Standard No.: GGNS-MS-48.0
Revision: 5
Date: July 31, 1997

Grand Gulf Nuclear Station
Core Operating Limits Report
Safety-Related

GRAND GULF NUCLEAR STATION **NUCLEAR PLANT ENGINEERING**

REVIEW AND APPROVAL SHEET

STANDARD NO.: GGNS-MS-48.0 REVISION: 5

STANDARD TITLE: Core Operating Limits Report

This document specifies items related to nuclear safety YES [X] NO [ ]

This document contains Special Requirements YES [ ] NO [X]

Signatures certify that the above standard was originated, verified, reviewed or waived and approved as noted below:

ORIGINATED BY: _____ DATE: 7/30/97

VERIFIED BY: _____ DATE: 7/30/97

REVIEWED BY: M. D. Wilkinson DATE: 7/31/97
Cognizant Group Supervisor

NPE SECTION	REVIEWED BY	REVIEW WAIVED BY	DATE
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MECHANICAL/CIVIL		WRM for ADO	7/31/97
SAFETY ANALYSIS	M. D. Wilkinson		7/31/97

ANII: N/A DATE: _____
(Insert N/A if not applicable)

APPROVED BY: M. D. Wilkinson DATE: 7/31/97
Responsible Manager

REVISION STATUS SHEET

STANDARD REVISION SUMMARY

REVISION	ISSUE DATE	DESCRIPTION
0	April 1, 1993	Issued for Cycle 6
1	November 12, 1993	Issued for Cycle 7
2	August, 26, 1994	Revised for Cycle 7 to update references for QDR 0159-94
3	May 18, 1995	Issued for Cycle 8
4	November 18, 1996	Issued for Cycle 9
5	July 31,1997	Revised for Cycle 9 per GGCR1997-0074-00

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PAGE REVISION STATUS

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ii	5	2	4
iii	5	3	5
iv	5	4	4
v	5	5	5
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APPENDIX/ATTACHMENT STATUS

APPENDIX NO.	REVISION	ATTACHMENT NO.	REVISION
		1	1
		2	0
		3	1

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1.0 PURPOSE

On October 4, 1988, the NRC issued Generic Letter 88-16 [1] encouraging licensees to remove cycle-specific parameter limits from Technical Specifications and to place these limits in a formal report to be prepared by the licensee. As long as the parameter limits were developed with NRC-approved methodologies, the letter indicated that this would remove unnecessary burdens on licensee and NRC resources.

On October 29, 1992, Entergy Operations submitted a Proposed Amendment to the Grand Gulf Operating License requesting changes to the GGNS Technical Specifications to remove certain reactor physics parameter limits that change each fuel cycle [2]. This amendment committed to placing these operating limits in a separate Core Operating Limits Report (COLR) which is defined in Technical Specifications. This PCOL was approved by the NRC by SER dated January 21, 1993 [3].

The COLR is controlled via Mechanical Standard GGNS-MS-48.0. This standard is revised accordingly for each fuel cycle or remaining portion of a fuel cycle. Revision 5 of the COLR revises the Cycle 9 core operating limits to include additional LHGR limits.

2.0 SCOPE

As defined in Technical Specification 1.1, the COLR is the GGNS document that provides the core operating limits for the current fuel cycle. This document is prepared in accordance with Technical Specification 5.6.5 for each reload cycle using NRC-approved analytical methods.

The Cycle 9 core operating limits included in this report are:

- the Average Planar Linear Heat Generation Rate (APLHGR),
- the Minimum Critical Power Ratio (MCPR), and
- the Linear Heat Generation Rate (LHGR) limit.

The cycle-specific MCPR safety limits are documented in Technical Specification 2.1.1.2.

3.0 REFERENCES

This section contains the background and cycle-specific references used in the safety analysis of Grand Gulf Cycle 9.

BACKGROUND REFERENCES:

1. MAEC-88/0313, Generic Letter 88-16, "Removal of Cycle-Specific Parameter Limits from Technical Specifications", October 4, 1988.

2. GNRO-92-00093, Proposed Amendment to Grand Gulf Operating License, PCOL-92/07, dated October 29, 1992.

3. GNRI-93-0008, Amendment 106 to Grand Gulf Operating License, January 21, 1993.

CURRENT CYCLE REFERENCES:

4. General Electric 24A5384, Supplemental Reload Licensing Report for Grand Gulf Unit 1 Reload 8 Cycle 9, Rev. 0, dated October 1996.

5. General Electric 24A5384AA, Lattice Dependent MAPLHGR Report for Grand Gulf Unit 1 Reload 8 Cycle 9, Rev. 2, dated March 1997.

6. ANF-88-152 (P)(A), Generic Mechanical Design for Advanced Nuclear Fuels 9x9-5 BWR Reload Fuel, dated November 1990.

7. EMF-94-186, Grand Gulf Unit 1 Cycle 8 Reload Analysis, dated December 1994.

8. GEXI 96-00484, R.E. Kingston to J.B. Lee, "Application of Single Loop Operation Safety Limit MCPR to Operating Limit MCPR," dated November 15, 1996.

9. GEXI 97-00035, R.E. Kingston to J.B. Lee, "Utilization of Power and Flow Dependent MAPLHGR and LHGR Limits," dated June 27, 1997.

4.0 DEFINITIONS

1. Average Planar Linear Heat Generation Rate (APLHGR) - the APLHGR shall be applicable to a specific planar height and is equal to the sum of the linear heat generation rates for all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the fuel bundle.

2. Average Planar Exposure - the Average Planar Exposure shall be applicable to a specific planar height and is equal to the sum of the exposure of all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the fuel bundle.

3. Critical Power Ratio (CPR) - the ratio of that power in the assembly, which is calculated by application of the fuel vendor's appropriate boiling correlation, to cause some point in the assembly to experience boiling transition, divided by the actual assembly operating power.

4. Core Operating Limits Report (COLR) - The Grand Gulf Nuclear Station specific document that provides core operating limits for the current reload cycle in accordance with Technical Specification 5.6.5.

5 Linear Heat Generation Rate (LHGR) - the LHGR shall be the heat generation per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length.

6. Minimum Critical Power Ratio (MCPR) - the MCPR shall be the smallest CPR which exists in the core.

7. MCPR Safety Limit - the minimum value of the CPR at which the fuel could be operated with the expected number of rods in boiling transition not exceeding 0.1% of the fuel rods in the core.

5.0 GENERAL REQUIREMENTS

This section reports the Grand Gulf Cycle 9 core operating limits. As discussed in Technical Specifications 3.2.1, 3.2.2, and 3.2.3, these operating limits are applicable when the core thermal power is greater than 25% of rated power.

5.1 Average Planar Linear Heat Generation Rates

Consistent with Technical Specification 3.2.1, all APLHGRs for Siemens 9x9-5 bundles shall not exceed the limits reported in Attachment 1 as a functions of exposure [7]. All APLHGRs for GE11 lattices shall not exceed the limits reported in Reference 5 as a function of exposure multiplied by the smaller of either the power-dependent or flow dependent MAPLHGR factors reported in attachment 1 [4]. For each GE11 bundle type, Attachment 1 reports the MAPLHGR for the most limiting lattice at each exposure for reference purposes [4].

5.2 Minimum Critical Power Ratio

Consistent with Technical Specification 3.2.2, the MCPR shall be equal to or greater than the limits reported in Attachment 2 as functions of power, flow, and exposure [4].

5.3 Linear Heat Generation Rate

Consistent with Technical Specification 3.2.3, The LHGR for Siemens 9x9-5 bundles shall not exceed the limits reported in Attachment 3 as a function of exposure as multiplied by the smaller of either the power-dependent or flow-dependent LHGR factors reported in Attachment 3 [4,6]. The LHGR for GE11 lattices shall not exceed the limits reported in Reference 5 as a function of exposure multiplied by the smaller of either the power-dependent or flow-dependent MAPLHGR factors reported in Attachment 1 [4,5,9].

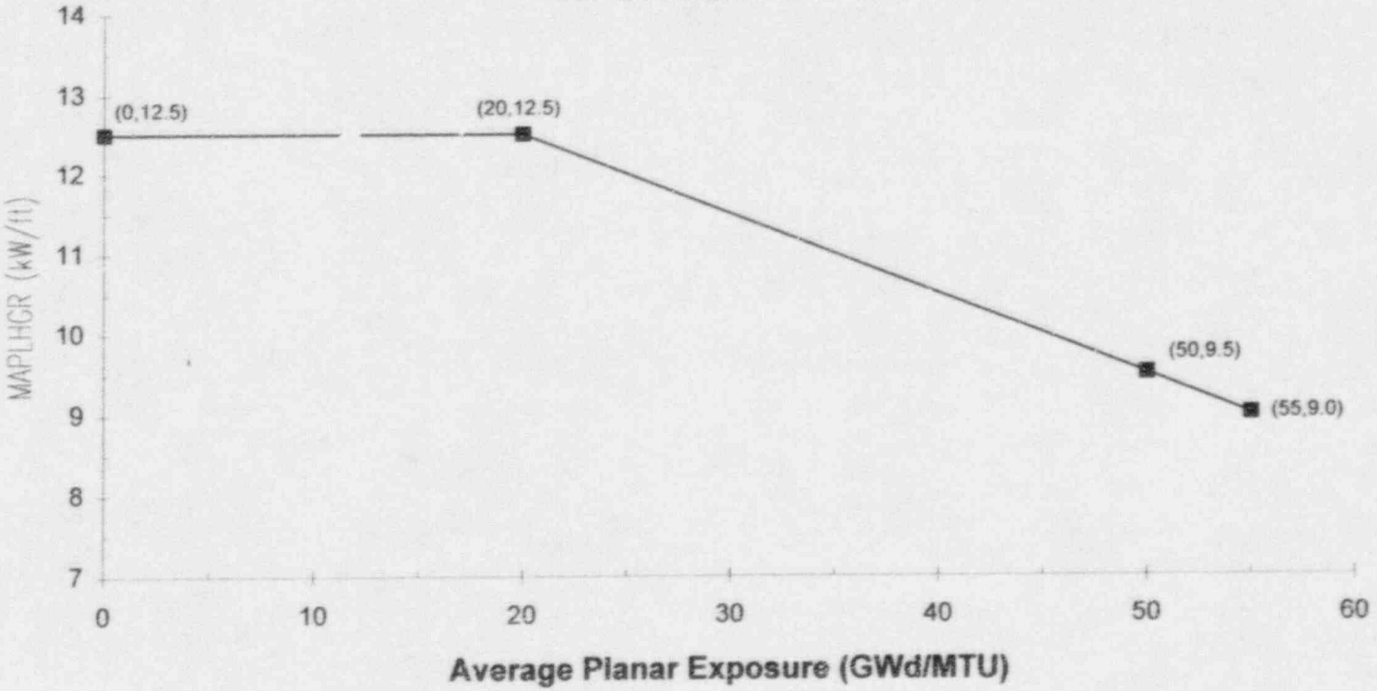
5.4 Applicability

These limits are applicable for operation in the Maximum Extended Operating Domain (MEOD) and with Feedwater Heaters Out of Service. For single-loop operation, the following changes must be performed.

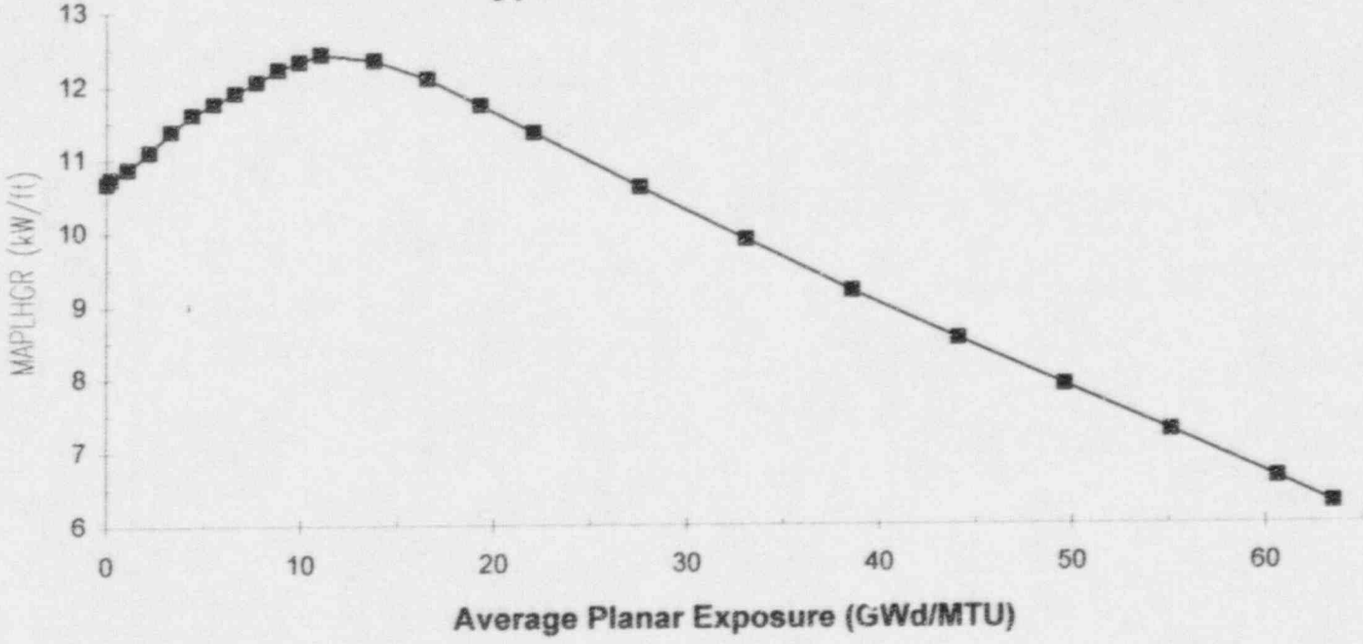
1. The APLHGR for the GE11 bundles shall not exceed the MAPLHGR limit as a function of exposure reported in Reference 5 multiplied by 0.83 [4]. The APLHGR for Siemens 9x9-5 bundles shall not exceed the MAPLHGR limit reported in Attachment 1 multiplied by .86 [4].

2. The MCPR shall be equal to or greater than the limits determined in accordance with Section 5.2 above multiplied by the ratio of the single-loop MCPR safety limit to the two-loop MCPR safety limit reported in Technical Specification 2.1.1.2 [8].

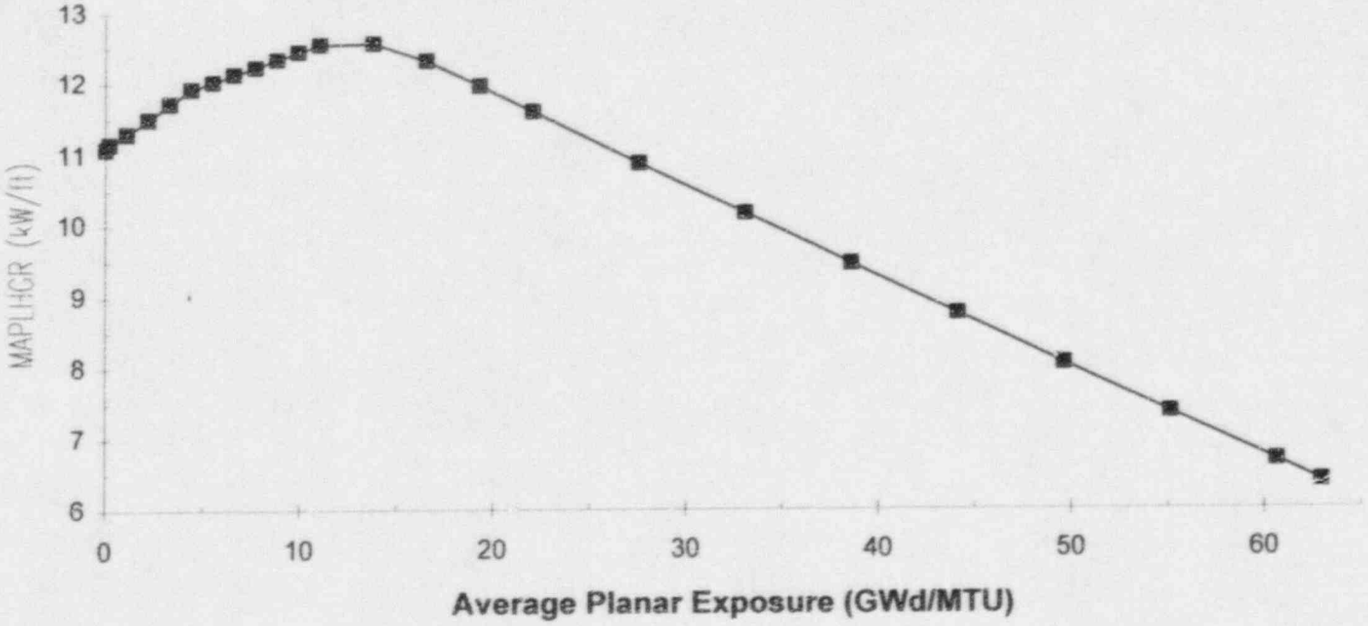
Cycle 9 Maximum Average Planar Linear Heat Generation Rate for Siemens 9x9-5



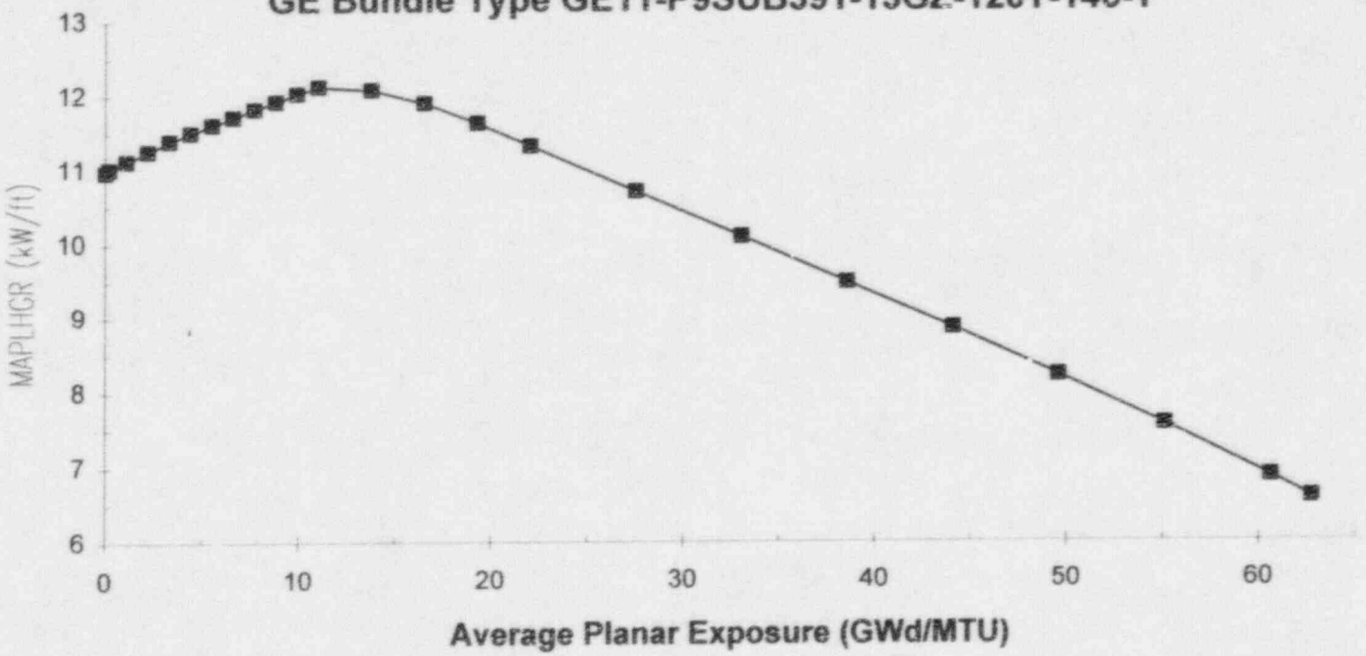
Cycle 9 Maximum Average Planar Linear Heat Generation Rate for Limiting Lattice of GE Bundle Type GE11-P9SUB355-15GZ-120T-146-T



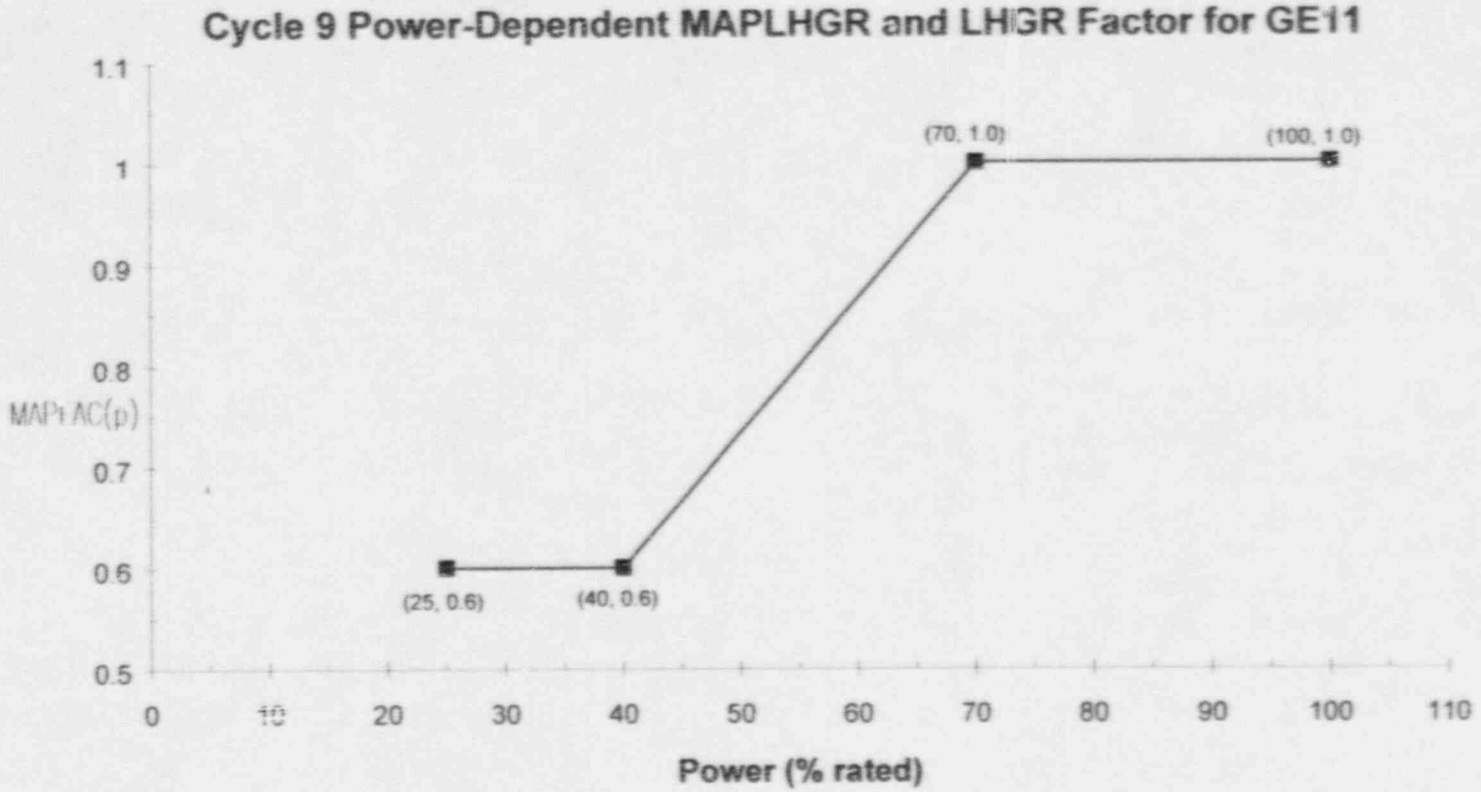
Cycle 9 Maximum Average Planar Linear Heat Generation Rate for Limiting Lattice of GE Bundle Type GE11-P9SUB371-12GZ1-120T-146-T



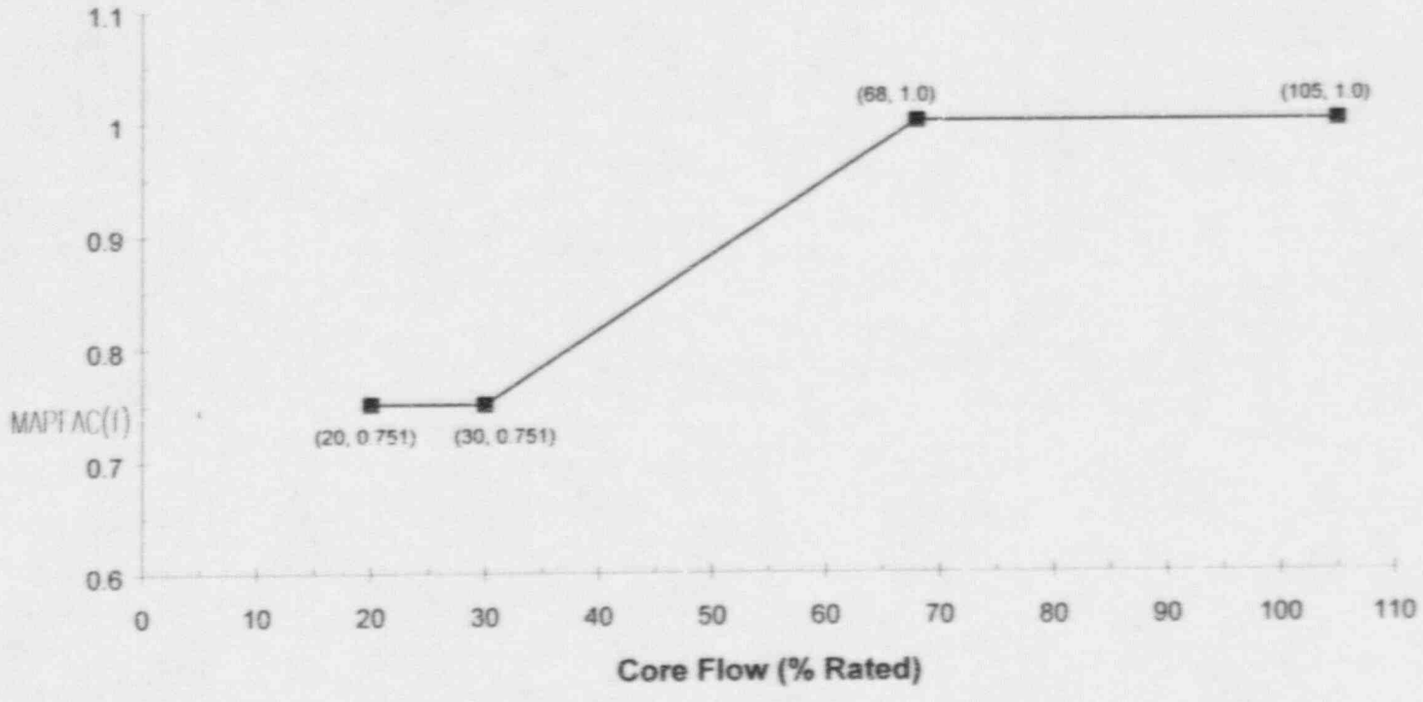
Cycle 9 Maximum Average Planar Linear Heat Generation Rate for Limiting Lattice of GE Bundle Type GE11-P9SUB391-13GZ-120T-146-T



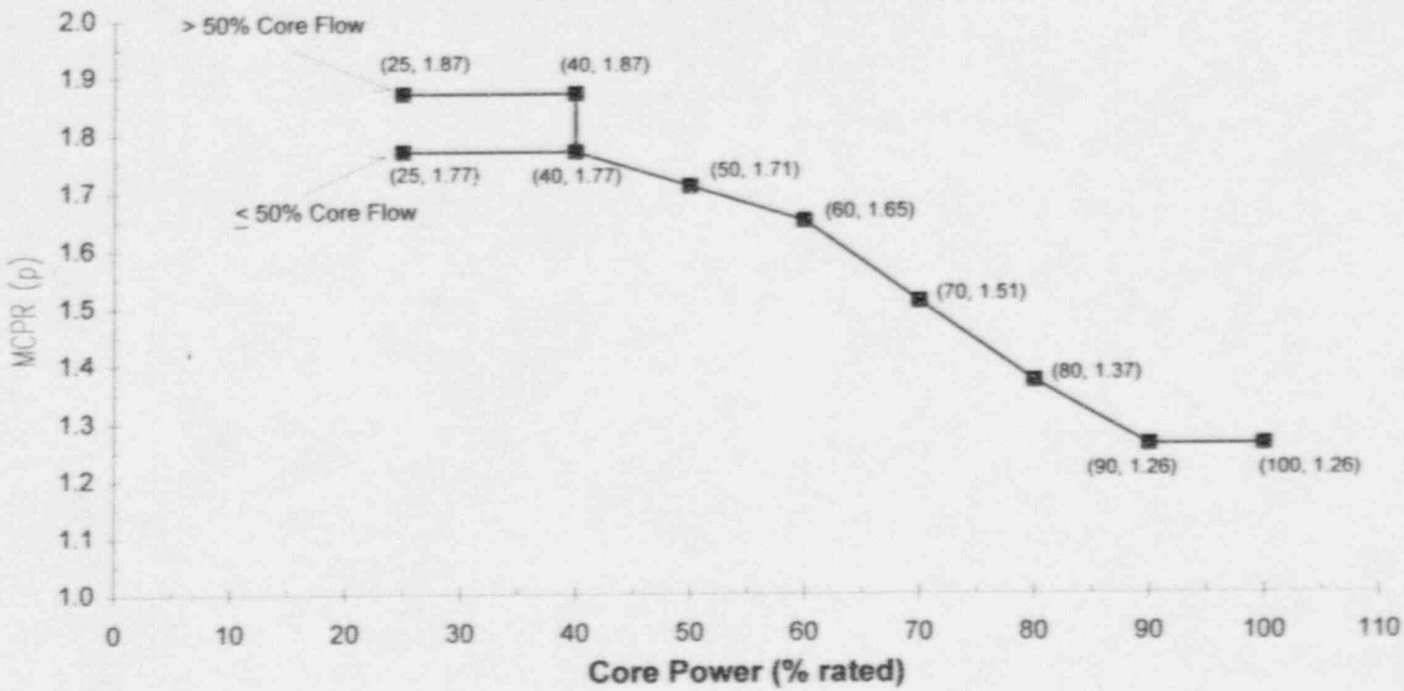
Exposure (GWd/MTU)	GE Bundle Type GE11-P9SUB355-15GZ-120T-146-T	GE Bundle Type GE11-P9SUB371-12GZ1-120T-146-T	GE Bundle Type GE11-P9SUB391-13GZ-120T-146-T
0.00	10.68	11.09	10.97
0.22	10.74	11.16	11.01
1.10	10.87	11.30	11.12
2.20	11.10	11.50	11.25
3.31	11.38	11.72	11.39
4.41	11.61	11.92	11.50
5.51	11.76	12.02	11.61
6.61	11.91	12.13	11.71
7.72	12.06	12.23	11.82
8.82	12.23	12.34	11.92
9.92	12.33	12.45	12.03
11.02	12.43	12.55	12.12
13.78	12.35	12.57	12.08
16.53	12.10	12.32	11.90
19.29	11.73	11.96	11.63
22.05	11.35	11.60	11.32
27.56	10.61	10.88	10.70
33.07	9.89	10.17	10.09
38.58	9.19	9.46	9.48
44.09	8.53	8.76	8.86
49.60	7.89	8.06	8.22
55.12	7.26	7.37	7.56
60.63	6.62	6.68	6.86
62.76			6.58
62.96		6.38	
63.51	6.28		


Cycle 9 Power-Dependent MAPLHGR and LHGR Factor for GE11
1.1
1
0.9
0.8
MAPLHGR(p)
0.7
0.6
0.5
(70, 1.0)
(100, 1.0)
(25, 0.6)
(40, 0.6)
0
10
20
30
40
50
60
70
80
90
100
110
Power (% rated)

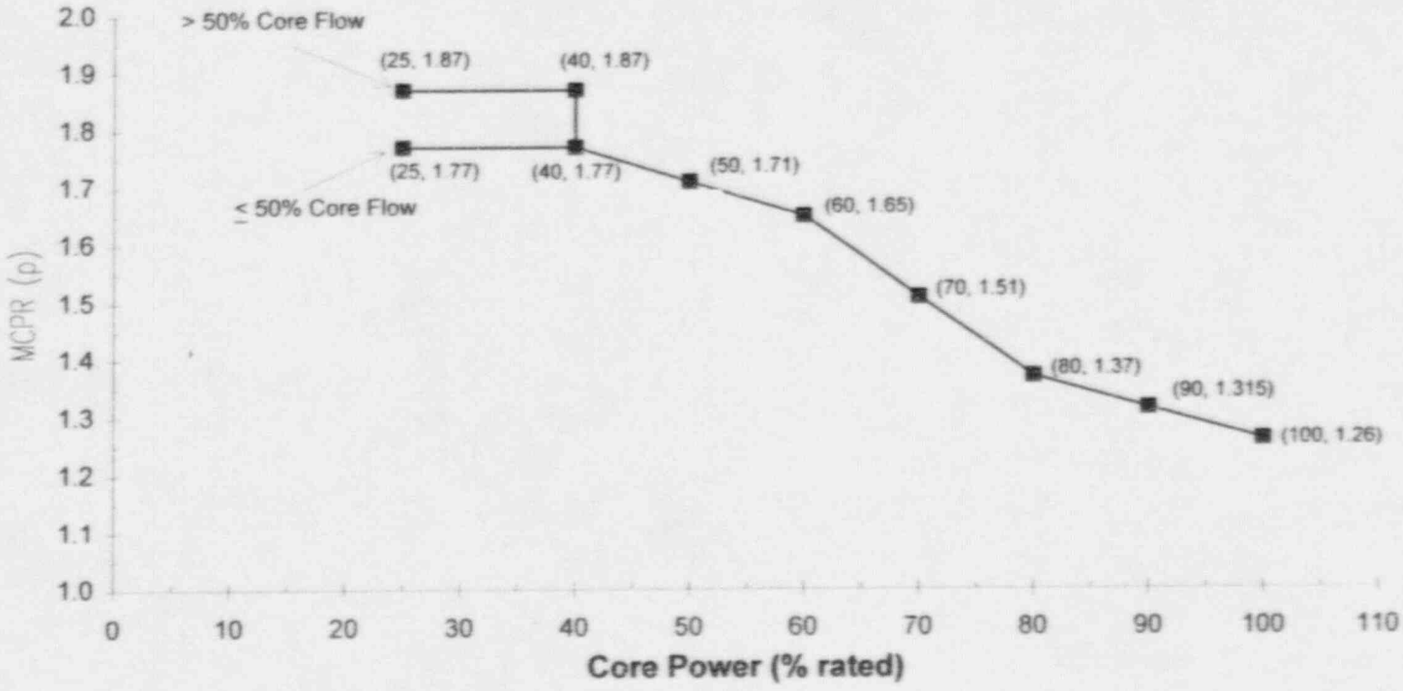
Cycle 9 Flow-Dependent MAPLHGR and LHGR Factor for GE11



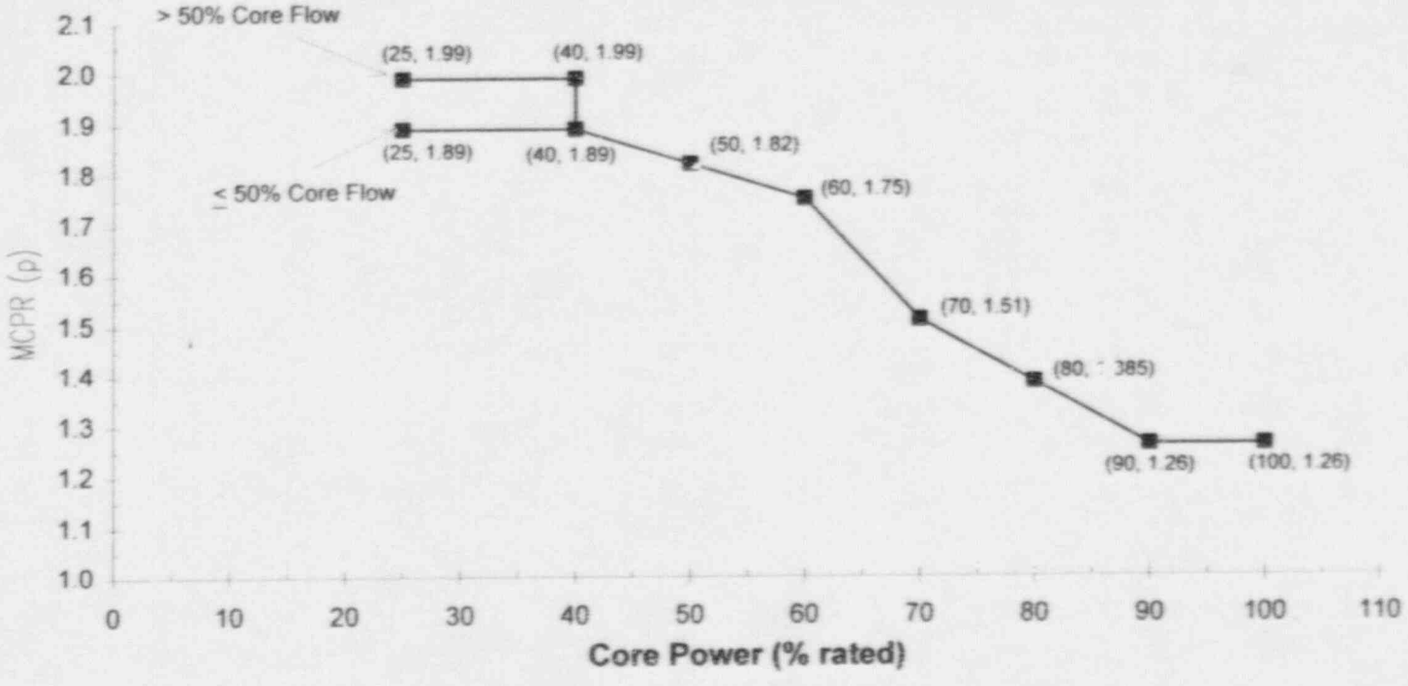
Cycle 9 Power-Dependent MCPR Limit for GE11
BOC - EOC-3307 MWd/MT



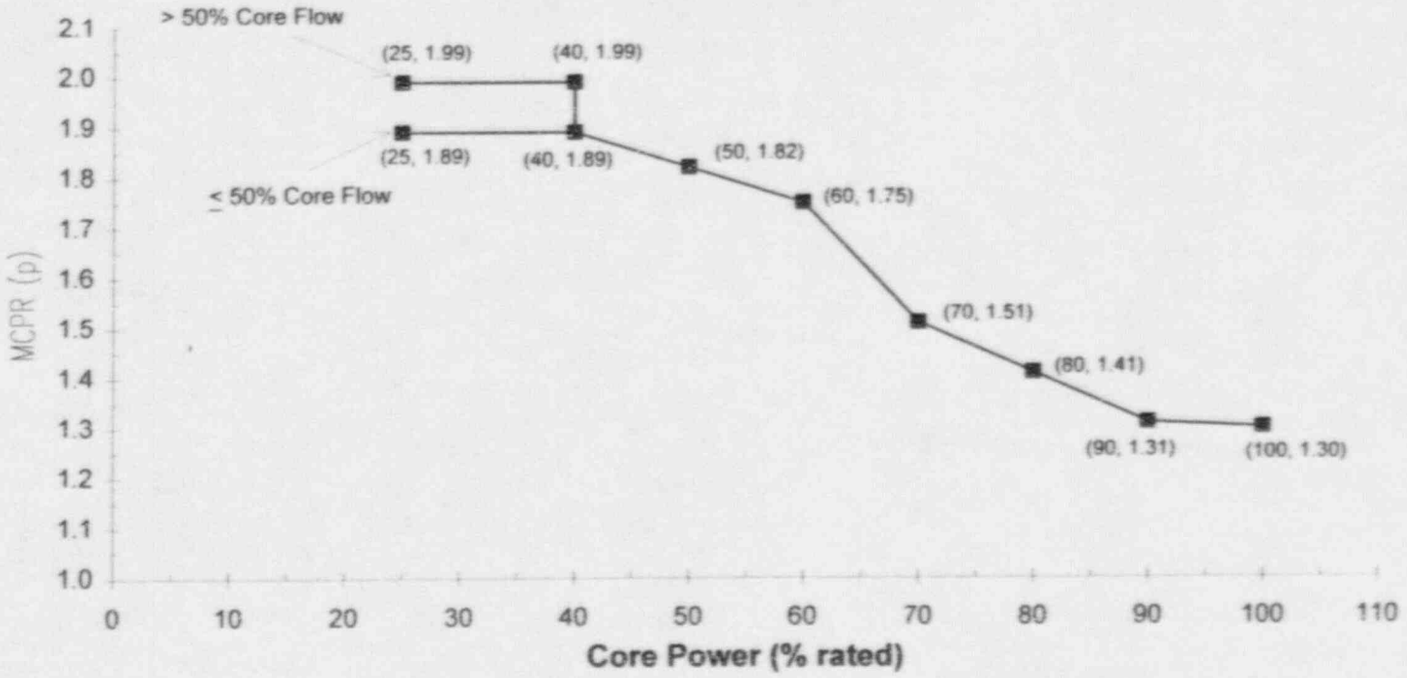
Cycle 9 Power-Dependent MCPR Limit for GE11
EOC-3307 MWd/MT - EEOC

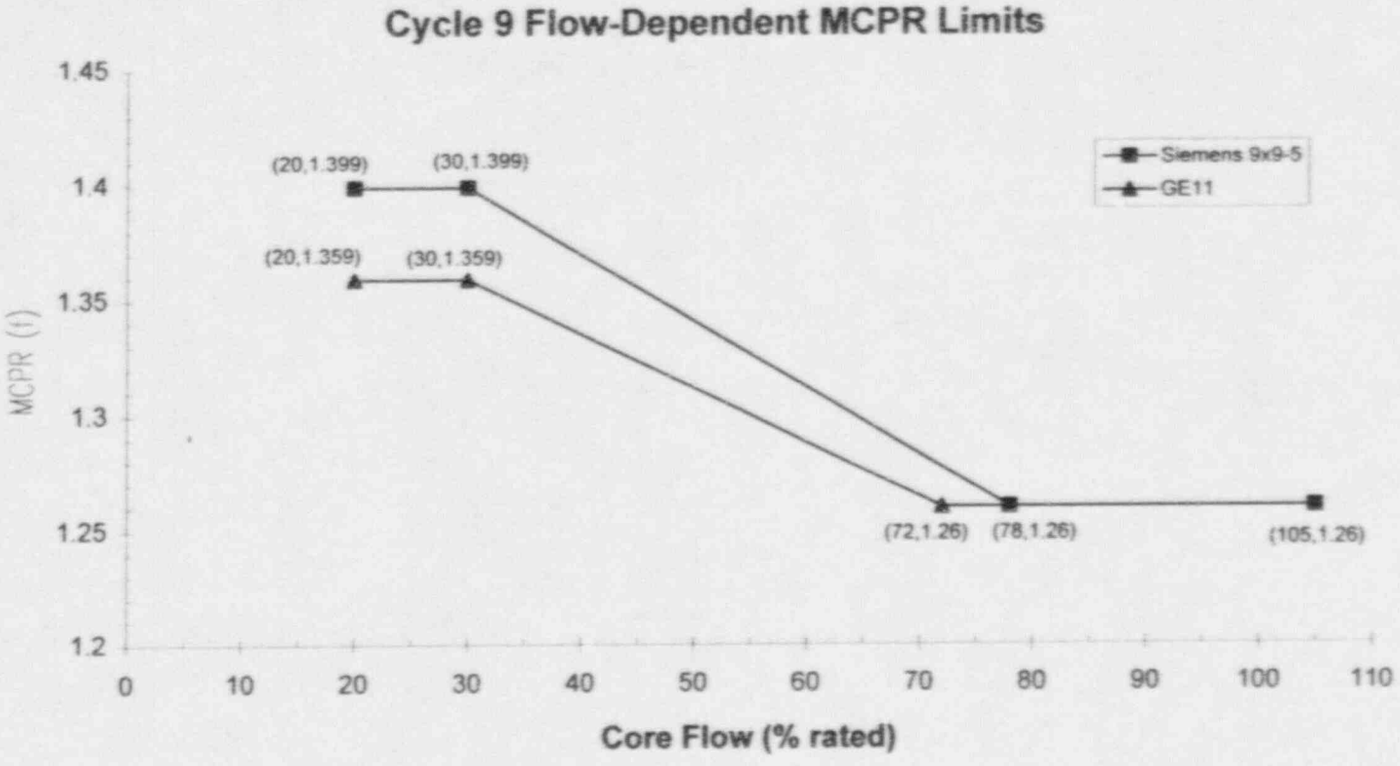


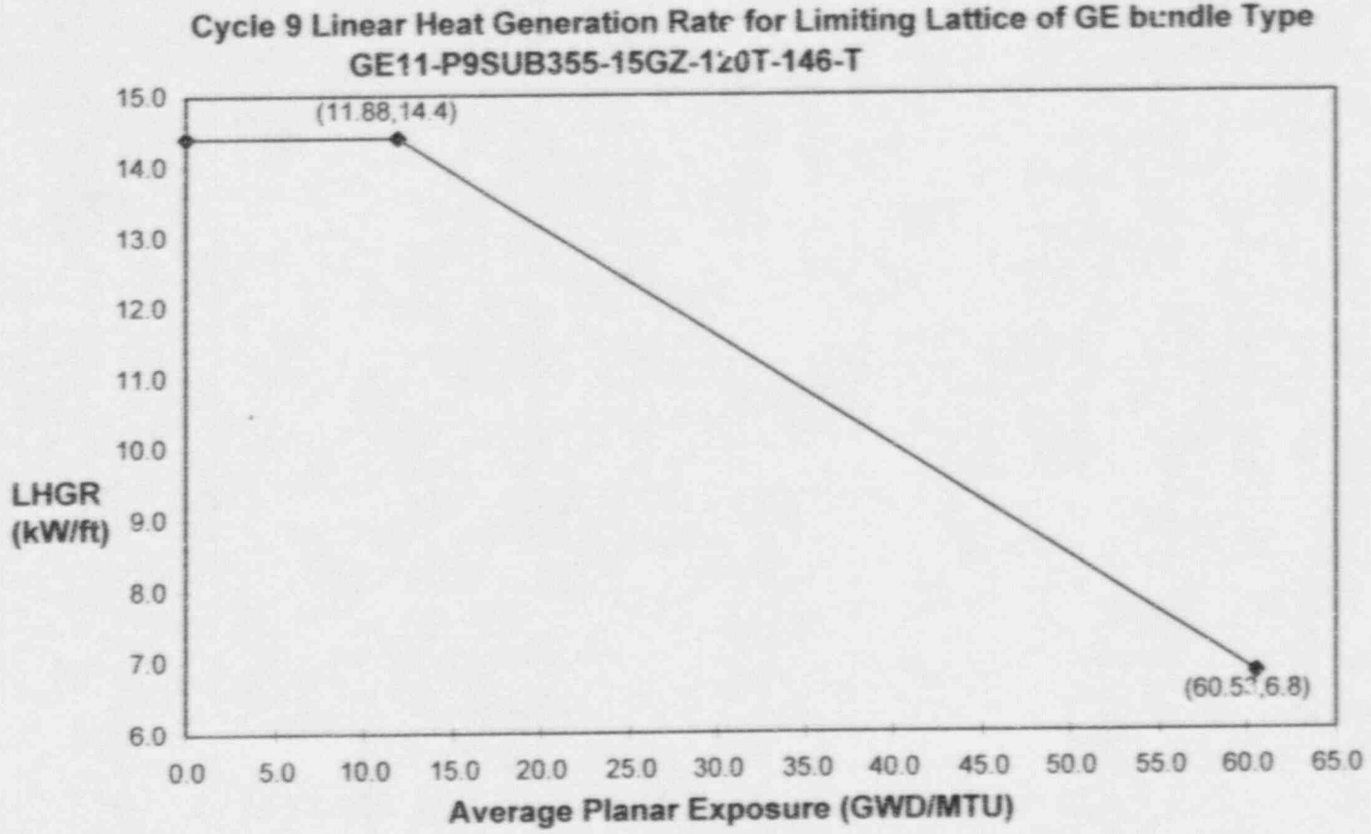
Cycle 9 Power-Dependent MCPR Limit for Siemens 9x9-5
BOC - EOC-3307 MWd/MT



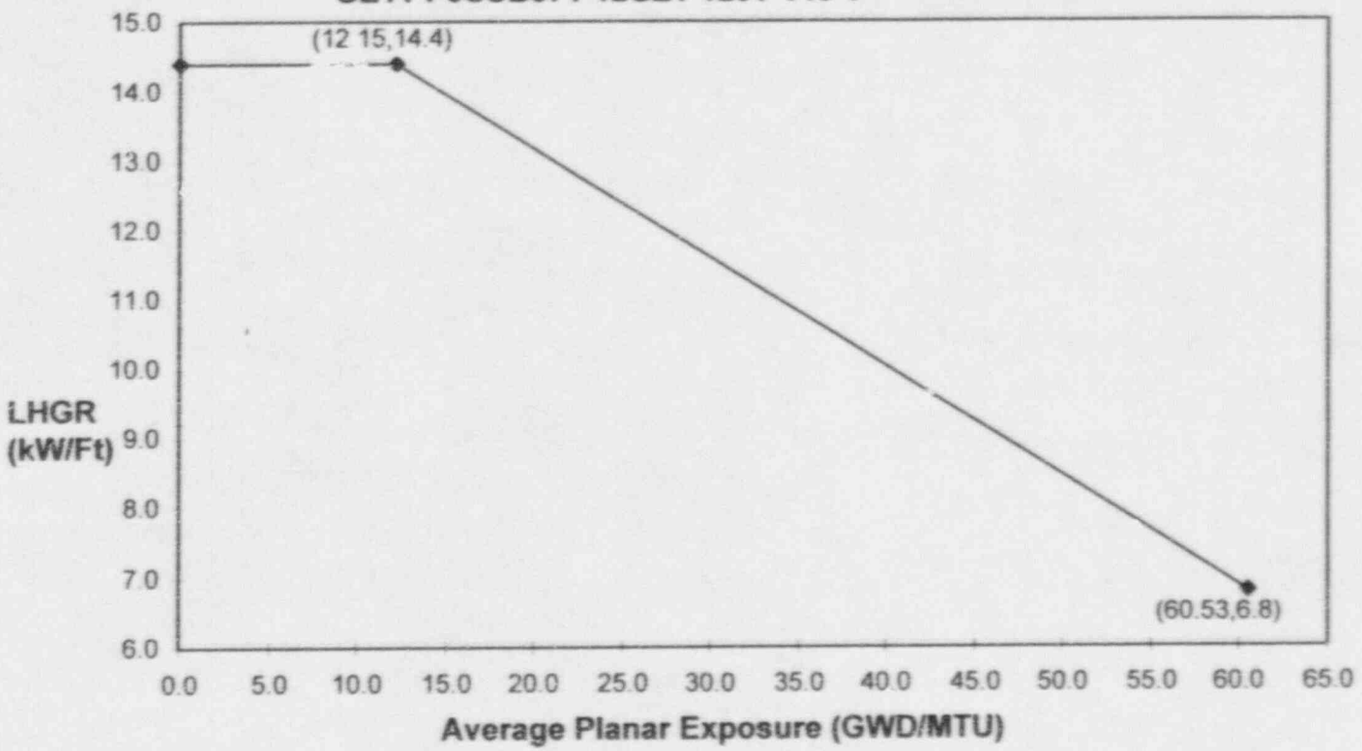
Cycle 9 Power-Dependent MCPR Limit for Siemens 9x9-5
EOC-3307 MWd/MT - EEOC



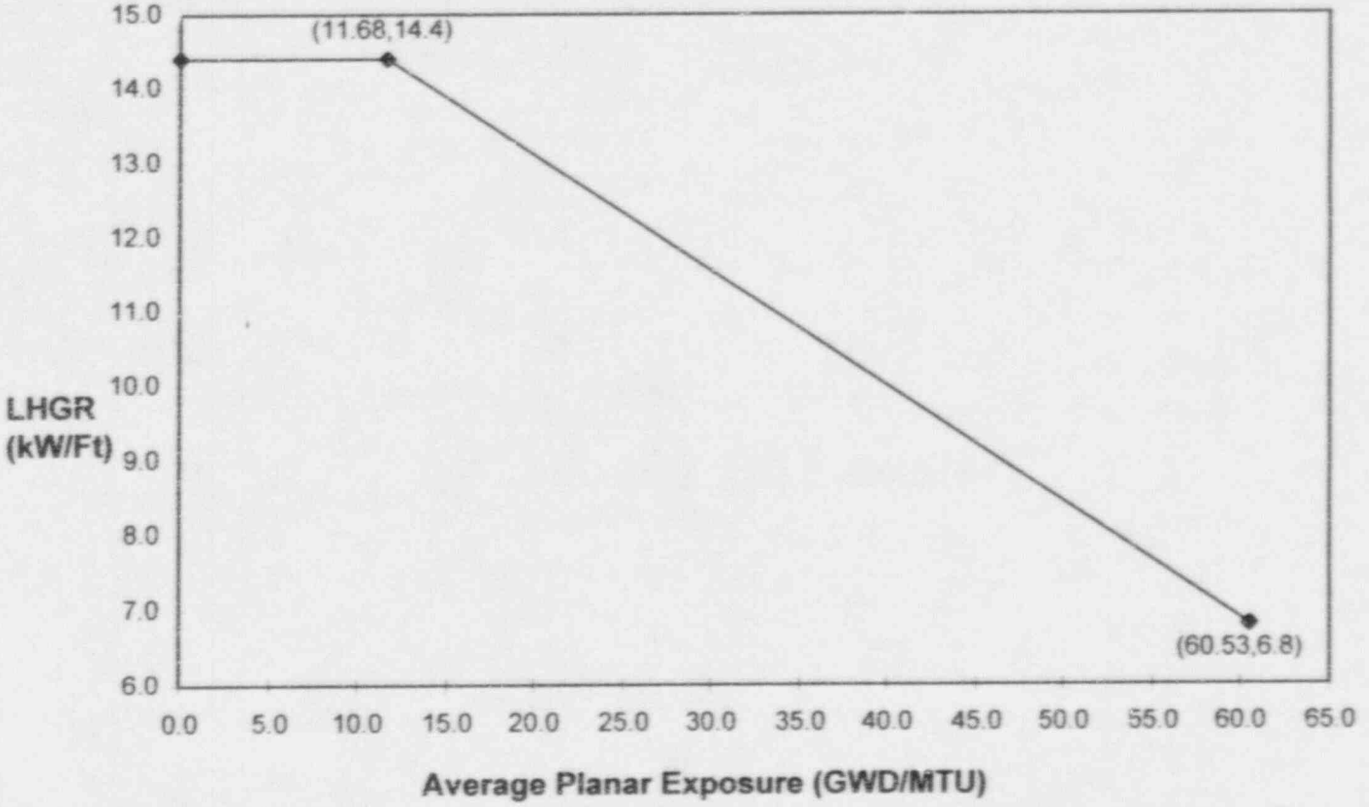

Cycle 9 Flow-Dependent MCPR Limits
MCPR (f)
Core Flow (% rated)
Siemens 9x9-5
GE11
(20,1.399)
(30,1.399)
(20,1.359)
(30,1.359)
(72,1.26)
(78,1.26)
(105,1.26)
1.45
1.4
1.35
1.3
1.25
1.2
0
10
20
30
40
50
60
70
80
90
100
110

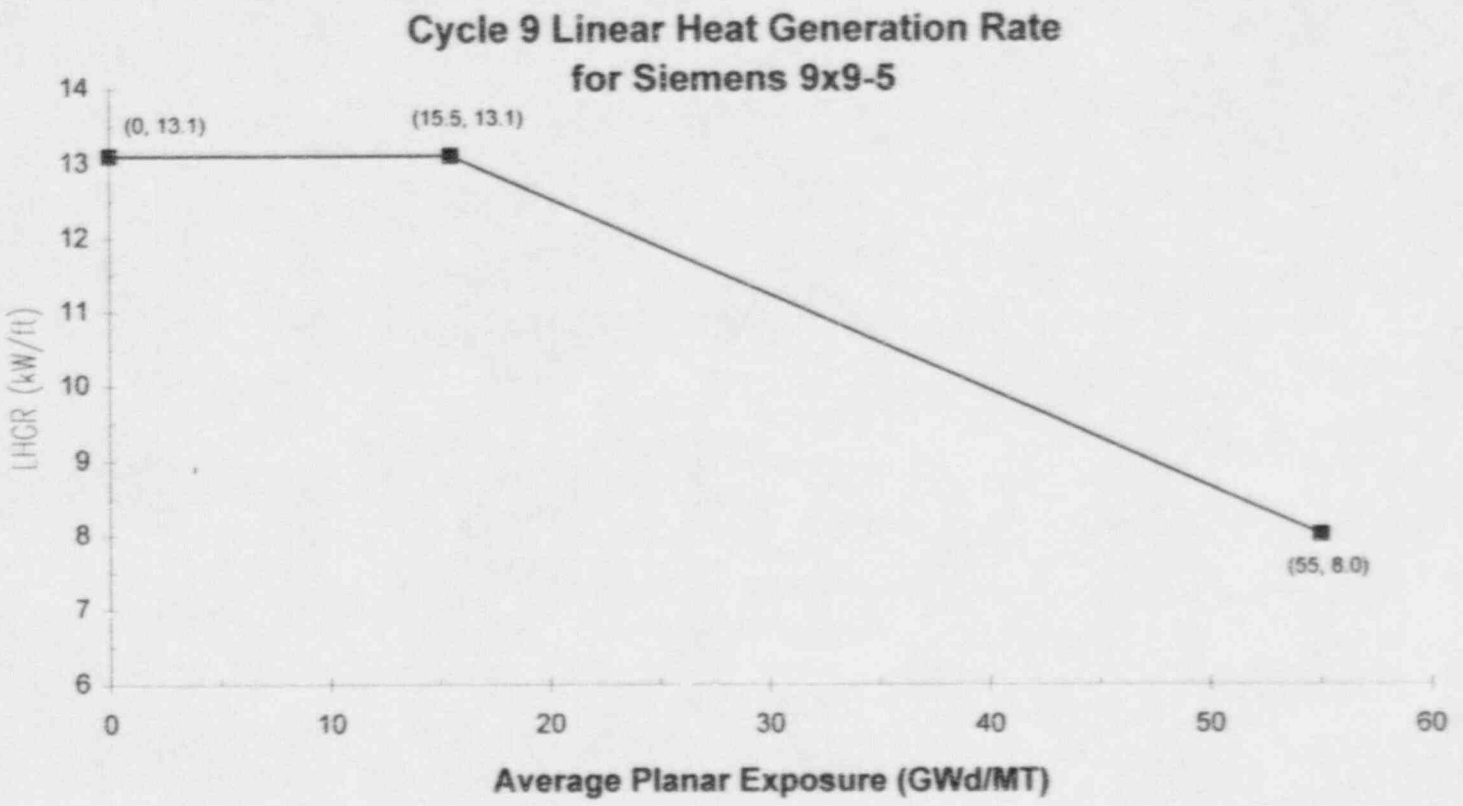

Cycle 9 Linear Heat Generation Rate for Limiting Lattice of GE bundle Type
GE11-P9SUB355-15GZ-120T-146-T
LHGR (kW/ft)
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
(11.88,14.4)
(60.53,6.8)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
Average Planar Exposure (GWD/MTU)

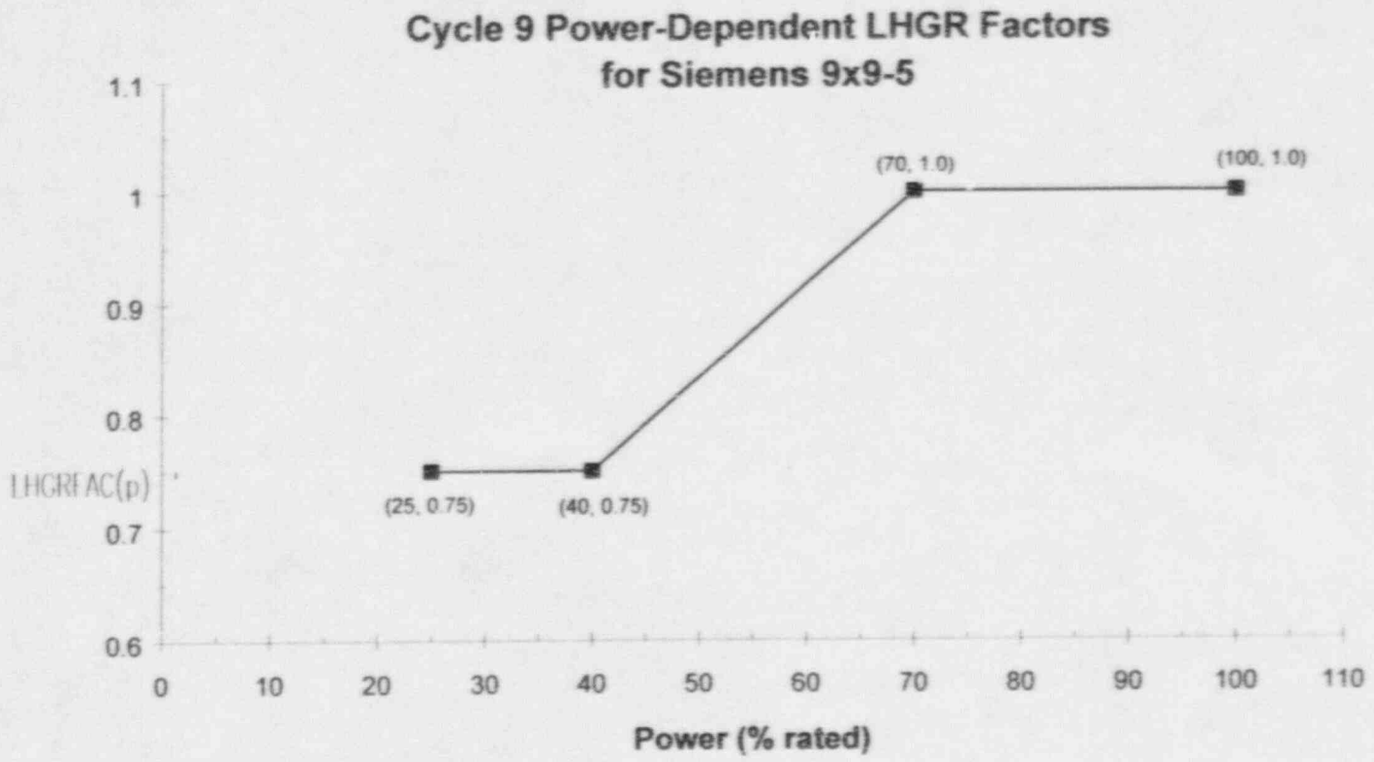
Cycle 9 Linear Heat Generation Rate for Limiting Lattice of GE bundle Type GE11-P9SUB371-12GZ1-120T-146-T

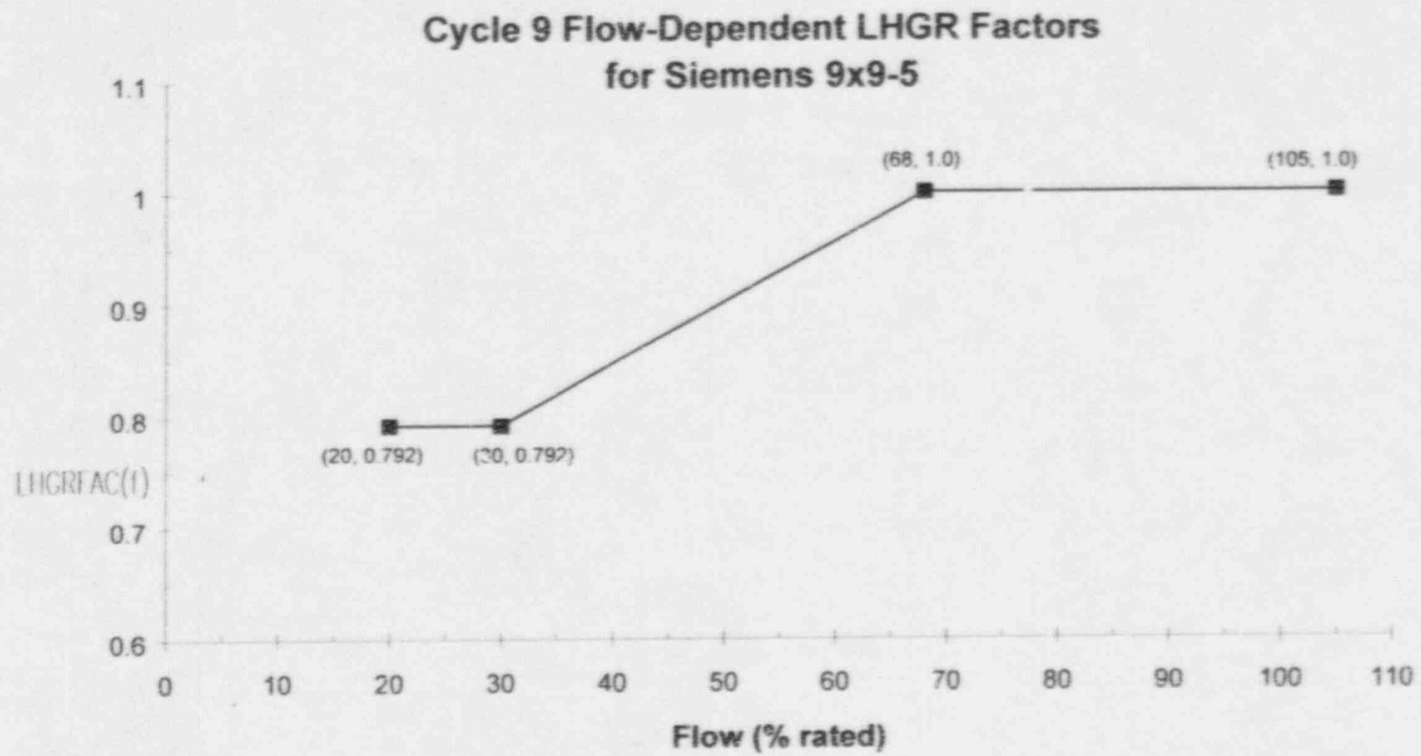


Cycle 9 Linear Heat Generation Rate for Limiting Lattice of GE bundle Type GE11-P9SUB391-13GZ-120T-146-T




Cycle 9 Linear Heat Generation Rate
for Siemens 9x9-5
LHGR (kW/ft)
14
13
12
11
10
9
8
7
6
(0, 13.1)
(15.5, 13.1)
(55, 8.0)
0
10
20
30
40
50
60
Average Planar Exposure (GWd/MT)


Cycle 9 Power-Dependent LHGR Factors
for Siemens 9x9-5
1.1
1
0.9
0.8
0.7
0.6
LHGRFAC(p)
(70, 1.0)
(100, 1.0)
(25, 0.75)
(40, 0.75)
0
10
20
30
40
50
60
70
80
90
100
110
Power (% rated)


Cycle 9 Flow-Dependent LHGR Factors
for Siemens 9x9-5
1.1
1
0.9
0.8
0.7
0.6
LHGRFAC(f)
(68, 1.0)
(105, 1.0)
(20, 0.792)
(20, 0.792)
0
10
20
30
40
50
60
70
80
90
100
110
Flow (% rated)