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January 29, 2001

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United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Byron Station, Units 1 and 2
Facility Operating License Nos. NPF-37 and NPF-66
NRC Docket Nos. STN 50-454 and STN 50-455

Subject: Byron Station Unit 1 Cycle 11 Core Operating Limits Report
Byron Station Unit 2 Cycle 9 Core Operating Limits Report

In accordance with Technical Specification 5.6.5, "Core Operating Limits Report (COLR)," item d., we are submitting a revised COLR for Byron Station Unit 1, Cycle 11 and Byron Station Unit 2, Cycle 9. Specifically, item 2.12.2 of each COLR was revised to reflect a revision made to our Technical Requirements Manual.

Should you have any questions concerning these reports, please contact Ms. P. Reister, Regulatory Assurance Manager, at (815) 234-5441, extension 2280.

Respectfully,



William Levis
Site Vice President
Byron Station

Attachments: 1) Revised Byron Station Unit 1 Cycle 11 COLR
2) Revised Byron Station Unit 2 Cycle 9 COLR

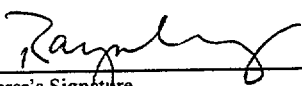
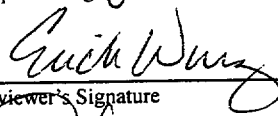

WL/JL/dpk

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Byron Station

A001

ATTACHMENT 1

Revised Byron Station Unit 1 Cycle 11 COLR

NUCLEAR FUEL MANAGEMENT DEPARTMENT TRANSMITTAL OF DESIGN INFORMATION			
<input checked="" type="checkbox"/> SAFETY RELATED <input type="checkbox"/> NON-SAFETY RELATED <input type="checkbox"/> REGULATORY RELATED	Originating Organization <input checked="" type="checkbox"/> Nuclear Fuel Management <input type="checkbox"/> Other (specify) _____	NFM ID # <u>NFM0000119</u> Rev. No. <u>3</u> Page 1 of 19	
Station <u>Byron</u> Unit <u>1</u> Cycle <u>11</u> Generic _____			
To: <u>Kenneth N. Kovar - Byron</u>			
Subject <u>Byron Unit 1 Cycle 11 Core Operating Limits Report in ITS Format and W(z) Function</u>			
R. Ng Preparer	 Preparer's Signature	<u>11/15/00</u> Date	
E. Wurz Reviewer	 Reviewer's Signature	<u>11/15/00</u> Date	
D. Redden NFM Supervisor	 Approver's Signature	<u>11/15/00</u> Date	
Status of Information: <div style="display: inline-block; vertical-align: top; margin-left: 20px;"> <input checked="" type="checkbox"/> Verified <input type="checkbox"/> Unverified <input type="checkbox"/> Engineering Judgement </div>			
Method and Schedule of Verification for Unverified NDITs: _____			
Description of Information: Attached is the Byron Unit 1 Cycle 11 Core Operating Limits Report (COLR) in the ITS format and W(z) function.			
Purpose of Information: Revision 3 of this TODI supersedes TODI NFM0000119, Rev. 2. This revision modifies Section 2.12.2 of the COLR to support the requirement for the new TRM TLCO 3.1.g. Revision 2 incorporated the correct K(Z) curve for Assembly Burnup ≤ 4000 MWD/MTU case. Revision 1 incorporated new W(z) values as a result of an evaluation of the Cycle 10 temperature coastdown effects on the Cycle 11 Design. This COLR incorporates the BY1C11 cycle-specific parameters and the Expanded COLR format which includes Reactor Core Safety Limits, Reactor Trip System Instrumentation, and RCS DNB Parameters. Furthermore, the analytical limit of 224 rods out position is included. 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 (Raymond Ng) with a copy of Byron Station's completed Plant Review and COLR submittal to the NRC.			
Source of Information: 1) TODI NFM000112, Seq. 0, "BY1C11 Minimum Required Boron Concentration for Modes 3, 4, 5, and 6 and Control Rod Testing," dated August 4, 2000. 2) Westinghouse Letter 00CB-G-0107 (CAC-00-259), "Byron 1 Cycle 11 Input for COLR," dated September 1, 2000. 3) Byron Technical Specification Amendment 113, dated May 15, 2000 4) TODI NFM0000099, Rev. 1, "BY1C11 Reload Design Initialization," dated August 3, 2000. 5) Westinghouse Letter 00CB-G-0116 (CAC-00-280), "Byron 1 Cycle 11 Input for COLR Revision 1," dated September 18, 2000.			
Supplemental Distribution: <u>P. E. Reister / J. E. Langan (BY)</u>			

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Byron Station Unit 1 Cycle 11 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:

SL	2.1.1	Reactor Core Safety Limits (SLs)
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	3.3.1	Reactor Trip System (RTS) Instrumentation
LCO	3.3.9	Boron Dilution Protection System (BDPS)
LCO	3.4.1	Reactor Coolant System (RCS) DNB Parameters
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.g	Position Indication System - Shutdown
TRM TLCO 3.1.h	Shutdown Margin (SDM) – MODE 1 and MODE 2 with $k_{eff} \geq 1.0$
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 1 CYCLE 11

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 Reactor Core Limits (SL 2.1.1)

- 2.1.1 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 Figure 2.1.1.

2.2 Shutdown Margin (SDM)

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

- 2.2.1 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:

- 2.2.2.1 SDM shall be greater than or equal to 1.0% $\Delta k/k$ (LCO 3.1.1)
- 2.2.2.2 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)

2.3 Moderator Temperature Coefficient (LCO 3.1.3)

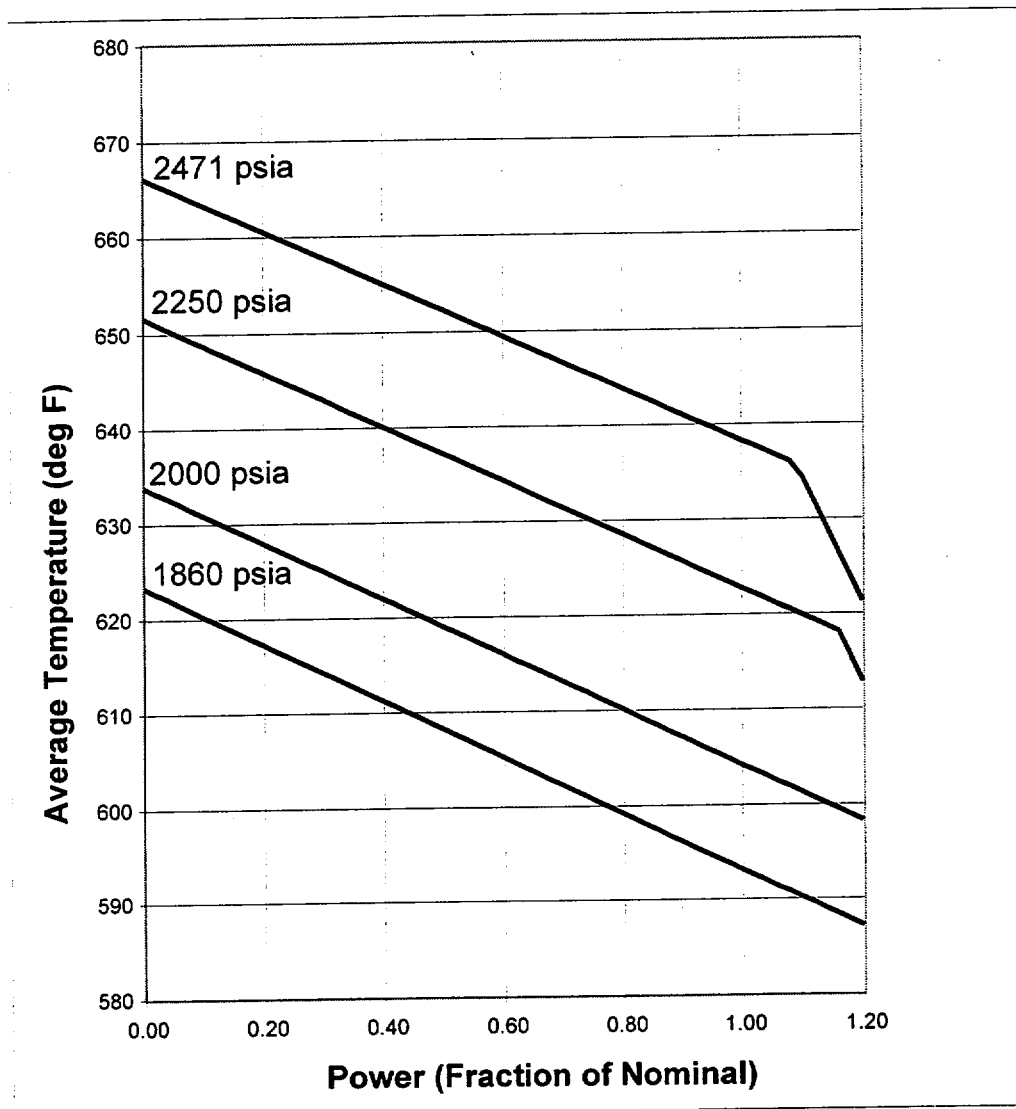
The Moderator Temperature Coefficient (MTC) limits are:

- 2.3.1 The BOL/ARO/HZP-MTC upper limit shall be $+3.7 \times 10^{-5} \Delta k/k/^{\circ}F$.
- 2.3.2 The EOL/ARO/HFP-MTC lower limit shall be $-4.1 \times 10^{-4} \Delta k/k/^{\circ}F$.
- 2.3.3 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 1 CYCLE 11

Figure 2.1.1: Reactor Core Limits



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

2.4 Shutdown Bank Insertion Limit (LCO 3.1.5)

2.4.1 All shutdown banks shall be fully withdrawn to at least 224 steps.

2.5 Control Bank Insertion Limits (LCO 3.1.6)

2.5.1 The control banks shall be limited in physical insertion as shown in Figure 2.5.1.

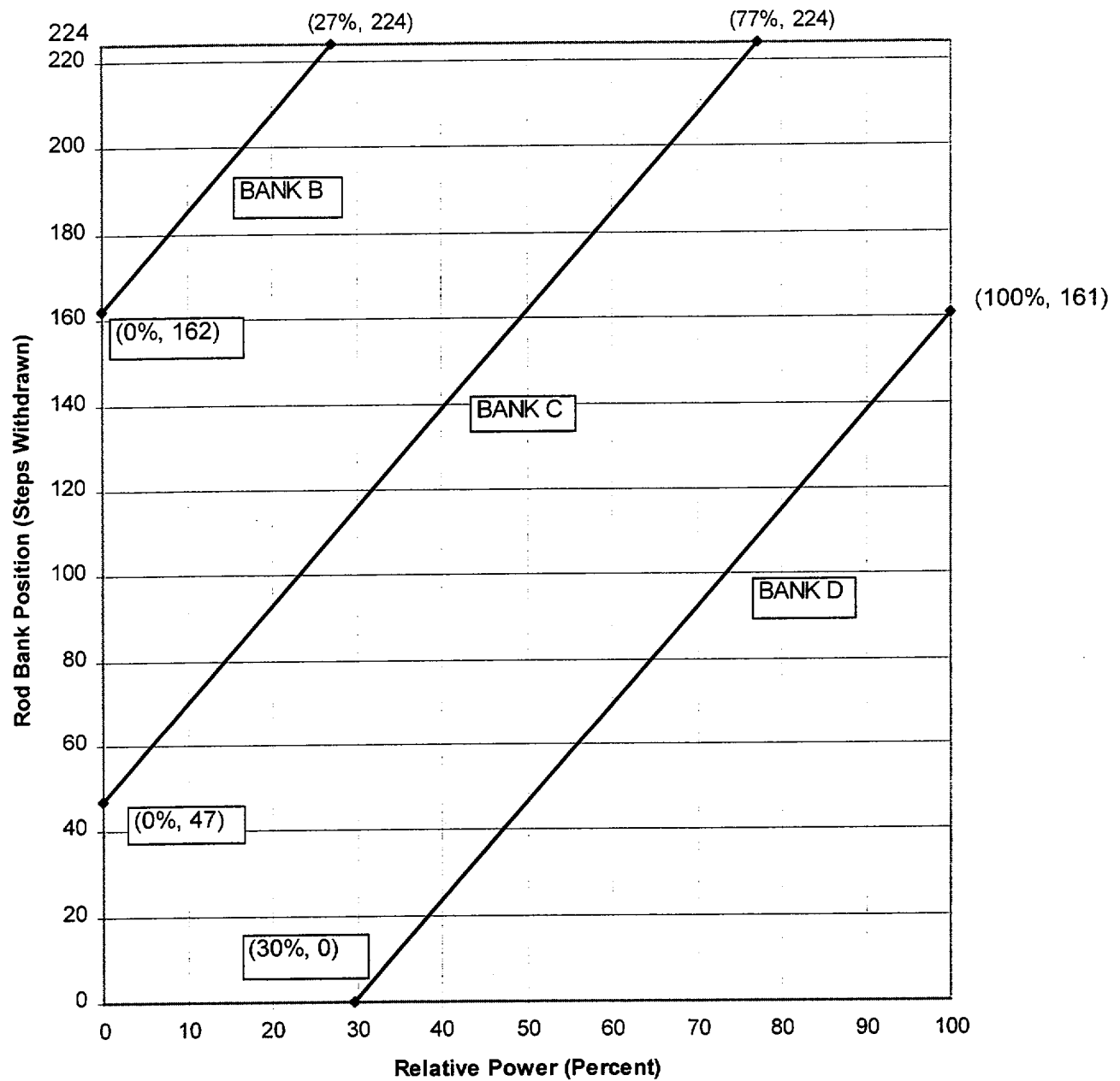
2.5.2 Each control bank shall be considered fully withdrawn from the core at greater than or equal to 224 steps.

2.5.3 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.

2.5.4 Each control bank not fully withdrawn from the core shall be operated with a 113 step overlap limit.

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Figure 2.5.1:
Control Bank Insertion Limits Versus Percent Rated Thermal Power



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

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

2.6.1

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

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

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 2.6.1. $K(Z)$ for assembly average burnup \leq 4000 MWD/MTU is provided in Figure 2.6.1.a.

2.6.2 $W(Z)$ is provided in Figures 2.6.2.a through 2.6.2.d.

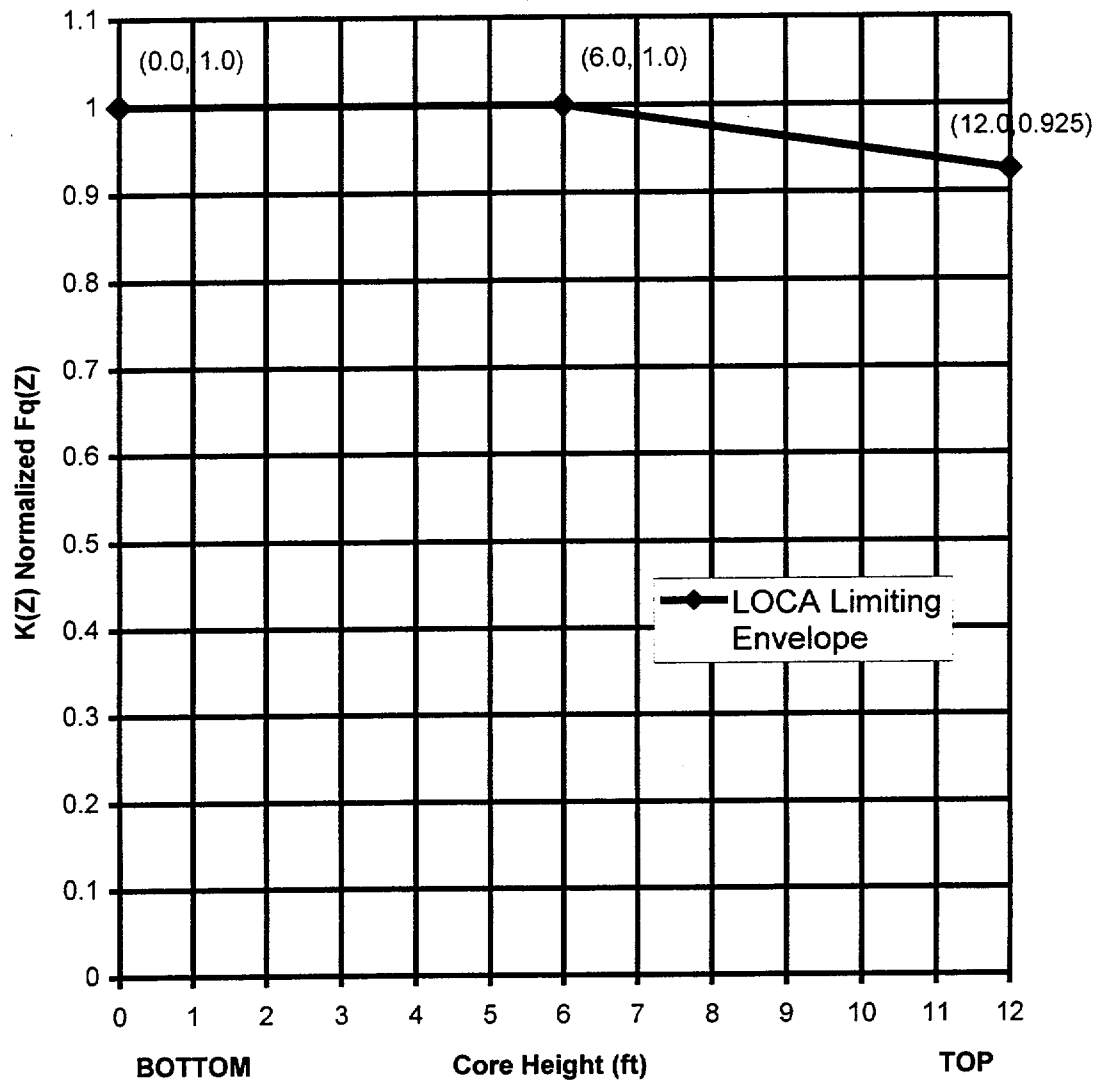
The normal operation $W(Z)$ values have been determined at burnups of 150, 4000, 10000, and 18000 MWD/MTU.

Table 2.6.2 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 2.6.2.

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

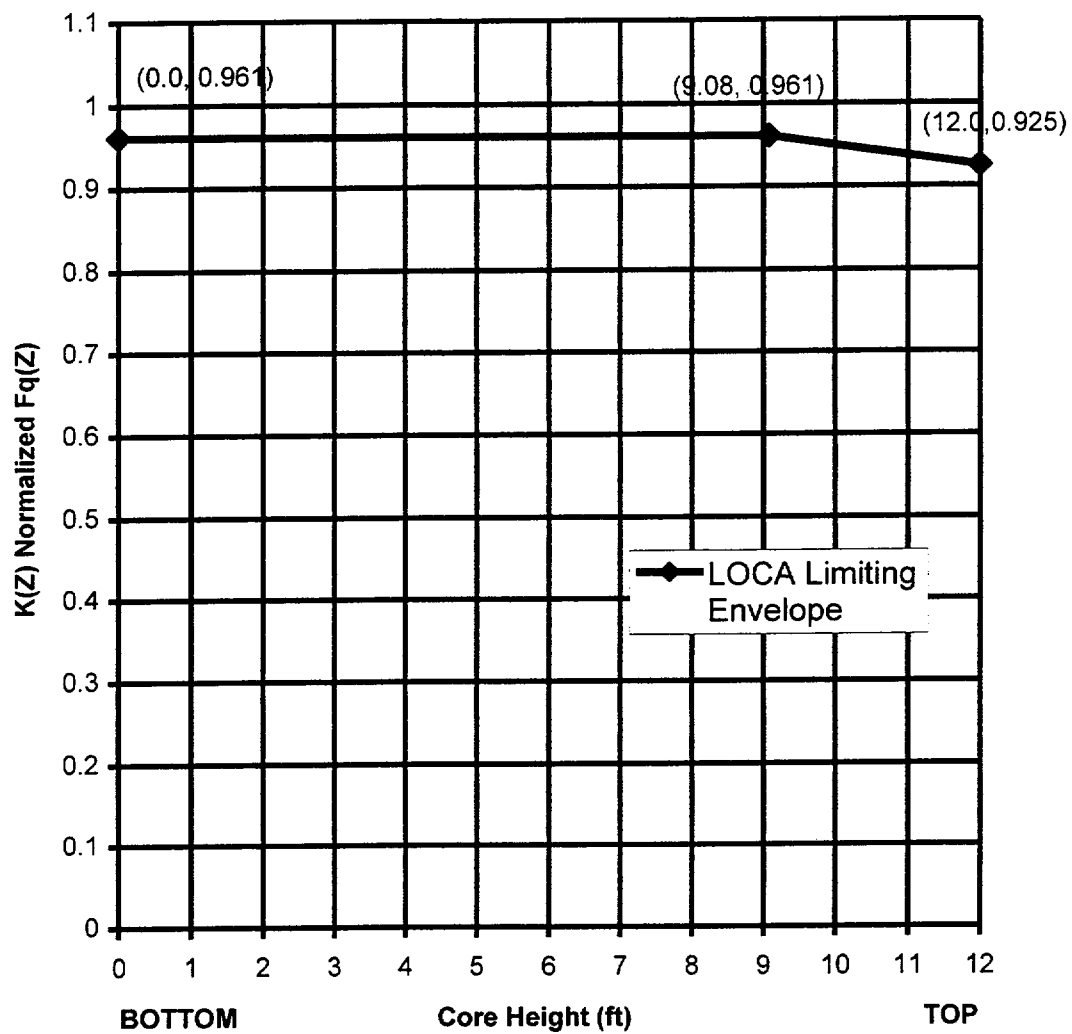
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Figure 2.6.1: $K(Z)$ - Normalized $F_q(Z)$ as a Function of Core Height (Assembly Average > 4000 MWD/MTU)



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Figure 2.6.1.a: $K(Z)$ - Normalized $F_q(Z)$ as a Function of Core Height (Assembly BU ≤ 4000 MWD/MTU)



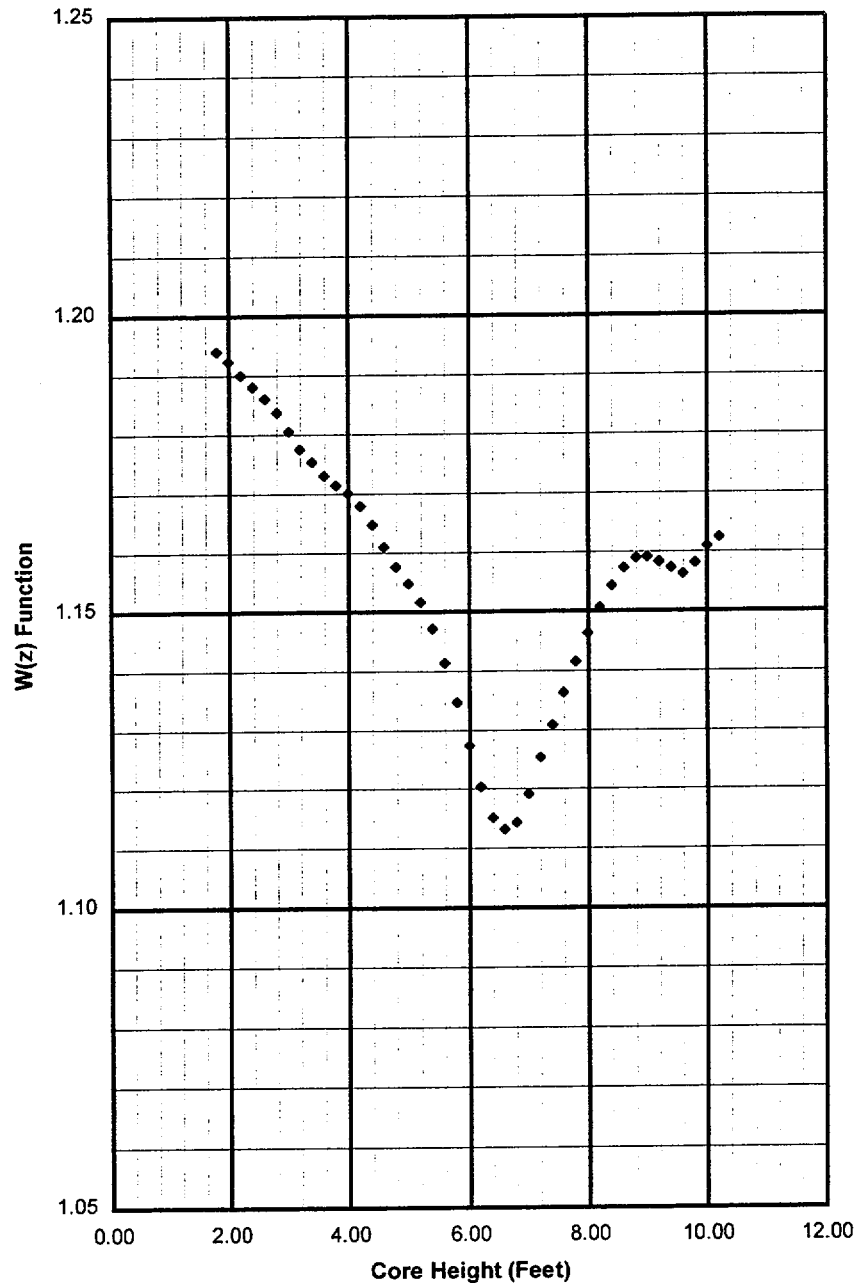
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Height (Feet)	W(z)
0.00	1.0000
0.20	1.0000
0.40	1.0000
0.60	1.0000
0.80	1.0000
1.00	1.0000
1.20	1.0000
1.40	1.0000
1.60	1.0000
1.80	1.1939
2.00	1.1922
2.20	1.1899
2.40	1.1879
2.60	1.1860
2.80	1.1836
3.00	1.1805
3.20	1.1775
3.40	1.1754
3.60	1.1730
3.80	1.1714
4.00	1.1700
4.20	1.1679
4.40	1.1647
4.60	1.1609
4.80	1.1575
5.00	1.1547
5.20	1.1516
5.40	1.1471
5.60	1.1412
5.80	1.1346
6.00	1.1273
6.20	1.1202
6.40	1.1151
6.60	1.1131
6.80	1.1143
7.00	1.1190
7.20	1.1253
7.40	1.1308
7.60	1.1363
7.80	1.1415
8.00	1.1462
8.20	1.1506
8.40	1.1543
8.60	1.1573
8.80	1.1589
9.00	1.1590
9.20	1.1583
9.40	1.1573
9.60	1.1562
9.80	1.1581
10.00	1.1609
10.20	1.1624
10.40	1.0000
10.60	1.0000
10.80	1.0000
11.00	1.0000
11.20	1.0000
11.40	1.0000
11.60	1.0000
11.80	1.0000
12.00	1.0000

Byron Unit 1 Cycle 11

Figure 2.6.2.a

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



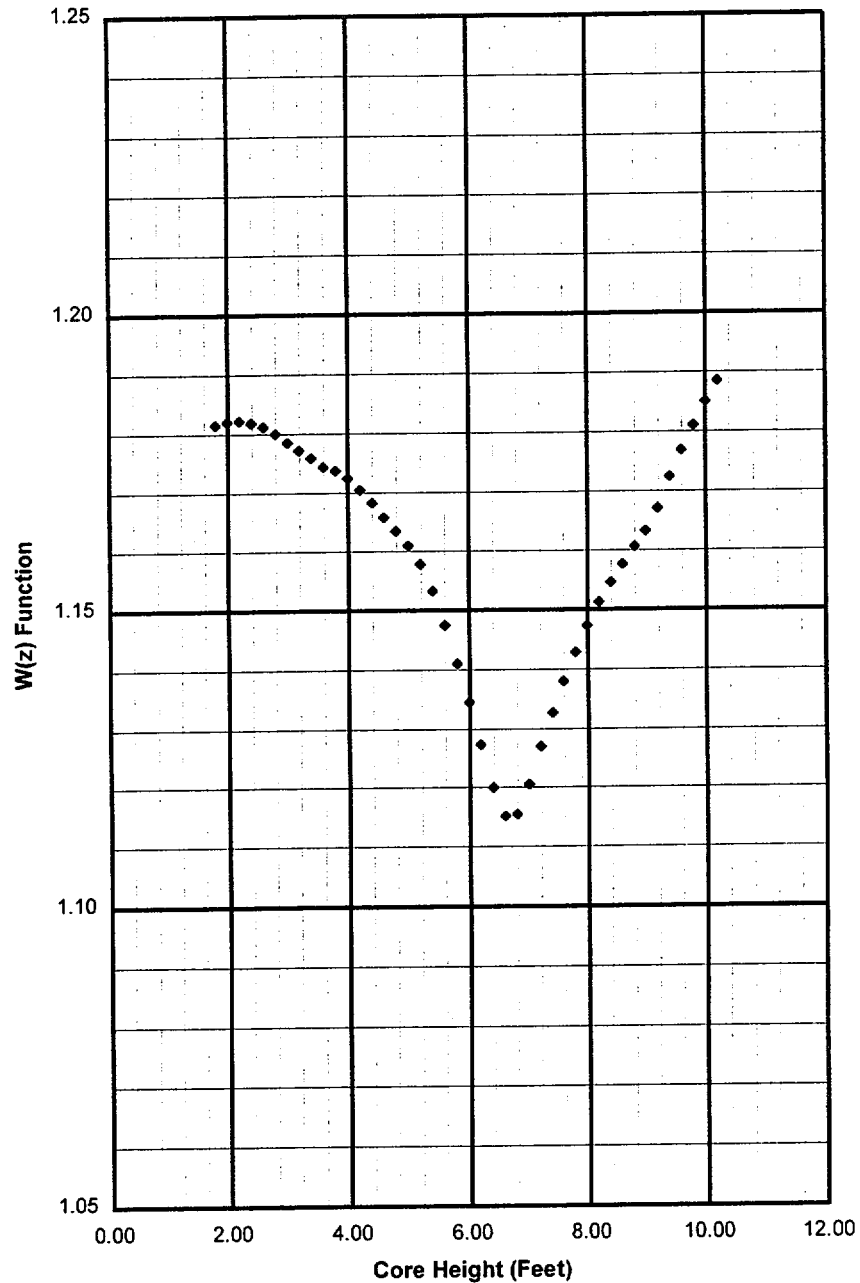
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Height (Feet)	W(z)
0.00	1.0000
0.20	1.0000
0.40	1.0000
0.60	1.0000
0.80	1.0000
1.00	1.0000
1.20	1.0000
1.40	1.0000
1.60	1.0000
1.80	1.1815
2.00	1.1820
2.20	1.1821
2.40	1.1818
2.60	1.1811
2.80	1.1799
3.00	1.1785
3.20	1.1772
3.40	1.1758
3.60	1.1744
3.80	1.1736
4.00	1.1724
4.20	1.1704
4.40	1.1681
4.60	1.1657
4.80	1.1634
5.00	1.1609
5.20	1.1578
5.40	1.1532
5.60	1.1474
5.80	1.1410
6.00	1.1345
6.20	1.1274
6.40	1.1199
6.60	1.1150
6.80	1.1153
7.00	1.1204
7.20	1.1270
7.40	1.1326
7.60	1.1379
7.80	1.1428
8.00	1.1473
8.20	1.1512
8.40	1.1545
8.60	1.1575
8.80	1.1605
9.00	1.1632
9.20	1.1671
9.40	1.1724
9.60	1.1768
9.80	1.1809
10.00	1.1849
10.20	1.1885
10.40	1.0000
10.60	1.0000
10.80	1.0000
11.00	1.0000
11.20	1.0000
11.40	1.0000
11.60	1.0000
11.80	1.0000
12.00	1.0000

Byron Unit 1 Cycle 11

Figure 2.6.2.b

Summary of W(z) Function at 4000 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



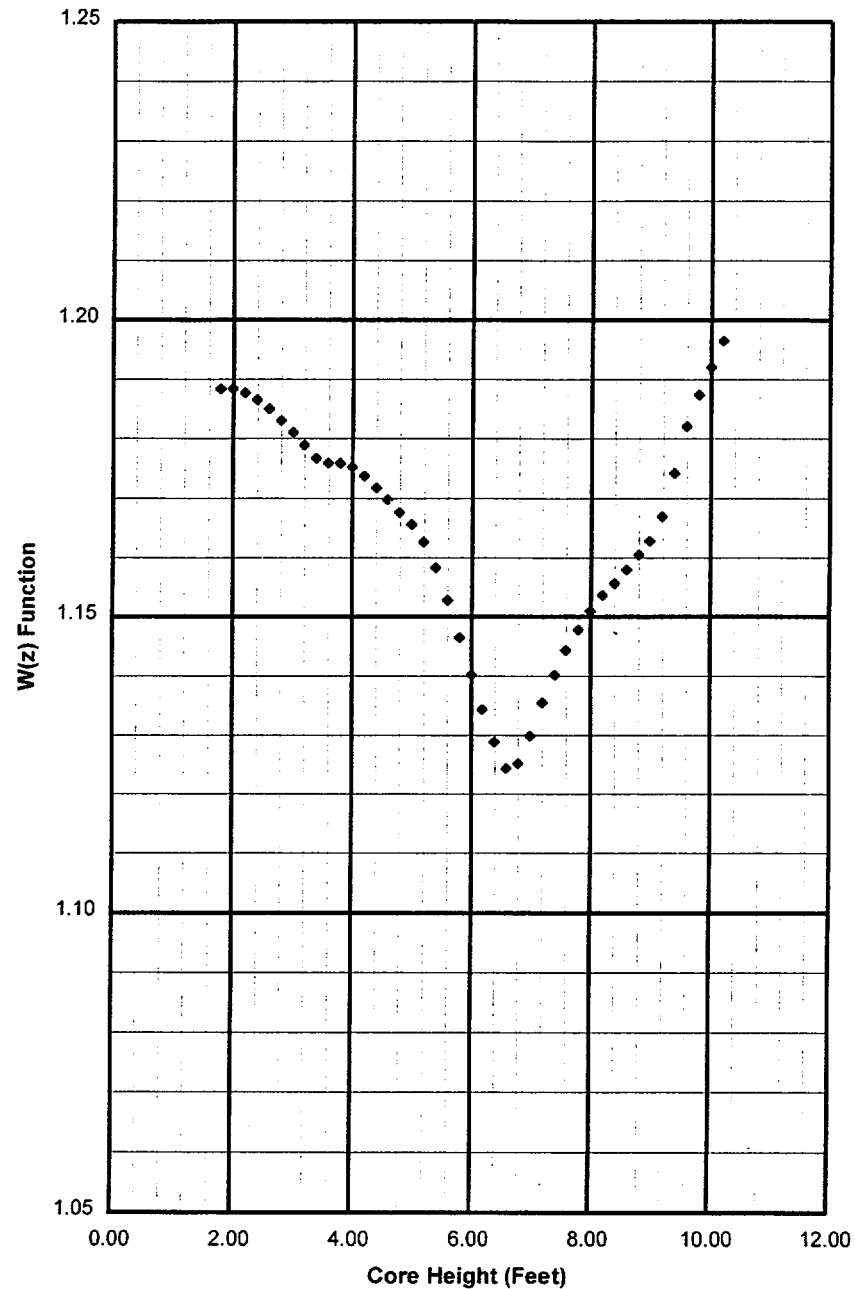
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Height (Feet)	W(z)
0.00	1.0000
0.20	1.0000
0.40	1.0000
0.60	1.0000
0.80	1.0000
1.00	1.0000
1.20	1.0000
1.40	1.0000
1.60	1.0000
1.80	1.1883
2.00	1.1882
2.20	1.1876
2.40	1.1865
2.60	1.1850
2.80	1.1830
3.00	1.1810
3.20	1.1788
3.40	1.1767
3.60	1.1759
3.80	1.1758
4.00	1.1751
4.20	1.1736
4.40	1.1717
4.60	1.1697
4.80	1.1676
5.00	1.1655
5.20	1.1626
5.40	1.1583
5.60	1.1527
5.80	1.1464
6.00	1.1402
6.20	1.1343
6.40	1.1289
6.60	1.1244
6.80	1.1252
7.00	1.1299
7.20	1.1355
7.40	1.1401
7.60	1.1442
7.80	1.1478
8.00	1.1509
8.20	1.1535
8.40	1.1556
8.60	1.1579
8.80	1.1603
9.00	1.1627
9.20	1.1669
9.40	1.1742
9.60	1.1819
9.80	1.1873
10.00	1.1919
10.20	1.1964
10.40	1.0000
10.60	1.0000
10.80	1.0000
11.00	1.0000
11.20	1.0000
11.40	1.0000
11.60	1.0000
11.80	1.0000
12.00	1.0000

Byron Unit 1 Cycle 11

Figure 2.6.2.c

Summary of W(z) Function at 10000 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



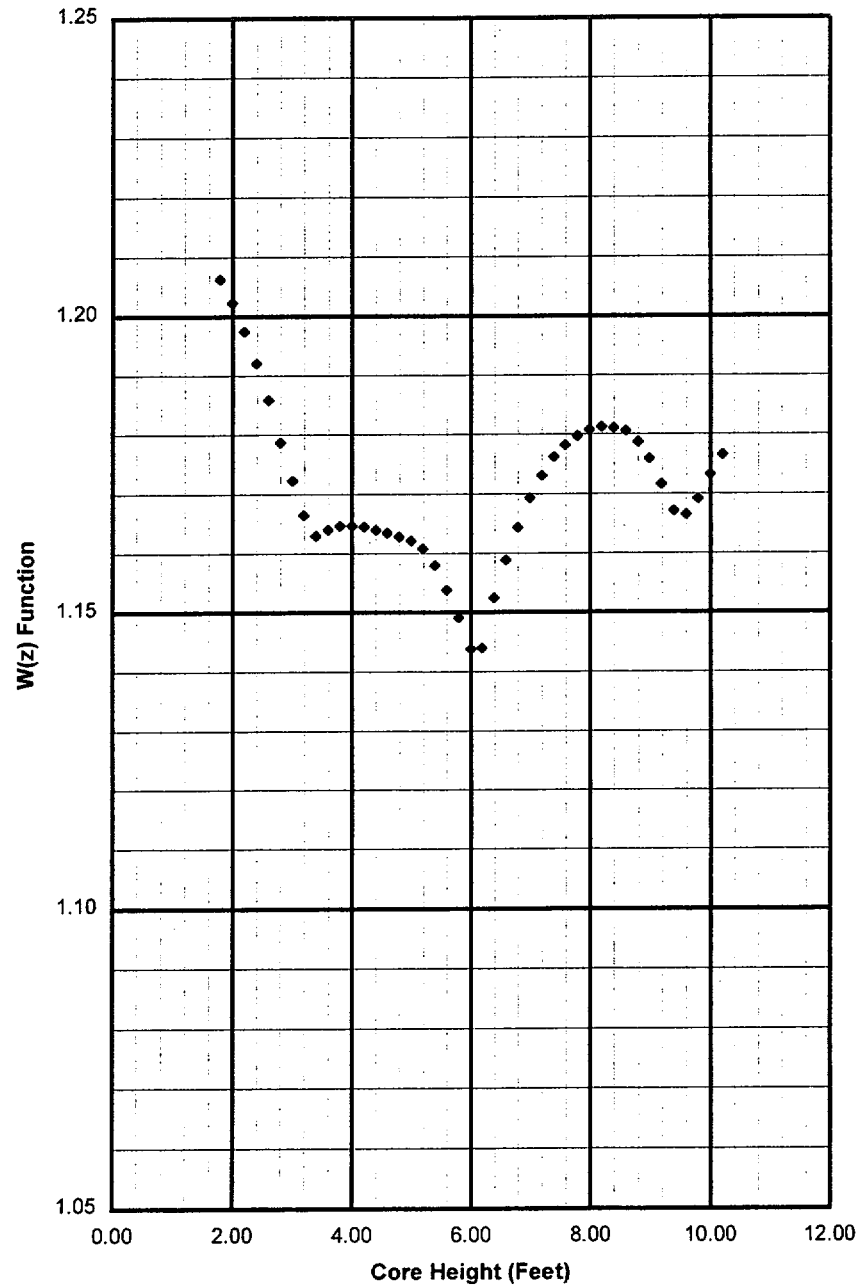
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Height (Feet)	W(z)
0.00	1.0000
0.20	1.0000
0.40	1.0000
0.60	1.0000
0.80	1.0000
1.00	1.0000
1.20	1.0000
1.40	1.0000
1.60	1.0000
1.80	1.2062
2.00	1.2022
2.20	1.1974
2.40	1.1919
2.60	1.1857
2.80	1.1787
3.00	1.1722
3.20	1.1663
3.40	1.1629
3.60	1.1638
3.80	1.1645
4.00	1.1646
4.20	1.1644
4.40	1.1639
4.60	1.1633
4.80	1.1627
5.00	1.1621
5.20	1.1607
5.40	1.1579
5.60	1.1538
5.80	1.1491
6.00	1.1437
6.20	1.1440
6.40	1.1524
6.60	1.1587
6.80	1.1642
7.00	1.1691
7.20	1.1730
7.40	1.1761
7.60	1.1782
7.80	1.1796
8.00	1.1806
8.20	1.1811
8.40	1.1810
8.60	1.1805
8.80	1.1787
9.00	1.1758
9.20	1.1715
9.40	1.1671
9.60	1.1664
9.80	1.1690
10.00	1.1731
10.20	1.1765
10.40	1.0000
10.60	1.0000
10.80	1.0000
11.00	1.0000
11.20	1.0000
11.40	1.0000
11.60	1.0000
11.80	1.0000
12.00	1.0000

Byron Unit 1 Cycle 11

Figure 2.6.2.d

Summary of W(z) Function at 18000 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

Table 2.6.2	
Fq Margin Decreases in Excess of 2% per 31 EFPD	
Cycle Burnup (MWD/MTU)	Max % Decrease in Fq Margin
150	4.15
314	4.31
479	4.40
643	4.40
808	4.27
972	3.99
1137	3.59
1301	3.09
1465	2.54
≥1630	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 1 CYCLE 11

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

$$2.7.1 \quad F_{\Delta H}^N \leq F_{\Delta H}^{RTP} [1.0 + PF_{\Delta H}(1.0 - P)]$$

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

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

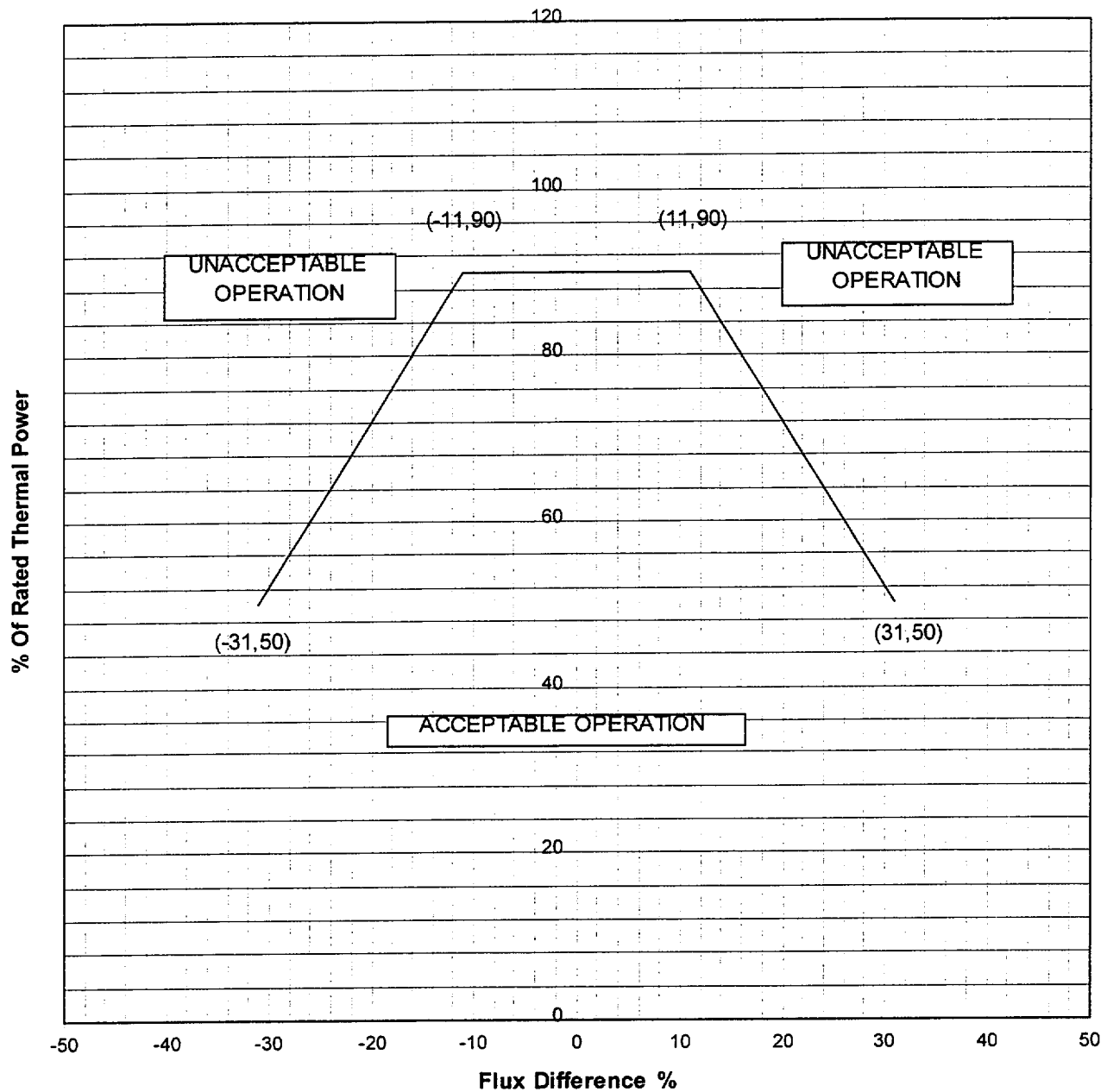
$$PF_{\Delta H} = 0.3$$

2.8 Axial Flux Difference (AFD) (LCO 3.2.3)

2.8.1 The AXIAL FLUX DIFFERENCE (AFD) target band is +5, -10% of the target flux difference.

2.8.2 The AFD Acceptable Operation Limits are provided in Figure 2.8.1.

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

FIGURE 2.8.1: Axial Flux Difference Limits As A Function of Rated Thermal Power

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

2.9 Reactor Trip System Overtemperature ΔT Setpoint Parameter Values (LCO 3.3.1)

- 2.9.1 The Overtemperature ΔT reactor trip setpoint K_1 shall be equal to 1.325.
- 2.9.2 The Overtemperature ΔT reactor trip setpoint T_{avg} coefficient K_2 shall be equal to 0.0297 / °F.
- 2.9.3 The Overtemperature ΔT reactor trip setpoint pressure coefficient K_3 shall be equal to 0.00181 / psig.
- 2.9.4 The nominal T_{avg} at RTP (indicated) T' shall be less than or equal to 588.4 °F.
- 2.9.5 The nominal RCS operating pressure (indicated) P' shall be equal to 2235 psig.
- 2.9.6 The measured reactor vessel ΔT lead/lag time constant τ_1 shall be equal to 8 sec.
- 2.9.7 The measured reactor vessel ΔT lead/lag time constant τ_2 shall be equal to 3 sec.
- 2.9.8 The measured reactor vessel ΔT lag time constant τ_3 shall be less than or equal to 2 sec.
- 2.9.9 The measured reactor vessel average temperature lead/lag time constant τ_4 shall be equal to 33 sec.
- 2.9.10 The measured reactor vessel average temperature lead/lag time constant τ_5 shall be equal to 4 sec.
- 2.9.11 The measured reactor vessel average temperature lag time constant τ_6 shall be less than or equal to 2 sec.
- 2.9.12 The $f_1(\Delta I)$ "positive" breakpoint shall be +10% ΔI .
- 2.9.13 The $f_1(\Delta I)$ "negative" breakpoint shall be - 24% ΔI .
- 2.9.14 The $f_1(\Delta I)$ "positive" slope shall be +4.11% / % ΔI .
- 2.9.15 The $f_1(\Delta I)$ "negative" slope shall be - 3.35% / % ΔI .

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

2.10 Reactor Trip System Overpower ΔT Setpoint Parameter Values (LCO 3.3.1)

- 2.10.1 The Overpower ΔT reactor trip setpoint K_4 shall be equal to 1.072.
- 2.10.2 The Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient K_5 shall be equal to 0.02 / °F for increasing T_{avg} .
- 2.10.3 The Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient K_5 shall be equal to 0 / °F for decreasing T_{avg} .
- 2.10.4 The Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient K_6 shall be equal to 0.00245 / °F when $T > T''$.
- 2.10.5 The Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient K_6 shall be equal to 0 / °F when $T \leq T''$.
- 2.10.6 The nominal T_{avg} at RTP (indicated) T'' shall be less than or equal to 588.4 °F.
- 2.10.7 The measured reactor vessel ΔT lead/lag time constant τ_1 shall be equal to 8 sec.
- 2.10.8 The measured reactor vessel ΔT lead/lag time constant τ_2 shall be equal to 3 sec.
- 2.10.9 The measured reactor vessel ΔT lag time constant τ_3 shall be less than or equal to 2 sec.
- 2.10.10 The measured reactor vessel average temperature lag time constant τ_6 shall be less than or equal to 2 sec.
- 2.10.11 The measured reactor vessel average temperature rate/lag time constant τ_7 shall be equal to 10 sec.
- 2.10.12 The $f_2(\Delta I)$ "positive" breakpoint shall be 0 for all ΔI .
- 2.10.13 The $f_2(\Delta I)$ "negative" breakpoint shall be 0 for all ΔI .
- 2.10.14 The $f_2(\Delta I)$ "positive" slope shall be 0 for all ΔI .
- 2.10.15 The $f_2(\Delta I)$ "negative" slope shall be 0 for all ΔI .

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 11

2.11 Reactor Coolant System (RCS) DNB Parameter Limits (LCO 3.4.1)

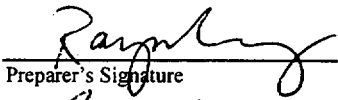
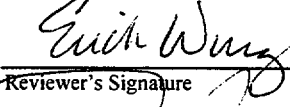
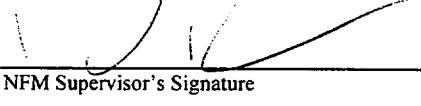
- 2.11.1 The pressurizer pressure shall be greater than or equal to 2219 psig.
- 2.11.2 The RCS average temperature (T_{avg}) shall be less than or equal to 591.2 °F.
- 2.11.3 The RCS total flow rate shall be greater than or equal to 371,400 gpm.

2.12 Boron Concentration

- 2.12.1 The refueling boron concentration shall be greater than or equal to 2000 ppm (LCO 3.9.1).
- 2.12.2 The Reactor Coolant System boron concentration shall be greater than or equal to 1894 ppm prior to initial criticality of Cycle 11, or greater than or equal to 2075 ppm at all other times in core life, to maintain adequate shutdown margin for MODES 3, 4, and 5 during performance of rod drop time measurements and during the surveillance of Digital Rod Position Indication (DRPI) for OPERABILITY (TLCO 3.1.g and TLCO 3.1.k)

ATTACHMENT 2

Revised Byron Station Unit 2 Cycle 9 COLR

NUCLEAR FUEL MANAGEMENT DEPARTMENT NUCLEAR DESIGN INFORMATION TRANSMITTAL			
<input checked="" type="checkbox"/> SAFETY RELATED <input type="checkbox"/> NON-SAFETY RELATED <input type="checkbox"/> REGULATORY RELATED	Originating Organization <input checked="" type="checkbox"/> Nuclear Fuel Management <input type="checkbox"/> Other (specify) _____	NDIT No. <u>NFM9900202</u> Seq. No. <u>3</u> Page 1 of 18	
Station <u>Byron</u> Unit <u>2</u> Cycle <u>9</u> Generic _____			
To: <u>Kenneth N. Kovar - Byron</u>			
Subject <u>Byron Unit 2 Cycle 9 Core Operating Limits Report in ITS Format and W(z) Function</u>			
R. Ng Preparer	 Preparer's Signature	<u>11/15/00</u> Date	
E. Wurz Reviewer	 Reviewer's Signature	<u>11/15/00</u> Date	
D. Redden NFM Supervisor	 NFM Supervisor's Signature	<u>11/15/00</u> Date	
Status of Information: <div style="display: inline-block; vertical-align: top; margin-left: 20px;"> <input checked="" type="checkbox"/> Verified <input type="checkbox"/> Unverified <input type="checkbox"/> Engineering Judgement </div>			
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: Sequence 3 of this NDIT supersedes Sequence 2. Sequence 3 modifies Section 2.12.2 of the COLR to support the requirement for the new TRM TLCO 3.1.g. Sequence 2 revised Page 9 to include the correct Figure 2.6.1.a for the K(z) curve with assembly average burnup \leq 4000 MWD/MTU. Sequence 1 added clarification for the minimum boron concentration for TLCO 3.1.k to include DRPI operability surveillance and it incorporated the Expanded COLR format which includes Reactor Core Safety Limits, Reactor Trip System Instrumentation, and RCS DNB parameters. The analytical 224 position limit for rods out was included in Sequence 1. 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 (Raymond Ng) 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. 3, "Safety Assessment Summary for Byron Unit 2 Cycle 9," dated October 11, 1999. 6) Byron Technical Specification Amendment 113, dated May 15, 2000. 7) PND Calculation Number PND-CN:00-003, "Evaluation of SPIL Using 224 Steps Rod Withdrawn as Definition of ARO," dated May 8, 2000.			
Supplemental Distribution: <u>P. E. Reister / J. Langan (BY)</u>			

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:

SL	2.1.1	Reactor Core Safety Limits (SLs)
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	3.3.1	Reactor Trip System (RTS) Instrumentation
LCO	3.3.9	Boron Dilution Protection System (BDPS)
LCO	3.4.1	Reactor Coolant System (RCS) DNB Parameters
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.g	Position Indication System – Shutdown
TRM TLCO 3.1.h	Shutdown Margin (SDM) – MODE 1 and MODE 2 with $k_{eff} \geq 1.0$
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 Reactor Core Limits (SL 2.1.1)

- 2.1.1 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 Figure 2.1.1.

2.2 Shutdown Margin (SDM)

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

- 2.2.1 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:

- 2.2.2.1 SDM shall be greater than or equal to 1.0% $\Delta k/k$ (LCO 3.1.1)
- 2.2.2.2 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)

2.3 Moderator Temperature Coefficient (LCO 3.1.3)

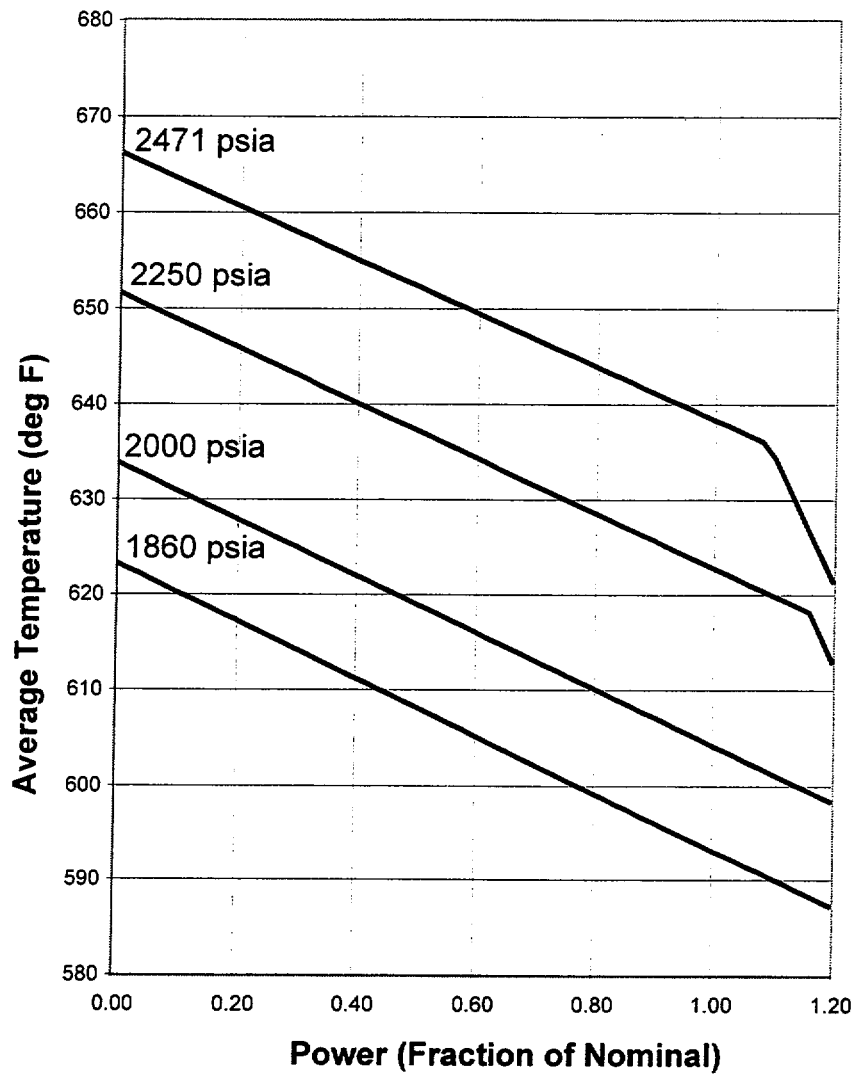
The Moderator Temperature Coefficient (MTC) limits are:

- 2.3.1 The BOL/ARO/HZP-MTC upper limit shall be $+3.3 \times 10^{-5} \Delta k/k/^\circ F$.
- 2.3.2 The EOL/ARO/HFP-MTC lower limit shall be $-4.1 \times 10^{-4} \Delta k/k/^\circ F$.
- 2.3.3 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

Figure 2.1.1: Reactor Core Limits



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

2.4 Shutdown Bank Insertion Limit (LCO 3.1.5)

2.4.1 All shutdown banks shall be fully withdrawn to at least 224 steps.

2.5 Control Bank Insertion Limits (LCO 3.1.6)

2.5.1 The control banks shall be limited in physical insertion as shown in Figure 2.5.1.

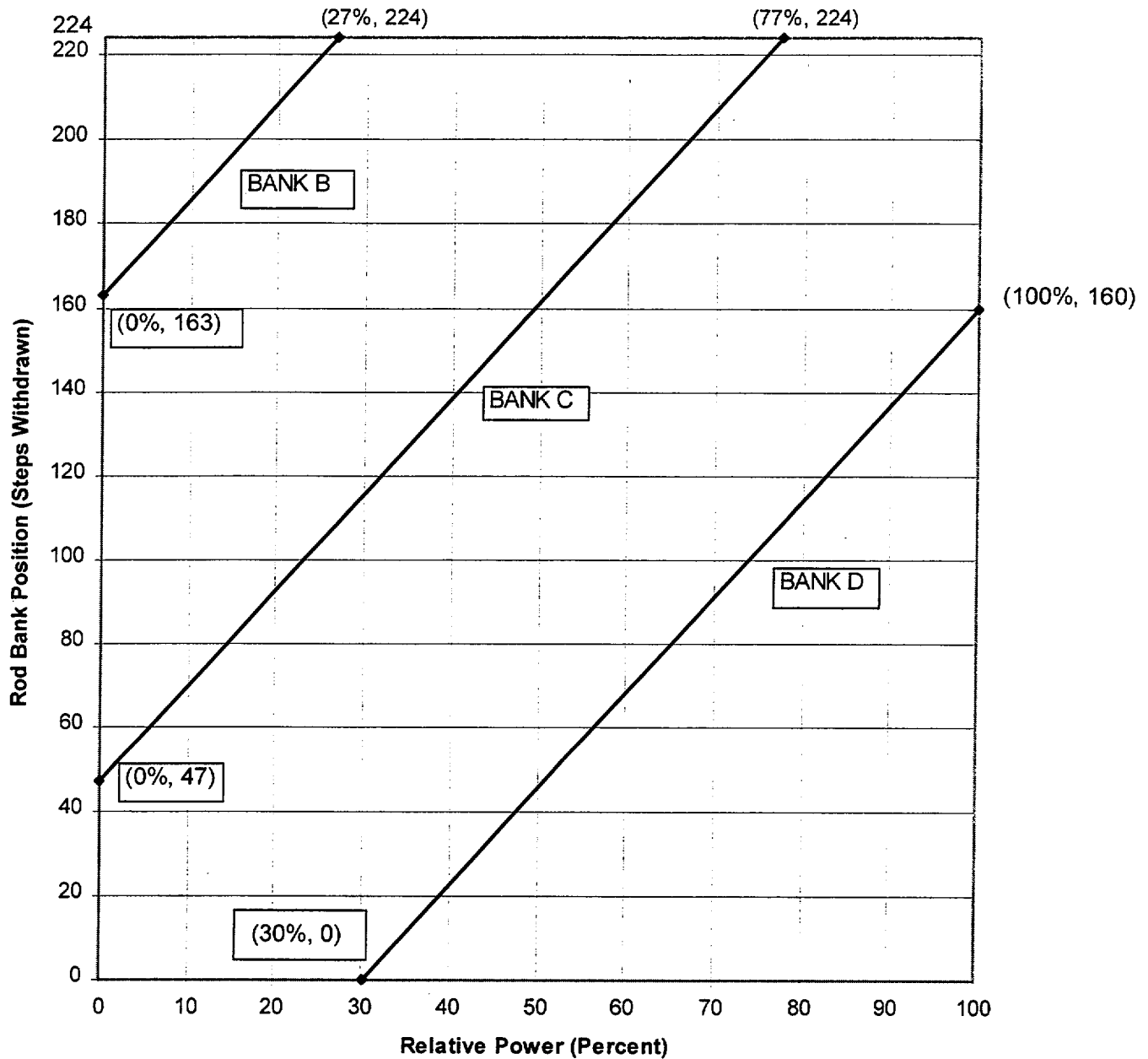
2.5.2 Each control bank shall be considered fully withdrawn from the core at greater than or equal to 224 steps.

2.5.3 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.

2.5.4 Each control bank not fully withdrawn from the core shall be operated with a 115 step overlap limit.

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

Figure 2.5.1:
Control Bank Insertion Limits Versus Percent Rated Thermal Power



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

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

2.6.1

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

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

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 2.6.1.
 $K(Z)$ for assembly average burnup \leq 4000 MWD/MTU is provided in Figure 2.6.1.a.

2.6.2 $W(Z)$ is provided in Figures 2.6.2.a through 2.6.2.c.

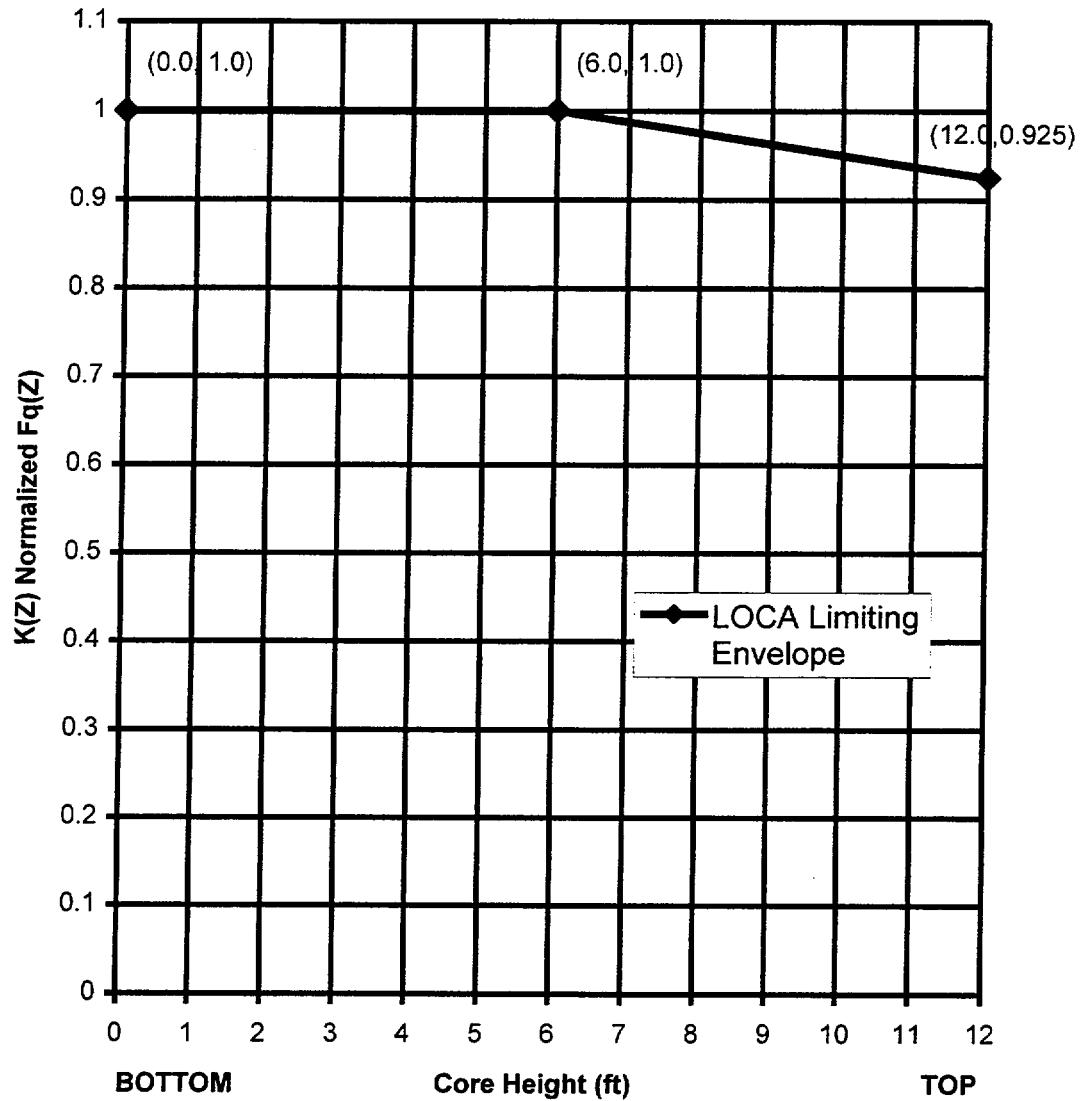
The normal operation $W(Z)$ values have been determined at burnups of 150, 8000 and 18800 MWD/MTU.

Table 2.6.2 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 2.6.2.

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

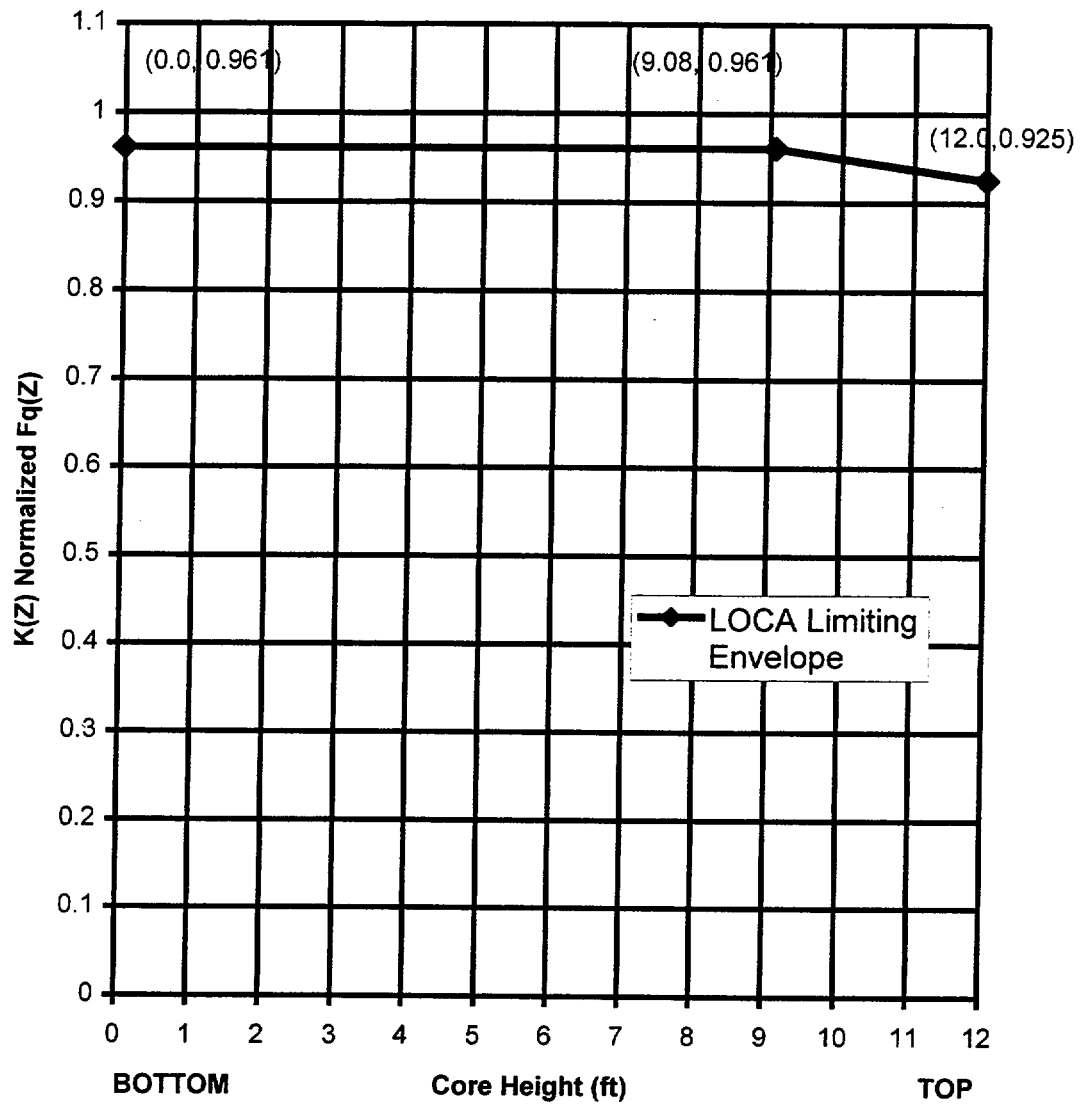
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 9

Figure 2.6.1: $K(Z)$ - Normalized $F_q(Z)$ as a Function of Core Height (Assembly Average > 4000 MWD/MTU)



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

Figure 2.6.1.a: $K(Z)$ - Normalized $F_q(Z)$ as a Function of Core Height (Assembly Average ≤ 4000 MWD/MTU)



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

Height
Feet

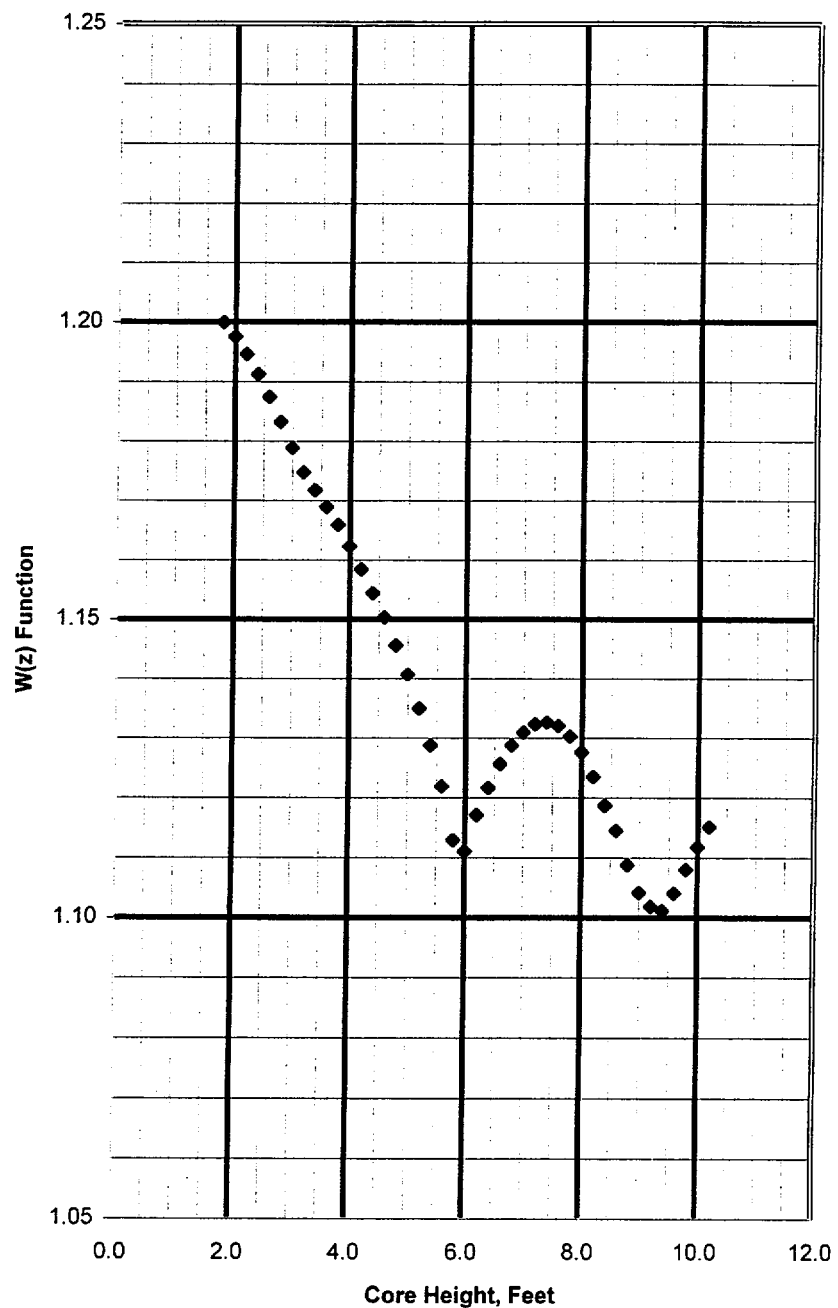
Max W(z)

Byron Unit 2 Cycle 9

Figure 2.6.2.a

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

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



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

Height
Feet

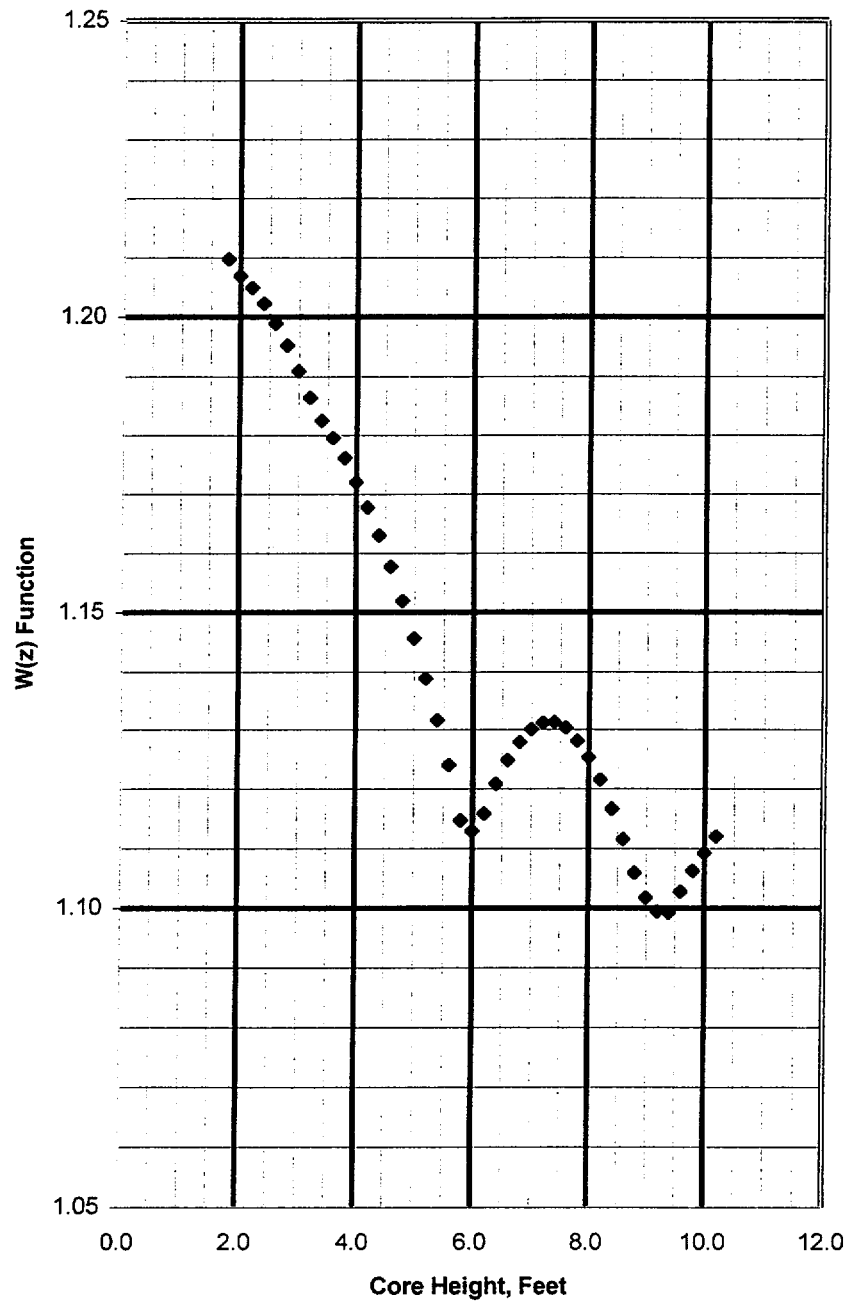
Max W(z)

Byron Unit 2 Cycle 9

Figure 2.6.2.b

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

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



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

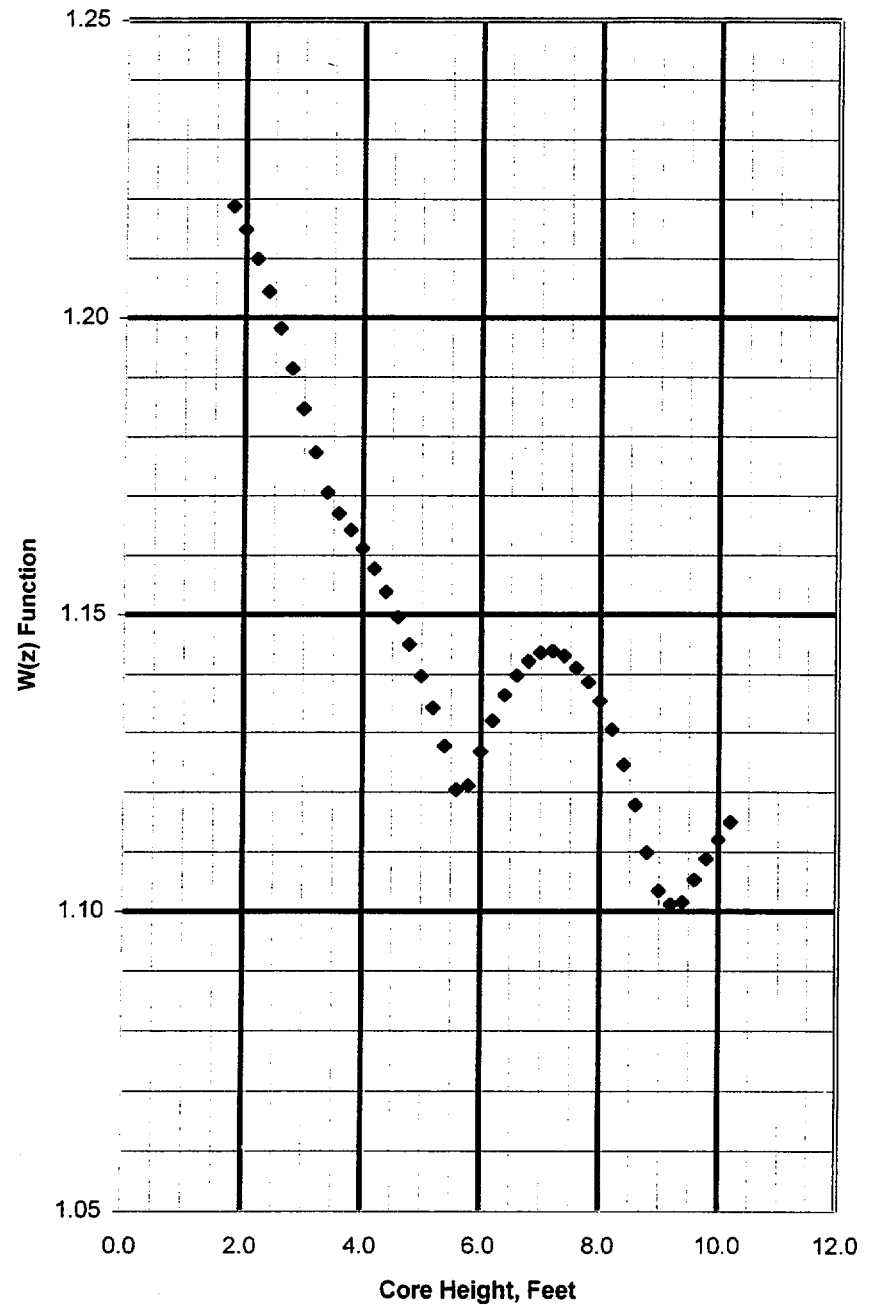
Height
Feet

Byron Unit 2 Cycle 9

Figure 2.6.2.c

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

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



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

Table 2.6.2	
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

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

$$2.7.1 \quad F_{\Delta H}^N \leq F_{\Delta H}^{RTP} [1.0 + PF_{\Delta H}(1.0 - P)]$$

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

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

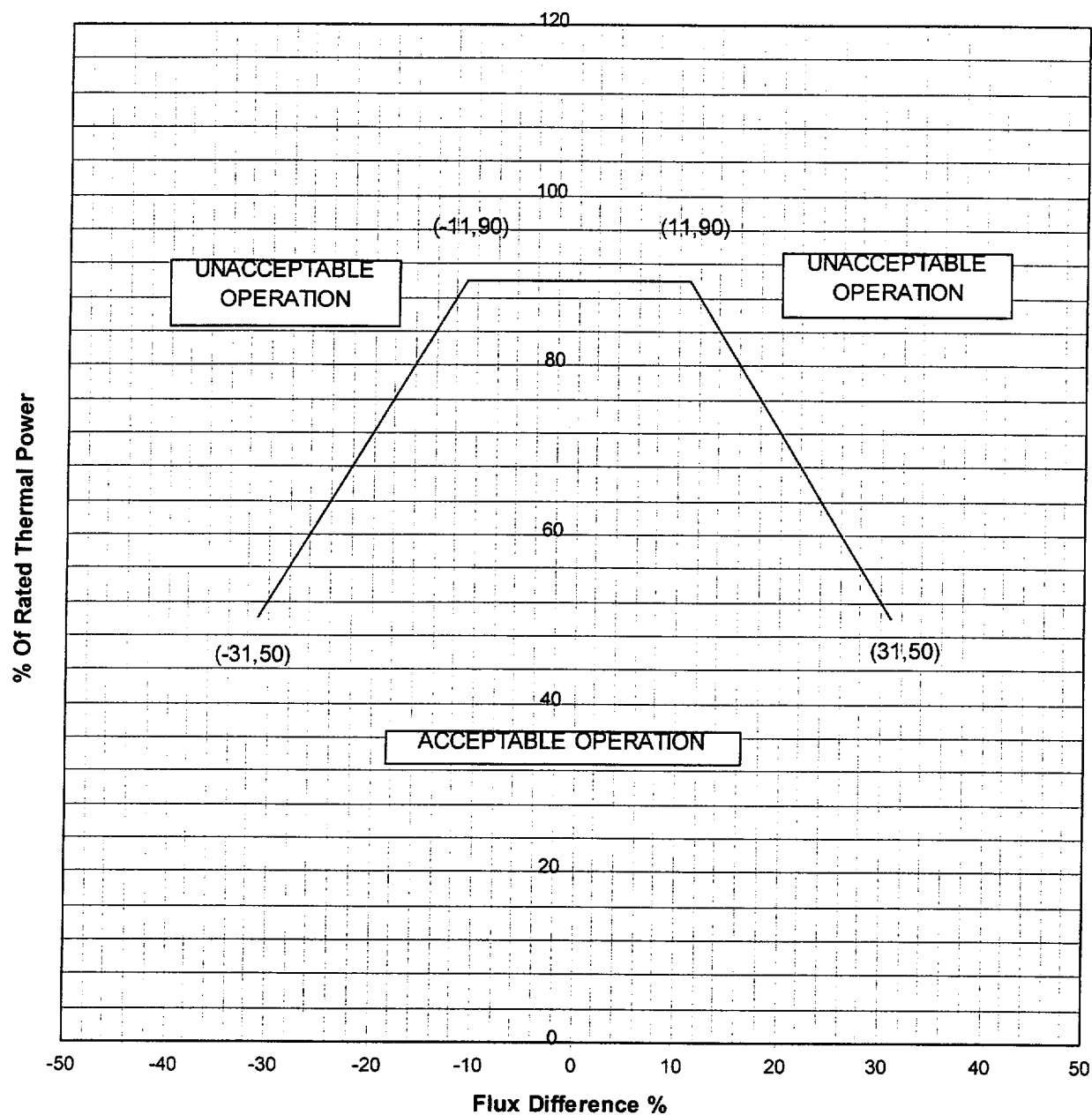
$$PF_{\Delta H} = 0.3$$

2.8 Axial Flux Difference (AFD) (LCO 3.2.3)

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

2.8.2 The AFD Acceptable Operation Limits are provided in Figure 2.8.1.

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

FIGURE 2.8.1: Axial Flux Difference Limits As A Function of Rated Thermal Power

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

2.9 Reactor Trip System Overtemperature ΔT Setpoint Parameter Values (LCO 3.3.1)

- 2.9.1 The Overtemperature ΔT reactor trip setpoint K_1 shall be equal to 1.325.
- 2.9.2 The Overtemperature ΔT reactor trip setpoint T_{avg} coefficient K_2 shall be equal to 0.0297 / °F.
- 2.9.3 The Overtemperature ΔT reactor trip setpoint pressure coefficient K_3 shall be equal to 0.00181 / psig.
- 2.9.4 The nominal T_{avg} at RTP (indicated) T' shall be less than or equal to 588.4 °F.
- 2.9.5 The nominal RCS operating pressure (indicated) P' shall be equal to 2235 psig.
- 2.9.6 The measured reactor vessel ΔT lead/lag time constant τ_1 shall be equal to 8 sec.
- 2.9.7 The measured reactor vessel ΔT lead/lag time constant τ_2 shall be equal to 3 sec.
- 2.9.8 The measured reactor vessel ΔT lag time constant τ_3 shall be less than or equal to 2 sec.
- 2.9.9 The measured reactor vessel average temperature lead/lag time constant τ_4 shall be equal to 33 sec.
- 2.9.10 The measured reactor vessel average temperature lead/lag time constant τ_5 shall be equal to 4 sec.
- 2.9.11 The measured reactor vessel average temperature lag time constant τ_6 shall be less than or equal to 2 sec.
- 2.9.12 The $f_1(\Delta I)$ "positive" breakpoint shall be +10% ΔI .
- 2.9.13 The $f_1(\Delta I)$ "negative" breakpoint shall be - 24% ΔI .
- 2.9.14 The $f_1(\Delta I)$ "positive" slope shall be +4.11% / % ΔI .
- 2.9.15 The $f_1(\Delta I)$ "negative" slope shall be - 3.35% / % ΔI .

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

2.10 Reactor Trip System Overpower ΔT Setpoint Parameter Values (LCO 3.3.1)

- 2.10.1 The Overpower ΔT reactor trip setpoint K_4 shall be equal to 1.072.
- 2.10.2 The Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient K_5 shall be equal to 0.02 / °F for increasing T_{avg} .
- 2.10.3 The Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient K_5 shall be equal to 0 / °F for decreasing T_{avg} .
- 2.10.4 The Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient K_6 shall be equal to 0.00245 / °F when $T > T''$.
- 2.10.5 The Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient K_6 shall be equal to 0 / °F when $T \leq T''$.
- 2.10.6 The nominal T_{avg} at RTP (indicated) T'' shall be less than or equal to 588.4 °F.
- 2.10.7 The measured reactor vessel ΔT lead/lag time constant τ_1 shall be equal to 8 sec.
- 2.10.8 The measured reactor vessel ΔT lead/lag time constant τ_2 shall be equal to 3 sec.
- 2.10.9 The measured reactor vessel ΔT lag time constant τ_3 shall be less than or equal to 2 sec.
- 2.10.10 The measured reactor vessel average temperature lag time constant τ_6 shall be less than or equal to 2 sec.
- 2.10.11 The measured reactor vessel average temperature rate/lag time constant τ_7 shall be equal to 10 sec.
- 2.10.12 The $f_2(\Delta I)$ "positive" breakpoint shall be 0 for all ΔI .
- 2.10.13 The $f_2(\Delta I)$ "negative" breakpoint shall be 0 for all ΔI .
- 2.10.14 The $f_2(\Delta I)$ "positive" slope shall be 0 for all ΔI .
- 2.10.15 The $f_2(\Delta I)$ "negative" slope shall be 0 for all ΔI .

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

2.11 Reactor Coolant System (RCS) DNB Parameter Limits (LCO 3.4.1)

2.11.1 The pressurizer pressure shall be greater than or equal to 2219 psig.

2.11.2 The RCS average temperature (T_{avg}) shall be less than or equal to 591.2 °F.

2.11.3 The RCS total flow rate shall be greater than or equal to 371,400 gpm.

2.12 Boron Concentration

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

2.12.2 The Reactor Coolant System boron concentration shall be greater than or equal to 1919 ppm to maintain adequate shutdown margin for MODES 3, 4, and 5 during performance of rod drop time measurements and during the surveillance of Digital Rod Position Indication (DRPI) for OPERABILITY. (TLCO 3.1.g and TLCO 3.1.k)