWR Design Methodology for Rod Burnups of 62 GWd/MTU," Advanced Nuclear Fuels Corporation, dated December 1991.

COLR Section	Parameter	NRC Approved Methodology
	($F_Q(Z)$)	WCAP-14449-P-A, "Application Of Best Estimate Large Break LOCA Methodology To Westinghouse PWRs With Upper Plenum Injection," Revision1, and WCAP-14450-NP-A, Rev.1 (Non-Proprietary), October 1999.
	Model	WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Using the NOTRUMP Code," August 1985.
	NOTRUMP	WCAP-10054-P-A, Addendum 2, Revision 1, "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the Code: Safety Injection into the Broken Loop and COSI Condensation Model," July 1997.
2.7	Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		Kewaunee Nuclear Power Plant-Review forKewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
		XN-82-06 (P)(A) Revision 1 and Supplements 2, 4, and 5, "Qualifications of Exxon Nuclear Fuel for Extended Burnup, Exxon Nuclear Company, dated October 1986.
		ANF-88-133 (P)(A) and Supplement 1, "Qualification of Advanced Nuclear Fuels' PWR Design Methodology for Rod Burnups for 62 GWd/MTU," Advanced Nuclear Fuels Corporation, dated December 1991.

COLR Section	Parameter	NRC Approved Methodology
		EMF-92-116 (P)(A) Revision 0, "Generic Mechanical Design Criteria for PWR Fuel Designs," Siemens Power Corporation, dated February 1999.
2.8	Axial Flux Difference	WCAP-10216-P-A, Revision 1A, "Relaxation of Constant Axial Offset (AFD) Control-F_Q Surveillance Technical Specification," February 1994.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.9	Reactor Protection System (RPS) Instrumentation-Overtemperature ΔT	WCAP-8745-P-A, "Design Bases For The Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.10	Reactor Protection System (RPS) Instrumentation-Overpower ΔT	WCAP-8745-P-A, "Design Bases For The Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.

COLR Section	Parameter	NRC Approved Methodology
2.11	RCS Pressure, Temperature, and Flow Departure From Nucleate (DNB) Limits	WCAP-11397-P-A, "Revised Thermal Design Procedure, "April 1989, for those events analyzed using RTDP
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
		WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985 for those events not utilizing RTDP.
2.12	Boron Concentration	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.