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

Byron Station, Unit 2  
Facility Operating License No. NPF- 66  
NRC Docket No. STN 50-455

Subject:      Byron Station Unit 2 Cycle 14 Core Operating Limits Report

In accordance with Technical Specification 5.6.5, "Core Operating Limits Report (COLR)," we are submitting the Unit 2 Cycle 14 COLR. Please note an administrative change has been made to record keeping of revisions to the COLR. Instead of starting each cycle with revision 0, we will continue to use the next sequential number. This attached COLR is revision 1, which is the first COLR for Unit 2 cycle 14.

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

Respectfully,



David M Hoots  
Site Vice President  
Byron Nuclear Generating Station

Attachment:      Byron Station Unit 2 Cycle 14 COLR

DMH/JEL/rah

**ATTACHMENT**

**Byron Station Unit 2 Cycle 14 Core Operating Limits Report  
Revision 1**

CORE OPERATING LIMITS REPORT (COLR)

FOR

BYRON UNIT 2 CYCLE 14

EXELON TRACKING ID:

COLR BYRON 2 REVISION 1

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Byron Station Unit 2 Cycle 14 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 ( $F_{\Delta H}^N$ )
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 $keff \geq 1.0$
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 14

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 (SLs) (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.

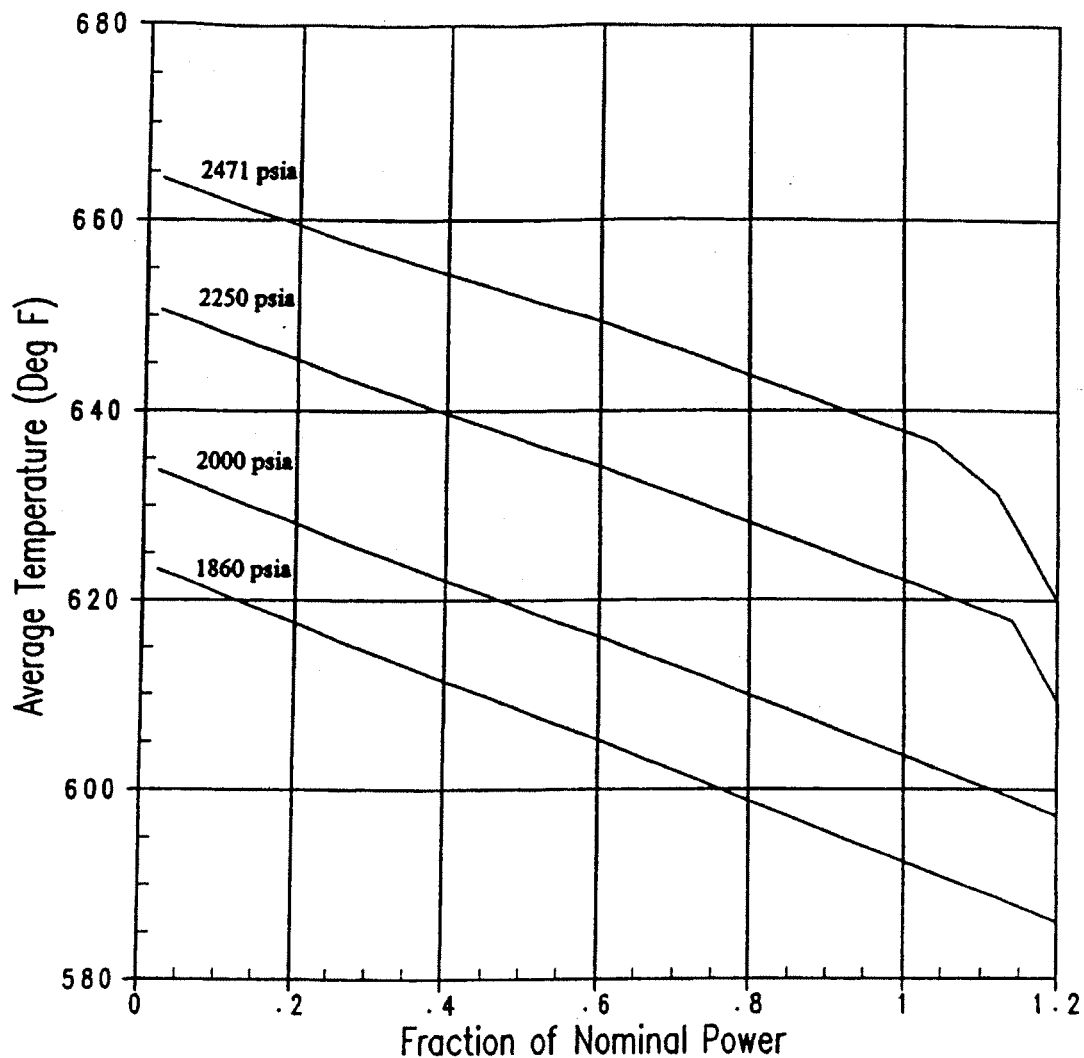


Figure 2.1.1: Reactor Core Limits

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

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 limit for MODE 5 is:

2.2.2 SDM shall be greater than or equal to 1.3%  $\Delta k/k$  (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  $+1.09 \times 10^{-5} \Delta k/k/^{\circ}F$ .

2.3.2 The EOL/ARO/HFP-MTC lower limit shall be  $-4.6 \times 10^{-4} \Delta k/k/^{\circ}F$ .

2.3.3 The EOL/ARO/HFP-MTC Surveillance limit at 300 ppm shall be  $-3.7 \times 10^{-4} \Delta k/k/^{\circ}F$ .

2.3.4 The EOL/ARO/HFP-MTC Surveillance limit at 60 ppm shall be  $-4.3 \times 10^{-4} \Delta k/k/^{\circ}F$ .

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

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.

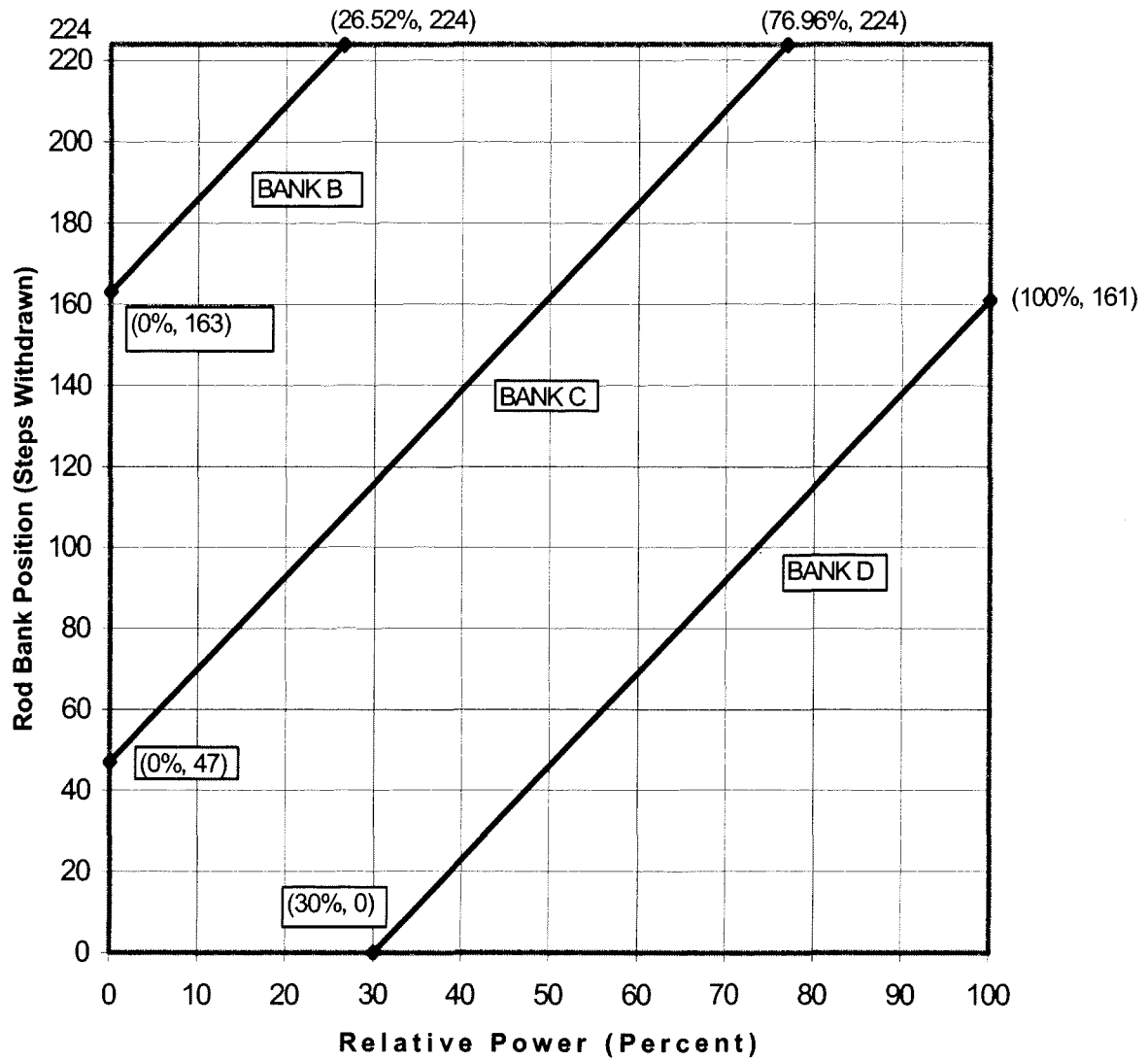
2.5.3 The control banks shall be operated in sequence by withdrawal of Bank A, Bank B, Bank C and Bank D. The control banks shall be sequenced in reverse order upon insertion.

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)
231	115

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

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



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

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

2.6.1 Total Peaking Factor:

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

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

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

$$F_Q^{RTP} = 2.60$$

$K(Z)$  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 Table 2.6.2.a.

The normal operation  $W(Z)$  values have been determined at burnups of 150, 6000, 14000, and 20000 MWD/MTU.

Table 2.6.2.b shows the  $F_Q^C(z)$  penalty factors that are greater than 2% per 31 Effective Full Power Days (EFPD). 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.b.

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

$$U_{FQ} = U_{qu} \bullet U_e$$

where:

$U_{qu}$  = Base  $F_Q$  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:

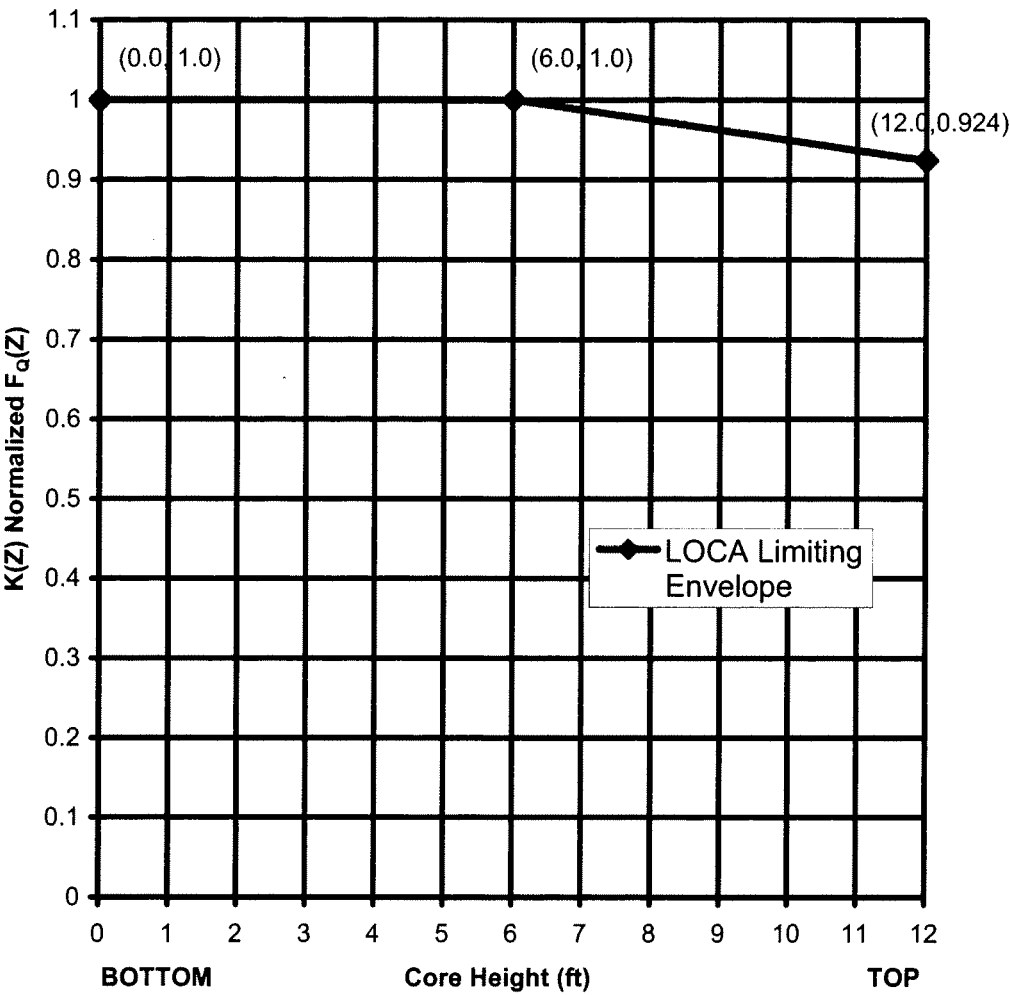
$F_Q(Z)$  Warning Setpoint  $\geq 2\%$  of  $F_Q(Z)$  Margin

$F_Q(Z)$  Alarm Setpoint  $\geq 0\%$  of  $F_Q(Z)$  Margin



CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

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



## CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

Table 2.6.2.a				
W(Z) versus Core Height				
(Top and Bottom 8% Excluded per WCAP-10216)				
Height (feet)	150 MWD/MTU	6000 MWD/MTU	14000 MWD/MTU	20000 MWD/MTU
0.00 (core bottom)	1.3365	1.4179	1.4291	1.3140
0.20	1.3208	1.3848	1.3995	1.2946
0.40	1.3102	1.3644	1.3871	1.2869
0.60	1.2977	1.3472	1.3690	1.2897
0.80	1.2813	1.3282	1.3520	1.2843
1.00	1.2765	1.3084	1.3308	1.2836
1.20	1.2722	1.3031	1.3236	1.2751
1.40	1.2798	1.2863	1.3103	1.2707
1.60	1.2641	1.2654	1.2915	1.2585
1.80	1.2499	1.2470	1.2723	1.2504
2.00	1.2346	1.2226	1.2551	1.2407
2.20	1.2172	1.1971	1.2353	1.2273
2.40	1.2013	1.1732	1.2243	1.2156
2.60	1.1829	1.1592	1.2117	1.2004
2.80	1.1659	1.1562	1.2039	1.1868
3.00	1.1511	1.1523	1.1956	1.1713
3.20	1.1487	1.1465	1.1844	1.1590
3.40	1.1461	1.1406	1.1756	1.1590
3.60	1.1421	1.1337	1.1658	1.1570
3.80	1.1385	1.1268	1.1607	1.1540
4.00	1.1338	1.1193	1.1552	1.1566
4.20	1.1295	1.1164	1.1484	1.1649
4.40	1.1293	1.1133	1.1423	1.1742
4.60	1.1285	1.1093	1.1350	1.1853
4.80	1.1271	1.1051	1.1358	1.1945
5.00	1.1245	1.1000	1.1374	1.2016
5.20	1.1218	1.0953	1.1404	1.2064
5.40	1.1174	1.0909	1.1406	1.2098
5.60	1.1126	1.0893	1.1429	1.2104
5.80	1.1104	1.0960	1.1585	1.2102
6.00	1.1270	1.1027	1.1722	1.2258
6.20	1.1426	1.1097	1.1848	1.2394
6.40	1.1565	1.1244	1.1945	1.2500
6.60	1.1702	1.1393	1.2002	1.2566
6.80	1.1831	1.1542	1.2060	1.2613
7.00	1.1943	1.1682	1.2098	1.2641
7.20	1.2045	1.1856	1.2107	1.2612
7.40	1.2139	1.1989	1.2105	1.2581
7.60	1.2214	1.2096	1.2065	1.2491
7.80	1.2291	1.2193	1.2025	1.2381
8.00	1.2349	1.2290	1.1965	1.2242
8.20	1.2381	1.2393	1.1856	1.2055
8.40	1.2423	1.2488	1.1777	1.1928
8.60	1.2436	1.2561	1.1772	1.1835
8.80	1.2449	1.2646	1.1754	1.1748
9.00	1.2455	1.2715	1.1737	1.1726
9.20	1.2435	1.2790	1.1687	1.1739
9.40	1.2382	1.2949	1.1711	1.1792
9.60	1.2252	1.3090	1.1755	1.2168
9.80	1.2278	1.3242	1.1820	1.2524
10.00	1.2338	1.3373	1.2090	1.2861
10.20	1.2360	1.3445	1.2350	1.3157
10.40	1.2403	1.3466	1.2527	1.3435
10.60	1.2500	1.3458	1.2725	1.3713
10.80	1.2670	1.3480	1.2893	1.3881
11.00	1.2780	1.3561	1.3021	1.4008
11.20	1.2513	1.3623	1.3060	1.4107
11.40	1.2543	1.3714	1.3088	1.4096
11.60	1.2586	1.3826	1.2997	1.3966
11.80	1.2638	1.3896	1.2897	1.3875
12.00 (core top)	1.2736	1.4038	1.2846	1.3834

**Note:** W(Z) values at 20000 MWD/MTU may be applied to cycle burnups greater than 20000 MWD/MTU to prevent W(Z) function extrapolation

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

<p><b>Table 2.6.2.b</b></p> <p><b>Penalty Factors in Excess of 2% per 31 EFPD</b></p>	
<b>Cycle Burnup (MWD/MTU)</b>	<b>Penalty Factor <math>F_{a(z)}^c</math></b>
323	1.0200
495	1.0212
668	1.0261
1186	1.0429
1358	1.0482
1531	1.0522
1704	1.0548
1876	1.0531
2049	1.0492
2222	1.0444
2740	1.0256
2912	1.0200
18105	1.0200
18277	1.0225
18450	1.0265
18623	1.0282
18795	1.0274
19141	1.0253
19313	1.0234
19659	1.0200

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.

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

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

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

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

2.7.2 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:

$$U_{F_{\Delta Hm}} = \text{Base } F_{\Delta H}^N \text{ measurement uncertainty} = 1.04$$

2.7.3 PDMS Alarms:

$$F_{\Delta H}^N \text{ Warning Setpoint} \geq 2\% \text{ of } F_{\Delta H}^N \text{ Margin}$$

$$F_{\Delta H}^N \text{ Alarm Setpoint} \geq 0\% \text{ of } F_{\Delta H}^N \text{ Margin}$$

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)

$$2.9.1 \quad DNBR_{APSL} \geq 1.536$$

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

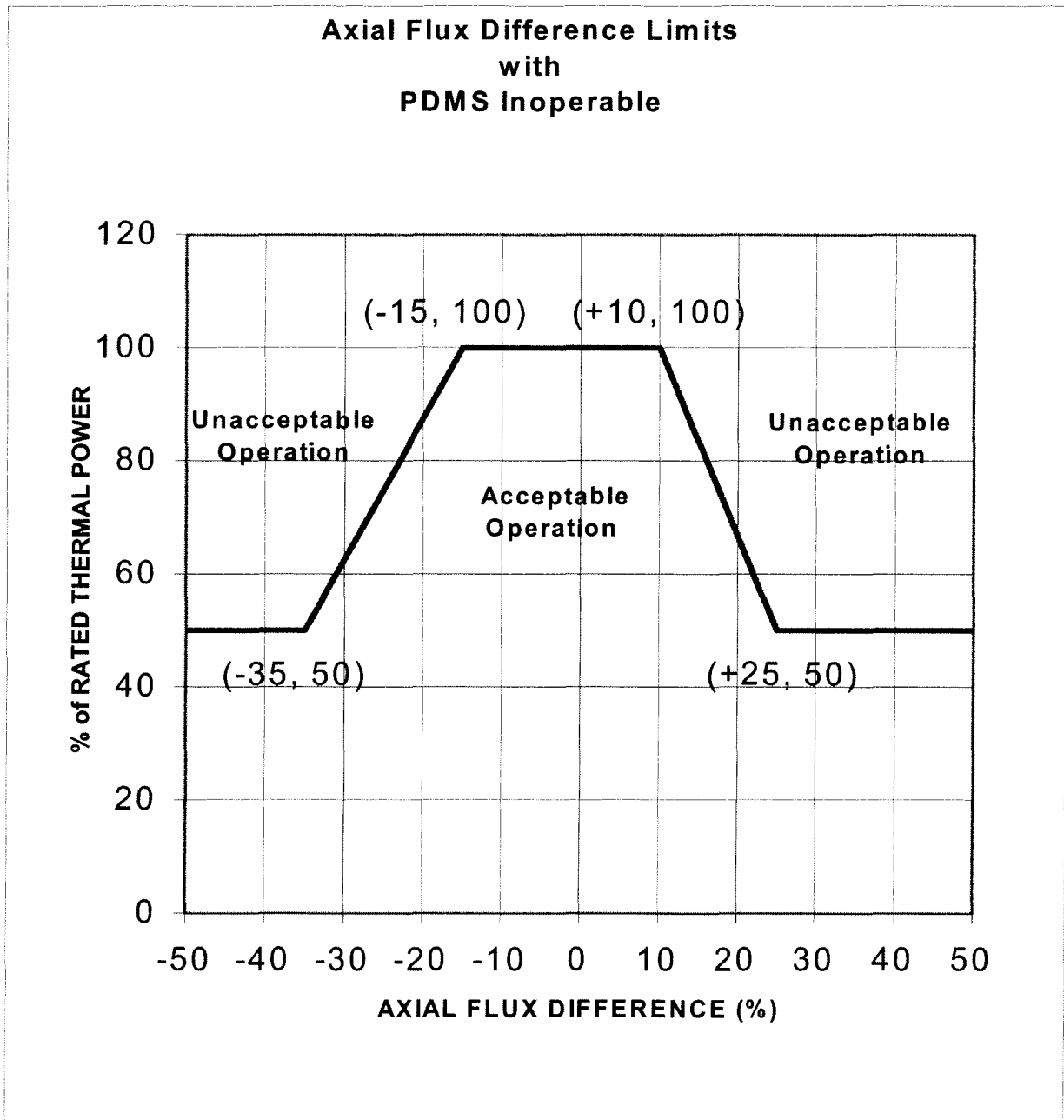
2.9.2 PDMS Alarms:

$$DNBR \text{ Warning Setpoint} \geq 2\% \text{ of DNBR Margin}$$

$$DNBR \text{ Alarm Setpoint} \geq 0\% \text{ of DNBR Margin}$$

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

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 14

2.10 Reactor Trip System (RTS) Instrumentation (LCO 3.3.1) - Overtemperature  $\Delta T$  Setpoint Parameter Values

- 2.10.1 The Overtemperature  $\Delta T$  reactor trip setpoint  $K_1$  shall be equal to 1.325.
- 2.10.2 The Overtemperature  $\Delta T$  reactor trip setpoint  $T_{avg}$  coefficient  $K_2$  shall be equal to 0.0297 / °F.
- 2.10.3 The Overtemperature  $\Delta T$  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  $\Delta T$  lead/lag time constant  $\tau_1$  shall be equal to 8 sec.
- 2.10.7 The measured reactor vessel  $\Delta T$  lead/lag time constant  $\tau_2$  shall be equal to 3 sec.
- 2.10.8 The measured reactor vessel  $\Delta T$  lag time constant  $\tau_3$  shall be less than or equal to 2 sec.
- 2.10.9 The measured reactor vessel average temperature lead/lag time constant  $\tau_4$  shall be equal to 33 sec.
- 2.10.10 The measured reactor vessel average temperature lead/lag time constant  $\tau_5$  shall be equal to 4 sec.
- 2.10.11 The measured reactor vessel average temperature lag time constant  $\tau_6$  shall be less than or equal to 2 sec.
- 2.10.12 The  $f_1 (\Delta I)$  "positive" breakpoint shall be +10%  $\Delta I$ .
- 2.10.13 The  $f_1 (\Delta I)$  "negative" breakpoint shall be -18%  $\Delta I$ .
- 2.10.14 The  $f_1 (\Delta I)$  "positive" slope shall be +3.47% / %  $\Delta I$ .
- 2.10.15 The  $f_1 (\Delta I)$  "negative" slope shall be -2.61% / %  $\Delta I$ .

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

- 2.11 Reactor Trip System (RTS) Instrumentation (LCO 3.3.1) - Overpower  $\Delta T$  Setpoint Parameter Values
- 2.11.1 The Overpower  $\Delta T$  reactor trip setpoint  $K_4$  shall be equal to 1.072.
  - 2.11.2 The Overpower  $\Delta T$  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  $\Delta T$  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  $\Delta T$  reactor trip setpoint  $T_{avg}$  heatup coefficient  $K_6$  shall be equal to 0.00245 / °F when  $T > T''$ .
  - 2.11.5 The Overpower  $\Delta T$  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  $\Delta T$  lead/lag time constant  $\tau_1$  shall be equal to 8 sec.
  - 2.11.8 The measured reactor vessel  $\Delta T$  lead/lag time constant  $\tau_2$  shall be equal to 3 sec.
  - 2.11.9 The measured reactor vessel  $\Delta T$  lag time constant  $\tau_3$  shall be less than or equal to 2 sec.
  - 2.11.10 The measured reactor vessel average temperature lag time constant  $\tau_6$  shall be less than or equal to 2 sec.
  - 2.11.11 The measured reactor vessel average temperature rate/lag time constant  $\tau_7$  shall be equal to 10 sec.
  - 2.11.12 The  $f_2(\Delta I)$  "positive" breakpoint shall be 0 for all  $\Delta I$ .
  - 2.11.13 The  $f_2(\Delta I)$  "negative" breakpoint shall be 0 for all  $\Delta I$ .
  - 2.11.14 The  $f_2(\Delta I)$  "positive" slope shall be 0 for all  $\Delta I$ .
  - 2.11.15 The  $f_2(\Delta I)$  "negative" slope shall be 0 for all  $\Delta I$ .

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 14

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 the value given in the Table below (LCO 3.9.1). The reported value also bounds the end-of-cycle requirements for the previous cycle.

2.13.2 To maintain  $k_{eff} \leq 0.987$  with all shutdown and control rods fully withdrawn in MODES 3, 4, or 5 (TRM TLCO 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 the values given in the Table below.

COLR Section	Conditions	Boron Concentration (ppm)
2.13.1	Refueling	1668
2.13.2	a) prior to initial criticality	1746
2.13.2	b) all other times in core life	1949