COOPER NUCLEAR STATION

CORE OPERATING LIMITS REPORT

Cycle 19
Revision 0

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1.0 INTRODUCTION

The Core Operating Limits Report provides the limits for operation of the Cooper Nuclear Station for Cycle 19. It includes the limits for the Rod Block Monitor Upscale Set Point, Average Planar Linear Heat Generation Rate (APLHGR), and Minimum Critical Power Ratio (MCPR.) If any of these limits is exceeded, action will be taken as defined in the Technical Specifications.

The core operating limit values have been determined using the NRC-approved methodologies given in References 1, 2, 10, and 11 and have been established such that all applicable plant safety analysis limits are met.

2.0 CORE OPERATING LIMITS

Cooper Nuclear Station shall operate within the bounds of the below limits/values. The applicable Technical Specifications are referenced in each subsection.

2.1 Rod Block Monitor Upscale Set Point

The Technical Specifications reflect a reference to Allowable Values for the Rod Block Monitor (RBM) upscale (power referenced) trip level setting, found in Reference 9, are as follows:

Lowest Rated MCPR Limit	Low Trip Set Point (LTSP) (LPSP≤P≤IPSP)	Intermed Trip Set Point (ITSP) (IPSP≤P≤HPSP)	High Trip Set Point (HTSP) (HPSP≤P)
≥1.20	≤114.0/125	≤108.5/125	≤104.5/125
≥1.25	≤117.0/125	≤112.5/125	≤107.5/125
≥1.30	≤120.0/125	≤115.0/125	≤110.5/125

LPSP, IPSP, and HPSP are the Low Power Set Point, Intermediate Power Set Point, and High Power Set Point, respectively.

The trip level settings associated with this MCPR limit have been generically calculated and verified to bound the Rod Withdrawal Error Analysis for Cycle 19 operation.

Technical Specification Reference: 3.3.2.1

2.2 Average Planar Linear Heat Generation Limits

The most limiting lattice APLHGR value (excluding natural uranium) for each fuel bundle as a function of Planar Average Exposure, core power, and core flow is calculated by multiplying the value from Figures 1, 2, 3, and 4 by the smaller of the MAPLHGR Flow Factor, $MAPFAC_F$ (Figure 5) or the Power-Dependent MAPLHGR Factor, $MAPFAC_P$, (Figure 6). APLHGR values determined with the SAFER/GESTR-LOCA methodology are given in References 2, 3, and 5 while $MAPFAC_F$ and $MAPFAC_P$ were determined in Reference 8.

The fuel bundles referred to in Figures 1, 2, 3, and 4 consist of multiple combinations of enriched uranium and gadolinium filled lattices each having its own calculated maximum APLHGR (MAPLHGR) value. Hence, these fuel bundles have multiple MAPLHGR limiting values at a given planar exposure. The MAPLHGR values for these lattices, along with the axial location of each lattice in the bundle, are considered proprietary information by General Electric and are given in Reference 3 as a function of planar average exposure.

The MAPLHGR limits referred to above are for two recirculation loop operations. For single loop operation, the limiting APLHGR value is multiplied by 0.77 for GE8x8 NB fuel, as can be found in Reference 5.

Technical Specification Reference: 3.2.1

2.3 Linear Heat Generation Rate Limit

The limiting power density and maximum allowable Linear Heat Gernation Rate (LHGR) referred to in Technical Requirements Manual Section T 3.2.1 is the design LHGR. The design LHGR for fuel type GE 8x8 NB is 14.4 kW/ft as found in Reference 12.

2.4 Minimum Critical Power Ratio Limits

The operating limit MCPR (OLMCPR) values are a function of core thermal power, core flow, fuel bundle, scram time (τ), and fuel exposure. The scram time (τ) is determined from CNS Procedure 10.9, Control Rod Scram Time evaluation. The OLMCPR values are as follows:

For core thermal power $\geq$ 25 percent and <30 percent of rated power, the OLMCPR is the power dependent MCPR ($MCPR_P$) from Figure 7.

For core thermal power $\geq$ 30 percent of rated power, the OLMCPR is the greater of either:

The applicable flow dependent MCPR ($MCPR_F$) determined from Figure 8, or

The appropriate scram time (τ) dependent MCPR at rated power from Figures 9 and 10, multiplied by the applicable power dependent MCPR multiplier (K_P) from Figure 7.

Technical Specification References: 3.2.2 and 3.7.7

2.4 Power/Flow Map

The power/flow map defining the Stability Exclusion Region can be found as Figure 12. References 5 and 6 reflect the documents describing the current Cooper Nuclear Station power/flow map.

Technical Specification Reference: 3.4.1

3.0 REFERENCES

1. NEDE-24011-P-A-13-US, August 1996, *General Electric Standard Application for Reactor Fuel.* (The approved revision at the time the reload analyses were performed.)

2. NEDC-32687P, Revision 1, March 1997, *Cooper Nuclear Station SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis.*

3. *Lattice Dependent MAPLHGR Report for Cooper Nuclear Station Reload 18, Cycle 19,* J11-03354-10M, Revision 0.

4. Letter (with attachment), R.H. Buckholz (GE) to P.S. Check (NRC) dated September 5, 1980, *Response to NRC Request for Information on ODYN Computer Model.*

5. *Supplemental Reload Licensing Report for Cooper Nuclear Station Reload 18, Cycle 19,* J11-03354-10, Revision 0.

6. GENE-A13-00395-01, Class I, November, 1996, *Application of the "Regional Exclusion with Flow-Biased APRM Neutron Flux Scram" Stability Solution (Option 1-D) to the Cooper Nuclear Station, Licensing Topical Report.*

7. Letter from James R. Hall (NRC) to G. R. Horn (NPPD) dated September 23, 1997, *Approval of SAFER/GESTAR LOCA Analysis for Cooper Nuclear Station (TAC NO. M98293.)*

8. NEDC-31892P, Revision 1, May 1991, *Extended Load Line Limit and ARTS Improvement Program Analysis for Cooper Nuclear Station, Cycle 14.*

9. NEDC 98-024, Revision 1, July 1998, *APRM - RBM Setpoint Calculation.*

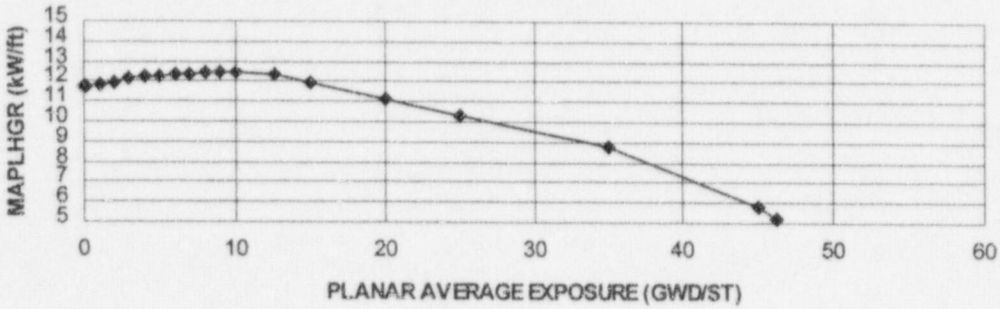
10. NEDO-31960-A and NEDO-31960-A Supplement 1, *BWR Owner's Group Long-Term Stability Solutions Licensing Methodology.* (The approved revision at the time the reload analysis is performed.)

11. NEDE-23785-1-P-A, *The GESTR-LOCA and SAFER Models for the Evaluation of the Loss-of-Coolant Accident,* Volume III, Revision 1, October 1984.

12. *Nuclear Design Report for Cooper Nuclear Station Reload, 18,* J11-03354-03, July 1998.

Figure 1

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Exposure with LPCI Modification and Bypass Holes Plugged, 3.50 w/o with 10GZ GE8x8NB Fuel

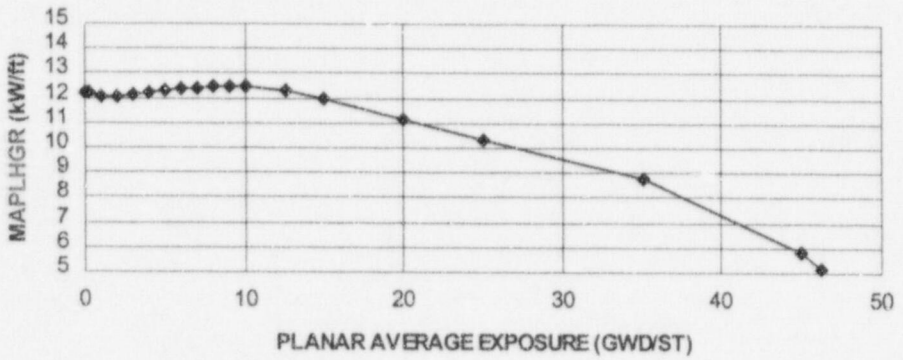


DATA COORDINATES (Reference 3)

Planar Average Exposure (GWD/ST)	MAPLHGR (kW/ft)
0.0	11.70
0.2	11.72
1.0	11.82
2.0	11.97
3.0	12.13
4.0	12.21
5.0	12.28
6.0	12.34
7.0	12.39
8.0	12.43
9.0	12.46
10.0	12.49
12.5	12.31
15.0	11.93
20.0	11.13
25.0	10.33
35.0	8.77
45.0	5.80
46.26	5.16

Figure 2

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Exposure with LPCI Modification and Bypass Holes Plugged, 3.50 w/o with 10GZ1 GE8x8NB Fuel

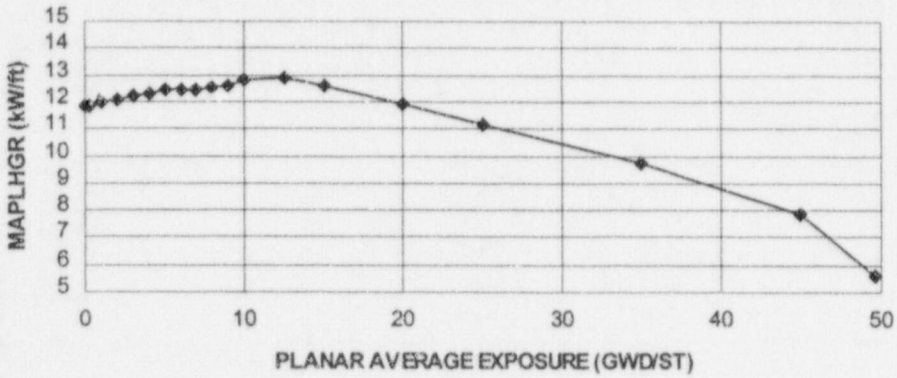


DATA COORDINATES (Reference 3)

Planar Average Exposure (GWD/ST)	MAPLHGR (kW/ft)
0.0	12.25
0.2	12.21
1.0	12.09
2.0	12.08
3.0	12.14
4.0	12.21
5.0	12.28
6.0	12.34
7.0	12.39
8.0	12.43
9.0	12.46
10.0	12.49
12.5	12.31
15.0	11.93
20.0	11.13
25.0	10.33
35.0	8.77
45.0	5.80
46.26	5.16

Figure 3

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Exposure with LPCI Modification and Bypass Holes Plugged, 3.48 w/o with 11GZ GE8x8NB Fuel

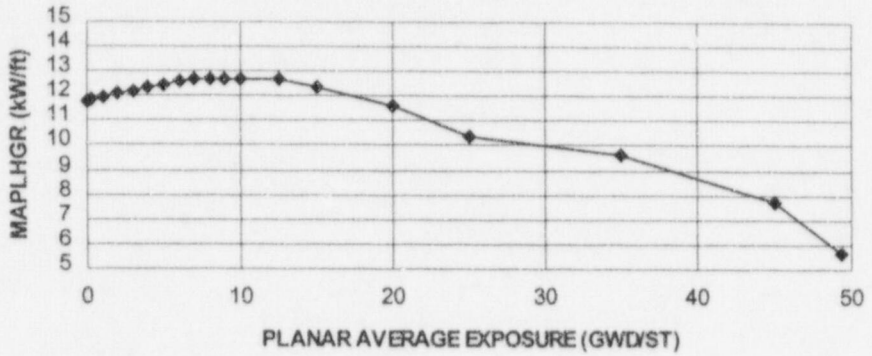


DATA COORDINATES (Reference 3)

Planar Average Exposure (GWD/ST)	MAPLHGR (kW/ft)
0.0	11.82
0.2	11.87
1.0	11.96
2.0	12.08
3.0	12.19
4.0	12.30
5.0	12.41
6.0	12.48
7.0	12.46
8.0	12.50
9.0	12.63
10.0	12.80
12.5	12.93
15.0	12.60
20.0	11.91
25.0	11.17
35.0	9.70
45.0	7.86
49.56	5.62

Figure 4

Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) versus Exposure with LPCI Modification and Bypass Holes Plugged, 3.48 w/o with 12GZ GE8x8NB Fuel



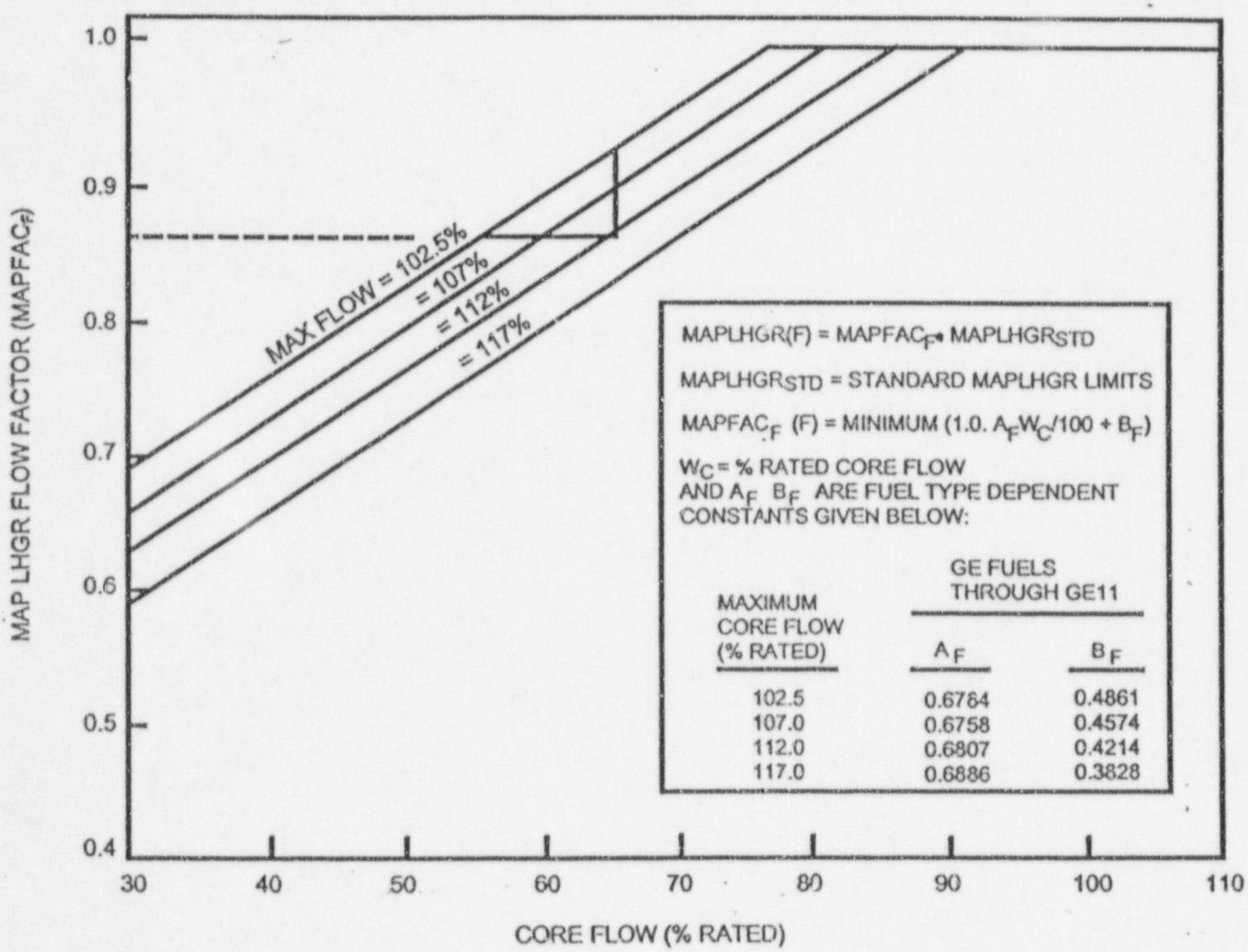
DATA COORDINATES (Reference 3)

Planar Average Exposure (GWD/ST)	MAPLHGR (kW/ft)
0.0	11.78
0.2	11.85
1.0	11.96
2.0	12.12
3.0	12.23
4.0	12.35
5.0	12.47
6.0	12.60
7.0	12.72
8.0	12.69
9.0	12.67
10.0	12.70
12.5	12.70
15.0	12.35
20.0	11.60
25.0	10.89
35.0	9.61
45.0	7.76
49.29	5.68

Figure 5

Flow Dependent MAPLHGR Factor
($MAPFAC_F$)

(Reference 8, Section 5.4.4, Figure 5-9)



MAXIMUM CORE FLOW (% RATED)	GE FUELS THROUGH GE11	
	A_F	B_F
102.5	0.6764	0.4861
107.0	0.6758	0.4574
112.0	0.6807	0.4214
117.0	0.6886	0.3828

Figure 6

Power Dependent MAPLHGR Factor
($MAPFAC_P$)

(Reference 8, Section 5.4.2, Figure 5-7)

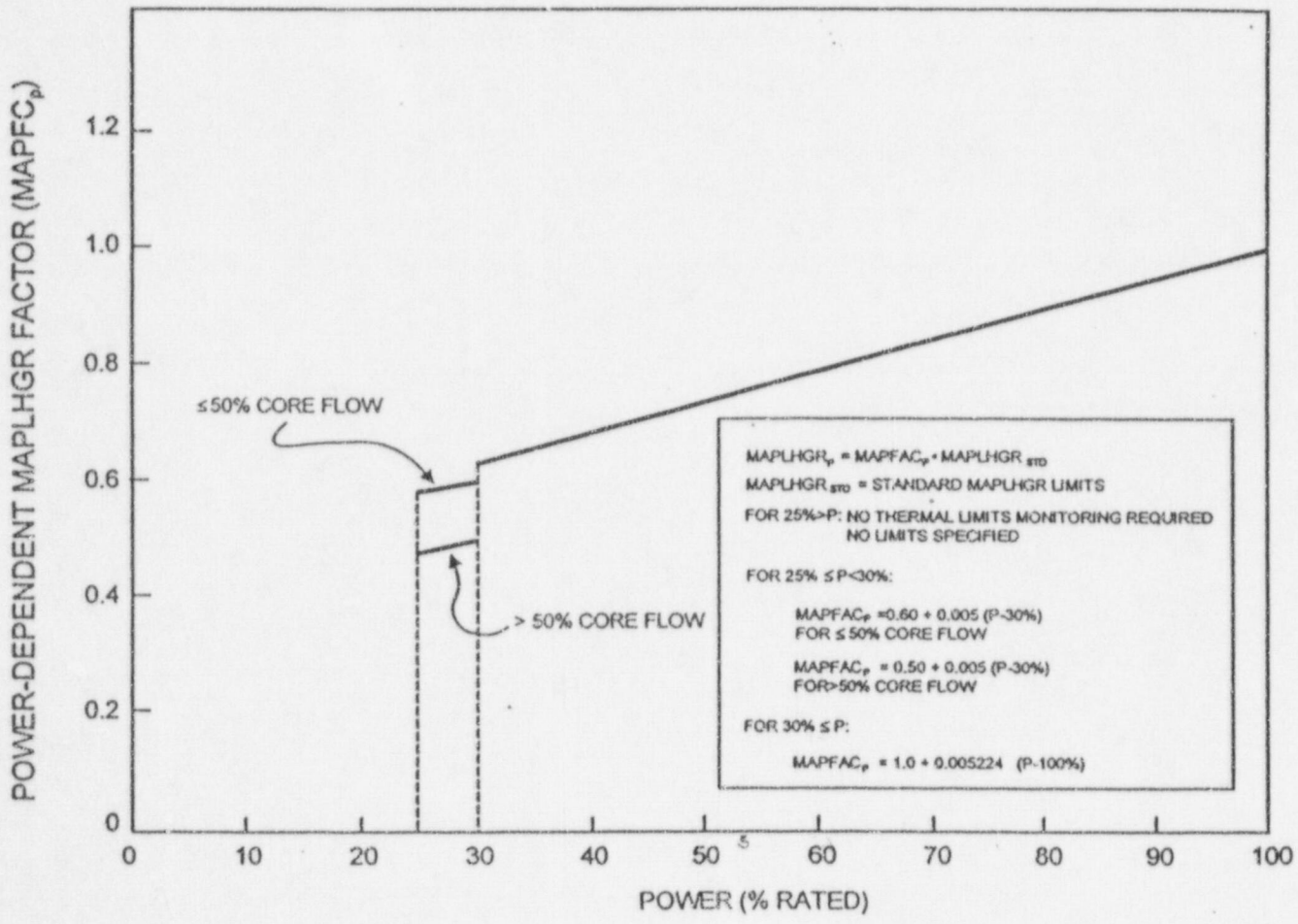


Figure 7

Power Dependent MCPR Limits
($MCPR_P$ and K_P)

(Reference 8, Section 5.4.1, Figure 5-6)

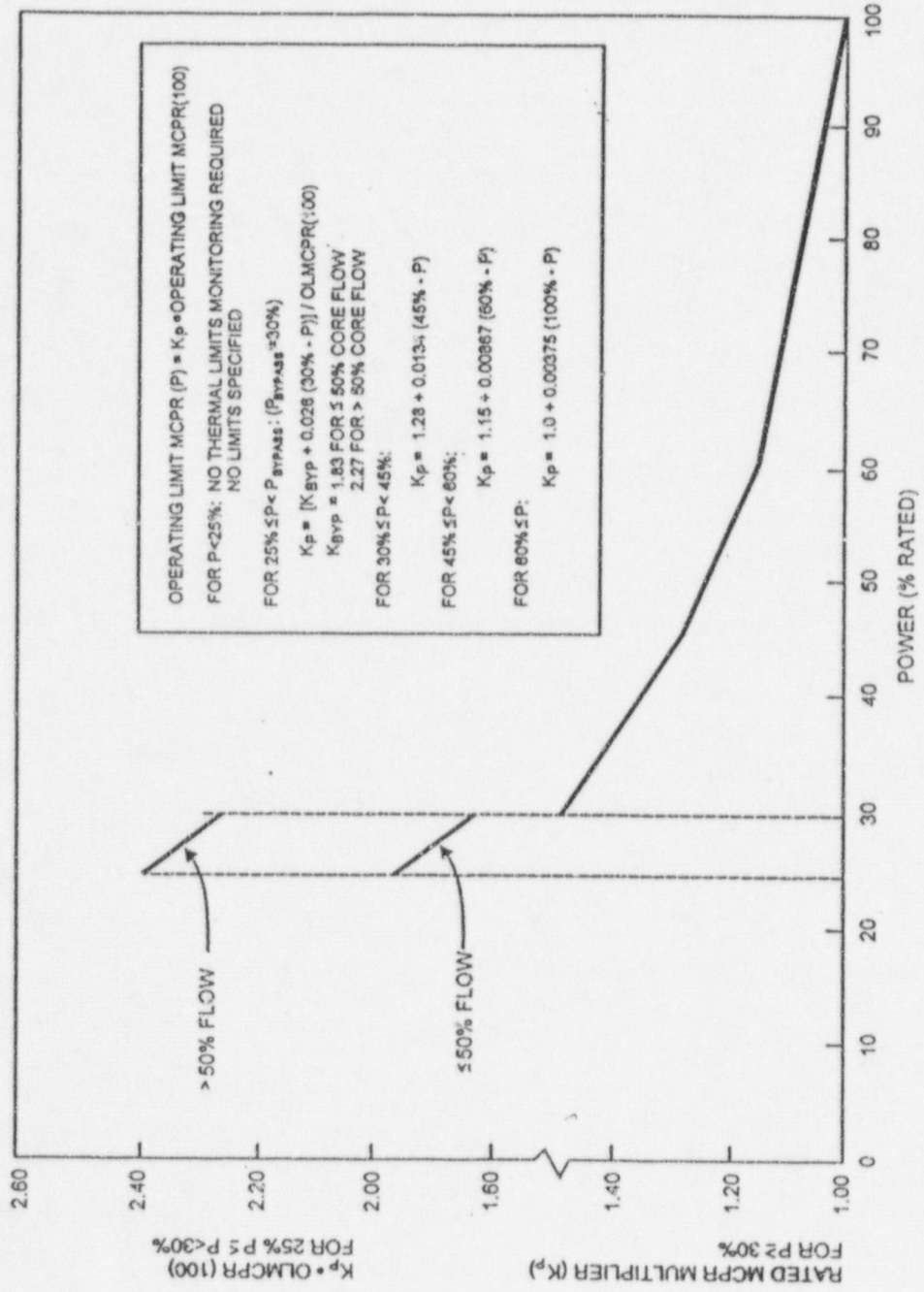


Figure 8

Flow Dependent MCPR Limits
($MCPR_F$)

(Reference 8, Section 5.4.3, Figure 5-8)

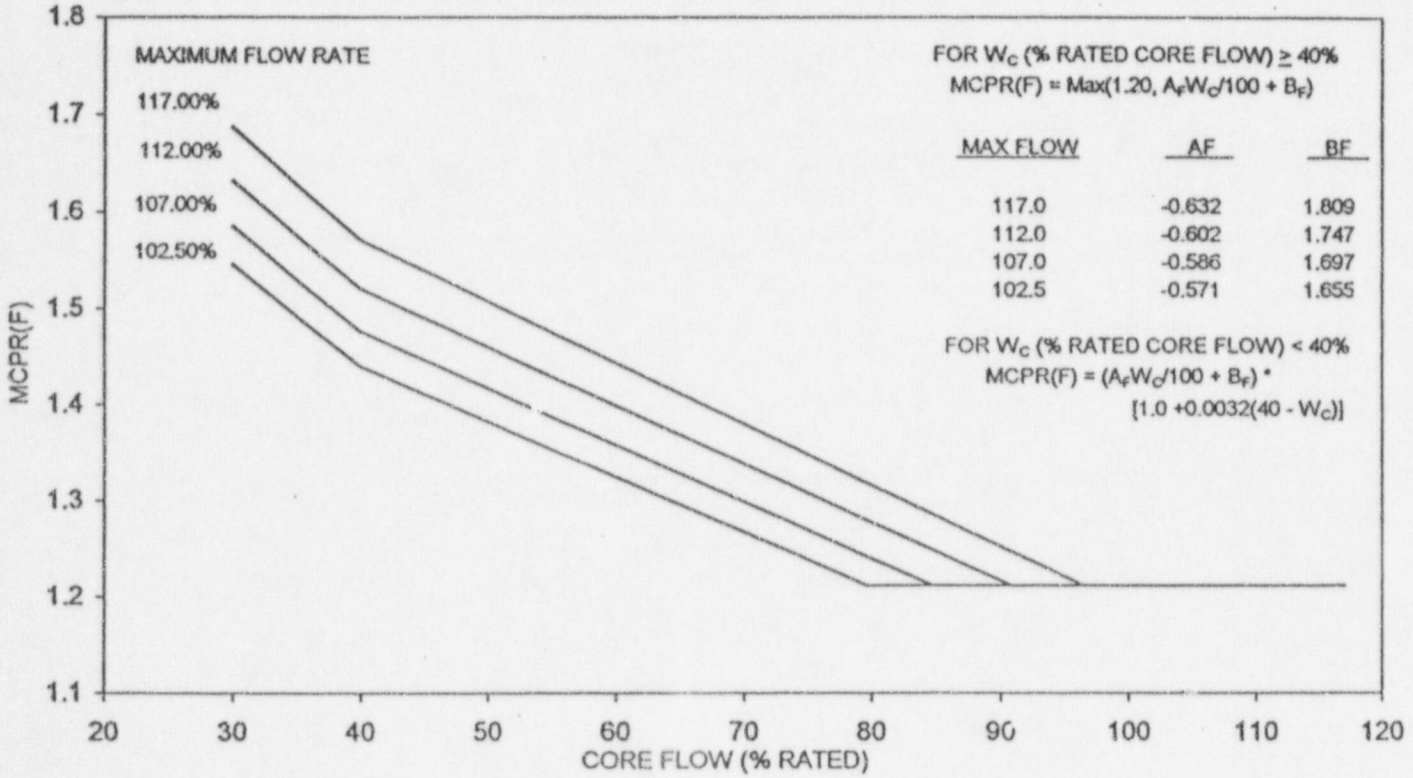
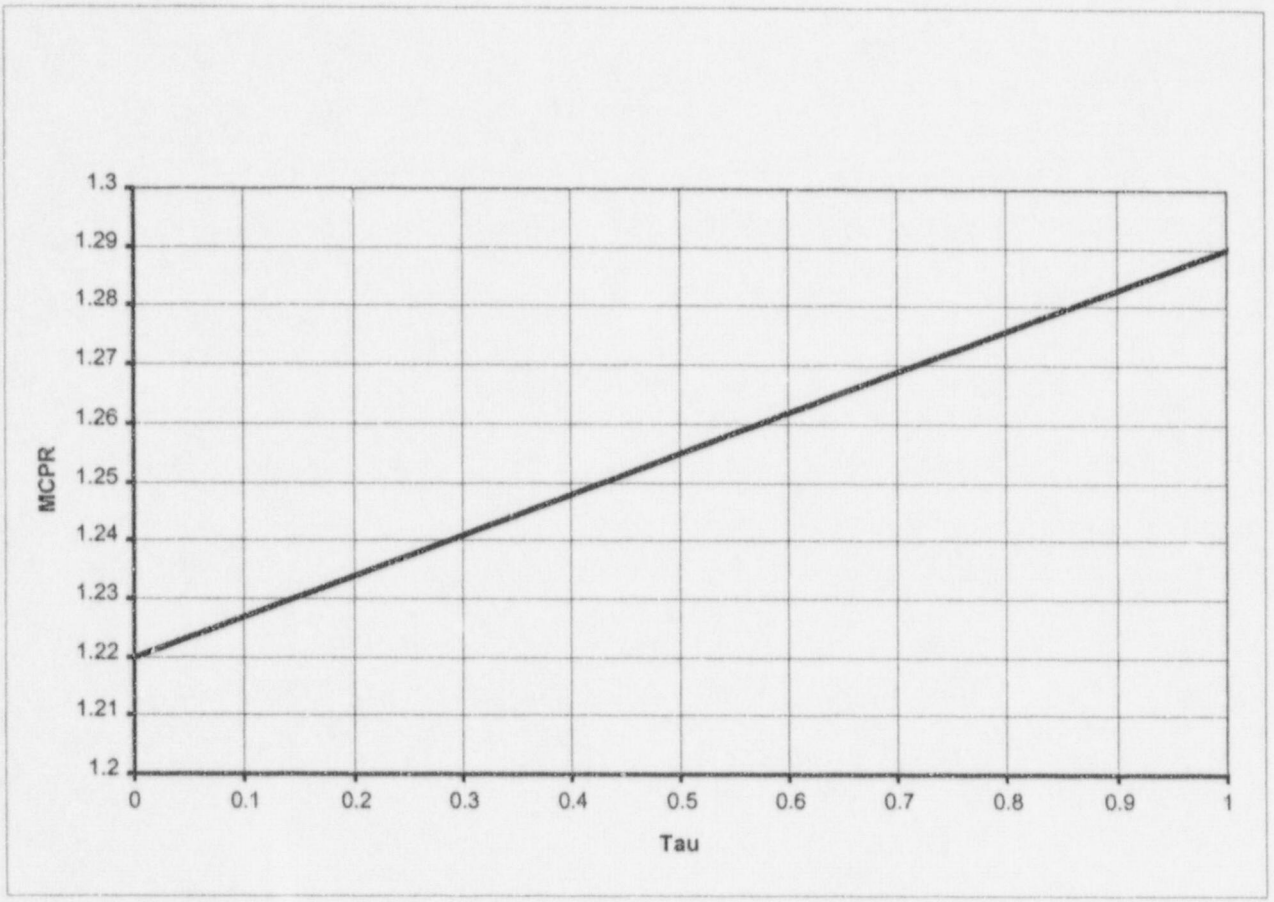


Figure 9

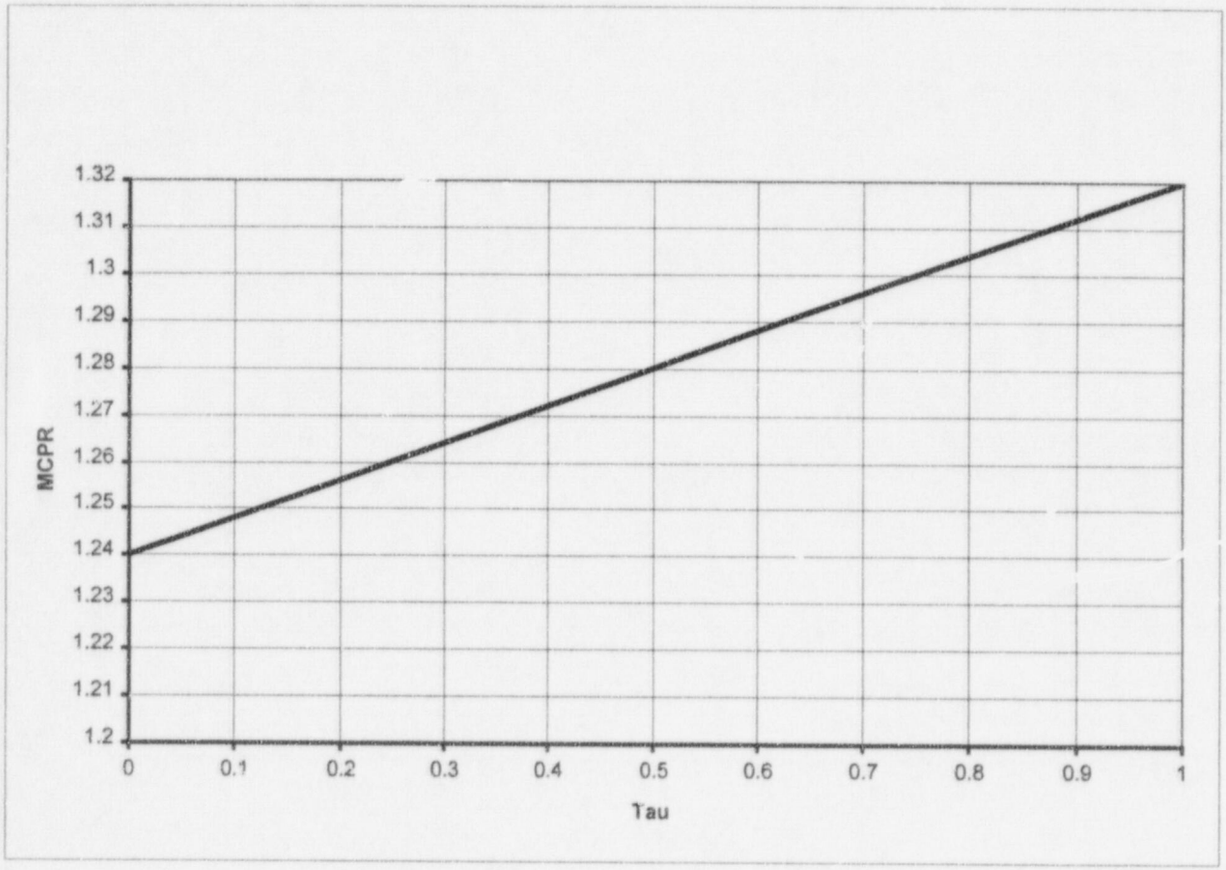
Minimum Critical Power Ratio (MCPR) versus Tau (based on tested measured scram time as defined in Reference 4), GE 8x8 NB fuel



Exposure range: BOC19 to EHFP19 - 2205 MWd/MT

Figure 10

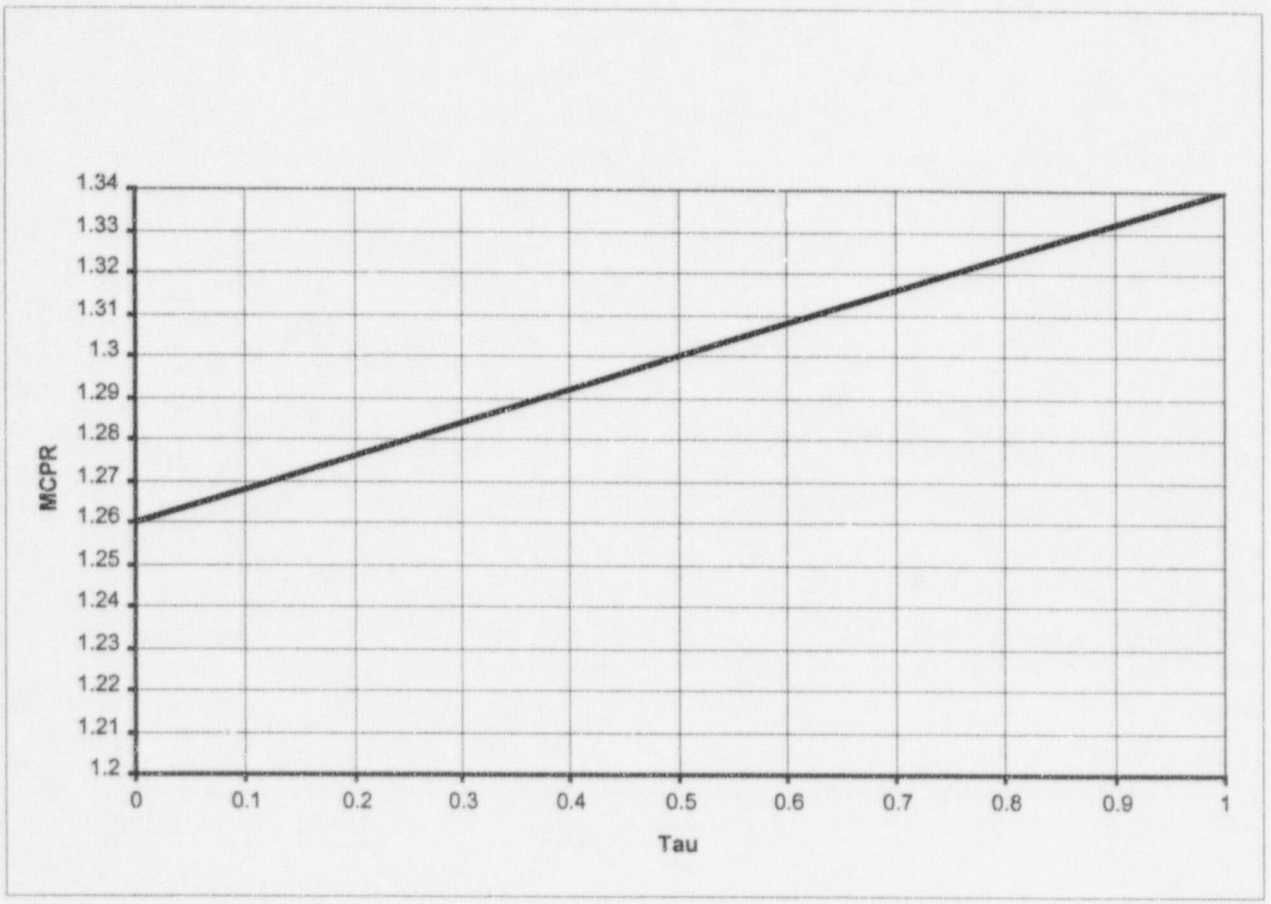
Minimum Critical Power Ratio (MCPR) versus Tau (based on tested measured scram time as defined in Reference 4), GE 8x8 NB Fuel



Exposure range: EHFP19 - 2205 MWd/MT to EOC19

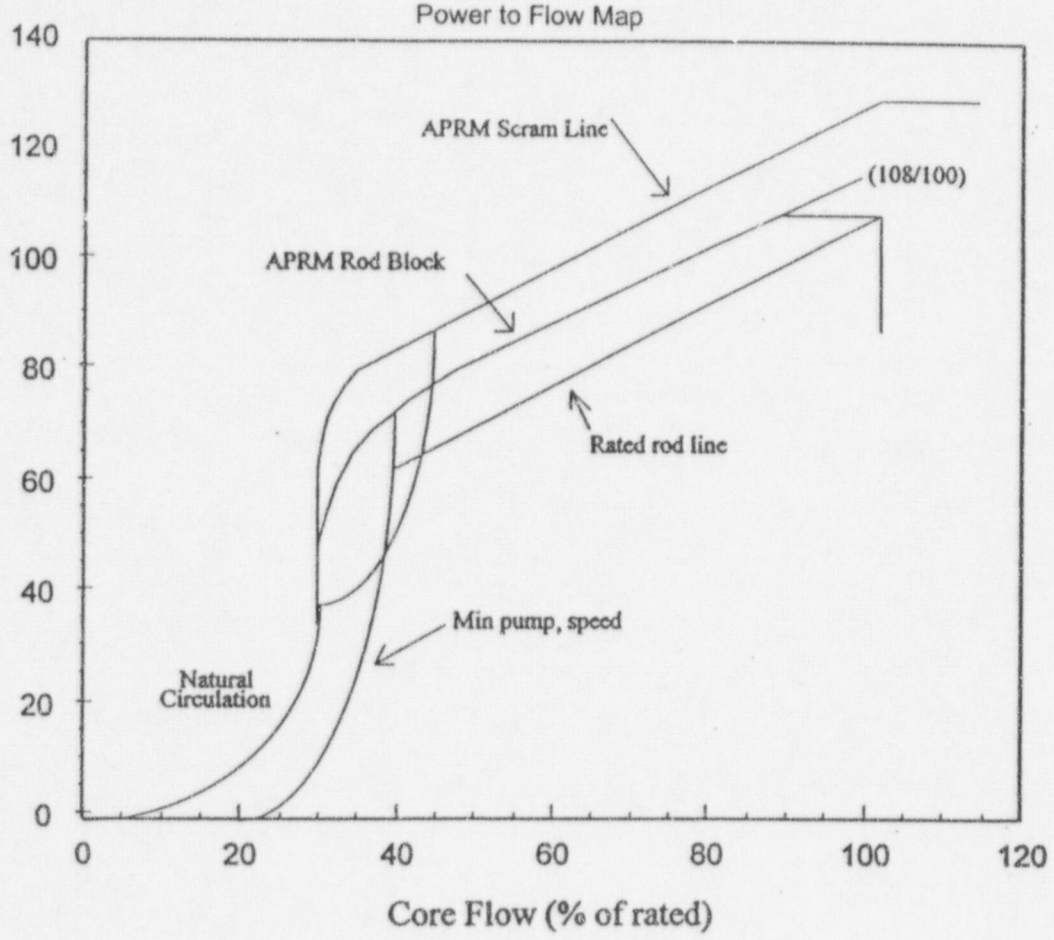
Figure 11

Minimum Critical Power Ratio (MCPR) versus Tau with One Turbine Bypass Valve Unavailable (based on tested measured scram time as defined in Reference 4), GE 8x8 NB Fuel



Exposure range: BOC19 to EOC19

Figure 12
Power to Flow Map



$$P = P_B\left(\frac{P_A}{P_B}\right)^{\frac{1}{2}\left[\frac{W-W_B}{W_A-W_B}+\left(\frac{W-W_B}{W_A-W_B}\right)^2\right]}$$

where,

P = a core thermal power value on the Exclusion Region boundary (% of rated),

W = the core flow rate corresponding to power, P, on the Exclusion Region boundary (% of rated),

P_A = core thermal power at State Point A (% of rated),

P_B = core thermal power at State Point B (% of rated),

W_A = core flow rate at State Point A (% of rated),

W_B = core flow rate at State Point B (% of rated),

Coordinates of Exclusion Region Boundary

Point #	Power (%)	Flow (%)
A	75.4	43.8
B	36.3	30.0