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U.S. Nuclear Regulatory Commission
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Edwin I. Hatch Nuclear Plant - Unit 1
Unit 1 Cycle 21 Core Operating Limits Report (COLR)

Ladies and Gentlemen:

In accordance with Technical Specification 5.6.5, Southern Nuclear Operating Company hereby submits the Edwin I. Hatch Nuclear Plant Unit 1 Cycle 21 Core Operating Limits Report, Revision 0.

Should you have any questions in this regard, please contact this office.

Respectfully submitted,

A handwritten signature in cursive script, appearing to read "Lewis Sumner".

H. L. Sumner, Jr.

IFL/eb

Enclosure: Unit 1 Cycle 21 Core Operating Limits Report, Revision 0

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A001

SOUTHERN NUCLEAR OPERATING COMPANY
EDWIN I. HATCH NUCLEAR PLANT

Unit 1 Cycle 21
CORE OPERATING LIMITS REPORT

Revision 0

Southern Nuclear Operating Company
Post Office Box 1295
Birmingham, Alabama 35201

Edwin I. Hatch Nuclear Plant
Unit 1 Cycle 21
Core Operating Limits Report

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1.0 INTRODUCTION

The Core Operating Limits Report (COLR) for Plant Hatch Unit 1 Cycle 21 is prepared in accordance with the requirements of Technical Specification 5.6.5. The core operating limits presented herein were developed using NRC-approved methods (Reference 1). Results from the reload analyses for the fuel in Unit 1 Cycle 21 are documented in References 2, 3, and 4.

The following core operating limits are included in this report:

- a. Average Planar Linear Heat Generation Rate (APLHGR) – Technical Specification 3.2.1.
- b. Minimum Critical Power Ratio (MCPR) – Technical Specification 3.2.2.
- c. Maximum allowable scram setpoints for the Period Based Detection Algorithm (PBDA) in the Oscillation Power Range Monitor (OPRM) system.

From a fuel thermal limits perspective, Unit 1 can be operated with only one of the following two systems inoperable at a time:

- End-of-cycle recirculation pump trip (EOC-RPT)
- Turbine bypass valves

2.0 APLHGR LIMITS (Technical Specification 3.2.1)

The APLHGR limit for each fuel assembly is the applicable rated-power, rated-flow APLHGR limit taken from Figures 2-3 through 2-8, multiplied by the smaller of either:

- a. The flow-dependent multiplier, $MAPFAC_F$, from Figure 2-1,

or

- b. The power-dependent multiplier, $MAPFAC_P$, as determined by Table 2-1.

Since every assembly in the core contains more than one enriched lattice, GESTAR-II (Reference 1) requires that the appropriate APLHGR limit from Figures 2-3 through 2-8 be applied to every axial location in the fuel assembly, when APLHGR values are hand-calculated. The limits shown in those figures are the values for the most limiting enriched lattice in each fuel bundle as a function of average planar exposure.

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

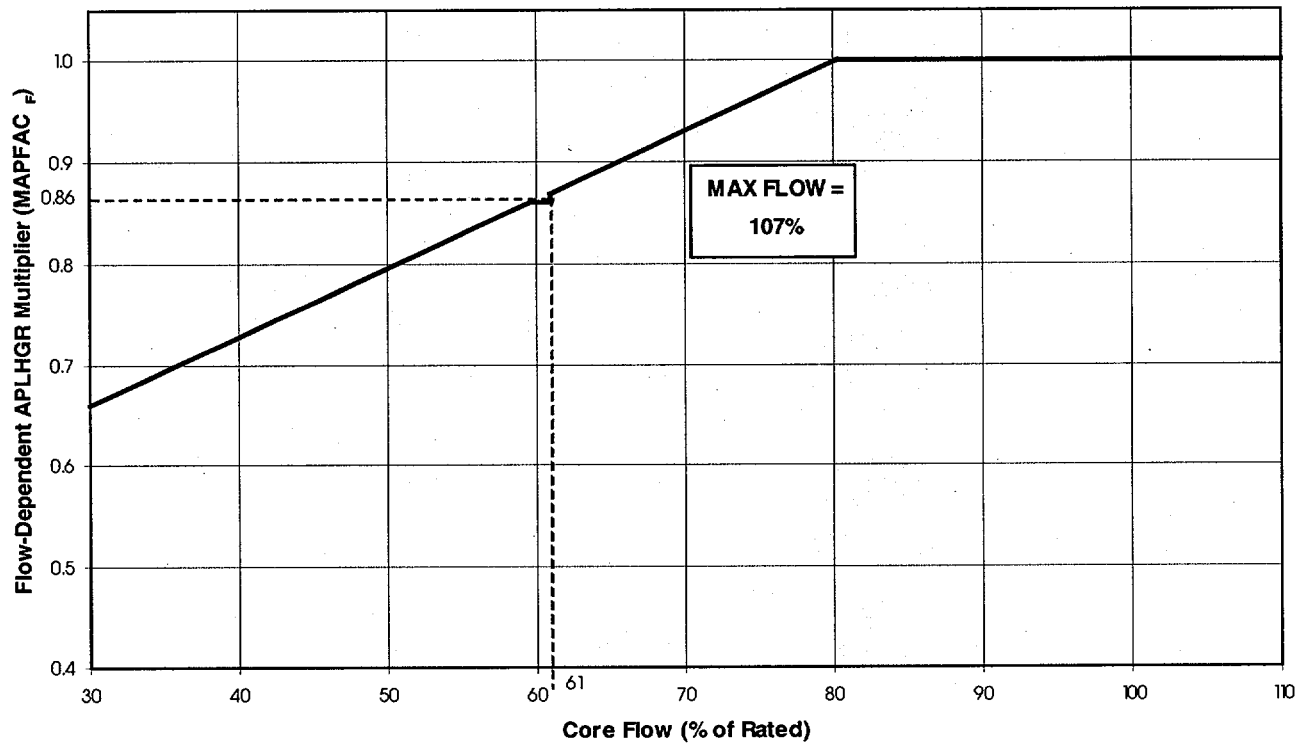
When APLHGR values are determined by the process computer, the lattice type-dependent APLHGR limits are used. Under these conditions, some axial locations may have APLHGR values exceeding the values shown in the figures.

TABLE 2-1

APLHGR Operating Flexibility Options

Cycle Average Exposure	Bypass Valves	Pressure Regulator	MAPFAC _p Curve
BOC to EEOC	Operable	Operable	Figure 2-2A
BOC to EEOC	Inoperable	Operable	Figure 2-2B
BOC to EEOC	Operable or Inoperable	Inoperable	Figure 2-2C

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report



$$\text{MAPFAC}_F = \text{Minimum} [1.0, (A+B \cdot F), \text{MAPMULT}]$$

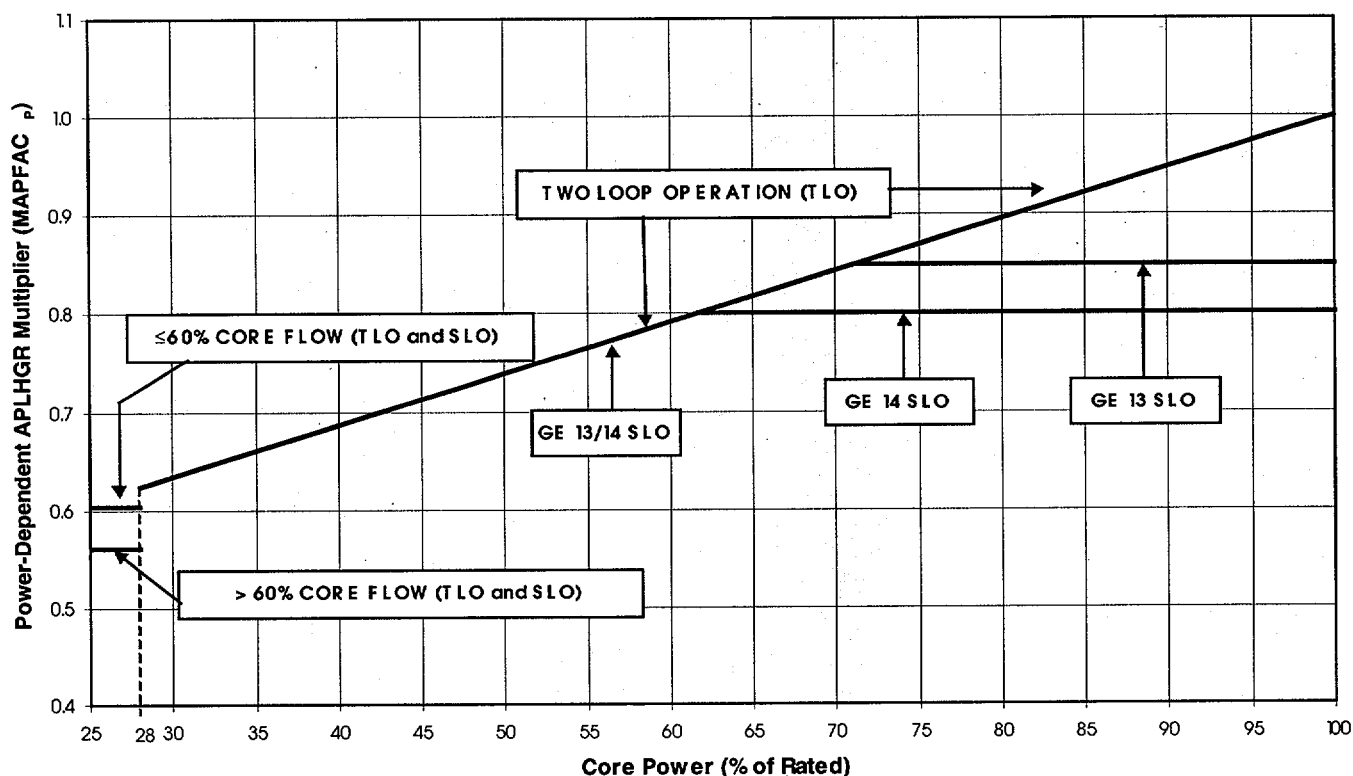
Maximum Core Flow (% of Rated)	A	B
107.0	0.4574	0.006758

MAPMULT = 1.0 for $F > 61.0$
0.86 for $F \leq 61.0$

F = Percent of Rated Core Flow

FIGURE 2-1

Flow-Dependent APLHGR Multiplier (MAPFAC_F) versus Core Flow



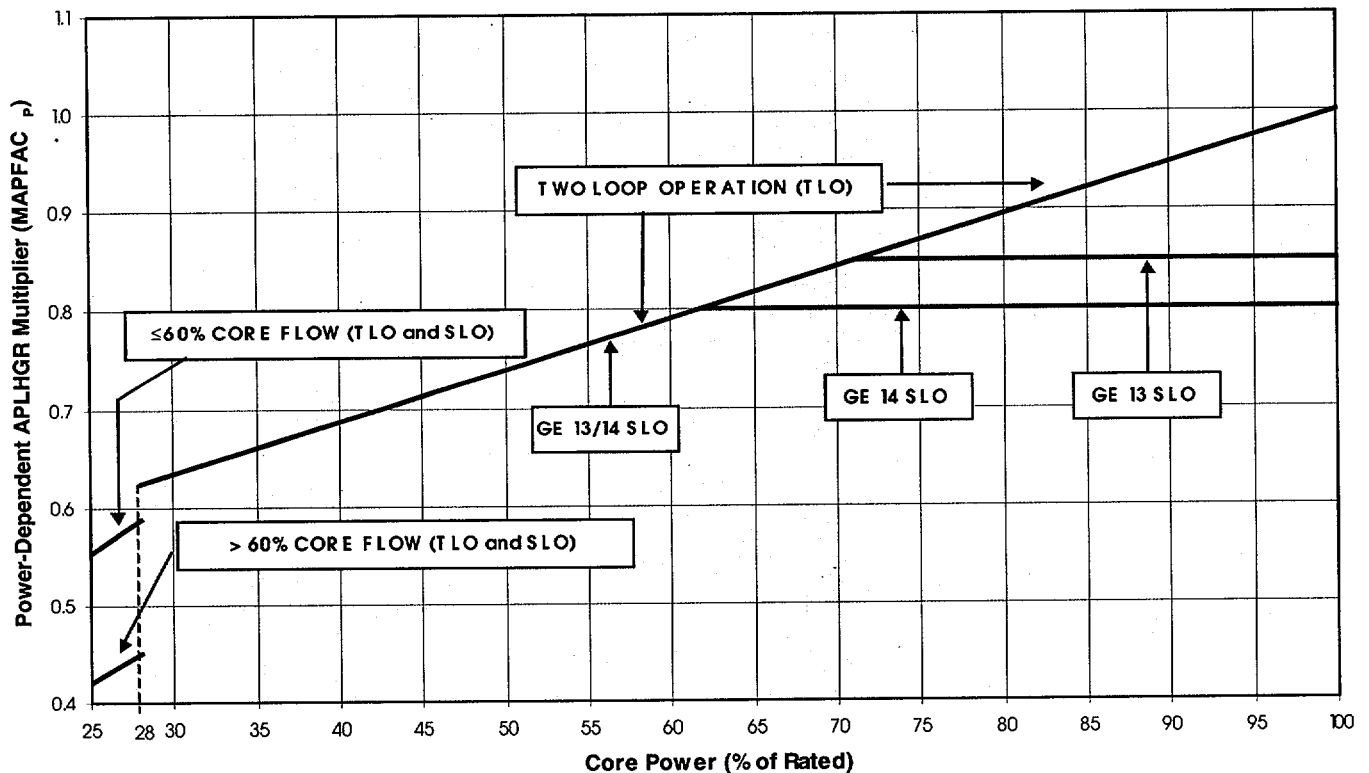
$$\text{MAPFAC}_P = A - B (P_0 - P)$$

Operating Conditions				Values of Variables		
P	F	Fuel Type	SLO/TLO	A	B	P ₀
25 ≤ P < 28	F ≤ 60	GE13/14	SLO/TLO	0.603	0	28
25 ≤ P < 28	F > 60	GE13/14	SLO/TLO	0.560	0	28
28 ≤ P < 61.72	All	GE13/14	SLO/TLO	1.00	0.005224	100
61.72 ≤ P < 71.28	All	GE13	SLO/TLO	1.00	0.005224	100
61.72 ≤ P < 71.28	All	GE14	TLO	1.00	0.005224	100
71.28 ≤ P	All	GE13/14	TLO	1.00	0.005224	100
71.28 ≤ P	All	GE13	SLO	0.85	0.000	100
61.72 ≤ P	All	GE14	SLO	0.80	0.000	100

P = Percent of Rated Core Power
F = Percent of Rated Core Flow

FIGURE 2-2A

Power-Dependent APLHGR Multiplier (MAPFAC_p) versus Core Power
(Bypass Valves Operable and Pressure Regulator Operable)



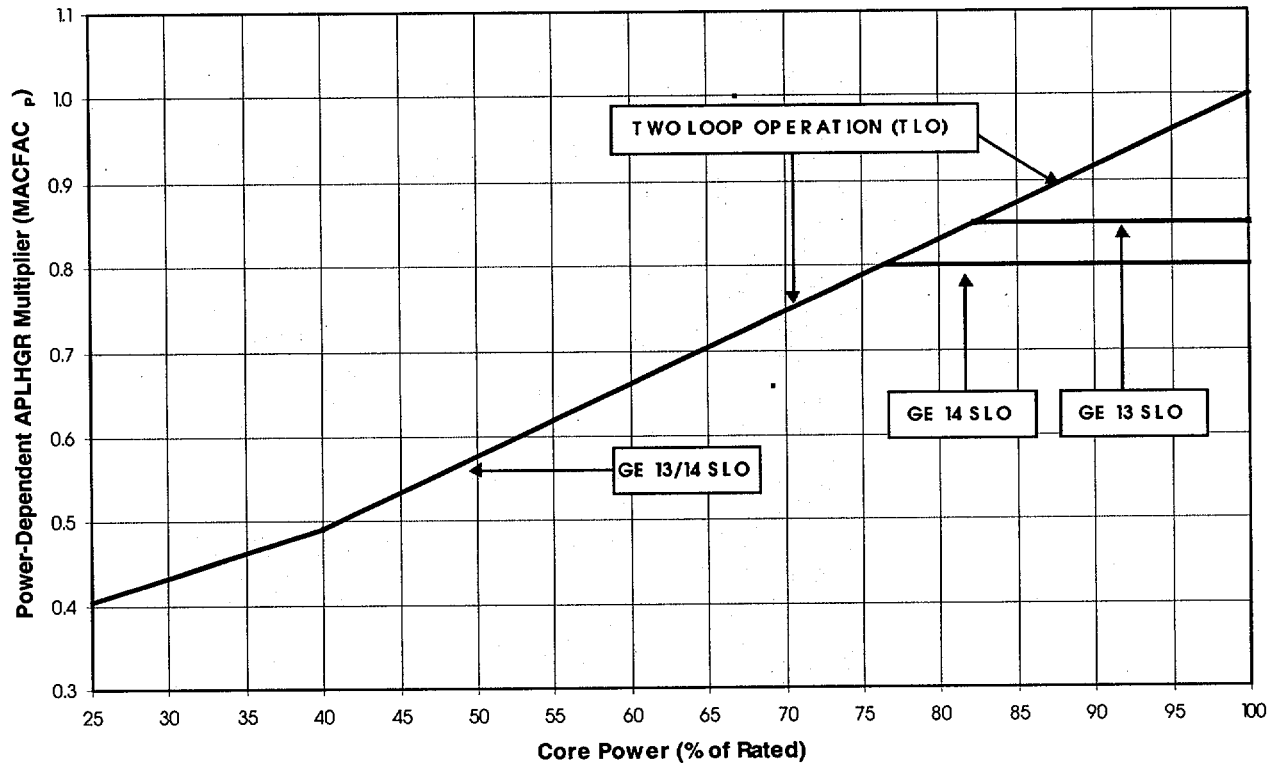
$$\text{MAPFAC}_P = A - B (P_0 - P)$$

Operating Conditions				Values of Variables		
P	F	Fuel Type	SLO/TLO	A	B	P ₀
25 ≤ P < 28	F ≤ 60	GE13/14	SLO/TLO	0.588	0.01167	28
25 ≤ P < 28	F > 60	GE13/14	SLO/TLO	0.450	0.00967	28
28 ≤ P < 61.72	All	GE13/14	SLO/TLO	1.00	0.005224	100
61.72 ≤ P < 71.28	All	GE13	SLO/TLO	1.00	0.005224	100
61.72 ≤ P < 71.28	All	GE14	TLO	1.00	0.005224	100
71.28 ≤ P	All	GE13/14	TLO	1.00	0.005224	100
71.28 ≤ P	All	GE13	SLO	0.85	0.000	100
61.72 ≤ P	All	GE14	SLO	0.80	0.000	100

P = Percent of Rated Core Power
F = Percent of Rated Core Flow

FIGURE 2-2B

Power-Dependent APLHGR Multiplier (MAPFAC_P) versus Core Power
(Bypass Valves Inoperable and Pressure Regulator Operable)



$$\text{MAPFAC}_P = A - B (P_0 - P)$$

Operating Conditions				Values of Variables		
P	F	Fuel Type	SLO/TLO	A	B	P ₀
25 ≤ P < 40	All	GE13/14	SLO/TLO	0.49	0.00580	40
40 ≤ P < 100	All	GE13/14	SLO/TLO	1.00	0.0085	100

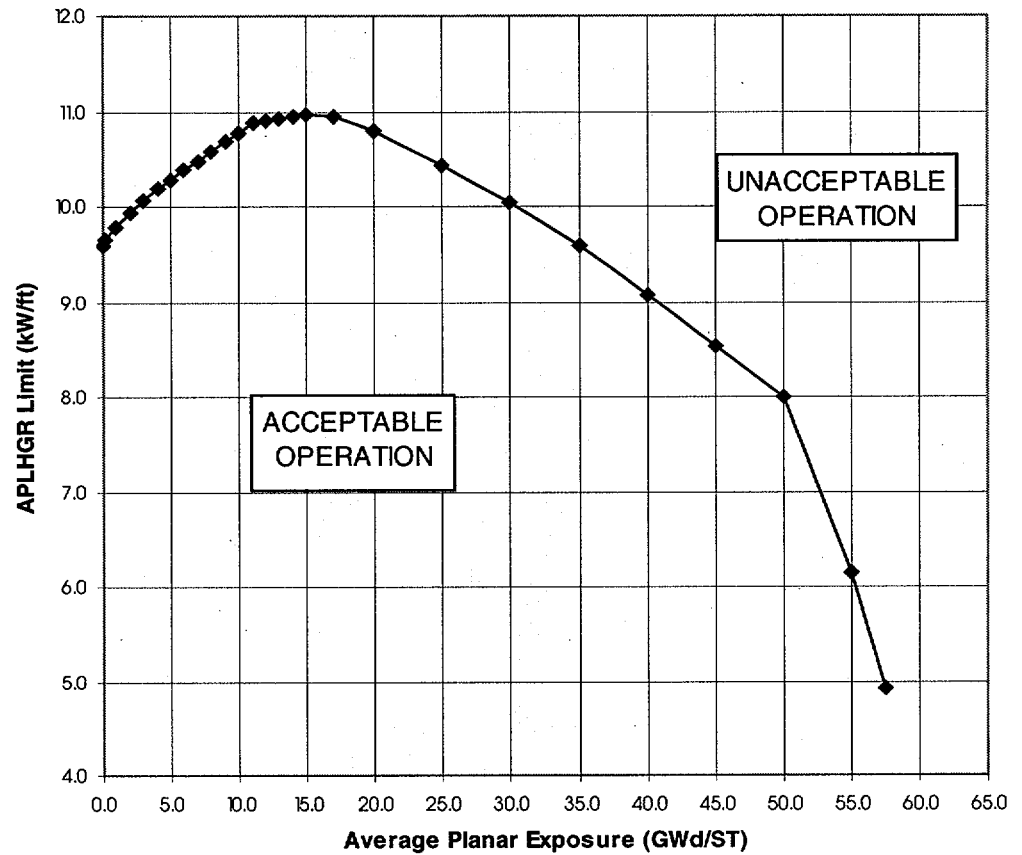
P = Percent of Rated Core Power
F = Percent of Rated Core Flow

FIGURE 2-2C

Power-Dependent APLHGR Multiplier (MAPFAC_P) versus Core Power
(Pressure Regulator Inoperable)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

Average Planar Exposure	APLHGR Limit
0.00	9.59
0.20	9.66
1.00	9.78
2.00	9.94
3.00	10.06
4.00	10.19
5.00	10.28
6.00	10.38
7.00	10.48
8.00	10.58
9.00	10.68
10.00	10.78
11.00	10.89
12.00	10.91
13.00	10.93
14.00	10.95
15.00	10.97
17.00	10.94
20.00	10.80
25.00	10.44
30.00	10.05
35.00	9.59
40.00	9.07
45.00	8.54
50.00	7.99
55.00	6.16
57.45	4.92



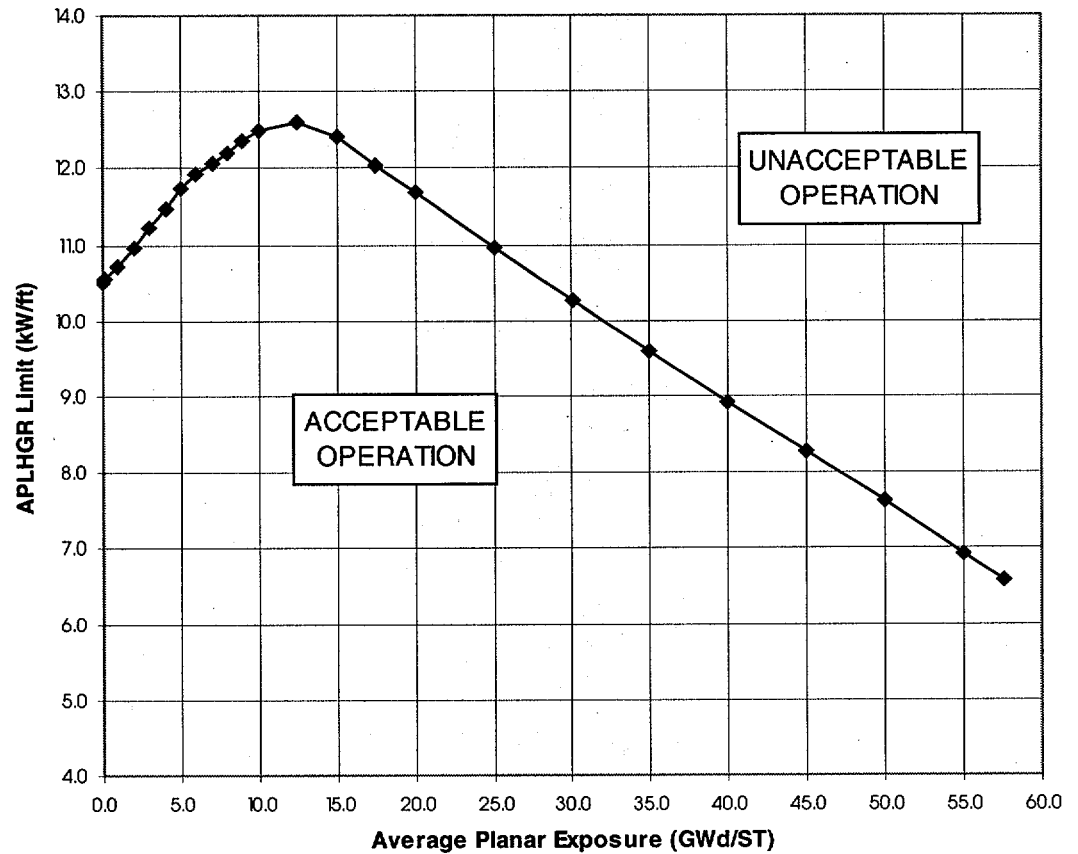
NOTE: THIS IS THE APLHGR LIMIT FOR THE MOST LIMITING LATTICE AS A FUNCTION OF AVERAGE PLANAR EXPOSURE.

FIGURE 2-3

APLHGR Limit versus Average Planar Exposure
(Bundle Type: GE14-P10DNAB399-16GZ-100T-150-T-2517)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

Average Planar Exposure	APLHGR Limit
0.00	10.51
0.20	10.57
1.00	10.73
2.00	10.97
3.00	11.24
4.00	11.48
5.00	11.73
6.00	11.92
7.00	12.06
8.00	12.21
9.00	12.36
10.00	12.49
12.50	12.60
15.00	12.42
17.50	12.05
20.00	11.69
25.00	10.97
30.00	10.27
35.00	9.60
40.00	8.93
45.00	8.28
50.00	7.62
55.00	6.94
57.53	6.59



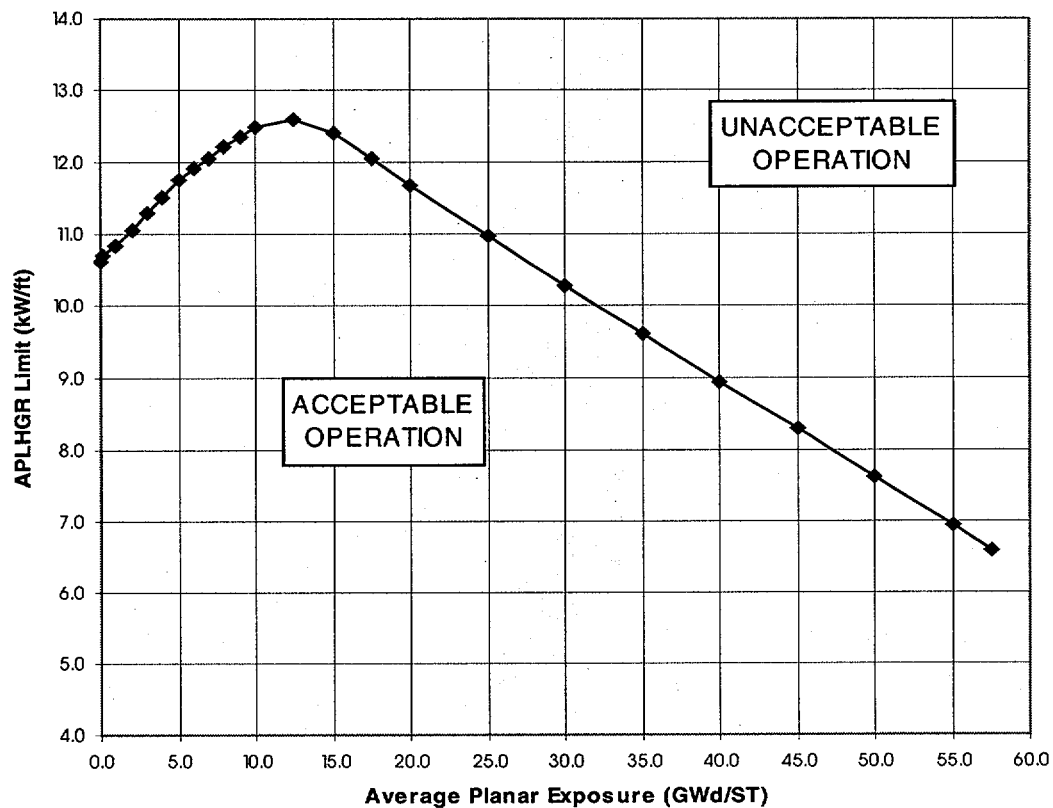
NOTE: THIS IS THE APLHGR LIMIT FOR THE MOST LIMITING LATTICE AS A FUNCTION OF AVERAGE PLANAR EXPOSURE.

FIGURE 2-4

APLHGR Limit versus Average Planar Exposure
(Bundle Type: GE13-P9HTB378-6G5.0/6G4.0/1G2.0-100T-146-T)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

Average Planar Exposure	APLHGR Limit
0.00	10.64
0.20	10.70
1.00	10.85
2.00	11.06
3.00	11.30
4.00	11.51
5.00	11.75
6.00	11.92
7.00	12.06
8.00	12.21
9.00	12.35
10.00	12.49
12.50	12.61
15.00	12.42
17.50	12.06
20.00	11.69
25.00	10.97
30.00	10.28
35.00	9.60
40.00	8.94
45.00	8.28
50.00	7.62
55.00	6.95
57.54	6.59



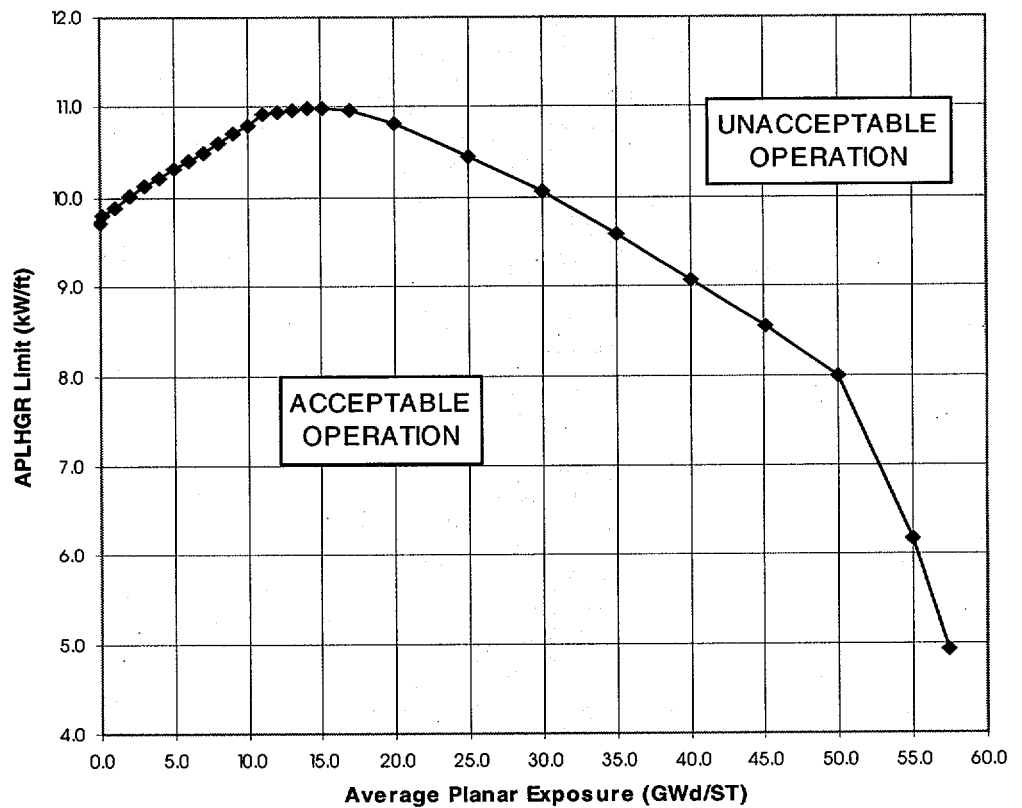
NOTE: THIS IS THE APLHGR LIMIT FOR THE MOST LIMITING LATTICE AS A FUNCTION OF AVERAGE PLANAR EXPOSURE.

FIGURE 2-5

APLHGR Limit versus Average Planar Exposure
(Bundle Type: GE13-P9HTB378-6G5.0/6G4.0-100T-146-T)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

Average Planar Exposure	APLHGR Limit
0.00	9.72
0.20	9.79
1.00	9.89
2.00	10.01
3.00	10.13
4.00	10.22
5.00	10.31
6.00	10.41
7.00	10.50
8.00	10.60
9.00	10.70
10.00	10.80
11.00	10.92
12.00	10.94
13.00	10.96
14.00	10.98
15.00	10.99
17.00	10.96
20.00	10.81
25.00	10.44
30.00	10.05
35.00	9.59
40.00	9.07
45.00	8.54
50.00	7.99
55.00	6.17
57.47	4.92



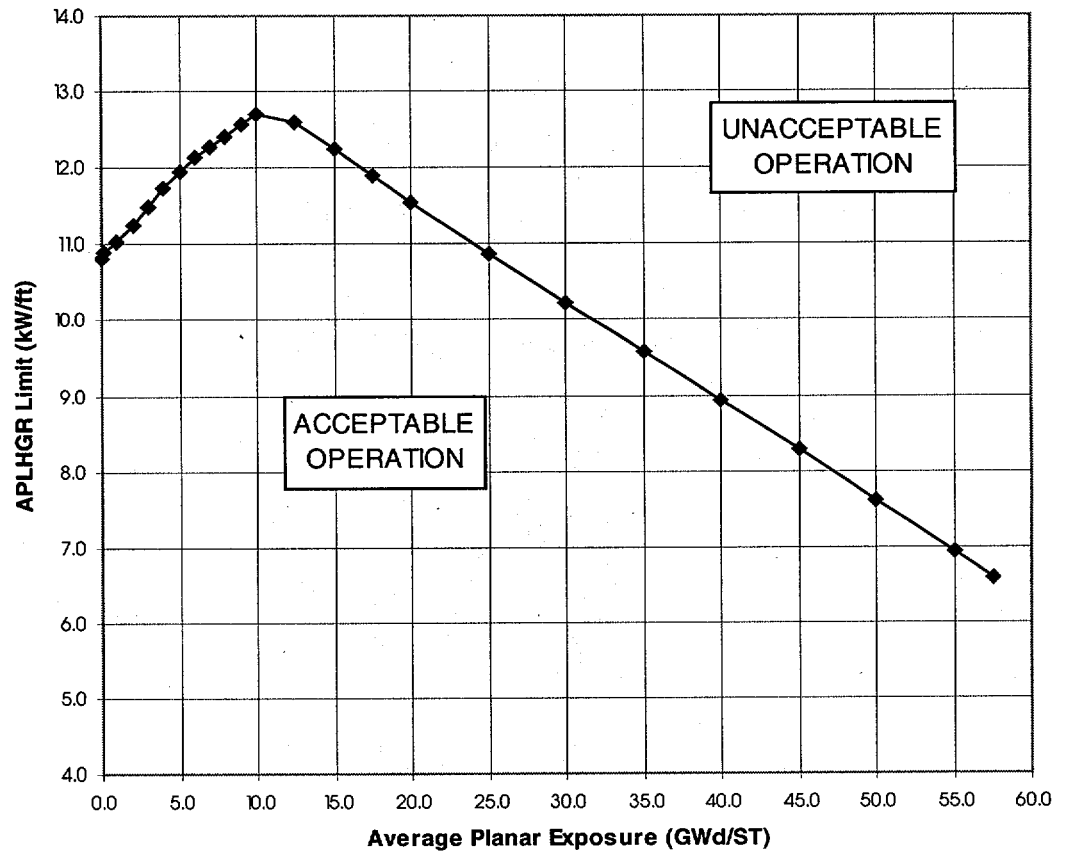
NOTE: THIS IS THE APLHGR LIMIT FOR THE MOST LIMITING LATTICE AS A FUNCTION OF AVERAGE PLANAR EXPOSURE.

FIGURE 2-6

APLHGR Limit versus Average Planar Exposure
(Bundle Type: GE14-P10DNAB398-15GZ-100T-150-T-2518)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

Average Planar Exposure	APLHGR Limit
0.00	10.83
0.20	10.89
1.00	11.04
2.00	11.25
3.00	11.48
4.00	11.73
5.00	11.96
6.00	12.14
7.00	12.28
8.00	12.42
9.00	12.57
10.00	12.71
12.50	12.61
15.00	12.25
17.50	11.91
20.00	11.56
25.00	10.88
30.00	10.22
35.00	9.57
40.00	8.92
45.00	8.28
50.00	7.62
55.00	6.94
57.54	6.58



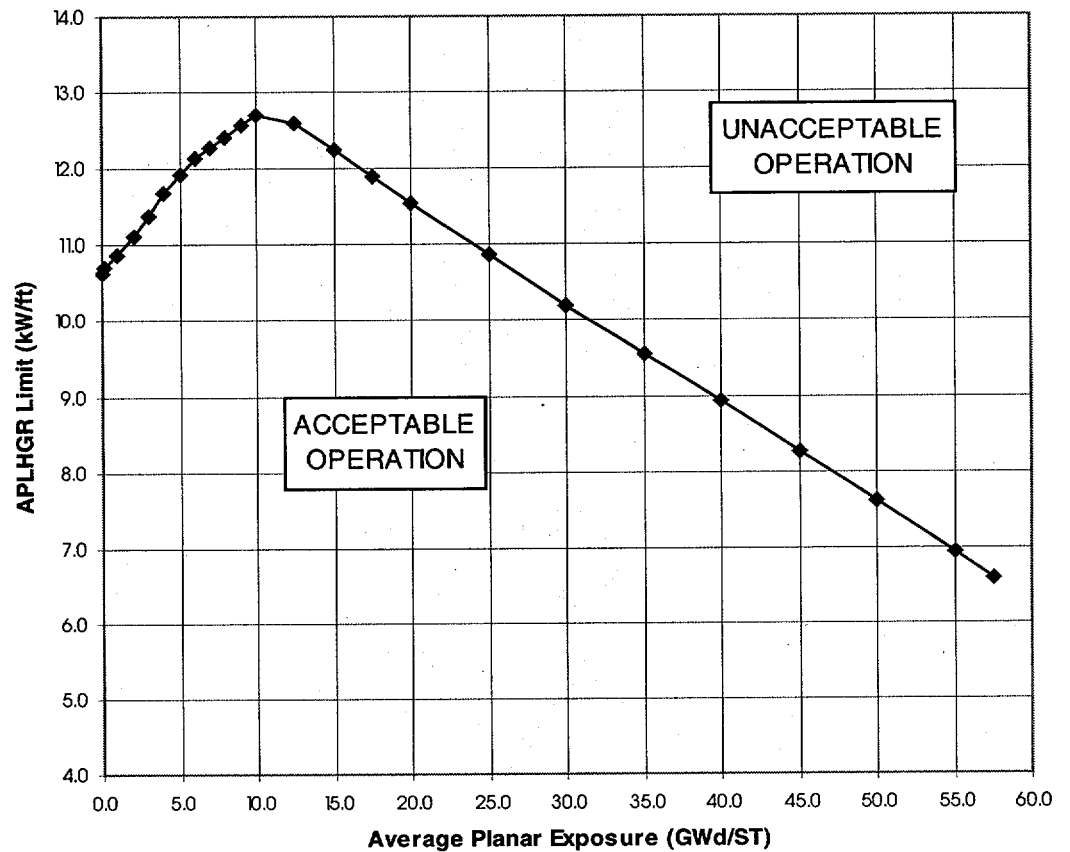
NOTE: THIS IS THE APLHGR LIMIT FOR THE MOST LIMITING LATTICE AS A FUNCTION OF AVERAGE PLANAR EXPOSURE.

FIGURE 2-7

APLHGR Limit versus Average Planar Exposure
(Bundle Type: GE13-P9DTB378-6G5.0/6G4.0-100T-146-T-2411)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

Average Planar Exposure	APLHGR Limit
0.00	10.64
0.20	10.71
1.00	10.88
2.00	11.12
3.00	11.39
4.00	11.67
5.00	11.93
6.00	12.14
7.00	12.28
8.00	12.42
9.00	12.58
10.00	12.71
12.50	12.60
15.00	12.25
17.50	11.90
20.00	11.56
25.00	10.88
30.00	10.21
35.00	9.56
40.00	8.92
45.00	8.27
50.00	7.62
55.00	6.93
57.53	6.58



NOTE: THIS IS THE APLHGR LIMIT FOR THE MOST LIMITING LATTICE AS A FUNCTION OF AVERAGE PLANAR EXPOSURE.

FIGURE 2-8

ALPHGR Limit versus Average Planar Exposure
(Bundle Type: GE13-P9DTB378-6G5.0/6G4.0/1G2.0-100T-146-T)

3.0 MCPR OPERATING LIMITS (Technical Specification 3.2.2)

The MCPR operating limit (OLMCPR) for each fuel type is a function of core power, core flow, average scram time, number of operating recirculation loops, operability of the EOC-RPT system, operability of the turbine bypass valve system, and whether both pressure regulators are operable.

With both recirculation pumps in operation (TLO), the OLMCPR for each fuel type is determined as follows:

- a. For $25\% \leq \text{power} < 28\%$, the power-dependent MCPR limit, MCPR_P , as determined by Table 3-1A or 3-1B.
- b. For $\text{power} \geq 28\%$, the OLMCPR is the greater of either:
 - 1) The flow-dependent MCPR limit, MCPR_F , from Figure 3-2,

or
 - 2) The product of the power-dependent multiplier, K_P , and the rated-power, rated-flow MCPR limit as determined by Table 3-1A or 3-1B.

With only one recirculation pump in operation (SLO), the OLMCPR for each fuel type is the TLO OLMCPR plus 0.02.

These limits apply to all modes of operation with intermittent feedwater temperature reduction, as well as operation with normal feedwater temperatures.

In figures 3-4A through 3-4E, Option A scram time MCPR limits correspond to $\tau = 1.0$, where τ is determined from scram time measurements performed in accordance with Technical Specifications Surveillance Requirements 3.1.4.1 and 3.1.4.2. Option B values correspond to $\tau = 0.0$. For scram times between Option A and Option B, the MCPR limit for each fuel corresponds to τ . If τ has not been determined, Option A limits are to be used. Refer to Table 3-1A or 3-1B to determine the applicable set of fuel-type dependent curves.

The average scram time of the control rods, τ , is defined as:

$$\tau = 0, \text{ or } \frac{\tau_{ave} - \tau_B}{\tau_A - \tau_B}, \text{ whichever is greater.}$$

where: $\tau_A = 1.08 \text{ sec}$ (Technical Specification 3.1.4, Table 3.1.4-1, scram time limit to notch 36).

$$\tau_B = \mu + 1.65 * \sigma * \left[\frac{N_1}{\sum_{i=1}^n N_i} \right]^{1/2}$$

where: $\mu = 0.822 \text{ sec}$ (mean scram time used in the transient analysis).

$\sigma = 0.018 \text{ sec}$ (standard deviation of μ).

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

where: $n =$ number of surveillance tests performed to date in the cycle.

$N_i =$ number of active control rods measured in the i th surveillance test.

$\tau_i =$ average scram time to notch 36 of all rods in the i th surveillance test.

$N_1 =$ total number of active rods measured in Technical Specifications Surveillance Requirement 3.1.4.1.

TABLE 3-1A

**MCPR Operating Flexibility Options
for Cycle Exposures BOC to EOC-2100**

EOC-RPT System	Turbine Bypass Valve System	Pressure Regulator System	MCPR _p Curve	Kp Curve	Rated-Power, Rated-Flow MCPR Limits
Operable	Operable	Operable	Figure 3-1A	Figure 3-3A	Figure 3-4A
Operable	Operable	Inoperable	Figure 3-1A	Figure 3-3B	Figure 3-4A
Inoperable	Operable	Operable	Figure 3-1A	Figure 3-3A	Figure 3-4B
Inoperable	Operable	Inoperable	Figure 3-1A	Figure 3-3B	Figure 3-4B
Operable	Inoperable	Operable	Figure 3-1B	Figure 3-3A	Figure 3-4C
Operable	Inoperable	Inoperable	Figure 3-1B	Figure 3-3B	Figure 3-4C

BOC = Beginning of Cycle
EOC = End of Cycle
EEOC = Extended End of Cycle

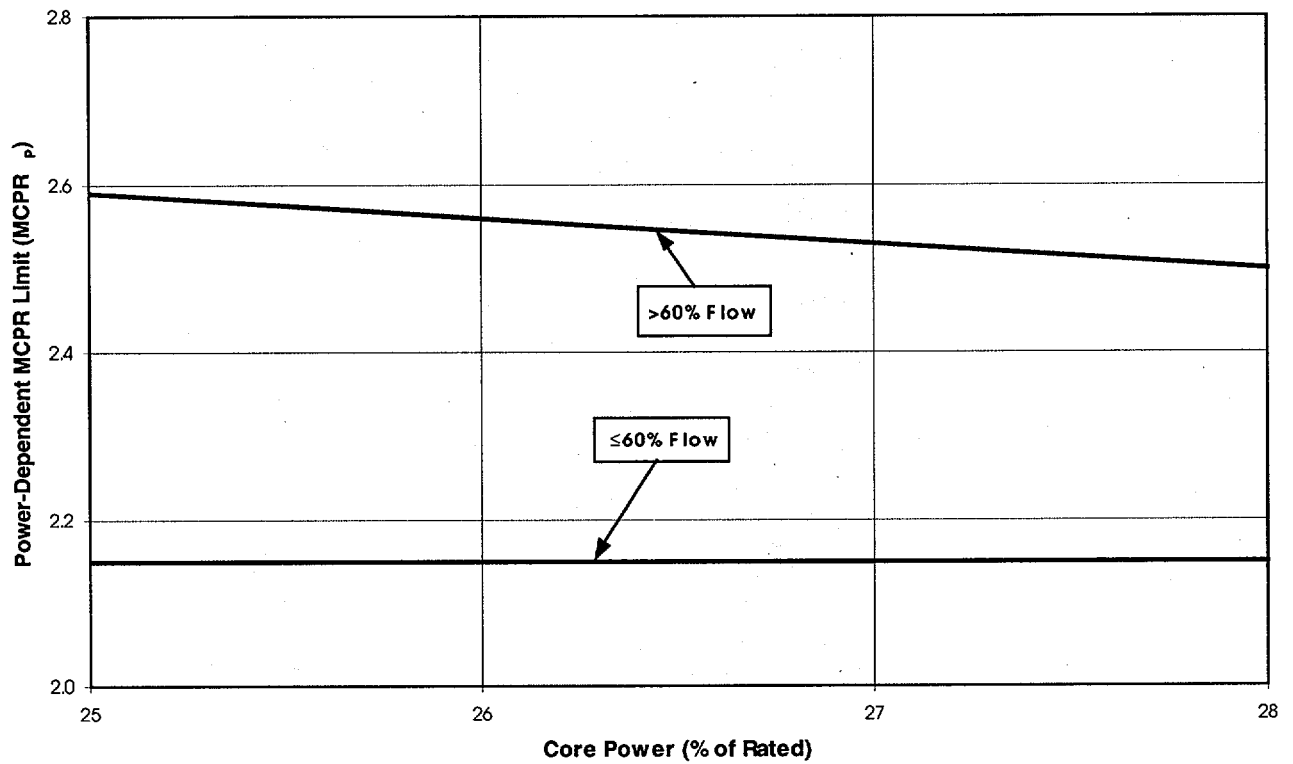
TABLE 3-1B

**MCPR Operating Flexibility Options
for Cycle Exposures EOC-2100 to EEOC**

EOC-RPT System	Turbine Bypass Valve System	Pressure Regulator System	MCPR _P Curve	Kp Curve	Rated-Power, Rated-Flow MCPR Limits
Operable	Operable	Operable	Figure 3-1A	Figure 3-3A	Figure 3-4D
Operable	Operable	Inoperable	Figure 3-1A	Figure 3-3B	Figure 3-4D
Inoperable	Operable	Operable	Figure 3-1A	Figure 3-3A	Figure 3-4E
Inoperable	Operable	Inoperable	Figure 3-1A	Figure 3-3B	Figure 3-4E
Operable	Inoperable	Operable	Figure 3-1B	Figure 3-3A	Figure 3-4C
Operable	Inoperable	Inoperable	Figure 3-1B	Figure 3-3B	Figure 3-4C

BOC = Beginning of Cycle
EOC = End of Cycle
EEOC = Extended End of Cycle

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report



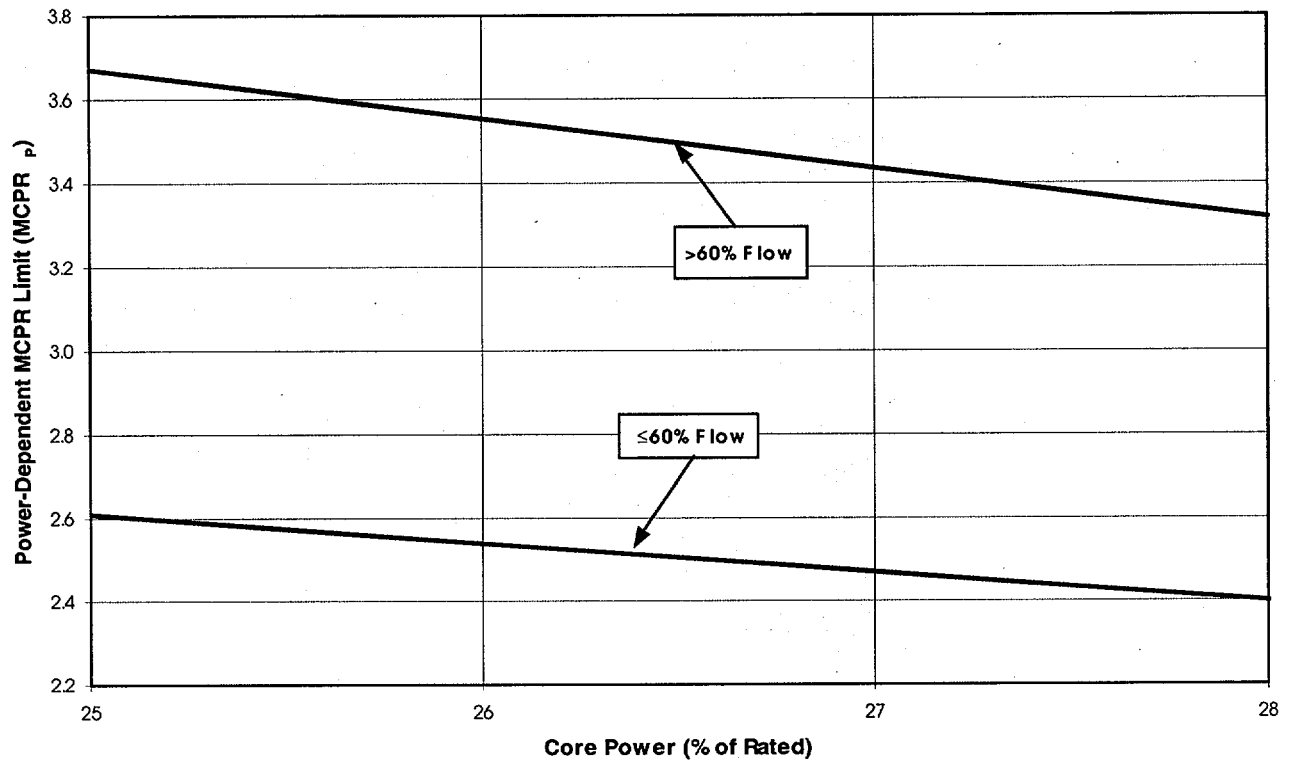
$$\text{MCPR}_p = A + B (28-P)$$

F	A	B
≤ 60%	2.15	0
> 60%	2.5	0.03

P = Percent of Rated Core Thermal Power
F = Percent of Rated Core Flow

FIGURE 3-1A

**Power-Dependent MCPR Limit (MCPR_p) versus Core Power
from 25% to 28% of Rated Core Power
(Bypass Valves Operable)**



$$MCPR_p = A + B (28-P)$$

F	A	B
≤ 60%	2.40	0.070
> 60%	3.32	0.1167

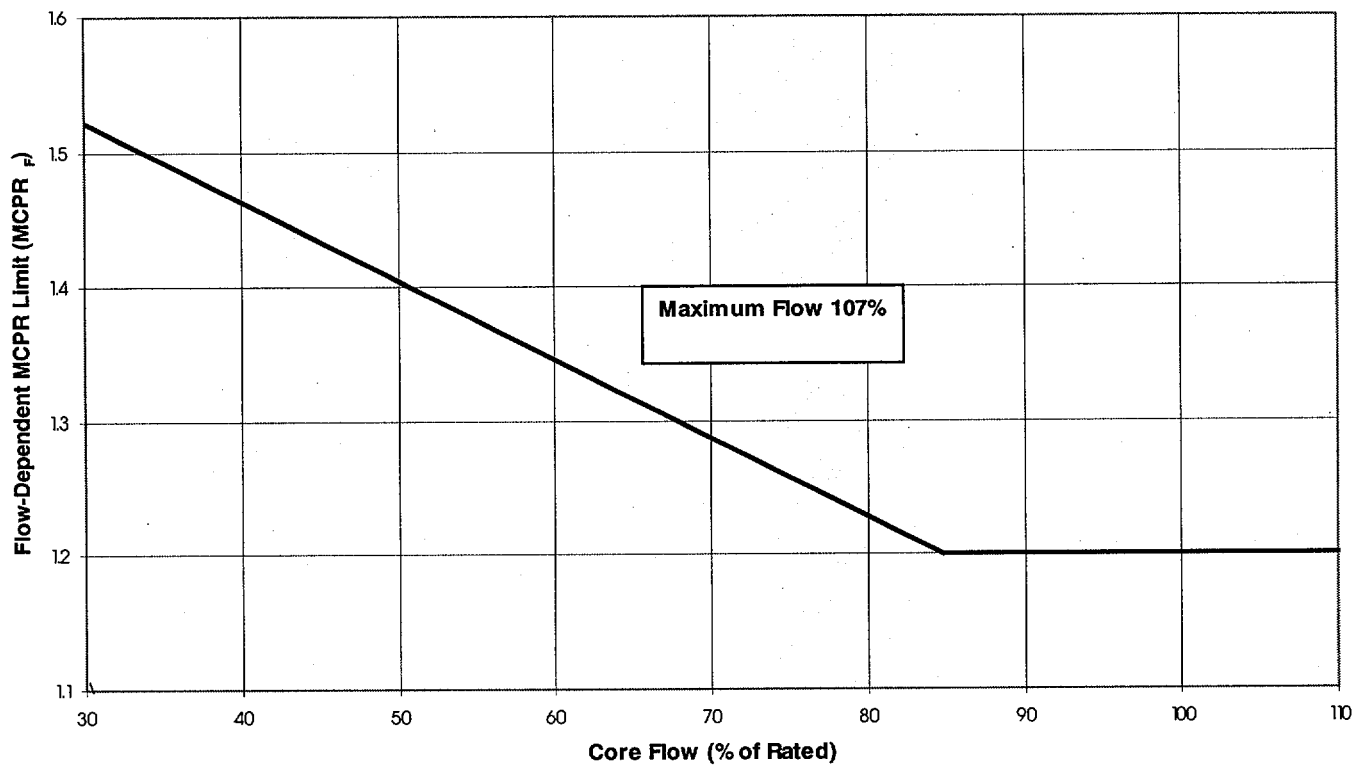
P = Percent of Rated Core Thermal Power

F = Percent of Rated Core Flow

FIGURE 3-1B

**Power-Dependent MCPR Limit (MCPR_p) versus Core Power
From 25% to 28% of Rated Core Power
(Bypass Valves Inoperable)**

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Core Operating Limits Report



$$MCPR_F = \text{Maximum} [1.20, (A * F + B)]$$

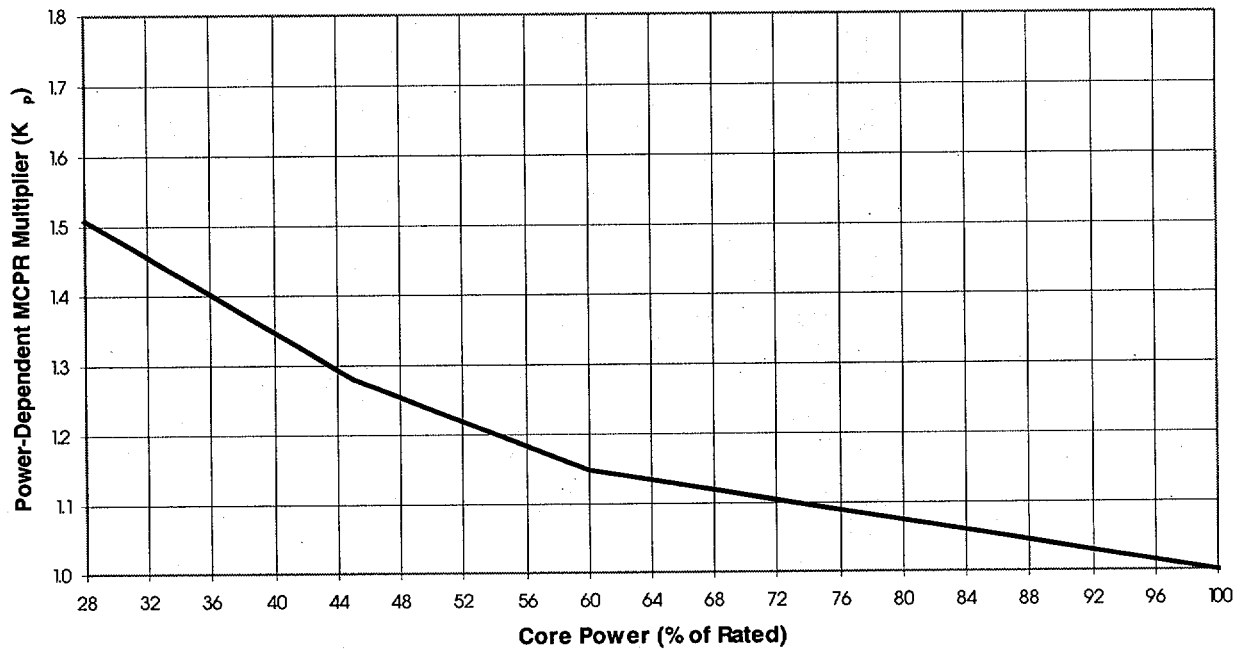
Maximum Core Flow (% of Rated)	A	B
107.0	-0.00586	1.697

F = Percent of Rated Core Flow

FIGURE 3-2

Flow-Dependent MCPR Limit (MCPR_F) versus Core Flow

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report



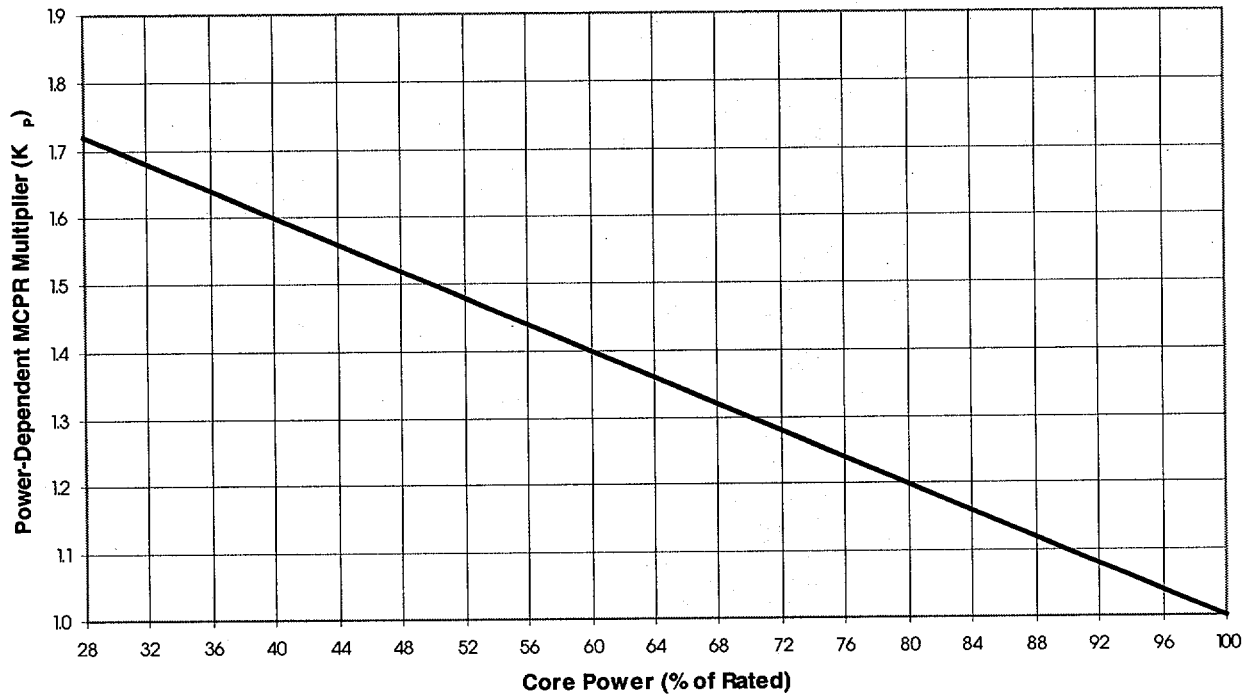
$$K_p = A + B*(P_o - P)$$

P	A	B	P _o
28 ≤ P < 45	1.28	0.01340	45
45 ≤ P < 60	1.15	0.00867	60
60 ≤ P	1.00	0.00375	100

P = Percent of Rated Core Power

FIGURE 3-3A

Power-Dependent MCPR Multiplier (K_p) versus Core Power
(Pressure Regulator Operable)



$$K_p = A + B \cdot (P_o - P)$$

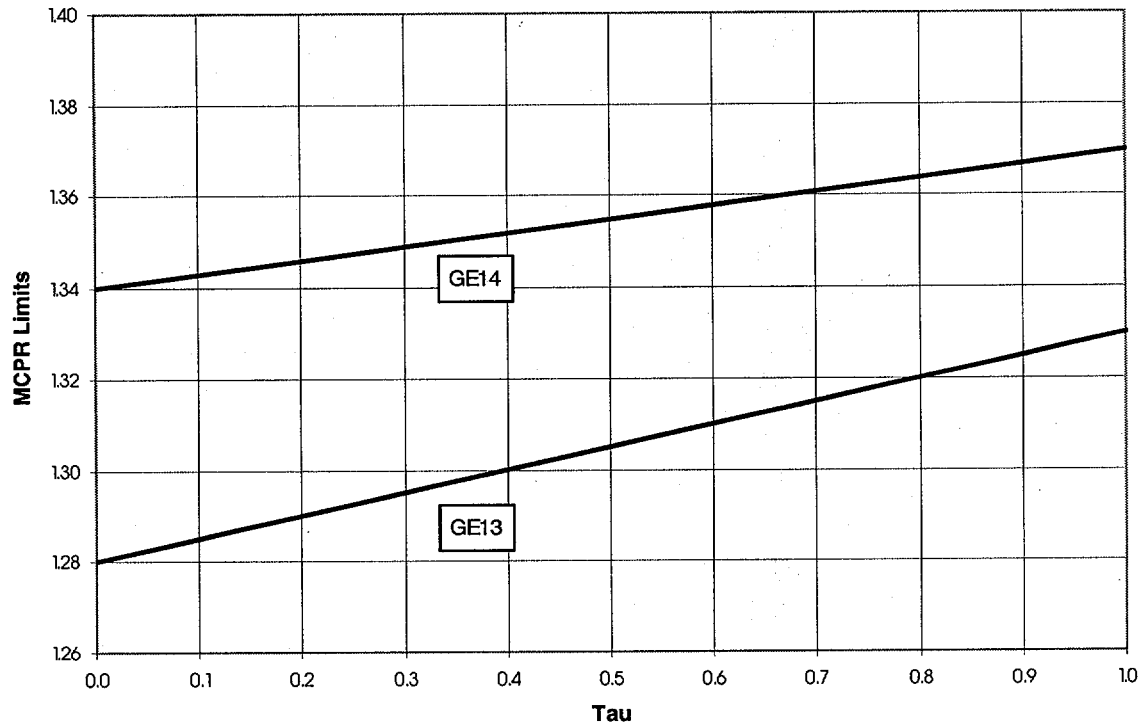
P	A	B	P _o
28 ≤ P < 100	1.00	0.010	100

P = Percent of Rated Core Power

FIGURE 3-3B

Power-Dependent MCPR Multiplier (K_p) versus Core Power
(Pressure Regulator Inoperable)

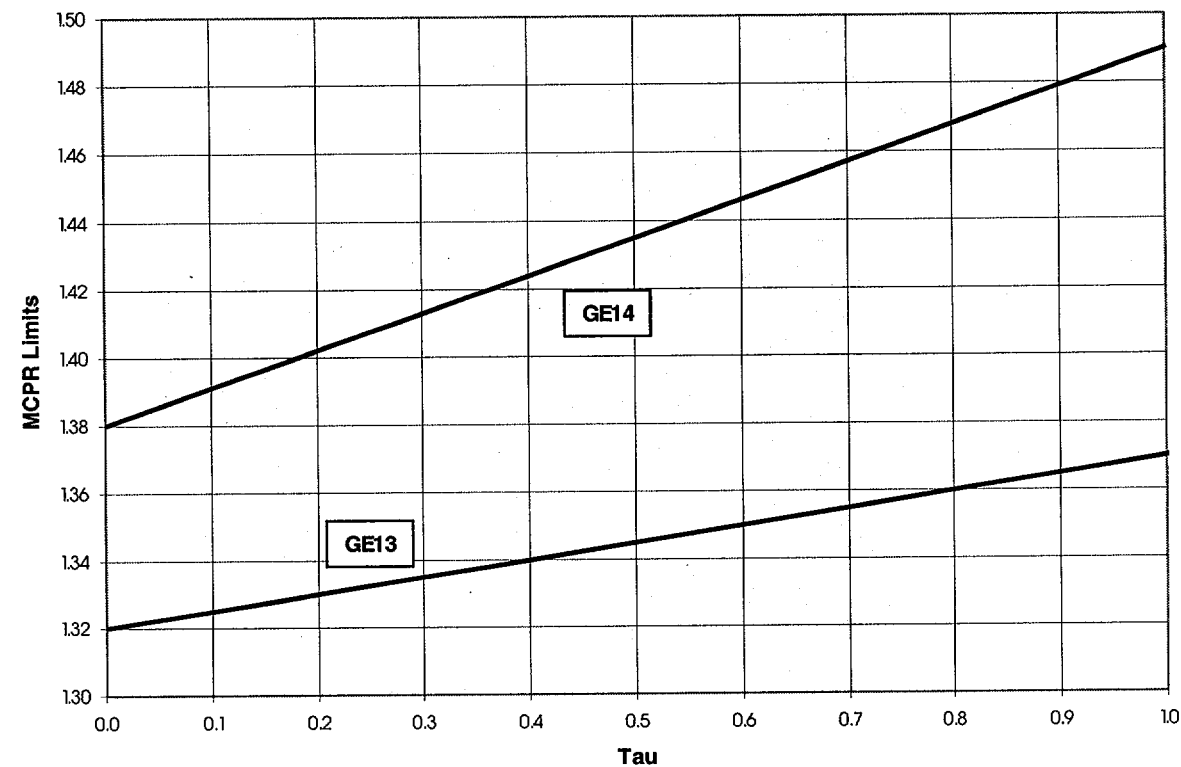
Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report



Tau	GE14	GE13
1.0	1.37	1.33
0.0	1.34	1.28

FIGURE 3-4A

MCPR Limits versus Average Scram Time
(BOC to EOC-2100 with EOC-RPT System Operable
and Bypass Valves Operable)

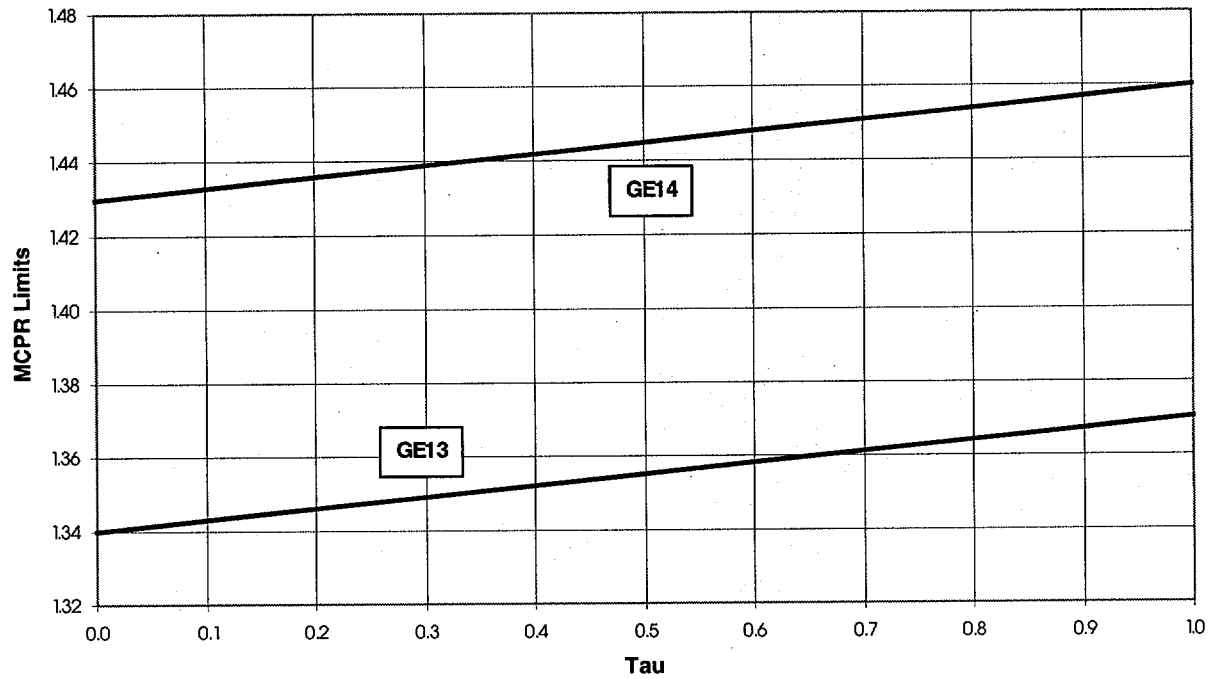


Tau	GE14	GE13
1.0	1.49	1.37
0.0	1.38	1.32

FIGURE 3-4B

MCPR Limits versus Average Scram Time
(BOC to EOC-2100 with EOC-RPT System Inoperable
and Bypass Valves Operable)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

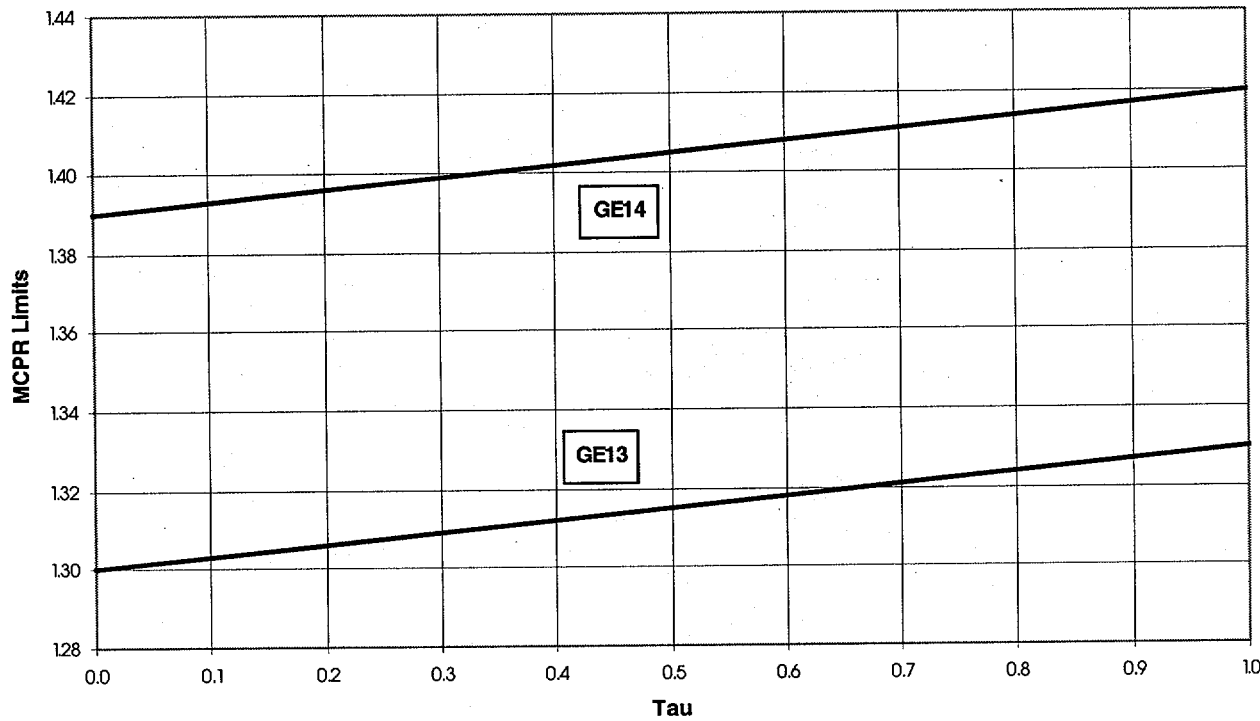


Tau	GE14	GE13
1.0	1.46	1.37
0.0	1.43	1.34

FIGURE 3-4C

**MCPR Limits versus Average Scram Time
(BOC to EEOC with EOC-RPT System Operable
and Bypass Valves Inoperable)**

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report

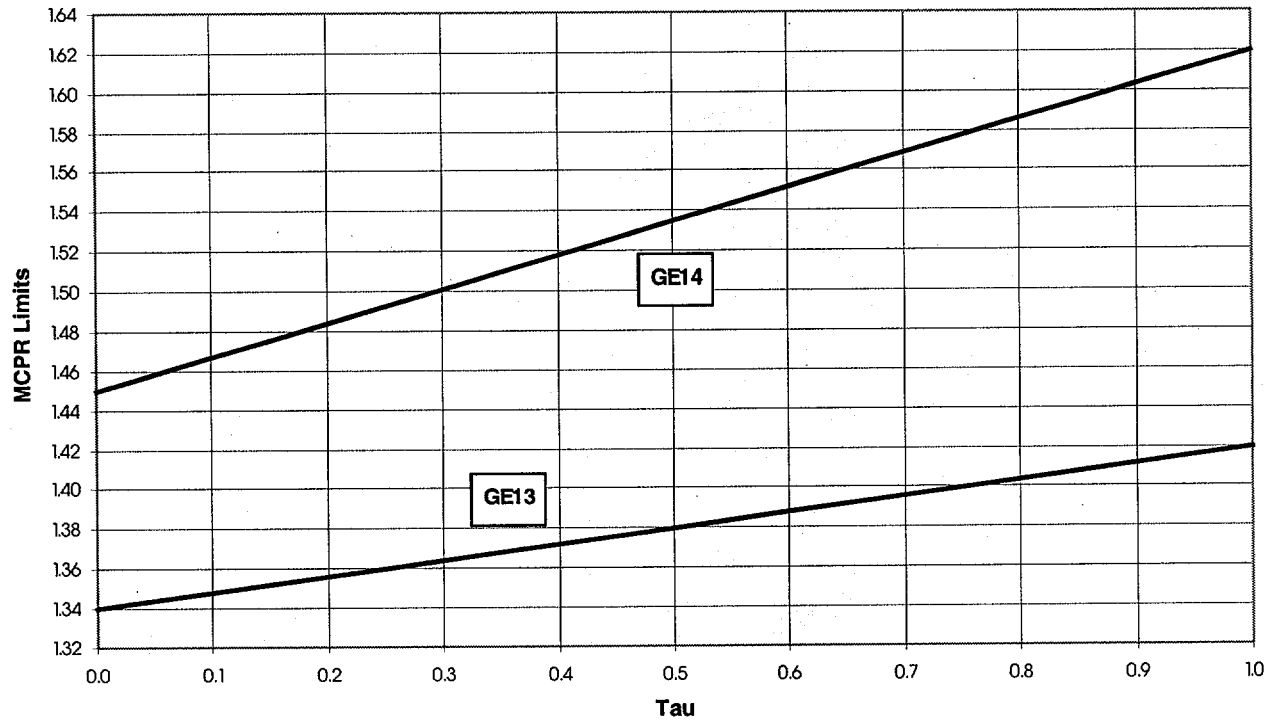


Tau	GE14	GE13
1.0	1.42	1.33
0.0	1.39	1.30

FIGURE 3-4D

MCPR Limits versus Average Scram Time
(EOC-2100 to EEOC with EOC-RPT System Operable
and Bypass Valves Operable)

Plant Hatch Unit 1 Cycle 21
Core Operating Limits Report



Tau	GE14	GE13
1.0	1.62	1.42
0.0	1.45	1.34

FIGURE 3-4E

**MCPR Limits versus Average Scram Time
(EOC-2100 to EEOC with EOC-RPT System Inoperable
and Bypass Valves Operable)**

4.0 PBDA AMPLITUDE SETPOINT

The amplitude trip setpoint in the Period Based Detection Algorithm in the OPRM system shall not exceed the values reported in the table below. This applies to instruments 1C51K615 A, B, C, and D. These are the nominal trip setpoint values, not the allowable values. Projected Figure of Merit (FOM) value(s) throughout the cycle will be supplied by the Hatch Core Analysis Group. The values in this table are based on GE13 fuel, since it has lower OLMCPRs than the GE14 fuel.

FOM >	FOM ≤	$1.28 \leq \text{OLMCPR}$ < 1.30	$1.30 \leq \text{OLMCPR}$ < 1.34	OLMCPR ≥ 1.34
0.0	92.1	1.11	1.12	1.13
92.1	96.9	1.10	1.10	1.11
96.9	102.4	1.08	1.09	1.10
102.4	108.0	1.07	1.08	1.09

5.0 REFERENCES

1. "General Electric Standard Application for Reactor Fuel," NEDE-24011-P-A-14, June 2000, and the US Supplement, NEDE-24011-P-A-14-US, June 2000.
2. "Supplemental Reload Licensing Report for Edwin I. Hatch Nuclear Power Plant Unit 1, Reload 20 Cycle 21," Global Nuclear Fuel document 0000-0002-7058-SRLR, Revision 0, March 2002.
3. Letter CAH-NF-2370, "Hatch-1 Cycle 21 Pressure Regulator Out-of-Service ARTS Limits," E. B. Gibson to K. S. Folk, April 8, 2002.
4. Letter CAH-NF-2371, "GE14 Low Power ARTS Below P_{BYP} With Bypass Valves Inoperable," W. R. Mertz to K. S. Folk, April 8, 2002.