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Dominion

December 10, 2007

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION
CYCLE 28, REVISION 1, CORE OPERATING LIMITS REPORT

Pursuant to Kewaunee Power Station (KPS) Technical Specification 6.9.a.4.D, enclosed is Revision 1 of the Cycle 28, Core Operating Limits Report (COLR).

If you have questions or require additional information, please feel free to contact Mr. Craig Sly at (804) 273-2784.

Very truly yours,

Gerald T. Bischof
Vice President – Nuclear Engineering

Attachment:

1. Kewaunee Power Station, Cycle 28, Revision 1, Core Operating Limits Report.

Commitments made by this letter: NONE

cc: Regional Administrator, Region III
U. S. Nuclear Regulatory Commission
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NRC Senior Resident Inspector
Kewaunee Power Station

ATTACHMENT 1

KEWAUNEE POWER STATION
CYCLE 28 REVISION 1 CORE OPERATING LIMITS REPORT

DOMINION ENERGY KEWAUNEE, INC.

TRM 2.1

Kewaunee Power Station

CORE OPERATING LIMITS REPORT (COLR)

CYCLE 28

REVISION 1

Approved	Tom Webb / M Wehl	14 Nov 2007	07-107
	PORC Chairman	**Date**	**Mtg.#**

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1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Kewaunee Power Station (KPS) has been prepared in accordance with the requirements of Technical Specification (TS) 6.9.a.4.

A cross-reference between the COLR sections and the KPS Technical Specifications affected by this report is given below:

COLR Section	KPS TS	Description
2.1	2.1	Reactor Core Safety Limits
2.2	3.10.a	Shutdown Margin
2.3	3.1.f.3	Moderator Temperature Coefficient
2.4	3.10.d.1	Shutdown Bank Insertion Limit
2.5	3.10.d.2	Control Bank Insertion Limits
2.6	3.10.b.1.A 3.10.b.5 3.10.b.6 3.10.b.6.C.i 3.10.b.7	Heat Flux Hot Channel Factor ($F_Q(Z)$)
2.7	3.10.b.1.B	Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}^N$)
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2.9	2.3.a.3.A	Overtemperature ΔT Setpoint
2.10	2.3.a.3.B	Overpower ΔT Setpoint
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Figure 1		Reactor Core Safety Limits (1772 MWt)
Figure 2		Required Shutdown Margin
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Figure 7		Axial Flux Difference

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 have been developed using the NRC approved methodologies specified in Technical Specification 6.9.a.4.

2.1 Reactor Core Safety Limits

The combination of rated power level, coolant pressure, and coolant temperature shall not exceed the limits shown in COLR Figure 1 (1772 MWt). The safety limit is exceeded if the point defined by the combination of Reactor Coolant System average temperature and power level is at any time above the appropriate pressure line.

2.2 Shutdown Margin

2.2.1 When the reactor is subcritical prior to reactor startup, the SHUTDOWN margin shall be at least that shown in COLR Figure 2.

2.3 Moderator Temperature Coefficient

2.3.1 When the reactor is critical and ≤ 60% RATED POWER, the moderator temperature coefficient shall be ≤ 5.0 pcm/°F, except during LOW POWER PHYSICS TESTING. When the reactor is > 60% RATED POWER, the moderator temperature coefficient shall be zero or negative.

2.3.2 The reactor will have a moderator temperature coefficient no less negative than -8 pcm/°F for 95% of the cycle time at full power.

2.4 Shutdown Bank Insertion Limit

2.4.1 The shutdown rods shall be fully withdrawn (≥ 225 steps and ≤ 230 steps) when the reactor is critical or approaching criticality.

2.5 Control Bank Insertion Limits

2.5.1 The control banks shall be limited in physical insertion; insertion limits are shown in COLR Figure 4.

2.6 Nuclear Heat Flux Hot Channel Factor ($F_Q^N(Z)$)

2.6.1 $F_Q^N(Z)$ Limits for Fuel

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.50)/P \times K(Z)$ for $P > 0.5$ **[422 V+]**

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (5.00) \times K(Z)$ for $P \leq 0.5$ **[422 V+]**

where:

P is the fraction of full power at which the core is OPERATING

K(Z) is the function given in Figure 3

Z is the core height location for the F_Q of interest

2.6.2 The measured $F_Q^{EQ}(Z)$ hot channel factors under equilibrium conditions shall satisfy the following relationship for the central axial 80% of the core for fuel:

$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times W(Z) \times F_p \leq (2.5)/ P \times K(Z)$ **[422 V +]**

where:

P is the fraction of full power at which the core is OPERATING

K(Z) is the function given in Figure 3

Z is the core height location for the F_Q of interest

F_p is the $F_Q^{EQ}(Z)$ penalty factor described in 2.6.3.

W(Z) Is the function given in Figure 5

$F_Q^{EQ}(Z)$ is a measured F_Q distribution obtained during the target flux determination

2.6.3 The penalty factor of 1.0 shall be used for TS 3.10.b.6.A and TS 3.10.b.6.B. The penalty factor provided in Figure 6 shall be used for TS 3.10.b.6.C.i. The penalty factor for all burnups outside the range of Figure 6 shall be 2%.

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

2.7.1 $F_{\Delta H}^{N}$ Limits for Fuel

$$F_{\Delta H}^{N} \times 1.04 \leq 1.70\,[1 + 0.3(1-P)]$$ **[422 V+]**

where:

P is the fraction of full power at which the core is OPERATING

2.8 Axial Flux Difference (AFD)

2.8.1 The Axial Flux Difference (AFD) acceptable operation limits are provided in Figure 7.

2.9 Overtemperature ΔT Setpoint

Overtemperature ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, %
T	=	Average temperature, °F
T'	$\leq$	573.0 °F
P	=	Pressurizer Pressure, psig
P'	=	2235 psig
K_1	=	1.195
K_2	=	0.015/°F
K_3	=	0.00072/psig
τ_1	=	30 seconds
τ_2	=	4 seconds
$f(\Delta I)$	=	An even function of the indicated difference between top and bottom detectors of the power range nuclear ion chambers. Selected gains are based on measured instrument response during plant startup tests, where q_t and q_b are the percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of RATED POWER, such that

(a) For $q_t - q_b$ within -15, +10 %, $f(\Delta I) = 0$

(b) For each percent that the magnitude of $q_t - q_b$ exceeds +10 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 1.51 % of RATED POWER.

(c) For each percent that the magnitude of $q_t - q_b$ exceed -15 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 3.78% of RATED POWER.

2.10 <u>Overpower ΔT Setpoint</u>

Overpower ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, %
T	=	Average temperature, °F
T'	$\leq$	573.0 °F
K_4	$\leq$	1.095
K_5	$\geq$	0.0275/°F for increasing T; 0 for decreasing T
K_6	$\geq$	0.00103/°F for T > T' ; 0 for T < T'
τ_3	=	10 seconds
$f(\Delta I)$	=	0 for all ΔI

2.11 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits

2.11.1 During steady state power operation, Tavg shall be < 576.7°F for control board indication or < 576.5°F for computer indication.

2.11.2 During steady state power operation, Pressurizer Pressure shall be > 2217 psig for control board indication or > 2219 psig for computer indication

2.11.3 During steady state power operation, reactor coolant total flow rate shall be ≥ 189,720 gpm.

2.12 <u>Refueling Boron Concentration</u>

2.12.1 When there is fuel in the reactor, a minimum boron concentration of 2500 ppm and a shutdown margin of ≥ 5% Δ k/k shall be maintained in the Reactor Coolant System during reactor vessel head removal or while loading and unloading fuel from the reactor.

Figure 1

**Reactor Core Safety Limits Curve (1772 Mwt)
(Cores Containing 422V+ fuel)**

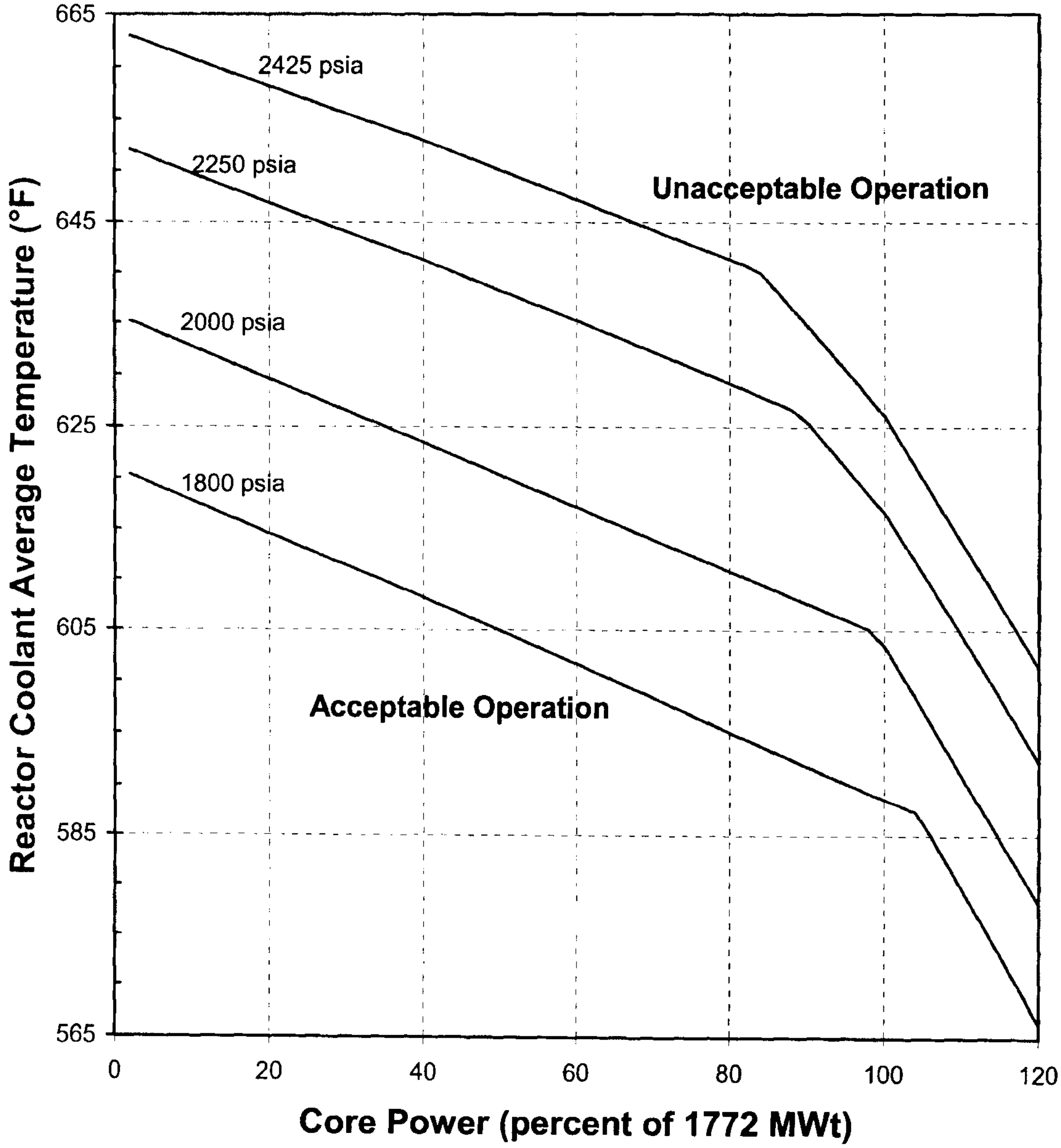


Figure 2

Required Shutdown Reactivity vs. Boron Concentration

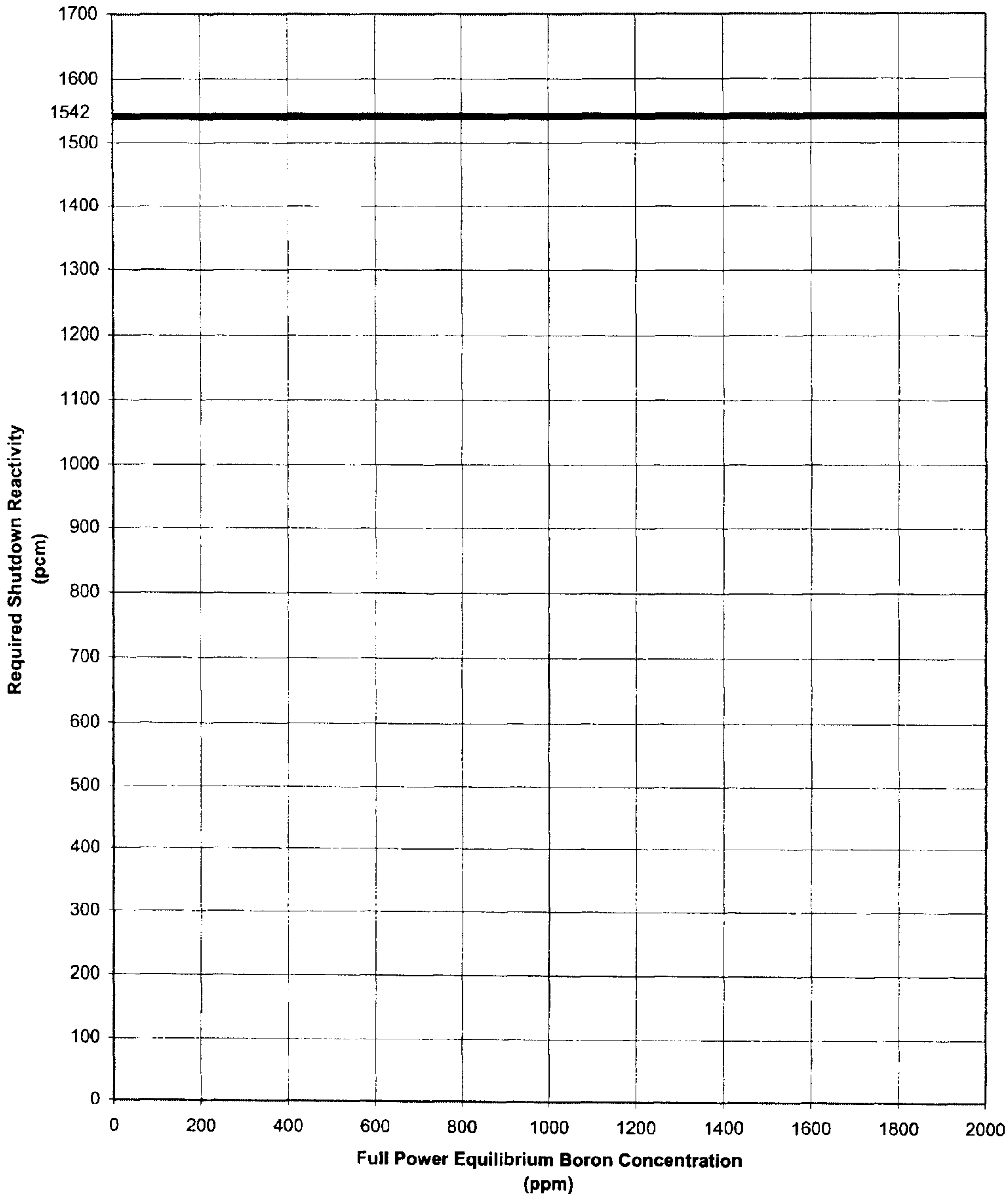


Figure 3

Hot Channel Factor Normalized Operating Envelope (K(z))

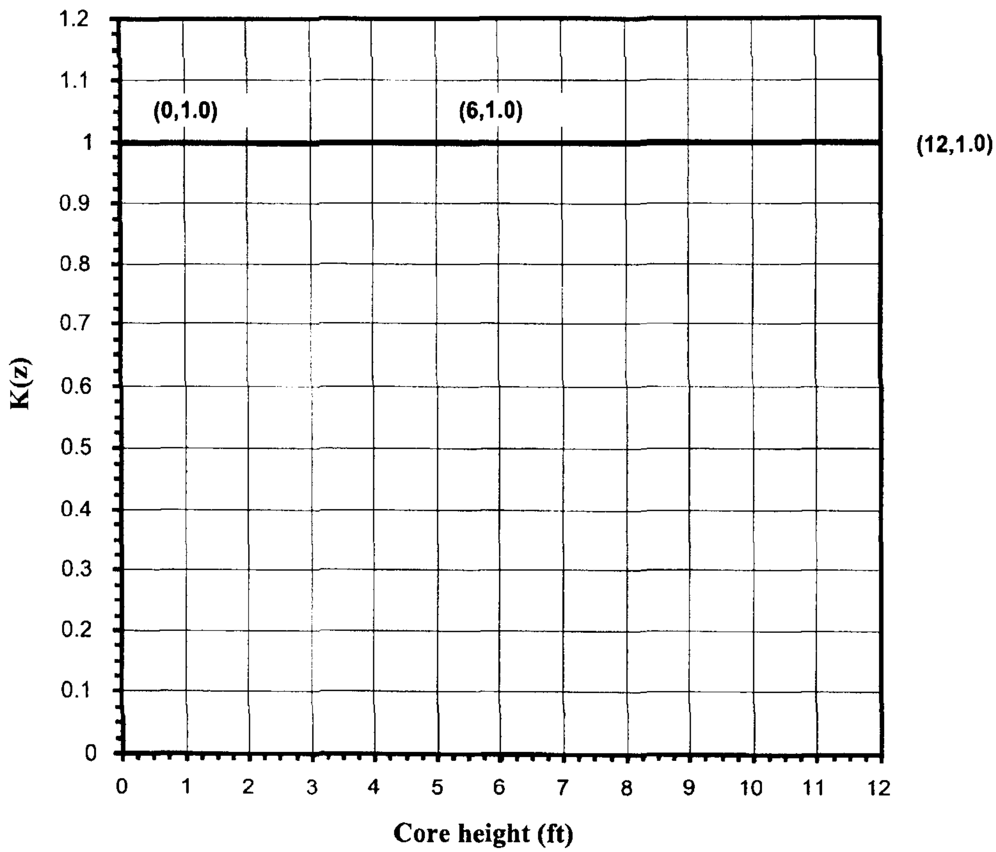
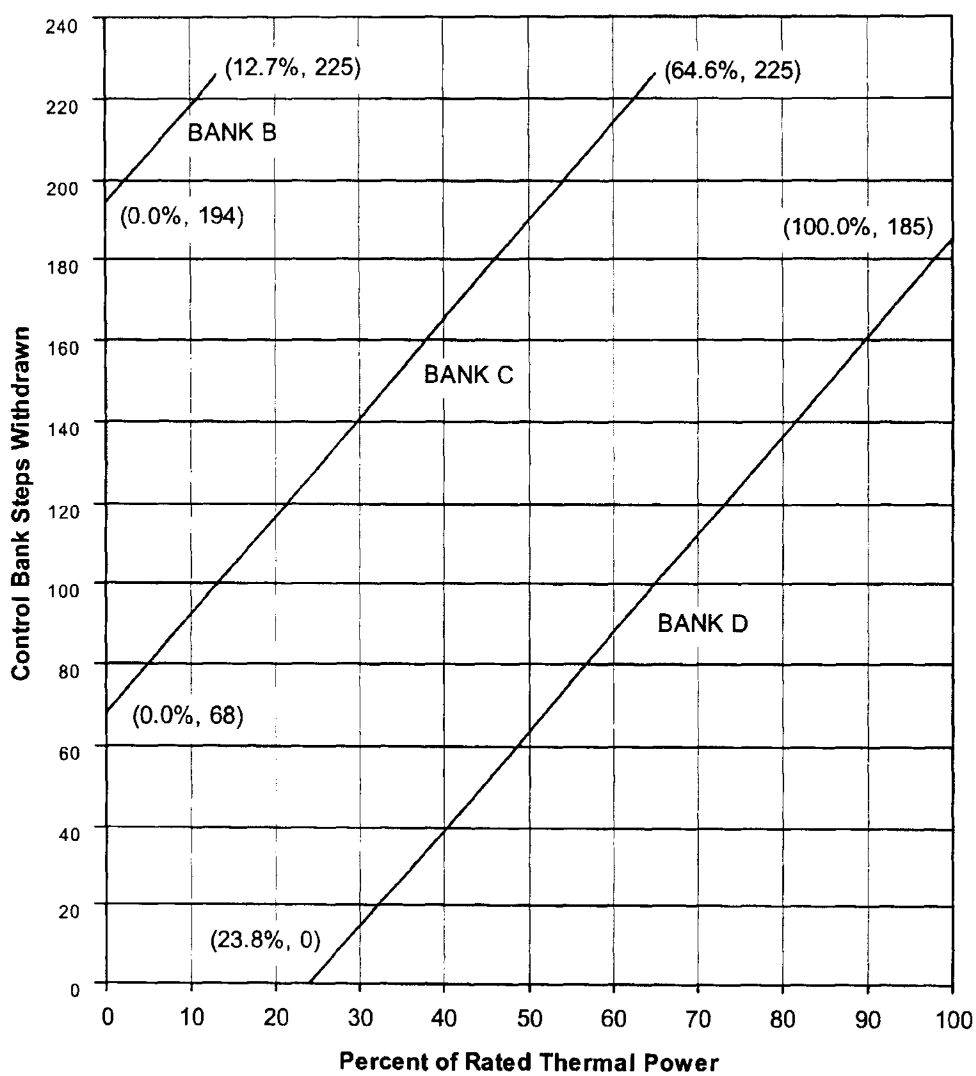


Figure 4

Control Bank Insertion Limits



Fully withdrawn shall be the condition where control rods are at a position between the interval ≥ 225 and ≤ 230 steps withdrawn.

Note: The Rod Bank Insertion Limits are based on a control bank tip-to-tip distance of 126 steps.

Figure 5 - W(Z) Values
(Top and Bottom 9% excluded)

	Height	BU (MWd/MTU)			
	[ft]	150	6000	12000	16000
		AO = 0.90	AO = -3.20	AO = -3.36	AO = -1.32
[BOTTOM] 1	0.00	1.0000	1.0000	1.0000	1.0000
2	0.20	1.0000	1.0000	1.0000	1.0000
3	0.40	1.0000	1.0000	1.0000	1.0000
4	0.60	1.0000	1.0000	1.0000	1.0000
5	0.80	1.0000	1.0000	1.0000	1.0000
6	1.00	1.0000	1.0000	1.0000	1.0000
7	1.20	1.3228	1.2245	1.2002	1.2060
8	1.40	1.3076	1.2135	1.1899	1.1971
9	1.60	1.2899	1.2007	1.1782	1.1870
10	1.80	1.2699	1.1864	1.1652	1.1757
11	2.00	1.2507	1.1709	1.1512	1.1635
12	2.20	1.2316	1.1547	1.1367	1.1508
13	2.40	1.2116	1.1382	1.1217	1.1377
14	2.60	1.1916	1.1218	1.1071	1.1247
15	2.80	1.1724	1.1073	1.0985	1.1127
16	3.00	1.1553	1.0997	1.0953	1.1033
17	3.20	1.1434	1.0972	1.0935	1.1013
18	3.40	1.1372	1.0951	1.0912	1.1033
19	3.60	1.1341	1.0929	1.0888	1.1056
20	3.80	1.1313	1.0934	1.0858	1.1078
21	4.00	1.1281	1.0945	1.0858	1.1098
22	4.20	1.1246	1.0950	1.0891	1.1114
23	4.40	1.1207	1.0954	1.0933	1.1126
24	4.60	1.1164	1.0955	1.0970	1.1132
25	4.80	1.1115	1.0954	1.1001	1.1140
26	5.00	1.1073	1.0946	1.1029	1.1151
27	5.20	1.1034	1.0945	1.1050	1.1158
28	5.40	1.0989	1.0960	1.1066	1.1159
29	5.60	1.0940	1.0979	1.1077	1.1165
30	5.80	1.0895	1.1018	1.1084	1.1220
31	6.00	1.0899	1.1057	1.1130	1.1314
32	6.20	1.0954	1.1104	1.1198	1.1421
33	6.40	1.1021	1.1174	1.1267	1.1529
34	6.60	1.1079	1.1244	1.1376	1.1626
35	6.80	1.1127	1.1307	1.1480	1.1711
36	7.00	1.1167	1.1354	1.1571	1.1783
37	7.20	1.1197	1.1411	1.1663	1.1842
38	7.40	1.1222	1.1501	1.1753	1.1886
39	7.60	1.1246	1.1583	1.1831	1.1915
40	7.80	1.1260	1.1655	1.1896	1.1928
41	8.00	1.1264	1.1718	1.1949	1.1924
42	8.20	1.1256	1.1769	1.1988	1.1903
43	8.40	1.1238	1.1809	1.2013	1.1864
44	8.60	1.1209	1.1838	1.2023	1.1803
45	8.80	1.1180	1.1842	1.2017	1.1757
46	9.00	1.1214	1.1880	1.1993	1.1755
47	9.20	1.1366	1.1975	1.1996	1.1773
48	9.40	1.1498	1.2089	1.2069	1.1769
49	9.60	1.1624	1.2237	1.2161	1.1765
50	9.80	1.1768	1.2413	1.2232	1.1782

Figure 5 Cont'd

(Top and Bottom 9% excluded)

	Height	BU [MWd/MTU]			
		150	6000	12000	16000
	[ft]	AO = 0.90	AO = -3.20	AO = -3.36	AO = -1.32
51	10.00	1.1913	1.2555	1.2311	1.1834
52	10.20	1.2053	1.2661	1.2410	1.1893
53	10.40	1.2214	1.2764	1.2504	1.1996
54	10.60	1.2398	1.2816	1.2632	1.2128
55	10.80	1.2526	1.2878	1.2732	1.2258
56	11.00	1.0000	1.0000	1.0000	1.0000
57	11.20	1.0000	1.0000	1.0000	1.0000
58	11.40	1.0000	1.0000	1.0000	1.0000
59	11.60	1.0000	1.0000	1.0000	1.0000
60	11.80	1.0000	1.0000	1.0000	1.0000
[TOP] 61	12.00	1.0000	1.0000	1.0000	1.0000

Figure 6

Penalty Factor, F_p (%), for $F_Q^{EQ}(Z)$

Cycle Burnup (MWD/MTU)	**Penalty Factor F_p (%)**
150	2.00
20,743	2.00

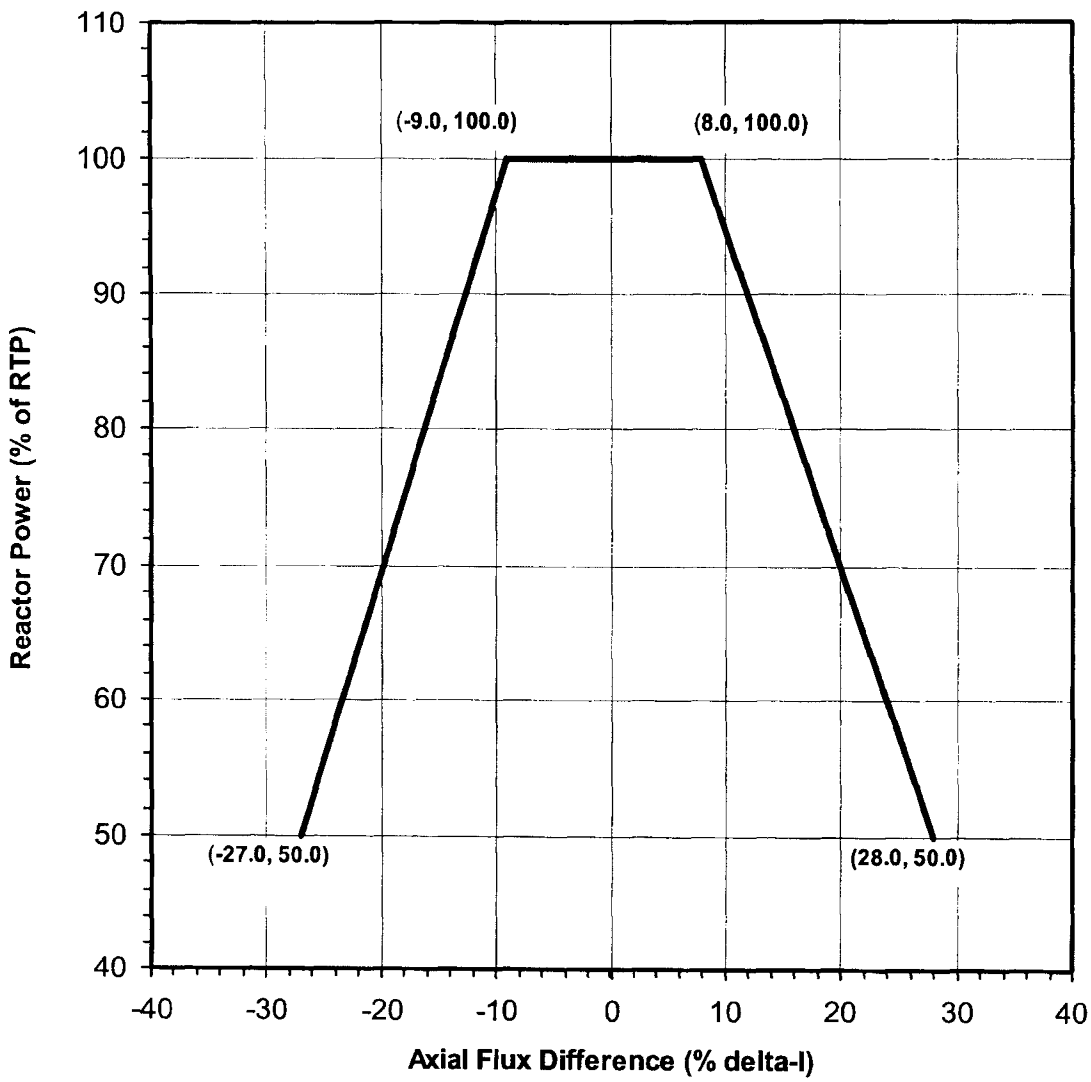
Note: Linear interpolation is adequate for intermediate cycle burnups.

All cycle burnups outside the range of the table shall use a penalty factor, F_p, of 2.0%.

Refer to TS 3.10.b.6.C.

Figure 7

Axial Flux Difference



Note: This figure represents the Relaxed Axial Offset Control (RAOC) band used in safety analyses, it may be administratively tightened depending on in-core flux map results. Refer to Figure RD 11.4.1 of the Reactor Data Manual.

Table 1

NRC Approved Methodologies for COLR Parameters

COLR Section	Parameter	NRC Approved Methodology
2.1	Reactor Core Safety Limits	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985. Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978. Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.2	Shutdown Margin	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985 Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
2.3	Moderator Temperature Coefficient	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985. Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
2.4	Shutdown Bank Insertion Limit	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985. Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.

Table 1 (cont)

NRC Approved Methodologies for COLR Parameters

COLR Section	Parameter	NRC Approved Methodology
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.5	Control Bank Insertion Limits	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.6	Heat Flux Hot Channel Factor	WCAP-10216-P-A, Revision 1A, "Relaxation of Constant Axial Offset Control-F_Q Surveillance Technical Specification," February 1994.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		WCAP-12945-P-A (Proprietary), "Westinghouse Code Qualification Document for Best-Estimate Loss-of-Coolant Accident Analysis," Volume I, Rev.2, and Volumes II-V, Rev.1, and WCAP-14747 (Non-Proprietary), March 1998.

Table 1 (cont)

NRC Approved Methodologies for COLR Parameters

COLR Section	Parameter	NRC Approved Methodology
		ANF-88-133 (P)(A) and Supplement 1, "Qualification of Advanced Nuclear Fuels' PWR Design Methodology for Rod Burnups of 62 GWd/MTU," Advanced Nuclear Fuels Corporation, dated December 1991.
	($F_Q(Z)$)	WCAP-14449-P-A, "Application Of Best Estimate Large Break LOCA Methodology To Westinghouse PWRs With Upper Plenum Injection," Revision1, and WCAP-14450-NP-A, Rev.1 (Non-Proprietary), October 1999.
		WCAP-12610-P-A, "Vantage+ Fuel Assembly Reference Core Report," April 1995.
	Model	WCAP-10054-P-A/WCAP-10081-NP-A, "Westinghouse Small Break ECCS Evaluation Using the NOTRUMP Code," August 1985.
	NOTRUMP	WCAP-10054-P-A/WCAP-10081-NP-A, Addendum 2, Revision 1, "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the Code: Safety Injection into the Broken Loop and COSI Condensation Model," July 1997.
2.7	Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$)	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		Kewaunee Nuclear Power Plant-Review forKewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP,

Revision 3 (TAC NO MB0306) dated September 10, 2001.

Table 1 (cont)

NRC Approved Methodologies for COLR Parameters

COLR Section	Parameter	NRC Approved Methodology
		XN-82-06 (P)(A) Revision 1 and Supplements 2, 4, and 5, "Qualifications of Exxon Nuclear Fuel for Extended Burnup, Exxon Nuclear Company, dated October 1986.
		ANF-88-133 (P)(A) and Supplement 1, "Qualification of Advanced Nuclear Fuels' PWR Design Methodology for Rod Burnups for 62 GWd/MTU," Advanced Nuclear Fuels Corporation, dated December 1991.
		EMF-92-116 (P)(A) Revision 0, "Generic Mechanical Design Criteria for PWR Fuel Designs," Siemens Power Corporation, dated February 1999.
2.8	Axial Flux Difference	WCAP-10216-P-A, Revision 1A, "Relaxation of Constant Axial Offset (AFD) Control-F_Q Surveillance Technical Specification," February 1994.
		Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
2.9	Reactor Protection System (RPS) Instrumentation-Overtemperature ΔT	WCAP-8745-P-A, "Design Bases For The Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.

Table 1 (cont)

NRC Approved Methodologies for COLR Parameters

COLR Section	Parameter	NRC Approved Methodology
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
		CENP-397-P-A, "Improved Flow Measurement Accuracy Using Cross Flow Ultrasonic Flow Measurement Technology," Rev. 1, May 2000.
2.10	Reactor Protection System (RPS) Instrumentation-Overpower ΔT	WCAP-8745-P-A, "Design Bases For The Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.
		Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001.
		CENP-397-P-A, "Improved Flow Measurement Accuracy Using Cross Flow Ultrasonic Flow Measurement Technology," Rev. 1, May 2000.

Table 1 (cont)

NRC Approved Methodologies for COLR Parameters

COLR Section	Parameter	NRC Approved Methodology
2.11	RCS Pressure, Temperature, and Flow Departure From Nucleate (DNB) Limits	WCAP-11397-P-A, "Revised Thermal Design Procedure, "April 1989, for those events analyzed using RTDP Kewaunee Nuclear Power Plant-Review for Kewaunee Reload Safety Evaluation Methods Topical Report WPSRSEM-NP, Revision 3 (TAC NO MB0306) dated September 10, 2001. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985 for those events not utilizing RTDP.
2.12	Boron Concentration	WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985. Safety Evaluation by the Office of Nuclear Reactor Regulation on "Qualifications of Reactor Physics Methods for Application to Kewaunee" Report, dated August 21, 1979, report date September 29, 1978.