CORE OPERATING LIMITS REPORT

FOR

LIMERICK GENERATING STATION UNIT 1

RELOAD 5, CYCLE 6

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INTRODUCTION AND SUMMARY

This report provides the cycle-specific parameter limits for: Maximum Average Planar Linear Heat Generation Rate (MAPLHGR); Minimum Critical Power Ratio (MCPR); ARTS MCPR thermal limit adjustments and multipliers; ARTS MAPLHGR thermal limit multipliers; Rod Block Monitor (RBM) setpoints; MAPLHGR single loop operation (SLO) reduction factor; Linear Heat Generation Rate (LHGR); Turbine Bypass Valve parameters; Recirculation Pump Motor Generator (MG) Set Scoop Tube Stops; and Reactor Coolant System Recirculation Flow Upscale Trips for Limerick Generating Station Unit 1, Cycle 6. These values have been determined using NRC-approved methodology and are established such that all applicable limits of the plant safety analysis are met.

This report is submitted in accordance with Technical Specification 6.9.1.9 of Reference 1. Preparation of this report was performed in accordance with PECO Energy Fuel and Services Division Procedure FM-300.

This report contains all thermal limit parameters related to the implementation of the Maximum Extended Load Line Limit and ARTS Improvement Program analyses (ARTS/MELLLA) for Limerick-1 Cycle 6. This is the first application of ARTS/MELLLA at Limerick Generating Station.

Revision 4 of the Limerick-1 Cycle 6 COLR contains revised Recirculation Pump Motor-Generator (MG) Set Scoop Tube Stops and the corresponding MCPR(F) and MAPFAC(F) ARTS thermal limits adjustments and multipliers. The MG Set Scoop Tube Stops are being reset to allow access to the relatively higher core flow region of the licensed operating domain (up to 110% of rated) in order to improve reactor maneuvering capability. More restrictive values of MCPR(F) and MAPFAC(F) must therefore be used for thermal limits administration to ensure compliance with fuel licensing limits in the event of a recirculation flow increase event.

MAPLHGR LIMITS

The limiting MAPLHGR value for the most limiting lattice (excluding natural uranium) of each fuel type as a function of average planar exposure is given in Figures 1 through 6.

No reduction in MAPLHGR limits is required under ARTS during single loop operation (Table 2).

MCPR LIMITS

The MCPR value for use in Technical Specification 3.2.3 is given in Figures 7 through 10. These tables are valid for all Cycle 6 fuel types. Information regarding the validity of these MCPR limits in various operating domains and for SLO is also provided.

The MCPR values shown in these figures are the bounding values for all points on the power flow map including Maximum Extended Load Line Limit (MELLL) down to 75% of rated core flow during full power operation, Increased Core Flow (ICF) up to 110% of rated core flow, Rated Core Flow (RCF, the area between the MELLL and ICF operating domains), Feedwater Temperature Reduction (FWTR) up to 105°F at end of cycle, Feedwater Heater Out of Service (FWHOOS) up to 60°F feedwater temperature reduction during the cycle, and Power Coastdown operation.

Bounding MCPR values are also provided for inoperable Recirculation Pump Trip (RPTOOS) or inoperable Steam Bypass System (TBVOOS). These two options represent the Equipment Out Of Service (EOOS) conditions.

Note in these figures the term "EOC" refers to the cycle exposure at which operation at "rated conditions" is no longer possible (i.e., the cycle exposure at which cycle extension begins) which was assumed during the cycle specific reload licensing (Reference 2).

ARTS THERMAL LIMIT ADMINISTRATION

ARTS provides for power- and flow-dependent thermal limit adjustments and multipliers which allow for a more reliable administration of the MCPR and MAPLHGR thermal limits. The flow-dependent multiplier MAPFAC(F) and flow-dependent adjustment MCPR(F) are sufficiently generic to apply to all fuel types and operating domains. There are two sets of power-dependent MAPLHGR multipliers for with- and without-EOOS conditions. There are two sets of power-dependent MCPR adjustments and multipliers for with- and without-EOOS conditions.

These adjustments and multipliers are shown in Figures 11

through 16.

ROD BLOCK MONITOR SETPOINTS

The ARTS RBM provides for power-dependent RBM trips to replace the previous flow-dependent trips. The trip setpoints and applicable RBM signal filter time constant data are shown in Table 1.

LINEAR HEAT GENERATION RATES

The LHGR value for each fuel type for use in Technical Specification 3.2.4 is given in Table 3.

STEAM BYPASS SYSTEM OPERABILITY

The operability requirements for the steam bypass system for use in Technical Specifications 3.7.8 and 4.7.8.C are found in Table 4. If these requirements cannot be met, the thermal limit multipliers and MCPR limits for Turbine Bypass Valve Out of Service (TBVOOS) must be used.

RECIRCULATION PUMP MOTOR-GENERATOR (MG) SET STOPS

The electrical and mechanical stops are set to limit the reactor core coolant flow rate during an event in which the recirculation flow rate increases to its maximum value. Technical Specification Surveillance Requirement number 4.4.1.1.2 requires that each pump MG set scoop tube mechanical and electrical stop shall be demonstrated OPERABLE, with overspeed setpoints less than or equal to specified values, at least once per 24 months. These values are cycle specific and can be found in Table 5 of this COLR.

CONTROL ROD BLOCK INSTRUMENTATION
REACTOR COOLANT SYSTEM RECIRCULATION FLOW UPSCALE TRIP

Technical Specification Limiting Condition for Operation number 3.3.6 requires control rod block instrumentation channels shall be OPERABLE with their trip setpoints consistent with the values shown in the Trip Setpoint column of Technical Specification Table 3.3.6-2. The Reactor Coolant System Recirculation Flow Upscale Trip is a cycle specific value and as such is found in Table 6 of this COLR. Table 6 lists the Trip Setpoint and Allowable Value.

REFERENCES

1) "Technical Specifications and Bases for Limerick Generating Station Unit 1", Docket No. 50-352, License No. NPF-39.

2) "Supplemental Reload Licensing Report for Limerick Generating Station Unit 1, Reload 5, Cycle 6", General Electric Company Document No. 23A7232, Rev. 0, January, 1994.

3) "Basis of MAPLHGR Technical Specifications for Limerick Unit 1", NEDE-31401-P, February 1987, as amended.

4) "Lattice-Dependent MAPLHGR Report for Limerick Generating Station Unit 1 Reload 5 Cycle 6", General Electric Company Document No. 23A7232AA, Rev. 1, July 1995.

5) "Maximum Extended Load Line Limit and ARTS Improvement Program Analyses for Limerick Generating Station Units 1 and 2", General Electric Company Document NEDC-32193P, Rev. 2, October, 1993.

6) "Limerick Generating Station Units 1 and 2 SAFER/GESTR-LOCA Loss-of-Coolant Accident Analysis", General Electric Company Document NEDC-32170P, Rev.1, June 1993.

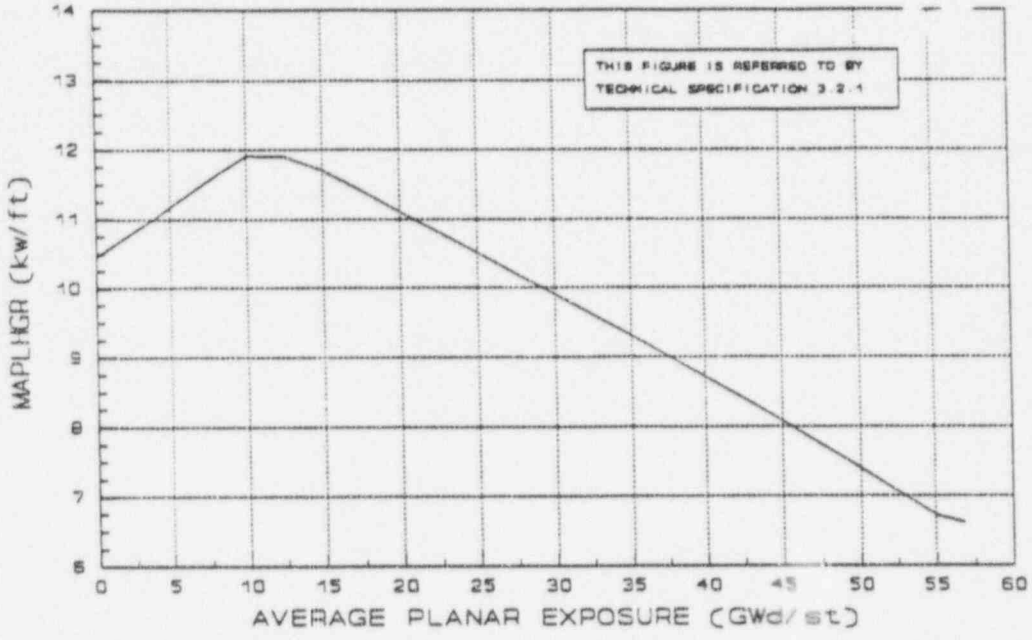
7) Letter, G. V. Kumar to K. M. McGinnis, "Limerick ARTS Application with Equipment Out-of-Service", December 10, 1993.

8) "Power Rerate Condition Setpoint Calculations for the Philadelphia Electric Company Limerick Generating Station Units 1 and 2", General Electric Company Document GE-NE-208-20-0993-1, February, 1994.

9) Letter, R. M. Butrovich to H. J. Diamond, "Safety Review of the Limerick-1 Cycle 6 Revised Loading Pattern due to Replacement of a Leaker Fuel Bundle", August 23, 1995.

FIGURE 1

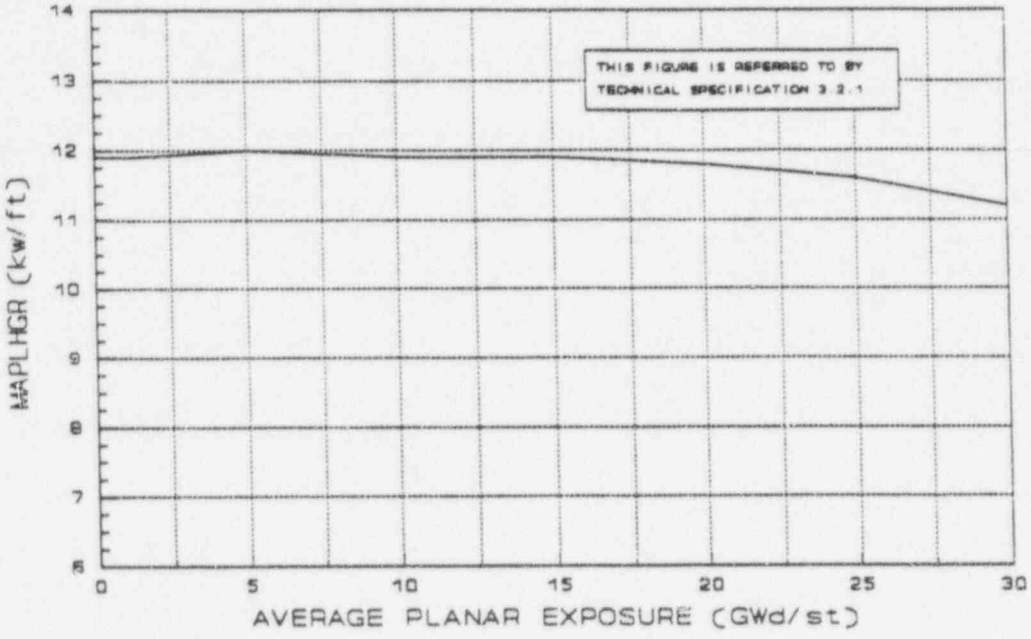
MAXIMUM AVERAGE PLANAR LINEAR HEAT
GENERATION RATE (MAPLHGR) VERSUS
AVERAGE PLANAR EXPOSURE
FUEL TYPE P9CUB384 (GE11)



Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	10.46	12.5	11.90	35.0	9.31
2.0	10.75	15.0	11.71	40.0	8.71
4.0	11.03	17.5	11.41	45.0	8.08
6.0	11.33	20.0	11.10	50.0	7.41
8.0	11.63	25.0	10.50	55.0	6.72
10.0	11.91	30.0	9.91	56.1	6.56

FIGURE 2

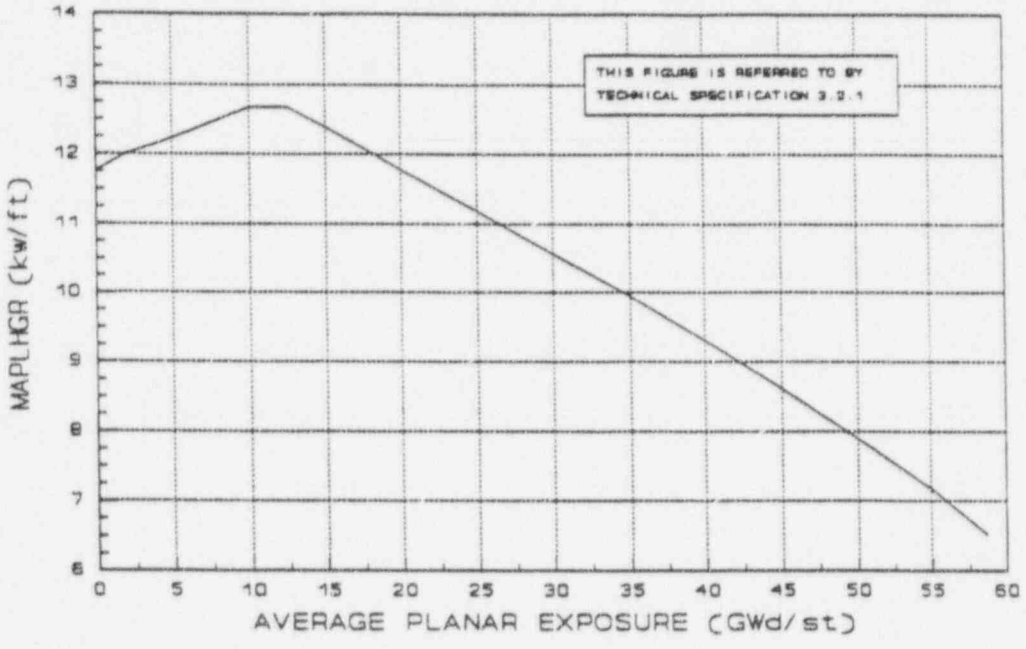
MAXIMUM AVERAGE PLANAR LINEAR HEAT
GENERATION RATE (MAPLHGR) VERSUS
AVERAGE PLANAR EXPOSURE
FUEL TYPE P8CIB219 (GE6)



Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	11.9	5.0	12.0	20.0	11.8
0.2	11.9	10.0	11.9	25.0	11.6
1.0	11.9	15.0	11.9	30.0	11.2

FIGURE 3

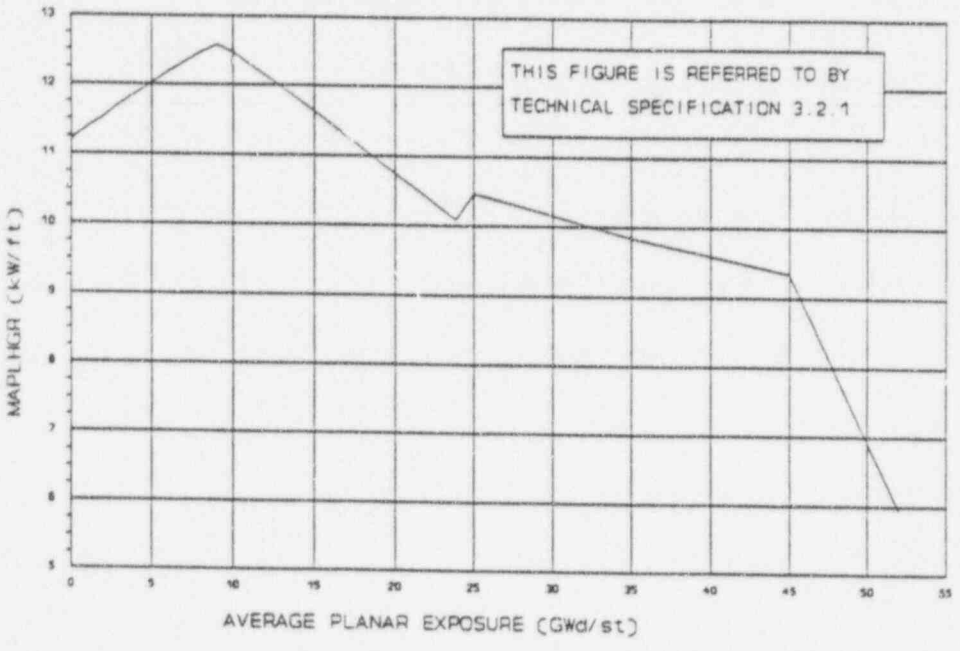
MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE
FUEL TYPE P9CUB331 (GE11)



Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	11.76	12.5	12.67	35.0	9.95
2.0	12.01	15.0	12.39	40.0	9.30
4.0	12.16	17.5	12.08	45.0	8.62
6.0	12.32	20.0	11.77	50.0	7.90
8.0	12.49	25.0	11.17	55.0	7.16
10.0	12.67	30.0	10.57	58.7	6.52

FIGURE 4

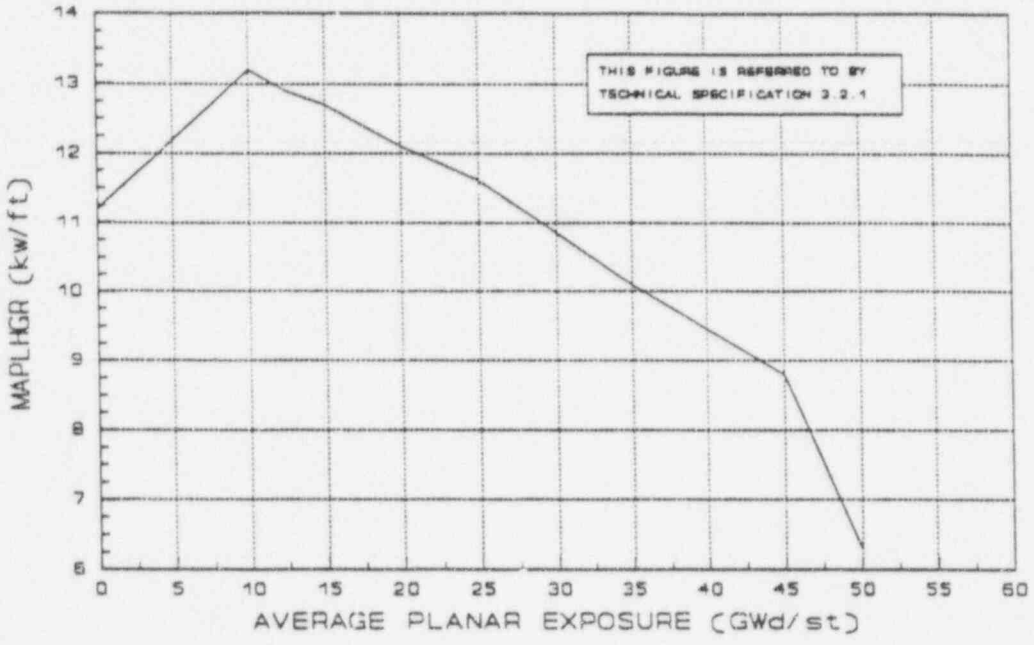
MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FUEL TYPE P8CWB319 (GE9)



Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	11.18	6.0	12.18	20.0	10.75
0.2	11.24	7.0	12.33	23.83	10.08
1.0	11.38	8.0	12.47	24.24	10.21
2.0	11.52	9.0	12.58	25.0	10.47
3.0	11.71	10.0	12.47	35.0	9.84
4.0	11.86	12.5	12.07	45.0	9.34
5.0	12.02	15.0	11.63	52.02	5.94

FIGURE 5

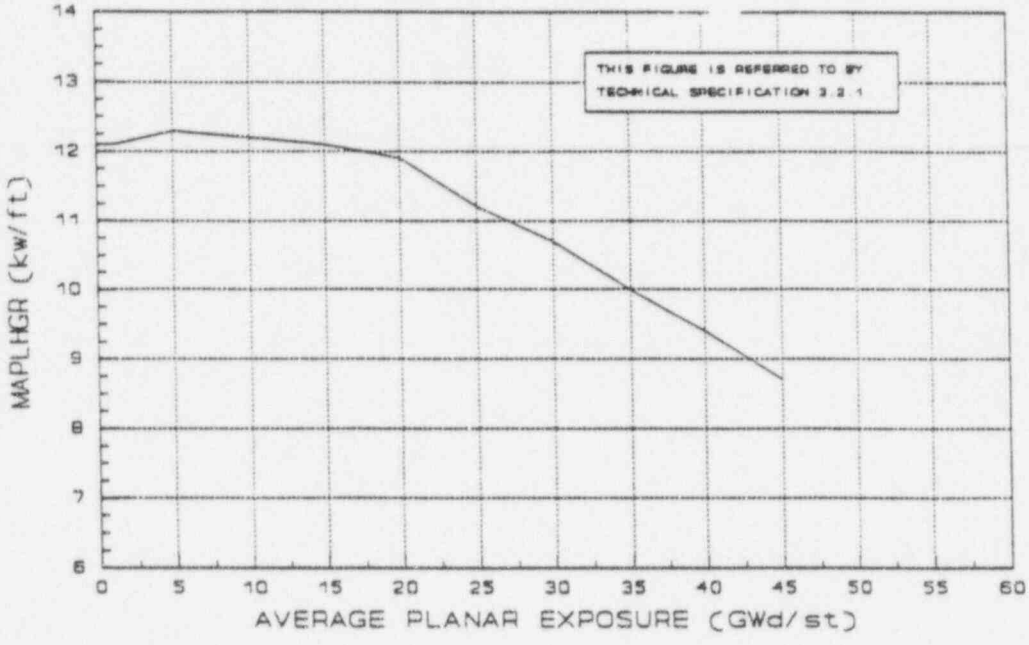
MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FUEL TYPE P8CQB318 (GE8)



Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	11.2	10.0	13.2	25.0	11.6
3.0	11.8	12.5	12.9	35.0	10.1
4.0	12.0	15.0	12.7	45.0	8.8
5.0	12.2	20.0	12.1	50.0	6.3

FIGURE 6

MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FUEL TYPE P8CIB248 (GE7)



Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)	Avg Plan Exposure (GWd/ST)	MAPLHGR (kW/ft)
0.0	12.1	15.0	12.1	35.0	10.0
1.0	12.1	20.0	11.9	40.0	9.4
5.0	12.3	25.0	11.2	45.0	8.7
10.0	12.2	30.0	10.7		

FIGURE 7

MCPR vs. TAU

THIS FIGURE IS VALID FOR ALL CYCLE 6 FUEL TYPES

THIS FIGURE IS VALID FOR THE RCF, MELLL, FWTR, AND FWHOOS OPERATING DOMAINS

This figure is valid for two-loop operation. For single-loop operation, increase any value obtained from the figure by 0.01.

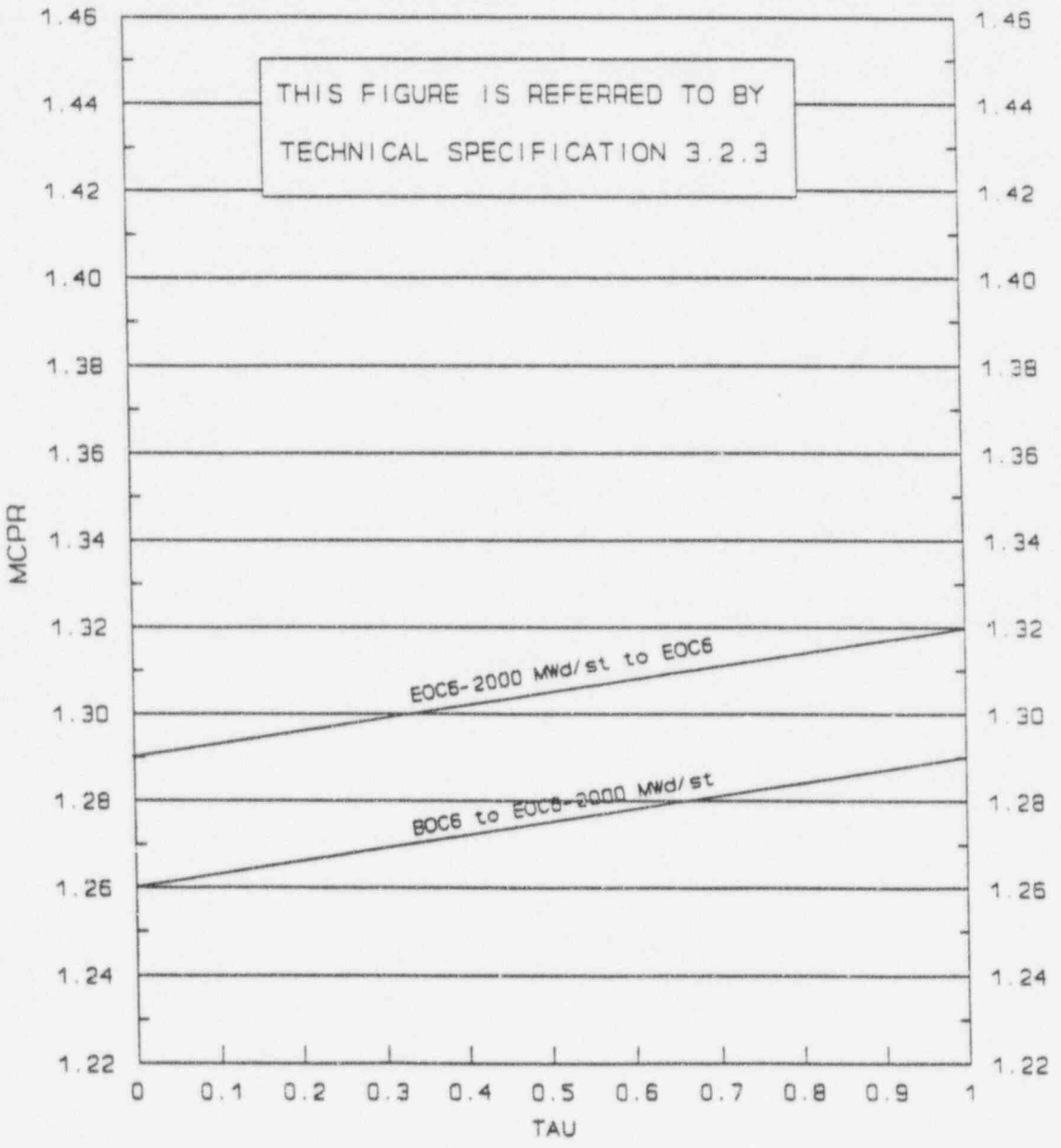


FIGURE 8

MCPR vs. TAU

THIS FIGURE IS VALID FOR ALL CYCLE 6 FUEL TYPES

THIS FIGURE IS VALID FOR THE ICF OPERATING DOMAIN

This figure is valid for two-loop operation. For single-loop operation, increase any value obtained from the figure by 0.01.

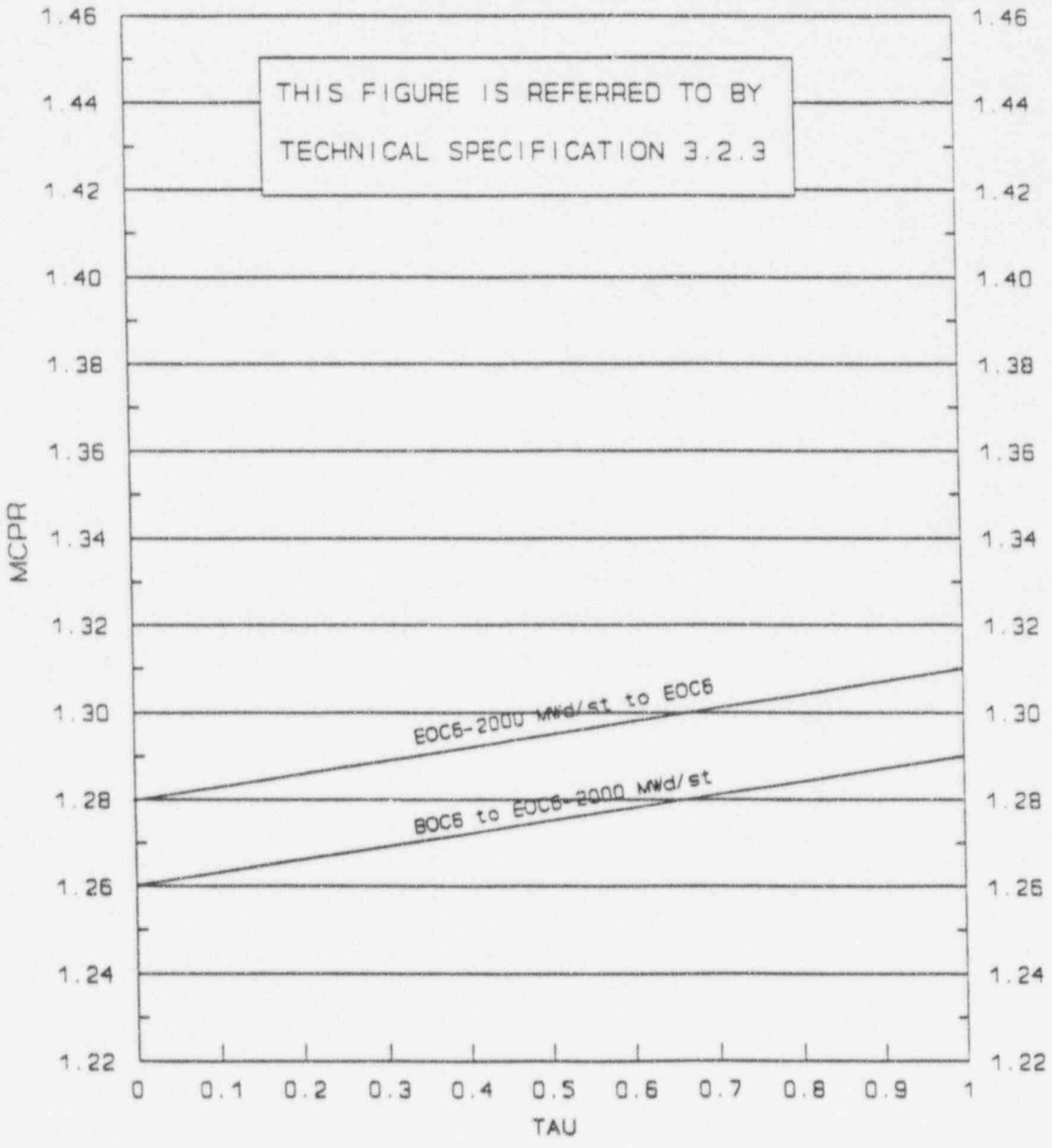


FIGURE 9

MCPR vs. TAU

THIS FIGURE IS VALID FOR ALL CYCLE 6 FUEL TYPES

THIS FIGURE IS VALID FOR THE RPTOOS OPERATING DOMAIN

This figure is valid for two-loop operation For single-loop operation, increase any value obtained from the figure by 0.01.

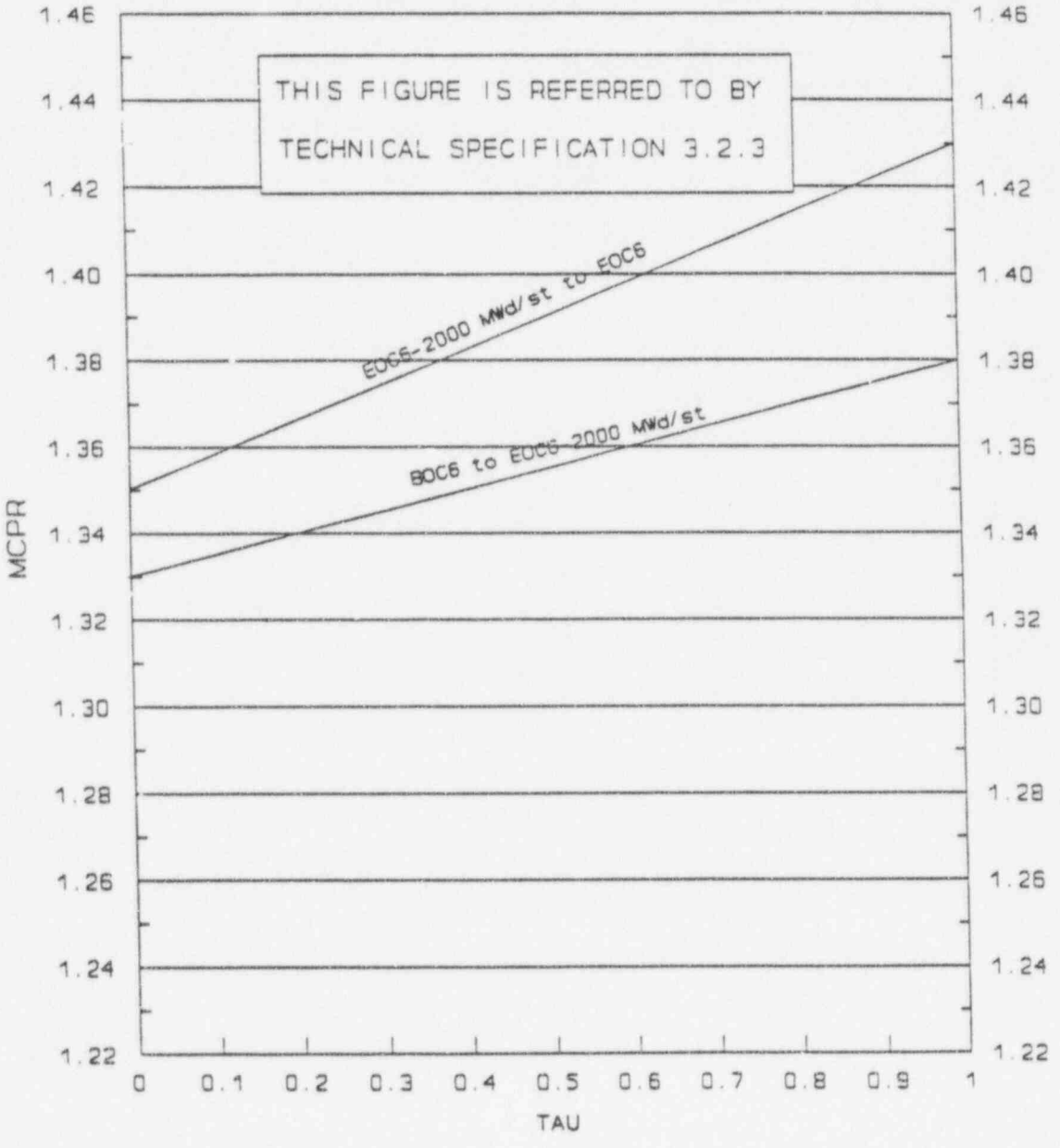


FIGURE 10

MCPR vs. TAU

THIS FIGURE IS VALID FOR ALL CYCLE 6 FUEL TYPES

THIS FIGURE IS VALID FOR THE TBVOOS OPERATING DOMAIN

This figure is valid for two-loop operation. For single-loop operation, increase any value obtained from the figure by 0.01.

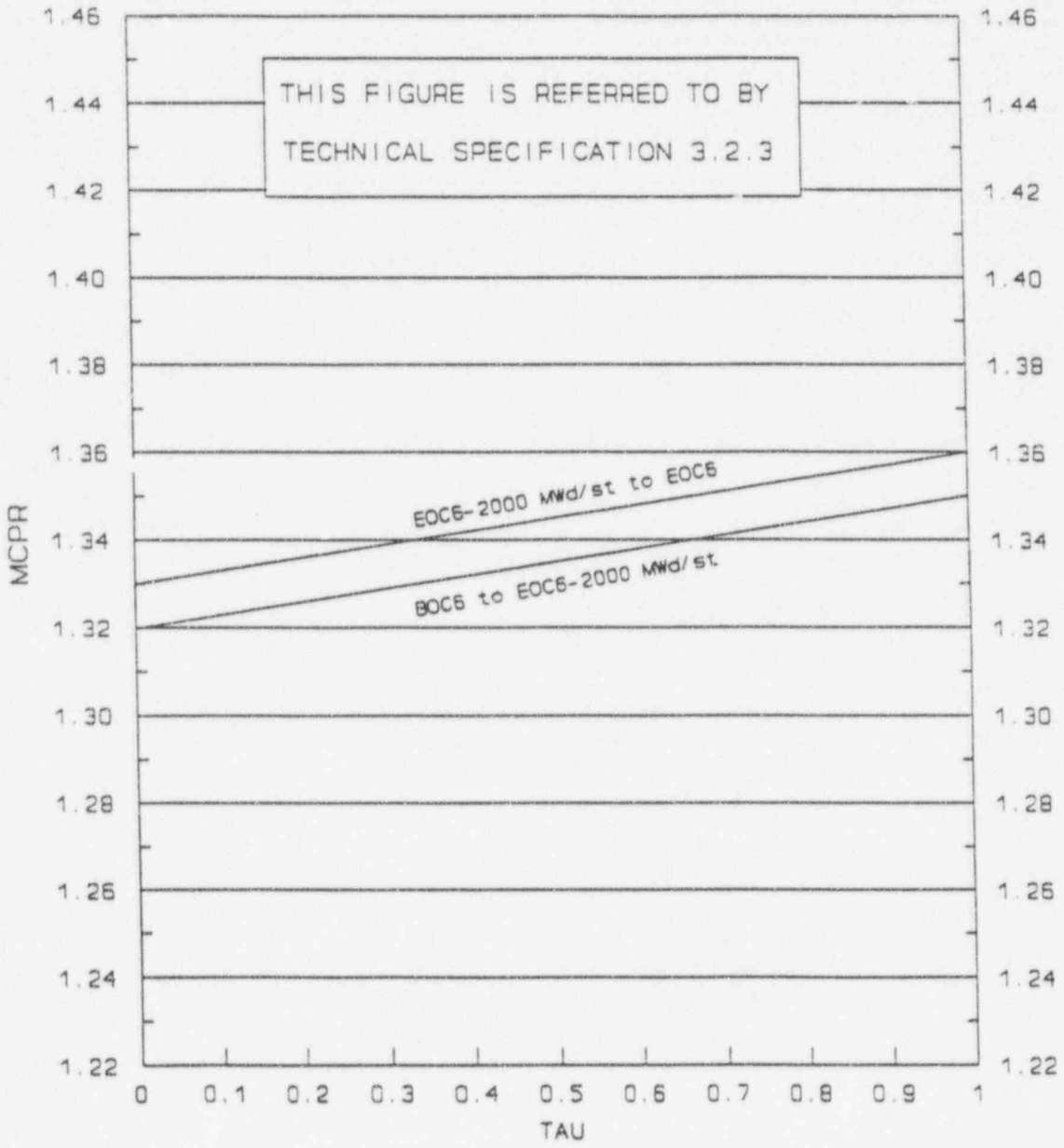


FIGURE 11

POWER DEPENDENT MAPLHGR MULTIPLIER MAPFAC(P)
THIS FIGURE IS REFERRED TO BY TECHNICAL SPECIFICATION 3.2.1
THIS FIGURE IS VALID FOR THE RCF, ICF, MELLL, FWHOOS AND FWTR OPERATING DOMAINS

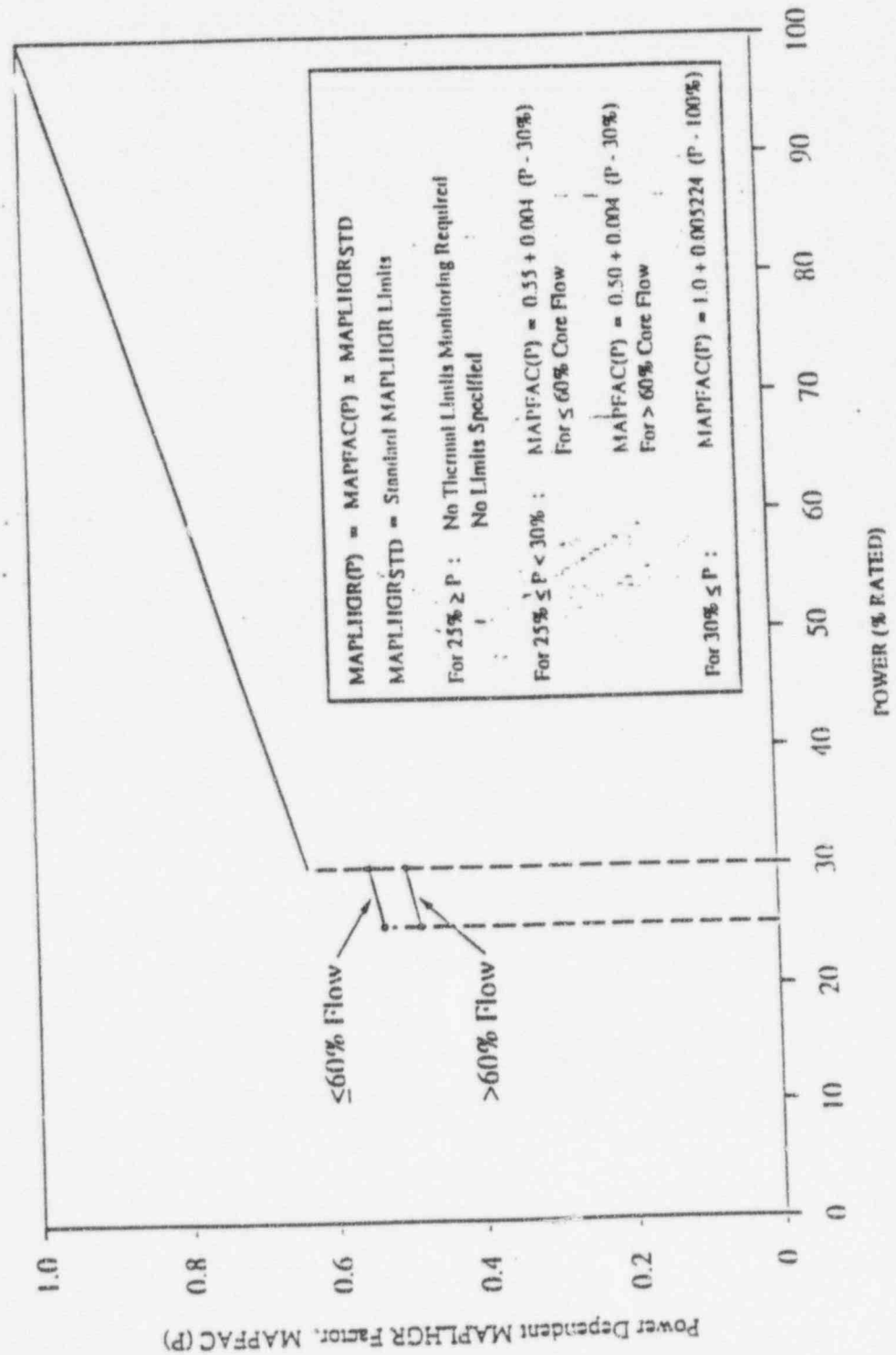


FIGURE 12

POWER DEPENDENT MAPLHGR MULTIPLIER MAPFAC(P)
THIS FIGURE IS REFERRED TO BY TECHNICAL SPECIFICATION 3.2.1
THIS FIGURE IS VALID FOR THE RPTOOS AND/OR TBVOOS
OPERATING DOMAINS

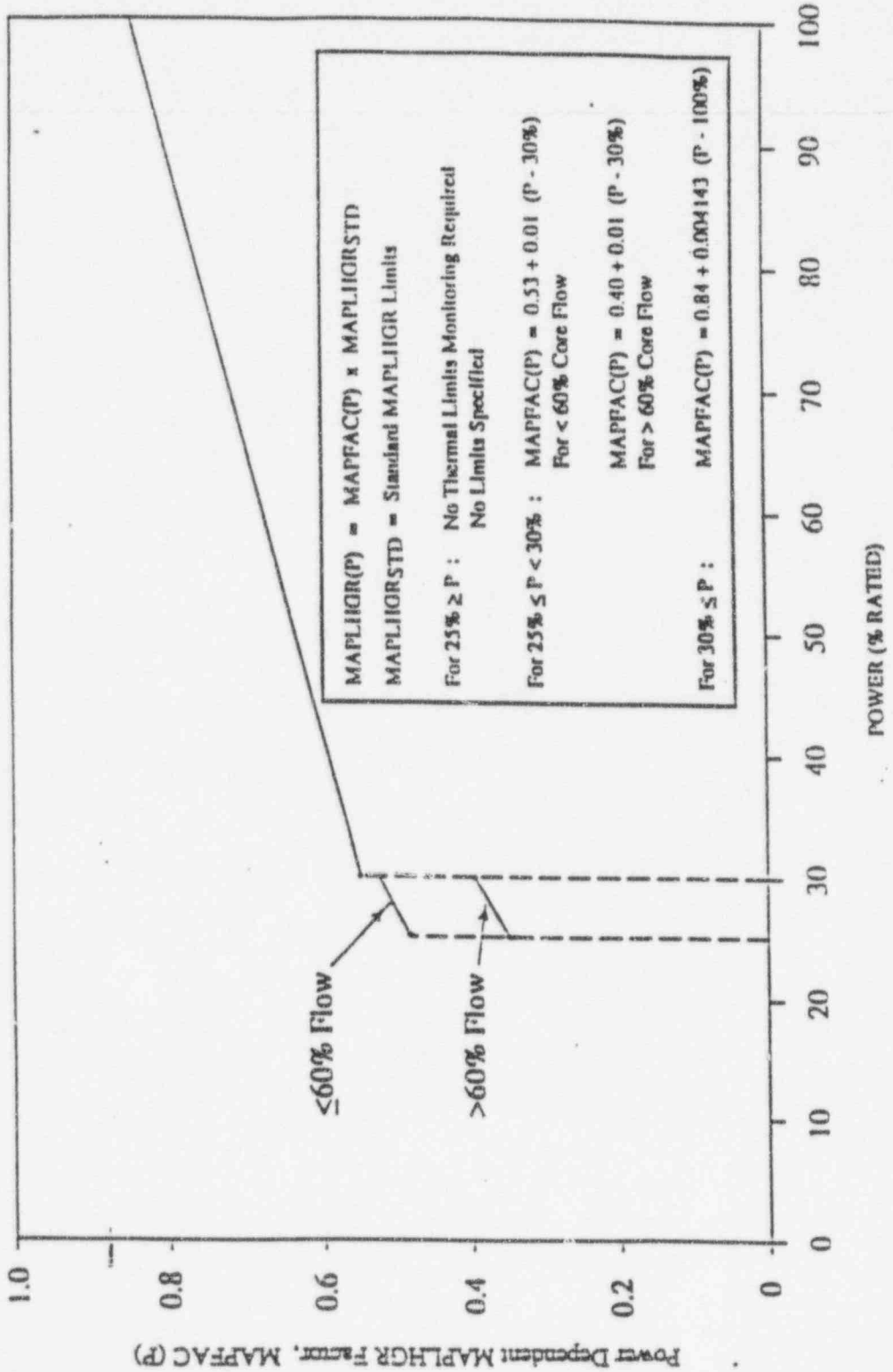


FIGURE 13

FLOW DEPENDENT MAPLHGR MULTIPLIER MAPFAC(F)
THIS FIGURE IS REFERRED TO BY TECHNICAL SPECIFICATION 3.2.1
THIS FIGURE IS VALID FOR ALL OPERATING DOMAINS

THIS FIGURE IS VALID ONLY FOR A MAXIMUM CORE FLOW SETTING OF 114% OF RATED

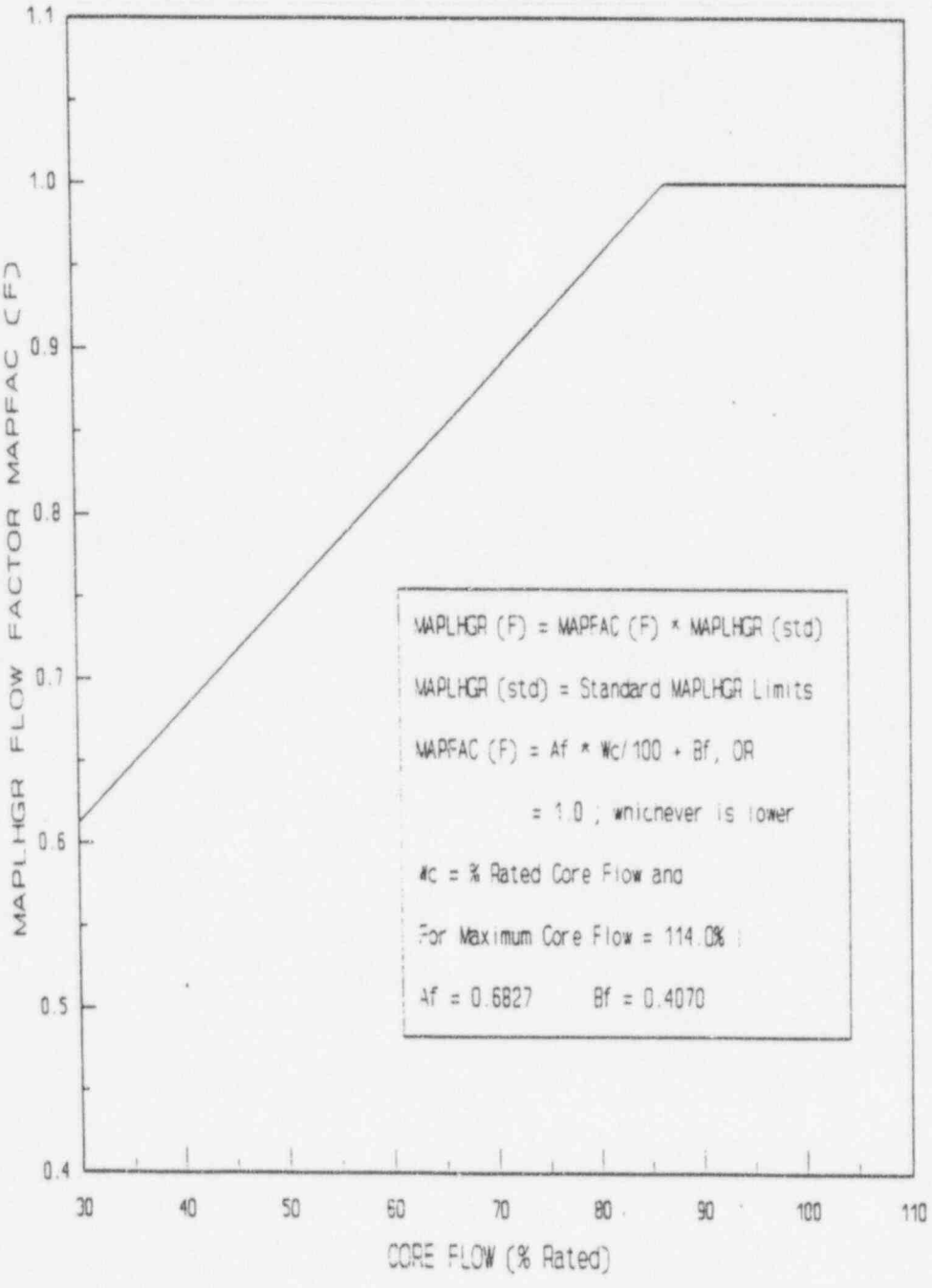


FIGURE 14

POWER DEPENDENT MCPR LIMIT ADJUSTMENTS AND MULTIPLIERS
THIS FIGURE IS REFERRED TO BY TECHNICAL SPECIFICATION 3.2.3
THIS FIGURE IS VALID FOR THE RCF, ICF, MELLL, FWHOOS AND FWTR
OPERATING DOMAINS

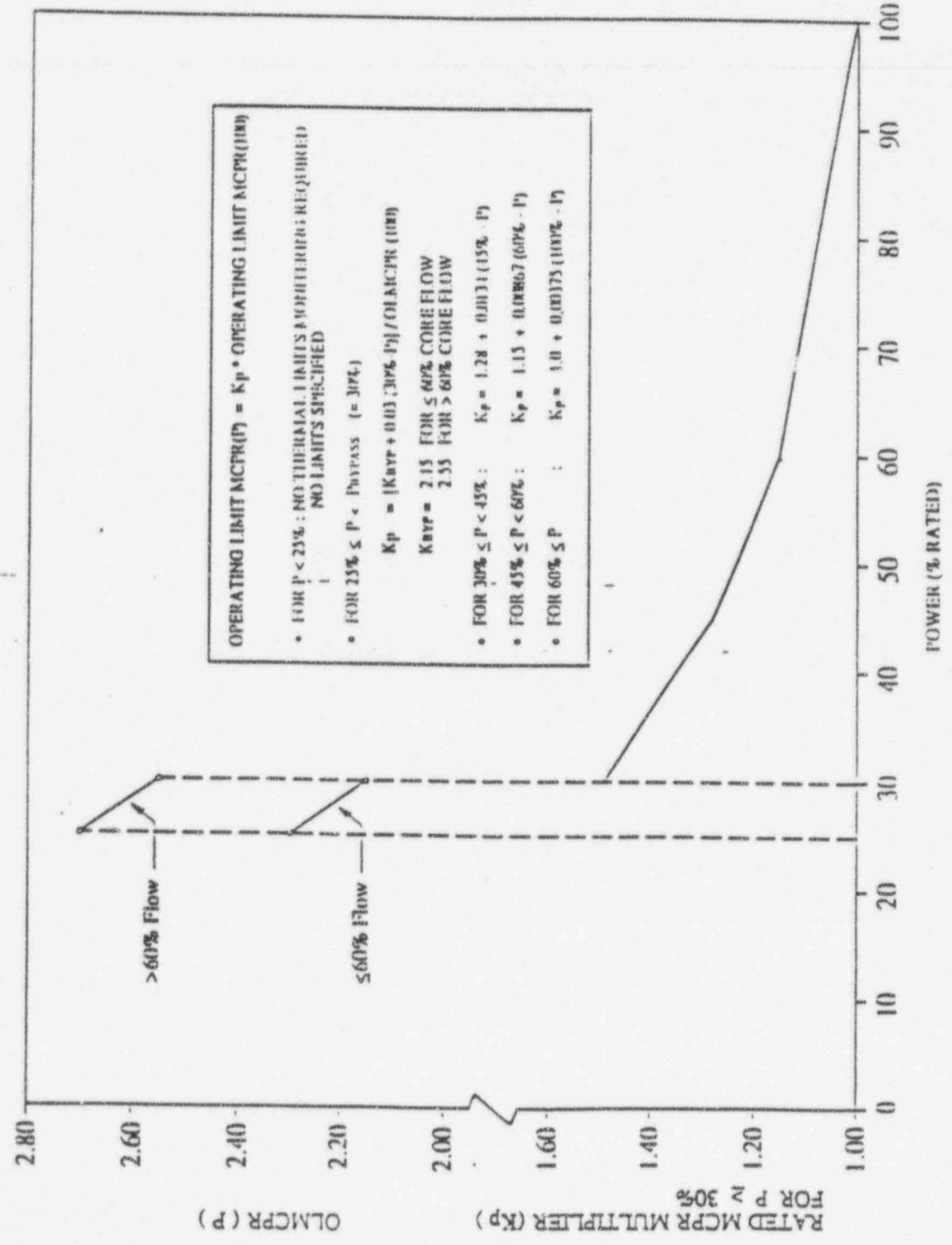


FIGURE 15

POWER DEPENDENT MCPR LIMIT ADJUSTMENTS AND MULTIPLIERS
THIS FIGURE IS REFERRED TO BY TECHNICAL SPECIFICATION 3.2.3
THIS FIGURE IS VALID FOR THE RPTOOS AND/OR TBVOOS
OPERATING DOMAINS

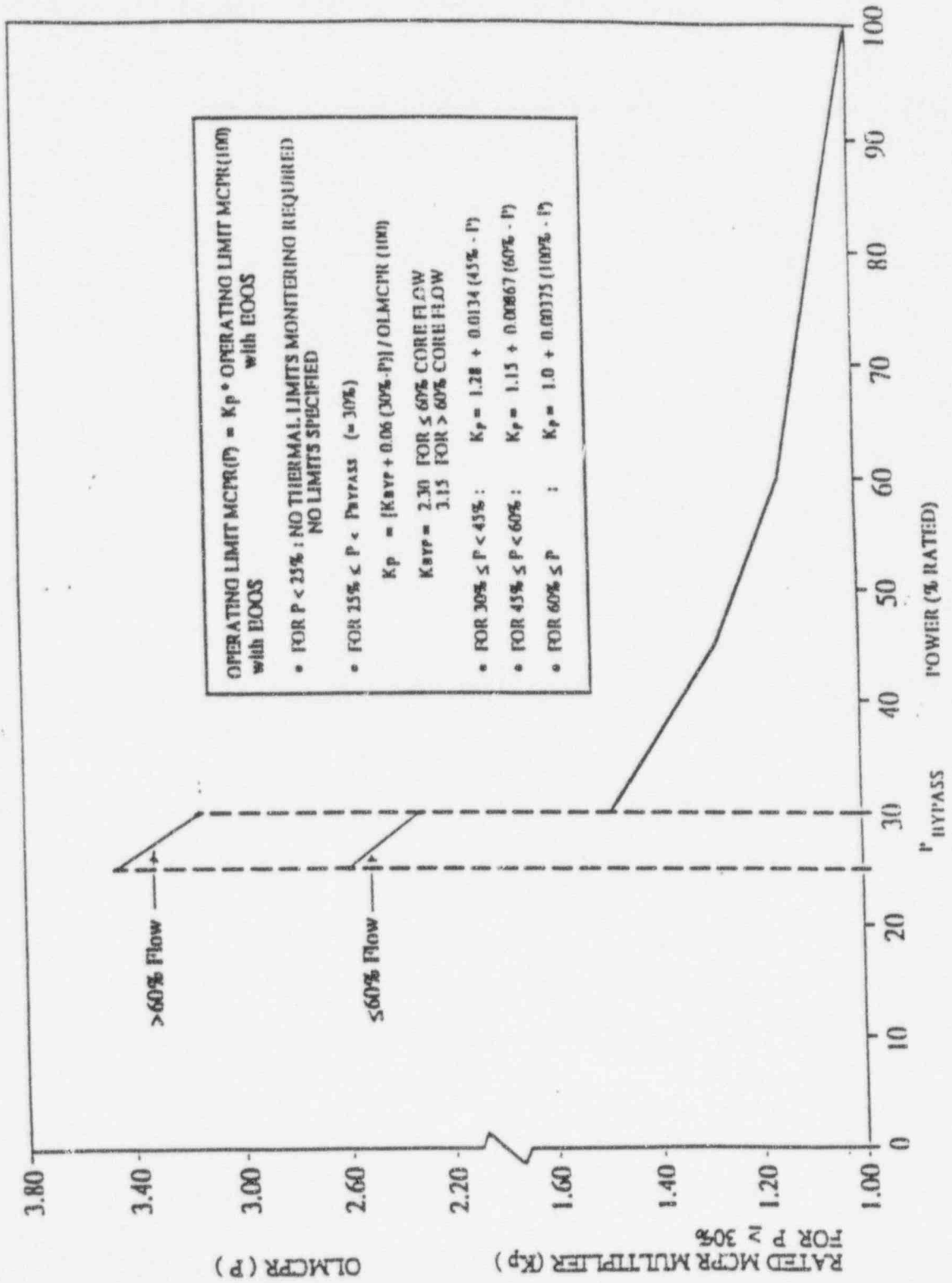


FIGURE 16

FLOW DEPENDENT MCPR LIMITS MCPR(F)
THIS FIGURE IS REFERRED TO BY TECHNICAL SPECIFICATION 3.2.3
THIS FIGURE IS VALID FOR ALL OPERATING DOMAINS

THIS FIGURE IS VALID ONLY FOR A MAXIMUM CORE FLOW SETTING OF 114% OF RATED

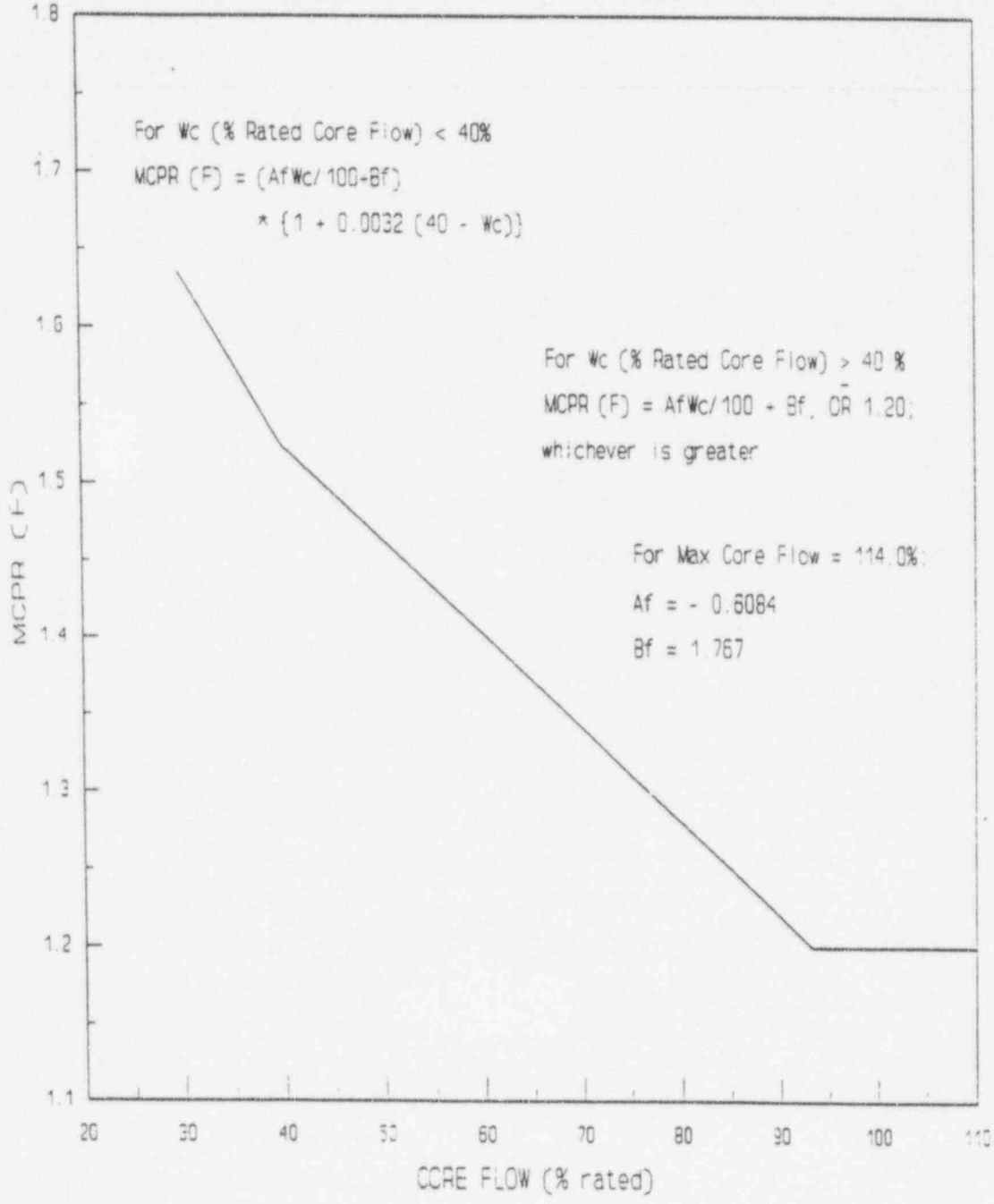


TABLE 1

ROD BLOCK MONITOR SETPOINTS

	Nominal Trip Setpoint	Allowable Value
LTSP	117.1%	118.3%
ITSP	112.3%	113.5%
HTSP	107.3%	108.5%
DTSP	92%	89%

These setpoints are based on a MCPR limit of 1.25 and are consistent with an RBM filter time constant between 0.1 seconds and 0.55 seconds.

TABLE 2

MAPLHGR SINGLE LOOP OPERATION (SLO) REDUCTION FACTOR

SLO reduction factor = 1.00 for all Cycle 6 fuel types.

TABLE 3

LINEAR HEAT GENERATION RATE LIMITS

Fuel Type	Maximum LHGR
GE6	13.4 kW/ft
GE7	13.4 kW/ft
GE8	14.4 kW/ft
GE9	14.4 kW/ft
GE11	14.4 kW/ft

TABLE 4

TURBINE BYPASS VALVE PARAMETERS

TURBINE BYPASS SYSTEM RESPONSE TIME

Maximum delay time before start of bypass valve opening following generation of the turbine bypass valve flow signal	0.10 sec
Maximum time after generation of a turbine bypass valve flow signal for bypass valve position to reach 80% of full flow (includes the above delay time)	0.30 sec

MINIMUM REQUIRED BYPASS VALVES TO MAINTAIN SYSTEM OPERABILITY

Number of valves = 7

TABLE 5

RECIRCULATION PUMP MOTOR-GENERATOR (MG) SET SCOOP TUBE STOPS

Mechanical: ≤ 114% of rated core flow

Electrical: ≤ 112% of rated core flow

TABLE 6

CONTROL ROD BLOCK INSTRUMENTATION
REACTOR COOLANT SYSTEM RECIRCULATION FLOW UPSCALE TRIP

Trip Setpoint: ≤ 111.0%

Allowable Value: ≤ 114.0%