MONTICELLO NUCLEAR GENERATING PLANT

Core Operating Limits Report

Cycle 19

Revision 3

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Introduction

This report provides the values of the limits for Cycle 19 as required by Technical Specification Section 6.7.A.7. These values have been established using NRC approved methodology and are established such that all applicable limits of the plant safety analysis are met.

A SLCPR of 1.10 was used for two-loop operation for all fuel types in Cycle 19 (GE10, GE11, GE12, and Siemens QFA fuel). This is consistent with the values specified by GE in Reference 2. The SLCPR for single-loop operation is 1.11. Preliminary SLCPR values of 1.11 (two-loop) and 1.13 (single-loop) were accepted by Siemens in Reference 3. However, Siemens did not review the updated SLCPR values of 1.10 (two-loop) and 1.11 (single-loop) for the revised core loading pattern. Therefore, it was decided by the Monticello Engineering staff to apply a 0.02 administrative adder to the OLCPR for the Siemens QFA bundles in the core monitoring database as a conservative bounding measure.

This report includes stability exclusion region definition, buffer region definition, and power distribution limits as required by amendment 97 to Monticello's operating license approved by the NRC in Reference 4.

Reference 1: NSPNAD-98001 revision 2, "Monticello Cycle 19 Final Reload Design Report (Reload Safety Evaluation)", October 1999.

Reference 2: Letter from T. R. Brohaugh (GE Nuclear) to K. S. Schnoebelen (NSP), "Monticello Cycle 19 SLMCPR Calculation", January 26, 1998.

Reference 3: Letter from K. V. Walters (Siemens) to K. S. Schnoebelen (NSP), "MCPR Safety Limit for SPC QFAs in Monticello Cycle 19", KVW97:238, October 29, 1997.

Reference 4: Letter from Tae Kim (USNRC) to Roger O. Anderson (NSP), "Monticello Nuclear Generating Plant - Issuance of Amendment Re: Implementation of Boiling Water Reactor Owners Group Option I-D Core Stability Solution (TAC No. M92947)", including enclosures, September 17, 1996.

Reference 5: Letter from M. F. Hammer (NSP) to USNRC dated December 4, 1997, "Revision 1 to License Amendment Request Dated July 26, 1996 Supporting the Monticello Nuclear Generating Plant Power Rerate Program," including attached exhibits.

Reference 6: Letter from Tae Kim (USNRC) to Roger O. Anderson (NSP), "Monticello Nuclear Generating Plant - Issuance of Amendment Re: Power Uprate Program (Tac No. M96238)", including enclosures, September 16, 1998.

Rod Block Monitor Operability Requirements

The MCPR limit associated with the Rod Block Monitor operability is:

MCPR < 1.86

Whenever the monitored core MCPR is less than 1.86, a limiting control rod pattern exists and the RBM system is required to be operable.

Reference Technical Specification Section 3.2.C.2.a

Rod Block Monitor Upscale Trip Setpoints

Low Trip Setpoint (LTSP)	≤	120/125 of full scale
Intermediate Trip Setpoint (ITSP)	≤	115/125 of full scale
High Trip Setpoint (HTSP)	≤	110/125 of full scale

Reference Technical Specification Sections: Table 3.2.3 Item 4.a, Table 3.2.3 Note 8.

Minimum Critical Power Ratio

The Minimum Critical Power Ratio (MCPR) limit shall be determined for two Recirculation Loop Operation as follows:

If thermal power > 45%, then the MCPR for GE10 is the greater of:

1.50 * K_P (K_P from Figure 3) or $TICPR_F$ from Figure 5.

If thermal power > 45%, then the MCPR for Siemens Fuel is the greater of:

1.52 * K_P (K_P from Figure 3) or $TICPR_F$ from Figure 5[(1)].

If thermal power > 45%, then the MCPR for GE11 fuel is the greater of:

1.47 * K_P (K_P from Figure 4) or $TICPR_F$ from Figure 5.

If thermal power > 45%, then the MCPR for GE12 Fuel is the greater of:

1.49 * K_P (K_P from Figure 4) or $TICPR_F$ from Figure 5.

If thermal power ≤ 45%, then the MCPR limit for GE10 and Siemens fuel is obtained in figure 3.
If thermal power ≤ 45%, then the MCPR limit for GE11 and GE12 fuel is obtained in figure 4.

For single recirculation loop operation the MCPR limit as defined previously by two recirculation loop operation is increased by the following adders:

0.01 ΔMCPR to account for core flow measuring and TIP reading uncertainties.

0.05 ΔMCPR to preclude fuel failures for a 1 out of 2 Pump Seizure Event (Reference 1).

Reference Technical Specification Section: 3.11.C.

(1.) *Note that the only reason that the QFAs are higher than GE10 was an NSP decision to add a 0.02 administrative adder because NSP did not ask Siemens to re-review the impact of 1.10/1.11 SLCPRs compared to the 1.11/1.13 SLCPR values that they reviewed.*

The MCPRs calculated above may be replaced by values calculated in table 3 if taking credit for scram speed.

Power-Flow Operating Map

The Power-Flow Operating Map based on analysis to support Cycle 19 is shown in Figures 6 & 7. This Power-Flow Operating Map is consistent with the new rated power of 1775 as described in References 5 and 6.

Approved Analytical Methods

NEDE-24011-P-A	Rev 13	"General Electric Standard Application for Reactor Fuel"
NSPNAD-8608-A	Rev 4	"Reload Safety Evaluation Methods for Application to the Monticello Nuclear Generating Plant"
NSPNAD-8609-A	Rev 3	"Qualification of Reactor Physics Methods for Application to Monticello"
ANF-91-048 (P) (A)	Rev 0	"Advanced Nuclear Fuels Corporation Methodology for Boiling Water Reactors-EXEM BWR Evaluation Model," Siemens Power Corporation
NEDO-31960-A		"BWR Owners Group Long-Term Stability Solutions Licensing Methodology," Licensing Topical Report, November 1995.
NEDO-31960-A	Sup 1	"BWR Owners Group Long-Term Stability Solutions Licensing Methodology," Licensing Topical Report, Supplement 1, March 1992.

Maximum Average Linear Heat Generation Rate as a Function of Exposure

When hand calculations are required, the Maximum Average Linear Heat Generation Rate (MAPLHGR) for each fuel bundle design as a function of average planar exposure shall not exceed the limiting lattice (excluding natural Uranium) provided in Table 1 (based on straight line interpolation between data points) multiplied by the smaller of the two MAPFAC factors determined from Figures 1 and 2.

The MAPLHGR limits in Table 1 are conservative values bounding all fuel lattice types (excluding natural Uranium) in a given fuel bundle design and are intended only for use in hand calculations as described in Technical Specification 3.11.A. No channel bow effects are included in the bounding MAPLHGR values below because there are no reused channels. MAPLHGR limits for each individual fuel lattice design in a bundle design as a function of axial location and average planar exposure are determined based on the approved methodology referenced in Monticello Technical Specification 6.7.A.7.b and loaded in the process computer for use in core monitoring calculations.

The SPC 9x9-IX Qualification Fuel Assemblies (QFAs) will be monitored to the GE10-DXB333-10GZ MAPLHGR and LHGR limits to protect the steady state LHGR limit of the QFAs. When hand calculations are required, the GE10-DXB333-10GZ MAPLHGR and LHGR limits can be used to calculate the appropriate limits for the QFAs.

Reference Technical Specification Section 3.11.A.

Table 1

MAPLHGR for each fuel type (kW/ft)

Exposure MWD/STU	GE10-HXB324-11GZ	GE10-HXB324-10GZ1	GE10-DXB333-10GZ	GE10-DXB324-11GZ
200	10.36	11.19	11.64	10.71
1000	10.47	11.42	11.70	10.82
5000	11.55	12.20	12.30	11.78
10000	12.95	12.65	12.88	13.17
15000	12.97	12.47	12.65	12.88
20000	12.22	11.81	11.97	12.25
25000	11.52	11.21	11.31	11.60
30000	10.90	10.67	10.67	10.95
35000	10.28	10.14	10.02	10.30
40000	9.61	9.55	9.21	9.61
45000	8.94	8.97	8.40	8.92
50000	6.45	6.49	5.93	6.43

Exposure MWD/STU	GE11-DUB348-10GZ	GE11-DUB347-10GZ	GE12-DSB330-12GZ	GE11-DUB366-16GZ	GE11-DUB366-17GZ
200	10.32	9.96	8.54	9.96	9.45
1000	10.47	10.02	8.57	10.17	9.64
5000	11.21	11.04	9.31	11.21	10.73
10000	12.21	12.32	10.25	12.21	12.05
15000	12.06	11.93	10.13	12.03	11.92
20000	11.40	11.32	9.78	11.58	11.50
25000	10.71	10.73	9.45	10.90	10.75
30000	10.03	10.15	9.08	10.20	10.00
35000	9.37	9.56	8.66	9.54	9.28
40000	8.71	8.91	8.19	8.88	8.54
45000	8.05	8.27	7.46	8.22	7.85
50000	7.38	7.59	6.70	7.56	7.19
55000	6.70	6.62	5.99	6.90	6.55
57680	6.28			6.29	
57900					6.18
58050		6.06			
58220					6.14
60060			5.31		

Note: Table 1 is for two recirculation loop operation. For single loop operation, multiply these values by 0.85.

Linear Heat Generation Rate

Table 2 LHGR for Each Fuel Type (kW/ft)								
GE10-DXB324-10GZ	**GE10-DXB324-11GZ**	**GE10-DXB333-10GZ**	**GE10-DXB324-11GZ**	**GE11-DUB347-10GZ**	**GE11-DUB348-10GZ**	**GE12-DSB330-12GZ**	**GE11-DUB366-16GZ**	**GE11-DUB366-17GZ**
14.4	14.4	14.4	14.4	14.4	14.4	11.8	14.4	14.4

Reference Technical Specification Section: 3.11.B.

Core Stability Requirements

Stability Exclusion Region
The stability exclusion region is shown in Figure 6 and is given in greater detail in Figure 7.

Stability Buffer Region
The stability buffer region is shown in Figure 6 and is given in greater detail in Figure 7.

Power Distribution Controls
Prior to intentionally entering the stability buffer region, the hot channel and core wide decay ratios will be shown to be within the stable portion of Figure 8. While operating in the stability buffer region, the hot channel and core wide decay ratios will be maintained within the stable portion of Figure 8.

Reference Technical Specification Section 3.5.F.

Scram Time Dependence

Technical Specification 3.3.C provides the scram insertion time versus position requirements for continued operations. Technical Specification 4.3.C provides the surveillance requirements for the CRDs. Data from testing of the CRDs, or from an unplanned scram, is summarized in Surveillance Test 0081. Using this cycle specific information, values of τ_{20} can be calculated in accordance with the equation at the 20% insertion position, which is:

$$\tau_{20} = \frac{\sum_{i=1}^{n} N_i t_i}{\sum_{i=1}^{n} N_i} + 1.65\sigma \left[\frac{N_1}{\sum_{i=1}^{n} N_i} \right]^{1/2} \qquad \text{Eq. [5.1]}$$

where: τ_{20} = the weighted cycle average scram time at a 95% confidence level at the 20% insertion position.

n = the number of surveillance tests performed following core alterations.

N_i = the number of control rods measured in the i^{th} test.

N_1 = the total number of active rods measured in the first test following core alterations.

t_i = average scram time at the 20% insertion position of all rods measured in the i^{th} test.

σ = Standard deviation of scram times

τ_{20} = 0.900 sec. shall be assumed until cycle specific scram data following a core alteration becomes available. When scram insertion time data is available, credit may be taken for faster insertion times, if desired. It should also be noted that when data does become available, the average scram time values must be calculated with either CRD insertion time data at reactor pressures above 965 psia, or with data that is corrected for low reactor pressures in accordance with Surveillance Test 0081 Appendix A.

After obtaining the cycle specific values of τ_{20} for the 20% insertion positions, a comparison can be made to Table 3 in order to get the scram time adjusted OLCPR. The value of the scram time adjusted OLCPR is obtained from Table 3 by linearly interpolating the value of τ at the 20% insertion position. Note that extrapolation is not permitted in Table 3.

Table 3

Monticello Cycle 19 Full Power/Flow OLCPR as a Function of Scram Time

τ_{20}	**0.682**	**0.769**	**0.845**	**0.900**
OLCPR GE10*	1.41	1.42	1.45	1.50
OLCPR GE11	1.45	1.45	1.45	1.47
OLCPR GE12	1.45	1.45	1.45	1.49

* The eight Siemens QFA bundles are included with the GE10 data.

Sample Interpolation

After a Surveillance Test 0081 has been completed for cycle 19 the results can be used to calculate a new average scram insertion time at the 20% insertion position. This time can then be linearly interpolated to change the OLCPR values found in Table 3. If the scram insertion time changed from 0.769 seconds to 0.750 seconds then the OLCPR values would change as follows:

Table 4

τ_{20}	**0.682**	**0.750**	**0.769**	**0.845**	**0.900**
OLCPR GE10*	1.41	1.42	1.42	1.45	1.50
OLCPR GE11	1.45	1.45	1.45	1.45	1.47
OLCPR GE12	1.45	1.45	1.45	1.45	1.49

From Table 4 the OLCPR for GE10 would be 1.42 instead of 1.50 at the technical specification scram insertion time thus increasing operating margin.

Figure 1

Monticello Cycle 19
Power Dependent MAPLHGR Limits

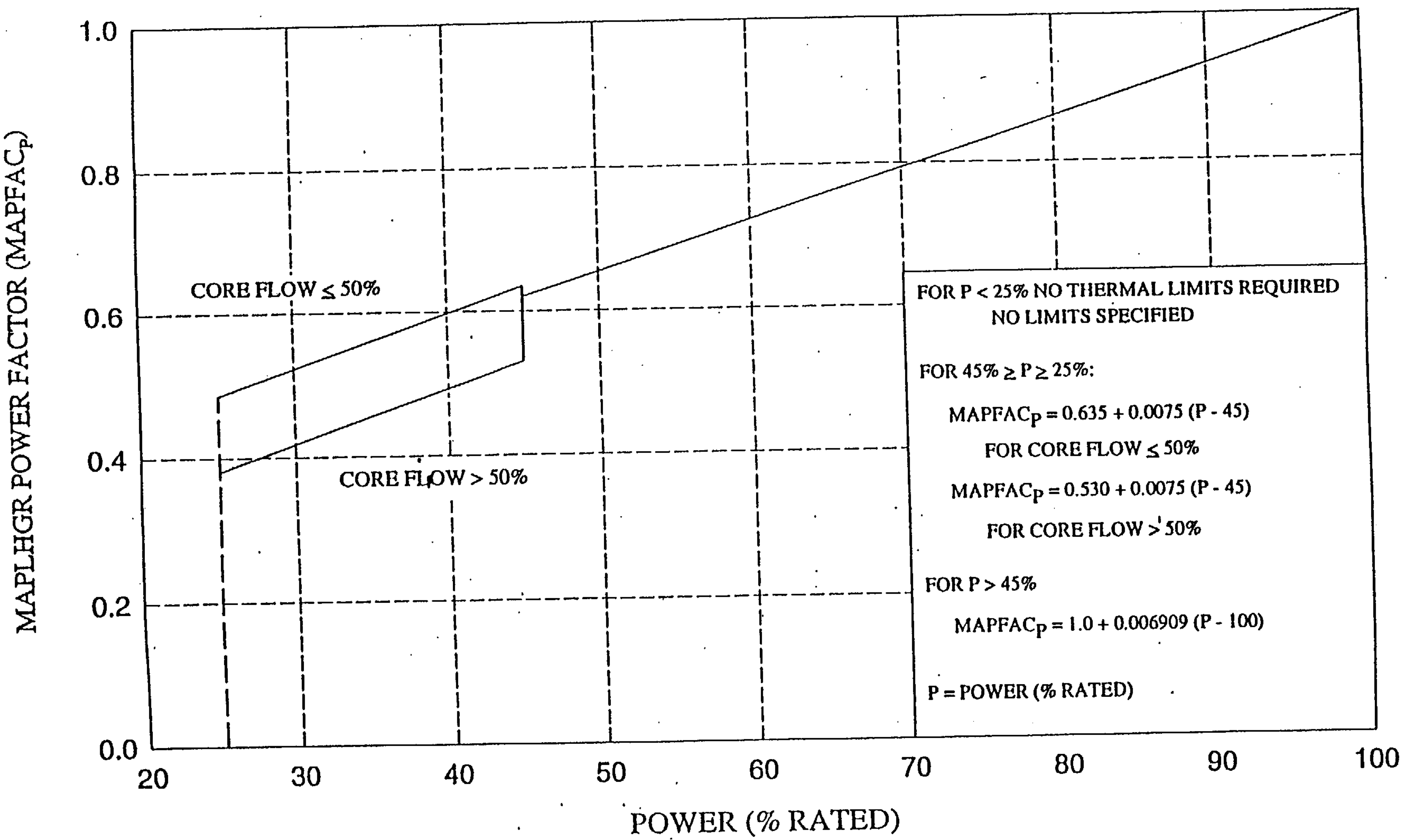

Figure 2

Monticello Cycle 19
Flow Dependent MAPLHGR Limits

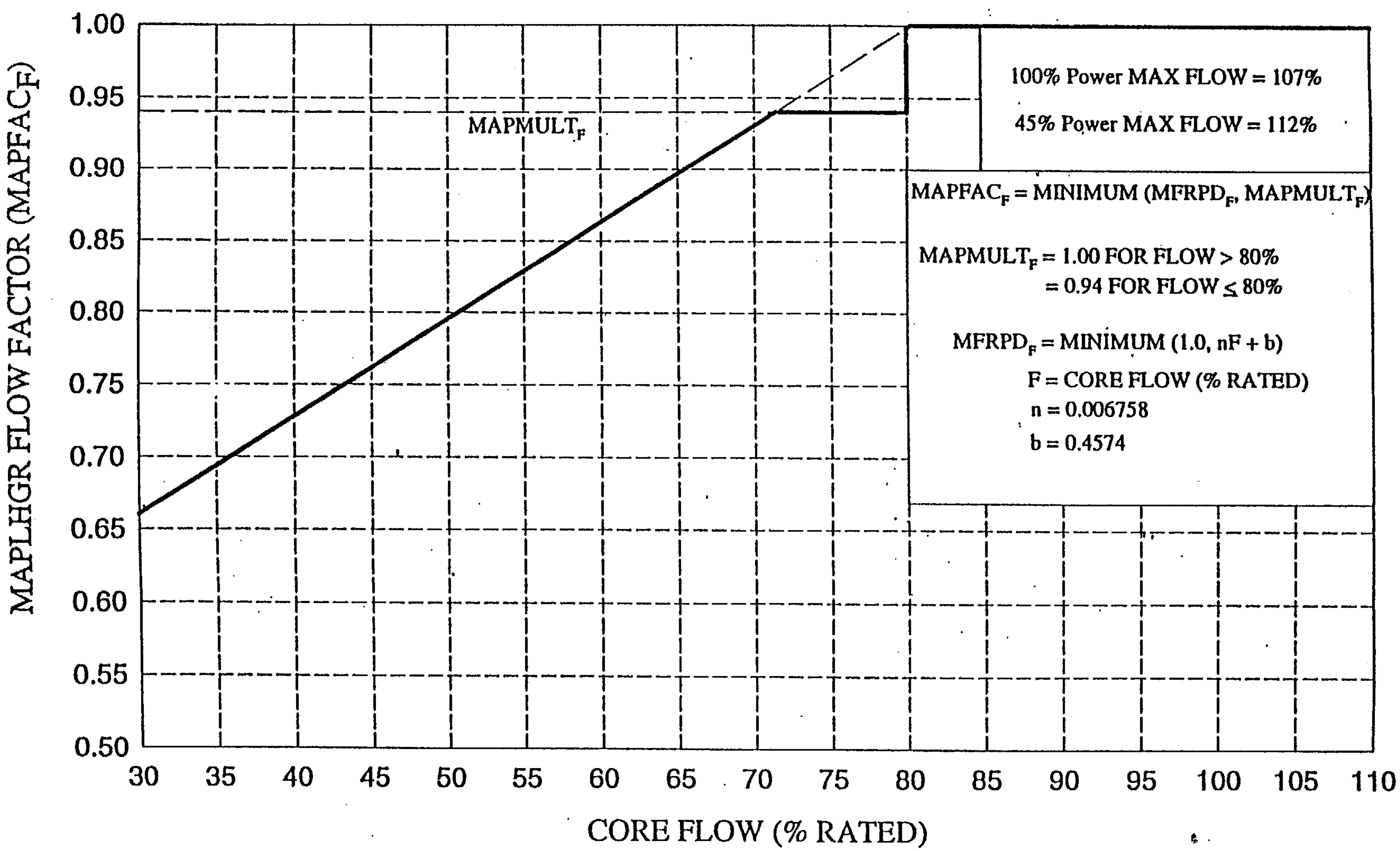

Figure 3

Monticello Cycle 19
Power Dependent CPR Limits (GE10, QFA)

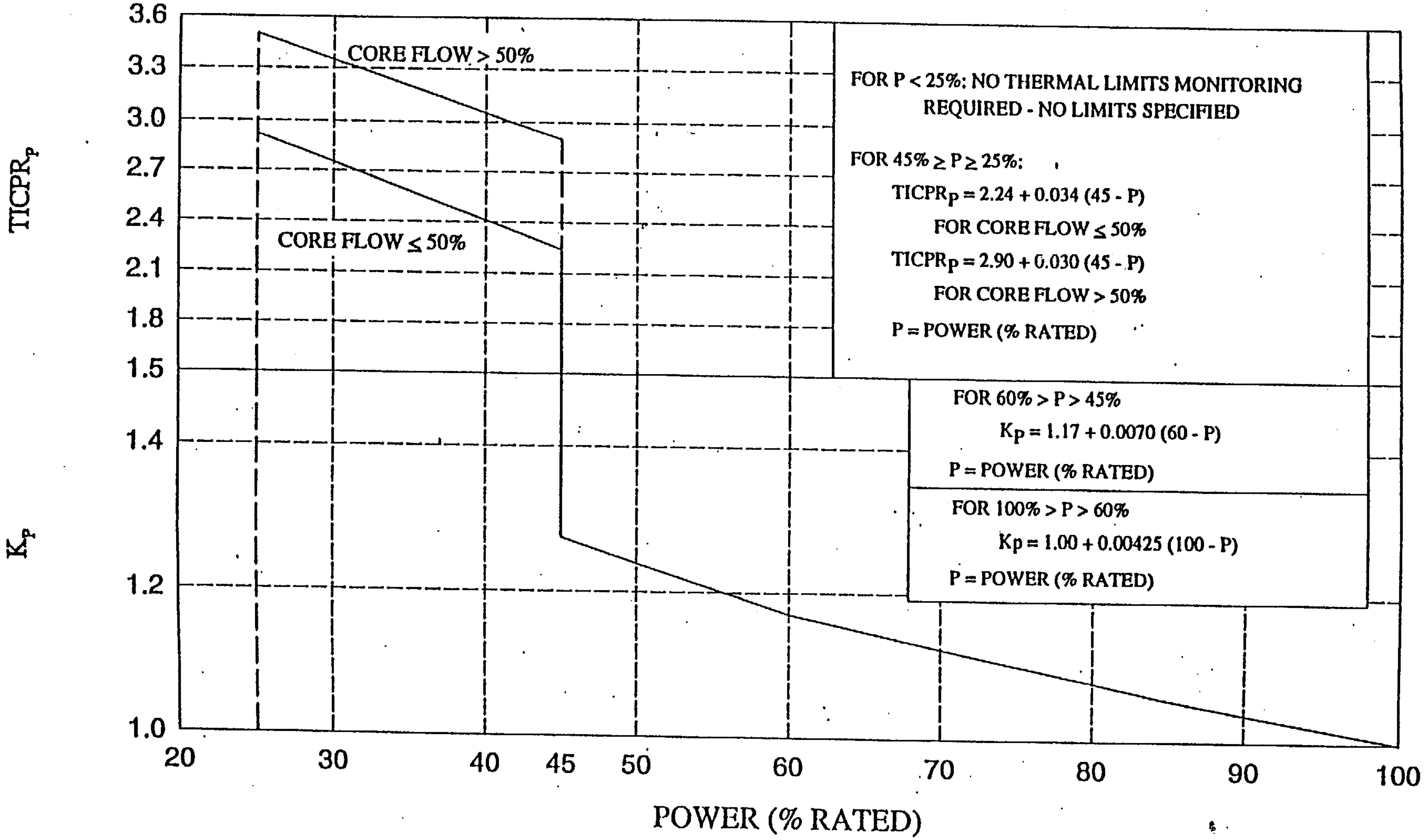

Figure 4

Monticello Cycle 19
Power Dependent CPR Limits (GE11, GE12)

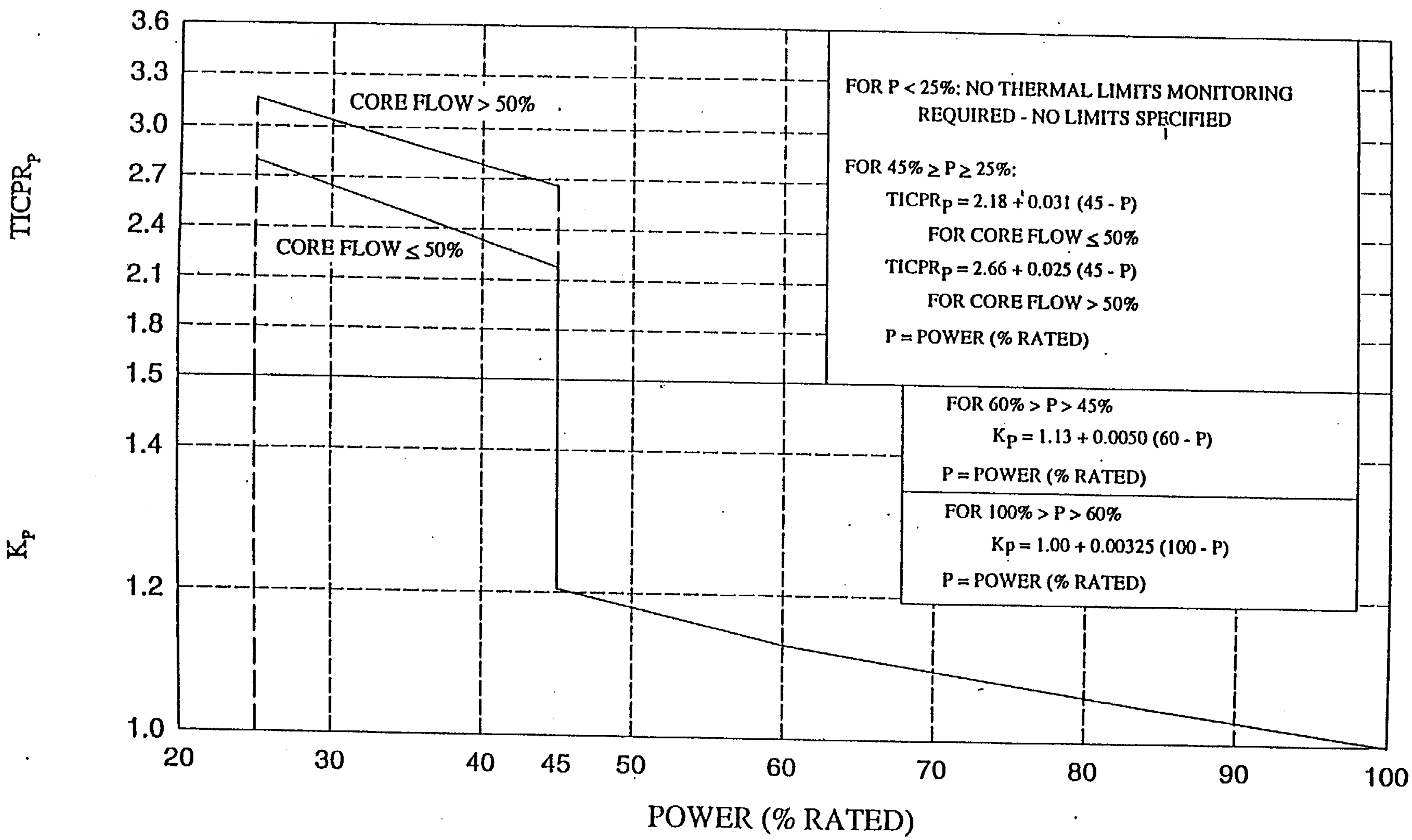

Figure 5

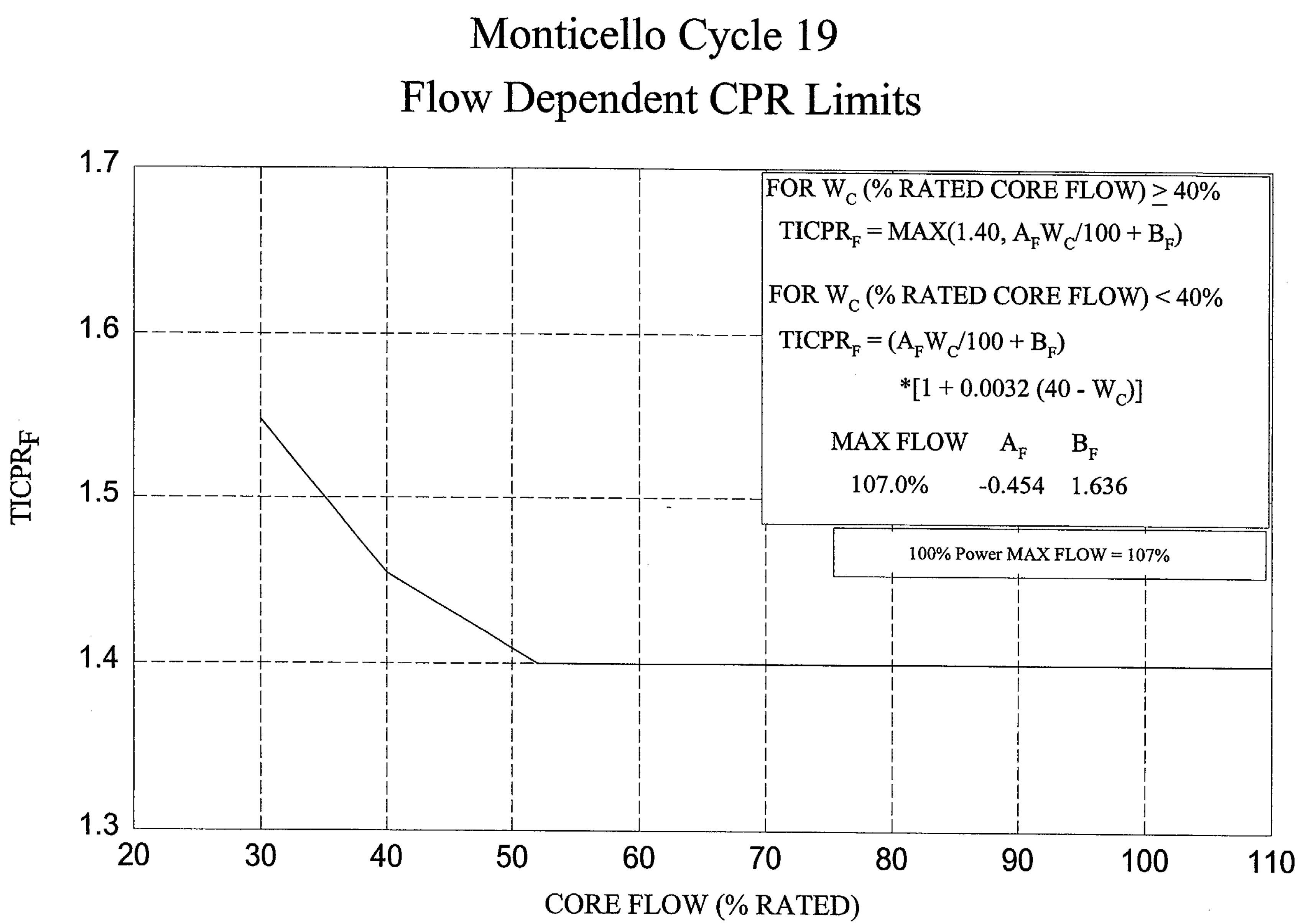
Monticello Cycle 19
Flow Dependent CPR Limits
FOR W_C (% RATED CORE FLOW) ≥ 40%
$TICPR_F = MAX(1.40, A_F W_C/100 + B_F)$
FOR W_C (% RATED CORE FLOW) < 40%
$TICPR_F = (A_F W_C/100 + B_F)$
$*[1 + 0.0032 (40 - W_C)]$
MAX FLOW A_F B_F
107.0% -0.454 1.636
100% Power MAX FLOW = 107%
$TICPR_F$
1.7
1.6
1.5
1.4
1.3
20
30
40
50
60
70
80
90
100
110
CORE FLOW (% RATED)

Figure 6

Power-Flow Operating Map

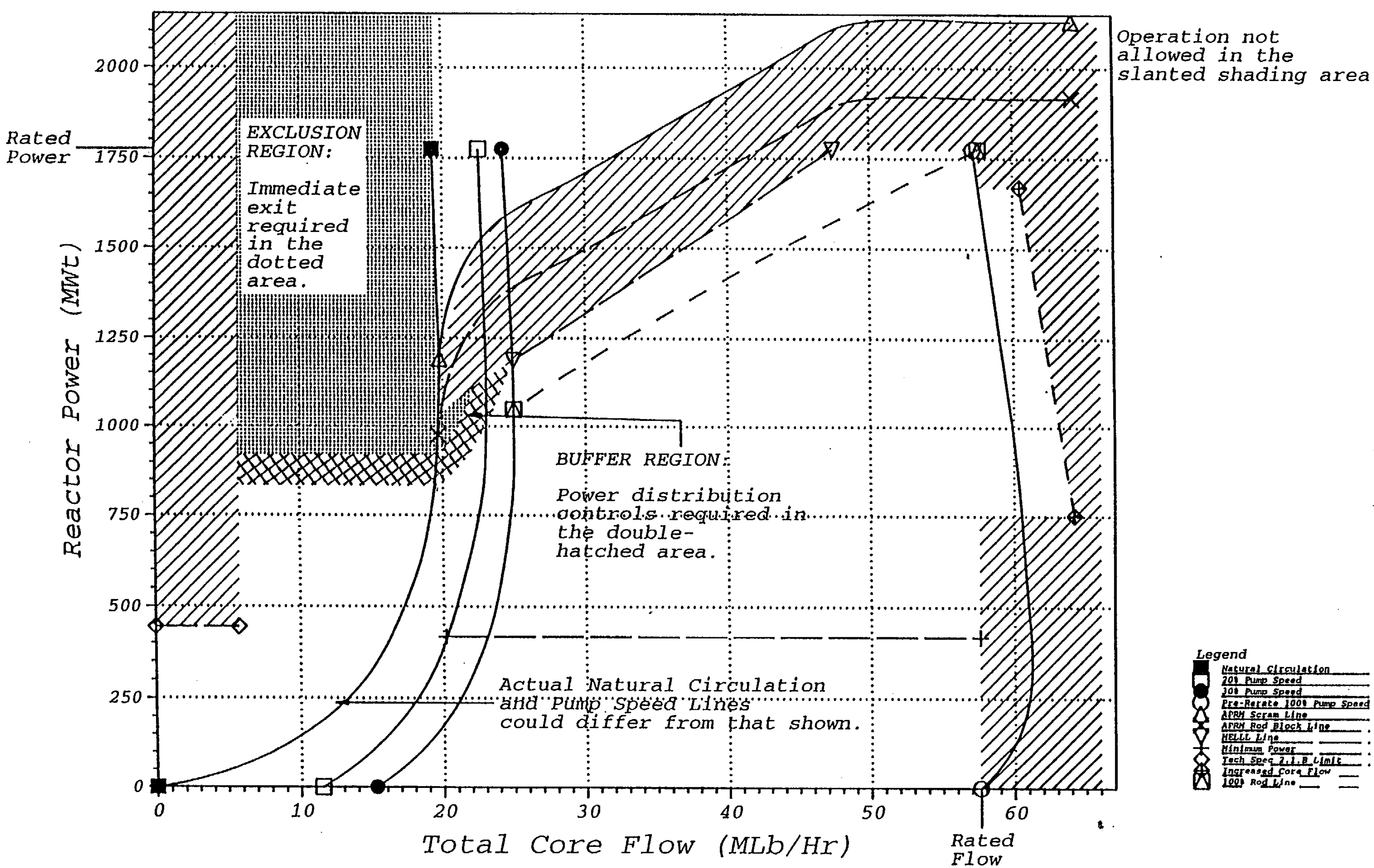

Figure 7

Power-Flow Operating Map

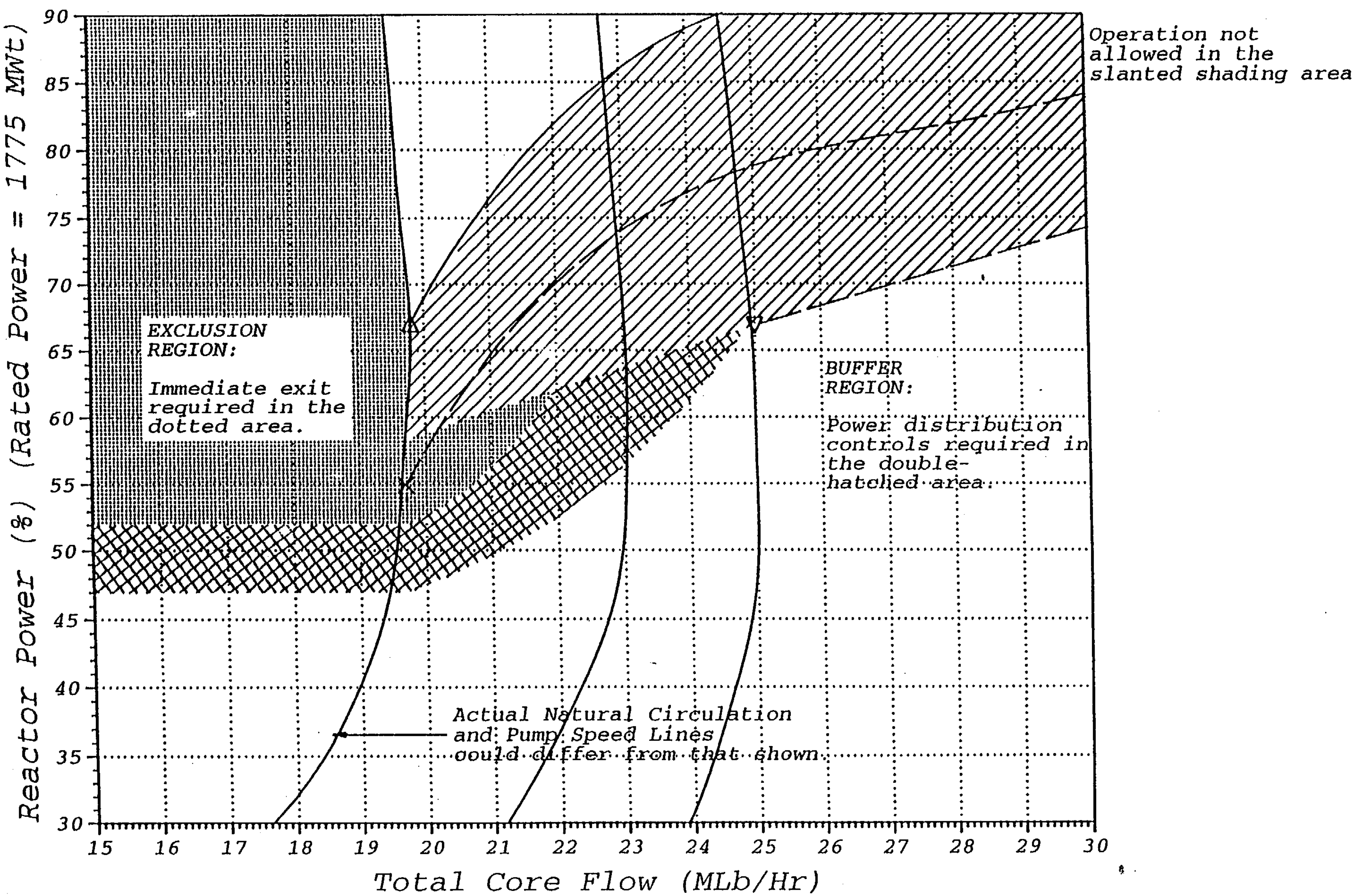

Figure 8

Stability Criterion Map