Ameren MISSOURI

Callaway Plant

January 26, 2018

ULNRC-06413

U.S. Nuclear Regulatory Commission
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Ladies and Gentlemen:

DOCKET NUMBER 50-483
CALLAWAY PLANT UNIT 1
UNION ELECTRIC CO.
RENEWED FACILITY OPERATING LICENSE NPF-30
CORE OPERATING LIMITS REPORT

Please find enclosed the Callaway Plant Cycle 23 Core Operating Limits Report (COLR). This report is provided to the NRC Staff for information. It has been prepared in accordance with the requirements of Technical Specification 5.6.5.

This letter does not contain new commitments. If you have any questions concerning this report, please contact Tom Elwood at 314-225-1905.

Sincerely,

Roger C. Wink,
Manager, Regulatory Affairs
PIN 6381

Enclosure: Callaway Cycle 23 Core Operating Limits Report

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Callaway Cycle 23
REDESIGN

Core Operating Limits Report
Revision 1

November 2017

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1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Callaway Plant Cycle 23 has been prepared in accordance with the requirements of Technical Specification 5.6.5.

The Core Operating Limits affecting the following Technical Specifications are included in this report.

3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.1.8	SHUTDOWN MARGIN (SDM)
3.1.3	Moderator Temperature Coefficient (MTC)
3.1.5	Shutdown Bank Insertion Limits
3.1.6	Control Bank Insertion Limits
3.2.1	Heat Flux Hot Channel Factor ($F_Q(z)$)
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor $F_{\Delta H}^N$
3.2.3	AXIAL FLUX DIFFERENCE (AFD)
2.1.1	Reactor Core SLs
3.3.1	Reactor Trip System (RTS) Instrumentation
3.4.1	RCS Pressure and Temperature Departure from Nucleate Boiling (DNB) Limits

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the subsections which follow. These limits have been developed using the NRC-approved methodologies specified in Technical Specification 5.6.5.

2.1 SHUTDOWN MARGIN (SDM)

(Specifications 3.1.1, 3.1.4, 3.1.5, 3.1.6, and 3.1.8)

2.1.1 The Shutdown Margin in MODES 1-4 shall be greater than or equal to 1.3% Δk/k.

2.1.2 The Shutdown Margin prior to blocking Safety Injection below P-11 in MODES 3 and 4 shall be greater than 0% Δk/k as calculated at 200°F.

2.1.3 The Shutdown Margin in MODE 5 shall be greater than or equal to 1.0% Δk/k.

2.2 Moderator Temperature Coefficient (MTC)

(Specification 3.1.3)

2.2.1 The Moderator Temperature Coefficient shall be less positive than the limits shown in Figure 1. These limits shall be referred to as the upper limit.

The Moderator Temperature Coefficient shall be less negative than -47.9 pcm/°F. This limit shall be referred to as the lower limit.

2.2.2 The MTC 300 ppm surveillance limit is -40.4 pcm/°F (all rods withdrawn, Rated Thermal Power condition).

2.2.3 The MTC 60 ppm surveillance limit is -45.5 pcm/°F (all rods withdrawn, Rated Thermal Power condition).

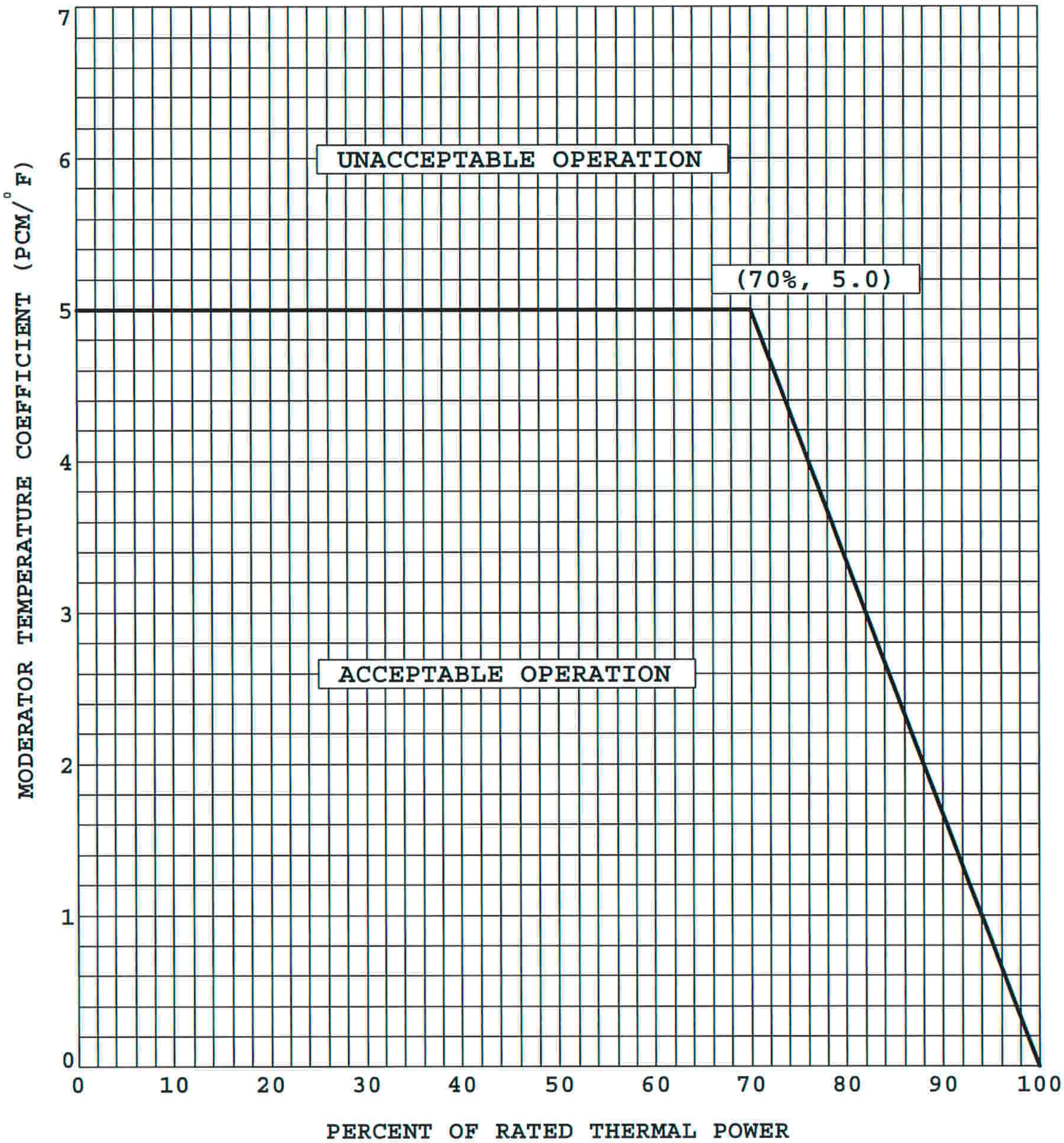

Figure 1

Callaway Cycle 23
Moderator Temperature Coefficient
Versus Power Level

2.3 Shutdown Bank Insertion Limits
(Specification 3.1.5)

The shutdown banks shall be withdrawn to at least 225 steps.

2.4 Control Bank Insertion Limits
(Specification 3.1.6)

2.4.1 Control Bank insertion limits are specified by Figure 2.

2.4.2 Control Bank withdrawal sequence is A-B-C-D. The insertion sequence is the reverse of the withdrawal sequence.

2.4.3 The difference between each sequential Control Bank position is 115 steps when not fully inserted and not fully withdrawn.

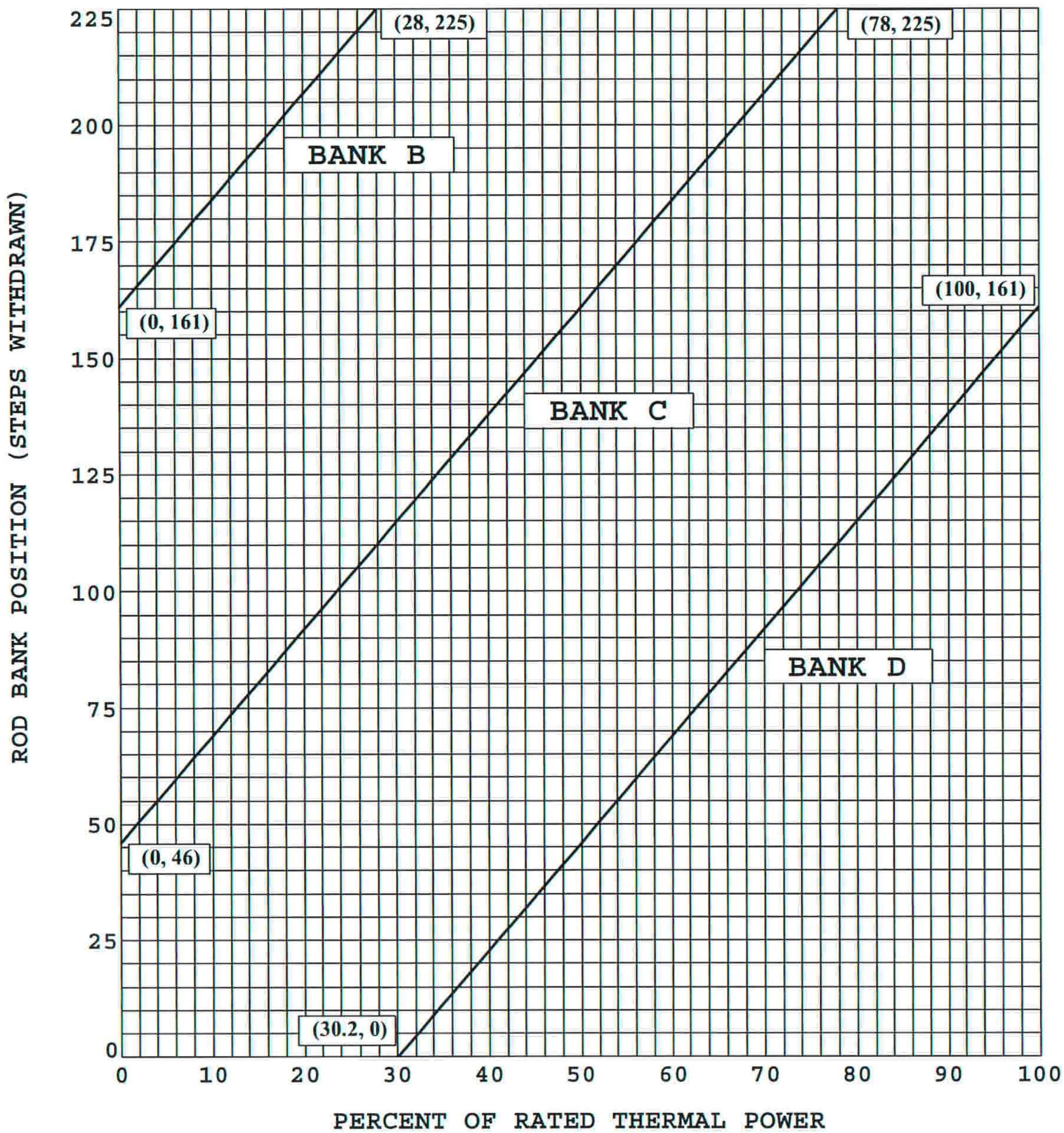

Figure 2

Callaway Cycle 23
Rod Bank Insertion Limits
Versus Rated Thermal Power - Four Loop Operation

2.5 Heat Flux Hot Channel Factor (FQ(z))
(Specification 3.2.1)

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

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

where: $P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$

2.5.1 $F_Q^{RTP} = 2.50$.

2.5.2 K(Z) is provided in Figure 3.

2.5.3 The W(z) functions that are to be used in Technical Specification 3.2.1 and Surveillance Requirement 3.2.1.2 for determining $F_Q^W(z)$ are shown in Table A.1a and A.1b.** The W(z) functions shown in Table A.1a are only applicable to Figure 4a. The W(z) functions shown in Table A.1b are only applicable to Figure 4b. The data in these tables should be used independently; cross interpolation or extrapolation between W(z) sets is prohibited.

The Axial Flux Difference (AFD) Band in Figure 4b is more restrictive than the AFD Band in Figure 4a. Prior to switching from Figure 4b to Figure 4a, $F_Q^W(z)$ must be confirmed to meet Technical Specification requirements by one of the following methods:

1. Confirm $F_Q^W(z)$ meets the Technical Specification Limit with the Table A.1a W(z) values for the most recent surveillance performed.
2. Perform a new surveillance and confirm $F_Q^W(z)$ meets the Technical Specification Limit with the Table A.1a W(z) values.

The W(z) values have been determined for several burnups up to 18000 MWD/MTU in Cycle 23. This permits determination of W(z) at any cycle burnup up to 18000 MWD/MTU through the use of three point interpolation. For cycle burnups greater than 18000 MWD/MTU, use of 18000 MWD/MTU W(z) values without extrapolation is conservative. The W(z) values were determined assuming Cycle 23 operates with RAOC strategy.

The W(z) values are provided for 73 axial points within the core height boundaries of 0 and 12.07 feet (hot core height) at equally spaced intervals.

The W(z) values are generated assuming that they will be used for a full power surveillance. When a part power surveillance is performed from beginning of cycle to 150 MWD/MTU and at 45% +/- 5% RTP, the W(z) values listed in Table A.2 should be used. When a part power surveillance is performed after 150 MWD/MTU, or at a power level other than the level specified above, the HFP W(z) values in Table A.1a or A.1b should be used.

W(z) values should be adjusted by the factor 1/P, when P is > 0.5. When P is ≤ 0.5, the W(z) values should be adjusted by the factor 1/(0.5), or 2.0. This is consistent with the adjustment in the $F_Q(z)$ limit at part power conditions.

Table A.3 shows the burnup dependent F_Q penalty factors for Cycle 23 that are applicable to both Figures 4a and 4b. These values shall be used to increase $F_Q^W(z)$ when required by Technical Specification Surveillance Requirement 3.2.1.2. A 2% penalty factor should be used at all cycle burnups that are outside the range of Table A.3.

** Refer to Table A.2 for W(z) values for evaluating the startup testing flux map at 150 MWD/MTU burnup and 45% +/- 5% RTP.

2.5.4 The uncertainty, U_{FQ}, to be applied to measured $F_Q(Z)$ shall be calculated by the following

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

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

Table A.1a
W(z) versus Core Height
for +10%/-15% RAOC Band
(Top and Bottom 8% Excluded)

Height (feet)	150 MWD/MTU	5000 MWD/MTU	10000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
0.00 (bottom)	1.0000	1.0000	1.0000	1.0000	1.0000
0.17	1.0000	1.0000	1.0000	1.0000	1.0000
0.34	1.0000	1.0000	1.0000	1.0000	1.0000
0.50	1.0000	1.0000	1.0000	1.0000	1.0000
0.67	1.0000	1.0000	1.0000	1.0000	1.0000
0.84	1.0000	1.0000	1.0000	1.0000	1.0000
1.01	1.4578	1.4959	1.3451	1.2980	1.3083
1.17	1.4428	1.4786	1.3337	1.2886	1.2983
1.34	1.4276	1.4601	1.3219	1.2793	1.2886
1.51	1.4112	1.4400	1.3089	1.2693	1.2782
1.68	1.3931	1.4181	1.2948	1.2583	1.2671
1.84	1.3734	1.3945	1.2797	1.2468	1.2556
2.01	1.3527	1.3698	1.2640	1.2351	1.2441
2.18	1.3316	1.3447	1.2479	1.2229	1.2321
2.35	1.3103	1.3192	1.2309	1.2095	1.2185
2.52	1.2891	1.2942	1.2141	1.1961	1.2047
2.68	1.2681	1.2689	1.1968	1.1828	1.1914
2.85	1.2457	1.2463	1.1834	1.1705	1.1777
3.02	1.2288	1.2286	1.1751	1.1664	1.1663
3.19	1.2209	1.2162	1.1699	1.1684	1.1633
3.35	1.2129	1.2079	1.1672	1.1699	1.1666
3.52	1.2082	1.1987	1.1639	1.1715	1.1747
3.69	1.2030	1.1914	1.1599	1.1729	1.1829
3.86	1.1972	1.1865	1.1598	1.1745	1.1908
4.02	1.1912	1.1817	1.1604	1.1766	1.1971
4.19	1.1849	1.1761	1.1595	1.1784	1.2016
4.36	1.1782	1.1703	1.1585	1.1795	1.2055
4.53	1.1708	1.1639	1.1569	1.1800	1.2086
4.70	1.1629	1.1571	1.1548	1.1798	1.2107
4.86	1.1548	1.1499	1.1521	1.1786	1.2115
5.03	1.1463	1.1423	1.1489	1.1773	1.2124
5.20	1.1371	1.1345	1.1450	1.1765	1.2132
5.37	1.1294	1.1256	1.1408	1.1745	1.2134
5.53	1.1276	1.1187	1.1353	1.1742	1.2150
5.70	1.1330	1.1174	1.1332	1.1782	1.2200
5.87	1.1413	1.1198	1.1396	1.1847	1.2290
6.04	1.1492	1.1234	1.1488	1.1930	1.2415
6.20	1.1562	1.1311	1.1573	1.2007	1.2525
6.37	1.1620	1.1387	1.1647	1.2072	1.2620
6.54	1.1687	1.1458	1.1727	1.2139	1.2699
6.71	1.1745	1.1532	1.1802	1.2196	1.2753
6.87	1.1795	1.1599	1.1884	1.2261	1.2788
7.04	1.1830	1.1654	1.1966	1.2316	1.2805

Table A.1a
W(z) versus Core Height
for +10%/-15% RAOC Band
(Top and Bottom 8% Excluded)

Height (feet)	150 MWD/MTU	5000 MWD/MTU	10000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
7.21	1.1854	1.1701	1.2039	1.2362	1.2806
7.38	1.1870	1.1739	1.2104	1.2394	1.2788
7.55	1.1862	1.1751	1.2137	1.2390	1.2722
7.71	1.1845	1.1754	1.2160	1.2374	1.2639
7.88	1.1814	1.1744	1.2173	1.2347	1.2540
8.05	1.1758	1.1713	1.2170	1.2305	1.2422
8.22	1.1705	1.1684	1.2156	1.2249	1.2274
8.38	1.1653	1.1659	1.2125	1.2175	1.2177
8.55	1.1595	1.1625	1.2082	1.2100	1.2059
8.72	1.1530	1.1588	1.2036	1.2044	1.1968
8.89	1.1467	1.1626	1.2042	1.1980	1.1969
9.05	1.1493	1.1663	1.2038	1.1930	1.1970
9.22	1.1608	1.1693	1.2055	1.1935	1.1967
9.39	1.1757	1.1764	1.2134	1.1965	1.2065
9.56	1.1951	1.1887	1.2241	1.2068	1.2251
9.73	1.2165	1.2017	1.2339	1.2154	1.2368
9.89	1.2370	1.2200	1.2436	1.2167	1.2423
10.06	1.2589	1.2461	1.2528	1.2295	1.2600
10.23	1.2789	1.2721	1.2617	1.2437	1.2813
10.40	1.2970	1.2954	1.2769	1.2527	1.2965
10.56	1.3154	1.3124	1.2933	1.2560	1.2998
10.73	1.3320	1.3289	1.3091	1.2590	1.3009
10.90	1.3376	1.3461	1.3207	1.2625	1.3059
11.07	1.3360	1.3602	1.3271	1.2654	1.3088
11.23	1.0000	1.0000	1.0000	1.0000	1.0000
11.40	1.0000	1.0000	1.0000	1.0000	1.0000
11.57	1.0000	1.0000	1.0000	1.0000	1.0000
11.74	1.0000	1.0000	1.0000	1.0000	1.0000
11.90	1.0000	1.0000	1.0000	1.0000	1.0000
12.07 (top)	1.0000	1.0000	1.0000	1.0000	1.0000

Table A.1b
W(z) versus Core Height
for +8%/-12% RAOC Band
(Top and Bottom 8% Excluded)

Height (feet)	150 MWD/MTU	5000 MWD/MTU	10000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
0.00 (bottom)	1.0000	1.0000	1.0000	1.0000	1.0000
0.17	1.0000	1.0000	1.0000	1.0000	1.0000
0.34	1.0000	1.0000	1.0000	1.0000	1.0000
0.50	1.0000	1.0000	1.0000	1.0000	1.0000
0.67	1.0000	1.0000	1.0000	1.0000	1.0000
0.84	1.0000	1.0000	1.0000	1.0000	1.0000
1.01	1.3857	1.4299	1.2939	1.2711	1.2825
1.17	1.3726	1.4139	1.2833	1.2621	1.2728
1.34	1.3594	1.3970	1.2724	1.2532	1.2633
1.51	1.3452	1.3786	1.2605	1.2436	1.2532
1.68	1.3294	1.3585	1.2474	1.2331	1.2423
1.84	1.3124	1.3369	1.2335	1.2221	1.2312
2.01	1.2945	1.3144	1.2192	1.2110	1.2201
2.18	1.2762	1.2916	1.2045	1.1995	1.2085
2.35	1.2579	1.2684	1.1890	1.1868	1.1953
2.52	1.2396	1.2452	1.1735	1.1740	1.1820
2.68	1.2214	1.2255	1.1588	1.1618	1.1690
2.85	1.2032	1.2069	1.1431	1.1491	1.1565
3.02	1.1909	1.1908	1.1335	1.1395	1.1438
3.19	1.1861	1.1818	1.1332	1.1378	1.1365
3.35	1.1806	1.1764	1.1322	1.1400	1.1380
3.52	1.1775	1.1703	1.1325	1.1418	1.1425
3.69	1.1742	1.1634	1.1350	1.1428	1.1509
3.86	1.1704	1.1585	1.1378	1.1485	1.1617
4.02	1.1663	1.1548	1.1396	1.1550	1.1712
4.19	1.1620	1.1509	1.1405	1.1595	1.1788
4.36	1.1573	1.1468	1.1411	1.1638	1.1858
4.53	1.1521	1.1423	1.1413	1.1675	1.1922
4.70	1.1464	1.1375	1.1411	1.1705	1.1977
4.86	1.1405	1.1324	1.1404	1.1726	1.2020
5.03	1.1344	1.1270	1.1391	1.1739	1.2051
5.20	1.1274	1.1210	1.1373	1.1744	1.2071
5.37	1.1257	1.1167	1.1350	1.1737	1.2080
5.53	1.1282	1.1160	1.1325	1.1737	1.2112
5.70	1.1327	1.1176	1.1327	1.1747	1.2180
5.87	1.1412	1.1194	1.1386	1.1768	1.2264
6.04	1.1490	1.1225	1.1473	1.1841	1.2369
6.20	1.1561	1.1310	1.1552	1.1900	1.2460
6.37	1.1621	1.1387	1.1621	1.1951	1.2537
6.54	1.1675	1.1457	1.1698	1.2002	1.2598
6.71	1.1720	1.1517	1.1763	1.2049	1.2635
6.87	1.1755	1.1569	1.1819	1.2105	1.2654
7.04	1.1774	1.1607	1.1863	1.2147	1.2656

Table A.1b
W(z) versus Core Height
for +8%/-12% RAOC Band
(Top and Bottom 8% Excluded)

Height (feet)	150 MWD/MTU	5000 MWD/MTU	10000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
7.21	1.1782	1.1636	1.1898	1.2181	1.2642
7.38	1.1780	1.1654	1.1921	1.2203	1.2610
7.55	1.1753	1.1646	1.1914	1.2191	1.2533
7.71	1.1717	1.1628	1.1896	1.2168	1.2439
7.88	1.1665	1.1595	1.1865	1.2135	1.2332
8.05	1.1593	1.1544	1.1816	1.2087	1.2196
8.22	1.1496	1.1472	1.1751	1.2026	1.2075
8.38	1.1464	1.1428	1.1696	1.1947	1.1982
8.55	1.1384	1.1346	1.1637	1.1862	1.1880
8.72	1.1305	1.1253	1.1580	1.1814	1.1773
8.89	1.1241	1.1306	1.1600	1.1765	1.1671
9.05	1.1233	1.1384	1.1643	1.1702	1.1636
9.22	1.1304	1.1446	1.1682	1.1655	1.1644
9.39	1.1452	1.1502	1.1704	1.1682	1.1734
9.56	1.1617	1.1688	1.1810	1.1803	1.1906
9.73	1.1767	1.1963	1.2001	1.1884	1.2019
9.89	1.1913	1.2203	1.2186	1.1899	1.2071
10.06	1.2066	1.2462	1.2351	1.2026	1.2247
10.23	1.2201	1.2723	1.2510	1.2167	1.2455
10.40	1.2319	1.2958	1.2674	1.2253	1.2603
10.56	1.2441	1.3129	1.2836	1.2275	1.2636
10.73	1.2545	1.3296	1.2998	1.2295	1.2649
10.90	1.2547	1.3469	1.3114	1.2326	1.2699
11.07	1.2481	1.3612	1.3181	1.2344	1.2729
11.23	1.0000	1.0000	1.0000	1.0000	1.0000
11.40	1.0000	1.0000	1.0000	1.0000	1.0000
11.57	1.0000	1.0000	1.0000	1.0000	1.0000
11.74	1.0000	1.0000	1.0000	1.0000	1.0000
11.90	1.0000	1.0000	1.0000	1.0000	1.0000
12.07 (top)	1.0000	1.0000	1.0000	1.0000	1.0000

Table A.2
W(z) versus Core Height for Partial Power Operation
(45% Power, 150 MWD/MTU, D-bank at 185 steps)
(Top and Bottom 8% Excluded)

*** The W(z)'s are not increased by the nominal power ratio. In order to be applicable, the W(z)'s must be adjusted for relative power per Section 2.5.3 at the time of the surveillance*

Height (feet)	W(z)**
0.00 (bottom)	1.0000
0.17	1.0000
0.34	1.0000
0.50	1.0000
0.67	1.0000
0.84	1.0000
1.01	1.6819
1.17	1.6469
1.34	1.6149
1.51	1.5847
1.68	1.5543
1.84	1.5227
2.01	1.4894
2.18	1.4556
2.35	1.4236
2.52	1.3925
2.68	1.3617
2.85	1.3296
3.02	1.3034
3.19	1.2867
3.35	1.2691
3.52	1.2552
3.69	1.2411
3.86	1.2261
4.02	1.2119
4.19	1.1988
4.36	1.1847
4.53	1.1698
4.70	1.1545
4.86	1.1391
5.03	1.1233
5.20	1.1065
5.37	1.0917
5.53	1.0829
5.70	1.0806
5.87	1.0822
6.04	1.0837

Table A.2
W(z) versus Core Height for Partial Power Operation
(45% Power, 150 MWD/MTU, D-bank at 185 steps)
(Top and Bottom 8% Excluded)

*** The W(z)'s are not increased by the nominal power ratio. In order to be applicable, the W(z)'s must be adjusted for relative power per Section 2.5.3 at the time of the surveillance*

Height (feet)	W(z)**
6.20	1.0837
6.37	1.0836
6.54	1.0854
6.71	1.0842
6.87	1.0818
7.04	1.0787
7.21	1.0778
7.38	1.0829
7.55	1.0779
7.71	1.0670
7.88	1.0590
8.05	1.0515
8.22	1.0468
8.38	1.0439
8.55	1.0396
8.72	1.0343
8.89	1.0282
9.05	1.0282
9.22	1.0355
9.39	1.0474
9.56	1.0637
9.73	1.0813
9.89	1.0983
10.06	1.1169
10.23	1.1326
10.40	1.1465
10.56	1.1616
10.73	1.1752
10.90	1.1775
11.07	1.1785
11.23	1.0000
11.40	1.0000
11.57	1.0000
11.74	1.0000
11.90	1.0000
12.07 (top)	1.0000

Table A.3

F_Q Penalty Factors as a Function of Cycle Burnup

Cycle 23 Burnup	$F_Q^W(z)$ Penalty Factor (%)
150	2.00
322	2.00
493	2.08
665	3.21
837	3.37
1008	3.04
1180	3.06
1352	2.57
1523	2.15
1695	2.00
5129	2.00
5300	2.27
5472	2.61
5644	2.62
5815	2.50
5987	2.38
6159	2.35
6330	2.37
6502	2.32
6674	2.25
6845	2.16
7017	2.06
7189	2.00

Note: All cycle burnups not in the range of the above table shall use a 2.0% penalty factor for compliance with Surveillance Requirement 3.2.1.2.

For values of burnup between two of those listed in the first column, the greater of the two corresponding penalty factors shall be used for compliance with Surveillance Requirement 3.2.1.2.

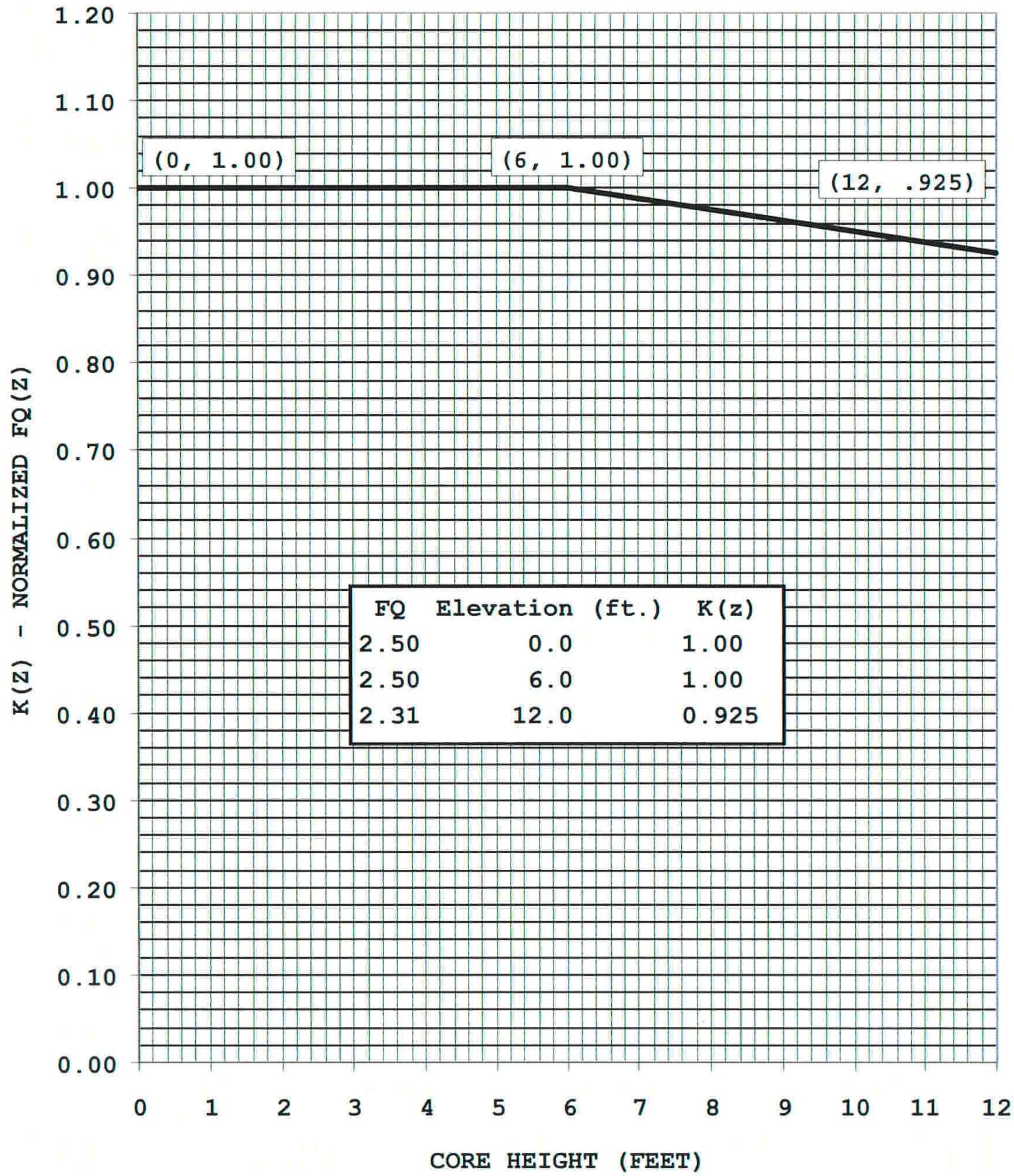

Figure 3

Callaway Cycle 23
K(z) - Normalized $F_Q(z)$
as a Function of Core Height

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

$$F_{\Delta H}^{N} * U_{\Delta H} \leq F_{\Delta H}^{RTP} [1 + PF_{\Delta H}(1-P)]$$

where: $$P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

2.6.1 $F_{\Delta H}^{RTP} = 1.65$

2.6.2 $PF_{\Delta H} = 0.3$

2.6.3 The uncertainty, $U_{\Delta H}$, to be applied to measured $F_{\Delta H}$ shall be 1.04 when PDMS is inoperable ($U_{\Delta H}$ is defined by PDMS when OPERABLE).

2.7 Axial Flux Difference
(Specification 3.2.3)

The Axial Flux Difference (AFD) Limits are provided in Figures 4a and 4b.

Prior to switching to the more restrictive AFD band (Figure 4b), it should be confirmed that the plant is within the specified AFD band.

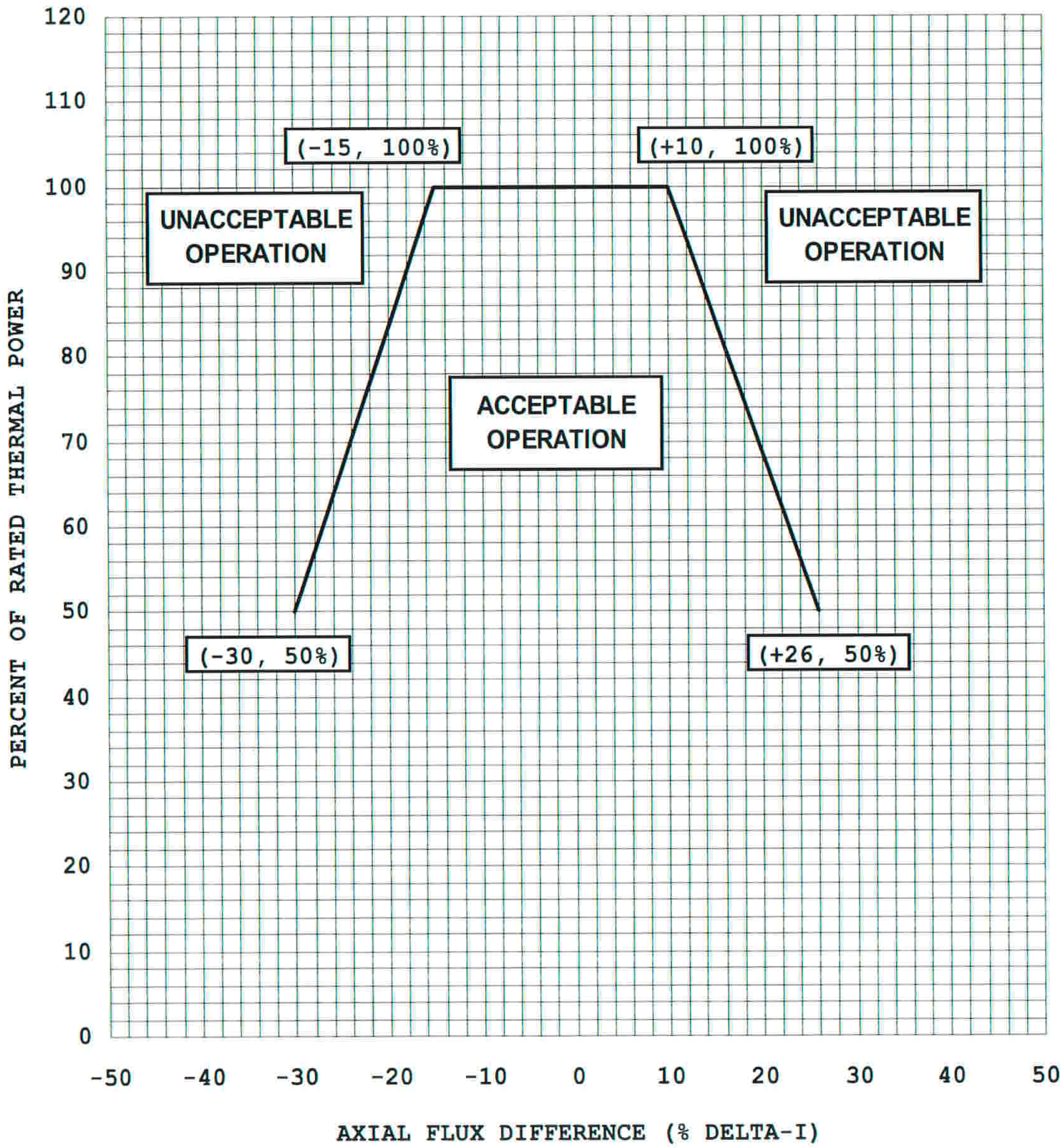

Figure 4a

Callaway Cycle 23
Axial Flux Difference Limits as a Function of Rated Thermal Power for RAOC Band +10/-15%

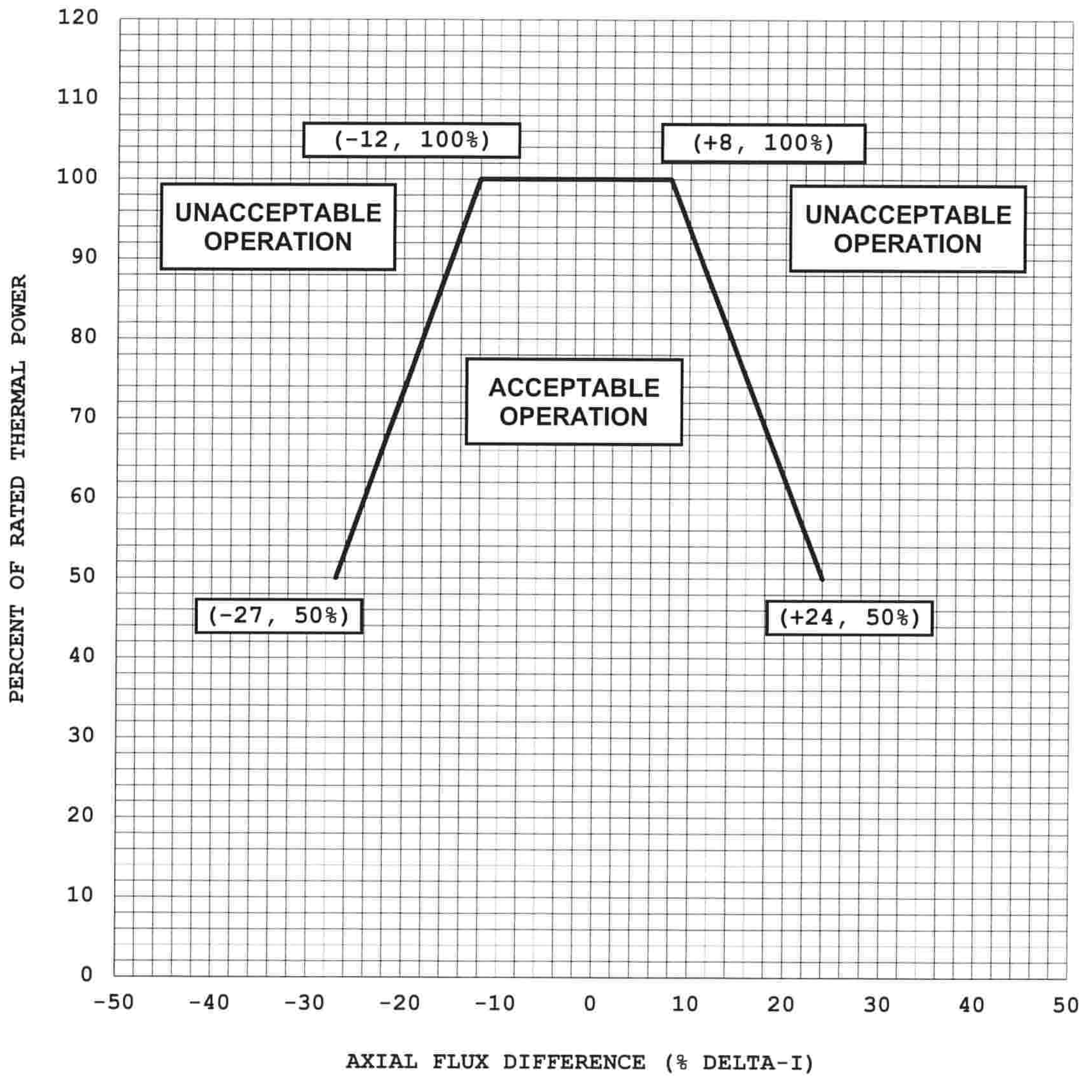

Figure 4b

Callaway Cycle 23
Alternate Axial Flux Difference Limits as a Function of Rated Thermal Power for RAOC Band +8/-12%

2.8 Reactor Core SLs
(Safety Limit 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 in Figure 5.

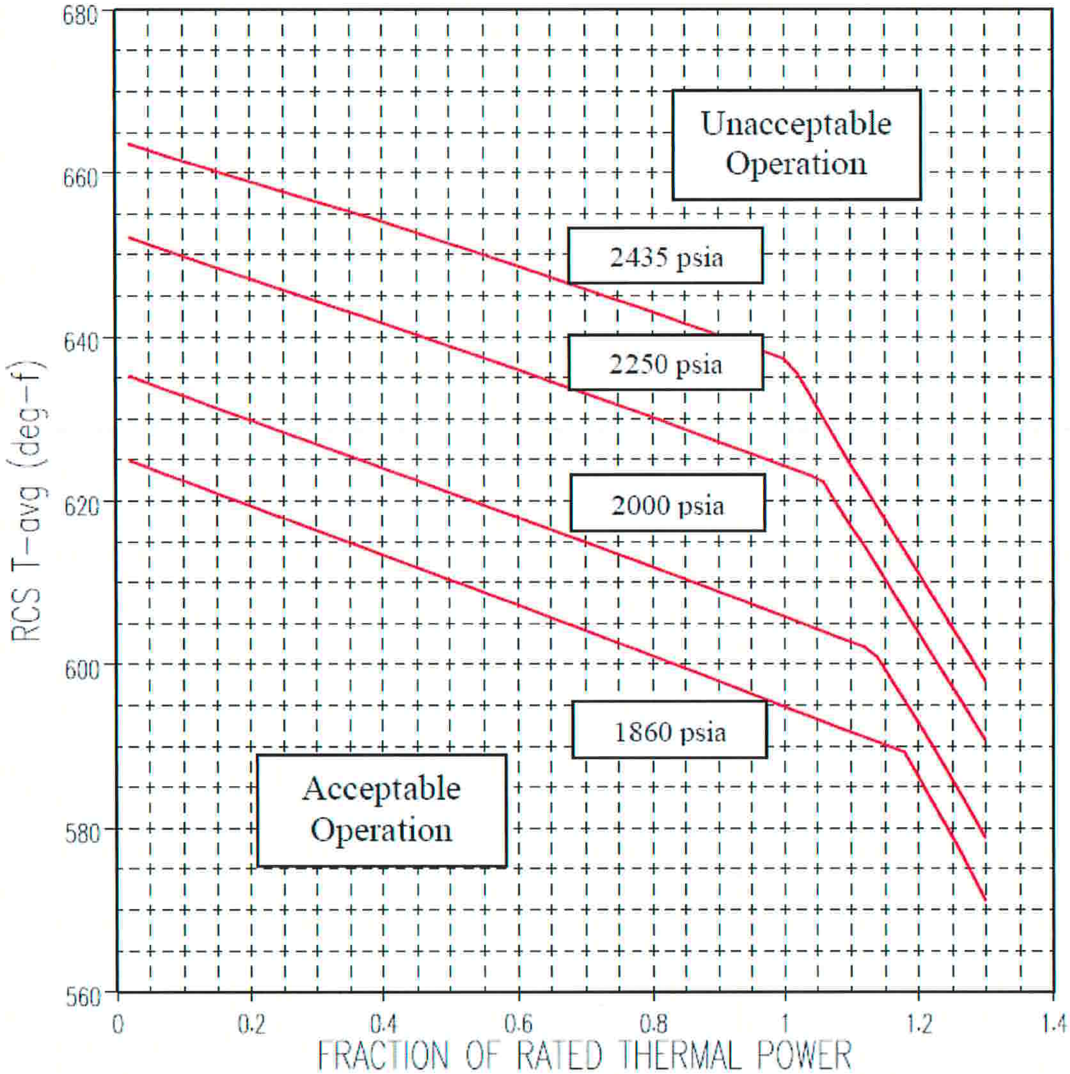

Figure 5

Callaway Cycle 23
Reactor Core Safety Limits

2.9 Reactor Trip System (RTS) Instrumentation
(Specification 3.3.1)

Parameter	Value
Overtemperature ΔT reactor trip setpoint	$K_1 = 1.2260$
Overtemperature ΔT reactor trip setpoint T_{avg} coefficient	$K_2 = 0.019/°F$
Overtemperature ΔT reactor trip setpoint pressure coefficient	$K_3 = 0.0011/psig$
Nominal T_{avg} at RTP	$T' \leq 585.3$ °F
Nominal RCS operating pressure	P' = 2235 psig
Measured RCS ΔT lead/lag time constants	$\tau_1 \geq 0$ sec $\tau_2 \leq 0$ sec
Measured RCS ΔT lag time constant	$\tau_3 \leq 4$ sec
Measured RCS average temperature lead/lag time constants	$t_4 \geq 27$ sec $t_5 \leq 4$ sec
Measured RCS average temperature lag time constant	$\tau_6 \leq 2$ sec

$f_1(\Delta I) = -0.0280\ \{18\% + (q_t - q_b)\}$	when $(q_t - q_b) < -18\%$ RTP
0	when -18% RTP $\leq (q_t - q_b) \leq 10\%$ RTP
$0.0224\ \{(q_t - q_b) - 10\%\}$	when $(q_t - q_b) > 10\%$ RTP

Where, q_t and q_b are percent RTP in the upper and lower halves of the core, respectively, and $q_t + q_b$ is the total THERMAL POWER in percent RTP.

2.10 Reactor Trip System (RTS) Instrumentation
(Specification 3.3.1)

Parameter	Value
Overpower ΔT reactor trip setpoint	$K_4 = 1.1073$
Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient	$K_5 = 0.02/°F$ for increasing T_{avg} $= 0/°F$ for decreasing T_{avg}
Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient	$K_6 = 0.0015/°F$ for $T > T''$ $= 0/°F$ for $T \leq T''$
Nominal T_{avg} at RTP	$T'' \leq 585.3°F$
Measured RCS ΔT lead/lag time constants	$\tau_1 \geq 0$ sec $\tau_2 \leq 0$ sec
Measured RCS ΔT lag time constant	$\tau_3 \leq 4$ sec
Measured RCS average temperature lag time constant	$\tau_6 \leq 2$ sec
Measured RCS average temperature rate/lag time constant	$\tau_7 \geq 10$ sec

$f_2(\Delta I) = 0$ for all ΔI.

2.11 RCS Pressure and Temperature Departure from Nucleate Boiling (DNB) Limits
(Specification 3.4.1)

Parameter	Indicated Value
Pressurizer pressure	≥ 2195 psig
RCS average temperature	≤ 590.1 °F

APPENDIX A

Approved Analytical Methods for Determining Core Operating Limits

The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.

   NRC letter dated May 28, 1985, "Acceptance for Referencing of Licensing Topical Report WCAP-9272(P)/9273(NP), 'Westinghouse Reload Safety Evaluation Methodology.'"

2. WCAP-10216-P-A, Revision 1A, "Relaxation of Constant Axial Offset Control - F_Q Surveillance Technical Specification," February 1994.

   NRC Safety Evaluation Report dated November 26, 1993, "Acceptance for Referencing of Revised Version of Licensing Topical Report WCAP-10216-P, Rev. 1, Relaxation of Constant Axial Offset Control - F_Q Surveillance Technical Specification" (TAC No. M88206).

3. WCAP-10266-P-A, Revision 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code," March 1987.

   NRC letter dated November 13, 1986, "Acceptance for Referencing of Licensing Topical Report WCAP-10266 'The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code."

   WCAP-10266-P-A, Addendum 1, Revision 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code Addendum 1: Power Shape Sensitivity Studies," December 1987.

   NRC letter dated September 15, 1987, "Acceptance for Referencing of Addendum 1 to WCAP-10266, BASH Power Shape Sensitivity Studies."

   WCAP-10266-P-A, Addendum 2, Revision 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code Addendum 2: BASH Methodology Improvements and Reliability Enhancements," May 1988.

   NRC letter dated January 20, 1988, "Acceptance for Referencing Topical Report Addendum 2 to WCAP-10266, Revision 2, 'BASH Methodology Improvements and Reliability Enhancements.'"

   WCAP-10266-P-A, Addendum 3, Revision 0, "Incorporation of the LOCBART Transient Extension Method into the 1981 Westinghouse Large Break LOCA Evaluation Model with BASH (BASH-EM)," December 2002 (cited as Reference 4.5 in the NRC Safety Evaluation for Callaway License Amendment 168).

4. WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995.

   NRC Safety Evaluation Reports dated July 1, 1991, "Acceptance for Referencing of Topical Report WCAP-12610, 'VANTAGE+ Fuel Assembly Reference Core Report' (TAC NO. 77258)."

   NRC Safety Evaluation Report dated September 15, 1994, "Acceptance for Referencing of Topical Report WCAP-12610, Appendix B, Addendum 1, 'Extended Burnup Fuel Design Methodology and ZIRLO Fuel Performance Models' (TAC NO. M86416)."

5. WCAP-11397-P-A, "Revised Thermal Design Procedure," April 1989.

   NRC Safety Evaluation Report dated January 17, 1989, "Acceptance for Referencing of Licensing Topical Report WCAP-11397, 'Revised Thermal Design Procedure.'"

6. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis," October 1999.

   NRC letter dated January 19, 1999, "Acceptance for Referencing of Licensing Topical Report WCAP-14565, 'VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal/Hydraulic Safety Analysis' (TAC No. M98666)."

7. WCAP-10851-P-A, "Improved Fuel Performance Models for Westinghouse Fuel Rod Design and Safety Evaluations," August 1988.

   NRC letter dated May 9, 1988, "Westinghouse Topical Report WCAP-10851, 'Improved Fuel Performance Models for Westinghouse Fuel Rod Design and Safety Evaluations.'"

8. WCAP-15063-P-A, Revision 1, with Errata, "Westinghouse Improved Performance Analysis and Design Model (PAD 4.0)," July 2000.

   NRC letter dated April 24, 2000, "Safety Evaluation Related to Topical Report WCAP-15063, Revision 1, 'Westinghouse Improved Performance Analysis and Design Model (PAD 4.0)' (TAC NO. MA2086)."

9. WCAP-8745-P-A, "Design Bases for the Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.

   NRC Safety Evaluation Report dated April 17, 1986, "Acceptance for Referencing of Licensing Topical Report WCAP-8745(P)/8746(NP), 'Design Bases for the Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions.'"

10. WCAP-10965-P-A, "ANC: A Westinghouse Advanced Nodal Computer Code," September 1986.

NRC letter dated June 23, 1986, "Acceptance for Referencing of Topical Report WCAP 10965-P and WCAP 10966-NP."

11. WCAP-10965-P-A, Addendum 2-A, Revision 0, "Qualification of the New Pin Power Recovery Methodology," September, 2010.

NRC Safety Evaluation Report dated September 10, 2010, "FINAL SAFETY EVALUATION FOR WESTINGHOUSE ELECTRIC COMPANY TOPICAL REPORT WCAP-10965-P-A, ADDENDUM 2/WCAP-10966-A, ADDENDUM 2, "QUALIFICATION OF THE NEW PIN POWER RECOVERY METHODOLOGY," (TAC NO. ME1420)."

12. WCAP-13524-P-A, Revision 1-A, "APOLLO: A One Dimensional Neutron Diffusion Theory Program," September 1997.

NRC letter dated June 9, 1997, "Acceptance for Referencing of Licensing Topical Reports WCAP-13524 and WCAP-13524, Revision 1, 'APOLLO – A One-Dimensional Neutron Diffusion Theory Program.'"

13. WCAP-14565-P-A, Addendum 2-P-A, "Extended Application of ABB-NV Correlation and Modified ABB-NV Correlation WLOP for PWR Low Pressure Applications," April 2008.

14. WCAP-16045-P-A, Revision 0, "Qualification of the Two-Dimensional Transport Code PARAGON," August 2004.

NRC letter dated March 18, 2004, "FINAL SAFETY EVALUATION FOR WESTINGHOUSE TOPICAL REPORT WCAP-16045-P, REVISION 0, 'QUALIFICATION OF THE TWO-DIMENSIONAL TRANSPORT CODE PARAGON' (TAC NO. MB8040)"

15. WCAP-16045-P-A, Addendum 1-A, Revision 0, "Qualification of the NEXUS Nuclear Data Methodology," August 2007.

NRC letter dated February 23, 2007, "FINAL SAFETY EVALUATION FOR WESTINGHOUSE ELECTRIC COMPANY (WESTINGHOUSE) TOPICAL REPORT (TR) WCAP-16045-P, ADDENDUM 1, 'QUALIFICATION OF THE NEXUS NUCLEAR DATA METHODOLOGY' (TAC NO. MC9606)"