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

Subject: Duke Energy Carolinas, LLC (Duke)
McGuire Nuclear Station
Docket Nos. 50-370
Unit 2, Cycle 21
Core Operating Limits Report

Pursuant to McGuire Technical Specification (TS) 5.6.5.d, please find enclosed the McGuire Unit 2 Cycle 21 Core Operating Limits Report (COLR).

Questions regarding this submittal should be directed to Kay Crane, McGuire Regulatory Compliance at (980) 875-4306.

Regis T. Repko

Attachment

A001
NRR

cc: Mr. Jon H. Thompson, Project Manager
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Senior Resident Inspector
McGuire Nuclear Station

McGuire Unit 2 Cycle 21

Core Operating Limits Report
Revision 0

January 2011

Calculation Number: MCC-1553.05-00-0533, Revision 0

Duke Energy

		Date
Prepared By:	Nicholas R Hager	1/19/11
Checked By:	ML Elder	1/19/11
Checked By:	Nathan S. Hoffman (Sections 2.2 and 2.10 – 2.18)	1/20/11
Approved By:	RC Harvey	1/25/11

QA Condition 1

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

McGuire 2 Cycle 21 Core Operating Limits Report

INSPECTION OF ENGINEERING INSTRUCTIONS

Inspection Waived By: RC Harvey (Sponsor) Date 1/25/2011

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 2 Cycle 21 Core Operating Limits Report

Implementation Instructions For Revision 0

Revision Description and PIP Tracking

Revision 0 of the McGuire Unit 2 Cycle 21 COLR contains limits specific to the reload core. There is no PIP associated with this revision.

Implementation Schedule

Revision 0 may become effective any time during No MODE between cycles 20 and 21 but must become effective prior to entering MODE 6 which starts cycle 21. The McGuire Unit 2 Cycle 21 COLR will cease to be effective during No MODE between cycle 21 and 22.

Data files to be Implemented

No data files are transmitted as part of this document.

McGuire 2 Cycle 21 Core Operating Limits Report

REVISION LOG

Revision	Effective Date	Pages Affected	COLR
0	January 2011	1-32, Appendix A*	M2C21 COLR, Rev. 0

* 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 2 Cycle 21 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 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 Tests 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	OTΔT and OPΔT Constants	2.10	24
3.4.1	RCS Pressure, Temperature, and Flow DNB limits	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
16.9.7	Standby Shutdown System	Standby Makeup Pump Water Supply	2.18	30

McGuire 2 Cycle 21 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 M2C21

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 M2C21

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 M2C21

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

   Revision 4a
   Report Date: July 2009

McGuire 2 Cycle 21 Core Operating Limits Report

1.1 Analytical Methods (continued)

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

   Revision 0a
   Report Date: May 2009

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

   Revision 4a
   Report Date: April 2009

9. DPC-NE-2004P-A, "Duke Power Company McGuire and Catawba Nuclear Stations Core Thermal-Hydraulic Methodology using VIPRE-01," (DPC Proprietary).

   Revision 2a
   Report Date: December 2008

10. DPC-NE-2005P-A, "Thermal Hydraulic Statistical Core Design Methodology," (DPC Proprietary).

    Revision 4a
    Report Date: December 2008

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

    Revision 1a
    Report Date: December 2008
    Not Used for M2C21

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

    Revision 2a
    Report Date: July 2009

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

    Revision 1a
    Report Date: January 2009
    Not Used for M2C21

McGuire 2 Cycle 21 Core Operating Limits Report

1.1 Analytical Methods (continued)

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

    Revision 2a
    Report Date: December 2009

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

    Revision 1a
    Report Date: June 2009

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

    Revision 1
    Report Date: November 12, 2008

McGuire 2 Cycle 21 Core Operating Limits Report

2.0 Operating Limits

Cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC approved methodologies specified in Section 1.1.

2.1 Requirements for Operational MODE 6

The following condition is required for operational MODE 6.

2.1.1 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 ≥ 1.3% ΔK/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 ≥ 1.0% ΔK/K in MODE 5.

2.3.3 For TS 3.1.4, SDM shall be ≥ 1.3% ΔK/K in MODES 1 and 2.

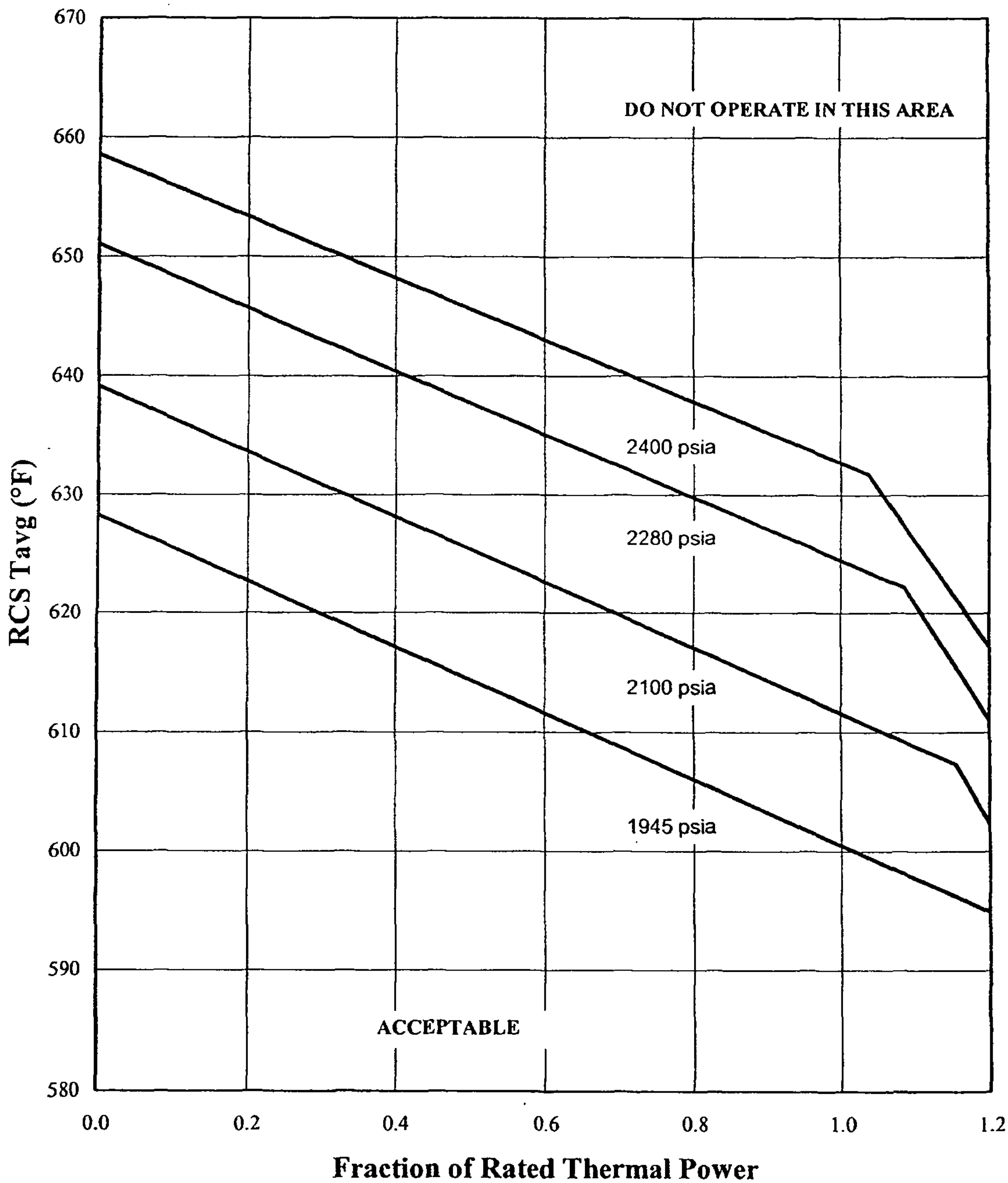
2.3.4 For TS 3.1.5, SDM shall be ≥ 1.3% ΔK/K in MODE 1 and MODE 2 with any control bank not fully inserted.

2.3.5 For TS 3.1.6, SDM shall be ≥ 1.3% ΔK/K in MODE 1 and MODE 2 with K-eff ≥ 1.0.

2.3.6 For TS 3.1.8, SDM shall be ≥ 1.3% ΔK/K in MODE 2 during PHYSICS TESTS.

McGuire 2 Cycle 21 Core Operating Limits Report

Figure 1
Reactor Core Safety Limits
Four Loops in Operation



McGuire 2 Cycle 21 Core Operating Limits Report

2.4 Moderator Temperature Coefficient - MTC (TS 3.1.3)

2.4.1 The Moderator Temperature Coefficient (MTC) Limits are:

MTC shall be less positive than the upper limits shown in Figure 2. BOC, ARO, HZP MTC shall be less positive than 0.7E-04 ΔK/K/°F.

EOC, ARO, RTP MTC shall be less negative than the -4.3E-04 ΔK/K/°F lower MTC limit.

2.4.2 300 PPM MTC Surveillance Limit is:

Measured 300 PPM ARO, equilibrium RTP MTC shall be less negative than or equal to -3.65E-04 ΔK/K/°F.

2.4.3 60 PPM MTC Surveillance Limit is:

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)

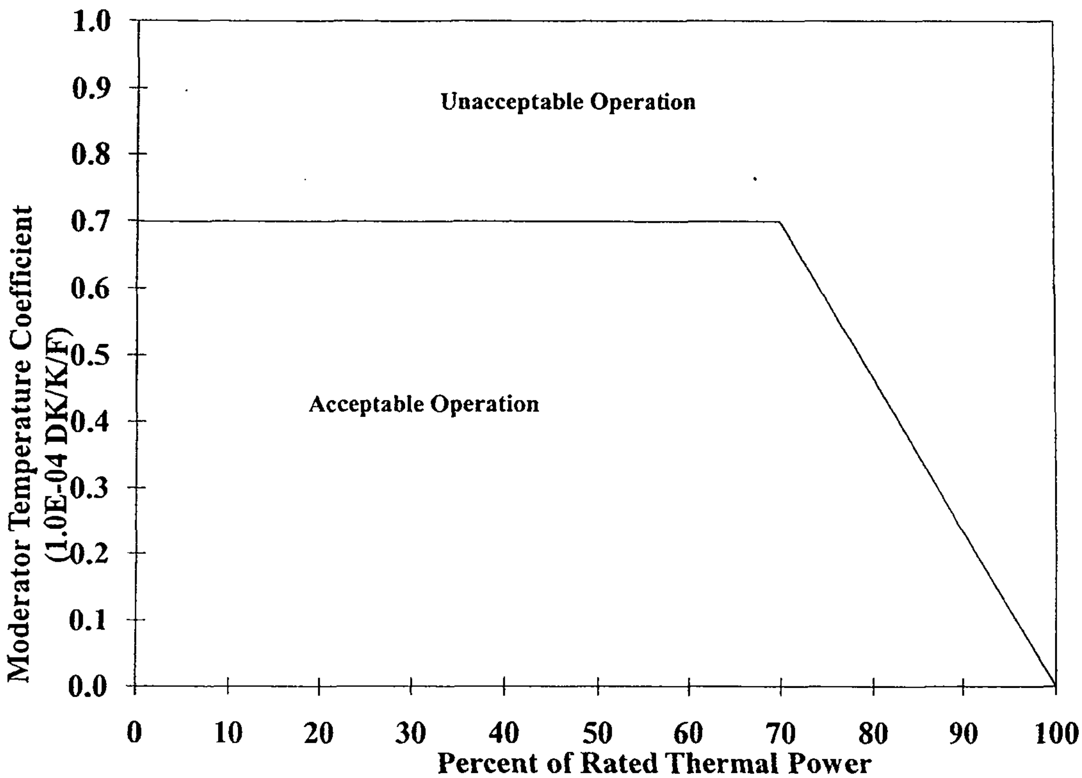
2.5.1 Each shutdown bank shall be withdrawn to at least 222 steps except under the conditions listed in Section 2.5.2. Shutdown banks are withdrawn in sequence and with no overlap.

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 2 Cycle 21 Core Operating Limits Report

Figure 2

Moderator Temperature Coefficient Upper Limit Versus Power Level

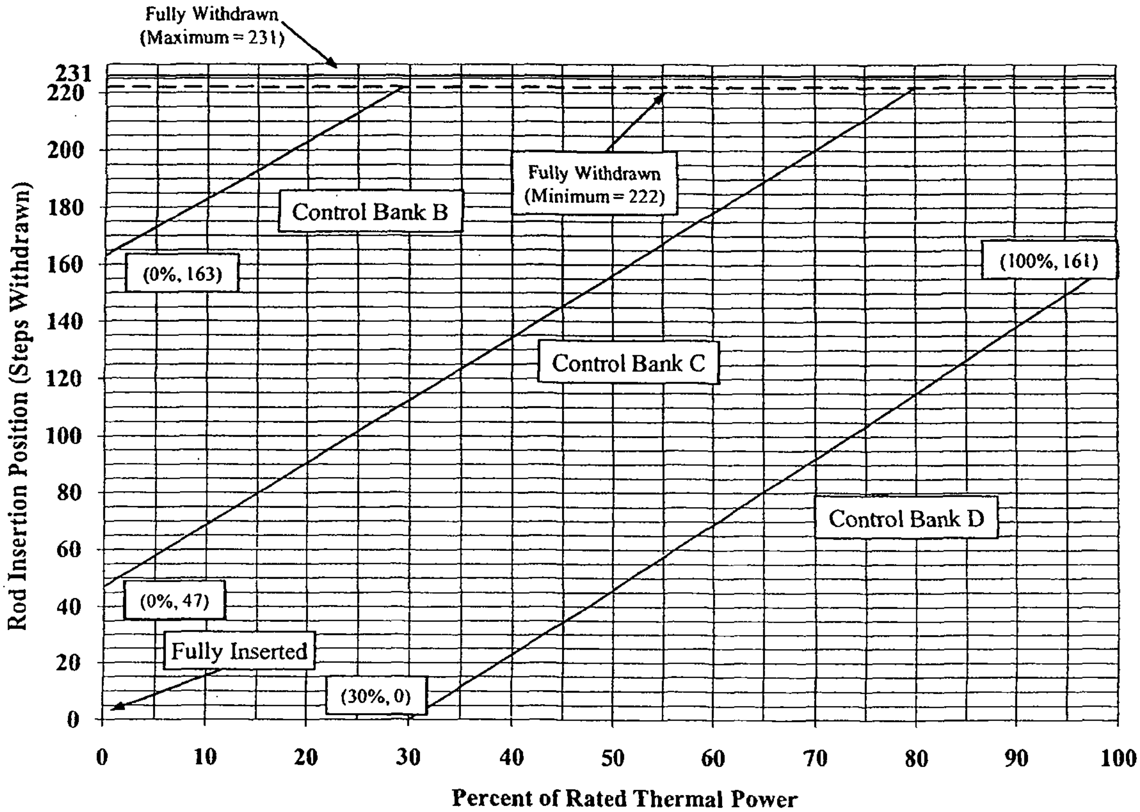


NOTE: Compliance with Technical Specification 3.1.3 may require rod withdrawal limits. Refer to OP/2/A/6100/22 Unit 2 Data Book for details.

McGuire 2 Cycle 21 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 $= 2.3(P) - 69 \quad \{30 \leq P \leq 100\}$
Bank CC RIL $= 2.3(P) + 47 \quad \{0 \leq P \leq 76.1\}$ *for CC RIL* $= 222 \; \{76.1 < P \leq 100\}$
Bank CB RIL $= 2.3(P) + 163 \quad \{0 \leq P \leq 25.7\}$ *for CB RIL* $= 222 \; \{25.7 < P \leq 100\}$

where P = %Rated Thermal Power

NOTES: (1) Compliance with Technical Specification 3.1.3 may require rod withdrawal limits. Refer to OP/2/A/6100/22 Unit 2 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 $\geq$ 200 steps withdrawn (see Sections 2.5.2 and 2.6.2)

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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 2 Cycle 21 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:

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

where,

P = (Thermal Power)/(Rated Power)

Note: 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 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 $F_Q^{RTP} = 2.70 \text{ x } K(BU)$

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

where:

$F_Q^L(X,Y,Z)^{OP}$ = Cycle dependent maximum allowable design peaking factor that ensures $F_Q(X,Y,Z)$ 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 Table 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 to account for 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 $F_Q(X,Y,Z)$ 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 2 Cycle 21 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 to account for allowable quadrant power tilt ratio of 1.02. (TILT = 1.035)

2.7.7 KSLOPE = 0.0725

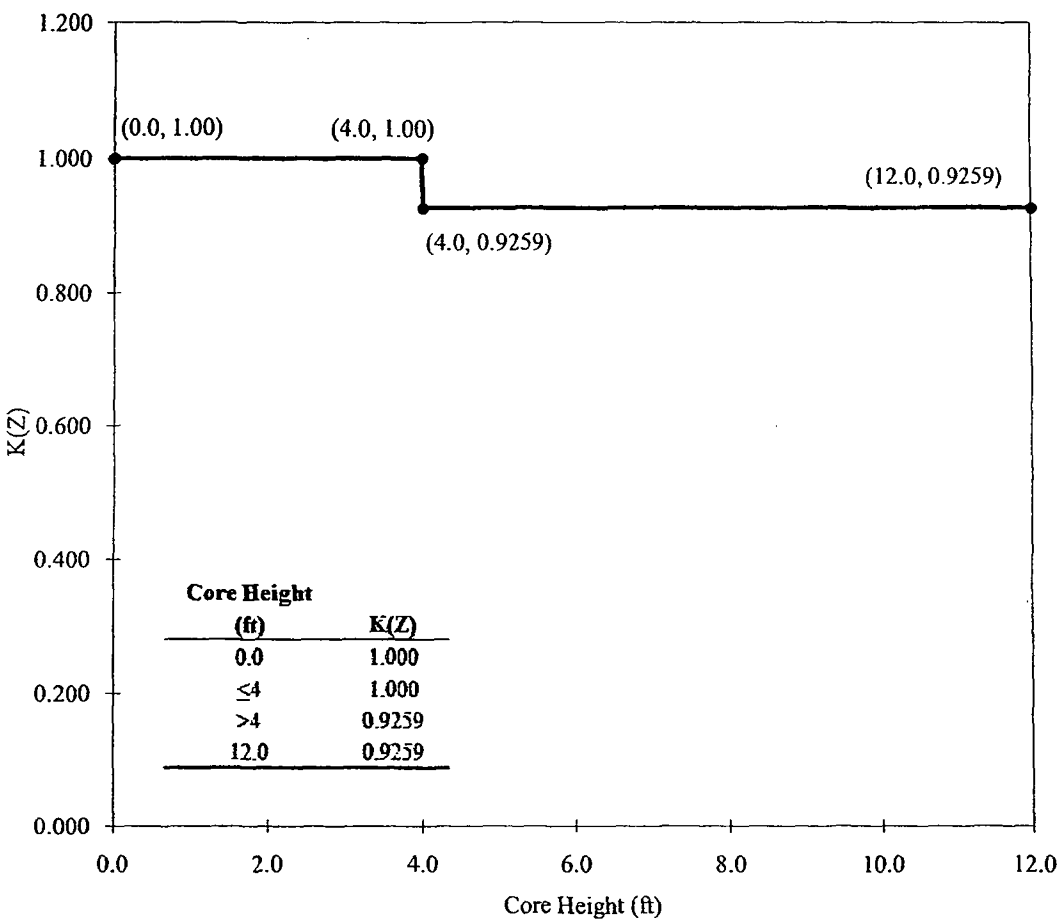
where:

KSLOPE is the adjustment to K_1 value from the 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 Surveillances 3.2.1.2 and 3.2.1.3 are provided in Table 2.

McGuire 2 Cycle 21 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	0.9259
12.0	0.9259

McGuire 2 Cycle 21 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 (%)	$F_{\Delta H}(X,Y)$ Penalty Factor (%)
0	2.00	2.00
4	2.00	2.00
12	2.00	2.00
25	2.00	2.00
50	2.79	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
450	2.00	2.00
475	2.00	2.00
500	2.00	2.00
510	2.00	2.00
523	2.00	2.00
531	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 2 Cycle 21 Core Operating Limits Report

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

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

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

where:

$F^{L}_{\Delta H}(X,Y)^{LCO}$ is the steady-state, maximum allowed radial peak and 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 its 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 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.

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$F^{D}_{\Delta H}$ (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 = 1.0). UMR is 1.0 since a factor of 1.04 is implicitly included in the variable $M_{\Delta H}$(X,Y).

TILT = Peaking penalty to account for 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 the 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)

RFA MARPS

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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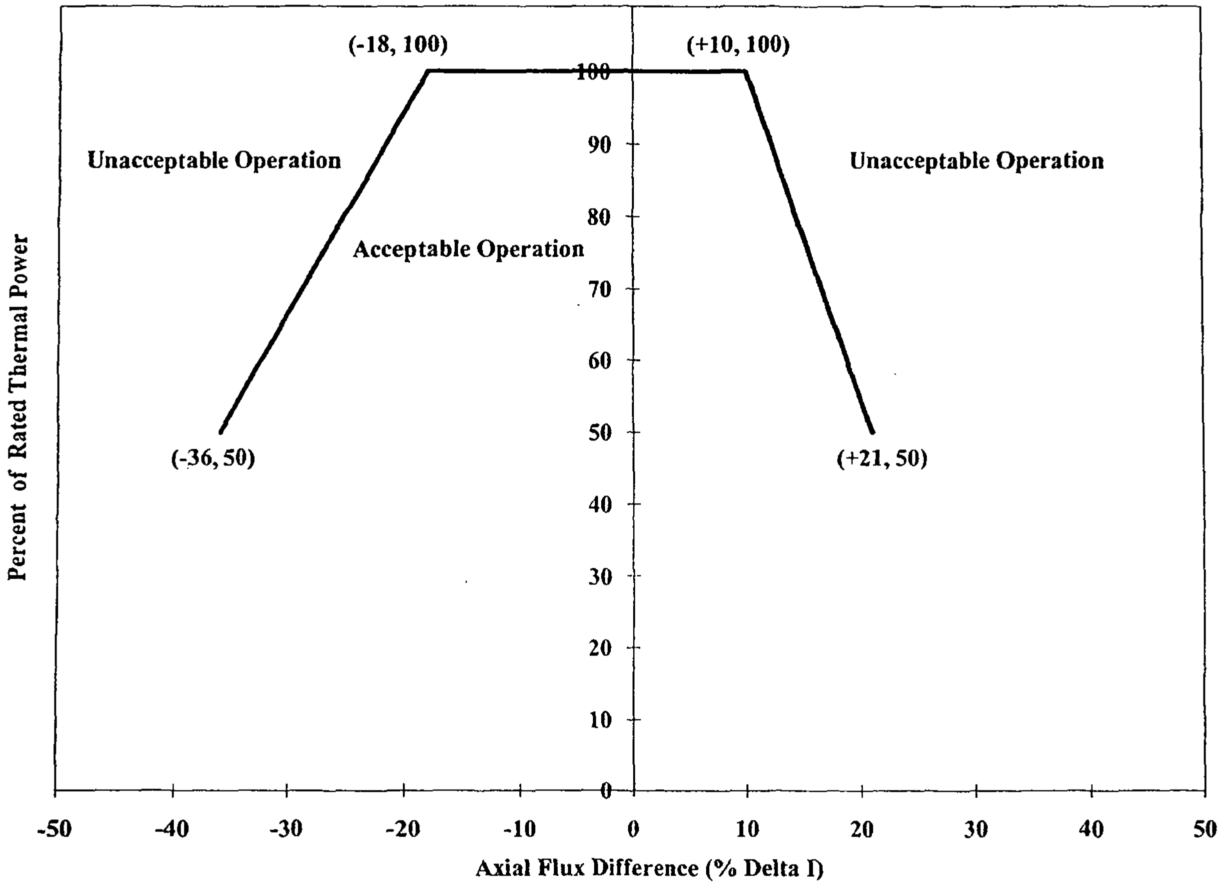
Figure 5

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/2/A/6100/22 Unit 2 Data Book for 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 $\%\Delta T_0/\ \%\Delta I$
$f_1(\Delta I)$ "negative" slope	= N/A*

* The $f_1(\Delta I)$ "negative" breakpoints and the $f_1(\Delta I)$ "negative" slope 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 the 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 $\%\Delta T_0/\ \%\Delta I$
$f_2(\Delta I)$ "negative" slope	= 7.0 $\%\Delta T_0/\ \%\Delta I$

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

2.11.1 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 MODES 1 and 2, and MODE 3 with RCS pressure >1000 psi:

Parameter	Applicable Burnup	Limit
Accumulator **minimum** boron concentration.	0 - 200 EFPD	2,475 ppm
Accumulator **minimum** boron concentration.	200.1 - 250 EFPD	2,475 ppm
Accumulator **minimum** boron concentration.	250.1 - 300 EFPD	2,418 ppm
Accumulator **minimum** boron concentration.	300.1 - 350 EFPD	2,327 ppm
Accumulator **minimum** boron concentration.	350.1 - 400 EFPD	2,253 ppm
Accumulator **minimum** boron concentration.	400.1 - 450 EFPD	2,194 ppm
Accumulator **minimum** boron concentration.	450.1 - 500 EFPD	2,136 ppm
Accumulator **minimum** boron concentration.	500.1 - 531 EFPD	2,076 ppm
Accumulator **maximum** boron concentration.	0 - 531 EFPD	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
RWST minimum boron concentration.	2,675 ppm
RWST 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	$\leq$ 587.2 °F
	meter	3	$\leq$ 586.9 °F
	computer	4	$\leq$ 587.7 °F
	computer	3	$\leq$ 587.5 °F
2. Indicated Pressurizer Pressure	meter	4	$\geq$ 2219.8 psig
	meter	3	$\geq$ 2222.1 psig
	computer	4	$\geq$ 2215.8 psig
	computer	3	$\geq$ 2217.5 psig
3. RCS Total Flow Rate			$\geq$ 388,000 gpm

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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 core Keff remains within 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
BAT minimum contained borated water volume	10,599 gallons 13.6% Level

> Note: When cycle burnup is > 460 EFPD, Figure 6 may be used to determine required BAT minimum level.

Parameter	Limit
BAT minimum boron concentration	7,000 ppm
BAT minimum water volume required to maintain SDM at 7,000 ppm	2,300 gallons
RWST minimum contained borated water volume	47,700 gallons 41 inches
RWST minimum boron concentration	2,675 ppm
RWST minimum water volume required to maintain SDM at 2,675 ppm	8,200 gallons

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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 temperature > 300 °F.

Parameter	Limit
BAT minimum contained borated water volume	22,049 gallons 38.0% Level

> Note: When cycle burnup is > 460 EFPD, Figure 6 may be used to determine required BAT minimum level.

BAT minimum boron concentration	7,000 ppm
BAT minimum water volume required to maintain SDM at 7,000 ppm	13,750 gallons
RWST minimum contained borated water volume	96,607 gallons 103.6 inches
RWST minimum boron concentration	2,675 ppm
RWST maximum boron concentration (TS 3.5.4)	2,875 ppm
RWST minimum water volume required to maintain SDM at 2,675 ppm	57,107 gallons

2.18 Standby Shutdown System - (SLC-16.9.7)

2.18.1 Minimum boron concentration limit for the spent fuel pool required for Standby Makeup Pump Water Supply. Applicable for MODES 1, 2, and 3.

Parameter	Limit
Spent fuel pool minimum boron concentration for TR 16.9.7.2.	2,675 ppm

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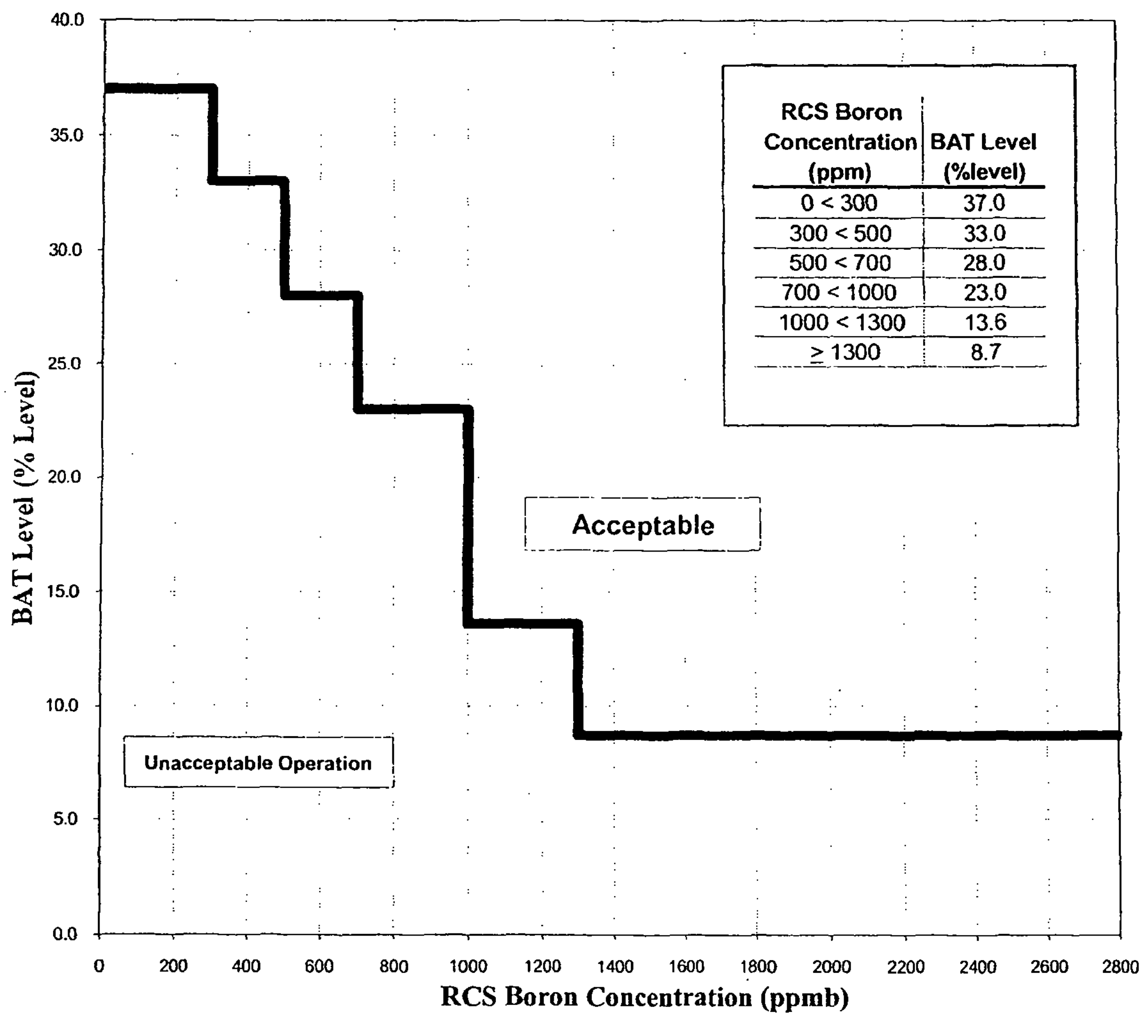
Figure 6
Boric Acid Storage Tank Indicated Level Versus RCS Boron Concentration

(Valid When Cycle Burnup is > 460 EFPD)

This figure includes additional volumes listed in SLC 16.9.14 and 16.9.11



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NOTE: Appendix A contains power distribution monitoring factors used in Technical Specification Surveillance. This data was generated in the McGuire 2 Cycle 21 Maneuvering Analysis calculation file, MCC-1553.05-00-0528. 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.