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January 7, 2009

U. S. Nuclear Regulatory Commission
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Washington, D.C. 20555

Subject: Duke Energy Carolinas, LLC (Duke)
McGuire Nuclear Station
Docket Nos. 50-369
Unit 1, Cycle 20, Revision 1
Core Operating Limits Report

Pursuant to McGuire Technical Specification (TS) 5.6.5.d, please find enclosed Revision 1 of the McGuire Unit 1 Cycle 20 Core Operating Limits Report (COLR). The COLR was revised to include limits specific for completion of the Rod Cluster Control Assembly (RCCA) movement test for all shutdown banks and control banks A, B, and C for the remainder of cycle 20.

Questions regarding this submittal should be directed to Kay Crane, McGuire Regulatory Compliance at (704) 875-4306.

HDBrewer for

Bruce H. Hamilton

Attachment

A001
NRR

cc: Mr. John Stang, Project Manager
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McGuire Unit 1 Cycle 20

Core Operating Limits Report
Revision 1

December 2008

Calculation Number: MCC-1553.05-00-0489, Rev. 1

Duke Energy

		Date
Prepared By:	Nicholas R Hager	12/10/08
Checked By:	ML Elder	12/11/08
Checked By:	M S. Henshaw (Sections 2.2 and 2.10 – 2.17)	12/11/08
Approved By:	RC Harvey	12/11/08

QA Condition 1

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

McGuire 1 Cycle 20 Core Operating Limits Report

INSPECTION OF ENGINEERING INSTRUCTIONS

Inspection Waived By: RC Harvey (Sponsor) Date: 12/11/08

CATAWBA

	Inspection Waived		
MCE (Mechanical & Civil)	☐	Inspected By/Date:	
RES (Electrical Only)	☐	Inspected By/Date:	
RES (Reactor)	☐	Inspected By/Date:	
MOD	☐	Inspected By/Date:	
Other (______)	☐	Inspected By/Date:	

OCONEE

	Inspection Waived		
MCE (Mechanical & Civil)	☐	Inspected By/Date:	
RES (Electrical Only)	☐	Inspected By/Date:	
RES (Reactor)	☐	Inspected By/Date:	
MOD	☐	Inspected By/Date:	
Other (______)	☐	Inspected By/Date:	

MCGUIRE

	Inspection Waived		
MCE (Mechanical & Civil)	☑	Inspected By/Date:	
RES (Electrical Only)	☑	Inspected By/Date:	
RES (Reactor)	☑	Inspected By/Date:	
MOD	☑	Inspected By/Date:	
Other (______)	☐	Inspected By/Date:	

McGuire 1 Cycle 20 Core Operating Limits Report

Implementation Instructions for Revision 1

Revision Description and PIP Tracking

Revision 1 of the McGuire Unit 1 Cycle 20 COLR contains limits specific to the reload core and was revised to include limits specific for completion of the RCCA movement test for all shutdown banks and control banks A, B, and C for the remainder of McGuire Unit 1 Cycle 20. Revision 1 was initiated by PIP #M-08-01203, CA#6.

Implementation Schedule

Revision 1 may become effective immediately but must become effective prior to 1/15/2009. This date is the expected date for the next scheduled quarterly RCCA movement test via PIP #M-08-01203, CA#6. The McGuire Unit 1 Cycle 20 COLR will cease to be effective during No MODE between Cycle 20 and 21.

Data files to be Implemented

No data files are transmitted as part of this document.

McGuire 1 Cycle 20 Core Operating Limits Report

REVISION LOG

Revision	Effective Date	Pages Affected	COLR
0	August 2008	1-32, Appendix A*	M1C20 COLR, Rev. 0
1	December 2008	1-32	M1C20 COLR, Rev. 1

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

McGuire 1 Cycle 20 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 the COLR are summarized below.

TS Number	Technical Specifications	COLR Parameter	COLR Section	EI Page
1.1	Requirements for Operational Mode 6	Mode 6 Definition	2.1	9
2.1.1	Reactor Core Safety Limits	RCS Temperature and Pressure Safety Limits	2.2	9
3.1.1	Shutdown Margin	Shutdown Margin	2.3	9
3.1.3	Moderator Temperature Coefficient	MTC	2.4	11
3.1.4	Rod Group Alignment Limits	Shutdown Margin	2.3	9
3.1.5	Shutdown Bank Insertion Limits	Shutdown Margin	2.3	9
3.1.5	Shutdown Bank Insertion Limits	Shutdown Bank Insertion Limit	2.5	11
3.1.6	Control Bank Insertion Limits	Shutdown Margin	2.3	9
3.1.6	Control Bank Insertion Limits	Control Bank Insertion Limit	2.6	15
3.1.8	Physics Test Exceptions	Shutdown Margin	2.3	9
3.2.1	Heat Flux Hot Channel Factor	Fq, AFD, OTΔT and Penalty Factors	2.7	15
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor	FΔH, AFD and Penalty Factors	2.8	20
3.2.3	Axial Flux Difference	AFD	2.9	21
3.3.1	Reactor Trip System Instrumentation Setpoint	OTΔT and OPΔT Constants	2.10	24
3.4.1	RCS Pressure, Temperature and Flow limits for DNB	RCS Pressure, Temperature and Flow	2.11	26
3.5.1	Accumulators	Max and Min Boron Conc.	2.12	26
3.5.4	Refueling Water Storage Tank	Max and Min Boron Conc.	2.13	26
3.7.14	Spent Fuel Pool Boron Concentration	Min Boron Concentration	2.14	28
3.9.1	Refueling Operations – Boron Concentration	Min Boron Concentration	2.15	28
5.6.5	Core Operating Limits Report (COLR)	Analytical Methods	1.1	6

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

SLC Number	Selected Licensing Commitment	COLR Parameter	COLR Section	EI Page
16.9.14	Borated Water Source – Shutdown	Borated Water Volume and Conc. for BAT/RWST	2.16	29
16.9.11	Borated Water Source – Operating	Borated Water Volume and Conc. for BAT/RWST	2.17	30

McGuire 1 Cycle 20 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 as specified in Technical Specification 5.6.5 are as follows.

1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," (W Proprietary).

   Revision 0
   Report Date: July 1985
   Not Used for M1C20

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

   Revision 0
   Report Date: August 1985

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 M1C20

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 Recirculating 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 M1C20

McGuire 1 Cycle 20 Core Operating Limits Report

1.1 Analytical Methods (continued)

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

   Revision 3
   SER Date: September 24, 2003

7. DPC-NE-3001-PA, "Multidimensional Reactor Transients and Safety Analysis Physics Parameter Methodology," (DPC Proprietary).

   Revision 0
   Report Date: November 1991 (Republished December 2000)

8. DPC-NE-3002-A, "FSAR Chapter 15 System Transient Analysis Methodology".

   Revision 4
   SER Date: April 6, 2001

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 3
    SER Date: September 16, 2002

11. DPC-NE-2008P-A, "Fuel Mechanical Reload Analysis Methodology Using TACO3," (DPC Proprietary).

    Revision 0
    SER Date: April 3, 1995
    Not Used for M1C20

12. DPC-NE-2009-P-A, "Westinghouse Fuel Transition Report," (DPC Proprietary).

    Revision 2
    SER Date: December 18, 2002

13. DPC-NE-1004A, "Nuclear Design Methodology Using CASMO-3/SIMULATE-3P."

    Revision 1
    SER Date: April 26, 1996
    Not Used for M1C20

McGuire 1 Cycle 20 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 2
    SER Date: June 24, 2003

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

    Revision 1
    SER Date: October 1, 2002

16. DPC-NE-1005-P-A, "Nuclear Design Methodology Using CASMO-4 / SIMULATE-3 MOX," (DPC Proprietary).

    Revision 0
    SER Date: August 20, 2004

McGuire 1 Cycle 20 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 Requirements for Operational Mode 6

The following condition is required for operational mode 6.

2.1.1 The Reactivity Condition requirement for operational mode 6 is that k_{eff} must be less than, or equal to 0.95.

2.2 Reactor Core Safety Limits (TS 2.1.1)

2.2.1 The Reactor Core Safety Limits are shown in Figure 1.

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

2.3.1 For TS 3.1.1, SDM shall be $\geq$ 1.3% $\Delta K/K$ in mode 2 with k-eff < 1.0 and in modes 3 and 4.

2.3.2 For TS 3.1.1, SDM shall be $\geq$ 1.0% $\Delta K/K$ in mode 5.

2.3.3 For TS 3.1.4, SDM shall be $\geq$ 1.3% $\Delta K/K$ in modes 1 and 2.

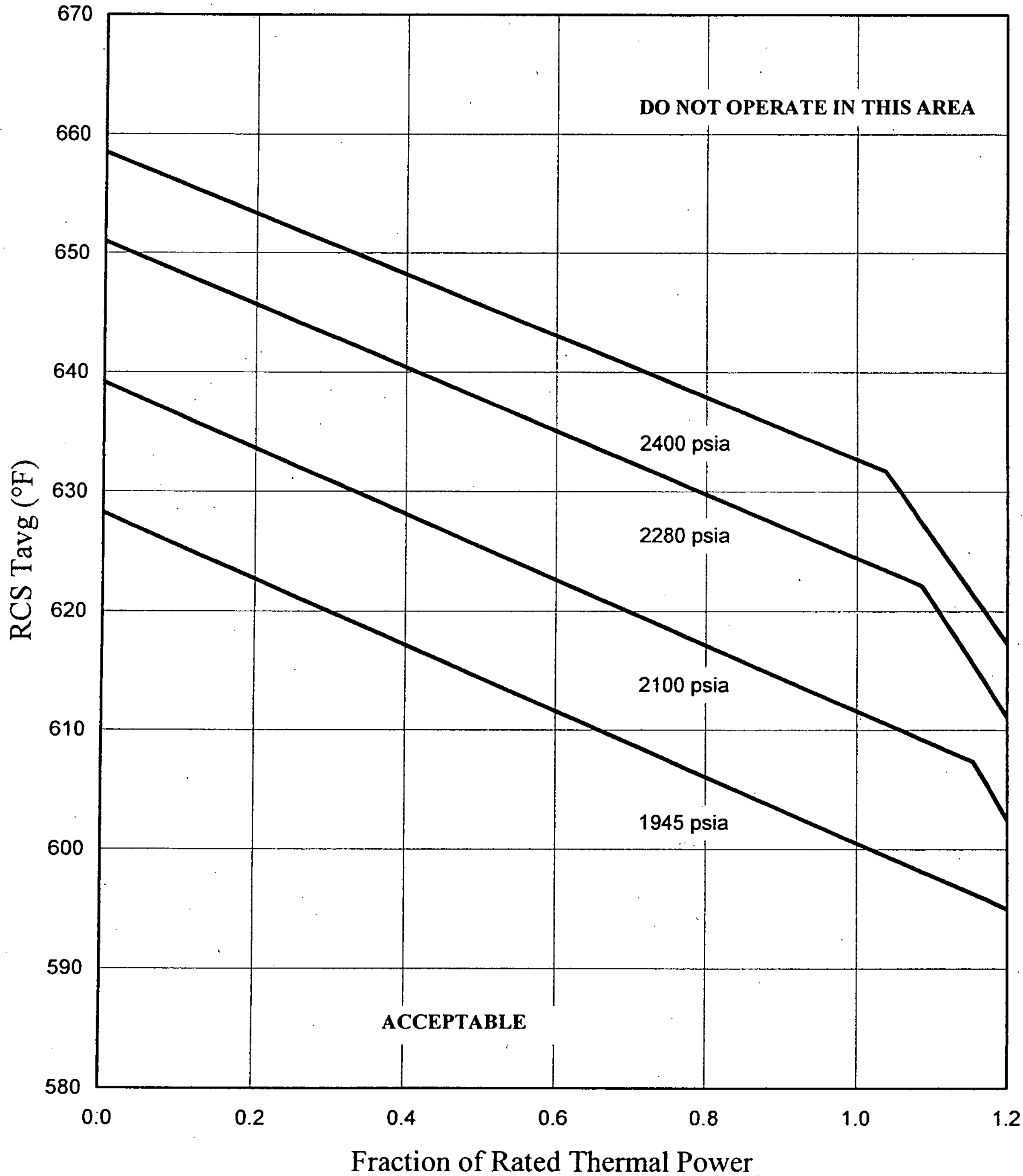
2.3.4 For TS 3.1.5, SDM shall be $\geq$ 1.3% $\Delta K/K$ in mode 1 and mode 2 with any control bank not fully inserted.

2.3.5 For TS 3.1.6, SDM shall be $\geq$ 1.3% $\Delta K/K$ in mode 1 and mode 2 with K-eff $\geq$ 1.0.

2.3.6 For TS 3.1.8, SDM shall be $\geq$ 1.3% $\Delta K/K$ in mode 2 during Physics Testing.

McGuire 1 Cycle 20 Core Operating Limits Report

Figure 1
Reactor Core Safety Limits
Four Loops in Operation



McGuire 1 Cycle 20 Core Operating Limits Report

2.4 Moderator Temperature Coefficient - MTC (TS 3.1.3)

2.4.1 The Moderator Temperature Coefficient (MTC) Limits are:

The MTC shall be less positive than the upper limits shown in Figure 2. 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 -4.3E-04 ΔK/K/°F lower MTC limit.

2.4.2 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 ΔK/K/°F.

2.4.3 The 60 PPM MTC Surveillance Limit is:

The 60 PPM ARO, equilibrium RTP MTC shall be less negative than or equal to -4.125E-04 ΔK/K/°F.

Where,

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

2.5 Shutdown Bank Insertion Limit (TS 3.1.5)

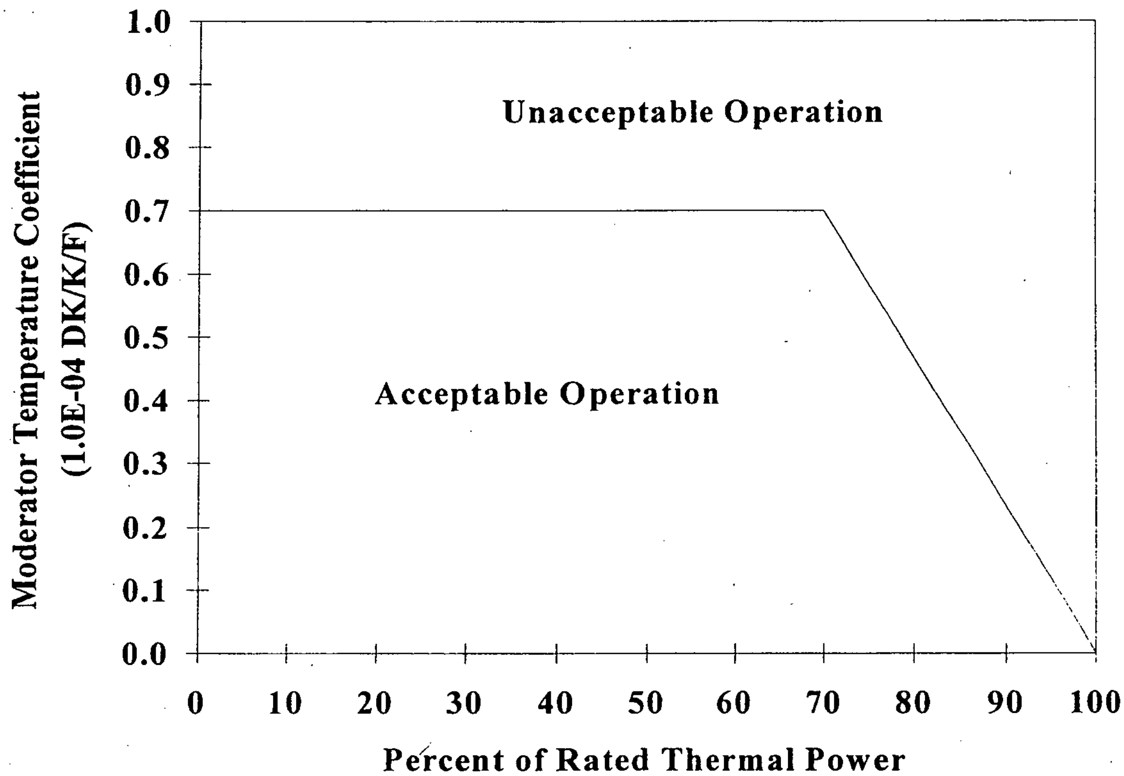
2.5.1 Each shutdown bank shall be withdrawn to at least 222 steps except under the conditions listed in Section 2.5.2. Shutdown banks are withdrawn in sequence and with no overlap.

2.5.2 Shutdown banks may be inserted to 219 steps withdrawn individually for up to 48 hours provided the plant was operated in steady state conditions near 100% FP prior to and during this exception.

McGuire 1 Cycle 20 Core Operating Limits Report

Figure 2

Moderator Temperature Coefficient Upper Limit Versus Power Level

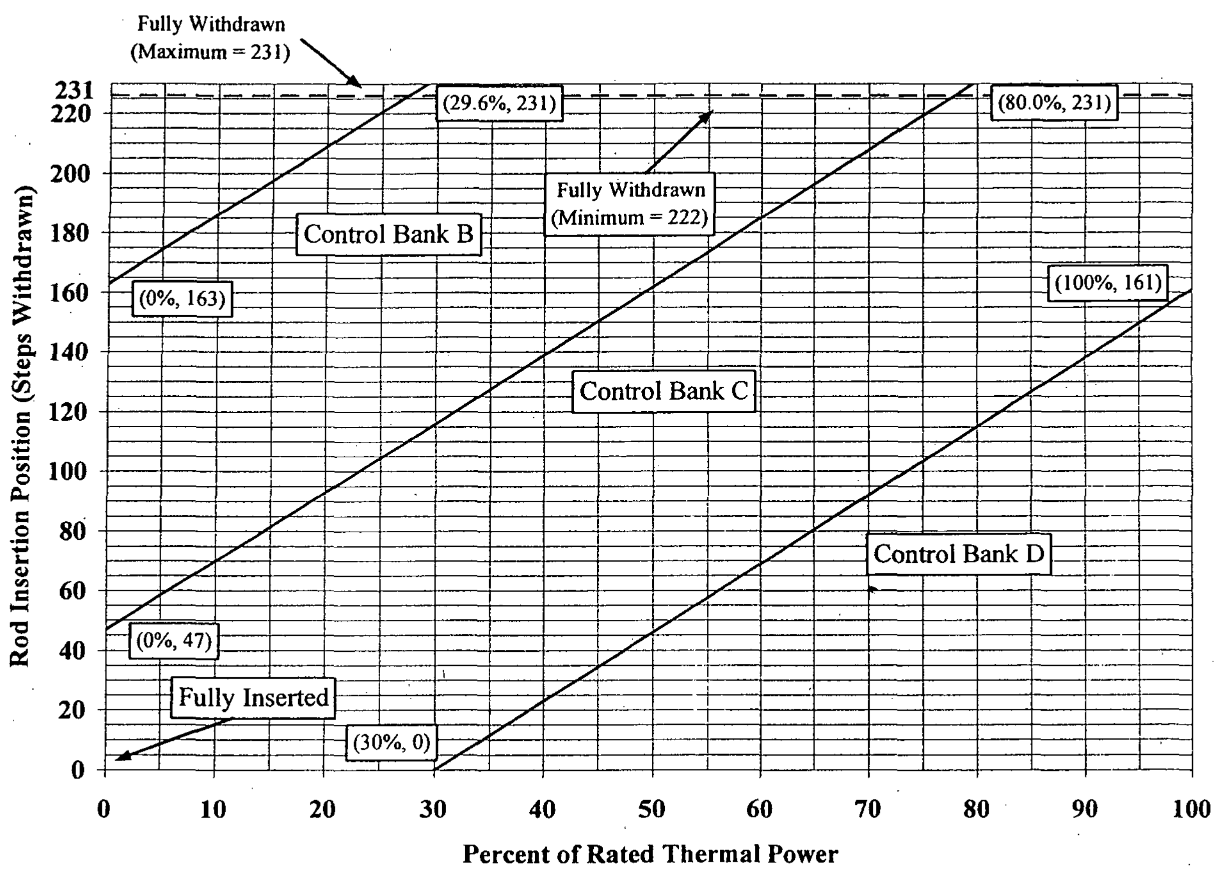


NOTE: Compliance with Technical Specification 3.1.3 may require rod withdrawal limits. Refer to OP/1/A/6100/22 Unit 1 Data Book for details.

McGuire 1 Cycle 20 Core Operating Limits Report

Figure 3

Control Bank Insertion Limits Versus Percent Rated Thermal Power



The Rod Insertion Limits (RIL) for Control Bank D (CD), Control Bank C (CC), and Control Bank B (CB) can be calculated by:

$$Bank\ \ CD\ RIL = 2.3(P) - 69\ \{30 \leq P \leq 100\}$$
$$Bank\ \ CC\ RIL = 2.3(P) + 47\ \{0 \leq P \leq 80\}$$
$$Bank\ \ CB\ RIL = 2.3(P) + 163\ \{0 \leq P \leq 29.6\}$$

$$where\ \ P = \%Rated\ \ Thermal\ \ Power$$

NOTES: (1) Compliance with Technical Specification 3.1.3 may require rod withdrawal limits. Refer to OP/1/A/6100/22 Unit 1 Data Book for details.

(2) Anytime any shutdown bank or control banks A, B, or C are inserted below 222 steps withdrawn, control bank D insertion is limited to ≥ 200 steps withdrawn (see Sections 2.5.2 and 2.6.2)

McGuire 1 Cycle 20 Core Operating Limits Report

Table 1
RCCA Withdrawal Steps and Sequence

Fully Withdrawn at 222 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
222 Stop	106	0	0
222	116	0 Start	0
222	222 Stop	106	0
222	222	116	0 Start
222	222	222 Stop	106

Fully Withdrawn at 223 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
223 Stop	107	0	0
223	116	0 Start	0
223	223 Stop	107	0
223	223	116	0 Start
223	223	223 Stop	107

Fully Withdrawn at 224 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
224 Stop	108	0	0
224	116	0 Start	0
224	224 Stop	108	0
224	224	116	0 Start
224	224	224 Stop	108

Fully Withdrawn at 225 Steps

Control Bank A	Control Bank B	Control Bank C	Control Bank D
0 Start	0	0	0
116	0 Start	0	0
225 Stop	109	0	0
225	116	0 Start	0
225	225 Stop	109	0
225	225	116	0 Start
225	225	225 Stop	109

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

McGuire 1 Cycle 20 Core Operating Limits Report

2.6 Control Bank Insertion Limits (TS 3.1.6)

2.6.1 Control banks shall be within the insertion, sequence, and overlap limits shown in Figure 3 except under the conditions listed in Section 2.6.2. Specific control bank withdrawal and overlap limits as a function of the fully withdrawn position are shown in Table 1.

2.6.2 Control banks A, B, or C may be inserted to 219 steps withdrawn individually for up to 48 hours provided the plant was operated in steady state conditions near 100% FP prior to and during this exception.

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

2.7.1 $F_Q(X,Y,Z)$ steady-state limits are defined by the following relationships:

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

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

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 LCO limits. The manufacturing tolerance and measurement uncertainty are implicitly included in the F_Q surveillance limits as defined in COLR Sections 2.7.5 and 2.7.6.

2.7.2 $F_Q^{RTP} = 2.60 \text{ x } K(BU)$

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

2.7.4 K(BU) is the normalized $F_Q(X,Y,Z)$ as a function of burnup. K(BU) for Westinghouse RFA fuel is 1.0 for all burnups.

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

2.7.5 $$F_Q^L(X,Y,Z)^{OP} = \frac{F_Q^D(X,Y,Z) * M_Q(X,Y,Z)}{UMT * MT * TILT}$$

McGuire 1 Cycle 20 Core Operating Limits Report

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 will be preserved for operation within the LCO limits. $F_Q^L(X,Y,Z)^{OP}$ includes allowances for calculation and measurement uncertainties.

$F_Q^D(X,Y,Z)$ = Design power distribution for F_Q. $F_Q^D(X,Y,Z)$ is provided in Appendix A-1 for normal operating conditions and in Appendix Table A-4 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 Appendix Table A-1 for normal operating conditions and in Appendix Table A-4 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 the peaking increase from an allowable quadrant power tilt ratio of 1.02. (TILT = 1.035)

2.7.6 $$F_Q^L(X,Y,Z)^{RPS} = \frac{F_Q^D(X,Y,Z) * M_C(X,Y,Z)}{UMT * MT * TILT}$$

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 will be preserved for operation within the LCO limits. $F_Q^L(X,Y,Z)^{RPS}$ includes allowances for calculation and measurement uncertainties.

$F_Q^D(X,Y,Z)$ = Design power distributions for F_Q. $F_Q^D(X,Y,Z)$ is provided in Appendix Table A-1 for normal operating conditions and in Appendix Table A-4 for power escalation testing during initial startup operation.

McGuire 1 Cycle 20 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 Appendix Table A-2 for normal operating conditions and in Appendix Table A-5 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 the peaking increase for an allowable quadrant power tilt ratio of 1.02. (TILT = 1.035)

2.7.7 KSLOPE = 0.0725

where:

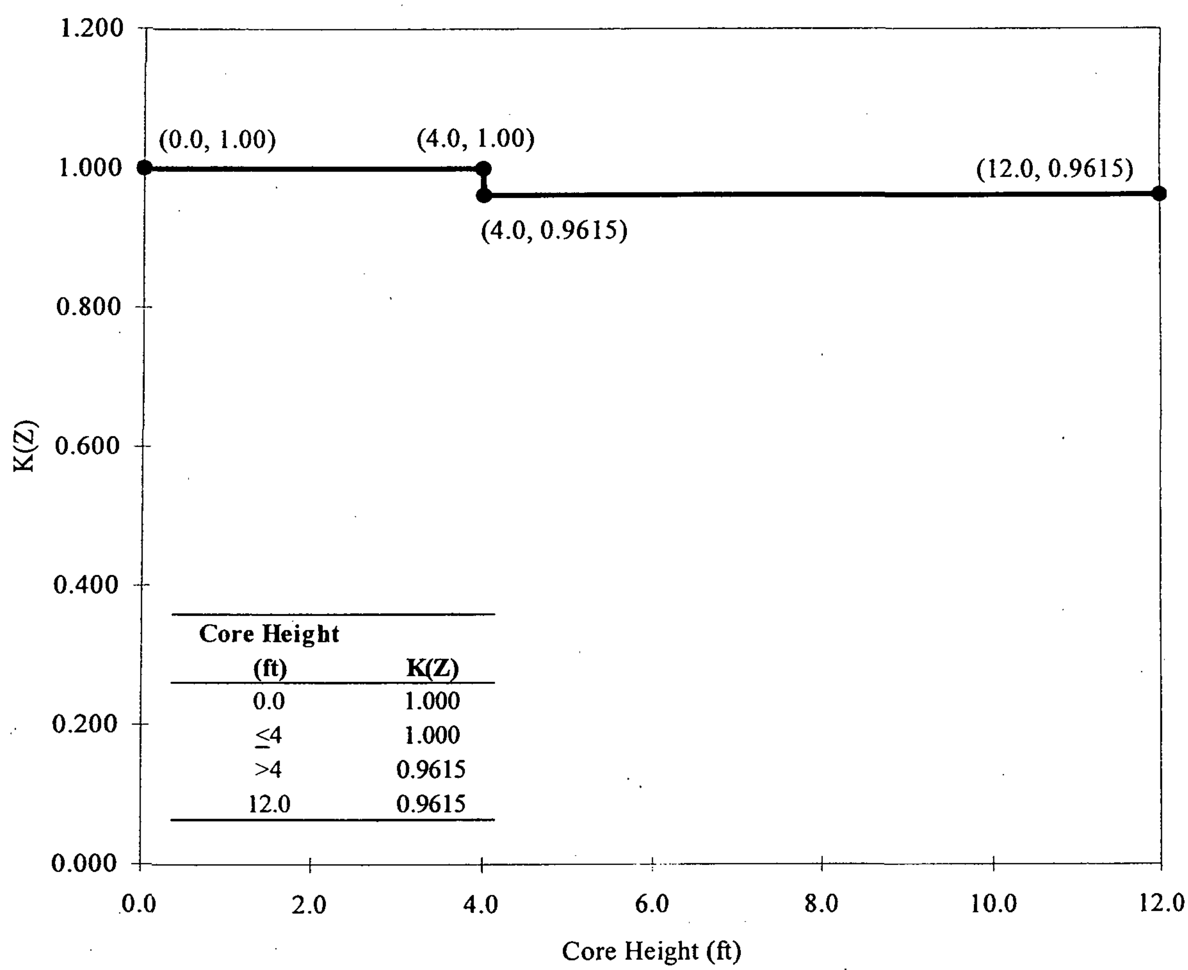
KSLOPE is the adjustment to the K_1 value from OTΔT trip setpoint required to compensate for each 1% that $F_Q^M(X,Y,Z)$ exceeds $F_Q^L(X,Y,Z)^{RPS}$.

2.7.8 $F_Q(X,Y,Z)$ penalty factors for Technical Specification Surveillance's 3.2.1.2 and 3.2.1.3 are provided in Table 2.

McGuire 1 Cycle 20 Core Operating Limits Report

Figure 4

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



Core Height (ft)	K(Z)
0.0	1.000
≤4	1.000
>4	0.9615
12.0	0.9615

McGuire 1 Cycle 20 Core Operating Limits Report

Table 2
$F_Q(X,Y,Z)$ and $F_{\Delta H}(X,Y)$ Penalty Factors
For Technical Specification Surveillance's 3.2.1.2, 3.2.1.3 and 3.2.2.2

Burnup (EFPD)	$F_Q(X,Y,Z)$ Penalty Factor (%)	$F_{\Delta H}(X,Y,Z)$ Penalty Factor (%)
0	2.00	2.00
4	2.00	2.00
12	2.00	2.00
25	2.00	2.00
50	**2.47**	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
325	2.00	2.00
350	2.00	2.00
375	2.00	2.00
400	2.00	2.00
425	2.00	2.00
440	2.00	2.00
465	2.00	2.00
483	2.00	2.00
498	2.00	2.00
513	2.00	2.00

Note: Linear interpolation is adequate for intermediate cycle burnups. All cycle burnups outside of 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 Technical Specification Surveillances 3.2.1.2, 3.2.1.3 and 3.2.2.2.

McGuire 1 Cycle 20 Core Operating Limits Report

2.8 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.

2.8.1 $$F^{L}_{\Delta H}(X,Y)^{LCO} = MARP(X,Y) * \left[1.0 + \frac{1}{RRH} * (1.0 - P)\right]$$

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 also is used to scale the MARP limits as a function of power per the $F^{L}_{\Delta H}(X,Y)^{LCO}$ equation. ($RRH = 3.34$ $(0.0 < P \leq 1.0)$)

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

2.8.2 $$F^{L}_{\Delta H}(X,Y)^{SURV} = \frac{F^{D}_{\Delta H}(X,Y) \times M_{\Delta H}(X,Y)}{UMR \times TILT}$$

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 will be preserved for operation within the LCO limits. $F^{L}_{\Delta H}(X,Y)^{SURV}$ includes allowances for calculation-measurement uncertainty.

$F^{D}_{\Delta H}(X,Y)$ = Design radial power distribution for $F_{\Delta H}$. $F^{D}_{\Delta H}(X,Y)$ is provided in Appendix Table A-3 for normal operation and in Appendix Table A-6 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 Appendix Table A-3 for normal operation and in Appendix Table A-6 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 the peaking increase for an allowable quadrant power tilt ratio of 1.02, (TILT = 1.035).

2.8.3 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. $(0 < P \leq 1.0)$

2.8.4 TRH = 0.04

where:

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

2.8.5 $F_{\Delta H}(X,Y)$ penalty factors for Technical Specification Surveillance 3.2.2.2 are provided in Table 2.

2.9 Axial Flux Difference – AFD (TS 3.2.3)

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

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Table 3
Maximum Allowable Radial Peaks (MARPs)
(Applicable for RFA Fuel)

Core	Axial Peak												
Ht (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	1.809	1.855	1.949	1.995	1.974	2.107	2.050	2.009	1.933	1.863	1.778	1.315	1.246
1.2	1.810	1.854	1.940	1.995	1.974	2.107	2.019	1.978	1.901	1.831	1.785	1.301	1.224
2.4	1.809	1.853	1.931	1.978	1.974	2.074	1.995	1.952	1.876	1.805	1.732	1.463	1.462
3.6	1.810	1.851	1.920	1.964	1.974	2.050	1.966	1.926	1.852	1.786	1.700	1.468	1.387
4.8	1.810	1.851	1.906	1.945	1.974	2.006	1.944	1.923	1.854	1.784	1.671	1.299	1.258
6.0	1.810	1.851	1.892	1.921	1.946	1.934	1.880	1.863	1.802	1.747	1.671	1.329	1.260
7.2	1.807	1.844	1.872	1.893	1.887	1.872	1.809	1.787	1.733	1.681	1.598	1.287	1.220
8.4	1.807	1.832	1.845	1.857	1.816	1.795	1.736	1.709	1.654	1.601	1.513	1.218	1.158
9.6	1.807	1.810	1.809	1.791	1.738	1.718	1.657	1.635	1.581	1.530	1.444	1.143	1.091
10.8	1.798	1.787	1.761	1.716	1.654	1.632	1.574	1.557	1.509	1.462	1.383	1.101	1.047
11.4	1.789	1.765	1.725	1.665	1.606	1.583	1.529	1.510	1.464	1.422	1.346	1.067	1.014

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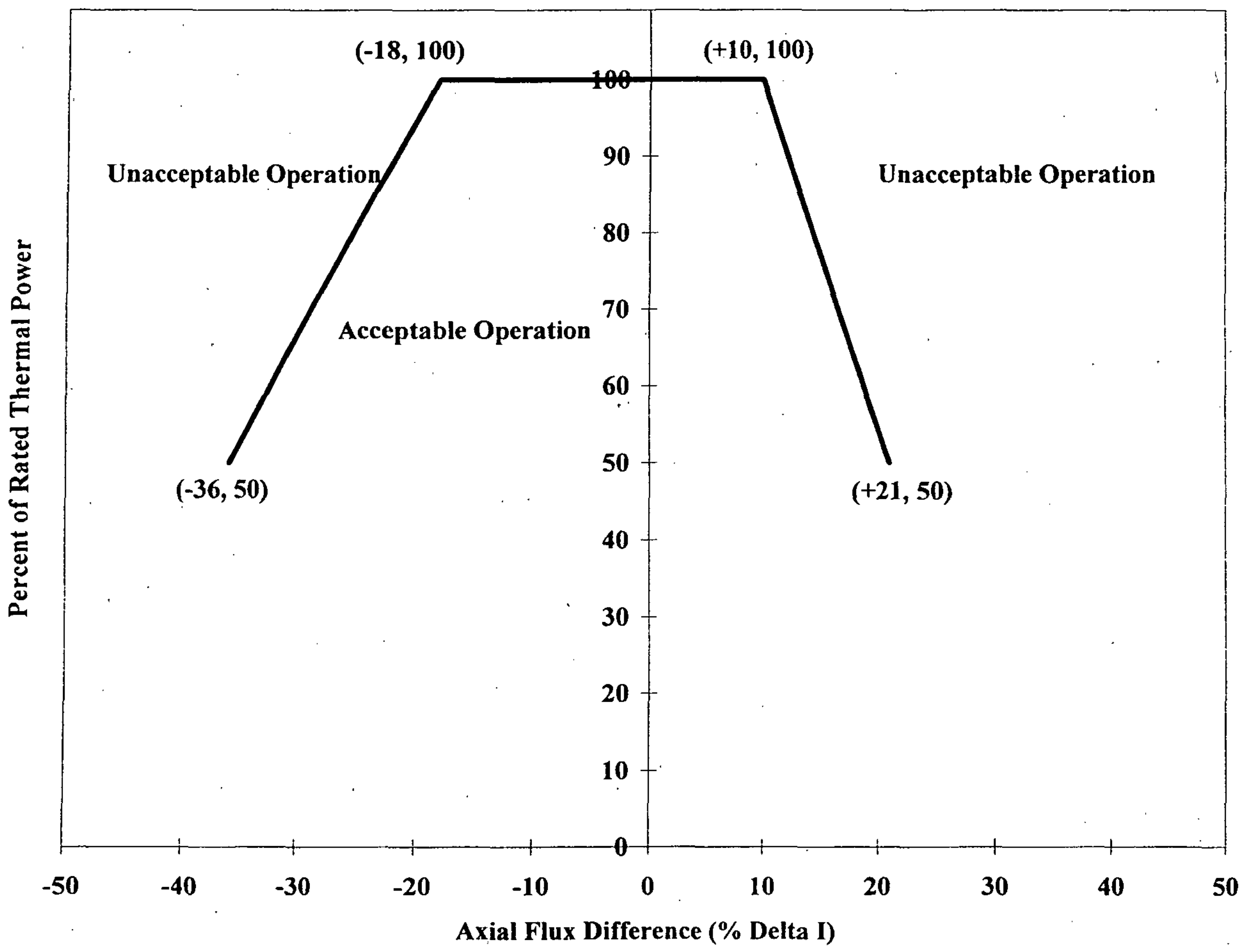
Figure 5

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 OP/1/A/6100/22 Unit 1 Data Book of more details.

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

2.10.1 Overtemperature ΔT Setpoint Parameter Values

Parameter	Value
Nominal Tavg at RTP	$T' \leq 585.1°F$
Nominal RCS Operating Pressure	$P' = 2235$ psig
Overtemperature ΔT reactor trip setpoint	$K_1 \leq 1.1978$
Overtemperature ΔT reactor trip heatup setpoint penalty coefficient	$K_2 = 0.0334/°F$
Overtemperature ΔT reactor trip depressurization setpoint penalty coefficient	$K_3 = 0.001601$/psi
Time constants utilized in the lead-lag compensator for ΔT	$\tau_1 \geq 8$ sec. $\tau_2 \leq 3$ sec.
Time constant utilized in the lag compensator for ΔT	$\tau_3 \leq 2$ sec.
Time constants utilized in the lead-lag compensator for T_{avg}	$\tau_4 \geq 28$ sec. $\tau_5 \leq 4$ sec.
Time constant utilized in the measured T_{avg} lag compensator	$\tau_6 \leq 2$ sec.
$f_1(\Delta I)$ "positive" breakpoint	= 19.0 %ΔI
$f_1(\Delta I)$ "negative" breakpoint	= N/A*
$f_1(\Delta I)$ "positive" slope	= 1.769 %ΔT_0/ %ΔI
$f_1(\Delta I)$ "negative" slope	= N/A*

* The $f_1(\Delta I)$ negative breakpoints and slopes for OTΔT are less restrictive than the OPΔT $f_2(\Delta I)$ negative breakpoint and slope. Therefore, during a transient which challenges the negative imbalance limits the OPΔT $f_2(\Delta I)$ limits will result in a reactor trip before the OTΔT $f_1(\Delta I)$ limits are reached. This makes implementation of an OTΔT $f_1(\Delta I)$ negative breakpoint and slope unnecessary.

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2.10.2 Overpower ΔT Setpoint Parameter Values

Parameter	Value
Nominal Tavg at RTP	$T'' \leq 585.1°F$
Overpower ΔT reactor trip setpoint	$K_4 \leq 1.0864$
Overpower ΔT reactor trip Penalty	$K_5 = 0.02/°F$ for increasing Tavg $K_5 = 0.0$ for decreasing Tavg
Overpower ΔT reactor trip heatup setpoint penalty coefficient	$K_6 = 0.001179/°F$ for $T > T''$ $K_6 = 0.0$ for $T \leq T''$
Time constants utilized in the lead-lag compensator for ΔT	$\tau_1 \geq 8$ sec. $\tau_2 \leq 3$ sec.
Time constant utilized in the lag compensator for ΔT	$\tau_3 \leq 2$ sec.
Time constant utilized in the measured T_{avg} lag compensator	$\tau_6 \leq 2$ sec.
Time constant utilized in the rate-lag controller for T_{avg}	$\tau_7 \geq 5$ 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

2.11 RCS Pressure, Temperature and Flow Limits for DNB (TS 3.4.1)

2.11.1 The RCS pressure, temperature and flow limits for DNB are shown in Table 4.

2.12 Accumulators (TS 3.5.1)

2.12.1 Boron concentration limits during mod es 1 and 2, and mode 3 with RCS pressure >1000 psi:

Parameter	Limit
Cold Leg Accumulator minimum boron concentration.	2,475 ppm
Cold Leg Accumulator maximum boron concentration.	2,875 ppm

2.13 Refueling Water Storage Tank - RWST (TS 3.5.4)

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

Parameter	Limit
Refueling Water Storage Tank minimum boron concentration.	2,675 ppm
Refueling Water Storage Tank maximum boron concentration.	2,875 ppm

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Table 4

Reactor Coolant System DNB Parameters

PARAMETER	INDICATION	No. Operable CHANNELS	LIMITS
1. Indicated RCS Average Temperature	meter	4	≤ 587.2 °F
	meter	3	≤ 586.9 °F
	computer	4	≤ 587.7 °F
	computer	3	≤ 587.5 °F
2. Indicated Pressurizer Pressure	meter	4	≥ 2219.8 psig
	meter	3	≥ 2222.1 psig
	computer	4	≥ 2215.8 psig
	computer	3	≥ 2217.5 psig
3. RCS Total Flow Rate			≥ 390,000 gpm*

*Note: The RCS minimum coolant flow rate assumed in the licensing analyses for the M1C20 core is 388,000 gpm. However, the flow is set at 390,000 gpm, which is conservative

2.14 Spent Fuel Pool Boron Concentration (TS 3.7.14)

2.14.1 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.	2,675 ppm

2.15 Refueling Operations - Boron Concentration (TS 3.9.1)

2.15.1 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.	2,675 ppm

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2.16 Borated Water Source – Shutdown (SLC 16.9.14)

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 ≤ 300 °F and modes 5 and 6.

Parameter	Limit
Boric Acid Tank minimum contained borated water volume	10,599 gallons 13.6% Level

> Note: When cycle burnup is > 455 EFPD, Figure 6 may be used to determine the required BAT minimum level.

Parameter	Limit
Boric Acid Tank minimum boron concentration	7,000 ppm
Boric Acid Tank minimum water volume required to maintain SDM at 7,000 ppm	2,300 gallons
Refueling Water Storage Tank minimum contained borated water volume	47,700 gallons 41 inches
Refueling Water Storage Tank minimum boron concentration	2,675 ppm
Refueling Water Storage Tank minimum water volume required to maintain SDM at 2,675 ppm	8,200 gallons

2.17 Borated Water Source - Operating (SLC 16.9.11)

2.17.1 Volume and boron concentrations for the Boric Acid Tank (BAT) and the Refueling Water Storage Tank (RWST) during modes 1, 2, 3, and mode 4 with all RCS cold leg temperatures > 300°F.

Parameter	Limit
Boric Acid Tank minimum contained borated water volume	22,049 gallons 38.0% Level
Note: When cycle burnup is > 455 EFPD, Figure 6 may be used to determine the required BAT minimum level.	
Boric Acid Tank minimum boron concentration	7,000 ppm
Boric Acid Tank minimum water volume required to maintain SDM at 7,000 ppm	13,750 gallons
Refueling Water Storage Tank minimum contained borated water volume	96,607 gallons 103.6 inches
Refueling Water Storage Tank minimum boron concentration	2,675 ppm
Refueling Water Storage Tank maximum boron concentration (TS 3.5.4)	2875 ppm
Refueling Water Storage Tank minimum water volume required to maintain SDM at 2,675 ppm	57,107 gallons

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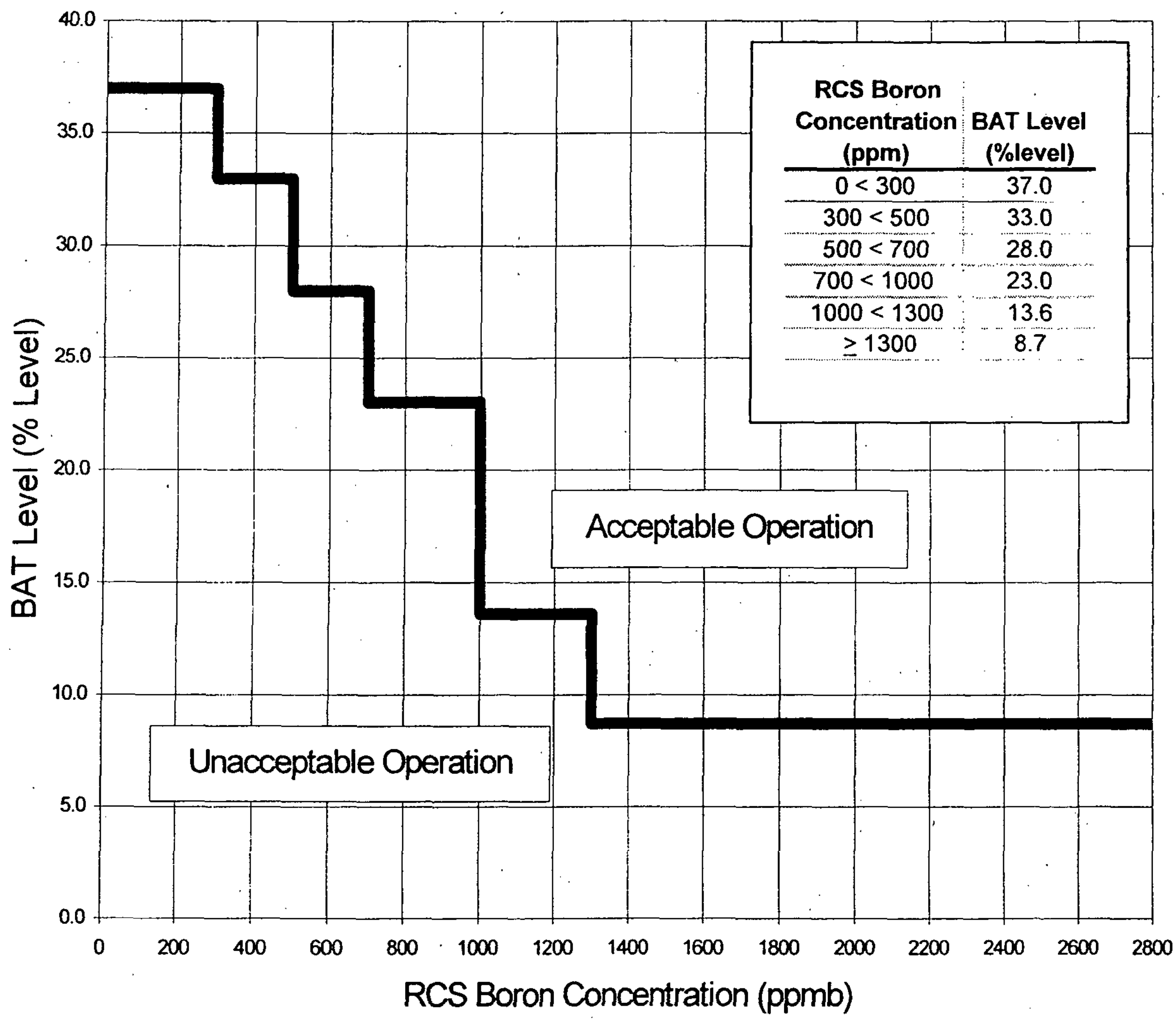
Figure 6

Boric Acid Storage Tank Indicated Level Versus RCS Boron Concentration

(Valid When Cycle Burnup is > 455 EFPD)

This figure includes additional volumes listed in SLC 16.9.14 and 16.9.11



RCS Boron Concentration (ppm)	BAT Level (%level)
0 < 300	37.0
300 < 500	33.0
500 < 700	28.0
700 < 1000	23.0
1000 < 1300	13.6
≥ 1300	8.7

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NOTE: Appendix A contains power distribution monitoring factors used in Technical Specification Surveillance. This data was generated in the McGuire 1 Cycle 20 Maneuvering Analysis calculation file, MCC-1553.05-00-0481. 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 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.

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