Duke Power
A Duke Energy Company

Gary R. Peterson
Vice President

Duke Power
Catawba Nuclear Station
4800 Concord Road
York, SC 29745
(803) 831-4251 OFFICE
(803) 831-3221 FAX

October 18, 2001

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

Subject: Duke Energy Corporation
Catawba Nuclear Station Unit 1 and 2
Docket No.: 50-413, 50-414
Core Operating Limits Report (COLR)

Attached, pursuant to Catawba Technical Specification 5.6.5, is an information copy of the Core Operating Limits Reports for Catawba as follows:

Attachment 1 - Unit 1 revision 20
Attachment 2 - Unit 1 revision 21
Attachment 3 - Unit 2 revision 19
Attachment 4 - Unit 2 revision 20

An electronic copy of Unit 2 COLR revision 19 Attachment A is included with the letter submitted to the NRC Document Control Desk. The electronic files are submitted in accordance with the NRC Regulatory Issue Summary 2001-05, Guidance on Submitting Documents to the NRC by Electronic Information Exchange or on CD-ROM.

The enclosed attachments does not contain any new commitments.

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

Sincerely,

G. R. Peterson

A001

Attachments

Rec'd 01/14/02

xc w/att: L. A. Reyes, Regional, Administrator
USNRC, Region II

C. P. Patel, NRC Senior Project Manager (CNS)
USNRC, ONRR

D. E. Billings
Senior Resident Inspector - acting (CNS)

Attachment 1 - Unit 1 COLR revision 20

Catawba Unit 1 Cycle 13

Core Operating Limits Report
Revision 20

September 2001

Duke Power Company

		Date
Prepared By:	Sandra L. Abbey	9/17/2001
Checked By:	Scott B. Thomas	9/17/2001
Checked By:	[illegible]	9/17/2001
Approved By:	R. R. St. Clair	9/17/2001

QA Condition 1

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

Catawba 1 Cycle 13 Core Operating Limits Report

IMPLEMENTATION INSTRUCTIONS FOR REVISION 20

Revision 20 of the Catawba Unit 1 COLR should be implemented concurrently with associated changes to SLC section 16.9-11 and 16.9-12.

Catawba 1 Cycle 13 Core Operating Limits Report

REVISION LOG

Revision	EI Date	Pages Affected	COLR
0 – 1	Superceded	N/A	C1C07
2 – 5	Superceded	N/A	C1C08
6 – 8	Superceded	N/A	C1C09
9 – 11	Superceded	N/A	C1C10
12 - 14	Superceded	N/A	C1C11
15 – 17	Superceded	N/A	C1C12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)

Catawba 1 Cycle 13 Core Operating Limits Report

INSERTION SHEET FOR REVISION 20

Remove pages	Insert Rev. 20 pages
Pages 1-4, 25, 26	Pages 1-4, 25, 26a, 26b

Catawba 1 Cycle 13 Core Operating Limits Report

2.15 Standby Shutdown System - Standby Makeup Pump Water Supply - (SLC-16.7-9.3)

2.15.1 Minimum boron concentration limit for the spent fuel pool. Applicable for modes 1, 2, and 3.

Parameter	Limit
Spent fuel pool minimum boron concentration for surveillance SLC-16.7-9.3.	2,700 ppm

2.16 Borated Water Source – Shutdown (SLC 16.9-11)

2.16.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Mode 4 with any RCS cold leg temperature $\leq 285^{O}$F, and Modes 5 and 6.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 68°F	2000 gallons
Boric Acid Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	13,086 gallons (14.9%)

NOTE: When sampled primary coolant boron concentration is less than 154 ppm, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Parameter	Limit
Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM of 68 °F	7,000 gallons
Refueling Water Storage Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	48,500 gallons (8.7%)

Catawba 1 Cycle 13 Core Operating Limits Report

2.17 Borated Water Source - Operating (SLC 16.9-12)

2.17.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Modes 1, 2, and 3 and Mode 4 with all RCS cold leg temperatures > 285°F.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 285°F	13,500 gallons
Boric Acid Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	25,200 gallons (45.8%)

NOTE: When sampled primary coolant boron concentration is less than 154 ppm, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Parameter	Limit
Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM of 68°F	57,107 gallons
Refueling Water Storage Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	98,607 gallons (22.0%)

NOTE: Data contained in the Appendix to this document was generated in the Catawba 1 Cycle 13 Maneuvering Analysis calculation file, CNC-1553.05-00-0337. The Plant Nuclear Engineering Section will control this information via computer file(s) and should be contacted if there is a need to access this information.

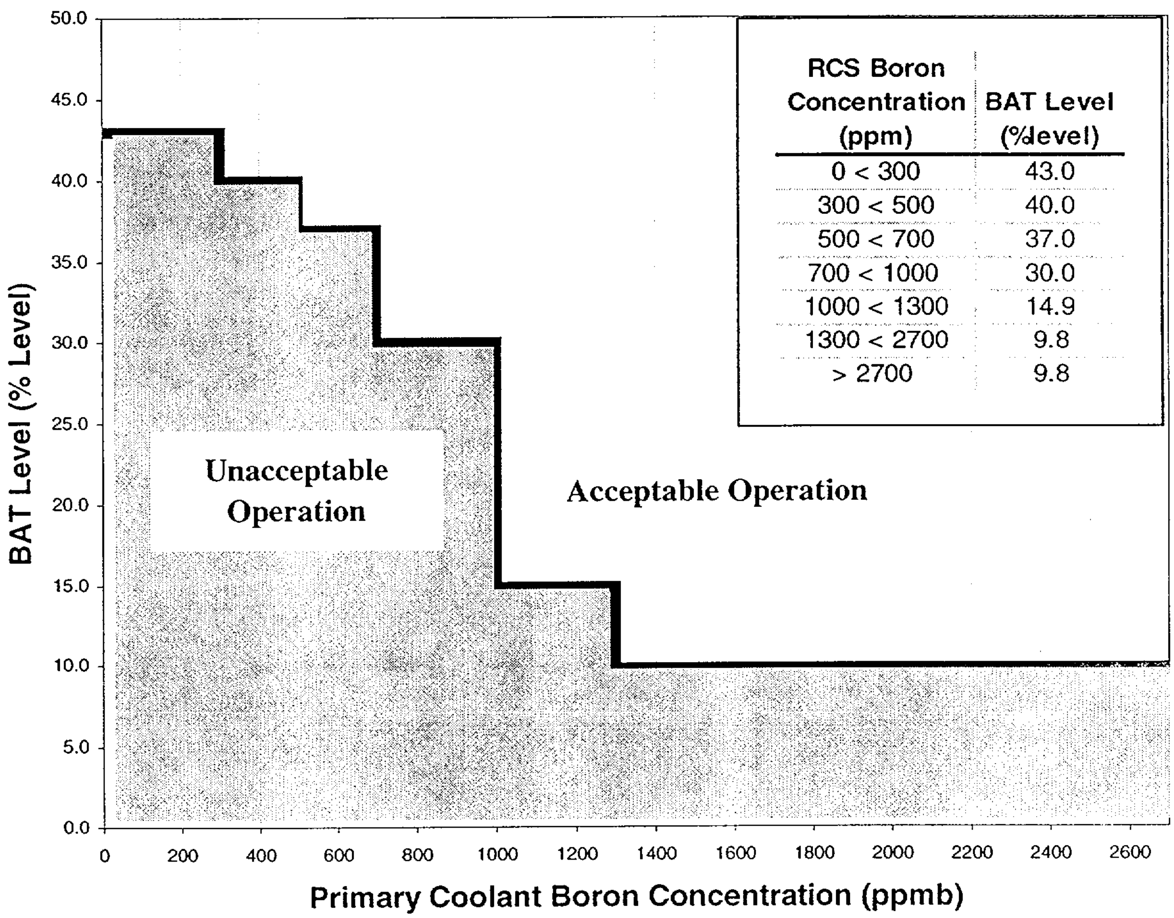
Catawba 1 Cycle 13 Core Operating Limits Report

Figure 6

Boric Acid Storage Tank Indicated Level Versus Primary Coolant Boron Concentration

(Valid When Sampled Primary Coolant Boron Concentration < 154 ppm)

This figure includes additional volumes listed in SLC 16.9-11 and 16.9-12



RCS Boron Concentration (ppm)	BAT Level (%level)
0 < 300	43.0
300 < 500	40.0
500 < 700	37.0
700 < 1000	30.0
1000 < 1300	14.9
1300 < 2700	9.8
> 2700	9.8

Attachment 2 - Unit 1 COLR revision 21

Catawba Unit 1 Cycle 13

Core Operating Limits Report
Revision 21

September 2001

Duke Power Company

		Date
Prepared By:	Sandra L. Abbey	9/18/01
Checked By:	Scott B. Thomas	9/18/01
Checked By:	[illegible]	9/18/01
Approved By:	P. M. Abraham	9/18/01

QA Condition 1

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

Catawba 1 Cycle 13 Core Operating Limits Report

IMPLEMENTATION INSTRUCTIONS FOR REVISION 21

Revision 21 of the Catawba Unit 1 COLR should be implemented concurrently with associated changes to SLC section 16.9-11 and 16.9-12.

Catawba 1 Cycle 13 Core Operating Limits Report

REVISION LOG

Revision	EI Date	Pages Affected	COLR
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)

Catawba 1 Cycle 13 Core Operating Limits Report

INSERTION SHEET FOR REVISION 21

Remove pages	Insert Rev. 21 pages
Pages 1-4, 25, 26a,26b	Pages 1-4, 25, 26a, 26b

Catawba 1 Cycle 13 Core Operating Limits Report

2.15 Standby Shutdown System - Standby Makeup Pump Water Supply - (SLC-16.7-9.3)

2.15.1 Minimum boron concentration limit for the spent fuel pool. Applicable for modes 1, 2, and 3.

Parameter	Limit
Spent fuel pool minimum boron concentration for surveillance SLC-16.7-9.3.	2,700 ppm

2.16 Borated Water Source – Shutdown (SLC 16.9-11)

2.16.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Mode 4 with any RCS cold leg temperature $\leq 285^{O}$F, and Modes 5 and 6.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 68°F	2000 gallons
Boric Acid Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	13,086 gallons (14.9%)

NOTE: When cycle burnup is > 450 EFPD, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Parameter	Limit
Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM of 68°F	7,000 gallons
Refueling Water Storage Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	48,500 gallons (8.7%)

Catawba 1 Cycle 13 Core Operating Limits Report

2.17 Borated Water Source - Operating (SLC 16.9-12)

2.17.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Modes 1, 2, and 3 and Mode 4 with all RCS cold leg temperatures > 285°F.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 285°F	13,500 gallons
Boric Acid Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	25,200 gallons (45.8%)

NOTE: When cycle burnup is > 450 EFPD, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Parameter	Limit
Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM of 68°F	57,107 gallons
Refueling Water Storage Tank Minimum Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	98,607 gallons (22.0%)

NOTE: Data contained in the Appendix to this document was generated in the Catawba 1 Cycle 13 Maneuvering Analysis calculation file, CNC-1553.05-00-0337. The Plant Nuclear Engineering Section will control this information via computer file(s) and should be contacted if there is a need to access this information.

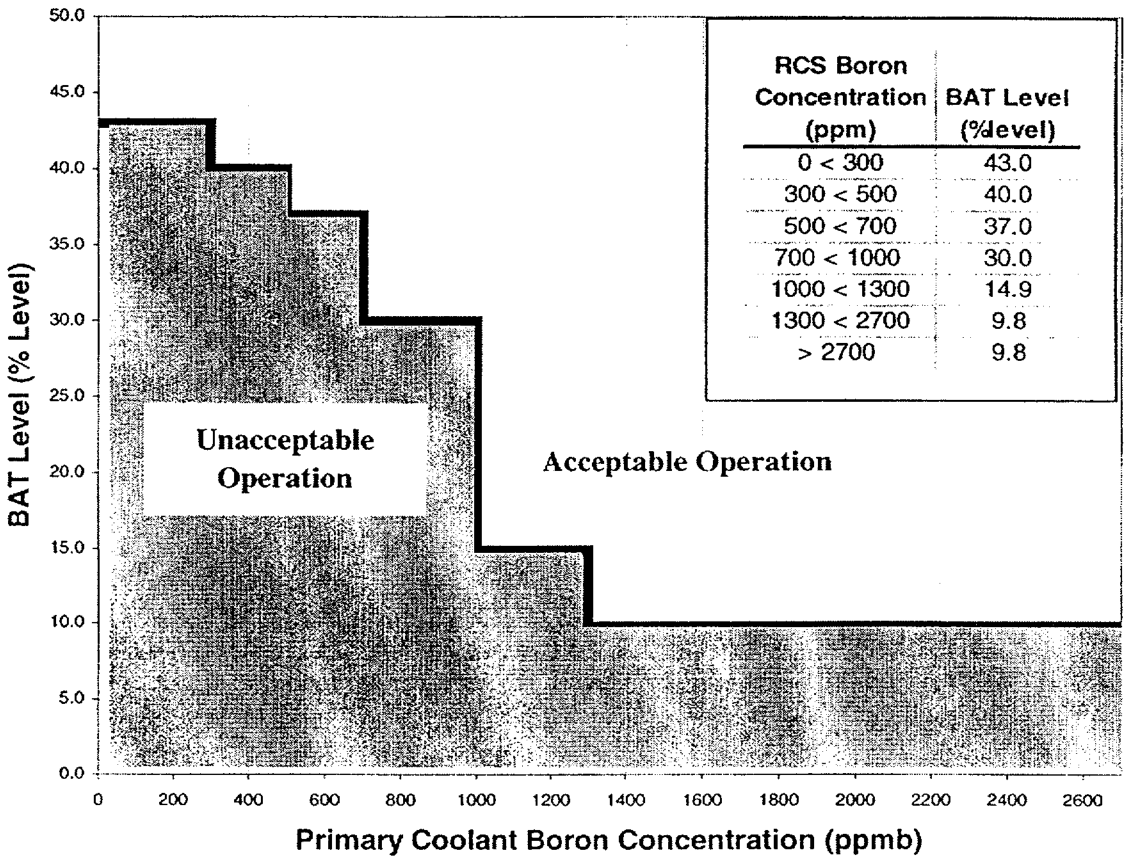
Catawba 1 Cycle 13 Core Operating Limits Report

Figure 6

Boric Acid Storage Tank Indicated Level Versus Primary Coolant Boron Concentration

(Valid When Cycle Burnup is > 450 EFPD)

This figure includes additional volumes listed in SLC 16.9-11 and 16.9-12



Attachment 3 - Unit 2 COLR revision 19

Catawba Unit 2 Cycle 12

Core Operating Limits Report
Revision 19

September 2001

Duke Power Company

		Date
Prepared By:	Scott B. Thomas	9/14/01
Checked By:	Nicholas R Hagy	9/14/01
Checked By:	[illegible]	9/14/01
Approved By:	P. M. Abraham	9-17-01

QA Condition 1

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

Catawba 2 Cycle 12 Core Operating Limits Report

IMPLEMENTATION INSTRUCTIONS FOR REVISION 19

Revision 19 of the Catawba Unit 2 COLR may become effective any time during No-Mode between cycles 11 and 12.

This revision must become effective prior to entering Mode 6 which starts cycle 12.

In addition, this revision must be made concurrently with the associated SLC 16.9-11 and 16.9-12 changes.

Catawba 2 Cycle 12 Core Operating Limits Report

REVISION LOG

Revision	Effective Date	Pages Affected	COLR
Revisions 1-13	N/A	N/A	C2C06 – C2C09
Revision 14	August 1998	N/A	C2C10 COLR
Revision 15	October 1998	N/A	C2C10 COLR rev 1
Revision 16	December 1998	N/A	C2C10 COLR rev 2
Revision 17	February 2000	N/A	C2C11 COLR
Revision 18	February 2001	N/A	C2C11 COLR rev 1
Revision 19	September 2001	ALL	C2C12 COLR

Catawba 2 Cycle 12 Core Operating Limits Report

INSERTION SHEET FOR REVISION 19

Remove pages	Insert Rev. 19 pages
Pages 1-25	Pages 1-27
Appendix A, Pages 1-331	Appendix A, Pages 1-311

Catawba 2 Cycle 12 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 the 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	6
3.1.3	Moderator Temperature Coefficient	MTC	2.2	6
3.1.4	Rod Group Alignment Limits	Shutdown Margin	2.1	6
3.1.5	Shutdown Bank Insertion Limit	Shutdown Margin Rod Insertion Limits	2.1 2.3	6 7
3.1.6	Control Bank Insertion Limit	Shutdown Margin Rod Insertion Limits	2.1 2.4	6 7
3.1.8	Physics Tests Exceptions	Shutdown Margin	2.1	6
3.2.1	Heat Flux Hot Channel Factor	F_Q AFD OTΔT Penalty Factors	2.5 2.7 2.8 2.5	11 18 21 13
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor	FΔH Penalty Factors	2.6 2.6	17 18
3.2.3	Axial Flux Difference	AFD	2.7	18
3.3.1	Reactor Trip System Instrumentation	OTΔT OPΔT	2.8 2.8	21 22
3.3.9	Boron Dilution Mitigation System	Reactor Makeup Water Flow Rate	2.9	23
3.5.1	Accumulators	Max and Min Boron Conc.	2.10	23
3.5.4	Refueling Water Storage Tank	Max and Min Boron Conc..	2.11	23
3.7.15	Spent Fuel Pool Boron Concentration	Min Boron Concentration	2.12	24
3.9.1	Refueling Operations - Boron Concentration	Min Boron Concentration	2.13	24
3.9.2	Refueling Operations – Nuclear Instrumentation	Reactor Makeup Water Flow Rate	2.14	24

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	25
16.9-11	Boration Systems – Borated Water Source – Shutdown	Borated Water Volume and Conc. for BAT/RWST	2.16	25
16.9-12	Boration Systems – Borated Water Source – Operating	Borated Water Volume and Conc. for BAT/RWST	2.17	26

Catawba 2 Cycle 12 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 Technical Specification 5.6.5.

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% ΔK/K in mode 2 with Keff < 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% ΔK/K in mode 5.

2.1.3 For TS 3.1.4, shutdown margin shall be greater than or equal to 1.3% ΔK/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% ΔK/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% ΔK/K in mode 1 and mode 2 with Keff ≥ 1.0.

2.1.6 For TS 3.1.8, shutdown margin shall be greater than or equal to 1.3% ΔK/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 ΔK/K/°F.

The EOC, ARO, RTP MTC shall be less negative than the -4.1E-04 ΔK/K/°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 -3.2E-04 ΔK/K/°F.

Catawba 2 Cycle 12 Core Operating Limits Report

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 -3.85E-04 ΔK/K/°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.

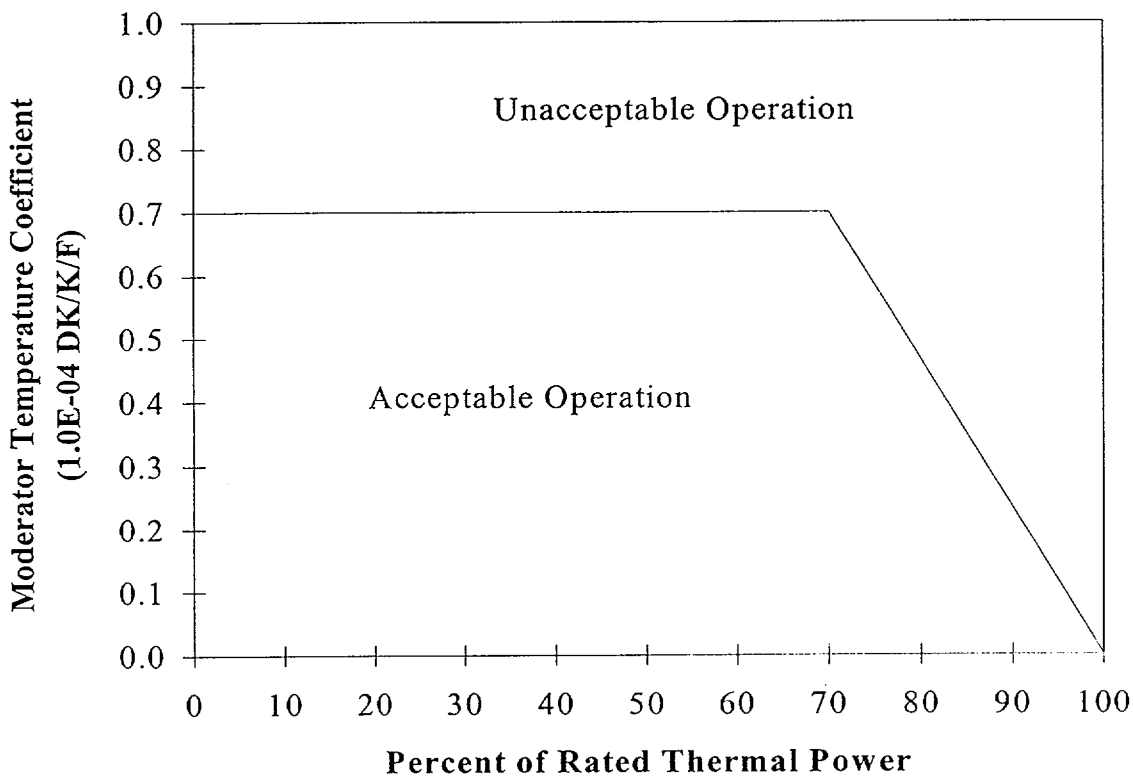
2.4 Control Bank Insertion Limits (TS 3.1.6)

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.

Catawba 2 Cycle 12 Core Operating Limits Report

Figure 1

Moderator Temperature Coefficient Upper Limit Versus Power Level

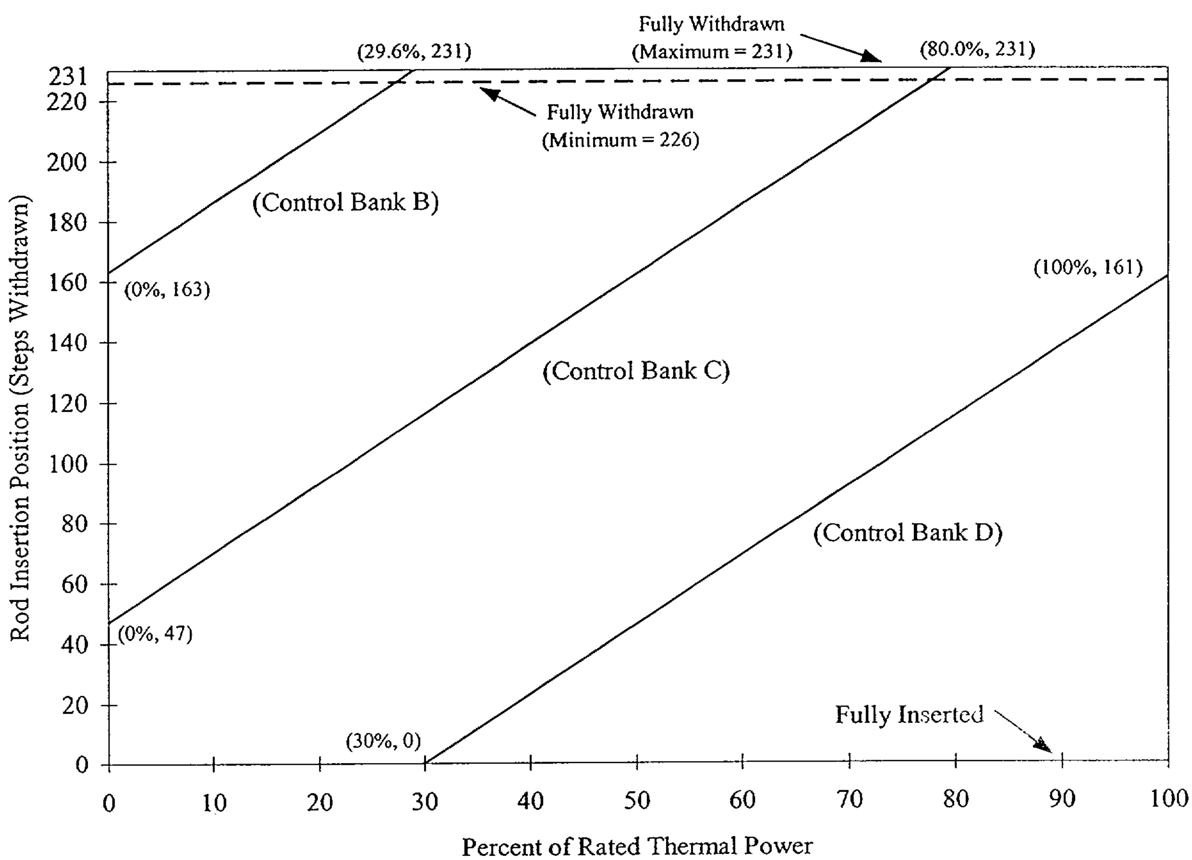


NOTE: Compliance with Technical Specification 3.1.3 may require rod withdrawal limits. Refer to the Unit 2 ROD manual for details.

Catawba 2 Cycle 12 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 2 ROD manual for details.

Catawba 2 Cycle 12 Core Operating Limits Report

Table 1
Control Bank Withdrawal Steps and Sequence

Fully Withdrawn at 226 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
226 Stop	110	0	0
226	116	0 Start	0
226	226 Stop	110	0
226	226	116	0 Start
226	226	226 Stop	110

Fully Withdrawn at 227 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
227 Stop	111	0	0
227	116	0 Start	0
227	227 Stop	111	0
227	227	116	0 Start
227	227	227 Stop	111

Fully Withdrawn at 228 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
228 Stop	112	0	0
228	116	0 Start	0
228	228 Stop	112	0
228	228	116	0 Start
228	228	228 Stop	112

Fully Withdrawn at 229 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
229 Stop	113	0	0
229	116	0 Start	0
229	229 Stop	113	0
229	229	116	0 Start
229	229	229 Stop	113

Fully Withdrawn at 230 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
230 Stop	114	0	0
230	116	0 Start	0
230	230 Stop	114	0
230	230	116	0 Start
230	230	230 Stop	114

Fully Withdrawn at 231 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
231 Stop	115	0	0
231	116	0 Start	0
231	231 Stop	115	0
231	231	116	0 Start
231	231	231 Stop	115

Catawba 2 Cycle 12 Core Operating Limits Report

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:

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

where,

P = (Thermal Power)/(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 $F_Q^{RTP} = 2.50 \times K(BU)$

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(BU) is the normalized $F_Q(X,Y,Z)$ as a function of burnup. K(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.

Catawba 2 Cycle 12 Core Operating Limits Report

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 5, 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 5, 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 $$[F_Q^L(X,Y,Z)]^{RPS} = \frac{F_Q^D(X,Y,Z) * M_C(X,Y,Z)}{UMT * MT * TILT}$$

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 5, Appendix A for power escalation testing during initial startup operations.

Catawba 2 Cycle 12 Core Operating Limits Report

$M_C(X,Y,Z)$ = 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 6, Appendix A for normal operating conditions and in Table 7, Appendix A for power escalation testing during initial startup operations.

UMT = 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)

2.5.7 KSLOPE = 0.0725

where:

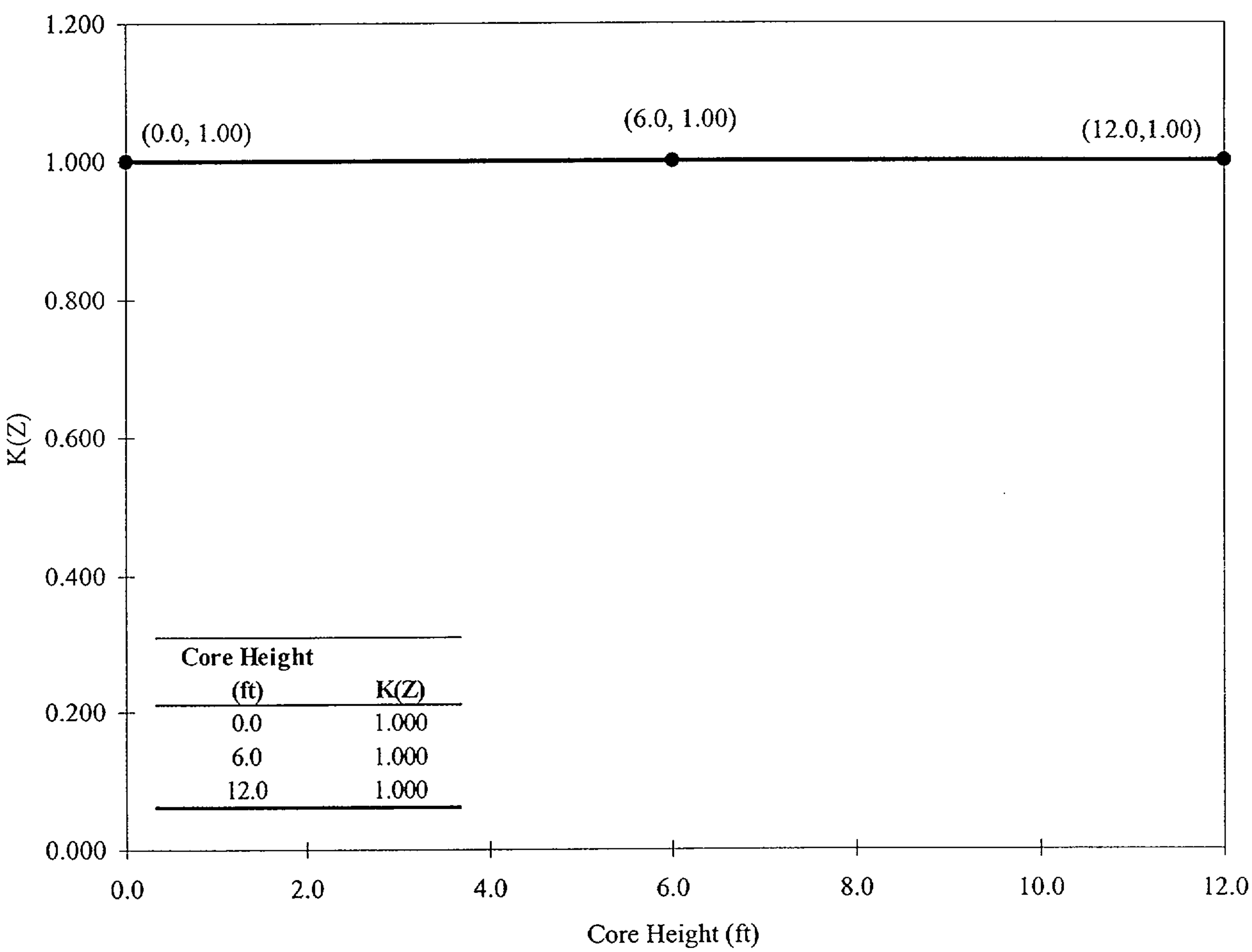
KSLOPE = the adjustment to the K_1 value from OTΔT trip setpoint required to compensate for each 1% that $F_Q^M(X,Y,Z)$ exceeds $F_Q^L(X,Y,Z)^{RPS}$.

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.

Catawba 2 Cycle 12 Core Operating Limits Report

Figure 3

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

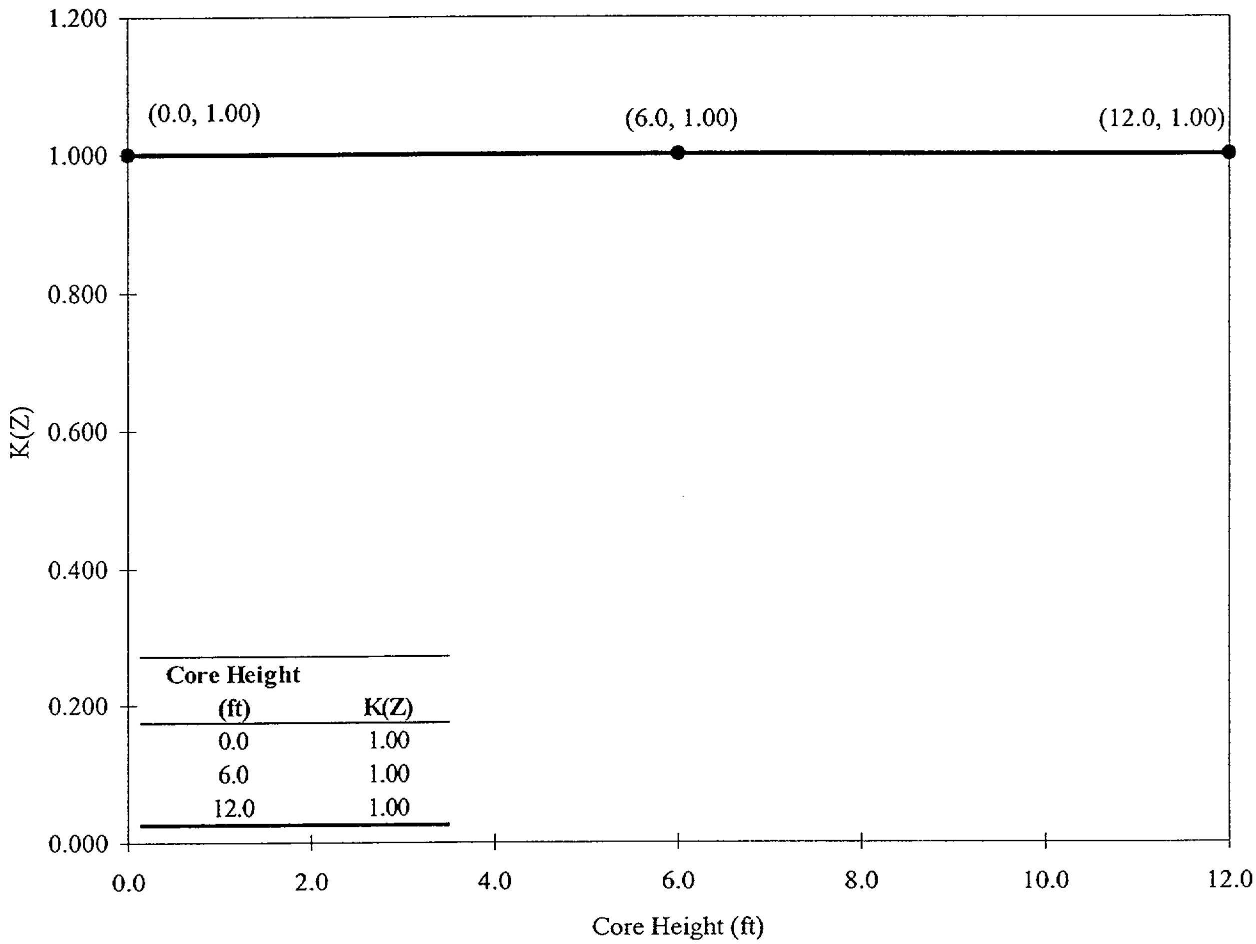


Core Height (ft)	K(Z)
0.0	1.000
6.0	1.000
12.0	1.000

Catawba 2 Cycle 12 Core Operating Limits Report

Figure 4

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



Core Height (ft)	K(Z)
0.0	1.00
6.0	1.00
12.0	1.00

Catawba 2 Cycle 12 Core Operating Limits Report

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	2.00	2.00
25	2.00	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
275	2.00	2.00
300	2.00	2.00
325	2.00	2.00
505	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.

Catawba 2 Cycle 12 Core Operating Limits Report

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

where:

$[F^L_{\Delta H}(X,Y)]^{LCO}$ is defined as the steady-state, maximum allowed radial peak. $[F^L_{\Delta H}(X,Y)]^{LCO}$ includes allowances for calculation/measurement uncertainty.

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

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

RRH = Thermal Power reduction required to compensate for each 1% that the measured radial peak, $F^M_{\Delta H}(X,Y)$, exceeds the limit.
($RRH = 3.34,\ 0.0 < P \leq 1.0$)

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

2.6.2 $[F^L_{\Delta H}(X,Y)]^{SURV} = \frac{F^D_{\Delta H}(X,Y) \times M_{\Delta H}(X,Y)}{UMR \times TILT}$

where:

$[F^L_{\Delta H}(X,Y)]^{SURV}$ = 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 QPRT limits. $F^L_{\Delta H}(X,Y)^{SURV}$ includes allowances for calculational and measurement uncertainty.

$F^D_{\Delta H}(X,Y)$ = Design power distribution for $F_{\Delta H}$. $F^D_{\Delta H}(X,Y)$ is provided in Table 8, Appendix A for normal operation and in Table 9,

Catawba 2 Cycle 12 Core Operating Limits Report

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 8, 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)

2.6.3 RRH = 3.34

where:

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

2.6.4 TRH = 0.04

where:

TRH = Reduction in OTΔT 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)

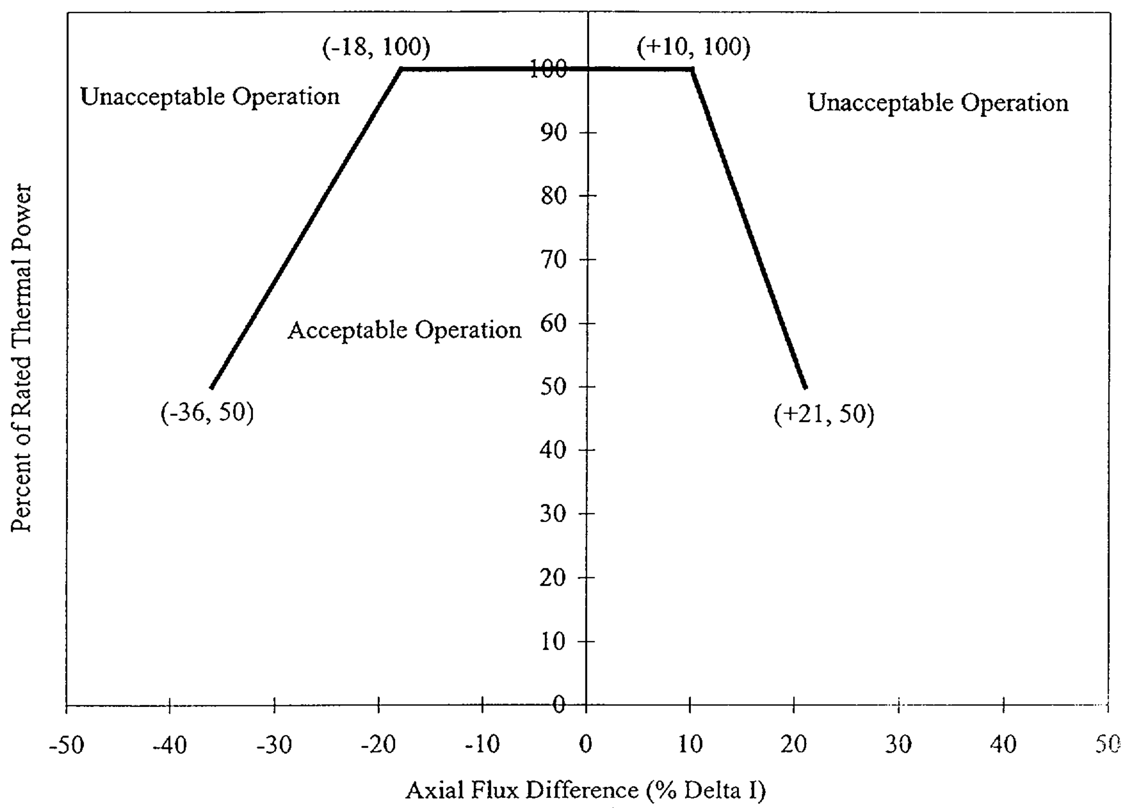
MkBW and RFA Fuel MARPs

Height	Axial Peak												
(ft)	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

Catawba 2 Cycle 12 Core Operating Limits Report

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 2 ROD manual for operational AFD limits.

Catawba 2 Cycle 12 Core Operating Limits Report

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

2.8.1 Overtemperature ΔT Setpoint Parameter Values

Parameter	Nominal Value
Overtemperature ΔT reactor trip setpoint	$K_1 = 1.1953$
Overtemperature ΔT reactor trip heatup setpoint penalty coefficient	$K_2 = 0.03163/^{o}F$
Overtemperature ΔT reactor trip depressurization setpoint penalty coefficient	$K_3 = 0.001414/psi$
Time constants utilized in the lead-lag compensator for ΔT	$\tau_1 = 8$ sec. $\tau_2 = 3$ sec.
Time constant utilized in the lag compensator for ΔT	$\tau_3 = 0$ sec.
Time constants utilized in the lead-lag compensator for T_{avg}	$\tau_4 = 22$ sec. $\tau_5 = 4$ sec.
Time constant utilized in the measured T_{avg} lag compensator	$\tau_6 = 0$ sec.
$f_1(\Delta I)$ "positive" breakpoint	= 3.0 %ΔI
$f_1(\Delta I)$ "negative" breakpoint	= -39.9 %ΔI
$f_1(\Delta I)$ "positive" slope	= 1.525 $\%\Delta T_0/\ \%\Delta I$
$f_1(\Delta I)$ "negative" slope	= 3.910 $\%\Delta T_0/\ \%\Delta I$

Catawba 2 Cycle 12 Core Operating Limits Report

2.8.2 Overpower ΔT Setpoint Parameter Values

Parameter	Nominal Value
Overpower ΔT reactor trip setpoint	$K_4 = 1.0819$
Overpower ΔT reactor trip heatup setpoint penalty coefficient (for T>T”)	$K_6 = 0.001291/^oF$
Time constants utilized in the lead-lag compensator for ΔT	$\tau_1 = 8$ sec. $\tau_2 = 3$ sec.
Time constant utilized in the lag compensator for ΔT	$\tau_3 = 0$ sec.
Time constant utilized in the measured T_{avg} lag compensator	$\tau_6 = 0$ sec.
Time constant utilized in the rate-lag controller for T_{avg}	$\tau_7 = 10$ sec.
$f_2(\Delta I)$ "positive" breakpoint	= 35.0 %ΔI
$f_2(\Delta I)$ "negative" breakpoint	= -35.0 %ΔI
$f_2(\Delta I)$ "positive" slope	= 7.0 %ΔT_0/ %ΔI
$f_2(\Delta I)$ "negative" slope	= 7.0 %ΔT_0/ %ΔI

Catawba 2 Cycle 12 Core Operating Limits Report

2.9 Boron Dilution Mitigation System (TS 3.3.9)

2.9.1 Reactor Makeup Water Pump flow rate limits:

Applicable Mode	Limit
Mode 3	$\leq$ 150 gpm
Mode 4 or 5	$\leq$ 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:

Parameter	Limit
Cold Leg Accumulator minimum boron concentration.	2,500 ppm
Cold Leg Accumulator maximum boron concentration.	3,075 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:

Parameter	Limit
Refueling Water Storage Tank minimum boron concentration.	2,700 ppm
Refueling Water Storage Tank maximum boron concentration.	3,075 ppm

Catawba 2 Cycle 12 Core Operating Limits Report

2.12 Spent Fuel Pool Boron Concentration (TS 3.7.15)

2.12.1 Minimum boron concentration limit for the spent fuel pool. Applicable when fuel assemblies are stored in the spent fuel pool.

Parameter	Limit
Spent fuel pool minimum boron concentration.	2,700 ppm

2.13 Refueling Operations - Boron Concentration (TS 3.9.1)

2.13.1 Minimum boron concentration limit for the filled portions of the Reactor Coolant System, refueling canal, and refueling cavity for mode 6 conditions. The minimum boron concentration limit and plant refueling procedures ensure that the Keff of the core will remain within the mode 6 reactivity requirement of Keff $\leq$ 0.95.

Parameter	Limit
Minimum Boron concentration of the Reactor Coolant System, the refueling canal, and the refueling cavity.	2,700 ppm

2.14 Refueling Operations - Instrumentation (TS 3.9.2)

2.14.1 Reactor Makeup Water Pump Flow rate Limit:

Applicable Mode	Limit
Mode 6	$\leq$ 70 gpm

Catawba 2 Cycle 12 Core Operating Limits Report

2.15 Standby Makeup Pump Water Supply - Boron Concentration (SLC-16.7-9.3)

2.15.1 Minimum boron concentration limit for the spent fuel pool. Applicable for modes 1, 2, and 3.

Parameter	Limit
Spent fuel pool minimum boron concentration for surveillance SLC-16.7-9.3.	2,700 ppm

2.16 Borated Water Source – Shutdown (SLC 16.9-11)

2.16.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Mode 4 with any RCS cold leg temperature $\leq 285^{O}$F, and Modes 5 and 6.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 68°F	2,000 gallons
Boric Acid Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	13,086 gallons (14.9%)

NOTE: When sampled primary coolant boron concentration is less than 179 ppm, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM at 68°F	7,000 gallons
Refueling Water Storage Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	48,500 gallons (8.7%)

Catawba 2 Cycle 12 Core Operating Limits Report

2.17 Borated Water Source - Operating (SLC 16.9-12)

2.17.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Modes 1, 2, and 3 and Mode 4 with all RCS cold leg temperatures > 285°F.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 285°F	13,500 gallons
Boric Acid Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	25,200 gallons (45.8%)

NOTE: When sampled primary coolant boron concentration is less than 179 ppm, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM at 285°F	57,107 gallons
Refueling Water Storage Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	98,607 gallons (22.0%)

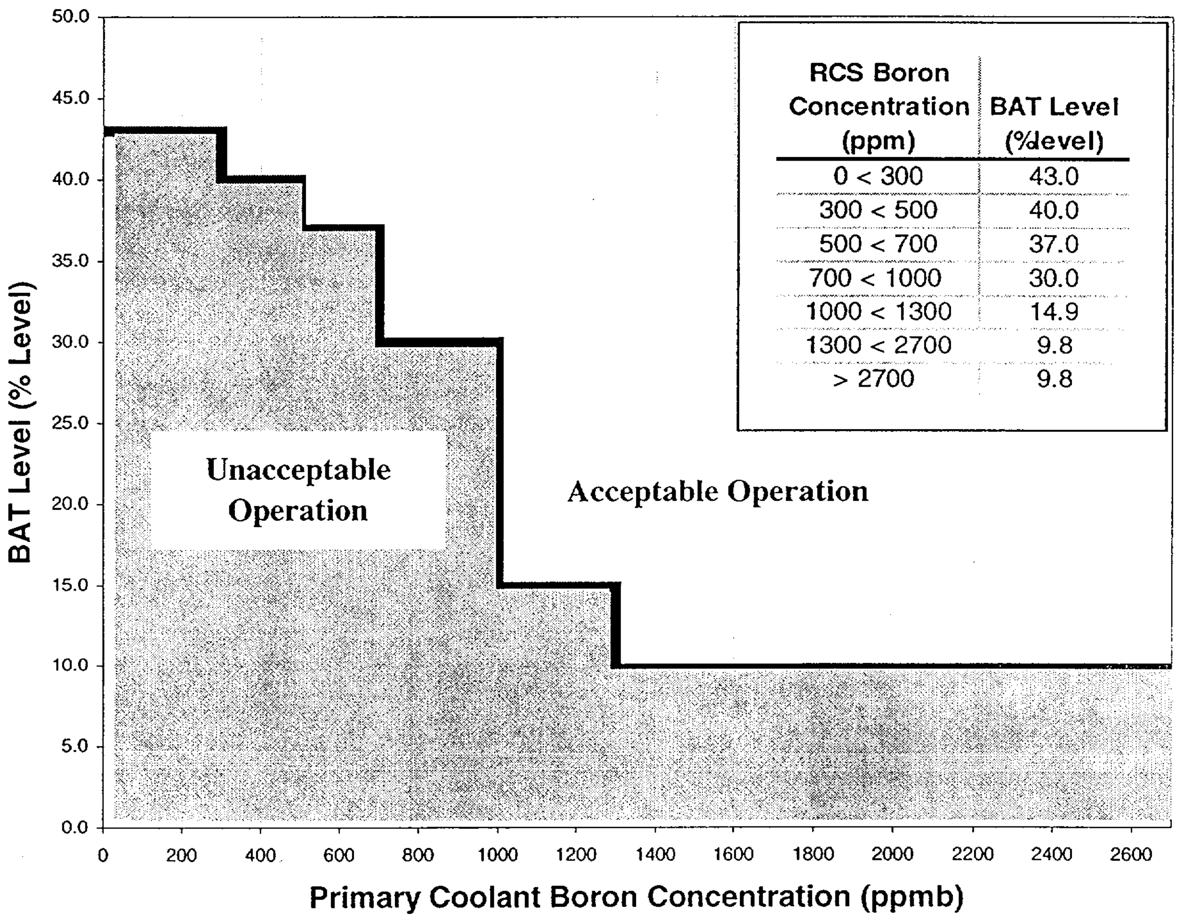
Catawba 2 Cycle 12 Core Operating Limits Report

Figure 6

Boric Acid Storage Tank Indicated Level Versus Primary Coolant Boron Concentration

(Valid When Sampled Primary Coolant Boron Concentration < 179 ppm)

This figure includes additional volumes listed in SLC 16.9-11 and 16.9-12



RCS Boron Concentration (ppm)	BAT Level (%level)
0 < 300	43.0
300 < 500	40.0
500 < 700	37.0
700 < 1000	30.0
1000 < 1300	14.9
1300 < 2700	9.8
> 2700	9.8

Catawba 2 Cycle 12 Core Operating Limits Report

Appendix A

Catawba 2 Cycle 12 Monitoring Factors

NOTE: Data contained in Appendix A was generated in the Catawba 2 Cycle 12 Maneuvering Analysis calculation file, CNC-1553.05-00-0349. The Plant Nuclear Engineering Section will control this information via computer file(s) and should be contacted if there is a need to access this information.

Attachment 4 - Unit 2 COLR revision 20

Catawba Unit 2 Cycle 12

Core Operating Limits Report
Revision 20

September 2001

Duke Power Company

		Date
Prepared By:	Scott B. Thomas	9/18/01
Checked By:	Sandra L. Abbey	9/18/01
Checked By:	[illegible]	9/18/01
Approved By:	P. M. Abraham	9/18/01

QA Condition 1

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

Catawba 2 Cycle 12 Core Operating Limits Report

IMPLEMENTATION INSTRUCTIONS FOR REVISION 20

Revision 20 of the Catawba Unit 2 COLR may become effective any time during No-Mode between cycles 11 and 12.

This revision must become effective prior to entering Mode 6 which starts cycle 12.

In addition, this revision must be made concurrently with the associated SLC 16.9-11 and 16.9-12 changes.

Catawba 2 Cycle 12 Core Operating Limits Report

REVISION LOG

Revision	Effective Date	Pages Affected	COLR
Revisions 1-13	N/A	N/A	C2C06 – C2C09
Revision 14	August 1998	N/A	C2C10 COLR
Revision 15	October 1998	N/A	C2C10 COLR rev 1
Revision 16	December 1998	N/A	C2C10 COLR rev 2
Revision 17	February 2000	N/A	C2C11 COLR
Revision 18	February 2001	N/A	C2C11 COLR rev 1
Revision 19	September 2001	ALL	C2C12 COLR
Revision 20	September 2001	1,2,3,4,25,26,27	C2C12 COLR rev 1

Catawba 2 Cycle 12 Core Operating Limits Report

INSERTION SHEET FOR REVISION 20

Remove pages	Insert Rev. 20 pages
1,2,3,4,24,25,26	1,2,3,4,25,26,27

Catawba 2 Cycle 12 Core Operating Limits Report

2.15 Standby Makeup Pump Water Supply - Boron Concentration (SLC-16.7-9.3)

2.15.1 Minimum boron concentration limit for the spent fuel pool. Applicable for modes 1, 2, and 3.

Parameter	Limit
Spent fuel pool minimum boron concentration for surveillance SLC-16.7-9.3.	2,700 ppm

2.16 Borated Water Source – Shutdown (SLC 16.9-11)

2.16.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Mode 4 with any RCS cold leg temperature $\leq 285^{O}$F, and Modes 5 and 6.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 68°F	2,000 gallons
Boric Acid Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	13,086 gallons (14.9%)

NOTE: When cycle burnup is > 450 EFPD, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM at 68 °F	7,000 gallons
Refueling Water Storage Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-11)	48,500 gallons (8.7%)

Catawba 2 Cycle 12 Core Operating Limits Report

2.17 Borated Water Source - Operating (SLC 16.9-12)

2.17.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during Modes 1, 2, and 3 and Mode 4 with all RCS cold leg temperatures > 285°F.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Volume of 7,000 ppm boric acid solution required to maintain SDM at 285°F	13,500 gallons
Boric Acid Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	25,200 gallons (45.8%)

NOTE: When cycle burnup is > 450 EFPD, Figure 6 may be used to determine the required Boric Acid Tank Minimum Level.

Refueling Water Storage Tank minimum boron concentration	2,700 ppm
Volume of 2,700 ppm boric acid solution required to maintain SDM at 285 °F	57,107 gallons
Refueling Water Storage Tank Minimum Contained Shutdown Volume (Includes the additional volumes listed in SLC 16.9-12)	98,607 gallons (22.0%)

Catawba 2 Cycle 12 Core Operating Limits Report

Figure 6

Boric Acid Storage Tank Indicated Level Versus Primary Coolant Boron Concentration

(Valid when the cycle burnup is greater than 450 EFPD)

This figure includes additional volumes listed in SLC 16.9-11 and 16.9-12