McGuire Unit 1 Cycle 13

Core Operating Limits Report
Revision 17

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Duke Power Company

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QA Condition 1

NOTE

The contents of this document have been reviewed to verify that no material herein either directly or indirectly changes or affects the results and conclusions presented in the 10CFR50.59 M1C13 Reload Safety Evaluation (calculation file: MCC-1552.08-00-0284).

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IMPLEMENTATION INSTRUCTIONS FOR REVISION 17

Revision 17 of the McGuire Unit 1 COLR updates this report to be compliant with the Improved Technical Specifications (ITS). This revision should be implemented concurrently with this release of ITS.

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REVISION LOG

Revision	Effective Date	Effective Pages	COLR
Original Issue	May 24, 1993	N/A	M1C09
Revision 1	May 27, 1993	N/A	M1C09, Rev. 1
Revision 2	February 24, 1994	N/A	M1C09, Rev. 2
Revision 3	June 20, 1994	N/A	M1C09, Rev. 3
Revision 4	September 13, 1994	N/A	M1C10
Revision 5	October 18, 1994	N/A	M1C10, Rev. 1
Revision 6	October 24, 1994	N/A	M1C10, Rev. 2
Revision 7	June 26, 1995	N/A	M1C10, Rev. 3
Revision 8	November 28, 1995	N/A	M1C10, Rev. 4
Revision 9	December 14, 1995	N/A	M1C11
Revision 10	March 11, 1996	N/A	M1C11, Rev. 1
Revision 11	June 24, 1996	N/A	M1C11, Rev. 2
Revision 12	February 13, 1997	N/A	M1C12
Revision 13	June 13, 1997	N/A	M1C12, Rev. 1
Revision 14	July 08, 1997	N/A	M1C12, Rev. 2
Revision 15	March 12, 1998	N/A	M1C12, Rev. 3
Revision 16	May 27, 1998	1-21	M1C13
Revision 17	November 6, 1998	1-22	M1C13, Rev 2*

*Revision 1 of the M1C13 COLR calculation file did not require a revision to the COLR EI.

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INSERTION SHEET FOR REVISION 17

Remove pages	Insert Rev. 17 pages
Pages 1-21	Pages 1-22

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1.0 Core Operating Limits Report

This Core Operating Limits Report (COLR) has been prepared in accordance with the requirements of the Technical Specification Limiting Conditions for Operation (LCO) from Section 5.6.5.

The Technical Specifications that reference this report are listed below:

	Technical Specifications	Section	Page
1.1	Requirements for Operational Mode 6	2.1	5
3.1.1	Shutdown Margin	2.2	6
3.1.3	Moderator Temperature Coefficient	2.3	6
3.1.5	Shutdown Bank Insertion Limit	2.4	6
3.1.6	Control Bank Insertion Limit	2.5	6
3.2.1	Heat Flux Hot Channel Factor	2.6	9
3.2.2	Nuclear Enthalpy Rise Hot Channel Factor	2.7	14
3.2.3	Axial Flux Difference	2.8	15
3.3.1	Reactor Trip System Instrumentation Setpoint	2.9	17
3.5.1	Accumulators	2.10	19
3.5.4	Refueling Water Storage Tank	2.11	19
3.7.14	Spent Fuel Pool Boron Concentration	2.12	20
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The Selected Licensee Commitments that reference this report are listed below:

SLC Section	Selected License Commitment	Section	Page
16-15.3.1.2.5	Borated Water Source – Shutdown	2.14	21
16-15.3.1.2.6	Borated Water Source – Operating	2.15	22

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 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.

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2.2 Shutdown Margin - SDM (LCO 3.1.1)

2.2.1 Shutdown margin shall be greater than 1.3% ΔK/K in modes 1-4.

2.2.2 Shutdown margin shall be greater than or equal to 1.0% ΔK/K in mode 5

2.3 Moderator Temperature Coefficient - MTC (LCO 3.1.3)

2.3.1 The Moderator Temperature Coefficient (MTC) LCO 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.

2.3.2 The 300 ppm MTC Surveillance Limit is:

The measured 300 PPM ARO, equilibrium RTP MTC should be less negative than or equal to -3.2E-04 ΔK/K/°F.

2.3.3 The 60 PPM MTC Surveillance Limit is:

The 60 PPM ARO, equilibrium RTP MTC should be less negative than or equal to -3.85E-04 ΔK/K/°F.

Where:
BOC = Beginning of Cycle
EOC = End of Cycle
ARO = All Rods Out
HZP = Hot Zero Thermal Power
RTP = Rated Thermal Power
PPM = Parts per million (Boron)

2.4 Shutdown Bank Insertion Limit (LCO 3.1.5)

2.4.1 Each shutdown bank shall be withdrawn to at least 222 steps.

2.5 Control Bank Insertion Limits (LCO 3.1.6)

2.5.1 Control banks shall be within the LCO insertion, sequence, and overlap limits shown in Figure 2.

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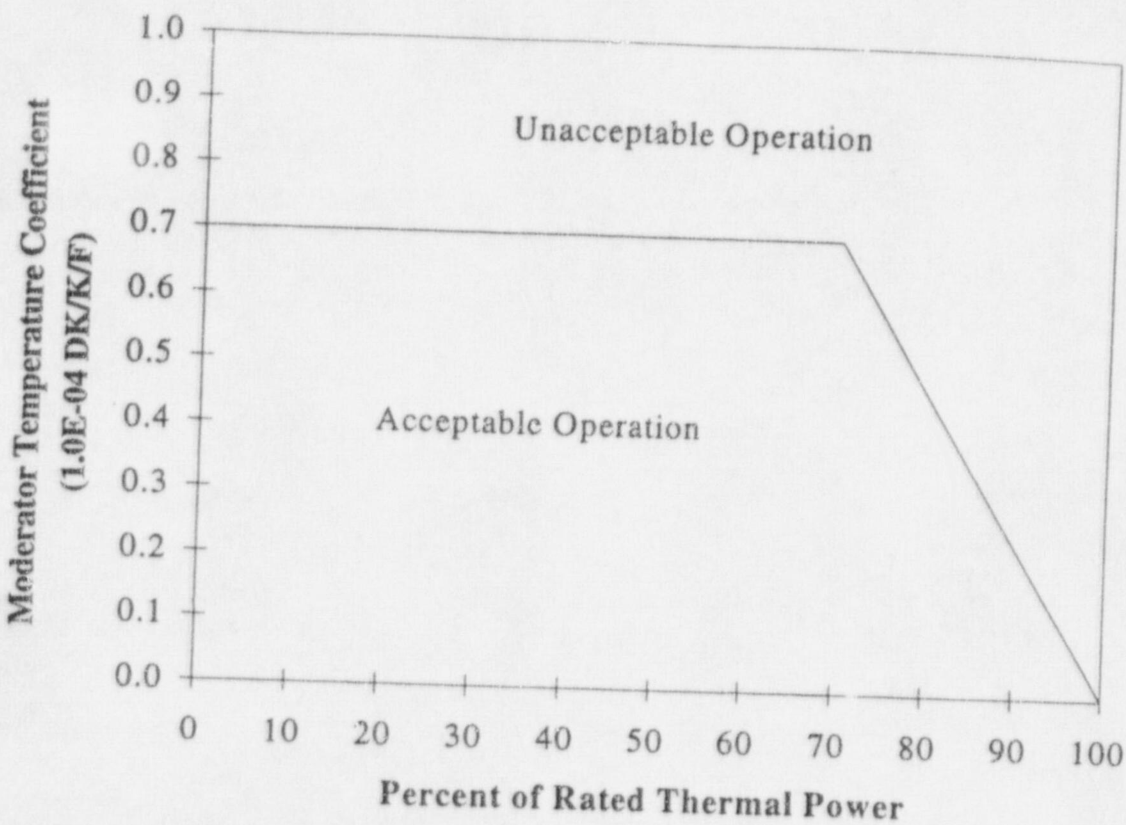
Figure 1
Moderator Temperature Coefficient Upper Limit Versus Power Level



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

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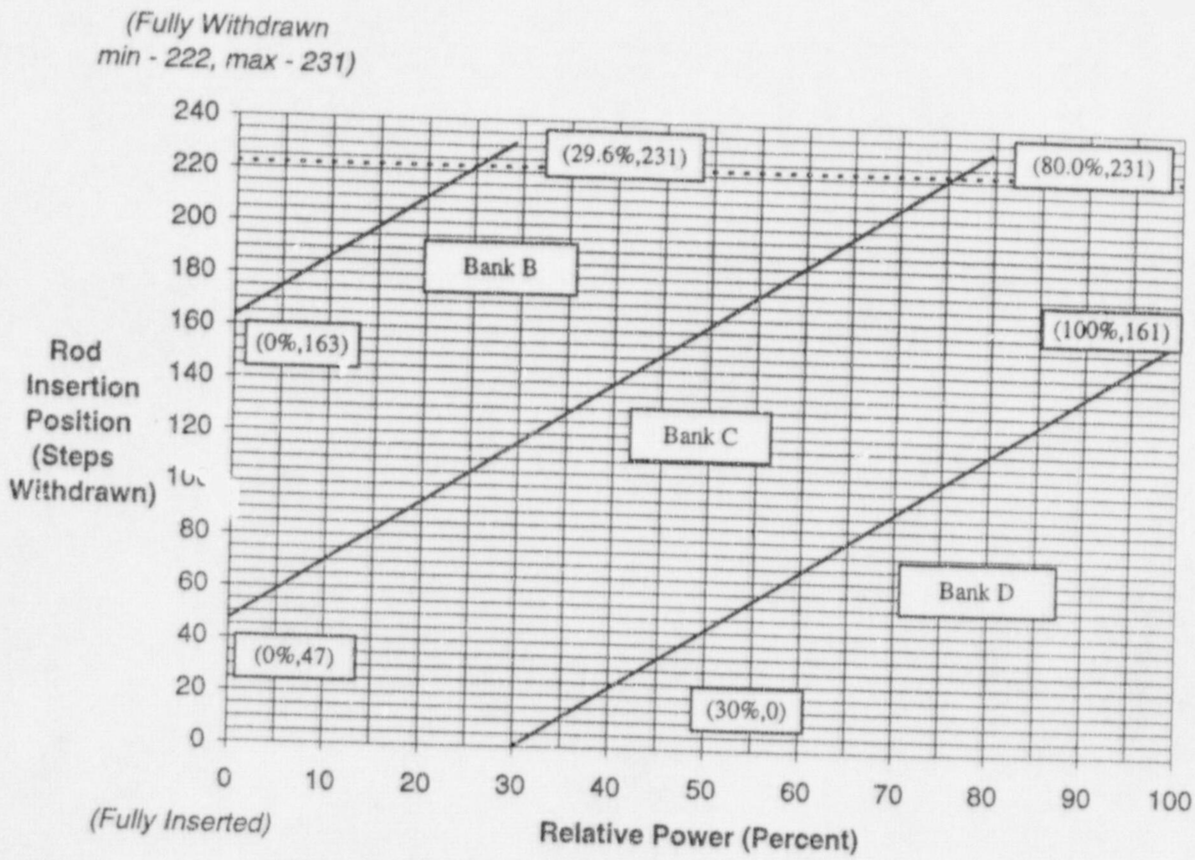
Figure 2

Control Bank Insertion Limits Versus Percent Rated Thermal Power



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

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2.6 Heat Flux Hot Channel Factor - FQ(X,Y,Z) (LCO 3.2.1)

2.6.1 $F_Q(X,Y,Z)$ 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 LCO limit. The manufacturing tolerance and measurement uncertainty are implicitly included in the F_Q surveillance limits as defined in Sections 2.6.5 and 2.6.6.

2.6.2 $F_Q^{RTP} = 2.50 \times K(BU)$

2.6.3 K(Z) is the normalized FQ(X,Y,Z) as a function of core height for MkBW fuel and is provided in Figure 3.

2.6.4 K(BU) is the normalized FQ(X,Y,Z) as a function of burnup for MkBW fuel and is provided in Figure 4.

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

2.6.5 $F_Q^L(X,Y,Z)^{OP} = F_Q^D(X,Y,Z) \times M_Q(X,Y,Z)/(UMT \times MT \times TILT)$

where:

$F_Q^L(X,Y,Z)^{OP}$ = cycle dependent maximum allowable design peaking factor which ensures that the FQ(X,Y,Z) limit will be preserved for operation

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

$F_Q^D(X,Y,Z)$ = design power distribution for FQ. $F_Q^D(X,Y,Z)$ is provided in Table 1, Appendix A, for normal operating conditions and in Table 2, Appendix A for power escalation testing during initial startup operation.

MQ(X,Y,Z) = margin remaining in core location X,Y,Z to the LOCA limit in the transient power distribution. MQ(X,Y,Z) is provided in Table 1, Appendix A for normal operating conditions and in Table 2, Appendix A for power escalation testing during initial startup operation.

UMT = Total Peak Measurement Uncertainty, = 1.05.

MT = Engineering Hot Channel Factor, = 1.03.

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

NOTE: $F_Q^L(X,Y,Z)^{OP}$ is the parameter identified as $F_Q^{MAX}(X,Y,Z)$ in DPC-NE-2011PA.

2.6.6 $F_Q^L(X,Y,Z)^{RPS} = F_Q^D(X,Y,Z) \times (M_C(X,Y,Z)/(UMT \times MT \times TILT))$

where:

$F_Q^L(X,Y,Z)^{RPS}$ = cycle dependent maximum allowable design peaking factor which ensures that the centerline fuel melt (CFM) limit will be preserved for operation within the LCO 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 FQ. $F_Q^D(X,Y,Z)$ is provided in Table 1, Appendix A for normal operating conditions and in Table 2, Appendix A for power escalation testing during initial startup operation.

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$M_C(X,Y,Z)$ = margin remaining to the CFM limit in core location X,Y,Z from the transient power distribution. $M_C(X,Y,Z)$ calculations parallel the $M_Q(X,Y,Z)$ calculations described in DPC-NE-2011PA, except that the LOCA limit is replaced with the CFM limit. $M_C(X,Y,Z)$ is provided in Table 3, Appendix A for normal operating conditions and in Table 4, Appendix A for power escalation testing during initial startup operation.

UMT = Total Peak Measurement Uncertainty, = 1.05.

MT = Engineering Hot Channel Factor, = 1.03.

TILT = Factor to account for a peaking increase due to the allowed quadrant power tilt ratio of 1.02. (TILT = 1.035).

NOTE: $F_Q^L(X,Y,Z)^{RPS}$ is the parameter identified as $F_Q^{MAX}(X,Y,Z)$ in DPC-NE-2011PA, except that MQ(X,Y,Z) is replaced by MC(X,Y,Z).

2.6.7 KSLOPE = 0.0725

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 $F_Q^L(X,Y,Z)^{RPS}$.

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Figure 3

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

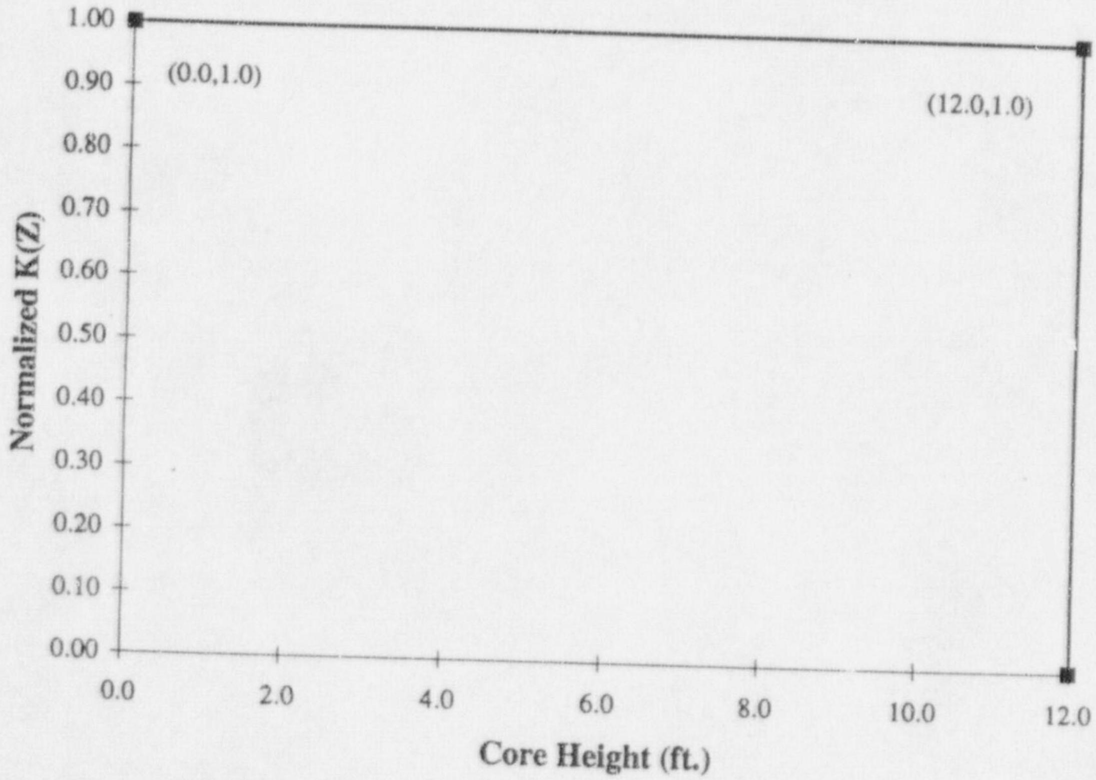

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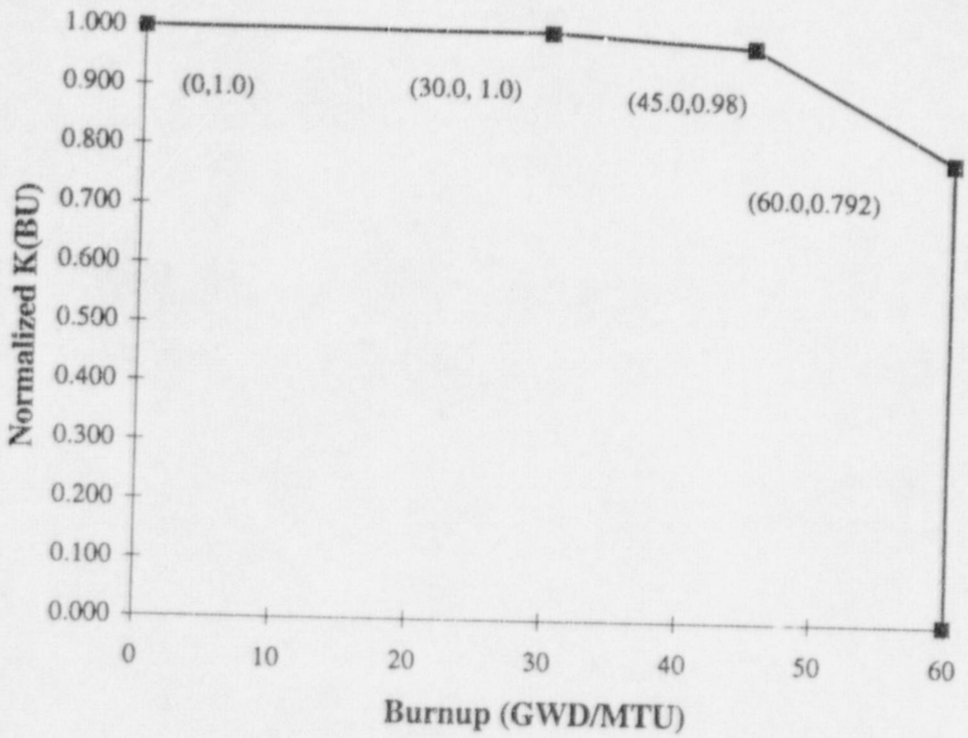
Figure 4

K(BU), Normalized FQ(X,Y,Z) as a Function of Burnup for MkBW Fuel



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

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

2.7.1 $F^{L}_{\Delta H}(X,Y)^{LCO} = \text{MARP}(X,Y) \times [1.0 + (1/\text{RRH}) \times (1.0 - P)]$

where:

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

MARP(X,Y) = Cycle-specific operating limit Maximum Allowable Radial Peaks. MARP(X,Y) radial peaking limits are provided in Table 7, Appendix A.

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

RRH = 3.34 when $0.0 < P \leq 1.0$, and

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

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

2.7.2 $F^{L}_{\Delta H}(X,Y)^{SURV} = F^{D}_{\Delta H}(X,Y) \times M_{\Delta H}(X,Y)/(\text{UMR} \times \text{TILT})$

where:

$F^{L}_{\Delta H}(X,Y)^{SURV}$ = cycle dependent maximum allowable design peaking factor which 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 calculational and measurement uncertainty.

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$F_{\Delta H}^{D}(X,Y)$ = the design power distribution for $F_{\Delta H}$. $F_{\Delta H}^{D}(X,Y)$ is provided in Table 5, Appendix A for normal operation and in Table 6, 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 5, Appendix A for normal operation and in Table 6, Appendix A for power escalation testing during initial startup operation.

UMR = Uncertainty value for measured radial peaks, = 1.04.

TILT = Factor to account for a peaking increase due to the allowed quadrant tilt ratio of 1.02. (TILT = 1.035).

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

2.7.3 RRH = 3.34 when $0.0 < P \leq 1.0$,

where:

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

2.7.4 TRH = 0.04

where:

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

2.8 Axial Flux Difference – AFD (LCO 3.2.3)

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

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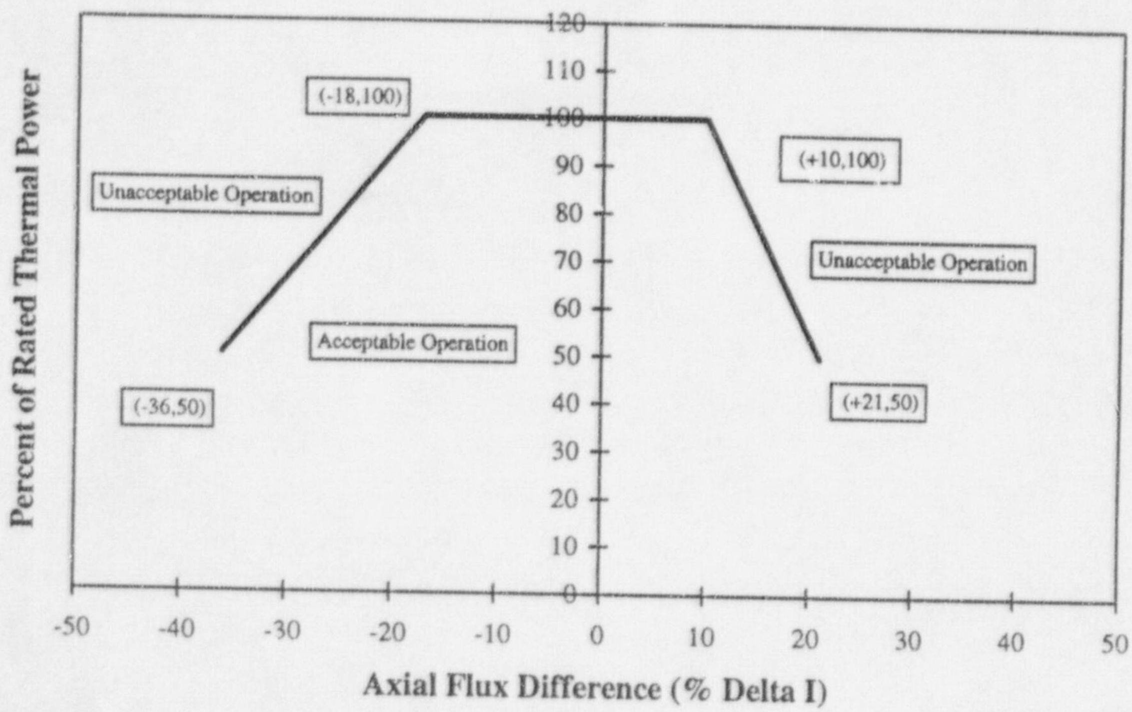
Figure 5

Percent of Rated Thermal Power Versus Percent Axial Flux Difference Limits



NOTE: Compliance with Technical Specification LCO 3.2.1 may require more restrictive AFD limits. Refer to OP/1/A/6100/22 Unit 1 Data Book for details.

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2.9 Reactor Trip System Instrumentation Setpoints (LCO 3.3.1) Table 3.3.1-1

2.9.1 Overtemperature ΔT Setpoint Parameter Values

Parameter	Value
Overtemperature ΔT reactor trip setpoint	$K_1 \leq 1.1978$
Overtemperature ΔT reactor trip heatup setpoint penalty coefficient	$K_2 = 0.0334/^oF$
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" breakpoint and the $f_1(\Delta I)$ "negative" slope are not applicable since the $f_1(\Delta I)$ function is not required below the $f_1(\Delta I)$ "positive" breakpoint of 19.0% ΔI.

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2.9.2 Overpower ΔT Setpoint Parameter Values

Parameter	Value
Overpower ΔT reactor trip setpoint	$K_4 \leq 1.086359$
Overpower ΔT reactor trip heatup setpoint penalty coefficient	$K_6 = 0.001179/^oF$
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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2.10 Accumulators (LCO 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.	2,475 ppm
Cold Leg Accumulator maximum boron concentration.	2,875 ppm

2.11 Refueling Water Storage Tank - RWST (LCO 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.	2,675 ppm
Refueling Water Storage Tank maximum boron concentration.	2,875 ppm

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2.12 Spent Fuel Pool Boron Concentration (LCO 3.7.14)

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.	2675 ppm

2.13 Refueling Operations - Boron Concentration (LCO 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.

Parameter	Limit
Minimum Boron concentration of the Reactor Coolant System, the refueling canal, and the refueling cavity.	2675 ppm

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2.14 Borated Water Source – Shutdown (SLC 16-15.3.1.2.5)

2.14.1 Volume and boron concentrations for the Boric Acid Storage System and the Refueling Water Storage Tank (RWST) during modes 5 & 6:

Parameter	Limit
Boric Acid Storage System minimum contained borated water volume	8,884 gallons 10.0% level
Boric Acid Storage System minimum boron concentration	7,000 ppm
Boric Acid Storage System minimum water volume required to maintain SDM at 7,000 ppm	585 gallons
Refueling Water Storage Tank minimum contained borated water volume	43,000 gallons 35.0 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	3,500 gallons

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2.15 Borated Water Source - Operating (SLC 16-15.3.1.2.6)

2.15.1 Volume and boron concentrations for the Boric Acid Storage System and the Refueling Water Storage Tank (RWST) during modes 1, 2, 3, & 4:

Parameter	Limit
Boric Acid Storage System minimum contained borated water volume	22,520 gallons 39.0% level
Boric Acid Storage System minimum boron concentration	7,000 ppm
Boric Acid Storage System minimum water volume required to maintain SDM at 7,000 ppm	11,851 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	2,875 ppm
Refueling Water Storage Tank minimum water volume required to maintain SDM at 2,675 ppm	57,107 gallons

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NOTE: Data contained in the Appendix to this document was generated in the McGuire 1 Cycle 13 Maneuvering Analysis calculational file, MCC-1553.05-00-0256. 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.