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TITLE MCGUIRE UNIT 1 CYCLE 9
CORE OPERATING LIMITS REPORT

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McGuire Nuclear Station COLR

McGuire Unit 1 Cycle 9

Core Operating Limits Report

June 1994

Revision 3

Duke Power Company

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 M1C9 Reload Safety Evaluation (calculation file: MCC-1552.08-00-0184).

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REVISION LOG

Revision	Effective Date	Effective Pages
Original Issue	May 24, 1993	Pages 6, 12, 13, 15-153
Revision 1	May 27, 1993	Page 9
Revision 2	February 24, 1994	Page 8
Revision 3	June 20, 1994	Pages 1-3, 3A, 4, 5, 5A, 5B, 7, 7A, 10, 11, 14, 14A

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INSERTION SHEET FOR REVISION 3

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McGuire 1 Cycle 9 Core Operating Limits Report

1.0 Core Operating Limits Report

This Core Operating Limits Report, (COLR), for McGuire, Unit 1, Cycle 9 has been prepared in accordance with the requirements of Technical Specification 6.9.1.9.

The Technical Specifications affected by this report are listed below:

2.2.1	Reactor Trip System Instrumentation Setpoints
3/4.1.1.3	Moderator Temperature Coefficient
3/4.1.2.5	Borated Water Source - Shutdown
3/4.1.2.6	Borated Water Source - Operating
3/4.1.3.5	Shutdown Rod Insertion Limit
3/4.1.3.6	Control Rod Insertion Limit
3/4.2.1	Axial Flux Difference
3/4.2.2	Heat Flux Hot Channel Factor
3/4.2.3	Nuclear Enthalpy Rise Hot Channel Factor
3/4.5.1.1	Accumulators
3/4.5.5	Refueling Water Storage Tank

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1.1 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 6.9.1.9.

2.0 Reactor Trip System Instrumentation Setpoints (Specification 2.2.1)

2.1 Overtemperature ΔT Setpoint Parameter Values

Parameter	Value
Overtemperature ΔT reactor trip setpoint	$K_1 \leq 1.1988$
Overtemperature ΔT reactor trip heatup setpoint penalty coefficient	$K_2 = 0.03354/^{o}F$
Overtemperature ΔT reactor trip depressurization setpoint penalty coefficient	$K_3 = 0.001522/psi$
Measured reactor vessel ΔT lead/lag time constants	$\tau_1 \geq 8$ sec. $\tau_2 \leq 3$ sec.
Measured ΔT lag time constant	$\tau_3 \leq 2$ sec.
Measured reactor vessel average temperature lead/lag time constants	$\tau_4 \geq 28$ sec. $\tau_5 \leq 4$ sec.
Measure reactor vessel average temperature lag time constant	$\tau_6 \leq 2$ sec.
$f_1(\Delta I)$ "positive" breakpoint	= 12.0 %ΔI
$f_1(\Delta I)$ "negative" breakpoint	= -44.0 %ΔI
$f_1(\Delta I)$ "positive" slope	= 1.619 $\%\Delta T_0 / \%\Delta I$
$f_1(\Delta I)$ "negative" slope	= 3.436 $\%\Delta T_0 / \%\Delta I$

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2.2 Overpower ΔT Setpoint Parameter Values

Parameter	Value
Overpower ΔT reactor trip setpoint	$K_4 \leq 1.0851$
Overpower ΔT reactor trip heatup setpoint penalty coefficient	$K_6 = 0.001207/^oF$
Measured reactor vessel ΔT lead/lag time constants	$\tau_1 \geq 8$ sec. $\tau_2 \leq 3$ sec.
Measured ΔT lag time constant	$\tau_3 \leq 2$ sec.
Measure reactor vessel average temperature lag time constant	$\tau_6 \leq 2$ sec.
Measure reactor vessel average temperature rate-lag time constant	$\tau_7 \geq 5$ 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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3.0 Moderator Temperature Coefficient (Specification 3/4.1.1.3)

3.0.1 The Moderator Temperature Coefficient (MTC) Limits are:

The MTC shall be less positive than the limits shown in Figure 1. The BOC, ARO, HZP MTC shall be less positive than 0.7 x 10E-04 ΔK/K/°F.

The EOC, APO, RTP MTC shall be less negative than -4.1 x 10E-04 ΔK/K/°F.

3.0.2 The MTC Surveillance Limit is:

The 300 PPM ARO, RTP MTC should be less negative than or equal to -3.2 x 10E-04 ΔK/K/°F.

Where: BOC stands for Beginning of Cycle
EOC stands for End of Cycle
ARO stands for All Rods Out
HZP stands for Hot Zero Thermal Power
RTP stands for Rated Thermal Power

3.1 Borated Water Source - Shutdown (Specification 3/4.1.2.5)

3.1.1 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 for LCO 3.1.2.5a	6,132 gallons
Boric Acid Storage System minimum boron concentration for LCO 3.1.2.5a	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 for LCO 3.1.2.5b	26,000 gallons
Refueling Water Storage Tank minimum boron concentration for LCO 3.1.2.5b	2,000 ppm
Refueling Water Storage Tank minimum water volume required to maintain SDM at 2,000 ppm	3,500 gallons

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3.2 Borated Water Source - Operating (Specification 3/4.1.2.6)

3.2.1 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 for LCO 3.1.2.6a	20,453 gallons
Boric Acid Storage System minimum boron concentration for LCO 3.1.2.6a	7,000 ppm
Boric Acid Storage System minimum water volume required to maintain SDM at 7,000 ppm	9,851 gallons
Refueling Water Storage Tank minimum contained borated water volume for LCO 3.1.2.6b	372,100 gallons
Refueling Water Storage Tank minimum boron concentration for LCO 3.1.2.6b	2,000 ppm
Refueling Water Storage Tank maximum boron concentration for LCO 3.1.2.6b	2,275 ppm
Refueling Water Storage Tank minimum water volume required to maintain SDM at 2,000 ppm	57,107 gallons

3.3 Shutdown Rod Insertion Limit (Specification 3/4.1.3.5)

3.3.1 The shutdown rods shall be withdrawn to at least 222 steps.

3.4 Control Rod Insertion Limits (Specification 3/4.1.3.6)

3.4.1 The control rod banks shall be limited to physical insertion as shown in Figure 2.

3.5 Axial Flux Difference (Specification 3/4.2.1)

3.5.1 The Axial Flux Difference (AFD) Limits are provided in Figure 3.

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3.6 Heat Flux Hot Channel Factor, $F_Q(X,Y,Z)$ (Specification 3/4.2.2)

3.6.1 $F_Q^{RTP} = 2.32$

3.6.2 K(Z) is provided in Figure 4 for Mark-BW fuel.

3.6.3 K(Z) is provided in Figure 5 for OFA fuel.

The following parameters are required for core monitoring per the Surveillance Requirements of Specification 3/4.2.2:

3.6.4 $[F_Q^L(X,Y,Z)]^{OP} = F_Q^D(X,Y,Z) \times M_Q(X,Y,Z)/(UMT \times MT \times TILT)$

where $[F_Q^L(X,Y,Z)]^{OP}$ = cycle dependent maximum allowable design peaking factor which ensures that the $F_Q(X,Y,Z)$ limit will be preserved for operation within the LCO limits $[F_Q^L(X,Y,Z)]^{OP}$. $[F_Q^L(X,Y,Z)]^{OP}$ includes allowances for calculational and measurement uncertainties.

$F_Q^D(X,Y,Z)$ = the design power distribution for F_Q. $F_Q^D(X,Y,Z)$ is provided in Table 1 for normal operating conditions and in Table 2 for power escalation during startup operations.

$M_Q(X,Y,Z)$ = the 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 1 for normal operating conditions and in Table 2 for power escalation during 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)

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

3.6.5 $[F_Q^L(X,Y,Z)]^{RPS} = F_Q^D(X,Y,Z) \times (M_C(X,Y,Z)/(UMT \times MT \times TILT))$

where $[F_Q^L(X,Y,Z)]^{RPS}$ = cycle dependent maximum allowable design peaking factor which ensures that the centerline fuel melt limit will be preserved for operation within the LCO limits. $[F_Q^L(X,Y,Z)]^{RPS}$ includes allowances for calculational and measurement uncertainties.

$F_Q^D(X,Y,Z)$ = the design power distributions for F_Q. $F_Q^D(X,Y,Z)$ is provided in Table 1 for normal operating conditions and in Table 2 for power escalation during startup operations.

$M_C(X,Y,Z)$ = the 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 for normal operating conditions and in Table 4 for power escalation during 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)

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

3.6.6 KSLOPE = 0.0725

where KSLOPE = Adjustment to the K_1 value from OTΔT required to compensate for each 1% that $[F_Q^L(X,Y,Z)]^{RPS}$ exceeds its limit.

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3.7 Nuclear Enthalpy Rise Hot Channel Factor, $F_{\Delta H}(X,Y,Z)$ (Specification 3/4.2.3)

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

3.7.1 McGuire 1 Cycle 9 Operating Limit Maximum Allowable Radial Peaks, (MARP(X,Y)), are provided in Table 7.

The following parameters are required for core monitoring per the Surveillance Requirements of Specification 3/4.2.3:

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

as identified in DPC-NE-2011PA.

where

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

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

3.7.2 $F^{D}_{\Delta H}(X,Y)$ = the design power distribution for $F_{\Delta H}$. $F^{D}_{\Delta H}(X,Y)$ is provided in Table 5 for normal operating conditions and in Table 6 for power escalation during startup operations.

3.7.3 $M_{\Delta H}(X,Y)$ = the margin remaining in core location X,Y to the DNB limit from the transient power distribution. $M_{\Delta H}(X,Y)$ is provided in Table 5 for normal operating conditions and in Table 6 for power escalation during startup operations.

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

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

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

3.7.5 TRH = 0.04

where TRH = Reduction in OTΔT K_1 setpoint required to compensate for each 1% that $F_{\Delta H}(X,Y)$ exceeds its limit.

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3.8 Accumulators (Specification 3/4.5.1.1)

3.8.1 Boron concentration limits during modes 1, 2, & 3:

Parameter	Limit
Cold Leg Accumulator minimum boron concentration for LCO 3.5.1.1c	1,900 ppm
Cold Leg Accumulator maximum boron concentration for LCO 3.5.1.1c	2,275 ppm
Minimum Cold Leg Accumulator boron concentration required to ensure post-LOCA subcriticality	1,800 ppm

3.9 Refueling Water Storage Tank (Specification 3/4.5.5)

3.9.1 Boron concentration limits during modes 1, 2, 3, & 4:

Parameter	Limit
Refueling Water Storage Tank minimum boron concentration for LCO 3.5.5b	2,000 ppm
Refueling Water Storage Tank maximum boron concentration for LCO 3.5.5b	2,275 ppm