

CPSSES UNIT 2 CYCLE 5

CORE OPERATING LIMITS REPORT

September 1999

Prepared: *Daniel E. Brozak* Date: 9/15/99
Daniel E. Brozak
Reactor Physics

Approved: *Stephen M. Maier* Date: 9/15/99
Stephen M. Maier
Reactor Physics Supervisor

Approved: *Whee G. Choe* Date: 9/16/99
Whee G. Choe
Safety Analysis Manager

DISCLAIMER

The information contained in this report was prepared for the specific requirement of TXU Electric and may not be appropriate for use in situations other than those for which it was specifically prepared. TXU Electric PROVIDES NO WARRANTY HEREUNDER, EXPRESS OR IMPLIED, OR STATUTORY, OF ANY KIND OR NATURE WHATSOEVER, REGARDING THIS REPORT OR ITS USE, INCLUDING BUT NOT LIMITED TO ANY WARRANTIES ON MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

By making this report available, TXU Electric does not authorize its use by others, and any such use is forbidden except with the prior written approval of TXU Electric. Any such written approval shall itself be deemed to incorporate the disclaimers of liability and disclaimers of warranties provided herein. In no event shall TXU Electric have any liability for any incidental or consequential damages of any type in connection with the use, authorized or unauthorized, of this report or of the information in it.

TABLE OF CONTENTS

DISCLAIMER	ii
TABLE OF CONTENTS	iii
LIST OF FIGURES	iv

<u>SECTION</u>	<u>PAGE</u>
1.0 CORE OPERATING LIMITS REPORT	1
2.0 OPERATING LIMITS	2
2.1 SAFETY LIMITS	2
2.2 SHUTDOWN MARGIN	2
2.3 MODERATOR TEMPERATURE COEFFICIENT	2
2.4 ROD GROUP ALIGNMENT LIMITS	3
2.5 SHUTDOWN BANK INSERTION LIMITS	3
2.6 CONTROL BANK INSERTION LIMITS	4
2.7 PHYSICS TESTS EXCEPTIONS - MODE 2	4
2.8 HEAT FLUX HOT CHANNEL FACTOR	4
2.9 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	5
2.10 AXIAL FLUX DIFFERENCE	6
2.11 REACTOR TRIP SYSTEM INSTRUMENTATION	6
2.12 RCS PRESSURE, TEMPERATURE, AND FLOW DEPARTURE FROM NUCLEATE BOILING LIMITS	7
2.13 BORON CONCENTRATION	8

LIST OF FIGURES

<u>FIGURE</u>		<u>PAGE</u>
1	REACTOR CORE SAFETY LIMITS	9
2	ROD BANK INSERTION LIMITS VERSUS THERMAL POWER	10
3	K(Z) - NORMALIZED $F_0(Z)$ AS A FUNCTION OF CORE HEIGHT	11
4	W(Z) AS A FUNCTION OF CORE HEIGHT - (MAXIMUM)	12
5	W(Z) AS A FUNCTION OF CORE HEIGHT - (150 MWD/MTU)	13
6	W(Z) AS A FUNCTION OF CORE HEIGHT - (10,000 MWD/MTU)	14
7	W(Z) AS A FUNCTION OF CORE HEIGHT - (20,000 MWD/MTU)	15
8	AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF RATED THERMAL POWER	16

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for CPSES UNIT 2 CYCLE 5 has been prepared in accordance with the requirements of Technical Specification 5.6.5 as described in Amendment 67 to the CPSES Technical Specifications.

The Technical Specifications affected by this report are listed below:

SL 2.1	SAFETY LIMITS
LCO 3.1.1	SHUTDOWN MARGIN
LCO 3.1.3	MODERATOR TEMPERATURE COEFFICIENT
LCO 3.1.4	ROD GROUP ALIGNMENT LIMITS
LCO 3.1.5	SHUTDOWN BANK INSERTION LIMITS
LCO 3.1.6	CONTROL BANK INSERTION LIMITS
LCO 3.1.8	PHYSICS TESTS EXCEPTIONS - MODE 2
LCO 3.2.1	HEAT FLUX HOT CHANNEL FACTOR
LCO 3.2.2	NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR
LCO 3.2.3	AXIAL FLUX DIFFERENCE
LCO 3.3.1	REACTOR TRIP SYSTEM INSTRUMENTATION
LCO 3.4.1	RCS PRESSURE, TEMPERATURE, AND FLOW DEPARTURE FROM NUCLEATE BOILING LIMITS
LCO 3.9.1	BORON CONCENTRATION

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 5.6.5b, Items 5 and 9 through 19. These limits have been determined such that all applicable limits of the safety analysis are met.

2.1 SAFETY LIMITS (SL 2.1)

2.1.1 In MODES 1 and 2, the combination of thermal power, reactor coolant system highest loop average temperature, and pressurizer pressure shall not exceed the safety limits specified in Figure 1.

2.2 SHUTDOWN MARGIN (SDM) (LCO 3.1.1)

2.2.1 The SDM shall be greater than or equal to 1.3% $\Delta k/k$ in MODE 2 with $K_{eff} < 1.0$, MODES 3, 4, and 5.

2.3 MODERATOR TEMPERATURE COEFFICIENT (MTC) (LCO 3.1.3))

2.3.1 The MTC upper and lower limits, respectively, are:

The BOL/ARO/HZP-MTC shall be less positive than +5 pcm/ °F.

The EOL/ARO/RTP-MTC shall be less negative than -40 pcm/ °F.

2.3.2 SR 3.1.3.2

The MTC surveillance limit is:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to $-31 \text{ pcm/}^\circ\text{F}$.

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to $-38 \text{ pcm/}^\circ\text{F}$.

where: BOL stands for Beginning of Cycle Life
ARO stands for All Rods Out
HZP stands for Hot Zero THERMAL POWER
EOL stands for End of Cycle Life
RTP stands for RATED THERMAL POWER

2.4 ROD GROUP ALIGNMENT LIMITS (LCO 3.1.4)

2.4.1 The SD shall be greater than or equal to $\pm 3\% \Delta k/k$ in MODES 1 and 2.

2.5 SHUTDOWN BANK INSERTION LIMITS (LCO 3.1.5)

2.5.1 The shutdown rods shall be fully withdrawn. Fully withdrawn shall be the condition where shutdown rods are at a position within the interval of 222 and 231 steps withdrawn, inclusive.

2.6 CONTROL BANK INSERTION LIMITS (LCO 3.1.6)

2.6.1 The control banks shall be limited in physical insertion as shown in Figure 2.

2.6.2 The control banks shall always be withdrawn and inserted in the prescribed sequence. For withdrawal, the sequence is control bank A, control bank B, control bank C, and control bank D. The insertion sequence is the reverse of the withdrawal sequence.

2.6.3 A 115 step Tip-to-Tip relationship between each sequential control bank shall be maintained.

2.7 PHYSICS TESTS EXCEPTIONS - MODE 2 (LCO 3.1.8)

2.7.1 The SDM shall be greater than or equal to 1.3% $\Delta k/k$ in MODE 2 during PHYSICS TESTS.

2.8 HEAT FLUX HOT CHANNEL FACTOR ($F_0(Z)$) (LCO 3.2.1)

$$2.8.1 \quad F_0(Z) \leq \frac{F_0^{RTP}}{P} [K(Z)] \text{ for } P > 0.5$$

$$F_0(Z) \leq \frac{F_0^{RTP}}{0.5} [K(Z)] \text{ for } P \leq 0.5$$

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

2.8.2 $F_0^{RTP} = 2.42$

2.8.3 $K(Z)$ is provided in Figure 3.

2.8.4 Maximum elevation dependent $W(Z)$ values are given in Figure 4. Figures 5, 6, and 7 give burnup dependent values for $W(Z)$. Figures 5, 6, and 7 can be used in place of Figure 4 to interpolate or extrapolate (via a three point fit) the $W(Z)$ at a particular burnup.

2.8.5 SR 3.2.1.2

If the two most recent $F_0(Z)$ evaluations show an increase in the expression

$$\text{maximum over } Z \quad [F_0^c(Z) / K(Z)]$$

$F_0^M(Z)$ shall be increased by a factor of 1.02. This requirement is for all cycle burnups.

2.9 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR ($F_{\Delta H}^N$) (LCO 3.2.2)

2.9.1 $F_{\Delta H}^N \leq F_{\Delta H}^{RTP} [1 + PF_{\Delta H} (1-P)]$

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

2.9.2 $F_{\Delta H}^{RTP} = 1.55$

2.9.3 $PF_{\Delta H} = 0.3$

2.10 AVAILABLE FLUX DIFFERENCE (AFD) (LCO 3.2.3)

2.10.1 The AFD target band is +5%, -12% at 100% kIP linearly expanding to +20%, -17% at 50% RTP. Below 50% RTP, the AFD target band remains constant at +20%, -17%.

2.10.2 The AFD Acceptable Operation Limits are provided in Figure 8.

2.11 REACTOR TRIP SYSTEM (RTS) INSTRUMENTATION (LCO 3.3.1)

2.11.1 The numerical values pertaining to the Overtemperature N-16 reactor trip setpoint are listed below:

$$K_1 = 1.150$$

$$K_2 = 0.0147 / ^\circ\text{F}$$

$$K_3 = 0.00077 / \text{psig}$$

$$T_c^\circ = 560.6 \text{ } ^\circ\text{F}$$

$$P^1 \geq 2235 \text{ psig}$$

$$T_1 \geq 10 \text{ sec}$$

$$T_2 \leq 3 \text{ sec}$$

$$f_1(\Delta q) = 0.00 \cdot \{(q_t - q_b) + 65\% \} \quad \text{when } (q_t - q_b) \leq -65\% \text{ RTP}$$

$$= 0\% \quad \text{when } -65\% \text{ RTP} < (q_t - q_b) < +5.1\% \text{ RTP}$$

$$= 2.28 \cdot \{(q_t - q_b) - 5.1\% \} \quad \text{when } (q_t - q_b) \geq +5.1\% \text{ RTP}$$

2.12.4 SR 3.4.1.3

The RCS total flow rate based on precision heat balance shall be $\geq 408,000$ gpm.

2.12.5 SR 3.4.1.4

The RCS total flow rate based on precision heat balance shall be $\geq 408,000$ gpm.

The required RCS flow, based on an elbow tap differential pressure measurement prior to MODE 1 after the refueling outage, shall be greater than 317,000 gpm.

2.13 BORON CONCENTRATION (LCO 3.9.1)

2.13.1 The required refueling boron concentration is 2400 ppm.

FIGURE 1

REACTOR CORE SAFETY LIMITS

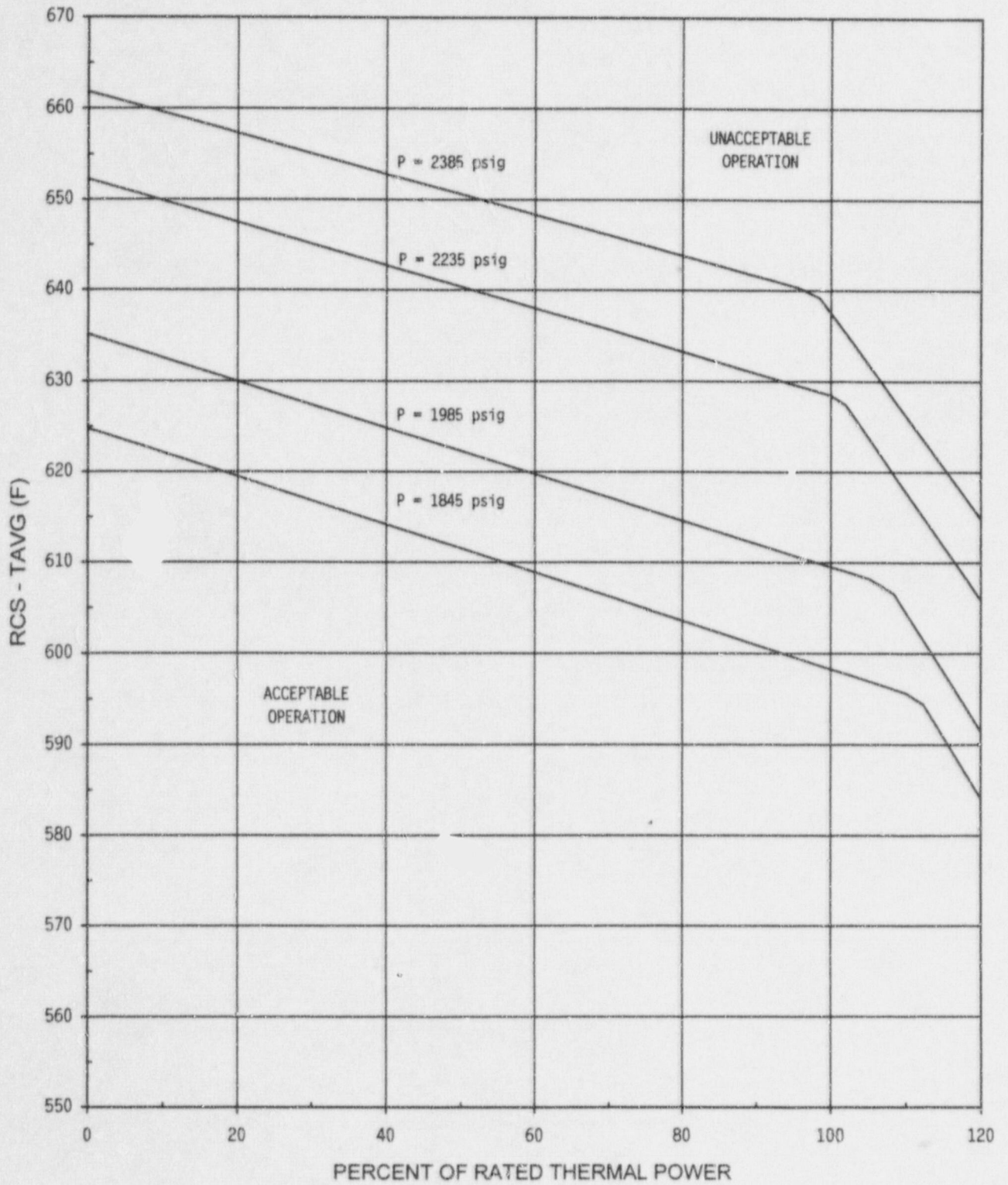
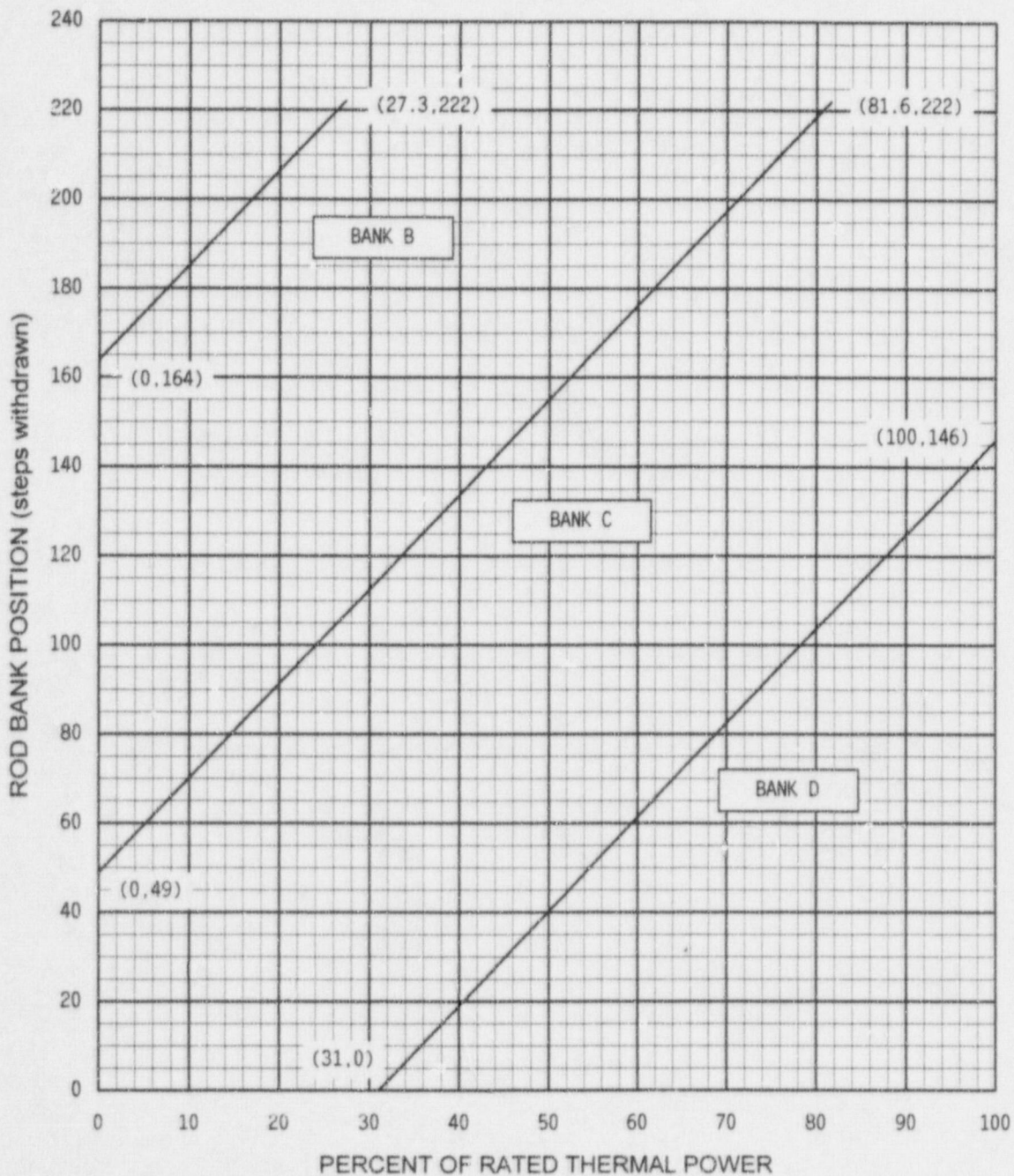


FIGURE 2

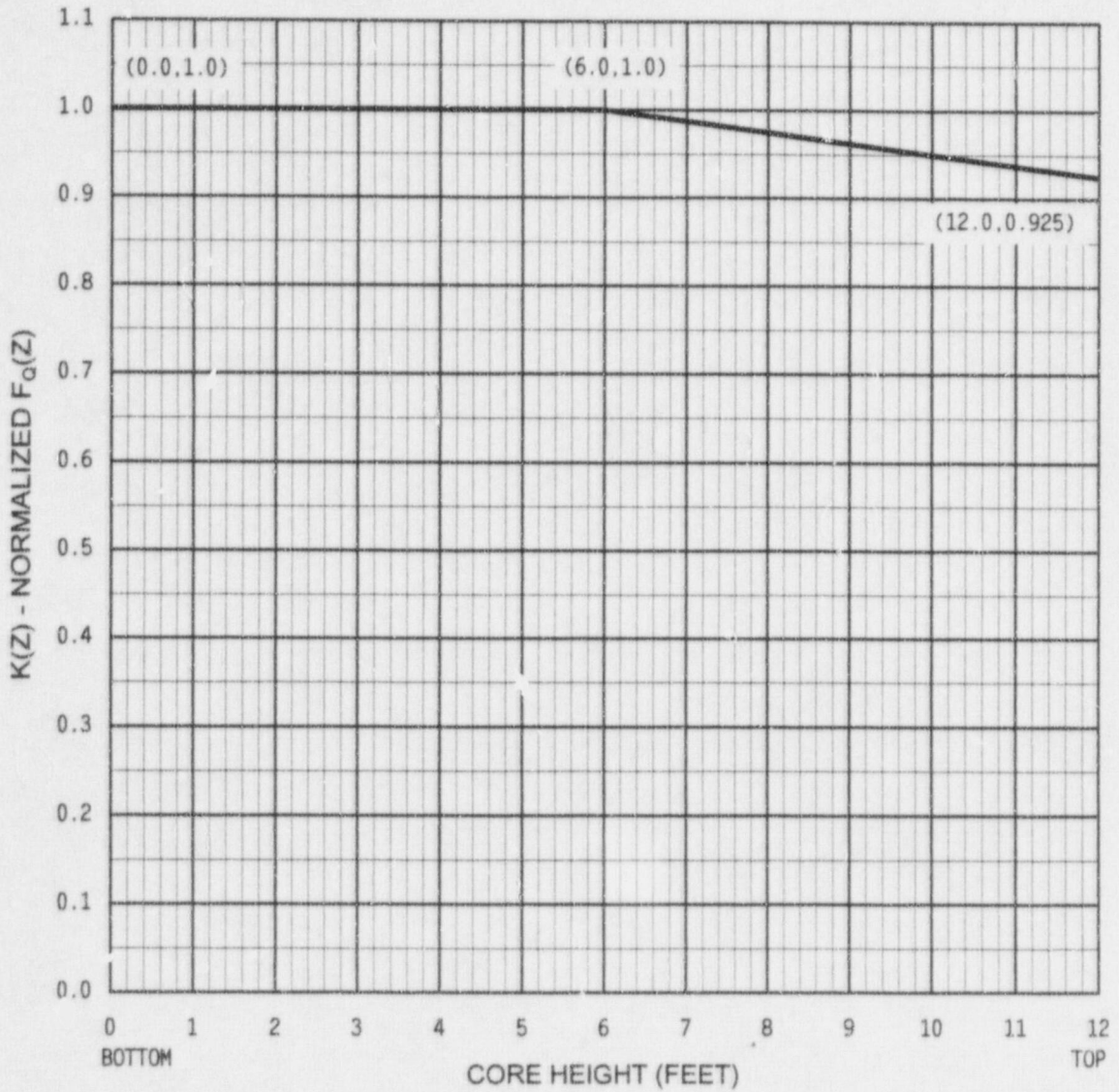
ROD BANK INSERTION LIMITS VERSUS THERMAL POWER



- NOTES:
1. Fully withdrawn shall be the condition where control rods are at a position within the interval of 222 and 231 steps withdrawn, inclusive.
 2. Control Bank A shall be fully withdrawn.

FIGURE 3

K(Z) - NORMALIZED F₀(Z) AS A FUNCTION OF CORE HEIGHT

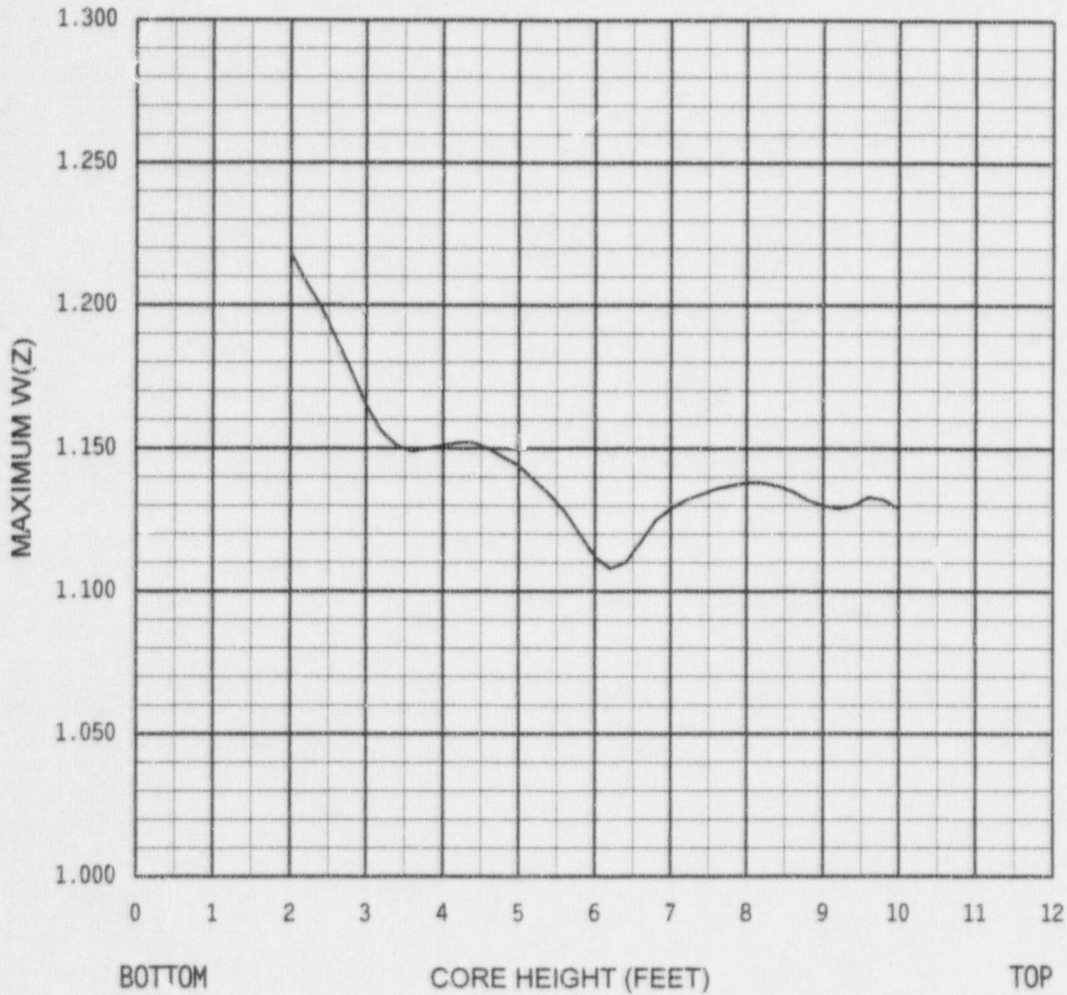


Axial Node	K(Z)	Axial Node	K(Z)	Axial Node	K(Z)	Axial Node	K(Z)
61	0.9250	53	0.9450	45	0.9550	37	0.9850
60	0.9275	52	0.9475	44	0.9675	36	0.9875
59	0.9300	51	0.9500	43	0.9700	35	0.9900
58	0.9325	50	0.9525	42	0.9725	34	0.9925
57	0.9350	49	0.9550	41	0.9750	33	0.9950
56	0.9375	48	0.9575	40	0.9775	32	0.9975
55	0.9400	47	0.9600	39	0.9800	1 - 31	1.0000
54	0.9425	46	0.9625	38	0.9825		

Core Height (ft) = (Node - 1) * 0.2

FIGURE 4

W(Z) AS A FUNCTION OF CORE HEIGHT
(MAXIMUM)

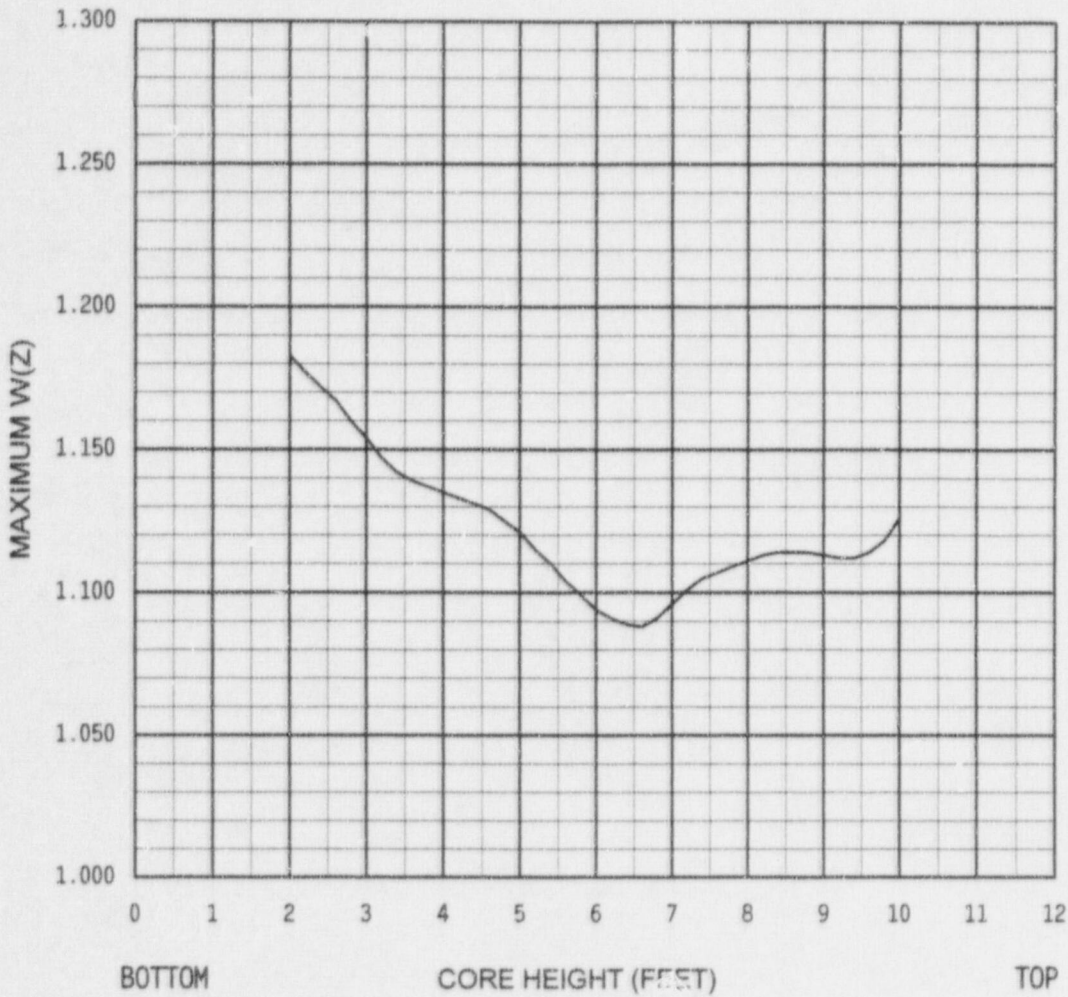


Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)
52 - 61	---	41	1.138	30	1.120	19	1.149
51	1.129	40	1.137	29	1.128	18	1.151
50	1.132	39	1.136	28	1.134	17	1.156
49	1.133	38	1.134	27	1.139	16	1.165
48	1.130	37	1.132	26	1.144	15	1.177
47	1.129	36	1.129	25	1.147	14	1.188
46	1.130	35	1.125	24	1.150	13	1.199
45	1.132	34	1.117	23	1.152	12	1.208
44	1.135	33	1.110	22	1.152	11	1.218
43	1.137	32	1.108	21	1.151	1 - 10	---
42	1.138	31	1.112	20	1.150		

Core Height (ft) = (Node - 1) * 0.2

FIGURE 5

W(Z) AS A FUNCTION OF CORE HEIGHT
(150 MWD/MTU)

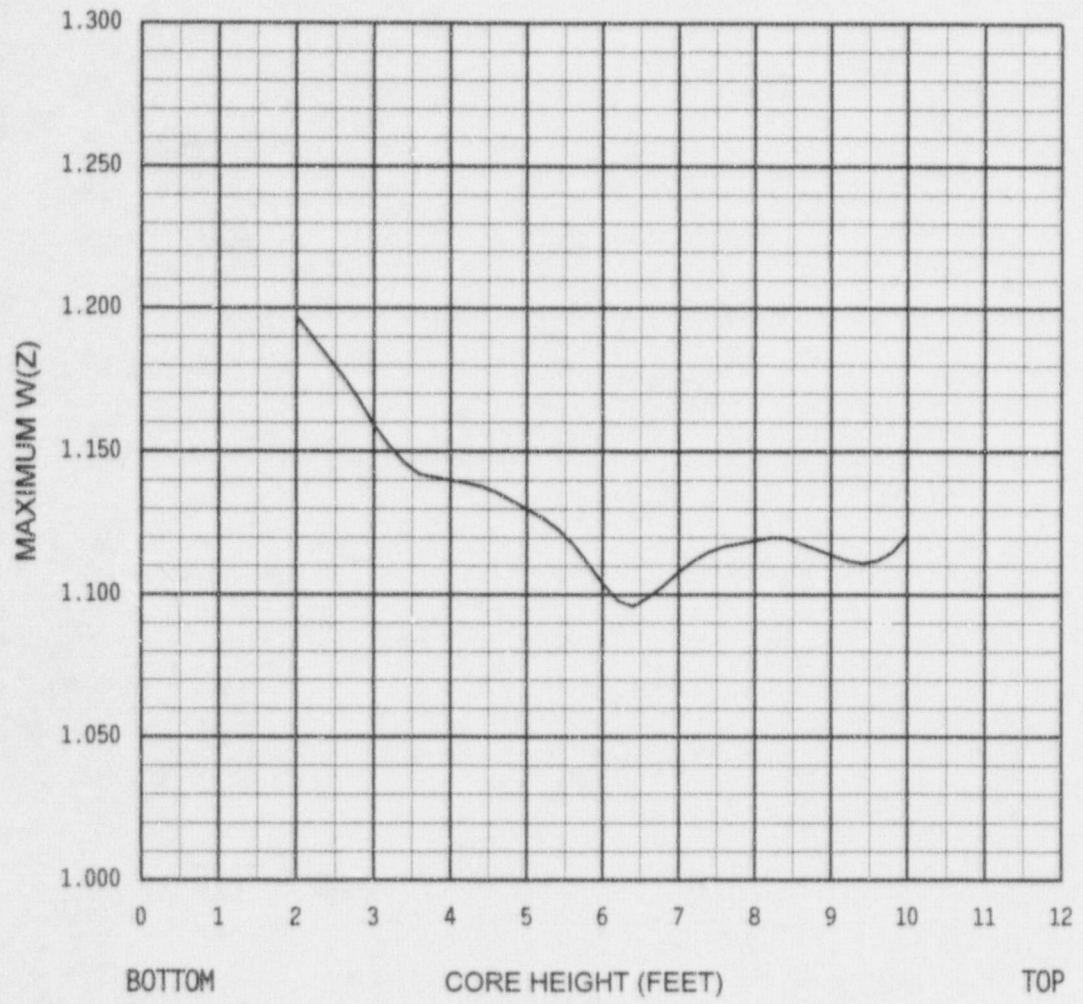


Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)
52 - 61	---	41	1.111	30	1.099	19	1.139
51	1.126	40	1.109	29	1.104	18	1.142
50	1.118	39	1.107	28	1.110	17	1.147
49	1.114	38	1.105	27	1.115	16	1.154
48	1.112	37	1.101	26	1.121	15	1.160
47	1.112	36	1.096	25	1.125	14	1.167
46	1.113	35	1.091	24	1.129	13	1.172
45	1.114	34	1.088	23	1.131	12	1.177
44	1.114	33	1.089	22	1.133	11	1.183
43	1.114	32	1.091	21	1.135	1 - 10	---
42	1.113	31	1.094	20	1.137		

Core Height (ft) = (Node - 1) * 0.2

FIGURE 6

W(Z) AS A FUNCTION OF CORE HEIGHT
(10,000 MWD/MTU)

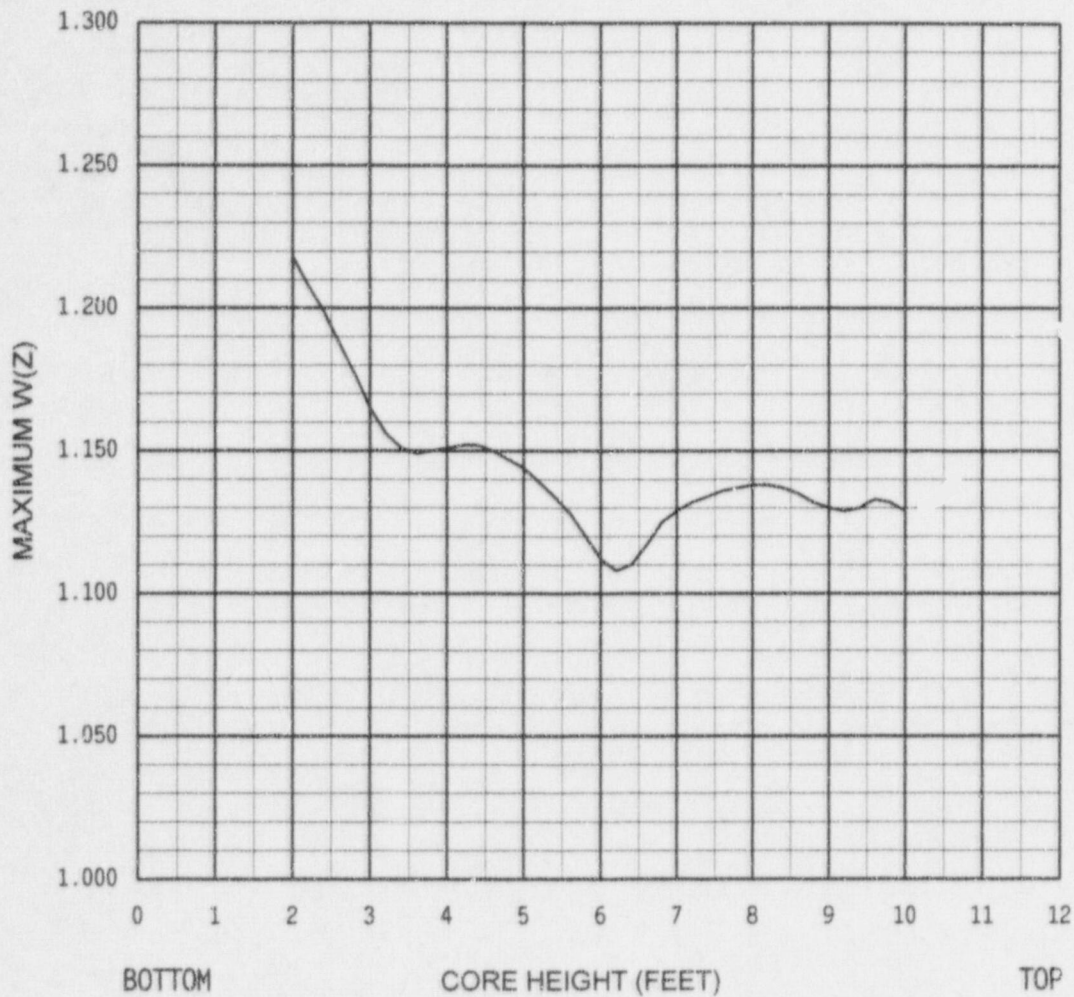


Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)
52 - 61	---	41	1.119	30	1.111	19	1.142
51	1.121	40	1.118	29	1.118	18	1.146
50	1.115	39	1.117	28	1.123	17	1.152
49	1.112	38	1.115	27	1.127	16	1.159
48	1.111	37	1.112	26	1.130	15	1.168
47	1.112	36	1.108	25	1.133	14	1.176
46	1.114	35	1.103	24	1.136	13	1.183
45	1.116	34	1.099	23	1.138	12	1.190
44	1.118	33	1.096	22	1.139	11	1.197
43	1.120	32	1.098	21	1.140	1 - 10	---
42	1.120	31	1.104	20	1.141		

Core Height (ft) = (Node - 1) * 0.2

FIGURE 7

W(Z) AS A FUNCTION OF CORE HEIGHT
(20,000 MWd/MTU)



Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)	Axial Node	W(Z)
52 - 61	---	41	1.138	30	1.120	19	1.149
51	1.129	40	1.137	29	1.128	18	1.151
50	1.132	39	1.136	28	1.134	17	1.156
49	1.133	38	1.134	27	1.139	16	1.165
48	1.130	37	1.132	26	1.144	15	1.177
47	1.129	36	1.129	25	1.147	14	1.188
46	1.130	35	1.125	24	1.150	13	1.199
45	1.132	34	1.117	23	1.152	12	1.208
44	1.135	33	1.110	22	1.152	11	1.218
43	1.137	32	1.108	21	1.151	1 - 10	---
42	1.138	31	1.112	20	1.150		

Core Height (ft) = (Node - 1) * 0.2

FIGURE 8

AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF
RATED THERMAL POWER

