

August 4, 2003

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, D.C. 20555-0001

Subject: Duke Energy Corporation
Catawba Nuclear Station Unit 1
Docket No.: 50-413
Core Operating Limits Report (COLR)
Catawba Unit 1 Cycle 14, Revision 23

Attached, pursuant to Catawba Technical Specification 5.6.5,
is an information copy of the Core Operating Limits Report
for Catawba Unit 1 Cycle 14 revision 23.

This letter and attachment do not contain any new
commitments.

Please direct any questions or concerns to George Strickland
at (803) 831-3585.

Sincerely,



D. M. Jamil

Attachment

A001

U. S. Nuclear Regulatory Commission
August 4, 2003
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xc w/att:

L. A. Reyes, Regional, Administrator
USNRC, Region II

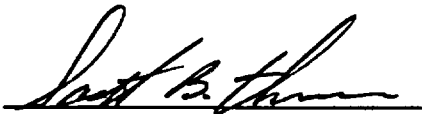
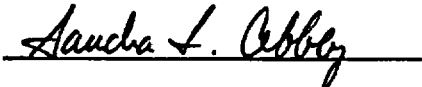
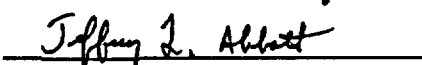

R. E. Martin, NRC Senior Project Manager
USNRC, ONRR

E. F. Guthrie
Senior Resident Inspector (Catawba)

Catawba Unit 1 Cycle 14
Core Operating Limits Report
Revision 23

July 2003

Duke Power Company

		Date
Prepared By:	<u></u>	<u>7/30/03</u>
Checked By:	<u></u>	<u>7/30/03</u>
Checked By:	<u></u>	<u>30 Jul 03</u>
Approved By:	<u></u>	<u>7/30/03</u>

QA Condition 1

The information presented in this report has been prepared and issued in accordance with Catawba Technical Specification 5.6.5.

INSPECTION OF ENGINEERING INSTRUCTIONS

Inspection Waived By: P.m. Alsaaboun
(Sponsor)

Date: 7/30/03

CATAWBA

	Inspection Waived	Inspected By/Date:
MCE (Mechanical & Civil)	<input checked="" type="checkbox"/>	_____
RES (Electrical Only)	<input checked="" type="checkbox"/>	_____
RES (Reactor)	<input checked="" type="checkbox"/>	_____
MOD	<input checked="" type="checkbox"/>	_____
Other (_____)	<input type="checkbox"/>	_____

OCONEE

	Inspection Waived	Inspected By/Date:
MCE (Mechanical & Civil)	<input type="checkbox"/>	_____
RES (Electrical Only)	<input type="checkbox"/>	_____
RES (Reactor)	<input type="checkbox"/>	_____
MOD	<input type="checkbox"/>	_____
Other (_____)	<input type="checkbox"/>	_____

MCGUIRE

	Inspection Waived	Inspected By/Date:
MCE (Mechanical & Civil)	<input type="checkbox"/>	_____
RES (Electrical Only)	<input type="checkbox"/>	_____
RES (Reactor)	<input type="checkbox"/>	_____
MOD	<input type="checkbox"/>	_____
Other (_____)	<input type="checkbox"/>	_____

Catawba 1 Cycle 14 Core Operating Limits Report

IMPLEMENTATION INSTRUCTIONS FOR REVISION 23

Revision 23 of the Catawba Unit 1 COLR contains new end-of-cycle Moderator Temperature Coefficient limits and should be implemented as soon as possible.

Catawba 1 Cycle 14 Core Operating Limits Report

REVISION LOG

<u>Revision</u>	<u>EI Date</u>	<u>Pages Affected</u>	<u>COLR</u>
0 – 1	Superceded	N/A	C1C07
2 – 5	Superceded	N/A	C1C08
6 – 8	Superceded	N/A	C1C09
9 – 11	Superceded	N/A	C1C10
12 - 14	Superceded	N/A	C1C11
15 – 17	Superceded	N/A	C1C12
18	October 2000	1 – 26 Appendix A	C1C13 (Orig. Issue)
19	February 2001	1-4, 25, 26	C1C13 (Revision)
20	September 2001	1-4, 25, 26	C1C13 (Revision)
21	September 2001	1-4, 25, 26a, 26b	C1C13 (Revision)
22	April 2002	ALL	C1C14
23	July 2003	ALL	C1C14 (Revision)

Catawba 1 Cycle 14 Core Operating Limits Report

INSERTION SHEET FOR REVISION 23

Remove pages

Pages 1-31

Insert Rev. 23 pages

Pages 1-31

* Appendix A contains power distribution monitoring factors used in Technical Specification Surveillance. Appendix A is only included in the COLR copy sent to the NRC.

Catawba 1 Cycle 14 Core Operating Limits Report

1.0 Core Operating Limits Report

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

The Technical Specifications that reference this report are listed below:

TS Section	Technical Specifications	COLR Parameter	COLR Section	COLR Page
3.1.1	Shutdown Margin	Shutdown Margin	2.1	9
3.1.3	Moderator Temperature Coefficient	MTC	2.2	9
3.1.4	Rod Group Alignment Limits	Shutdown Margin	2.1	9
3.1.5	Shutdown Bank Insertion Limit	Shutdown Margin	2.1	9
		Rod Insertion Limits	2.3	10
3.1.6	Control Bank Insertion Limit	Shutdown Margin	2.1	9
		Rod Insertion Limits	2.4	10
3.1.8	Physics Tests Exceptions	Shutdown Margin	2.1	9
3.2.1	Heat Flux Hot Channel Factor	F _Q	2.5	14
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3.3.1	Reactor Trip System Instrumentation	OTΔT	2.8	24
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3.9.2	Refueling Operations – Nuclear Instrumentation	Reactor Makeup Water Flow Rate	2.14	27

The Selected License Commitments that reference this report are listed below:

SLC Section	Selected Licensing Commitment	COLR Parameter	COLR Section	COLR Page
16.7-9.3	Standby Shutdown System	Standby Makeup Pump Water Supply	2.15	28
16.9-11	Boration Systems – Borated Water Source – Shutdown	Borated Water Volume and Conc. for BAT/RWST	2.16	28
16.9-12	Boration Systems – Borated Water Source – Operating	Borated Water Volume and Conc. for BAT/RWST	2.17	29

Catawba 1 Cycle 14 Core Operating Limits Report

1.1 Analytical Methods

The analytical methods used to determine core operating limits for parameters identified in Technical Specifications and previously reviewed and approved by the NRC are as follows.

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

Revision 0
Report Date: July 1985
Not Used for C1C14

2. WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model using the NOTRUMP Code," (W Proprietary).

Revision 0
Report Date: August 1985
Note: Amendments to this report are included in Ref. 12.

3. WCAP-10266-P-A, "THE 1981 VERSION OF WESTINGHOUSE EVALUATION MODEL USING BASH CODE", (W Proprietary).

Revision 2
Report Date: March 1987
Not Used for C1C14

4. WCAP-12945-P-A, Volume 1 and Volumes 2-5, "Code Qualification Document for Best-Estimate Loss of Coolant Analysis," (W Proprietary).

Revision: Volume 1 (Revision 2) and Volumes 2-5 (Revision 1)
Report Date: March 1998

5. BAW-10168P-A, "B&W Loss-of-Coolant Accident Evaluation Model for Recalculating Steam Generator Plants," (B&W Proprietary).

Revision 1
SER Date: January 22, 1991
Revision 2
SER Dates: August 22, 1996 and November 26, 1996.
Revision 3
SER Date: June 15, 1994.
Not Used for C1C14

Catawba 1 Cycle 14 Core Operating Limits Report

1.1 Analytical Methods (continued)

6. DPC-NE-3000PA, "Thermal-Hydraulic Transient Analysis Methodology," (DPC Proprietary).

Revision 2
SER Date: October 14, 1998
7. DPC-NE-3001PA, "Multidimensional Reactor Transients and Safety Analysis Physics Parameter Methodology," (DPC Proprietary).

Revision 0
Report Date: November 1991
8. DPC-NE-3002A, "FSAR Chapter 15 System Transient Analysis Methodology".

Revision 3
SER Date: February 5, 1999
9. DPC-NE-2004P-A, "Duke Power Company McGuire and Catawba Nuclear Stations Core Thermal-Hydraulic Methodology using VIPRE-01," (DPC Proprietary).

Revision 1
SER Date: February 20, 1997
10. DPC-NE-2005P-A, "Thermal Hydraulic Statistical Core Design Methodology," (DPC Proprietary).

Revision 1
SER Date: November 7, 1996
11. DPC-NE-2008P-A, "Fuel Mechanical Reload Analysis Methodology Using TACO3," (DPC Proprietary).

Revision 0
SER Date: April 3, 1995
12. DPC-NE-2009-P-A, "Westinghouse Fuel Transition Report," (DPC Proprietary).

Revision 0
SER Date: September 22, 1999
13. DPC-NE-1004A, "Nuclear Design Methodology Using CASMO-3/SIMULATE-3P."

Revision 1
SER Date: April 26, 1996

Catawba 1 Cycle 14 Core Operating Limits Report

1.1 Analytical Methods (continued)

14. DPC-NF-2010A, "Duke Power Company McGuire Nuclear Station Catawba Nuclear Station Nuclear Physics Methodology for Reload Design."

Revision 0

Report Date: June 1985

15. DPC-NE-2011PA, "Duke Power Company Nuclear Design Methodology for Core Operating Limits of Westinghouse Reactors," (DPC Proprietary).

Revision 0

Report Date: March 1990

Catawba 1 Cycle 14 Core Operating Limits Report

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 NRC approved methodologies specified in Section 1.1.

2.1 Shutdown Margin - SDM (TS 3.1.1, TS 3.1.4, TS 3.1.5, TS 3.1.6, TS 3.1.8)

- 2.1.1 For TS 3.1.1, shutdown margin shall be greater than or equal to 1.3% $\Delta K/K$ in mode 2 with $K_{eff} < 1.0$ and in modes 3 and 4.
- 2.1.2 For TS 3.1.1, shutdown margin shall be greater than or equal to 1.0% $\Delta K/K$ in mode 5.
- 2.1.3 For TS 3.1.4, shutdown margin shall be greater than or equal to 1.3% $\Delta K/K$ in mode 1 and mode 2.
- 2.1.4 For TS 3.1.5, shutdown margin shall be greater than or equal to 1.3% $\Delta K/K$ in mode 1 and mode 2 with any control bank not fully inserted.
- 2.1.5 For TS 3.1.6, shutdown margin shall be greater than or equal to 1.3% $\Delta K/K$ in mode 1 and mode 2 with $K_{eff} \geq 1.0$.
- 2.1.6 For TS 3.1.8, shutdown margin shall be greater than or equal to 1.3% $\Delta K/K$ in mode 2 during Physics Testing.

2.2 Moderator Temperature Coefficient - MTC (TS 3.1.3)

2.2.1 The Moderator Temperature Coefficient (MTC) Limits are:

The MTC shall be less positive than the upper limits shown in Figure 1. The BOC, ARO, HZP MTC shall be less positive than $0.7E-04 \Delta K/K/^{\circ}F$.

The EOC, ARO, RTP MTC shall be less negative than the $-4.3E-04 \Delta K/K/^{\circ}F$ lower MTC limit.

2.2.2 The 300 ppm MTC Surveillance Limit is:

The measured 300 PPM ARO, equilibrium RTP MTC shall be less negative than or equal to $-3.65E-04 \Delta K/K/^{\circ}F$.

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2.2.3 The 60 PPM MTC Surveillance Limit is:

The 60 PPM ARO, equilibrium RTP MTC shall be less negative than or equal to $-4.125\text{E-}04 \Delta\text{K/K}/^{\circ}\text{F}$.

Where:

- BOC = Beginning of Cycle (burnup corresponding to most positive MTC)
- EOC = End of Cycle
- ARO = All Rods Out
- HZP = Hot Zero Thermal Power
- RTP = Rated Thermal Power
- PPM = Parts per million (Boron)

2.3 Shutdown Bank Insertion Limit (TS 3.1.5)

2.3.1 Each shutdown bank shall be withdrawn to at least 226 steps. Shutdown banks are withdrawn in sequence and with no overlap.

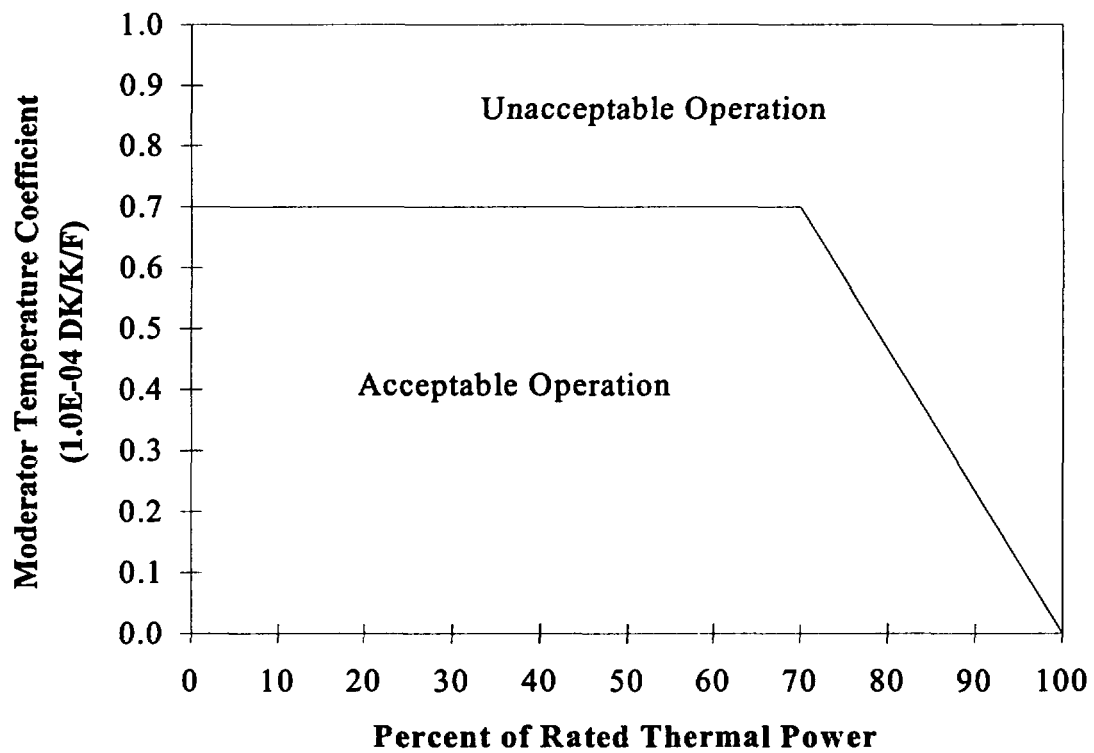
2.4 Control Bank Insertion Limits (TS 3.1.6)

2.4.1 Control banks shall be within the insertion, sequence, and overlap limits shown in Figure 2. Specific control bank withdrawal and overlap limits as a function of the fully withdrawn position are shown in Table 1.

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Figure 1

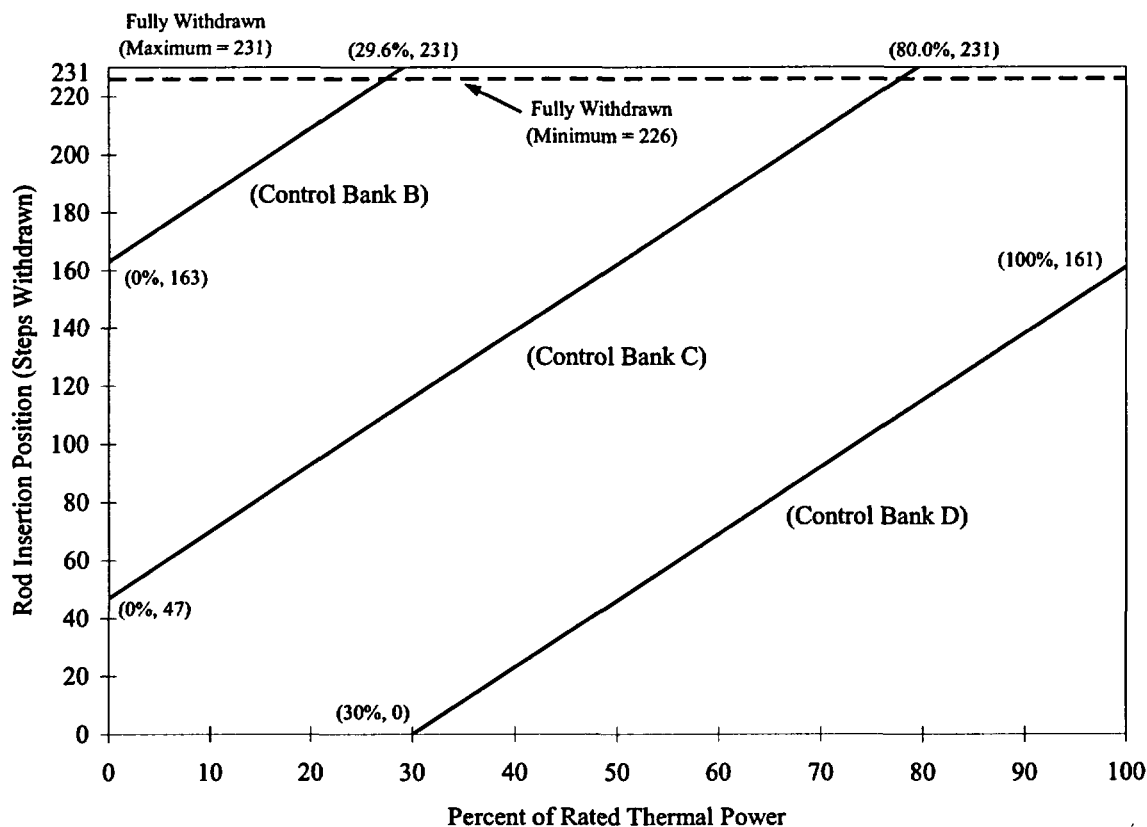
Moderator Temperature Coefficient Upper Limit Versus Power Level



NOTE: Compliance with Technical Specification 3.1.3 may require rod withdrawal limits.
Refer to the Unit 1 ROD manual for details.

Catawba 1 Cycle 14 Core Operating Limits Report

Figure 2
Control Bank Insertion Limits Versus Percent Rated Thermal Power



NOTE: Compliance with Technical Specification 3.1.3 may require rod withdrawal limits.
Refer to the Unit 1 ROD manual for details.

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Table 1
Control Bank Withdrawal Steps and Sequence

Fully Withdrawn at 226 Steps				Fully Withdrawn at 227 Steps			
Control Bank A	Control Bank B	Control Bank C	Control Bank D	Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0	0 Start	0	0	0
116	0 Start	0	0	116	0 Start	0	0
226 Stop	110	0	0	227 Stop	111	0	0
226	116	0 Start	0	227	116	0 Start	0
226	226 Stop	110	0	227	227 Stop	111	0
226	226	116	0 Start	227	227	116	0 Start
226	226	226 Stop	110	227	227	227 Stop	111
Fully Withdrawn at 228 Steps				Fully Withdrawn at 229 Steps			
Control Bank A	Control Bank B	Control Bank C	Control Bank D	Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0	0 Start	0	0	0
116	0 Start	0	0	116	0 Start	0	0
228 Stop	112	0	0	229 Stop	113	0	0
228	116	0 Start	0	229	116	0 Start	0
228	228 Stop	112	0	229	229 Stop	113	0
228	228	116	0 Start	229	229	116	0 Start
228	228	228 Stop	112	229	229	229 Stop	113
Fully Withdrawn at 230 Steps				Fully Withdrawn at 231 Steps			
Control Bank A	Control Bank B	Control Bank C	Control Bank D	Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0	0 Start	0	0	0
116	0 Start	0	0	116	0 Start	0	0
230 Stop	114	0	0	231 Stop	115	0	0
230	116	0 Start	0	231	116	0 Start	0
230	230 Stop	114	0	231	231 Stop	115	0
230	230	116	0 Start	231	231	116	0 Start
230	230	230 Stop	114	231	231	231 Stop	115

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2.5 Heat Flux Hot Channel Factor - $F_Q(X,Y,Z)$ (TS 3.2.1)

2.5.1 $F_Q(X,Y,Z)$ steady-state limits are defined by the following relationships:

$$\begin{aligned} F_Q^{RTP} * K(Z) / P & \quad \text{for } P > 0.5 \\ F_Q^{RTP} * K(Z) / 0.5 & \quad \text{for } P \leq 0.5 \end{aligned}$$

where,

$$P = (\text{Thermal Power}) / (\text{Rated Power})$$

Note: The measured $F_Q(X,Y,Z)$ shall be increased by 3% to account for manufacturing tolerances and 5% to account for measurement uncertainty when comparing against the limits. The manufacturing tolerance and measurement uncertainty are implicitly included in the F_Q surveillance limits as defined in COLR Sections 2.5.5 and 2.5.6.

2.5.2 $F_Q^{RTP} = 2.50 \times K(\text{BU})$

2.5.3 $K(Z)$ is the normalized $F_Q(X,Y,Z)$ as a function of core height. $K(Z)$ for MkBW fuel is provided in Figure 3, and the $K(Z)$ for Westinghouse RFA fuel is provided in Figure 4.

2.5.4 $K(\text{BU})$ is the normalized $F_Q(X,Y,Z)$ as a function of burnup. $K(\text{BU})$ for both MkBW fuel and Westinghouse RFA fuel is 1.0 at all burnups.

The following parameters are required for core monitoring per the Surveillance Requirements of Technical Specification 3.2.1:

2.5.5 $[F_Q^L(X,Y,Z)]^{OP} = \frac{F_Q^D(X,Y,Z) * M_Q(X,Y,Z)}{UMT * MT * TILT}$

where:

$[F_Q^L(X,Y,Z)]^{OP}$ = Cycle dependent maximum allowable design peaking factor that ensures that the $F_Q(X,Y,Z)$ LOCA limit is not exceeded for operation within the AFD, RIL, and QPTR limits.
 $F_Q^L(X,Y,Z)^{OP}$ includes allowances for calculational and measurement uncertainties.

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$F_Q^D(X,Y,Z)$ = Design power distribution for F_Q . $F_Q^D(X,Y,Z)$ is provided in Table 4, Appendix A, for normal operating conditions and in Table 7, Appendix A for power escalation testing during initial startup operation.

$M_Q(X,Y,Z)$ = Margin remaining in core location X,Y,Z to the LOCA limit in the transient power distribution. $M_Q(X,Y,Z)$ is provided in Table 4, Appendix A for normal operating conditions and in Table 7, Appendix A for power escalation testing during initial startup operation.

UMT = Total Peak Measurement Uncertainty. (UMT = 1.05)

MT = Engineering Hot Channel Factor. (MT = 1.03)

TILT = Peaking penalty that accounts for allowable quadrant power tilt ratio of 1.02. (TILT = 1.035)

$$2.5.6 \quad [F_Q^L(X,Y,Z)]^{RPS} = \frac{F_Q^D(X,Y,Z) * M_C(X,Y,Z)}{UMT * MT * TILT}$$

where:

$[F_Q^L(X,Y,Z)]^{RPS}$ = Cycle dependent maximum allowable design peaking factor that ensures that the $F_Q(X,Y,Z)$ Centerline Fuel Melt (CFM) limit is not exceeded for operation within the AFD, RIL, and QPRT limits. $[F_Q^L(X,Y,Z)]^{RPS}$ includes allowances for calculational and measurement uncertainties.

$F_Q^D(X,Y,Z)$ = Design power distributions for F_Q . $F_Q^D(X,Y,Z)$ is provided in Table 4, Appendix A for normal operating conditions and in Table 7, Appendix A for power escalation testing during initial startup operations.

$M_C(X,Y,Z)$ = Margin remaining to the CFM limit in core location X,Y,Z from the transient power distribution. $M_C(X,Y,Z)$ is provided in Table 5, Appendix A for normal operating conditions and in Table 8, Appendix A for power escalation testing during initial startup operations.

UMT = Measurement Uncertainty (UMT = 1.05)

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MT = Engineering Hot Channel Factor (MT = 1.03)

TILT = Peaking penalty that accounts for allowable quadrant power tilt ratio of 1.02. (TILT = 1.035)

2.5.7 KSLOPE = 0.0725

where:

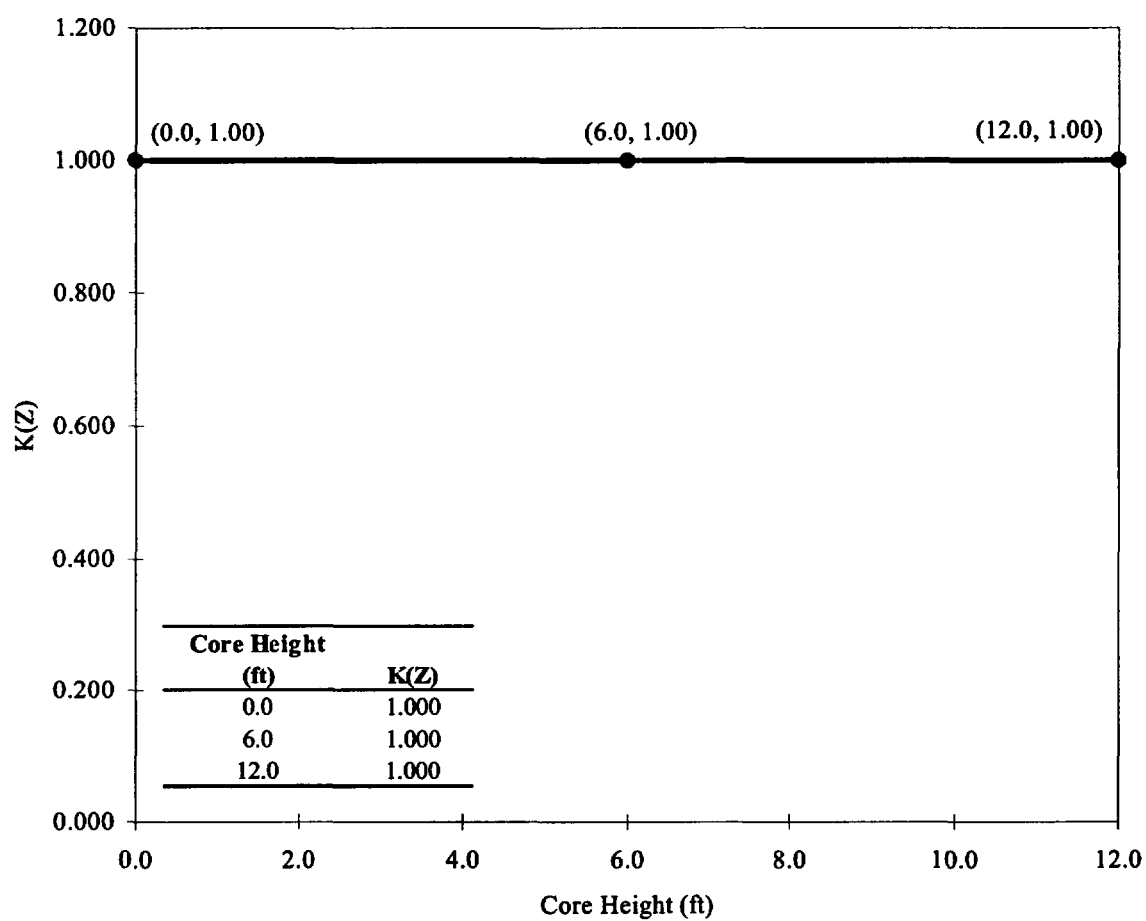
KSLOPE = the adjustment to the K_1 value from OTΔT trip setpoint required to compensate for each 1% that $F_Q^M(X,Y,Z)$ exceeds $F_Q^L(X,Y,Z)^{RPS}$.

2.5.8 $F_Q(X,Y,Z)$ Penalty Factors for Technical Specification Surveillances 3.2.1.2 and 3.2.1.3 are provided in Table 2.

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Figure 3

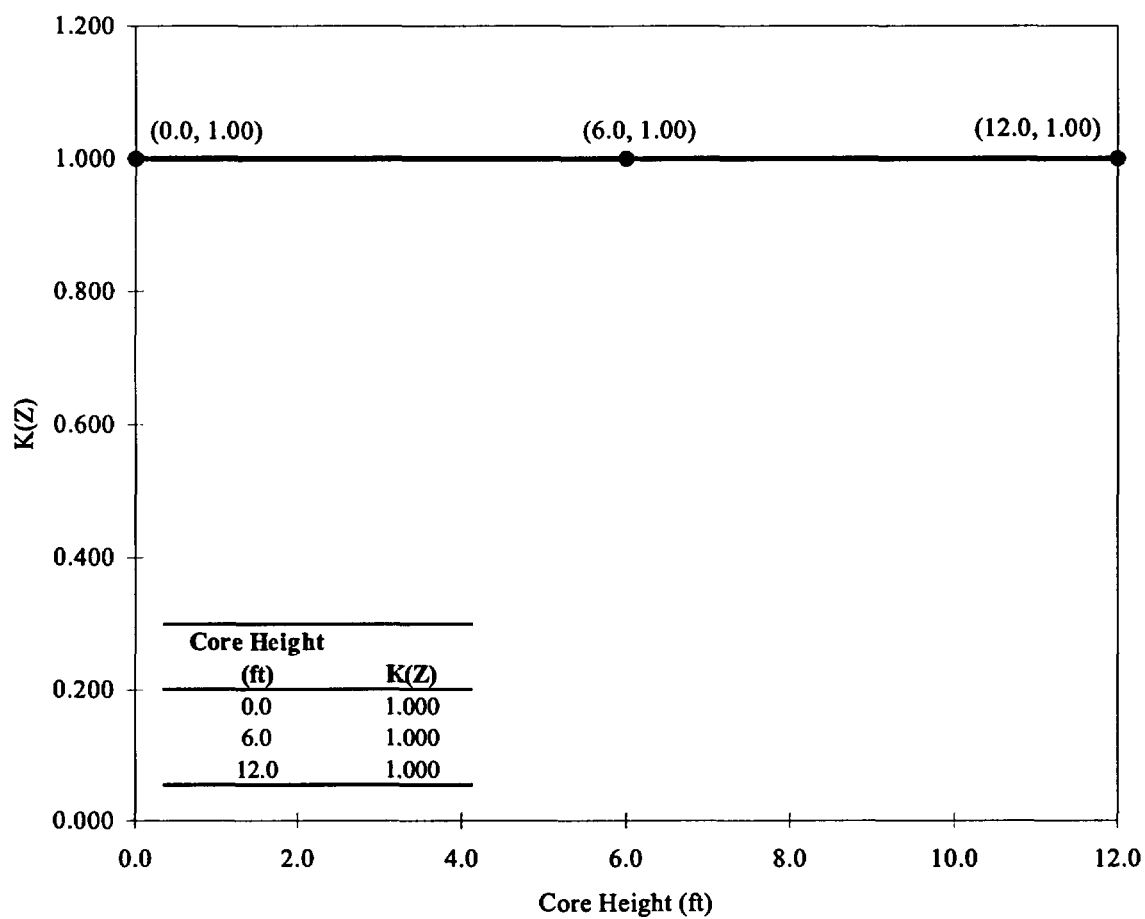
**K(Z), Normalized $F_Q(X,Y,Z)$ as a Function of Core Height
for MkBW Fuel**



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Figure 4

**$K(Z)$, Normalized $F_Q(X,Y,Z)$ as a Function of Core Height
for RFA Fuel**



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Table 2

**$F_Q(X,Y,Z)$ and $F_{\Delta H}(X,Y)$ Penalty Factors
For Tech Spec Surveillances 3.2.1.2, 3.2.1.3 and 3.2.2.2**

Burnup (EFPD)	$F_Q(X,Y,Z)$ Penalty Factor(%)	$F_{\Delta H}(X,Y)$ Penalty Factor (%)
4	2.00	2.00
12	2.21	2.00
25	2.08	2.00
50	2.00	2.00
75	2.00	2.00
100	2.00	2.00
125	2.00	2.00
150	2.00	2.00
175	2.00	2.00
200	2.00	2.00
225	2.00	2.00
250	2.00	2.00
275	2.00	2.00
300	2.00	2.00
400	2.00	2.00
500	2.00	2.00
530	2.00	2.00

Note: Linear interpolation is adequate for intermediate cycle burnups.
All cycle burnups outside the range of the table shall use a 2% penalty factor for both $F_Q(X,Y,Z)$ and $F_{\Delta H}(X,Y)$ for compliance with the Tech Spec Surveillances 3.2.1.2, 3.2.1.3 and 3.2.2.2.

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2.6 Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}(X,Y)$ (TS 3.2.2)

The $F_{\Delta H}$ steady-state limits referred to in Technical Specification 3.2.2 is defined by the following relationship.

$$2.6.1 \quad [F_{\Delta H}^L(X,Y)]^{LCO} = \text{MARP}(X,Y) * \left[1.0 + \frac{1}{\text{RRH}} * (1.0 - P) \right]$$

where:

$[F_{\Delta H}^L(X,Y)]^{LCO}$ is defined as the steady-state, maximum allowed radial peak.

$[F_{\Delta H}^L(X,Y)]^{LCO}$ includes allowances for calculation/measurement uncertainty.

$\text{MARP}(X,Y) =$ Cycle-specific operating limit Maximum Allowable Radial Peaks. $\text{MARP}(X,Y)$ radial peaking limits are provided in Table 3.

$$P = \frac{\text{Thermal Power}}{\text{Rated Thermal Power}}$$

$\text{RRH} =$ Thermal Power reduction required to compensate for each 1% that the measured radial peak, $F_{\Delta H}^M(X,Y)$, exceeds the limit.

$$(\text{RRH} = 3.34, 0.0 < P \leq 1.0)$$

The following parameters are required for core monitoring per the Surveillance requirements of Technical Specification 3.2.2.

$$2.6.2 \quad [F_{\Delta H}^L(X,Y)]^{SURV} = \frac{F_{\Delta H}^D(X,Y) \times M_{\Delta H}(X,Y)}{\text{UMR} \times \text{TILT}}$$

where:

$[F_{\Delta H}^L(X,Y)]^{SURV} =$ Cycle dependent maximum allowable design peaking factor that ensures that the $F_{\Delta H}(X,Y)$ limit is not exceeded for operation within the AFD, RIL, and QPTR limits.

$F_{\Delta H}^L(X,Y)^{SURV}$ includes allowances for calculational and measurement uncertainty.

$F_{\Delta H}^D(X,Y) =$ Design power distribution for $F_{\Delta H}$. $F_{\Delta H}^D(X,Y)$ is provided in Table 6, Appendix A for normal operation and in Table 9,

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Appendix A for power escalation testing during initial startup operation.

$M_{\Delta H}(X,Y)$ = The margin remaining in core location X,Y relative to the Operational DNB limits in the transient power distribution. $M_{\Delta H}(X,Y)$ is provided in Table 6, Appendix A for normal operation and in Table 9, Appendix A for power escalation testing during initial startup operation.

UMR = Uncertainty value for measured radial peaks. UMR is set to 1.0 since a factor of 1.04 is implicitly included in the variable $M_{\Delta H}(X,Y)$.

TILT = Peaking penalty that accounts for allowable quadrant power tilt ratio of 1.02. (TILT = 1.035)

NOTE: $[F_{\Delta H}^L(X,Y)]^{SURV}$ is the parameter identified as $[F_{\Delta H}(X,Y)]^{MAX}$ in DPC-NE-2011PA.

2.6.3 $RRH = 3.34$

where:

RRH = Thermal Power reduction required to compensate for each 1% that the measured radial peak, $F_{\Delta H}^M(X,Y)$ exceeds its limit. ($0 < P \leq 1.0$)

2.6.4 $TRH = 0.04$

where:

TRH = Reduction in $OT\Delta T K_1$ setpoint required to compensate for each 1% that the measured radial peak, $F_{\Delta H}(X,Y)$ exceeds its limit.

2.6.5 $F_{\Delta H}(X,Y)$ Penalty Factors for Technical Specification Surveillance 3.2.2.2 are provided in Table 2.

2.7 Axial Flux Difference – AFD (TS 3.2.3)

2.7.1 The Axial Flux Difference (AFD) Limits are provided in Figure 5.

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Table 3
Maximum Allowable Radial Peaks (MARPS)

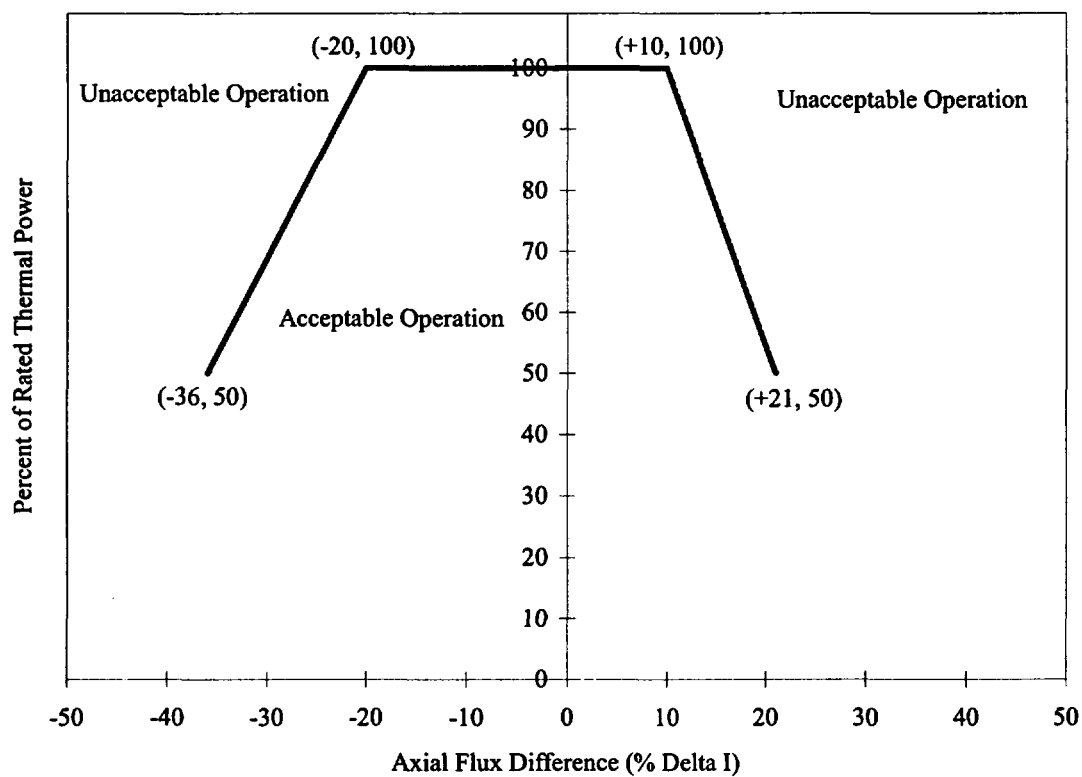
MkBW and RFA Fuel MARPs
100% Full Power

Height (ft)	Axial Peak												
	1.05	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	3.0	3.25
0.12	1.678	1.708	1.772	1.829	1.878	1.922	1.852	1.798	1.714	1.636	1.535	1.211	1.147
1.20	1.675	1.706	1.766	1.821	1.867	1.886	1.829	1.806	1.731	1.655	1.540	1.182	1.117
2.40	1.679	1.708	1.763	1.815	1.853	1.841	1.786	1.769	1.711	1.655	1.557	1.168	1.106
3.60	1.682	1.709	1.760	1.804	1.812	1.797	1.743	1.722	1.669	1.619	1.556	1.202	1.131
4.80	1.684	1.708	1.754	1.792	1.766	1.750	1.699	1.681	1.630	1.581	1.516	1.232	1.186
6.00	1.686	1.708	1.745	1.761	1.715	1.703	1.654	1.638	1.590	1.544	1.476	1.206	1.156
7.20	1.686	1.704	1.733	1.714	1.666	1.649	1.603	1.587	1.542	1.503	1.438	1.177	1.127
8.40	1.681	1.692	1.702	1.660	1.612	1.595	1.549	1.537	1.494	1.454	1.387	1.145	1.100
9.60	1.673	1.677	1.651	1.601	1.558	1.544	1.502	1.491	1.450	1.413	1.350	1.121	1.076
10.80	1.662	1.649	1.603	1.550	1.503	1.491	1.448	1.441	1.404	1.369	1.307	1.086	1.043
12.00	1.636	1.608	1.553	1.505	1.456	1.446	1.408	1.403	1.370	1.340	1.286	1.072	1.027

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Figure 5

Percent of Rated Thermal Power Versus Percent Axial Flux Difference Limits



NOTE: Compliance with Technical Specification 3.2.1 may require more restrictive AFD limits. Refer to the Unit 1 ROD manual for operational AFD limits.

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2.8 Reactor Trip System Instrumentation Setpoints (TS 3.3.1) Table 3.3.1-1

2.8.1 Overtemperature ΔT Setpoint Parameter Values

<u>Parameter</u>	<u>Nominal Value</u>
Overtemperature ΔT reactor trip setpoint	$K_1 = 1.1978$
Overtemperature ΔT reactor trip heatup setpoint penalty coefficient	$K_2 = 0.03340/^{\circ}\text{F}$
Overtemperature ΔT reactor trip depressurization setpoint penalty coefficient	$K_3 = 0.001601/\text{psi}$
Time constants utilized in the lead-lag compensator for ΔT	$\tau_1 = 8 \text{ sec.}$ $\tau_2 = 3 \text{ sec.}$
Time constant utilized in the lag compensator for ΔT	$\tau_3 = 0 \text{ sec.}$
Time constants utilized in the lead-lag compensator for T_{avg}	$\tau_4 = 22 \text{ sec.}$ $\tau_5 = 4 \text{ sec.}$
Time constant utilized in the measured T_{avg} lag compensator	$\tau_6 = 0 \text{ sec.}$
$f_1(\Delta I)$ "positive" breakpoint	$= 19.0 \% \Delta I$
$f_1(\Delta I)$ "negative" breakpoint	$= \text{N/A}^*$
$f_1(\Delta I)$ "positive" slope	$= 1.769 \% \Delta T_0 / \% \Delta I$
$f_1(\Delta I)$ "negative" slope	$= \text{N/A}^*$

- * The $f_1(\Delta I)$ "negative" breakpoint and the $f_1(\Delta I)$ "negative" slope are not applicable since the $f_1(\Delta I)$ function is not required below the $f_1(\Delta I)$ "positive" breakpoint of 19.0% ΔI .

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2.8.2 Overpower ΔT Setpoint Parameter Values

<u>Parameter</u>	<u>Nominal Value</u>
Overpower ΔT reactor trip setpoint	$K_4 = 1.0864$
Overpower ΔT reactor trip heatup setpoint penalty coefficient (for $T > T''$)	$K_6 = 0.001179/^{\circ}\text{F}$
Time constants utilized in the lead-lag compensator for ΔT	$\tau_1 = 8 \text{ sec.}$ $\tau_2 = 3 \text{ sec.}$
Time constant utilized in the lag compensator for ΔT	$\tau_3 = 0 \text{ sec.}$
Time constant utilized in the measured T_{avg} lag compensator	$\tau_6 = 0 \text{ sec.}$
Time constant utilized in the rate-lag controller for T_{avg}	$\tau_7 = 10 \text{ sec.}$
$f_2(\Delta I)$ "positive" breakpoint	$= 35.0 \% \Delta I$
$f_2(\Delta I)$ "negative" breakpoint	$= -35.0 \% \Delta I$
$f_2(\Delta I)$ "positive" slope	$= 7.0 \% \Delta T_0 / \% \Delta I$
$f_2(\Delta I)$ "negative" slope	$= 7.0 \% \Delta T_0 / \% \Delta I$

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2.9 Boron Dilution Mitigation System (TS 3.3.9)

2.9.1 Reactor Makeup Water Pump flow rate limits:

<u>Applicable Mode</u>	<u>Limit</u>
Mode 3	≤ 150 gpm
Mode 4 or 5	≤ 70 gpm

2.10 Accumulators (TS 3.5.1)

2.10.1 Boron concentration limits during modes 1 and 2, and mode 3 with RCS pressure >1000 psi:

<u>Parameter</u>	<u>Limit</u>
Cold Leg Accumulator minimum boron concentration.	2,500 ppm
Cold Leg Accumulator maximum boron concentration.	2,975 ppm

2.11 Refueling Water Storage Tank - RWST (TS 3.5.4)

2.11.1 Boron concentration limits during modes 1, 2, 3, and 4:

<u>Parameter</u>	<u>Limit</u>
Refueling Water Storage Tank minimum boron concentration.	2,700 ppm
Refueling Water Storage Tank maximum boron concentration.	2,975 ppm

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Appendix A

Power Distribution Monitoring Factors

Appendix A contains power distribution monitoring factors used in Technical Specification Surveillance. Due to the size of the monitoring factor data, Appendix A is controlled electronically within Duke and is not included in the Duke internal copies of the COLR. The Catawba Reactor and Electrical Systems Engineering Section controls this information via computer files and should be contacted if there is a need to access this information.

Appendix A is included in the COLR copy transmitted to the NRC.