

CORE OPERATING LIMITS REPORT (COLR)

FOR

BYRON UNIT 2 CYCLE 24

CONSTELLATION TRACKING ID:

COLR BYRON 2 REVISION 14

CORE OPERATING LIMITS REPORT (COLR) for BYRON UNIT 2 CYCLE 24

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Byron Station Unit 2 Cycle 24 has been prepared in accordance with the requirements of Technical Specification 5.6.5 (ITS).

The Technical Specification Safety Limits and Limiting Conditions for Operation (LCOs) 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 (TRM) 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)    |

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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.

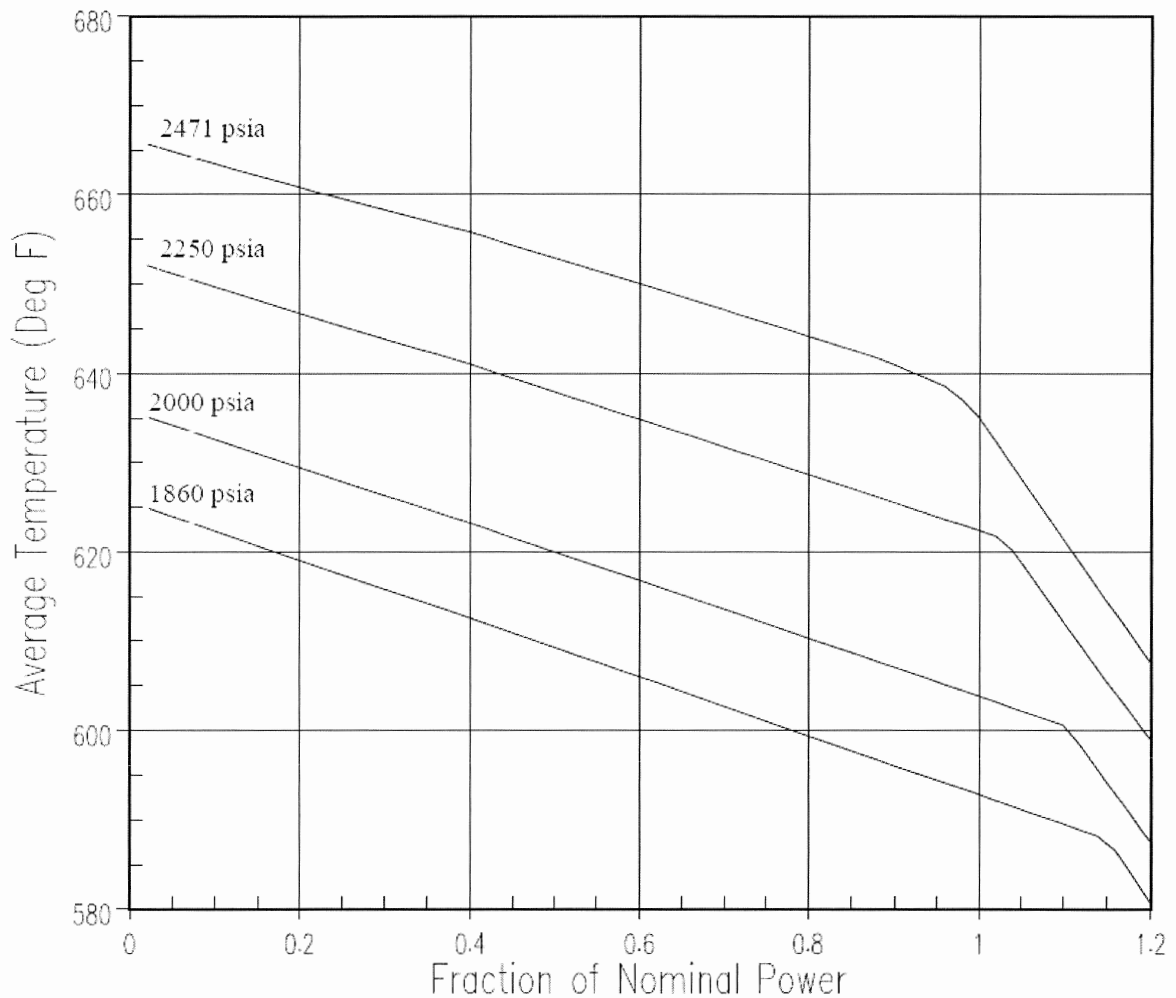


Figure 2.1.1: Reactor Core Limits

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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  $+2.275 \times 10^{-5} \Delta k/k/^{\circ}F$ .

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.

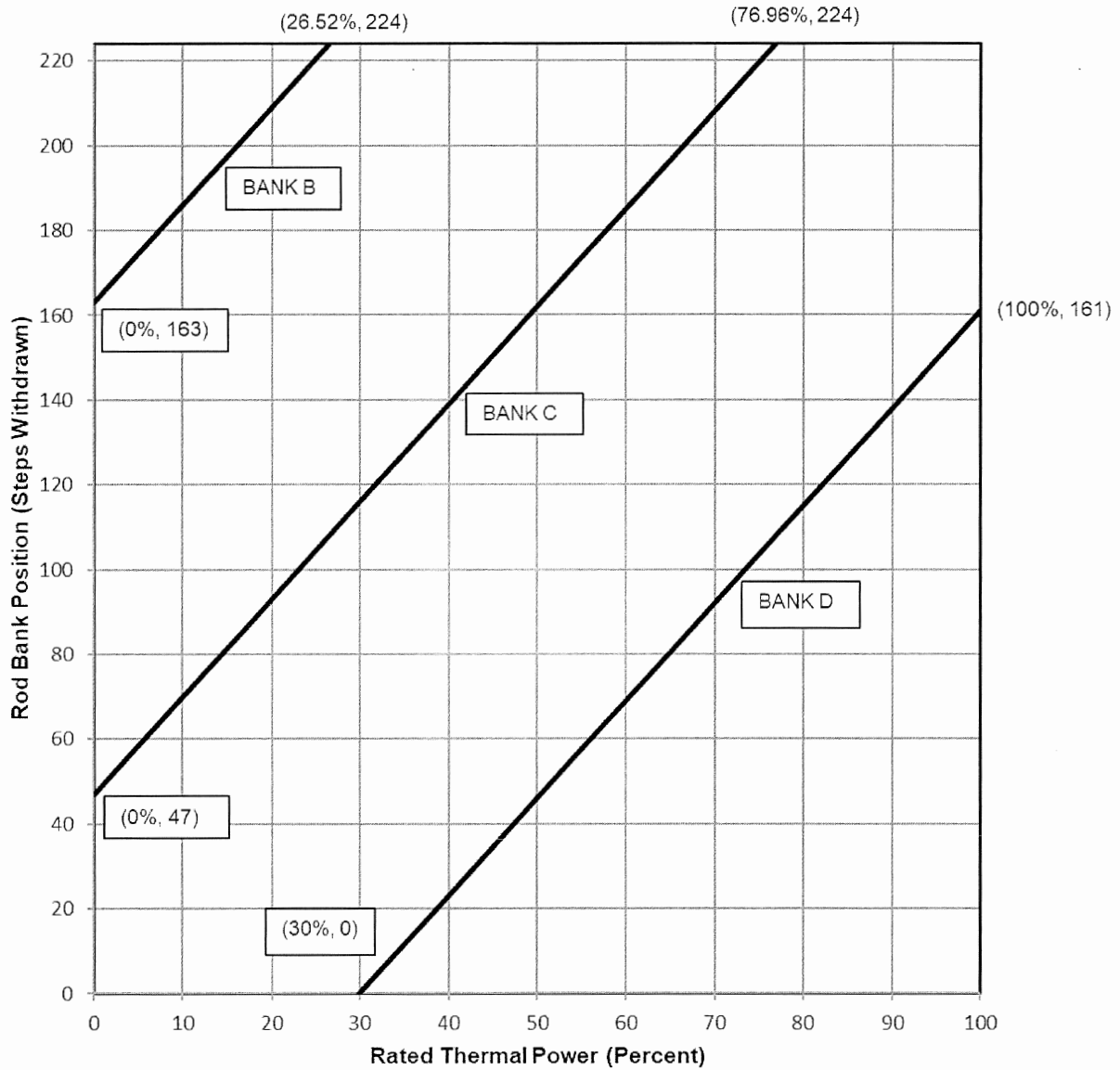
2.5.3 The control banks shall be operated in sequence by withdrawal of Bank A, Bank B, Bank C and Bank D. The control banks shall be sequenced in reverse order upon insertion.

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                  |

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



The bank position is given as follows:

**Control Bank D:  $(161/70) * (P-100) + 161$  (for  $30 \leq P \leq 100$ )**

Where P is defined as the core power (in percent).

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

2.6.1 Total Peaking Factor:

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

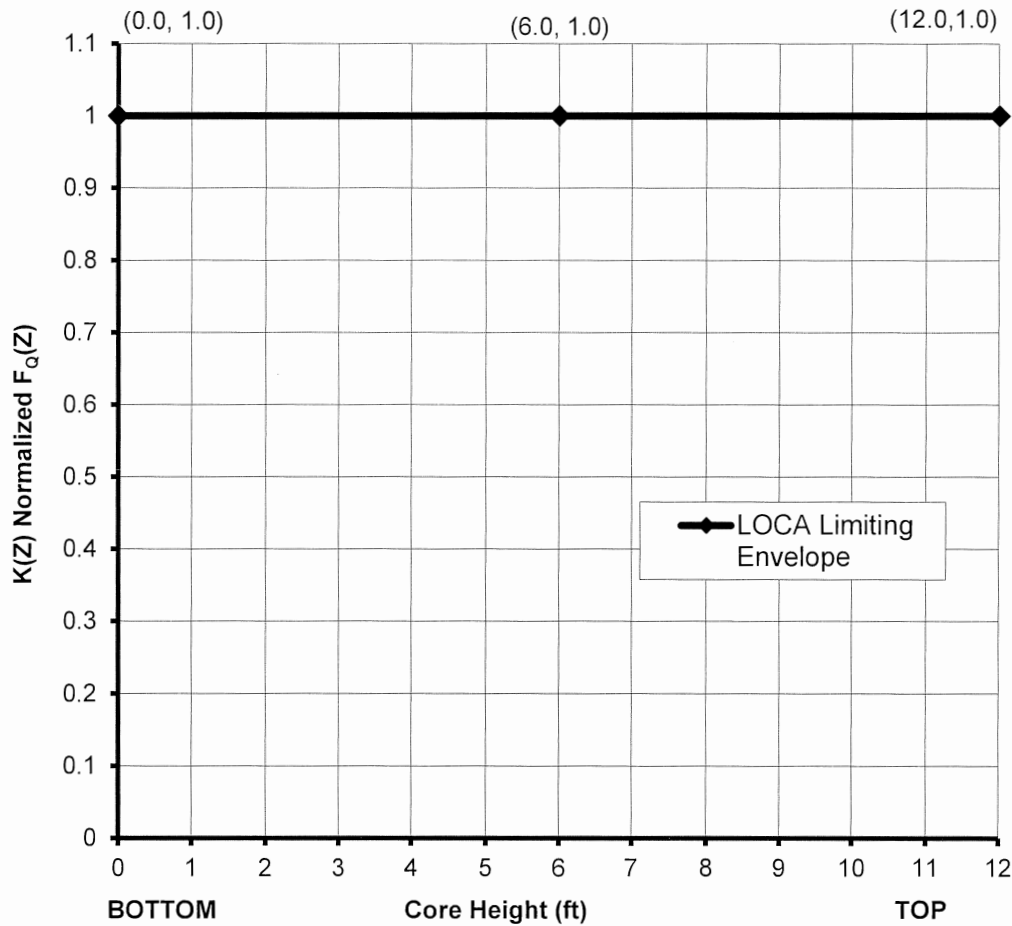
$$F_Q(Z) \leq \frac{F_Q^{RTP}}{P} \times K(Z) \text{ for } P > 0.5$$

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.

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



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2.6.2 W(Z) Values:

a) When the Power Distribution Monitoring System (PDMS) is OPERABLE,  $W(Z) = 1.00000$  for all axial points.

b) When PDMS is inoperable,  $W(Z)$  is provided as:

- 1) Table 2.6.2.a are the normal operation  $W(Z)$  values that correspond to the NORMAL AXIAL FLUX DIFFERENCE (AFD) Acceptable Operation Limits provided in Figure 2.8.1.a. The Normal AFD Acceptable Operation Limits may be invoked at any time and must be used with the corresponding  $W(Z)$  values.
- 2) Table 2.6.2.b are the Expanded normal operation  $W(Z)$  values that correspond to the EXPANDED AXIAL FLUX DIFFERENCE (AFD) Acceptable Operation Limits provided in Figure 2.8.1.b. The Expanded AFD Acceptable Operation Limits may be invoked at any time and must be used with the corresponding  $W(Z)$  values.

Table 2.6.2.c shows the  $F_Q^C(Z)$  penalty factors that are greater than 2% per the allowable surveillance frequency. 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.c.

Table 2.6.2.d contains the required operating space reduction values for THERMAL POWER and AXIAL FLUX DIFFERENCE (AFD) when  $F_Q^W(Z)$  is not within its limits. These values are used in conjunction with Technical Specification LCO 3.2.1 Required Actions B.1 and B.2.

2.6.3 Uncertainty:

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

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

where:

$U_{qu}$  = Base  $F_Q$  measurement uncertainty = 1.05 when PDMS is inoperable  
( $U_{qu}$  is defined by PDMS and cannot be less than 1.05 when OPERABLE.)  
 $U_e$  = Engineering uncertainty factor = 1.03

2.6.4 PDMS Alarms:

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

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| Table 2.6.2.a                                                                                                                                   |                |                 |                  |                  |
|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------------|------------------|------------------|
| W(Z) versus Core Height for Normal AFD Acceptable Operation Limits in Figure 2.8.1.a<br>(Top and Bottom 8% Excluded per Byron SR 3.2.1.2 Bases) |                |                 |                  |                  |
| Height<br>(feet)                                                                                                                                | 150<br>MWD/MTU | 4000<br>MWD/MTU | 14000<br>MWD/MTU | 20000<br>MWD/MTU |
| 0.00 (core bottom)                                                                                                                              | 1.2747         | 1.3654          | 1.2041           | 1.2007           |
| 0.20                                                                                                                                            | 1.2676         | 1.3542          | 1.1974           | 1.1925           |
| 0.40                                                                                                                                            | 1.2677         | 1.3499          | 1.2024           | 1.1942           |
| 0.60                                                                                                                                            | 1.2717         | 1.3495          | 1.2085           | 1.2016           |
| 0.80                                                                                                                                            | 1.2801         | 1.3523          | 1.2210           | 1.2156           |
| 1.00                                                                                                                                            | 1.2791         | 1.3449          | 1.2246           | 1.2203           |
| 1.20                                                                                                                                            | 1.2694         | 1.3298          | 1.2188           | 1.2145           |
| 1.40                                                                                                                                            | 1.2555         | 1.3106          | 1.2095           | 1.2049           |
| 1.60                                                                                                                                            | 1.2412         | 1.2902          | 1.2003           | 1.1957           |
| 1.80                                                                                                                                            | 1.2256         | 1.2682          | 1.1906           | 1.1860           |
| 2.00                                                                                                                                            | 1.2086         | 1.2447          | 1.1799           | 1.1752           |
| 2.20                                                                                                                                            | 1.1904         | 1.2203          | 1.1686           | 1.1637           |
| 2.40                                                                                                                                            | 1.1724         | 1.1956          | 1.1573           | 1.1520           |
| 2.60                                                                                                                                            | 1.1580         | 1.1711          | 1.1470           | 1.1403           |
| 2.80                                                                                                                                            | 1.1433         | 1.1510          | 1.1398           | 1.1279           |
| 3.00                                                                                                                                            | 1.1321         | 1.1395          | 1.1326           | 1.1190           |
| 3.20                                                                                                                                            | 1.1284         | 1.1339          | 1.1287           | 1.1200           |
| 3.40                                                                                                                                            | 1.1281         | 1.1297          | 1.1302           | 1.1310           |
| 3.60                                                                                                                                            | 1.1275         | 1.1288          | 1.1352           | 1.1411           |
| 3.80                                                                                                                                            | 1.1266         | 1.1286          | 1.1402           | 1.1507           |
| 4.00                                                                                                                                            | 1.1251         | 1.1279          | 1.1447           | 1.1598           |
| 4.20                                                                                                                                            | 1.1232         | 1.1267          | 1.1487           | 1.1684           |
| 4.40                                                                                                                                            | 1.1208         | 1.1250          | 1.1521           | 1.1771           |
| 4.60                                                                                                                                            | 1.1195         | 1.1227          | 1.1546           | 1.1848           |
| 4.80                                                                                                                                            | 1.1187         | 1.1198          | 1.1562           | 1.1909           |
| 5.00                                                                                                                                            | 1.1185         | 1.1163          | 1.1568           | 1.1959           |
| 5.20                                                                                                                                            | 1.1187         | 1.1121          | 1.1562           | 1.2005           |
| 5.40                                                                                                                                            | 1.1181         | 1.1075          | 1.1544           | 1.2043           |
| 5.60                                                                                                                                            | 1.1197         | 1.1058          | 1.1522           | 1.2063           |
| 5.80                                                                                                                                            | 1.1243         | 1.1081          | 1.1518           | 1.2114           |
| 6.00                                                                                                                                            | 1.1331         | 1.1132          | 1.1553           | 1.2218           |
| 6.20                                                                                                                                            | 1.1476         | 1.1199          | 1.1669           | 1.2336           |
| 6.40                                                                                                                                            | 1.1609         | 1.1250          | 1.1767           | 1.2430           |
| 6.60                                                                                                                                            | 1.1729         | 1.1292          | 1.1865           | 1.2514           |
| 6.80                                                                                                                                            | 1.1835         | 1.1325          | 1.1949           | 1.2576           |
| 7.00                                                                                                                                            | 1.1925         | 1.1382          | 1.2012           | 1.2609           |
| 7.20                                                                                                                                            | 1.1996         | 1.1473          | 1.2056           | 1.2616           |
| 7.40                                                                                                                                            | 1.2048         | 1.1558          | 1.2078           | 1.2596           |
| 7.60                                                                                                                                            | 1.2080         | 1.1631          | 1.2078           | 1.2547           |
| 7.80                                                                                                                                            | 1.2080         | 1.1672          | 1.2058           | 1.2474           |
| 8.00                                                                                                                                            | 1.2092         | 1.1741          | 1.2007           | 1.2365           |
| 8.20                                                                                                                                            | 1.2160         | 1.1866          | 1.1951           | 1.2248           |
| 8.40                                                                                                                                            | 1.2209         | 1.1979          | 1.1946           | 1.2182           |
| 8.60                                                                                                                                            | 1.2285         | 1.2124          | 1.1937           | 1.2149           |
| 8.80                                                                                                                                            | 1.2365         | 1.2293          | 1.1970           | 1.2196           |
| 9.00                                                                                                                                            | 1.2445         | 1.2510          | 1.2085           | 1.2340           |
| 9.20                                                                                                                                            | 1.2522         | 1.2764          | 1.2232           | 1.2443           |
| 9.40                                                                                                                                            | 1.2609         | 1.2963          | 1.2390           | 1.2501           |
| 9.60                                                                                                                                            | 1.2911         | 1.3167          | 1.2501           | 1.2547           |
| 9.80                                                                                                                                            | 1.3272         | 1.3314          | 1.2602           | 1.2625           |
| 10.00                                                                                                                                           | 1.3586         | 1.3488          | 1.2675           | 1.2752           |
| 10.20                                                                                                                                           | 1.3886         | 1.3796          | 1.2694           | 1.2900           |
| 10.40                                                                                                                                           | 1.4156         | 1.4099          | 1.2743           | 1.3018           |
| 10.60                                                                                                                                           | 1.4398         | 1.4374          | 1.2802           | 1.3114           |
| 10.80                                                                                                                                           | 1.4580         | 1.4608          | 1.2837           | 1.3171           |
| 11.00                                                                                                                                           | 1.4737         | 1.4803          | 1.2858           | 1.3216           |
| 11.20                                                                                                                                           | 1.4883         | 1.4967          | 1.2849           | 1.3230           |
| 11.40                                                                                                                                           | 1.4904         | 1.5047          | 1.2719           | 1.3092           |
| 11.60                                                                                                                                           | 1.4871         | 1.5053          | 1.2595           | 1.2913           |
| 11.80                                                                                                                                           | 1.4859         | 1.5109          | 1.2590           | 1.2790           |
| 12.00 (core top)                                                                                                                                | 1.4842         | 1.5185          | 1.2583           | 1.2615           |

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 24

| Table 2.6.2.b<br>W(Z) versus Core Height for Expanded AFD Acceptable Operation Limits in Figure 2.8.1.b<br>(Top and Bottom 8% Excluded per Byron SR 3.2.1.2 Bases) |                |                 |                  |                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------------|------------------|------------------|
| Height<br>(feet)                                                                                                                                                   | 150<br>MWD/MTU | 4000<br>MWD/MTU | 14000<br>MWD/MTU | 20000<br>MWD/MTU |
| 0.00 (core bottom)                                                                                                                                                 | 1.3754         | 1.5023          | 1.3159           | 1.3129           |
| 0.20                                                                                                                                                               | 1.3663         | 1.4886          | 1.3093           | 1.3029           |
| 0.40                                                                                                                                                               | 1.3659         | 1.4823          | 1.3114           | 1.3035           |
| 0.60                                                                                                                                                               | 1.3675         | 1.4804          | 1.3183           | 1.3102           |
| 0.80                                                                                                                                                               | 1.3748         | 1.4815          | 1.3306           | 1.3240           |
| 1.00                                                                                                                                                               | 1.3717         | 1.4714          | 1.3328           | 1.3274           |
| 1.20                                                                                                                                                               | 1.3594         | 1.4532          | 1.3250           | 1.3196           |
| 1.40                                                                                                                                                               | 1.3429         | 1.4304          | 1.3132           | 1.3076           |
| 1.60                                                                                                                                                               | 1.3265         | 1.4061          | 1.3010           | 1.2958           |
| 1.80                                                                                                                                                               | 1.3088         | 1.3798          | 1.2876           | 1.2831           |
| 2.00                                                                                                                                                               | 1.2894         | 1.3515          | 1.2728           | 1.2690           |
| 2.20                                                                                                                                                               | 1.2691         | 1.3221          | 1.2568           | 1.2538           |
| 2.40                                                                                                                                                               | 1.2483         | 1.2922          | 1.2403           | 1.2380           |
| 2.60                                                                                                                                                               | 1.2275         | 1.2624          | 1.2237           | 1.2218           |
| 2.80                                                                                                                                                               | 1.2091         | 1.2330          | 1.2054           | 1.2051           |
| 3.00                                                                                                                                                               | 1.1977         | 1.2059          | 1.1943           | 1.1892           |
| 3.20                                                                                                                                                               | 1.1917         | 1.1899          | 1.1911           | 1.1814           |
| 3.40                                                                                                                                                               | 1.1860         | 1.1879          | 1.1880           | 1.1812           |
| 3.60                                                                                                                                                               | 1.1805         | 1.1840          | 1.1845           | 1.1820           |
| 3.80                                                                                                                                                               | 1.1771         | 1.1790          | 1.1800           | 1.1858           |
| 4.00                                                                                                                                                               | 1.1741         | 1.1738          | 1.1766           | 1.1933           |
| 4.20                                                                                                                                                               | 1.1700         | 1.1686          | 1.1757           | 1.2013           |
| 4.40                                                                                                                                                               | 1.1654         | 1.1632          | 1.1753           | 1.2079           |
| 4.60                                                                                                                                                               | 1.1601         | 1.1570          | 1.1738           | 1.2130           |
| 4.80                                                                                                                                                               | 1.1540         | 1.1501          | 1.1712           | 1.2164           |
| 5.00                                                                                                                                                               | 1.1472         | 1.1424          | 1.1677           | 1.2181           |
| 5.20                                                                                                                                                               | 1.1396         | 1.1350          | 1.1642           | 1.2175           |
| 5.40                                                                                                                                                               | 1.1313         | 1.1277          | 1.1606           | 1.2150           |
| 5.60                                                                                                                                                               | 1.1230         | 1.1196          | 1.1551           | 1.2170           |
| 5.80                                                                                                                                                               | 1.1233         | 1.1122          | 1.1570           | 1.2252           |
| 6.00                                                                                                                                                               | 1.1336         | 1.1125          | 1.1687           | 1.2389           |
| 6.20                                                                                                                                                               | 1.1475         | 1.1201          | 1.1820           | 1.2520           |
| 6.40                                                                                                                                                               | 1.1607         | 1.1250          | 1.1929           | 1.2620           |
| 6.60                                                                                                                                                               | 1.1727         | 1.1290          | 1.2018           | 1.2692           |
| 6.80                                                                                                                                                               | 1.1832         | 1.1326          | 1.2086           | 1.2736           |
| 7.00                                                                                                                                                               | 1.1920         | 1.1385          | 1.2131           | 1.2749           |
| 7.20                                                                                                                                                               | 1.1990         | 1.1474          | 1.2151           | 1.2731           |
| 7.40                                                                                                                                                               | 1.2041         | 1.1555          | 1.2148           | 1.2682           |
| 7.60                                                                                                                                                               | 1.2073         | 1.1627          | 1.2122           | 1.2605           |
| 7.80                                                                                                                                                               | 1.2071         | 1.1668          | 1.2058           | 1.2483           |
| 8.00                                                                                                                                                               | 1.2083         | 1.1738          | 1.2020           | 1.2381           |
| 8.20                                                                                                                                                               | 1.2151         | 1.1863          | 1.2019           | 1.2326           |
| 8.40                                                                                                                                                               | 1.2200         | 1.1976          | 1.2013           | 1.2252           |
| 8.60                                                                                                                                                               | 1.2277         | 1.2121          | 1.2028           | 1.2255           |
| 8.80                                                                                                                                                               | 1.2360         | 1.2294          | 1.2106           | 1.2285           |
| 9.00                                                                                                                                                               | 1.2442         | 1.2515          | 1.2246           | 1.2303           |
| 9.20                                                                                                                                                               | 1.2521         | 1.2768          | 1.2397           | 1.2312           |
| 9.40                                                                                                                                                               | 1.2617         | 1.2967          | 1.2496           | 1.2308           |
| 9.60                                                                                                                                                               | 1.2919         | 1.3170          | 1.2595           | 1.2336           |
| 9.80                                                                                                                                                               | 1.3277         | 1.3317          | 1.2660           | 1.2476           |
| 10.00                                                                                                                                                              | 1.3589         | 1.3490          | 1.2697           | 1.2678           |
| 10.20                                                                                                                                                              | 1.3888         | 1.3795          | 1.2743           | 1.2846           |
| 10.40                                                                                                                                                              | 1.4155         | 1.4097          | 1.2781           | 1.2992           |
| 10.60                                                                                                                                                              | 1.4394         | 1.4370          | 1.2816           | 1.3113           |
| 10.80                                                                                                                                                              | 1.4574         | 1.4602          | 1.2880           | 1.3210           |
| 11.00                                                                                                                                                              | 1.4728         | 1.4795          | 1.2949           | 1.3256           |
| 11.20                                                                                                                                                              | 1.4872         | 1.4957          | 1.2959           | 1.3237           |
| 11.40                                                                                                                                                              | 1.4890         | 1.5035          | 1.2870           | 1.3117           |
| 11.60                                                                                                                                                              | 1.4855         | 1.5039          | 1.2730           | 1.2933           |
| 11.80                                                                                                                                                              | 1.4841         | 1.5093          | 1.2657           | 1.2861           |
| 12.00 (core top)                                                                                                                                                   | 1.4821         | 1.5165          | 1.2698           | 1.2757           |

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

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| Table 2.6.2.c<br>Penalty Factors in Excess of 2% |                              |
|--------------------------------------------------|------------------------------|
| Cycle Burnup<br>(MWD/MTU)                        | Penalty Factor<br>$F_Q^C(Z)$ |
| 0                                                | 1.0200                       |
| 150                                              | 1.0780                       |
| 371                                              | 1.0890                       |
| 592                                              | 1.0900                       |
| 842                                              | 1.0890                       |
| 1254                                             | 1.0770                       |
| 1695                                             | 1.0600                       |
| 1916                                             | 1.0500                       |
| 2137                                             | 1.0400                       |
| 2578                                             | 1.0200                       |
| 5448                                             | 1.0200                       |
| 6753                                             | 1.0540                       |
| 7215                                             | 1.0500                       |
| 7676                                             | 1.0370                       |
| 8319                                             | 1.0200                       |
| 8981                                             | 1.0200                       |
| 9202                                             | 1.0240                       |
| 9422                                             | 1.0230                       |
| 9643                                             | 1.0220                       |
| 9864                                             | 1.0200                       |

Notes:

Linear interpolation is adequate for intermediate cycle burnups.

All cycle burnups outside the range of Table 2.6.2.c shall use a 2% penalty factor for compliance with the 3.2.1.2 Surveillance Requirements.

| Table 2.6.2.d<br>Required Operating Space Reduction When $F_Q^W(Z)$ Exceeds Its Limits |                                    |                                        |                                        |
|----------------------------------------------------------------------------------------|------------------------------------|----------------------------------------|----------------------------------------|
| Required $F_Q^W(Z)$<br>Margin Improvement                                              | THERMAL POWER<br>Reduction (% RTP) | Negative AFD Band<br>Reduction (% AFD) | Positive AFD Band<br>Reduction (% AFD) |
| $\leq 1\%$                                                                             | $\geq 3\%$                         | $\geq 1\%$                             | $\geq 1\%$                             |
| $> 1\%$ AND $\leq 2\%$                                                                 | $\geq 6\%$                         | $\geq 2\%$                             | $\geq 2\%$                             |
| $> 2\%$ AND $\leq 3\%$                                                                 | $\geq 9\%$                         | $\geq 3\%$                             | $\geq 3\%$                             |
| $> 3\%$                                                                                | $\geq 50\%$                        | N/A                                    | N/A                                    |

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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 (RTP)

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

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

2.7.2 Uncertainty:

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:

$$U_{F_{\Delta H}} = U_{F_{\Delta H}m}$$

where:

$$U_{F_{\Delta H}m} = \text{Base } F_{\Delta H}^N \text{ measurement uncertainty} = 1.04 \text{ when PDMS is inoperable} \\ (U_{F_{\Delta H}m} \text{ is defined by PDMS and cannot be less than 1.04 when OPERABLE.)}$$

2.7.3 PDMS Alarms:

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

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

2.8 AXIAL FLUX DIFFERENCE (AFD) (LCO 3.2.3)

2.8.1 The AXIAL FLUX DIFFERENCE (AFD) Acceptable Operation Limits are provided in the Figures described below.

- a) Figure 2.8.1.a is the Normal AFD Acceptable Operation Limits associated with the W(Z) values in Table 2.6.2.a. These limits may be modified in accordance with Table 2.6.2.d if LCO 3.2.1 Required Actions B.1 and B.2 must be taken. Prior to changing to Figure 2.8.1.a, confirm that the plant is within the specified AFD envelope.
- b) Figure 2.8.1.b is the Expanded AFD Acceptable Operation Limits associated with the W(Z) values in Table 2.6.2.b. These limits may be modified in accordance with Table 2.6.2.d if LCO 3.2.1 Required Actions B.1 and B.2 must be taken.

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

$$2.9.1 \quad DNBR_{APSL} \geq 1.563$$

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

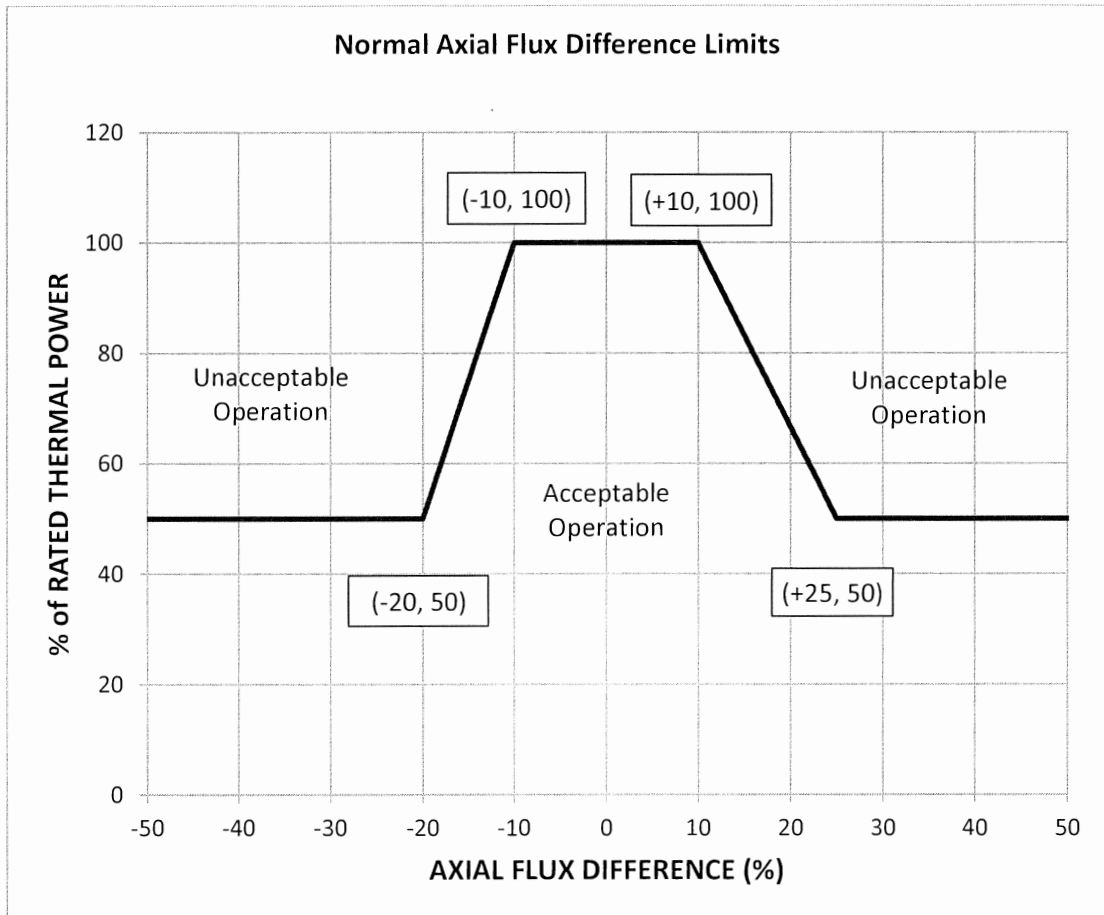
2.9.2 PDMS Alarms:

$$DNBR \text{ Warning Setpoint} = 2\% DNBR \text{ Margin}$$

$$DNBR \text{ Alarm Setpoint} = 0\% DNBR \text{ Margin}$$

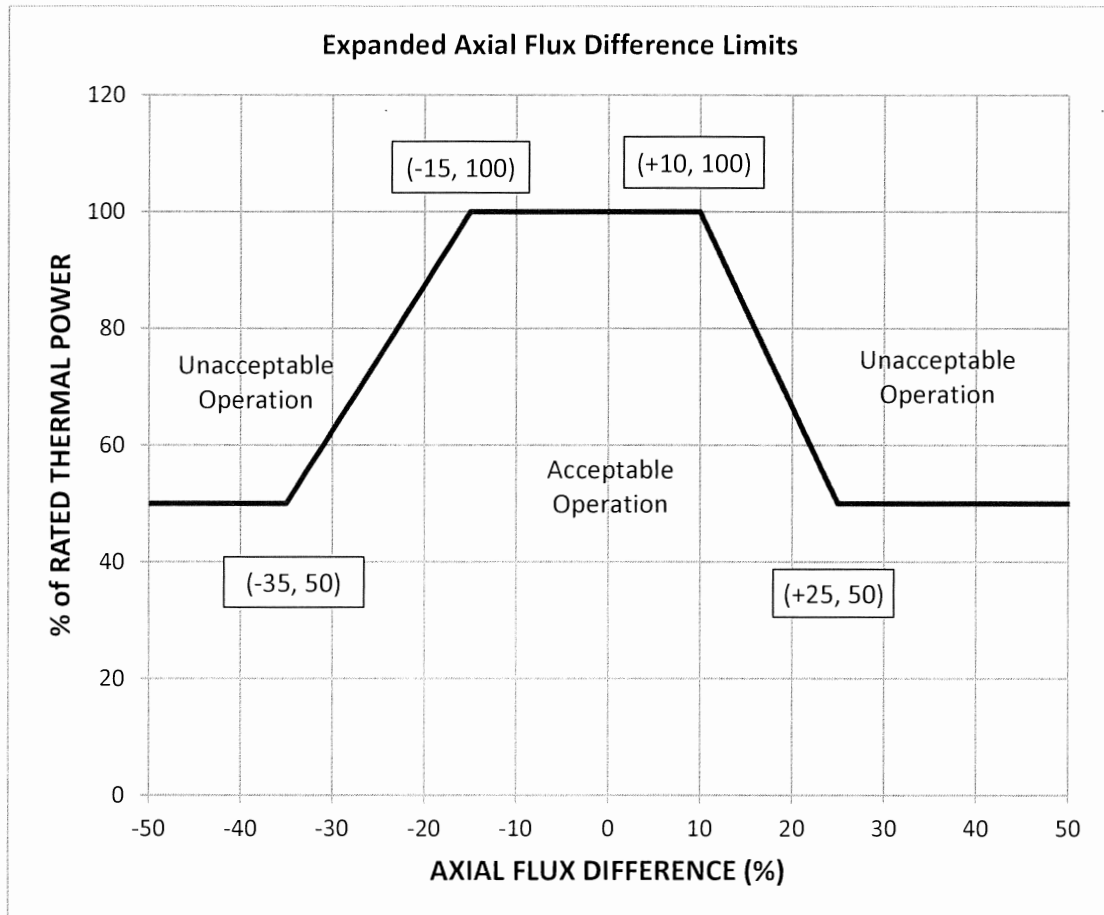
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**Figure 2.8.1.a:**  
**Normal Axial Flux Difference Limits**  
**as a Function of Rated Thermal Power**



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**Figure 2.8.1.b:**  
**Expanded Axial Flux Difference Limits**  
**as a Function of Rated Thermal Power**



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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 0.00135 / psi.
- 2.10.4 The nominal  $T_{avg}$  at RTP (indicated)  $T'$  shall be less than or equal to 583.5 °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% / %  $\Delta I$ .

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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 583.5 °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  $\Delta I$ .

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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 588.6 °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 applicable value given in the Table below (LCO 3.9.1). The reported "prior to initial criticality" value also bounds the end-of-cycle requirements for the previous cycle.

2.13.2 To maintain  $keff \leq 0.987$  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 applicable value given in the Table below.

| COLR Section | Conditions                                                  | Boron Concentration (ppm) |
|--------------|-------------------------------------------------------------|---------------------------|
| 2.13.1       | a) prior to initial criticality                             | 1748                      |
|              | b) for cycle burnups $\geq 0$ MWD/MTU and $< 16000$ MWD/MTU | 1880                      |
|              | c) for cycle burnups $\geq 16,000$ MWD/MTU                  | 1436                      |
| 2.13.2       | a) prior to initial criticality                             | 1826                      |
|              | b) for cycle burnups $\geq 0$ MWD/MTU and $< 16000$ MWD/MTU | 2090                      |
|              | c) for cycle burnups $\geq 16000$ MWD/MTU                   | 1561                      |