Entergy

Entergy Operations, Inc.
River Bend Station
5485 U.S. Highway 61
P.O. Box 220
St. Francisville, LA 70775

October 9, 2003

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
Twelfth Fuel Cycle Core Operating Limits Report (COLR)

File Nos.: G9.5, G9.25.1.5

RBG-46184
RBF1-03-0190

Ladies and Gentlemen:

Enclosed is Revision 1 of the River Bend Station (RBS) Core Operation Limits Report (COLR) for the twelfth fuel cycle. This report is submitted in accordance with Technical Specification 5.6.5 of Appendix A of the Facility Operating License NPF-47. This COLR report will support operation from 5200 MWd/MTU through the end of the fuel cycle.

There are no commitments in this letter. For further information, contact Mr. B. M. Burmeister at (225) 381-4148.

Sincerely,

J. W. Leavines
Manager - Site Licensing

JWL/BMB
Enclosure

A001

cc: Mr. Michael Webb
U. S. Nuclear Regulatory Commission
M/S OWFN 07-D1
Washington, DC 20555

NRC Resident Inspector
P. O. Box 1050
St. Francisville, LA 70775

U. S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011

Core Operating Limits Report
Cycle 12
Revision 1

RIVER BEND STATION, CYCLE 12

CORE OPERATING LIMITS REPORT (COLR)

PREPARED BY:	Wai Law **Responsible Engineer**	**Date:**	8-18-2003
REVIEWED BY:	Jon Vo **Review Engineer**	**Date:**	8-18-2003
APPROVED BY:	[signature] **Manager – Nuclear Engineering**	**Date:**	8/26/03
APPROVED BY:	[signature] **Director, Engineering** **River Bend Nuclear Station**	**Date:**	8/27/03
APPROVED BY:	[signature] **On-site Safety Review Committee** **River Bend Nuclear Station**	**Date:**	9/4/03

TABLE OF CONTENTS

INTRODUCTION AND SUMMARY

This report provides Cycle 12 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 FRA-ANP are listed in the section titled Analytical Methods Documents.

This report also provides Cycle 12 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.

In some cases limits in the COLR differ from the limits in the core monitoring system. This is sometimes due to limitations in the core monitoring system to model the actual limits, in which case the core monitoring limits may be more conservative than the COLR limit. In other cases the limits in the COLR are presented in less detail than in the core monitoring system. When these situations exist the core monitoring limits will be explained or be referenced by the COLR and will be made available to Operations.

The Cycle 12 COLR supports power operation with FHOOS, FFWTR, PROOS, SLO and Loop Manual Operation. In addition to the specific requirements listed in the Sections 3.2.1 to 3.2.4, the MCPRp and LHGRFAC-p limits as shown in Appendix A shall be used for the applicable modes of operation. For Loop Manual Operation, the MCPRf as shown in Appendix A shall be used. Figures 49 and 50 are applicable to FHOOS or PROOS but not for simultaneous FHOOS and PROOS.

The reload analyses were performed in accordance with FRA-ANP methodology and its applicability to Cycle 12 was confirmed by Reference 5.

[1] Note that for Figures 35 to 42, 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 both GE control rods and ABB CR-82M bottom entry cruciform control rods. These Control Rod designs are discussed in more detail in Reference 7.

DEFINITIONS

BOC – Beginning of Cycle (Core Exposure 14,857 MWd/MTU).

MOC – Middle of Cycle (Core Exposure 29,157 MWd/MTU).

EOC – End of Cycle (Core Exposure 30,157 MWd/MTU).

EEOC – Extended cycle with Increased Core Flow (Core Exposure 30,563 MWd/MTU).

EEEOC – Extended cycle with Increased Core Flow and Final Feedwater Temperature Reduction (Core Exposure 31,146 MWd/MTU).

FFWTR – Final Feedwater Temperature Reduction.

FHOOS – Feedwater Heater Out of Service.

PROOS – Pressure Regulator Out of Service.

SLO – Single Loop Operation.

FRA-ANP – Framatome ANP

KAN – The designator for the once-burnt ATRIUM-10 assemblies.

REVISION HISTORY

Revision 0 provided the thermal limits from BOC to 5200 MWD/MT.

Revision 1 extends the thermal limits from BOC + 5200 MWD/MT to EEEOC.

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) value for the most limiting lattice (excluding natural uranium) of each fuel type as a function of AVERAGE PLANAR EXPOSURE is given in Figures 2 through 5. Two sets of MAPLHGR are provided herein for ATRIUM-10 and GE-11. The GE-11 set was determined with the SAFER/GESTR LOCA and GESTR-Mechanical methodology described in GESTAR-II (Reference 1). The ATRIUM-10 set was determined with the FRA-ANP methodology (Reference 5). Core location by fuel type is provided in Figure 1 and is the reference core loading pattern in reference 5. These figures are used if alternate calculations are required. The limits of these figures shall be reduced to a value of 0.79 and 0.83 times the two recirculation loop operation limit when in single loop operation for GE-11 and ATRIUM-10, respectively (Reference 5). Thermal power and core flow dependent multipliers are provided. The value of the exposure dependent limit is reduced by the value of the multiplier at a given offrated power or flow condition. The multipliers for single loop operation are shown in Appendix A.

The APLHGR limits for GE-11 in the core monitoring system are in more detail than the limits that appear in the COLR due to their proprietary nature. The core monitoring system has APLHGR limits for each lattice in a bundle rather than listing only the most limiting value for the entire bundle. References 4 and 5 list the core monitoring system 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 ($MCPR_F$) (Reference 5), power dependent MCPR ($MCPR_P$) (Reference 5) are shown in Figures 10, 11, 12 and Figures 15 to 29, respectively. Figures 53, 54 and 55 are used in lieu of Figures 10, 11 and 12 when the Reactor Recirculation System is operating in Loop Manual Mode. The most limiting value from the applicable $MCPR_f$ and $MCPR_p$ figures is the operating limit. These values were determined with FRA-ANP methodology as described in Reference 5 and are consistent with a Safety Limit MCPR from Technical Specification 2.0. At a power level greater than 40%, the power dependent $MCPR_P$ (Figures 27, 28 and 29) shall be increased by 0.02 for Single Loop Operation. At a power lower than 40%, the most limiting $MCPR_P$ value is the operating limit, and it shall be increased by 0.02 for Single Loop Operation.

TECHNICAL SPECIFICATION 3.2.3

POWER DISTRIBUTION LIMITS

LINEAR HEAT GENERATION RATE (LHGR)

The limiting LHGR value for ATRIUM-10 and for the most limiting lattice of each GE-11 fuel type as a function of AVERAGE PLANAR EXPOSURE is given in Figures 6 through 9. Core location by fuel type is provided in Figure 1 and is the reference core loading pattern in reference 5. These figures are used if alternate calculations are required. The LHGR limits for GE-11 in the core monitoring system are in more detail than the limits that appear in the COLR due to proprietary nature (Reference 9). Thermal power and core flow dependent multipliers for ATRIUM-10 and GE-11 are provided in Figures 13, 30 & 32 and Figures 14 & 31, respectively. The value of the exposure dependent limit is reduced by the value of the multiplier at a given offrated power or flow condition.

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 35 through 38 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 35 through 38. 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 35 through 38 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:

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

and rated equivalent at off-rated reactor conditions.

OR

$P \leq 30\%$

b. Case 2 - Reduced Feedwater Heating Operation

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

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.

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 6):

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 33 and 34.

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 35 through 38 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:

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

and rated equivalent at off-rated reactor conditions.

OR

$$P \leq 30\%$$

b. Case 2 - Reduced Feedwater Heating Operation

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

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 35 through 38 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:

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

and rated equivalent at off-rated reactor conditions.

OR

$P \leq 30\%$

b. Case 2 - Reduced Feedwater Heating Operation

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

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 39 through 42 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

1) NEDE-24011-P-A-14 and US Supplement, "General Electric Standard Application for Reactor Fuel," June 2000.

2) Letter, J.S. Charnley (GE) to M.W. Hodges (NRC), Recommended MAPLHGR Technical Specifications for Multiple Lattice Fuel Designs, March 9,1987

3) J11-03660SRLR Rev. 2 Supplemental Reload Licensing Report for River Bend Station Reload 9 Cycle 10" November 2000.

4) J11-03660MAPL, Revision 1 "Lattice Dependent MAPLHGR Report for River Bend Station Reload 9 Cycle 10" November 2000.

5) EMF-2848 Revision 1, "River Bend Station Cycle 12 Reload Analysis."

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

7) RBS USAR Section 4.1

8) CEO 2003-00047, "River Bend Station Unit 1 E1A Stability Power Uprate Evalutaion."

9) RBC-48838, "Transmittal of River Bend Cycle 10 LHGR/MAPLHGR Relaxation Results."

ANALYTICAL METHODS DOCUMENTS (TS 5.6.5):

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.

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.

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.

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.

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

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.

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.

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.

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.

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.

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.

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.

13) ANF-1358(P)(A) Revision 1, The Loss of Feedwater Heating Transient in Boiling Water Reactors, Advanced Nuclear Fuels Corporation, September 1992.

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

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

16) EMF-2209(P)(A) Revision 1, SPCB Critical Power Correlation, Siemens Power Corporation, July 2000.

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.

18) XN-NF-80-19(P)(A) Volumes 2, 2A, 2B, and 2C, Exxon Nuclear Methodology for Boiling Water Reactors: EXEM BWR ECCS Evaluation Model, Exxon Nuclear Company, September 1982.

19) ANF-91-048(P)(A), Advanced Nuclear Fuels Corporation Methodology for Boiling Water Reactors EXEM BWR Evaluation Model, Advanced Nuclear Fuels Corporation, January 1993.

20) ANF-91-048(P)(A) Supplements 1 and 2, BWR Jet Pump Model Revision for RELAX, Siemens Power Corporation, October 1997.

21) XN-CC-33(A) Revision 1, HUXY: A Generalized Multirod Heatup Code with 10 CFR 50 Appendix K Heatup Option Users Manual, Exxon Nuclear Company, November 1975.

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.

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

24) NEDE-24011-P-A-14 and US Supplement, "General Electric Standard Application for Reactor Fuel," June 2000.

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

	29	31	33	35	37	39	41	43	45	47	49	51	53	55
28	19 32.7	21 17.2	23 0.0	20 18.7	23 0.0	20 18.9	23 0.0	20 18.3	23 0.0	24 0.0	23 0.0	23 0.0	14 32.8	15 26.0
26	21 17.0	23 0.0	21 14.3	23 0.0	24 0.0	23 0.0	21 18.5	23 0.0	21 18.7	23 0.0	19 32.5	23 0.0	21 19.3	14 35.7
24	23 0.0	21 14.3	19 32.6	21 13.6	19 33.8	20 17.9	23 0.0	21 17.5	23 0.0	24 0.0	23 0.0	22 0.0	14 33.5	14 35.2
22	20 18.6	23 0.0	21 13.5	23 0.0	21 18.4	23 0.0	21 15.9	23 0.0	20 17.5	22 0.0	24 0.0	22 0.0	14 31.1	15 28.2
20	23 0.0	24 0.0	19 33.7	21 18.0	23 0.0	21 17.6	19 33.6	21 14.9	19 33.6	15 32.2	23 0.0	21 18.5	14 32.6	
18	20 16.9	23 0.0	20 17.5	23 0.0	21 17.4	22 0.0	19 30.5	22 0.0	15 31.9	22 0.0	24 0.0	21 18.1	15 26.9	
16	23 0.0	21 18.4	23 0.0	21 15.7	19 33.4	19 31.1	22 0.0	21 17.4	22 0.0	14 36.0	22 0.0	14 34.9	14 31.6	
14	20 17.8	23 0.0	21 17.5	23 0.0	21 14.8	22 0.0	21 17.3	22 0.0	19 33.6	21 16.0	15 30.1	14 33.9		
12	23 0.0	21 18.2	23 0.0	20 17.5	19 33.2	15 31.8	22 0.0	19 33.5	19 32.9	15 30.5	14 32.4			
10	24 0.0	23 0.0	24 0.0	22 0.0	15 32.0	22 0.0	14 35.9	21 15.9	15 30.4	14 35.8				
8	23 0.0	19 32.4	23 0.0	24 0.0	23 0.0	24 0.0	22 0.0	15 30.2	14 33.7					
6	23 0.0	23 0.0	22 0.0	22 0.0	21 17.7	21 18.1	14 32.6	14 34.2						
4	14 32.8	21 18.9	14 32.6	14 31.1	14 31.8	15 26.4	15 30.4							
2	15 26.3	14 33.2	14 34.9	15 28.2										

Nuclear Fuel Type
BOC Exposure (GWd/MTU)

Fuel Type	Description	Cycle Loaded
14	GE11 3.88B-13GZ-120T-146	9
15	GE11 4.00B-13GZ-120T-146	9
19	GE11 3.36B-12GZ-120T-146	10
20	ATRIUM-10 A10-3552B-12GV60	11
21	ATRIUM-10 A10-3899B-12GV60	11
22	ATRIUM-10 A10-3996B-11G45	12
23	ATRIUM-10 A10-3981B-15GV75	12
24	ATRIUM-10 A10-1997B-0Gd	12

FIGURE 2. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FOR ATRIUM-10

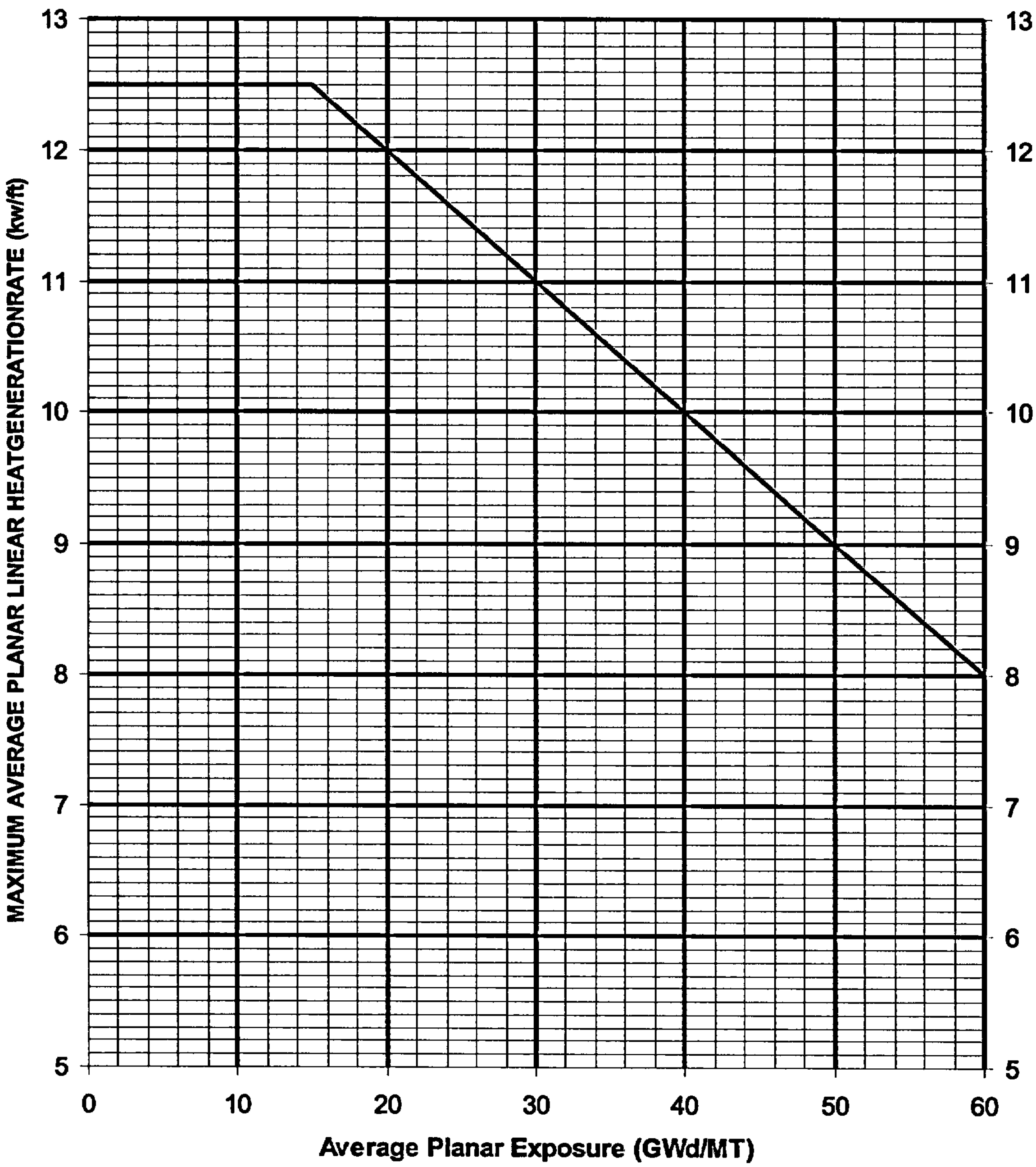


FIGURE 3. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE GE11-P9SUB336-12GZ-120T-146-T

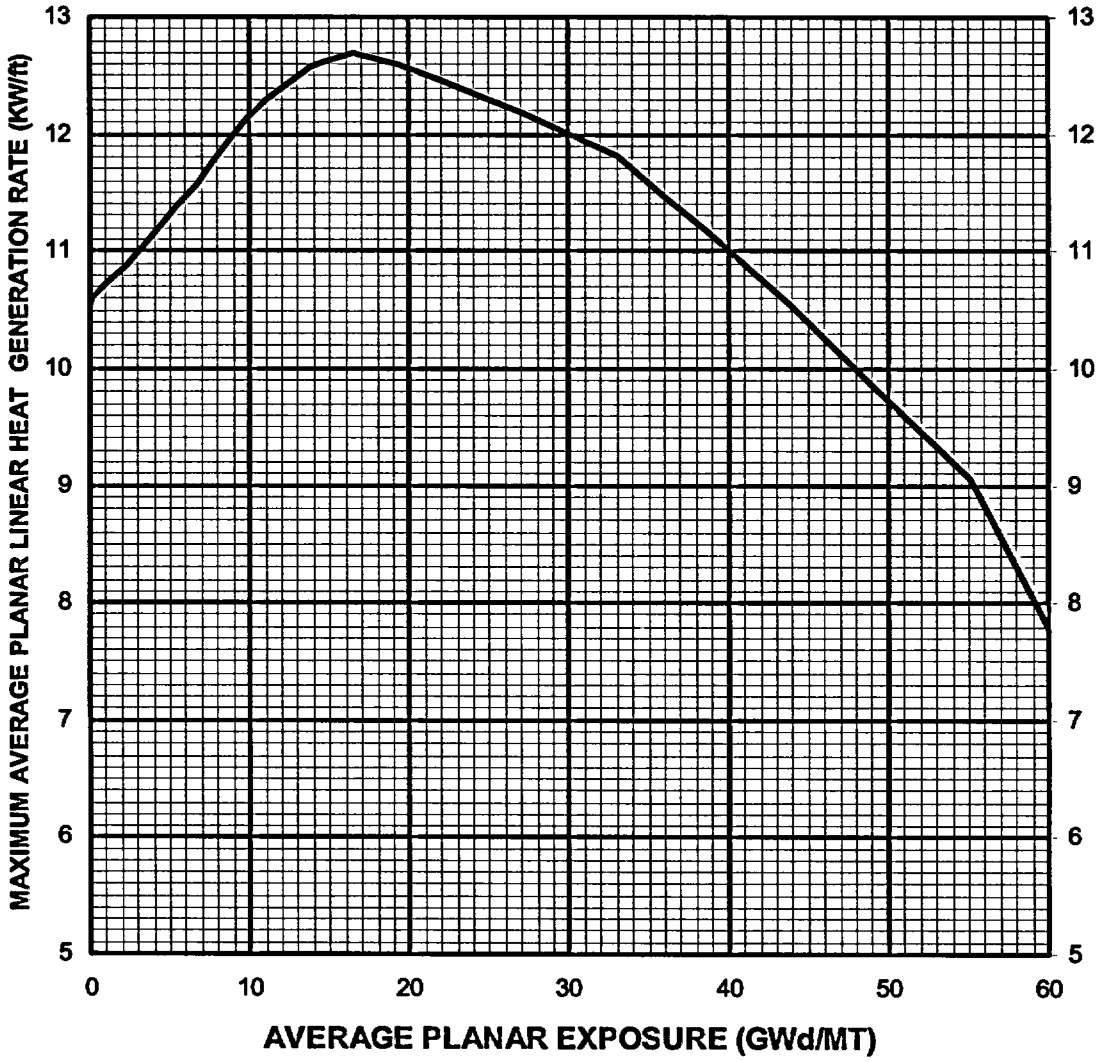


FIGURE 4. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FOR GE11-P9SUB400-13GZ-120T-146-T

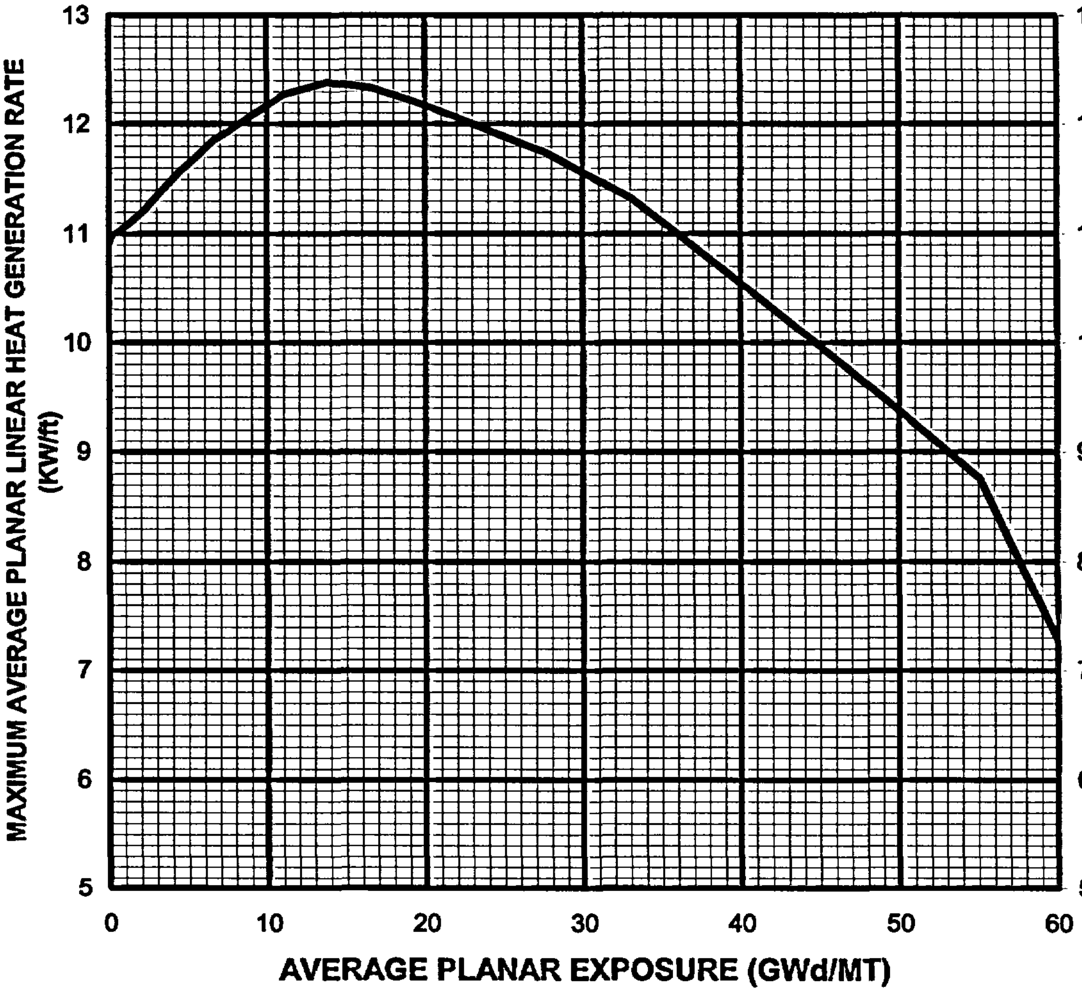


FIGURE 5. MAXIMUM AVERAGE PLANAR LINEAR HEAT GENERATION RATE (MAPLHGR) VERSUS AVERAGE PLANAR EXPOSURE FOR GE11-P9SUB388-13GZ-120T-146-T

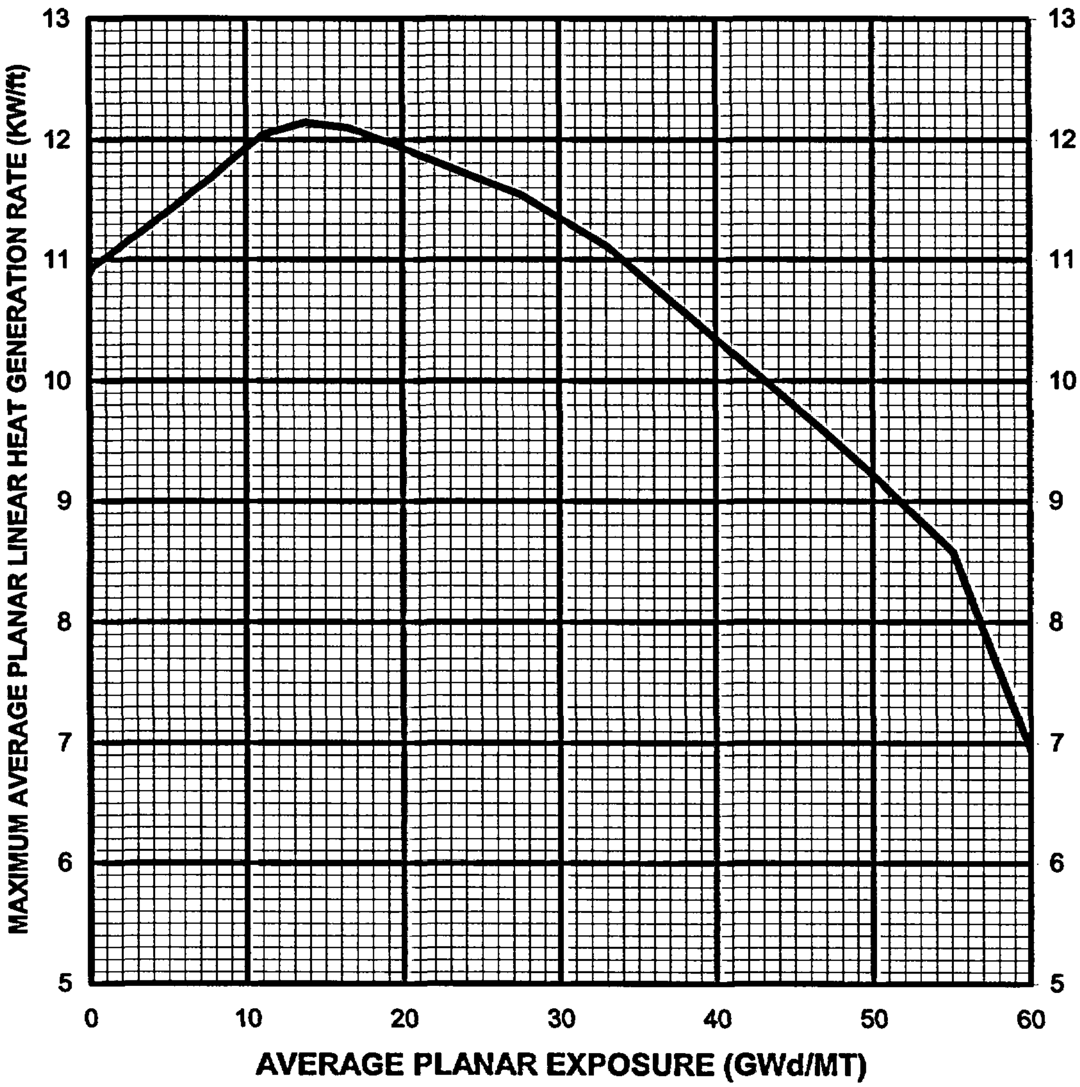


FIGURE 6. LINEAR HEAT GENERATION RATE (LHGR) LIMIT VERSUS AVERAGE PLANAR EXPOSURE FOR ATRIUM-10

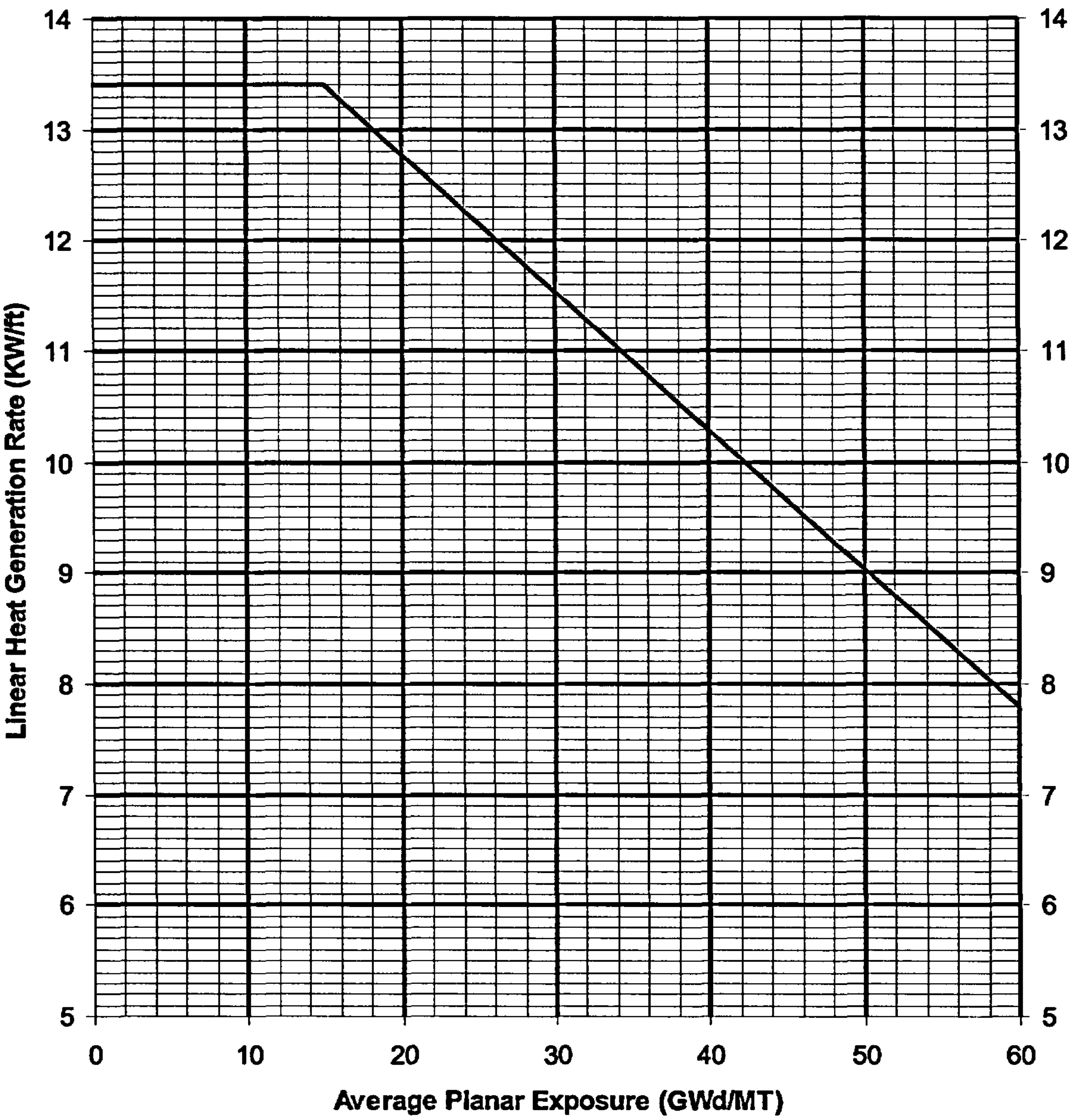


FIGURE 7. LINEAR HEAT GENERATION RATE (LHGR) LIMIT VERSUS AVERAGE PLANAR EXPOSURE GE11-P9SUB400-13GZ-120T-146-T

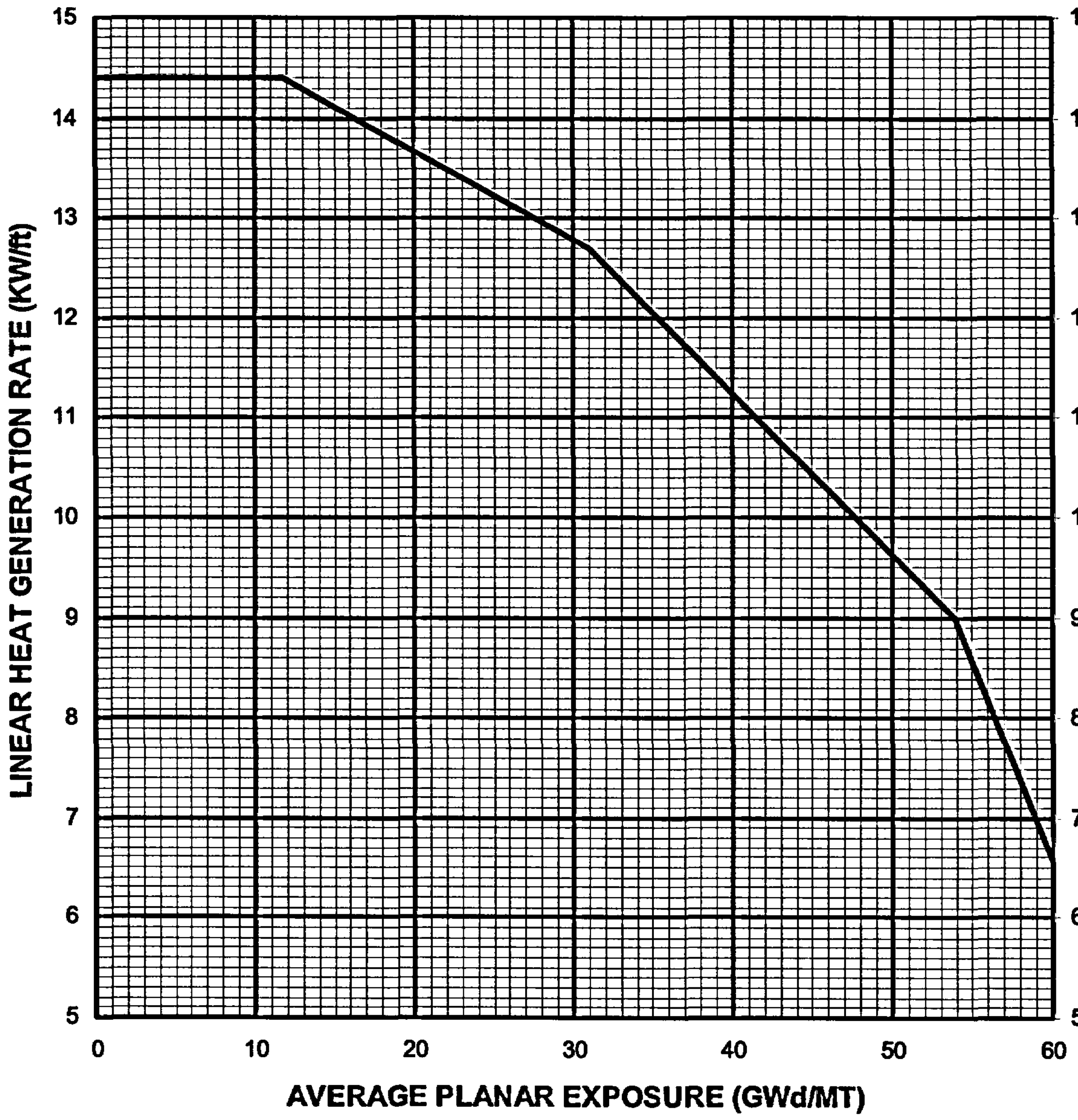


FIGURE 8. LINEAR HEAT GENERATION RATE (LHGR) LIMIT VERSUS AVERAGE PLANAR EXPOSURE GE11-P9SUB336-12GZ-120T-146-T

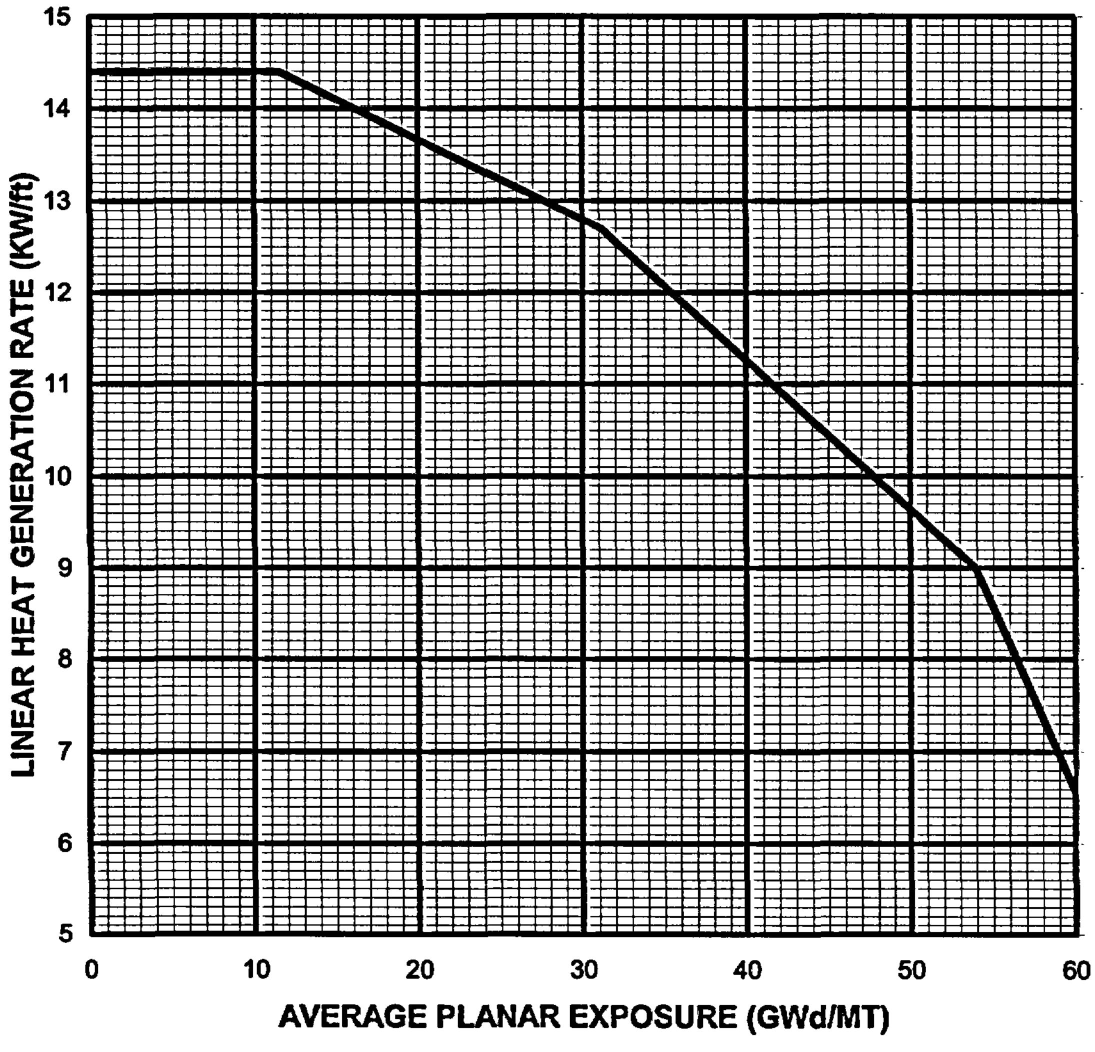


FIGURE 9. LINEAR HEAT GENERATION RATE (LHGR) LIMIT VERSUS AVERAGE PLANAR EXPOSURE GE11-PSUB388-13GZ-120T-146-T

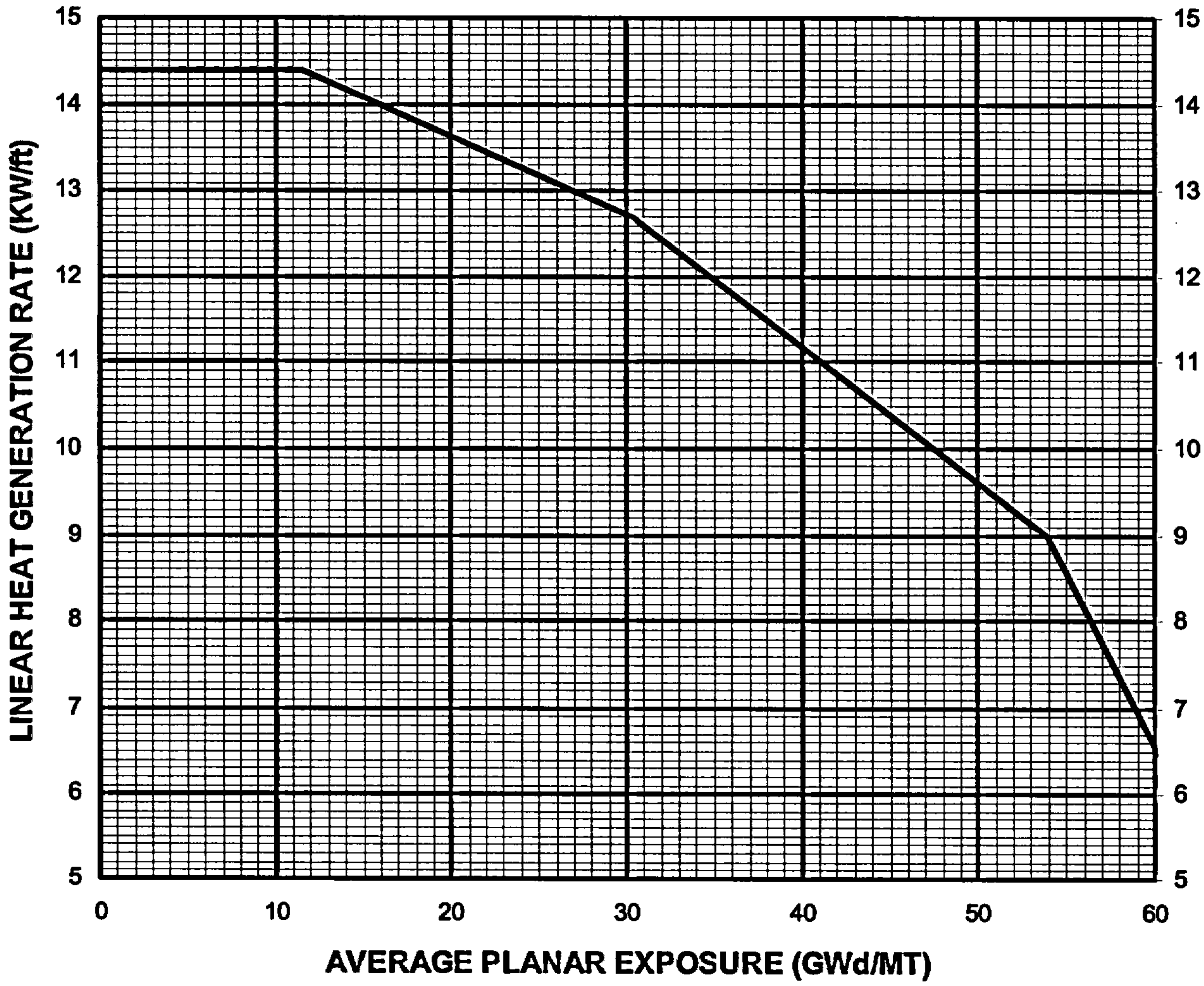


FIGURE 10. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR NON-KAN ATRIUM-10 FOR RECIRCULATION SYSTEM IN LOOP AUTO CONTROL, ALL EXPOSURES

FIGURE 11. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR KAN ATRIUM-10 FOR RECIRCULATION SYSTEM IN LOOP AUTO CONTROL, ALL EXPOSURES

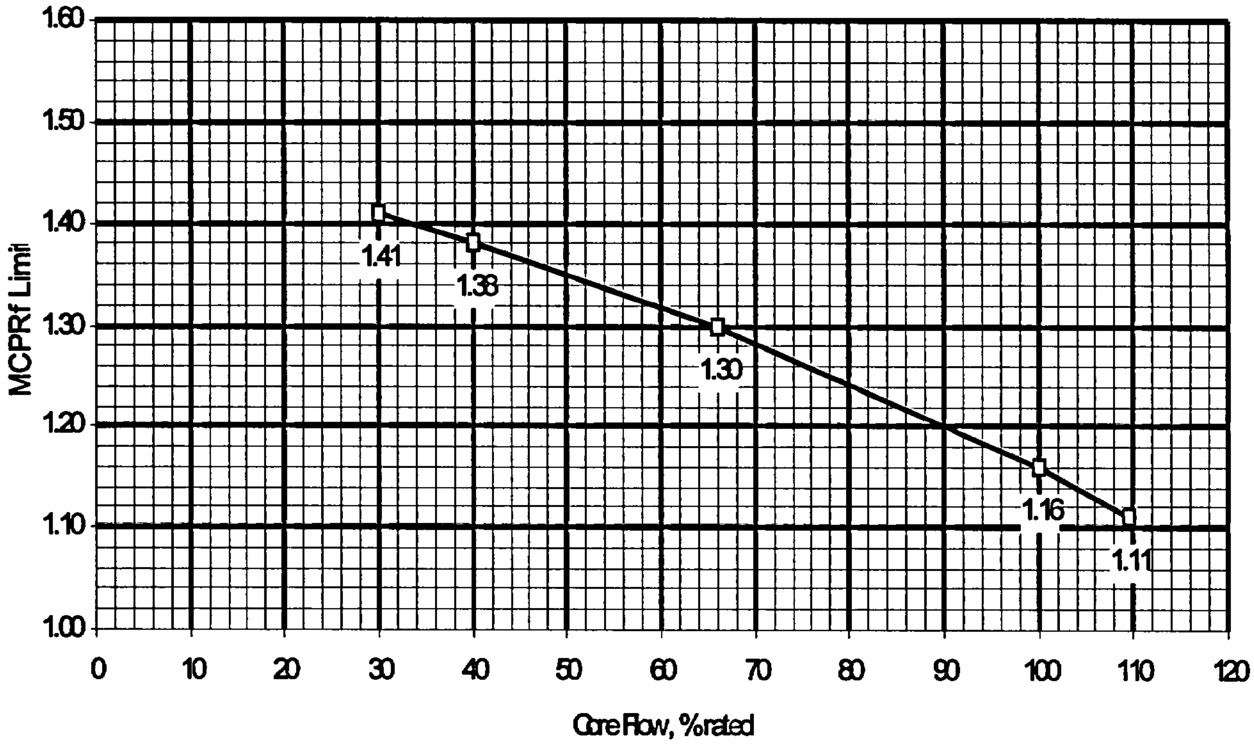


FIGURE 12. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR GE-11 FOR RECIRCULATION SYSTEM IN LOOP AUTO CONTROL, ALL EXPOSURES

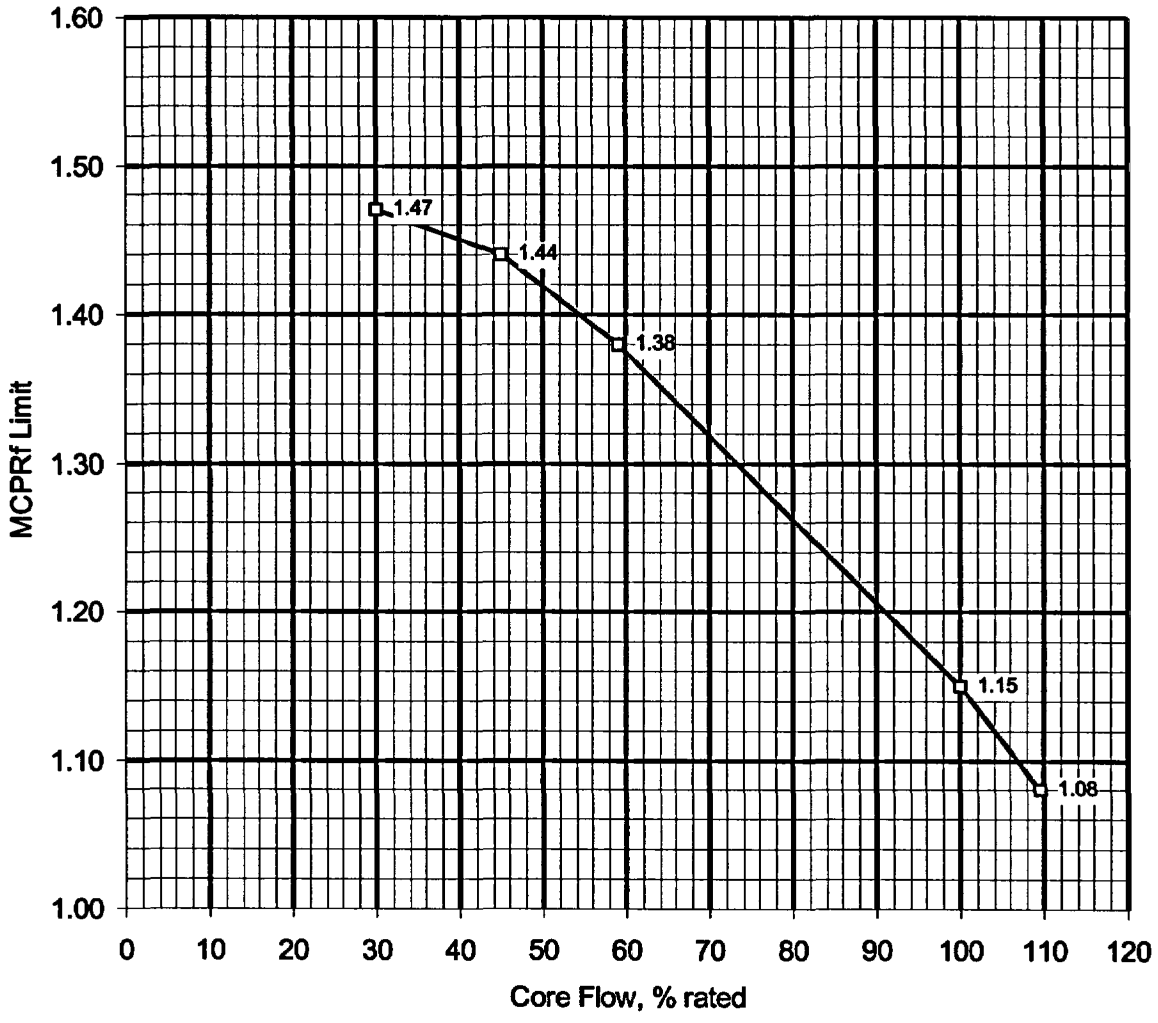


FIGURE 13. LHGR MULTIPLIER VERSUS CORE FLOW FOR ALL ATRIUM-10, ALL EXPOSURES

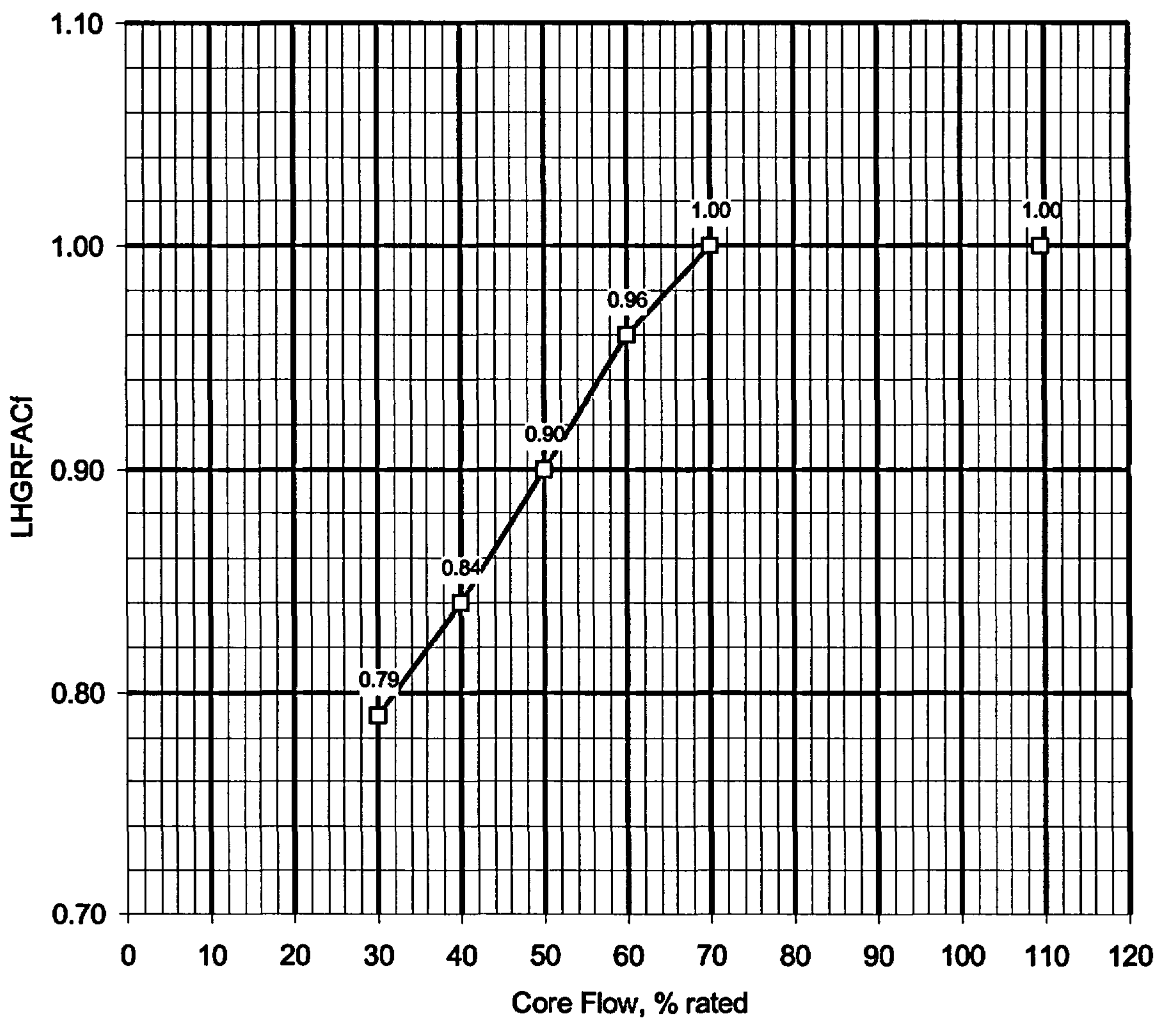


FIGURE 14. LHGR AND MAPLHGR MULTIPLIER VERSUS CORE FLOW FOR GE-11, ALL EXPOSURES

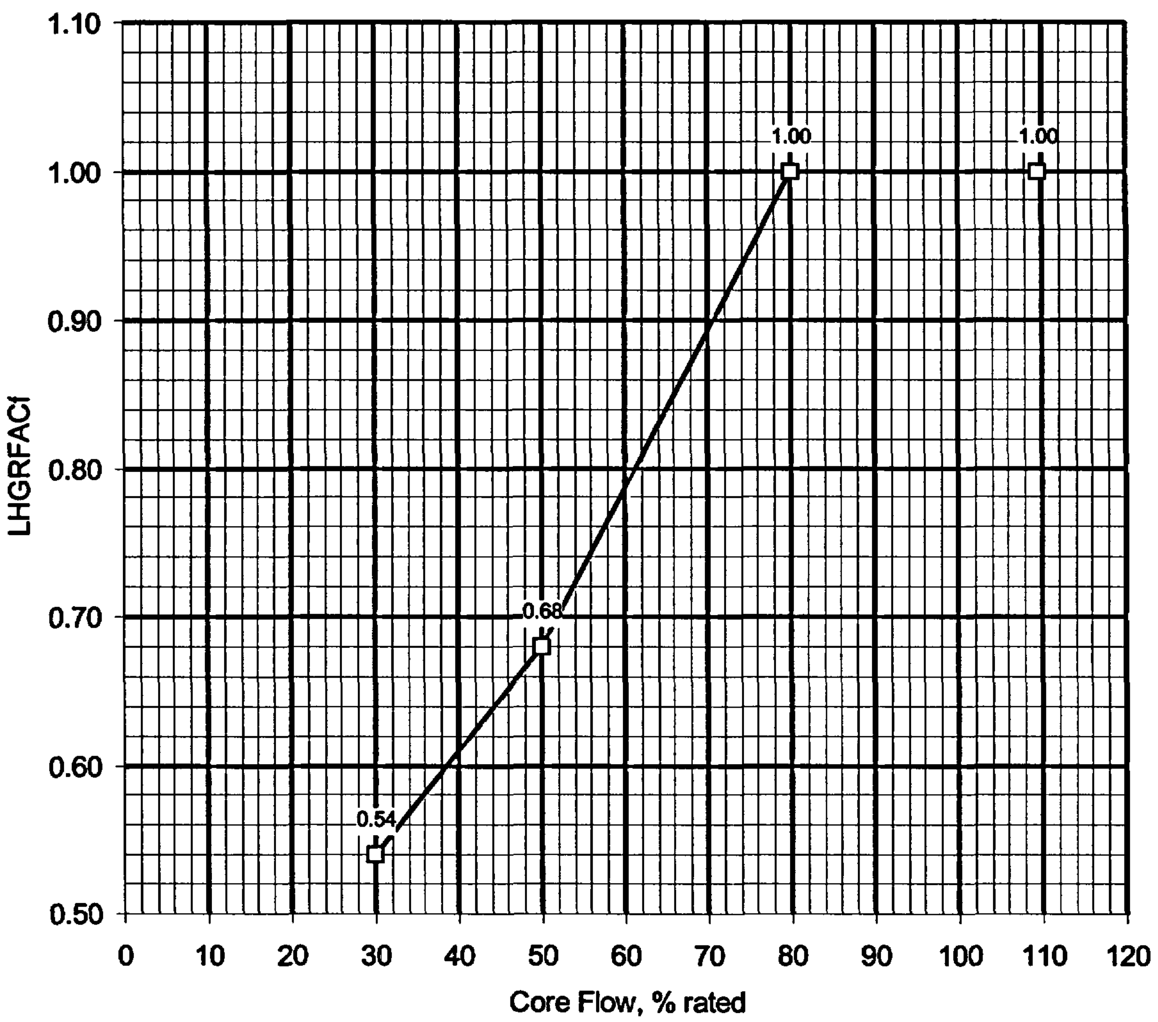


FIGURE 15. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR NON-KAN ATRIUM-10, EXPOSURE RANGE BOC TO BOC + 5200 MWD/MTU

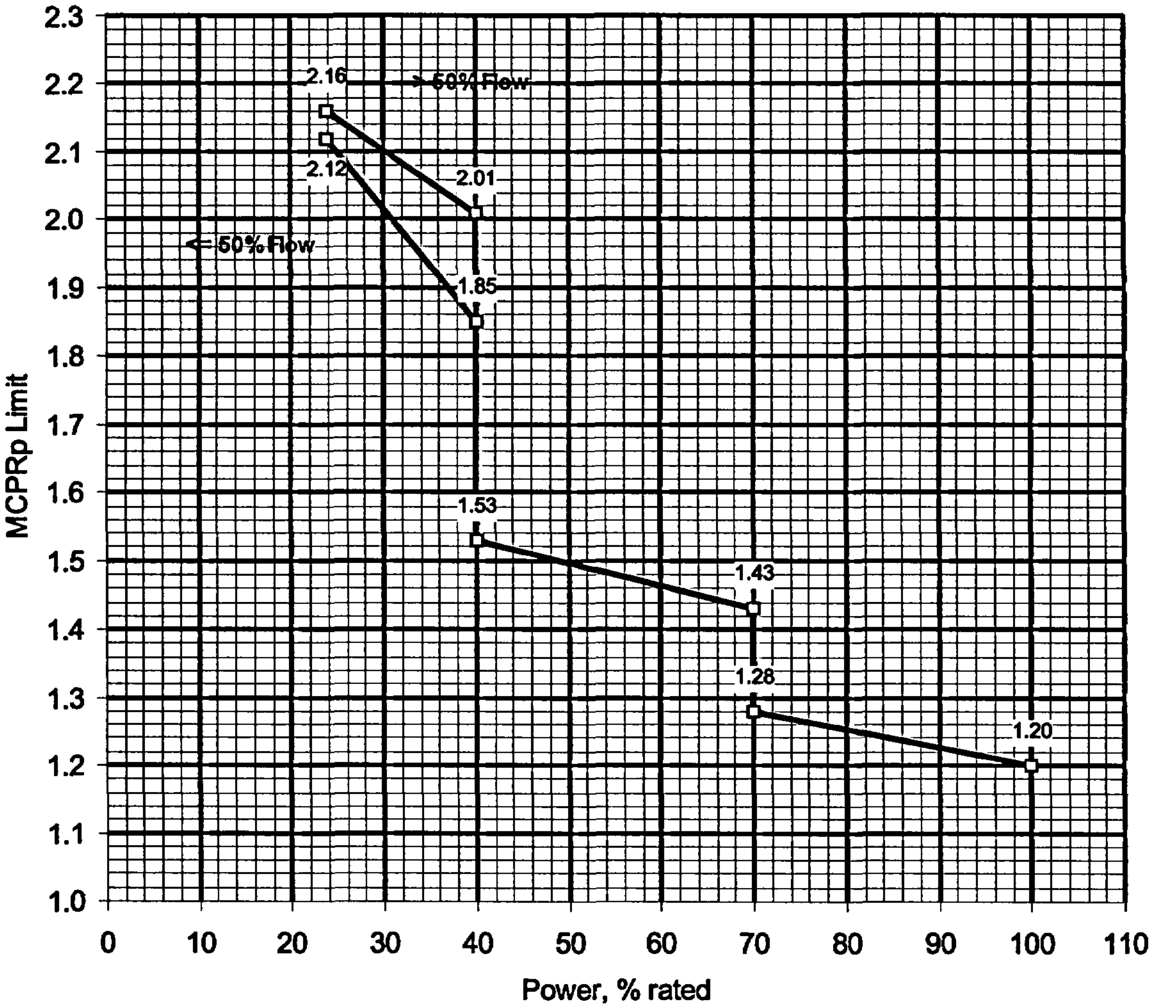


FIGURE 16. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR KAN ATRIUM-10, EXPOSURE RANGE BOC TO BOC + 5200 MWD/MTU

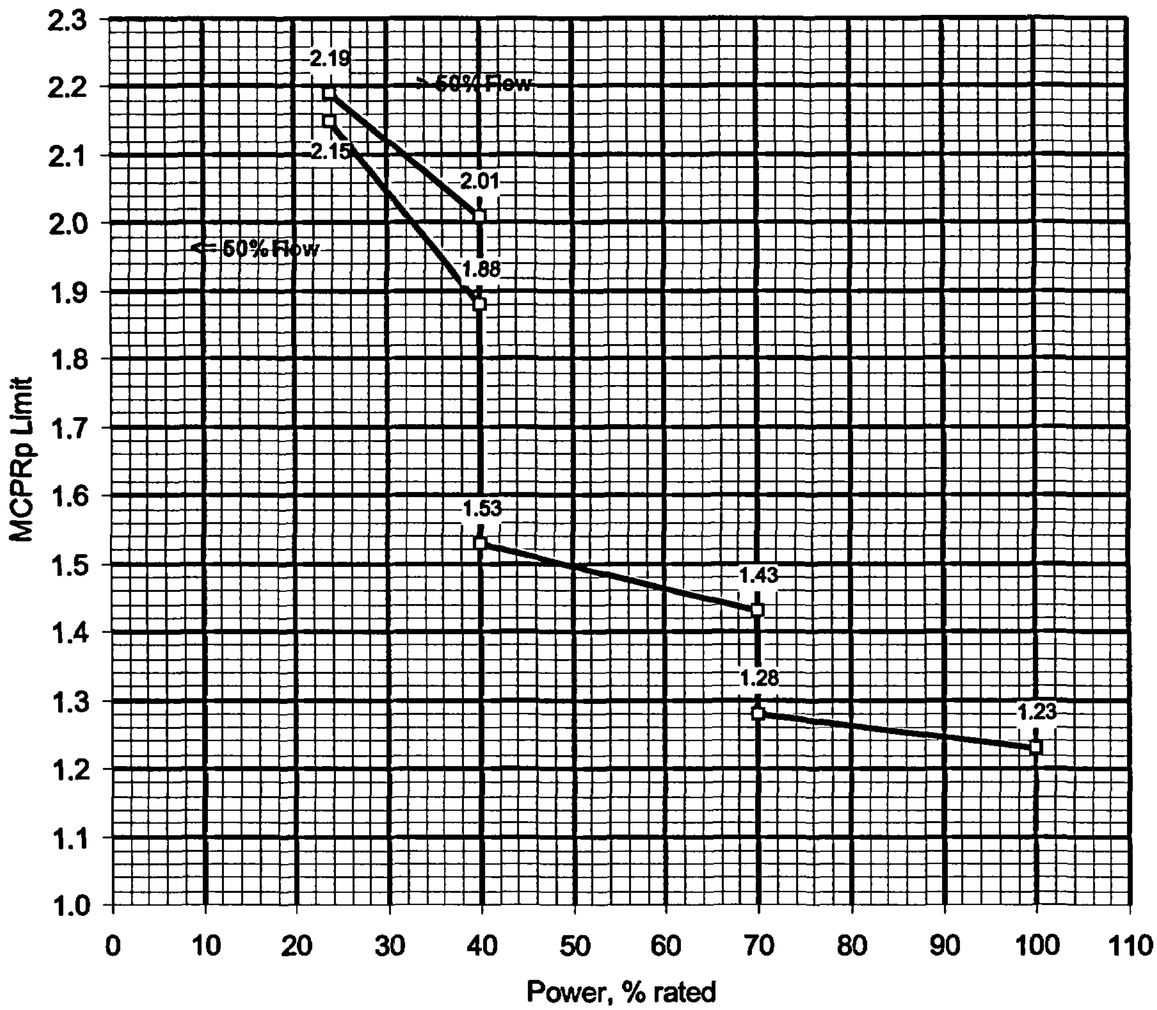


FIGURE 17. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE-11, EXPOSURE RANGE BOC TO BOC + 5200 MWD/MTU

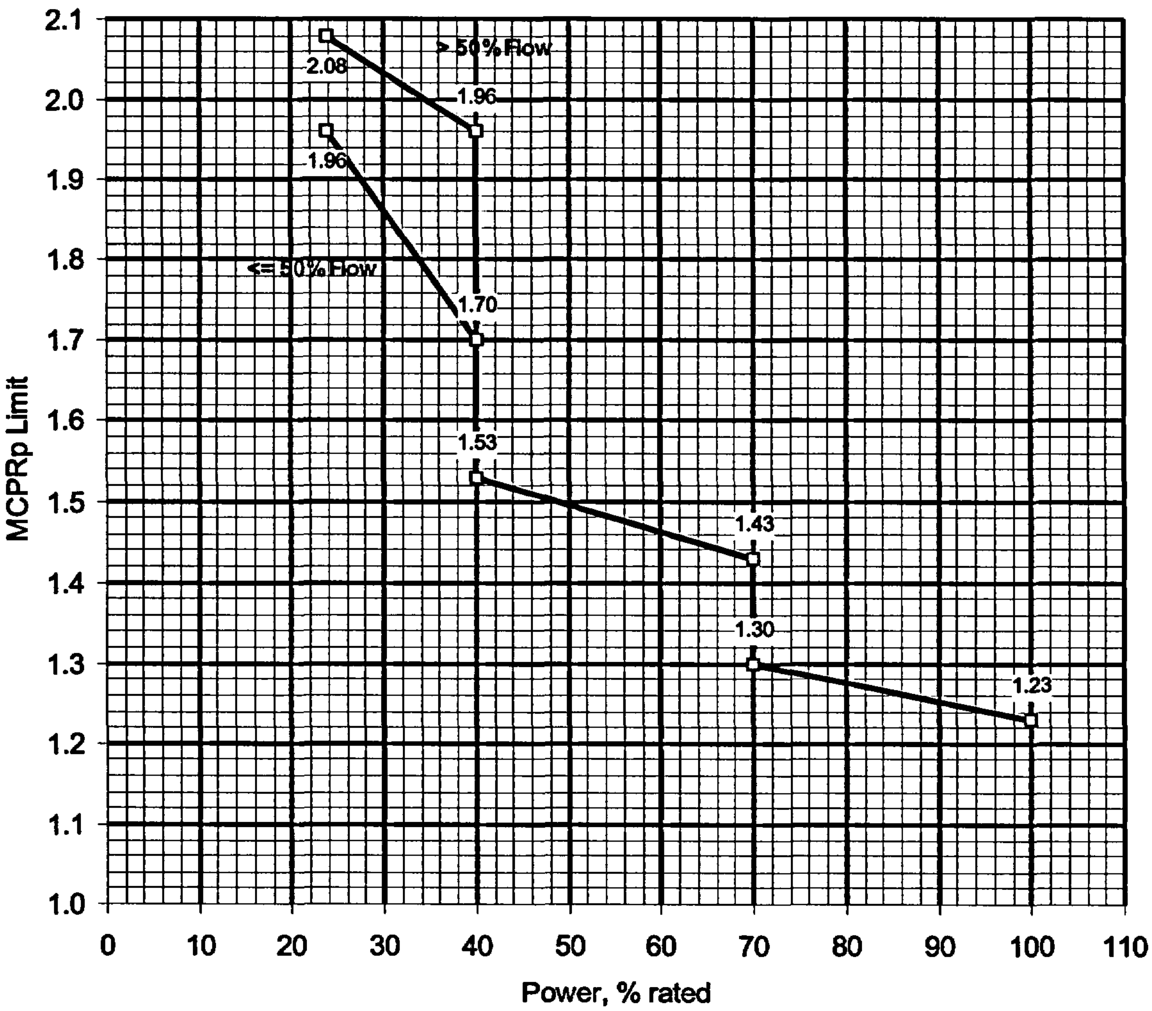


FIGURE 18. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR NON-KAN ATRIUM-10, EXPOSURE RANGE BOC + 5200 MWD/MTU TO MOC

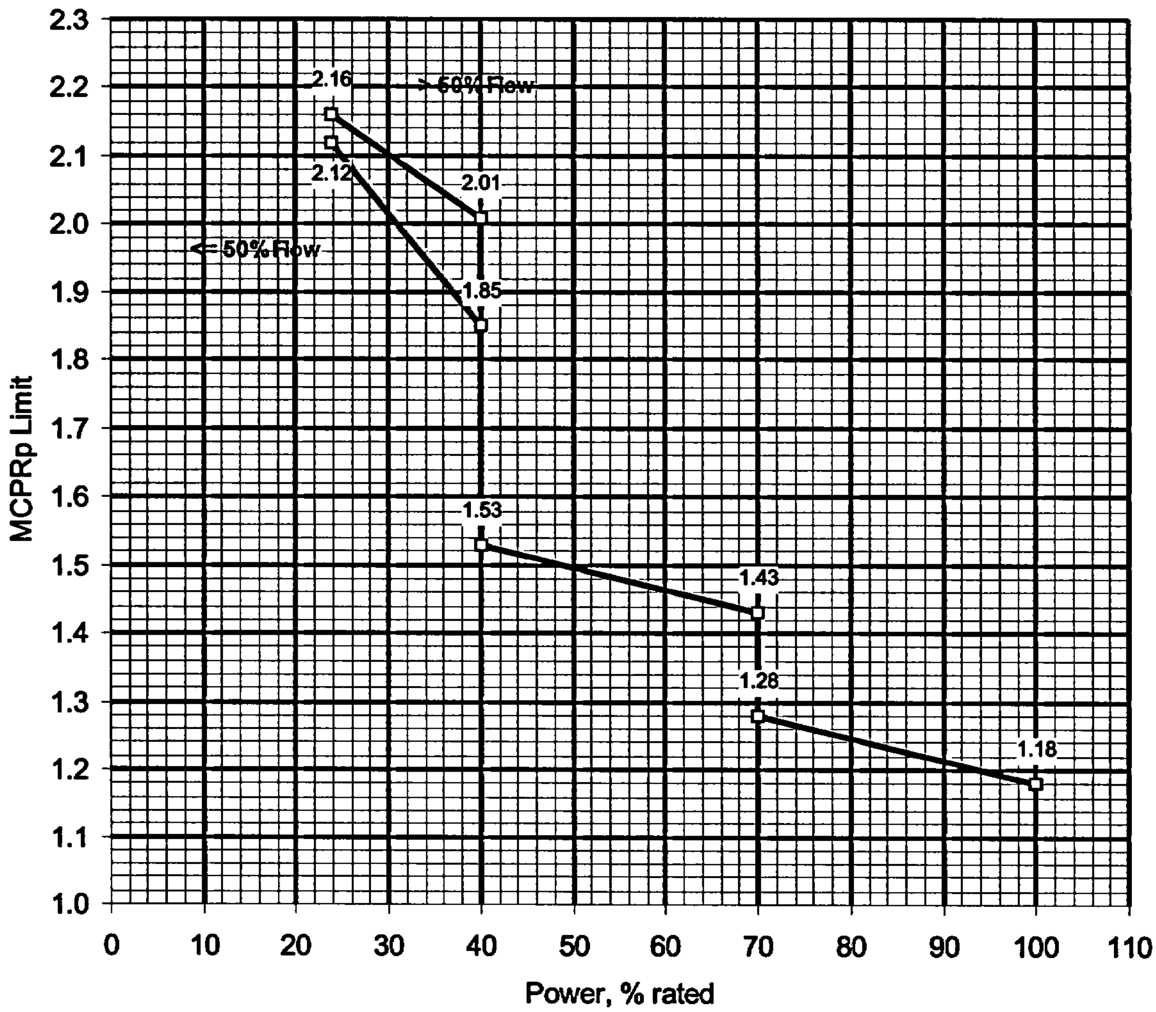


FIGURE 19. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR KAN ATRIUM-10, EXPOSURE RANGE BOC + 5200 MWD/MTU TO MOC

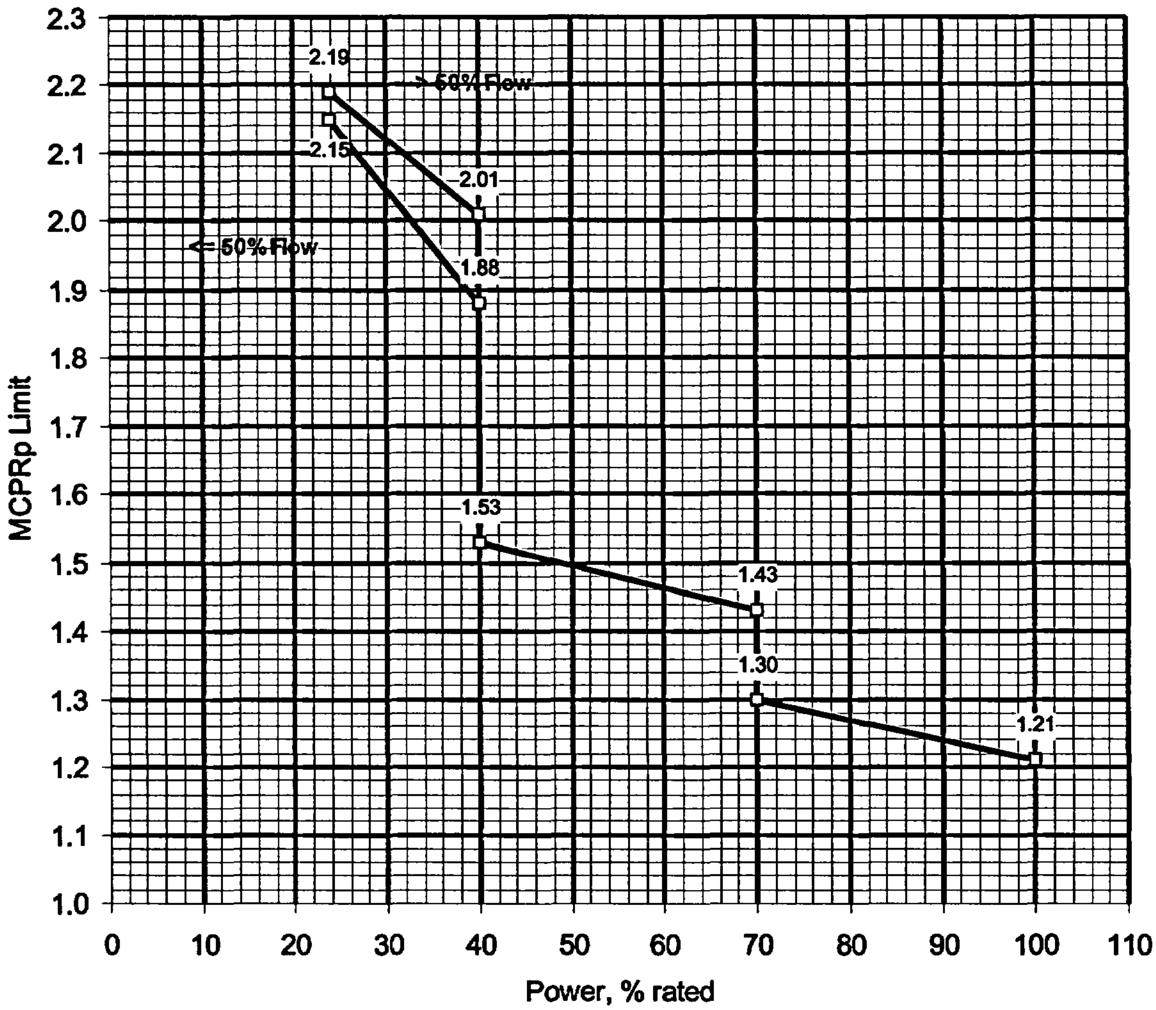


FIGURE 20. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE-11, EXPOSURE RANGE BOC + 5200 MWD/MTU TO MOC

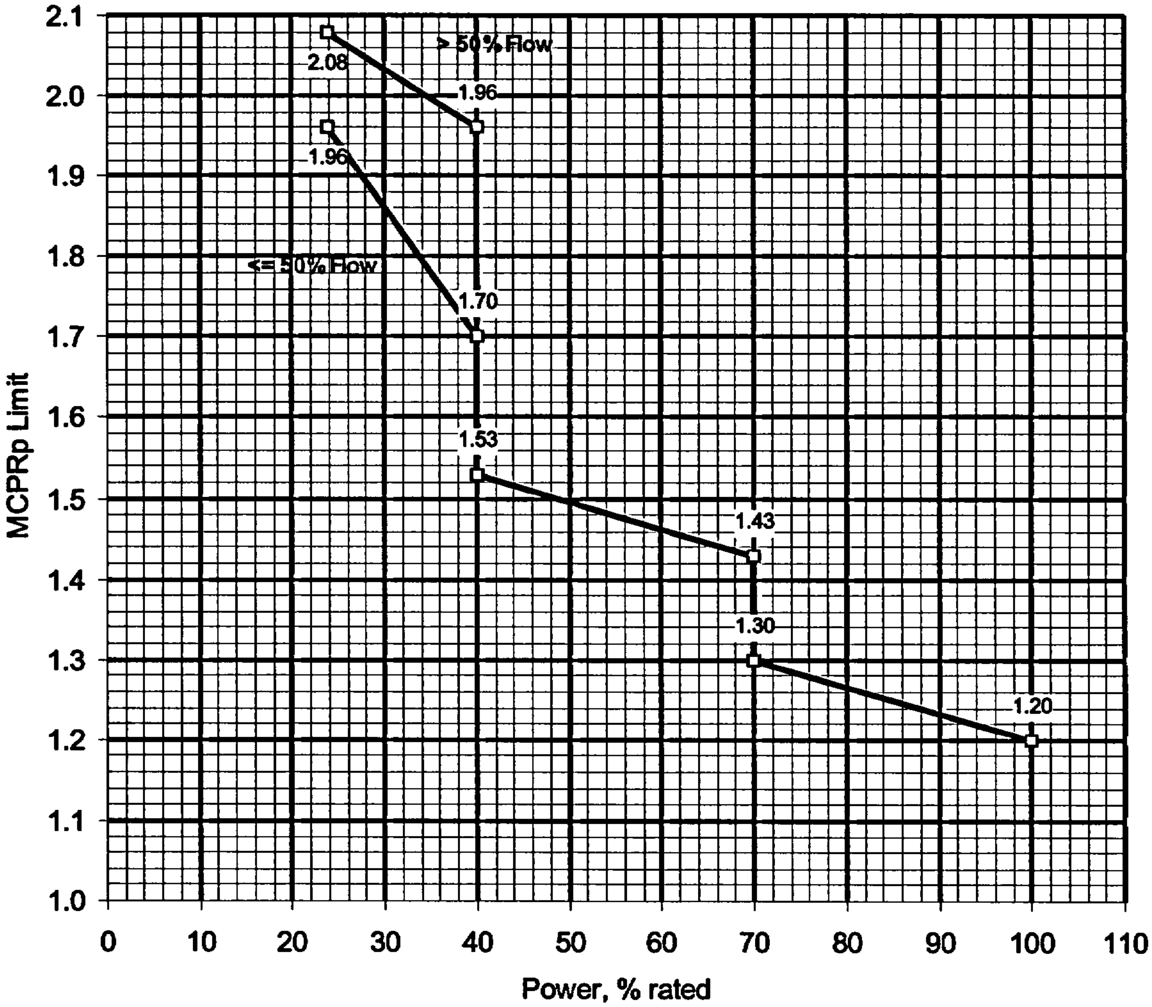


FIGURE 21. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR NON-KAN ATRIUM-10, EXPOSURE RANGE MOC TO EOC

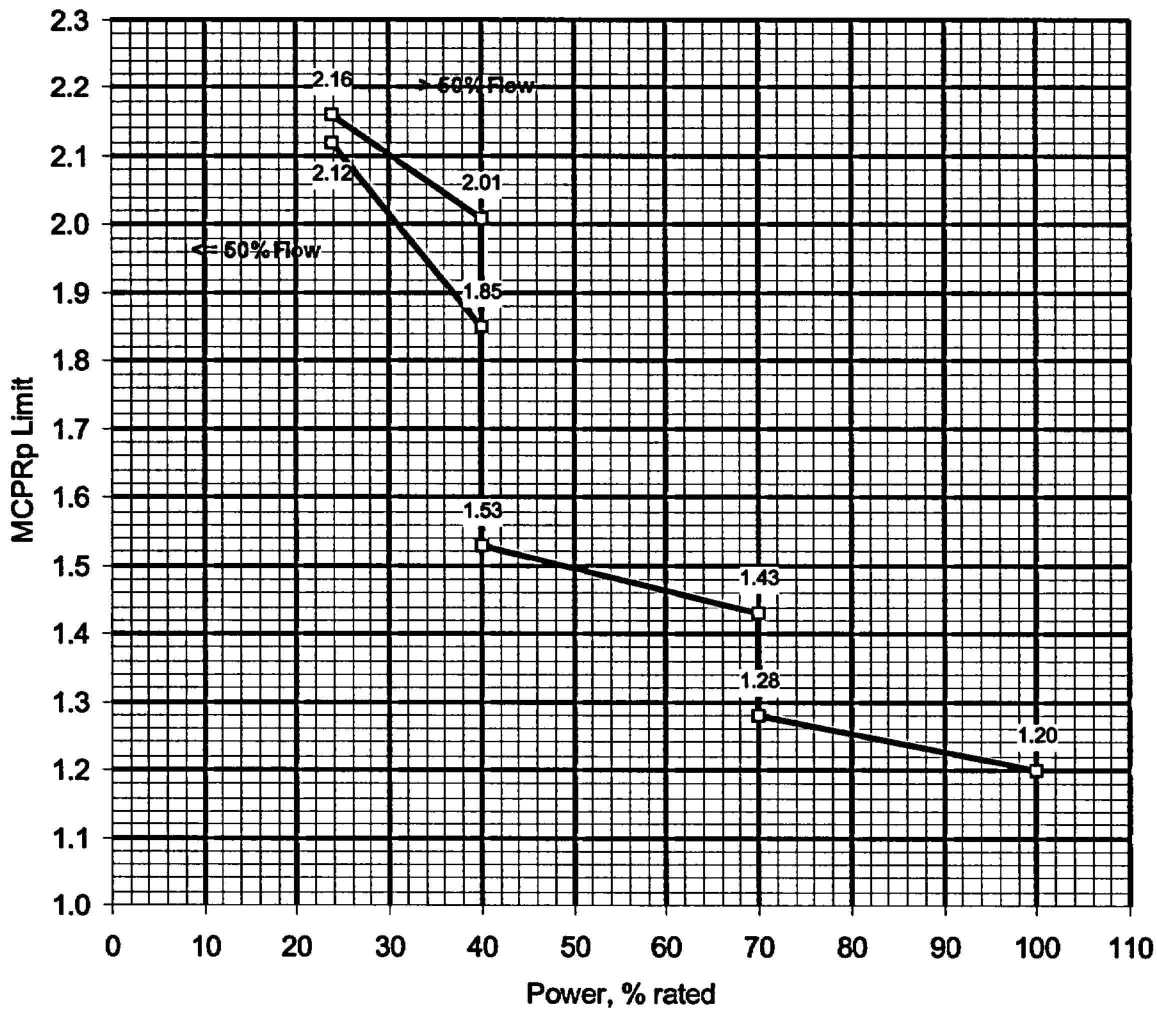


FIGURE 22. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR KAN ATRIUM-10, EXPOSURE RANGE MOC TO EOC

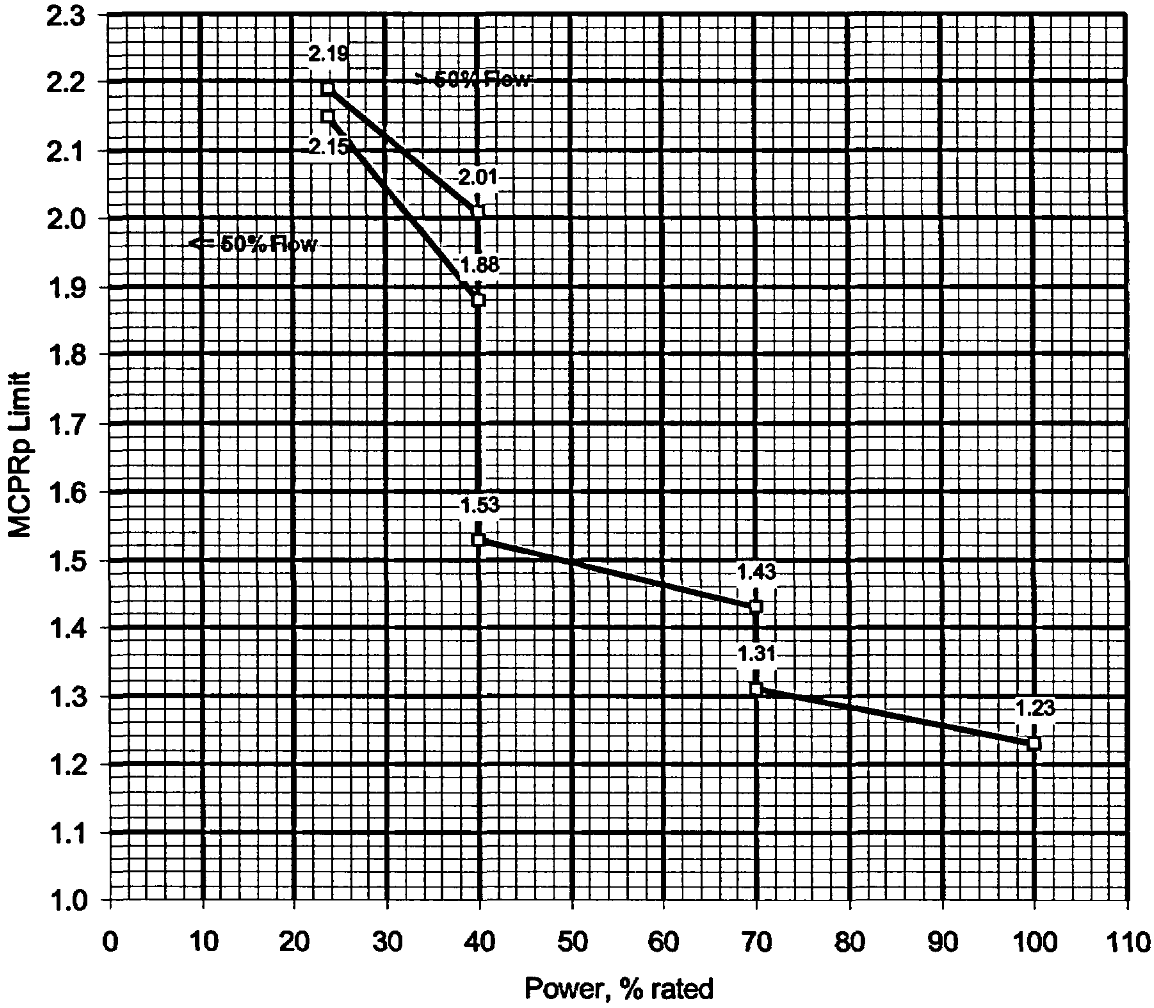


FIGURE 23. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE-11, EXPOSURE RANGE MOC TO EOC

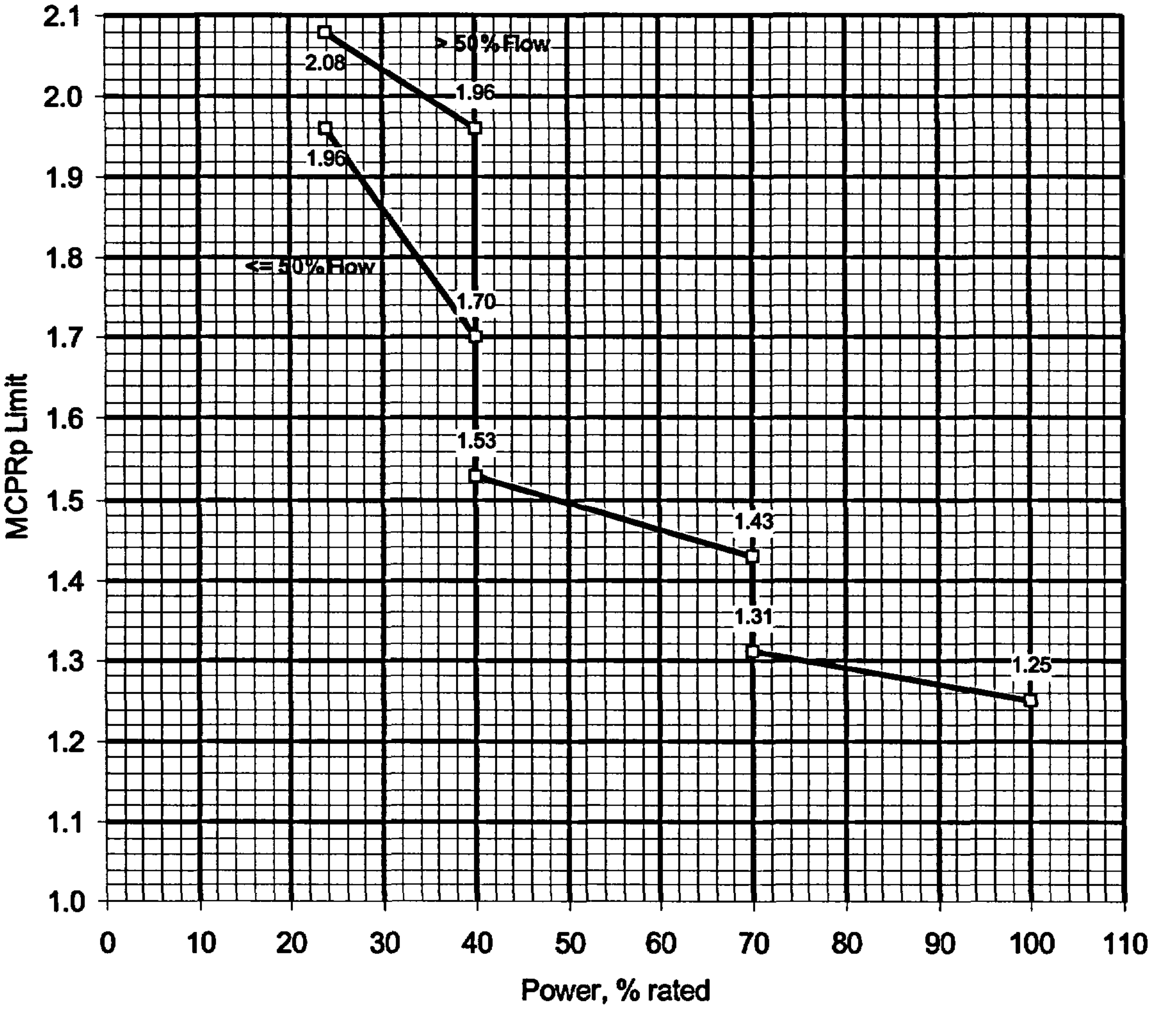


FIGURE 24. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR NON-KAN ATRIUM-10, EXPOSURE RANGE EOC TO EEOC

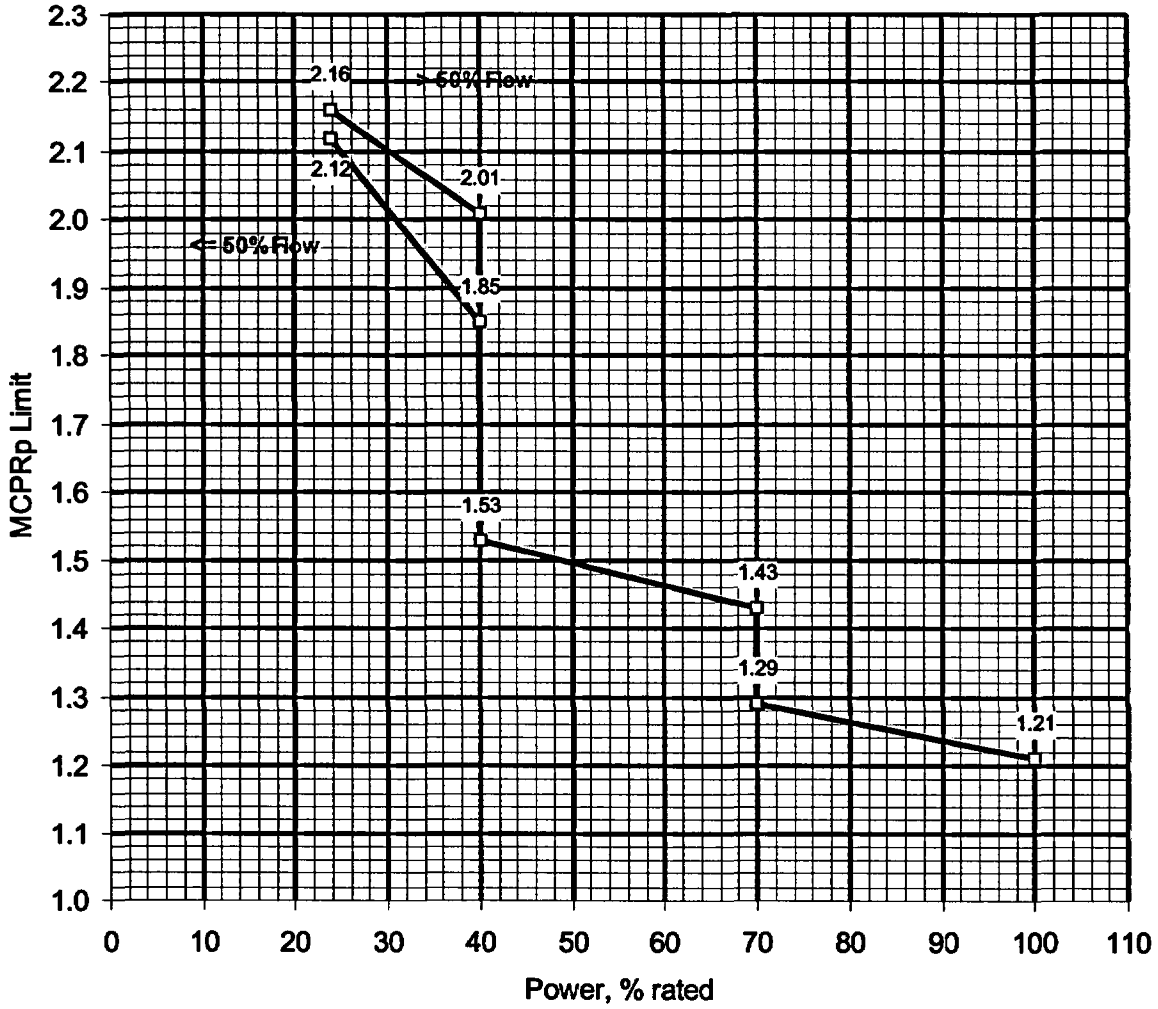


FIGURE 25. OPERATING LIMIT MCPR (MCPR$_P$) VERSUS CORE POWER FOR KAN ATRIUM-10, EXPOSURE RANGE EOC TO EEOC

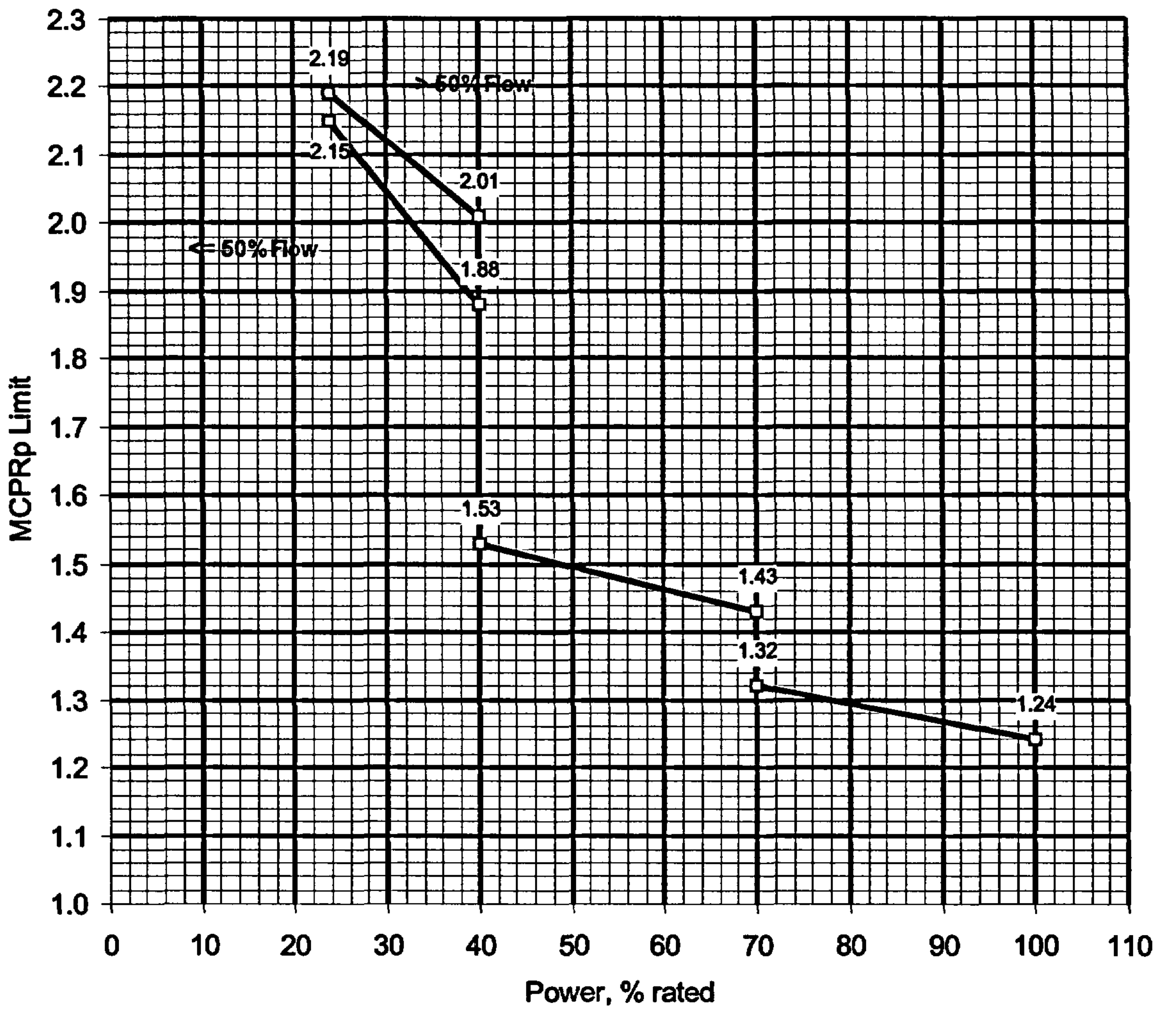


FIGURE 26. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE-11, EXPOSURE RANGE EOC TO EEOC

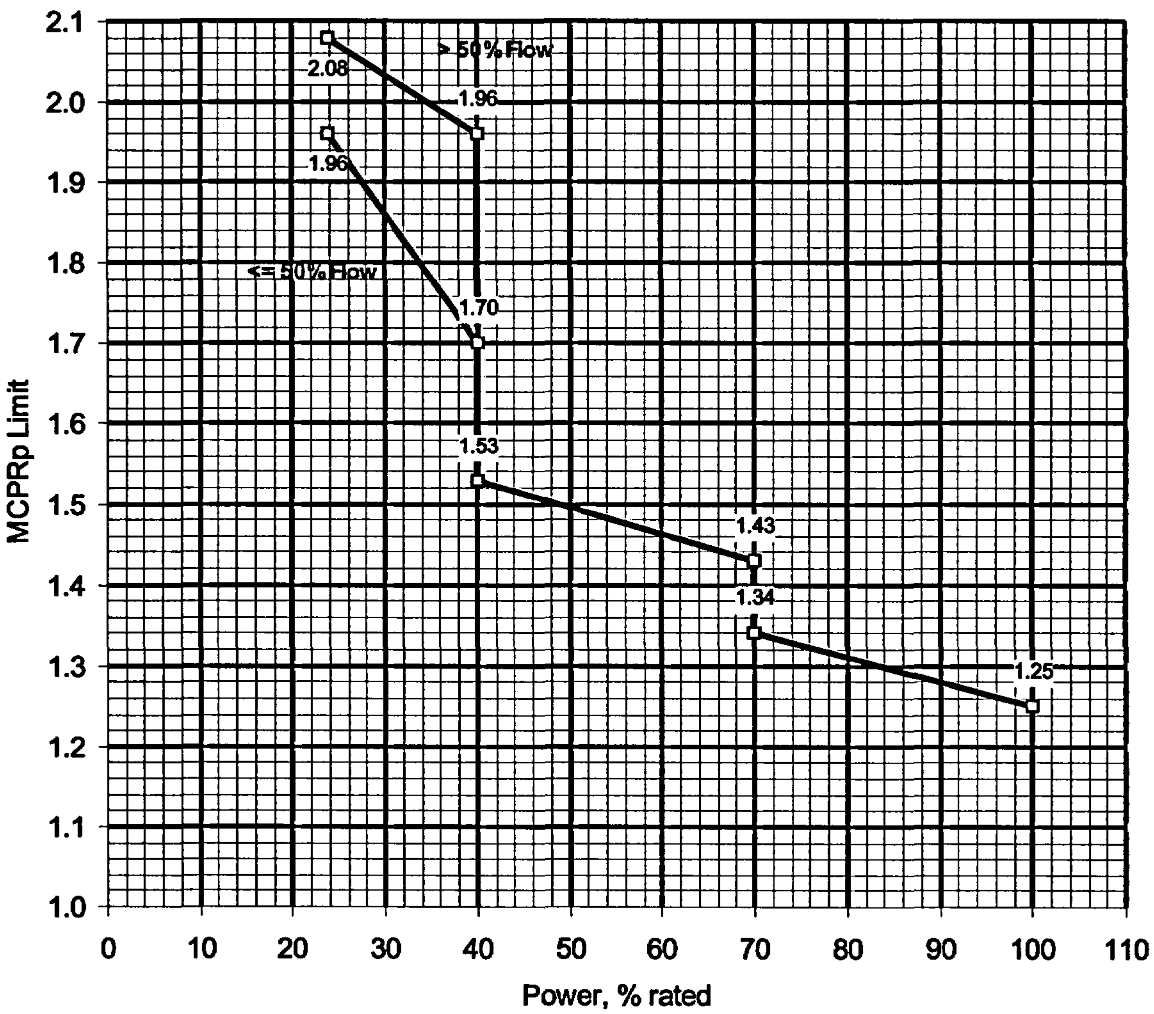


FIGURE 27. OPERATING LIMIT MCPR (MCPR$_P$) VERSUS CORE POWER FOR NON-KAN ATRIUM-10, EXPOSURE RANGE EEOC TO EEEOC

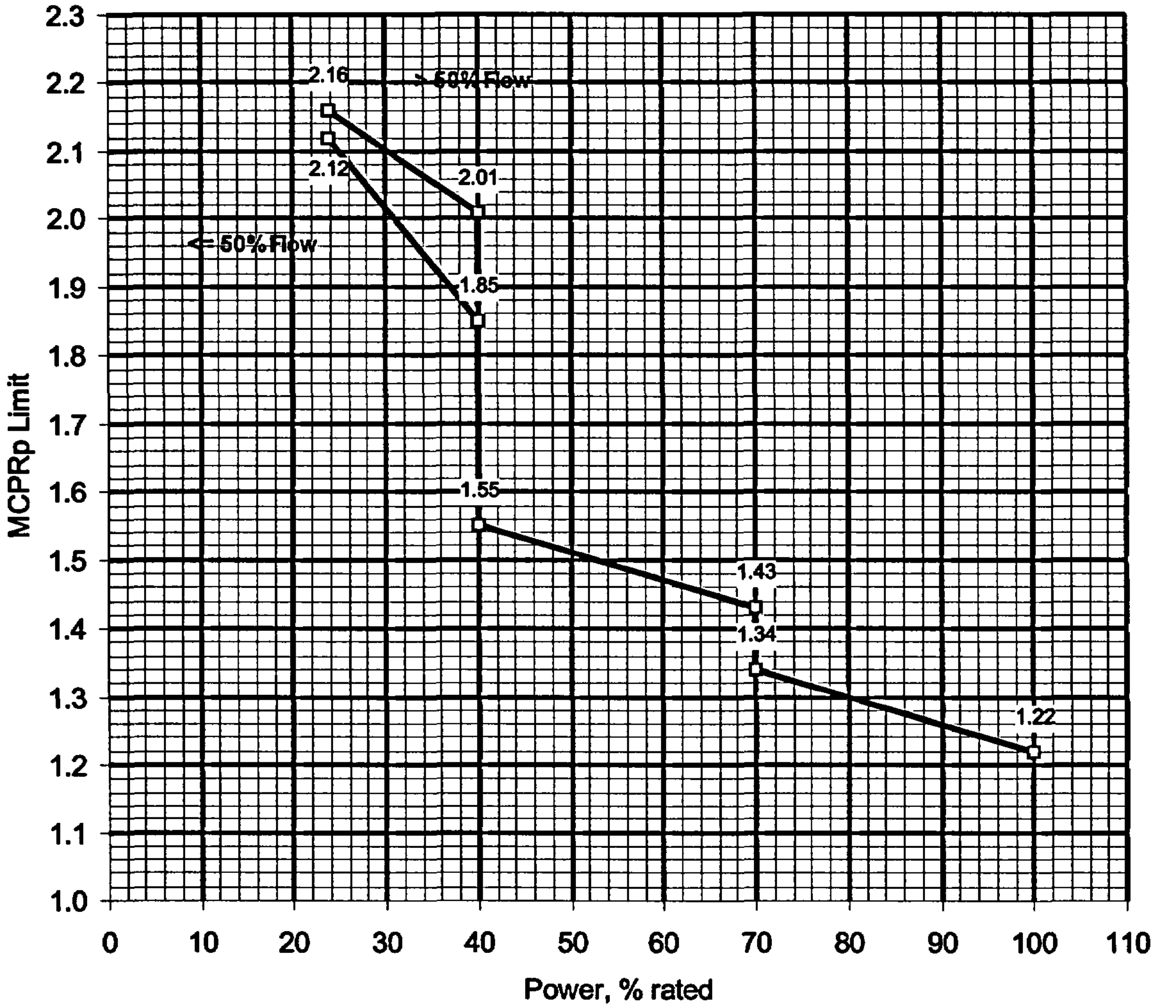


FIGURE 28. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR KAN ATRIUM-10, EXPOSURE RANGE EEOC TO EEEOC

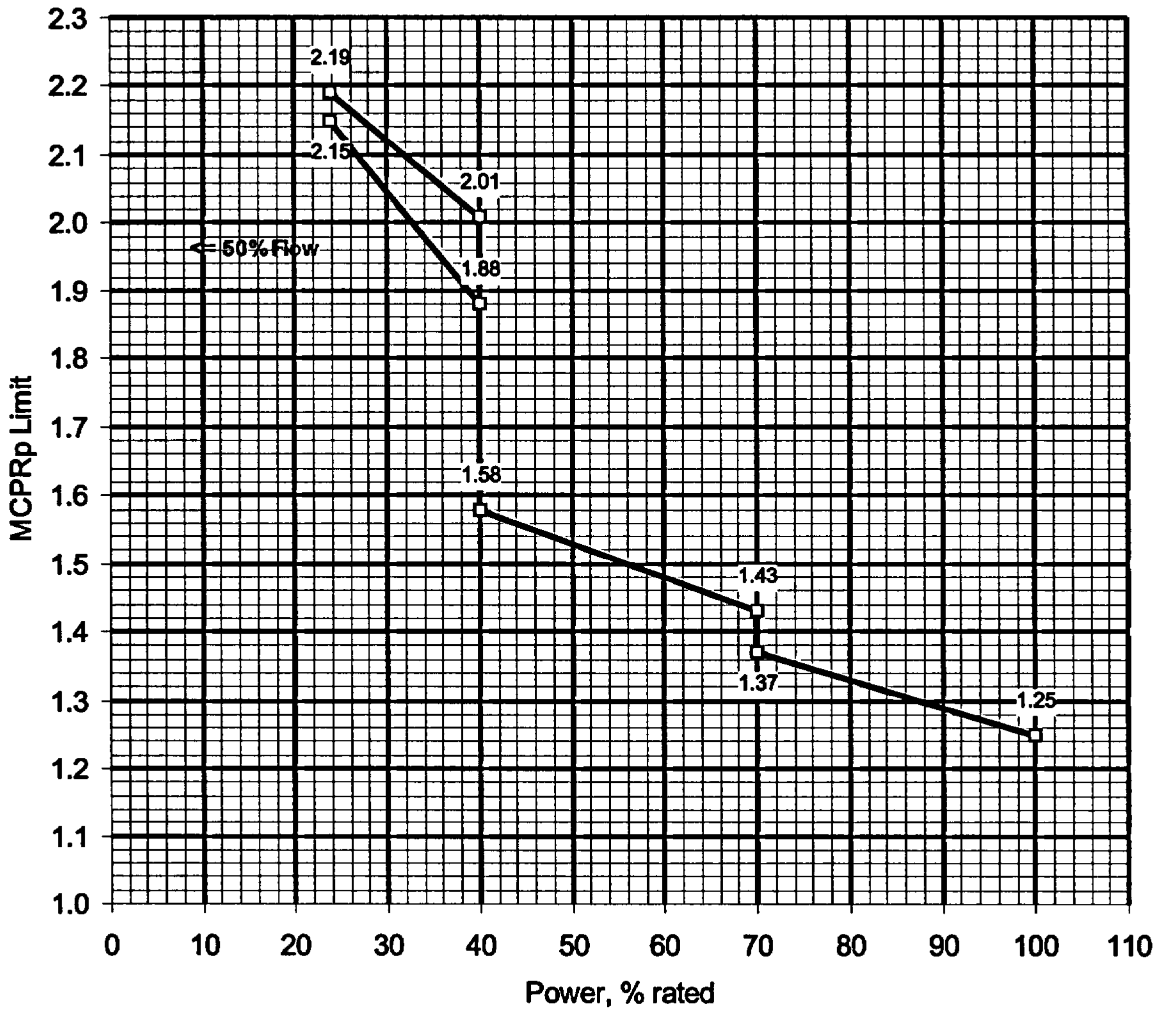


FIGURE 29. OPERATING LIMIT MCPR (MCPR$_P$) VERSUS CORE POWER FOR GE-11, EXPOSURE RANGE EEOC TO EEEOC

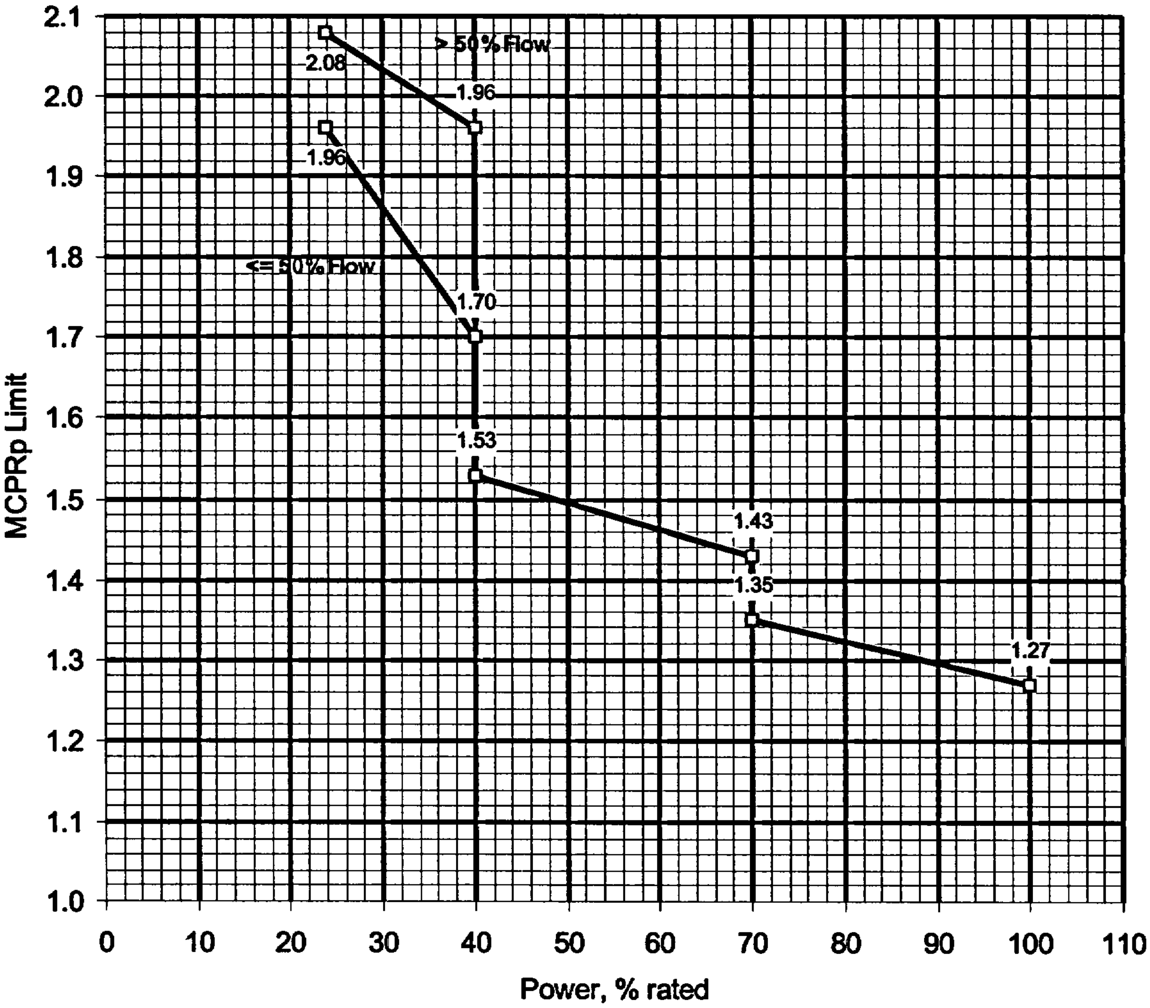


FIGURE 30. LHGR MULTIPLIER VERSUS CORE POWER FOR ALL ATRIUM-10, EXPOSURE RANGE BOC TO EEOC

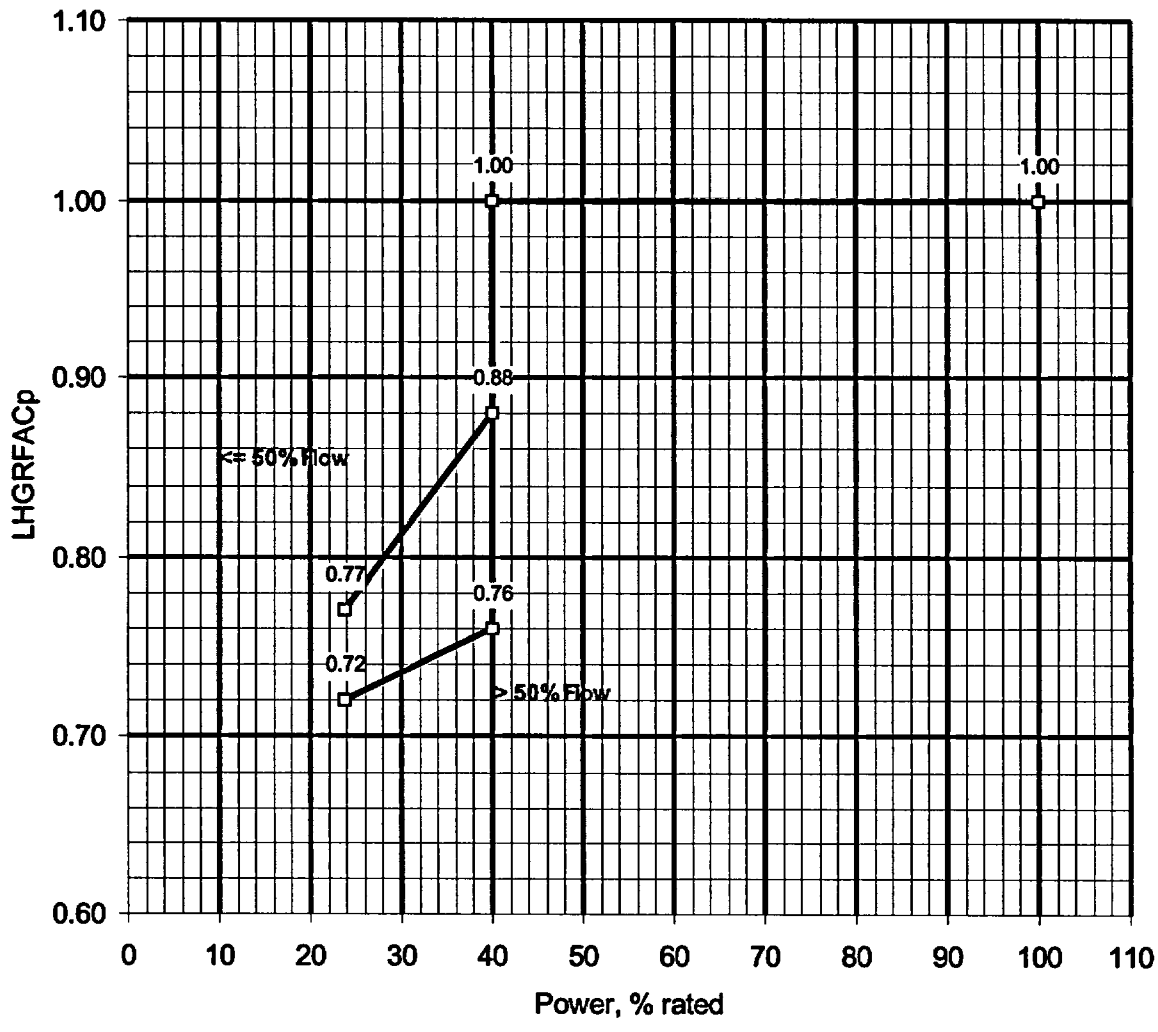


FIGURE 31. LHGR AND MAPLHGR MULTIPLIER VERSUS CORE POWER FOR GE-11, ALL EXPOSURES

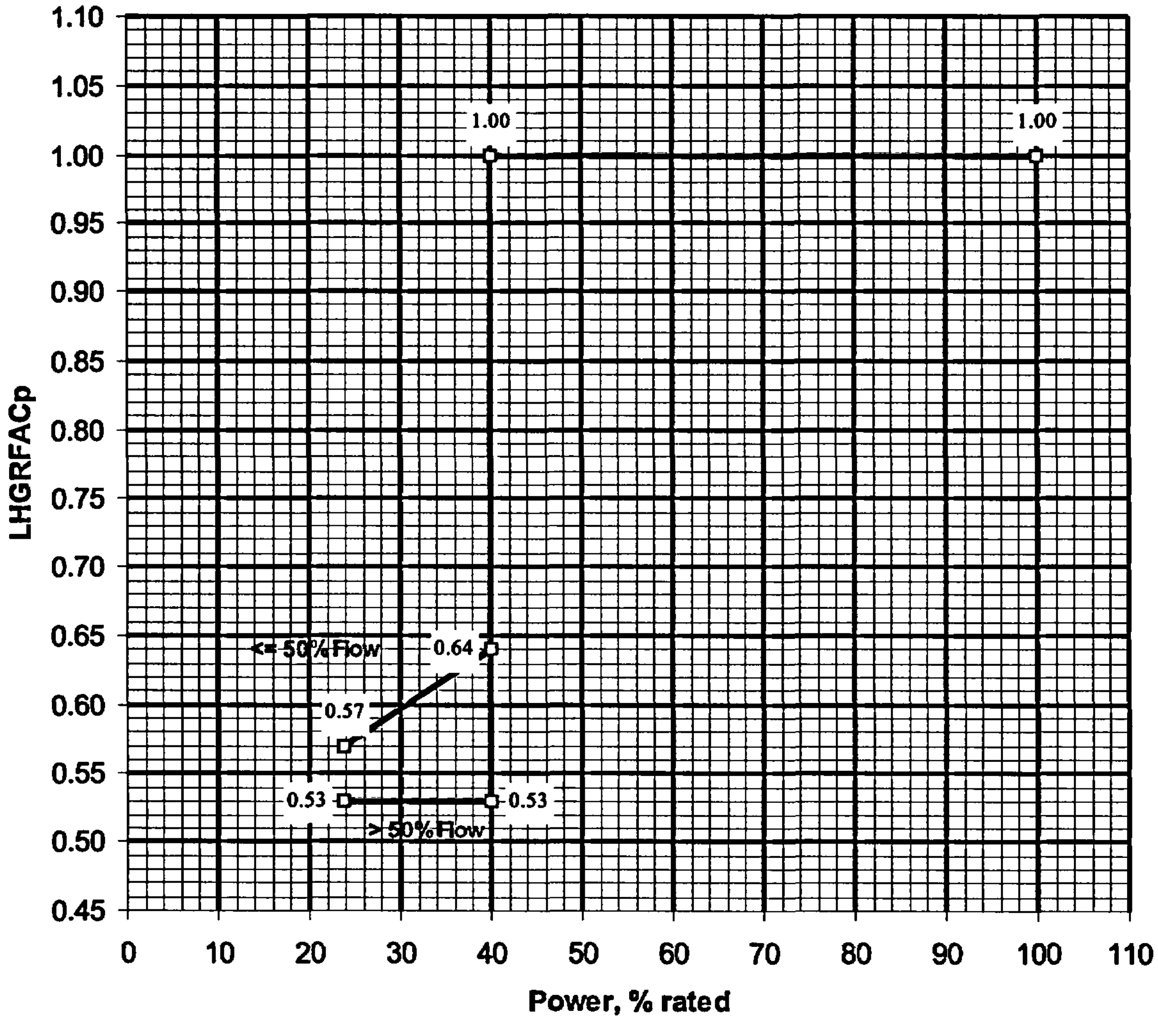


FIGURE 32. LHGR MULTIPLIER VERSUS CORE POWER FOR ALL ATRIUM-10, EXPOSURE RANGE EEOC TO EEEOC

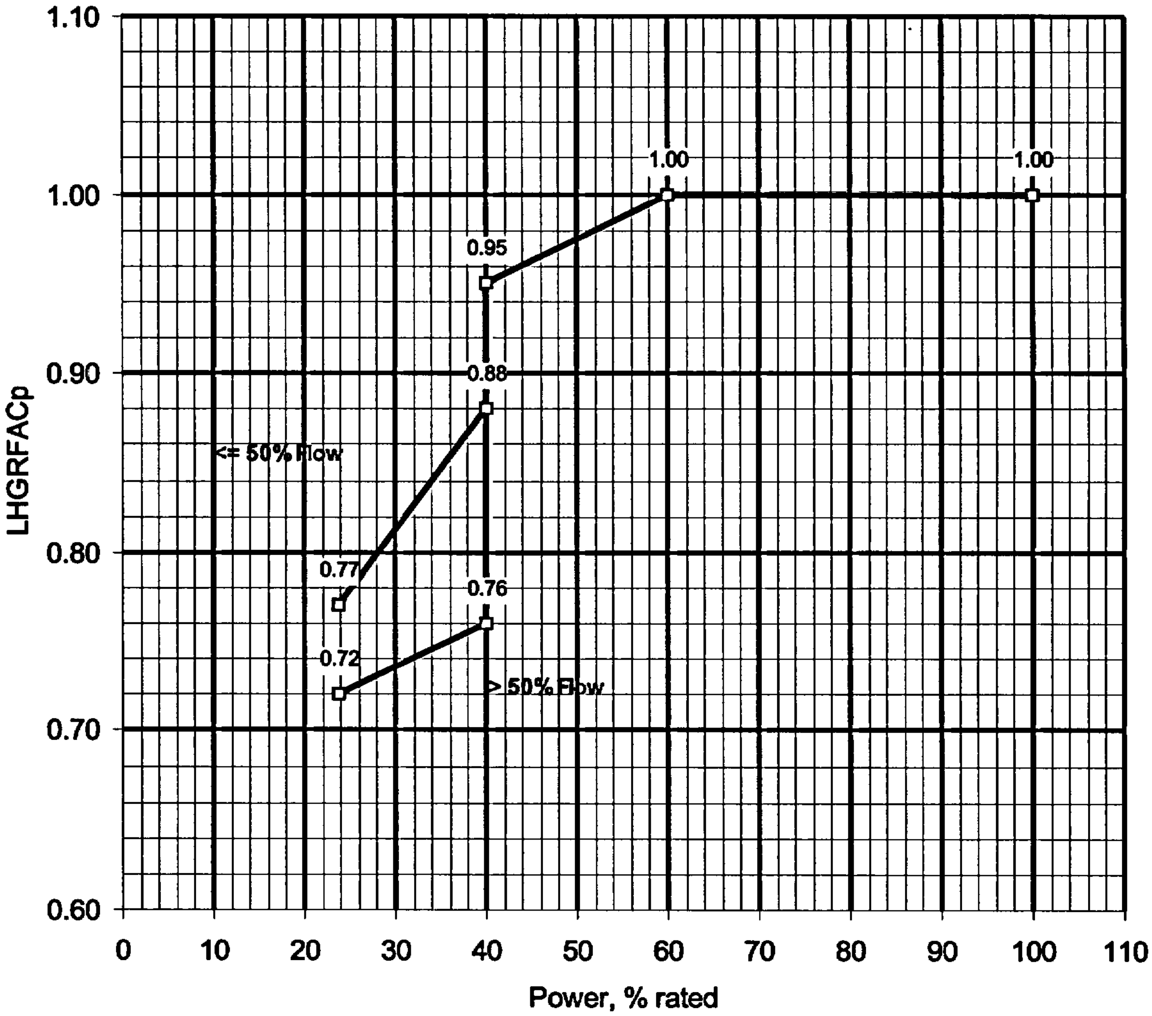


FIGURE 33. MONITORED REGION BOUNDARY (CASE 1)

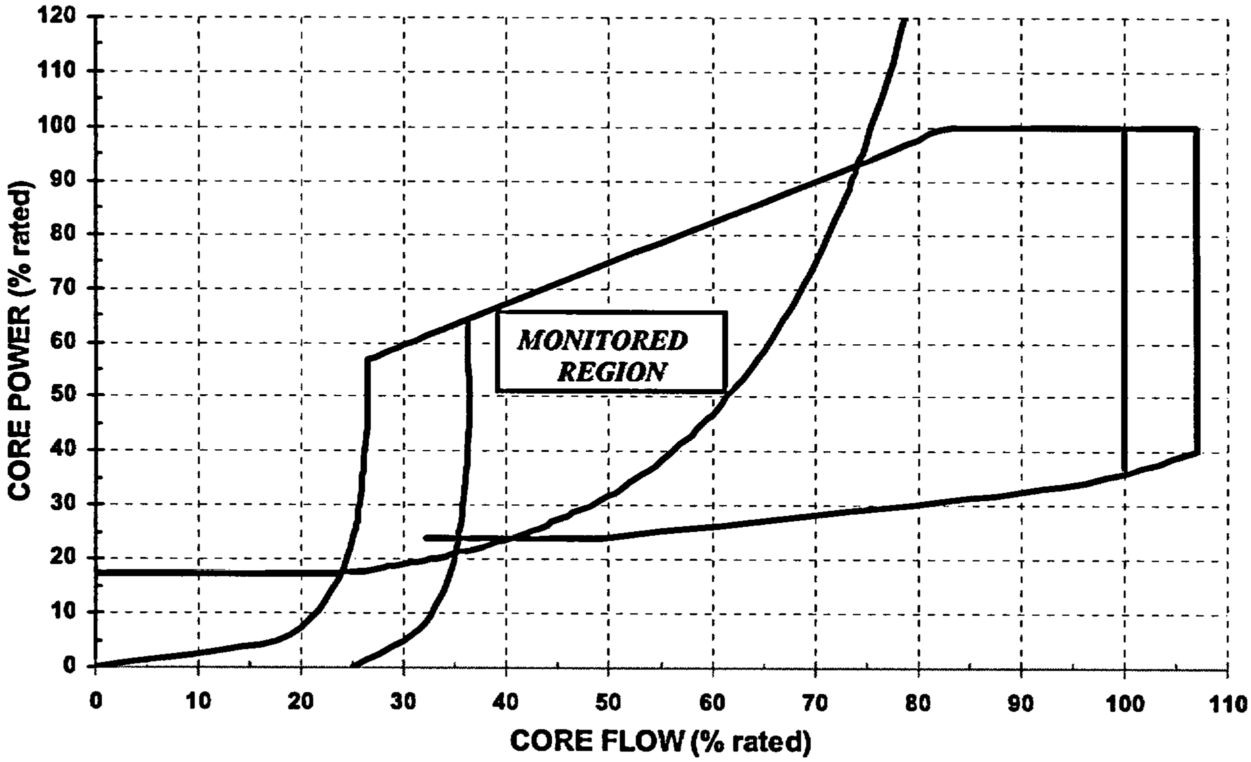


FIGURE 34. MONITORED REGION BOUNDARY (CASE 2)

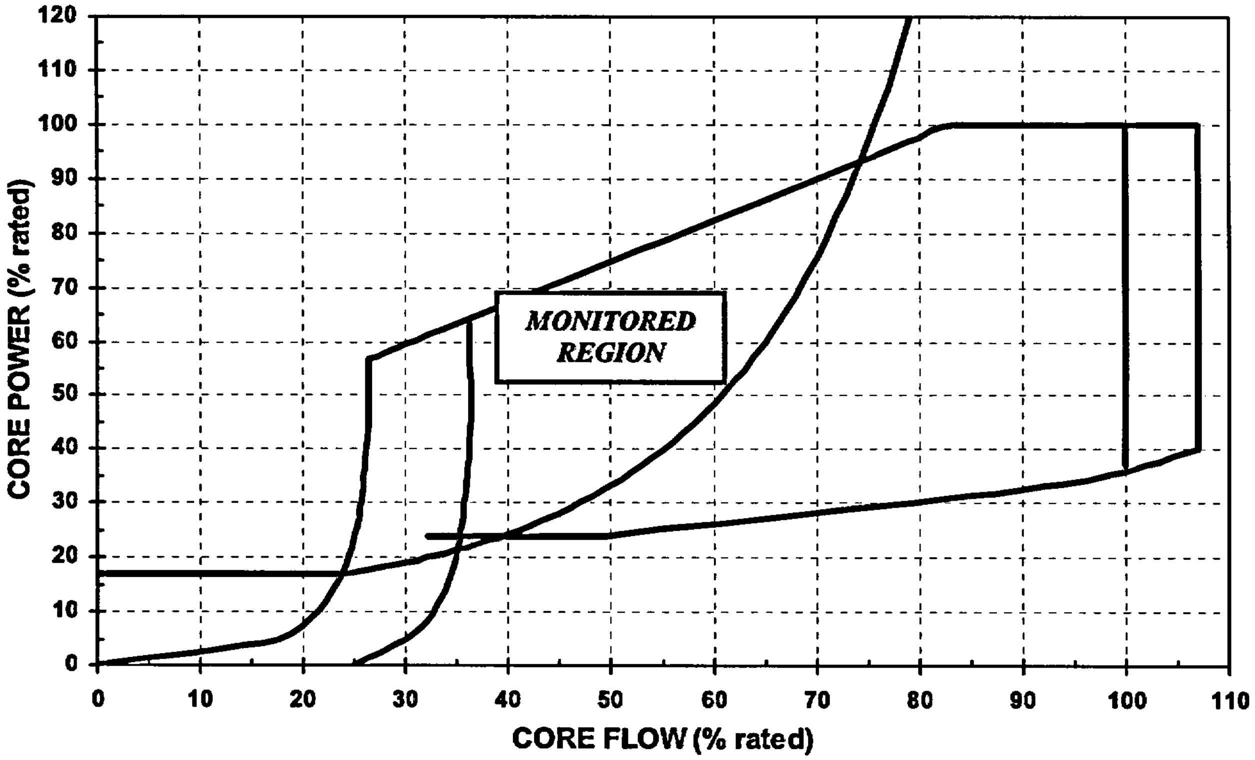


FIGURE 35. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY

(TWO RECIRCULATION LOOP OPERATION - CASE 1)

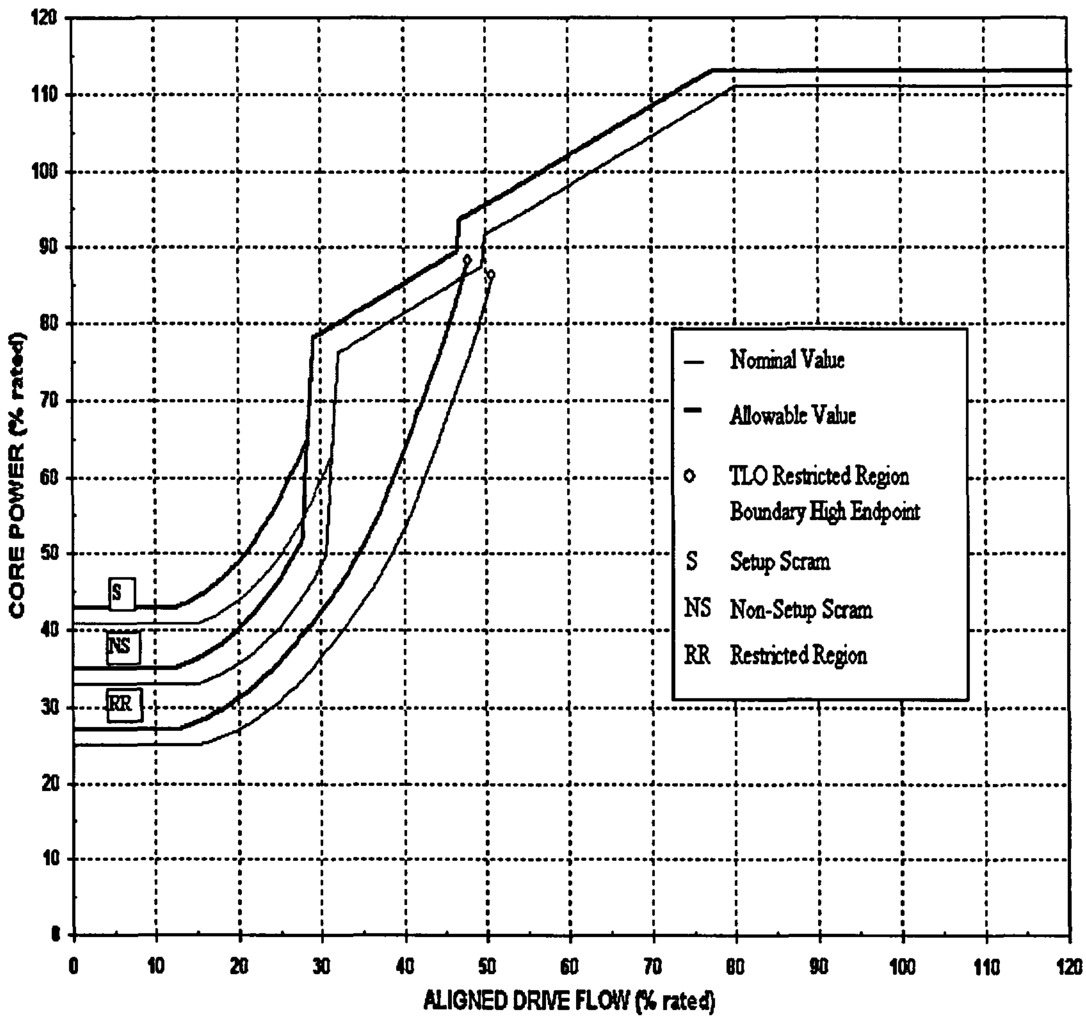


FIGURE 36. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY

(SINGLE RECIRCULATION LOOP OPERATION - CASE 1)

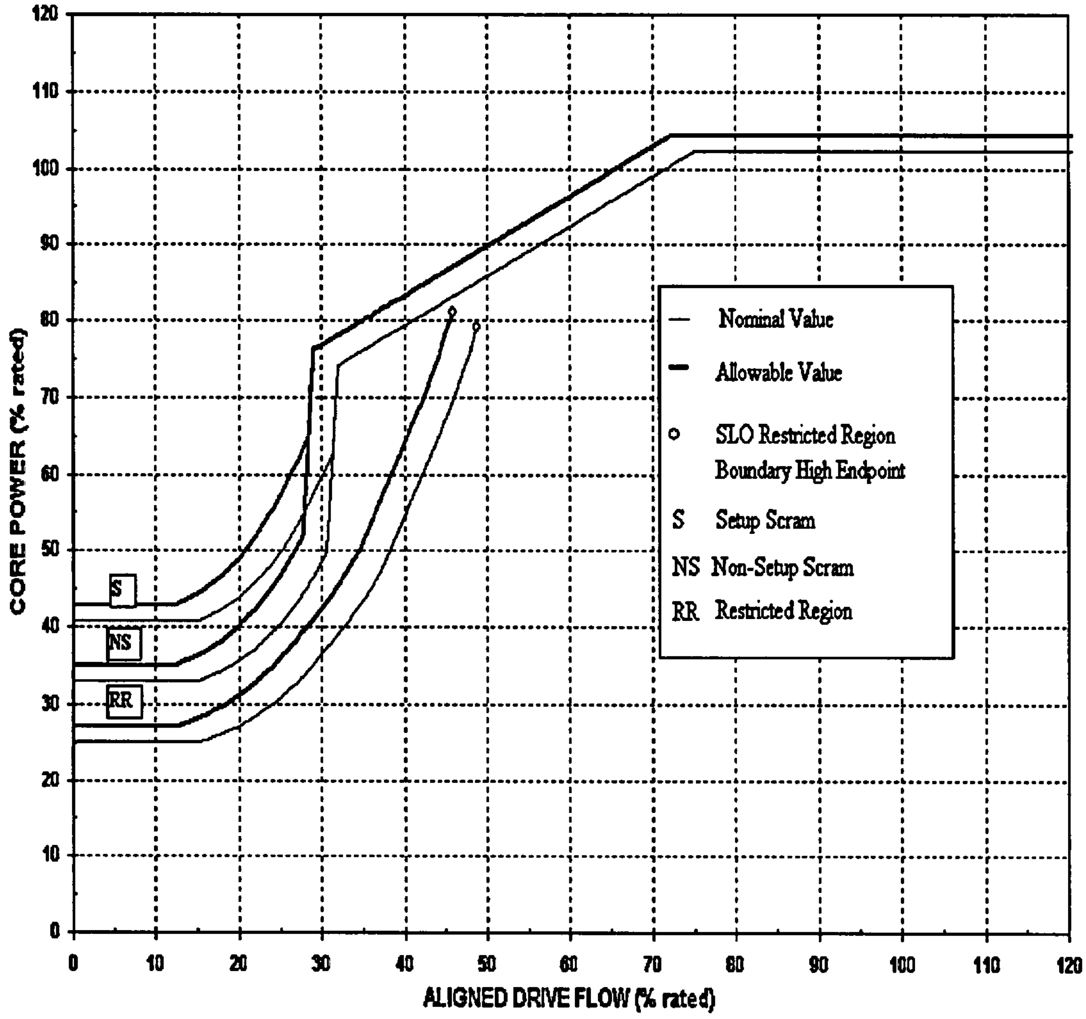


FIGURE 37. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY

(TWO RECIRCULATION LOOP OPERATION - CASE 2)

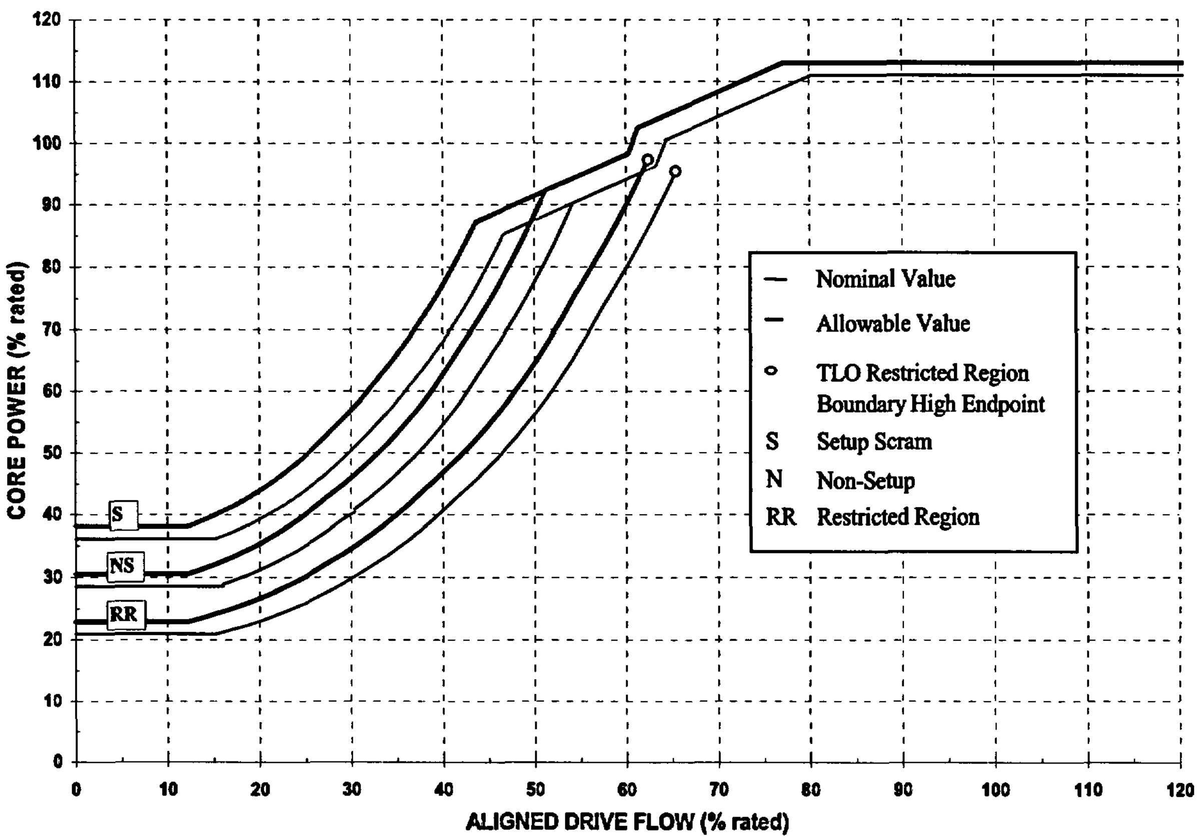


FIGURE 38. APRM FLOW BIASED SIMULATED THERMAL POWER - HIGH SCRAM SETPOINTS AND RESTRICTED REGION BOUNDARY

(SINGLE RECIRCULATION LOOP OPERATION - CASE 2)

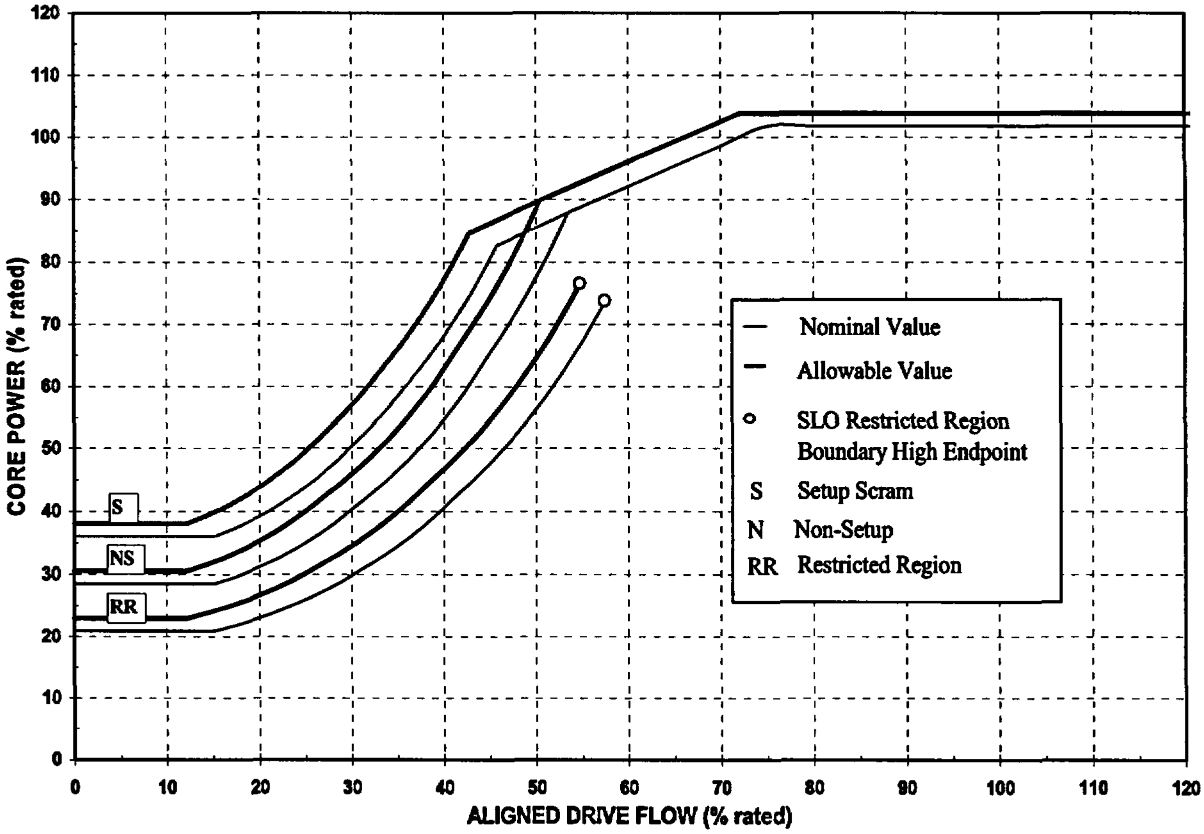


FIGURE 39. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(TWO RECIRCULATION LOOP OPERATION - CASE 1)

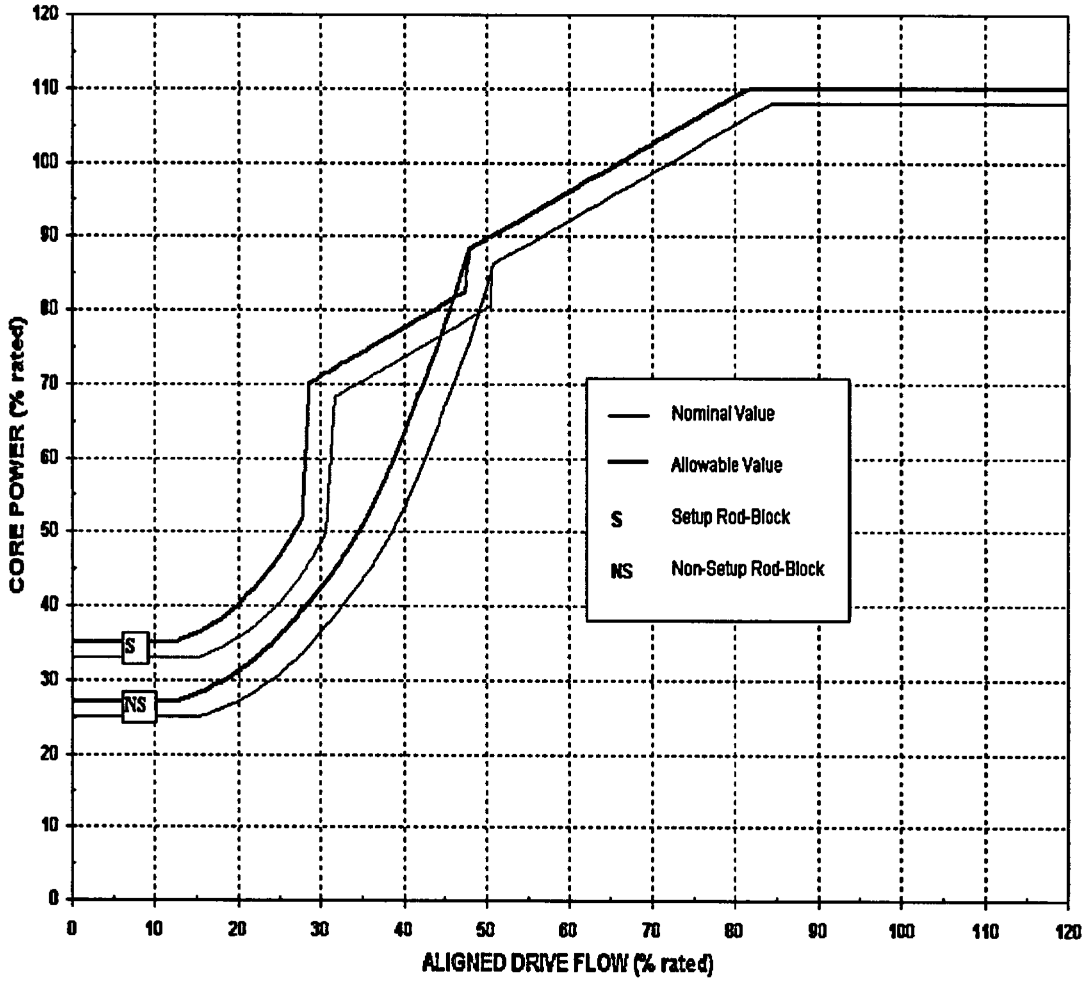


FIGURE 40. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(SINGLE RECIRCULATION LOOP OPERATION - CASE 1)

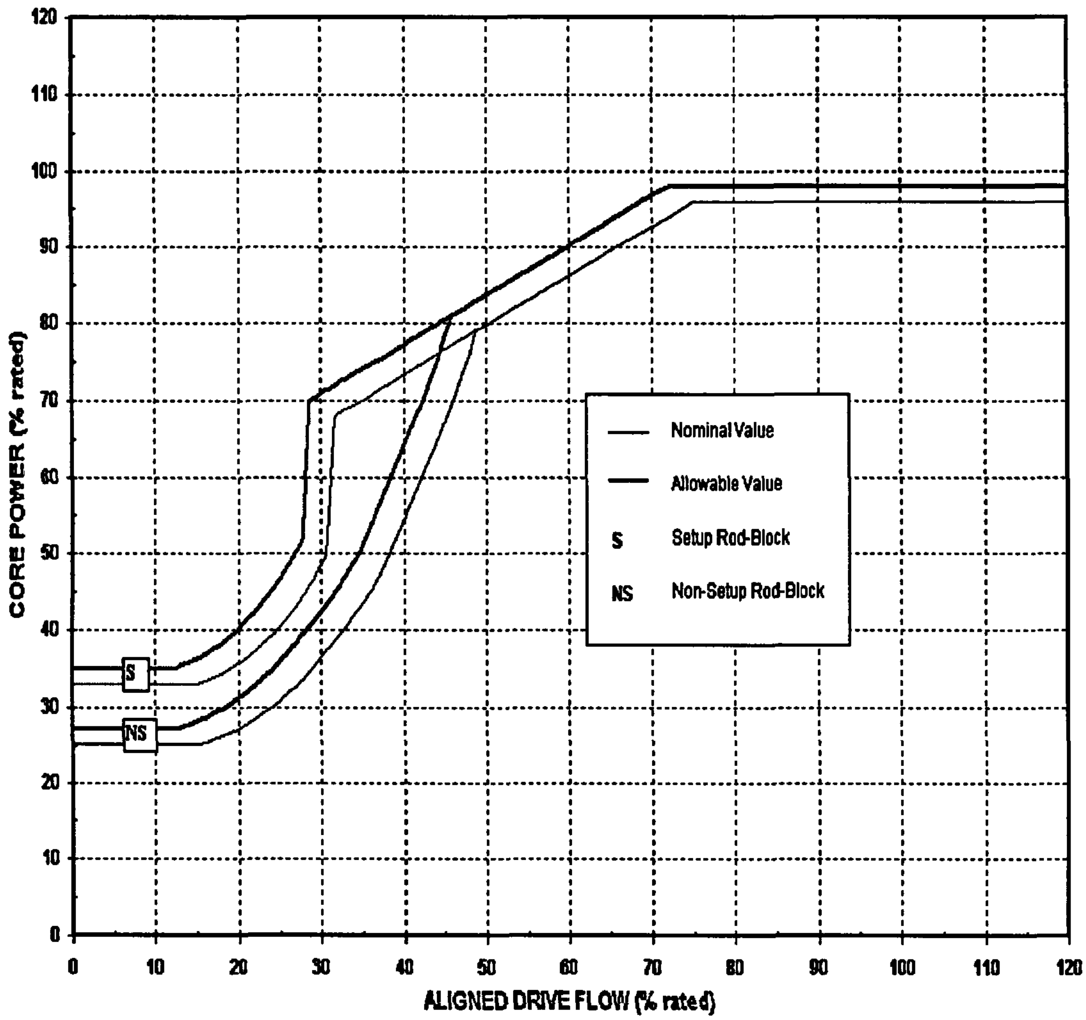


FIGURE 41. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(TWO RECIRCULATION LOOP OPERATION - CASE 2)

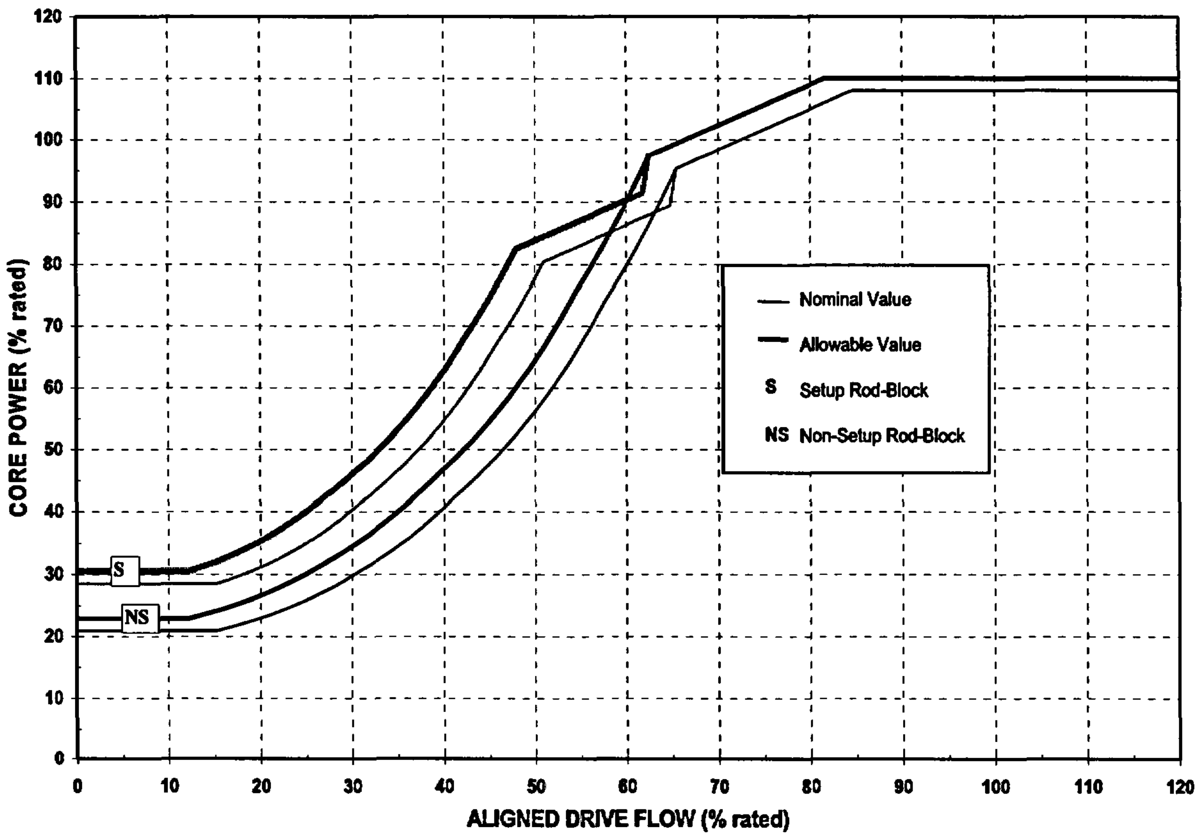
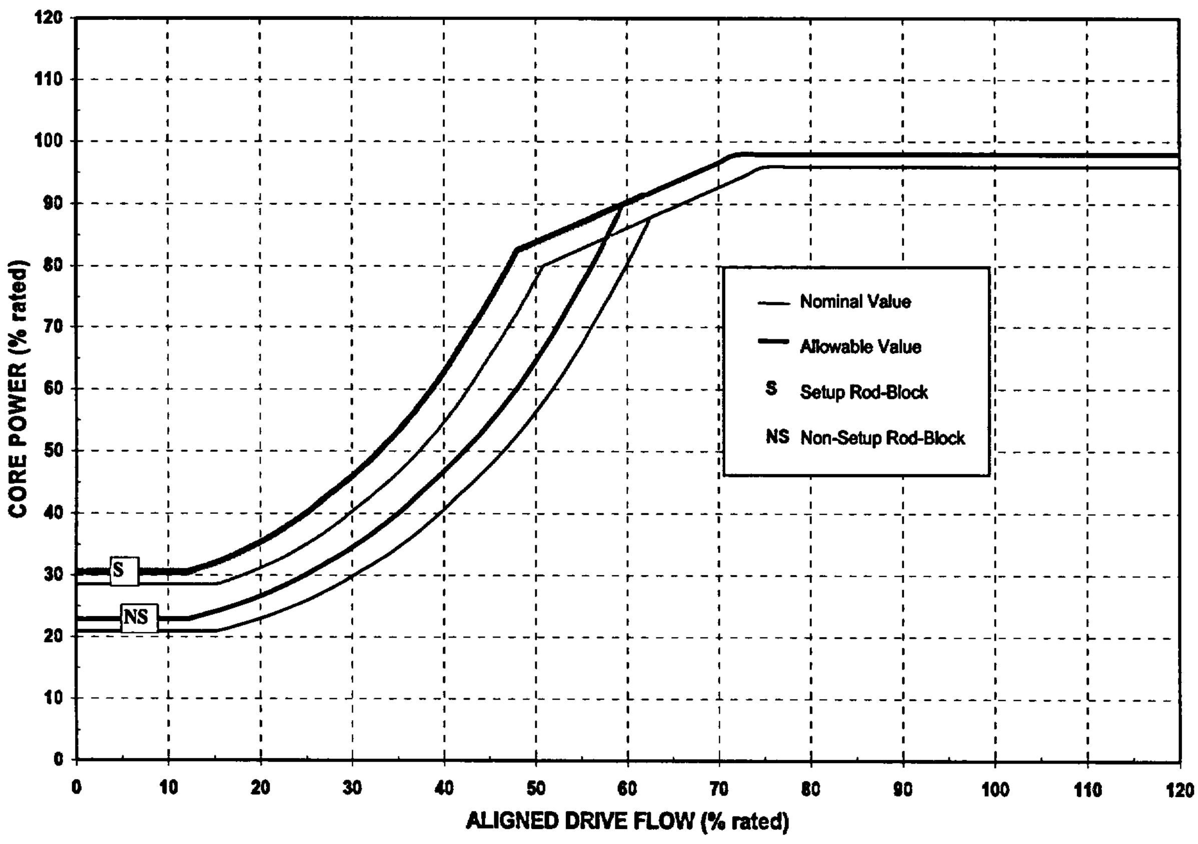


FIGURE 42. APRM FLOW BIASED NEUTRON FLUX - HIGH ROD-BLOCK SETPOINTS

(SINGLE RECIRCULATION LOOP OPERATION - CASE 2)



APPENDIX A

OPERATING LIMITS FOR EQUIPMENT OUT OF SERVICE OR LOOP MANUAL MODE

The operating limits listed in this appendix shall be used as indicated when operating in any of the following conditions:

- Feedwater Heater Out of Service (FHOOS)*
- Pressure Regulator Out of Service (PROOS)*
- Single-Loop Operation (SLO)
- Reactor Recirculation System in Loop Manual control.

*At a power level greater than 40%, the power dependent MCPRp (Figures 43, 44 and 45) shall be increased by 0.02 for concurrent SLO and FHOOS. At a power lower than 40%, the most limiting MCPRp value is the operating limit, and it shall be increased by 0.02 for SLO and FHOOS.

At a power level greater than 40%, the power dependent MCPRp (Figures 46, 47 and 48) shall be increased by 0.02 for concurrent SLO and PROOS. At a power lower than 40%, the most limiting MCPRp value is the operating limit, and it shall be increased by 0.02 for SLO and PROOS.

FIGURE 43. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR NON-KAN ATRIUM-10, ALL EXPOSURES, FEEDWATER HEATER OUT OF SERVICE (FHOOS)

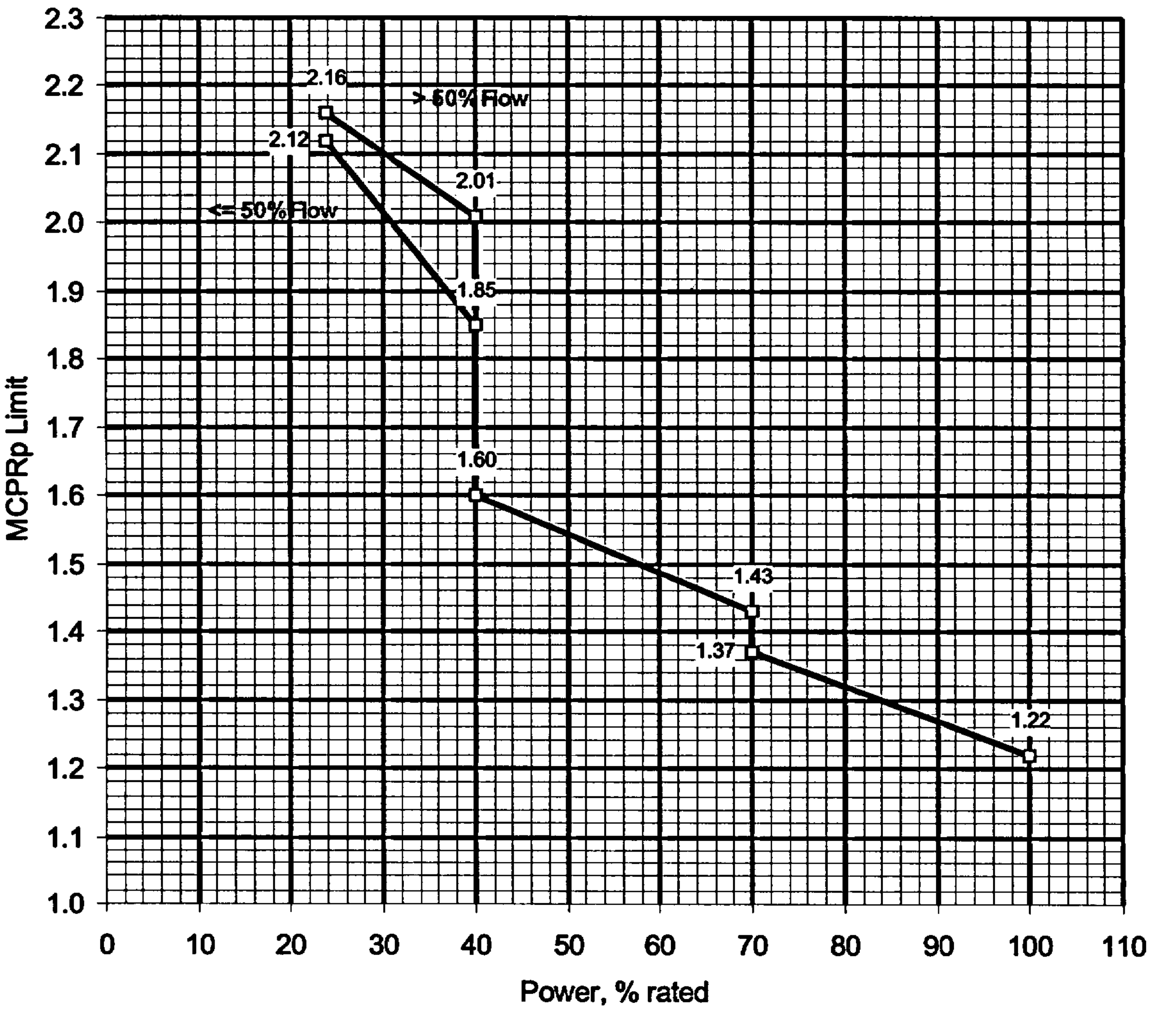


FIGURE 44. OPERATING LIMIT MCPR (MCPR$_P$) VERSUS CORE POWER FOR KAN ATRIUM-10, ALL EXPOSURES, FEEDWATER HEATER OUT OF SERVICE (FHOOS)

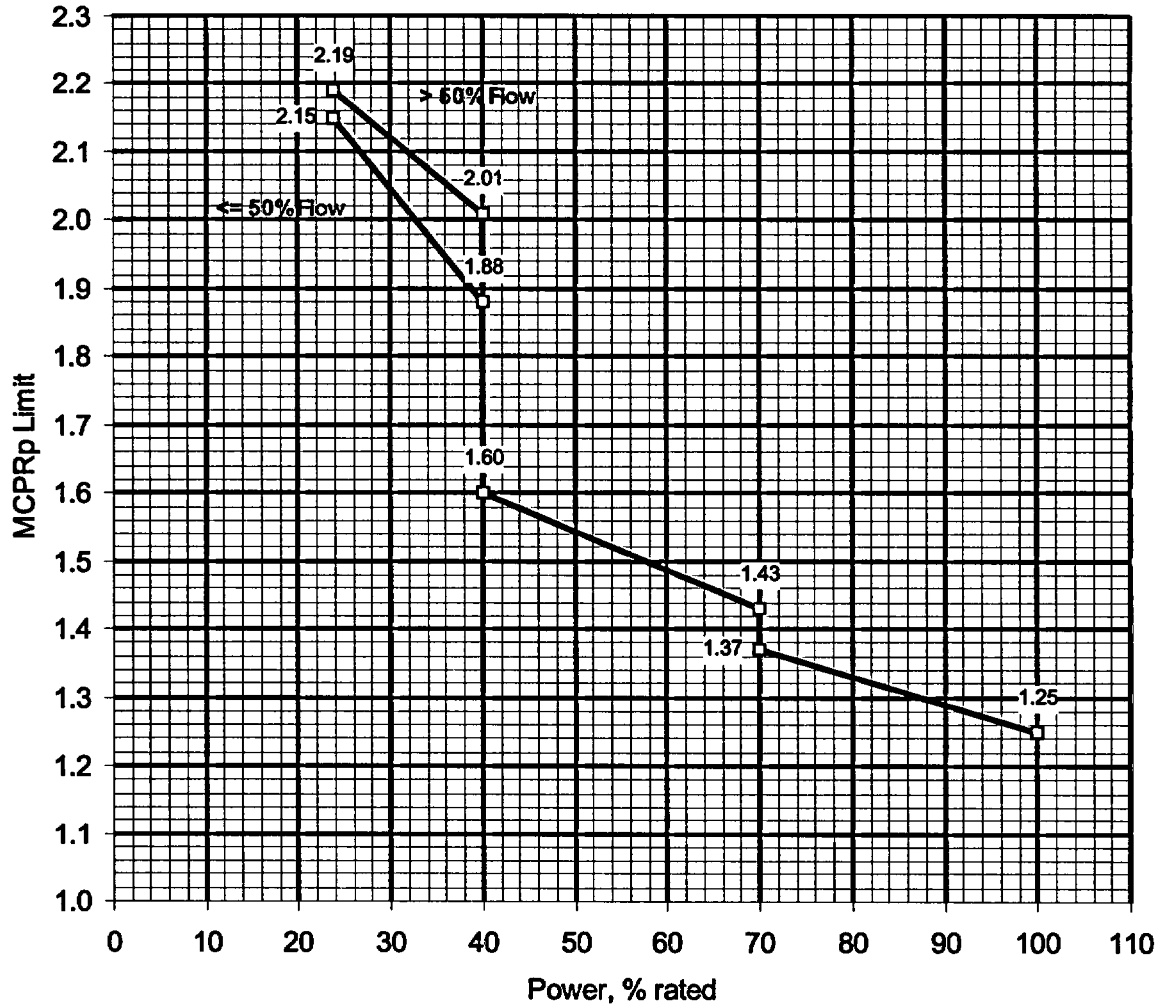


FIGURE 45. OPERATING LIMIT MCPR (MCPR$_P$) VERSUS CORE POWER FOR GE11, ALL EXPOSURES, FEEDWATER HEATER OUT OF SERVICE (FHOOS)

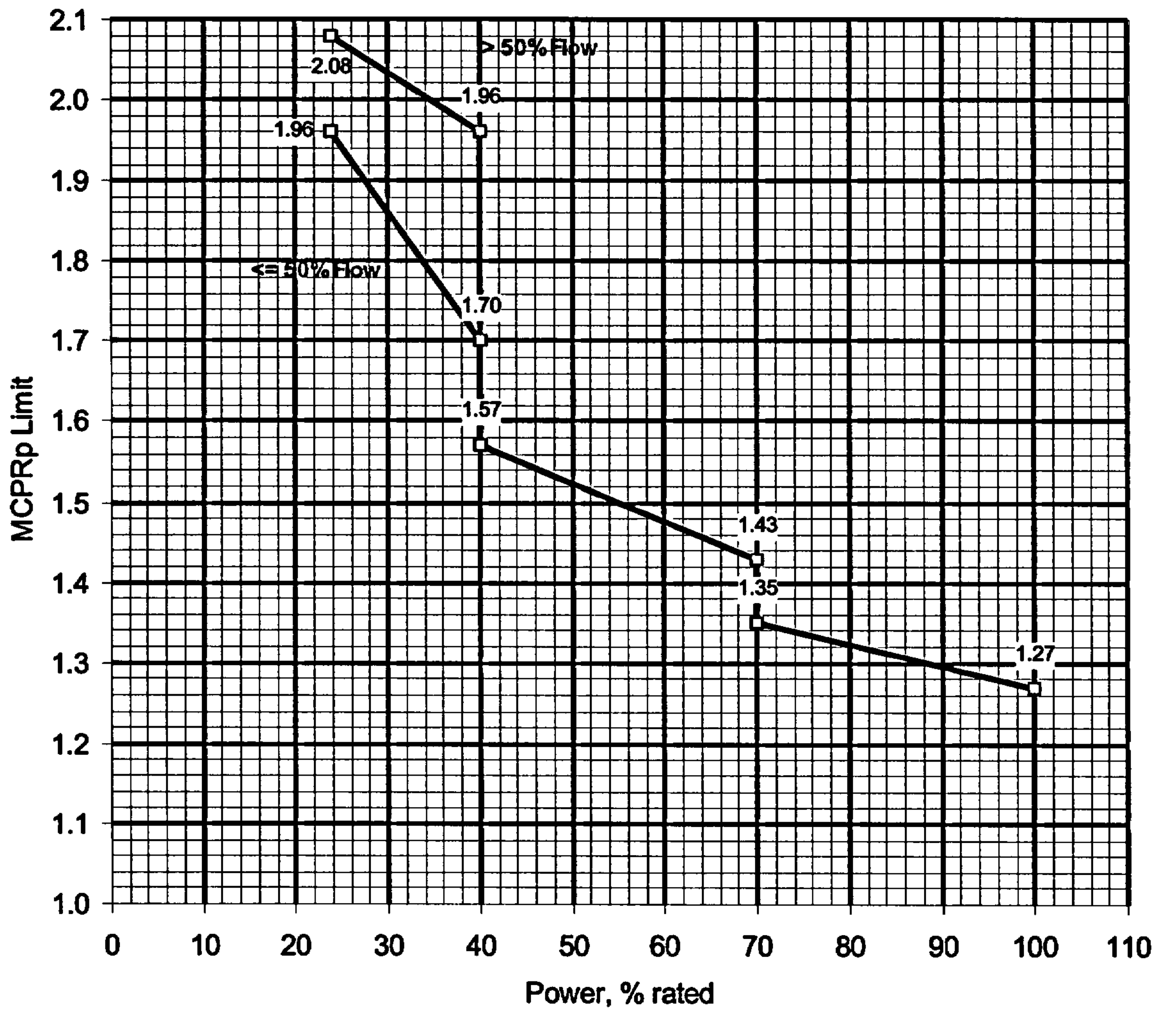


FIGURE 46. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR NON-KAN ATRIUM-10, ALL EXPOSURES, PRESSURE REGULATOR OUT OF SERVICE (PROOS)

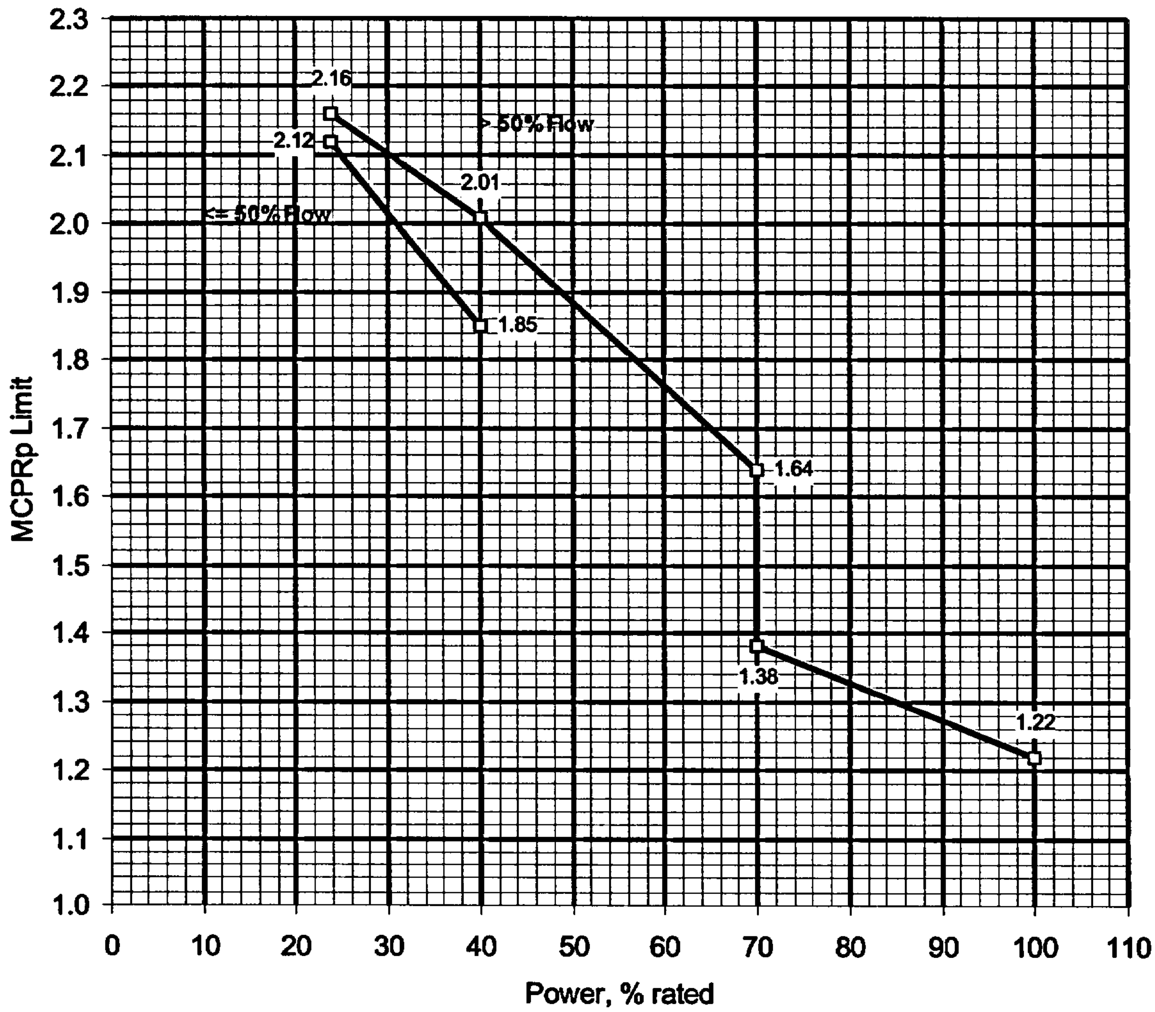


FIGURE 47. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR KAN ATRIUM-10, ALL EXPOSURES, PRESSURE REGULATOR OUT OF SERVICE (PROOS)

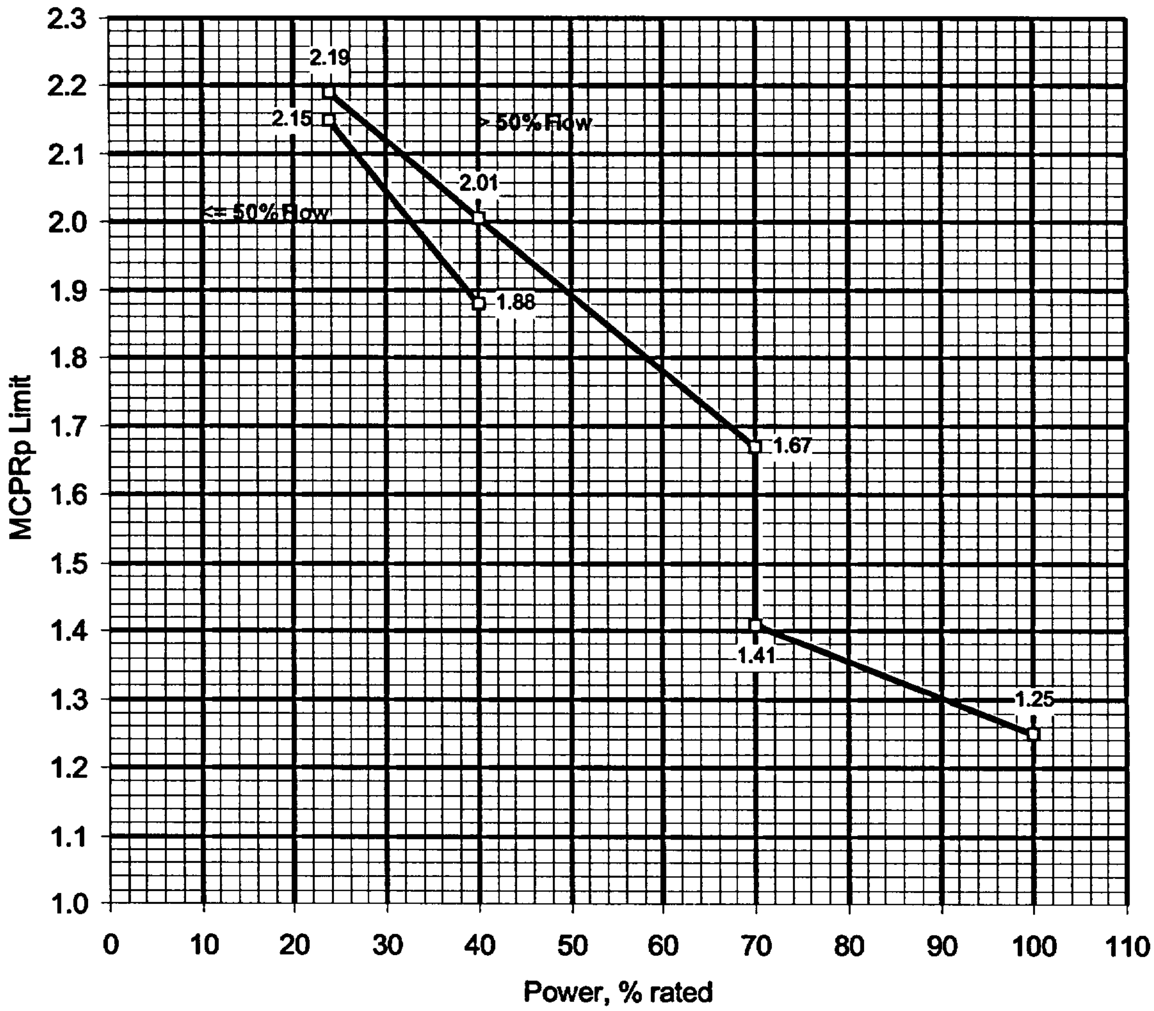


FIGURE 48. OPERATING LIMIT MCPR ($MCPR_P$) VERSUS CORE POWER FOR GE11, ALL EXPOSURES, PRESSURE REGULATOR OUT OF SERVICE (PROOS)

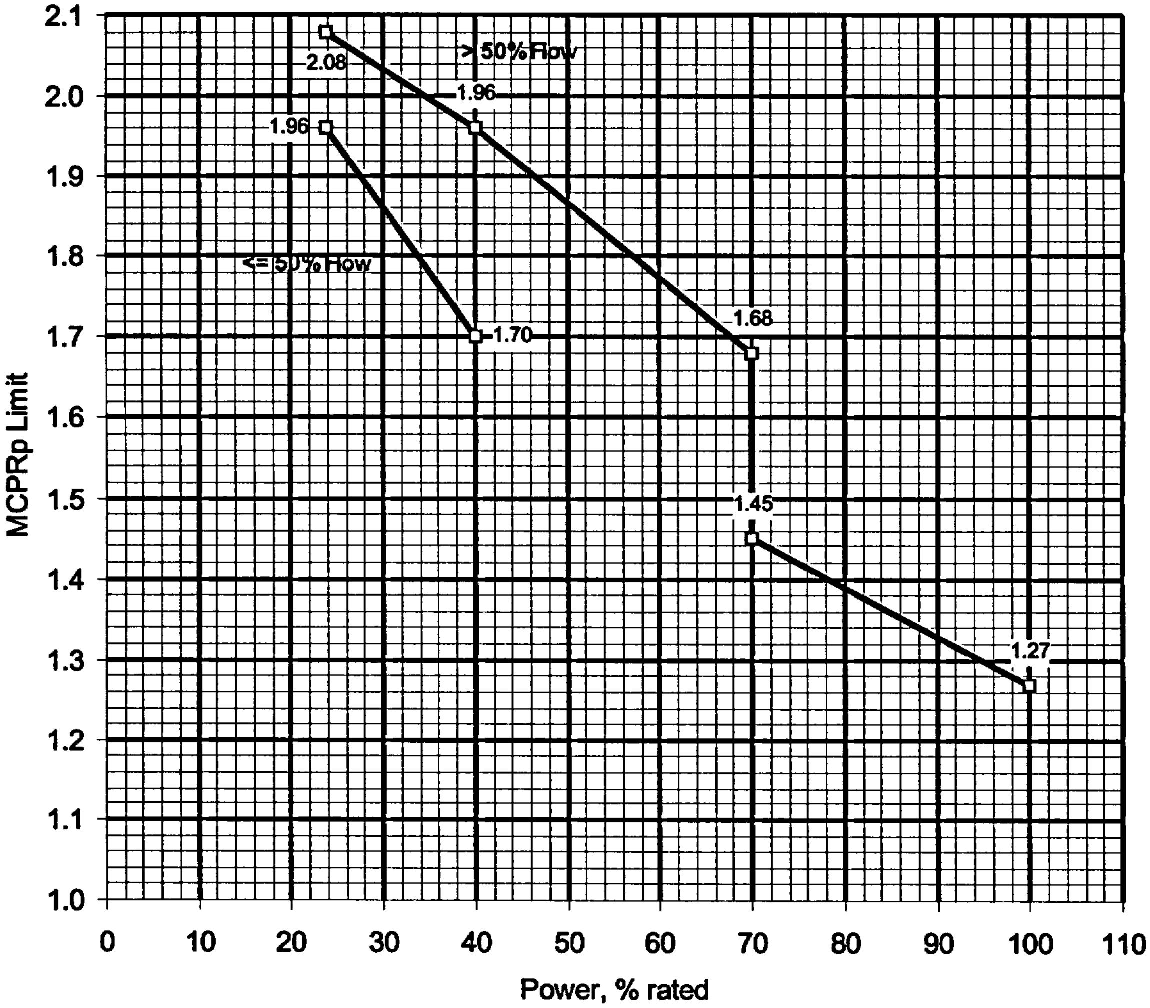


FIGURE 49. LHGR MULTIPLIER VERSUS CORE POWER FOR ALL ATRIUM-10, ALL EXPOSURES

FHOOS OR PROOS

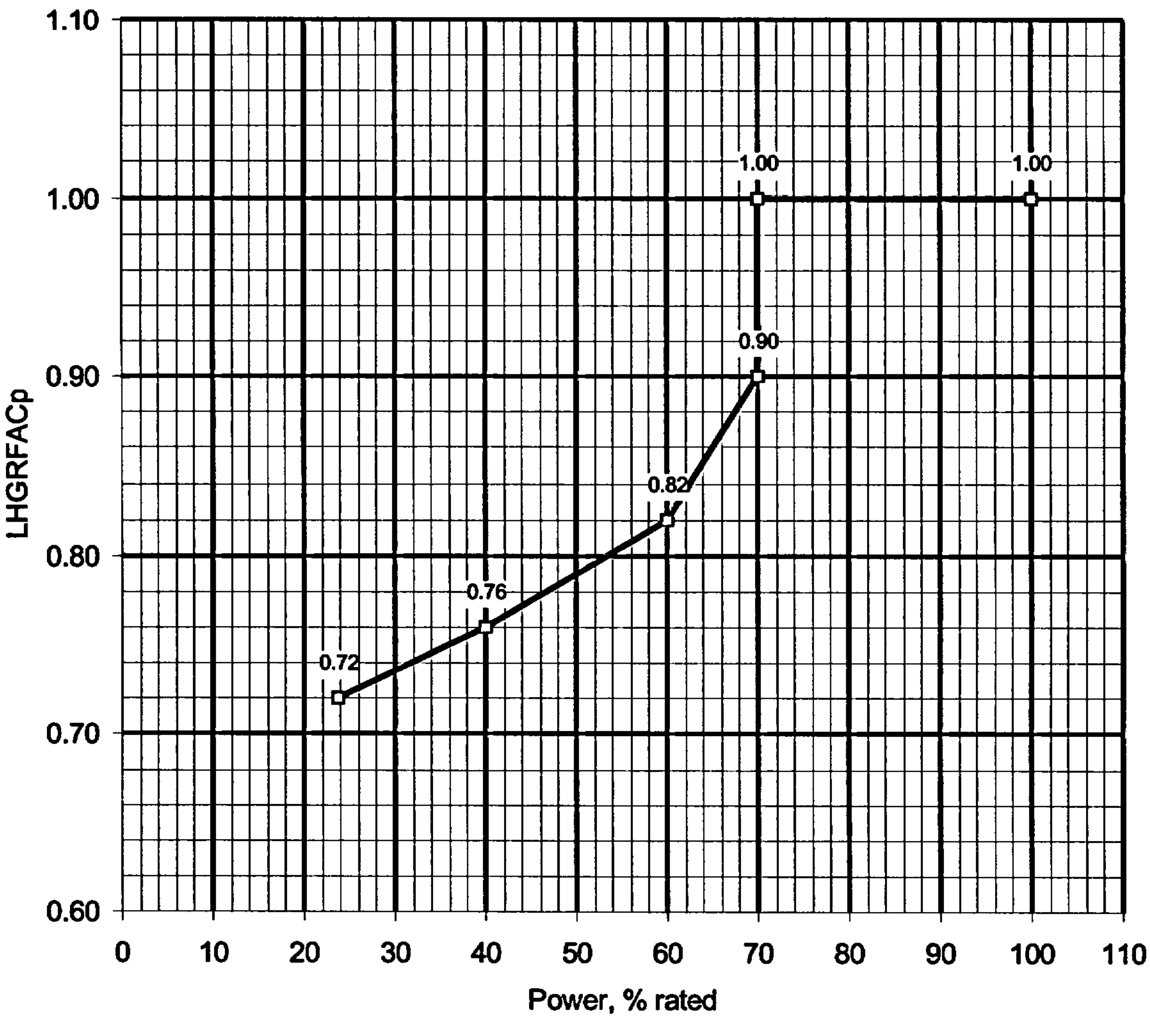


FIGURE 50. LHGR AND MAPLHGR MULTIPLIER VERSUS CORE POWER FOR GE-11, ALL EXPOSURES FHOOS OR PROOS

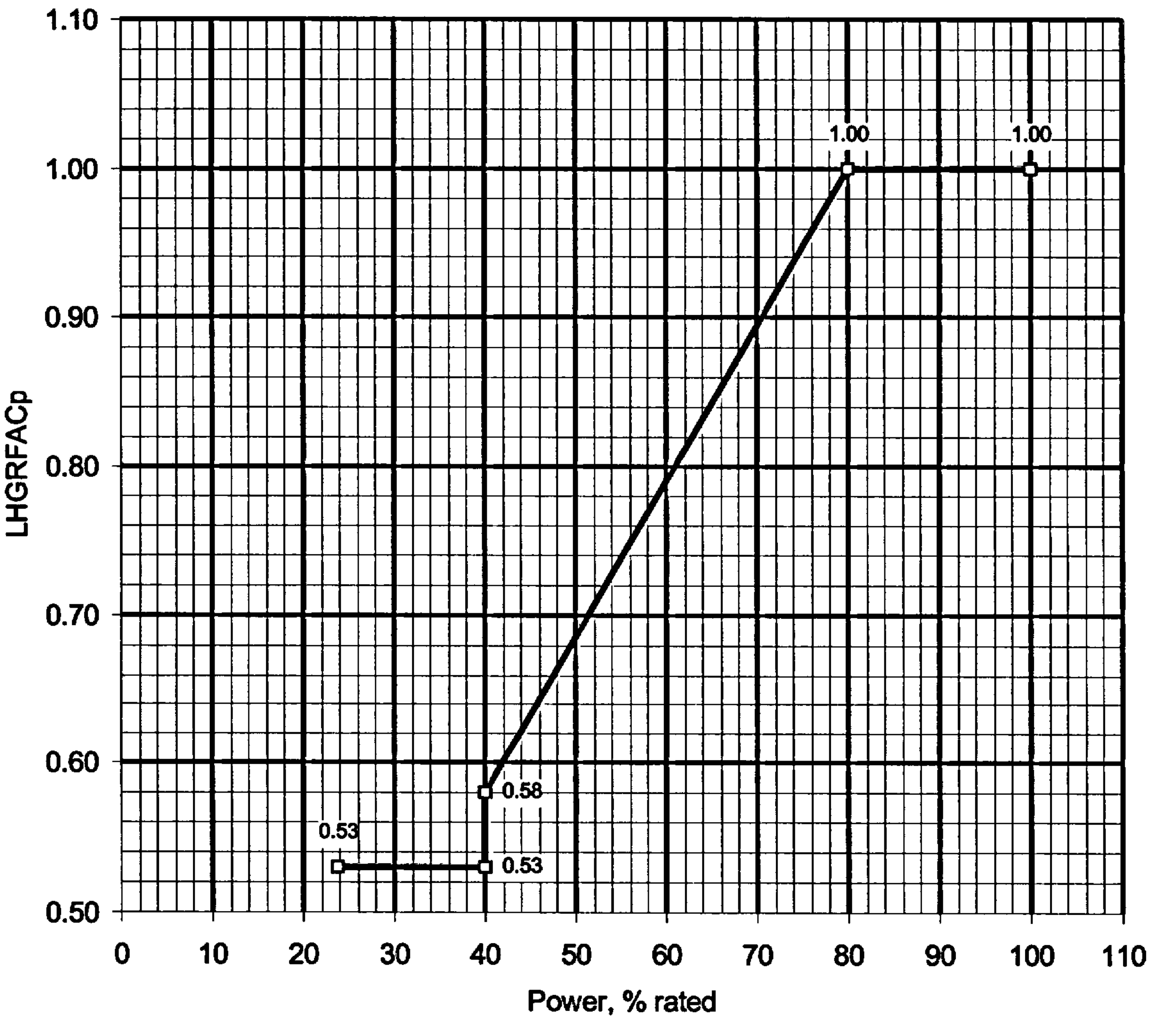


FIGURE 51. LHGR MULTIPLIER VERSUS CORE POWER FOR ALL ATRIUM-10, ALL EXPOSURES SINGLE LOOP OPERATION (SLO)

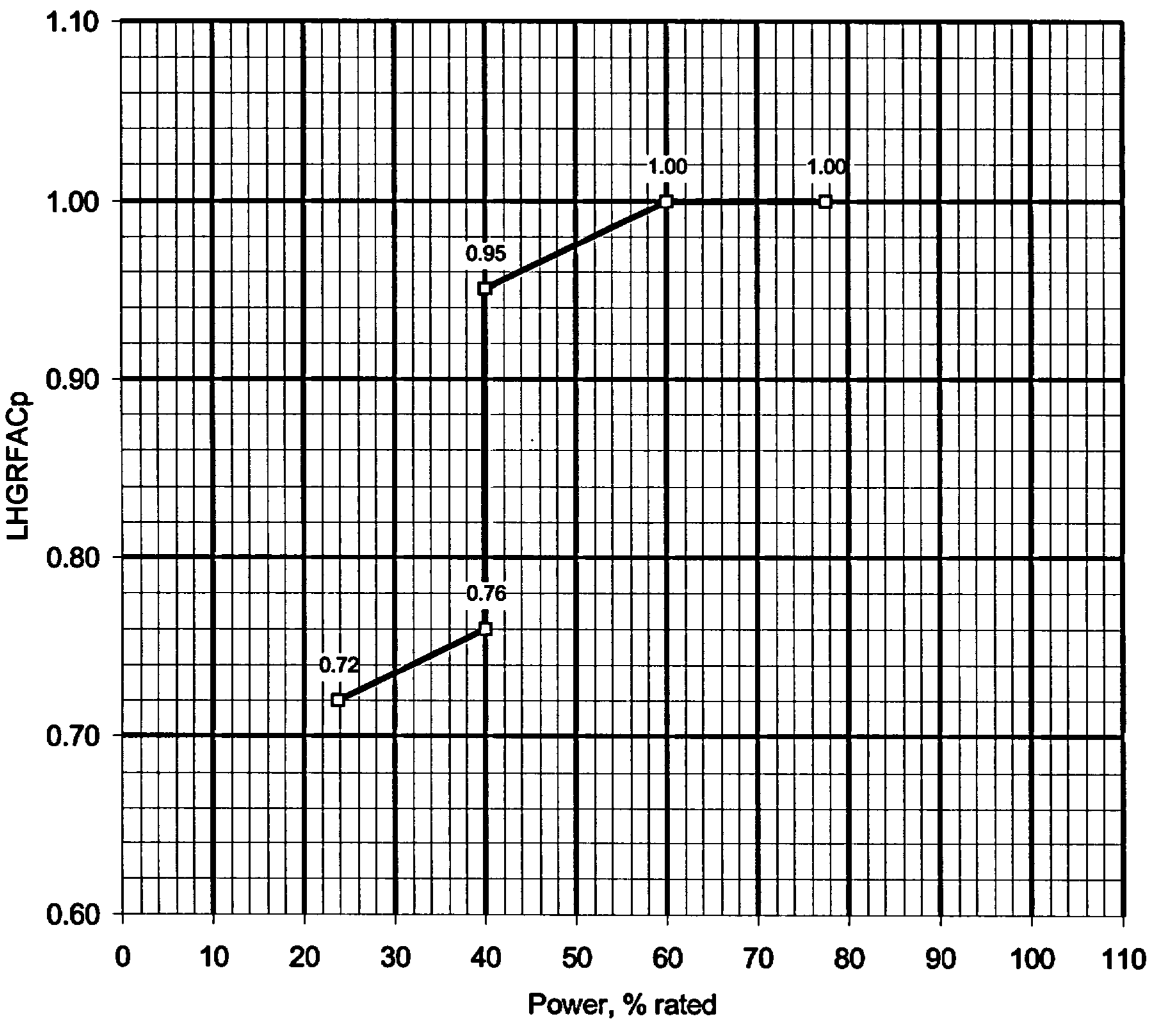


FIGURE 52. LHGR AND MAPLHGR MULTIPLIER VERSUS CORE POWER FOR GE-11, ALL EXPOSURES SINGLE LOOP OPERATION (SLO)

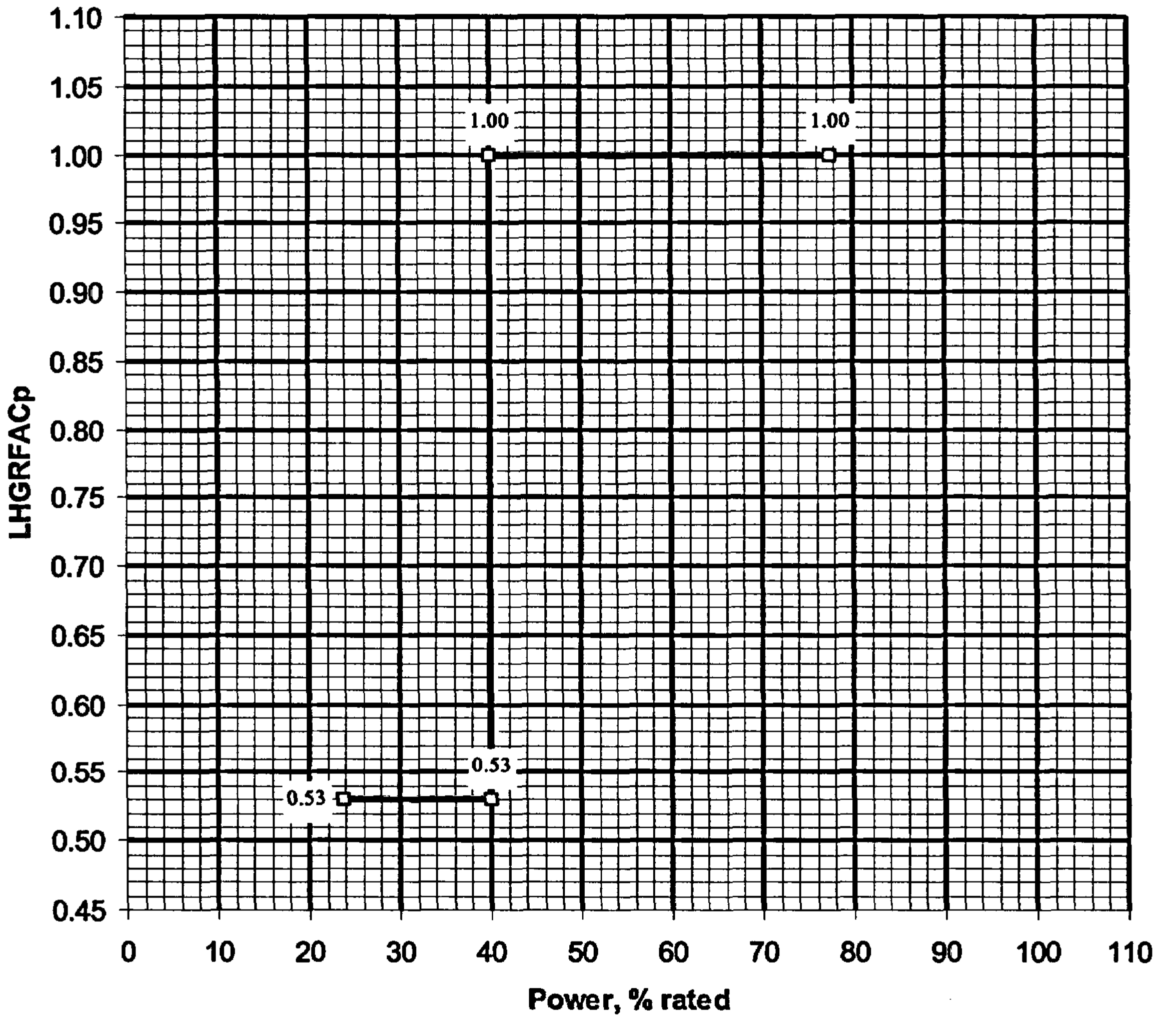


FIGURE 53. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR NON-KAN ATRIUM-10 FOR RECIRCULATION SYSTEM IN LOOP MANUAL, ALL EXPOSURES

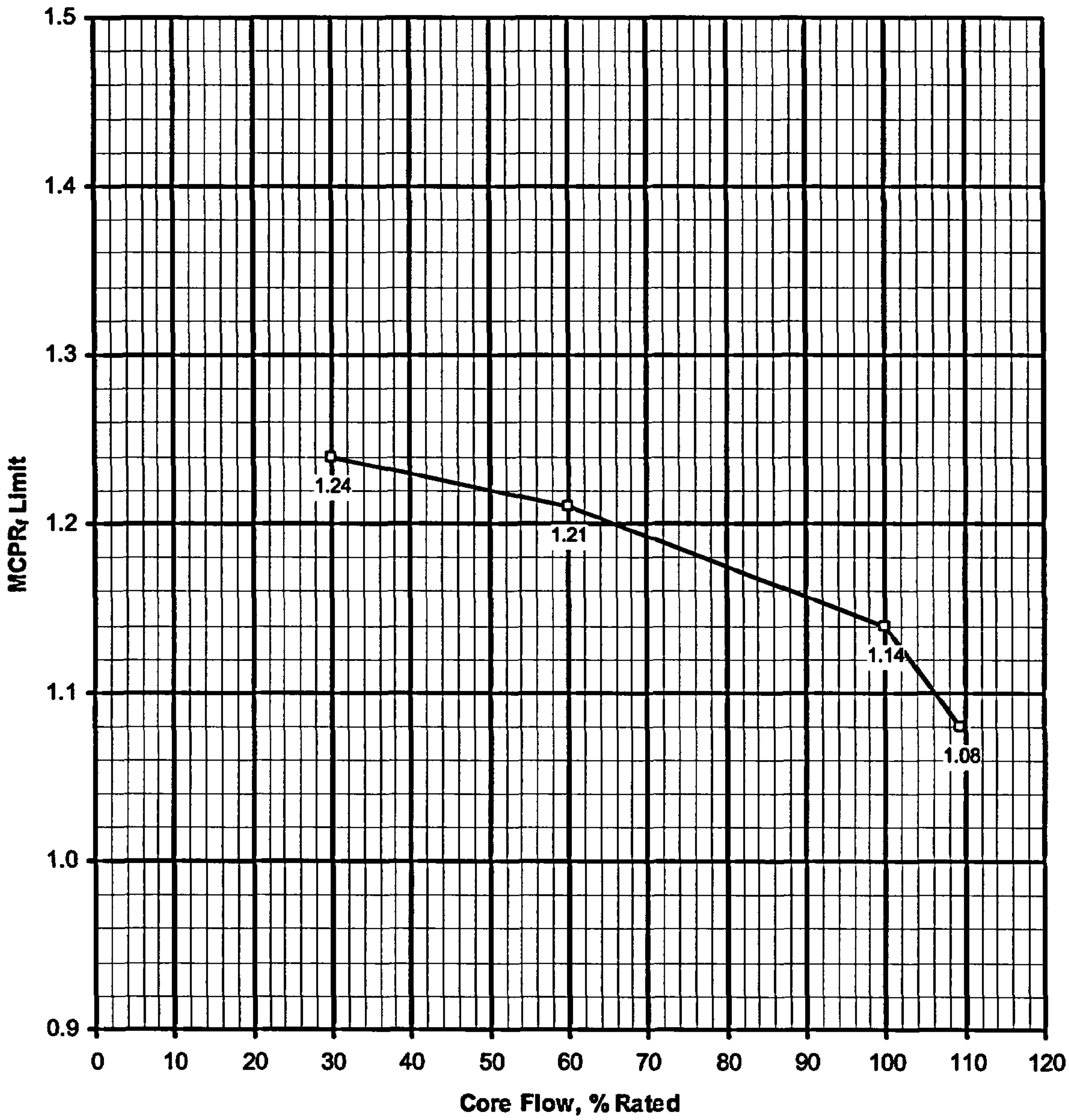


FIGURE 54. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR KAN ATRIUM-10 FOR RECIRCULATION SYSTEM IN LOOP MANUAL, ALL EXPOSURES

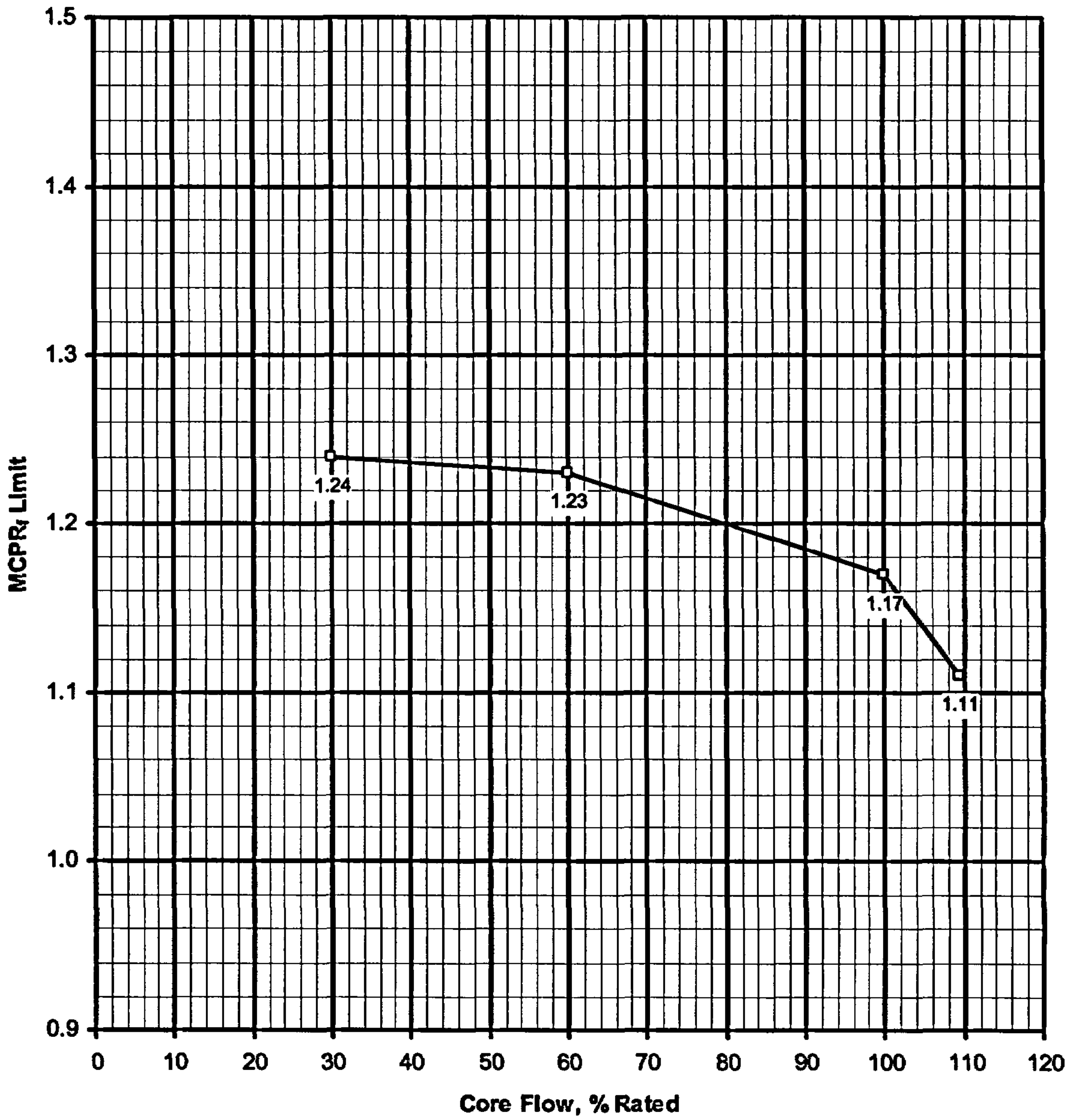


FIGURE 55. OPERATING LIMIT MCPR ($MCPR_F$) VERSUS CORE FLOW FOR GE-11 FOR RECIRCULATION SYSTEM IN LOOP MANUAL, ALL EXPOSURES