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David N. Lorfing
Manager, Licensing

October 21, 2009

RBG-46965

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: River Bend Station - Unit 1
Docket No. 50-458
License No. NPF-47
Sixteenth Fuel Cycle Core Operating Limits Report (COLR)

Dear Sir or Madam:

Enclosed is Revision 0 of the River Bend Station (RBS) Core Operation Limits Report (COLR) for the sixteenth fuel cycle. This report is submitted in accordance with Technical Specification 5.6.5 of Appendix A of the Facility Operating License NPF-47.

There are no commitments in this letter.

For further information, contact myself, David Lorfing at (225) 381-4157.

Sincerely,

[signature]

Manager, Licensing
River Bend Station - Unit 1

DNL/bmb

NMSS01
NMSS

cc: Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
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Core Operating Limits Report
Cycle 16
Revision 0

RIVER BEND STATION, CYCLE 16

CORE OPERATING LIMITS REPORT (COLR)

PREPARED BY:	**Thomas W. Oliphant*** **Responsible Engineer**	**Date:**	
REVIEWED BY:	**Phu V. Vo*** **Review Engineer**	**Date:**	
APPROVED BY:	**Frederick H. Smith*** **Manager – Nuclear Engineering**	**Date:**	10-8-09
APPROVED BY:	**Dennis P Wiles*** **Director, Engineering** **River Bend Nuclear Station**	**Date:**	10/8/09
APPROVED BY:	* **On-Site Safety Review Committee** **River Bend Nuclear Station**	**Date:**	

* See EC 16779 for signature & date

TABLE OF CONTENTS

INTRODUCTION AND SUMMARY

This report provides Cycle 16 values for the following Technical Specifications:

1. AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR) limits,
2. MINIMUM CRITICAL POWER RATIO (MCPR) limits,
3. LINEAR HEAT GENERATION RATE (LHGR) limits,
4. FRACTION OF CORE BOILING BOUNDARY (FCBB),
5. REACTOR PROTECTION SYSTEM (RPS) APRM Flow Biased Simulated Thermal Power - High Allowable Values,
6. REACTOR PROTECTION SYSTEM (RPS) APRM Flow Biased Simulated Thermal Power time constant.
7. PERIOD BASED DETECTION SYSTEM (PBDS) region boundaries.

Technical Specification section 5.6.5 requires these values be determined using NRC-approved methodology and are established such that all applicable limits of the plant safety analysis are met. The references for the pertinent methodology used by GNF are listed in the section titled Analytical Methods Documents.

This report also provides Cycle 16 values for the following Technical Requirements:

1. REACTOR PROTECTION SYSTEM (RPS) APRM Flow Biased Neutron Flux Power - High Allowable Values and Nominal Trip Setpoints[1],
2. CONTROL ROD BLOCK INSTRUMENTATION APRM Flow Biased Neutron Flux High limits.

The Cycle 16 COLR supports power operation with FHOOS, FFWTR, PROOS, SLO, EOC-RPT, and TBOOS INOPERABLE and Loop Manual Operation.

The reload analyses were performed in accordance with GNF methodology and its applicability to Cycle 16 was confirmed by Reference I.1.

[1] Note that for Figures 4 to 11, the Nominal Setpoints should be used for indicating the entry into a particular stability region as allowed and appropriate actions be taken prior to the entry

CONTROL RODS

The River Bend core utilizes the GE design control rods, non GE design CR-82M and CR-82M-1 bottom entry cruciform control rods. These Control Rod designs are discussed in more detail in Reference 3.

DEFINITIONS

MOC – Middle of Cycle (EOR- 2070 MWd/MT)

EOR - the cycle exposure corresponding to all rods out, 100% power/100% flow, and normal feedwater temperature

EOC – End of Cycle (Core Exposure 31,401 MWd/MTU).

FFWTR – Final Feedwater Temperature Reduction.

FHOOS – Feedwater Heater Out of Service.

PROOS – Pressure Regulator Out of Service.

SLO – Single Loop Operation.

TBOOS –Turbine Bypass Out of Service

AREVA – AREVA NP Inc.

GNF – Global Nuclear Fuel

EOC-RPT – End of Cycle Recirculation Pump Trip

REFERENCE CORE LOADING PATTERN – The Core Loading Pattern Used for Reload Licensing Analysis.

Application Condition – The combination of equipment out of service conditions for which LHGRFAC and MCPR limits are determined. The Application Conditions are as follows:

Application Condition	FWHOOS / FFWTR	EOC-RPT OOS	PROOS	TBOOS
1	X			
2	X	X		
3	X		X	
4	X			X
5	X	X		X
6	X		X	X
7	X	X	X	X

All application conditions address the licensed core flow.

REVISION HISTORY

Revision 0 is to provide the thermal limits for Cycle 16 power operation.

TECHNICAL SPECIFICATION 3.2.1

POWER DISTRIBUTION LIMITS

AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)

The limiting APLHGR (sometimes referred to as Maximum APLHGR, or MAPLHGR) as a function of AVERAGE PLANAR EXPOSURE for all fuel types are provided in the table below. These values were determined with the GNF methodology (Reference I.1). Core location by fuel type is provided in Figure 1 and is the reference core loading pattern in Reference I.1.

Fuel Type	Figure
GE14	12
ATRIUM-10	13

For single loop operation (SLO) a multiplier of 0.83 is applied to the APLHGR limits.

TECHNICAL SPECIFICATION 3.2.2

POWER DISTRIBUTION LIMITS

MINIMUM CRITICAL POWER RATIO (MCPR)

The MCPR limits for use in Technical Specification 3.2.2 for flow dependent MCPR ($MCPR_F$) and power dependent MCPR ($MCPR_P$) are obtained from Reference I.5 and are shown below for all fuel types, MOC and EOC points, as well as all Application Conditions which have been previously defined.

The most limiting value from the applicable $MCPR_f$ and $MCPR_p$ figures is the operating limit. These values were determined with GNF methodology as described in Reference I.5 and are consistent with a Safety Limit MCPR from Technical Specification 2.0.

$MCPR_F$ Values:

The $MCPR_F$ values bound all fuel types and the exposure range. For cases where the turbine bypass system is in service (Application Conditions 1, 2, and 3) use Figure 16. For cases where the turbine bypass system is out of service (Application Conditions 4, 5, 6, and 7) use Figure 17. Both figures contain curves for operation of the Recirculation Flow Control System in the loop manual and loop auto modes of operation.

$MCPR_P$ Values:

Application Conditions	Figure			
	GE14		ATRIUM-10	
	MOC	EOC	MOC	EOC
1	19	33	20	34
2	21	35	22	36
3	23	37	24	38
4	25	39	26	40
5	27	41	28	42
6	29	43	30	44
7	31	45	32	46

More limiting values of the power dependent limits may be used in lieu of those indicated by a particular operating mode. For example EOC values may be used instead of the MOC values.

For single loop operation (SLO), the $MCPR_F$ and $MCPR_P$ limits are determined from the two loop operation (TLO) limits above as follows:

$$MCPR_{SLO}^{GE14} = MAX\left(MCPR_{TLO}^{GE14} + 0.02, 1.44\right)$$

$$MCPR_{SLO}^{A10} = MAX\left(MCPR_{TLO}^{A10} + 0.02, 1.40\right)$$

TECHNICAL SPECIFICATION 3.2.3

POWER DISTRIBUTION LIMITS

LINEAR HEAT GENERATION RATE (LHGR)

The limiting LHGR value for GE14 and ATRIUM-10 as a function of PELLET EXPOSURE are given in Figure 14 and 15, respectively. Core location by fuel type is provided in Figure 1 and is the reference core loading pattern in Reference I.1. LHGR values were derived from Reference I.6. LHGRFAC values were obtained from Reference I.5.

Thermal power and core flow dependent multipliers are shown below for all fuel types, MOC and EOC points, as well as all Application Conditions which have been previously defined. The value of the exposure dependent limit is reduced by the value of the multiplier at a given off-rated power or flow condition.

$LHGRFAC_F$ Values:

The $LHGRFAC_F$ values bound all fuel types, exposure range, and Application Conditions and are found in Figure 18 and contains curves for operation of the Recirculation Flow Control System in the loop manual and loop auto modes of operation.

$LHGRFAC_P$ Values:

Application Conditions	Figure			
	GE14		ATRIUM-10	
	MOC	EOC	MOC	EOC
1, 2, 4, 5	47	51	48	52
3, 6, 7	49	53	50	54

More limiting values of the power dependent multipliers may be used in lieu of those indicated by a particular operating mode. For example EOC values may be used instead of the MOC values.

For two recirculation loop and single recirculation loop operation the LHGR multiplier is as follows:

For two recirculation loop operation:

$$LHGRFAC = MIN(LHGRFAC_P, LGHRFAC_F)$$

For single loop operation:

$$LHGRFAC = MIN(LHGRFAC_P, LGHRFAC_F, 0.83)$$

TECHNICAL SPECIFICATION 3.2.4

POWER DISTRIBUTION LIMITS

FRACTION OF CORE BOILING BOUNDARY (FCBB)

Restricted Region Boundary

Note: The boundary of the Restricted Region is established by analysis in terms of thermal power and core flow. The Restricted Region boundary is defined by the "non-setup" APRM Flow Biased Simulated Thermal Power - High Control Rod Block Setpoints, which are a function of reactor recirculation drive flow.

The Restricted Region boundaries as a function of aligned drive flow are given in Figures 4 through 7 in terms of aligned drive flow. The aligned drive flow is calculated from the input drive flow using the relationship given in Table 1.

Flow Biased Simulated Thermal Power - High Limits

The APRM Flow Biased Simulated Thermal Power - High Scram setpoints as a function of aligned drive flow are given in Figures 4 through 7. The aligned drive flow is calculated from the input drive flow using the relationship given in Table 1.

a. Case 1 - Normal Feedwater Heating Operation or Low Reactor Power:

$$T_{FW}(\text{at rated}) \geq T_{FW}^{DESIGN}(\text{at rated}) - 50°\,F,$$

and rated equivalent at off-rated reactor conditions.

OR

$$P \leq 30\%$$

b. Case 2 - Reduced Feedwater Heating Operation

$$T_{FW}(\text{at rated}) < T_{FW}^{DESIGN}(\text{at rated}) - 50°\,F,$$

and rated equivalent at off-rated reactor conditions.

AND

$$P > 30\%$$

Where: T_{FW} is feedwater temperature in °F, and P is reactor power in percent of rated.

TECHNICAL SPECIFICATION 3.3.1.1

INSTRUMENTATION

REACTOR PROTECTION SYSTEM (RPS) INSTRUMENTATION

AVERAGE POWER RANGE MONITORS

APRM Flow Biased Simulated Thermal Power - High Limits

The APRM Flow Biased Simulated Thermal Power - High scram setpoint Allowable Values are given in Figures 4 through 7 in terms of aligned drive flow. The aligned drive flow is calculated from the input drive flow using the relationship given in Table 1.

a. Case 1 - Normal Feedwater Heating Operation or Low Reactor Power:

$$T_{FW}(\text{at rated}) \geq T_{FW}^{DESIGN}(\text{at rated}) - 50°\,F,$$

and rated equivalent at off-rated reactor conditions.

OR

$P \leq 30\%$

b. Case 2 - Reduced Feedwater Heating Operation

$$T_{FW}(\text{at rated}) < T_{FW}^{DESIGN}(\text{at rated}) - 50°\,F,$$

and rated equivalent at off-rated reactor conditions.

AND

$P > 30\%$

Where: T_{FW} is feedwater temperature in °F, and P is reactor power in percent of rated.

APRM Simulated Thermal Power Time Constant

The simulated thermal power time constant for use in Technical Specification Table 3.3.1.1-1, SR 3.3.1.1.14, is (Reference 2):

6 ± 0.6 seconds.

The maximum simulated thermal power time constant for use in Technical Specification surveillance Table 3.3.1.1-1, SR 3.3.1.1.14 is:

6.6 seconds

TECHNICAL SPECIFICATION 3.3.1.3

INSTRUMENTATION

PERIOD BASED DETECTION SYSTEM (PBDS)

Monitored Region Boundary

The Monitored Region Boundaries as a function of core flow are given in Figures 2 and 3.

Restricted Region Boundary

Note: The boundary of the Restricted Region is established by analysis in terms of thermal power and core flow. The Restricted Region boundary is defined by the "non-setup" APRM Flow Biased Simulated Thermal Power - High Control Rod Block Setpoints, which are a function of reactor recirculation drive flow.

The Restricted Region boundaries as a function of aligned drive flow are given in Figures 4 through 7 in terms of aligned drive flow. The aligned drive flow is calculated from the input drive flow using the relationship given in Table 1.

a. Case 1 - Normal Feedwater Heating Operation or Low Reactor Power:

$$T_{FW}(\text{at rated}) \geq T_{FW}^{DESIGN}(\text{at rated}) - 50°\text{ F},$$

and rated equivalent at off-rated reactor conditions.

OR

$P \leq 30\%$

b. Case 2 - Reduced Feedwater Heating Operation

$$T_{FW}(\text{at rated}) < T_{FW}^{DESIGN}(\text{at rated}) - 50°\text{ F},$$

and rated equivalent at off-rated reactor conditions.

AND

$P > 30\%$

Where: T_{FW} is feedwater temperature in °F, and P is reactor power in percent of rated.

TECHNICAL REQUIREMENT 3.3.1.1

INSTRUMENTATION

REACTOR PROTECTION SYSTEM (RPS) INSTRUMENTATION

AVERAGE POWER RANGE MONITORS

APRM Flow Biased Simulated Thermal Power - High Limits

The APRM Flow Biased Simulated Thermal Power - High scram setpoint Nominal Trip Setpoints are given in Figures 4 through 7 in terms of aligned drive flow. The aligned drive flow is calculated from the input drive flow using the relationship given in Table 1.

a. Case 1 - Normal Feedwater Heating Operation or Low Reactor Power:

$$T_{FW}(\text{at rated}) \geq T_{FW}^{DESIGN}(\text{at rated}) - 50° F,$$

and rated equivalent at off-rated reactor conditions.

OR

$P \leq 30\%$

b. Case 2 - Reduced Feedwater Heating Operation

$$T_{FW}(\text{at rated}) < T_{FW}^{DESIGN}(\text{at rated}) - 50° F,$$

and rated equivalent at off-rated reactor conditions.

AND

$P > 30\%$

Where: T_{FW} is feedwater temperature in °F, and P is reactor power in percent of rated.

TECHNICAL REQUIREMENT 3.3.2.1

INSTRUMENTATION

CONTROL ROD BLOCK INSTRUMENTATION

AVERAGE POWER RANGE MONITORS

APRM Flow Biased Neutron Flux - High Limits

The APRM Flow Biased Neutron Flux - High rod block Allowable Values and Nominal Trip Setpoints are given in Figures 8 through 11 in terms of aligned drive flow. The aligned drive flow is calculated from the input drive flow using the relationship given in Table 1.

a. Case 1 - Normal Feedwater Heating Operation or Low Reactor Power:

$$T_{FW}(\text{at rated}) \geq T_{FW}^{DESIGN}(\text{at rated}) - 50°\,F,$$

and rated equivalent at off-rated reactor conditions.

OR

$P \leq 30\%$

b. Case 2 - Reduced Feedwater Heating Operation

$$T_{FW}(\text{at rated}) < T_{FW}^{DESIGN}(\text{at rated}) - 50°\,F,$$

and rated equivalent at off-rated reactor conditions.

AND

$P > 30\%$

Where: T_{FW} is feedwater temperature in °F, and P is reactor power in percent of rated.

REFERENCES

I.1. ECH-NE-09-00033, Revision 0, "Supplemental Reload Licensing Report for River Bend Station - Unit 1 Reload 15 Cycle 16"

I.2. Letter, R.E. Kingston to G. W. Scronce, "Time Constant Values for Simulated Thermal Power Monitor" GFP-1032 November 30, 1995.

I.3. RBS USAR Section 4.1 and 4.2

I.4. CEO 2003-00047, "River Bend Station Unit 1 E1A Stability Power Uprate Evaluation."

I.5. ECH-NE-09-00032, Revision 0, "GE14 Fuel Design Cycle-Independent Analyses For River Bend Station"

I.6. ECH-NE-09-00034, Revision 0, "Fuel Bundle Information Report for River Bend Station - Unit 1 Reload 15 Cycle 16"

ANALYTICAL METHODS DOCUMENTS (TS 5.6.5):

II.1. XN-NF-81-58(P)(A) Revision 2 and Supplements 1 and 2, RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model, Exxon Nuclear Company, March 1984.

II.2. XN-NF-85-67(P)(A) Revision 1, Generic Mechanical Design for Exxon Nuclear Jet Pump BWR Reload Fuel, Exxon Nuclear Company, September 1986.

II.3. EMF-85-74(P) Revision 0 Supplement 1 (P)(A) and Supplement 2 (P)(A), RODEX2A (BWR) Fuel Rod Thermal-Mechanical Evaluation Model, Siemens Power Corporation, February 1998.

II.4. ANF-89-98(P)(A) Revision 1 and Supplement 1, Generic Mechanical Design Criteria for BWR Fuel Designs, Advanced Nuclear Fuels Corporation, May 1995.

II.5. XN-NF-80-19(P)(A) Volume 1 Supplements 1 and 2, Exxon Nuclear Methodology for Boiling Water Reactors – Neutronic Methods for Design and Analysis, Exxon Nuclear Company, March 1983.

II.6. XN-NF-80-19(P)(A) Volume 4 Revision 1, Exxon Nuclear Methodology for Boiling Water Reactors: Application of the ENC Methodology to BWR Reloads, Exxon Nuclear Company, June 1986.

II.7. EMF-2158 (P)(A) Revision 0, Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2, Siemens Power Corporation, October 1999.

II.8. XN-NF-80-19(P)(A) Volume 3 Revision 2, Exxon Nuclear Methodology for Boiling Water Reactors, THERMEX: Thermal Limits Methodology Summary Description, Exxon Nuclear Company, January 1987.

II.9. XN-NF-84-105(P)(A) Volume 1 and Volume 1 Supplements 1 and 2, XCOBRA-T: A Computer Code for BWR Transient Thermal-Hydraulic Core Analysis, Exxon Nuclear Company, February 1987.

II.10. ANF-524(P)(A) Revision 2 and Supplements 1 and 2, ANF Critical Power Methodology for Boiling Water Reactors, Advanced Nuclear Fuels Corporation, November 1990.

II.11. ANF-913(P)(A) Volume 1 Revision 1 and Volume 1 Supplements 2, 3 and 4, COTRANSA2: A Computer Program for Boiling Water Reactor Transient Analyses, Advanced Nuclear Fuels Corporation, August 1990.

II.12. XN-NF-825(P)(A) Supplement 2, BWR/6 Generic Rod Withdrawal Error Analysis, MCPRp for Plant Operations within the Extended Operating Domain, Exxon Nuclear Company, October 1986.

II.13. ANF-1358(P)(A) Revision 3, The Loss of Feedwater Heating Transient in Boiling Water Reactors, Advanced Nuclear Fuels Corporation, September 2005.

II.14. EMF-1997(P)(A) Revision 0, ANFB-10 Critical Power Correlation, Siemens Power Corporation, July 1998.

II.15. EMF-1997(P) Supplement 1 (P)(A) Revision 0, ANFB-10 Critical Power Correlation: High Local Peaking Results, Siemens Power Corporation, July 1998.

II.16. EMF-2209(P)(A) Revision 2, SPCB Critical Power Correlation, Siemens Power Corporation, September 2003.

II.17. EMF-2245(P)(A) Revision 0, Application of Siemens Power Corporation's Critical Power Correlations to Co-Resident Fuel, Siemens Power Corporation, August 2000.

II.18. EMF-2361(P)(A), Revision 0 "EXEM BWR-2000 ECCS Evaluation Model," Framatome ANP Richland, Inc.

II.19. Deleted.

II.20. Deleted.

II.21. NEDC-33383-P, Revision 1, GEXL97 Correlation for Atrium 10 Fuel, (See Echelon EB document ID RA-ENO-GEN-08-039)

II.22. EMF-CC-074(P)(A) Volume 4 Revision 0, BWR Stability Analysis: Assessment of STAIF with Input from MICROBURN-B2, Siemens Power Corporation, August 2000.

II.23. EMF-2292(P)(A) Revision 0, ATRIUM™-10 Appendix K Spray Heat Transfer Coefficients, Siemens Power Corporation, September 2000.

II.24. NEDE-24011-P-A and US Supplement, "General Electric Standard Application for Reactor Fuel."

Table 1. Aligned Drive Flow

$$W_D = \frac{101.209 \cdot \Delta^{40} - 31.028 \cdot \Delta^{100} + 70.181 \cdot W_{\tilde{D}}}{70.181 - (\Delta^{100} - \Delta^{40})}$$

Where:

$W_{\tilde{D}}$ = FCTR card input drive flow in percent rated,

W_D = Aligned drive flow in percent rated,

Δ^{40} = Low flow drive flow alignment setting, and

Δ^{100} = High flow drive flow alignment setting.

FIGURE 1. REFERENCE CORE LOADING PATTERN

	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55
56											D	D	D	D	D	D	D	D										
54								C	D	D	D	F	F	D	D	F	F	D	D	D	C							
52							D	D	F	E	B	F	B	F	F	B	F	B	E	F	D	D						
50						D	D	D	E	B	E	B	F	B	B	F	B	E	B	E	D	D	D					
48					D	D	D	F	B	E	B	F	B	D	D	B	F	B	E	B	F	D	D	D				
46				D	D	F	F	B	F	B	F	A	F	A	A	F	A	F	B	F	B	F	F	D	D			
44			D	D	D	F	B	F	B	D	A	F	B	D	D	B	F	A	D	B	F	B	F	D	D	D		
42		C	D	D	F	B	F	B	F	B	D	B	F	A	A	F	B	D	B	F	B	F	B	F	D	D	C	
40		D	F	E	B	F	B	F	B	F	B	D	B	F	F	B	D	B	F	B	F	B	F	B	E	F	D	
38		D	E	B	E	B	D	B	F	A	E	B	E	A	A	E	B	E	A	F	B	D	B	E	B	E	D	
36	D	D	B	E	B	F	A	D	B	E	B	D	A	E	E	A	D	B	E	B	D	A	F	B	E	B	D	D
34	D	F	F	B	F	A	F	B	D	B	D	A	D	A	A	D	A	D	B	D	B	F	A	F	B	F	F	D
32	D	F	B	F	B	F	B	F	B	E	A	D	F	F	F	F	D	A	E	B	F	B	F	B	F	B	F	D
30	D	D	F	B	D	A	D	A	F	A	E	A	F	D	D	F	A	E	A	F	A	D	A	D	B	F	D	D
28	D	D	F	B	D	A	D	A	F	A	E	A	F	D	D	F	A	E	A	F	A	D	A	D	B	F	D	D
26	D	F	B	F	B	F	B	F	B	E	A	D	F	F	F	F	D	A	E	B	F	B	F	B	F	B	F	D
24	D	F	F	B	F	A	F	B	D	B	D	A	D	A	A	D	A	D	B	D	B	F	A	F	B	F	F	D
22	D	D	B	E	B	F	A	D	B	E	B	D	A	E	E	A	D	B	E	B	D	A	F	B	E	B	D	D
20		D	E	B	E	B	D	B	F	A	E	B	E	A	A	E	B	E	A	F	B	D	B	E	B	E	D	
18		D	F	E	B	F	B	F	B	F	B	D	B	F	F	B	D	B	F	B	F	B	F	B	E	F	D	
16		C	D	D	F	B	F	B	F	B	D	B	F	A	A	F	B	D	B	F	B	F	B	F	D	D	C	
14			D	D	D	F	B	F	B	D	A	F	B	D	D	B	F	A	D	B	F	B	F	D	D	D		
12				D	D	F	F	B	F	B	F	A	F	A	A	F	A	F	B	F	B	F	F	D	D			
10					D	D	D	F	B	E	B	F	B	D	D	B	F	B	E	B	F	D	D	D				
8						D	D	D	E	B	E	B	F	B	B	F	B	E	B	E	D	D	D					
6							D	D	F	E	B	F	B	F	F	B	F	B	E	F	D	D						
4								C	D	D	D	F	F	D	D	F	F	D	D	D	C							
2											D	D	D	D	D	D	D	D										

Fuel Type	Description	Cycle Loaded	# Loaded
A	GE14-P10SNAB410-18GZ-120T-150-T6-3197	16	64
B	GE14-P10SNAB409-17GZ-120T-150-T6-3196	16	152
C	ATRM10-P10SAEB378-9GZ-114T-9WR-149-T6-3065	13	8
D	ATRM10-P10SAEB371-13GZ-114T-9WR-149-T6-3067	14	184
E	ATRM10-P10SAEB385-12GZ-114T-9WR-149-T6-3068	15	56
F	ATRM10-P10SAEB381-14GZ-114T-9WR-149-T6-3069	15	160
	Total		624

FIGURE 2. MONITORED REGION BOUNDARY (CASE 1)

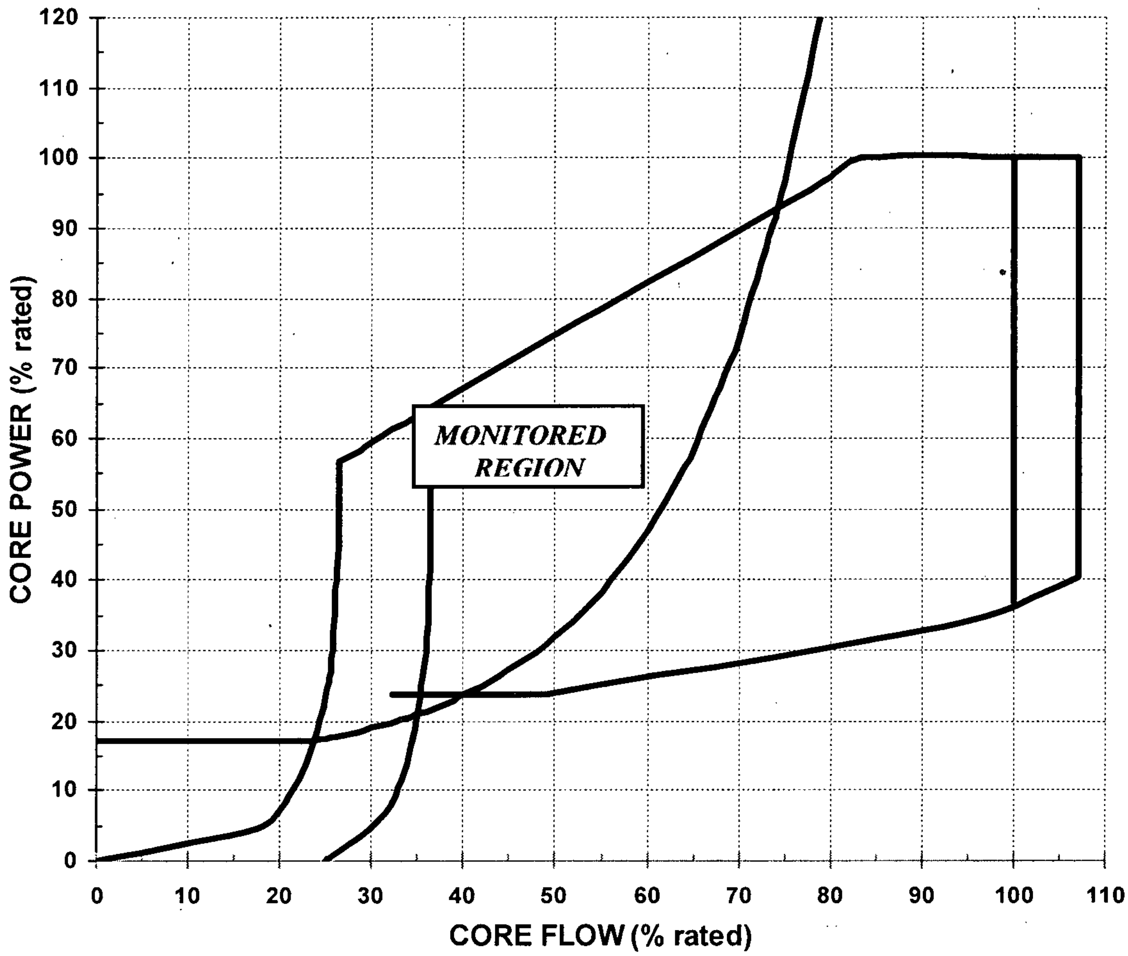


FIGURE 3. MONITORED REGION BOUNDARY (CASE 2)

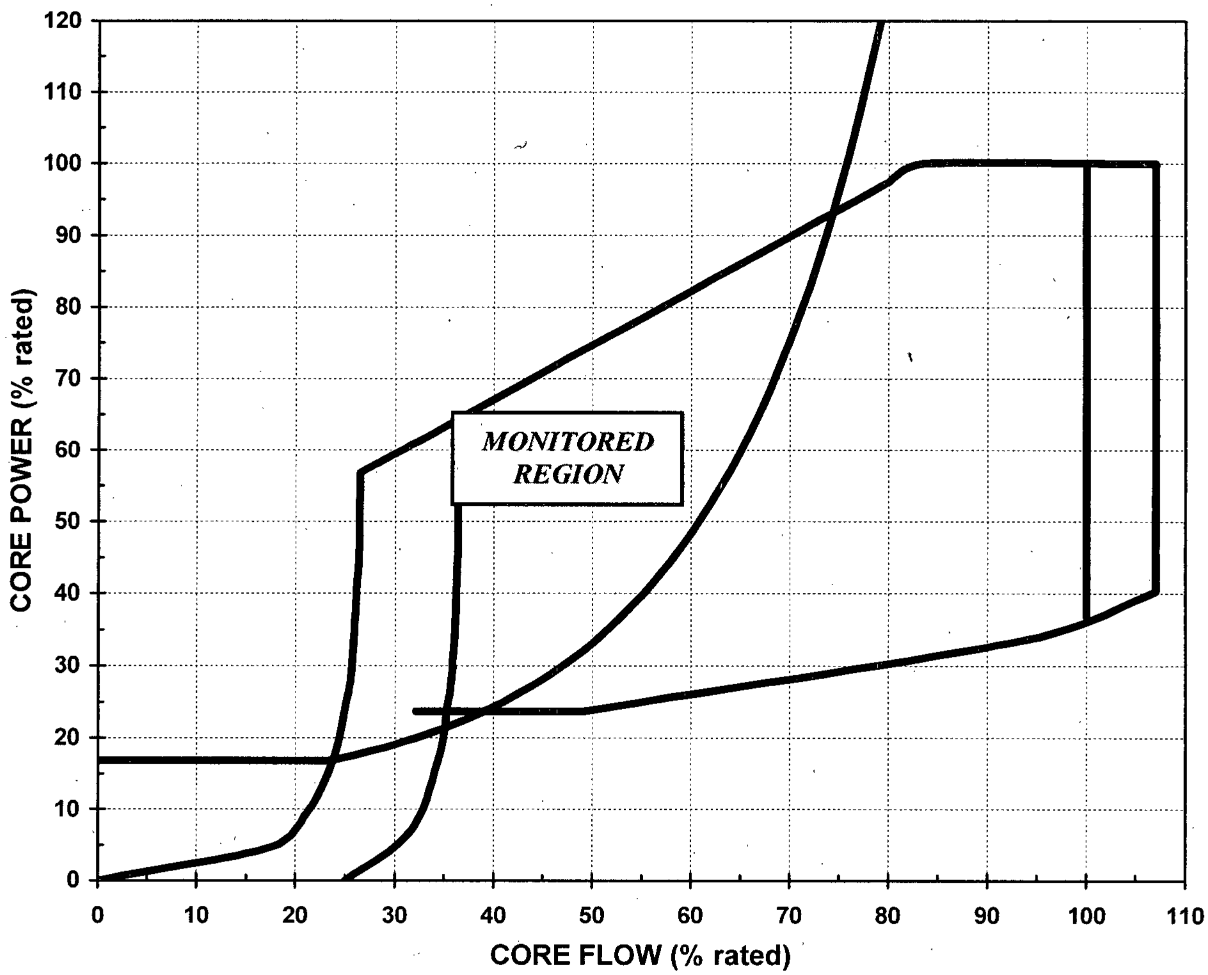


FIGURE 4. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY

(TWO RECIRCULATION LOOP OPERATION - CASE 1)

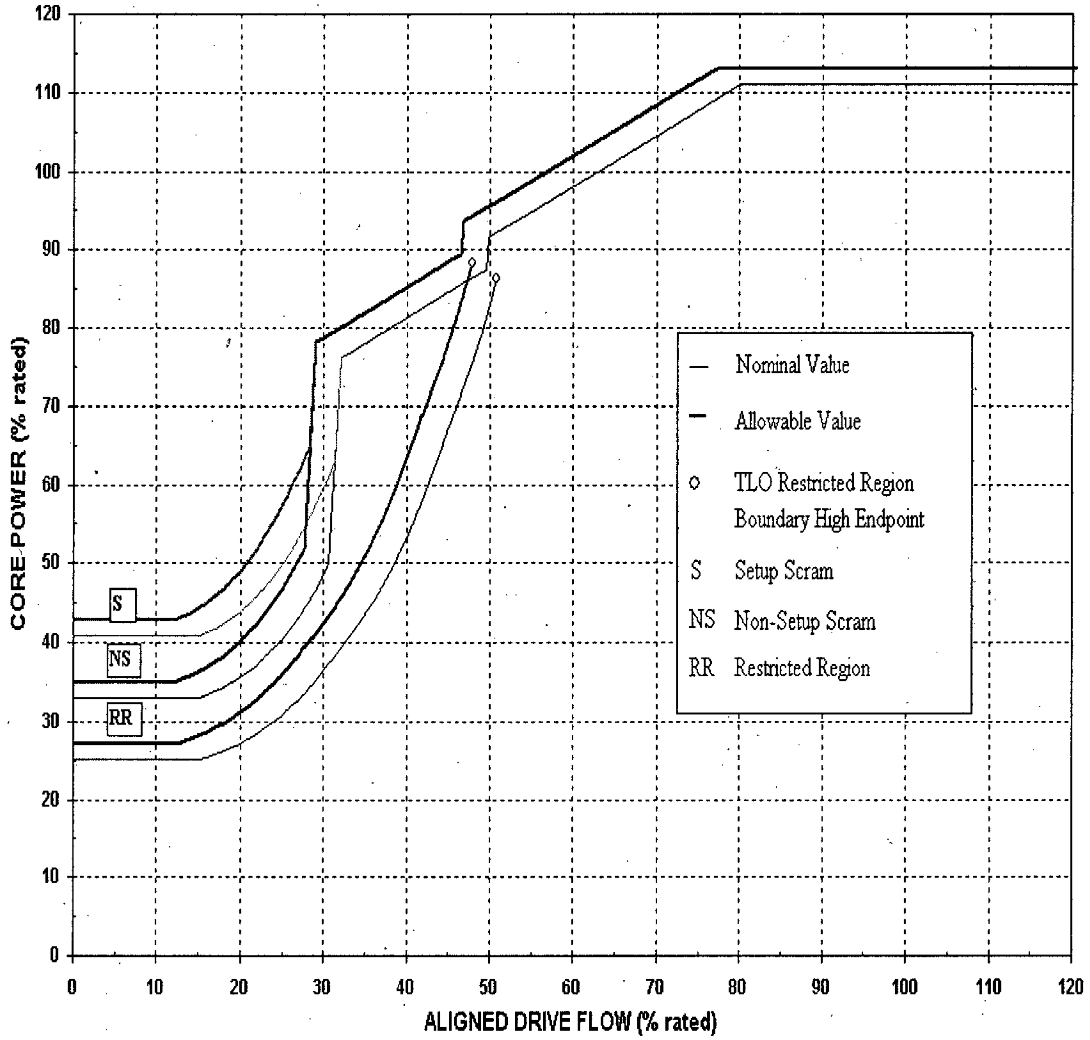


FIGURE 5. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY
(SINGLE RECIRCULATION LOOP OPERATION - CASE 1)

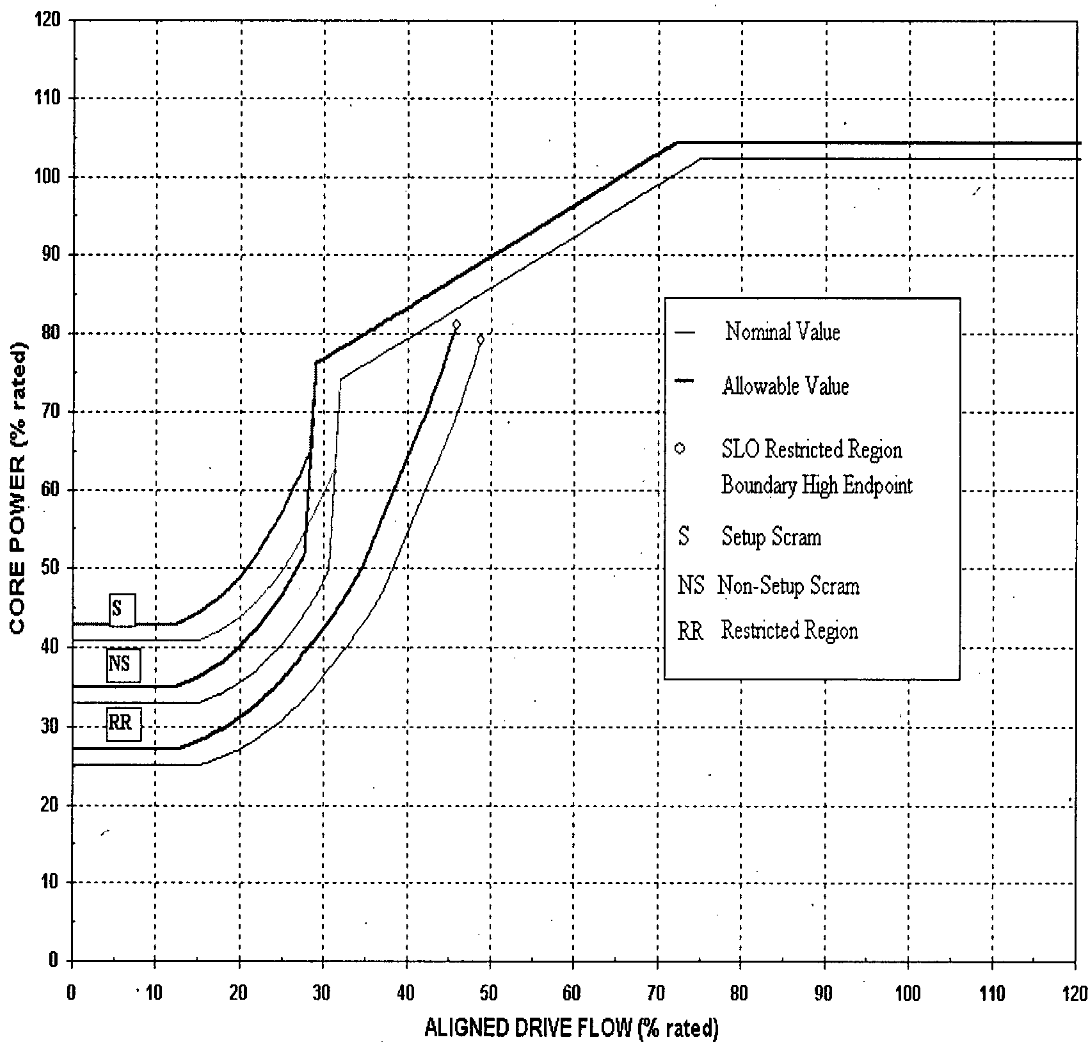


FIGURE 6. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY
(TWO RECIRCULATION LOOP OPERATION - CASE 2)

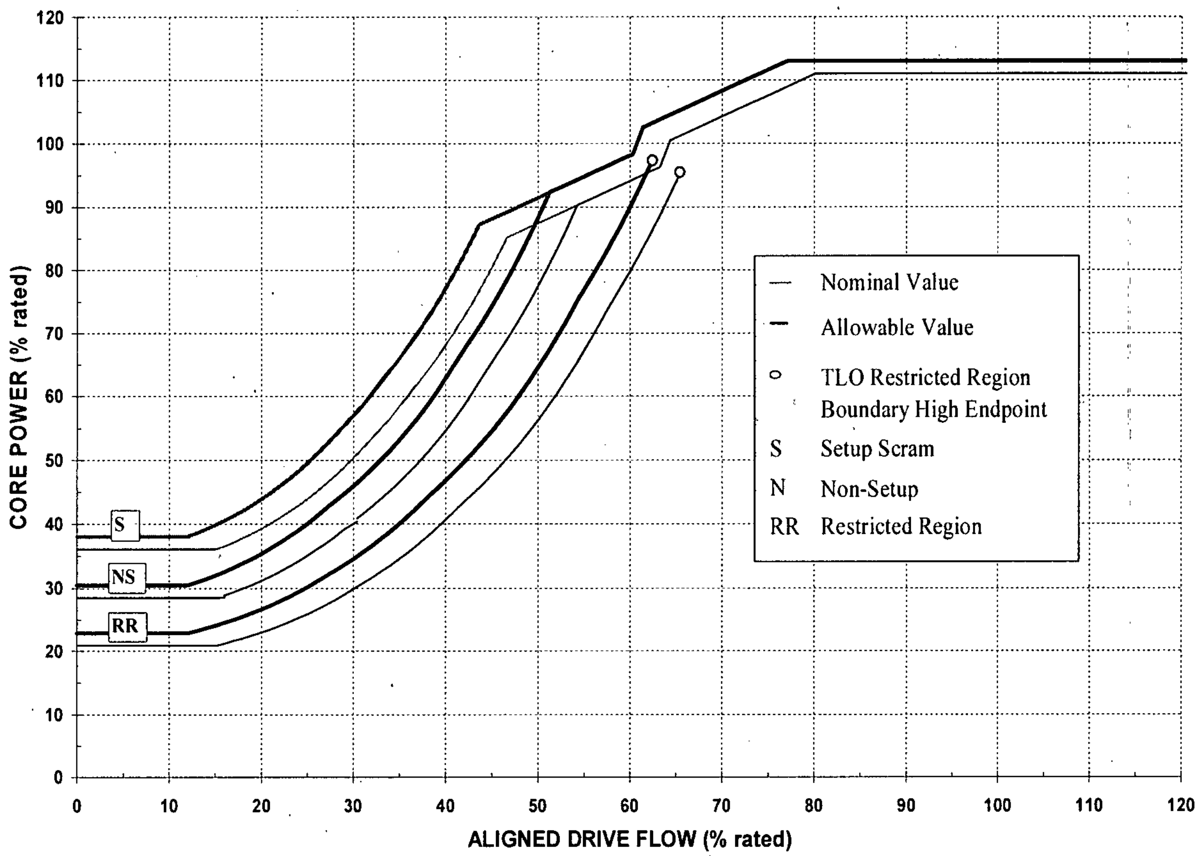


FIGURE 7. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY

(SINGLE RECIRCULATION LOOP OPERATION - CASE 2)

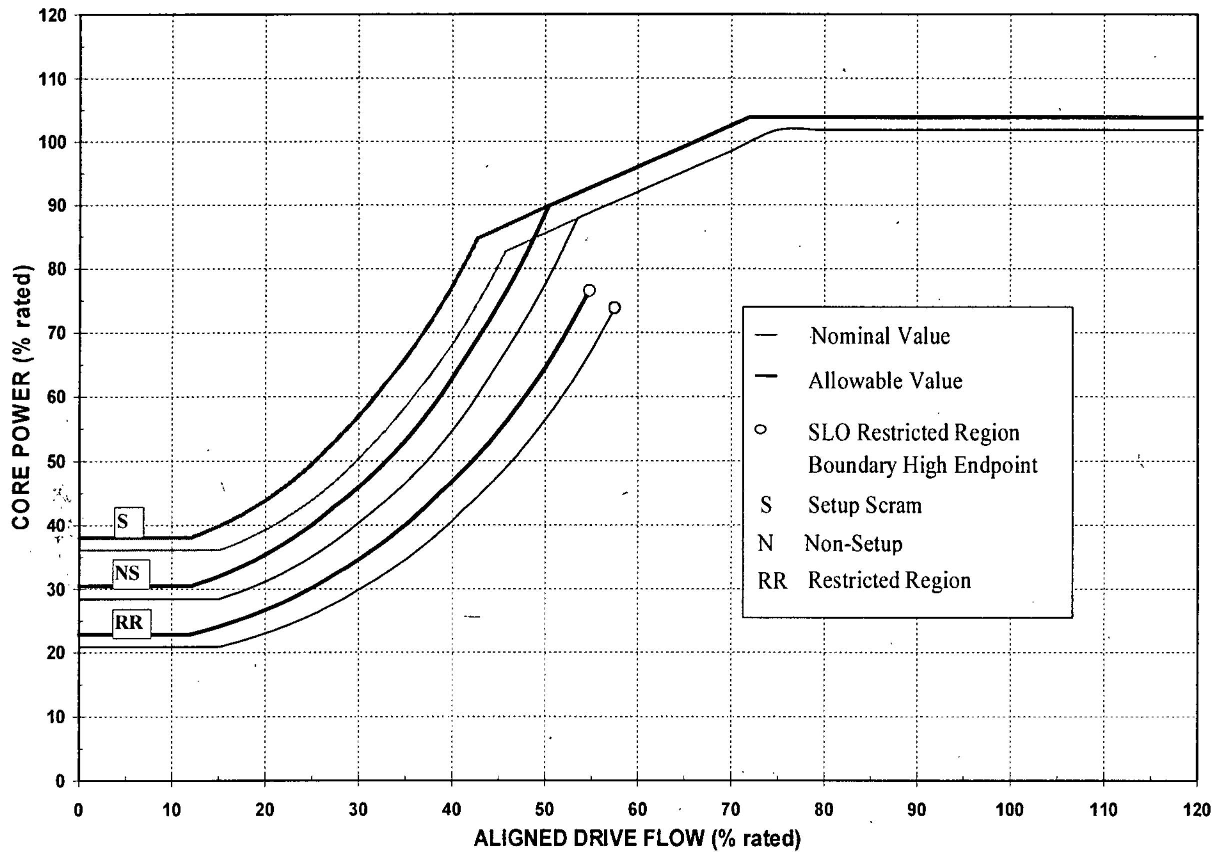


FIGURE 8. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(TWO RECIRCULATION LOOP OPERATION - CASE 1)

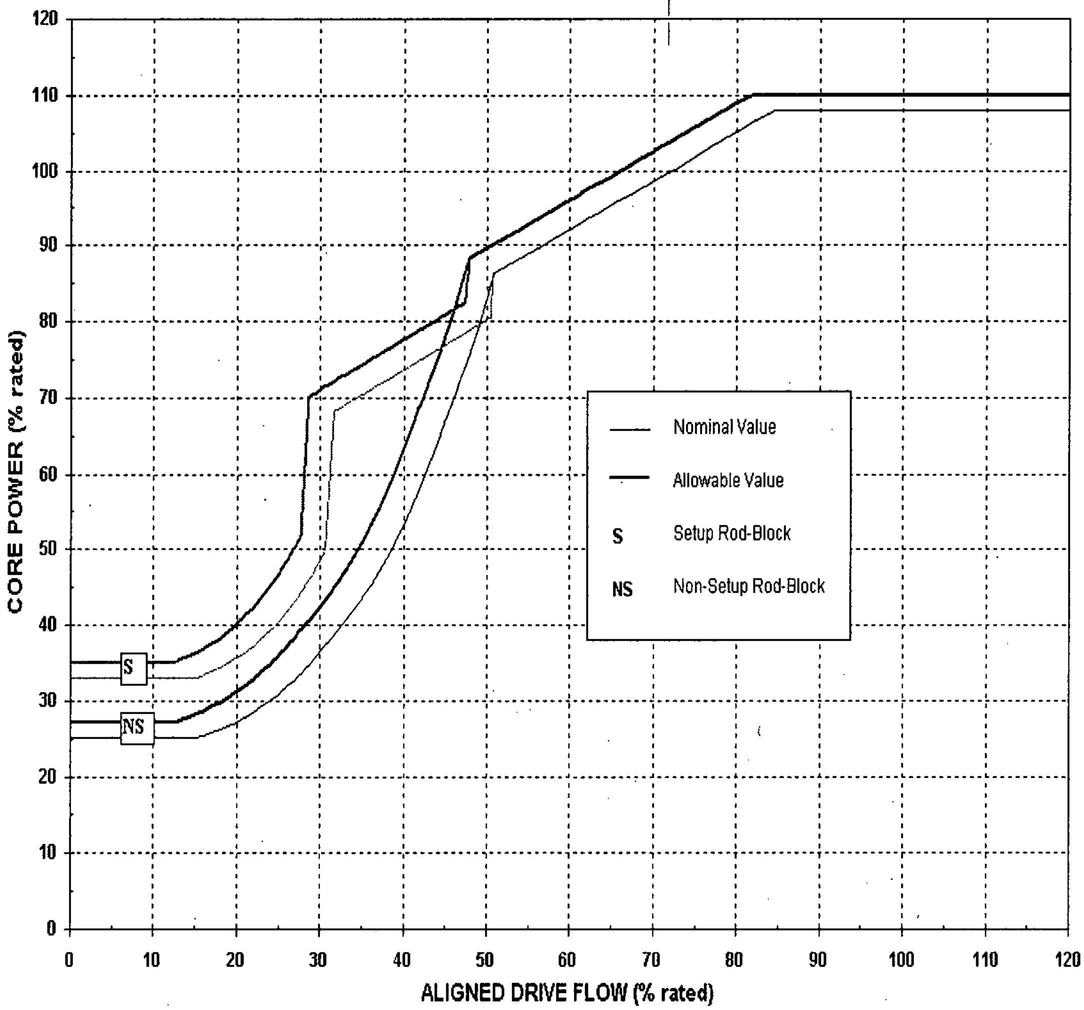


FIGURE 9. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(SINGLE RECIRCULATION LOOP OPERATION - CASE 1)

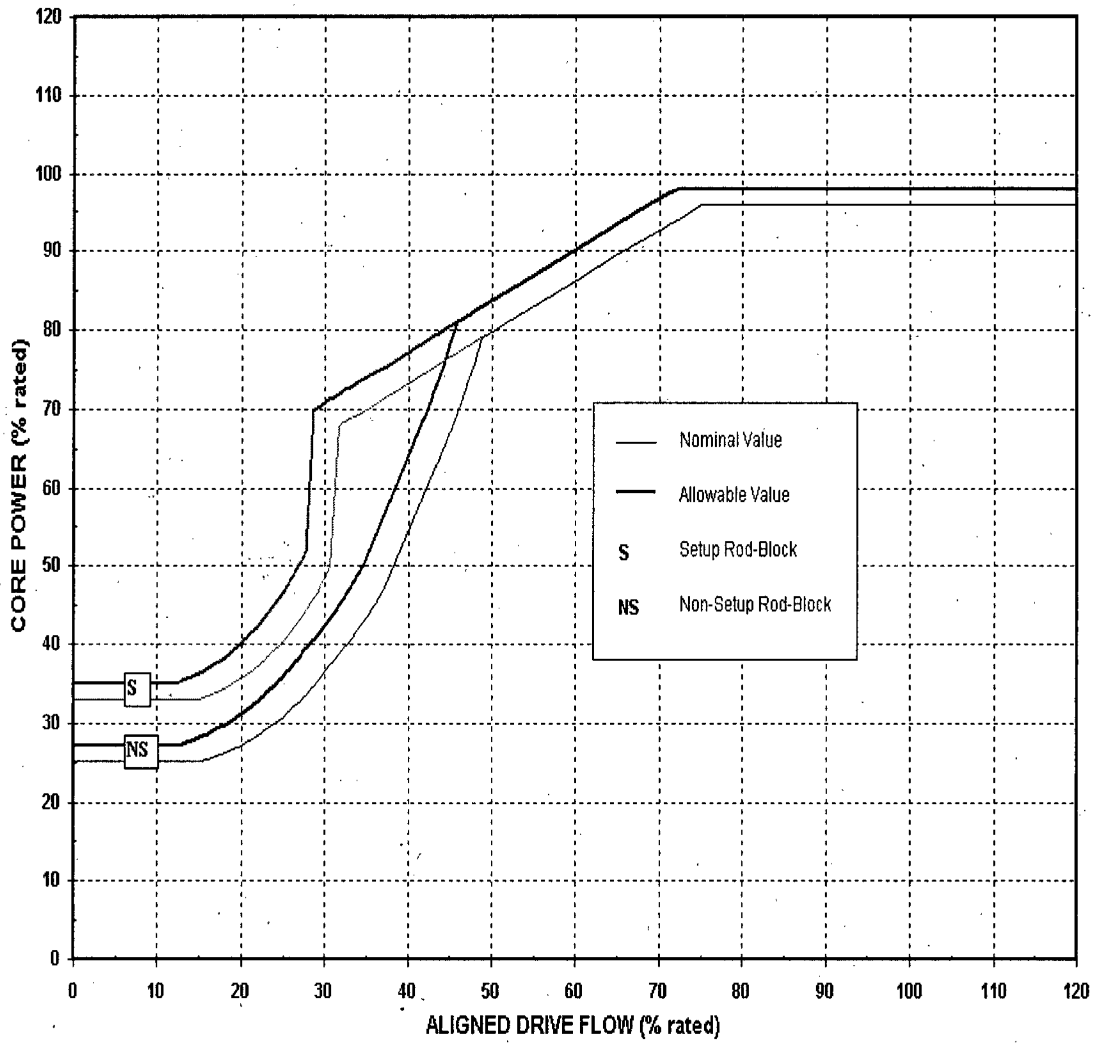


FIGURE 10. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(TWO RECIRCULATION LOOP OPERATION - CASE 2)

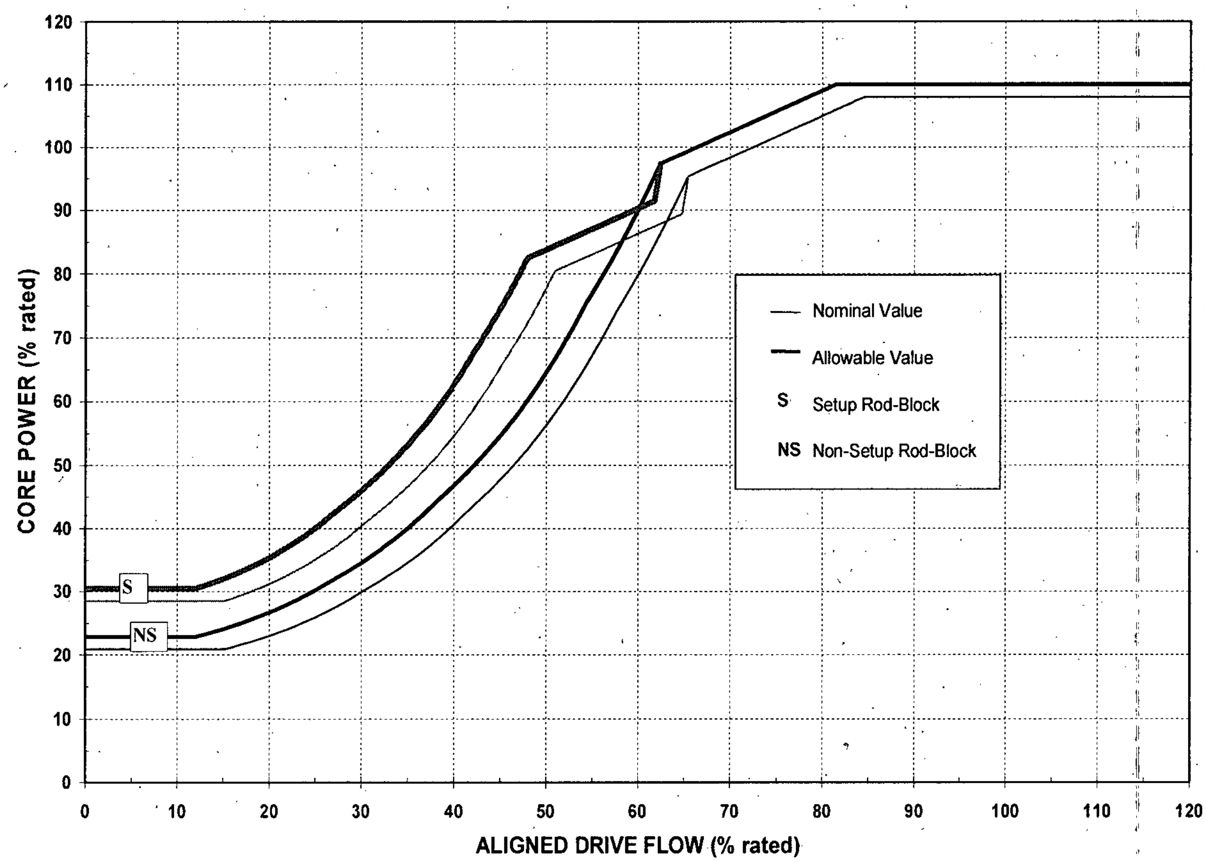


FIGURE 11. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(SINGLE RECIRCULATION LOOP OPERATION - CASE 2)

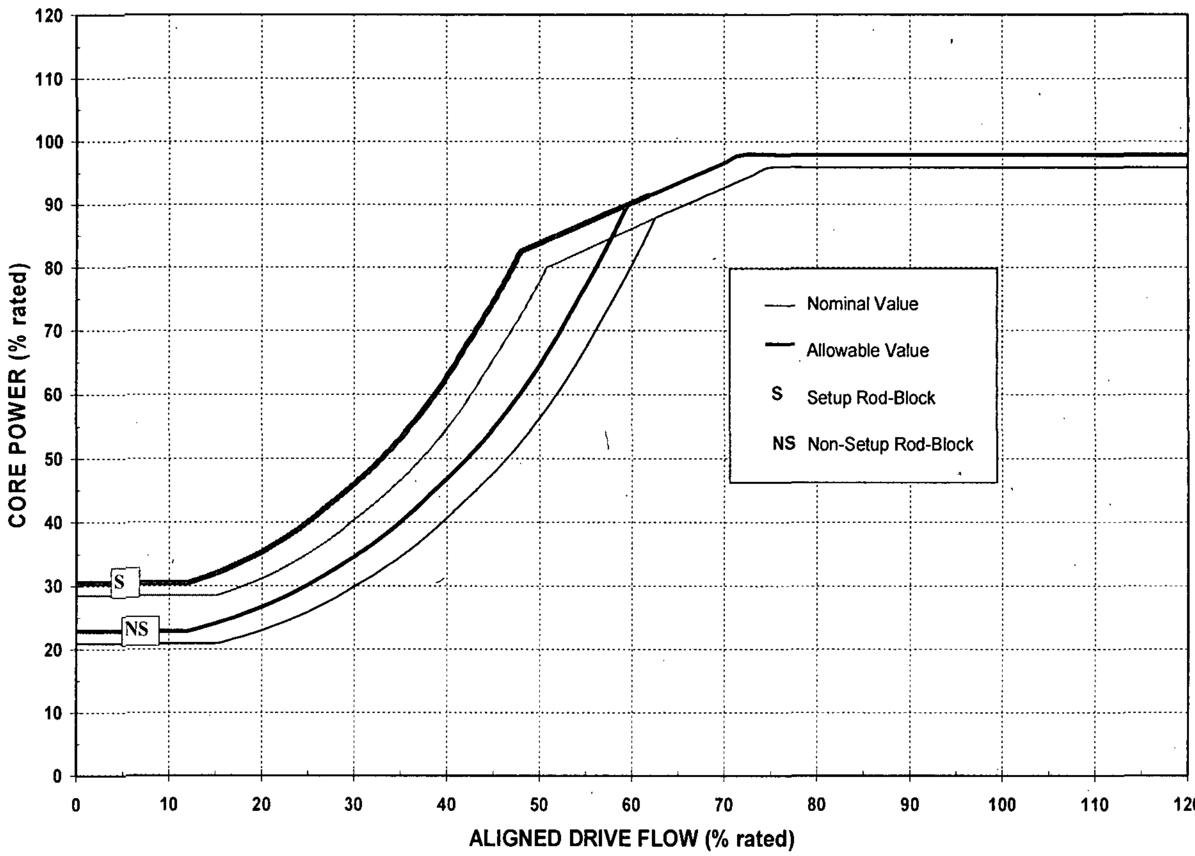
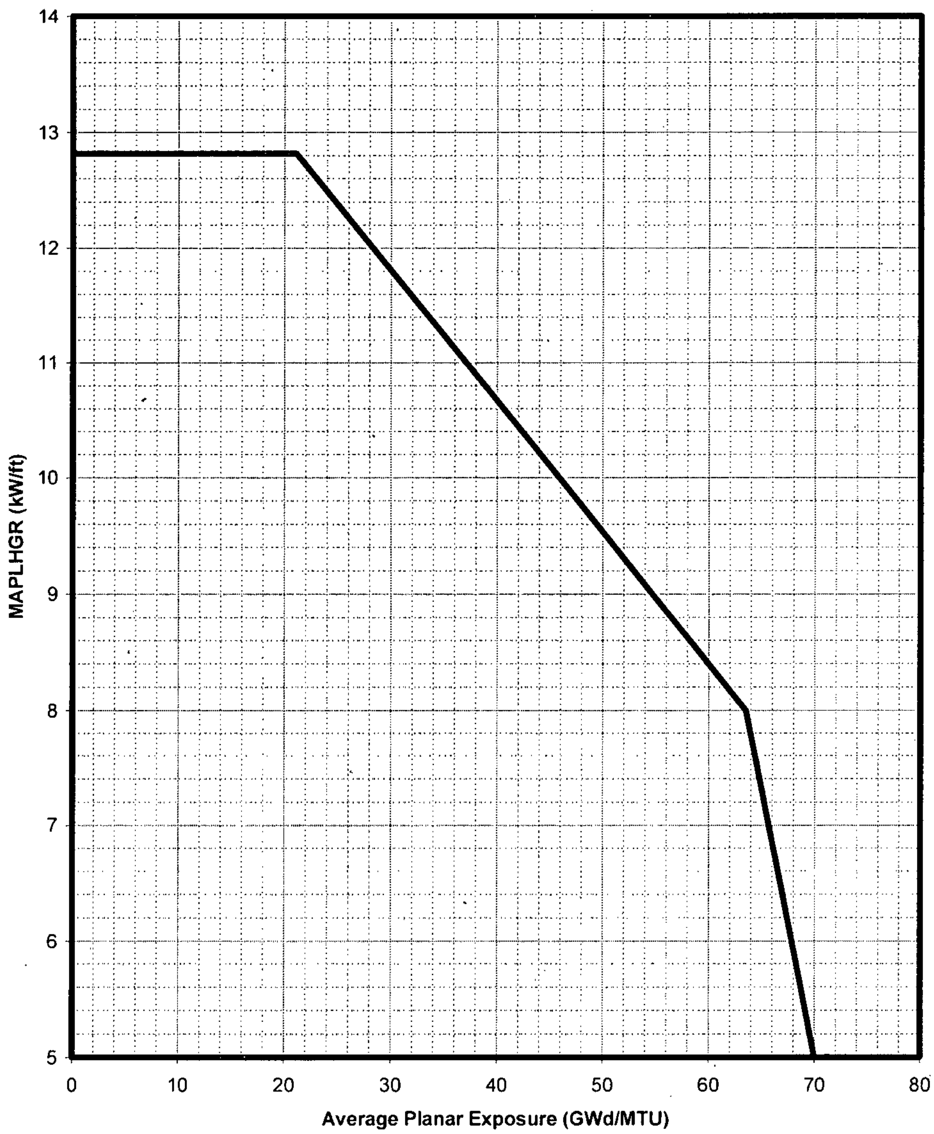
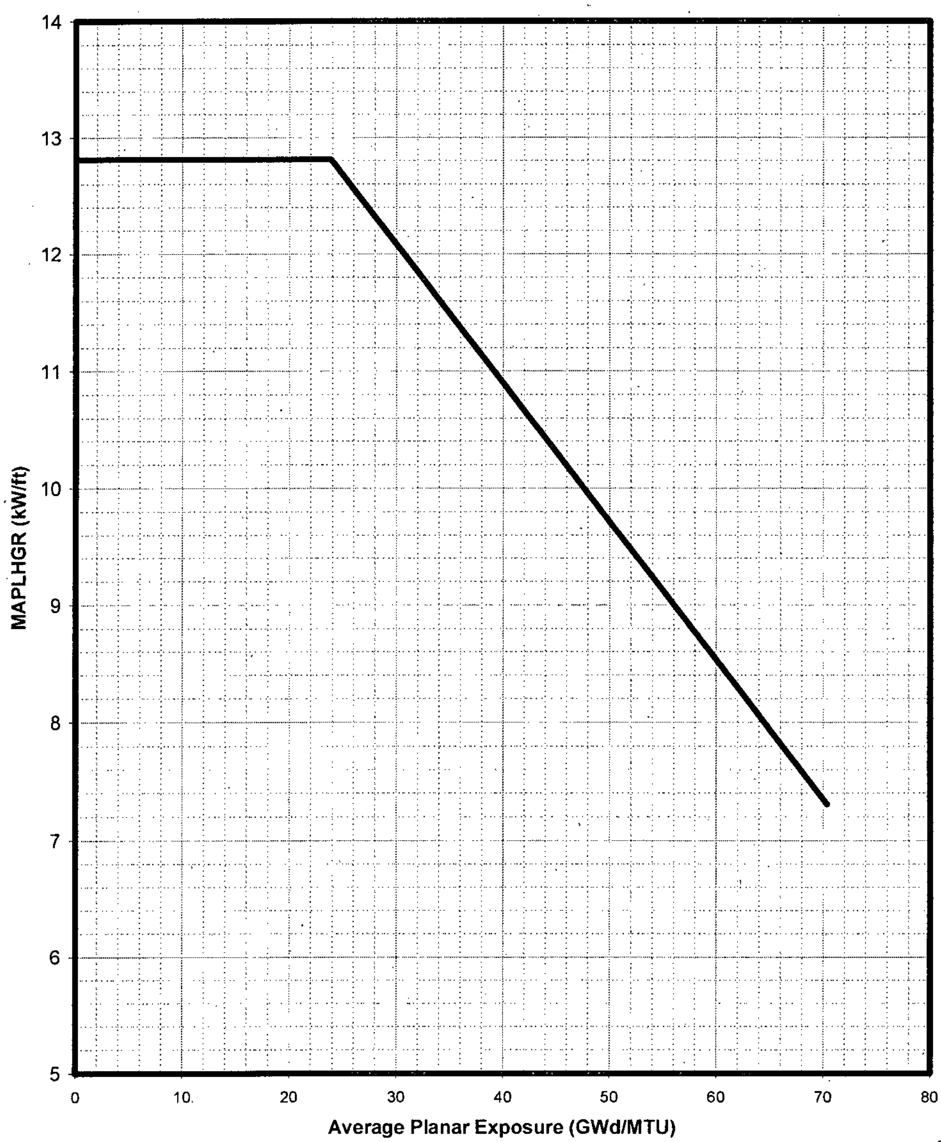


FIGURE 12. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FOR GE14



Average Planar Exposure (GWD/MT)	MAPLHGR Limit (kW/ft)
0.00	12.82
16.00	12.82
21.10	12.82
63.50	8.00
70.00	5.00

FIGURE 13. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FOR ATRIUM-10

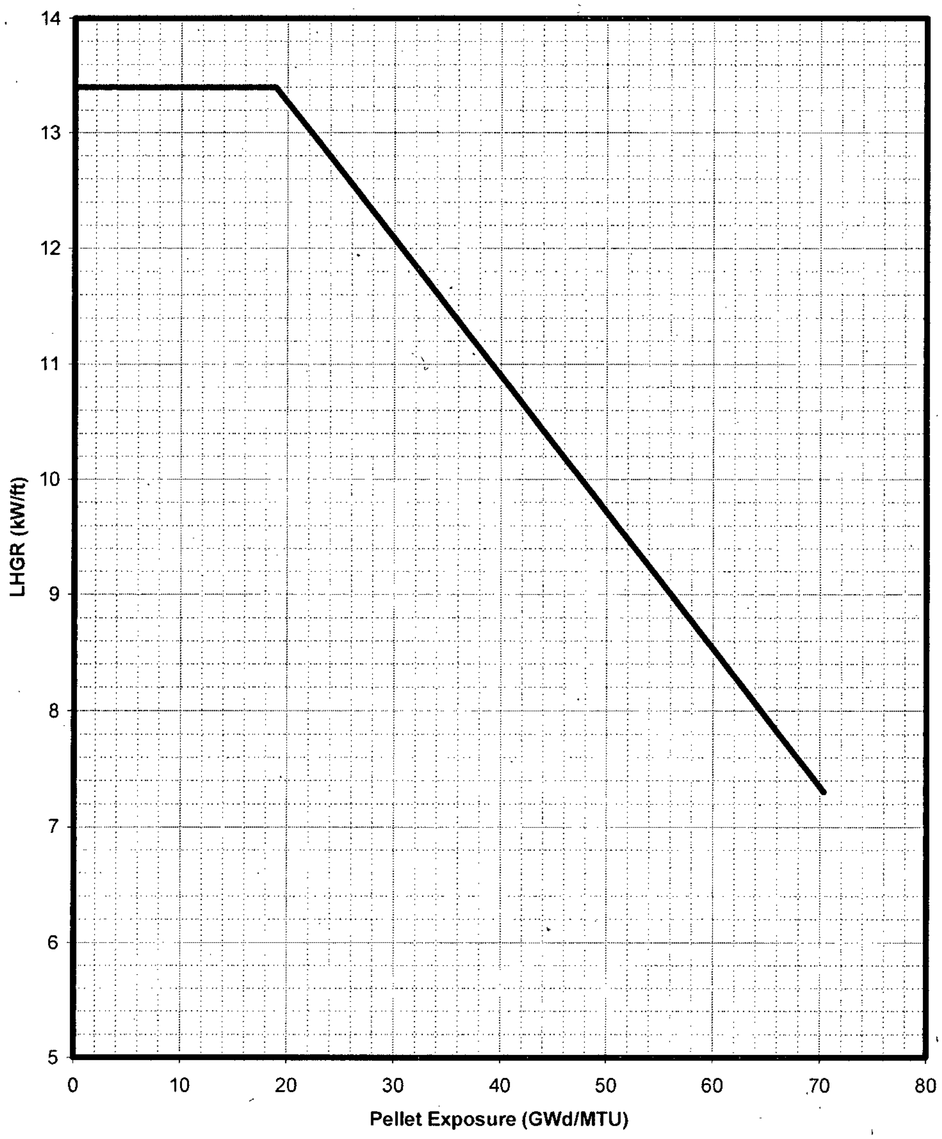


Average Planar Exposure (GWD/MT)	MAPLHGR Limit (kW/ft)
0.00	12.81
18.90	12.81
23.88	12.81
70.40	7.30

FIGURE 14. LINEAR HEAT GENERATION RATE (LHGR) LIMIT VERSUS PELLET EXPOSURE FOR GE14

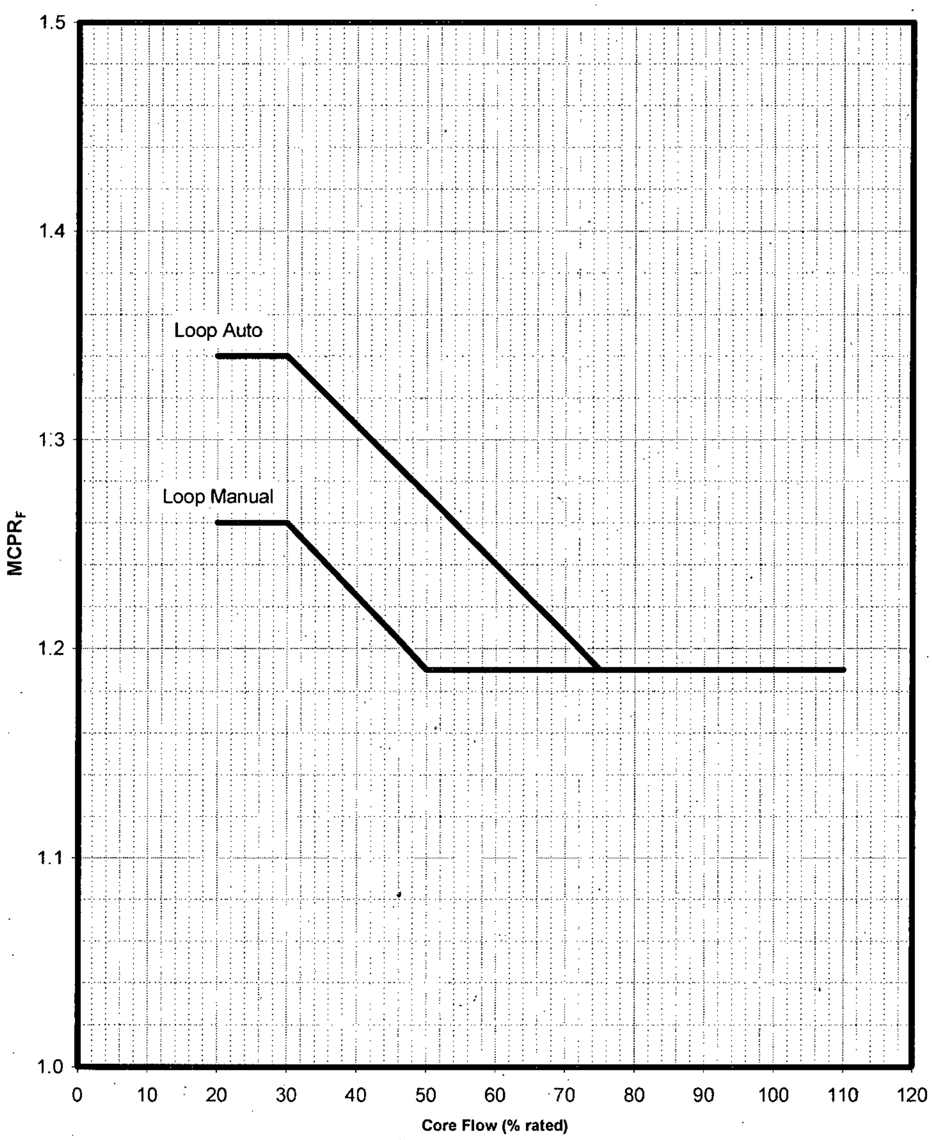
GE14 LHGR data is considered GNF proprietary and will not be contained in the COLR. The GE14 LHGR data may be found in Reference I.6.

FIGURE 15. LINEAR HEAT GENERATION RATE (LHGR) LIMIT VERSUS PELLET EXPOSURE FOR ATRIUM-10



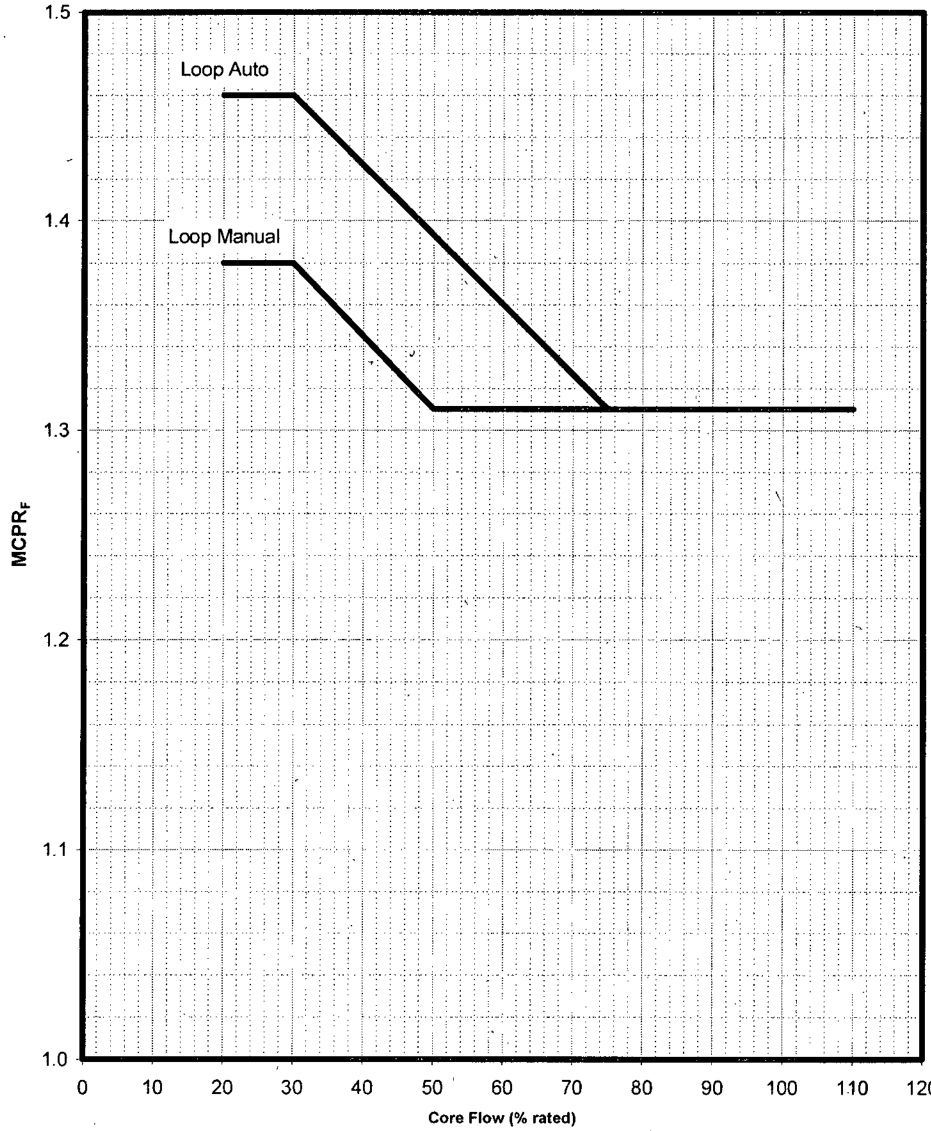
Peak Pellet Exposure (GWd/MT)	LHGR Limit (kW/ft)
0.00	13.4
18.90	13.4
70.40	7.3

FIGURE 16. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR ATRIUM-10 AND GE14, ALL EXPOSURES, APPLICATION CONDITIONS 1, 2, AND 3



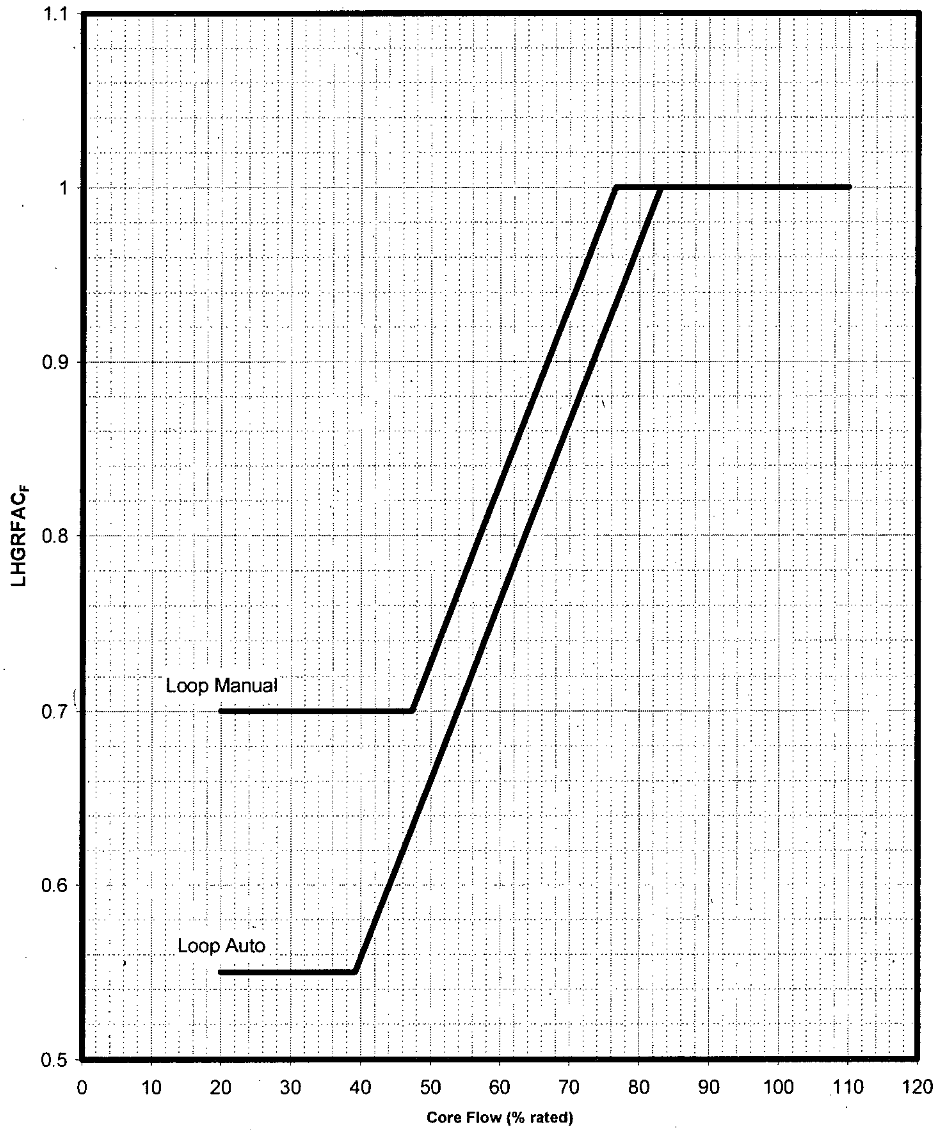
Loop Manual		Loop Auto	
Core Flow (% rated)	$MCPR_F$	Core Flow (% rated)	$MCPR_F$
20	1.26	20	1.34
30	1.26	30	1.34
50	1.19	75	1.19
110	1.19	110	1.19

FIGURE 17. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR ATRIUM-10 AND GE14, ALL EXPOSURES, APPLICATION CONDITIONS 4, 5, 6, AND 7



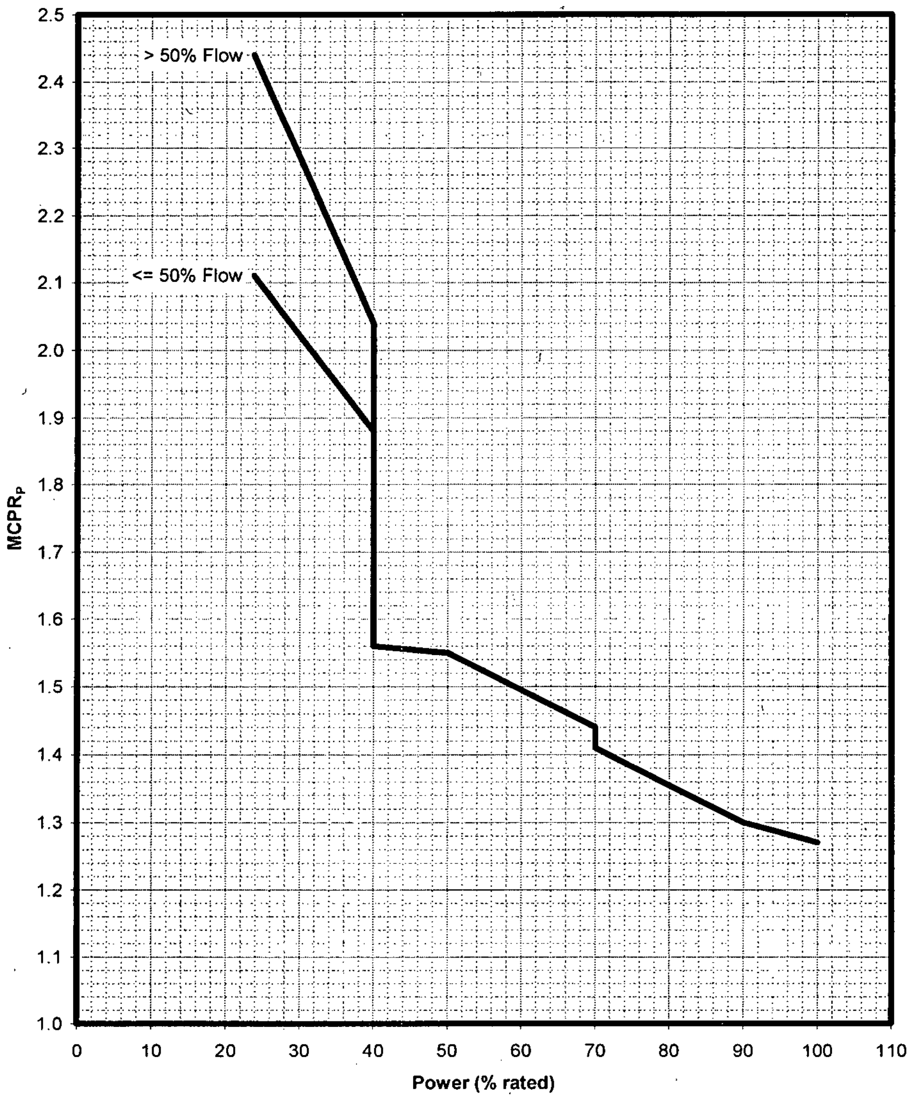
Loop Manual		Loop Auto	
Core Flow (% rated)	$MCPR_F$	Core Flow (% rated)	$MCPR_F$
20	1.38	20	1.46
30	1.38	30	1.46
50	1.31	75	1.31
110	1.31	110	1.31

FIGURE 18. LHGR MULTIPLIER VERSUS CORE FLOW ($LHGRFAC_F$) FOR ATRIUM-10 AND GE14, ALL EXPOSURES, ALL APPLICATION CONDITIONS



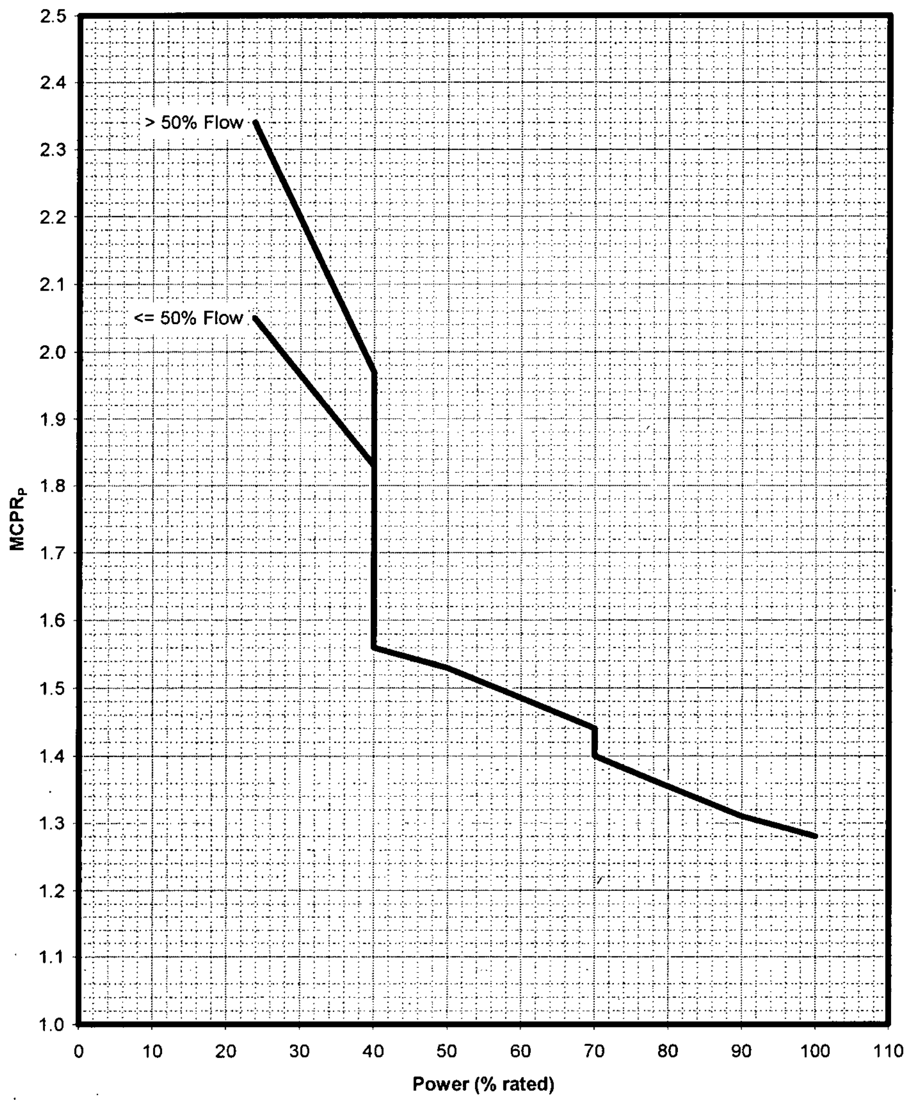
Loop Manual		Loop Auto	
Flow (% rated)	$LHGRFAC_F$	Flow (% rated)	$LHGRFAC_F$
20.00	0.70	20.00	0.55
47.30	0.70	39.20	0.55
76.60	1.00	83.10	1.00
110.00	1.00	110.00	1.00

FIGURE 19. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 1



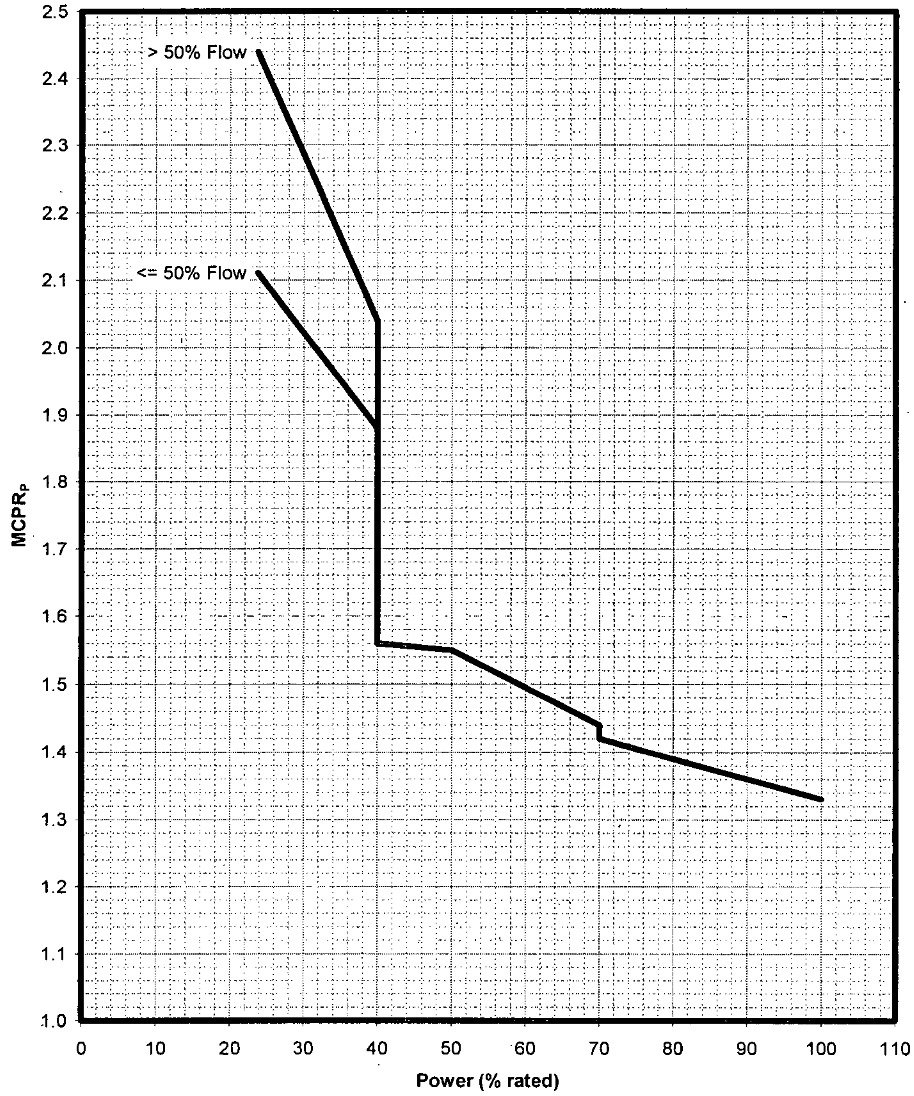
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.11	2.44
40.0	1.88	2.04
40.0		1.56
50.0		1.55
70.0		1.44
70.0		1.41
90.0		1.30
100.0		1.27

FIGURE 20. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 1



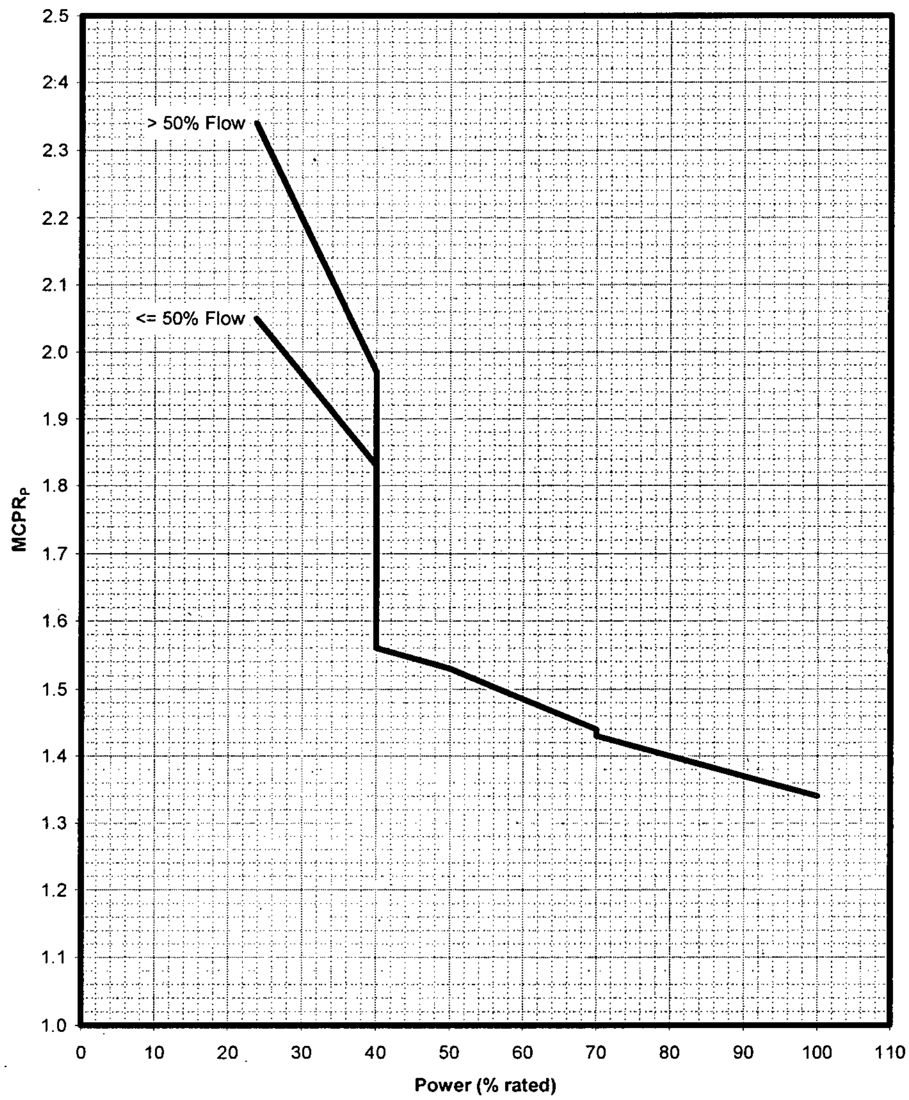
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.05	2.34
40.0	1.83	1.97
40.0		1.56
50.0		1.53
70.0		1.44
70.0		1.40
90.0		1.31
100.0		1.28

FIGURE 21. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 2



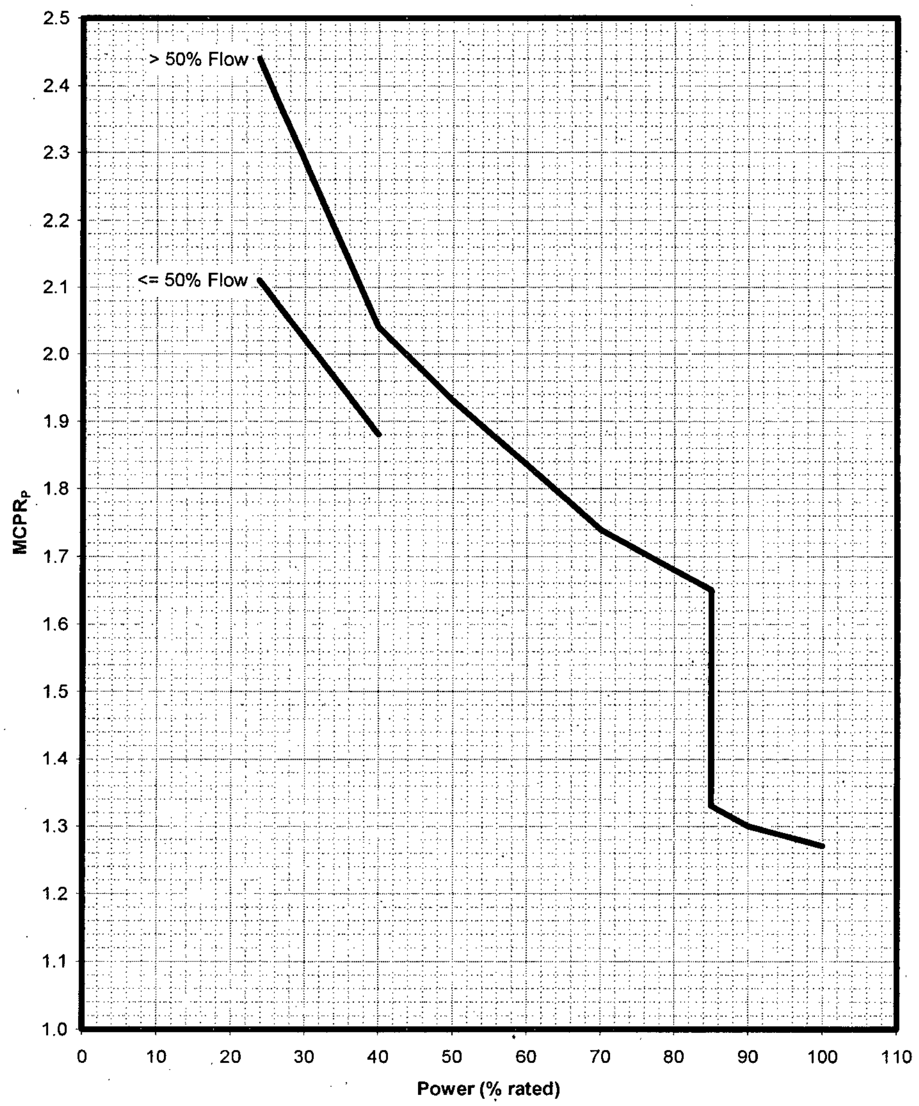
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.11	2.44
40.0	1.88	2.04
40.0		1.56
50.0		1.55
70.0		1.44
70.0		1.42
90.0		1.36
100.0		1.33

FIGURE 22. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 2



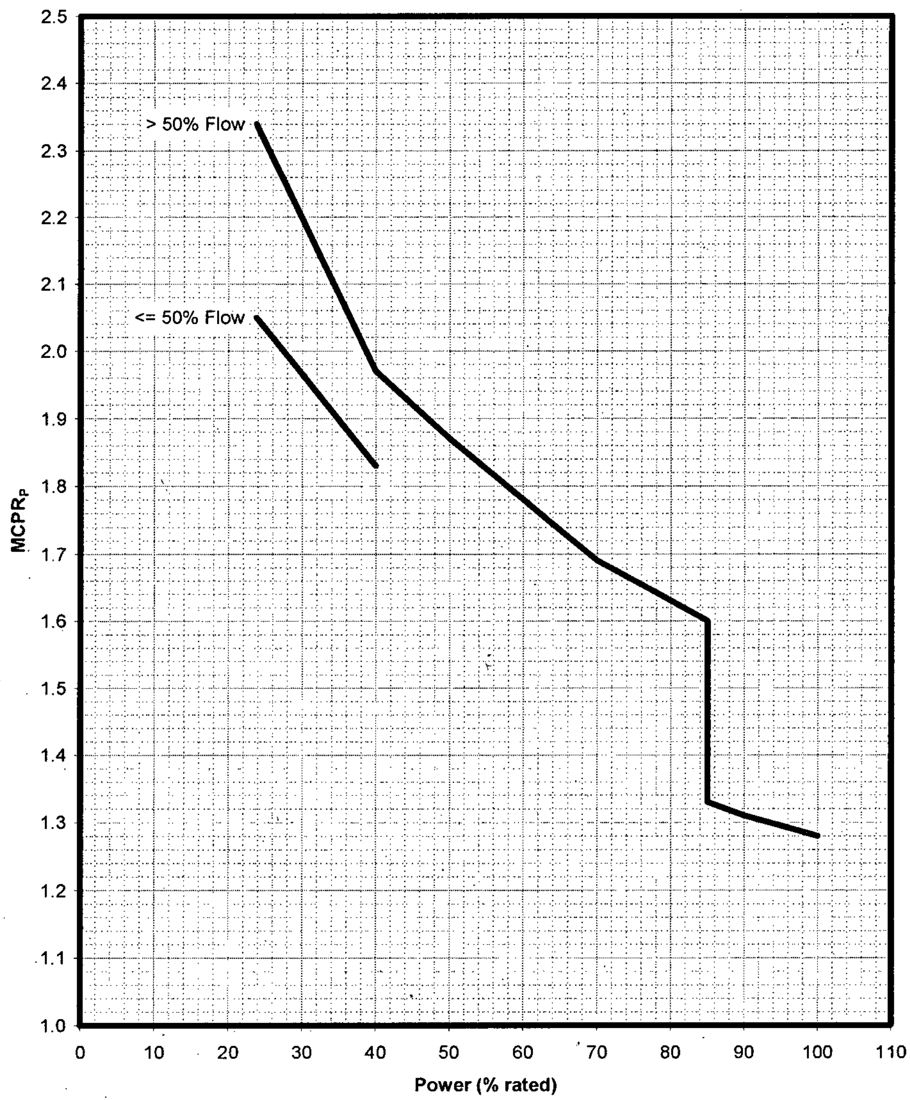
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.05	2.34
40.0	1.83	1.97
40.0		1.56
50.0		1.53
70.0		1.44
70.0		1.43
90.0		1.37
100.0		1.34

FIGURE 23. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 3



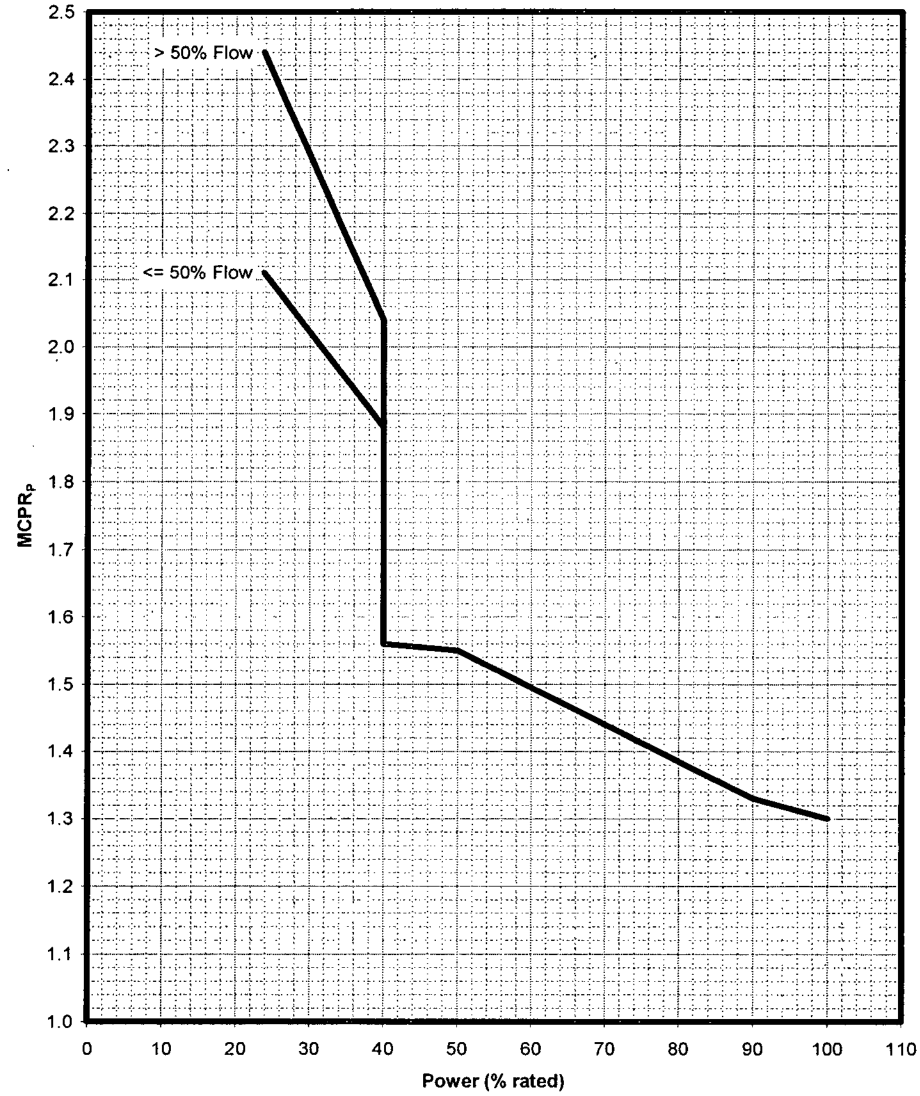
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.11	2.44
40.0	1.88	2.04
40.0		2.04
50.0		1.93
70.0		1.74
85.0		1.65
85.0		1.33
90.0		1.30
100.0		1.27

FIGURE 24. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 3



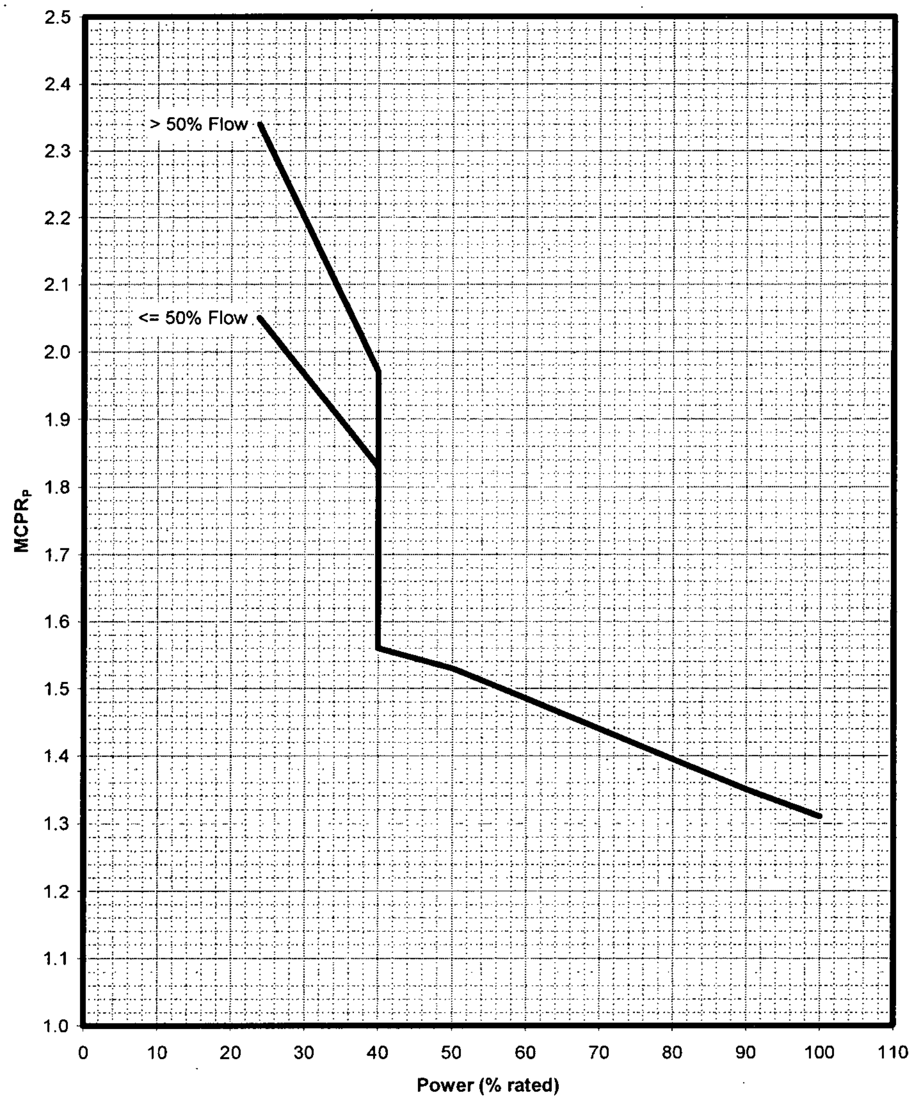
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.05	2.34
40.0	1.83	1.97
40.0		1.97
50.0		1.87
70.0		1.69
85.0		1.60
85.0		1.33
90.0		1.31
100.0		1.28

FIGURE 25. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 4



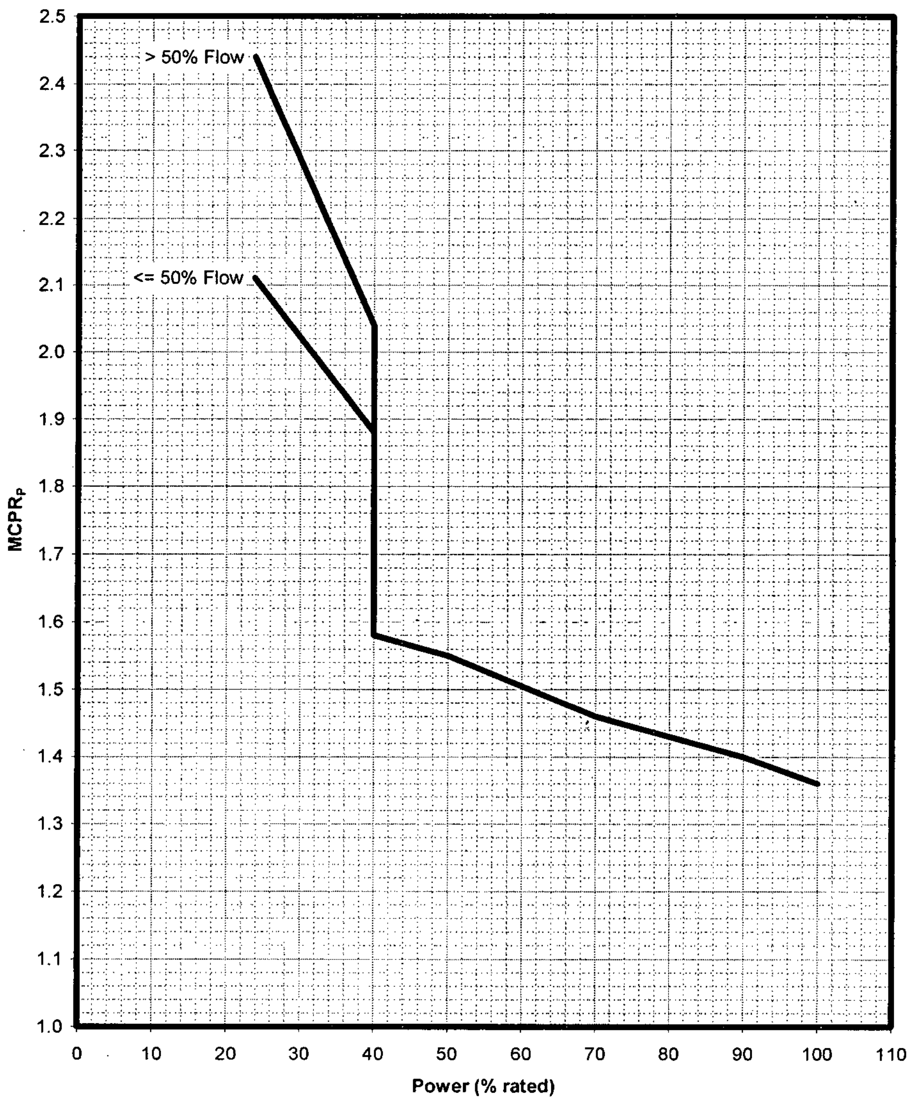
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.11	2.44
40.0	1.88	2.04
40.0		1.56
50.0		1.55
70.0		1.44
90.0		1.33
100.0		1.30

FIGURE 26. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 4



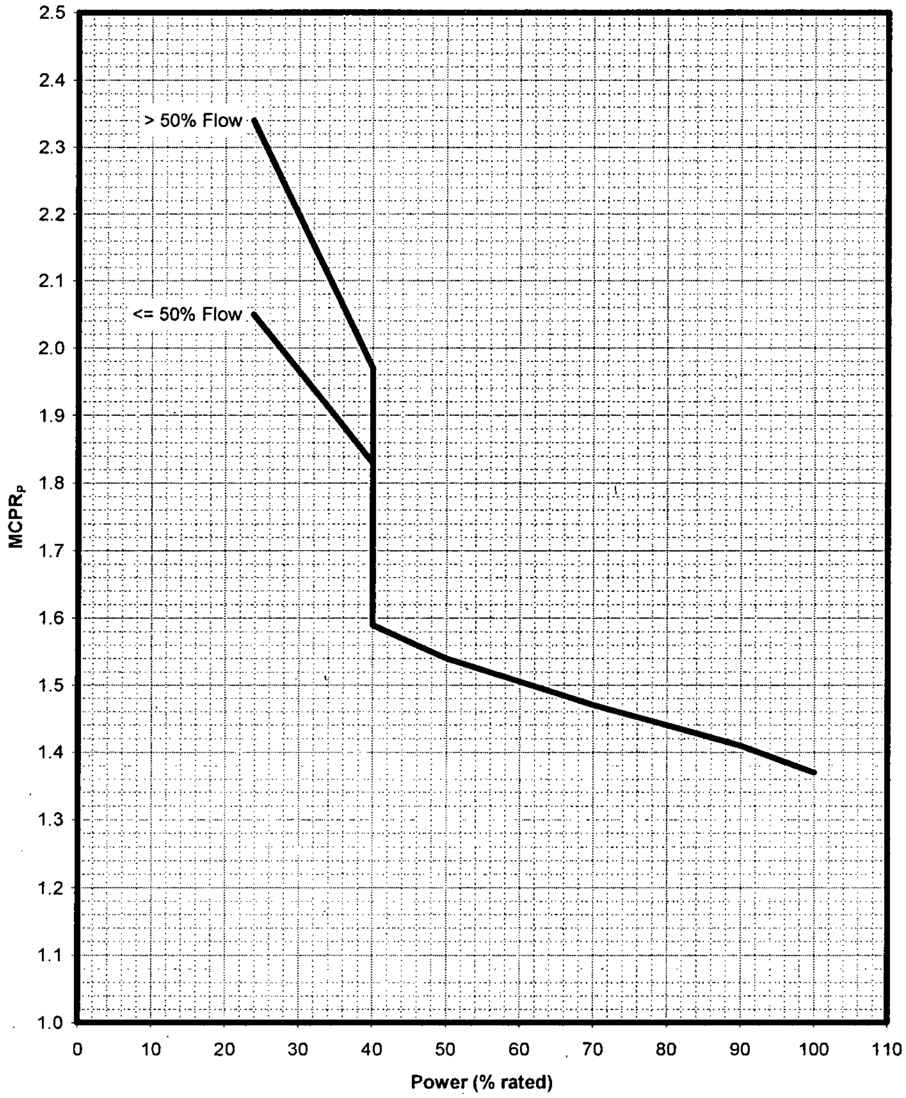
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.05	2.34
40.0	1.83	1.97
40.0		1.56
50.0		1.53
70.0		1.44
90.0		1.35
100.0		1.31

FIGURE 27. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 5



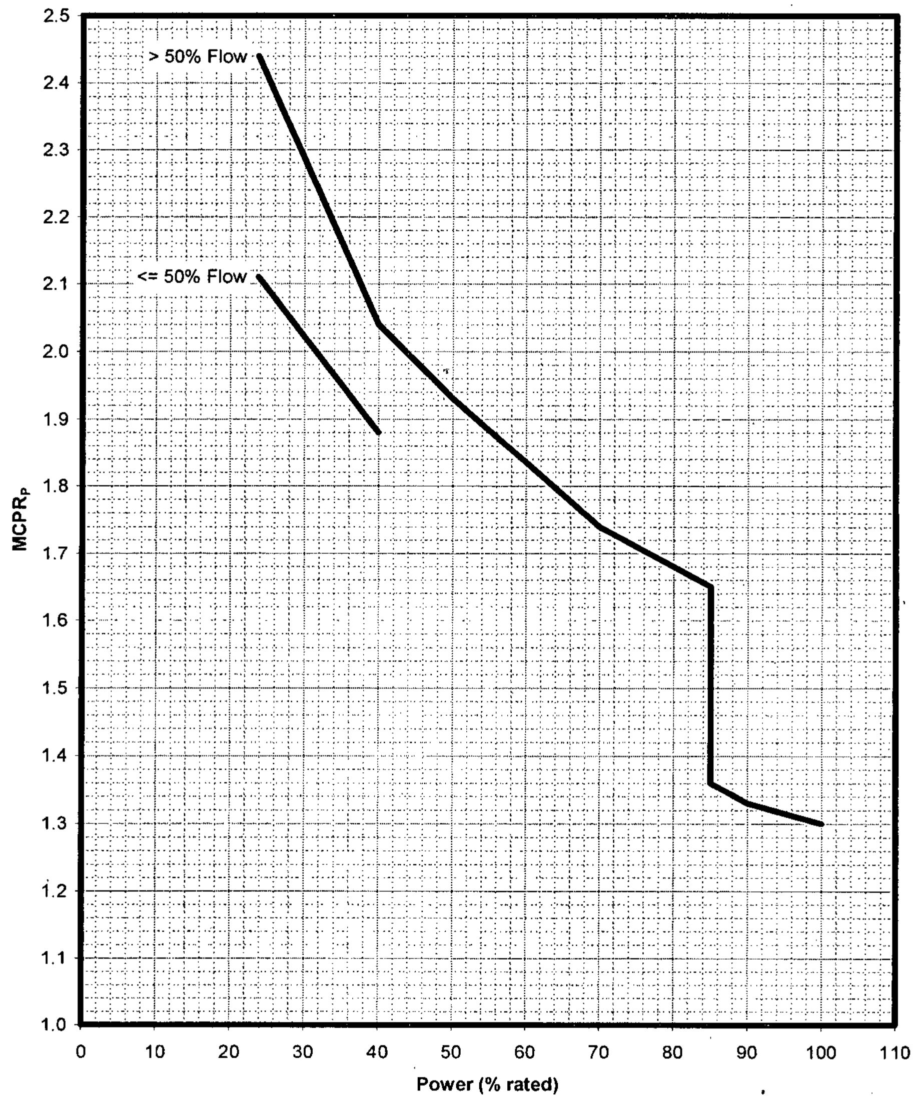
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.11	2.44
40.0	1.88	2.04
40.0		1.58
50.0		1.55
70.0		1.46
90.0		1.40
100.0		1.36

FIGURE 28. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 5



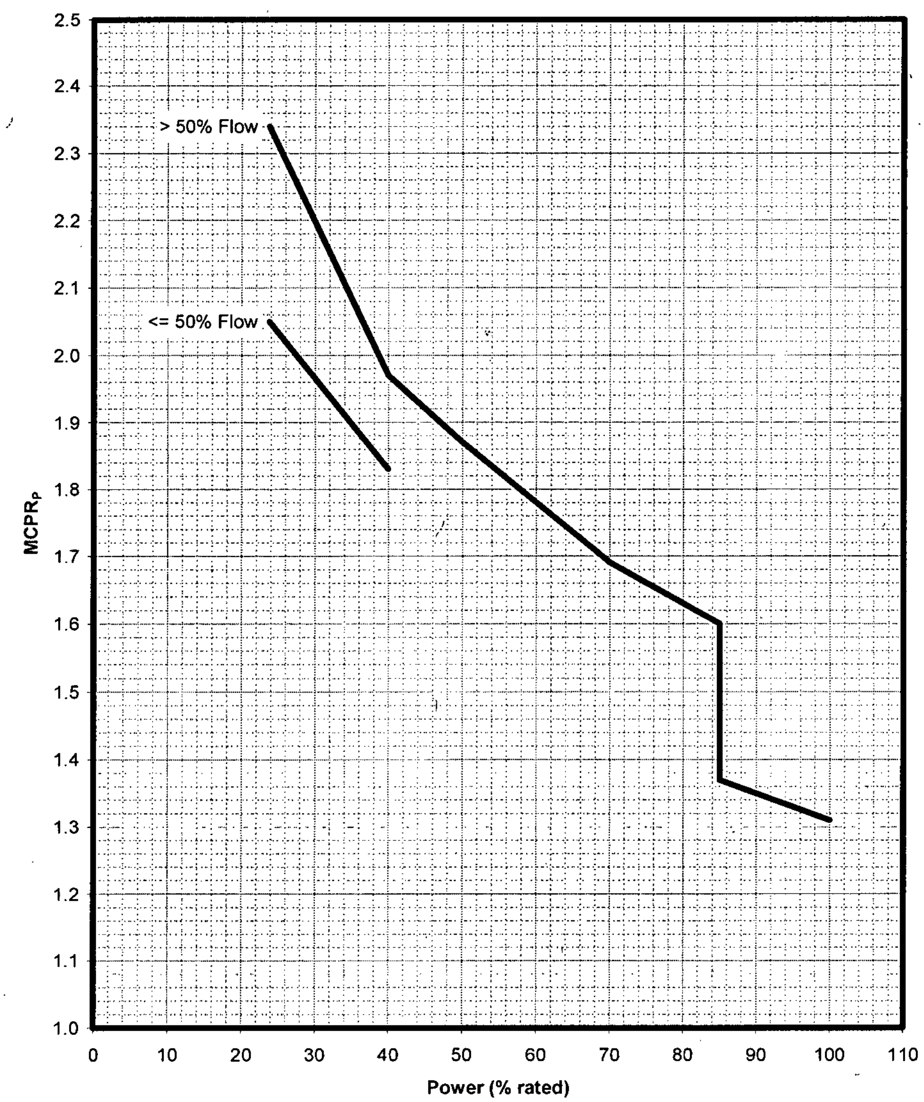
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.05	2.34
40.0	1.83	1.97
40.0		1.59
50.0		1.54
70.0		1.47
90.0		1.41
100.0		1.37

FIGURE 29. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 6



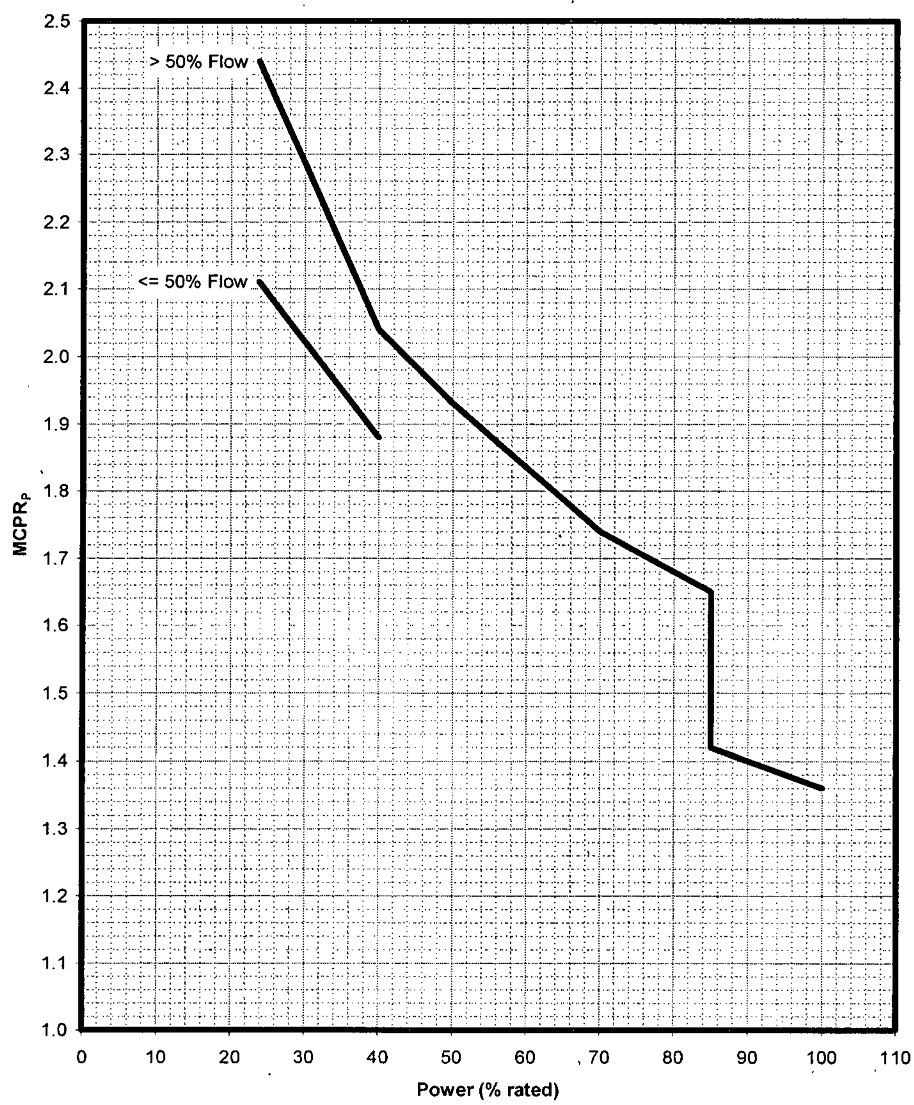
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.11	2.44
40.0	1.88	2.04
40.0		2.04
50.0		1.93
70.0		1.74
85.0		1.65
85.0		1.36
90.0		1.33
100.0		1.30

FIGURE 30. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 6



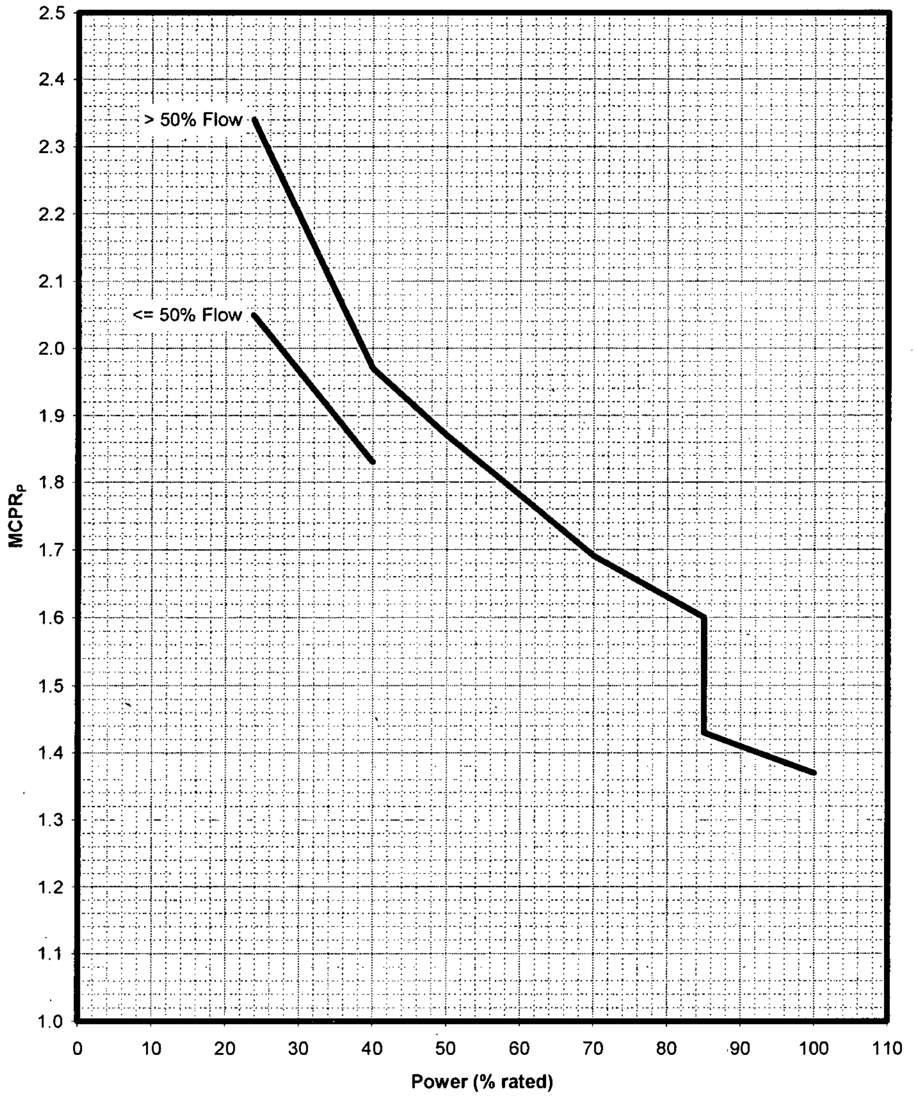
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.05	2.34
40.0	1.83	1.97
40.0		1.97
50.0		1.87
70.0		1.69
85.0		1.60
85.0		1.37
90.0		1.35
100.0		1.31

FIGURE 31. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 7



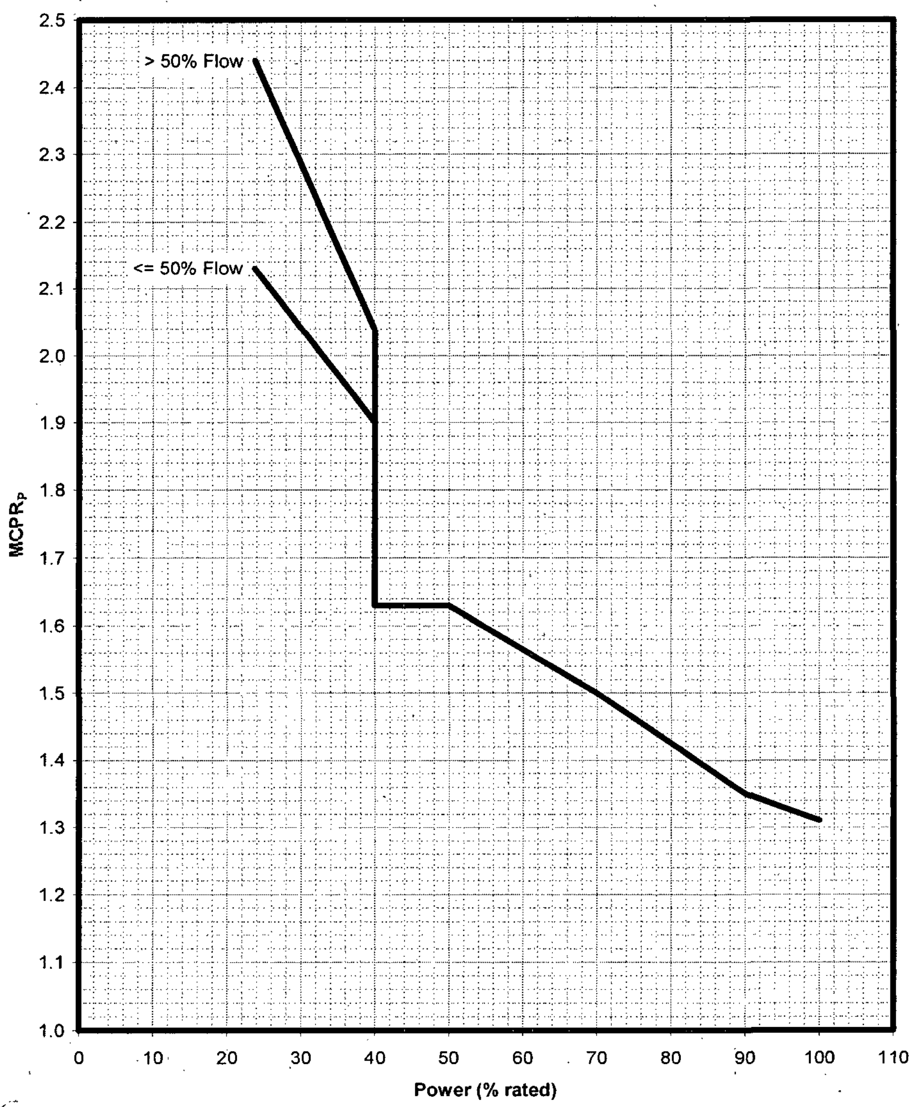
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.11	2.44
40.0	1.88	2.04
40.0		2.04
50.0		1.93
70.0		1.74
85.0		1.65
85.0		1.42
90.0		1.40
100.0		1.36

FIGURE 32. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITION 7



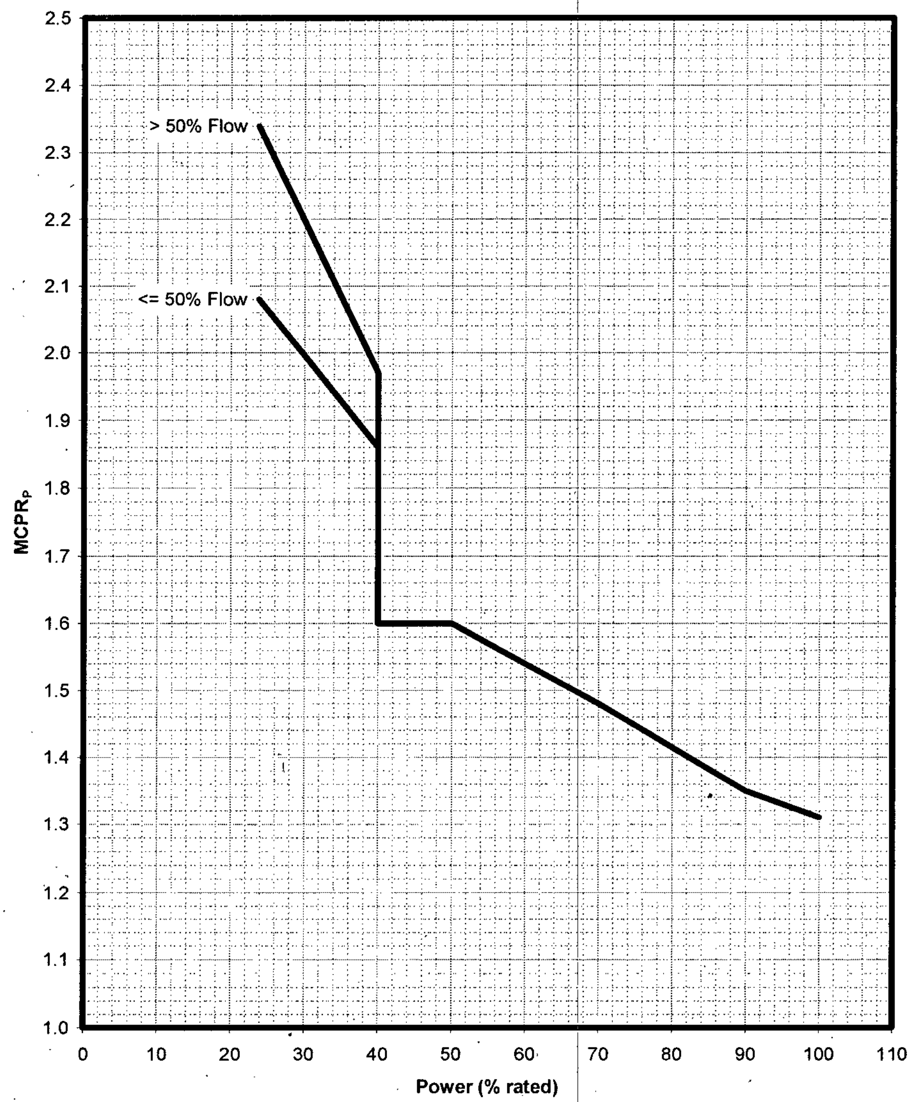
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.05	2.34
40.0	1.83	1.97
40.0		1.97
50.0		1.87
70.0		1.69
85.0		1.60
85.0		1.43
90.0		1.41
100.0		1.37

FIGURE 33. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 1



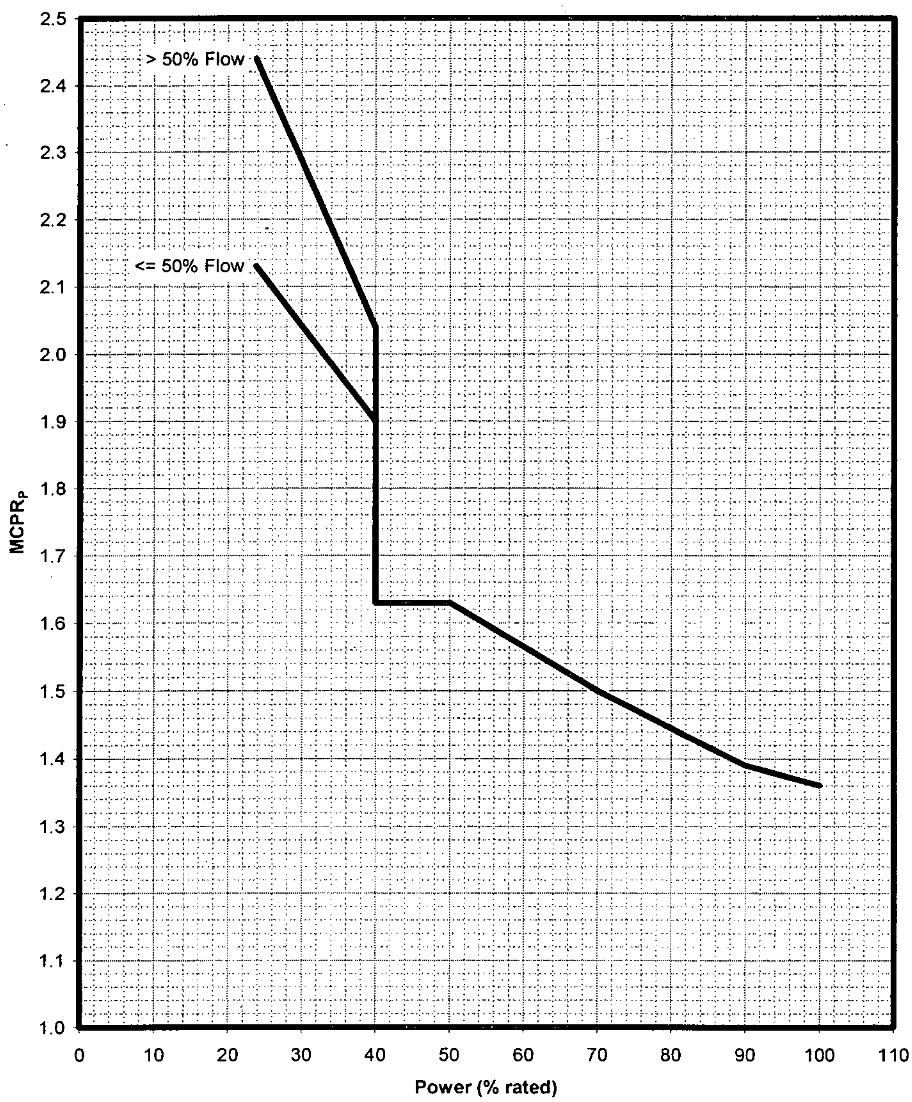
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.13	2.44
40.0	1.90	2.04
40.0		1.63
50.0		1.63
70.0		1.50
70.0		1.50
90.0		1.35
100.0		1.31

FIGURE 34. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 1



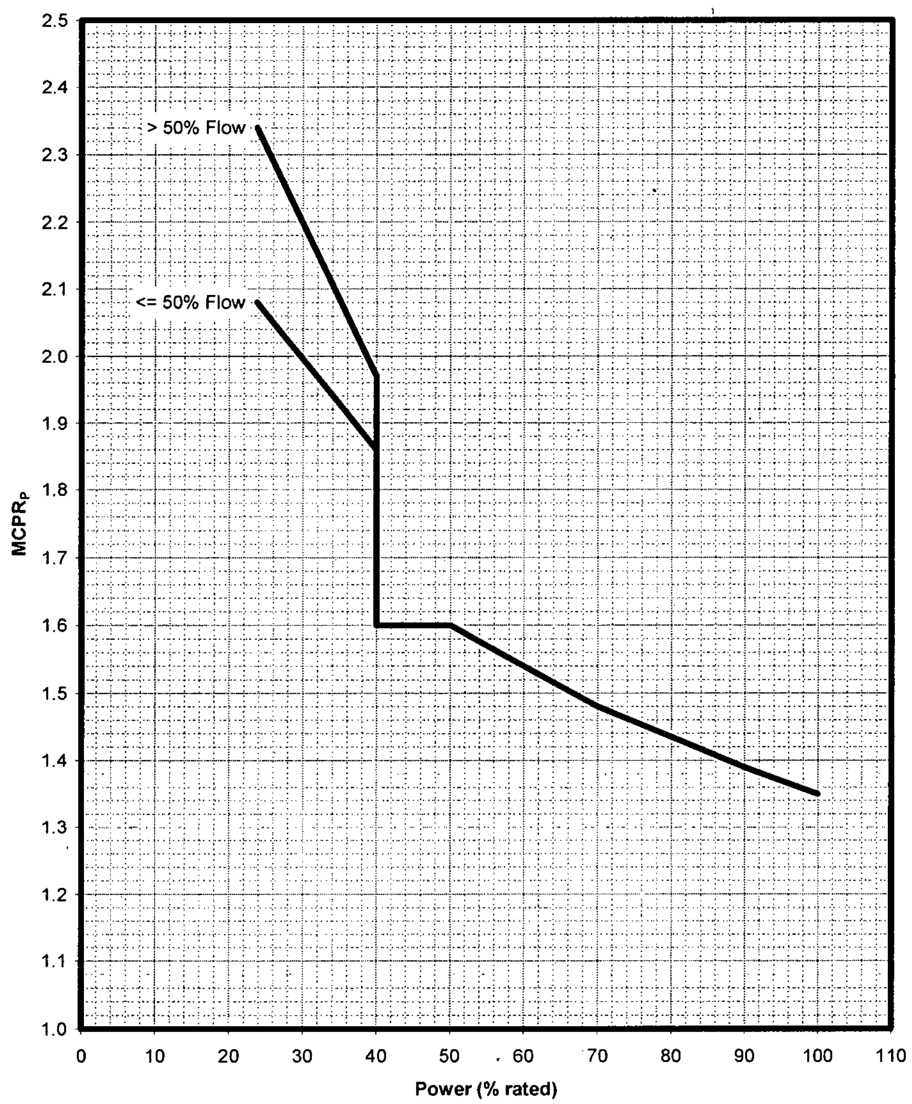
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.08	2.34
40.0	1.86	1.97
40.0		1.60
50.0		1.60
70.0		1.48
70.0		1.48
90.0		1.35
100.0		1.31

FIGURE 35. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 2



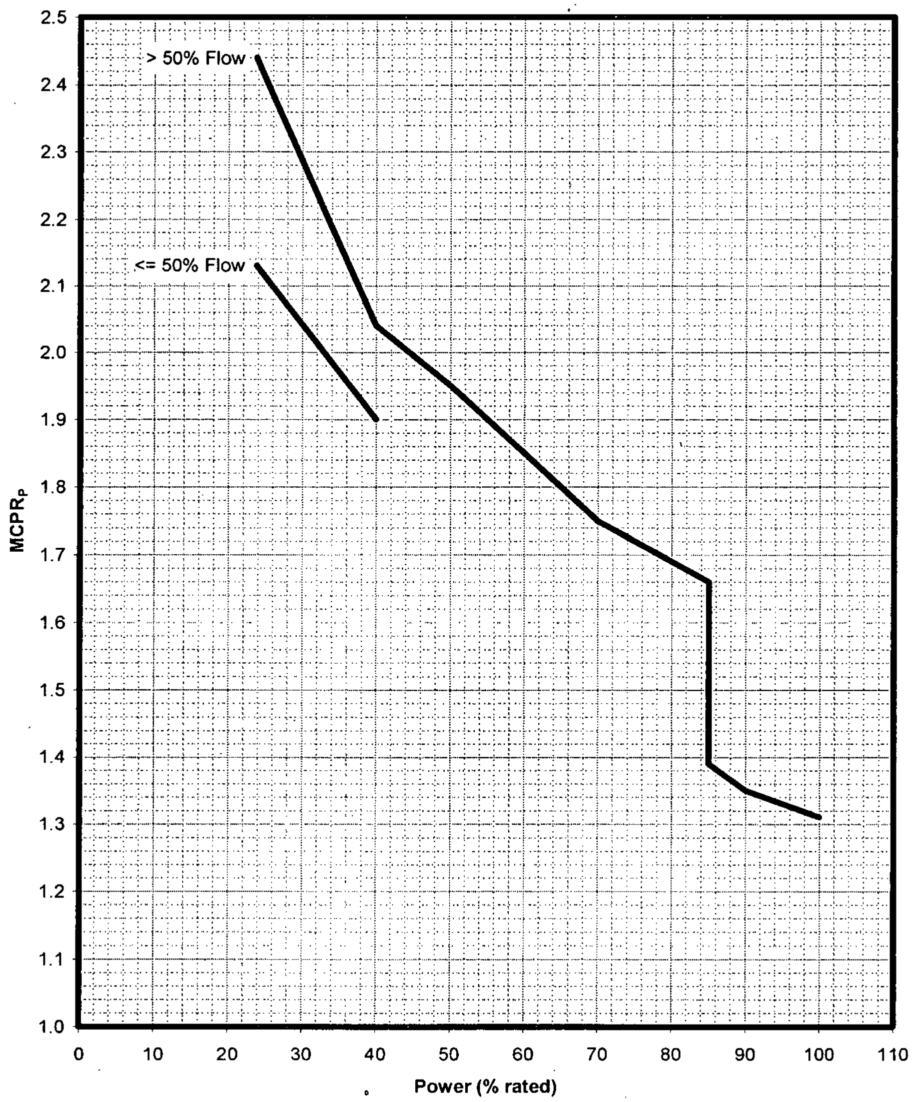
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.13	2.44
40.0	1.90	2.04
40.0		1.63
50.0		1.63
70.0		1.50
70.0		1.50
90.0		1.39
100.0		1.36

FIGURE 36. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 2



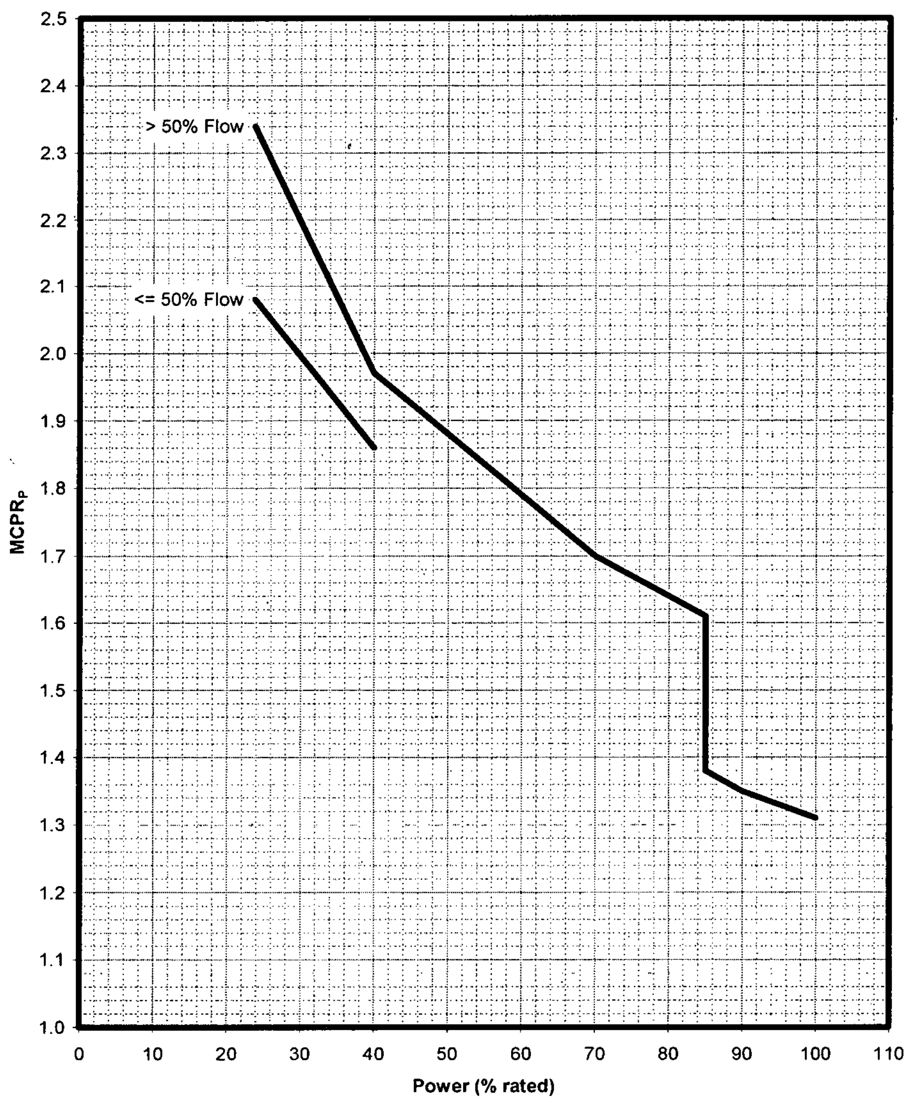
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.08	2.34
40.0	1.86	1.97
40.0		1.60
50.0		1.60
70.0		1.48
70.0		1.48
90.0		1.39
100.0		1.35

FIGURE 37. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 3



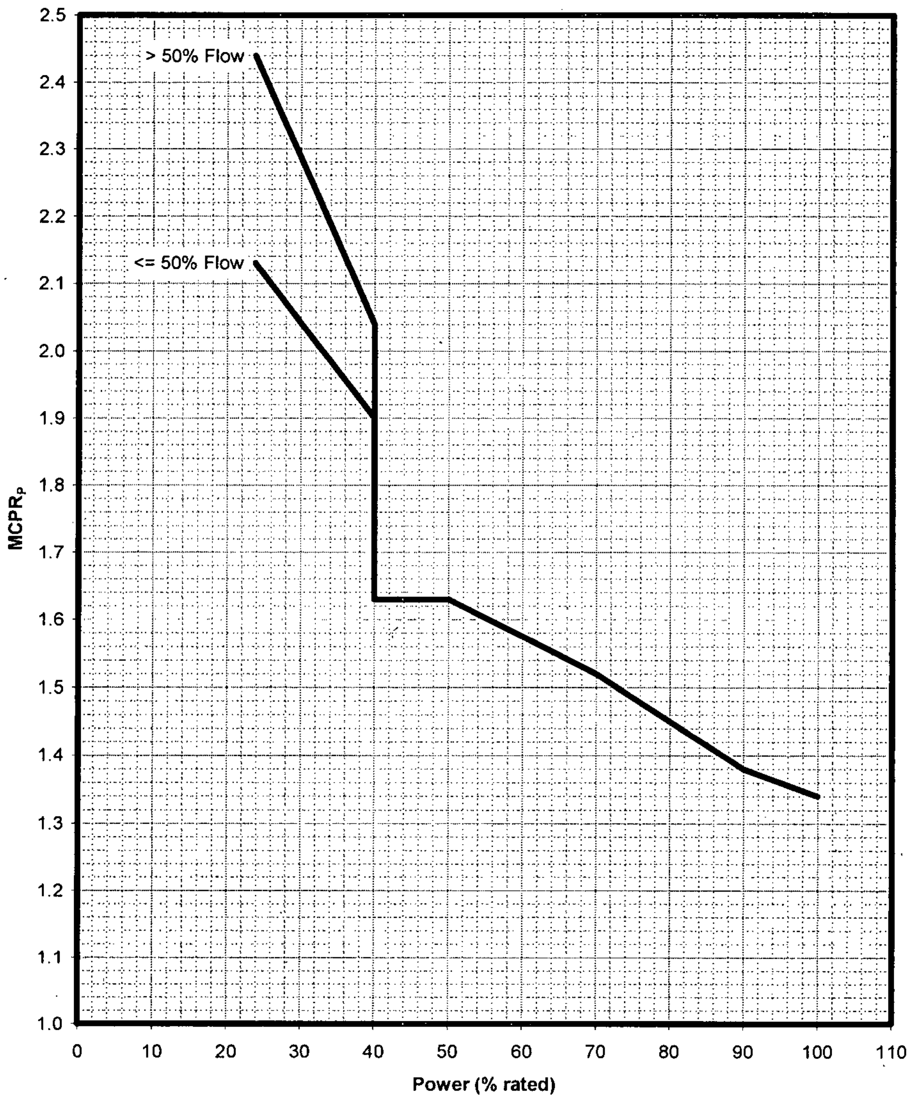
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.13	2.44
40.0	1.90	2.04
40.0		2.04
50.0		1.95
70.0		1.75
85.0		1.66
85.0		1.39
90.0		1.35
100.0		1.31

FIGURE 38. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 3



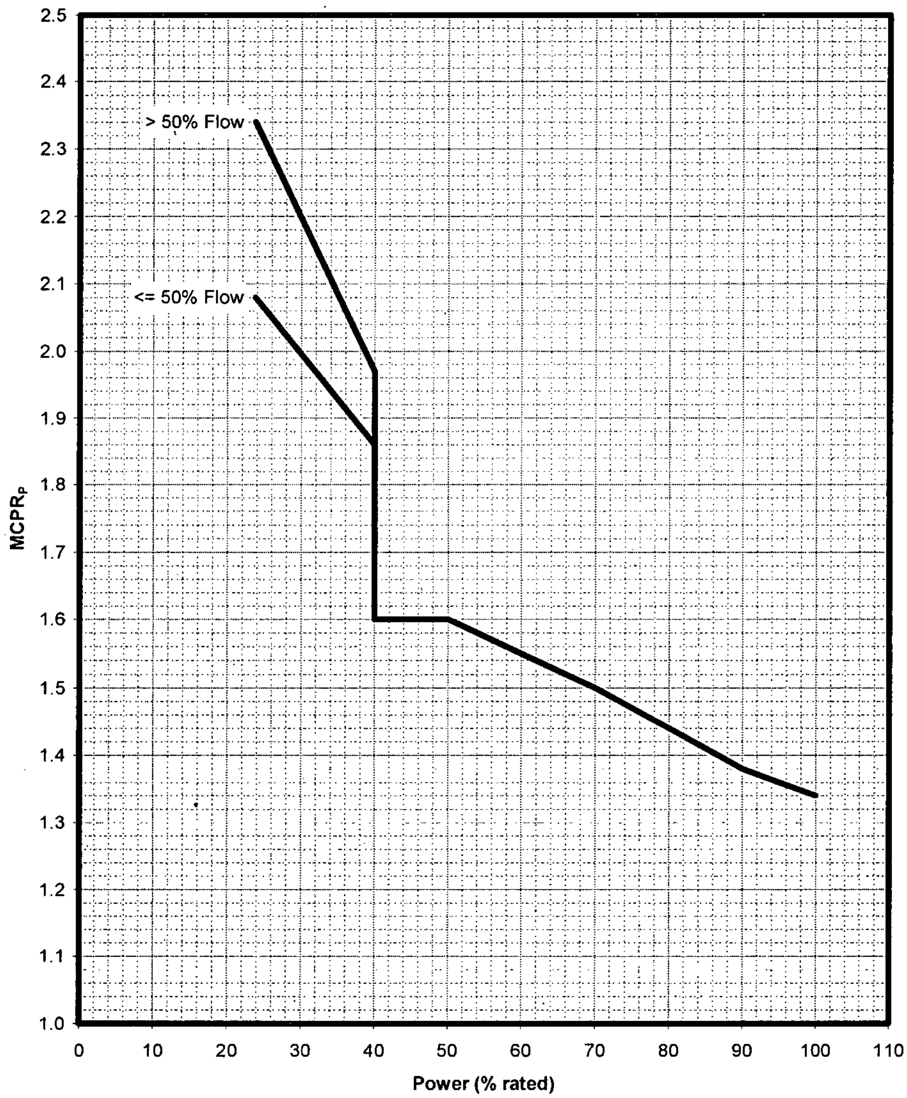
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.08	2.34
40.0	1.86	1.97
40.0		1.97
50.0		1.88
70.0		1.70
85.0		1.61
85.0		1.38
90.0		1.35
100.0		1.31

FIGURE 39. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 4



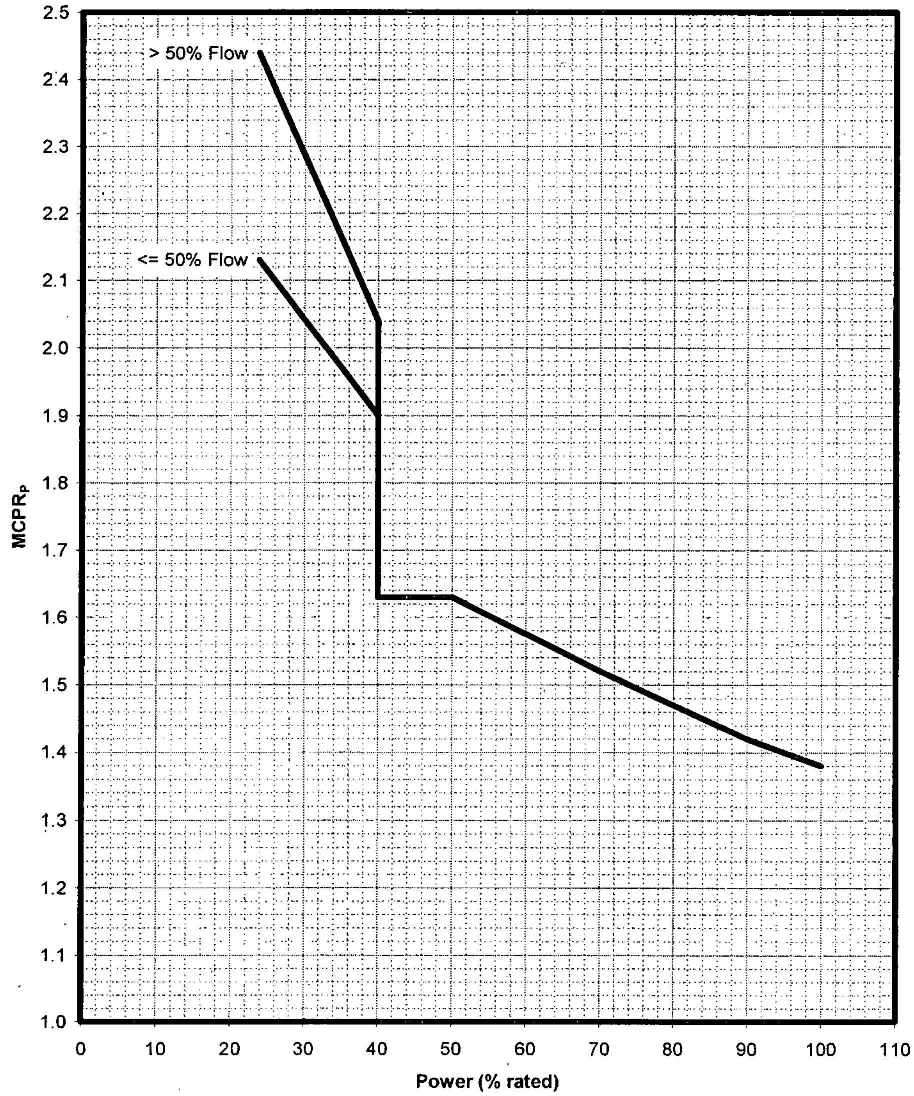
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.13	2.44
40.0	1.90	2.04
40.0		1.63
50.0		1.63
70.0		1.52
90.0		1.38
100.0		1.34

FIGURE 40. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 4



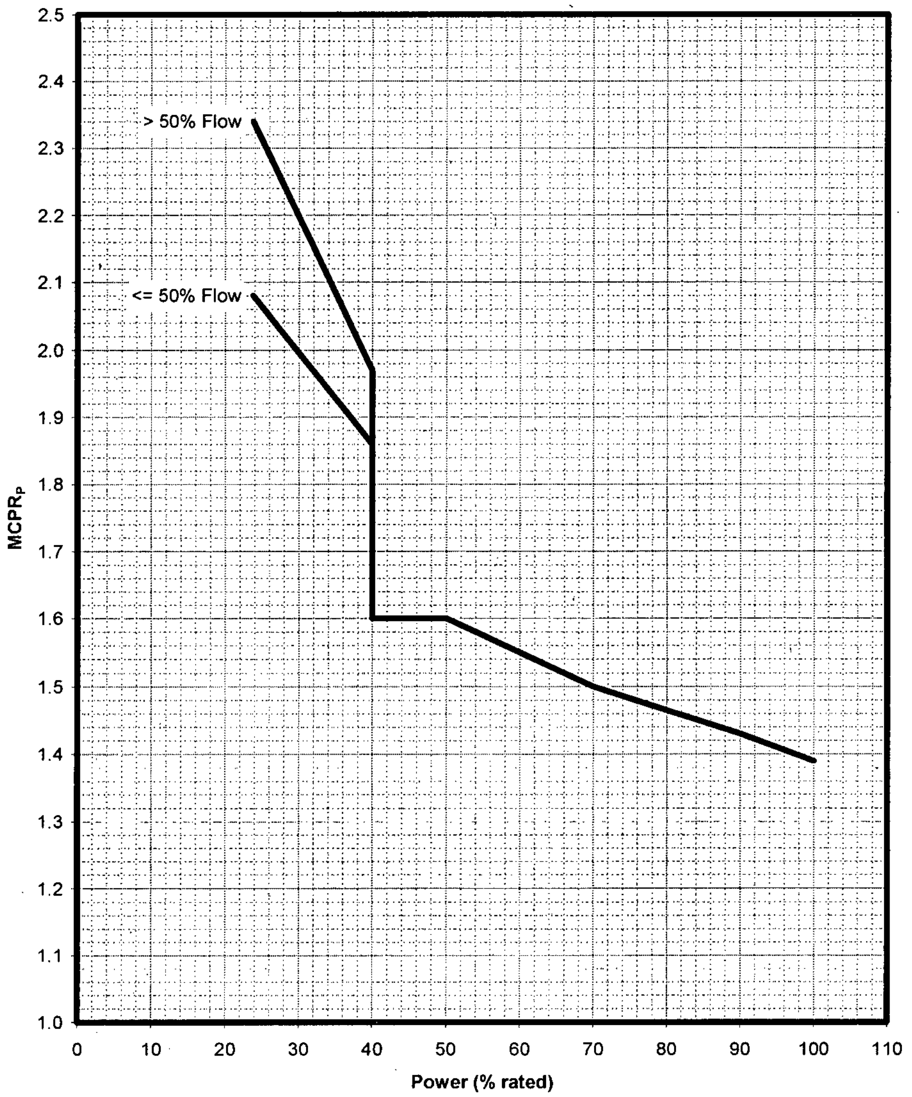
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.08	2.34
40.0	1.86	1.97
40.0		1.60
50.0		1.60
70.0		1.50
90.0		1.38
100.0		1.34

FIGURE 41. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 5



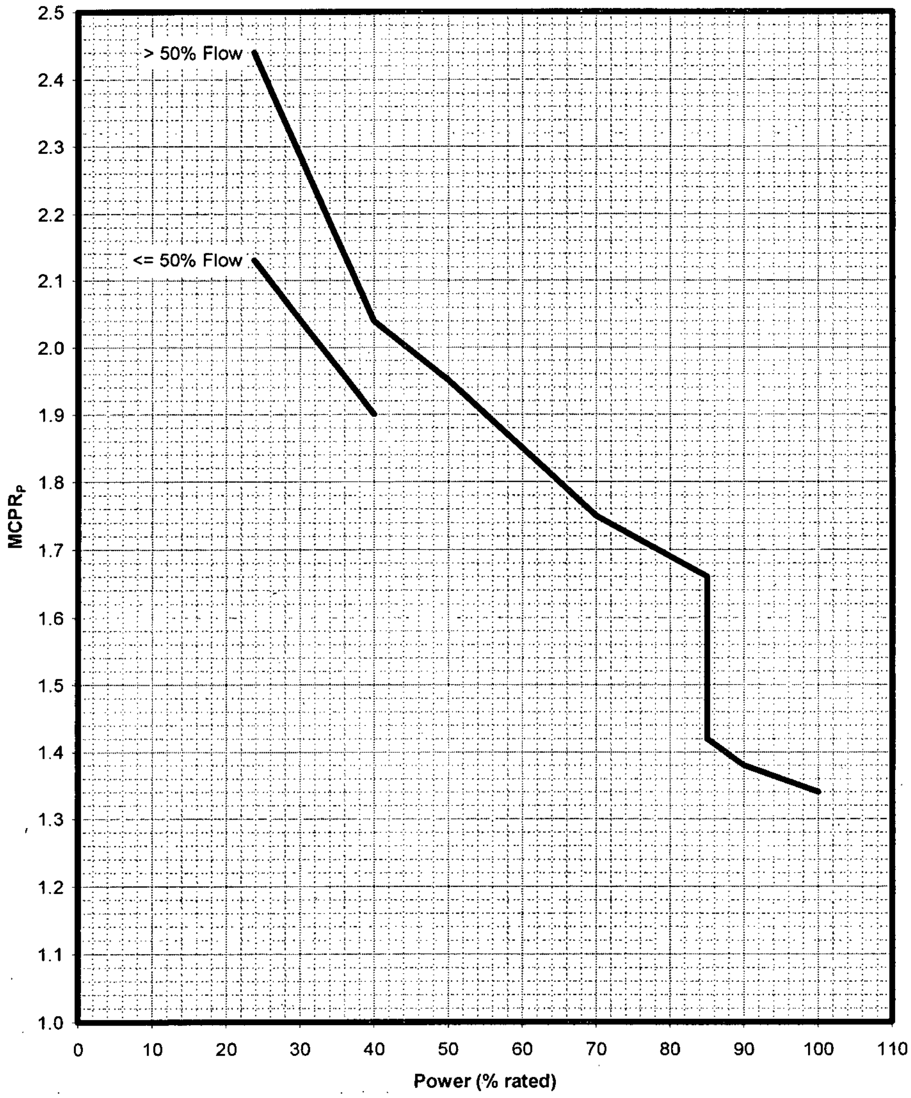
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.13	2.44
40.0	1.90	2.04
40.0		1.63
50.0		1.63
70.0		1.52
90.0		1.42
100.0		1.38

FIGURE 42. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 5



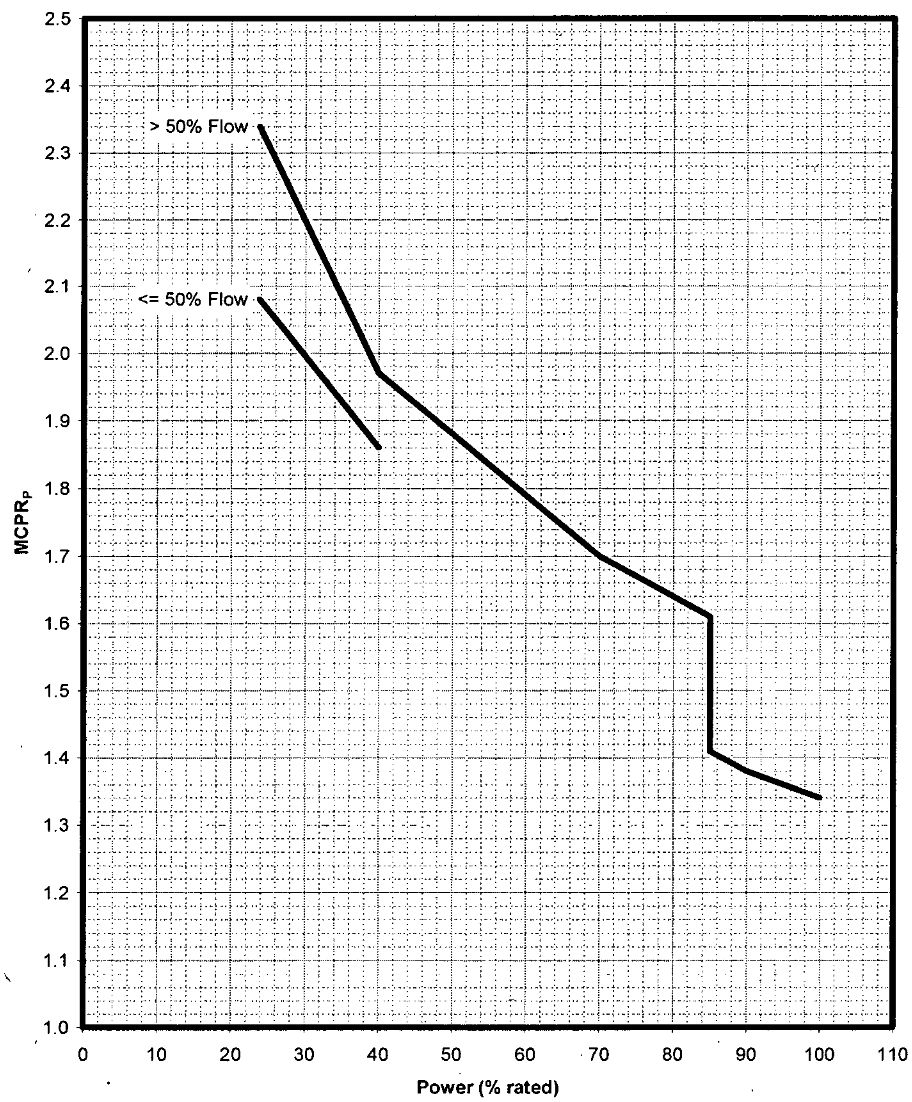
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.08	2.34
40.0	1.86	1.97
40.0		1.60
50.0		1.60
70.0		1.50
90.0		1.43
100.0		1.39

FIGURE 43. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 6



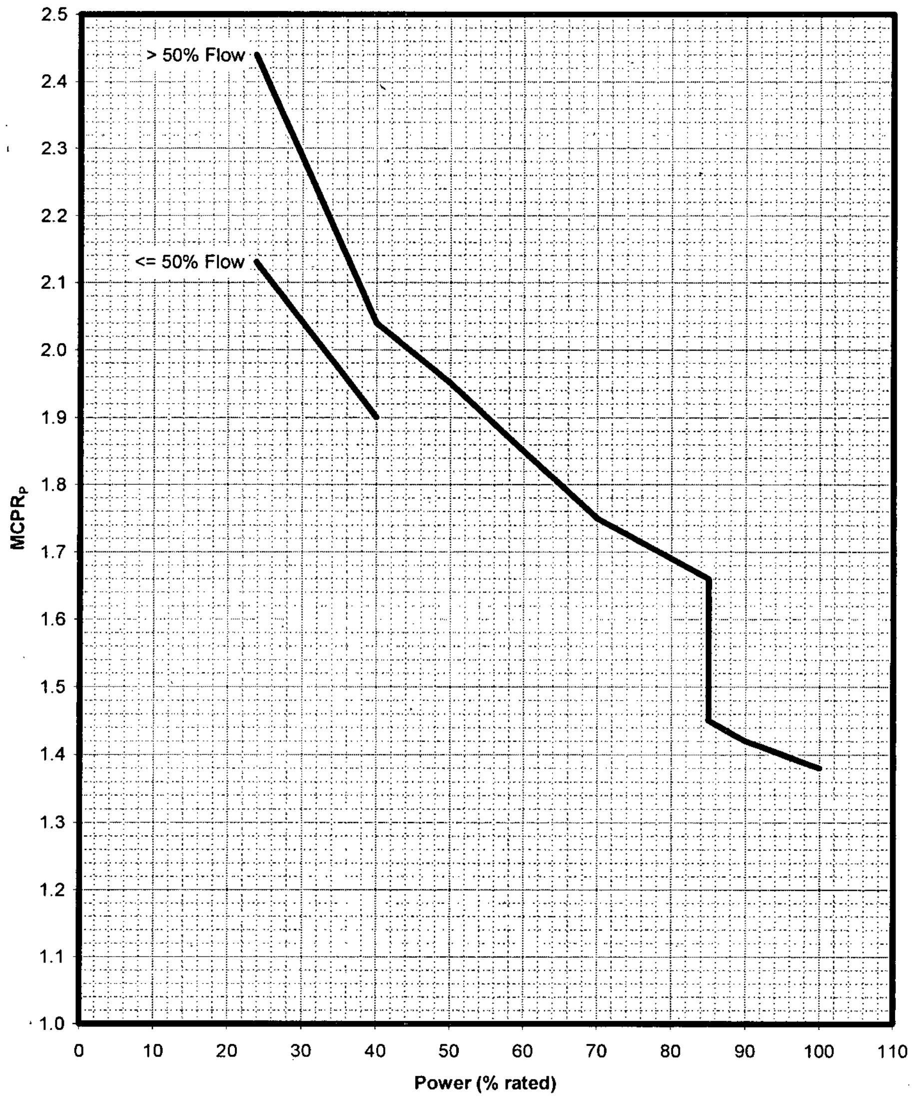
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.13	2.44
40.0	1.90	2.04
40.0		2.04
50.0		1.95
70.0		1.75
85.0		1.66
85.0		1.42
90.0		1.38
100.0		1.34

FIGURE 44. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 6



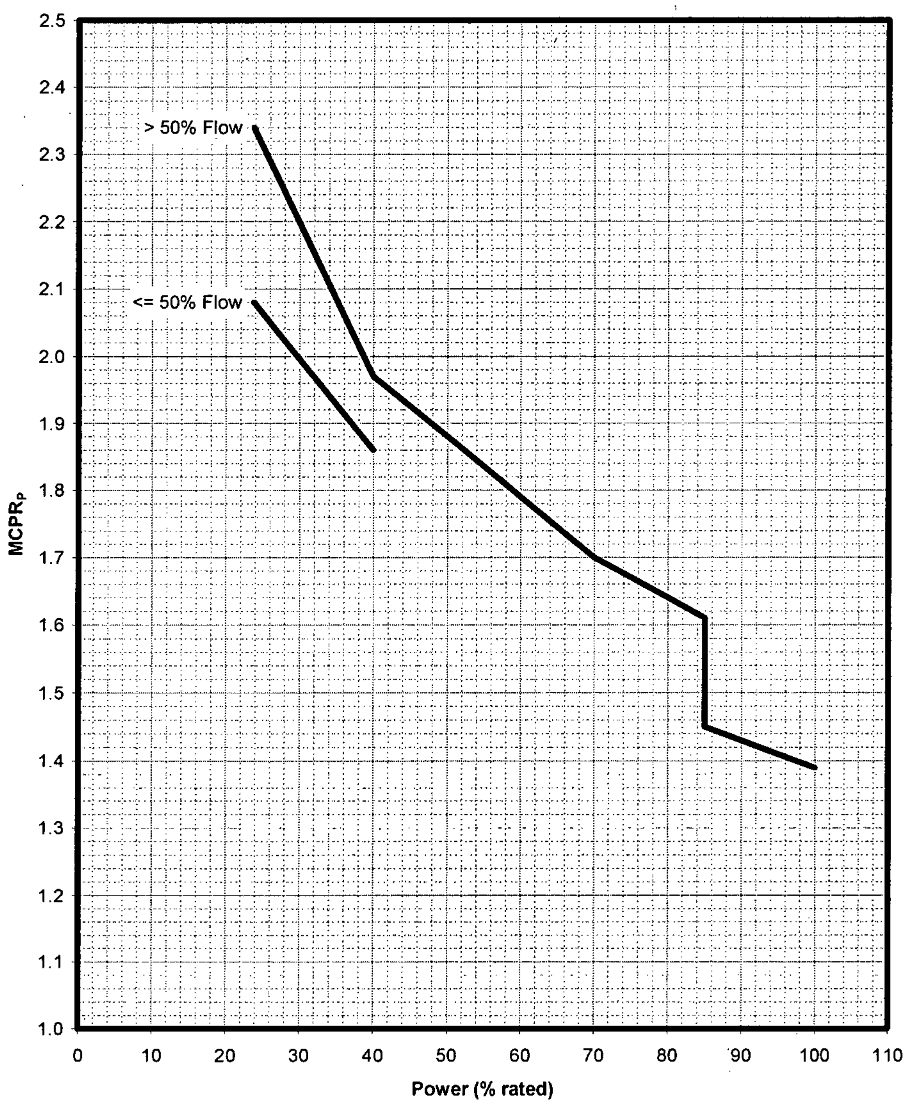
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.08	2.34
40.0	1.86	1.97
40.0		1.97
50.0		1.88
70.0		1.70
85.0		1.61
85.0		1.41
90.0		1.38
100.0		1.34

FIGURE 45. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 7



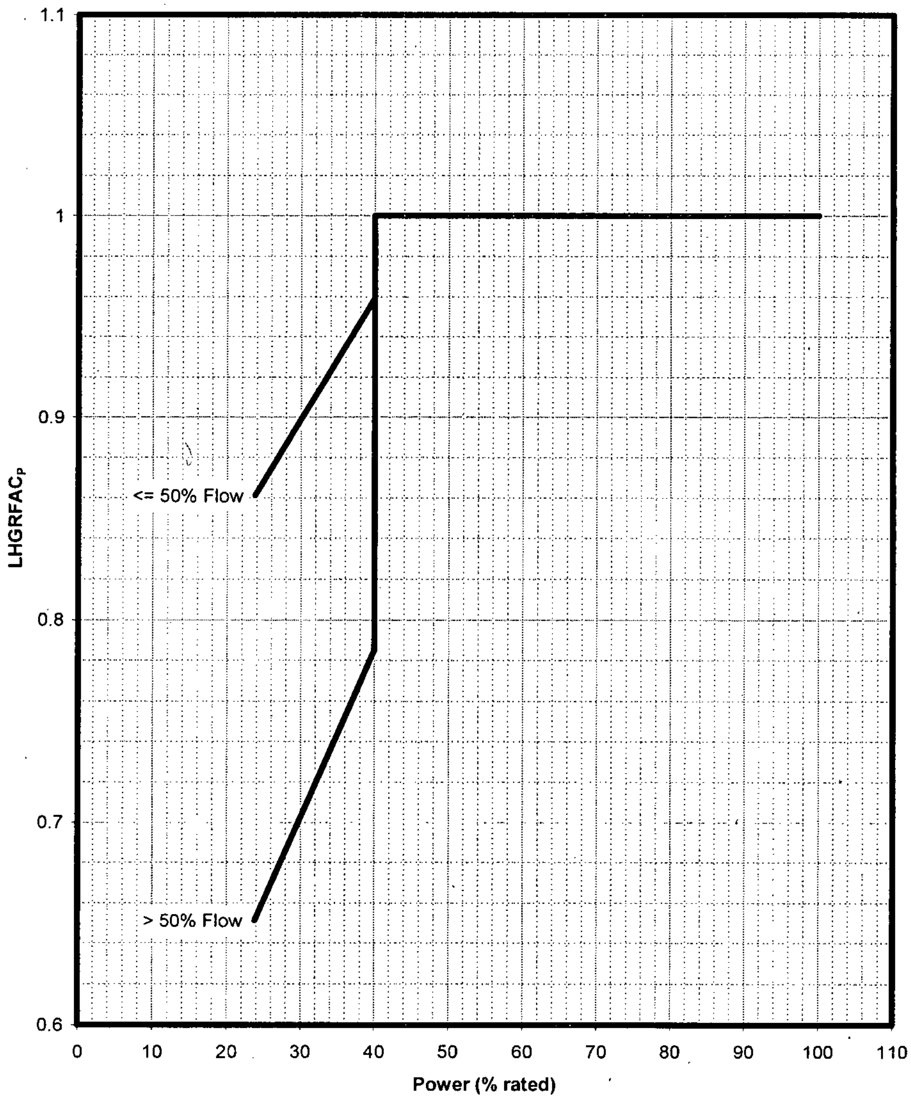
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.13	2.44
40.0	1.90	2.04
40.0		2.04
50.0		1.95
70.0		1.75
85.0		1.66
85.0		1.45
90.0		1.42
100.0		1.38

FIGURE 46. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITION 7



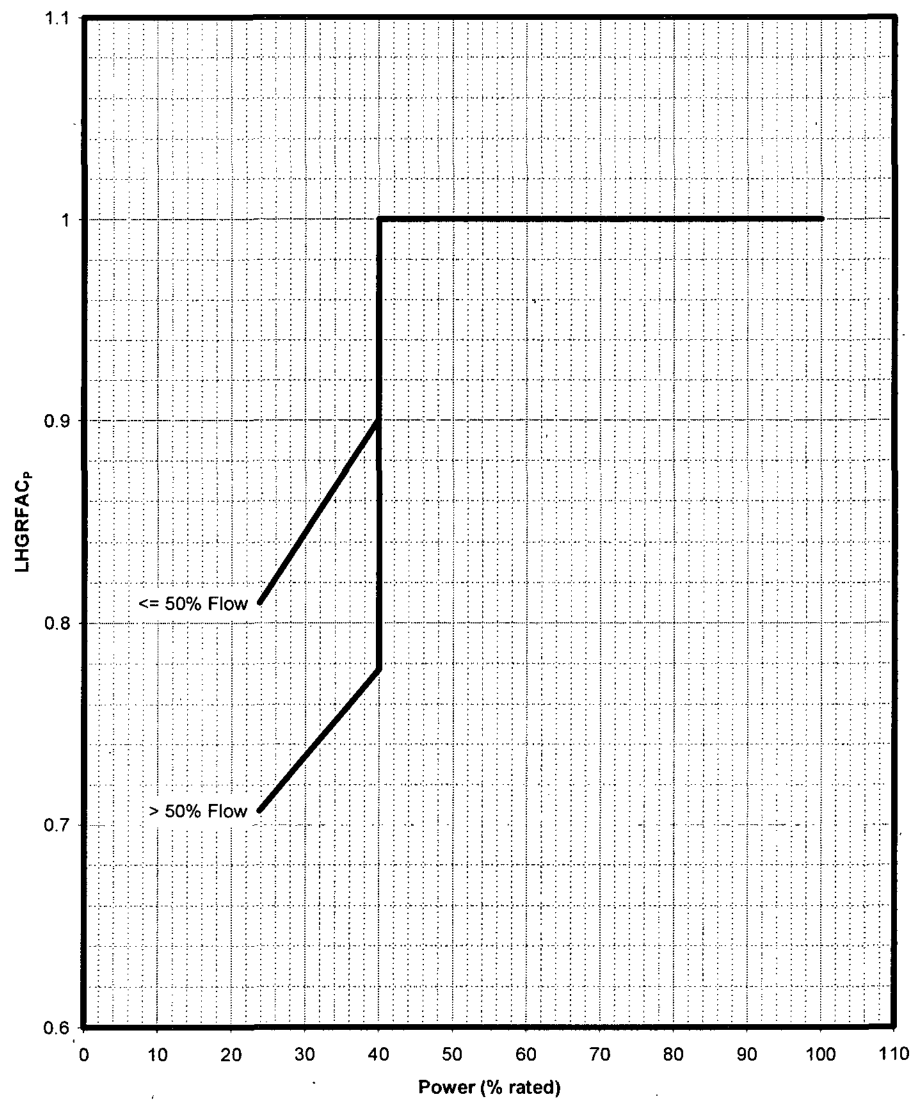
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	2.08	2.34
40.0	1.86	1.97
40.0		1.97
50.0		1.88
70.0		1.70
85.0		1.61
85.0		1.45
90.0		1.43
100.0		1.39

FIGURE 47. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITIONS 1, 2, 4, AND 5



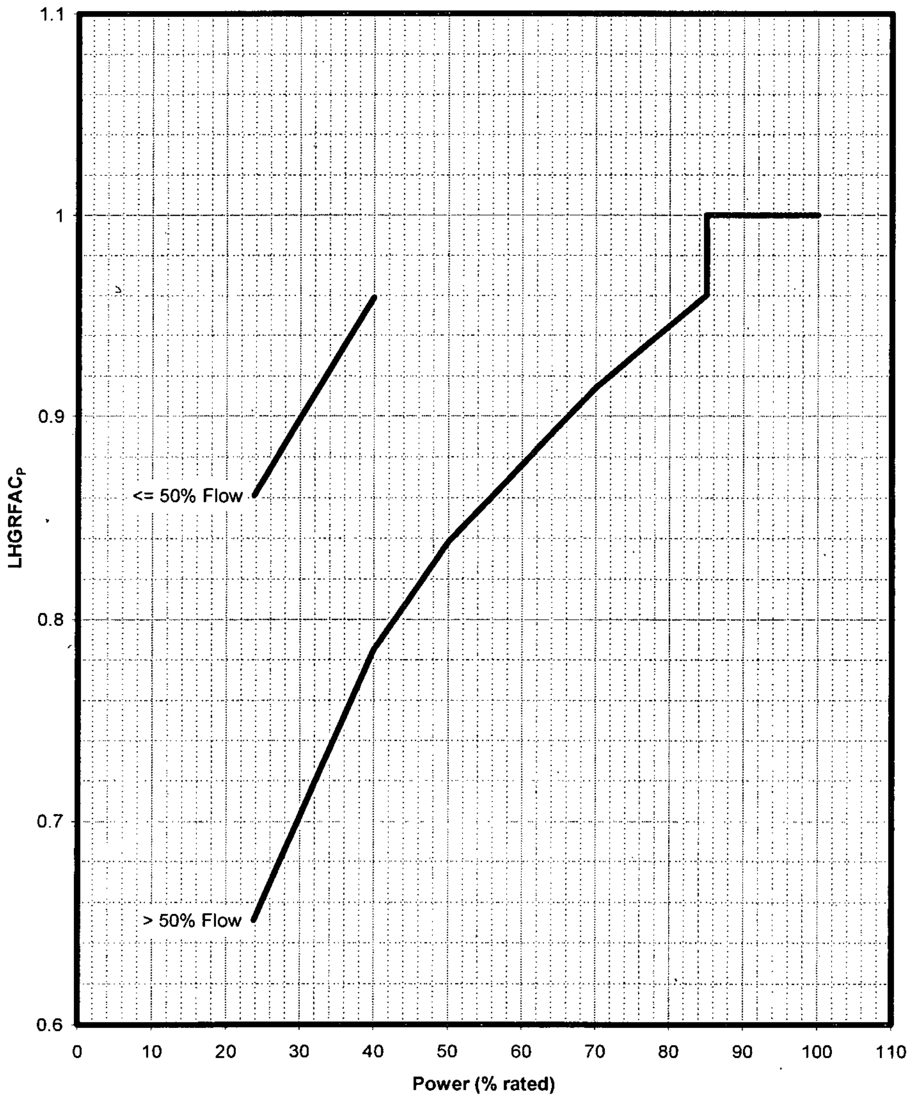
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.861	0.651
40.0	0.959	0.785
40.0		1.000
100.0		1.000

FIGURE 48. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITIONS 1, 2, 4, AND 5



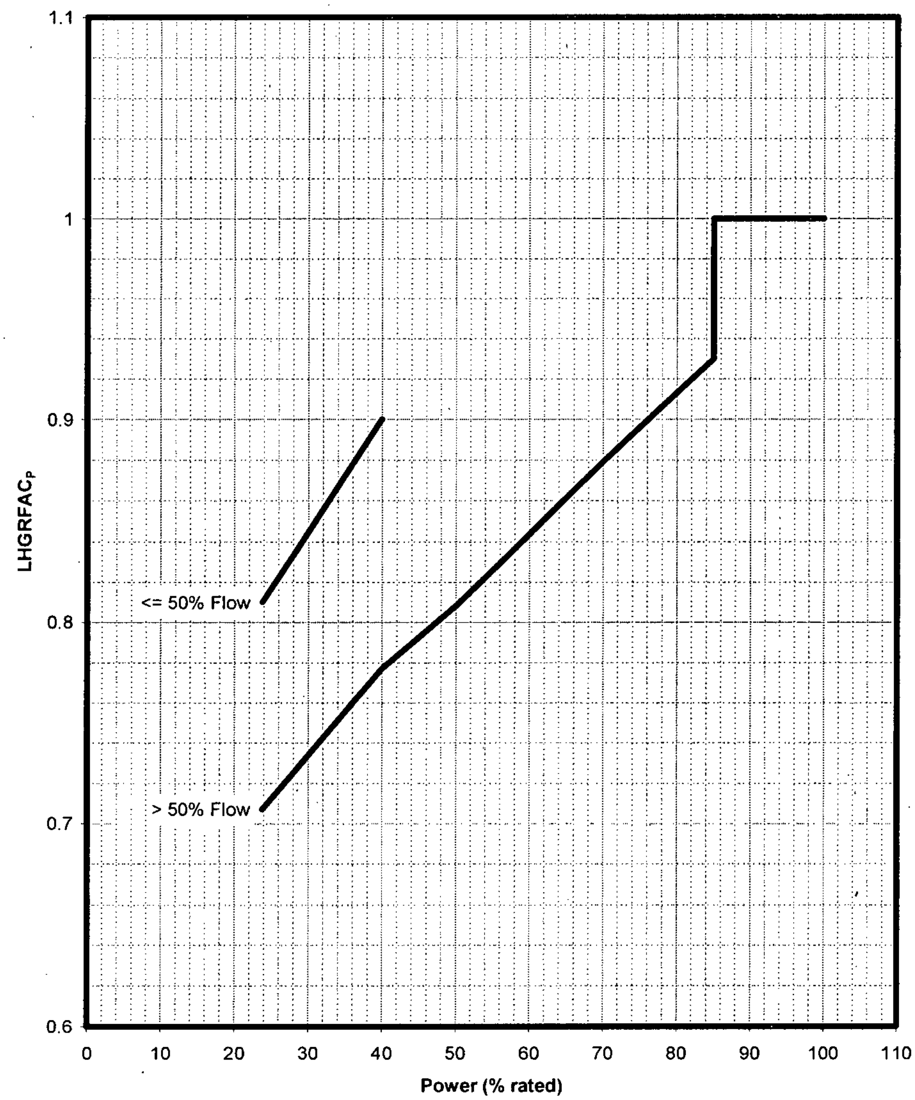
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.810	0.707
40.0	0.900	0.777
40.0		1.000
100.0		1.000

FIGURE 49. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR GE14, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITIONS 3, 6, AND 7



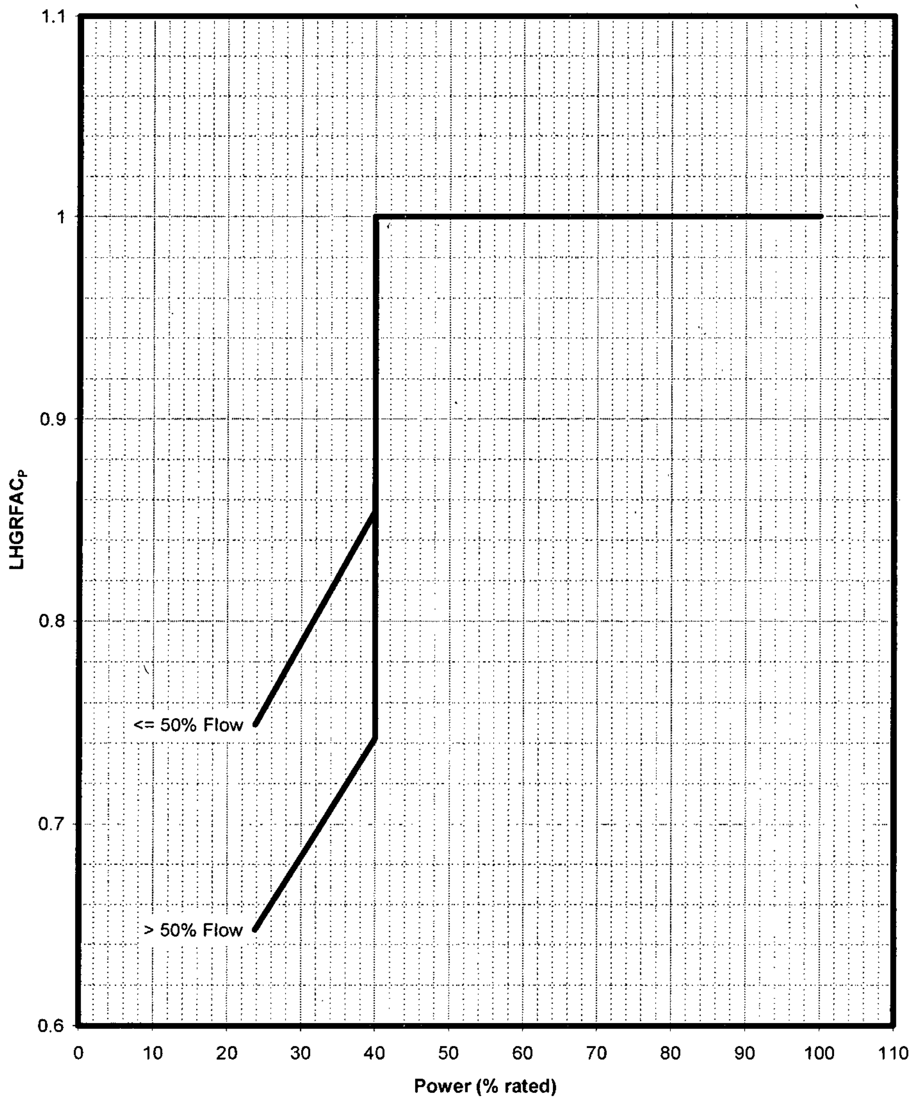
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.861	0.651
40.0	0.959	0.785
40.0		0.785
50.0		0.838
70.0		0.914
85.0		0.960
85.0		1.000
100.0		1.000

FIGURE 50. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR ATRIUM-10, EXPOSURE RANGE BOC TO MOC, APPLICATION CONDITIONS 3, 6, AND 7



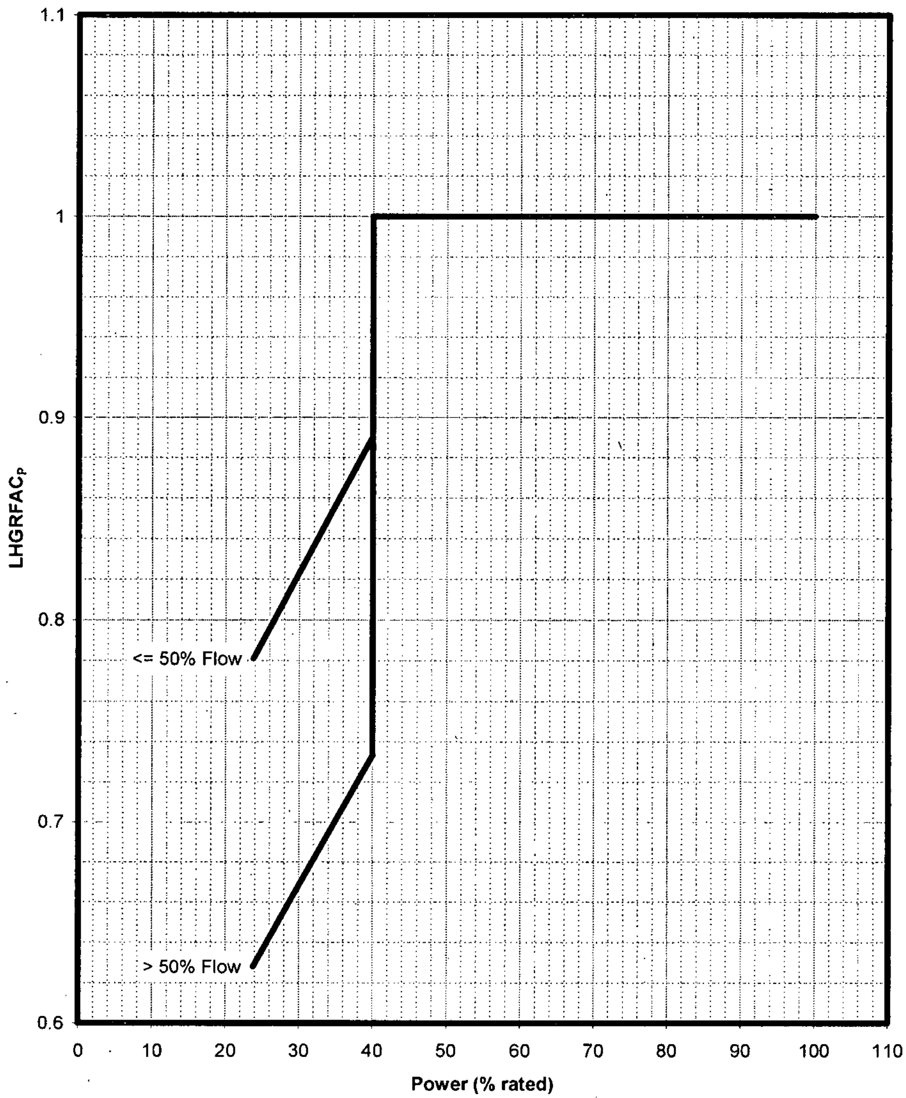
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.810	0.707
40.0	0.900	0.777
40.0		0.777
50.0		0.808
70.0		0.879
85.0		0.930
85.0		1.000
100.0		1.000

FIGURE 51. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITIONS 1, 2, 4, AND 5



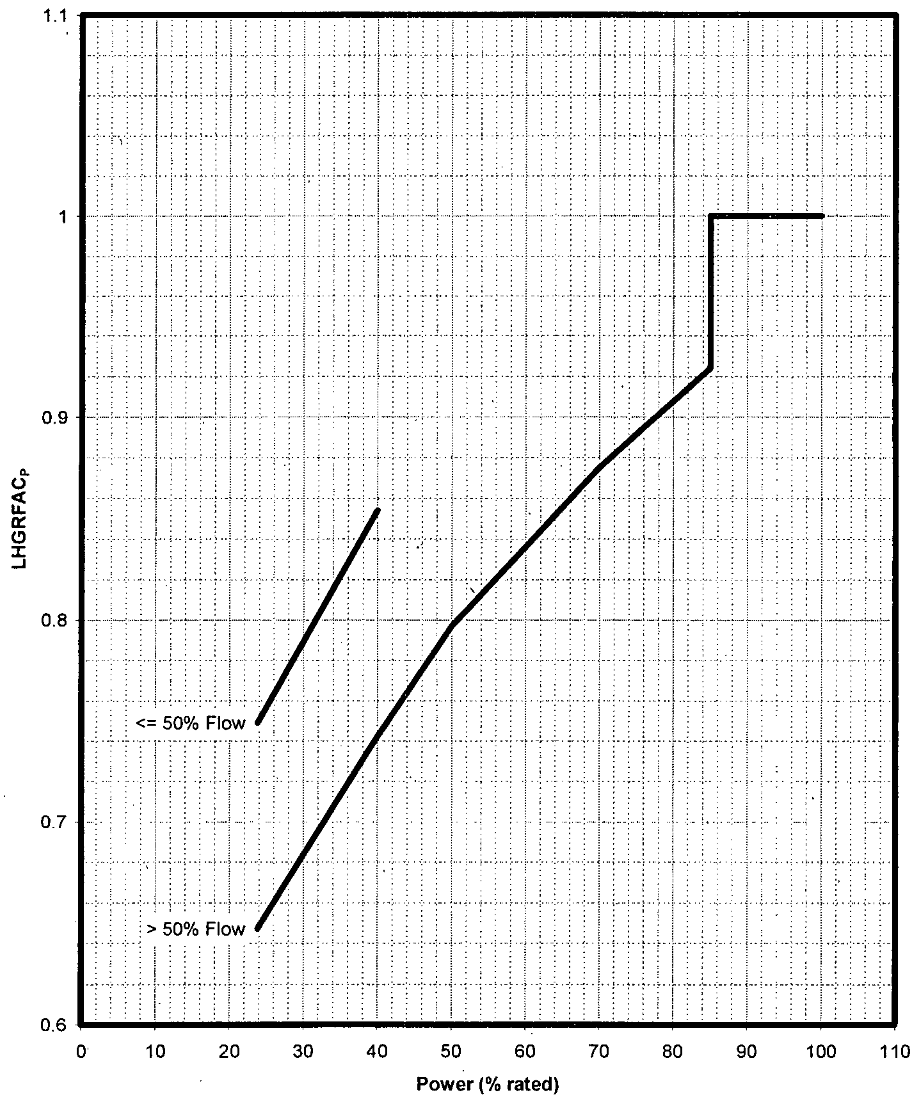
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.749	0.647
40.0	0.854	0.742
40.0		1.000
100.0		1.000

FIGURE 52. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITIONS 1, 2, 4, AND 5



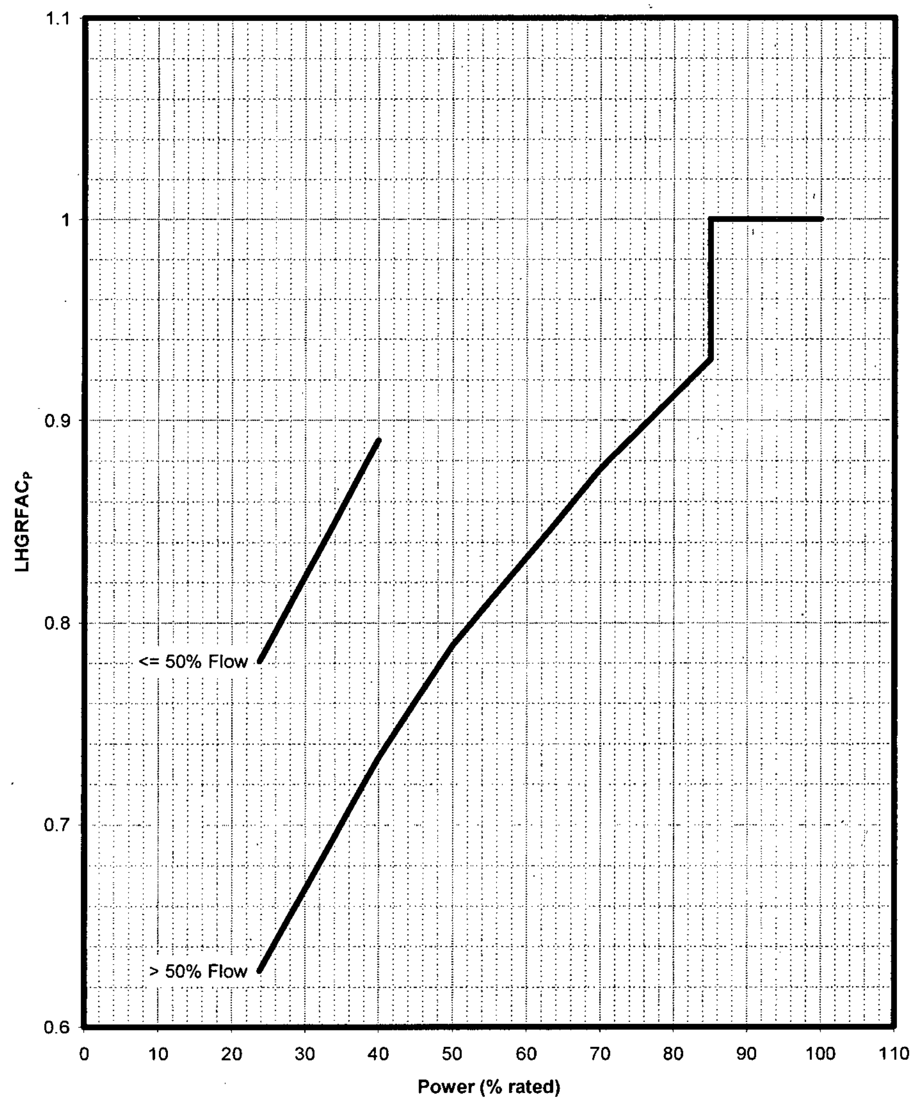
Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.781	0.628
40.0	0.890	0.733
40.0		1.000
100.0		1.000

FIGURE 53. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR GE14, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITIONS 3, 6, AND 7



Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.749	0.647
40.0	0.854	0.742
40.0		0.742
50.0		0.797
70.0		0.875
85.0		0.924
85.0		1.000
100.0		1.000

FIGURE 54. LHGR MULTIPLIER VERSUS CORE POWER ($LHGRFAC_P$) FOR ATRIUM-10, EXPOSURE RANGE MOC TO EOC, APPLICATION CONDITIONS 3, 6, AND 7



Power (% rated)	<= 50% Flow	> 50% Flow
23.8	0.781	0.628
40.0	0.890	0.733
40.0		0.733
50.0		0.789
70.0		0.876
85.0		0.930
85.0		1.000
100.0		1.000