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Dominion®

October 31, 2016

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Serial No.: 16-398
NRA/DEA: R0
Docket No.: 50-338
License No.: NPF-4

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
NORTH ANNA POWER STATION UNIT 1
CORE OPERATING LIMITS REPORT
NORTH ANNA 1 CYCLE 26 PATTERN CYA REVISION 1

Pursuant to North Anna Technical Specification 5.6.5.d, attached is a copy of the Dominion Core Operating Limits Report (COLR) for North Anna Unit 1 Cycle 26, Pattern CYA, Revision 1.

If you have any questions or require additional information, please contact Ms. Diane Aitken at (804) 273-2694.

Sincerely,

T. R. Huber, Director
Nuclear Regulatory Affairs
Dominion Resources Services, Inc. for
Virginia Electric and Power Company

Attachment:

COLR-N1C26, Revision 1, Core Operating Limits Report, North Anna Unit 1 Cycle 26 Pattern CYA

Commitment Summary: There are no new commitments contained in this letter.

A001
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ATTACHMENT

COLR-N1C26, Revision 1

CORE OPERATING LIMITS REPORT
North Anna Unit 1 Cycle 26 Pattern CYA

N1C26 CORE OPERATING LIMITS REPORT

INTRODUCTION

The Core Operating Limits Report (COLR) for North Anna Unit 1 Cycle 26 has been prepared in accordance with North Anna Technical Specification 5.6.5. The technical specifications affected by this report are listed below:

TS 2.1.1	Reactor Core Safety Limits
TS 3.1.1	Shutdown Margin (SDM)
TS 3.1.3	Moderator Temperature Coefficient (MTC)
TS 3.1.4	Rod Group Alignment Limits
TS 3.1.5	Shutdown Bank Insertion Limit
TS 3.1.6	Control Bank Insertion Limits
TS 3.1.9	PHYSICS TESTS Exceptions – Mode 2
TS 3.2.1	Heat Flux Hot Channel Factor
TS 3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)
TS 3.2.3	Axial Flux Difference (AFD)
TS 3.3.1	Reactor Trip System (RTS) Instrumentation
TS 3.4.1	RCS Pressure, Temperature, and Flow DNB Limits
TS 3.5.6	Boron Injection Tank (BIT)
TS 3.9.1	Boron Concentration

In addition, a technical requirement (TR) in the NAPS Technical Requirements Manual (TRM) refers to the COLR:

TR 3.1.1 Boration Flow Paths – Operating

The analytical methods used to determine the core operating limits are those previously approved by the NRC and discussed in the documents listed in the References Section.

Cycle-specific values are presented **in bold.** Text in *italics* is provided for information only.

REFERENCES

1. VEP-FRD-42, Rev. 2.1-A, "Reload Nuclear Design Methodology," August 2003.

   Methodology for:
   TS 3.1.1 – Shutdown Margin
   TS 3.1.3 – Moderator Temperature Coefficient
   TS 3.1.4 – Rod Group Alignment Limits
   TS 3.1.5 – Shutdown Bank Insertion Limit
   TS 3.1.6 – Control Bank Insertion Limits
   TS 3.1.9 – Physics Tests Exceptions – Mode 2
   TS 3.2.1 – Heat Flux Hot Channel Factor
   TS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor
   TS 3.5.6 – Boron Injection Tank (BIT) and
   TS 3.9.1 – Boron Concentration

2. Plant-specific adaptation of WCAP-16009-P-A, "Realistic Large Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," as approved by NRC Safety Evaluation Report dated February 29, 2012.

   Methodology for: TS 3.2.1 – Heat Flux Hot Channel Factor

3. WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code," August 1985.

   Methodology for: TS 3.2.1 – Heat Flux Hot Channel Factor

4. WCAP-10079-P-A, "NOTRUMP, A Nodal Transient Small Break and General Network Code," August 1985.

   Methodology for: TS 3.2.1 – Heat Flux Hot Channel Factor

5. WCAP-12610-P-A, "VANTAGE+ FUEL ASSEMBLY – REFERENCE CORE REPORT," April 1995.

   Methodology for:
   TS 2.1.1 – Reactor Core Safety Limits
   TS 3.2.1 – Heat Flux Hot Channel Factor

6. VEP-NE-2, Rev. 0-A, "Statistical DNBR Evaluation Methodology," June 1987.

   Methodology for:
   TS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and
   TS 3.4.1 – RCS Pressure, Temperature and Flow DNB Limits

7. VEP-NE-1, Rev. 0.1-A, "Relaxed Power Distribution Control Methodology and Associated FQ Surveillance Technical Specifications," August 2003.

   Methodology for:
   TS 3.2.1 – Heat Flux Hot Channel Factor and
   TS 3.2.3 – Axial Flux Difference

8. WCAP-8745-P-A, "Design Bases for the Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.

   Methodology for:
   TS 2.1.1 – Reactor Core Safety Limits and
   TS 3.3.1 – Reactor Trip System Instrumentation

9. WCAP-14483-A, "Generic Methodology for Expanded Core Operating Limits Report," January 1999.

   Methodology for:
   TS 2.1.1 – Reactor Core Safety Limits
   TS 3.1.1 – Shutdown Margin
   TS 3.1.4 – Rod Group Alignment Limits
   TS 3.1.9 – Physics Tests Exceptions – Mode 2
   TS 3.3.1 – Reactor Trip System Instrumentation
   TS 3.4.1 – RCS Pressure, Temperature, and Flow DNB Limits
   TS 3.5.6 – Boron Injection Tank (BIT) and
   TS 3.9.1 – Boron Concentration

10. DOM-NAF-2, Rev. 0.3- P-A, "Reactor Core Thermal-Hydraulics Using the VIPRE-D Computer Code," including Appendix C, "Qualification of the Westinghouse WRB-2M CHF Correlation in the Dominion VIPRE-D Computer Code," August 2010 and Appendix D, "Qualification of the ABB-NV and WLOP CHF Correlations in the Dominion VIPRE-D Computer Code," September 2014.

    Methodology for:
    TS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and
    TS 3.4.1 – RCS Pressure, Temperature and Flow DNB Limits

11. WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "Optimized ZIRLO™," July 2006.

    Methodology for:
    TS 2.1.1 – Reactor Core Safety Limits and
    TS 3.2.1 – Heat Flux Hot Channel Factor

2.0 SAFETY LIMITS (SLs)

2.1 SLs

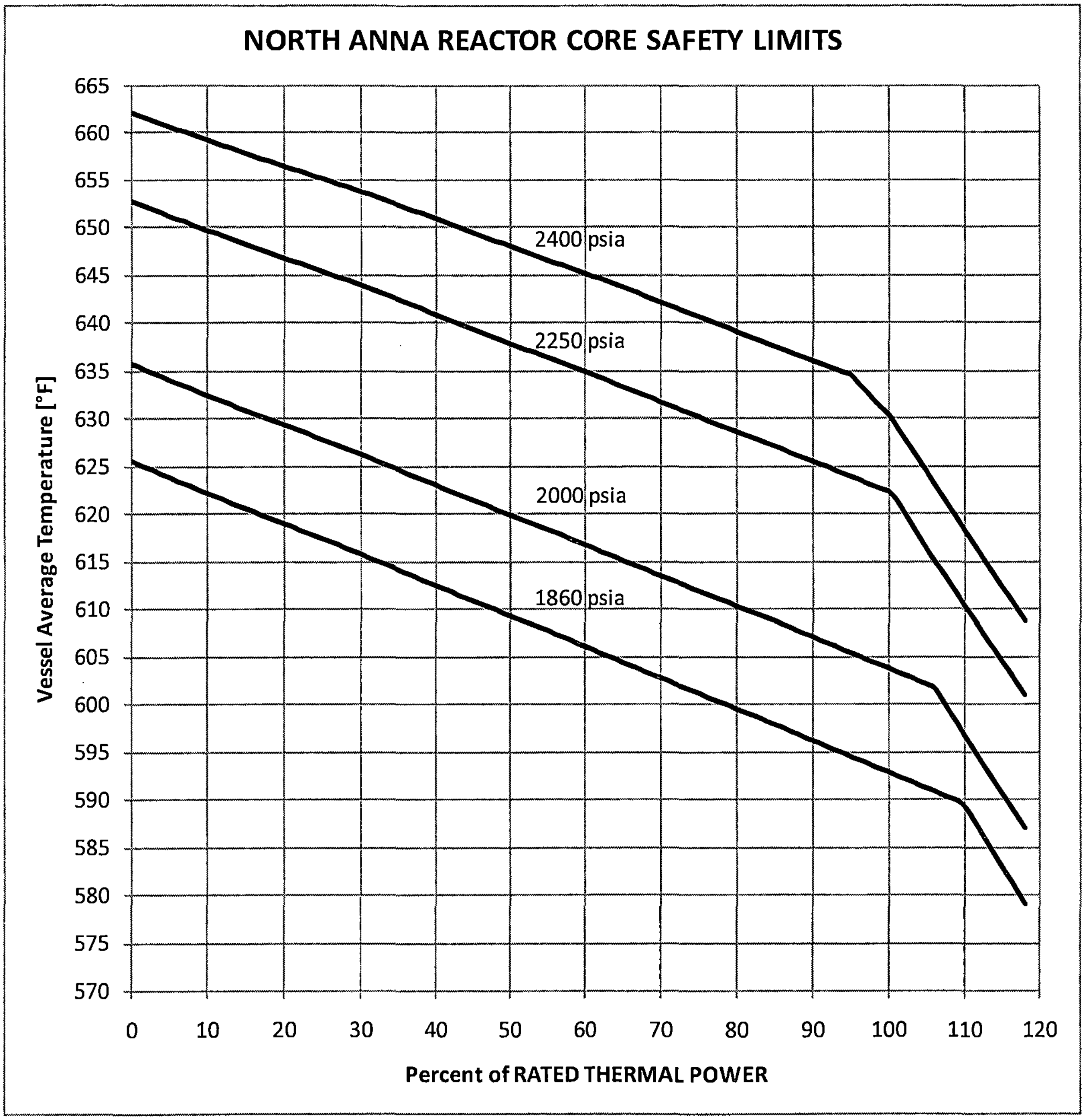
2.1.1 Reactor Core SLs

In MODES 1 and 2, the combination of THERMAL POWER, Reactor Coolant System (RCS) highest loop average temperature, and pressurizer pressure shall not exceed the limits specified in **COLR Figure 2.1-1**; and the following SLs shall not be exceeded.

2.1.1.1 The departure from nucleate boiling ratio (DNBR) shall be maintained greater than or equal to the 95/95 DNBR criterion for the DNB correlations and methodologies specified in the References Section.

2.1.1.2 The peak fuel centerline temperature shall be maintained < 5080°F, decreasing by 58°F per 10,000 MWD/MTU of burnup, for Westinghouse fuel *and < 5173°F, decreasing by 65°F per 10,000 MWD/MTU of burnup, for AREVA fuel.*

COLR Figure 2.1-1



3.1 REACTIVITY CONTROL SYSTEMS

3.1.1 SHUTDOWN MARGIN (SDM)

LCO 3.1.1 SDM shall be ≥ **1.77 % Δk/k.**

3.1.3 Moderator Temperature Coefficient (MTC)

LCO 3.1.3 The MTC shall be maintained within the limits specified below. The upper limit of MTC is **+0.6 x 10^{-4} Δk/k/°F**, when < 70% RTP, and **0.0 Δk/k/°F** when ≥ 70% RTP.

The BOC/ARO-MTC shall be ≤ **+0.6 x 10^{-4} Δk/k/°F** (upper limit), when < 70% RTP, and ≤ **0.0 Δk/k/°F** when ≥ 70% RTP.

The EOC/ARO/RTP-MTC shall be less negative than **–5.0 x 10^{-4} Δk/k/°F** (lower limit).

The MTC surveillance limits are:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to **–4.0 x 10^{-4} Δk/k/°F** [Note 1].

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to **–4.7 x 10^{-4} Δk/k/°F** [Note 2].

SR 3.1.3.2 Verify MTC is within **–5.0 x 10^{-4} Δk/k/°F** (lower limit).

Note 1: If the MTC is more negative than **–4.0 x 10^{-4} Δk/k/°F**, SR 3.1.3.2 shall be repeated once per 14 EFPD during the remainder of the fuel cycle.

Note 2: SR 3.1.3.2 need not be repeated if the MTC measured at the equivalent of equilibrium RTP-ARO boron concentration of ≤ 60 ppm is less negative than **–4.7 x 10^{-4} Δk/k/°F**.

3.1.4 Rod Group Alignment Limits

Required Action A.1.1 Verify SDM to be ≥ **1.77 % Δk/k.**

Required Action B.1.1 Verify SDM to be ≥ **1.77 % Δk/k.**

Required Action D.1.1 Verify SDM to be ≥ **1.77 % Δk/k.**

3.1.5 Shutdown Bank Insertion Limits

LCO 3.1.5 Each shutdown bank shall be withdrawn to at least **229** steps.

Required Action A.1.1 Verify SDM to be ≥ **1.77 % Δk/k.**

Required Action B.1 Verify SDM to be ≥ **1.77 % Δk/k.**

SR 3.1.5.1 Verify each shutdown bank is withdrawn to at least **229** steps.

3.1.6 Control Bank Insertion Limits

LCO 3.1.6 Control banks shall be limited in physical insertion as shown in **COLR Figure 3.1-1.** Sequence of withdrawal shall be A, B, C and D, in that order; and the overlap limit during withdrawal shall be **101** steps.

Required Action A.1.1 Verify SDM to be ≥ **1.77 % Δk/k.**

Required Action B.1.1 Verify SDM to be ≥ **1.77 % Δk/k.**

Required Action C.1 Verify SDM to be ≥ **1.77 % Δk/k.**

SR 3.1.6.1 Verify estimated critical control bank position is within the insertion limits specified in **COLR Figure 3.1-1.**

SR 3.1.6.2 Verify each control bank is within the insertion limits specified in **COLR Figure 3.1-1**.

SR 3.1.6.3 Verify each control bank not fully withdrawn from the core is within the sequence and overlap limits specified in **LCO 3.1.6 above.**

3.1.9 PHYSICS TESTS Exceptions – MODE 2

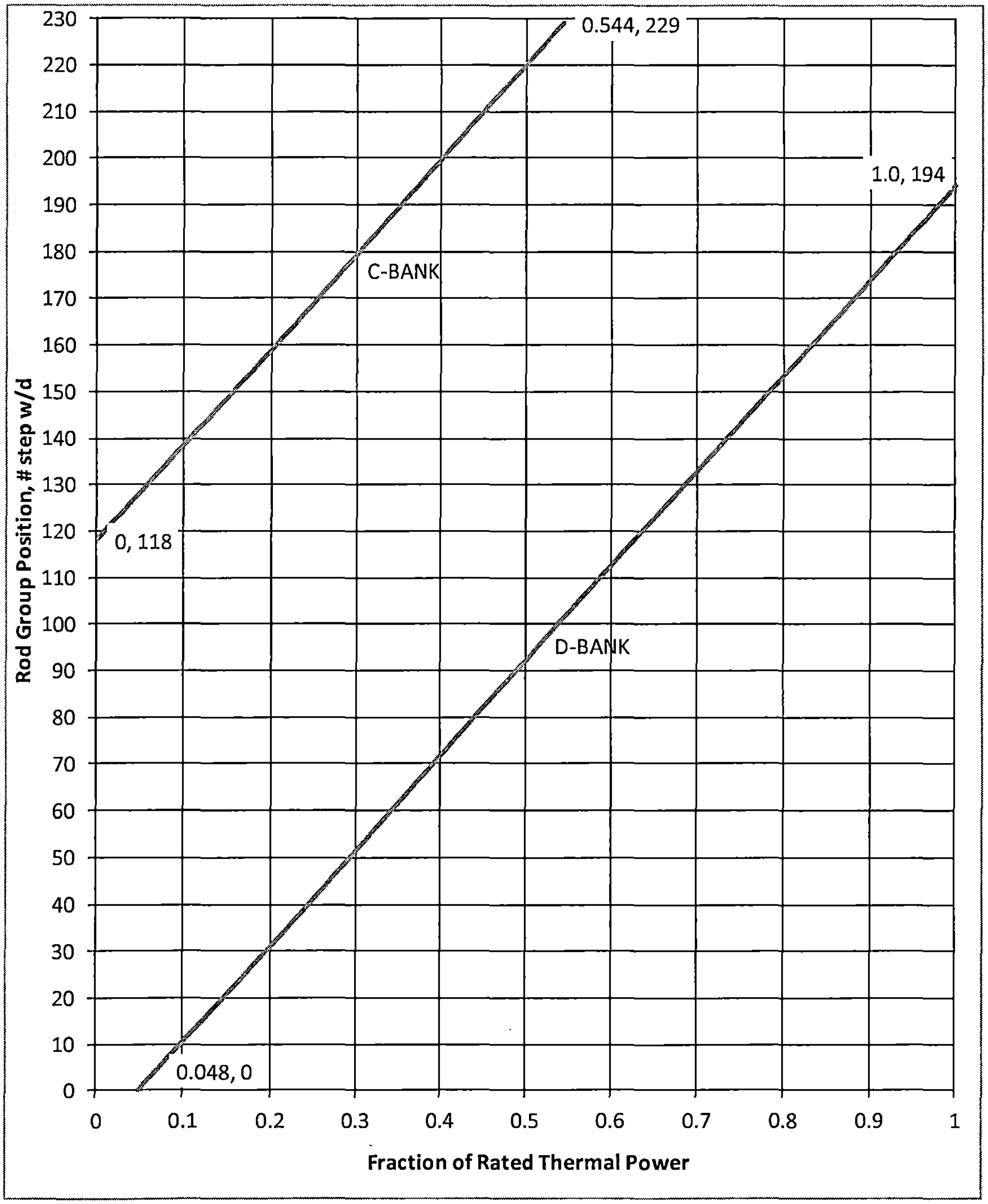
LCO 3.1.9.b SDM is ≥ **1.77 % Δk/k.**

SR 3.1.9.4 Verify SDM to be ≥ **1.77 % Δk/k.**

COLR Figure 3.1-1

North Anna 1 Cycle 26
Control Rod Bank Insertion Limits

Fully w/d position = 229 steps



3.2 POWER DISTRIBUTION LIMITS

3.2.1 Heat Flux Hot Channel Factor ($F_Q(Z)$)

LCO 3.2.1 $F_Q(Z)$, as approximated by $F_Q^M(Z)$, shall be within the limits specified below.

CFQ = 2.32

The Measured Heat Flux Hot Channel Factor, $F_Q(Z)$, shall be limited by the following relationships:

$$F_Q^M(Z) \leq \frac{CFQ}{P}\frac{K(Z)}{N(Z)} \qquad for\ P > 0.5$$

$$F_Q^M(Z) \leq \frac{CFQ}{0.5}\frac{K(Z)}{N(Z)} \qquad for\ P \leq 0.5$$

where: $P = \dfrac{THERMAL\ POWER}{RATED\ THERMAL\ POWER}$; and

K(Z) is provided in **COLR Figure 3.2-1**

N(Z) is a cycle-specific non-equilibrium multiplier on $F_Q^M(Z)$ to account for power distribution transients during normal operation, provided in **COLR Table 3.2-1.**

The discussion in the Bases Section B 3.2.1 for this LCO requires the application of a cycle dependent non-equilibrium multiplier, N(Z), to the CFQ 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 is typically generated from the actual EOC burnup distribution that can only be obtained after the shutdown of the previous cycle. The cycle-specific N(Z) function is presented in **COLR Table 3.2-1**.

COLR Table 3.2-1
N1C26 Normal Operation N(Z)

NODE	HEIGHT (FEET)	0 to 1000 MWD/MTU	1000 to 2000 MWD/MTU	2000 to 3000 MWD/MTU	3000 to 4000 MWD/MTU	4000 to 5000 MWD/MTU
5	11.2	1.093	1.092	1.128	1.160	1.160
6	11.0	1.098	1.098	1.126	1.161	1.161
7	10.8	1.105	1.106	1.127	1.161	1.161
8	10.6	1.112	1.112	1.128	1.160	1.160
9	10.4	1.116	1.116	1.129	1.158	1.158
10	10.2	1.120	1.120	1.129	1.155	1.155
11	10.0	1.123	1.123	1.130	1.151	1.151
12	9.8	1.126	1.126	1.130	1.146	1.146
13	9.6	1.127	1.127	1.130	1.141	1.141
14	9.4	1.127	1.128	1.128	1.137	1.138
15	9.2	1.129	1.130	1.130	1.138	1.138
16	9.0	1.135	1.135	1.138	1.141	1.137
17	8.8	1.141	1.141	1.148	1.148	1.141
18	8.6	1.144	1.144	1.154	1.153	1.149
19	8.4	1.147	1.147	1.159	1.159	1.158
20	8.2	1.153	1.153	1.164	1.163	1.163
21	8.0	1.156	1.157	1.166	1.166	1.166
22	7.8	1.158	1.159	1.167	1.167	1.167
23	7.6	1.158	1.160	1.166	1.166	1.165
24	7.4	1.157	1.159	1.163	1.163	1.161
25	7.2	1.155	1.157	1.160	1.160	1.155
26	7.0	1.151	1.153	1.156	1.156	1.149
27	6.8	1.149	1.152	1.156	1.156	1.145
28	6.6	1.148	1.149	1.154	1.154	1.142
29	6.4	1.142	1.138	1.145	1.145	1.135
30	6.2	1.134	1.125	1.133	1.133	1.127
31	6.0	1.132	1.119	1.128	1.129	1.125
32	5.8	1.129	1.116	1.124	1.124	1.122
33	5.6	1.115	1.106	1.109	1.108	1.109
34	5.4	1.108	1.104	1.102	1.097	1.100
35	5.2	1.111	1.110	1.108	1.097	1.102
36	5.0	1.119	1.120	1.118	1.100	1.108
37	4.8	1.127	1.128	1.124	1.101	1.111
38	4.6	1.135	1.135	1.129	1.105	1.114
39	4.4	1.139	1.139	1.132	1.112	1.115
40	4.2	1.144	1.144	1.135	1.117	1.114
41	4.0	1.148	1.148	1.139	1.123	1.115
42	3.8	1.153	1.152	1.146	1.134	1.122
43	3.6	1.159	1.156	1.154	1.148	1.132
44	3.4	1.162	1.159	1.160	1.155	1.135
45	3.2	1.166	1.165	1.165	1.159	1.138
46	3.0	1.169	1.168	1.169	1.164	1.146
47	2.8	1.176	1.176	1.175	1.171	1.157
48	2.6	1.187	1.188	1.185	1.180	1.167
49	2.4	1.202	1.202	1.197	1.191	1.178
50	2.2	1.213	1.213	1.208	1.201	1.189
51	2.0	1.224	1.224	1.220	1.211	1.198
52	1.8	1.234	1.234	1.230	1.221	1.206
53	1.6	1.243	1.243	1.239	1.230	1.214
54	1.4	1.252	1.252	1.247	1.238	1.221
55	1.2	1.259	1.259	1.255	1.245	1.227
56	1.0	1.265	1.265	1.261	1.250	1.232
57	0.8	1.270	1.270	1.266	1.255	1.237

These decks are generated for normal operation flux maps that are typically taken at full power ARO. Additional N(z) decks may be generated, if necessary, consistent with the methodology described in the RPDC topical (Reference 7). EOR is defined as Hot Full Power End of Reactivity.

COLR Table 3.2-1 (continued)
N1C26 Normal Operation N(Z)

NODE	HEIGHT (FEET)	5000 to 7000 MWD/MTU	7000 to 9000 MWD/MTU	9000 to 11000 MWD/MTU	11000 to 13000 MWD/MTU	13000 to 15000 MWD/MTU
5	11.2	1.154	1.136	1.098	1.099	1.095
6	11.0	1.155	1.137	1.098	1.097	1.093
7	10.8	1.156	1.140	1.101	1.095	1.091
8	10.6	1.155	1.140	1.107	1.094	1.092
9	10.4	1.153	1.140	1.114	1.096	1.095
10	10.2	1.151	1.139	1.120	1.101	1.101
11	10.0	1.147	1.138	1.124	1.109	1.109
12	9.8	1.142	1.138	1.131	1.116	1.115
13	9.6	1.138	1.139	1.139	1.122	1.121
14	9.4	1.135	1.140	1.142	1.124	1.124
15	9.2	1.136	1.144	1.144	1.127	1.130
16	9.0	1.143	1.148	1.149	1.136	1.142
17	8.8	1.153	1.154	1.154	1.146	1.156
18	8.6	1.155	1.153	1.152	1.150	1.161
19	8.4	1.157	1.158	1.157	1.157	1.170
20	8.2	1.162	1.173	1.173	1.171	1.190
21	8.0	1.167	1.186	1.186	1.183	1.205
22	7.8	1.169	1.189	1.189	1.187	1.208
23	7.6	1.171	1.195	1.195	1.197	1.213
24	7.4	1.174	1.203	1.203	1.211	1.223
25	7.2	1.174	1.208	1.208	1.220	1.229
26	7.0	1.173	1.208	1.208	1.222	1.229
27	6.8	1.174	1.210	1.209	1.224	1.230
28	6.6	1.172	1.208	1.208	1.223	1.229
29	6.4	1.165	1.203	1.203	1.220	1.228
30	6.2	1.154	1.194	1.194	1.213	1.226
31	6.0	1.148	1.192	1.190	1.212	1.227
32	5.8	1.143	1.185	1.186	1.206	1.223
33	5.6	1.134	1.165	1.178	1.190	1.212
34	5.4	1.128	1.150	1.172	1.178	1.199
35	5.2	1.124	1.149	1.170	1.176	1.192
36	5.0	1.120	1.151	1.166	1.175	1.188
37	4.8	1.114	1.149	1.160	1.170	1.185
38	4.6	1.115	1.145	1.150	1.164	1.186
39	4.4	1.123	1.139	1.140	1.158	1.187
40	4.2	1.127	1.134	1.136	1.151	1.189
41	4.0	1.127	1.132	1.139	1.147	1.189
42	3.8	1.133	1.134	1.144	1.147	1.183
43	3.6	1.141	1.141	1.150	1.151	1.172
44	3.4	1.143	1.142	1.153	1.154	1.163
45	3.2	1.144	1.144	1.152	1.158	1.158
46	3.0	1.147	1.147	1.151	1.158	1.155
47	2.8	1.154	1.154	1.149	1.159	1.159
48	2.6	1.164	1.158	1.146	1.157	1.161
49	2.4	1.177	1.169	1.150	1.160	1.171
50	2.2	1.191	1.187	1.164	1.170	1.188
51	2.0	1.201	1.200	1.174	1.179	1.202
52	1.8	1.206	1.201	1.175	1.181	1.209
53	1.6	1.211	1.203	1.178	1.185	1.213
54	1.4	1.218	1.211	1.186	1.193	1.217
55	1.2	1.225	1.219	1.193	1.200	1.223
56	1.0	1.230	1.224	1.199	1.207	1.231
57	0.8	1.235	1.229	1.204	1.212	1.238

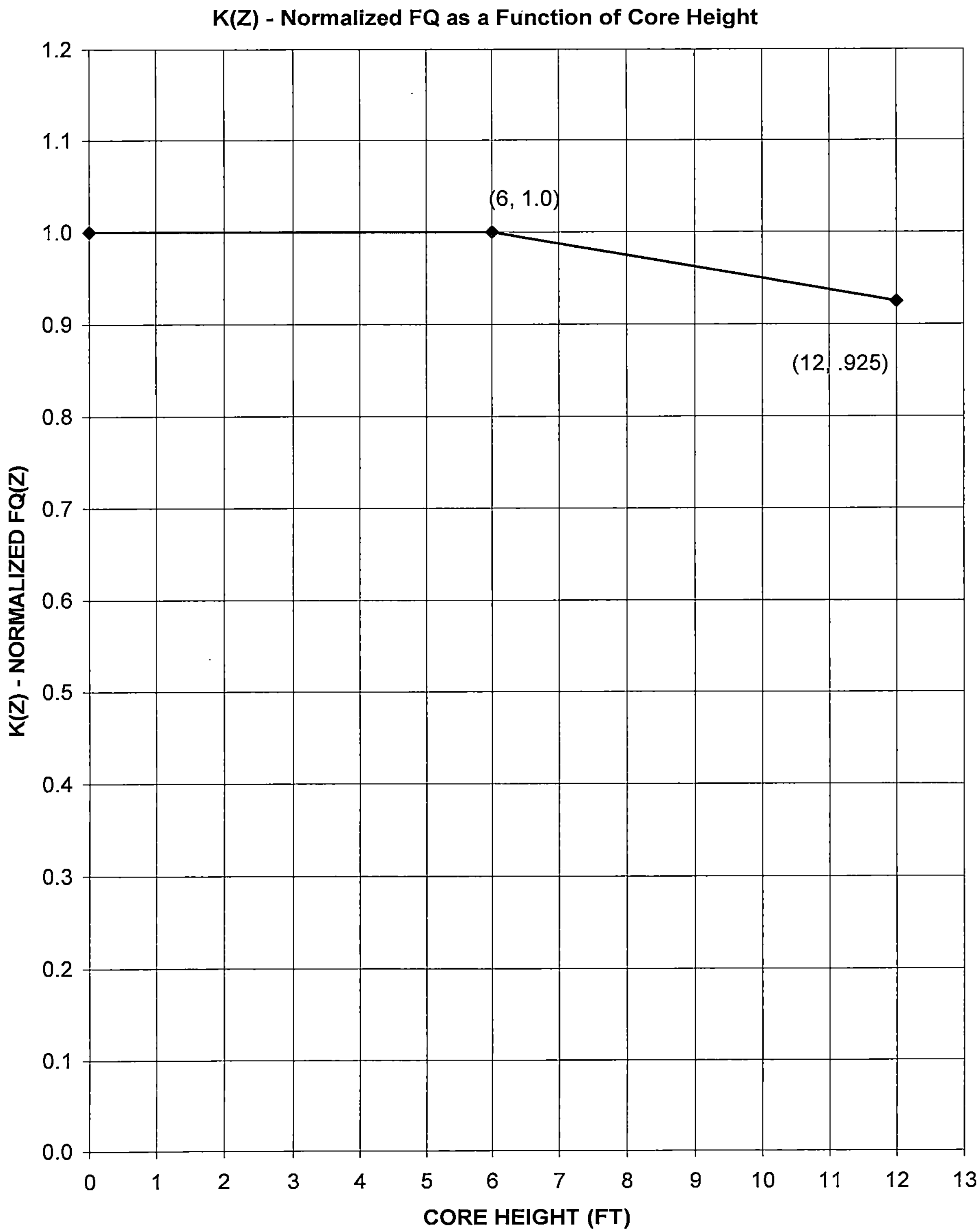
These decks are generated for normal operation flux maps that are typically taken at full power ARO. Additional N(z) decks may be generated, if necessary, consistent with the methodology described in the RPDC topical (Reference 7). EOR is defined as Hot Full Power End of Reactivity.

COLR Table 3.2-1 (continued)
N1C26 Normal Operation N(Z)

NODE	HEIGHT (FEET)	15000 to 17000 MWD/MTU	17000 to 19000 MWD/MTU	19000 to EOR MWD/MTU
5	11.2	1.088	1.080	1.079
6	11.0	1.087	1.081	1.081
7	10.8	1.087	1.085	1.085
8	10.6	1.092	1.092	1.090
9	10.4	1.100	1.101	1.095
10	10.2	1.106	1.106	1.097
11	10.0	1.108	1.109	1.099
12	9.8	1.114	1.113	1.104
13	9.6	1.121	1.119	1.112
14	9.4	1.124	1.120	1.113
15	9.2	1.130	1.125	1.119
16	9.0	1.142	1.140	1.141
17	8.8	1.156	1.159	1.164
18	8.6	1.161	1.164	1.170
19	8.4	1.170	1.173	1.176
20	8.2	1.190	1.193	1.195
21	8.0	1.205	1.208	1.208
22	7.8	1.208	1.212	1.211
23	7.6	1.213	1.217	1.217
24	7.4	1.224	1.226	1.226
25	7.2	1.231	1.232	1.231
26	7.0	1.233	1.234	1.231
27	6.8	1.236	1.236	1.232
28	6.6	1.235	1.235	1.230
29	6.4	1.232	1.232	1.224
30	6.2	1.226	1.225	1.213
31	6.0	1.226	1.224	1.210
32	5.8	1.223	1.218	1.206
33	5.6	1.212	1.202	1.196
34	5.4	1.199	1.187	1.187
35	5.2	1.192	1.181	1.183
36	5.0	1.188	1.177	1.176
37	4.8	1.185	1.170	1.166
38	4.6	1.186	1.164	1.159
39	4.4	1.187	1.159	1.158
40	4.2	1.189	1.158	1.159
41	4.0	1.189	1.161	1.162
42	3.8	1.181	1.164	1.165
43	3.6	1.172	1.166	1.167
44	3.4	1.170	1.170	1.164
45	3.2	1.174	1.174	1.162
46	3.0	1.175	1.174	1.164
47	2.8	1.176	1.177	1.172
48	2.6	1.174	1.179	1.177
49	2.4	1.178	1.189	1.190
50	2.2	1.189	1.206	1.207
51	2.0	1.203	1.224	1.224
52	1.8	1.211	1.235	1.235
53	1.6	1.216	1.240	1.240
54	1.4	1.218	1.242	1.242
55	1.2	1.223	1.246	1.246
56	1.0	1.231	1.255	1.255
57	0.8	1.238	1.262	1.262

These decks are generated for normal operation flux maps that are typically taken at full power ARO. Additional N(z) decks may be generated, if necessary, consistent with the methodology described in the RPDC topical (Reference 7). EOR is defined as Hot Full Power End of Reactivity.

COLR Figure 3.2-1



3.2.2 Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)

LCO 3.2.2 $F^N_{\Delta H}$ shall be within the limits specified below.

$$\mathbf{F^N_{\Delta H} \leq 1.587\{1 + 0.3(1 - P)\}}$$

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

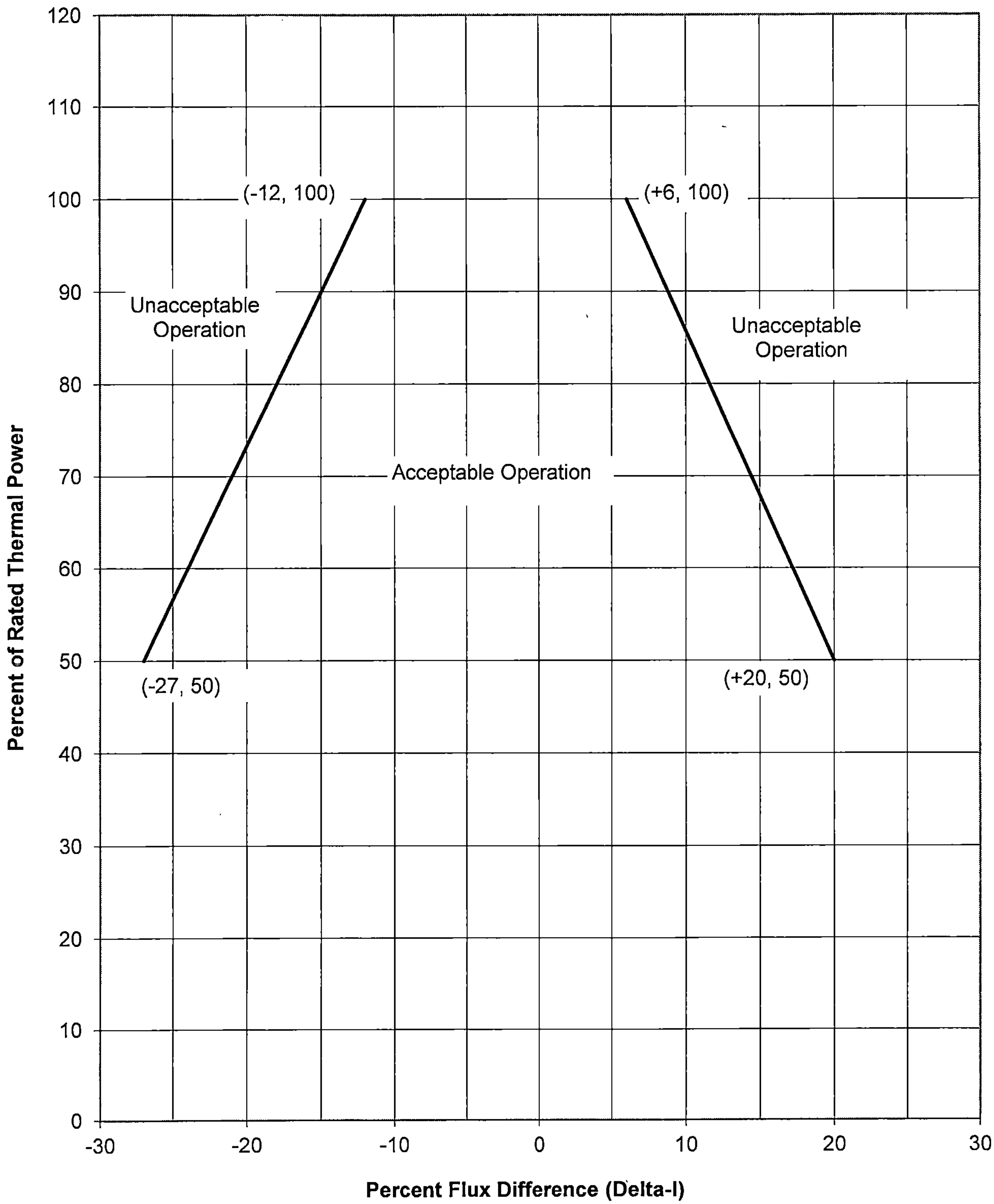
SR 3.2.2.1 Verify $F^N_{\Delta H}$ is within limits specified above.

3.2.3 AXIAL FLUX DIFFERENCE (AFD)

LCO 3.2.3 The AFD in % flux difference units shall be maintained within the limits specified in **COLR Figure 3.2-2.**

COLR Figure 3.2-2

North Anna 1 Cycle 26
Axial Flux Difference Limits



3.3 INSTRUMENTATION

3.3.1 Reactor Trip System (RTS) Instrumentation

TS Table 3.3.1-1 Note 1: Overtemperature ΔT

The Overtemperature ΔT Function Allowable Value shall not exceed the following nominal trip setpoint by more than 2% of ΔT span, with the numerical values of the parameters as specified below.

$$\Delta T \leq \Delta T_0 \left\{ K_1 - K_2 \frac{(1+\tau_1 s)}{(1+\tau_2 s)} [T - T'] + K_3 (P - P') - f_1(\Delta I) \right\}$$

where: ΔT is measured RCS ΔT, °F

ΔT_0 is the indicated ΔT at RTP, °F

s is the Laplace transform operator, sec^{-1}

T is the measured RCS average temperature, °F

T′ is the nominal T_{avg} at RTP, **≤ 586.8 °F**

P is the measured pressurizer pressure, psig

P′ is the nominal RCS operating pressure, **≥ 2235 psig**

K_1 ≤ **1.2715** K_2 ≥ **0.02174 /°F** K_3 ≥ **0.001145 /psig**

τ_1, τ_2 = *time constants utilized in the lead-lag controller for T_{avg}*

τ_1 ≥ **23.75 sec** τ_2 ≤ **4.4 sec**

$(1+\tau_1 s)/(1+\tau_2 s)$ = *function generated by the lead-lag controller for T_{avg} dynamic compensation*

$f_1(\Delta I) \geq$	**0.0291{-13.0** – $(q_t - q_b)$}	when $(q_t - q_b) <$ **–13.0%** RTP
	0	when **–13.0%** RTP ≤ $(q_t - q_b)$ ≤ **+7.0%** RTP
	0.0251{$(q_t - q_b)$ – **7.0**}	when $(q_t - q_b) >$ **+7.0%** RTP

Where q_t and q_b are percent RTP in the upper and lower halves of the core, respectively, and $q_t + q_b$ is the total THERMAL POWER in percent RTP.

TS Table 3.3.1-1 Note 2: Overpower ΔT

The Overpower ΔT Function Allowable Value shall not exceed the following nominal trip setpoint by more than 2% of ΔT span, with the numerical values of the parameters as specified below.

$$\Delta T \leq \Delta T_0 \left\{ K_4 - K_5 \left[\frac{\tau_3 s}{1+\tau_3 s} \right] T - K_6 [T - T'] - f_2(\Delta I) \right\}$$

where: ΔT is measured RCS ΔT, °F.

ΔT_0 is the indicated ΔT at RTP, °F.

s is the Laplace transform operator, sec^{-1}.

T is the measured RCS average temperature, °F.

T′ is the nominal T_{avg} at RTP, **≤ 586.8 °F.**

K_4 ≤ **1.0865**

K_5 ≥ **0.0198 /°F** for increasing T_{avg}; **0 /°F** for decreasing T_{avg}

K_6 ≥ **0.00162 /°F** when T > T′; **0 /°F** when T ≤ T′

τ_3 = *time constant utilized in the rate lag controller for T_{avg}*

τ_3 ≥ **9.5 sec**

$\tau_3 s/(1+\tau_3 s)$ = *function generated by the rate lag controller for T_{avg} dynamic compensation*

$f_2(\Delta I)$ = **0, for all ΔI.**

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.1 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits

LCO 3.4.1 RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure is greater than or equal to **2205 psig**;

b. RCS average temperature is less than or equal to **591 °F**; and

c. RCS total flow rate is greater than or equal to **295,000 gpm**.

SR 3.4.1.1 Verify pressurizer pressure is greater than or equal to **2205 psig**.

SR 3.4.1.2 Verify RCS average temperature is less than or equal to **591 °F**.

SR 3.4.1.3 Verify RCS total flow rate is greater than or equal to **295,000 gpm**.

SR 3.4.1.4 -----------------------------NOTE--
Not required to be performed until 30 days after ≥ 90% RTP.

Verify by precision heat balance that RCS total flow rate is **≥ 295,000 gpm**.

3.5 EMERGENCY CORE COOLING SYSTEMS (ECCS)

3.5.6 Boron Injection Tank (BIT)

Required Action B.2 Borate to a SDM ≥ **1.77 % Δk/k at 200 °F**.

3.9 REFUELING OPERATIONS

3.9.1 Boron Concentration

LCO 3.9.1 Boron concentrations of the Reactor Coolant System (RCS), the refueling canal, and the refueling cavity shall be maintained ≥ **2600 ppm**.

SR 3.9.1.1 Verify boron concentration is within the limit specified above.

NAPS TECHNICAL REQUIREMENTS MANUAL

TRM 3.1 REACTIVITY CONTROL SYSTEMS

TR 3.1.1 Boration Flow Paths – Operating

Required Action D.2 Borate to a SHUTDOWN MARGIN ≥ **1.77 % Δk/k at 200 °F**, after xenon decay.