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Technical Requirements Manual

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DTE
Energy

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TR 3.3 INSTRUMENTATION

TR 3.3.1.1 Reactor Protection System (RPS) Instrumentation

The RPS instrumentation trip setpoints and response times are listed in Table TR3.3.1.1-1.

TABLE TR3.3.1.1-1 (Page 1 of 2)
Reactor Protection System Instrumentation

FUNCTION	TRIP SETPOINT	RESPONSE TIME (seconds)
1. Intermediate Range Monitors		
a. Neutron Flux - High	$\leq 120/125$ divisions of full scale	NA
b. Inop	NA	NA
2. Average Power Range Monitors ^(a)		
a. Neutron Flux-Upscale (Setdown)	$\leq 15\%$ RTP	NA
b. Simulated Thermal Power - Upscale		NA
1. Flow Biased ^(g)	$\leq 0.62 (W-\Delta W)^{(b)} + 60.2\%$,	
2. High Flow Clamped	with a maximum of $\leq 113.5\%$ of RTP	
c. Neutron Flux - Upscale	$\leq 118\%$ RTP	NA
d. Inop	NA	NA
e. 2-out-of-4 Voters	NA	$\leq 0.05^{(a)}$
f. OPRM-Upscale		NA
1. Confirmation Count and	14	
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(a) Neutron detectors, APRM channel, and 2-out-of-4 Trip Voter digital electronics are exempt from response time testing. Response time shall be measured from activation of the 2-out-of-4 Trip Voter output relay.

(b) $\Delta W = 0\%$ for two loop operation. $\Delta W = 8\%$ for single loop operation.

TABLE TR3.3.1.1-1 (Page 2 of 2)
Reactor Protection System Instrumentation

FUNCTION		TRIP SETPOINT	RESPONSE TIME (seconds)
3.	Reactor Vessel Steam Dome Pressure - High	≤ 1093 psig	$\leq 0.55^{(c)}$
4.	Reactor Vessel Water Level - Low, Level 3	≥ 173.4 inches ^(d)	$\leq 1.05^{(c)}$
5.	Main Steam Isolation Valve - Closure	$\leq 8\%$ closed	≤ 0.06
6.	Main Steam Line Radiation - High	$\leq 3.0 \times$ full power background ^(f)	NA
7.	Drywell Pressure - High	≤ 1.68 psig	NA
8.	Scram Discharge Volume Water Level - High		
	a. Level Transmitter	≤ 592 ft. 6 inches	NA
	b. Float Switch	≤ 594 ft. 8 inches	NA
9.	Turbine Stop Valve-Closure	$\leq 5\%$ closed	≤ 0.06
10.	Turbine Control Valve Fast Closure	Initiation of fast closure	$\leq 0.08^{(e)}$

(c) The sensor and relays/logic response time need not be measured and may be assumed to be the design response time. Prior to return to service of a new transmitter/relay or following refurbishment of a transmitter (e.g., sensor cell or variable damper components/relay), a response time test will be performed to determine an initial sensor/relay specific response time value.

(d) As referenced to instrument zero Top of Active Fuel (TAF).

(e) Measured from de-energization of K37 relay, which inputs the turbine control valve closure signal, to the RPS.

(f) A new "full power background" level is established for hydrogen water chemistry based on 100% power operation with the established hydrogen injection rate. Actual background radiation levels may be less depending on actual power level or hydrogen injection rate.

Setpoint adjustment is not necessary for variations in power or hydrogen injection rate including interruptions in hydrogen flow.

(g) The method for determining the Nominal Trip Setpoints, as-found tolerances and as-left tolerances for this function are contained in Fermi 2 setpoint calculations. Setpoint calculations for this function are in accordance with the methods described in GEH Licensing Topical Reports NEDC-31336P-A, "General Electric Instrument Setpoint Methodology," September 1996 and NEDE-33633P-A, "GEH Methodology for Implementing TSTF-493 Revision 4," January 2014.

TABLE TR3.3.2.1-1 (Page 2 of 3)
Control Rod Block Instrumentation

FUNCTION	APPLICABLE MODES OR OTHER SPECIFIED CONDITIONS	REQUIRED CHANNELS PER FUNCTION	SURVEILLANCE REQUIREMENTS	ALLOWABLE VALUE
2. Intermediate Range Monitors				
a. Detector not full in	2, 5 ^(k)	6	TRSR 3.3.2.1.2	NA
b. Upscale	2, 5 ^(k)	6	TRSR 3.3.2.1.1 TRSR 3.3.2.1.2 TRSR 3.3.2.1.5	≤ 110/125 divisions of full scale
c. Inop	2, 5 ^(k)	6	TRSR 3.3.2.1.2	NA
d. Downscale ^(f)	2, 5 ^(k)	6	TRSR 3.3.2.1.1 TRSR 3.3.2.1.2 TRSR 3.3.2.1.5	≥ 3/125 divisions of full scale
3. Average Power Range Monitors				
a. Simulated Thermal Power - Upscale	1	3	TRSR 3.3.2.1.4 TRSR 3.3.2.1.8	
1. Flow Biased				≤ 0.62 (W - ΔW) ^(g) + 57.4%
2. High Flow Clamped				with a maximum of 110% RTP
b. Inop	1, 2	3	TRSR 3.3.2.1.4	NA
c. Neutron Flux - Downscale	1	3	TRSR 3.3.2.1.4 TRSR 3.3.2.1.8	≥ 3% RTP
d. Simulated Thermal Power - Upscale (Setdown)	2	3	TRSR 3.3.2.1.4 TRSR 3.3.2.1.8	≤ 14% RTP
e. Flow - Upscale	1	3	TRSR 3.3.2.1.4 TRSR 3.3.2.1.8	≤ 113% rated flow

(continued)

(f) This Function shall be automatically bypassed when the IRM channels are on range 1.

(g) The APRM Simulated Thermal Power - Upscale Flow Biased Rod Block setpoint varies as a function of recirculation loop drive flow (W). ΔW is defined as the difference in indicated drive flow (in percent of drive flow which produces rated core flow) between two loop and single loop operation at the same core flow. ΔW = 0% for two loop operation. ΔW = 8% for single loop operation.

(k) With any control rod withdrawn from a core cell containing one or more fuel assemblies.

TABLE TR3.3.2.1-2 (Page 1 of 1)
Control Rod Block Instrumentation

FUNCTION	TRIP SETPOINT
1. Source Range Monitors	
a. Detector not full in	NA
b. Upscale	$\leq 1.0 \times 10^5$ cps
c. Inop	NA
d. Downscale	≥ 3 cps ^(b)
2. Intermediate Range Monitors	
a. Detector not full in	NA
b. Upscale	$\leq 108/125$ divisions of full scale
c. Inop	NA
d. Downscale	$\geq 5/125$ divisions of full scale
3. Average Power Range Monitor	
a. Simulated Thermal Power - Upscale	
1) Flow Biased	$\leq 0.62(W - \Delta W)^{(a)} + 54.5\%$,
2) High Flow Clamped	with a maximum of 108% RTP
b. Inop	NA
c. Neutron Flux - Downscale	$\geq 5\%$ RTP
d. Simulated Thermal Power - Upscale (Setdown)	$\leq 12\%$ RTP
e. Flow - Upscale	$\leq 110\%$ rated flow
4. Scram Discharge Volume	
a. Water Level - High	≤ 589 ft. 11 1/2 inches
b. Scram Trip Bypass	NA

(a) The APRM Simulated Thermal Power - Upscale Flow Biased Rod Block setpoint varies as a function of recirculation loop drive flow (W). ΔW is defined as the difference in indicated drive flow (in percent of drive flow which produces rated core flow) between two loop and single loop operation at the same core flow. $\Delta W = 0\%$ for two loop operation. $\Delta W = 8\%$ for single loop operation.

(b) May be reduced to ≥ 0.7 cps provided the signal to noise ratio ≥ 20 .

TR 3.3 INSTRUMENTATION

TR 3.3.7.3 Feedwater Flow Instrumentation

TRLCO 3.3.7.3 The Leading Edge Flow Meter instrumentation system shall be OPERABLE.

APPLICABILITY: MODE 1 with THERMAL POWER > 3430 MWt

ACTIONS

-----NOTE-----
TRLCO 3.0.4.b is not applicable for the Leading Edge Flow Meter

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One or more systems inoperable.	A.1 Restore required instruments to OPERABLE status.	72 hours
B. REQUIRED ACTION and associated COMPLETION TIME OF CONDITION A not met.	B.1 Reduce power to ≤ 3430 MWt.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE	FREQUENCY
TRSR 3.3.7.3.1 Perform CHANNEL CHECK.	12 hours

TR B3.3 INSTRUMENTATION

TR B3.3.7.3 Feedwater Flow Instrumentation

BASES

The highly accurate Leading Edge Flow Meter CheckPlus Instrumentation allowed an increase in Licensed Thermal Power from 3430 MWt to 3486 MWt by reducing instrument uncertainty. When one or both channels of this instrumentation is out of service, operation at 3486 MWt is allowed for up to 72 hours following discovery of an INOPERABLE channel. If the instrumentation cannot be repaired within 72 hours, then power must be reduced to and maintained no higher than 3430 MWt until the instrumentation is repaired. If a decrease in power to below 3430 MWt occurs during the 72 hour period, then power must be maintained no higher than 3430 MWt until the instrumentation is repaired.

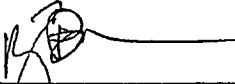
FERMI 2

CORE OPERATING LIMITS REPORT

CYCLE 17

REVISION 0


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1.0 INTRODUCTION AND SUMMARY

This report provides the cycle specific plant operating limits, which are listed below, for Fermi 2, Cycle 17, as required by Technical Specification 5.6.5. The analytical methods used to determine these core operating limits are those previously reviewed and approved by the Nuclear Regulatory Commission in GESTAR II (Reference 7).

The cycle specific limits contained within this report are valid for the full range of the licensed operating domain.

<u>OPERATING LIMIT</u>	<u>TECHNICAL SPECIFICATION</u>
APLHGR	3.2.1
MCPR	3.2.2
LHGR	3.2.3
RBM	3.3.2.1
BSP REGIONS	3.3.1.1
APLHGR = AVERAGE PLANAR LINEAR HEAT GENERATION RATE	
MCPR = MINIMUM CRITICAL POWER RATIO	
LHGR = LINEAR HEAT GENERATION RATE	
RBM = ROD BLOCK MONITOR SETPOINTS	
BSP = BACKUP STABILITY PROTECTION	

2.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE

2.1 Definition

TECH SPEC IDENT	OPERATING LIMIT
3.2.1	APLHGR

The AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR) shall be applicable to a specific planar height and is equal to the sum of the LINEAR HEAT GENERATION RATES (LHGRs) for all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the fuel bundle at the height.

2.2 Determination of MAPLHGR Limit

The maximum APLHGR (MAPLHGR) limit is a function of reactor power, core flow, fuel type, and average planar exposure. The limit is developed, using NRC approved methodology described in References 7 and 8, to ensure gross cladding failure will not occur following a loss of coolant accident (LOCA). The MAPLHGR limit ensures that the peak clad temperature during a LOCA will not exceed the limits as specified in 10CFR50.46(b)(1) and that the fuel design analysis criteria defined in References 7 and 8 will be met.

The MAPLHGR limit during dual loop operation is calculated by the following equation:

$$MAPLHGR_{limit} = \text{MIN} (MAPLHGR (P), MAPLHGR (F))$$

where:

$$MAPLHGR (P) = MAPFAC (P) \times MAPLHGR_{sm}$$

$$MAPLHGR (F) = MAPFAC (F) \times MAPLHGR_{sm}$$

Within four hours after entering single loop operation, the MAPLHGR limit is calculated by the following equation:

$$MAPLHGR_{limit} = \text{MIN} (MAPLHGR (P), MAPLHGR (F), MAPLHGR (SLO))$$

where:

$$MAPLHGR (SLO) = 1.0 \times MAPLHGR_{sm}$$

The Single Loop multiplier is 1.0 since the off-rated ARTS limits bound the single loop MAPLHGR limit. (Reference 2)

MAPLHGR_{STD}, the standard MAPLHGR limit, is defined at a power of 3486 MWth and flow of 105 Mlbs/hr for each fuel type as a function of average planar exposure and is presented in Table 1. (Reference 2) When hand calculations are required, MAPLHGR_{STD} shall be determined by interpolation from Table 1. MAPFAC(P), the core power-dependent MAPLHGR limit adjustment factor, shall be calculated by using Section 2.2.1. MAPFAC(F), the core flow-dependent MAPLHGR limit adjustment factor, shall be calculated by using Section 2.2.2.

TABLE 1
FUEL TYPE-DEPENDENT
STANDARD MAPLHGR LIMITS

GE14 Exposure <u>GWD/ST</u>	GE14 MAPLHGR <u>kW/ft</u>
0.0	12.82
19.13	12.82
57.61	8.00
63.50	5.00

Fuel Types

1 = GE14-P10CNAB400-16GZ-100T-150-T6-2787	14 = GE14-P10CNAB376-4G6/9G5/2G2-100T-150-T6-4061
7 = GE14-P10CNAB381-16G5-100T-150-T6-2999	15 = GE14-P10CNAB373-7G5/6G4-100T-150-T6-4064
8 = GE14-P10CNAB380-4G6/9G5-100T-150-T6-3150	16 = GE14-P10CNAB376-15GZ-100T-150-T6-4063
9 = GE14-P10CNAB380-7G5/8G4-100T-150-T6-3152	17 = GE14-P10CNAB379-14GZ-100T-T6-4259
10 = GE14-P10CNAB378-14GZ-100T-150-T6-3151	18 = GE14-P10CNAB381-4G6/11G5-100T-T6-4260
11 = GE14-P10CNAB375-13G5-100T-150-T6-3339	19 = GE14-P10CNAB381-4G6/12G5-100T-T6-4261
12 = GE14-P10CNAB376-15G5-100T-150-T6-3340	20 = GE14-P10CNAB379-15GZ-100T-T6-4262
13 = GE14-P10CNAB375-14G5-100T-150-T6-3338	

2.2.1 Calculation of MAPFAC(P)

The core power-dependent MAPLHGR limit adjustment factor, MAPFAC(P) (Reference 2, 3 & 11), shall be calculated by one of the following equations:

For $0 \leq P < 25$:

No thermal limits monitoring is required.

For $25 \leq P < 29.5$:

With turbine bypass OPERABLE,

For core flow ≤ 50 Mlbs/hr,

$$MAPFAC(P) = 0.604 + 0.0038(P - 29.5)$$

For core flow > 50 Mlbs/hr,

$$MAPFAC(P) = 0.584 + 0.0038(P - 29.5)$$

With turbine bypass INOPERABLE,

For core flow ≤ 50 Mlbs/hr,

$$MAPFAC(P) = 0.488 + 0.0050(P - 29.5)$$

For core flow > 50 Mlbs/hr,

$$MAPFAC(P) = 0.436 + 0.0050(P - 29.5)$$

For $29.5 \leq P \leq 100$:

$$MAPFAC(P) = 1.0 + 0.005224(P - 100)$$

where: P = Core power (fraction of rated power times 100).

Note: This range applies with pressure regulator in service and, for power $> 85\%$, it also applies with the pressure regulator out of service

MAPFAC(P) for Pressure Regulator Out of Service Limits

With one Turbine Pressure Regulator Out of Service and Reactor Power Greater Than or Equal to 29.5% and Less Than or Equal to 85% and both Turbine Bypass and Moisture Separator Reheater Operable:

For $29.5 \leq P < 45$:

$$MAPFAC(P) = 0.680 + 0.00627 (P - 45)$$

For $45 \leq P < 60$:

$$MAPFAC(P) = 0.758 + 0.0052 (P - 60)$$

For $60 \leq P \leq 85$:

$$MAPFAC(P) = 0.831 + 0.00292 (P - 85)$$

where: P = Core power (fraction of rated power times 100).

2.2.2 Calculation of MAPFAC(F)

The core flow-dependent MAPLHGR limit adjustment factor, MAPFAC(F) (Reference 2 & 3), shall be calculated by the following equation:

$$MAPFAC(F) = \text{MIN}(1.0, A_F \times \frac{WT}{100} + B_F)$$

where:

WT = Core flow (Mlbs/hr).

A_F = Given in Table 2.

B_F = Given in Table 2.

TABLE 2 FLOW-DEPENDENT MAPLHGR LIMIT COEFFICIENTS

Maximum Core Flow* (Mlbs/hr)	A_F	B_F
110	0.6787	0.4358

* As limited by the Recirculation System MG Set mechanical scoop tube stop setting.

3.0 MINIMUM CRITICAL POWER RATIO

TECH SPEC IDENT	OPERATING LIMIT
3.2.2	MCPR

3.1 Definition

The MINIMUM CRITICAL POWER RATIO (MCPR) shall be the smallest Critical Power Ratio (CPR) that exists in the core for each type of fuel. The CPR is that power in the assembly that is calculated by application of the appropriate correlation(s) to cause some point in the assembly to experience boiling transition, divided by the actual assembly operating power.

3.2 Determination of Operating Limit MCPR

The required Operating Limit MCPR (OLMCPR) (Reference 2) at steady-state rated power and flow operating conditions is derived from the established fuel cladding integrity Safety Limit MCPR and an analysis of abnormal operational transients. To ensure that the Safety Limit MCPR is not exceeded during any anticipated abnormal operational transient, the most limiting transients have been analyzed to determine which event will cause the largest reduction in CPR. Three different core average exposure conditions are evaluated. The result is an Operating Limit MCPR which is a function of exposure and τ . τ is a measure of scram speed, and is defined in Section 3.3.2. Cycle 17 operating limits are based on the Dual Loop SLMCPR of 1.08.

The OLMCPR shall be calculated by the following equation:

$$OLMCPR = \text{MAX}(MCPR(P), MCPR(F))$$

MCPR(P), the core power-dependent MCPR operating limit, shall be calculated using Section 3.3.

MCPR(F), the core flow-dependent MCPR operating limit, shall be calculated using Section 3.4.

In case of **Single Loop Operation**, the Safety Limit MCPR (Reference 2) is increased to account for increased uncertainties in core flow measurement and TIP measurement. However, OLMCPR is not increased when operating in single loop due to inherent conservatism.

In case of operation with one Turbine Pressure Regulator out of service, OLMCPR limits are bounding when reactor power is less than 29.5% or greater than 85%. When reactor power is greater than or equal to 29.5% and less than or equal to 85%, then operation with one Turbine Pressure Regulator out of service is permitted if both Turbine Bypass Valves and the Moisture Separator Reheater are operable. (Reference 2 and 11)

TABLE 3 OLMCPR_{100/105} AS A FUNCTION OF EXPOSURE AND τ
(Reference 2 and 11)

<u>CONDITION</u>	<u>EXPOSURE</u> <u>(MWD/ST)</u>		<u>OLMCPR_{100/105}</u>	
			Two Loop	Single Loop
BOTH Turbine Bypass Valves AND Moisture Separator Reheater OPERABLE	BOC to 8000	$\tau = 0$	1.29	1.29
		$\tau = 1$	1.45	1.45
	8000 to EOC	$\tau = 0$	1.32	1.32
		$\tau = 1$	1.49	1.49
ONE Turbine Pressure Regulator Out of Service AND Reactor Power between 29.5% and 85% AND BOTH Turbine Bypass Valves and Moisture Separator Reheater Operable	BOC to EOC	$\tau = 0$	1.32	1.32
		$\tau = 1$	1.49	1.49
Moisture Separator Reheater INOPERABLE	BOC to EOC	$\tau = 0$	1.38	1.38
		$\tau = 1$	1.55	1.55
Turbine Bypass Valve INOPERABLE	BOC to EOC	$\tau = 0$	1.38	1.38
		$\tau = 1$	1.55	1.55
BOTH Turbine Bypass Valve AND Moisture Separator Reheater INOPERABLE	BOC to EOC	$\tau = 0$	1.44	1.44
		$\tau = 1$	1.61	1.61

3.3 Calculation of MCPR(P)

MCPR(P), the core power-dependent MCPR operating limit (Reference 2, 3 & 11), shall be calculated by the following equation:

$$MCPR(P) = K_P \times OLMCPR_{100/105}$$

K_P , the core power-dependent MCPR Operating Limit adjustment factor, shall be calculated by using Section 3.3.1.

$OLMCPR_{100/105}$ shall be determined by interpolation on τ from Table 3 (Reference 2), and τ shall be calculated by using Section 3.3.2.

3.3.1 Calculation of K_P

The core power-dependent MCPR operating limit adjustment factor, K_P (Reference 2, 3, & 11), shall be calculated by using one of the following equations:

For $0 \leq P < 25$:

No thermal limits monitoring is required.

For $25 \leq P < 29.5$:

When turbine bypass is OPERABLE,

$$K_P = \frac{(K_{BYP} + (0.032 \times (29.5 - P)))}{OLMCPR_{100/105}}$$

where: $K_{BYP} = 2.18$ for core flow ≤ 50 Mlbs/hr
 $= 2.46$ for core flow > 50 Mlbs/hr

When turbine bypass is INOPERABLE,

$$K_P = \frac{(K_{BYP} + (0.076 \times (29.5 - P)))}{OLMCPR_{100/105}}$$

where: $K_{BYP} = 2.65$ for core flow ≤ 50 Mlbs/hr
 $= 3.38$ for core flow > 50 Mlbs/hr

For $29.5 \leq P < 45$:

$$K_P = 1.28 + (0.0134 \times (45 - P))$$

For $45 \leq P < 60$:

$$K_P = 1.15 + (0.00867 \times (60 - P))$$

For $60 \leq P \leq 100$:

$$K_P = 1.0 + (0.00375 \times (100 - P))$$

where: P = Core power (fraction of rated power times 100).

Note: This range applies with pressure regulator in service and, for power >85%, it also applies with the pressure regulator out of service

K_P for Pressure Regulator Out of Service Limits

With one Turbine Pressure Regulator Out of Service and Reactor Power Greater Than or Equal to 29.5% and Less Than or Equal to 85% and both Turbine Bypass and Moisture Separator Reheater Operable:

For $29.5 \leq P < 45$:

$$K_P = 1.52 + (0.01193 \times (45 - P))$$

For $45 \leq P < 60$:

$$K_P = 1.362 + (0.01053 \times (60 - P))$$

For $60 \leq P \leq 85$:

$$K_P = 1.217 + (0.0058 \times (85 - P))$$

where: P = Core power (fraction of rated power times 100).

3.3.2 Calculation of τ

The value of τ , which is a measure of the conformance of the actual control rod scram times to the assumed average control rod scram time in the reload licensing analysis (Reference 4), shall be calculated by using the following equation:

$$\tau = \frac{(\tau_{ave} - \tau_B)}{\tau_A - \tau_B}$$

where: $\tau_A = 1.096$ seconds

$$\tau_B = 0.830 + 0.019 \times 1.65 \sqrt{\frac{N_1}{\sum_{i=1}^n N_i}} \text{ seconds}$$

$$\tau_{ave} = \frac{\sum_{i=1}^n N_i \tau_i}{\sum_{i=1}^n N_i}$$

n = number of surveillance tests performed to date in cycle,

N_i = number of active control rods measured in the i^{th} surveillance test,

τ_i = average scram time to notch 36 of all rods measured in the i^{th} surveillance test, and

N_1 = total number of active rods measured in the initial control rod scram time test for the cycle (Technical Specification Surveillance Requirement 3.1.4.4).

The value of τ shall be calculated and used to determine the applicable OLMCPR_{100/105} value from Table 3 within 72 hours of the conclusion of each control rod scram time surveillance test required by Technical Specification Surveillance Requirements 3.1.4.1, 3.1.4.2, and 3.1.4.4.

3.4 Calculation of MCPR(F)

MCPR(F), the core flow-dependent MCPR operating limit (Reference 2 & 3), shall be calculated by using the following equation:

$$MCPR(F) = \text{MAX}(1.21, (A_F \times \frac{WT}{100} + B_F))$$

where:

WT = Core flow (Mlbs/hr).
A_F = Given in Table 4.
B_F = Given in Table 4.

TABLE 4 FLOW-DEPENDENT MCPR LIMIT COEFFICIENTS

	Maximum Core Flow* (Mlbs/hr)	A _F	B _F
Single or Two Loop	110	-0.601	1.743

*As limited by the Recirculation System MG Set mechanical scoop tube stop setting.

4.0 LINEAR HEAT GENERATION RATE

TECH SPEC IDENT	OPERATING LIMIT
3.2.3	LHGR

4.1 Definition

The LINEAR HEAT GENERATION RATE (LHGR) shall be the heat generation rate per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length. By maintaining the operating LHGR below the applicable LHGR limit, it is assured that all thermal-mechanical design bases and licensing limits for the fuel will be satisfied.

4.2 Determination of LHGR Limit

The maximum LHGR limit is a function of reactor power, core flow, fuel and rod type, and fuel rod nodal exposure. The limit is developed, using NRC approved methodology described in References 7 and 8, to ensure the cladding will not exceed its yield stress and that fuel thermal-mechanical design criteria will not be violated during any postulated transient events. The LHGR limit ensures the fuel mechanical design requirements as defined in References 1 & 21 will be met.

The LHGR limit during dual loop operation is calculated by the following equation:

$$LHGR_{LIM} = \text{MIN} (LHGR (P), LHGR (F))$$

where:

$$LHGR (P) = LHGRFAC (P) \times LHGR_{STD}$$

$$LHGR (F) = LHGRFAC (F) \times LHGR_{STD}$$

LHGR_{STD}, the standard LHGR limit, is defined at a power of 3486 MWth and flow of 105 Mlbs/hr for each fuel and rod type as a function of fuel rod nodal exposure and is presented in Table 5. Table 5 contains only the most limiting Gadolinia LHGR limit for the maximum allowed Gadolinia concentration of the applicable fuel product line. (References 1 & 21) When hand calculations are required, LHGR_{STD} shall be determined by interpolation from Table 5. LHGRFAC(P), the core power-dependent LHGR limit adjustment factor, shall be calculated by using Section 4.2.1. LHGRFAC(F), the core flow-dependent LHGR limit adjustment factor, shall be calculated by using Section 4.2.2.

TABLE 5 STANDARD LHGR LIMITS FOR VARIOUS FUEL TYPES

For GE14 fuel listed below, the most limiting LHGR for Uranium Only fuel rod is found in NEDC-32868P Revision 5 Table D-2 (References 1 & 21).

For GE14 fuel listed below, the most limiting LHGR for Gadolinia Bearing fuel rods is found in NEDC-32868P Revision 5 Table D-4 (References 1 & 21). Utilize the row for 6% Rod/Section wt-% Gd_2O_3

1 = GE14-P10CNAB400-16GZ-100T-150-T6-2787
7 = GE14-P10CNAB381-16G5-100T-150-T6-2999
8 = GE14-P10CNAB380-4G6/9G5-100T-150-T6-3150
9 = GE14-P10CNAB380-7G5/8G4-100T-150-T6-3152
10 = GE14-P10CNAB378-14GZ-100T-150-T6-3151
11 = GE14-P10CNAB375-13G5-100T-150-T6-3339
12 = GE14-P10CNAB376-15G5-100T-150-T6-3340
13 = GE14-P10CNAB375-14G5-100T-150-T6-3338

Fuel Types

14 = GE14-P10CNAB376-4G6/9G5/2G2-100T-150-T6-4061
15 = GE14-P10CNAB373-7G5/6G4-100T-150-T6-4064
16 = GE14-P10CNAB376-15GZ-100T-150-T6-4063
17 = GE14-P10CNAB379-14GZ-100T-T6-4259
18 = GE14-P10CNAB381-4G6/11G5-100T-T6-4260
19 = GE14-P10CNAB381-4G6/12G5-100T-T6-4261
20 = GE14-P10CNAB379-15GZ-100T-T6-4262

4.2.1 Calculation of LHGRFAC(P)

The core power-dependent LHGR limit adjustment factor, LHGRFAC(P) (Reference 2, 3, & 11), shall be calculated by one of the following equations:

For $0 \leq P < 25$:

No thermal limits monitoring is required.

For $25 \leq P < 29.5$:

With turbine bypass OPERABLE,

For core flow ≤ 50 Mlbs/hr,

$$LHGRFAC(P) = 0.604 + 0.0038 (P - 29.5)$$

For core flow > 50 Mlbs/hr,

$$LHGRFAC(P) = 0.584 + 0.0038 (P - 29.5)$$

With turbine bypass INOPERABLE,

For core flow ≤ 50 Mlbs/hr,

$$LHGRFAC(P) = 0.488 + 0.0050 (P - 29.5)$$

For core flow > 50 Mlbs/hr,

$$LHGRFAC(P) = 0.436 + 0.0050 (P - 29.5)$$

For $29.5 \leq P \leq 100$:

$$LHGRFAC(P) = 1.0 + 0.005224 (P - 100)$$

where: P = Core power (fraction of rated power times 100).

Note: This range applies with pressure regulator in service and, for power $> 85\%$, it also applies with the pressure regulator out of service

LHGRFAC(P) for Pressure Regulator Out of Service Limits

With one Turbine Pressure Regulator Out of Service and Reactor Power Greater Than or Equal to 29.5% and Less Than or Equal to 85% and both Turbine Bypass and Moisture Separator Reheater Operable:

For $29.5 \leq P < 45$:

$$LHGRFAC(P) = 0.680 + 0.00627(P - 45)$$

For $45 \leq P < 60$:

$$LHGRFAC(P) = 0.758 + 0.0052(P - 60)$$

For $60 \leq P \leq 85$:

$$LHGRFAC(P) = 0.831 + 0.00292(P - 85)$$

where: P = Core power (fraction of rated power times 100).

4.2.2 Calculation of LHGRFAC(F)

The core flow-dependent LHGR limit adjustment factor, LHGRFAC(F) (Reference 2 & 3), shall be calculated by the following equation:

$$LHGRFAC(F) = \text{MIN}(1.0, A_F \times \frac{WT}{100} + B_F)$$

where:

WT = Core flow (Mlbs/hr).
 A_F = Given in Table 6.
 B_F = Given in Table 6.

TABLE 6 FLOW-DEPENDENT LHGR LIMIT COEFFICIENTS

Maximum Core Flow* (Mlbs/hr)	A_F	B_F
110	0.6787	0.4358

*As limited by the Recirculation System MG Set mechanical scoop tube stop setting.

5.0 CONTROL ROD BLOCK INSTRUMENTATION

TECH SPEC IDENT	SETPOINT
3.3.2.1	RBM

5.1 Definition

The nominal trip setpoints and allowable values of the control rod withdrawal block instrumentation are shown in Table 7. These values are consistent with the bases of the APRM Rod Block Technical Specification Improvement Program (ARTS) and the MCPR operating limits. (References 2, 5, 6, & 10).

**TABLE 7 CONTROL ROD BLOCK INSTRUMENTATION SETPOINTS
WITH FILTER**

Setpoint	Trip Setpoint	Allowable Value
LPSP	27.0	28.4
IPSP	62.0	63.4
HPSP	82.0	83.4
LTSP	117.0	118.9
ITSP	112.2	114.1
HTSP	107.2	109.1
DTSP	94.0	92.3

Where:

LPSP	Low power setpoint; Rod Block Monitor (RBM) System trip automatically bypassed below this level
IPSP	Intermediate power setpoint
HPSP	High power setpoint
LTSP	Low trip setpoint
ITSP	Intermediate trip setpoint
HTSP	High trip setpoint
DTSP	Downscale trip setpoint

6.0 BACKUP STABILITY PROTECTION REGIONS

TECH SPEC REFERENCE 3.3.1.1 Action Condition J	OPERATING LIMIT Alternate method to detect and suppress thermal hydraulic instability oscillations
TRM REFERENCE 3.4.1.1	OPERATING LIMIT Scram, Exit, and Stability Awareness Regions

6.1 Definition

The Backup Stability Protection (BSP) Regions are an integral part of the Tech Spec required alternative method to detect and suppress thermal hydraulic instability oscillations in that they identify areas of the power/flow map where there is an increased probability that the reactor core could experience a thermal hydraulic instability. Regions are identified (refer to Table 8 and Figures 1 and 2) that are either excluded from planned entry (Scram Region), or where specific actions are required to be taken to immediately leave the region (Exit Region). A region is also identified where operation is allowed provided that additional monitoring is performed to verify that the reactor core is not exhibiting signs of core thermal hydraulic instability (Stability Awareness Region). (Reference 2)

The boundaries of these regions are established on a cycle specific basis based upon core decay ratio calculations performed using NRC approved methodology. The Cycle 17 regions are valid to a cycle exposure of 13,044 MWD/ST (Reference 22).

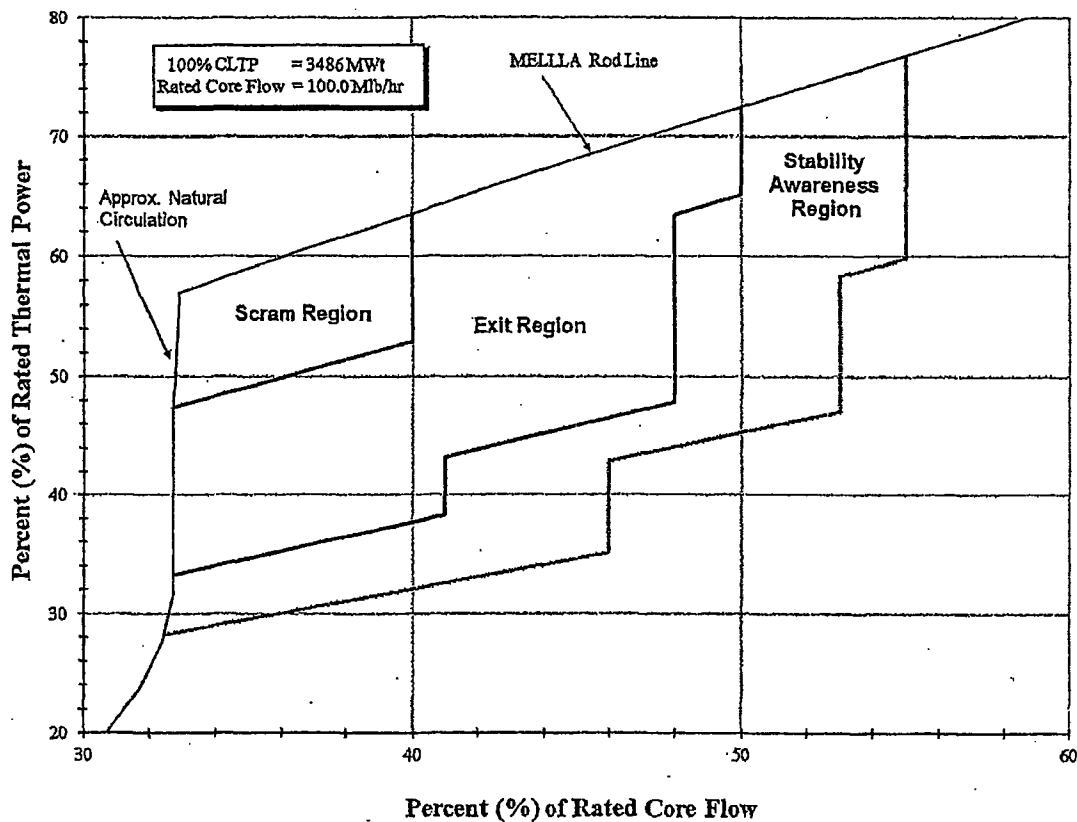
These regions are only applicable when the Oscillation Power Range Monitoring System (OPRM) is inoperable. The Cycle 17 region boundaries defined in Figure 1 are applicable when final feedwater temperature is in the optimum range as illustrated in 20.107.02, Loss of Feedwater Heating Abnormal Operating Instruction. Figure 2 is applicable to operation with Feedwater Heaters Out-Of-Service (FWHOOS) or with Final Feedwater Temperature Reduction (FFWTR) or when final feedwater temperature is below the optimum range.

TABLE 8 BSP REGION DESCRIPTIONS

Region:	Nominal Feedwater Temperature	Reduced Feedwater Temperature
Scram Region:	> 94% Rod Line, < 40% Flow	> 89% Rod Line, < 47% Flow
Exit Region:	> 66% Rod Line, < 41% Flow > 75% Rod Line, < 48% Flow > 101% Rod Line, < 50% Flow	> 66% Rod Line, < 41% Flow > 75% Rod Line, < 51% Flow > 102% Rod Line, < 53% Flow
Stability Awareness Region	> 56% Rod Line, < 46% Flow > 70% Rod Line, < 53% Flow > 87% Rod Line, < 55% Flow	> 56% Rod Line, < 46% Flow > 70% Rod Line, < 56% Flow > 84% Rod Line, < 60% Flow

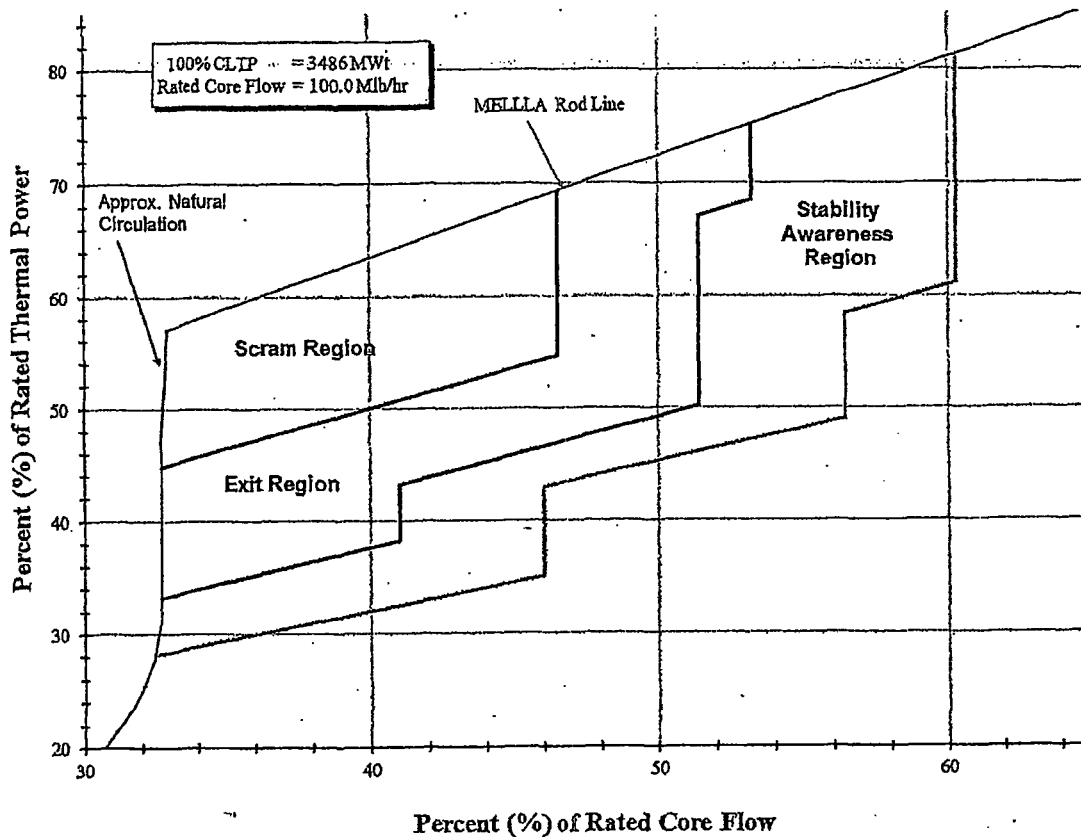
Table 8 values are conservatively rounded

FIGURE 1 - BSP REGIONS FOR NOMINAL FEEDWATER TEMPERATURE



Nominal feedwater heating exists with all feedwater heaters in service, the moisture separator reheaters in service, and reactor water cleanup in or out of service. Nominal Feedwater temperature is determined with the Loss of Feedwater Heating Abnormal Operating Instruction, 20.107.02. If feedwater temperature is less than 15 degrees Fahrenheit below the Optimum Line of the Feedwater Inlet Temperature vs. Reactor Power graph of Enclosure A of 20.107.02, Loss of Feedwater Heating, then Figure 1 shall be used if the Oscillation Power Range Monitor is out of service.

FIGURE 2 - BSP REGIONS FOR REDUCED FEEDWATER TEMPERATURE



Reduced feedwater temperature is analyzed for a 50 degree Fahrenheit reduction in feedwater temperature at 100% power. If feedwater temperature is more than 15 degrees Fahrenheit below the Optimum Line of the Feedwater Inlet Temperature vs. Reactor Power graph of Enclosure A of 20.107.02, Loss of Feedwater Heating, then Figure 2 shall be used if the Oscillation Power Range Monitor is out of service.

Figure 2 is valid until feedwater temperature meets the Minimum Line of the Feedwater Inlet Temperature vs. Reactor Power graph of Enclosure A of 20.107.02, Loss of Feedwater Heating.

7.0 REFERENCES

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