

Callaway Cycle 6  
Core Operating Limits Report

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*J.R. Secker*  
J. R. Secker  
Core Design E  
Date: 3/3/92

*L.R. Rios*  
L. R. Rios  
Core Design E  
Date: 3-31-92

Reviewed: *M. J. Hone*  
M. J. Hone  
Core Design E  
Date: 3/31/92

Approved: *S. Ray*  
S. Ray, Manager  
Core Design E  
4/1/92

## 1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Callaway Plant Cycle 6 has been prepared in accordance with the requirements of Technical Specification 6.9.1.9.

The Core Operating Limits affecting the following Technical Specifications are included in this report.

- 3.1.1.3 Moderator Temperature Coefficient
- 3.1.3.5 Shutdown Rod Insertion Limit
- 3.1.3.6 Control Rod Insertion Limits
- 3.2.1 Axial Flux Difference
- 3.2.2 Heat Flux Hot Channel Factor
- 3.2.3 Nuclear Enthalpy Rise Hot Channel Factor
- 3.9.1 Refueling Boron Concentration

## 2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the subsections which follow. These limits have been developed using the NRC-approved methodologies specified in Technical Specification 6.9.1.9.

### 2.1 Moderator Temperature Coefficient (Specification 3.1.1.3)

2.1.1 The Moderator Temperature Coefficient shall be less positive than the limits shown in Figure 1. These limits shall be referred to as the Beginning of Cycle Life (BOL) Limit.

The Moderator Temperature Coefficient shall be less negative than  $-41 \text{ pcm}/^{\circ}\text{F}$ . This limit shall be referred to as the End of Cycle Life (EOL) Limit.

2.1.2 The MTC 300 ppm surveillance limit is  $-32 \text{ pcm}/^{\circ}\text{F}$  (all rods withdrawn, Rated Thermal Power condition).

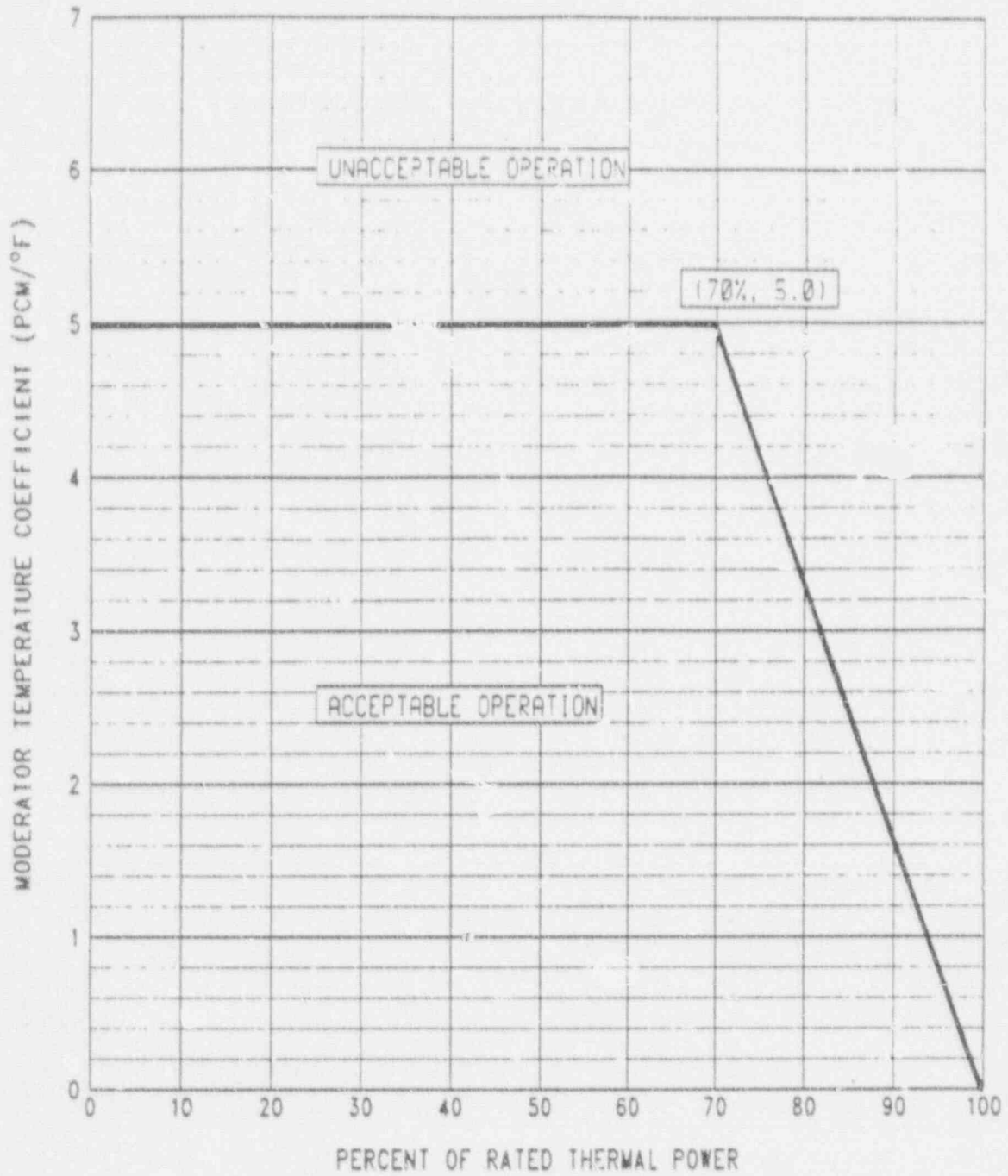


FIGURE 1

CALLAWAY UNIT 1 CYCLE 6  
MODERATOR TEMPERATURE COEFFICIENT VS POWER LEVEL

2.2 Shutdown Rod Insertion Limits (Specification 3.1.3.5)

The shutdown rods shall be withdrawn to at least 225 steps.

2.3 Control Rod Insertion Limits (Specification 3.1.3.6)

The Control Bank Insertion Limits are specified by Figure 2.

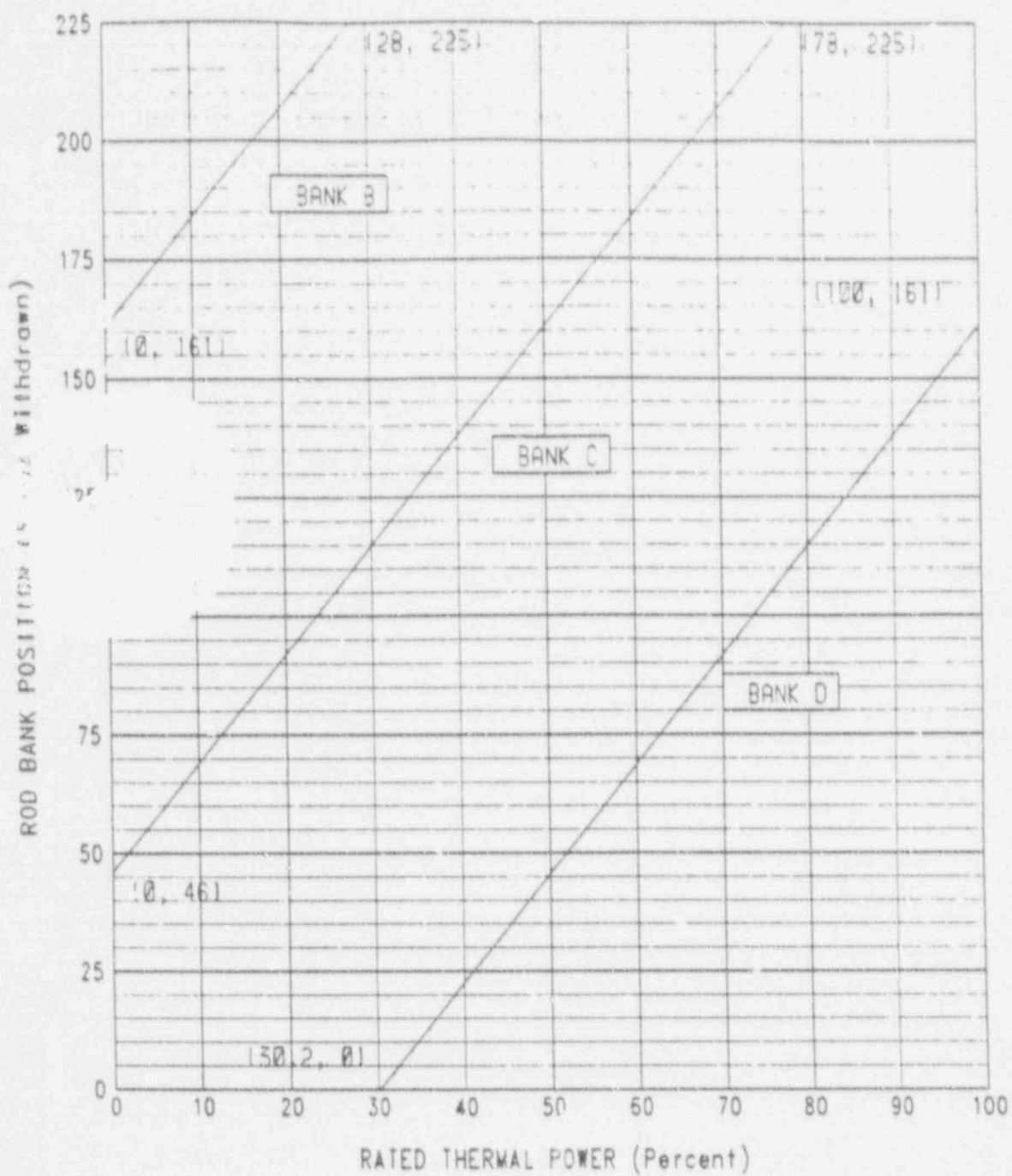


FIGURE 2

CALLAWAY UNIT 1 CYCLE 6  
 ROD BANK INSERTION LIMITS VERSUS  
 RATED THERMAL POWER - FOUR LOOP OPERATION

2.4 Axial Flux Difference (Specification 3.2.1)

2.4.1 The Axial Flux Difference (AFD) target bands are,

- a. +10%, -9% for Normal Operation
- b.  $\pm 3\%$  for Restricted AFD Operation

2.4.2 The Acceptable Operation Limits are shown in Figure 3.

2.4.3 The minimum allowable power level for Restricted AFD Operation,  $APL^{ND}$ , is 90% of RATED THERMAL POWER.

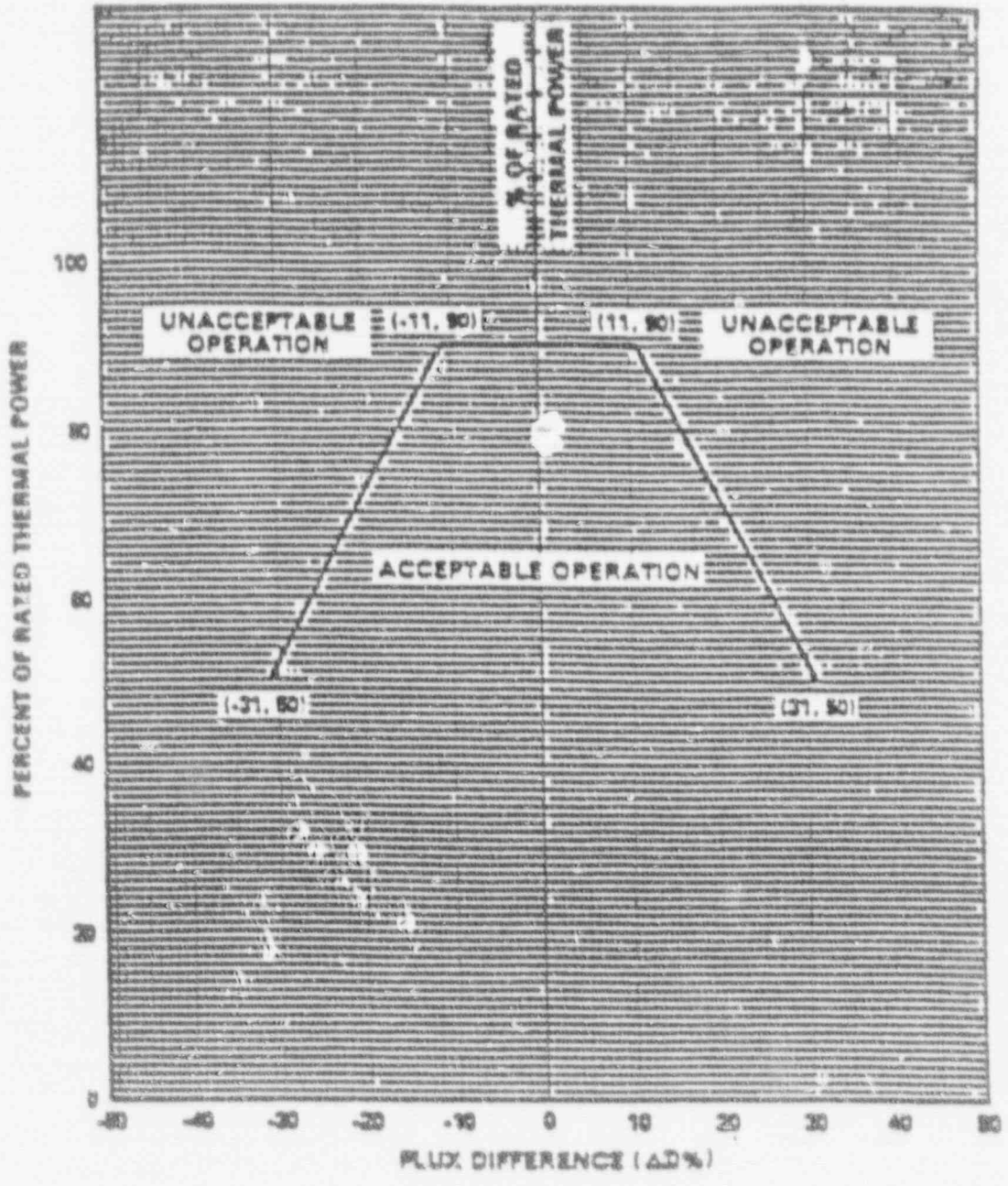


FIGURE 3

AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF RATED THERMAL POWER



2.5 Heat Flux Hot Channel Factor -  $F_Q(Z)$   
(Specification 3.2.2)

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{P} * K(Z) \quad \text{for } P > 0.5$$

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} * K(Z) \quad \text{for } P \leq 0.5$$

where:  $P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$

2.5.1  $F_Q^{RTP} = 2.50$

2.5.2  $K(Z)$  is provided in Figure 4.

2.5.3 The  $W(z)$  functions that are to be used in Technical Specifications 4.2.2.2, 4.2.2.3, and 4.2.2.4 for  $F_Q$  surveillance are shown in Figures 5 through 7.

Because significant margin exists between the analytically determined maximum  $F_Q(z) * P_{rel}$  values and their limit, Restricted Axial Flux Difference (RAFDO) operation is not expected to be required for Cycle 6. For this reason, no  $W(z)_{RAFDO}$  values are supplied for Cycle 6.

The Normal Operation  $W(z)$  values,  $W(z)_{no}$ , have been determined for three specific burnups in Cycle 6. This permits determination of  $W(z)$  at any cycle burnup up to 6000 MWD/MTU through the use of three point interpolation. The  $W(z)_{no}$  values were determined assuming Cycle 6 operates with the CAOC strategy and uses a +10%, -9%  $\Delta I$  band about the target flux difference.

The  $W(z)$  values are provided for 73 axial points assuming the core height boundaries of 0 and 12 feet and intervals of .167 feet between the core boundaries.

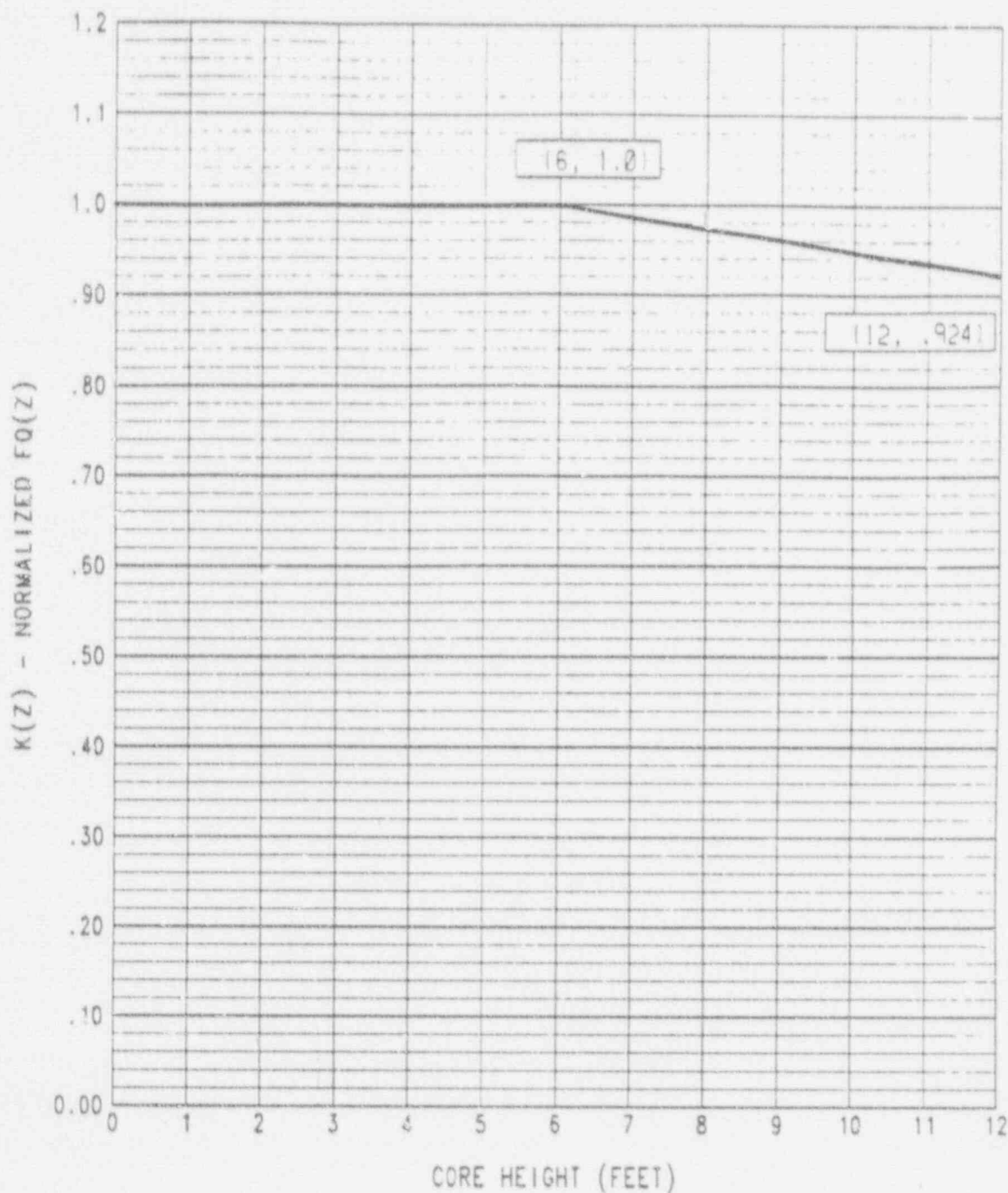


FIGURE 4

CALLAWAY UNIT 1 CYCLE 6

$K(Z) - \text{NORMALIZED } FQ(Z)$  AS A FUNCTION OF CORE HEIGHT

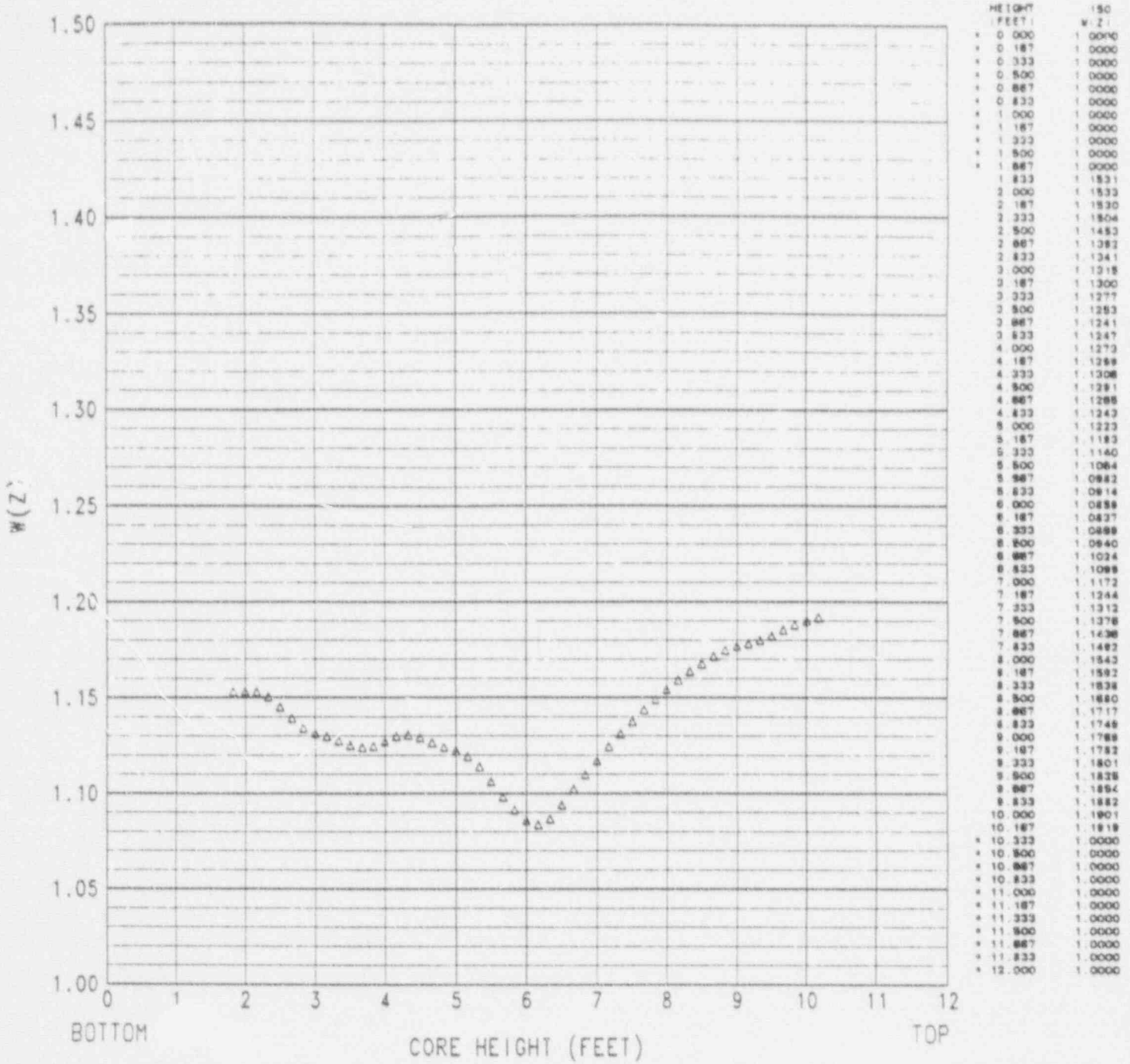


FIGURE 5

CALLAWAY UNIT 1 CYCLE 6

W(Z)<sub>NO</sub> AT 150 MWD/MTU

\* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

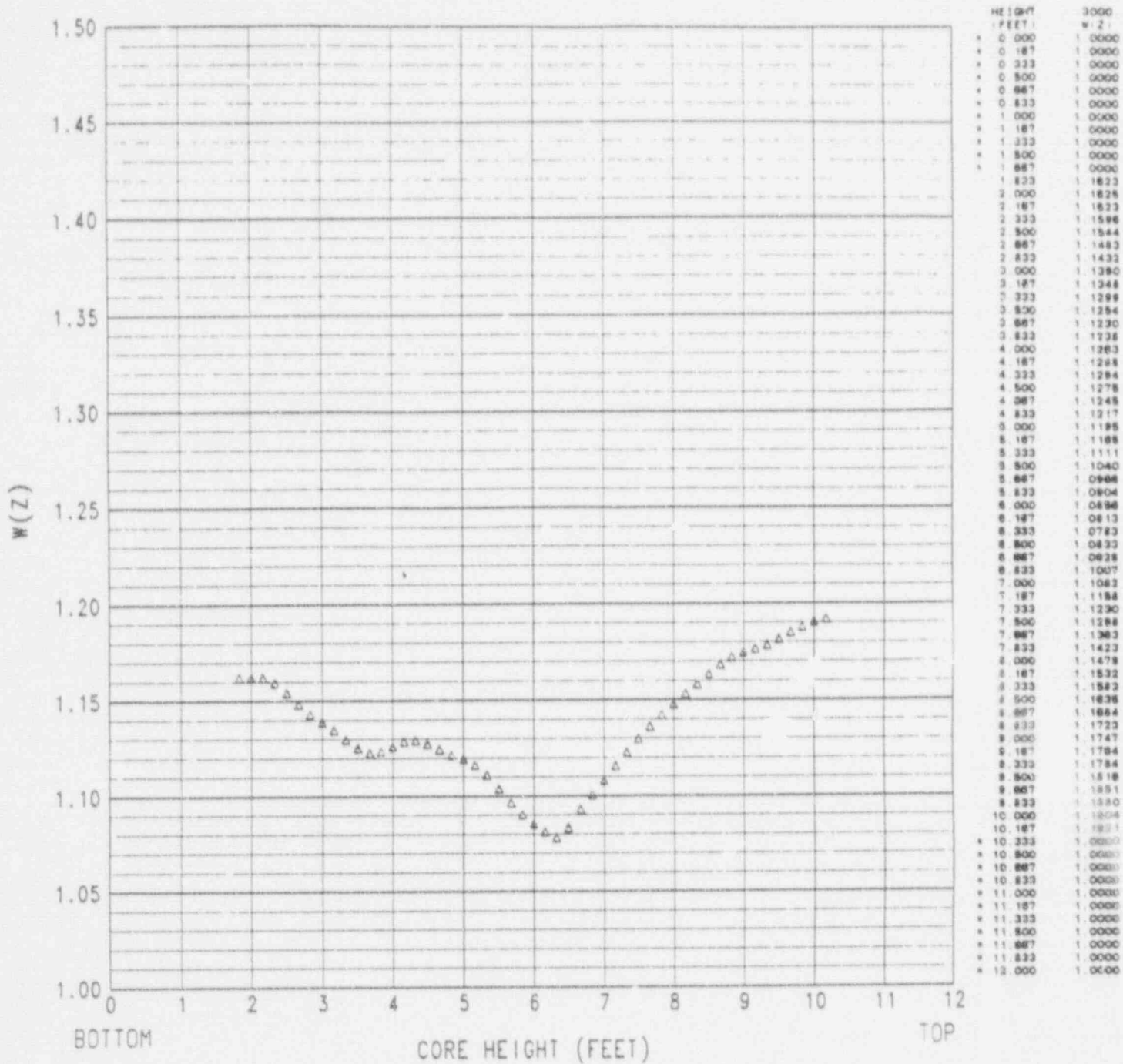


FIGURE 6

CALI.AWAY UNIT 1 CYCLE 6

$W(Z)_{NO}$  AT 3000 MWD/MTU

\* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

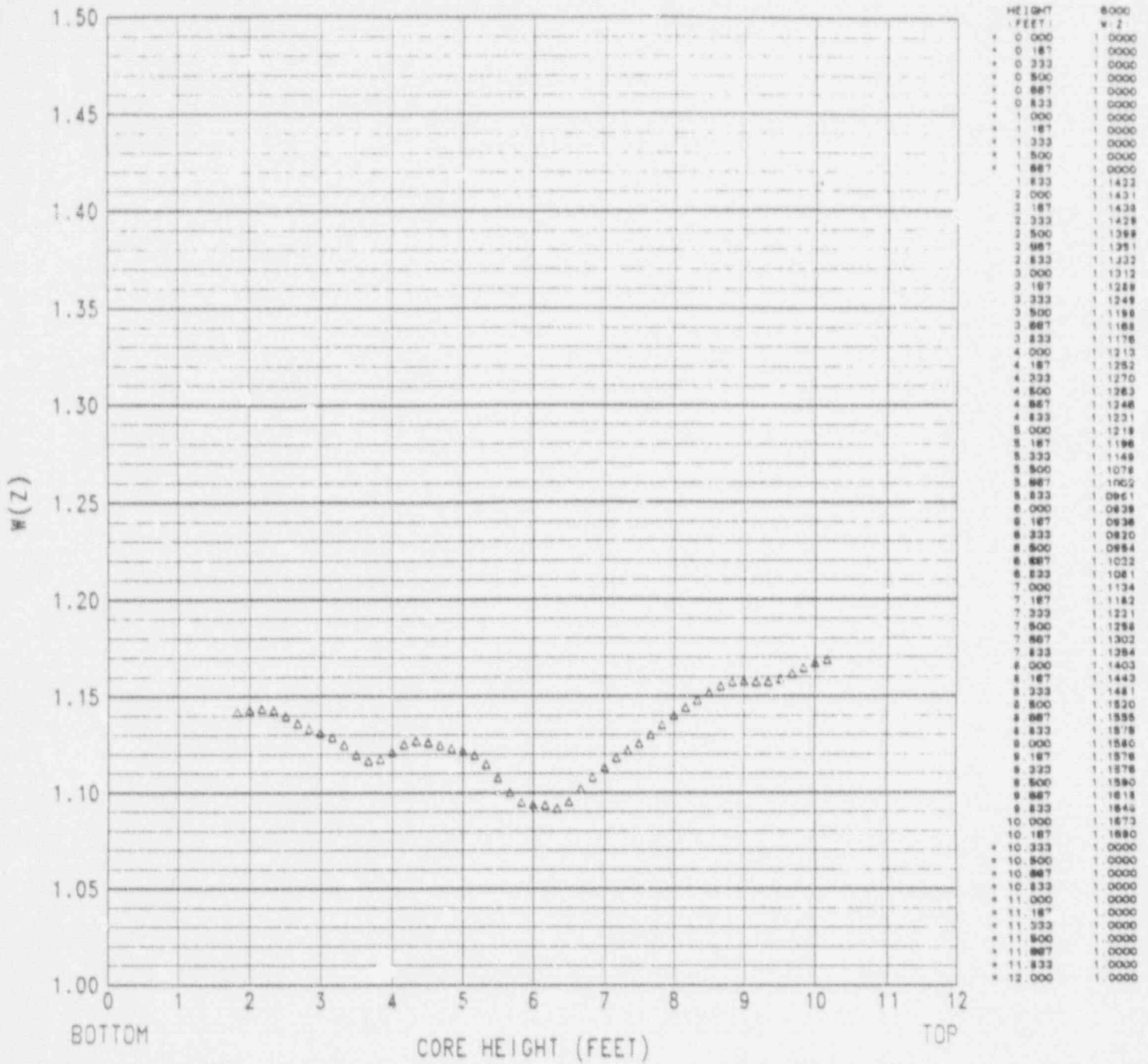


FIGURE 7

CALLAWAY UNIT 1 CYCLE 6

W(Z)<sub>NO</sub> AT 6000 MWD/MTU

\* Top and bottom 15% excluded as per Tech Spec 4.2.2.2G

2.6 Nuclear Enthalpy Rise Hot Channel Factor -  $F_{\Delta H}^N$   
(Specification 3.2.3)

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

where:  $P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$

2.6.1  $F_{\Delta H}^{RTP} = 1.59$

2.6.2  $PF_{\Delta H} = 0.3$

2.7 Refueling Boron Concentration  
(Specification 3.9.1)

2.7.1 The refueling boron concentration to maintain  $K_{\text{eff}} \leq 0.95$  shall be  $\geq 2000$  ppm.