

Attachment

Core Operating Limits Report, Byron Station, Unit 2, Cycle 9

(BY2C9)

NUCLEAR FUEL MANAGEMENT DEPARTMENT
NUCLEAR DESIGN INFORMATION TRANSMITTAL

SAFETY RELATED
 NON-SAFETY RELATED
 REGULATORY RELATED

Originating Organization
 Nuclear Fuel Management
 Other (specify) _____

NDIT No. NFM9900202
Seq. No. 0
Page 1 of 14

Station Byron Unit 2 Cycle 9 Generic _____

To: W. G. Kouba, Byron Site Engineering Manager

Subject Byron Unit 2 Cycle 9 Core Operating Limits Report in ITS Format and W(z) Function

E. Wurz
Preparer


Preparer's Signature


10/15/99
Date

J. Gurley
Reviewer


Reviewer's Signature

10/18/99
Date

D. Redden
NFM Supervisor


NFM Supervisor's Signature

10/18/99
Date

Status of Information: Verified
 Unverified
 Engineering Judgement

Method and Schedule of Verification for Unverified NDITs: _____

Description of Information: Attached is the Byron Unit 2 Cycle 9 Core Operating Limits Report (COLR) in the ITS format and W(z) function.

Purpose of Information: Byron Station is requested to perform a Plant Review of this document. Upon completion of the Plant Review, Byron Station is to transmit the COLR portion to the Nuclear Regulatory Commission pursuant to Technical Specification 5.6.5. Please provide NFM (Erich Wurz) with a copy of Byron Station's completed Plant Review and COLR submittal to the NRC.

Source of Information: 1) PND Calculation Number PC-01, Rev. 0, "Generation of W(z) Curve," Project Byron Unit 2 Cycle 9, dated September 24, 1999.
2) PND Calculation Number SP-18, "Unfavorable Exposure Time (UET) Analysis," Project Byron Unit 2 Cycle 9, dated July 23, 1999.
3) NDIT NFM9900158, Seq. 0, "Minimum Required Boron Concentration for Control Rod Drop Testing - BY2C9," dated August 13, 1999.
4) PSS Calculation Number PSSCN:99-015, "Byron Unit 2 Cycle 9 Bank Insertion Limits with 116 Step Separation," dated October 15, 1999.
5) CAC-99-346, Rev. J, "Safety Assessment Summary for Byron Unit 2 Cycle 9," dated October 11, 1999.

Supplemental Distribution: J. Bauer (DG)
E. Young (DG)
DIT Central Files

K. N. Kovar / B. K. Arnholt (BY)
H. S. Kim / T. Stevens (DG)
M. G. Kim (DG)

B. J. Adams / J. E. Langan (BY)
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CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Byron Station Unit 2 Cycle 9 has been prepared in accordance with the requirements of Technical Specification 5.6.5 (ITS).

The Technical Specifications affected by this report are listed below:

- LCO 3.1.1 Shutdown Margin (SDM)
- LCO 3.1.3 Moderator Temperature Coefficient
- LCO 3.1.4 Rod Group Alignment Limits
- LCO 3.1.5 Shutdown Bank Insertion Limits
- LCO 3.1.6 Control Bank Insertion Limits
- LCO 3.1.8 Physics Tests Exceptions – Mode 2
- LCO 3.2.1 Heat Flux Hot Channel Factor ($F_Q(Z)$)
- LCO 3.2.2 Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}^N$)
- LCO 3.2.3 Axial Flux Difference (AFD)
- LCO 3.3.9 Boron Dilution Protection System (BDPS)
- LCO 3.9.1 Boron Concentration

The portions of the Technical Requirements Manual affected by this report are listed below:

- TRM TLCO 3.1.b Boration Flow Paths – Operating
- TRM TLCO 3.1.d Charging Pumps – Operating
- TRM TLCO 3.1.f Borated Water Sources - Operating
- TRM TLCO 3.1.h Shutdown Margin (SDM) – MODE 1 and MODE 2 with $keff \geq 1.0$
- TRM TLCO 3.1.i Shutdown Margin (SDM) – MODE 5
- TRM TLCO 3.1.j Shutdown and Control Rods
- TRM TLCO 3.1.k Position Indication System – Shutdown (Special Test Exception)

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

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 are applicable for the entire cycle unless otherwise identified. These limits have been developed using the NRC-approved methodologies specified in Technical Specification 5.6.5.

2.1 Shutdown Margin (SDM)

The SDM limit for MODES 1, 2, 3, and 4 is:

2.1.1 The SDM shall be greater than or equal to 1.3% $\Delta k/k$ (LCOs 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.1.8, 3.3.9; TRM TLCOs 3.1.b, 3.1.d, 3.1.f, 3.1.h, and 3.1.j).

The SDM limits for MODE 5 are:

2.1.2.1 SDM shall be greater than or equal to 1.0% $\Delta k/k$ (LCO 3.1.1)

2.1.2.2 SDM shall be greater than or equal to 1.3% $\Delta k/k$ (LCO 3.3.9; TRM TLCO 3.1.i and 3.1.j)

2.2 Moderator Temperature Coefficient (LCO 3.1.3)

The Moderator Temperature Coefficient (MTC) limits are:

2.2.1 The BOL/ARO/HZP-MTC shall be less positive than $+3.3 \times 10^{-5} \Delta k/k/^\circ F$.

2.2.2 The EOL/ARO/HFP-MTC shall be less negative than $-4.1 \times 10^{-4} \Delta k/k/^\circ F$.

2.2.3 The EOL/ARO/HFP-MTC Surveillance limit at 300 ppm shall be less negative than or equal to $-3.2 \times 10^{-4} \Delta k/k/^\circ F$.

where: BOL stands for Beginning of Cycle Life
ARO stands for All Rods Out
HZP stands for Hot Zero Thermal Power
EOL stands for End of Cycle Life
HFP stands for Hot Full Thermal Power

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

2.3 Shutdown Bank Insertion Limit (LCO 3.1.5)

2.3.1 All shutdown banks shall be withdrawn to at least 231 steps.

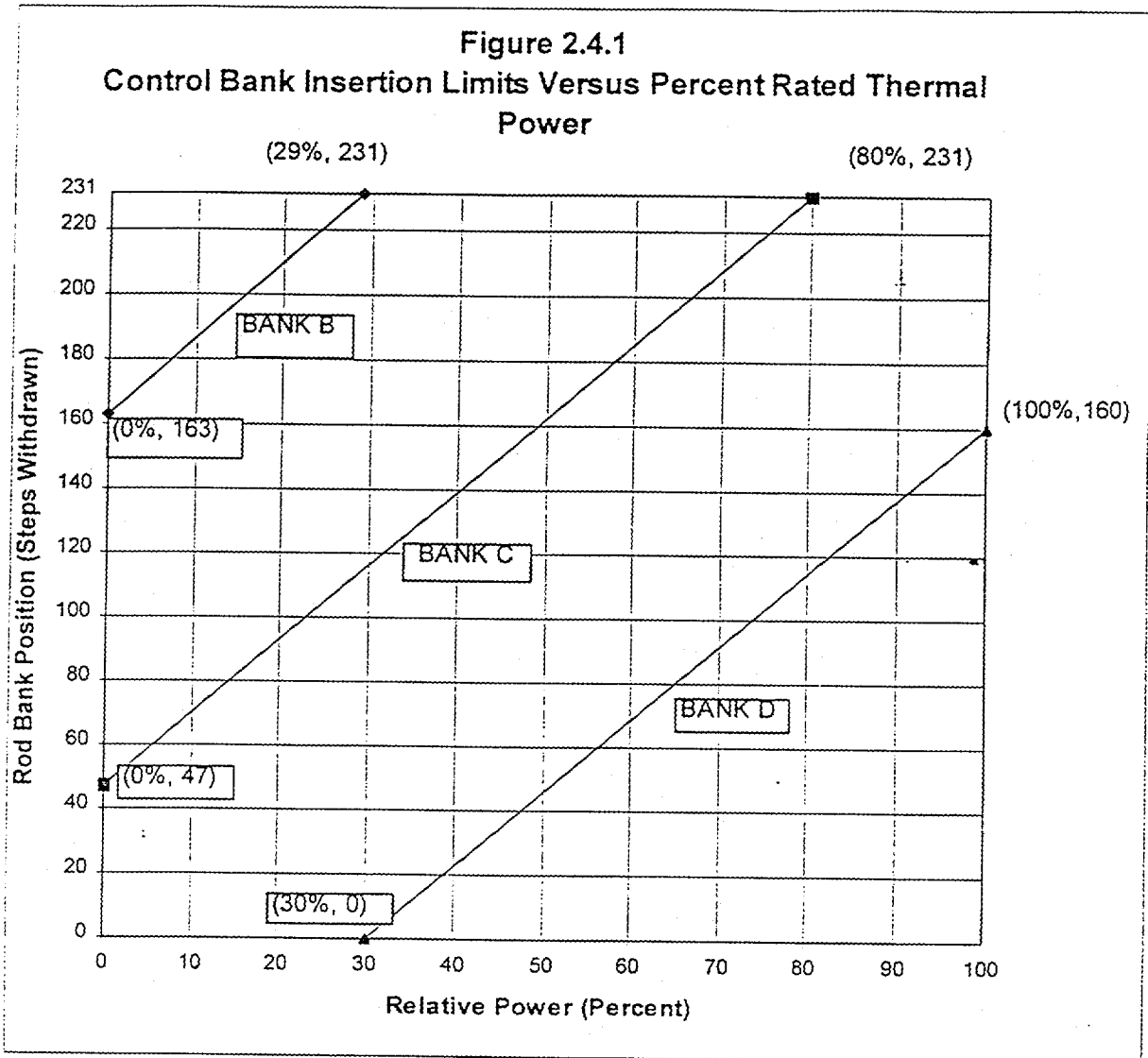
2.4 Control Bank Insertion Limits (LCO 3.1.6)

2.4.1 The control banks shall be limited in physical insertion as shown in Figure 2.4.1.

2.4.2 The control banks shall be operated in sequence by withdrawal of Bank A, Bank B, Bank C and Bank D. The control banks shall be sequenced in reverse order upon insertion.

2.4.3 The control banks shall be operated with a 115 step overlap.

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2.5 Heat Flux Hot Channel Factor ($F_q(Z)$) (LCO 3.2.1)

2.5.1

$$F_q(Z) \leq \frac{F_q^{RTP}}{0.5} \times K(Z) \text{ for } P \leq 0.5$$

$$F_q(Z) \leq \frac{F_q^{RTP}}{P} \times K(Z) \text{ for } P > 0.5$$

where: P = the ratio of THERMAL POWER to RATED THERMAL POWER

$$F_q^{RTP} = 2.60$$

$K(Z)$ for assembly average burnup > 4000 MWD/MTU is provided in Figure 2.5.1. $K(Z)$ for assembly average burnup ≤ 4000 MWD/MTU is provided in Figure 2.5.1.a.

2.5.2 $W(Z)$ is provided in Figures 2.5.2.a through 2.5.2.c.

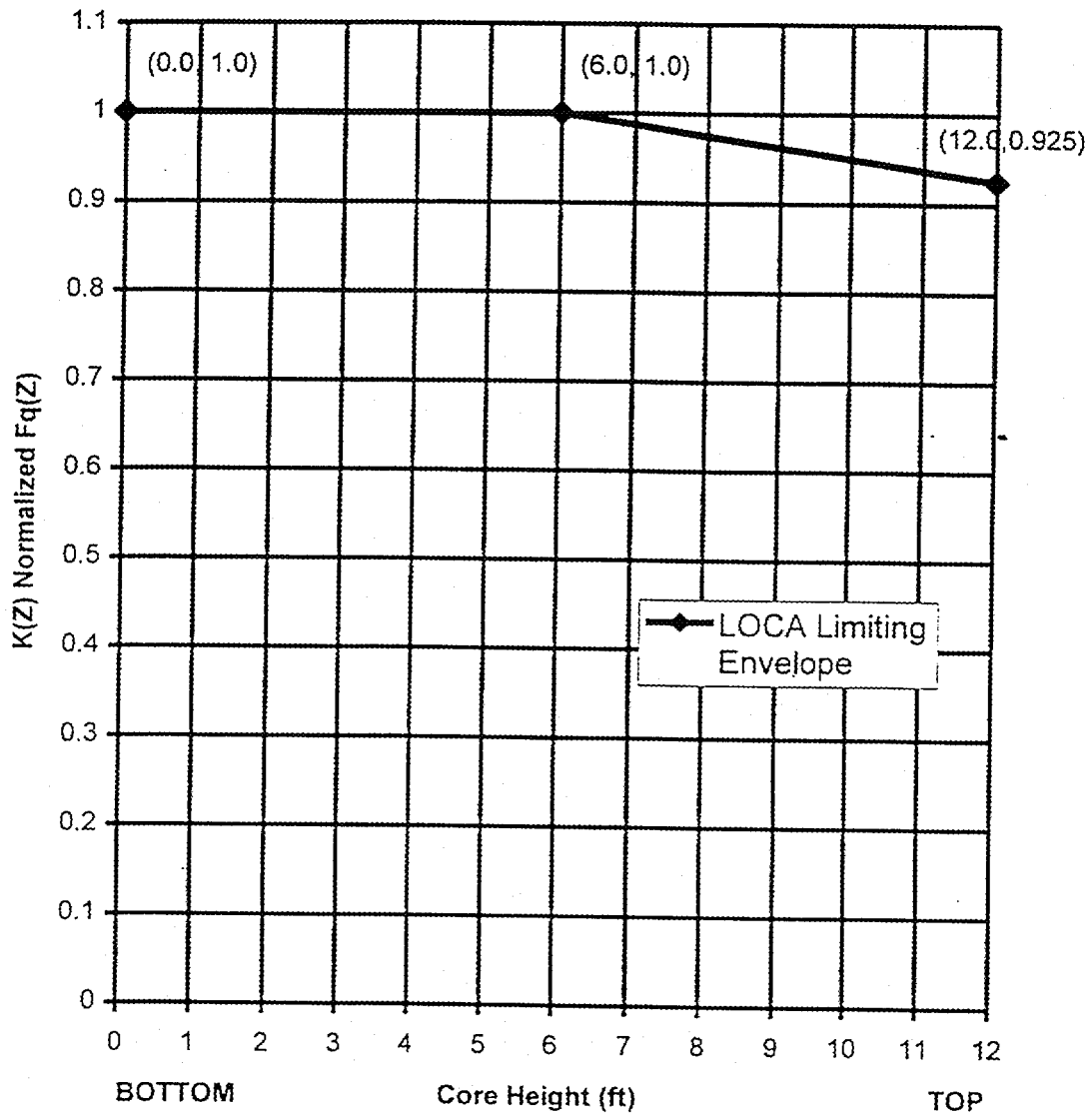
The normal operation $W(Z)$ values have been determined at burnups of 150, 8000 and 18800 MWD/MTU.

Table 2.5.2 shows the $F_q^c(z)$ penalty factors that are greater than 2% per 31 Effective Full Power Days. These values shall be used to increase the $F_q^w(z)$ as per Surveillance Requirement 3.2.1.2. A 2% penalty factor shall be used at all cycle burnups that are outside the range of Table 2.5.2.

$$\text{Multiplication Factor} = 1.02$$

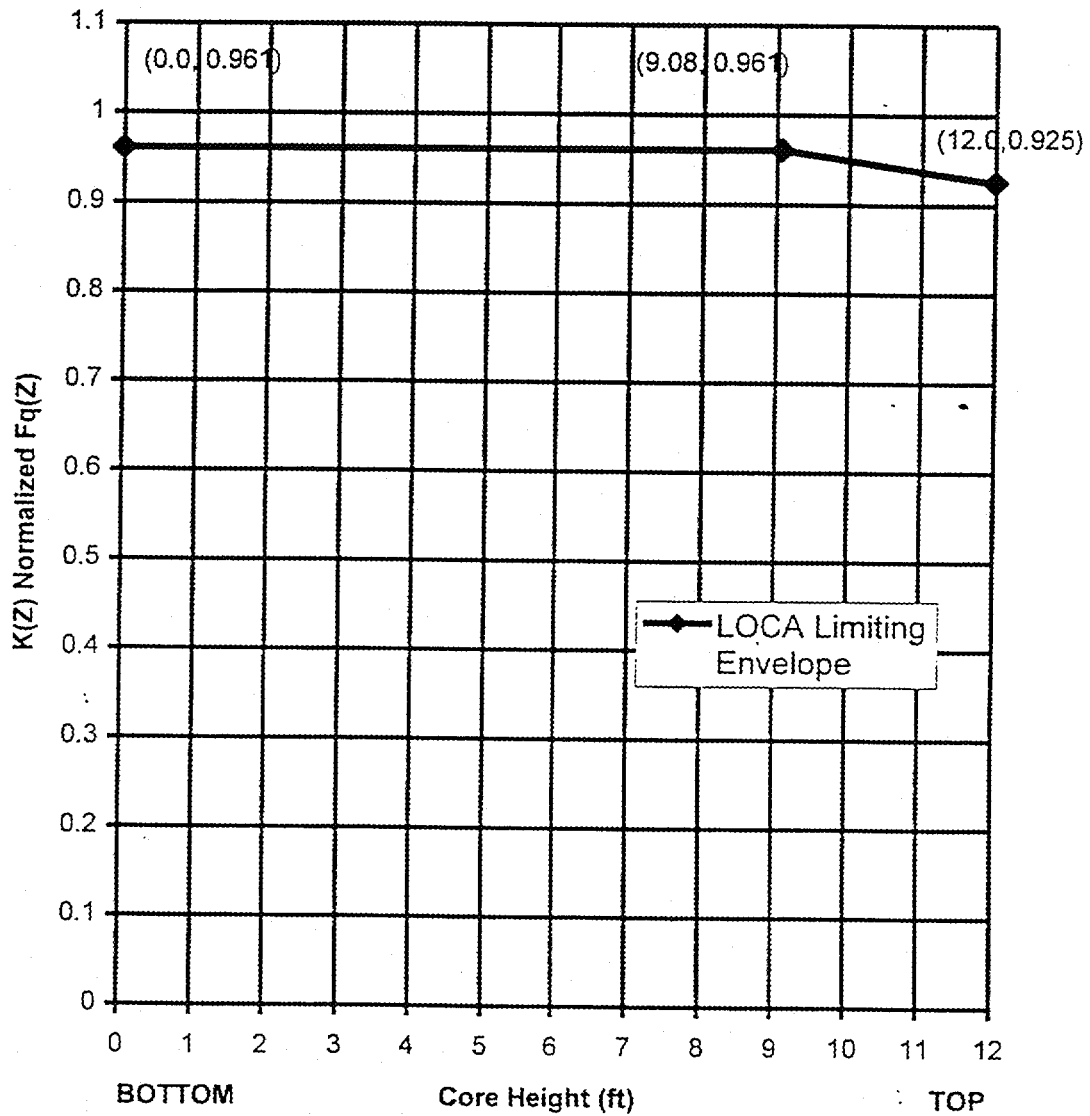
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

Figure 2.5.1: $K(Z)$ - Normalized $Fq(Z)$ as a Function of Core Height (Assembly Average > 4000 MWD/MTU)



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

Figure 2.5.1.a: K(Z) - Normalized Fq(Z) as a Function of Core Height (Assembly Average ≤ 4000 MWD/MTU)



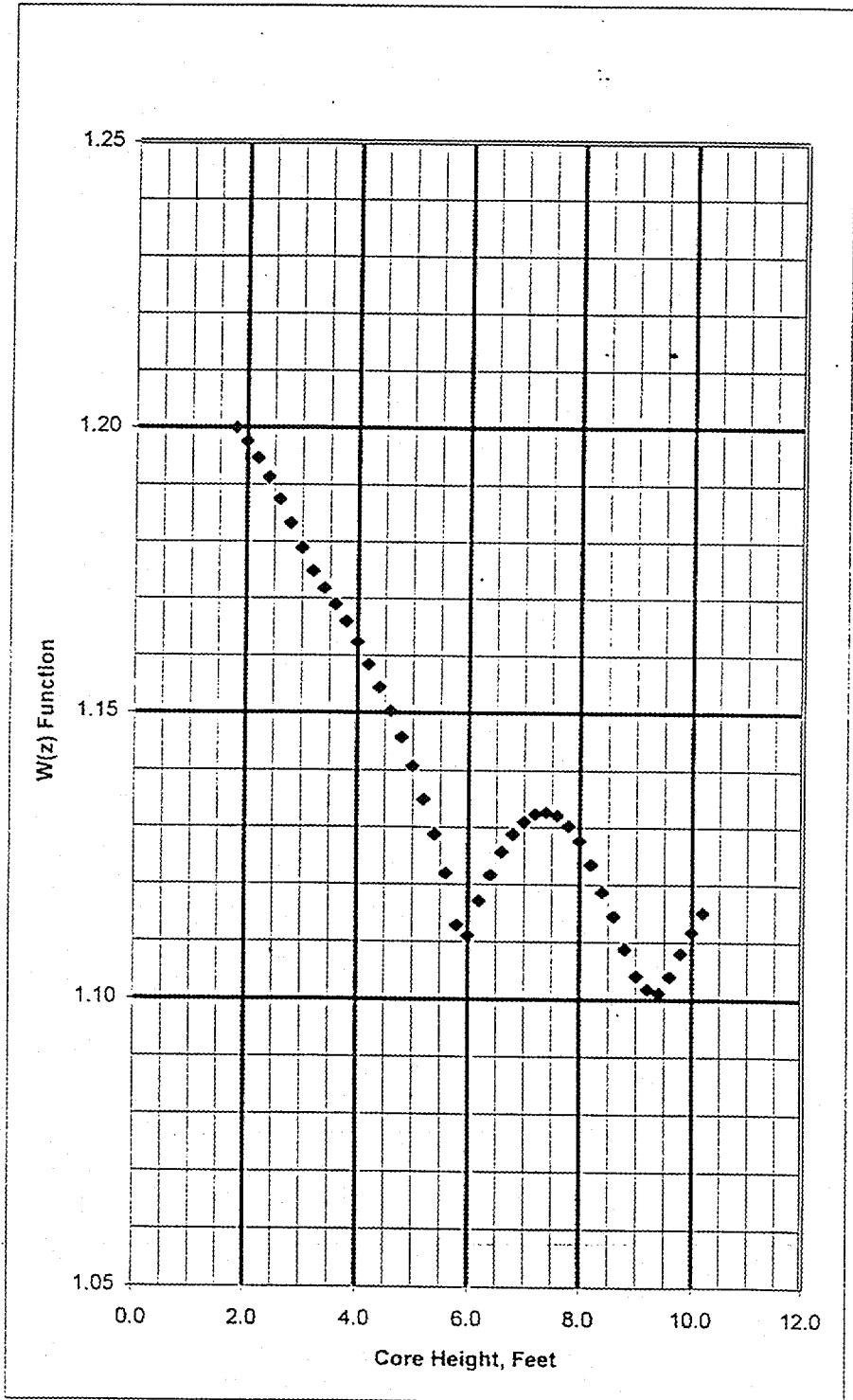
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

Height Feet	Max W(z)
0.0	1.0000
0.2	1.0000
0.4	1.0000
0.6	1.0000
0.8	1.0000
1.0	1.0000
1.2	1.0000
1.4	1.0000
1.6	1.0000
1.8	1.1999
2.0	1.1975
2.2	1.1946
2.4	1.1912
2.6	1.1874
2.8	1.1832
3.0	1.1788
3.2	1.1747
3.4	1.1717
3.6	1.1689
3.8	1.1659
4.0	1.1623
4.2	1.1584
4.4	1.1544
4.6	1.1503
4.8	1.1457
5.0	1.1407
5.2	1.1349
5.4	1.1287
5.6	1.1219
5.8	1.1129
6.0	1.1110
6.2	1.1171
6.4	1.1216
6.6	1.1256
6.8	1.1287
7.0	1.1309
7.2	1.1323
7.4	1.1326
7.6	1.1320
7.8	1.1302
8.0	1.1276
8.2	1.1235
8.4	1.1187
8.6	1.1145
8.8	1.1087
9.0	1.1041
9.2	1.1018
9.4	1.1011
9.6	1.1040
9.8	1.1080
10.0	1.1117
10.2	1.1151
10.4	1.0000
10.6	1.0000
10.8	1.0000
11.0	1.0000
11.2	1.0000
11.4	1.0000
11.6	1.0000
11.8	1.0000
12.0	1.0000

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Figure 2.5.2.a

Summary of W(z) Function at 150 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



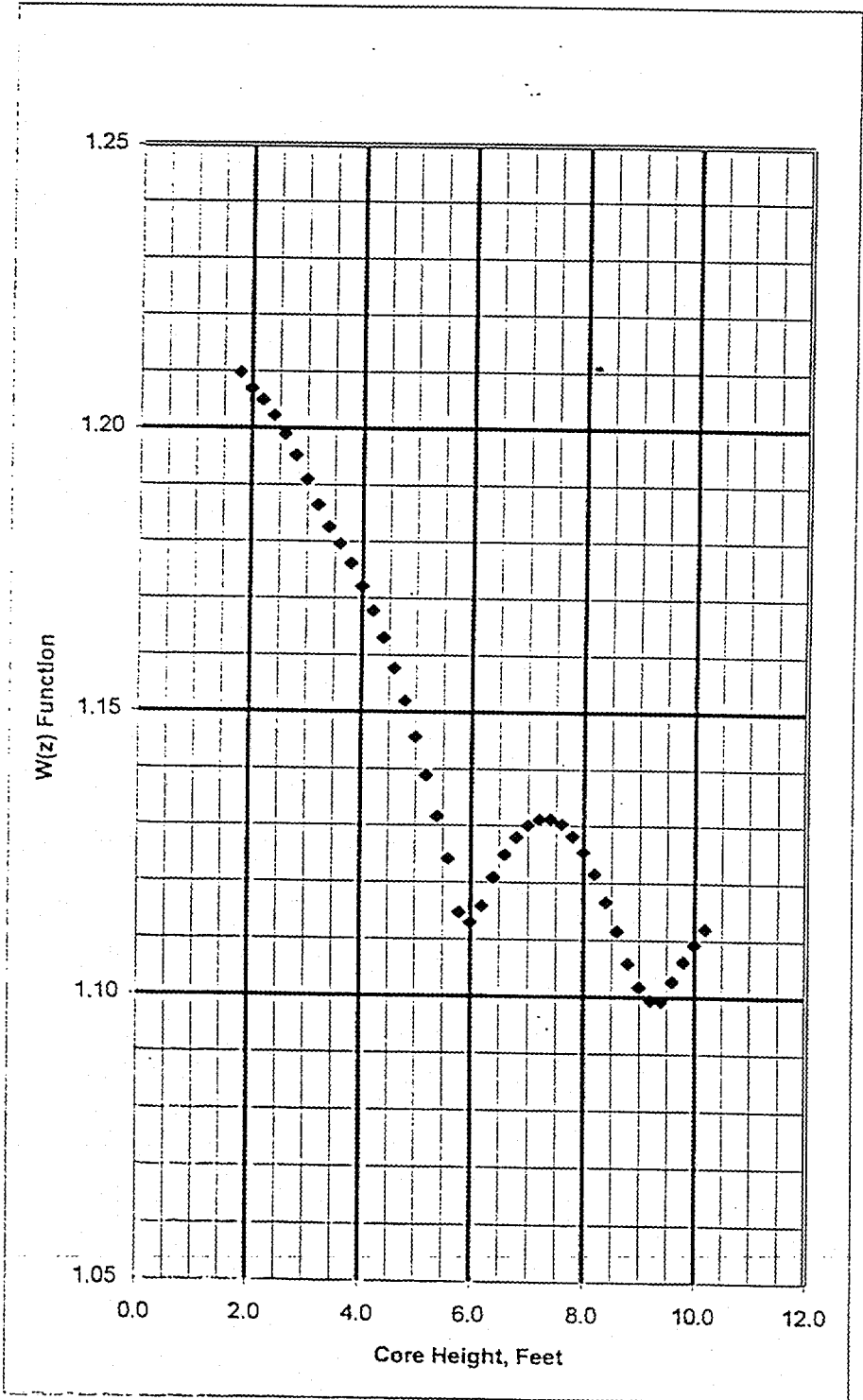
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

Height Feet	Max W(z)
0.0	1.0000
0.2	1.0000
0.4	1.0000
0.6	1.0000
0.8	1.0000
1.0	1.0000
1.2	1.0000
1.4	1.0000
1.6	1.0000
1.8	1.2097
2.0	1.2069
2.2	1.2049
2.4	1.2022
2.6	1.1989
2.8	1.1952
3.0	1.1909
3.2	1.1864
3.4	1.1825
3.6	1.1795
3.8	1.1761
4.0	1.1720
4.2	1.1677
4.4	1.1630
4.6	1.1577
4.8	1.1519
5.0	1.1456
5.2	1.1388
5.4	1.1316
5.6	1.1240
5.8	1.1147
6.0	1.1129
6.2	1.1158
6.4	1.1208
6.6	1.1248
6.8	1.1279
7.0	1.1300
7.2	1.1311
7.4	1.1312
7.6	1.1303
7.8	1.1281
8.0	1.1253
8.2	1.1215
8.4	1.1166
8.6	1.1115
8.8	1.1059
9.0	1.1017
9.2	1.0994
9.4	1.0992
9.6	1.1027
9.8	1.1062
10.0	1.1092
10.2	1.1120
10.4	1.0000
10.6	1.0000
10.8	1.0000
11.0	1.0000
11.2	1.0000
11.4	1.0000
11.6	1.0000
11.8	1.0000
12.0	1.0000

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Figure 2.5.2.b

Summary of W(z) Function at 8000 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



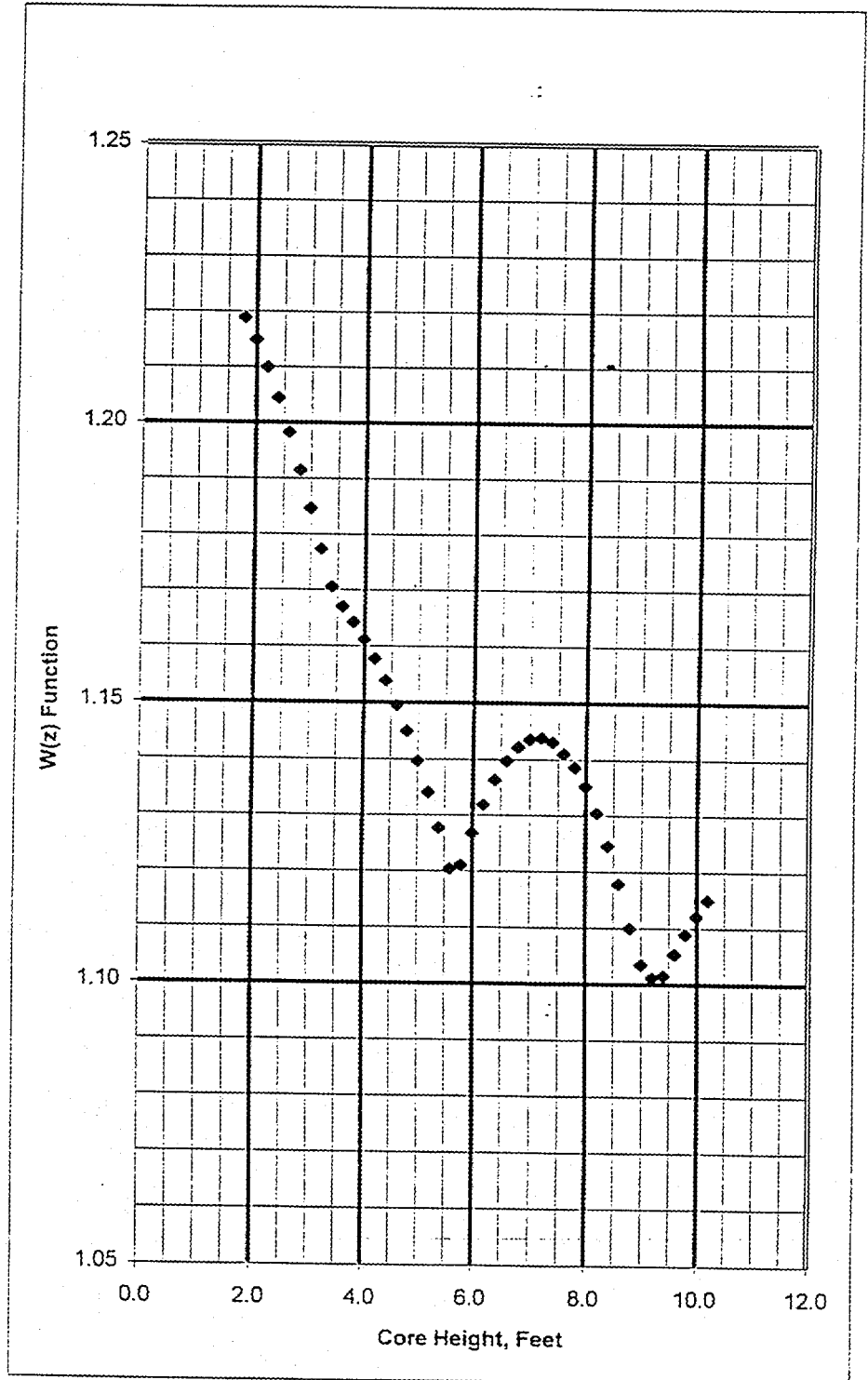
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

Height Feet	Max W(z)
0.0	1.0000
0.2	1.0000
0.4	1.0000
0.6	1.0000
0.8	1.0000
1.0	1.0000
1.2	1.0000
1.4	1.0000
1.6	1.0000
1.8	1.2188
2.0	1.2148
2.2	1.2099
2.4	1.2044
2.6	1.1982
2.8	1.1914
3.0	1.1846
3.2	1.1773
3.4	1.1705
3.6	1.1670
3.8	1.1642
4.0	1.1611
4.2	1.1577
4.4	1.1538
4.6	1.1495
4.8	1.1449
5.0	1.1396
5.2	1.1341
5.4	1.1276
5.6	1.1203
5.8	1.1210
6.0	1.1267
6.2	1.1319
6.4	1.1363
6.6	1.1397
6.8	1.1421
7.0	1.1435
7.2	1.1438
7.4	1.1430
7.6	1.1410
7.8	1.1386
8.0	1.1352
8.2	1.1304
8.4	1.1245
8.6	1.1178
8.8	1.1099
9.0	1.1034
9.2	1.1011
9.4	1.1015
9.6	1.1053
9.8	1.1088
10.0	1.1120
10.2	1.1149
10.4	1.0000
10.6	1.0000
10.8	1.0000
11.0	1.0000
11.2	1.0000
11.4	1.0000
11.6	1.0000
11.8	1.0000
12.0	1.0000

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Figure 2.5.2.c

Summary of W(z) Function at 18800 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

Table 2.5.2	
Fq Margin Decreases in Excess of 2% per 31 EFPD	
Cycle Burnup (MWD/MTU)	Max % Decrease in Fq Margin
150	3.54
275	3.50
400	3.48
525	3.44
650	3.38
775	3.29
900	3.15
1025	2.96
1150	2.69
1275	2.37
1400	2.01
1525	2.00

Note: All cycle burnups outside the range of the table shall use a 2% decrease in Fq margin for compliance with the 3.2.1.2 Surveillance Requirements.

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

2.6 Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}^N$) (LCO 3.2.2)

2.6.1
$$F_{\Delta H}^N \leq F_{\Delta H}^{RTP} [1.0 + PF_{\Delta H} (1.0 - P)]$$

where: P = the ratio of THERMAL POWER to RATED THERMAL POWER

$$F_{\Delta H}^{RTP} = 1.70$$

$$PF_{\Delta H} = 0.3$$

2.7 Axial Flux Difference (AFD) (LCO 3.2.3)

2.7.1 The AXIAL FLUX DIFFERENCE (AFD) target band is +3, -12% of the target flux difference.

2.7.2 The AFD Acceptable Operation Limits are provided in Figure 2.7.1.

2.8 Boron Concentration

2.8.1 The refueling boron concentration shall be greater than or equal to 2000 ppm. (LCO 3.9.1)

2.8.2 The Reactor Coolant System boron concentration shall be greater than or equal to 1919 ppm to maintain adequate shutdown margin for Rod Drop Time Measurements. (TLCO 3.1.k)

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

FIGURE 2.7.1: Axial Flux Difference Limits As A Function of Rated Thermal Power

