VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

June 27, 2002

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

Serial No.: 02-366
NL&OS/MM
Docket No.: 50-338/339
License No.: NPF-4/7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNITS 1 AND 2
CORE OPERATING LIMITS REPORTS

Pursuant to North Anna Technical Specification 6.9.1.7.d, attached are revised copies of the Virginia Electric and Power Company's (Dominion) Core Operating Limits Reports (COLR) for North Anna Unit 1 Cycle 16 (Revision 1) and North Anna Unit 2 Cycle 15 (Revision 1). These mid-cycle revisions are required as a result of converting to Improved Technical Specifications, which moved additional items to the COLR. These revised COLRs will become effective at the time of implementation of the Improved Technical Specifications.

No new commitments are intended by this letter. If you have any questions or require additional information, please contact us.

Very truly yours,

S. P. Sarver, Director
Nuclear Licensing and Operations Support

Attachment

cc: U.S. Nuclear Regulatory Commission
Region II
Sam Nunn Atlanta Federal Center
61 Forsyth St. SW, Suite 23 T85
Atlanta, Georgia 30303-8931

Mr. M. J. Morgan
NRC Senior Resident Inspector
North Anna Power Station

A001

CORE OPERATING LIMITS REPORT
North Anna Unit 1 Cycle 16
Rev 1

June 2002

Virginia Electric and Power Company (Dominion)

N1C16 CORE OPERATING LIMITS REPORT

INTRODUCTION

The Core Operating Limits Report (COLR) for North Anna Unit 1 Cycle 16 has been revised in accordance with North Anna Technical Specification 5.6.5. This revised expanded COLR is consistent with the requirements of North Anna Improved Technical Specifications (ITS). The technical specifications affected by this report are listed below:

ITS 2.1.1*	Reactor Core Safety Limits
ITS 3.1.1*	Shutdown Margin (SDM)
ITS 3.1.3	Moderator Temperature Coefficient (MTC)
ITS 3.1.5	Shutdown Bank Insertion Limit
ITS 3.1.6	Control Bank Insertion Limits
ITS 3.2.1	Heat Flux Hot Channel Factor
ITS 3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)
ITS 3.2.3	Axial Flux Difference (AFD)
ITS 3.3.1*	Reactor Trip System (RTS) Instrumentation
ITS 3.4.1*	RCS Pressure, Temperature, and Flow DNB Limits
ITS 3.9.1*	Boron Concentration

One of the technical requirements (TR) in the NAPS Technical Requirements Manual (TRM) refers to the COLR, as noted below; and this item is now added to the COLR.

TR 3.1.1* Boration Flow Paths – Operating

The parameters indicated by an asterisk (*) are new parameters relocated to the COLR as part of ITS conversion. 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 herein **in bold.** Text presented in *italics* is provided for information only.

REFERENCES

1. VEP-FRD-42 Rev 1-A, Reload Nuclear Design Methodology, September 1986; Supplement 1, November 1993; Supplement 2, September 1996.

   (Methodology for ITS 3.1.1 – Shutdown Margin, ITS 3.1.3 – Moderator Temperature Coefficient, ITS 3.1.5 – Shutdown Bank Insertion Limit, ITS 3.1.6 - Control Bank Insertion Limits, ITS 3.2.1 - Heat Flux Hot Channel Factor, ITS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and ITS 3.9.1 – Boron Concentration)

2. WCAP-9220-P-A Rev1, Westinghouse ECCS Evaluation Model – 1981 Version, February 1982.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

3. WCAP-9561-P-A Rev 1 Add. 3, BART A-1: A Computer Code for the Best Estimate Analysis of Reflood Transients – Special Report: Thimble Modeling in W ECCS Evaluation Model, July 1986.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

4. WCAP-10266-P-A Rev 2, The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code, March 1987.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

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

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

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

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

7. WCAP-12610-P-A, VANTAGE+ Fuel Assembly - Reference Core Report, April 1995.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

8. VEP-NE-2-A, Statistical DNBR Evaluation Methodology, June 1987.

   (Methodology for ITS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and ITS 3.4.1 – RCS Pressure, Temperature and Flow DNB Limits)

9. VEP-NE-3-A, Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code, July 1990.

(Methodology for ITS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and ITS 3.4.1 – RCS Pressure, Temperature and Flow DNB Limits)

10. VEP-NE-1-A, Virginia Power Relaxed Power Distribution Control Methodology and Associated FQ Surveillance Technical Specifications, March 1986; Supplement 1, September 1996.

(Methodology for ITS 3.2.1 – Heat Flux Hot Channel Factor and ITS 3.2.3 – Axial Flux Difference)

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

(Methodology for ITS 2.1.1 – Reactor Core Safety Limits and ITS 3.3.1 – Reactor Trip System Instrumentation)

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

(Methodology for ITS 2.1.1 – Reactor Core Safety Limits, ITS 3.1.1 – Shutdown Margin, ITS 3.3.1 – Reactor Trip System Instrumentation, ITS 3.4.1 – RCS Pressure, Temperature, and Flow DNB Limits and ITS 3.9.1 – Boron Concentration)

2.0 SAFETY LIMITS (SLs)

2.1 SLs

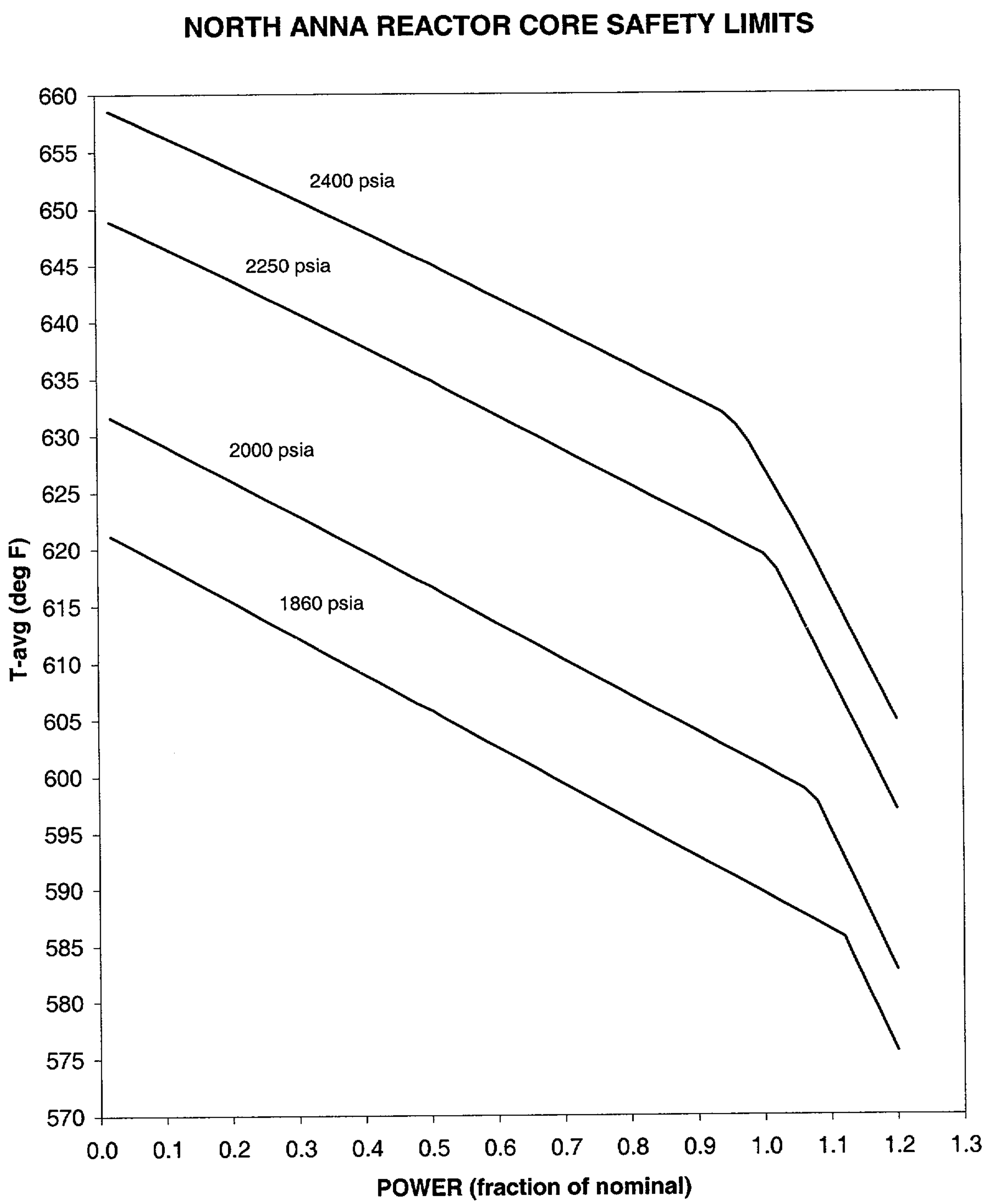
2.1.1 Reactor Core SLs

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 $< 4700\ ^{0}F$.

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/^{0}F, when < 70% RTP, and 0.0 Δk/k/^{0}F when ≥ 70% RTP.**

The BOC/ARO-MTC shall be ≤ +0.6 x 10^{-4} Δk/k/^{0}F (upper limit), when < 70% RTP, and ≤ 0.0 Δk/k/^{0}F when ≥ 70% RTP.

The EOC/ARO/RTP-MTC shall be less negative than –5.0 x 10^{-4} Δk/k/^{0}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/^{0}F [Note 2].

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to –4.7 x 10^{-4} Δk/k/^{0}F [Note 3].

SR 3.1.3.2 Verify MTC is within **–5.0 x 10^{-4} Δk/k/^{0}F (lower limit).**

Note 2: If the MTC is more negative than **–4.0 x 10^{-4} Δk/k/^{0}F**, SR 3.1.3.2 shall be repeated once per 14 EFPD during the remainder of the fuel cycle.

Note 3: 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/^{0}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 226 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 226 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 98 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.**

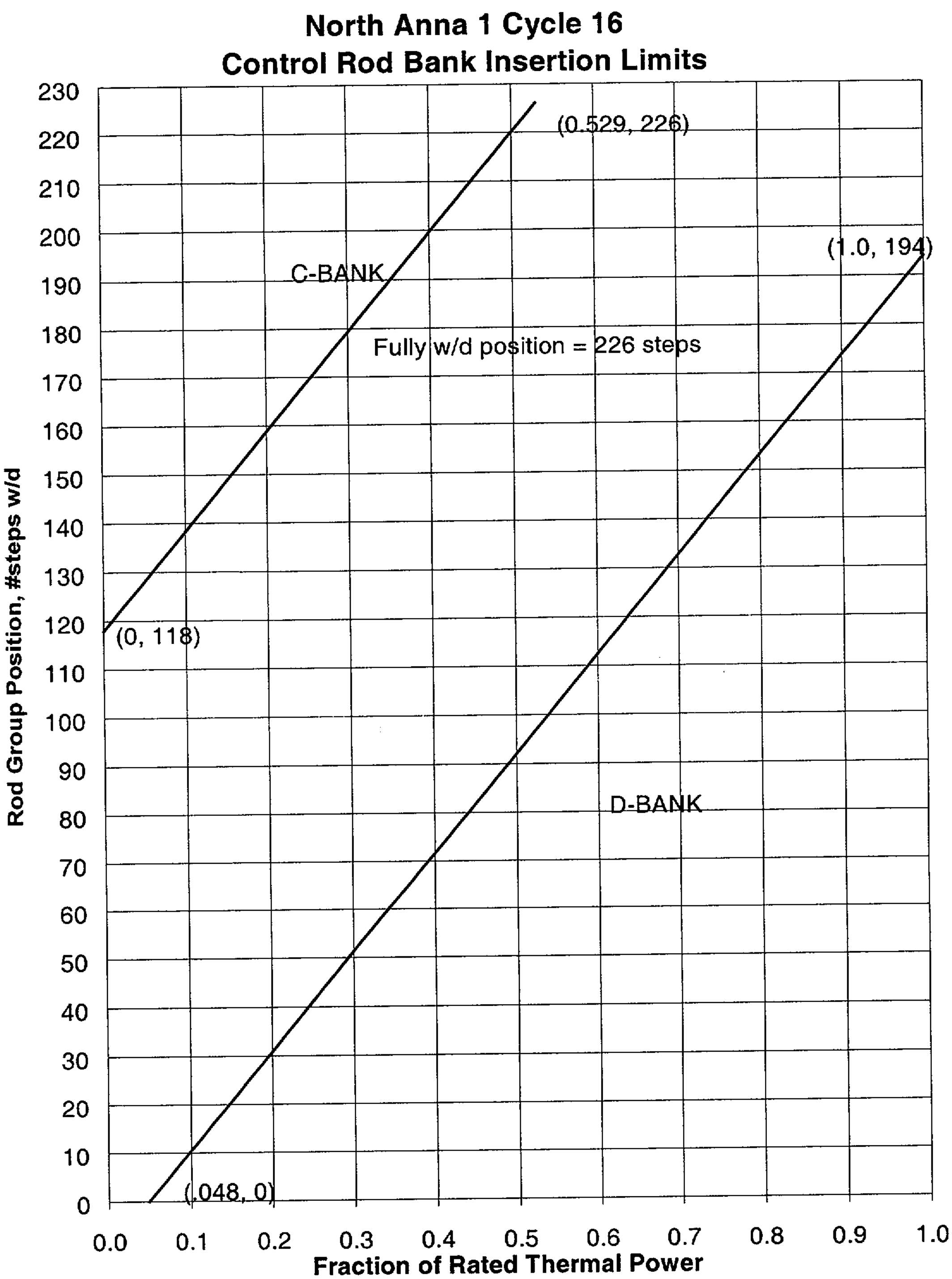
SR 3.1.6.3 Verify each control bank not fully withdrawn from the core is within the sequence and overlap limits specified in **LCO 3.1.6 above.**

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



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.**

The change in the $F_Q(Z)$ limit for coastdown operation is accommodated by defining a variable quantity, CFQ as indicated below. Then, the following expressions apply to both normal operation and Tavg coastdown regimes.

CFQ = 2.19, for normal operation at full power;

CFQ = 2.15, for flux map immediately preceding EOC temperature coastdown and during subsequent power coastdown operation.

The Measured Heat Flux Hot Channel Factor, $F_Q^M(Z)$, 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: $P = \frac{THERMAL\ POWER}{RATED\ THERMAL\ POWER}$ **; and**

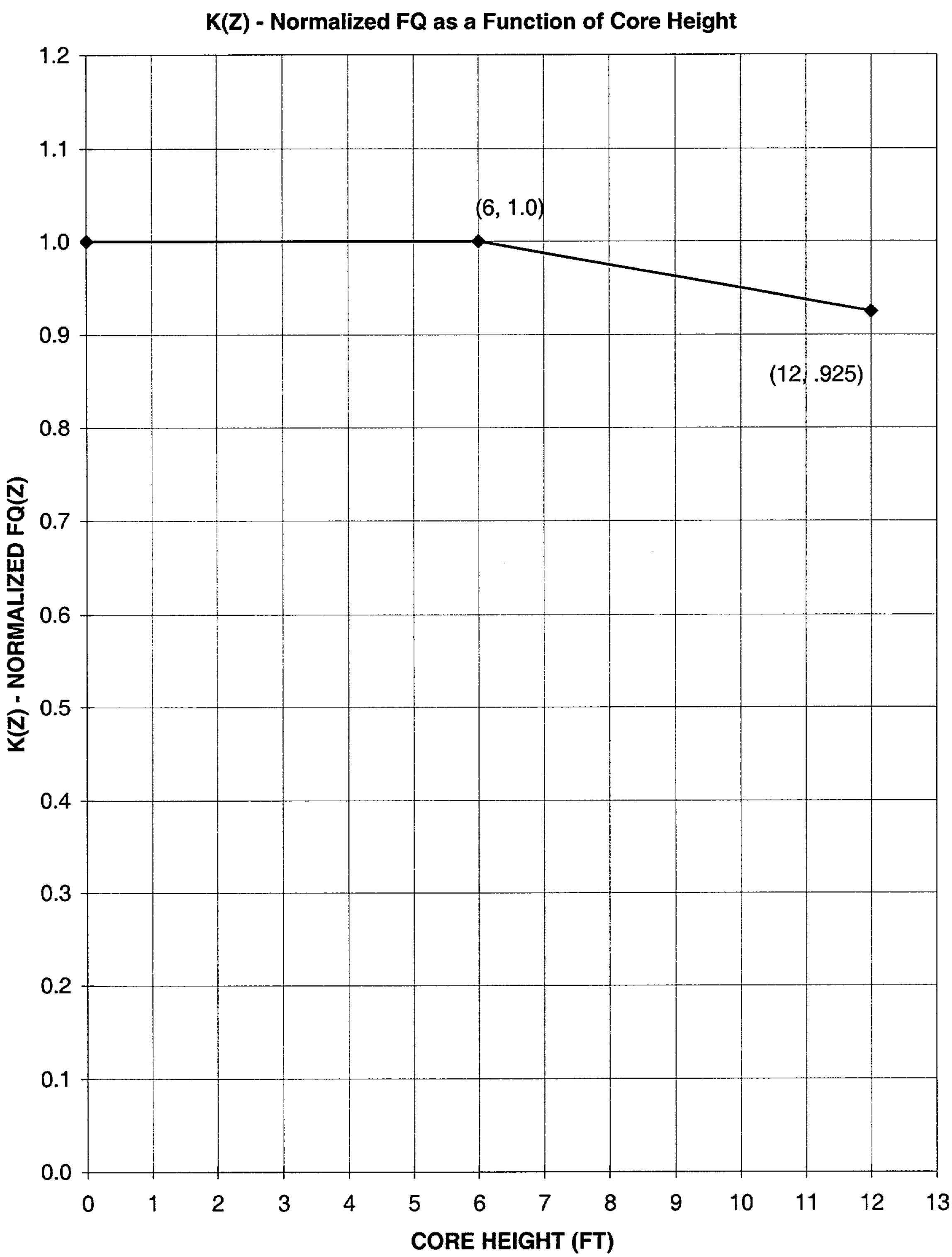
K(Z) is provided in COLR Figure 3.2-1; and
N(Z) is a cycle-specific non-equilibrium multiplier on $F_Q^M(Z)$ to account for power distribution transients during normal operation, provided in COLR Table 3.2-1.

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 measured peaking factor, $F_Q^M(Z)$, 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 must be 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
N1C16 Normal Operation N(Z)

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 17900 MWD/MTU	17900 to EOC MWD/MTU
10	10.2	1.185	1.185	1.185	1.142	1.142	1.142	1.116
11	10.0	1.182	1.182	1.182	1.141	1.141	1.141	1.117
12	9.8	1.178	1.178	1.178	1.139	1.139	1.139	1.122
13	9.6	1.176	1.176	1.176	1.139	1.139	1.139	1.132
14	9.4	1.178	1.178	1.178	1.140	1.140	1.141	1.140
15	9.2	1.184	1.184	1.184	1.144	1.144	1.147	1.147
16	9.0	1.191	1.191	1.191	1.146	1.146	1.152	1.153
17	8.8	1.196	1.196	1.196	1.149	1.149	1.158	1.158
18	8.6	1.200	1.200	1.200	1.155	1.155	1.163	1.163
19	8.4	1.200	1.200	1.200	1.161	1.161	1.169	1.169
20	8.2	1.200	1.200	1.200	1.165	1.165	1.175	1.175
21	8.0	1.200	1.200	1.200	1.167	1.167	1.180	1.180
22	7.8	1.200	1.200	1.200	1.169	1.169	1.183	1.183
23	7.6	1.199	1.199	1.199	1.169	1.169	1.186	1.186
24	7.4	1.198	1.198	1.198	1.168	1.168	1.188	1.188
25	7.2	1.195	1.195	1.195	1.166	1.166	1.190	1.190
26	7.0	1.190	1.190	1.190	1.161	1.161	1.190	1.190
27	6.8	1.185	1.185	1.185	1.156	1.156	1.188	1.188
28	6.6	1.177	1.177	1.177	1.150	1.150	1.183	1.183
29	6.4	1.168	1.168	1.168	1.145	1.145	1.176	1.176
30	6.2	1.157	1.157	1.157	1.139	1.139	1.166	1.166
31	6.0	1.145	1.145	1.144	1.135	1.135	1.160	1.160
32	5.8	1.132	1.132	1.133	1.131	1.131	1.154	1.154
33	5.6	1.115	1.115	1.124	1.125	1.125	1.150	1.150
34	5.4	1.105	1.105	1.118	1.118	1.118	1.144	1.144
35	5.2	1.099	1.099	1.107	1.108	1.108	1.133	1.133
36	5.0	1.102	1.102	1.104	1.104	1.104	1.124	1.124
37	4.8	1.107	1.107	1.107	1.106	1.106	1.120	1.120
38	4.6	1.114	1.114	1.114	1.110	1.110	1.121	1.121
39	4.4	1.119	1.119	1.119	1.113	1.113	1.125	1.125
40	4.2	1.123	1.123	1.122	1.117	1.117	1.129	1.129
41	4.0	1.125	1.125	1.125	1.123	1.123	1.132	1.132
42	3.8	1.126	1.126	1.128	1.127	1.127	1.137	1.137
43	3.6	1.128	1.128	1.132	1.132	1.132	1.142	1.142
44	3.4	1.131	1.131	1.134	1.134	1.134	1.146	1.146
45	3.2	1.136	1.136	1.138	1.138	1.138	1.149	1.149
46	3.0	1.141	1.141	1.145	1.145	1.145	1.151	1.151
47	2.8	1.146	1.146	1.155	1.155	1.155	1.155	1.154
48	2.6	1.150	1.150	1.163	1.163	1.163	1.162	1.158
49	2.4	1.154	1.154	1.172	1.172	1.172	1.172	1.166
50	2.2	1.160	1.160	1.179	1.179	1.179	1.179	1.173
51	2.0	1.166	1.166	1.187	1.187	1.187	1.187	1.183
52	1.8	1.171	1.171	1.196	1.196	1.196	1.195	1.193

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.**

$$\mathbf{F^N_{\Delta H} \leq 1.49\{1 + 0.3(1 - P)\}}$$

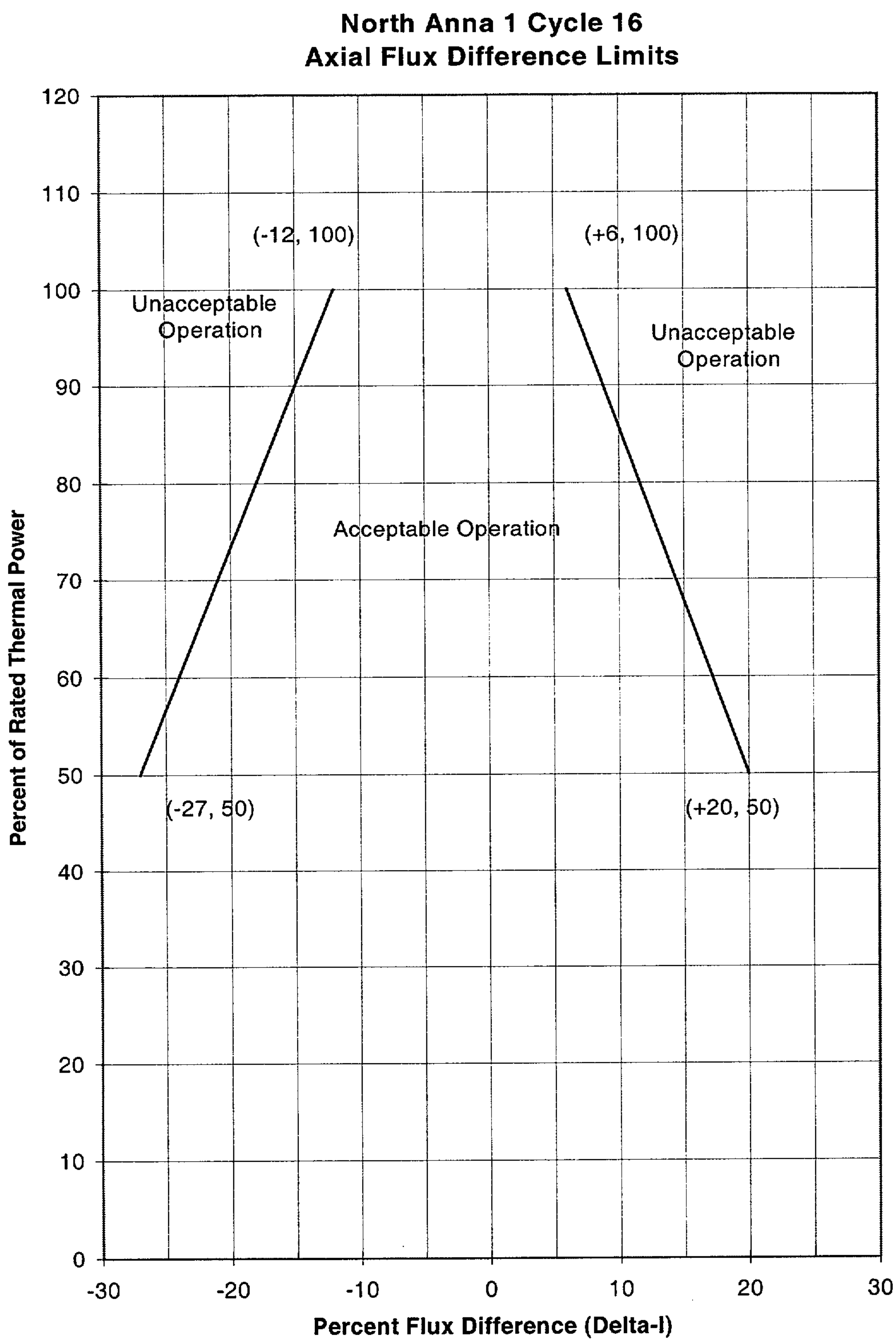
where: $P = \dfrac{\textit{THERMAL POWER}}{\textit{RATED THERMAL POWER}}$

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



3.3 INSTRUMENTATION

3.3.1 Reactor Trip System (RTS) Instrumentation

ITS 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, ^{0}F.

ΔT_0 is the indicated ΔT at RTP, ^{0}F.

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

T is the measured RCS average temperature, ^{0}F.

T' is the nominal T_{avg} at RTP, ≤ **586.8 ^{0}F.**

P is the measured pressurizer pressure, psig.

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

K_1 ≤ **1.2715** K_2 ≥ **0.02172 /^{0}F** K_3 ≥ **0.001144 /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

$f_1(\Delta I)$ ≥ **0.0165{−44 − ($q_t - q_b$)}**	when ($q_t - q_b$) < **−44%** RTP
0	when **−44%** RTP ≤ ($q_t - q_b$) ≤ **+3%** RTP
0.0198{($q_t - q_b$) − 3}	when ($q_t - q_b$) > **+3%** RTP
[See footnote]#	

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.

#Footnote: The units for $f_1(\Delta I)$ = 0 in the North Anna ITS and NUREG-1431 are incorrectly specified as "% of RTP." $f_1(\Delta I)$ being dimensionless should have no units. This discrepancy is being addressed by the North Anna Corrective Action System.

ITS 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, ^0F.

ΔT_0 is the indicated ΔT at RTP, ^0F.

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

T is the measured RCS average temperature, ^0F.

T' is the nominal T_{avg} at RTP, **$\leq$ 586.8 ^0F.**

$K_4 \leq$ 1.0865

$K_5 \geq$ **0.0197 /^0F** for increasing T_{avg}

0 /^0F for decreasing T_{avg}

$K_6 \geq$ **0.00162 /^0F** when T > T'

0 /^0F when $T \leq T'$

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

$\tau_3 \geq$ **9.5 sec** [See footnote]##

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

$f_2(\Delta I)$ = **0, for all ΔI.**

##Footnote: The sign of the time constant τ_3 in the NAPS ITS does not match what is specified in NUREG-1431. This inconsistency is being addressed by the North Anna Corrective Action System.

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 ^{0}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 ^{0}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 an SDM $\geq$ **1.77 % Δk/k at 200 ^{0}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**.

Note: The refueling boron concentration satisfies the more restrictive of the following conditions: (a) $k_{eff} \leq 0.95$*, or (b) boron concentration ≥ 2600 ppm.*

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

TRM 3.1 REACTIVITY CONTROL SYSTEMS

TR 3.1.1 Boration Flow Paths – Operating

Required Action E.2 Borate to a SHUTDOWN MARGIN ≥ **1.77 % Δk/k at 200 ^{0}F, after xenon decay**.

CORE OPERATING LIMITS REPORT
North Anna Unit 2 Cycle 15
Rev 1

June 2002

Virginia Electric and Power Company (Dominion)

N2C15 CORE OPERATING LIMITS REPORT

INTRODUCTION

The Core Operating Limits Report (COLR) for North Anna Unit 2 Cycle 15 has been revised in accordance with North Anna Technical Specification 5.6.5. This revised expanded COLR is consistent with the requirements of North Anna Improved Technical Specifications (ITS). The technical specifications affected by this report are listed below:

ITS 2.1.1*	Reactor Core Safety Limits
ITS 3.1.1*	Shutdown Margin (SDM)
ITS 3.1.3	Moderator Temperature Coefficient (MTC)
ITS 3.1.5	Shutdown Bank Insertion Limit
ITS 3.1.6	Control Bank Insertion Limits
ITS 3.2.1	Heat Flux Hot Channel Factor
ITS 3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)
ITS 3.2.3	Axial Flux Difference (AFD)
ITS 3.3.1*	Reactor Trip System (RTS) Instrumentation
ITS 3.4.1*	RCS Pressure, Temperature, and Flow DNB Limits
ITS 3.9.1*	Boron Concentration

One of the technical requirements (TR) in the NAPS Technical Requirements Manual (TRM) refers to the COLR, as noted below; and this item is now added to the COLR.

TR 3.1.1* Boration Flow Paths – Operating

The parameters indicated by an asterisk (*) are new parameters relocated to the COLR as part of ITS conversion. 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 herein **in bold.** Text presented in *italics* is provided for information only.

REFERENCES

1. VEP-FRD-42 Rev 1-A, Reload Nuclear Design Methodology, September 1986; Supplement 1, November 1993; Supplement 2, September 1996.

   (Methodology for ITS 3.1.1 – Shutdown Margin, ITS 3.1.3 – Moderator Temperature Coefficient, ITS 3.1.5 – Shutdown Bank Insertion Limit, ITS 3.1.6 - Control Bank Insertion Limits, ITS 3.2.1 - Heat Flux Hot Channel Factor, ITS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and ITS 3.9.1 – Boron Concentration)

2. WCAP-9220-P-A Rev1, Westinghouse ECCS Evaluation Model – 1981 Version, February 1982.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

3. WCAP-9561-P-A Rev 1 Add. 3, BART A-1: A Computer Code for the Best Estimate Analysis of Reflood Transients – Special Report: Thimble Modeling in W ECCS Evaluation Model, July 1986.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

4. WCAP-10266-P-A Rev 2, The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code, March 1987.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

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

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

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

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

7. WCAP-12610-P-A, VANTAGE+ Fuel Assembly - Reference Core Report, April 1995.

   (Methodology for ITS 3.2.1 - Heat Flux Hot Channel Factor)

8. VEP-NE-2-A, Statistical DNBR Evaluation Methodology, June 1987.

   (Methodology for ITS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and ITS 3.4.1 – RCS Pressure, Temperature and Flow DNB Limits)

9. VEP-NE-3-A, Qualification of the WRB-1 CHF Correlation in the Virginia Power COBRA Code, July 1990.

(Methodology for ITS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor and ITS 3.4.1 – RCS Pressure, Temperature and Flow DNB Limits)

10. VEP-NE-1-A, Virginia Power Relaxed Power Distribution Control Methodology and Associated FQ Surveillance Technical Specifications, March 1986; Supplement 1, September 1996.

(Methodology for ITS 3.2.1 – Heat Flux Hot Channel Factor and ITS 3.2.3 – Axial Flux Difference)

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

(Methodology for ITS 2.1.1 – Reactor Core Safety Limits and ITS 3.3.1 – Reactor Trip System Instrumentation)

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

(Methodology for ITS 2.1.1 – Reactor Core Safety Limits, ITS 3.1.1 – Shutdown Margin, ITS 3.3.1 – Reactor Trip System Instrumentation, ITS 3.4.1 – RCS Pressure, Temperature, and Flow DNB Limits and ITS 3.9.1 – Boron Concentration)

2.0 SAFETY LIMITS (SLs)

2.1 SLs

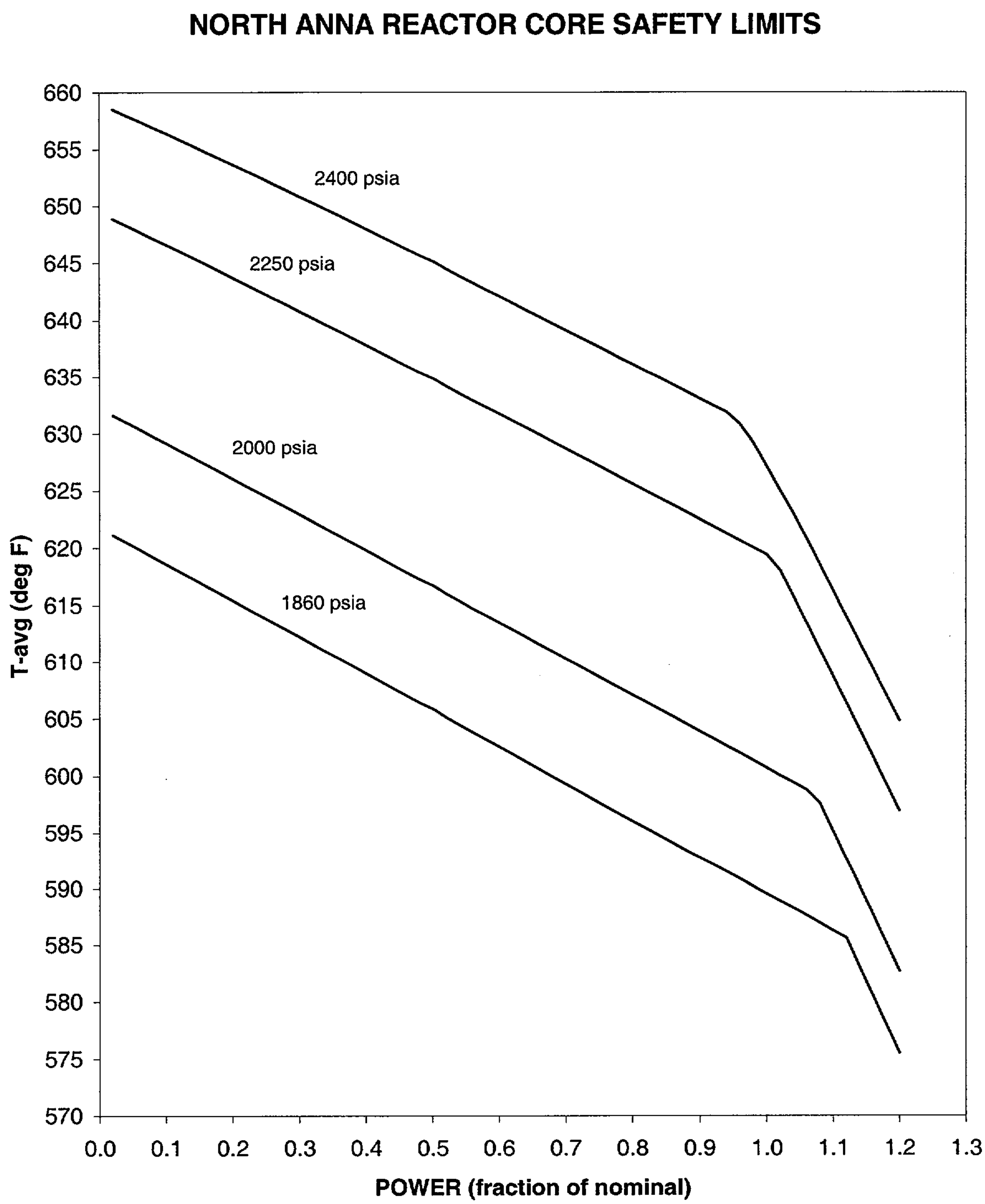
2.1.1 Reactor Core SLs

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 < 4700 ^{0}F.

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/^{0}F, when < 70% RTP, and 0.0 Δk/k/^{0}F when ≥ 70% RTP.**

The BOC/ARO-MTC shall be ≤ +0.6 x 10^{-4} Δk/k/^{0}F (upper limit), when < 70% RTP, and ≤ 0.0 Δk/k/^{0}F when ≥ 70% RTP.

The EOC/ARO/RTP-MTC shall be less negative than –5.0 x 10^{-4} Δk/k/^{0}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/^{0}F [Note 2].

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to –4.7 x 10^{-4} Δk/k/^{0}F [Note 3].

SR 3.1.3.2 Verify MTC is within **–5.0 x 10^{-4} Δk/k/^{0}F (lower limit).**

Note 2: If the MTC is more negative than **–4.0 x 10^{-4} Δk/k/^{0}F**, SR 3.1.3.2 shall be repeated once per 14 EFPD during the remainder of the fuel cycle.

Note 3: 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/^{0}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 226 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 226 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 98 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**.

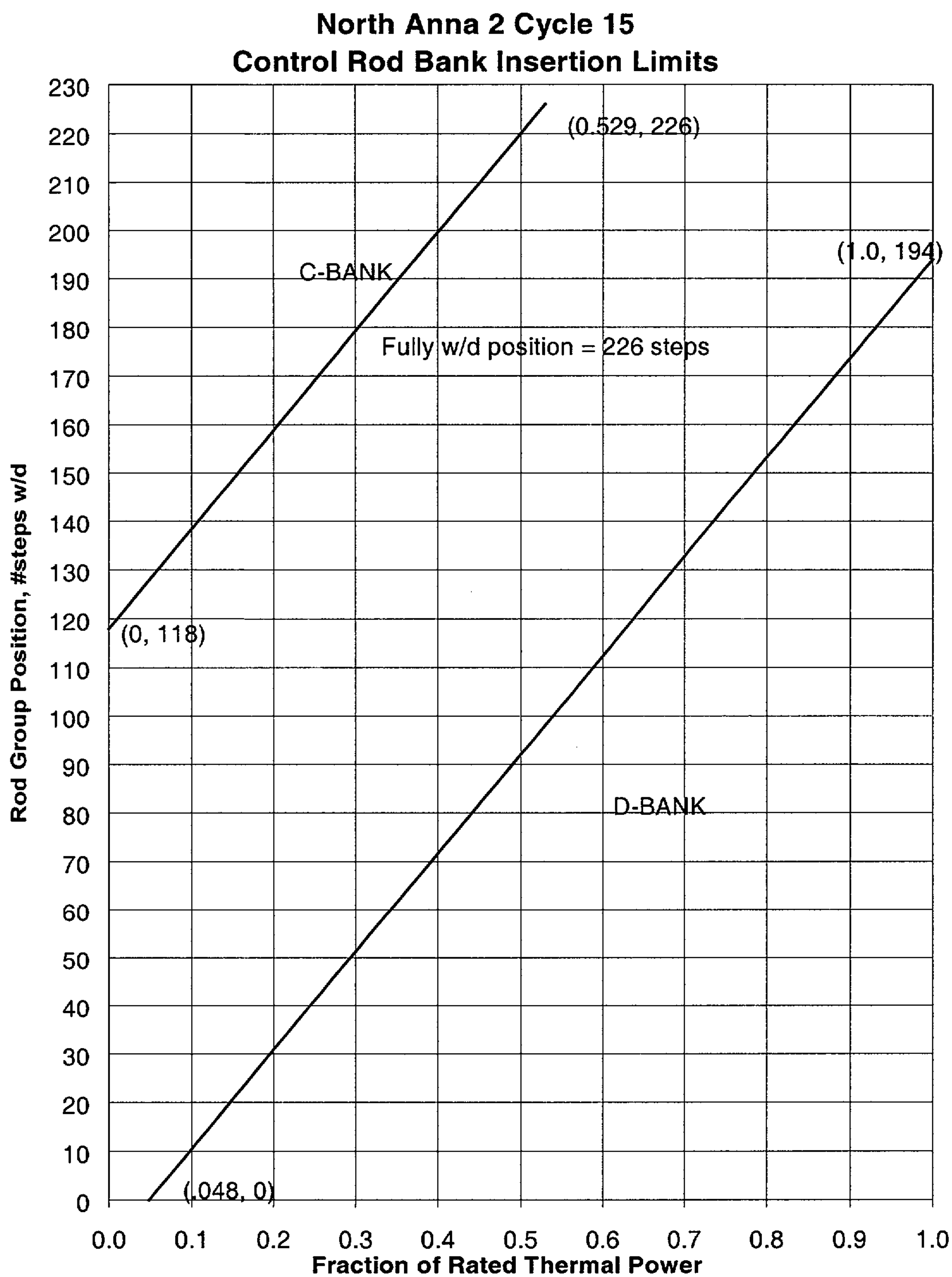
SR 3.1.6.3 Verify each control bank not fully withdrawn from the core is within the sequence and overlap limits specified in **LCO 3.1.6 above.**

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



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.**

The change in the $F_Q(Z)$ limit for coastdown operation is accommodated by defining a variable quantity, CFQ as indicated below. Then, the following expressions apply to both normal operation and Tavg coastdown regimes.

CFQ = 2.19, for normal operation at full power;

CFQ = 2.15, for flux map immediately preceding EOC temperature coastdown and during subsequent power coastdown operation.

The Measured Heat Flux Hot Channel Factor, $F_Q^M(Z)$, 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; and
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.

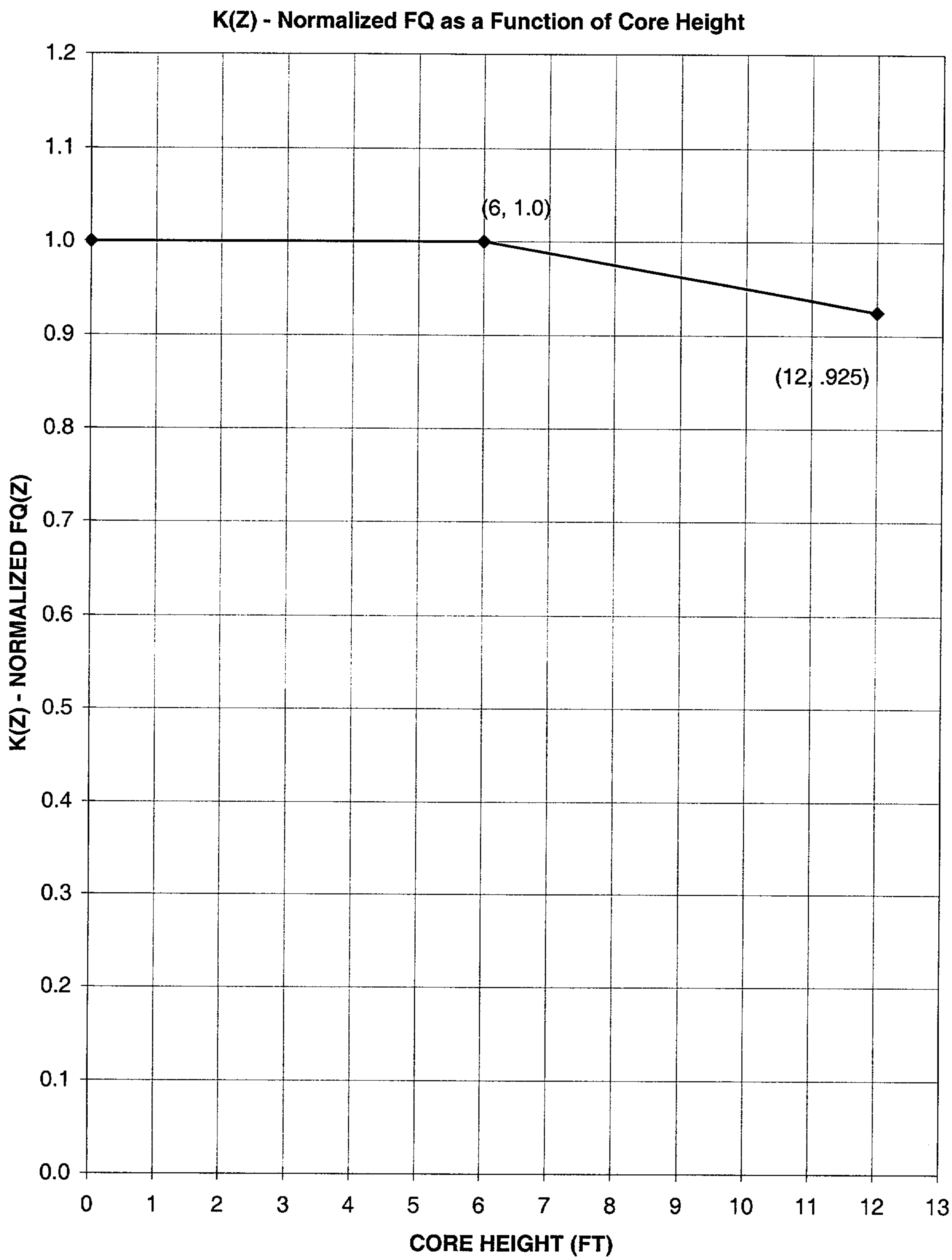
The discussion in the Bases Section B 3.2.1 for this LCO requires the application of a cycle dependent non-equilibrium multiplier, N(Z), to the measured peaking factor, $F_Q^M(Z)$, before comparing it to the limit. N(Z) accounts for power distribution transients encountered during normal operation. As function N(Z) is dependent on the predicted equilibrium $F_Q(Z)$ and is sensitive to the axial power distribution, it must be 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

N2C15 Normal Operation N(z)

Node	Height (ft)	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 17800 MWD/MTU	17800 to EOC MWD/MTU
10	10.2	1.168	1.168	1.168	1.140	1.140	1.140	1.116
11	10.0	1.166	1.166	1.166	1.140	1.140	1.140	1.117
12	9.8	1.163	1.163	1.163	1.138	1.138	1.138	1.124
13	9.6	1.160	1.160	1.160	1.138	1.138	1.138	1.134
14	9.4	1.160	1.160	1.160	1.140	1.140	1.142	1.142
15	9.2	1.164	1.164	1.164	1.145	1.145	1.149	1.149
16	9.0	1.170	1.170	1.170	1.148	1.148	1.155	1.155
17	8.8	1.177	1.177	1.177	1.153	1.153	1.160	1.160
18	8.6	1.181	1.181	1.181	1.159	1.159	1.164	1.164
19	8.4	1.184	1.184	1.184	1.165	1.165	1.168	1.168
20	8.2	1.186	1.186	1.186	1.169	1.169	1.173	1.173
21	8.0	1.187	1.187	1.187	1.171	1.171	1.178	1.178
22	7.8	1.187	1.187	1.187	1.173	1.173	1.182	1.182
23	7.6	1.186	1.186	1.186	1.173	1.173	1.185	1.185
24	7.4	1.183	1.183	1.183	1.171	1.171	1.187	1.187
25	7.2	1.179	1.179	1.179	1.168	1.168	1.188	1.188
26	7.0	1.174	1.174	1.174	1.163	1.163	1.186	1.186
27	6.8	1.167	1.167	1.167	1.158	1.158	1.184	1.184
28	6.6	1.159	1.159	1.158	1.152	1.152	1.180	1.180
29	6.4	1.150	1.150	1.149	1.146	1.146	1.173	1.173
30	6.2	1.138	1.138	1.141	1.141	1.141	1.165	1.165
31	6.0	1.126	1.126	1.136	1.137	1.137	1.158	1.158
32	5.8	1.114	1.114	1.132	1.132	1.132	1.152	1.152
33	5.6	1.098	1.098	1.125	1.126	1.126	1.149	1.149
34	5.4	1.089	1.089	1.118	1.118	1.118	1.144	1.144
35	5.2	1.086	1.086	1.108	1.108	1.108	1.133	1.133
36	5.0	1.090	1.090	1.103	1.103	1.103	1.125	1.125
37	4.8	1.095	1.095	1.106	1.106	1.106	1.121	1.121
38	4.6	1.101	1.101	1.110	1.110	1.110	1.122	1.122
39	4.4	1.106	1.106	1.113	1.113	1.113	1.126	1.126
40	4.2	1.110	1.110	1.117	1.117	1.117	1.129	1.129
41	4.0	1.113	1.113	1.122	1.122	1.122	1.131	1.131
42	3.8	1.115	1.115	1.126	1.126	1.126	1.134	1.134
43	3.6	1.118	1.118	1.130	1.130	1.130	1.138	1.138
44	3.4	1.123	1.123	1.134	1.134	1.134	1.141	1.142
45	3.2	1.132	1.132	1.140	1.140	1.140	1.145	1.145
46	3.0	1.140	1.140	1.146	1.146	1.146	1.148	1.146
47	2.8	1.148	1.148	1.154	1.154	1.154	1.154	1.149
48	2.6	1.156	1.156	1.162	1.162	1.162	1.161	1.155
49	2.4	1.164	1.164	1.170	1.170	1.170	1.170	1.163
50	2.2	1.171	1.171	1.178	1.178	1.178	1.178	1.170
51	2.0	1.178	1.178	1.186	1.186	1.186	1.185	1.180
52	1.8	1.185	1.185	1.193	1.193	1.193	1.193	1.191

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.**

$$\mathbf{F^N_{\Delta H} \leq 1.49\{1 + 0.3(1 - P)\}}$$

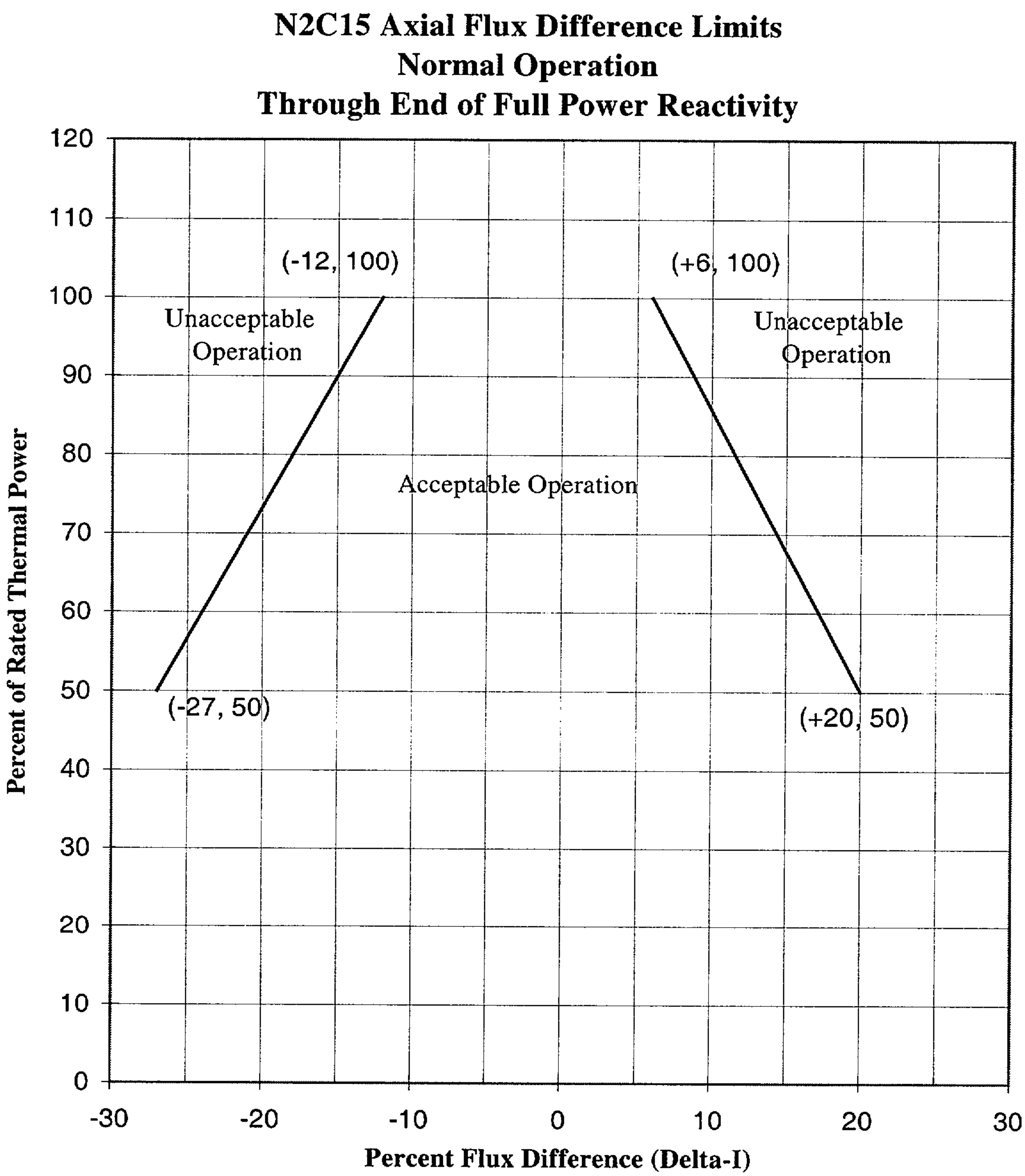
where: $P = \dfrac{THERMAL\ POWER}{RATED\ THERMAL\ POWER}$

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

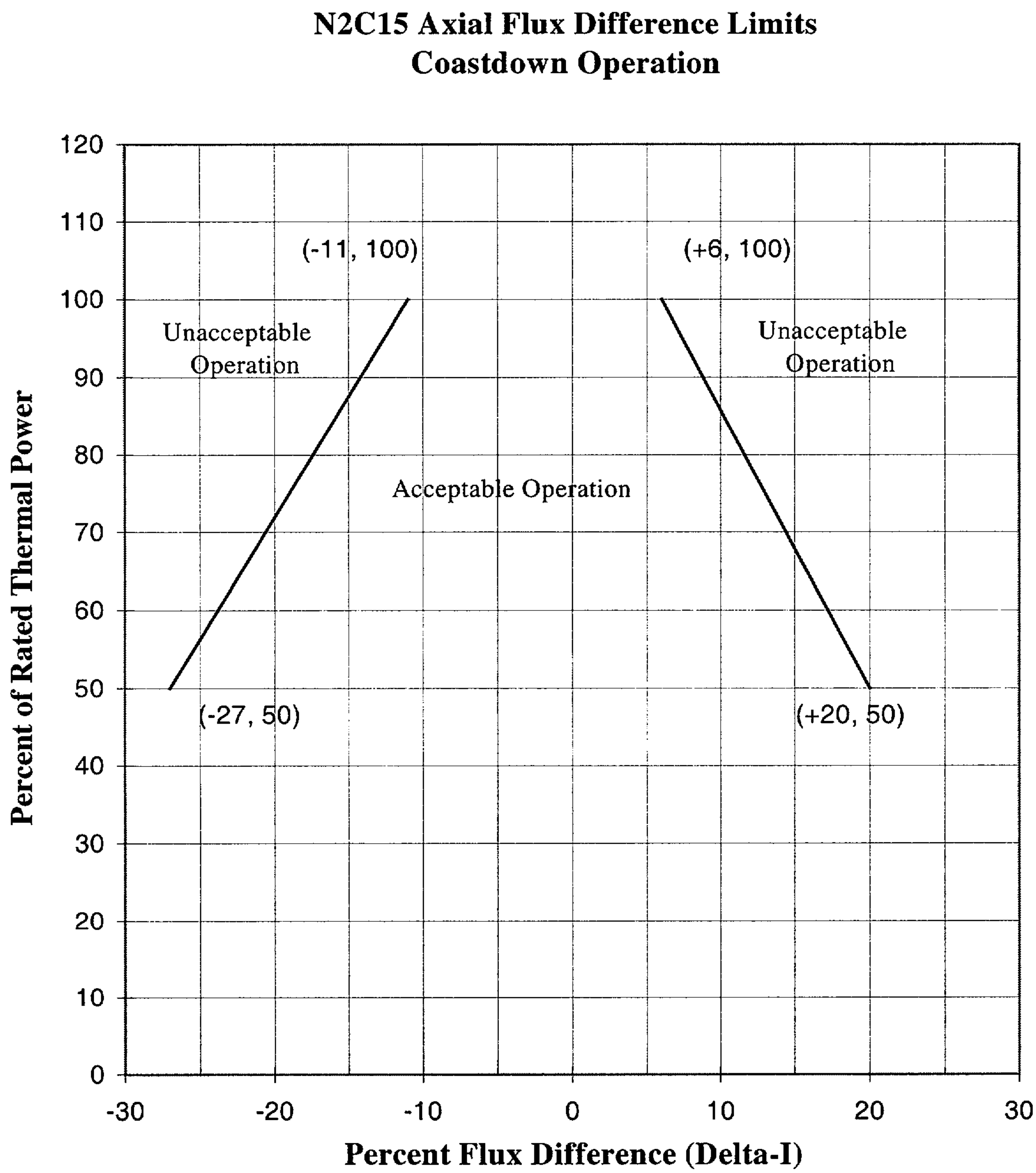
3.2.3 AXIAL FLUX DIFFERENCE (AFD)

LCO 3.2.3 The AFD in % flux difference units shall be maintained within the limits specified in **COLR Figures 3.2-2 and 3.2-3.**

COLR Figure 3.2-2



COLR Figure 3.2-3



3.3 INSTRUMENTATION

3.3.1 Reactor Trip System (RTS) Instrumentation

ITS 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, ^0F.

ΔT_0 is the indicated ΔT at RTP, ^0F.

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

T is the measured RCS average temperature, ^0F.

T' is the nominal T_{avg} at RTP, $\leq$ **586.8 ^{0}F.**

P is the measured pressurizer pressure, psig.

P' is the nominal RCS operating pressure, $\geq$ **2235 psig.**

$K_1 \leq$ **1.2715**	$K_2 \geq$ **0.02172 /^{0}F**	$K_3 \geq$ **0.001144 /psig**

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

$\tau_1 \geq$ **23.75 sec** $\tau_2 \leq$ **4.4 sec**

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

$f_1(\Delta I) \geq$ **0.0165{−44 − ($q_t - q_b$)}**	when $(q_t - q_b) <$ **−44%** RTP
0	when **−44%** RTP $\leq (q_t - q_b) \leq$ **+3%** RTP
0.0198{($q_t - q_b$) − 3}	when $(q_t - q_b) >$ **+3%** RTP
[See footnote]#	

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.

Footnote: The units for $f_1(\Delta I) = 0$ in the North Anna ITS and NUREG-1431 are incorrectly specified as "% of RTP." $f_1(\Delta I)$ being dimensionless should have no units. This discrepancy is being addressed by the North Anna Corrective Action System.

ITS 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, ^{0}F.
ΔT_0 is the indicated ΔT at RTP, ^{0}F.

s is the Laplace transform operator, sec^{-1}.
T is the measured RCS average temperature, ^{0}F.
T' is the nominal T_{avg} at RTP, ≤ **586.8 ^{0}F.**

K_4 ≤ **1.0865**

K_5 ≥ **0.0197 /^{0}F** for increasing T_{avg}
0 /^{0}F for decreasing T_{avg}

K_6 ≥ **0.00162 /^{0}F** when T > T'
0 /^{0}F when T ≤ T'

τ_3 = time constant utilized in the rate lag controller for T_{avg}
τ_3 ≥ **9.5 sec** [See footnote]##

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

$f_2(\Delta I)$ = **0, for all ΔI.**

##Footnote: The sign of the time constant τ_3 in the NAPS ITS does not match what is specified in NUREG-1431. This inconsistency is being addressed by the North Anna Corrective Action System.

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 ^{0}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 ^{0}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 an SDM ≥ **1.77 % Δk/k at 200 ^{0}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 ≥ **2300 ppm**.

Note: The refueling boron concentration satisfies the more restrictive of the following conditions: (a) $k_{eff} \leq 0.95$*, or (b) boron concentration ≥ 2300 ppm.*

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

TRM 3.1 REACTIVITY CONTROL SYSTEMS

TR 3.1.1 Boration Flow Paths – Operating

Required Action E.2 Borate to a SHUTDOWN MARGIN ≥ **1.77 % Δk/k at 200 ^{0}F, after xenon decay**.