North Anna Unit 2 Cycle 7

Core Operating Limits Report

March 26, 1990

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for North Anna Unit 2 Cycle 7 has been prepared in accordance with the requirements of 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 Rod Insertion Limit
3/4.1.3.6	Control Rod 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
3/4.9.1	Boron Concentration

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC-approved methodologies specified in Technical Specification 6.9.1.7.

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 Δk/k/°F below 70 percent of RATED THERMAL POWER.

The BOC/ARO-MTC shall be less positive than or equal to 0.0E-4 Δk/k/°F at or above 70 percent of RATED THERMAL POWER.

The EOC/ARO/RTP-MTC shall be less negative than -5.0E-4 Δk/k/°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 Δk/k/°F.

The 60 ppm/ARO/RTP-MTC should be less negative than or equal to -4.7E-4 Δk/k/°F.

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

2.2 Shutdown Rod Insertion Limit (Specification 3/4.1.3.5)

2.2.1 The shutdown rods shall be withdrawn to at least 228 steps.

2.3 Control Rod 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 Figure 2.

Note - These limits may be modified in the Control Room Reactor Data Book in accordance with Specification 4.2.2.2.f.2.a.

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

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

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

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

2.5.1 CFQ = 2.19

2.5.2 K(Z) is provided in Figure 3.

2.5.3 N(Z) values are provided in Figures 4 through 7.

2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}^{N}$ (Specification 3/4.2.3)

$$F_{\Delta H}^{N} \leq CFDH * (1 + PFDH * (1 - P))$$

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

2.6.1 CFDH = 1.49

2.6.2 PFDH = 0.3

2.7 Boron Concentration (Specification 3/4.9.1)

The refueling boron concentration shall be ≥ 2300 ppm.

3.0 REFERENCES

1. VEP-FRD-42, Rev. 1-A, "Reload Nuclear Design Methodology, September 1986.

   (Methodology for LCO 3.1.1.4 - Moderator Temperature Coefficient, LCO 3.1.3.5 - Shutdown Bank Insertion Limit, LCO 3.1.3.6 - Control Bank Insertion Limits, LCO 3.2.2 - Heat Flux Hot Channel Factor, LCO 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor, and LCO 3.9.1 - Boron Concentration).

2a. WCAP-9220-P-A, Rev. 1, "WESTINGHOUSE ECCS EVALUATION MODEL - 1981 VERSION", February 1982 (W Proprietary).

   (Methodology for LCO 3.2.2 - Heat Flux Hot Channel Factor.)

2b. WCAP-9561-P-A, ADD. 3, Rev. 1, "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, (W Proprietary).

   (Methodology for LCO 3.2.2 - Heat Flux Hot Channel Factor.)

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

   (Methodology for LCO 3.2.3, Nuclear Enthalpy Rise Hot Channel Factor.)

4. K. L. Basehore et al., "Vepco Relaxed Power Distribution Control Methodology and Associated FQ Surveillance Technical Specifications," VEP-NE-1-A, March 1986.

   (Methodology for LCO 3.2.2 - Heat Flux Hot Channel Factor and LCO 3.2.1 - Axial Flux Difference.)

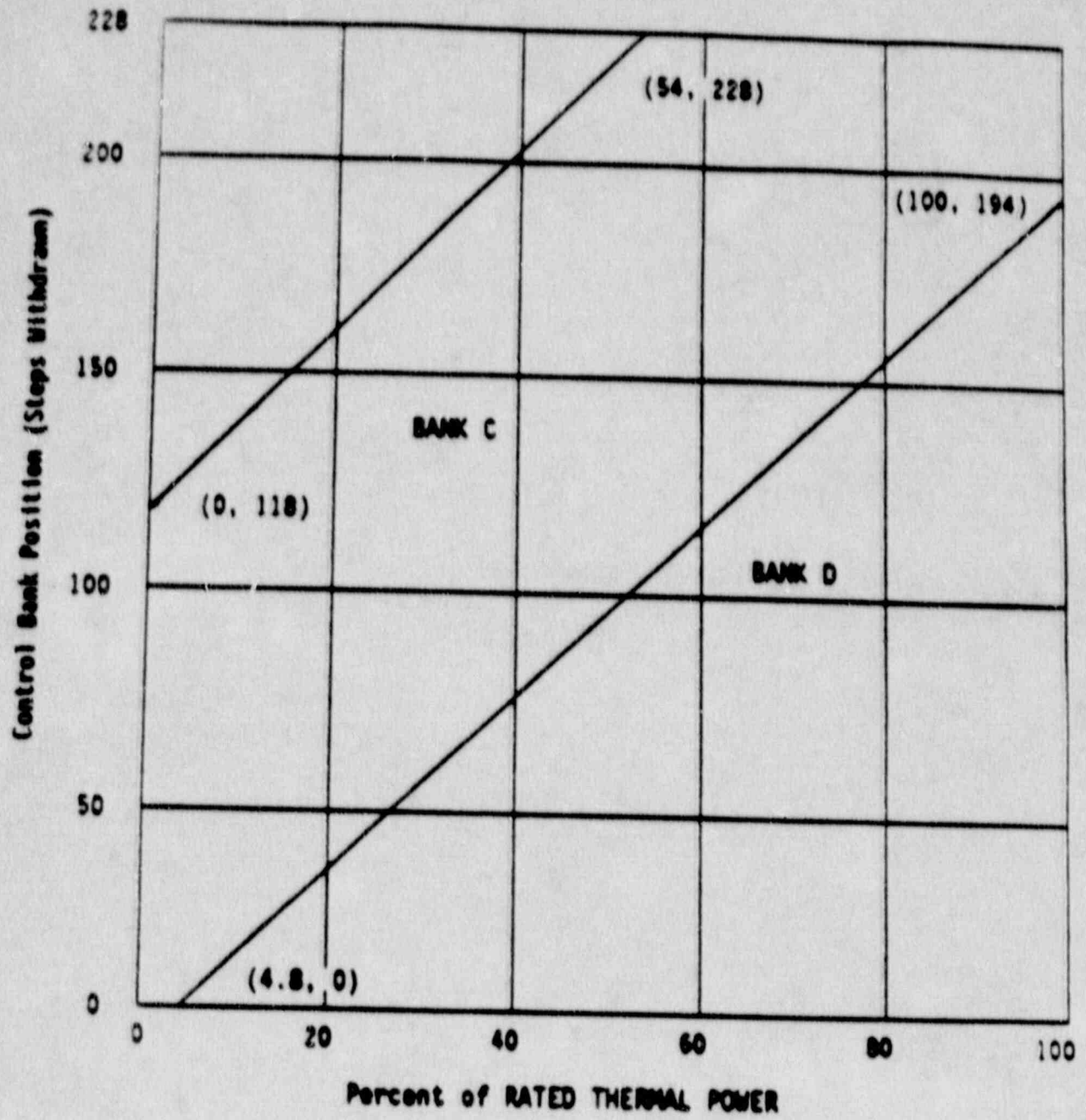


Figure 1

Control Rod Bank Insertion Limits vs Percent RATED THERMAL POWER

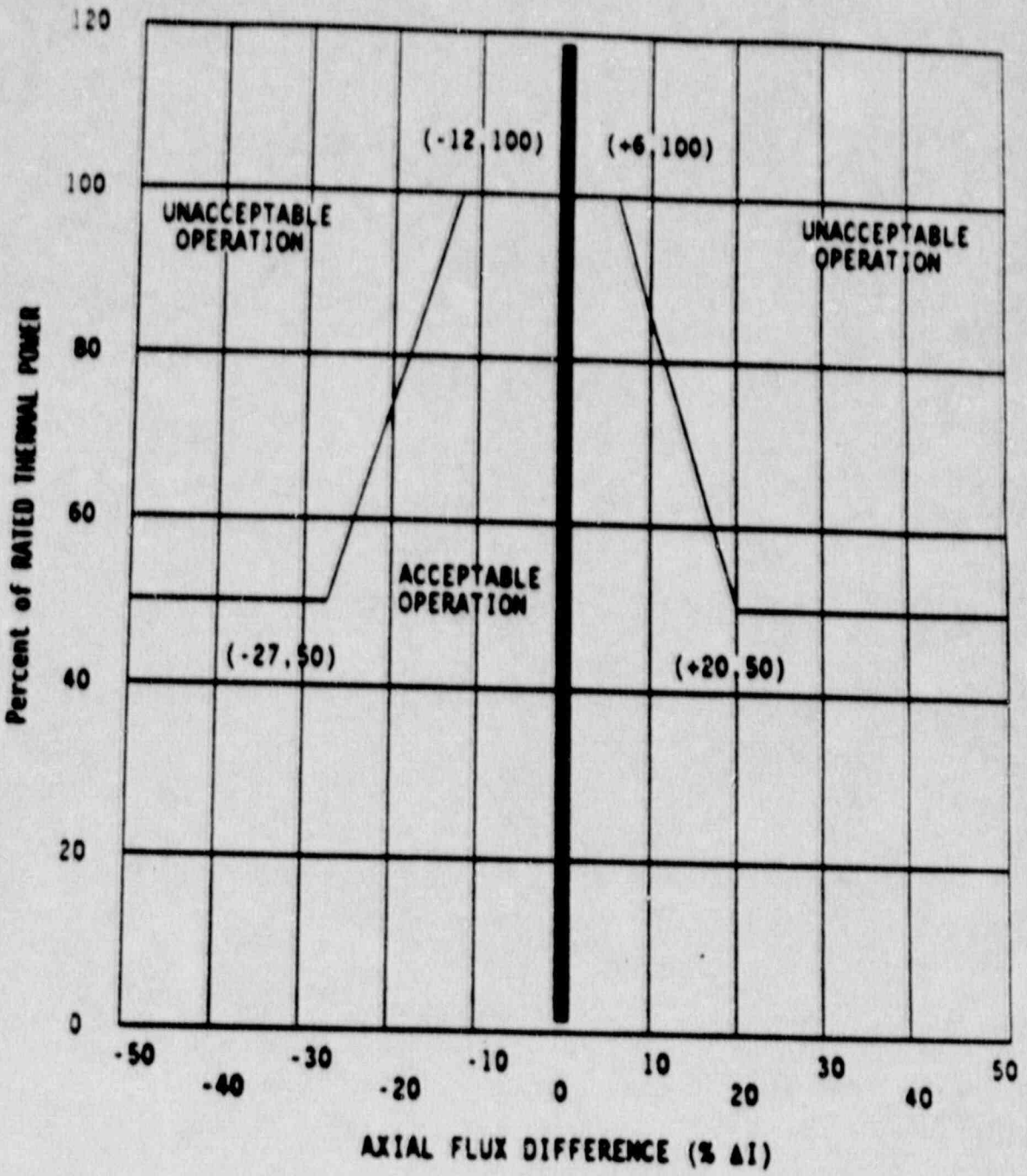
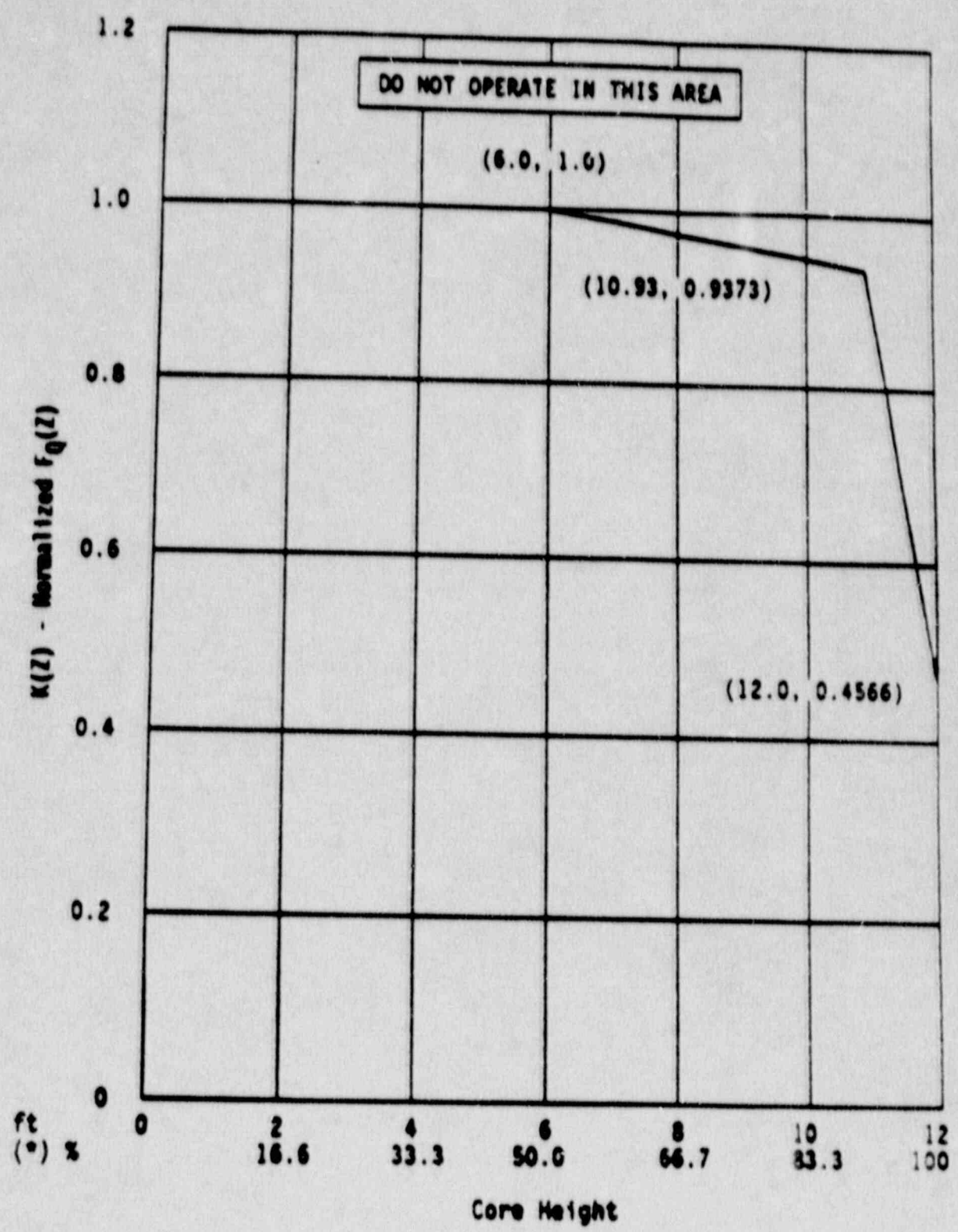


Figure 2

Axial Flux Difference Limits as a Function of RATED THERMAL POWER from 150 MWD/MTU Burnup to EOC



* For core height of 12 feet

FIGURE 3

K(Z) - Normalized F_Q as a Function of Core Height

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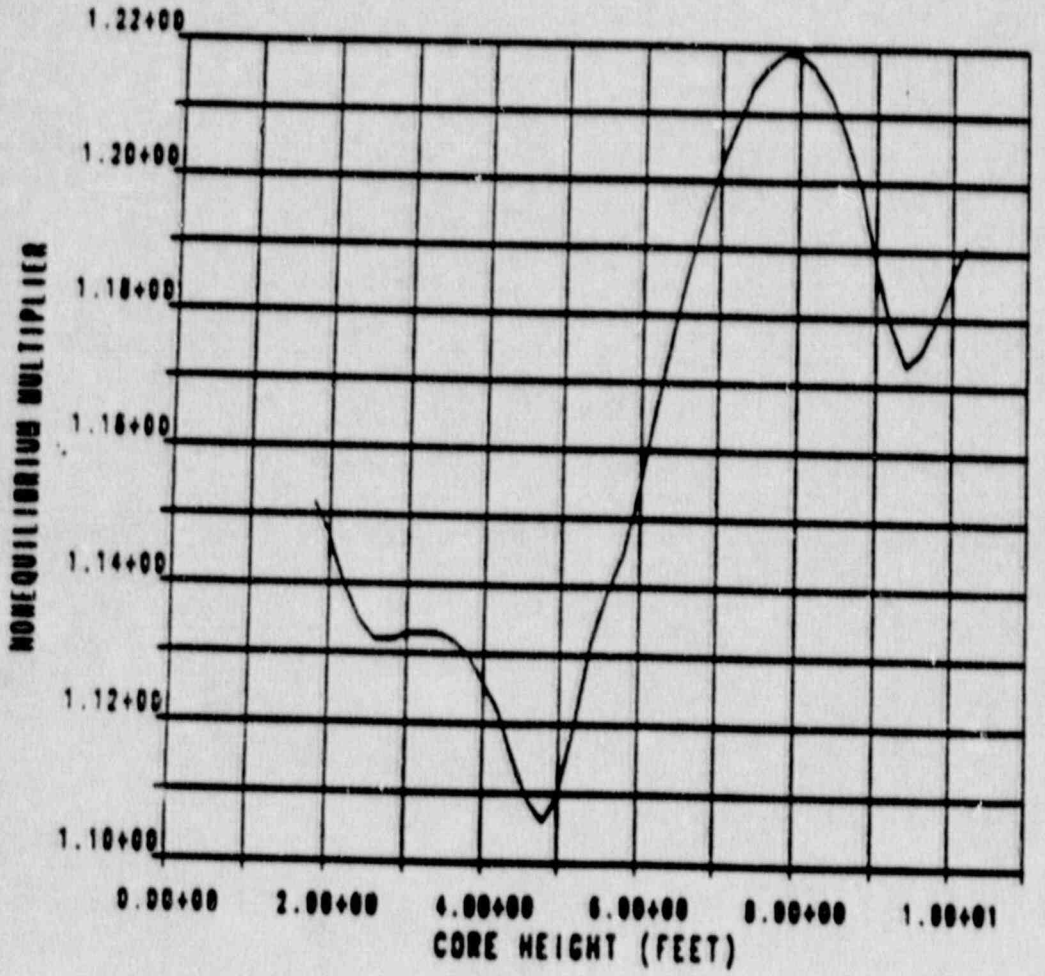
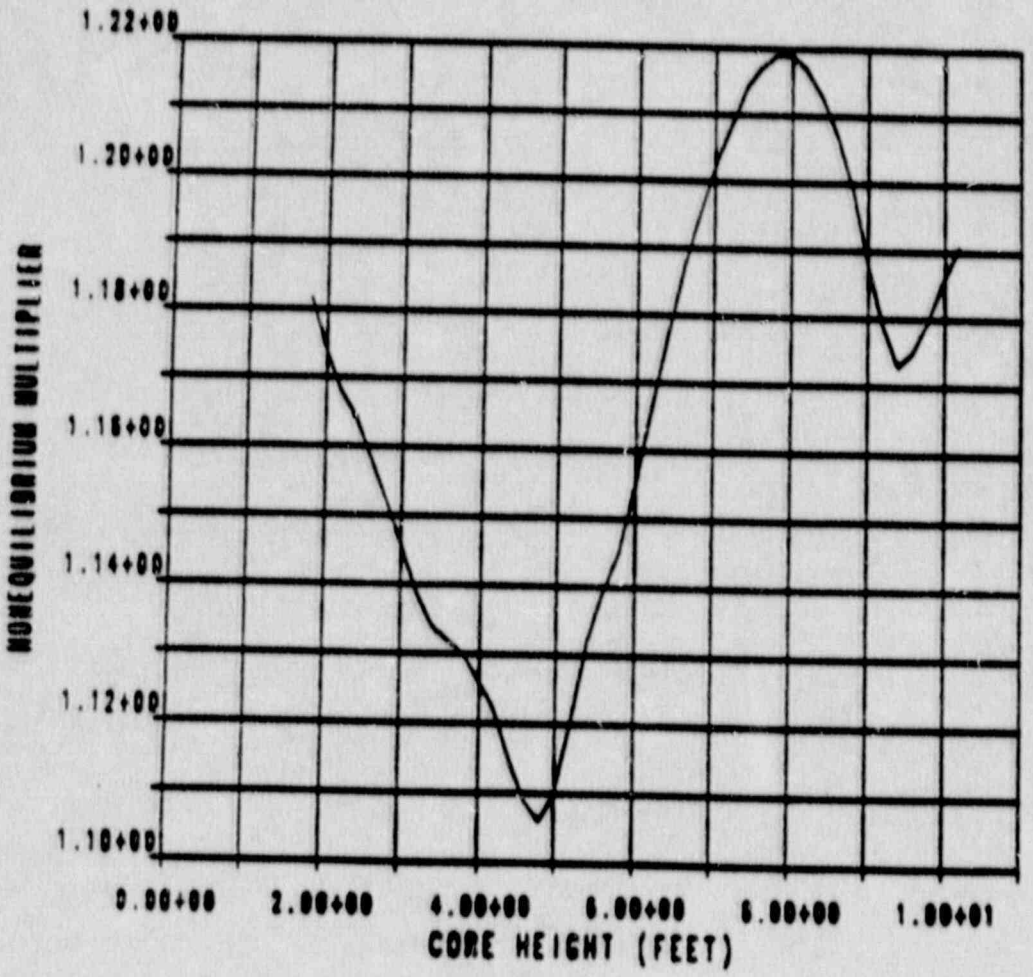


N2C7/JU N(Z) FUNCTION AT 5000-7000 MWD/MTU BURNUP

HEIGHT	NZ5
10.20	1.191
10.00	1.186
9.80	1.180
9.60	1.175
9.40	1.173
9.20	1.179
9.00	1.188
8.80	1.199
8.60	1.207
8.40	1.213
8.20	1.217
8.00	1.219
7.80	1.219
7.60	1.217
7.40	1.214
7.20	1.208
7.00	1.202
6.80	1.195
6.60	1.187
6.40	1.177
6.20	1.166
6.00	1.155
5.80	1.145
5.60	1.139
5.40	1.132
5.20	1.120
5.00	1.110
4.80	1.106
4.60	1.109
4.40	1.115
4.20	1.122
4.00	1.126
3.80	1.130
3.60	1.132
3.40	1.133
3.20	1.133
3.00	1.133
2.80	1.132
2.60	1.132
2.40	1.135
2.20	1.140
2.00	1.147
1.80	1.152

FIGURE 4

N(Z) FUNCTION FOR N2C7 AT 2893 MW
REDUCED TEMPERATURE OPERATION
FROM 5000 to 7000 MWD/MTU BURNUP
TOP AND BOTTOM 15 PERCENT EXCLUDED
AS PER TECH SPEC 4.2.2.2.G



N2C7/JU N(Z) FUNCTION AT 7000-9000 MWD/MTU BURNUP

HEIGHT	NZ6
10.20	1.191
10.00	1.186
9.80	1.180
9.60	1.175
9.40	1.173
9.20	1.179
9.00	1.188
8.80	1.199
8.60	1.207
8.40	1.213
8.20	1.217
8.00	1.219
7.80	1.219
7.60	1.217
7.40	1.214
7.20	1.208
7.00	1.202
6.80	1.195
6.60	1.187
6.40	1.177
6.20	1.166
6.00	1.155
5.80	1.145
5.60	1.139
5.40	1.132
5.20	1.120
5.00	1.110
4.80	1.106
4.60	1.109
4.40	1.115
4.20	1.122
4.00	1.126
3.80	1.130
3.60	1.132
3.40	1.134
3.20	1.139
3.00	1.146
2.80	1.152
2.60	1.158
2.40	1.164
2.20	1.168
2.00	1.174
1.80	1.182

FIGURE 5

N(Z) FUNCTION FOR N2C7 AT 2893 MW
REDUCED TEMPERATURE OPERATION
FROM 7000 to 9000 MWD/MTU BURNUP
TOP AND BOTTOM 15 PERCENT EXCLUDED
AS PER TECH SPEC 4.2.2.2.G

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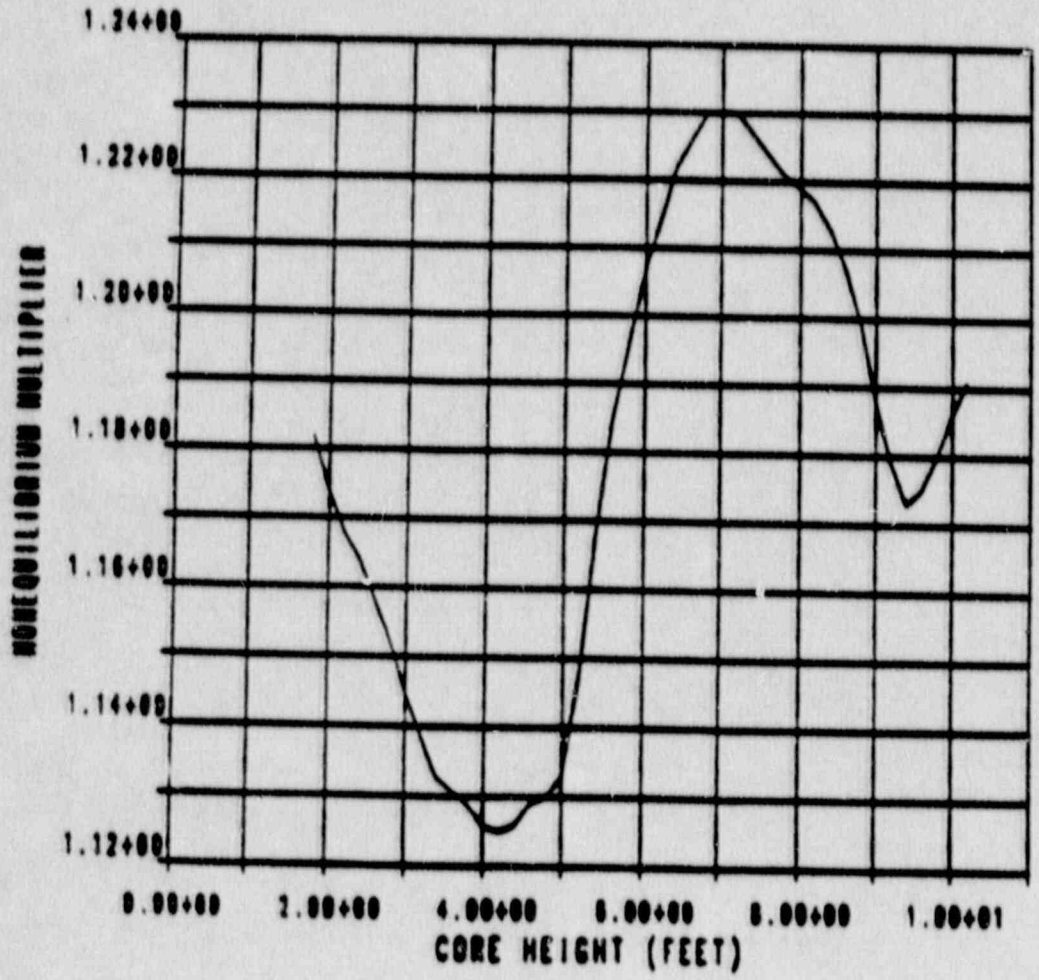


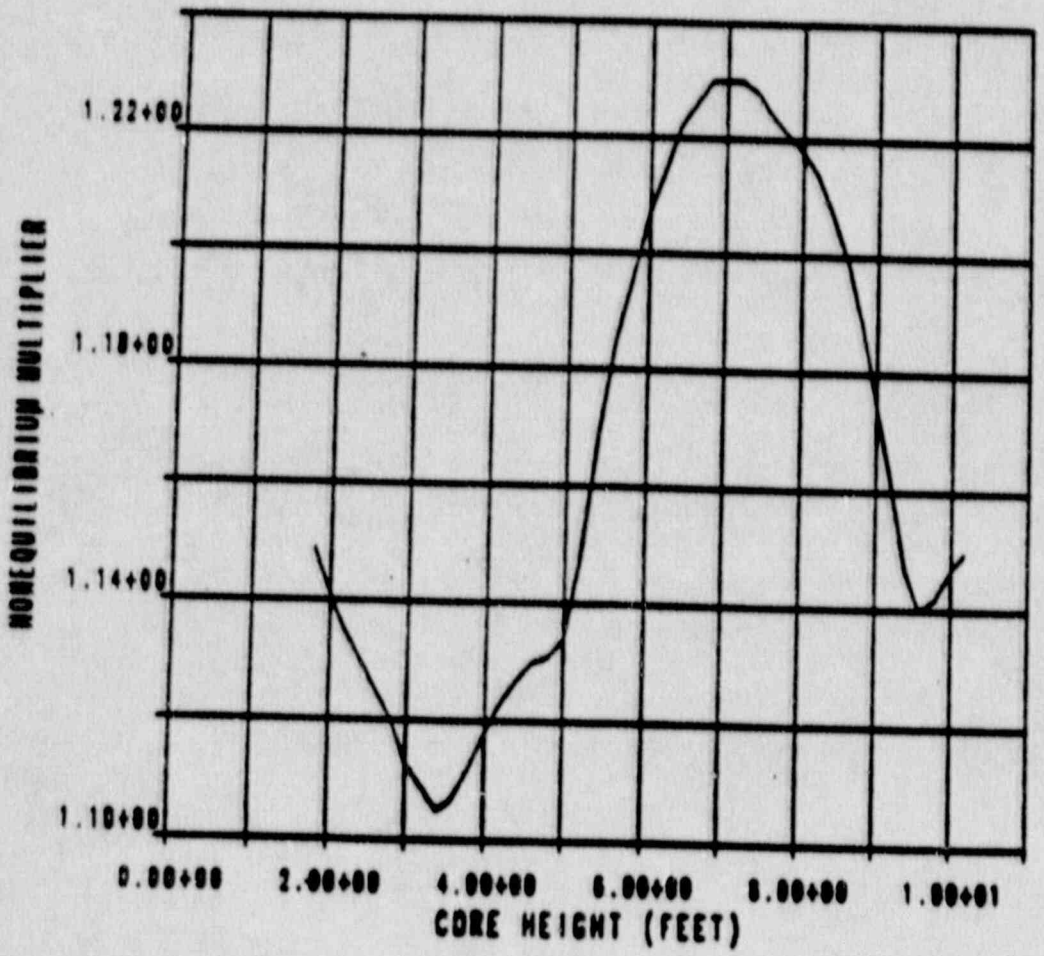
N2C7/JU N(Z) FUNCTION AT 9000-15600 MWD/MTU BURNUP

HEIGHT	NZ7
10.20	1.191
10.00	1.186
9.80	1.180
9.60	1.175
9.40	1.173
9.20	1.179
9.00	1.188
8.80	1.199
8.60	1.207
8.40	1.213
8.20	1.217
8.00	1.219
7.80	1.221
7.60	1.224
7.40	1.227
7.20	1.230
7.00	1.230
6.80	1.230
6.60	1.226
6.40	1.222
6.20	1.214
6.00	1.207
5.80	1.196
5.60	1.185
5.40	1.169
5.20	1.147
5.00	1.133
4.80	1.130
4.60	1.129
4.40	1.126
4.20	1.125
4.00	1.126
3.80	1.129
3.60	1.131
3.40	1.133
3.20	1.139
3.00	1.145
2.80	1.152
2.60	1.158
2.40	1.164
2.20	1.168
2.00	1.174
1.80	1.182

FIGURE 6

N(Z) FUNCTION FOR N2C7 AT 2893 MW
REDUCED TEMPERATURE OPERATION
FROM 9000 to 15600 MWD/MTU BURNUP
TOP AND BOTTOM 15 PERCENT EXCLUDED
AS PER TECH SPEC 4.2.2.2.G

COLR FOR NORTH ANNA UNIT 2 CYCLE 7



N2C7/JU N(Z) FUNCTION AT 15600-17700 MWD/MTU BURNUP

HEIGHT	NZB
10.20	1.150
10.00	1.147
9.80	1.142
9.60	1.140
9.40	1.147
9.20	1.162
9.00	1.175
8.80	1.188
8.60	1.199
8.40	1.207
8.20	1.214
8.00	1.218
7.80	1.221
7.60	1.224
7.40	1.228
7.20	1.230
7.00	1.230
6.80	1.230
6.60	1.226
6.40	1.222
6.20	1.214
6.00	1.207
5.80	1.196
5.60	1.185
5.40	1.169
5.20	1.148
5.00	1.134
4.80	1.131
4.60	1.130
4.40	1.127
4.20	1.123
4.00	1.118
3.80	1.112
3.60	1.107
3.40	1.105
3.20	1.109
3.00	1.113
2.80	1.120
2.60	1.125
2.40	1.130
2.20	1.135
2.00	1.141
1.80	1.149

FIGURE 7

N(Z) FUNCTION FOR N2C7 AT 2893 MW
REDUCED TEMPERATURE OPERATION
FROM 15600 MWD/MTU BURNUP TO EOL
TOP AND BOTTOM 15 PERCENT EXCLUDED
AS PER TECH SPEC 4.2.2.2.G

Attachment 7

Markup of the North Anna MERITS Technical Specifications

Virginia Electric and Power Company

3.1 REACTOR

3.1.3 Moderator Temperature Coefficient (MTC)

LCO 3.1.3 The MTC shall be within the limits ~~provided~~ specified in the CORE OPERATING LIMITS REPORT (COLR).

---NOTE---
The maximum upper limit shall be ≤ 0.6E-4 Δk/k/°F for THERMAL POWER < 70% of RTP, and ≤ 0.0 Δk/k/°F for THERMAL POWER ≥ 70% of RTP

APPLICABILITY MODE 1,
MODE 2 with k_{eff} ≥ 1.0 for Beginning of Cycle (BOC) limit,
MODES 1, 2, and 3 for End of Cycle (EOC) limit.

---NOTE---
LCO 3.0.4 is not applicable.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. MTC outside BOC limit.	---NOTE--- Subsequent operation is permitted. The requirements of LCO 3.1.6, Control Bank Insertion Limits, remain applicable. ---	
	A.1 Establish administrative withdrawal limits for control banks to maintain MTC within limit.	24 hours
	OR	
	A.2 Be in MODE 2 with K_{eff} < 1.0.	30 hours
B. MTC outside EOC limit.	B.1 Be in MODE 4.	12 hours

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
----------NOTE---------- SR 3.0.4 is not applicable for SR 3.1.3.1, SR 3.1.3.2 and SR 3.1.3.3. ----------	
SR 3.1.3.1 Verify BOC MTC within limit.	After each refueling prior to entering MODE 1
SR 3.1.3.2 ----------NOTES---------- (specified) 1. If the MTC is more negative than the 300 ppm surveillance limit ~~provided~~ in the COLR, SR 3.1.3.2 shall be repeated once per 14 Effective Full Power Days (EFPD) during the remainder of the fuel cycle. 2. SR 3.1.3.2 need not be repeated if the MTC measured at the equivalent of equilibrium RATED THERMAL POWER - All Rods Out (RTP-ARO) boron concentration of ≤ 60 ppm is more positive than the 60 ppm surveillance limit ~~provided~~ in the COLR. (2 specified) ---------- Verify EOC MTC within limit.	-----NOTE----- Required once within 7 EFPD after reaching the equivalent of an equilibrium RTP-ARO boron concentration of 300 ppm ---------- Each cycle

(continued)

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.1.3.3	Verify MTC within 300 ppm surveillance limit ~~provided in the COLR~~.	-----NOTE----- Required once within 7 EFPD after reaching the equivalent of an equilibrium RTP-ARO boron concentration of 300 ppm ---------- Each cycle

CROSS-REFERENCES

TITLE	NUMBER
MODE 2 Physics Tests Exceptions	3.1.13
Startup Reports	5.10

3.1 REACTOR

3.1.5 Shutdown Bank Insertion Limit

LCO 3.1.5 Shutdown banks shall be within the physical insertion limit ~~provided~~ specified in the CORE OPERATING LIMITS REPORT.

APPLICABILITY: MODE 1,
MODE 2 with $k_{eff} \geq 1.0$,
Within 15 minutes prior to initial control bank withdrawal during an approach to criticality.

----------NOTE----------
This LCO is not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more shutdown banks outside limit.	A.1 Restore shutdown banks to within limit.	2 hours
	OR	
B. Required Action not met within required Completion Time.	B.1 Be in MODE 2 with $k_{eff} \leq 1.0$.	6 hours

3.1 REACTOR

3.1.6 Control Bank Insertion Limits

LCO 3.1.6 Control banks shall be within the limits ~~provided~~ specified in the CORE OPERATING LIMITS REPORT for:

a. Physical insertion limits, and

b. Sequence and overlap requirements.

APPLICABILITY: MODE 1,
MODE 2 with $k_{eff} \geq 1.0$.

---NOTE---
This LCO is not applicable while performing SR 3.1.4.2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Control banks below insertion limits.	A.1 Restore control banks above insertion limits.	2 hours
B. Control banks sequence or overlap requirements not met.	B.1 Restore control banks sequence or overlap to meet requirements.	2 hours
C. Required Actions not met within required Completion Times.	C.1 Be in MODE 2 with $k_{eff} < 1.0$.	6 hours

3.1 REACTOR

3.1.7 Heat Flux Hot Channel Factor - $F_Q(Z)$

LCO 3.1.7 The Heat Flux Hot Channel Factor, $F_Q(Z)$, shall be limited by the following relationships:

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

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

where: CFQ is the F_Q limit at RATED THERMAL POWER (RTP) specified → ~~provided~~ in the CORE OPERATING LIMITS REPORT (COLR),

K(Z) is the normalized F_Q as a function of core height ~~provided~~ ↑ specified in the COLR, and

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

APPLICABILITY: MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. $F_Q^C(Z)$ exceeds limit.	A.1 Reduce THERMAL POWER at least 1% of RATED THERMAL POWER (RTP) for each 1% $F_Q^C(Z)$ exceeds limit. AND (continued)	15 minutes

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE	FREQUENCY
SR 3.1.7.2 ----------NOTES----------	
1. $F_Q^N(Z)$ evaluations are not applicable for the following axial core regions, measured in percent of core height:	6
a. Lower core region, from 0 to 15% inclusive, and	
b. Upper core region, from 85 to 100% inclusive.	
2. If $F_Q^N(Z)$ is within limits and measurements indicate	
maximum over Z $\left\{ \frac{F_Q^C(Z)}{K(Z)} \right\}$	
has increased since the previous evaluation of $F_Q(Z)$:	
a. Increase $F_Q^N(Z)$ by 2% and reverify that $F_Q^N(Z)$ is within limits.	
OR	
b. SR 3.1.7.2 shall be repeated once per 7 EFPD until 2 successive flux maps indicate	
maximum over Z $\left\{ \frac{F_Q^C(Z)}{K(Z)} \right\}$	
has not increased.	
3. $F_Q^N(Z) = F_Q^C(Z) \times N(Z)$ specified	
4. N(Z) and K(Z) are ~~provided~~ in the COLR.	
---------- (continued)	

3.1 REACTOR

3.1.8 Nuclear Enthalpy Rise Hot Channel Factor-$F_{\Delta H}^N$

LCO 3.1.8 The Nuclear Enthalpy Rise Hot Channel Factor, $F_{\Delta H}^N$, shall be limited by the following relationship:

$F_{\Delta H}^N \leq CFDH * (1 + PFDH * (1 - P))$

where CFDH = The $F_{\Delta H}^N$ limit at RATED THERMAL POWER (RTP) ~~provided~~ specified in the CORE OPERATING LIMITS REPORT (COLR),

PFDH = The Power Factor multiplier for $F_{\Delta H}^N$ ~~provided~~ specified in the COLR, and

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

APPLICABILITY: MODE 1.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ----------NOTE---------- Required Actions A.2 and A.3 must be completed whenever Condition A is entered. ----------		
$F_{\Delta H}^N$ outside limit.	A.1.1 Restore $F_{\Delta H}^N$ to within limit.	4 hours
	OR	
	A.1.2.1 Reduce THERMAL POWER to < 50% of RATED THERMAL POWER (RTP).	4 hours
	AND	
	(continued)	

3.1 REACTOR

3.1.9 Axial Flux Difference

LCO 3.1.9 The AXIAL FLUX DIFFERENCE (AFD) shall be maintained within the limits ~~provided~~ specified in the CORE OPERATING LIMITS REPORT.

----------NOTE----------
The AFD shall be considered outside limits when two or more OPERABLE excore channels indicate AFD to be outside limits.

APPLICABILITY: MODE 1 with THERMAL POWER ≥ 50% of RATED THERMAL POWER (RTP).

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. AFD outside limits.	A.1 Restore AFD to within limits.	15 minutes
	OR	
	----------NOTE---------- Required Action A.2.2 must be completed if Required Action A.2.1 is completed. ----------	
	A.2.1 Reduce THERMAL POWER to < 50% of RTP.	30 minutes
	AND	
	A.2.2 Reduce Power Range Neutron Flux--High trip setpoints to ≤ 55% of RTP.	4 hours and 30 minutes

3.8 REFUELING OPERATIONS

3.8.1 Boron Concentration

LCO 3.8.1 The boron concentration of all filled portions of the Reactor Coolant System (RCS), the refueling canal, and the refueling cavity shall be maintained within the limit ~~provided~~ specified in the CORE OPERATING LIMITS REPORT. 1

APPLICABILITY:
RCS - MODE 6.
Refueling Canal - MODE 6 with reactor head removed.
Refueling Cavity - MODE 6 with reactor head removed.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Boron concentration outside limit.	A.1 Suspend CORE ALTERATIONS and positive reactivity additions.	15 minutes
	AND	
	A.2.1 Initiate boration to restore concentration.	15 minutes
	AND	
	A.2.2 Continue action as required in A.2.1.	Until boron concentration is restored

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.8.1.1	Verify boron concentration within limit.	72 hours

CROSS-REFERENCES - None.

5.0 ADMINISTRATIVE CONTROLS

5.10 REPORTING REQUIREMENTS

5.10.7 Special Reports (continued)

e. Emergency Core Cooling Systems (ECCS). LCOs 3.4.2 and 3.4.3.

In the event the ECCS is actuated and injects water into the Reactor Coolant System prepare and submit a Special Report to the Commission within 90 days describing the circumstances of the actuation and the total accumulated actuation cycles to date. The current value of the usage factor for each affected safety injection nozzle shall be provided in this Special Report whenever its value exceeds 0.70.

5.10.8 CORE OPERATING LIMITS REPORT

5.10.8.a Core operating limits shall be established and documented in the CORE OPERATING LIMITS REPORT before each reload cycle or any remaining part of a reload cycle for the following:

1. Moderator Temperature Coefficient BOC and EOC limits, and 300 ppm surveillance limits for Specification 3.1.3, and 60 ppm

2. Shutdown Bank Insertion Limit for Specification 3.1.5,

3. Control Bank Insertion Limits for Specification 3.1.6,

4. Axial Flux Difference limits for Specification 3.1.9,

5. Heat Flux Hot Channel Factor, K(Z) and N(Z) for Specification 3.1.7

6. Nuclear Enthalpy Rise Hot Channel Factor and Power Factor Multiplier for Specification 3.8.1, and

7. Boron Concentration for Specification 3.8.1.

5.10.8.b The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC and shall be listed by reference in the CORE OPERATING LIMITS Report.

5.10.8.c The core operating limits shall be determined so that all applicable limits (e.g., fuel thermal-mechanical limits, core thermal-hydraulic limits, ECCS limits, nuclear limits such as shutdown margin, and transient and accident analysis limits) of the safety analysis are met.

(continued)