APPENDIX A

CORE OPERATING LIMITS REPORT Rev 1
North Anna 1 Cycle 14 Pattern XY
with EOC Tavg Coastdown

N1C14 CORE OPERATING LIMITS

1.0 INTRODUCTION

This revised Core Operating Limits Report (COLR) for North Anna Unit 1 Cycle 14 is being 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 14 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.

The heat flux hot channel factor surveillance specification 4.2.2.2 requires the application of a cycle dependent function, N(z) to the measured $F_Q(z)$ before comparing it to the limit. N(z) accounts for power distribution transients encountered during normal operation. As function N(z) is dependent on the predicted equilibrium $F_Q(z)$ and is sensitive to the axial power distribution, it has been generated using the actual EOC burnup distribution following the shutdown of Cycle 13. The N(z) function† is provided in Table A-1.

This revision specifies a revised limit for FQ(z) that is applicable to EOC temperature coastdown operation. All other COLR parameters remain unchanged.

† ET No. NAF 2000-0001 Rev 0, 01/04/2000

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 $\Delta k/k/^0F$ (+6 $pcm/^0F$) below 70 percent of RATED THERMAL POWER.

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

The EOC/ARO/RTP-MTC shall be less negative than -5.0E-4 $\Delta k/k/^0F$ (-50 $pcm/^0F$).

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 $\Delta k/k/^0F$ (-40 $pcm/^0F$).

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to -4.7E-4 $\Delta k/k/^0F$ (-47 $pcm/^0F$).

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 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-F_Q(z) (Specification 3/4.2.2)

The change in the FQ limit for temperature coastdown is accommodated by defining a variable quantity, FQ_{lim} as indicated below. Then, the following expressions can be used for both normal operation and Tavg coastdown regimes.

FQ_{lim} = 2.19, for normal operation at full power;

FQ_{lim} = 2.15, for flux map immediately preceding EOC temperature coastdown and during coastdown operation.‡

2.5.1 The F_Q(z) limits are:

$$F_Q(z) \leq \frac{FQ_{lim}}{P} * K(z) \quad \text{for } P > 0.5$$

$$F_Q(z) \leq 2*FQ_{lim} * K(z) \quad \text{for } P \leq 0.5$$

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

K(z) is provided in Figure A-3

2.5.2 The F_Q(z) surveillance limits are:

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

‡NAPS 1 & 2 Safety Evaluation No. 99-SE-OT-26 Rev 1, 8/5/1999

$$F_Q(z)^M \leq 2*FQ_{lim} * \frac{K(z)}{N(z)} \quad \text{for } P \leq 0.5$$

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

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.

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
N1C14 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 18200 MWD/MTU	18200 to EOC MWD/MTU
10	10.2	1.141	1.141	1.146	1.146	1.146	1.146	1.124
11	10.0	1.139	1.139	1.146	1.146	1.146	1.146	1.126
12	9.8	1.135	1.135	1.149	1.149	1.149	1.149	1.130
13	9.6	1.134	1.134	1.154	1.154	1.154	1.154	1.138
14	9.4	1.140	1.140	1.159	1.159	1.159	1.159	1.146
15	9.2	1.151	1.151	1.165	1.165	1.165	1.165	1.153
16	9.0	1.159	1.159	1.168	1.168	1.168	1.168	1.159
17	8.8	1.165	1.165	1.172	1.172	1.172	1.172	1.165
18	8.6	1.170	1.170	1.180	1.180	1.180	1.180	1.168
19	8.4	1.172	1.172	1.188	1.188	1.188	1.187	1.173
20	8.2	1.174	1.174	1.194	1.194	1.194	1.192	1.183
21	8.0	1.172	1.172	1.197	1.197	1.197	1.198	1.194
22	7.8	1.170	1.170	1.200	1.200	1.200	1.207	1.206
23	7.6	1.167	1.167	1.200	1.200	1.200	1.216	1.217
24	7.4	1.165	1.165	1.200	1.200	1.200	1.224	1.224
25	7.2	1.161	1.161	1.197	1.197	1.197	1.229	1.229
26	7.0	1.155	1.155	1.193	1.193	1.193	1.231	1.231
27	6.8	1.149	1.149	1.190	1.190	1.190	1.231	1.232
28	6.6	1.141	1.141	1.185	1.185	1.185	1.228	1.228
29	6.4	1.131	1.131	1.178	1.178	1.178	1.223	1.223
30	6.2	1.122	1.122	1.168	1.168	1.168	1.213	1.213
31	6.0	1.119	1.119	1.158	1.158	1.158	1.203	1.203
32	5.8	1.118	1.118	1.147	1.147	1.147	1.188	1.188
33	5.6	1.114	1.114	1.134	1.134	1.134	1.175	1.175
34	5.4	1.108	1.108	1.121	1.121	1.121	1.159	1.159
35	5.2	1.097	1.097	1.109	1.109	1.109	1.140	1.140
36	5.0	1.090	1.090	1.104	1.104	1.104	1.127	1.127
37	4.8	1.089	1.089	1.105	1.106	1.106	1.120	1.120
38	4.6	1.095	1.095	1.108	1.109	1.109	1.119	1.119
39	4.4	1.105	1.105	1.110	1.111	1.111	1.122	1.122
40	4.2	1.115	1.115	1.115	1.115	1.115	1.125	1.125
41	4.0	1.124	1.124	1.124	1.121	1.121	1.128	1.128
42	3.8	1.134	1.134	1.134	1.126	1.126	1.134	1.134
43	3.6	1.144	1.144	1.144	1.130	1.130	1.141	1.141
44	3.4	1.154	1.154	1.154	1.131	1.131	1.145	1.145
45	3.2	1.163	1.163	1.163	1.135	1.135	1.150	1.150
46	3.0	1.173	1.173	1.172	1.141	1.141	1.152	1.152
47	2.8	1.181	1.181	1.181	1.149	1.149	1.158	1.158
48	2.6	1.189	1.189	1.189	1.157	1.157	1.168	1.168
49	2.4	1.197	1.197	1.197	1.165	1.165	1.180	1.180
50	2.2	1.204	1.204	1.204	1.172	1.172	1.190	1.190
51	2.0	1.212	1.212	1.212	1.178	1.178	1.200	1.200
52	1.8	1.220	1.220	1.220	1.185	1.185	1.209	1.209

Figure A-1

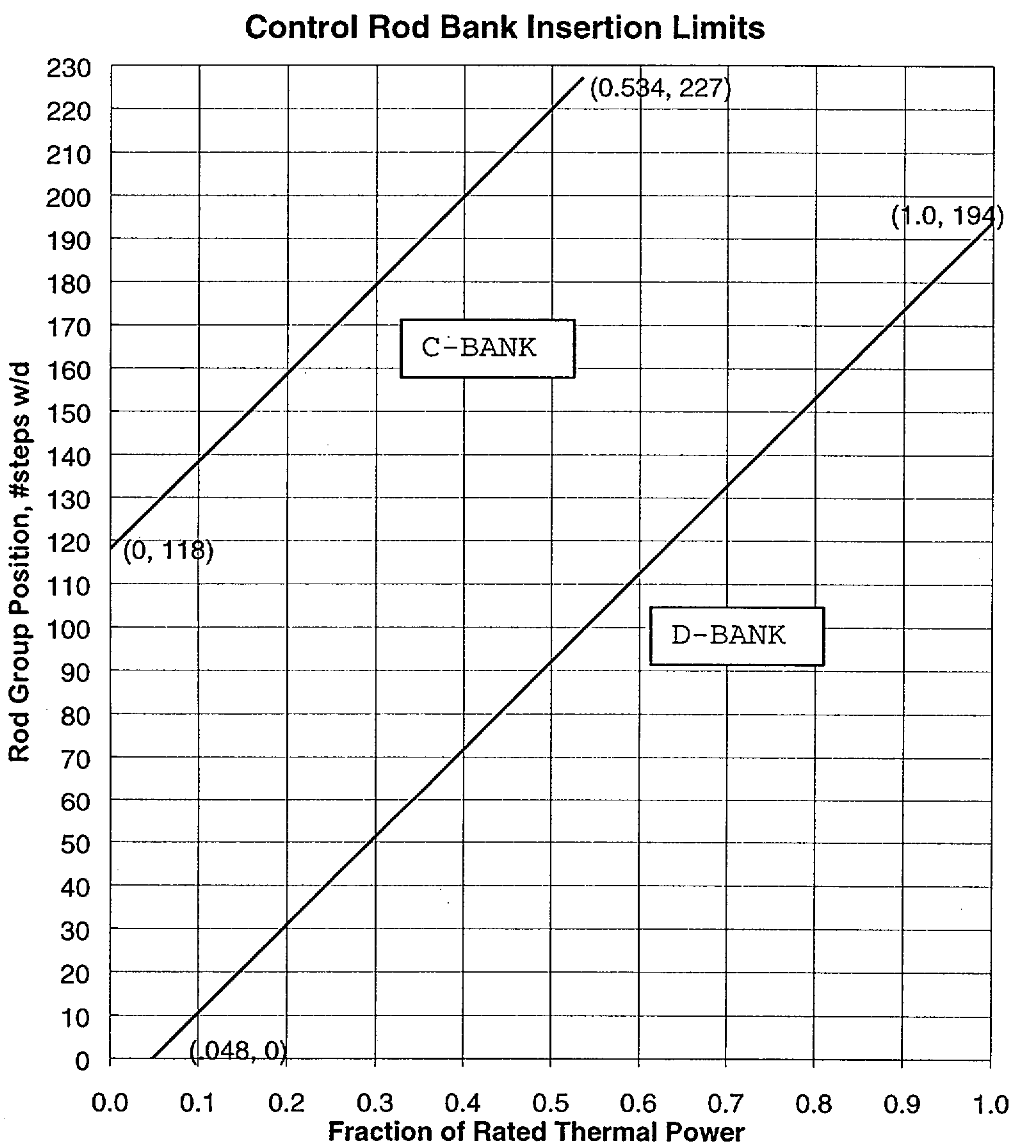
Control Rod Bank Insertion Limits
(0.534, 227)
(1.0, 194)
C-BANK
(0, 118)
D-BANK
(.048, 0)
Rod Group Position, #steps w/d
Fraction of Rated Thermal Power
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

Figure A-2
N1C14 Axial Flux Difference Limits

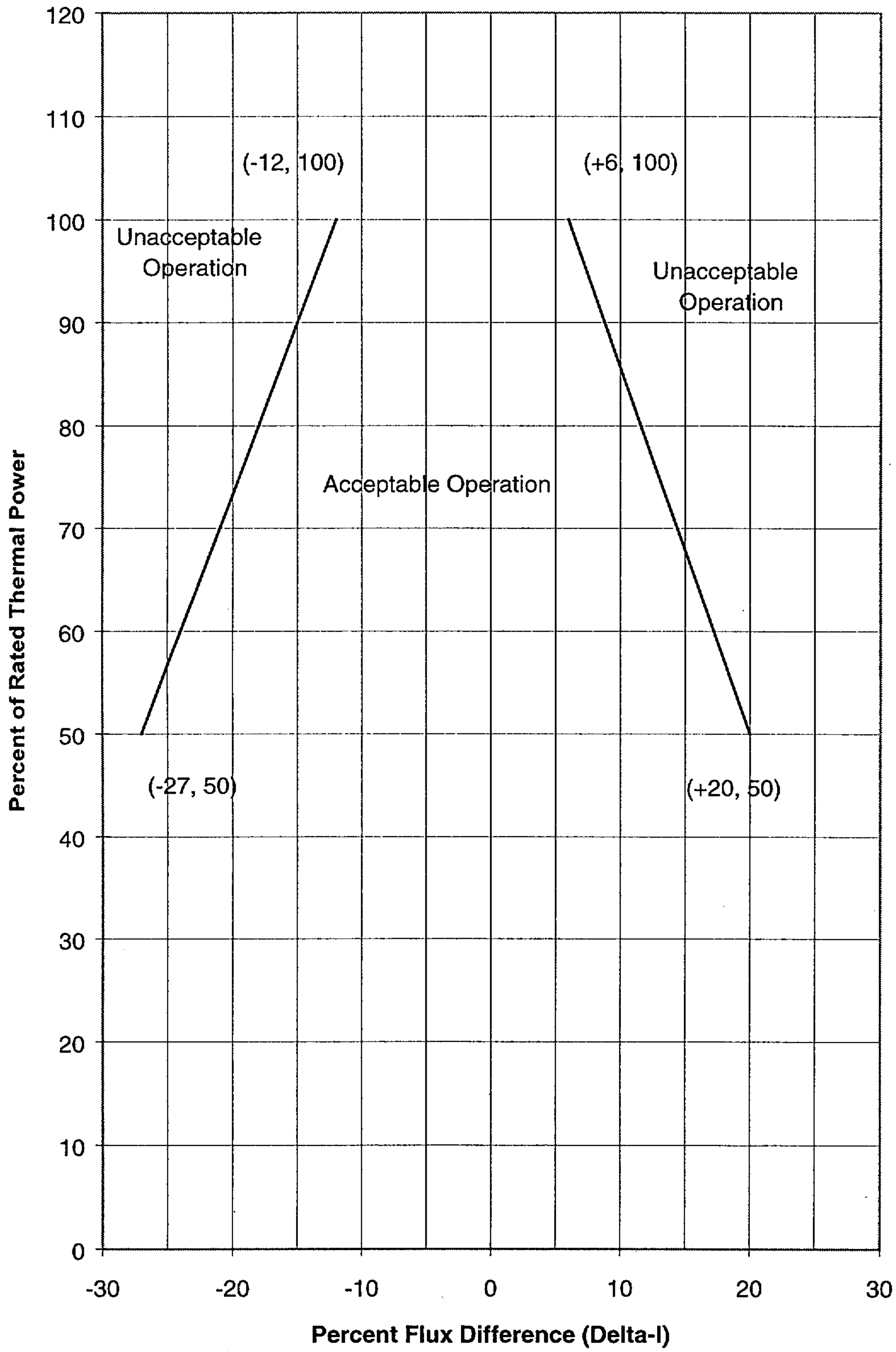

Figure A-3
K(Z) - Normalized FQ as a Function of Core Height