CORE OPERATING LIMITS REPORT (COLR)

NORTH ANNA UNIT 2 CYCLE 13 PATTERN UD

Virginia Electric and Power Company

N2C13 CORE OPERATING LIMITS REPORT

1.0 INTRODUCTION

The Core Operating Limits Report (COLR) for North Anna Unit 2 Cycle 13 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 2 Cycle 13 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 $\Delta k/k/^{0}F$ below 70 percent of RATED THERMAL POWER.

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

The EOC/ARO/RTP-MTC shall be less negative than -5.0E-4 $\Delta k/k/^{0}F$.

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 $\Delta k/k/^{0}F$.

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to -4.7E-04 $\Delta k/k/^{0}F$.

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2.2.1 The shutdown rods shall be withdrawn to 227 steps.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 A-1.

2.4 Axial Flux Difference (Specification 3/4.2.1)

2.4.1 The axial flux difference limits are provided in Figure A-2.

2.5 Heat Flux Hot Channel Factor-FQ(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 A-3

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

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

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

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

K(z) is provided in Figure A-3, and

N(z) is a non-equilibrium multiplier on $F_Q(z)^M$ to account for power distribution transients during normal operation, provided in Table A-1. The top and bottom 15% of the core is excluded per TS 4.2.2.2.G.

2.6 **Nuclear Enthalpy Rise Hot Channel Factor - FΔH(N) and Power Factor Multiplier** (Specification 3/4.2.3)

$$F\Delta H(N) \leq 1.49*\{1 + 0.3*(1 - P)\}$$

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

Table A-1

N2C13 NORMAL OPERATION N(z)'s

Node	Height (feet)	0 to 1000 MWD/MTU	1000 to 3000 MWD/MTU	3000 to 5000 MWD/MTU	5000 to 7000 MWD/MTU	7000 to 9000 MWD/MTU	9000 to 17700 MWD/MTU	17700 to EOC MWD/MTU
10	10.2	1.159	1.159	1.159	1.153	1.153	1.153	1.118
11	10.0	1.158	1.158	1.158	1.152	1.152	1.152	1.119
12	9.8	1.155	1.155	1.155	1.150	1.150	1.150	1.125
13	9.6	1.155	1.155	1.155	1.149	1.149	1.149	1.134
14	9.4	1.156	1.156	1.156	1.149	1.149	1.149	1.141
15	9.2	1.162	1.162	1.162	1.153	1.153	1.153	1.149
16	9.0	1.171	1.171	1.171	1.162	1.162	1.162	1.157
17	8.8	1.181	1.181	1.181	1.173	1.173	1.173	1.166
18	8.6	1.188	1.188	1.188	1.181	1.181	1.180	1.177
19	8.4	1.193	1.193	1.193	1.187	1.187	1.187	1.187
20	8.2	1.197	1.197	1.197	1.193	1.193	1.196	1.196
21	8.0	1.200	1.200	1.200	1.196	1.196	1.203	1.203
22	7.8	1.203	1.203	1.203	1.198	1.198	1.209	1.209
23	7.6	1.205	1.205	1.205	1.198	1.198	1.213	1.213
24	7.4	1.205	1.205	1.205	1.197	1.197	1.217	1.217
25	7.2	1.204	1.204	1.204	1.194	1.194	1.219	1.219
26	7.0	1.200	1.200	1.200	1.190	1.190	1.218	1.218
27	6.8	1.196	1.196	1.196	1.184	1.184	1.217	1.217
28	6.6	1.190	1.190	1.190	1.177	1.177	1.214	1.214
29	6.4	1.183	1.183	1.183	1.170	1.170	1.210	1.210
30	6.2	1.172	1.172	1.172	1.162	1.162	1.202	1.202
31	6.0	1.162	1.162	1.162	1.154	1.154	1.195	1.195
32	5.8	1.149	1.149	1.149	1.144	1.144	1.184	1.184
33	5.6	1.135	1.135	1.135	1.132	1.132	1.173	1.173
34	5.4	1.122	1.122	1.122	1.119	1.119	1.156	1.156
35	5.2	1.111	1.111	1.111	1.106	1.106	1.135	1.135
36	5.0	1.105	1.105	1.105	1.098	1.098	1.119	1.119
37	4.8	1.104	1.104	1.104	1.096	1.096	1.113	1.113
38	4.6	1.107	1.107	1.107	1.098	1.098	1.115	1.115
39	4.4	1.113	1.113	1.113	1.100	1.100	1.118	1.118
40	4.2	1.118	1.118	1.118	1.104	1.104	1.121	1.121
41	4.0	1.122	1.122	1.122	1.109	1.109	1.123	1.123
42	3.8	1.126	1.126	1.126	1.114	1.114	1.124	1.124
43	3.6	1.131	1.131	1.131	1.121	1.121	1.127	1.127
44	3.4	1.136	1.136	1.136	1.130	1.130	1.131	1.130
45	3.2	1.143	1.143	1.143	1.140	1.140	1.140	1.138
46	3.0	1.149	1.149	1.150	1.150	1.150	1.151	1.150
47	2.8	1.157	1.157	1.159	1.159	1.159	1.166	1.166
48	2.6	1.166	1.166	1.167	1.168	1.168	1.178	1.178
49	2.4	1.175	1.175	1.176	1.176	1.176	1.191	1.191
50	2.2	1.183	1.183	1.184	1.184	1.184	1.203	1.203
51	2.0	1.190	1.190	1.191	1.191	1.191	1.213	1.213
52	1.8	1.197	1.197	1.198	1.198	1.198	1.223	1.223

Figure A-1

Control Rod Bank Insertion Limits

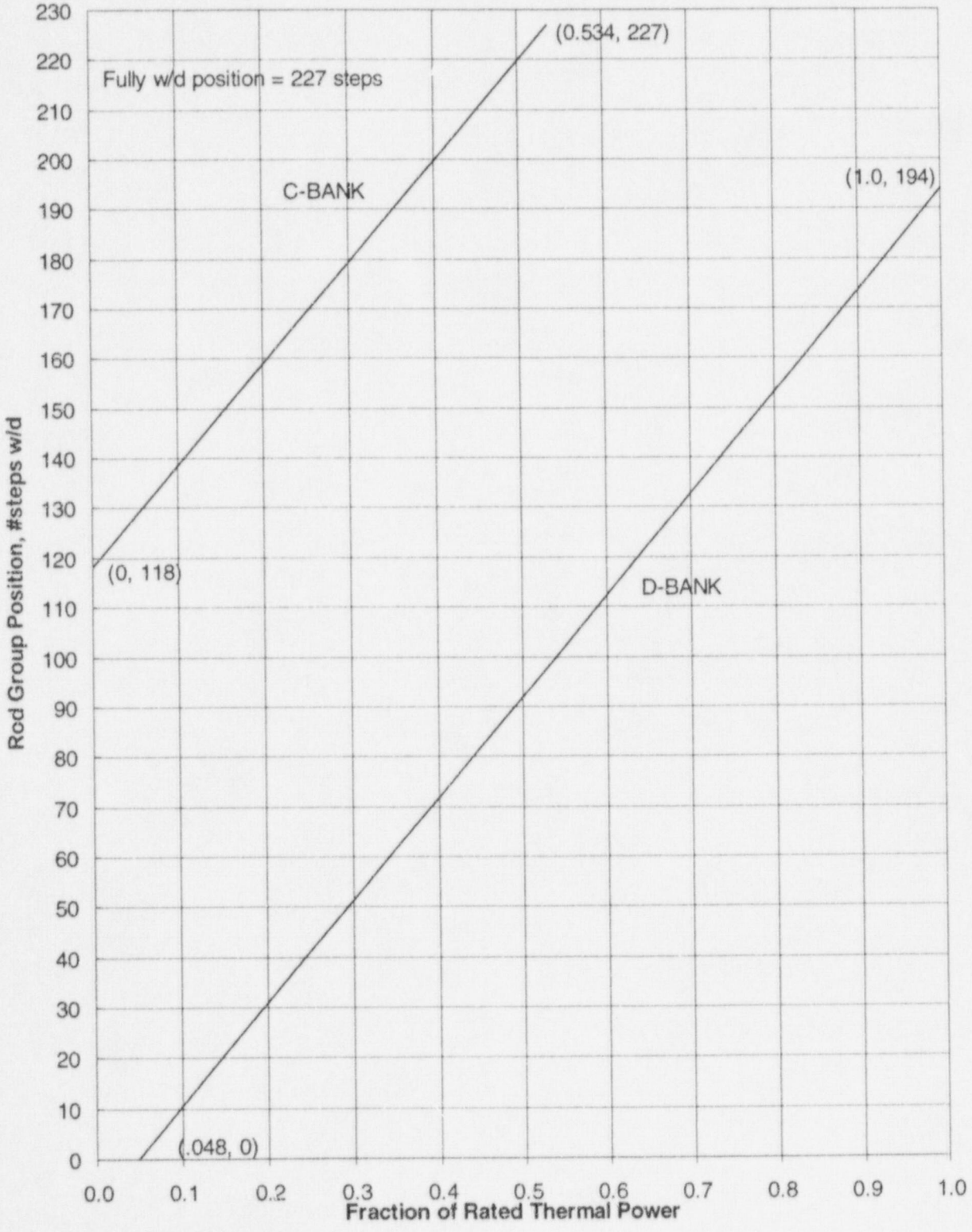

Figure A-2
N2C13 Axial Flux Difference Limits

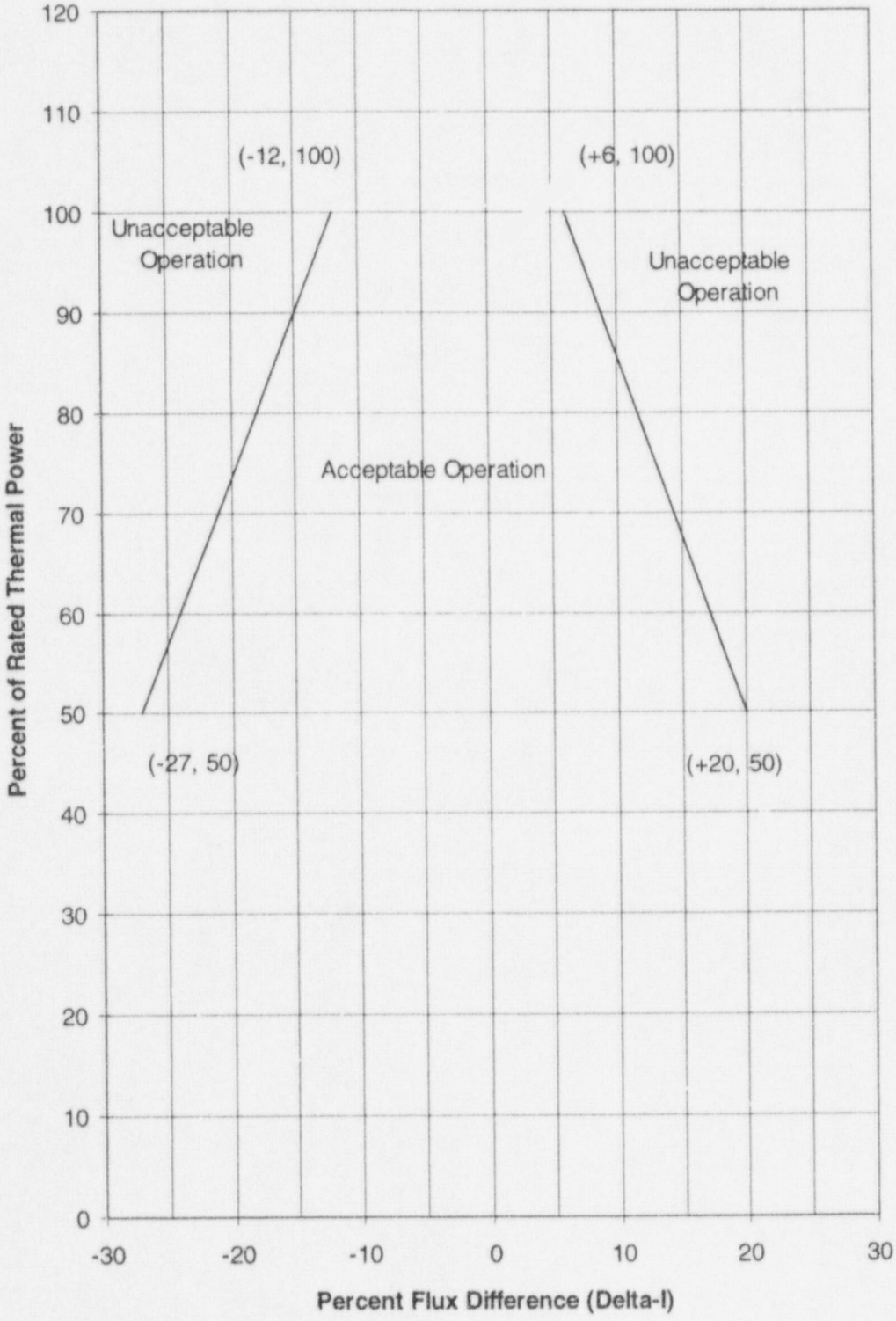

Figure A-3
K(Z) - Normalized FQ as a Function of Core Height