Exelon Generation Company, LLC
Byron Station
4450 North German Church Road
Byron, IL 61010-9794

www.exeloncorp.com

Exelon Nuclear

October 7, 2003

LTR: BYRON 2003-0093
File: 2.01.0700

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

Byron Station, Unit 1
Facility Operating License No. NPF-37
NRC Docket No. STN 50-454

Subject: Issuance of Core Operating Limits Report for Byron Station Unit One Cycle 13

References: (1) Licensee Event Report 454-2003-003-00, "Licensed Maximum Power Level Exceeded Due to Inaccuracies in Feedwater Ultrasonic Flow Measurements Caused by Signal Noise Contamination," Dated September 29, 2003

(2) Letter from Mahesh Chawla (NRC) to John L. Skolds (Exelon Generation Company, LLC), "Byron Station Unit 1 and 2, Exemption from the Requirements of 10 CFR 50.44, 10 CFR 50.46, and 10 CFR Part 50 Appendix K," Dated September 22, 2003

In accordance with Technical Specification 5.6.5, "Core Operating Limits Report (COLR)," we are submitting the COLR for Byron Station, Unit 1 Cycle 13.

One reload parameter pertains to the Byron Station Unit 1 Best Estimate Large Break Loss of Coolant (BELOCA) Accident composite Peak Clad Temperature (PCT). The BELOCA analyses operating envelope was expanded for Cycle 13 and resulted in an increase of 80°F above the base evaluation. The resultant PCT of 2136°F continues to satisfy the 10CFR 50.46 requirement of less than 2200°F. The reporting requirements of 10CFR50.46 will be satisfied in a separate letter within 30 days following the start of the cycle.

The nuclear design and safety analyses also considered the possible cumulative effects from overpower operation of Byron Station Units 1 and 2 that may have occurred due to the recently identified inaccuracies in the Ultrasonic Flow Measurement System flow correction factors. (See reference 1)

Cycle 13 will include four Lead Test Assemblies (LTA) that contain features requiring NRC approval. The LTAs will contain 24 new fuel rods that contain a low- low tin (LT-2) alloy of ZIRLO. In reference 2, the NRC has granted a temporary exemption from the requirements of 10CFR 50.44, 10CFR 50.46, and 10CFR Part 50, Appendix K, for the LTA assembly containing the 24 ZIRLO LT-2 fuel rods. The second feature is the high burnup evaluation of the LTAs. The four assemblies are expected to exceed the license limit burnup of 60,000 MWD/MTU. During the reload design and safety analyses, the use of four high burnup LTAs was evaluated and found acceptable. A License Amendment Request will be submitted to obtain NRC approval to exceed

A001

the design basis rod average burnup limit (60,000 MWD/MTU) for the LTAs prior to exceeding the 60,000 MWD/MTU rod average burnup limit.

Should you have any questions concerning these reports, please contact William Grundmann, Regulatory Assurance Manager, at (815) 406-2800.

Respectfully,

Stephen Kuczynski

Stephen E. Kuczynski
Site Vice President
Byron Nuclear Generating Station

Attachment: Byron Station, Unit 1 Cycle 13, COLR

cc: Regional Administrator – NRC Region III
NRC Senior Resident Inspector – Byron Station
NRC Project Manager – NRR – Byron Station
Office of Nuclear Facility Safety – Illinois Department of Nuclear Safety

Attachment

Byron Station, Unit 1 Cycle 13, COLR

FRTHD-03-99

CORE OPERATING LIMITS REPORT (COLR)

FOR

BYRON UNIT 1 CYCLE 13

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 13

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Byron Station Unit 1 Cycle 13 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 (MTC)
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 ($F^N_{\Delta H}$)
LCO	3.2.3	Axial Flux Difference (AFD)
LCO	3.2.5	Departure from Nucleate Boiling Ratio (DNBR)
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) Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits
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 keff ≥ 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)

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 Safety 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.

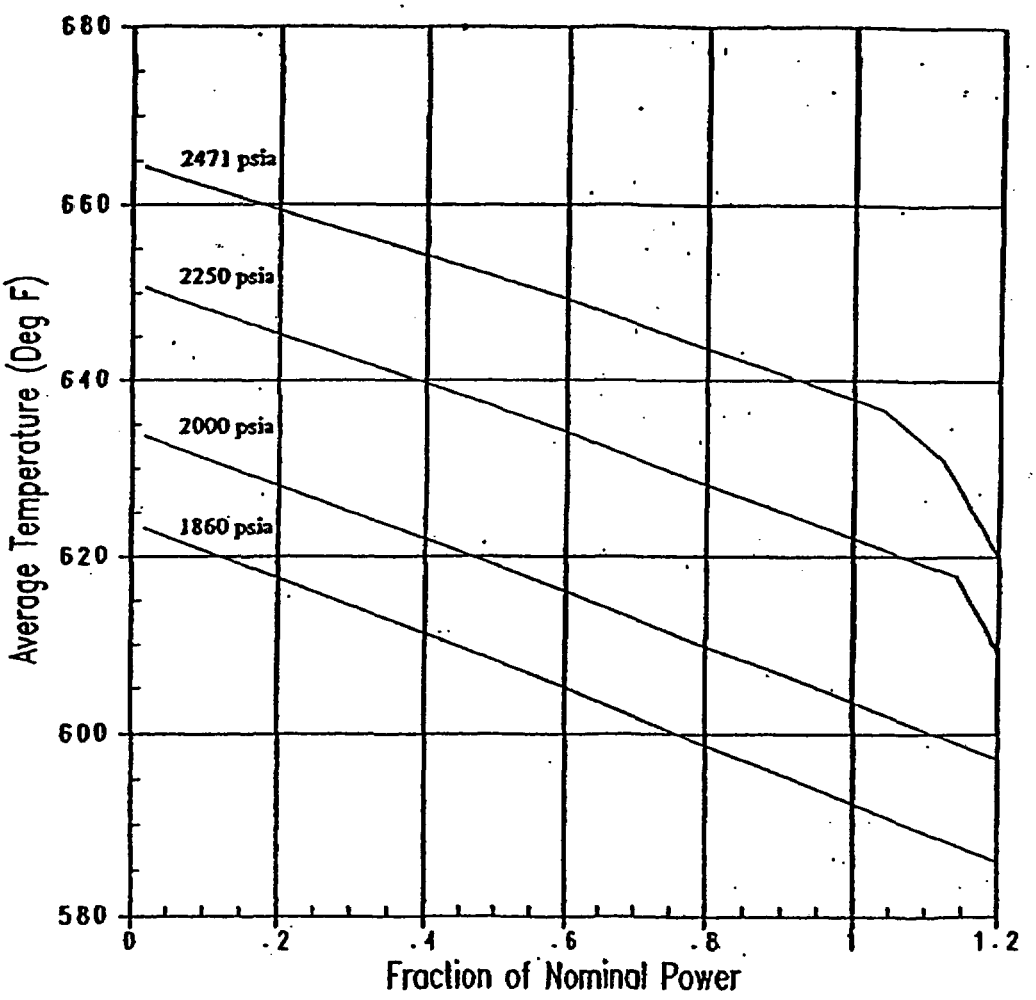


Figure 2.1.1: Reactor Core Limits

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% Δk/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 SDM shall be greater than or equal to 1.3% Δk/k (LCO 3.1.1, LCO 3.3.9; TRM TLCOs 3.1.i and 3.1.j).

2.3 Moderator Temperature Coefficient (MTC) (LCO 3.1.3)

The Moderator Temperature Coefficient (MTC) limits are:

2.3.1 The BOL/ARO/HZP-MTC upper limit shall be $+1.93 \times 10^{-5}$ Δk/k/°F.

2.3.2 The EOL/ARO/HFP-MTC lower limit shall be -4.6×10^{-4} Δk/k/°F.

2.3.3 The EOL/ARO/HFP-MTC Surveillance limit at 300 ppm shall be -3.7×10^{-4} Δk/k/°F.

2.3.4 The EOL/ARO/HFP-MTC Surveillance limit at 60 ppm shall be -4.3×10^{-4} Δk/k/°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

2.4 Shutdown Bank Insertion Limits (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, with Bank A greater than or equal to 224 steps, shall be limited in physical insertion as shown in Figure 2.5.1.

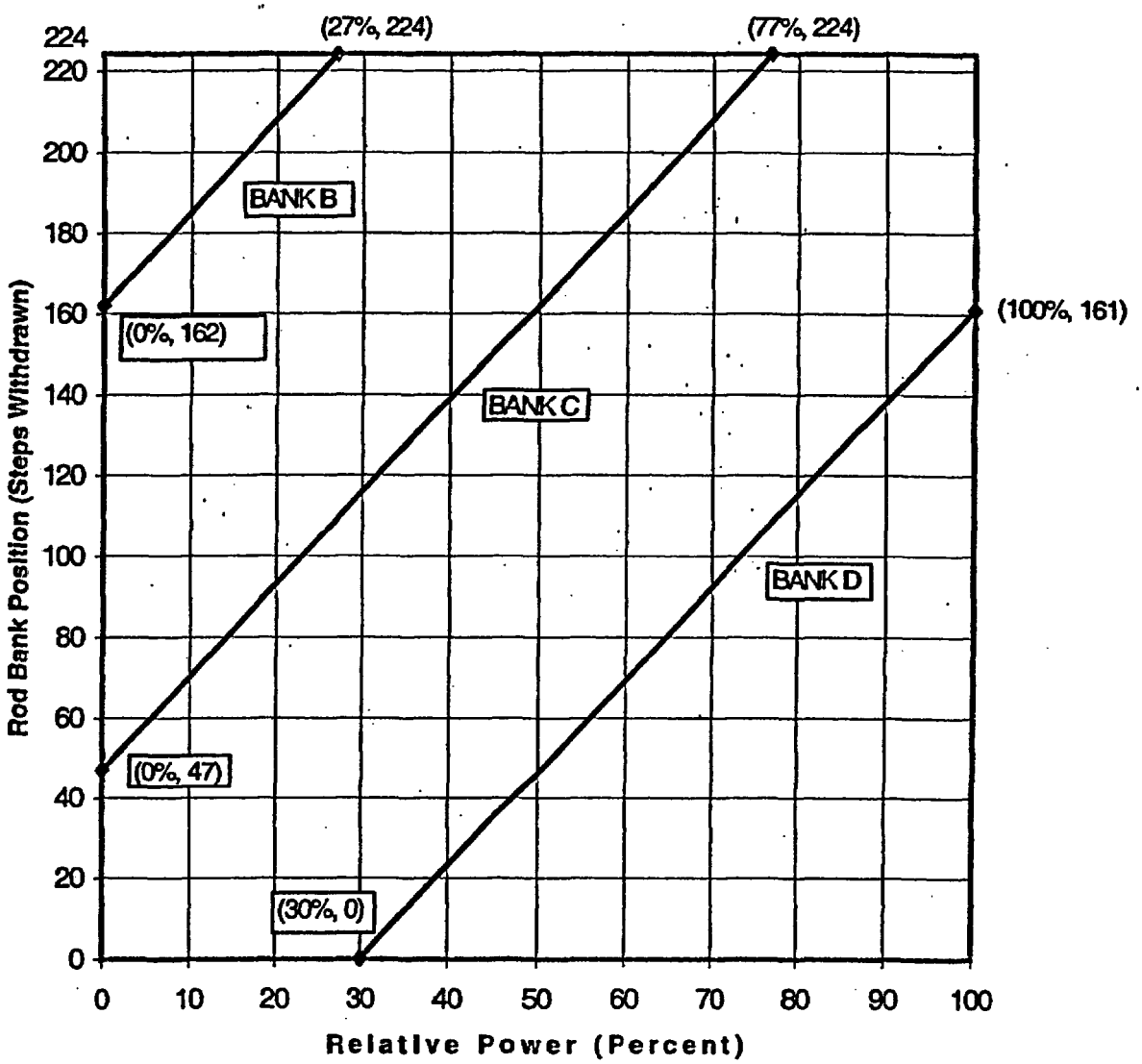
2.5.2 Each control bank shall be considered fully withdrawn from the core at greater than or equal to 224 steps.

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 the following overlap limits as a function of park position:

Park Position (step)	Overlap Limit (step)
228	113

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



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

2.6.1 Total Peaking Factor:

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{0.5} xK(Z) \quad \text{for } P \leq 0.5$$

$$F_Q(Z) \leq \frac{F_Q^{RTP}}{P} xK(Z) \quad \text{for } P > 0.5$$

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

F_Q^{RTP} = 2.60

K(Z) is provided in Figure 2.6.1.

2.6.2 W(Z) Values:

a) When PDMS is OPERABLE, W(Z) = 1.00000 for all axial points.

b) When PDMS is Inoperable, 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, 6000, 14000, and 20000 MWD/MTU.

Table 2.6.2 shows the $F^C_O(z)$ penalty factors that are greater than 2% per 31 Effective Full Power Days (EFPD). These values shall be used to increase the $F^W_O(z)$ 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.

2.6.3 Uncertainty:

The uncertainty, U_{FQ}, to be applied to the Heat Flux Hot Channel Factor $F_Q(Z)$ shall be calculated by the following formula

$$U_{FQ} = U_{qu} * U_e$$

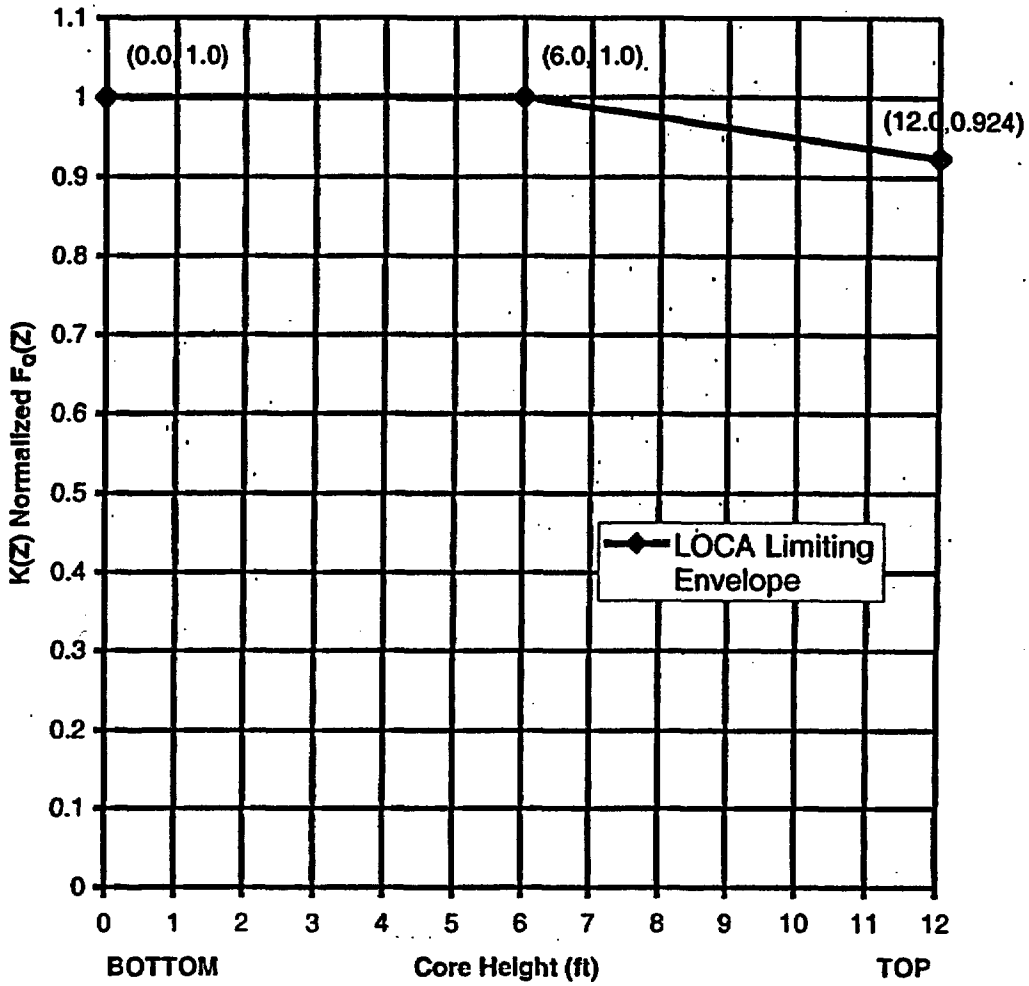
where:

U_{qu} = Base FQ measurement uncertainty = 1.05 when PDMS is Inoperable (U_{qu} is defined by PDMS when operable.)
U_e = Engineering uncertainty factor = 1.03

2.6.4 PDMS Alarms:

$F_Q(Z)$ Warning Setpoint ≥ 2% of $F_Q(Z)$ Margin
$F_Q(Z)$ Alarm Setpoint ≥ 0% of $F_Q(Z)$ Margin

Figure 2.6.1
K(Z) - Normalized $F_Q(Z)$ as a Function of Core Height



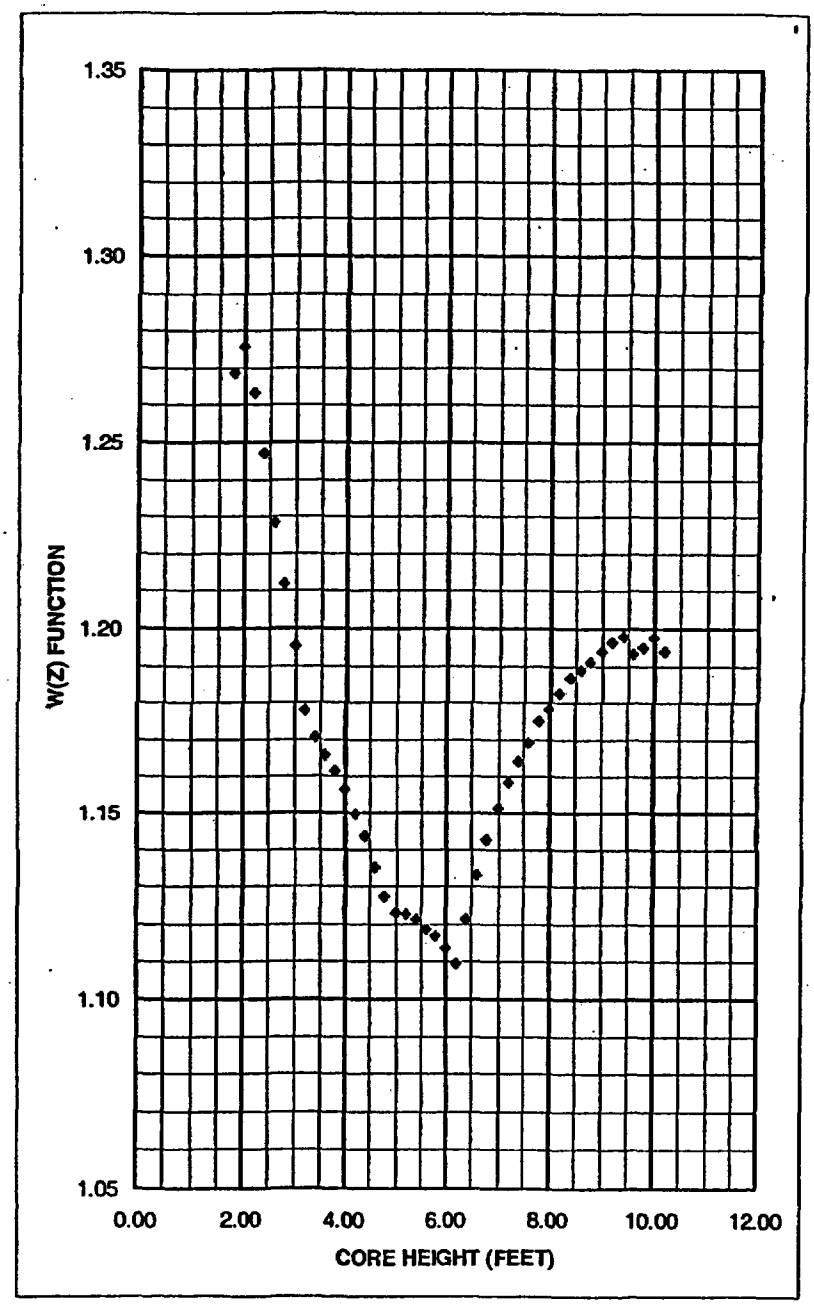
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 13

Height Feet	MAX 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	1.2687
2.00	1.2758
2.20	1.2633
2.40	1.2469
2.60	1.2285
2.80	1.2119
3.00	1.1954
3.20	1.1782
3.40	1.1705
3.60	1.1659
3.80	1.1614
4.00	1.1563
4.20	1.1497
4.40	1.1437
4.60	1.1351
4.80	1.1275
5.00	1.1231
5.20	1.1226
5.40	1.1212
5.60	1.1186
5.80	1.1168
6.00	1.1135
6.20	1.1095
6.40	1.1212
6.60	1.1330
6.80	1.1427
7.00	1.1515
7.20	1.1584
7.40	1.1642
7.60	1.1694
7.80	1.1750
8.00	1.1783
8.20	1.1824
8.40	1.1869
8.60	1.1889
8.80	1.1909
9.00	1.1938
9.20	1.1963
9.40	1.1981
9.60	1.1932
9.80	1.1949
10.00	1.1975
10.20	1.1940
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 13

Figure 2.6.2.a

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



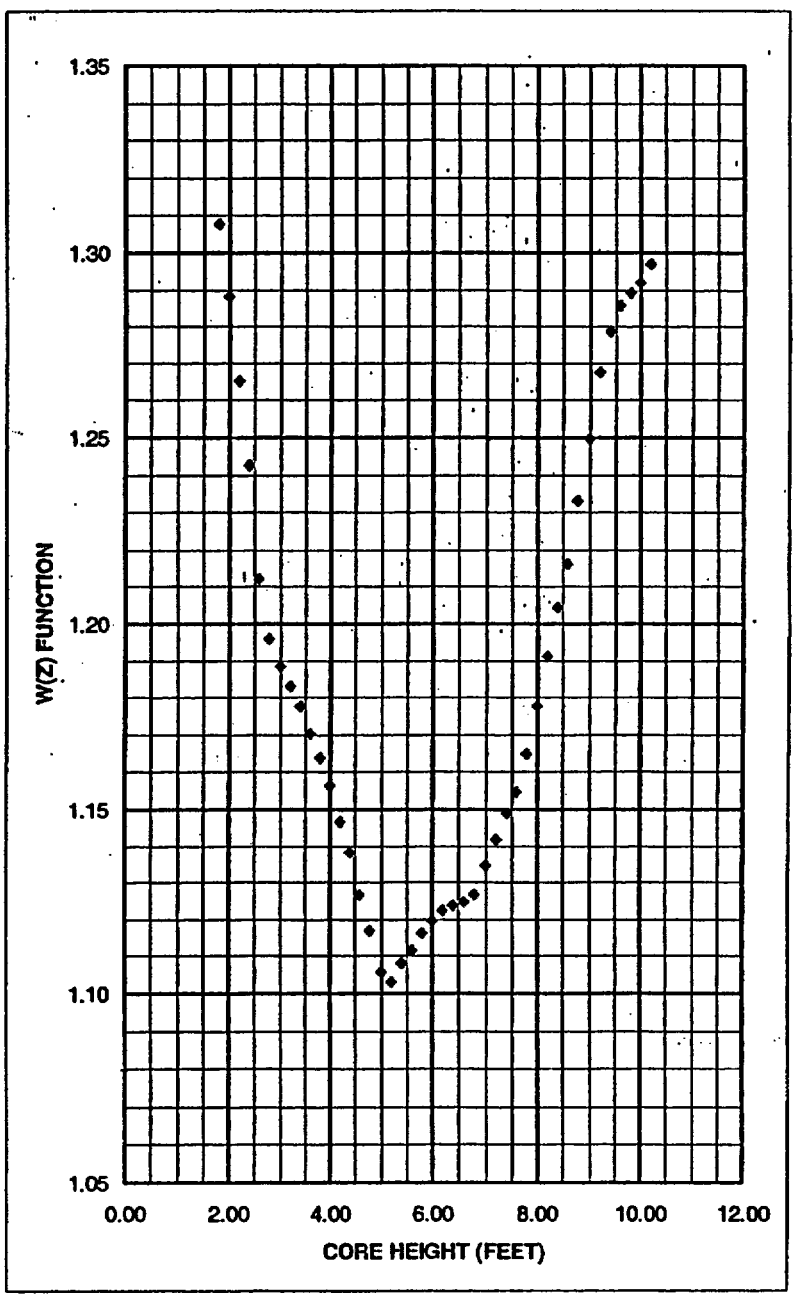
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 13

Height Feet	MAX 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	1.3077
2.00	1.2882
2.20	1.2651
2.40	1.2426
2.60	1.2120
2.80	1.1960
3.00	1.1886
3.20	1.1832
3.40	1.1777
3.60	1.1703
3.80	1.1639
4.00	1.1565
4.20	1.1466
4.40	1.1382
4.60	1.1267
4.80	1.1168
5.00	1.1059
5.20	1.1031
5.40	1.1080
5.60	1.1115
5.80	1.1161
6.00	1.1196
6.20	1.1222
6.40	1.1238
6.60	1.1246
6.80	1.1266
7.00	1.1344
7.20	1.1418
7.40	1.1489
7.60	1.1548
7.80	1.1648
8.00	1.1778
8.20	1.1911
8.40	1.2043
8.60	1.2162
8.80	1.2330
9.00	1.2498
9.20	1.2677
9.40	1.2788
9.60	1.2859
9.80	1.2891
10.00	1.2920
10.20	1.2968
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 13

Figure 2.6.2.b

Summary of W(Z) Function at 6000 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



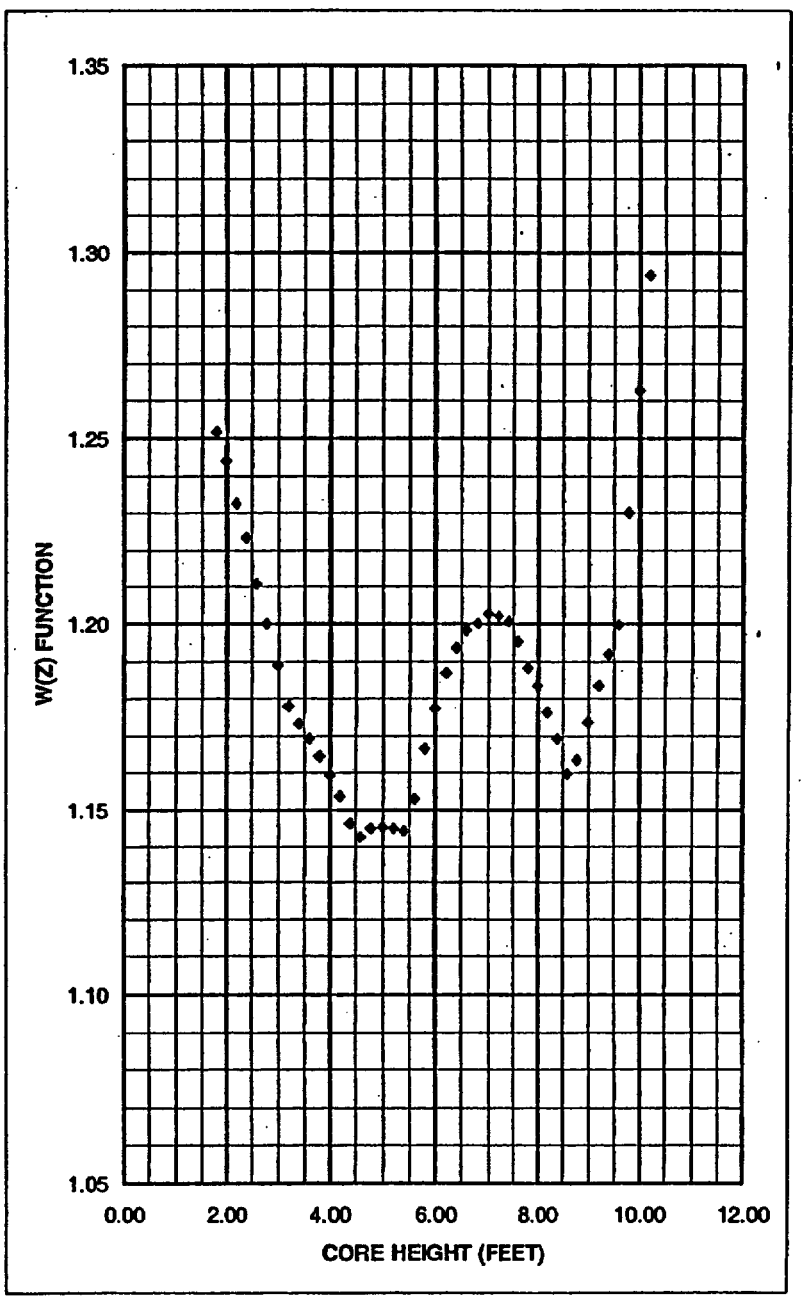
CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 13

Height Feet	MAX 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	1.2516
2.00	1.2438
2.20	1.2326
2.40	1.2233
2.60	1.2109
2.80	1.2000
3.00	1.1887
3.20	1.1782
3.40	1.1732
3.60	1.1691
3.80	1.1646
4.00	1.1595
4.20	1.1538
4.40	1.1464
4.60	1.1426
4.80	1.1449
5.00	1.1454
5.20	1.1448
5.40	1.1444
5.60	1.1531
5.80	1.1666
6.00	1.1773
6.20	1.1869
6.40	1.1936
6.60	1.1983
6.80	1.2001
7.00	1.2028
7.20	1.2021
7.40	1.2007
7.60	1.1953
7.80	1.1883
8.00	1.1835
8.20	1.1762
8.40	1.1691
8.60	1.1598
8.80	1.1634
9.00	1.1736
9.20	1.1833
9.40	1.1920
9.60	1.1998
9.80	1.2300
10.00	1.2630
10.20	1.2940
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 13

Figure 2.6.2.c

Summary of W(Z) Function at 14000 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 1 CYCLE 13

Height Feet	MAX 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	1.2761
2.00	1.2577
2.20	1.2357
2.40	1.2236
2.60	1.2095
2.80	1.1967
3.00	1.1839
3.20	1.1765
3.40	1.1807
3.60	1.1831
3.80	1.1855
4.00	1.1870
4.20	1.1931
4.40	1.2027
4.60	1.2090
4.80	1.2143
5.00	1.2176
5.20	1.2185
5.40	1.2222
5.60	1.2386
5.80	1.2539
6.00	1.2655
6.20	1.2732
6.40	1.2788
6.60	1.2786
6.80	1.2783
7.00	1.2771
7.20	1.2712
7.40	1.2641
7.60	1.2526
7.80	1.2404
8.00	1.2270
8.20	1.2088
8.40	1.1924
8.60	1.1815
8.80	1.1823
9.00	1.1827
9.20	1.1822
9.40	1.1980
9.60	1.2510
9.80	1.2940
10.00	1.3320
10.20	1.3690
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 13

Figure 2.6.2.d

Summary of W(Z) Function at 20000 MWD/MTU
(Top and Bottom 15% Excluded per WCAP-10216)

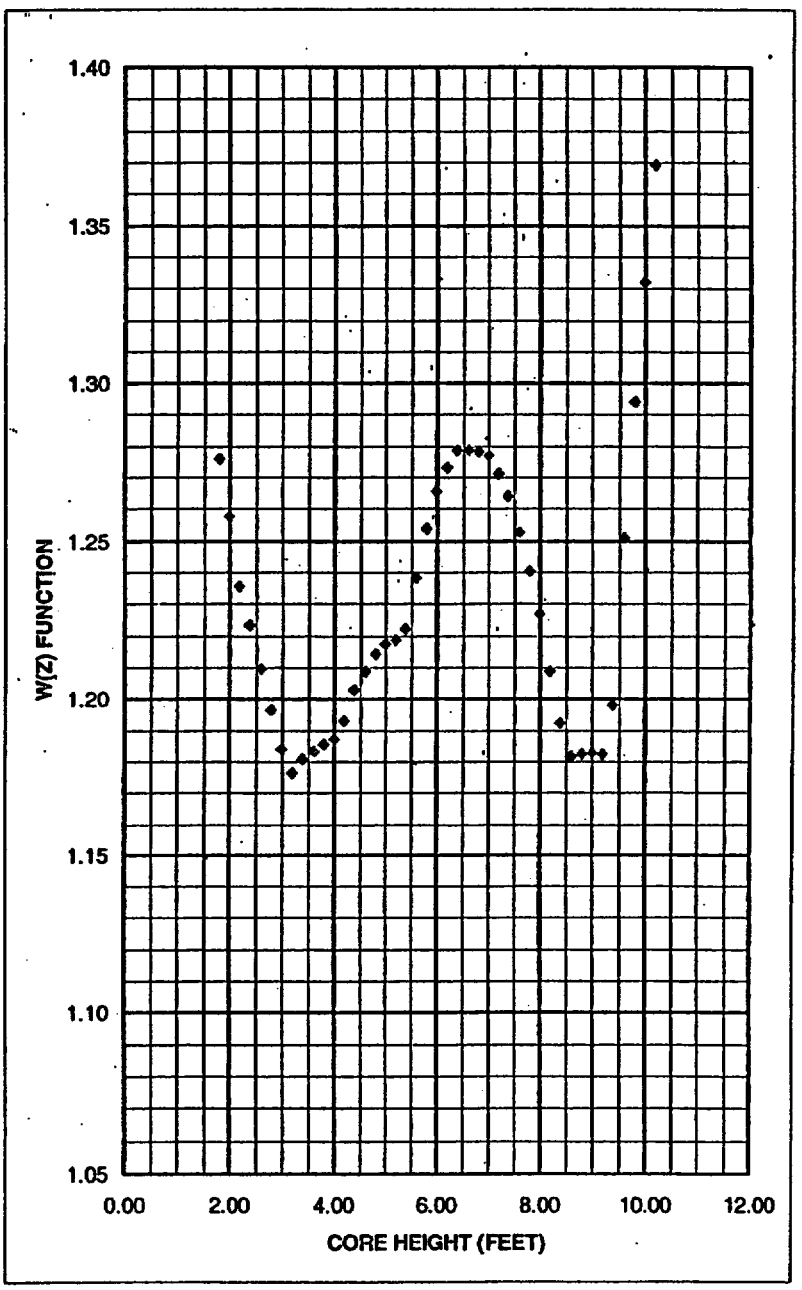


Table 2.6.2

Penalty Factors in Excess of 2% per 31 EFPD

Cycle Burnup (MWD/MTU)	Penalty Factor - $F^{C}_{Q}(z)$ (%)
1697	2.00
1869	2.05
2041	2.06
2213	2.00
14245	2.00
14417	2.01
14589	2.29
14761	2.21
14932	2.13
15104	2.05
15276	2.00

Notes:

Linear interpolation is adequate for intermediate cycle burnups.

All cycle burnups outside the range of the table shall use a 2% penalty factor for compliance with the 3.2.1.2 Surveillance Requirements.

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

2.7.1 $F^N_{\Delta H} = F^{RTP}_{\Delta H}[1.0 + PF_{\Delta H}(1.0 - P)]$

where: P = the ratio of THERMAL POWER to RATED THERMAL POWER
$F^{RTP}_{\Delta H} = 1.70$
$PF_{\Delta H} = 0.3$

2.7.2 Uncertainty when PDMS is inoperable

The uncertainty, $U_{F\Delta H}$, to be applied to the Nuclear Enthalpy Rise Hot Channel Factor $F_{\Delta H}{}^N$ shall be calculated by the following formula:

$U_{F\Delta H} = U_{F\Delta Hm}$

where:

$U_{F\Delta Hm}$ = Base $F^N_{\Delta H}$ measurement uncertainty = 1.04

2.7.3 PDMS Alarms:

$F^N_{\Delta H}$ Warning Setpoint ≥ 2% of $F^N_{\Delta H}$ Margin
$F^N_{\Delta H}$ Alarm Setpoint ≥ 0% of $F^N_{\Delta H}$ Margin

2.8 Axial Flux Difference (AFD) (LCO 3.2.3)

2.8.1 When PDMS is Inoperable, the AXIAL FLUX DIFFERENCE (AFD) Acceptable Operation Limits are provided in Figure 2.8.1 or the latest valid PDMS Surveillance Report, whichever is more conservative.

2.8.2 When PDMS is OPERABLE, no AFD Acceptable Operation Limits are applicable.

2.9 Departure from Nucleate Boiling Ratio (DNBR) (LCO 3.2.5)

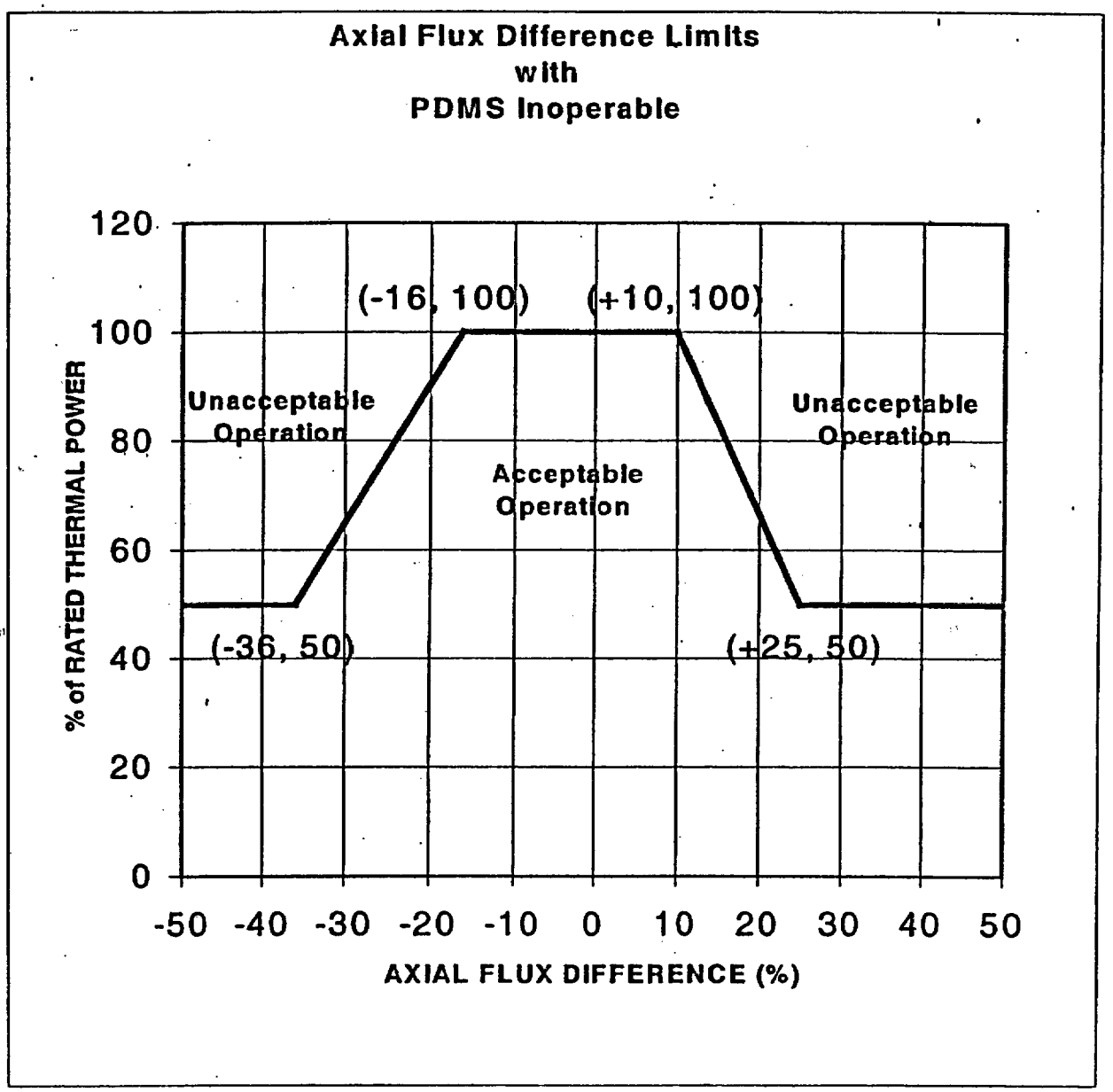
2.9.1 $DNBR_{APSL} \geq 1.536$

The Axial Power Shape Limiting DNBR ($DNBR_{APSL}$) is applicable with THERMAL POWER ≥ 50% RTP when PDMS is OPERABLE.

2.9.2 PDMS Alarms:

DNBR Warning Setpoint ≥ 2% of DNBR Margin
DNBR Alarm Setpoint ≥ 0% of DNBR Margin

Figure 2.8.1 Axial Flux Difference Limits as a Function of Rated Thermal Power



2.10 Reactor Trip System (RTS) Instrumentation (LCO 3.3.1) - Overtemperature ΔT Setpoint Parameter Values

2.10.1 The Overtemperature ΔT reactor trip setpoint K_1 shall be equal to 1.325.

2.10.2 The Overtemperature ΔT reactor trip setpoint T_{avg} coefficient K_2 shall be equal to 0.0297 / °F.

2.10.3 The Overtemperature ΔT reactor trip setpoint pressure coefficient K_3 shall be equal to 0.00181 / psi.

2.10.4 The nominal T_{avg} at RTP (indicated) T' shall be less than or equal to 588.0 °F.

2.10.5 The nominal RCS operating pressure (indicated) P' shall be equal to 2235 psig.

2.10.6 The measured reactor vessel ΔT lead/lag time constant τ_1 shall be equal to 8 sec.

2.10.7 The measured reactor vessel ΔT lead/lag time constant τ_2 shall be equal to 3 sec.

2.10.8 The measured reactor vessel ΔT lag time constant τ_3 shall be less than or equal to 2 sec.

2.10.9 The measured reactor vessel average temperature lead/lag time constant τ_4 shall be equal to 33 sec.

2.10.10 The measured reactor vessel average temperature lead/lag time constant τ_5 shall be equal to 4 sec.

2.10.11 The measured reactor vessel average temperature lag time constant τ_6 shall be less than or equal to 2 sec.

2.10.12 The $f_1(\Delta I)$ "positive" breakpoint shall be +10% ΔI.

2.10.13 The $f_1(\Delta I)$ "negative" breakpoint shall be -18% ΔI.

2.10.14 The $f_1(\Delta I)$ "positive" slope shall be +3.47% / % ΔI.

2.10.15 The $f_1(\Delta I)$ "negative" slope shall be -2.61% / % ΔI.

2.11 Reactor Trip System (RTS) Instrumentation (LCO 3.3.1) - Overpower ΔT Setpoint Parameter Values

2.11.1 The Overpower ΔT reactor trip setpoint K_4 shall be equal to 1.072.

2.11.2 The Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient K_5 shall be equal to 0.02 / °F for increasing T_{avg}.

2.11.3 The Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient K_5 shall be equal to 0 / °F for decreasing T_{avg}.

2.11.4 The Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient K_6 shall be equal to 0.00245 / °F when $T > T''$.

2.11.5 The Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient K_6 shall be equal to 0 / °F when $T \leq T''$.

2.11.6 The nominal T_{avg} at RTP (indicated) T'' shall be less than or equal to 588.0 °F

2.11.7 The measured reactor vessel ΔT lead/lag time constant τ_1 shall be equal to 8 sec.

2.11.8 The measured reactor vessel ΔT lead/lag time constant τ_2 shall be equal to 3 sec.

2.11.9 The measured reactor vessel ΔT lag time constant τ_3 shall be less than or equal to 2 sec.

2.11.10 The measured reactor vessel average temperature lag time constant τ_6 shall be less than or equal to 2 sec.

2.11.11 The measured reactor vessel average temperature rate/lag time constant τ_7 shall be equal to 10 sec.

2.11.12 The $f_2(\Delta I)$ "positive" breakpoint shall be 0 for all ΔI.

2.11.13 The $f_2(\Delta I)$ "negative" breakpoint shall be 0 for all ΔI.

2.11.14 The $f_2(\Delta I)$ "positive" slope shall be 0 for all ΔI.

2.11.15 The $f_2(\Delta I)$ "negative" slope shall be 0 for all ΔI.

2.12 Reactor Coolant System (RCS) Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits (LCO 3.4.1)

2.12.1 The pressurizer pressure shall be greater than or equal to 2209 psig.

2.12.2 The RCS average temperature (T_{avg}) shall be less than or equal to 593.1 °F.

2.12.3 The RCS total flow rate shall be greater than or equal to 386,000 gpm.

2.13 Boron Concentration

2.13.1 The refueling boron concentration shall be greater than or equal to 1812 ppm (LCO 3.9.1).

2.13.2 To maintain keff $\leq$ 0.987 with all shutdown and control rods fully withdrawn in MODES 3, 4, or 5 (TRM 3.1.g Required Action B.2 and TRM TLCO 3.1.k.2), the Reactor Coolant System boron concentration shall be greater than or equal to:

a. 1836 ppm prior to initial criticality.
b. 1999 ppm at all other times in core life.