

CORE OPERATING LIMITS REPORT
North Anna 1 Cycle 11 Pattern BW

Revision 0
September 1994

1.0 INTRODUCTION

The Core Operating Limits Report (COLR) for North Anna Unit 1 Cycle 11 has been prepared in accordance with Technical Specification 6.9.1.7. The technical specifications affected by this report are listed below:

3/4.1.1.4	Moderator Temperature Coefficient
3/4.1.3.5	Shutdown Bank Insertion Limit
3/4.1.3.6	Control Bank Insertion Limits
3/4.2.1	Axial Flux Difference
3/4.2.2	Heat Flux Hot Channel Factor
3/4.2.3	Nuclear Enthalpy Rise Hot Channel Factor and Power Factor Multiplier

The cycle-specific parameter limits for North Anna 1 Cycle 11 for the specifications listed above are provided on the following pages, and were developed using the NRC-approved methodologies specified in Technical Specification 6.9.1.7.

2.0 Operating Limits

2.1 Moderator Temperature Coefficient (Specification 3/4.1.1.4)

2.1.1 The moderator temperature coefficient (MTC) limits are:

The BOC/ARO MTC shall be less positive than or equal to $+0.6E-4 \Delta k/k/^{\circ}F$ below 70 percent of RATED THERMAL POWER.

The BOC/ARO MTC shall be less positive than or equal to $0 \Delta k/k/^{\circ}F$ at or above 70 percent of RATED THERMAL POWER.

The EOC/ARO/RTP-MTC shall be less negative than $-5.0E-4 \Delta k/k/^{\circ}F$.

2.1.2 The MTC surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to $-4.0E-4 \Delta k/k/^{\circ}F$.

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to $-4.7E-04 \Delta k/k/^{\circ}F$.

where: BOC - Beginning of Cycle
ARO - All Rods Out
EOC - End of Cycle
RTP - RATED THERMAL POWER

2.2 Shutdown Bank Insertion Limit (Specification 3/4.1.3.5)

2.2.1 The shutdown rods shall be withdrawn to at least 225 steps.

2.3 Control Bank Insertion Limits (Specification 3/4.1.3.6)

2.3.1 The control rod banks shall be limited in physical insertion as shown in Figure 1.

2.4 Axial Flux Difference (Specification 3/4.2.1)

2.4.1 The AXIAL FLUX DIFFERENCE limits are provided in Figures 2 and 3.

2.5 Heat Flux Hot Channel Factor- $F_Q(Z)$ (Specification 3/4.2.2)

2.5.1 The $F_Q(Z)$ limits are:

$$F_Q(Z) \leq \frac{2.19}{P} * K(Z) \quad \text{for } P > 0.5$$

$$F_Q(Z) \leq 4.38 * K(Z) \quad \text{for } P \leq 0.5$$

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

$K(Z)$ is provided in Figure 4

2.5.2 The $F_Q(Z)$ surveillance limits are:

$$F_Q(Z)^M \leq \frac{2.19}{P} * \frac{K(Z)}{N(Z)} \quad \text{for } P > 0.5$$

$$F_Q(Z)^M \leq 4.38 * \frac{K(Z)}{N(Z)} \quad \text{for } P \leq 0.5$$

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

$K(Z)$ is provided in Figure 4, and

$N(Z)$ is a non-equilibrium multiplier on $F_Q(Z)^M$

to account for power distribution transients during normal operation. It is provided in Table 1 (page 10), and plotted in Figures 5 thru 11. The top and bottom 15% of the core is excluded per Technical Specification 4.2.2.2.G.

2.6 Nuclear Enthalpy Rise Hot Channel Factor - F_{AH}^N
and Power Factor Multiplier (Specification 3/4.2.3)

$$F_{AH}^N \leq 1.49 * (1 + 0.3 * (1 - P))$$

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

FIGURE 1

NORTH ANNA UNIT 1 Cycle 11
CONTROL ROD BANK INSERTION LIMITS VS. RATED THERMAL POWER

FULLY WITHDRAWN = 225

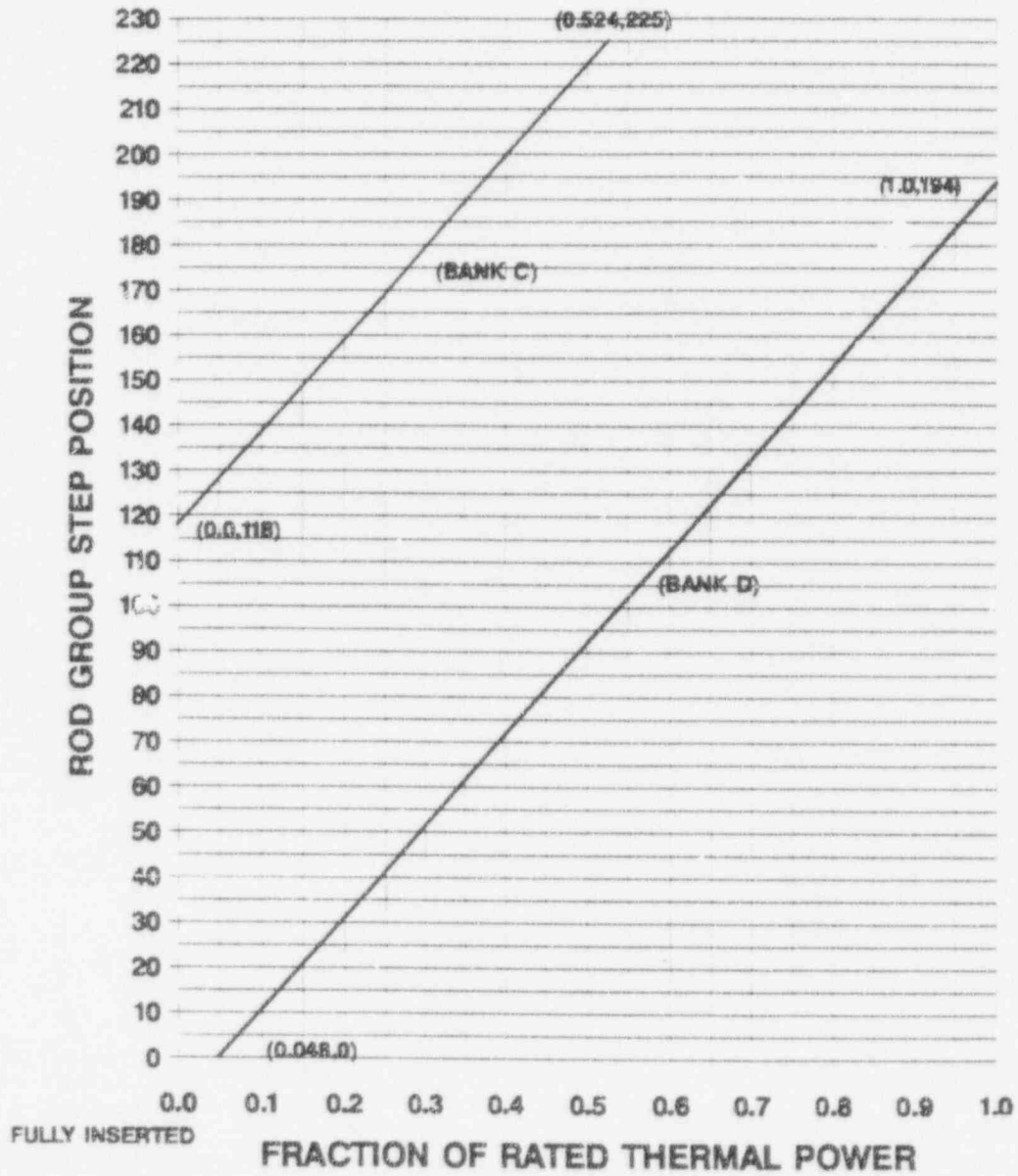


FIGURE 2

N1C11 AXIAL FLUX DIFFERENCE LIMITS
AS A FUNCTION OF RATED THERMAL POWER
(BOC to 9000 MWD/MTU)

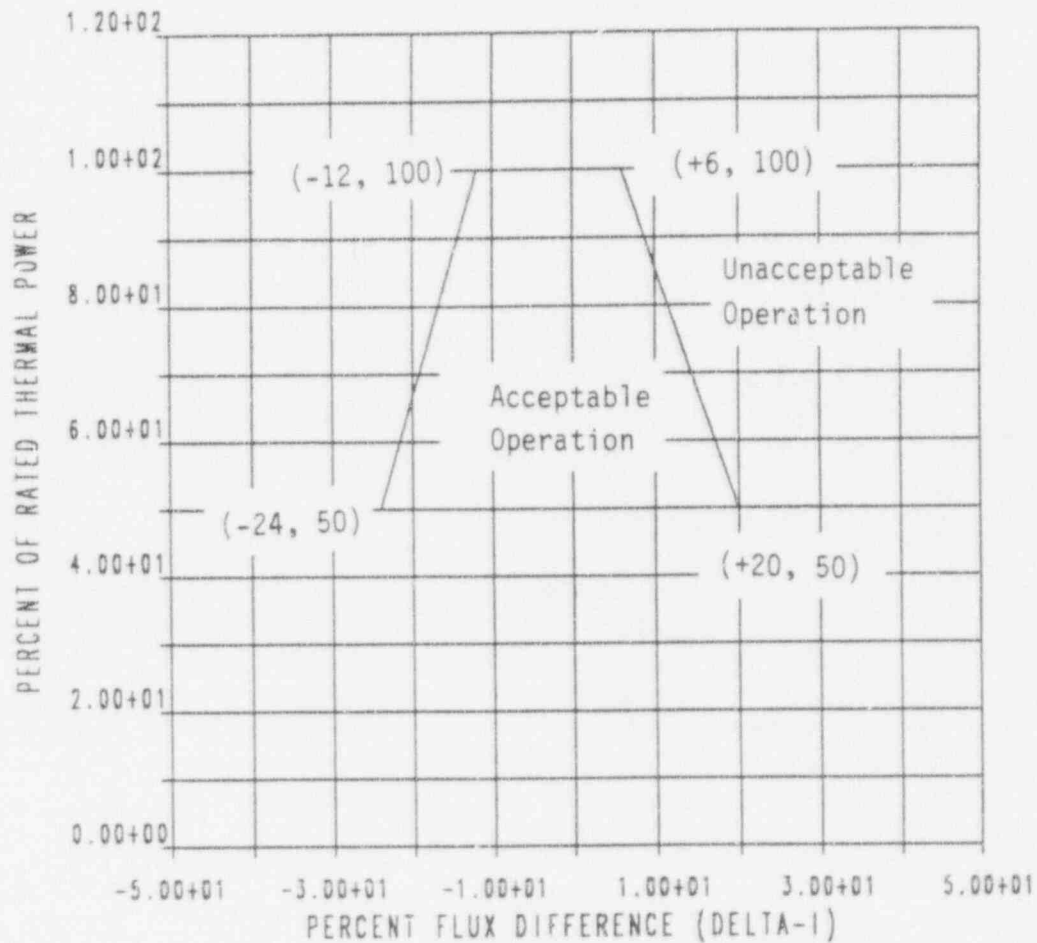


FIGURE 3

N1C11 AXIAL FLUX DIFFERENCE LIMITS
AS A FUNCTION OF RATED THERMAL POWER
(9000 MWD/MIU to EOC)

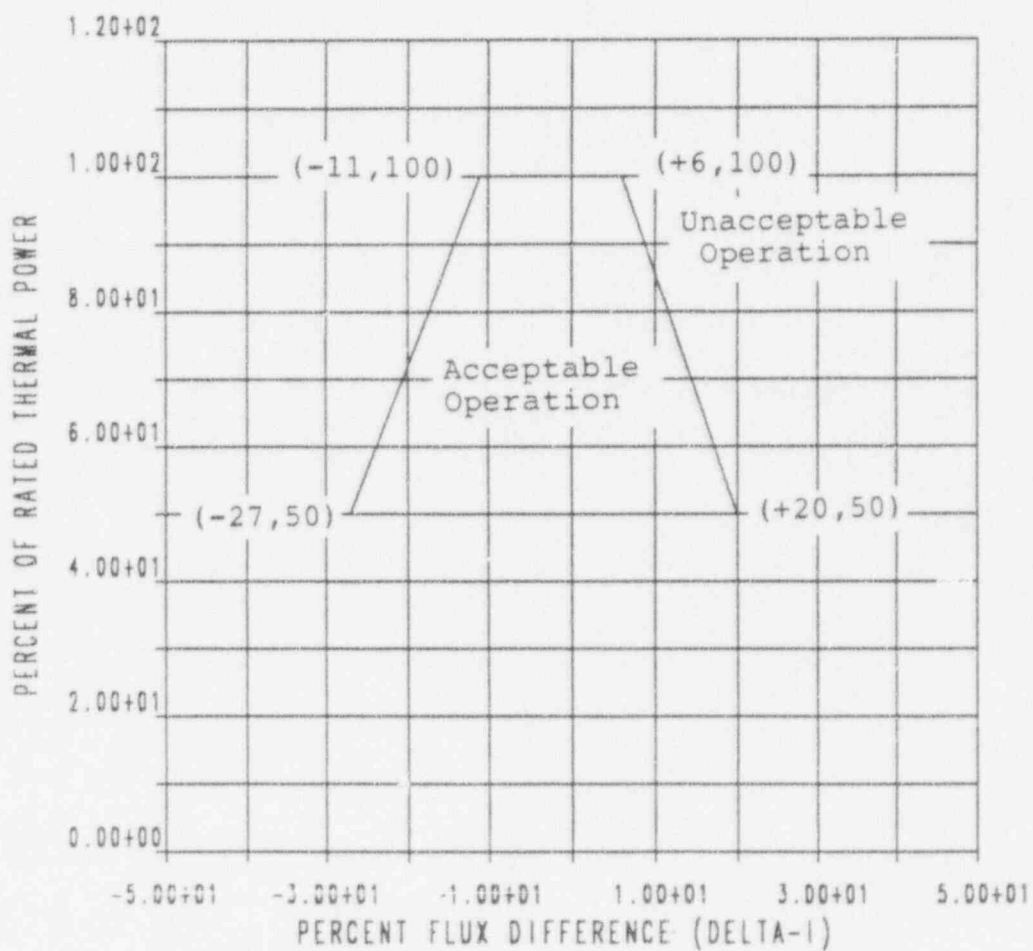


FIGURE 4

$K(Z)$ - NORMALIZED F_0 AS A FUNCTION OF CORE HEIGHT

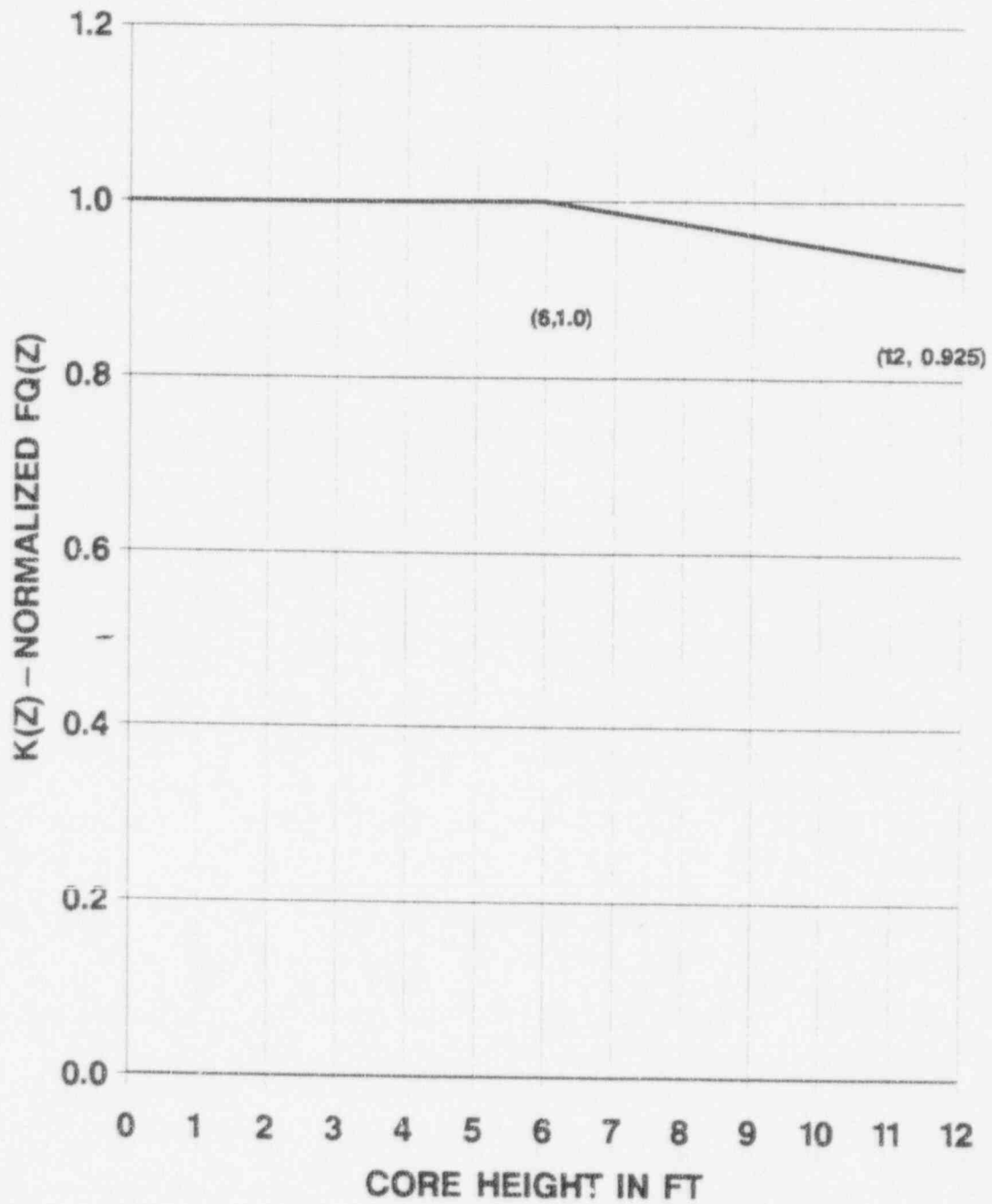


TABLE 1
COMBINED N(z) FOR NIC11 AS A FUNCTION OF CORE HEIGHT
(Plot data for Figures 5 thru 11)

	10^3 MWD/MT:	0-1	1-3	3-5	5-7	7-9	9-17.6	>17.6
	CORHT,ft	NZ1	NZ2	NZ3	NZ4	NZ5	NZ6	NZ7
Node								
10	10.2	1.196	1.196	1.196	1.151	1.151	1.179	1.18
11	10.0	1.189	1.189	1.189	1.161	1.161	1.176	1.177
12	9.8	1.18	1.179	1.179	1.171	1.171	1.175	1.173
13	9.6	1.171	1.177	1.177	1.178	1.178	1.178	1.169
14	9.4	1.161	1.182	1.182	1.183	1.183	1.181	1.162
15	9.2	1.157	1.187	1.187	1.187	1.187	1.187	1.161
16	9.0	1.159	1.191	1.191	1.191	1.191	1.191	1.168
17	8.8	1.167	1.197	1.197	1.197	1.197	1.197	1.181
18	8.6	1.172	1.206	1.206	1.206	1.206	1.205	1.19
19	8.4	1.176	1.214	1.214	1.214	1.214	1.214	1.2
20	8.2	1.178	1.220	1.220	1.220	1.220	1.220	1.208
21	8.0	1.178	1.223	1.223	1.223	1.223	1.223	1.216
22	7.8	1.177	1.225	1.225	1.225	1.225	1.226	1.223
23	7.6	1.174	1.225	1.225	1.225	1.225	1.231	1.232
24	7.4	1.17	1.223	1.223	1.223	1.223	1.24	1.241
25	7.2	1.164	1.219	1.219	1.219	1.219	1.247	1.247
26	7.0	1.157	1.213	1.213	1.213	1.213	1.25	1.25
27	6.8	1.149	1.206	1.206	1.206	1.206	1.251	1.251
28	6.6	1.14	1.195	1.195	1.195	1.195	1.247	1.247
29	6.4	1.129	1.184	1.184	1.184	1.184	1.243	1.243
30	6.2	1.117	1.171	1.171	1.171	1.171	1.232	1.232
31	6.0	1.102	1.159	1.159	1.159	1.159	1.223	1.223
32	5.8	1.091	1.148	1.148	1.148	1.148	1.207	1.207
33	5.6	1.081	1.133	1.133	1.133	1.133	1.19	1.19
34	5.4	1.081	1.122	1.122	1.122	1.122	1.169	1.169
35	5.2	1.084	1.115	1.115	1.115	1.115	1.145	1.145
36	5.0	1.093	1.116	1.116	1.116	1.116	1.131	1.131
37	4.8	1.101	1.119	1.119	1.119	1.119	1.129	1.129
38	4.6	1.109	1.122	1.122	1.122	1.122	1.13	1.13
39	4.4	1.116	1.123	1.123	1.124	1.124	1.131	1.131
40	4.2	1.122	1.124	1.124	1.124	1.124	1.131	1.131
41	4.0	1.127	1.127	1.127	1.124	1.124	1.129	1.129
42	3.8	1.135	1.134	1.134	1.123	1.123	1.125	1.125
43	3.6	1.143	1.143	1.143	1.122	1.122	1.121	1.121
44	3.4	1.152	1.152	1.152	1.120	1.120	1.117	1.117
45	3.2	1.161	1.161	1.161	1.123	1.123	1.119	1.119
46	3.0	1.169	1.169	1.169	1.128	1.128	1.123	1.123
47	2.8	1.176	1.176	1.176	1.137	1.137	1.131	1.131
48	2.6	1.185	1.185	1.185	1.145	1.145	1.14	1.14
49	2.4	1.194	1.194	1.194	1.153	1.153	1.149	1.149
50	2.2	1.202	1.202	1.202	1.16	1.160	1.157	1.157
51	2.0	1.21	1.21	1.21	1.167	1.167	1.165	1.165
52	1.8	1.218	1.218	1.218	1.173	1.173	1.171	1.171

The core height of the node is given by
CORHT,ft = 12.2 - 0.2*NODE. Node 10 is at the top of the core, node 52 at the bottom.

FIGURE 5
N(Z) FUNCTION FOR N1C11
0 - 1000 MWD/MTU BURNUP

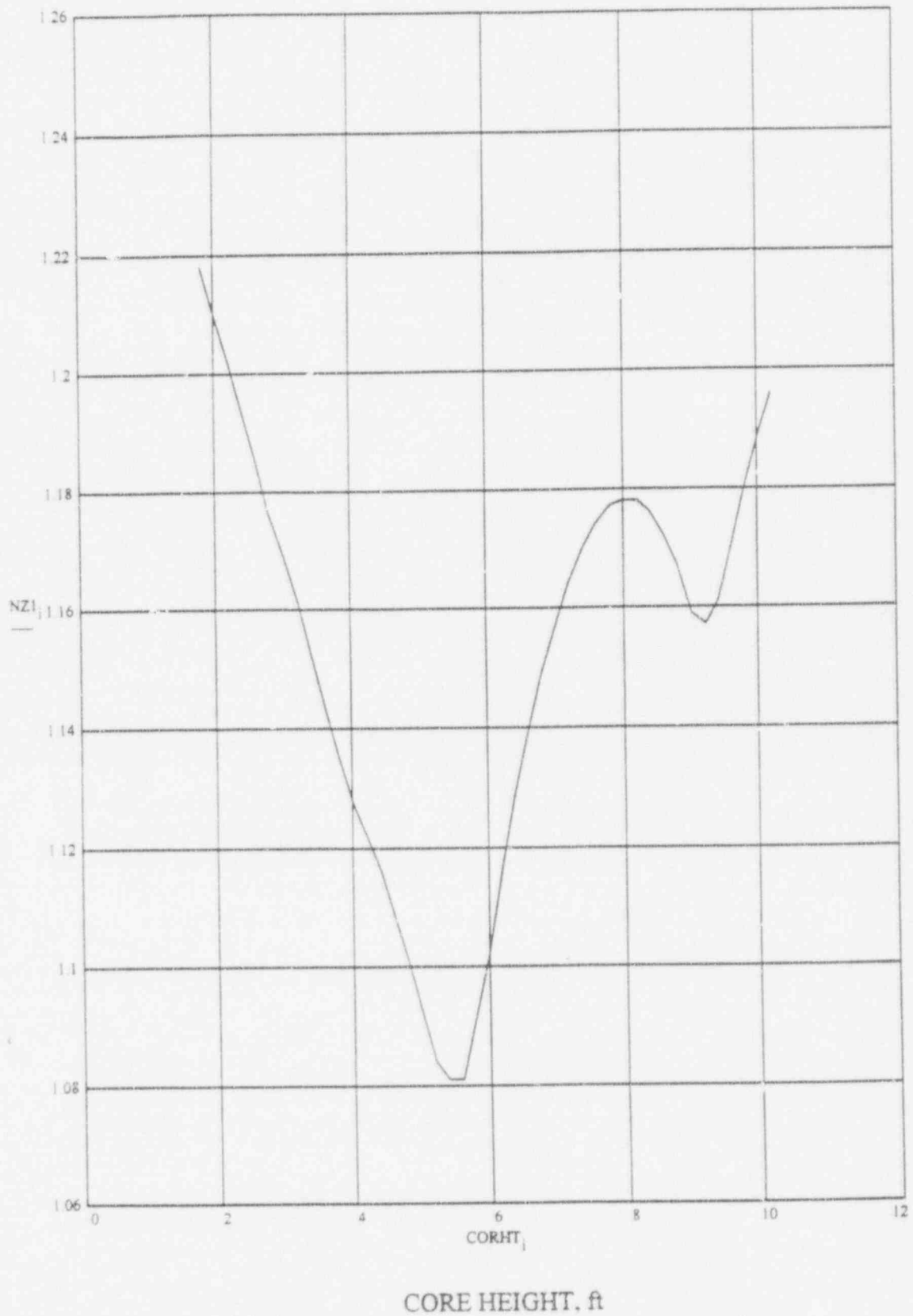
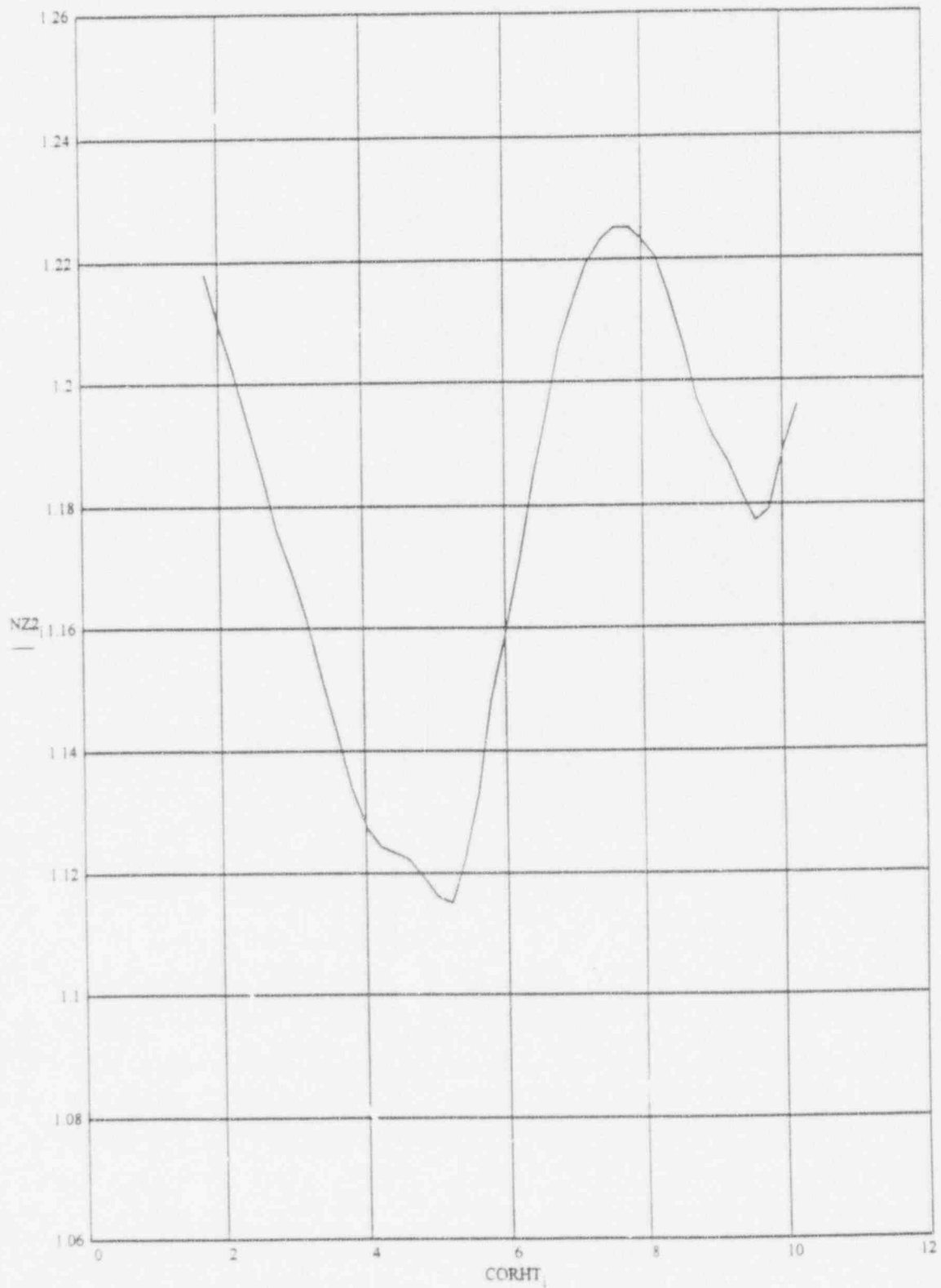
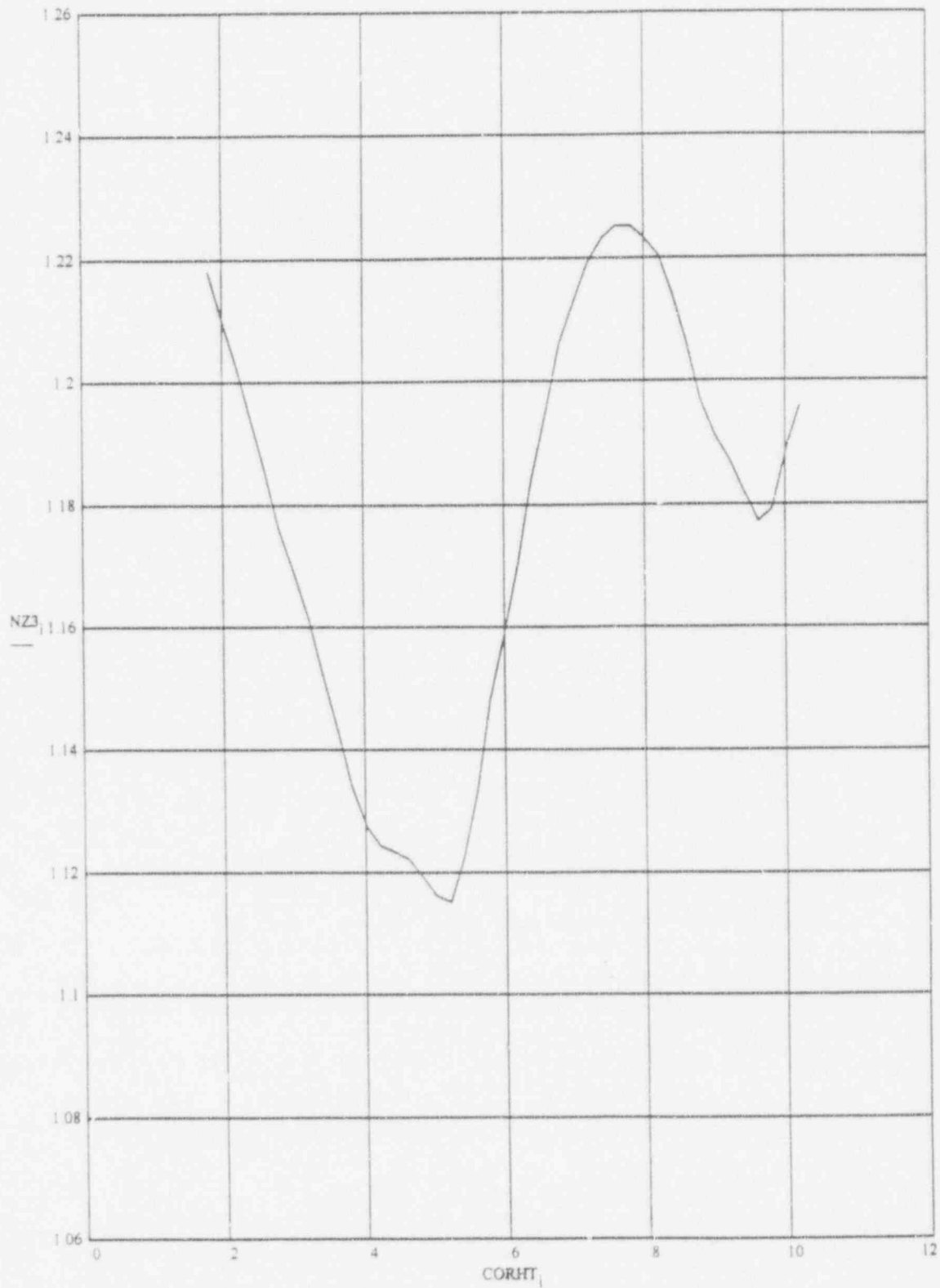


FIGURE 6
N(Z) FUNCTION FOR N1C11
1000 - 3000 M MTU BURNUP



CORE HEIGHT, ft

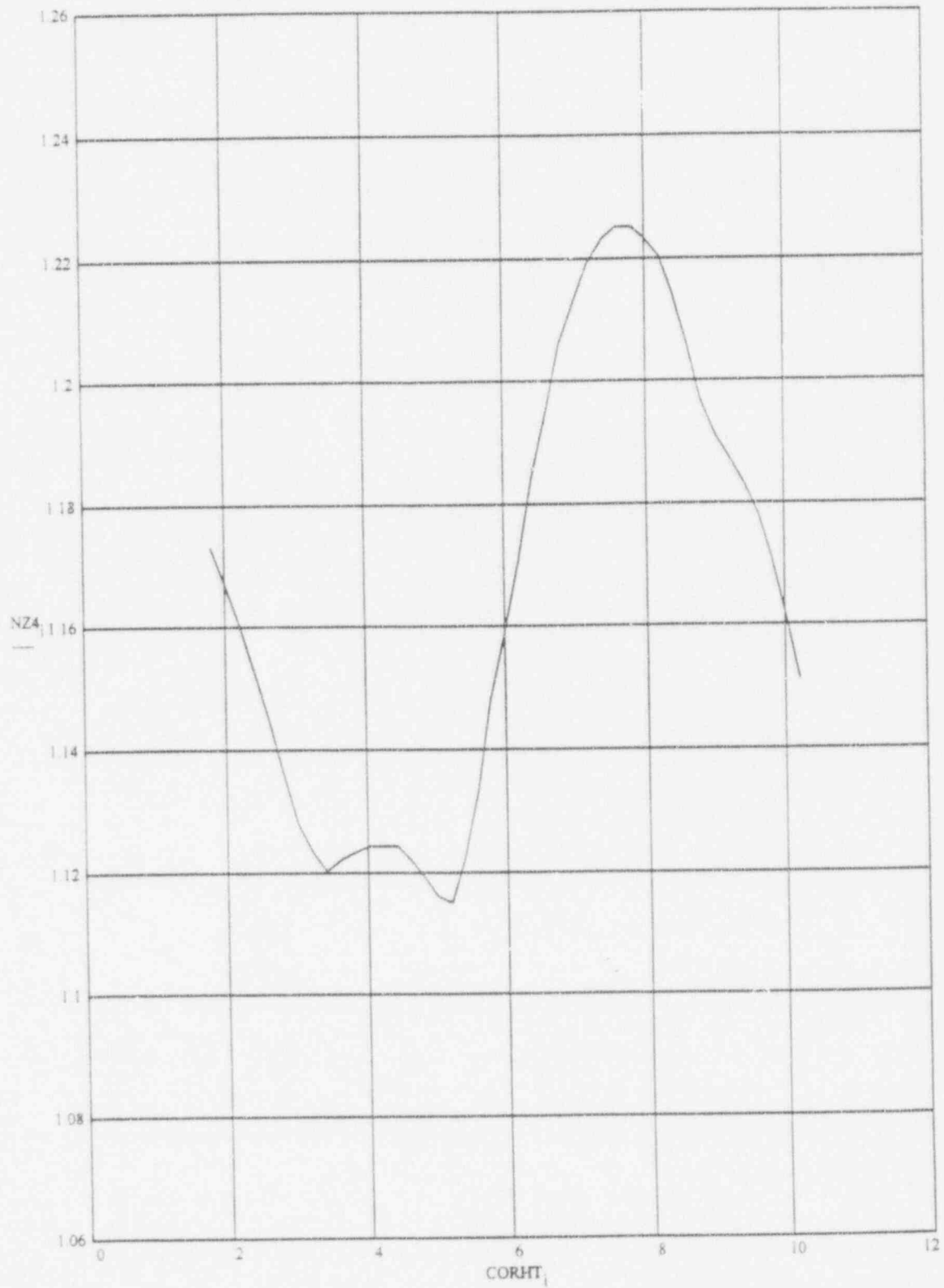
FIGURE 7
N(Z) FUNCTION FOR N1C11
3000 - 5000 MWD/MTU BURNUP



CORE HEIGHT, ft

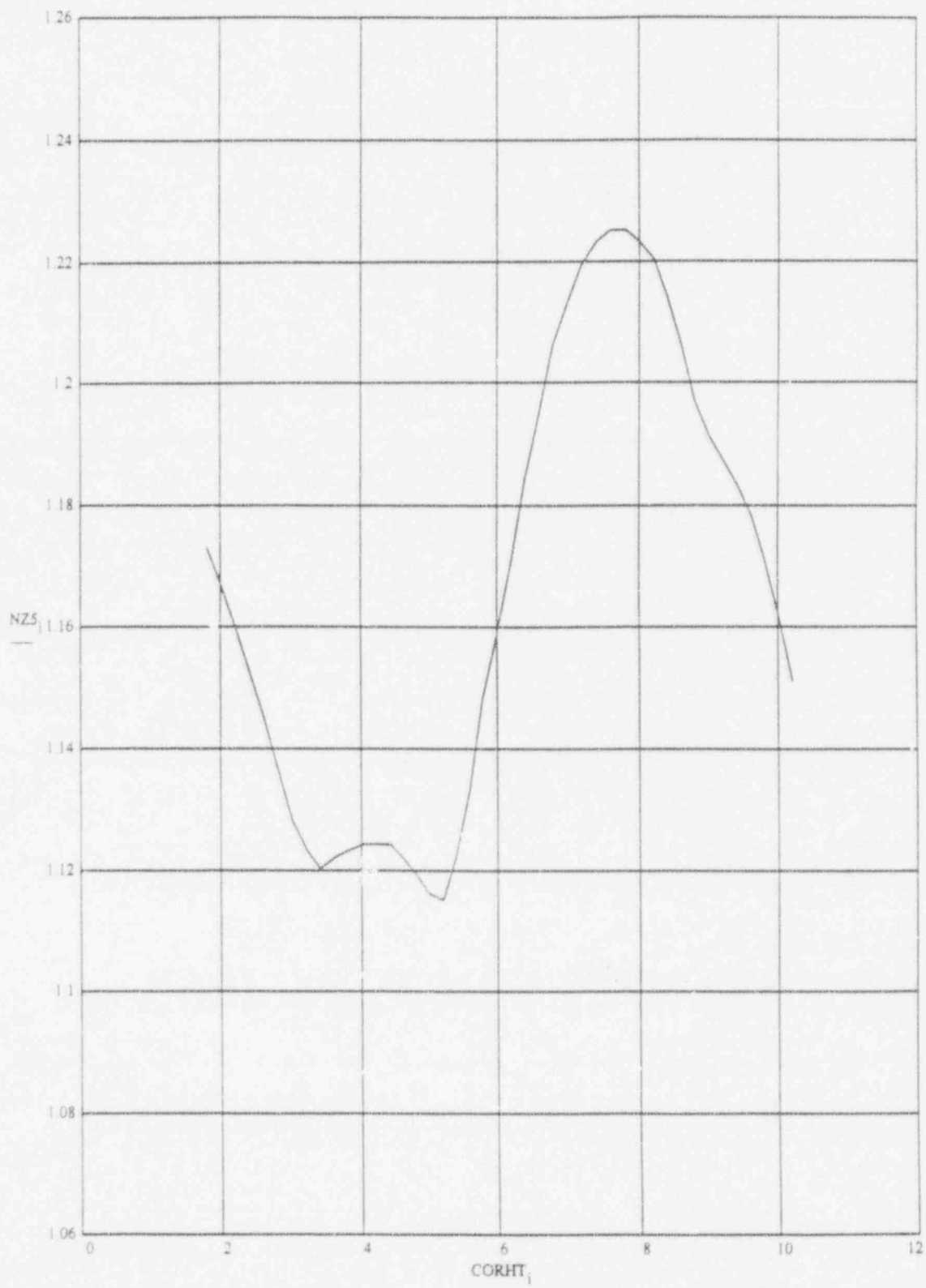
FIGURE 8

N(Z) FUNCTION FOR N1C11
5000 - 7000 MWD/MTU BURNUP



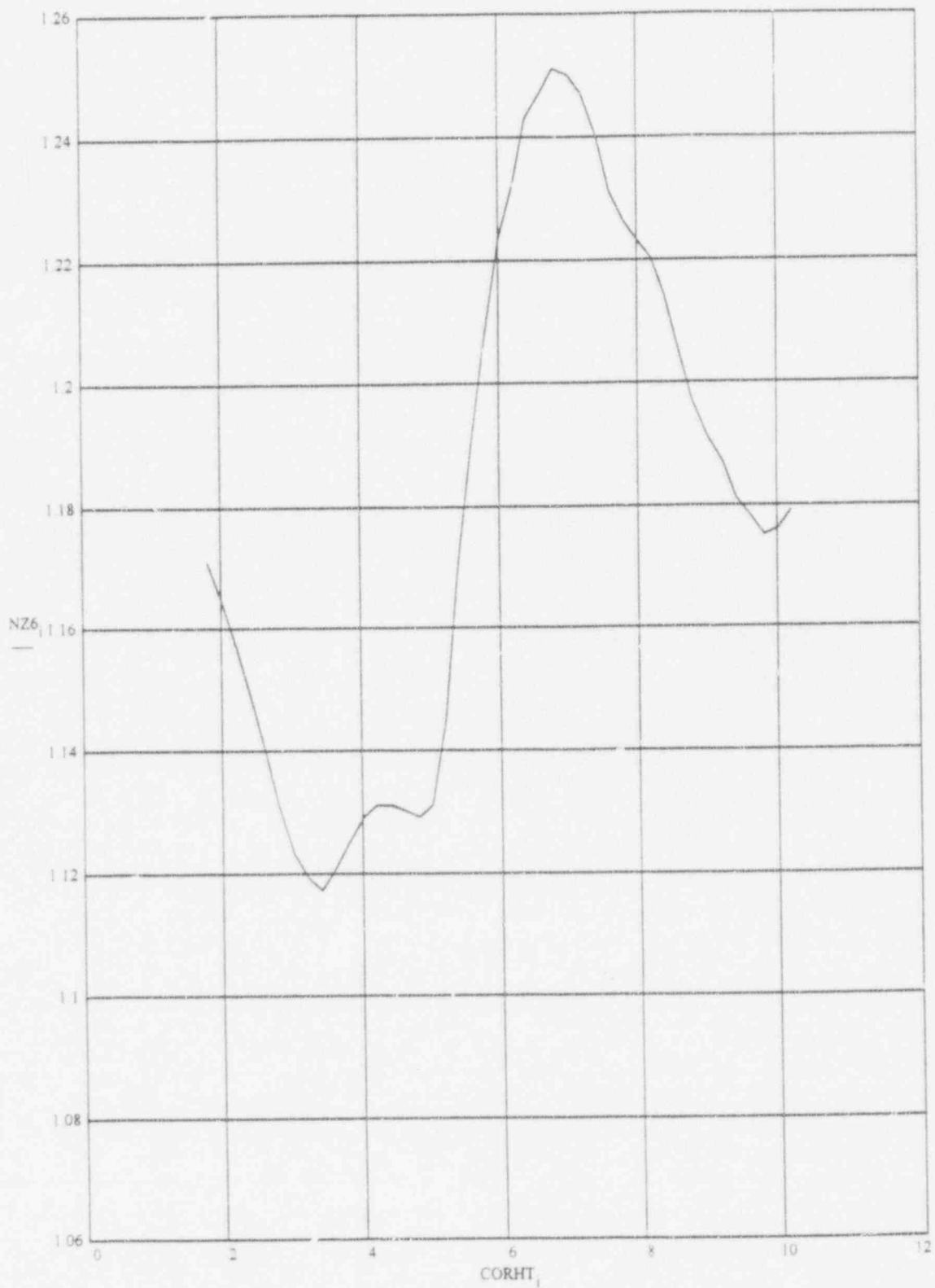
CORE HEIGHT.ft

FIGURE 9
N(Z) FUNCTION FOR N1C11
7000 - 9000 MWD/MTU BURNUP



CORE HEIGHT, ft

FIGURE 10
N(Z) FUNCTION FOR N1C11
9000 - 17600 MWD/MTU BURNUP



CORE HEIGHT.ft

FIGURE 11
N(Z) FUNCTION FOR N1C11
ABOVE 17600 MWD/MTU BURNUP

