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L-12-181

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT:
Beaver Valley Power Station Unit No. 2
Docket No. 50-412, License No. NPF-73
Core Operating Limits Report, Cycle 16-1

Pursuant to the requirements of Beaver Valley Power Station (BVPS) Technical Specification 5.6.3, "CORE OPERATING LIMITS REPORT (COLR)," FirstEnergy Nuclear Operating Company is submitting an update to the BVPS Unit No. 2 COLR for the remainder of BVPS Unit No. 2 Cycle 16. COLR Cycle 16-1 is enclosed.

The update incorporates a correction to the W(Z) factors due to an identified error in the existing values. The error, which only affected BVPS Unit No. 2 Cycle 16, resulted in the W(Z) factors being shifted by one axial plane. The results from the surveillances performed on the Heat Flux Hot Channel Factor [$F_Q(Z)$] for Cycle 16 prior to the implementation of the corrected values were reviewed. The review verified that positive margin to the $F_Q(Z)$ limit would still have existed had the correct W(Z) factors been used in those surveillances. COLR Cycle 16-1 changes pages 5.1-12 and 13 only and is otherwise unchanged from COLR Cycle 16 as submitted to the Nuclear Regulatory Commission on April 4, 2011 (Accession No. ML110960732).

There are no regulatory commitments contained in this letter. If there are any questions or if additional information is required, please contact Mr. Phil H. Lashley, Supervisor - Fleet Licensing, at (330) 315-6808.

Sincerely,

Paul A. Harden

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NRR

Enclosure:
Beaver Valley Power Station Unit No. 2 Core Operating Limits Report, Cycle 16-1

cc: NRC Region I Administrator
NRC Resident Inspector
NRC Project Manager
Director BRP/DEP
Site BRP/DEP Representative

Enclosure
L-12-181

Beaver Valley Power Station Unit No. 2 Core Operating Limits Report,
Cycle 16-1
(14 Pages Follow)

5.0 ADMINISTRATIVE CONTROLS

5.1 Core Operating Limits Report

This Core Operating Limits Report provides the cycle specific parameter limits developed in accordance with the NRC approved methodologies specified in Technical Specification Administrative Control 5.6.3.

5.1.1 SL 2.1.1 Reactor Core Safety Limits

See Figure 5.1-1.

5.1.2 SHUTDOWN MARGIN (SDM)

a. In MODES 1, 2, 3, and 4, SHUTDOWN MARGIN shall be ≥ 1.77% Δk/k.(1)

b. Prior to manually blocking the Low Pressurizer Pressure Safety Injection Signal, the Reactor Coolant System shall be borated to ≥ the MODE 5 boron concentration and shall remain ≥ this boron concentration at all times when this signal is blocked.

c. In MODE 5, SHUTDOWN MARGIN shall be ≥ 1.0% Δk/k.

5.1.3 LCO 3.1.3 Moderator Temperature Coefficient (MTC)

a. Upper Limit - MTC shall be maintained within the acceptable operation limit specified in Technical Specification Figure 3.1.3-1.

b. Lower Limit - MTC shall be maintained less negative than -4.29×10^{-4} Δk/k/°F at RATED THERMAL POWER.

c. 300 ppm Surveillance Limit: (- 35 pcm/°F)

d. 60 ppm Surveillance Limit: (- 41 pcm/°F)

5.1.4 LCO 3.1.5 Shutdown Bank Insertion Limits

The Shutdown Banks shall be withdrawn to at least 225 steps.(2)

5.1.5 LCO 3.1.6 Control Bank Insertion Limits

a. Control Banks A and B shall be withdrawn to at least 225 steps.(2)

b. Control Banks C and D shall be limited in physical insertion as shown in Figure 5.1-2.(2)

c. Sequence Limits - The sequence of withdrawal shall be A, B, C and D bank, in that order.

d. Overlap Limits(2) - Overlap shall be such that step 129 on banks A, B, and C corresponds to step 1 on the following bank. When C bank is fully withdrawn, these limits are verified by confirming D bank is withdrawn at least to a position equal to the all-rods-out position minus 128 steps.

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(1) The MODE 1 and MODE 2 with $k_{eff} \geq 1.0$ SDM requirements are included to address SDM requirements (e.g., MODE 1 Required Actions to verify SDM) that are not within the applicability of LCO 3.1.1, SHUTDOWN MARGIN (SDM).

(2) As indicated by the group demand counter

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

The Heat Flux Hot Channel Factor - $F_Q(Z)$ limit is defined by:

$$F_Q(Z) \le \left[\frac{CFQ}{P}\right] * K(Z) \qquad \text{for } P > 0.5$$

$$F_Q(Z) \le \left[\frac{CFQ}{0.5}\right] * K(Z) \qquad \text{for } P \le 0.5$$

Where: CFQ = 2.40

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

K(Z) = the function obtained from Figure 5.1-3.

$$F_Q^C(Z) = F_Q^M(Z) * 1.0815$$

$$F_Q^W(Z) = F_Q^C(Z) * W(Z)$$

W(Z) values are provided in Table 5.1-1. The W(Z) values are generated assuming that they will be used for a full power surveillance. When a part power surveillance is performed, the W(Z) values should be multiplied by the factor 1/P, when $P > 0.5$. When P is ≤ 0.5, the W(Z) values should be multiplied 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.

The $F_Q(Z)$ penalty function, applied when the analytic $F_Q(Z)$ function increases from one monthly measurement to the next, is provided in Table 5.1-2.

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

$$F_{\Delta H}^N \le CF_{\Delta H} * (1 + PF_{\Delta H}(1 - P))$$

Where:

$CF_{\Delta H}$ = 1.62

$PF_{\Delta H}$ = 0.3

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

5.1.8 LCO 3.2.3 Axial Flux Difference (AFD)

The AFD acceptable operation limits are provided in Figure 5.1-4.

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5.1.9 LCO 3.3.1 Reactor Trip System Instrumentation - Overtemperature and Overpower ΔT Parameter Values from Table Notations 3 and 4

a. Overtemperature ΔT Setpoint Parameter Values:

Parameter	Value
Overtemperature ΔT reactor trip setpoint	$K1 \leq 1.239$
Overtemperature ΔT reactor trip setpoint Tavg coefficient	$K2 \geq 0.0183/°F$
Overtemperature ΔT reactor trip setpoint pressure coefficient	$K3 \geq 0.001/psia$
Tavg at RATED THERMAL POWER	$T' \leq 574.2°F$[(1)]
Nominal pressurizer pressure	$P' \geq 2250$ psia
Measured reactor vessel ΔT lead/lag time constants (* The response time is toggled off to meet the analysis value of zero.)	$\tau_1 = 0$ sec* $\tau_2 = 0$ sec*
Measured reactor vessel ΔT lag time constant	$\tau_3 \leq 6$ secs
Measured reactor vessel average temperature lead/lag time constants	$\tau_4 \geq 30$ secs $\tau_5 \leq 4$ secs
Measured reactor vessel average temperature lag time constant	$\tau_6 \leq 2$ secs

f (ΔI) is a function of the indicated difference between top and bottom detectors of the power-range nuclear ion chambers; with gains to be selected based on measured instrument response during plant startup tests such that:

(i) For $q_t - q_b$ between -37% and +15%, $f_1(\Delta I) = 0$, where q_t and q_b are percent RATED THERMAL POWER in the top and bottom halves of the core respectively, and $q_t + q_b$ is total THERMAL POWER in percent of RATED THERMAL POWER.

(1) T' represents the cycle-specific Full Power Tavg value used in core design.

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(ii) For each percent that the magnitude of (q_t - q_b) exceeds -37%, the ΔT trip setpoint shall be automatically reduced by 2.52% of its value at RATED THERMAL POWER.

(iii) For each percent that the magnitude of (q_t - q_b) exceeds +15%, the ΔT trip setpoint shall be automatically reduced by 1.47% of its value at RATED THERMAL POWER.

b. Overpower ΔT Setpoint Parameter Values:

Parameter	Value
Overpower ΔT reactor trip setpoint	K4 ≤ 1.094
Overpower ΔT reactor trip setpoint Tavg rate/lag coefficient	K5 ≥ 0.02/°F for increasing average temperature K5 = 0/°F for decreasing average temperature
Overpower ΔT reactor trip setpoint Tavg heatup coefficient	K6 ≥ 0.0021/°F for T > T" K6 = 0/°F for T ≤ T"
Tavg at RATED THERMAL POWER	T" ≤ 574.2°F[(1)]
Measured reactor vessel ΔT lead/lag time constants	τ_1 = 0 sec* τ_2 = 0 sec*

(* The response time is toggled off to meet the analysis value of zero.)

Parameter	Value
Measured reactor vessel ΔT lag time constant	$\tau_3 \leq$ 6 secs
Measured reactor vessel average temperature lag time constant	$\tau_6 \leq$ 2 secs
Measured reactor vessel average temperature rate/lag time constant	$\tau_7 \geq$ 10 secs

(1) T" represents the cycle-specific Full Power Tavg value used in core design.

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5.1.10 LCO 3.4.1, RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits

Parameter	Indicated Value
Reactor Coolant System Tavg	Tavg ≤ 577.8°F(1)
Pressurizer Pressure	Pressure ≥ 2214 psia(2)
Reactor Coolant System Total Flow Rate	Flow ≥ 267,300 gpm(3)

(1) The Reactor Coolant System (RCS) indicated Tavg value is determined by adding the appropriate allowances for rod control operation and verification via control board indication (3.6°F) to the cycle specific full power Tavg used in the core design.

(2) The pressurizer pressure value includes allowances for pressurizer pressure control operation and verification via control board indication.

(3) The RCS total flow rate includes allowances for normalization of the cold leg elbow taps with a beginning of cycle precision RCS flow calorimetric measurement and verification on a periodic basis via control board indication.

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5.1.11 LCO 3.9.1 Boron Concentration (MODE 6)

The boron concentration of the Reactor Coolant System, the refueling canal, and the refueling cavity shall be maintained ≥ 2400 ppm. This value includes a 50 ppm conservative allowance for uncertainties.

5.1 Core Operating Limits Report

5.1.12 References

1. WCAP-9272-P-A, "WESTINGHOUSE RELOAD SAFETY EVALUATION METHODOLOGY," July 1985 (Westinghouse Proprietary).

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

3. WCAP-12945-P-A, Volume 1 (Revision 2) and Volumes 2 through 5 (Revision 1), "Code Qualification Document for Best Estimate LOCA Analysis," March 1998 (Westinghouse Proprietary).

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

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

6. WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995 (Westinghouse Proprietary).

7. WCAP-15025-P-A, "Modified WRB-2 Correlation, WRB-2M, for Predicating Critical Heat Flux in 17x17 Rod Bundles with Modified LPD Mixing Vane Grids," April 1999.

8. Caldon, Inc. Engineering Report-80P, "Improving Thermal Power Accuracy and Plant Safety While Increasing Operating Power Level Using the LEFM√™ System," Revision 0, March 1997.

9. Caldon, Inc. Engineering Report-160P, "Supplement to Topical Report ER-80P: Basis for a Power Uprate With the LEFM√™ System," Revision 0, May 2000.

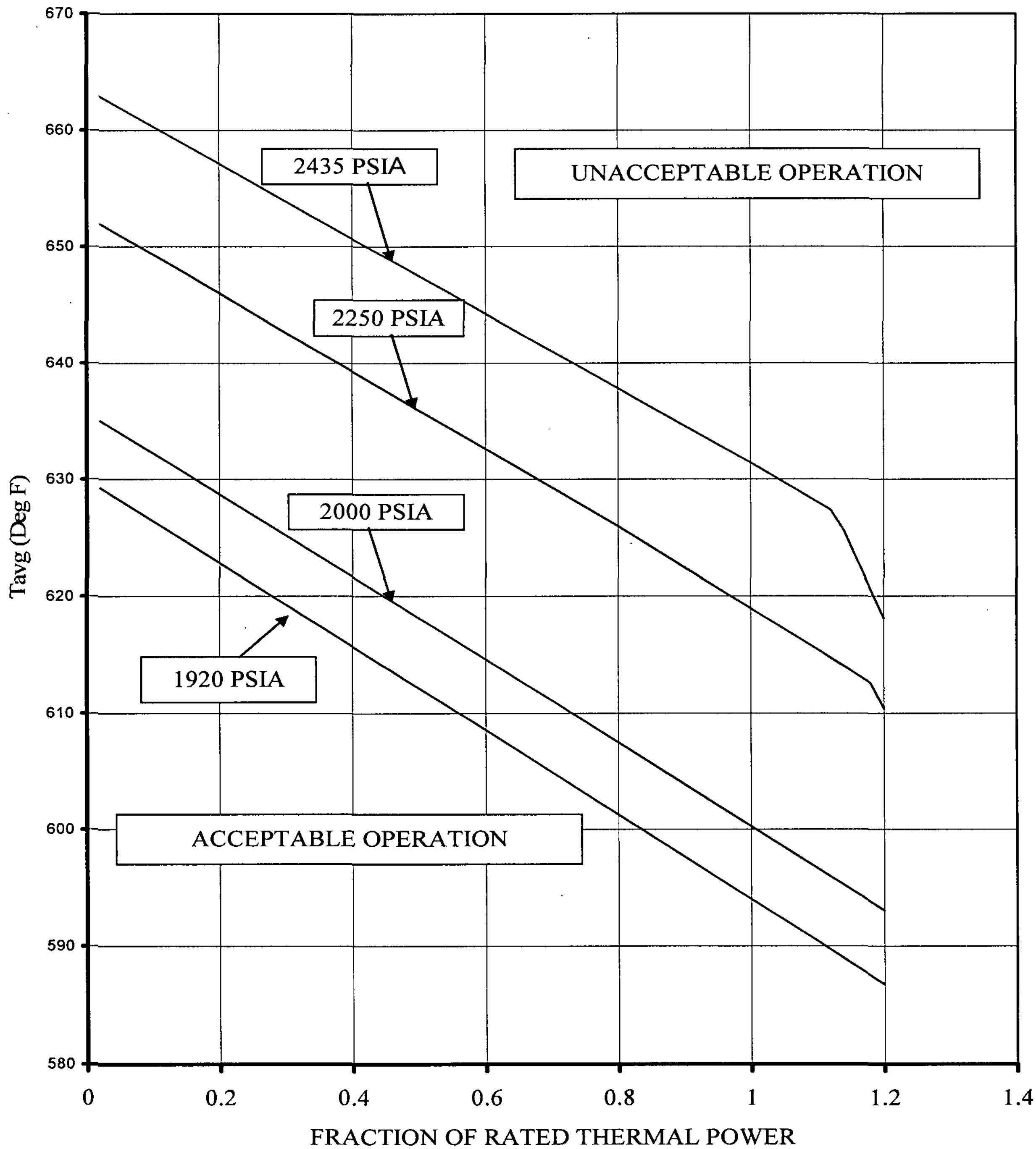

Figure 5.1-1 (Page 1 of 1)

REACTOR CORE SAFETY LIMIT
THREE LOOP OPERATION

(Technical Specification Safety Limit 2.1.1)

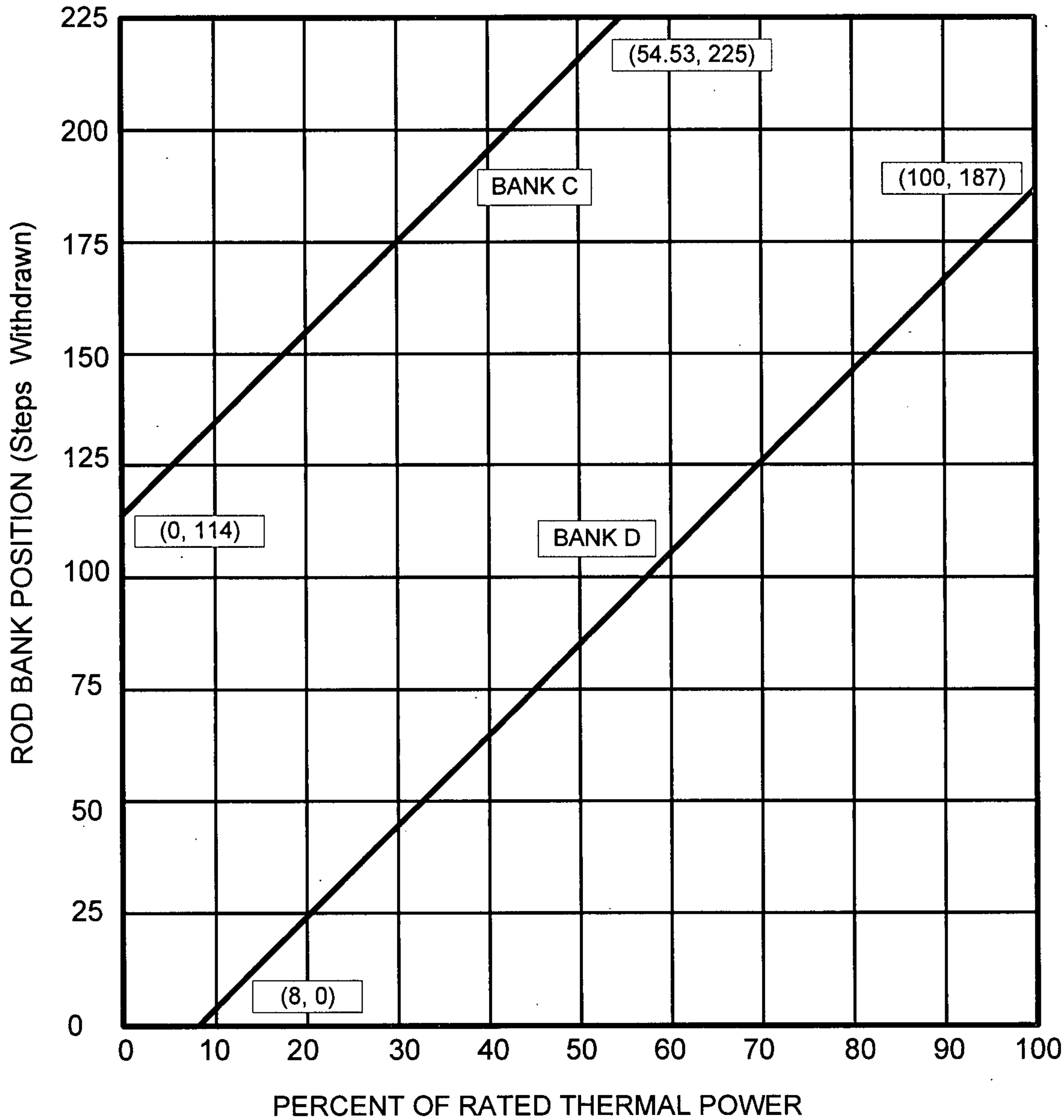

Figure 5.1-2 (Page 1 of 1)

CONTROL ROD INSERTION LIMITS AS A

FUNCTION OF RATED POWER LEVEL

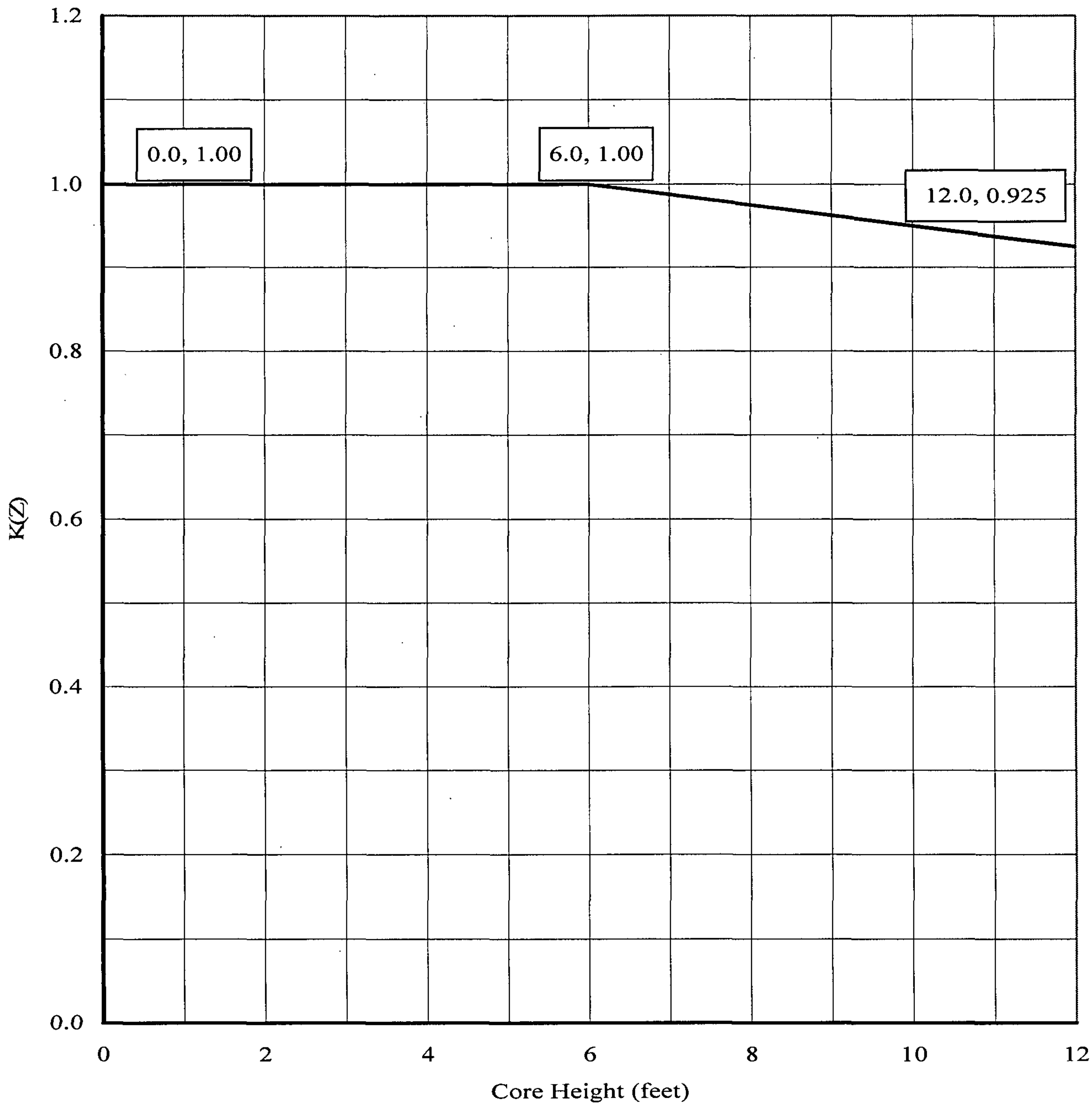

Figure 5.1-3 (Page 1 of 1)

$F_Q T$ NORMALIZED OPERATING ENVELOPE, K(Z)

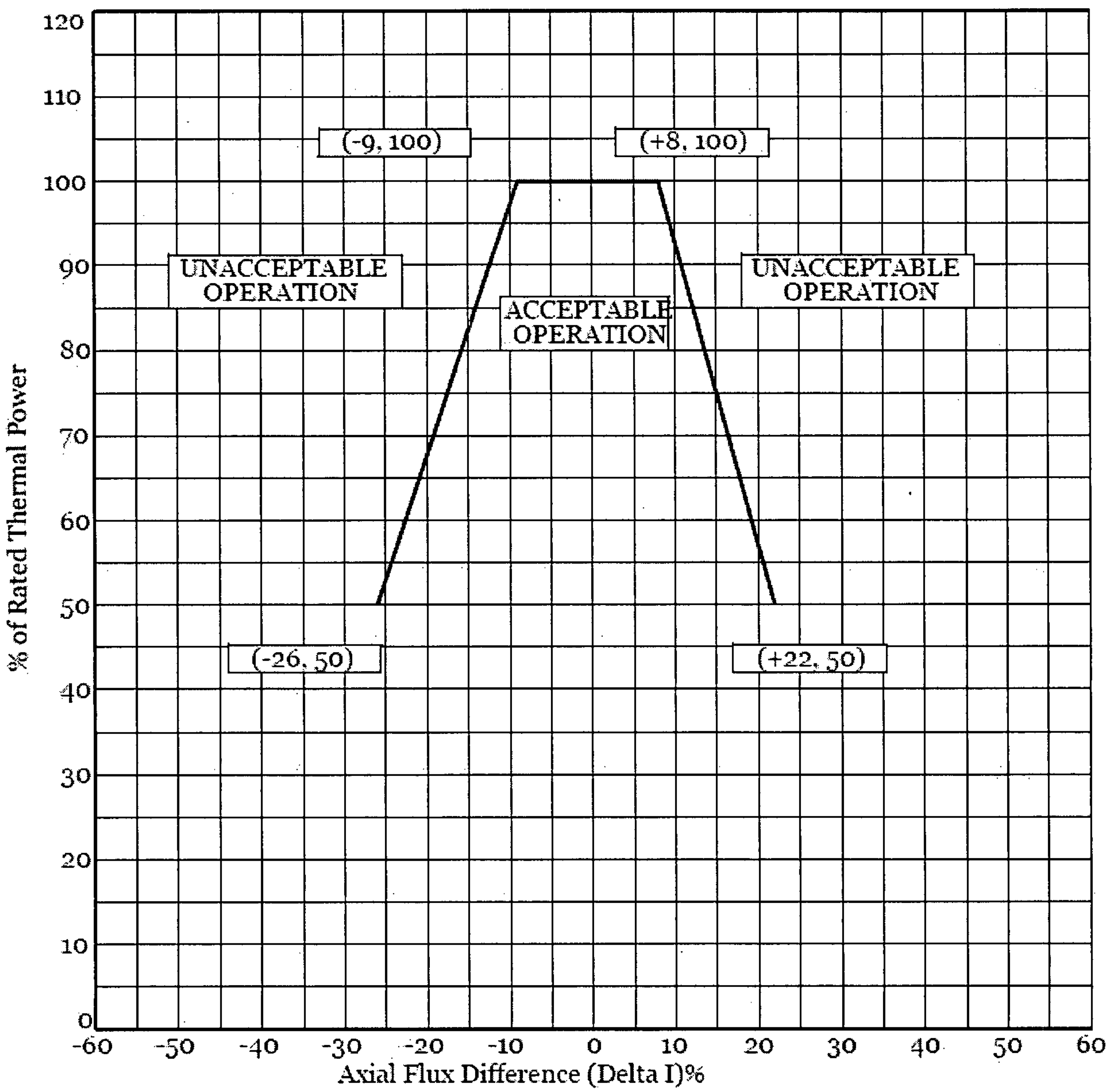

Figure 5.1-4 (Page 1 of 1)

AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF

PERCENT OF RATED THERMAL POWER FOR RAOC

Table 5.1-1 (Page 1 of 2)
F_Q Surveillance W(Z) Function versus Burnup

Exclusion Zone	Axial Point	Elevation (feet)	150 MWD/MTU	3000 MWD/MTU	8000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
*	1	12.1	1.0000	1.0000	1.0000	1.0000	1.0000
*	2	11.9	1.0000	1.0000	1.0000	1.0000	1.0000
*	3	11.7	1.0000	1.0000	1.0000	1.0000	1.0000
*	4	11.5	1.0000	1.0000	1.0000	1.0000	1.0000
*	5	11.3	1.0000	1.0000	1.0000	1.0000	1.0000
*	6	11.1	1.0000	1.0000	1.0000	1.0000	1.0000
*	7	10.9	1.0000	1.0000	1.0000	1.0000	1.0000
	8	10.7	1.1565	1.1948	1.2492	1.2056	1.2163
	9	10.5	1.1468	1.1875	1.2411	1.1991	1.2101
	10	10.3	1.1353	1.1791	1.2320	1.1925	1.2055
	11	10.1	1.1240	1.1701	1.2220	1.1863	1.2022
	12	9.9	1.1138	1.1673	1.2114	1.1789	1.1981
	13	9.7	1.1085	1.1672	1.2000	1.1773	1.1928
	14	9.5	1.1075	1.1652	1.1885	1.1819	1.1906
	15	9.3	1.1045	1.1612	1.1768	1.1886	1.1962
	16	9.1	1.1024	1.1542	1.1624	1.1920	1.2019
	17	8.9	1.1059	1.1551	1.1629	1.1965	1.2039
	18	8.7	1.1172	1.1603	1.1759	1.2077	1.2068
	19	8.5	1.1287	1.1617	1.1876	1.2239	1.2153
	20	8.3	1.1379	1.1615	1.1966	1.2362	1.2267
	21	8.1	1.1453	1.1588	1.2032	1.2456	1.2360
	22	7.9	1.1509	1.1580	1.2076	1.2525	1.2428
	23	7.6	1.1549	1.1590	1.2099	1.2570	1.2476
	24	7.4	1.1575	1.1581	1.2103	1.2590	1.2503
	25	7.2	1.1584	1.1562	1.2085	1.2585	1.2509
	26	7.0	1.1579	1.1551	1.2048	1.2554	1.2487
	27	6.8	1.1559	1.1536	1.1991	1.2500	1.2457
	28	6.6	1.1524	1.1502	1.1916	1.2421	1.2426
	29	6.4	1.1477	1.1457	1.1823	1.2321	1.2377
	30	6.2	1.1416	1.1398	1.1715	1.2200	1.2306
	31	6.0	1.1349	1.1329	1.1593	1.2061	1.2214
	32	5.8	1.1257	1.1247	1.1459	1.1898	1.2102

Note: Top and Bottom 10% Excluded

TABLE 5.1-1 (Page 2 of 2)
F_Q Surveillance W(Z) Function versus Burnup

Exclusion Zone	Axial Point	Elevation (feet)	150 MWD/MTU	3000 MWD/MTU	8000 MWD/MTU	14000 MWD/MTU	18000 MWD/MTU
	33	5.6	1.1188	1.1160	1.1335	1.1731	1.1971
	34	5.4	1.1225	1.1099	1.1238	1.1598	1.1831
	35	5.2	1.1279	1.1096	1.1121	1.1448	1.1724
	36	5.0	1.1321	1.1117	1.1058	1.1347	1.1622
	37	4.8	1.1360	1.1135	1.1042	1.1293	1.1519
	38	4.6	1.1392	1.1149	1.1009	1.1229	1.1425
	39	4.4	1.1420	1.1160	1.0975	1.1175	1.1315
	40	4.2	1.1444	1.1172	1.0939	1.1138	1.1231
	41	4.0	1.1463	1.1197	1.0901	1.1102	1.1162
	42	3.8	1.1479	1.1232	1.0867	1.1060	1.1086
	43	3.6	1.1500	1.1262	1.0844	1.1023	1.1008
	44	3.4	1.1550	1.1286	1.0866	1.1002	1.0941
	45	3.2	1.1639	1.1326	1.0880	1.0991	1.0891
	46	3.0	1.1772	1.1412	1.0948	1.1017	1.0904
	47	2.8	1.1950	1.1576	1.1112	1.1150	1.1000
	48	2.6	1.2166	1.1820	1.1278	1.1318	1.1130
	49	2.4	1.2419	1.2076	1.1447	1.1489	1.1288
	50	2.2	1.2679	1.2327	1.1618	1.1656	1.1450
	51	2.0	1.2931	1.2577	1.1785	1.1821	1.1607
	52	1.8	1.3175	1.2820	1.1948	1.1981	1.1760
	53	1.6	1.3407	1.3051	1.2103	1.2134	1.1908
	54	1.4	1.3618	1.3261	1.2244	1.2276	1.2048
*	55	1.2	1.0000	1.0000	1.0000	1.0000	1.0000
*	56	1.0	1.0000	1.0000	1.0000	1.0000	1.0000
*	57	0.8	1.0000	1.0000	1.0000	1.0000	1.0000
*	58	0.6	1.0000	1.0000	1.0000	1.0000	1.0000
*	59	0.4	1.0000	1.0000	1.0000	1.0000	1.0000
*	60	0.2	1.0000	1.0000	1.0000	1.0000	1.0000
*	61	0.0	1.0000	1.0000	1.0000	1.0000	1.0000

Note: Top and Bottom 10% Excluded

Table 5.1-2 (Page 1 of 1)
$F_Q(Z)$ Penalty Factor versus Burnup

Cycle Burnup (MWD/MTU)	$F_Q(Z)$ Penalty Factor
0 to 900	1.0251
> 900	1.02

Note: The Penalty Factor, to be applied to $F_Q(Z)$ in accordance with Technical Specification Surveillance Requirement (SR) 3.2.1.2, is the maximum factor by which $F_Q(Z)$ is expected to increase over a 39 Effective Full Power Day (EFPD) interval (surveillance interval of 31 EFPD plus the maximum allowable extension not to exceed 25% of the surveillance interval per Technical Specification SR 3.0.2) starting from the burnup at which the $F_Q(Z)$ was determined.