Tennessee Valley Authority, Post Office Box 2000, Decatur, Alabama 35609

May 8, 2000

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

Gentlemen:

In the Matter of) Docket No. 50-296
Tennessee Valley Authority)

BROWNS FERRY NUCLEAR PLANT (BFN) - UNIT 3 - CORE OPERATING LIMITS REPORT FOR UNIT 3 CYCLE 10 OPERATION

In accordance with the requirements of Technical Specification 5.6.5.d, enclosed is the BFN Unit 3 Cycle 10 Core Operating Limits Report.

There are no commitments contained in this letter. If you have any questions, please contact me at (256) 729-2636.

Sincerely,

T. E. Abney
Manager of Licensing
and Industry Affairs

Enclosure
cc: See page 2

A001

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ENCLOSURE

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT (BFN)
UNIT 3

CORE OPERATING LIMITS REPORT (COLR)
FOR CYCLE 10 OPERATION

(SEE ATTACHED)

Browns Ferry Nuclear Plant
Unit 3, Cycle 10

CORE OPERATING LIMITS REPORT
(COLR)

TENNESSEE VALLEY AUTHORITY
Nuclear Fuel Division
BWR Fuel Engineering Department

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Revision Log

Revision	Date	Description	Affected Pages
0	4/14/2000	Initial Release for New Cycle	All

1. INTRODUCTION

This Core Operating Limits Report for Browns Ferry Unit 3, Cycle 10 is prepared in accordance with the requirements of Browns Ferry Technical Specification 5.6.5. The core operating limits presented here were developed using NRC-approved methods (References 1 and 2). Results from the reload analyses for Browns Ferry Unit 3, Cycle 10 are documented in Reference 3.

The following core operating limits are included in this report:

a. Average Planar Linear Heat Generation Rate (APLHGR) Limit
(Technical Specifications 3.2.1 and 3.7.5)

b. Linear Heat Generation Rate (LHGR) Limit
(Technical Specification 3.2.3)

c. Minimum Critical Power Ratio Operating Limit (OLMCPR)
(Technical Specifications 3.2.2, 3.3.4.1, and 3.7.5)

d. Average Power Range Monitor (APRM) Flow Biased Rod Block Trip Setting
(Technical Requirements Manual Section 5.3.1 and Table 3.3.4-1)

e. Rod Block Monitor (RBM) Trip Setpoints and Operability
(Technical Specification Table 3.3.2.1-1)

f. Shutdown Margin (SDM) Limit
(Technical Specification 3.1.1)

2. APLHGR LIMIT (TECHNICAL SPECIFICATIONS 3.2.1 AND 3.7.5)

The APLHGR limits for full power and flow conditions for each type of fuel as a function of exposure are shown in Figures 1-6. The APLHGR limits for the GE11 and GE13 assemblies are for the most limiting lattice (excluding natural uranium) at each exposure point. The specific values for each lattice are given in Reference 4.

These APLHGR limits are adjusted for off-rated power and flow conditions using the ARTS factors, MAPFAC(P) and MAPFAC(F). The reduced power factor, MAPFAC(P), is given in Figure 7. Similarly, adjustments for reduced flow operation are performed using the MAPFAC(F) corrections given in Figure 8. Both factors are multipliers used to reduce the standard APLHGR limit. The most limiting power-adjusted or flow-adjusted value is taken as the APLHGR operating limit for the off-rated condition.

The APLHGR limits in figures 1-6 are applicable for both Turbine Bypass In-Service and Out-Of-Service. The off-rated power and flow corrections in figures 7 and 8 bound both Turbine Bypass In-Service and Out-Of-Service operation. No corrections are required to the APLHGR limits for TBOOS for either rated or off-rated operation.

For Single Recirculation Loop Operation (SLO), the most limiting of either the SLO multiplier or the off-rated MAPFAC correction is used to reduce the exposure dependent APLHGR limit. The SLO multiplier to be applied to this cycle is 0.84 (reference 3). It is not necessary to apply both the off-rated MAPFAC and SLO multiplier corrections at the same time.

3. LHGR LIMIT (TECHNICAL SPECIFICATION 3.2.3)

The LHGR limit is fuel type dependent. For unit 3 cycle 10 these limits are the same for all fuel types in the core, as shown below:

Fuel Type	LHGR Limit
GE11	14.4 kw/ft
GE13	14.4 kw/ft

4. OLMCPR (TECHNICAL SPECIFICATIONS 3.2.2, 3.3.4.1, AND 3.7.5)

a. The MCPR Operating Limit for rated power and flow conditions, OLMCPR(100), is equal to the fuel type and exposure dependent limit shown in Figures 9 and 10. Figure 9 applies to exposure up to 2846 MWD/ST prior to EOR (end of full power capability at rated flow with normal feedwater temperature) after which Figure 10 shall be used. It is acceptable to use the more restrictive Figure 10 limits at any point in the cycle. For cycle 10, only GE13 results are supplied since they bound all bundle types. As noted in Figures 9 and 10, an adder of 0.02 is applied for single loop operation. The actual OLMCPR(100) value is dependent upon the scram time testing results, as described below (ref. 10):

$$\tau = 0.0 \quad \text{or} \quad \frac{\tau_{ave} - \tau_B}{\tau_A - \tau_B}, \quad \text{whichever is greater}$$

where; τ_A = **1.096** sec (analytical Option A scram time limit - based on dropout time for notch position 36)

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

$$\tau_B = \mu + 1.65 * \sigma * \left[\frac{N}{n}\right]^{\frac{1}{2}}$$

where; μ = **0.830** sec (mean scram time used in transient analysis - based on dropout time for notch position 36)

σ = **0.019** sec (standard deviation of μ)

N = Total number of active rods measured in Technical Specification Surveillance Requirement SR3.1.4.1

n = Number of surveillance rod tests performed to date in cycle

τ_i = Scram time (dropout time) from fully withdrawn to notch position 36 for the i^{th} rod

b. Option A OLMCPR limits (τ=1.0) shall be used prior to the determination of τ in accordance with SR 3.1.4.1.

c. For off-rated power and flow conditions, power-adjusted and flow-adjusted operating limits are determined from Figures 11 and 12, respectively. The most limiting power-dependent or flow-dependent value is taken as the OLMCPR for the off-rated condition.

d. OLMCPR limits and off-rated corrections are provided for Recirculation Pump Trip out-of-service (RPTOOS) or Turbine Bypass out-of-service (TBOOS) conditions (ref. 5). These events are analyzed separately and the core is not analyzed for both systems Out-Of-Service at the same time.

5. APRM FLOW BIASED ROD BLOCK TRIP SETTING (TECHNICAL REQUIREMENTS MANUAL SECTION 5.3.1 AND TABLE 3.3.4-1)

The APRM Rod Block trip setting shall be:

$S_{RB} \leq (0.66(W-\Delta W) + 61\%)$ Allowable Value

$S_{RB} \leq (0.66(W-\Delta W) + 59\%)$ Nominal Trip Setpoint (NTSP)

where:

S_{RB} = Rod Block setting in percent of rated thermal power (3458 MWt)

W = Loop recirculation flow rate in percent of rated

ΔW = Difference between two-loop and single-loop effective recirculation flow at the same core flow ($\Delta W = 0.0$ for two-loop operation)

The APRM Rod Block trip setting is clamped at a maximum allowable value of 115% (corresponding to a NTSP of 113%).

6. ROD BLOCK MONITOR (RBM) TRIP SETPOINTS AND OPERABILITY (TECHNICAL SPECIFICATION TABLE 3.3.2.1-1)

The RBM trip setpoints and applicable power ranges shall be as follows (refs. 7-9):

RBM Trip Setpoint	Allowable Value (AV)	Nominal Trip Setpoint (NTSP)	
LPSP	27%	25%	
IPSP	62%	60%	
HPSP	82%	80%	
LTSP - unfiltered - filtered	118.7% 117.7%	117.0% 116.0%	(1),(2)
ITSP - unfiltered - filtered	113.7% 112.9%	112.0% 111.2%	(1),(2)
HTSP - unfiltered - filtered	108.7% 107.9%	107.0% 106.2%	(1),(2)
DTSP	90%	92%	

Notes: (1) These setpoints are based upon a MCPR operating limit of **1.29** using a safety limit of 1.10. This is consistent with a MCPR operating limit of 1.25 using a safety limit of 1.07, as reported in references 6, 7, and 8. These setpoints bound the cycle specific Option B MCPR operating limit of 1.30.

(2) The unfiltered setpoints are consistent with a nominal RBM filter setting of 0.0 seconds (reference 8). The filtered setpoints are consistent with a nominal RBM filter setting $\leq$ 0.5 seconds (reference 7).

The RBM setpoints in Technical Specification Table 3.3.2.1-1 are applicable when:

THERMAL POWER (% Rated)	Applicable MCPR [1]	Notes from Table 3.3.2.1-1	
$\geq$ 27% and < 90%	< 1.75 < 1.78	(a), (b), (f), (h) (a), (b), (f), (h)	dual loop operation single loop operation
$\geq$ 90%	< 1.44	(g)	dual loop operation [2]

Notes: (1) The given MCPR operating limits are adjusted to correspond to a MCPR safety limit of 1.10 for dual loop operation (1.12 for single loop operation). The values shown correspond to operating limits of 1.70 and 1.40 given the original 1.07 MCPR safety limit used in reference 6.

(2) Greater than 90% rated power is not attainable in single loop operation.

7. SHUTDOWN MARGIN (SDM) LIMIT (TECHNICAL SPECIFICATION 3.1.1)

The core shall be subcritical with the following margin with the strongest OPERABLE control rod fully withdrawn and all other OPERABLE control rods fully inserted.

SDM $\geq$ 0.38% dk/k

8. REFERENCES

1. NEDE-24011-P-A-13, "General Electric Standard Application for Reactor Fuel", August 1996.

2. NEDE-24011-P-A-13-US, "General Electric Standard Application for Reactor Fuel (Supplement for United States)", August 1996.

3. J11-03589SRLR Rev. 0, "Supplemental Reload Licensing Report for Browns Ferry Nuclear Plant Unit 3 Reload 9 Cycle 10", March 2000.

4. J11-03589MAPL Rev. 0, "Lattice-Dependent MAPLHGR Report for Browns Ferry Nuclear Plant Unit 3 Reload 9 Cycle 10", March 2000.

5. NEDC-32774P Rev. 1, "Safety Analyses for Browns Ferry Nuclear Plant Units 1, 2, and 3 Turbine Bypass and End-of-Cycle Recirculation Pump Trip Out-Of-Service", dated September 1997.

6. NEDC-32433P, "Maximum Extended Load Line Limit and ARTS Improvement Program Analyses for Browns Ferry Nuclear Plant Unit 1, 2, and 3", dated April 1995.

7. EDE-28-0990 Rev. 3 Supplement E, "PRNM (APRM, RBM, and RFM) Setpoint Calculations [ARTS/MELLL (NUMAC) - Power-Uprate Condition] for Tennessee Valley Authority Browns Ferry Nuclear Plant", dated October 1997.

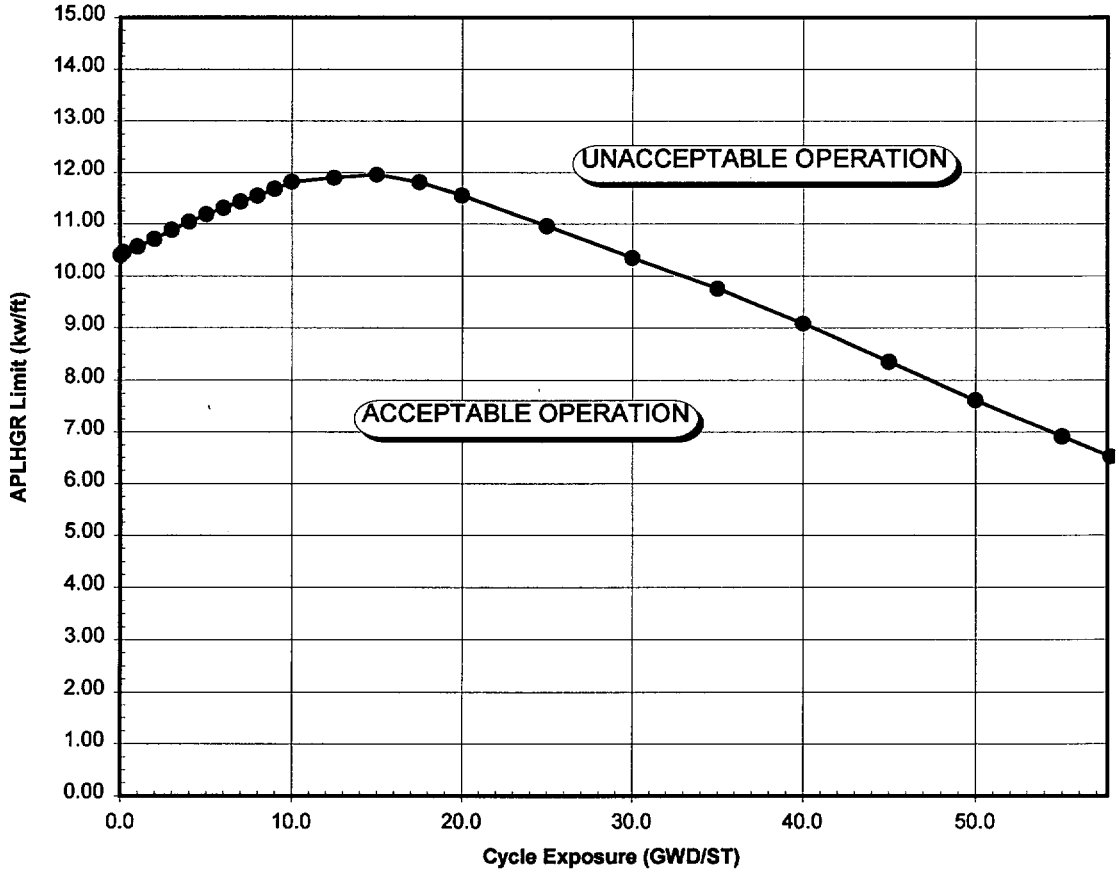
8. EDE-28-0990 Rev. 2 Supplement E, "PRNM (APRM, RBM, and RFM) Setpoint Calculations [ARTS/MELLL (NUMAC) - Power-Uprate Condition] for Tennessee Valley Authority Browns Ferry Nuclear Plant", dated October 1997.

9. GE Letter LB#: 262-97-133, "Browns Ferry Nuclear Plant Rod Block Monitor Setpoint Clarification - GE Proprietary Information", dated September 12, 1997. [L32 970912 800]

10. GE Letter JAB-T8019a, "Technical Specification Changes for Implementation of Advanced Methods", dated June 4, 1998. [L32 980608 800]

11. GE Letter 262-00-021-01, "TVA Unit 3 Cycle 10 MCPR(F) Limits", dated April 4, 2000. [L32 000406 803]

Figure 1
APLHGR Limits for Bundle Type GE13-P9DTB414-15GZ
(GE13)



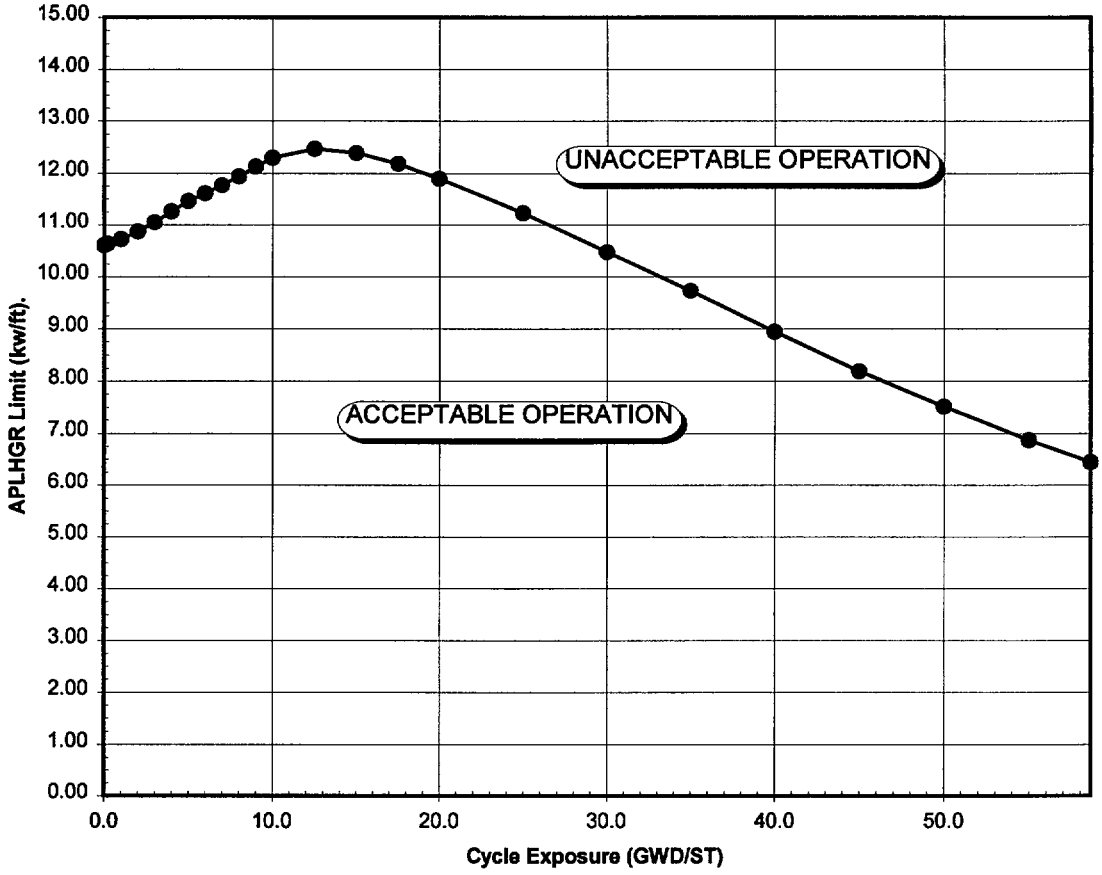
Most Limiting Lattice
for Each Exposure Point

Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)
0.0	10.40	7.0	11.43	25.0	10.96
0.2	10.46	8.0	11.54	30.0	10.35
1.0	10.56	9.0	11.67	35.0	9.75
2.0	10.71	10.0	11.81	40.0	9.08
3.0	10.88	12.5	11.89	45.0	8.35
4.0	11.04	15.0	11.95	50.0	7.62
5.0	11.18	17.5	11.80	55.0	6.91
6.0	11.31	20.0	11.55	57.81	6.52

These values apply to both Turbine Bypass In-Service and Out-Of-Service.

The APLHGR limits shown are for dual recirculation loop operation. For single loop operation, these values should be multiplied by the most limiting of either 0.84 or the MAPFAC correction, as described in Section 2.

Figure 2
APLHGR Limits for Bundle Type GE13-P9DTB400-13GZ1
(GE13)



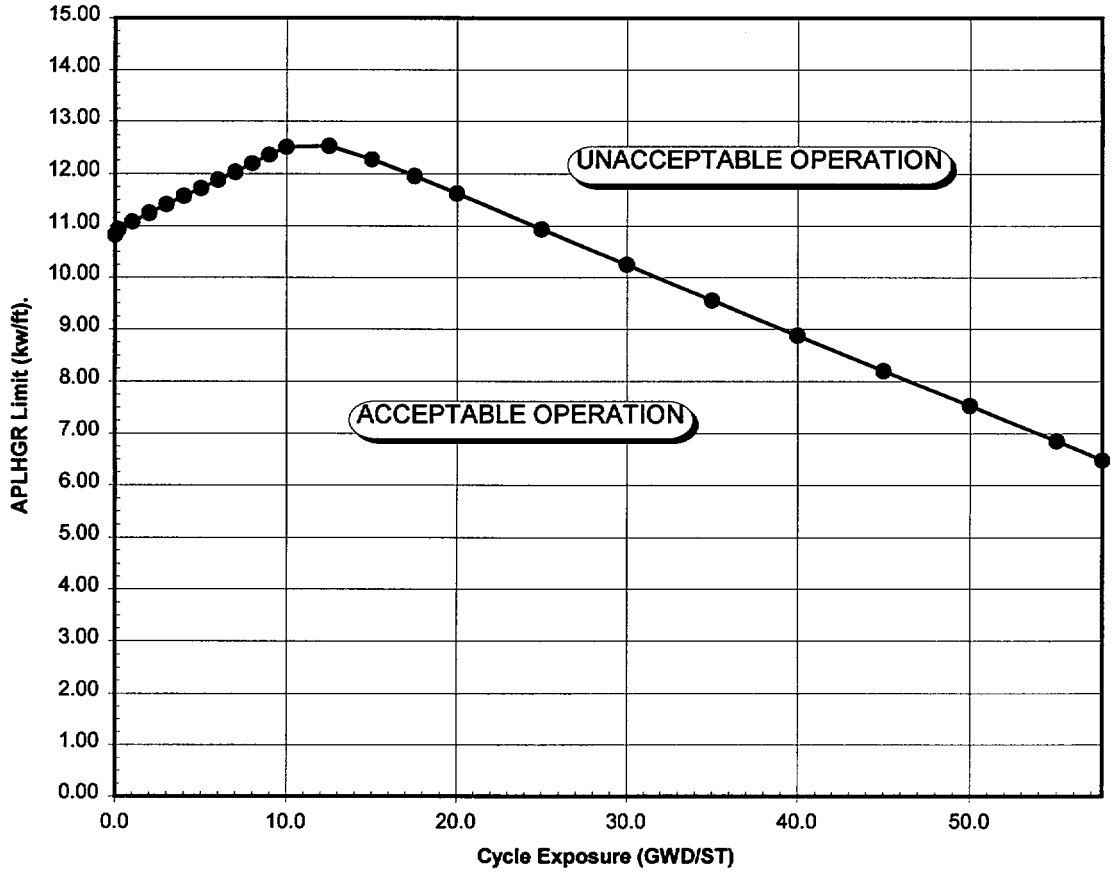
Most Limiting Lattice
for Each Exposure Point

Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)
0.0	10.61	7.0	11.77	25.0	11.23
0.2	10.64	8.0	11.94	30.0	10.47
1.0	10.72	9.0	12.13	35.0	9.73
2.0	10.87	10.0	12.30	40.0	8.94
3.0	11.05	12.5	12.47	45.0	8.19
4.0	11.26	15.0	12.39	50.0	7.51
5.0	11.46	17.5	12.18	55.0	6.87
6.0	11.61	20.0	11.89	58.61	6.44

These values apply to both Turbine Bypass In-Service and Out-Of-Service.

The APLHGR limits shown are for dual recirculation loop operation. For single loop operation, these values should be multiplied by the most limiting of either 0.84 or the MAPFAC correction, as described in Section 2.

Figure 3
APLHGR Limits for Bundle Type GE13-P9HTB386-12GZ
(GE13)



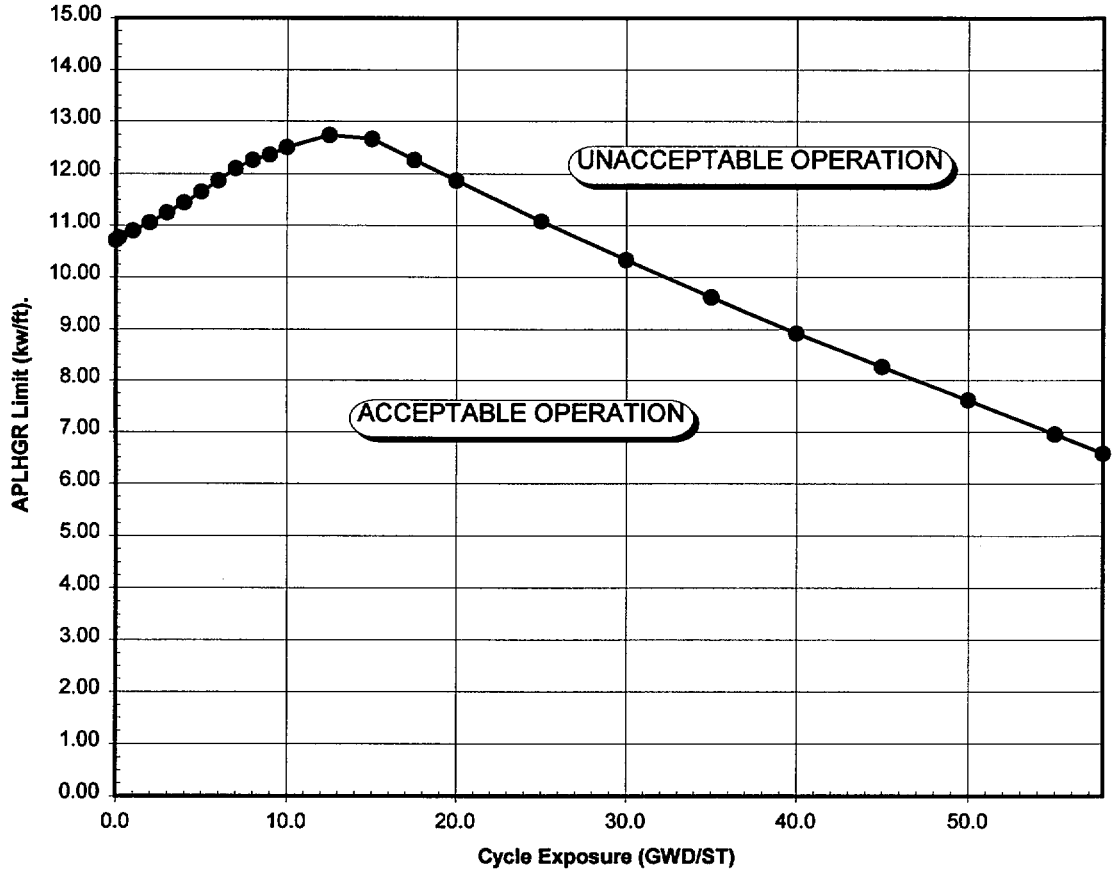
Most Limiting Lattice
for Each Exposure Point

Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)
0.0	10.83	7.0	12.03	25.0	10.94
0.2	10.94	8.0	12.19	30.0	10.24
1.0	11.08	9.0	12.36	35.0	9.55
2.0	11.25	10.0	12.51	40.0	8.87
3.0	11.41	12.5	12.53	45.0	8.20
4.0	11.57	15.0	12.27	50.0	7.53
5.0	11.72	17.5	11.95	55.0	6.85
6.0	11.88	20.0	11.62	57.62	6.48

These values apply to both Turbine Bypass In-Service and Out-Of-Service.

The APLHGR limits shown are for dual recirculation loop operation. For single loop operation, these values should be multiplied by the most limiting of either 0.84 or the MAPFAC correction, as described in Section 2.

Figure 4
APLHGR Limits for Bundle Type GE13-P9HTB372-11GZ
(GE13)



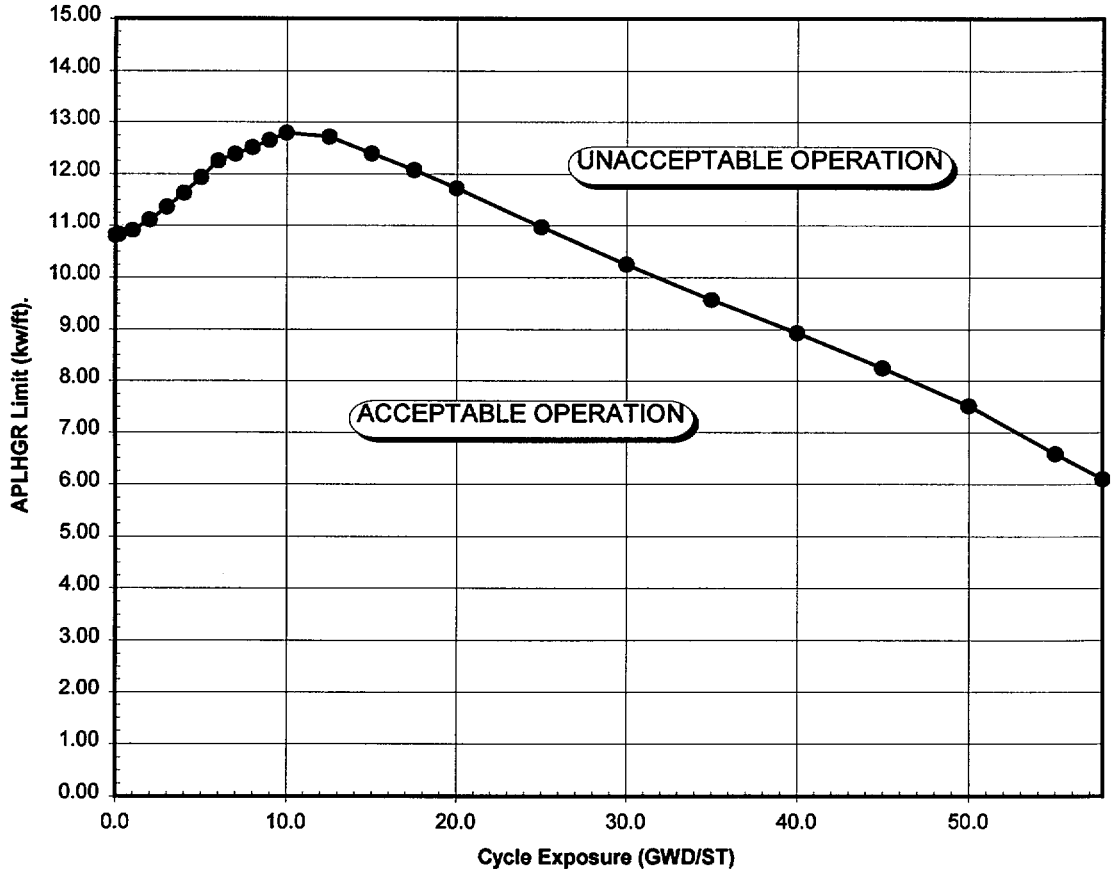
Most Limiting Lattice
for Each Exposure Point

Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)
0.0	10.71	7.0	12.10	25.0	11.08
0.2	10.77	8.0	12.26	30.0	10.33
1.0	10.89	9.0	12.36	35.0	9.61
2.0	11.06	10.0	12.50	40.0	8.92
3.0	11.25	12.5	12.73	45.0	8.26
4.0	11.44	15.0	12.66	50.0	7.61
5.0	11.65	17.5	12.26	55.0	6.95
6.0	11.87	20.0	11.87	57.79	6.58

These values apply to both Turbine Bypass In-Service and Out-Of-Service.

The APLHGR limits shown are for dual recirculation loop operation. For single loop operation, these values should be multiplied by the most limiting of either 0.84 or the MAPFAC correction, as described in Section 2.

Figure 5
APLHGR Limits for Bundle Type GE11-P9HUB323-8G4.0
(GE11)



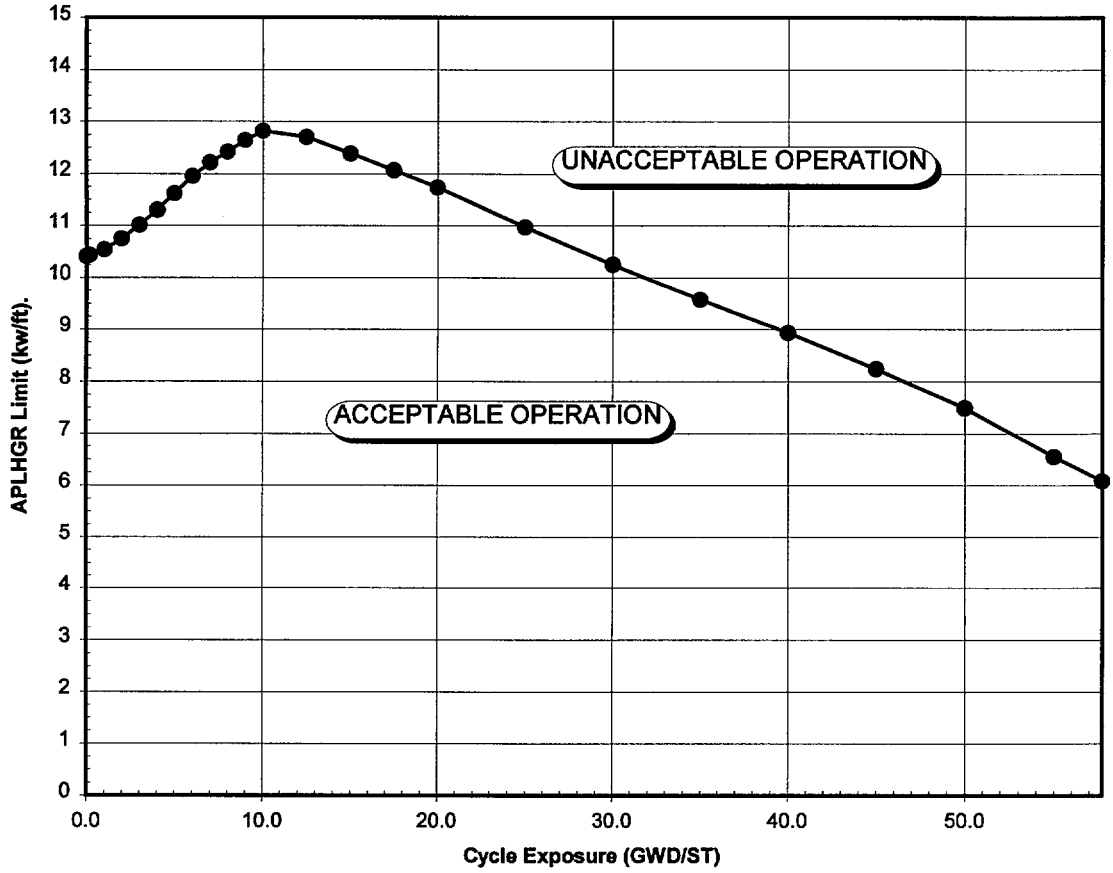
Most Limiting Lattice
for Each Exposure Point

Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)
0.0	10.81	7.0	12.38	25.0	10.97
0.2	10.83	8.0	12.51	30.0	10.25
1.0	10.91	9.0	12.65	35.0	9.57
2.0	11.11	10.0	12.79	40.0	8.93
3.0	11.36	12.5	12.71	45.0	8.25
4.0	11.63	15.0	12.39	50.0	7.51
5.0	11.93	17.5	12.07	55.0	6.58
6.0	12.25	20.0	11.72	57.72	6.10

These values apply to both Turbine Bypass In-Service and Out-Of-Service.

The APLHGR limits shown are for dual recirculation loop operation. For single loop operation, these values should be multiplied by the most limiting of either 0.84 or the MAPFAC correction, as described in Section 2.

Figure 6
APLHGR Limits for Bundle Type GE11-P9HUB323-5G5.0/4G4.0
(GE11)



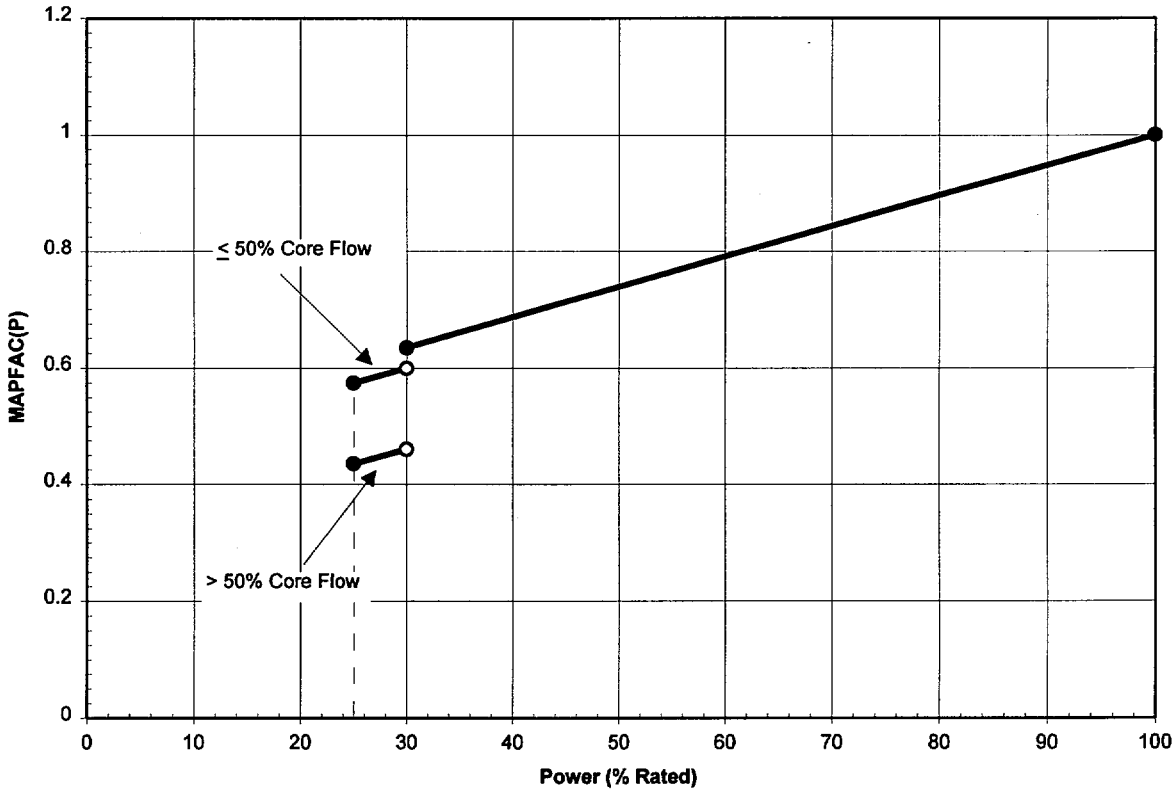
Most Limiting Lattice
for Each Exposure Point

Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)	Average Planar Exposure (GWD/ST)	LHGR Limit (kw/ft)
0.0	10.41	7.0	12.21	25.0	10.97
0.2	10.44	8.0	12.42	30.0	10.25
1.0	10.54	9.0	12.64	35.0	9.57
2.0	10.75	10.0	12.82	40.0	8.93
3.0	11.01	12.5	12.70	45.0	8.24
4.0	11.30	15.0	12.38	50.0	7.49
5.0	11.62	17.5	12.06	55.0	6.55
6.0	11.95	20.0	11.73	57.70	6.08

These values apply to both Turbine Bypass In-Service and Out-Of-Service.

The APLHGR limits shown are for dual recirculation loop operation. For single loop operation, these values should be multiplied by the most limiting of either 0.84 or the MAPFAC correction, as described in Section 2.

Figure 7
Power Dependent MAPLHGR Factor - MAPFAC(P)



MAPLHGR(P) = MAPFAC(P) x MAPLHGRstd

MAPLHGRstd = Standard MAPLHGR Limits

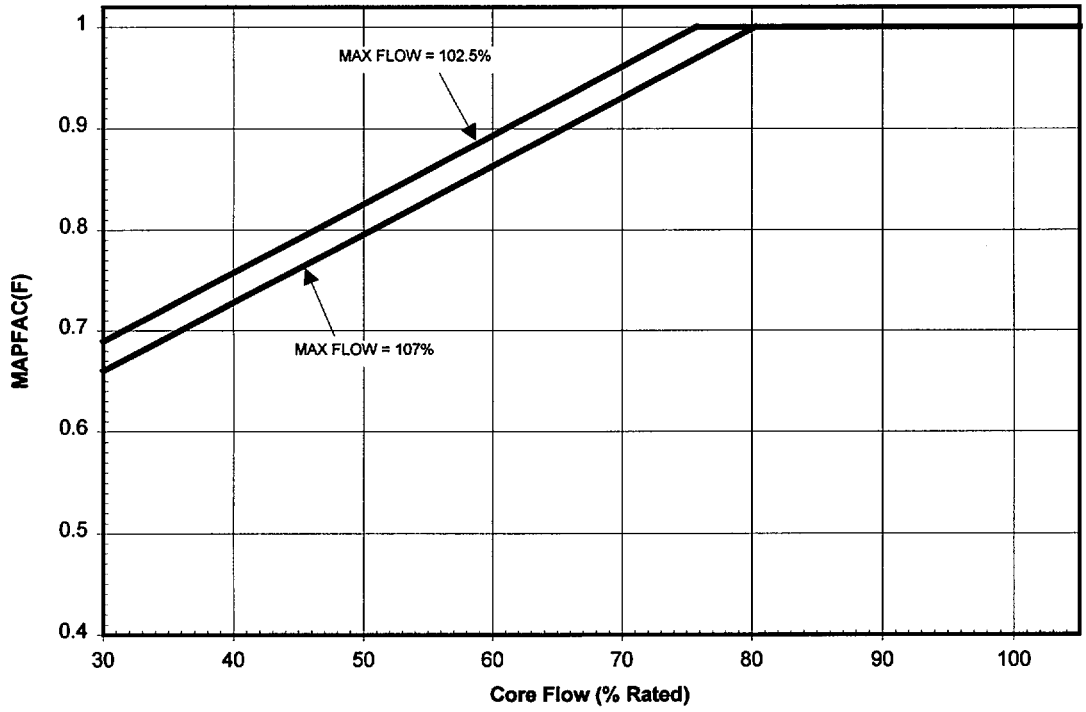
For 25% ≥ P : NO THERMAL LIMITS MONITORING REQUIRED

For 25% ≤ P < 30% : MAPFAC(P) = 0.60 + 0.005(P-30%) For ≤ 50% CORE FLOW
: MAPFAC(P) = 0.46 + 0.005(P-30%) For > 50% CORE FLOW

For 30% ≤ P : MAPFAC(P) = 1.0 + 0.005224(P-100%)

These values bound both Turbine Bypass In-Service and Out-Of-Service

Figure 8
Flow Dependent MAPLHGR Factor - MAPFAC(F)



MAPLHGR(F) = MAPFAC(F) x MAPLHGRstd

MAPLHGRstd = Standard MAPLHGR Limits

MAPFAC(F) = MINIMUM(1.0 , Af * Wc /100 + Bf)

Wc = % Rated Core Flow

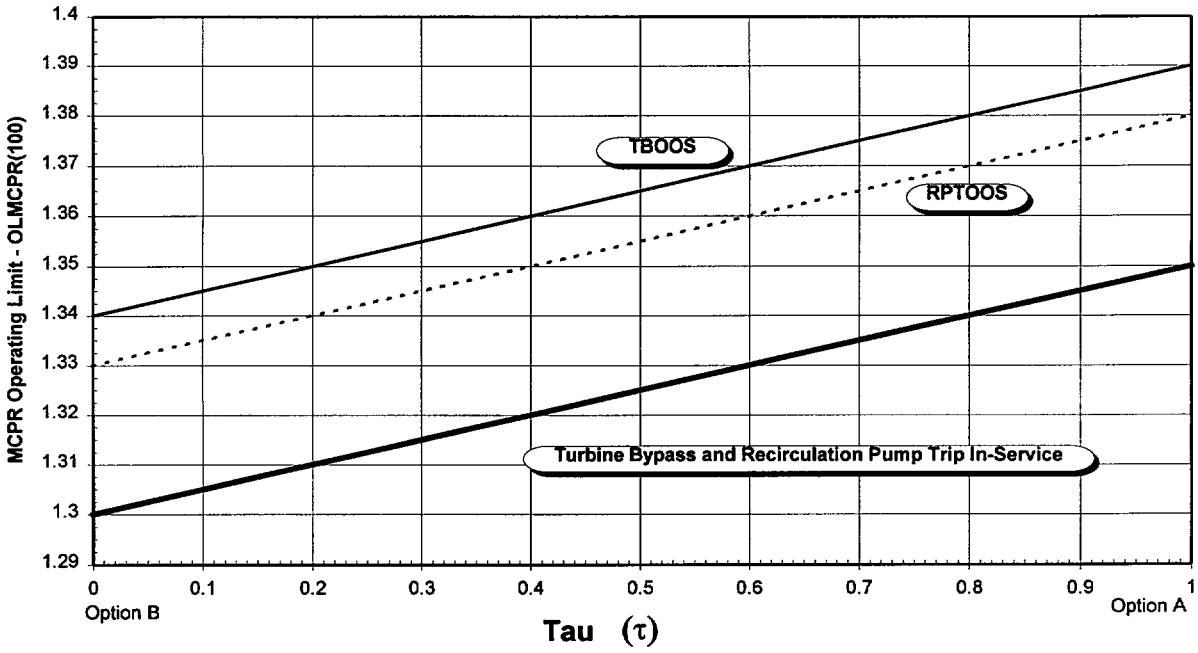
Af and Bf are Constants Given Below:

Maximum Core Flow (% Rated)	Af	Bf
102.5	0.6784	0.4861
107.0	0.6758	0.4574

These values bound both Turbine Bypass In-Service and Out-Of-Service.

The 102.5% maximum flow line is used for operation up to 100% rated flow.
The 107% maximum flow line is used for operation up to 105% rated flow (ICF).

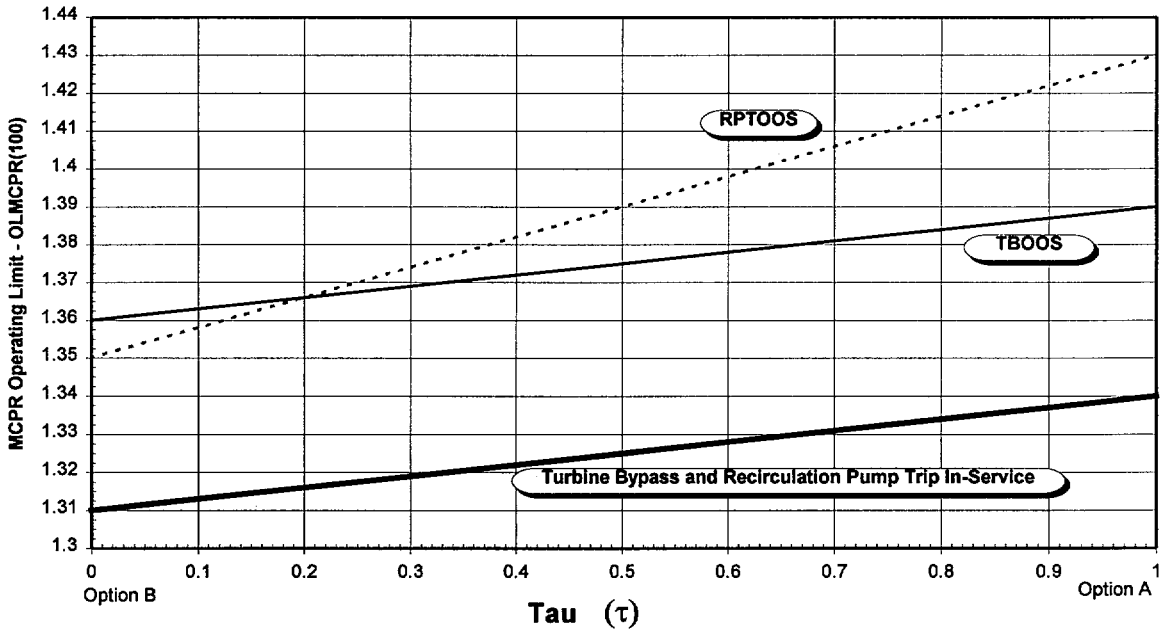
Figure 9
MCPR Operating Limit for All Bundle Types
For Cycle Exposures up to EOR-2846 MWD/ST (see note 4)



Exposure Range	Out-Of-Service	Option A Tau=1.0	Option B Tau=0.0
BOC10 to (EOR-2846 MWD/ST)	na	1.35 (1)	1.30
BOC10 to (EOR-2846 MWD/ST)	Turbine Bypass (TBOOS)	1.39	1.34
BOC10 to (EOR-2846 MWD/ST)	Recirculation Pump Trip (RPTOOS)	1.38	1.33

Notes
1. Use this value prior to performing scram time testing per SR 3.1.4.1.
2. Either Turbine Bypass or Recirculation Pump Trip may be Out-Of-Service. The core is not analyzed for both TBOOS and RPTOOS at the same time.
3. The values shown are for dual recirculation loop operation. Increase any value shown by 0.02 for Single Loop Operation (SLO).
4. EOR refers to the end of Full Power Capability at Rated Flow with normal Feedwater Heating.

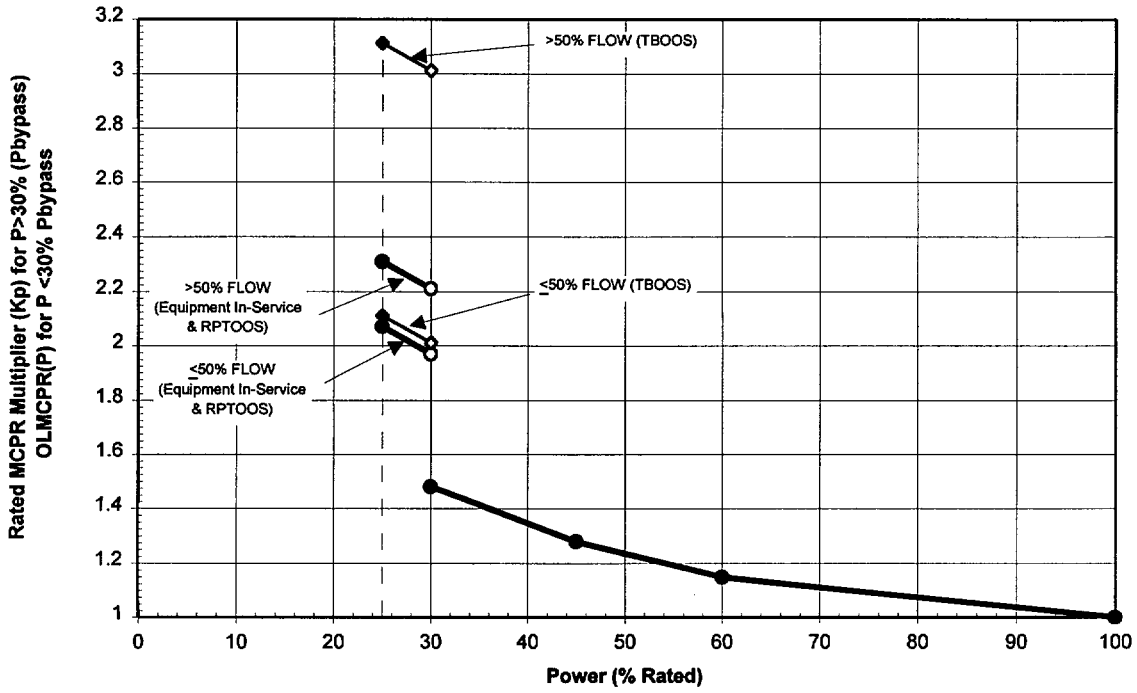
Figure 10
MCPR Operating Limit for All Bundle Types
Optional for All Cycle Exposures - Required after EOR-2846 MWD/ST is reached (see note 4)



Exposure Range	Out-Of-Service	Option A Tau=1.0	Option B Tau=0.0
BOC10 to EOC10	na	1.34 (1)	1.31
BOC10 to EOC10	Turbine Bypass (TBOOS)	1.39	1.36
BOC10 to EOC10	Recirculation Pump Trip (RPTOOS)	1.43	1.35

Notes
1. Use this value prior to performing scram time testing per SR 3.1.4.1.
2. Either Turbine Bypass or Recirculation Pump Trip may be Out-Of-Service. The core is not analyzed for both TBOOS and RPTOOS at the same time.
3. The values shown are for dual recirculation loop operation. Increase any value shown by 0.02 for Single Loop Operation (SLO).
4. EOR refers to the end of Full Power Capability at Rated Flow with normal Feedwater Heating.

Figure 11
Power Dependent MCPR(P) Limits



OPERATING LIMIT MCPR(P) = Kp * OLMCPR(100)

For P ≤ 25% : NO THERMAL LIMITS MONITORING REQUIRED

For 25% ≤ P < Pbypass : (Pbypass = 30%)

: Kp = [Kbyp + 0.02(30%-P)]/OLMCPR(100)

Turbine Bypass and RPT In-Service, or RPT Out-Of-Service (RPTOOS)

Kbyp = 1.97 For ≤ 50% CORE FLOW

Kbyp = 2.21 For > 50% CORE FLOW

Turbine Bypass Out-Of-Service (TBOOS)

Kbyp = 2.01 For ≤ 50% CORE FLOW

Kbyp = 3.01 For > 50% CORE FLOW

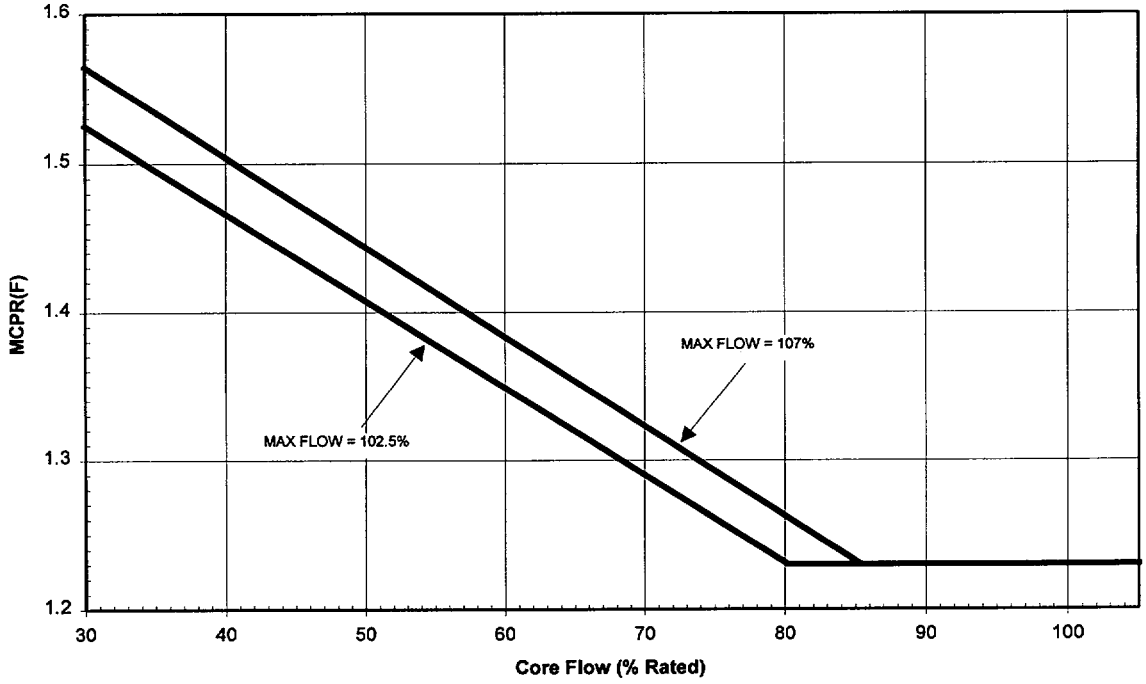
For 30% ≤ P < 45% : Kp = 1.28 + 0.01340(45%-P)

For 45% ≤ P < 60% : Kp = 1.15 + 0.00867(60%-P)

For 60% ≤ P : Kp = 1.00 + 0.00375(100%-P)

Note: Either Turbine Bypass or Recirculation Pump Trip may be Out-Of-Service. The core is not analyzed for both TBOOS and RPTOOS at the same time.

Figure 12
Flow Dependent MCPR Operating Limit - MCPR(F)



For Wc ≥ 30% : MCPR(F) = MAX(1.23, Af*Wc/100 + Bf)

Wc = % Rated Core Flow

Af and Bf are Constants Given Below:

Maximum Core Flow (% Rated)	Af	Bf
102.5	-0.587	1.701
107.0	-0.603	1.745

These values bound both Turbine Bypass In-Service and Out-Of-Service.

These values bound both Recirculation Pump Trip In-Service and Out-Of-Service

Either Turbine Bypass or Recirculation Pump Trip may be Out-Of-Service.
The core is not analyzed for a combination of TBOOS and RPTOOS.

The 102.5% maximum flow line is used for operation up to 100% rated flow.
The 107% maximum flow line is used for operation up to 105% rated flow (ICF).