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WNP-2 Cycle 8 Core Operating Limits Report

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WNP-2
Cycle 8
Core Operating Limits Report

List of Effective Pages

<u>Page</u>	<u>Revision</u>
i	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0
19	0
20	0
21	0
22	0
23	0
24	0
25	0
26	0
27	0
28	0
29	0
30	0
31	0
32	0
33	0
34	0
35	0

WNP-2
Cycle 8
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Table of Contents

	<u>Page #</u>
1.0 Introduction and Summary	1
2.0 Average Planar Linear Heat Generation Rate (APLHGR) Limits for Use in Technical Specification 3.2.1	2
3.0 Minimum Critical Power Ratio (MCPR) Limit for Use in Technical Specification 3.2.3	8
4.0 Linear Heat Generation Rate (LHGR) Limit for Use in Technical Specification 3.2.4	27
5.0 References	33

1.0 Introduction and Summary

This report provides the Average Planar Linear Heat Generation Rate (APLHGR) limits, the Minimum Critical Power Ratio (MCPR) limits, and the Linear Heat Generation Rate (LHGR) limits for WNP-2, Cycle 8 as required by Technical Specification 6.9.3.1. As required by Technical Specifications 6.9.3.2 and 6.9.3.3, these limits were determined using NRC-approved methodology and are established so that all applicable limits of the plant safety analysis are met. The thermal limits for SNP fuel given in this report are documented in the *Cycle 8 Plant Transient Analysis Report* (Reference 5.1), the *Cycle 8 Reload Analysis Report* (Reference 5.2), and the *Power Dependent MCPR Limits for WNP-2 Cycle 8* letter report (Reference 5.9). The thermal limits determined through the approved methodology are modified for the GE11 and SVEA-96 LFA's as discussed below.

The WNP-2 Cycle 8 reload will include four Siemens Nuclear Power (SNP), four General Electric (GE), and four ABB Atom (ABB) Lead Fuel Assemblies (LFA's). The four SNP LFA's were inserted during the reload for Cycle 5. The four GE and ABB LFA's were inserted at the beginning of Cycle 6 and were designed to be compatible with the reload fuel utilized in Cycle 6. The Supply System will load the LFA's in core locations which, according to analysis, have sufficient margin such that the LFA's are not expected to be the limiting assemblies. This approach is intended to exclude the LFA's ever being the limiting fuel assemblies on either a nodal or an assembly power basis. The GE11 LFA is described in the *GE11 Lead Fuel Assembly Report for Washington Public Power Supply System Nuclear Project No. 2, Reload 5, Cycle 6* (Reference 5.3). This reference describes the design goals of the GE11 LFA's and provides support for monitoring the GE11 LFA's at thermal limits based on the SNP 8x8 reload fuel thermal limits. The SVEA-96 LFA is described in the *Supplemental LFA Licensing Report—SVEA-96 LFA's for WNP-2* (Reference 5.4). The process for developing thermal limits for the SVEA-96 LFA fuel based upon the SNP 8x8 reload fuel thermal limits is described in this reference and Reference 5.5.

The MAPLHGR limits for the GE11 LFA's are the same as the SNP 8x8 reload fuel, except that a ratio $([64-2]/[81-7])$ is applied to account for the different number of fuel pins in the two designs. The MAPLHGR limits for the SVEA-96 LFA's are the same as the SNP 8x8 reload fuel, except that a ratio $([64-2]/[100-4])$ is applied to account for the different number of fuel pins in the two designs. Furthermore, the MAPLHGR limits for the SVEA-96 LFA's are multiplied 1) by 1.04 to account for a different estimation of the local power in the output from POWERPLEX compared to ABB Atom methods and 2) by 1.02 to account for a different estimation of exposure in the output from POWERPLEX compared ABB Atom methods. This produces a combined multiplier of 1.06.

A power dependent MCPR is specified in this report to define operating limits at other than rated power conditions. For the WNP-2 core, feedwater-controller-failure transients from reduced power are calculated to be more severe than from full power conditions. A flow dependent MCPR is specified in this report to define operating limits at other than rated flow conditions. The reduced flow MCPR operating limit provides bounding protection for the limiting recirculation flow increase transient. At less than rated conditions, the MCPR limit is the maximum of the rated power MCPR limit, the reduced power MCPR limit, and the reduced

flow MCPR limit. This stipulation assures that the safety limit MCPR will not be violated throughout the WNP-2 operating regime.

The LHGR limits for the GE11 LFA's are the same as the SNP 8x8 reload fuel, except that a ratio $([64-2]/[81-7])$ is applied to account for the different number of fuel pins in the two designs. The LHGR limits for the SVEA-96 LFA's are taken directly from Reference 5.4.

Preparation, review and approval of this report were performed in accordance with applicable Supply System procedures. The specific topical report revisions and supplements which describe the methodology utilized in this cycle specific analysis are referenced in Section 5.0

2.0 Average Planar Linear Heat Generation Rate (APLHGR) Limits for Use in Technical Specification 3.2.1

The APLHGR's for use in Technical Specification 3.2.1 shall not exceed the limits shown in Figures 1, 2, 4, and 5 when in two-loop operation and in Figures 1, 3, 4, and 5 when in single loop operation. The limits for each fuel type as a function of Average Planar Exposure are provided for the Siemens Nuclear Power fuel, including the SNP LFA's, the SVEA-96 LFA fuel, and the GE11 LFA fuel.

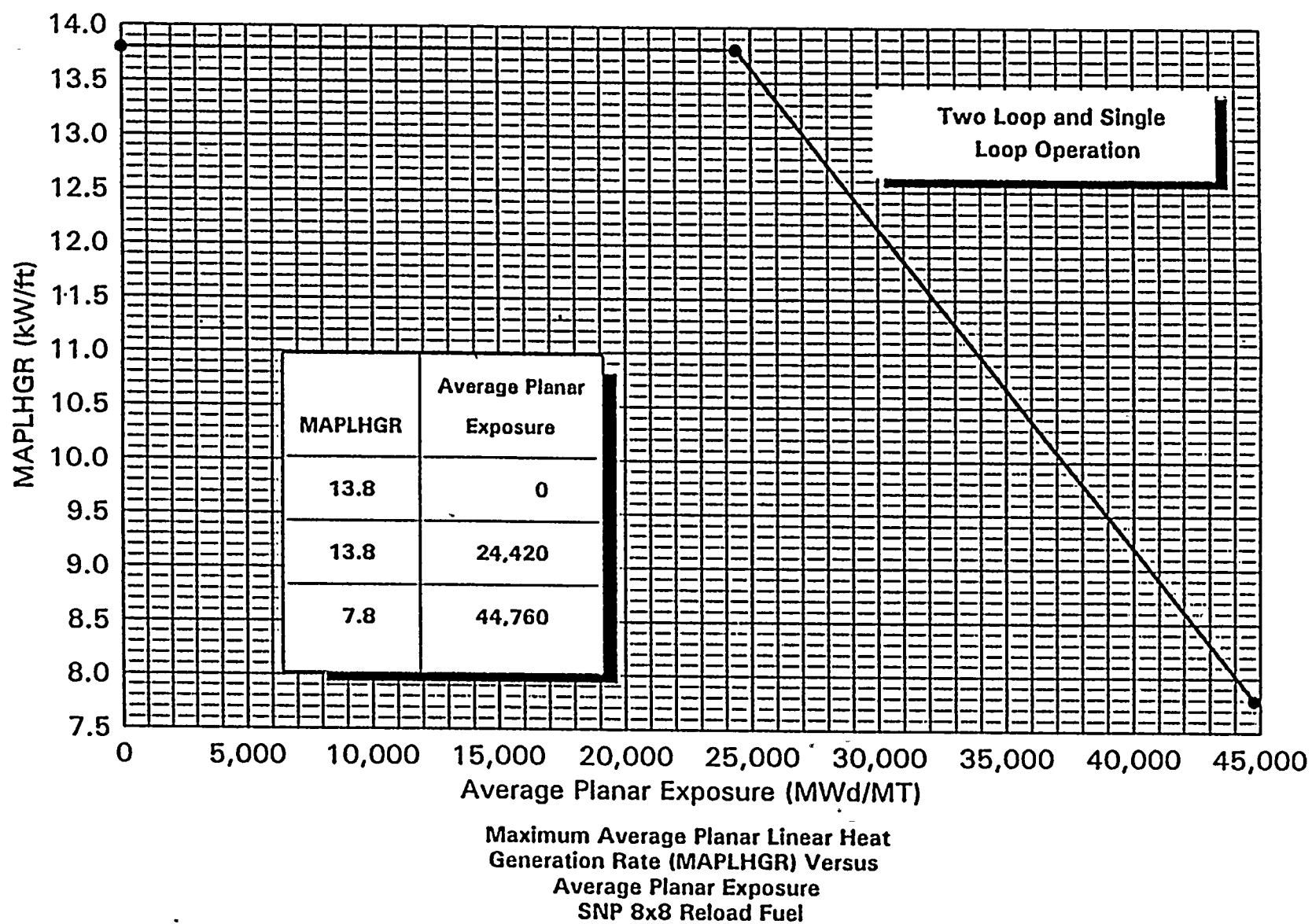
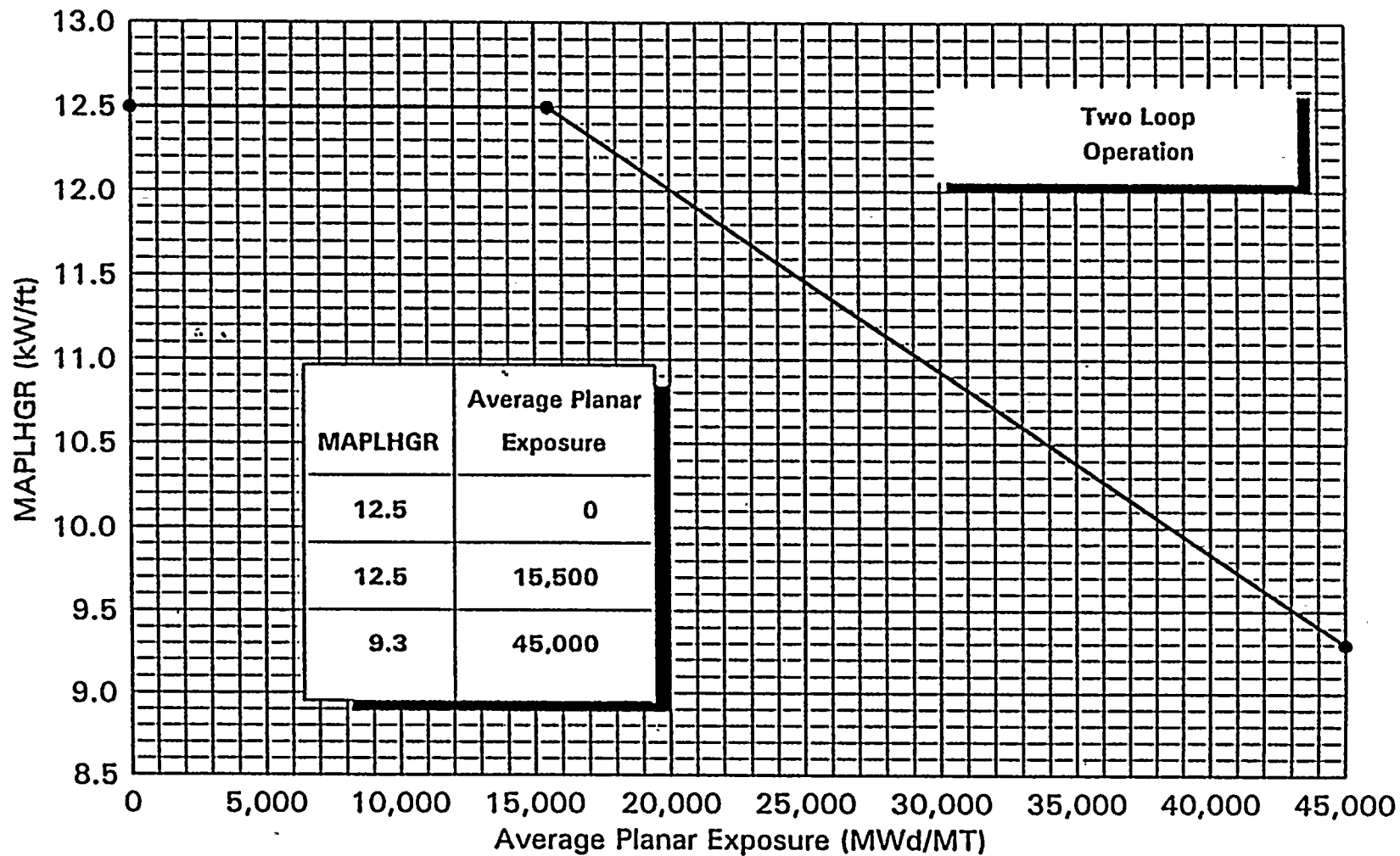
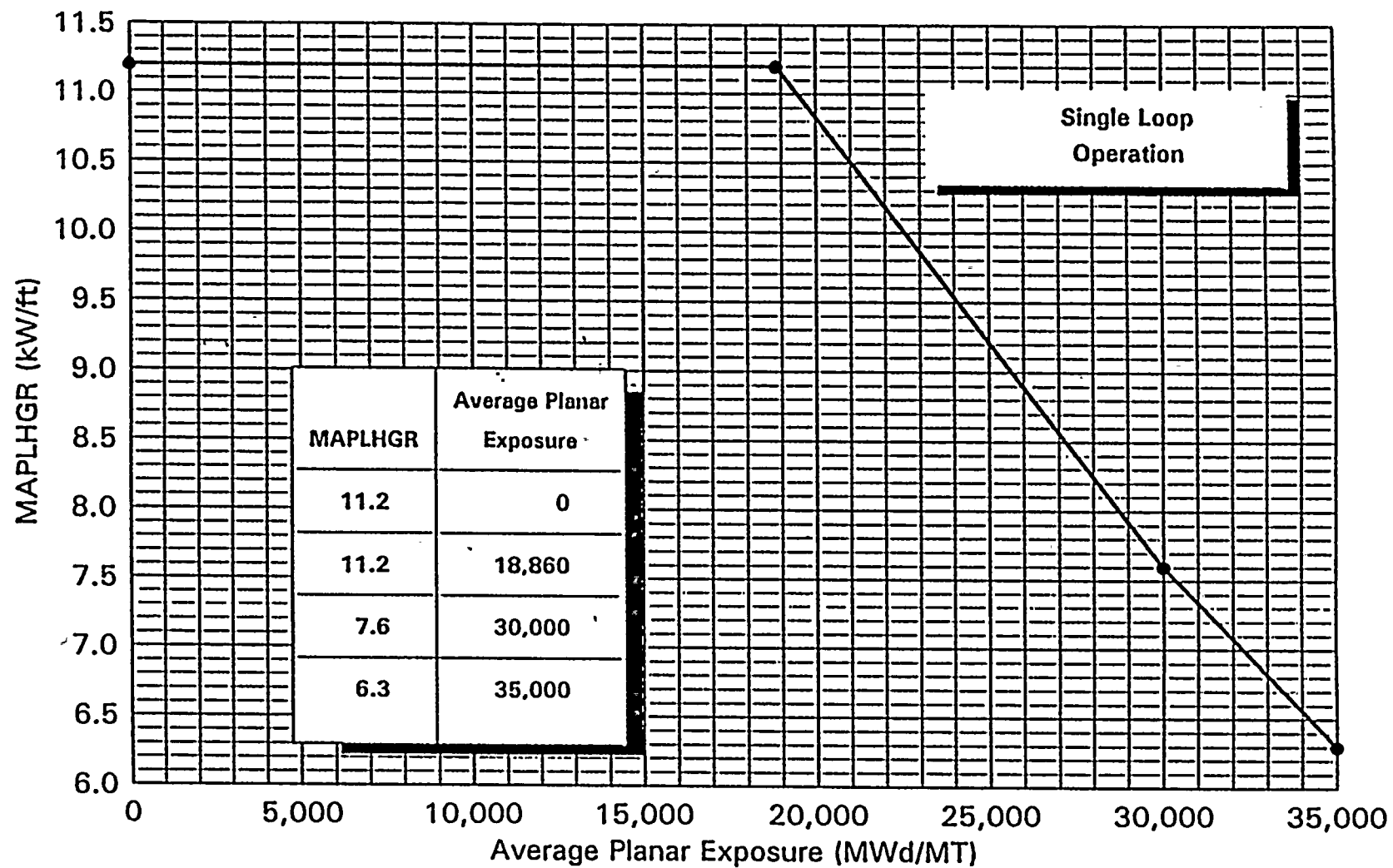


Figure 1



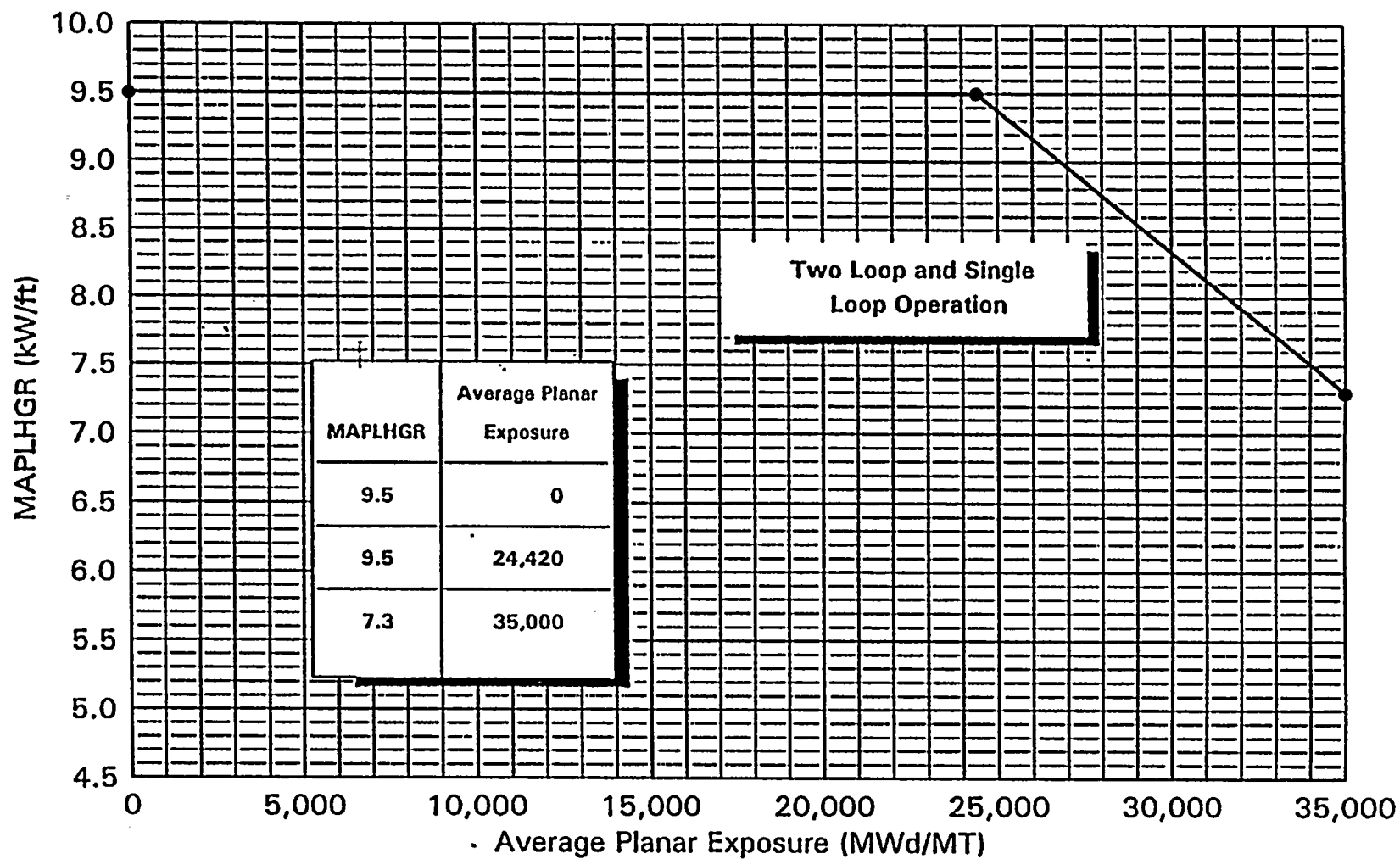
Maximum Average Planar Linear Heat
Generation Rate (MAPLHGR) Versus
Average Planar Exposure
SNP 9x9-9X Reload Fuel and SNP 9x9 LFA's

Figure 2



Maximum Average Planar Linear Heat
Generation Rate (MAPLHGR) Versus
Average Planar Exposure
SNP 9x9-9X Reload Fuel and SNP 9x9 LFA's

Figure 3



Maximum Average Planar Linear Heat
Generation Rate (MAPLHGR) Versus
Average Planar Exposure
SVEA-96 Lead Fuel Assemblies

Figure 4

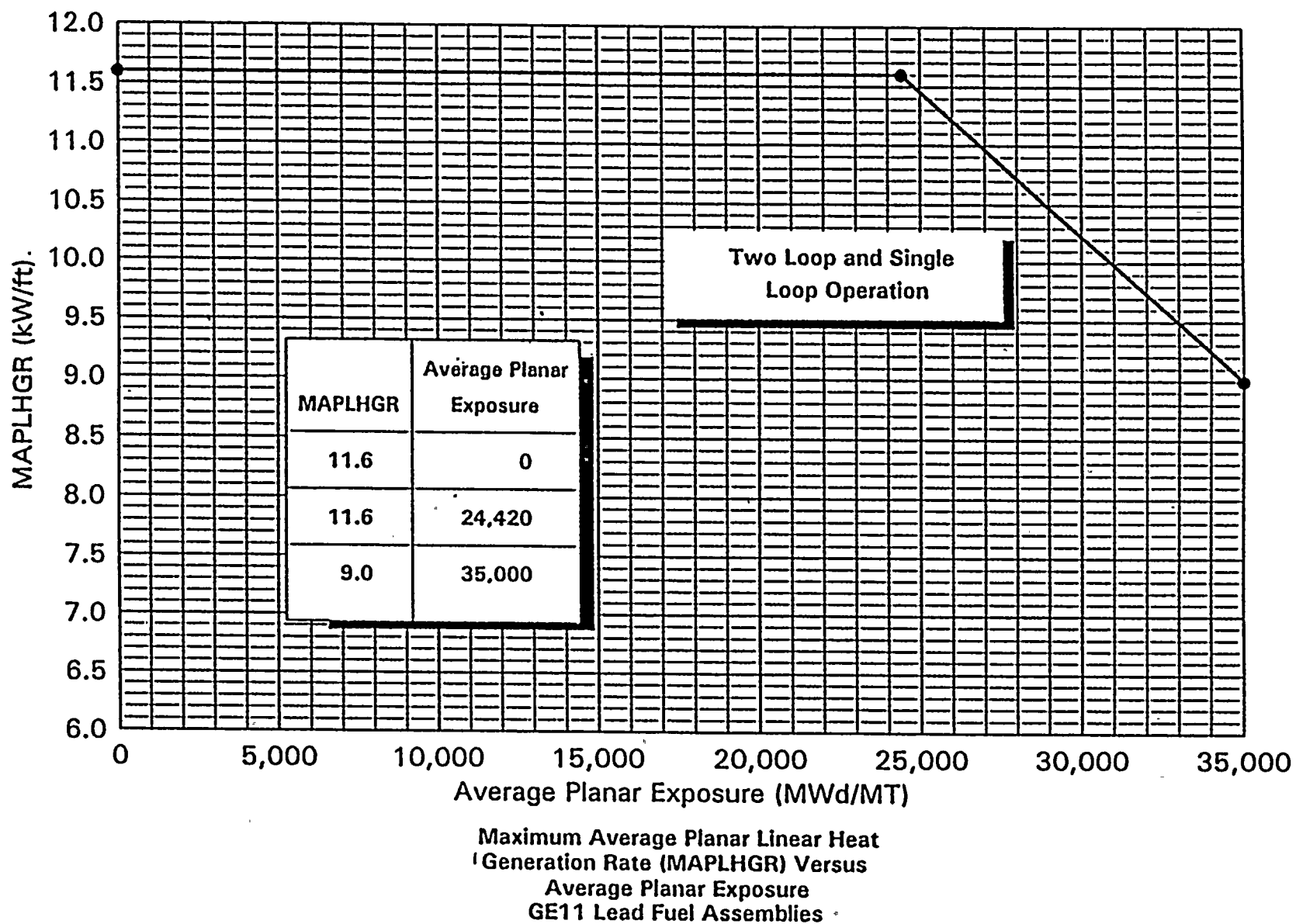


Figure 5

3.0 Minimum Critical Power Ratio (MCPR) Limit for Use in Technical Specification 3.2.3

The MCPR limit for use in Technical Specification 3.2.3 shall be:

- a) Greater than or equal to the greater of the limits determined from Tables 1a and 1b and Figures 6 and 7a through 14b.
- b) The full power limit is determined at 104% power and 106% core flow.

Table 1a
WNP-2 Cycle 8 MCPR Operating Conditions
Cycle Exposures < 4244 MWd/MT

Condition Limit		SLMCPR = 1.07 ⁽²⁾			
		SNP 8x8 GE11 LFA	SNP 9x9 LFA	SNP 9x9 LFA	SVEA-96 LFA
NSS ⁽¹⁾	Full Power	1.23 ⁽²⁾	1.23 ⁽²⁾	1.25	1.36 ⁽²⁾
	Flow Dependent	Figure 6			
	Power Dependent	Fig. 7a	Fig. 7a	Fig. 8a	Fig. 7a
TSSS ⁽¹⁾	Full Power	1.24	1.25	1.32	1.37
	Flow Dependent	Figure 6			
	Power Dependent	Fig. 9a	Fig. 9a	Fig. 10a	Fig. 9a
NSS ⁽¹⁾ RPT Inoperable	Full Power	1.26	1.28	1.37	1.40
	Flow Dependent	Figure 6			
	Power Dependent	Fig. 13a	Fig. 13a	Fig. 14a	Fig. 13a
SLO ⁽²⁾ NSS	Full Power	1.56	1.36	1.36	1.85
	Flow Dependent	None			
	Power Dependent	Fig. 7a	Fig. 7a	Fig. 8a	Fig. 7a
SLO ⁽²⁾ TSSS	Full Power	1.56	1.36	1.36	1.85
	Flow Dependent	None			
	Power Dependent	Fig. 9a	Fig. 9a	Fig. 10a	Fig. 9a
SLO ⁽²⁾ NSS RPT Inoperable	Full Power	1.56	1.36	1.36	1.85
	Flow Dependent	None			
	Power Dependent	Fig. 13a	Fig. 13a	Fig. 14a	Fig. 13a

Table 1b
WNP-2 Cycle 8 MCPR Operating Conditions
Cycle Exposures ≥ 4244 MWd/MT

Condition Limit		SLMCPR = 1.07 ⁽²⁾				SLMCPR = 1.07 ⁽²⁾ FFTR			
		SNP 8x8 GE11 LFA	SNP 9x9 LFA	SNP 9x9 LFA	SVEA-96	SNP 8x8 GE11 LFA	SNP 9x9 LFA	SNP 9x9 LFA	SVEA-96
NSS ⁽¹⁾	Full Power	1.24	1.25	1.32	1.37	1.26	1.27	1.34	1.40
	Flow Dependent	Figure 6				Figure 6			
	Power Dependent	Fig. 7b	Fig. 7b	Fig. 8b	Fig. 7b	Fig. 11	Fig. 11	Fig. 12	Fig. 11
TSSS ⁽¹⁾	Full Power	1.28	1.29	1.38	1.43	Not Analyzed			
	Flow Dependent	Figure 6							
	Power Dependent	Fig. 9b	Fig. 9b	Fig. 10b	Fig. 9b				
NSS ⁽¹⁾ RPT Inoperable	Full Power	1.31	1.33	1.46	1.48	Not Analyzed			
	Flow Dependent	Figure 6							
	Power Dependent	Fig. 13b	Fig. 13b	Fig. 14b	Fig. 13b				
SLO ⁽²⁾ NSS	Full Power	1.56	1.36	1.36	1.85	1.56	1.36	1.36	1.85
	Flow Dependent	None				None			
	Power Dependent	Fig. 7b	Fig. 7b	Fig. 8b	Fig. 7b	Fig. 11	Fig. 11	Fig. 12	Fig. 11
SLO ⁽²⁾ TSSS	Full Power	1.56	1.36	1.36	1.85	Not Analyzed			
	Flow Dependent	None							
	Power Dependent	Fig. 9b	Fig. 9b	Fig. 10b	Fig. 9b				
SLO ⁽²⁾ NSS RPT Inoperable	Full Power	1.56	1.36	1.36	1.85	Not Analyzed			
	Flow Dependent	None							
	Power Dependent	Fig. 13b	Fig. 13b	Fig. 14b	Fig. 13b				

Notes for Table 1

Note 1: These MCPR values are based on the SNP Reload Safety Analysis performed using the control rod insertion times shown below (defined as normal scram speed: NSS). In the event that Surveillance 4.1.3.2 shows these scram insertion times have been exceeded, the plant thermal margin limits associated with NSS default to the values associated with the Technical Specification scram speed (TSSS). The scram insertion times must meet the requirements of Technical Specification 3.1.3.4.

Position Inserted From Fully Withdrawn	Slowest measured average control rod insertion times to specified notches for all operable control rods for each group of four control rods arranged in a two-by-two array (seconds)
Notch 45	0.380
Notch 39	0.690
Notch 25	1.500
Notch 5	2.750

Note 2: For Single Loop Operation, the SLMCPR increases by 0.01.

Note 3: The control rod withdrawal error (CRWE) analysis was performed with the nominal rod block monitor (RBM) setting value of 1.06. Use of the nominal setpoint is in accordance with the methodology described in Reference 5.12, consistent with approved industry practice. CRWE is limiting for the noted full power limits for cycle exposures less than 4244 MWd/MT. The load rejection without bypass (LRNB) event is limiting for the remaining full power events.

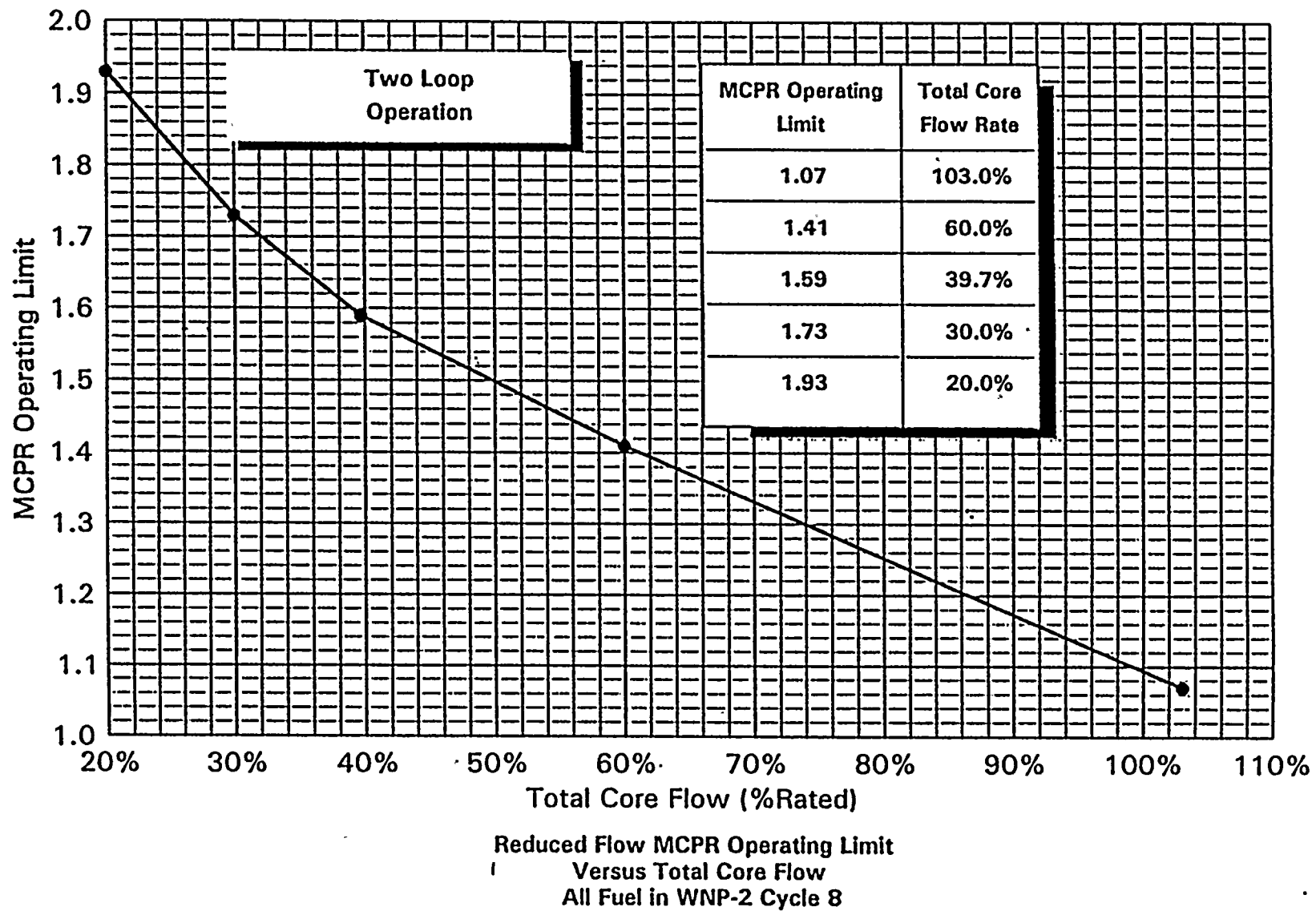
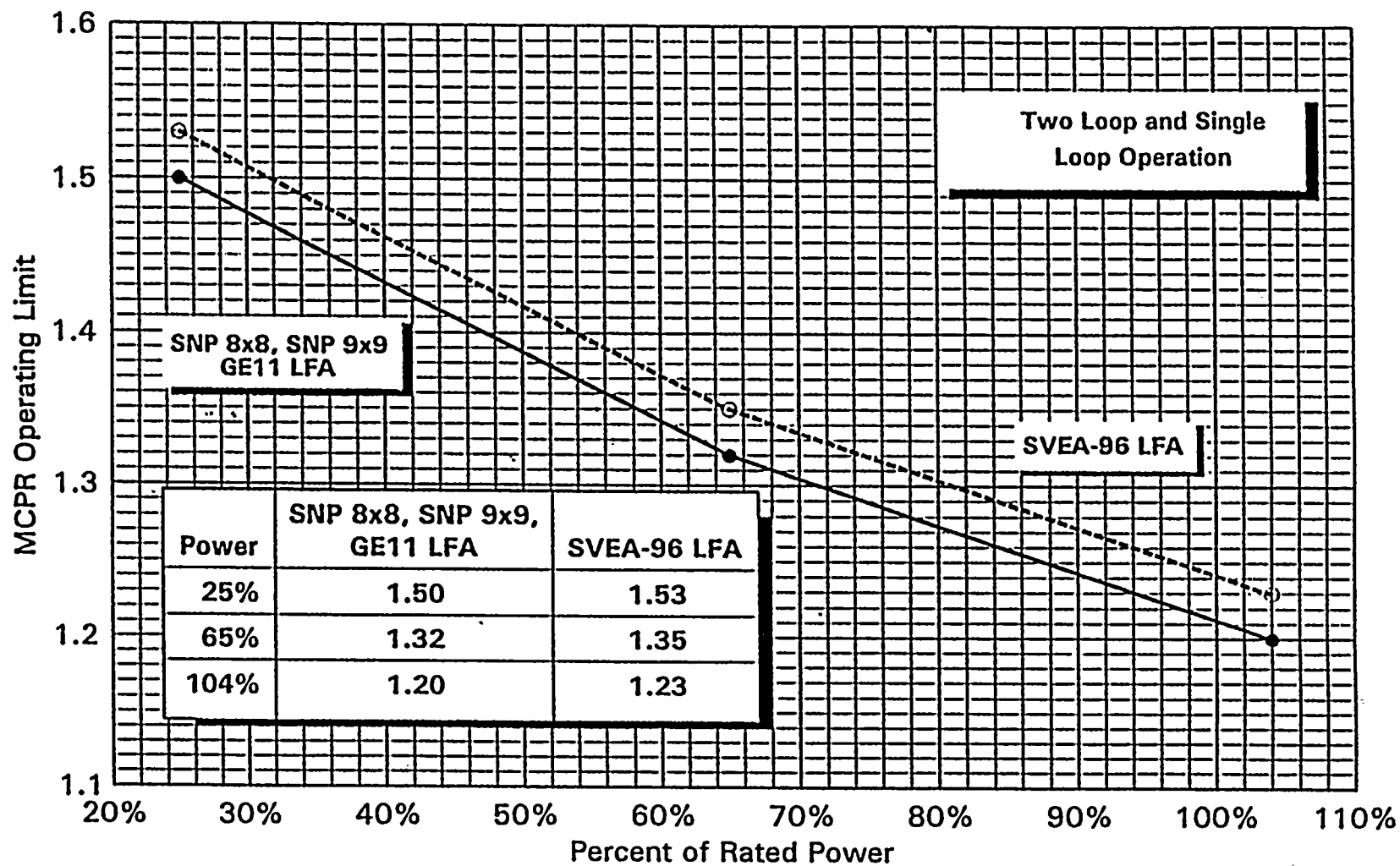
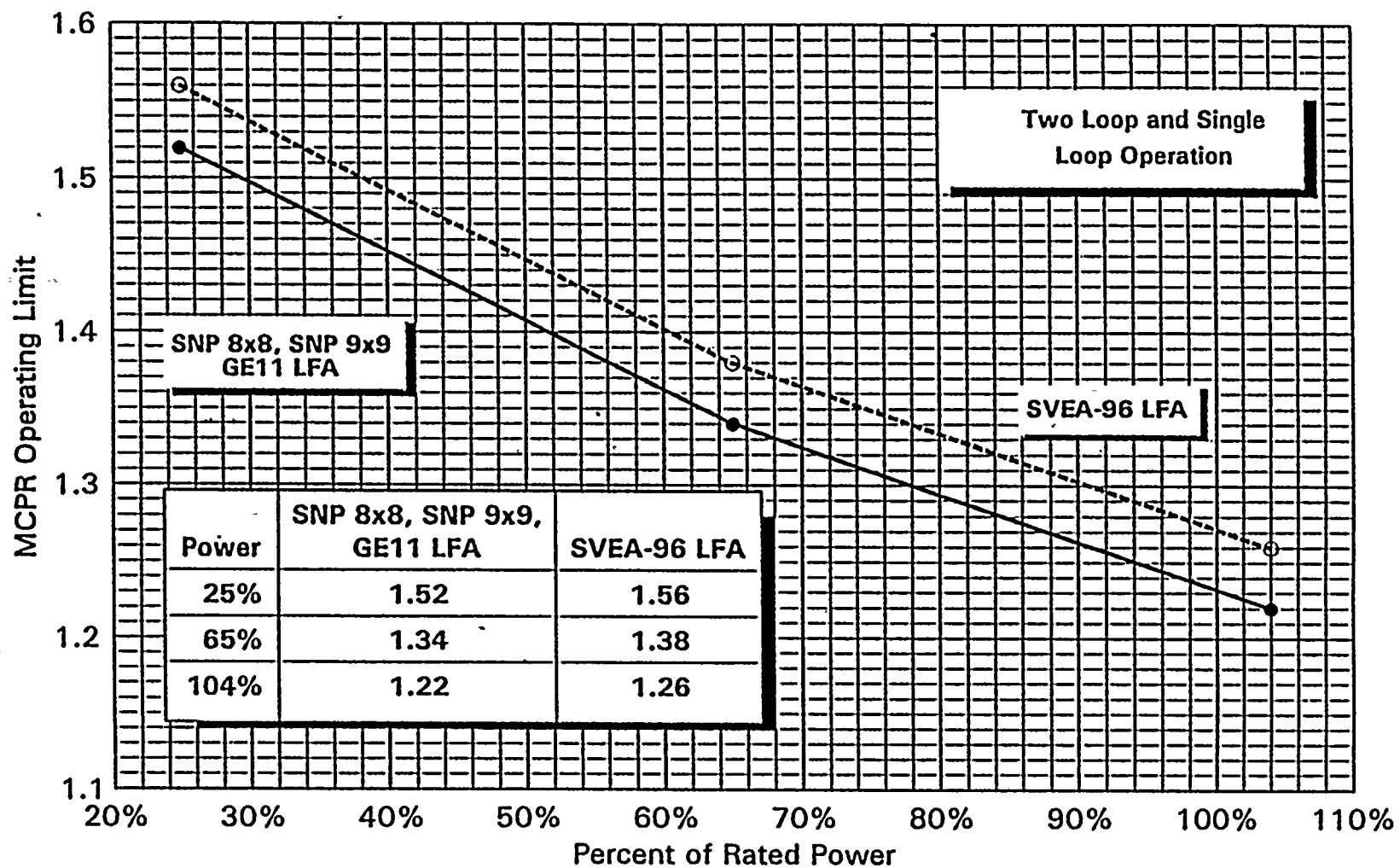


Figure 6



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Operable
SNP 8x8, SNP 9x9, GE11 LFA, SVEA-96 LFA
Cycle Exposures < 4244 MWd/MT

Figure 7a



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Operable
SNP 8x8, SNP 9x9, GE11 LFA, SVEA-96 LFA
Cycle Exposures ≥ 4244 MWd/MT

Figure 7b

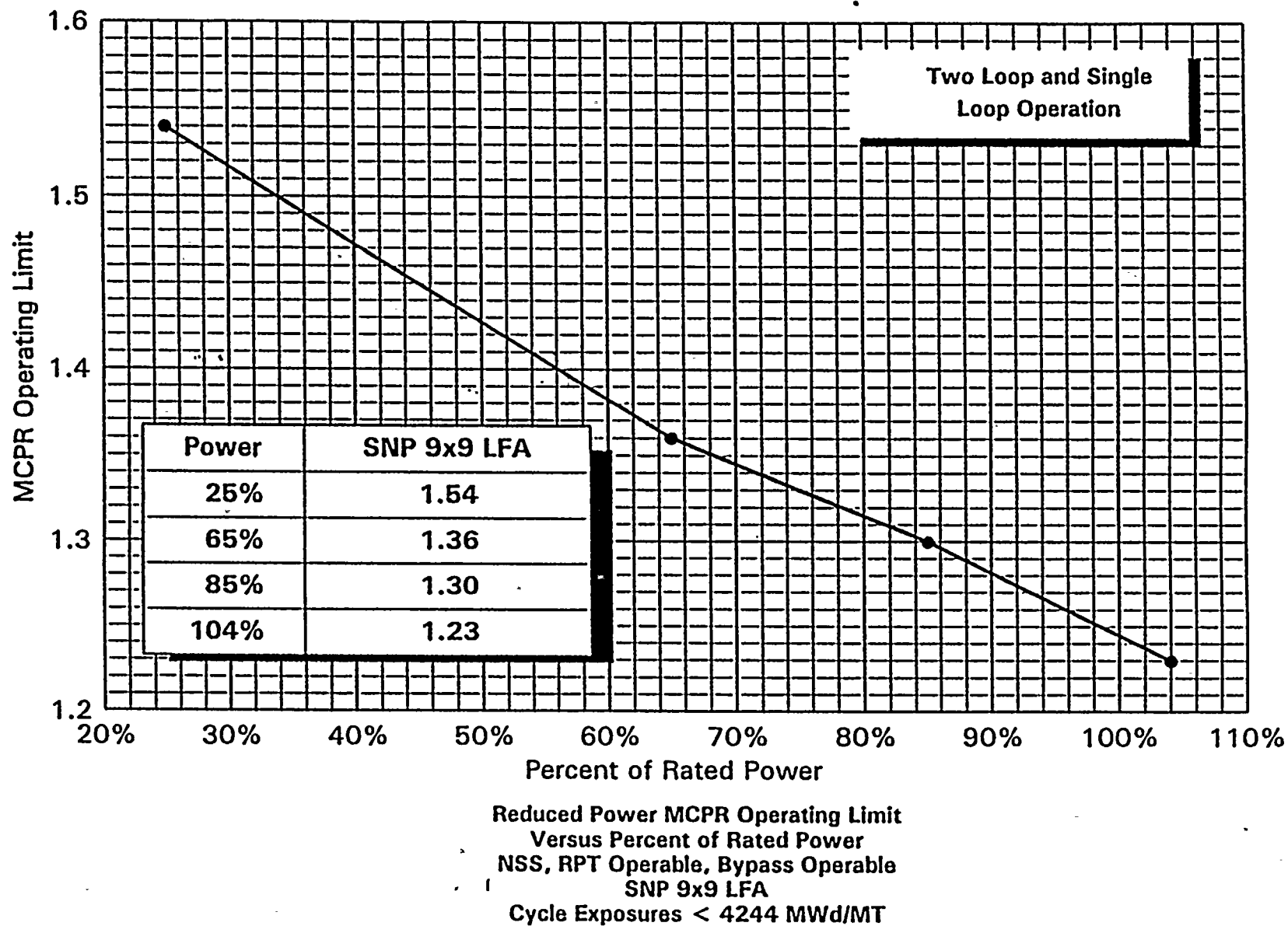
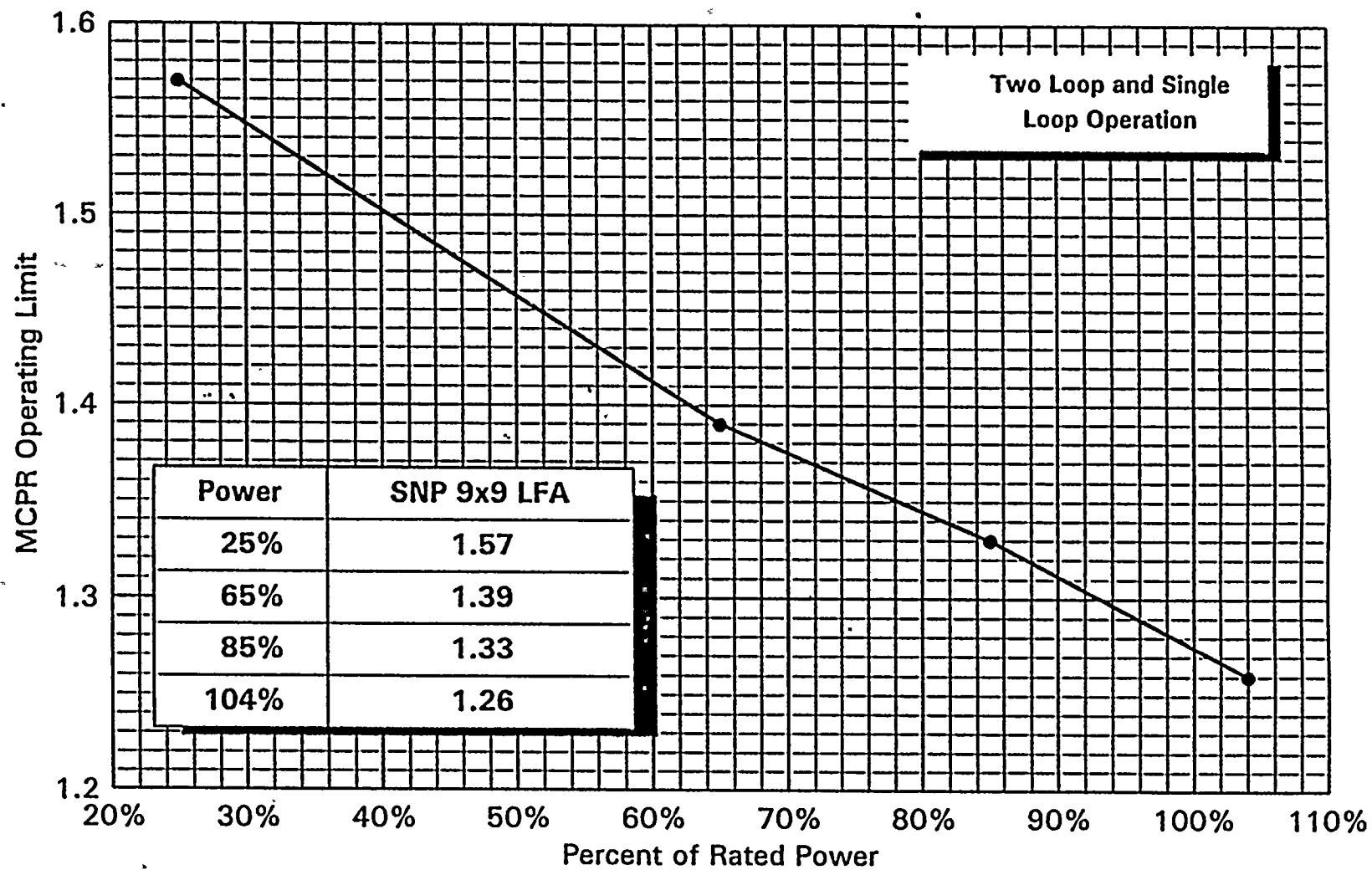
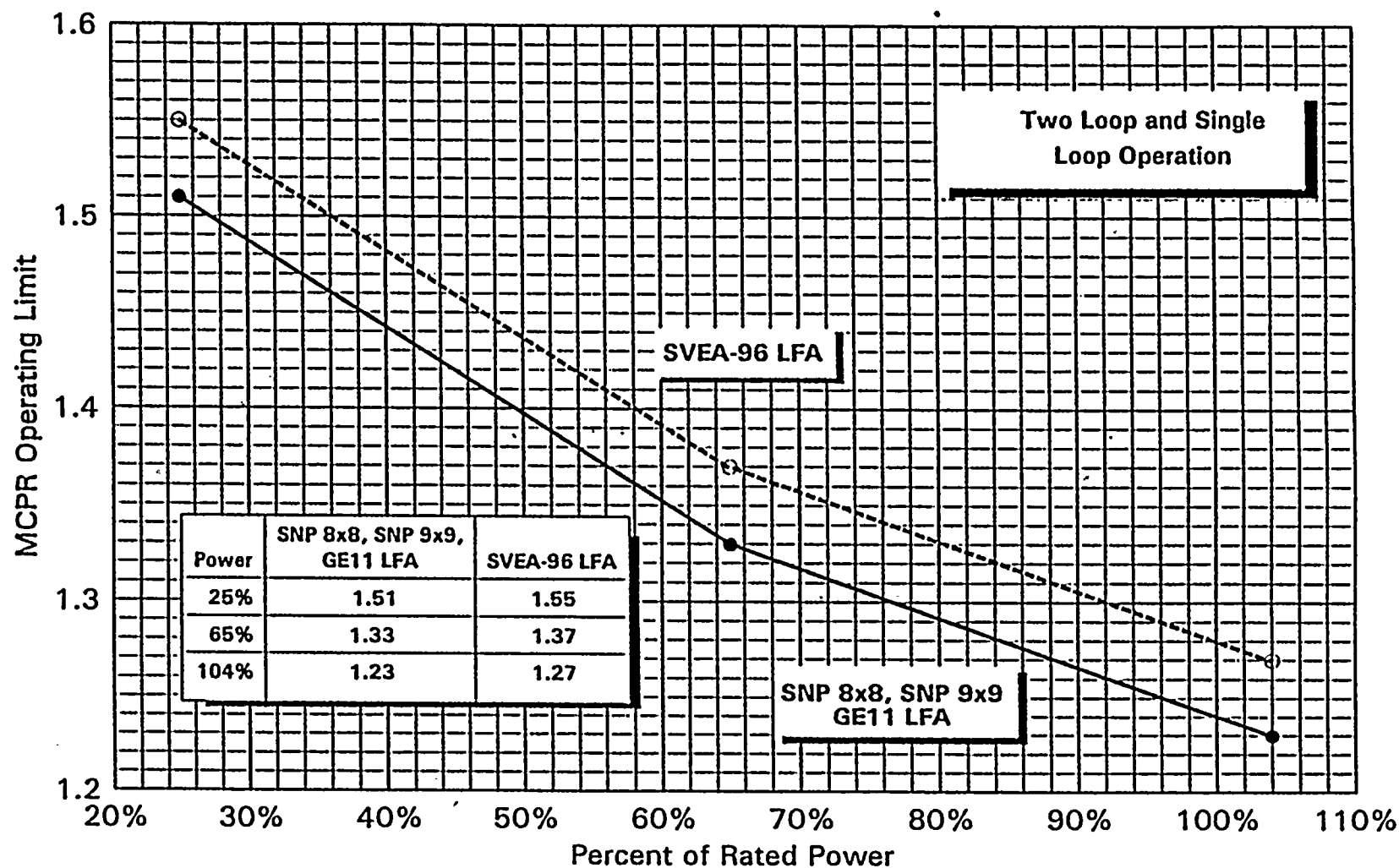


Figure 8a



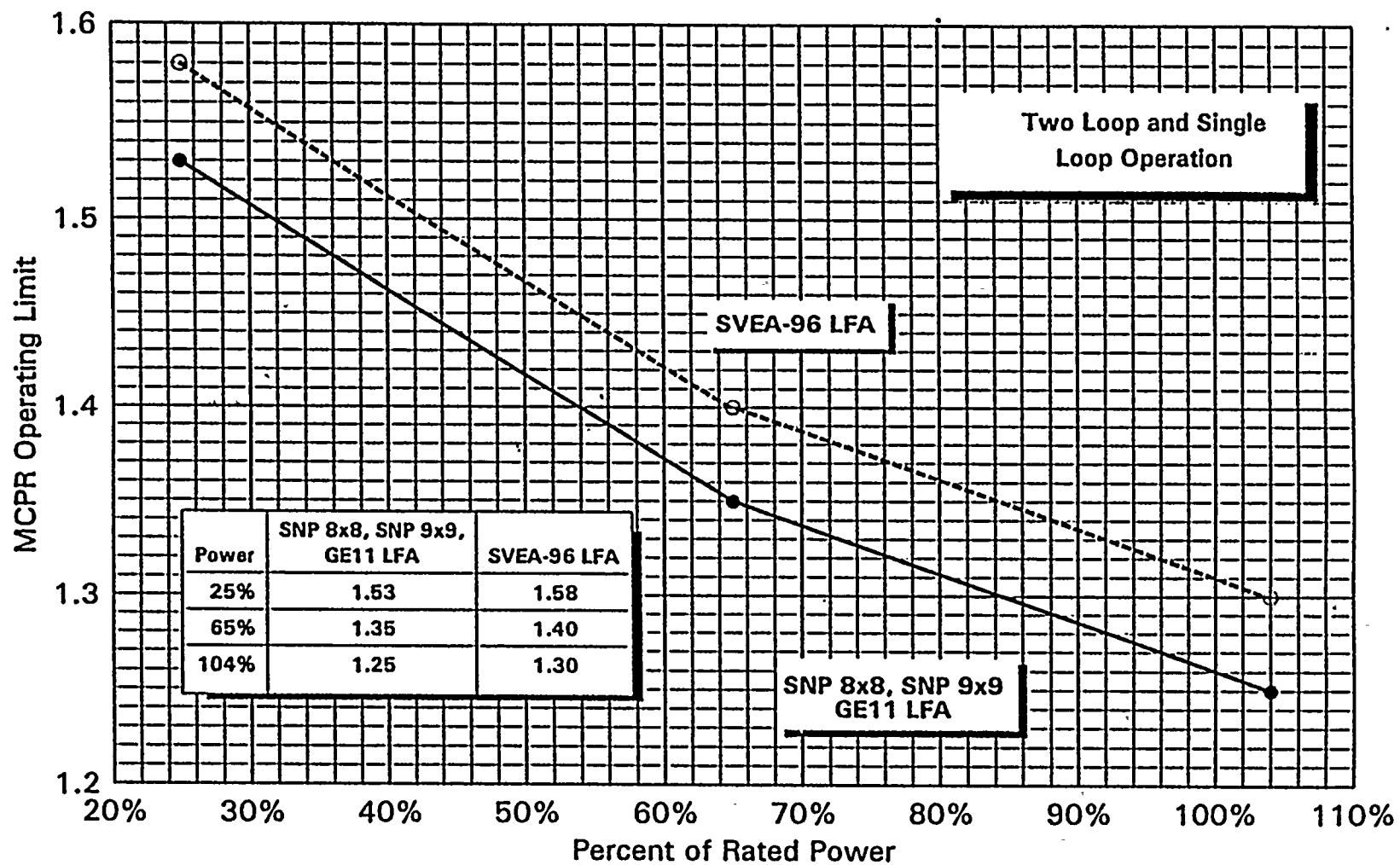
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Operable
SNP 9x9 LFA
Cycle Exposures ≥ 4244 MWd/MT

Figure 8b



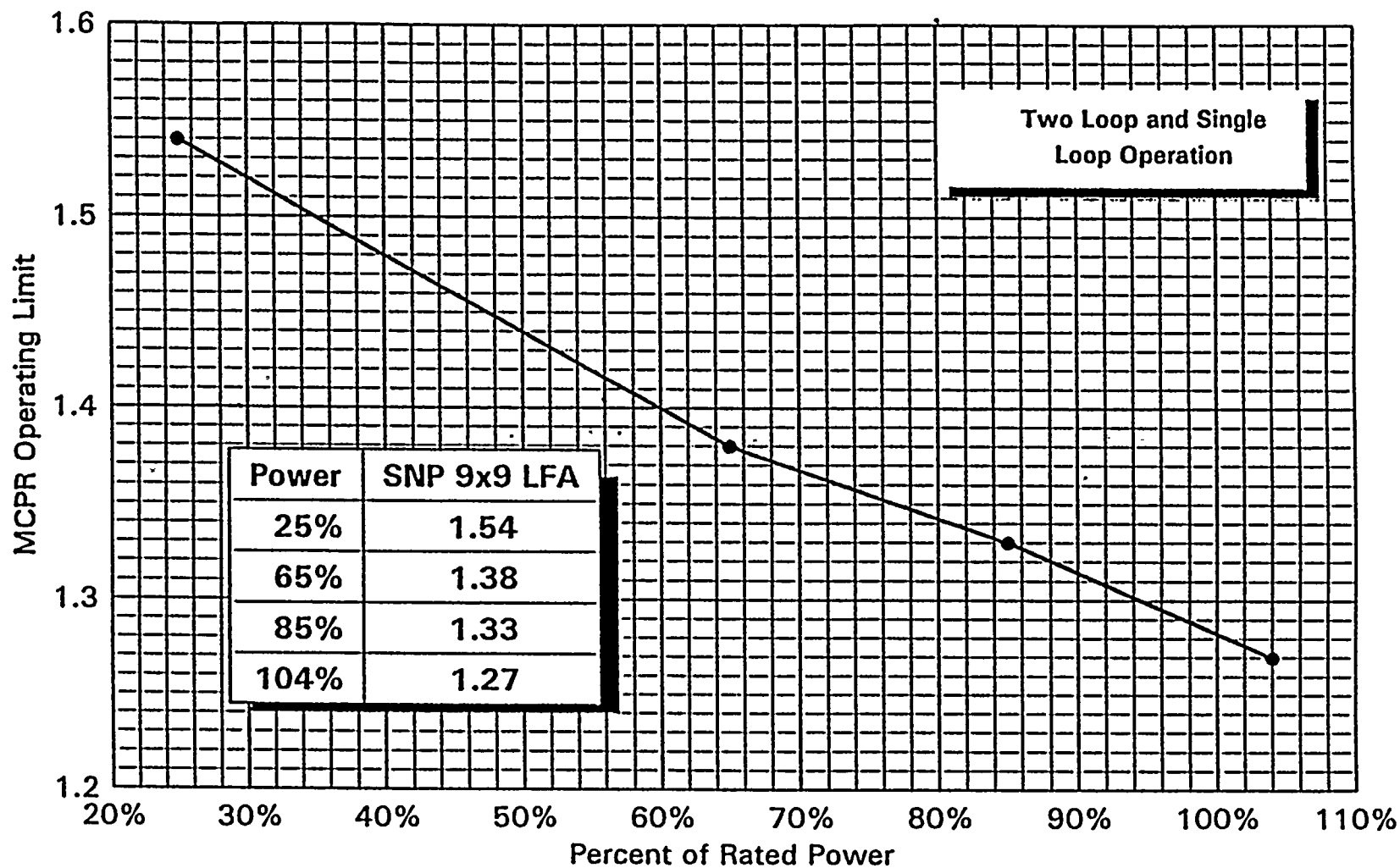
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable, Bypass Operable
SNP 8x8, SNP 9x9, GE11 LFA, SVEA-96 LFA
Cycle Exposures < 4244 MWd/MT

Figure 9a



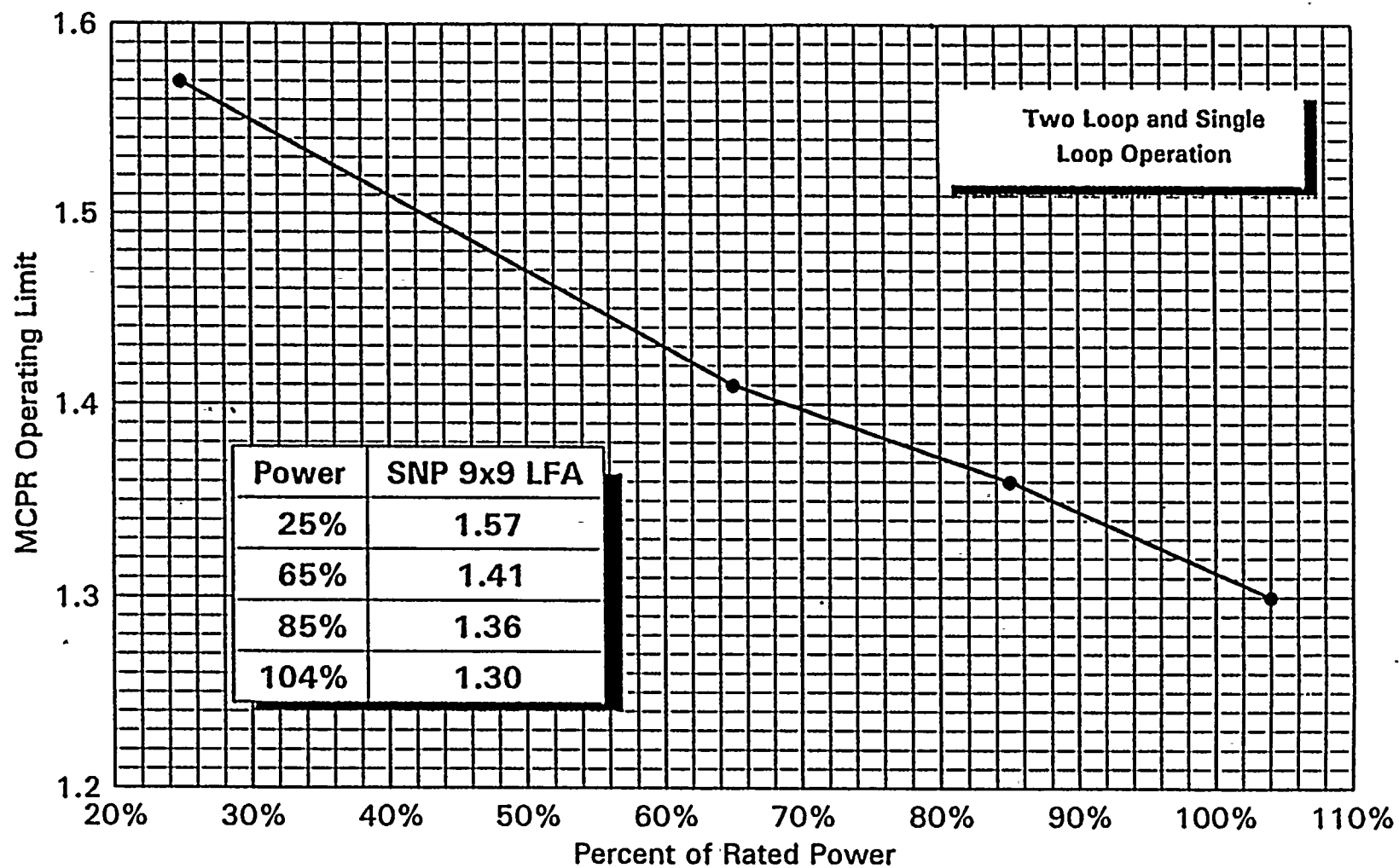
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable, Bypass Operable
SNR 8x8, SNP 9x9, GE11 LFA, SVEA-96 LFA
Cycle Exposures ≥ 4244 MWd/MT

Figure 9b



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable, Bypass Operable
SNP 9x9 LFA
Cycle Exposures < 4244 MWd/MT

Figure 10a



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable, Bypass Operable
SNP 9x9 LFA
Cycle Exposures ≥ 4244 MWd/MT

Figure 10b

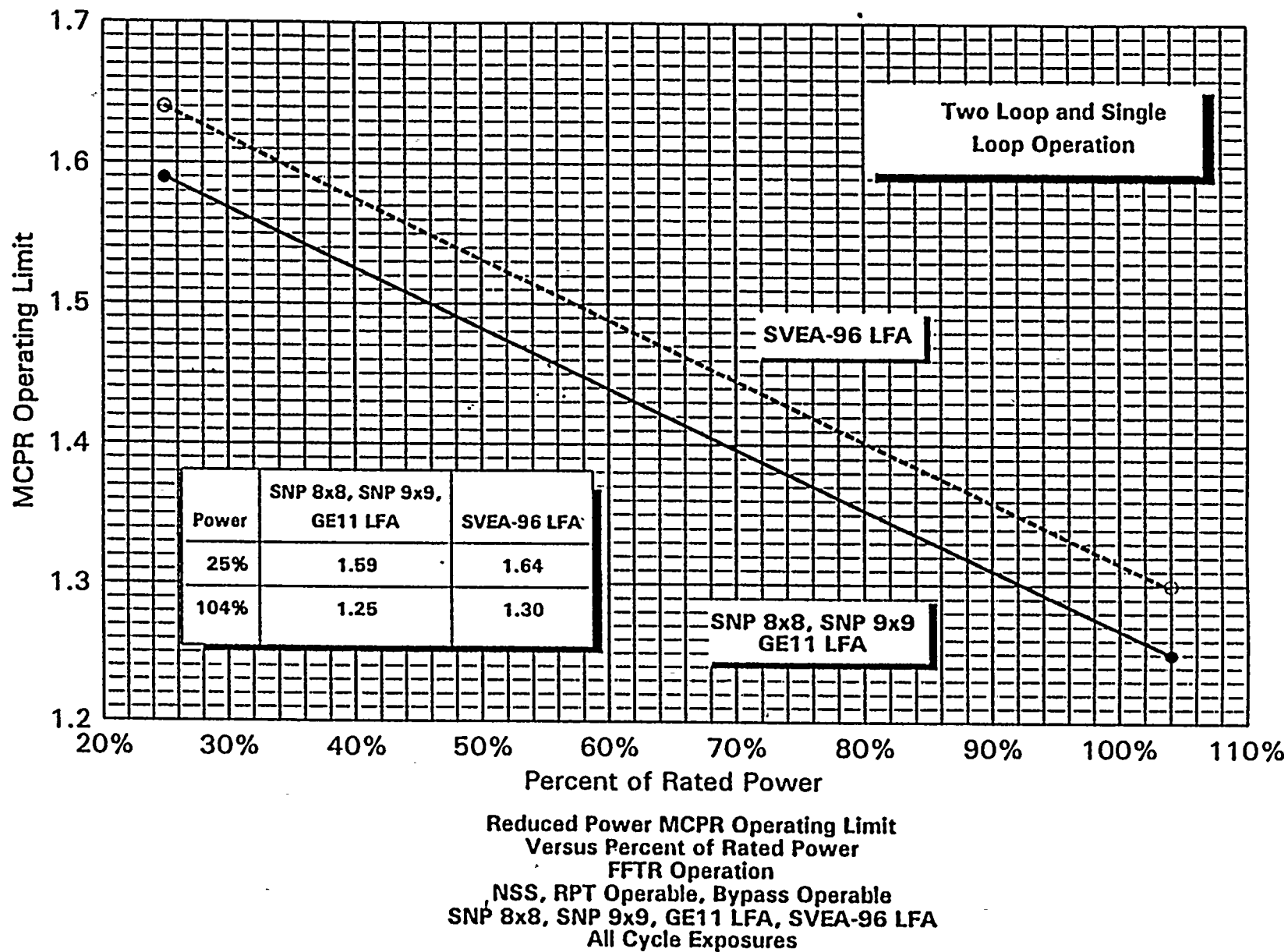
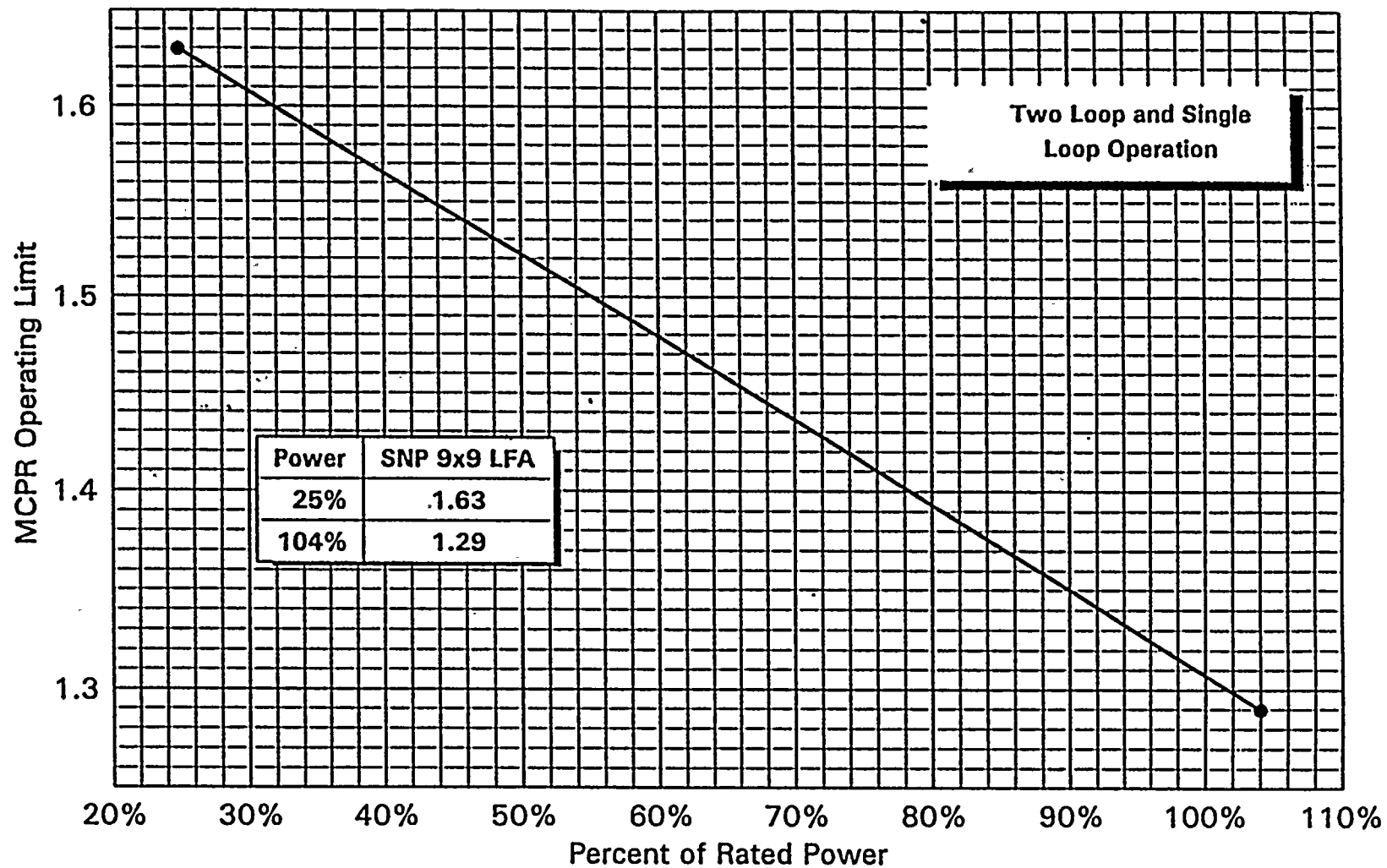
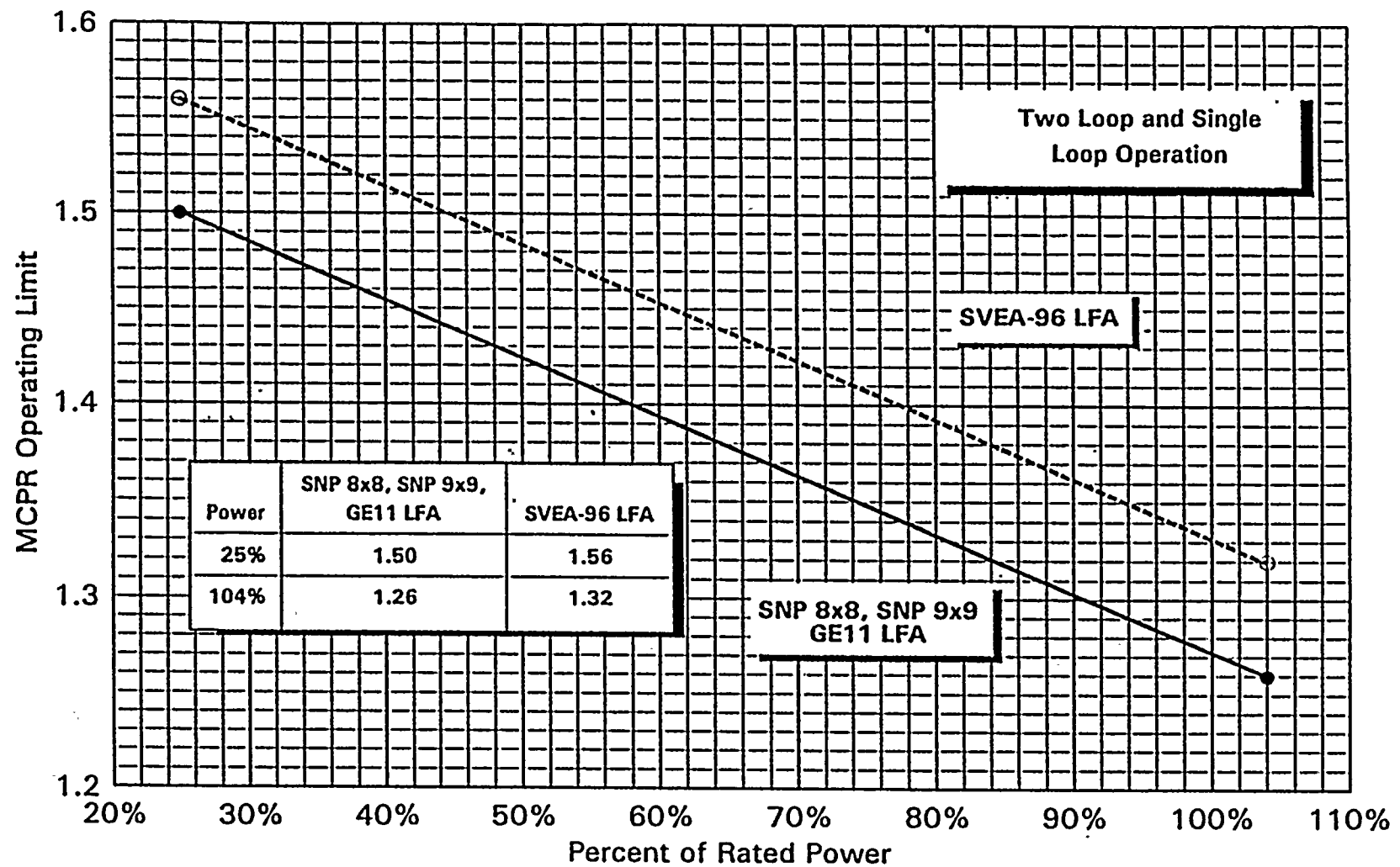


Figure 11



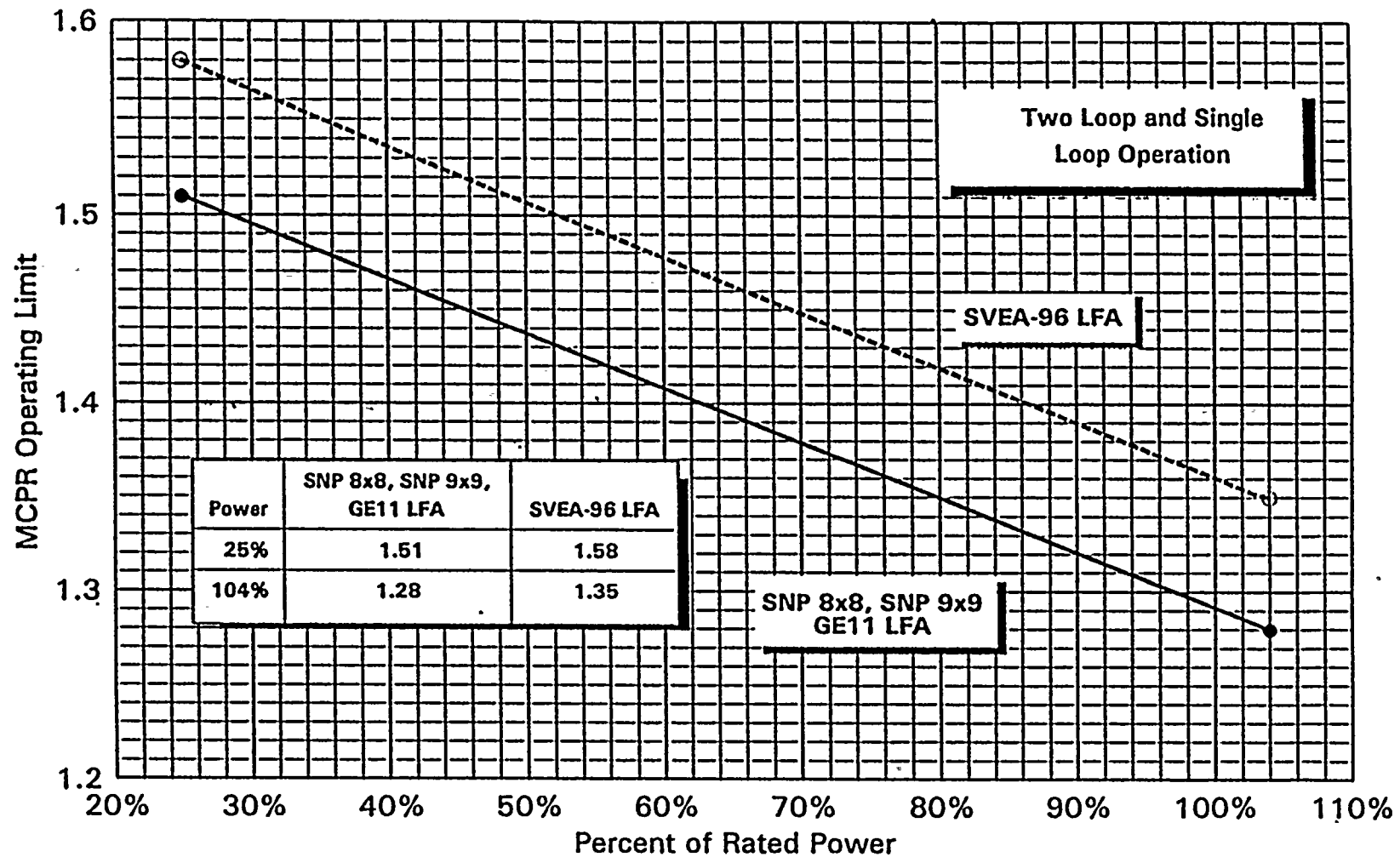
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
FFTR Operation
NSS, RPT Operable, Bypass Operable
SNP 9x9 LFA
All Cycle Exposures

Figure 12



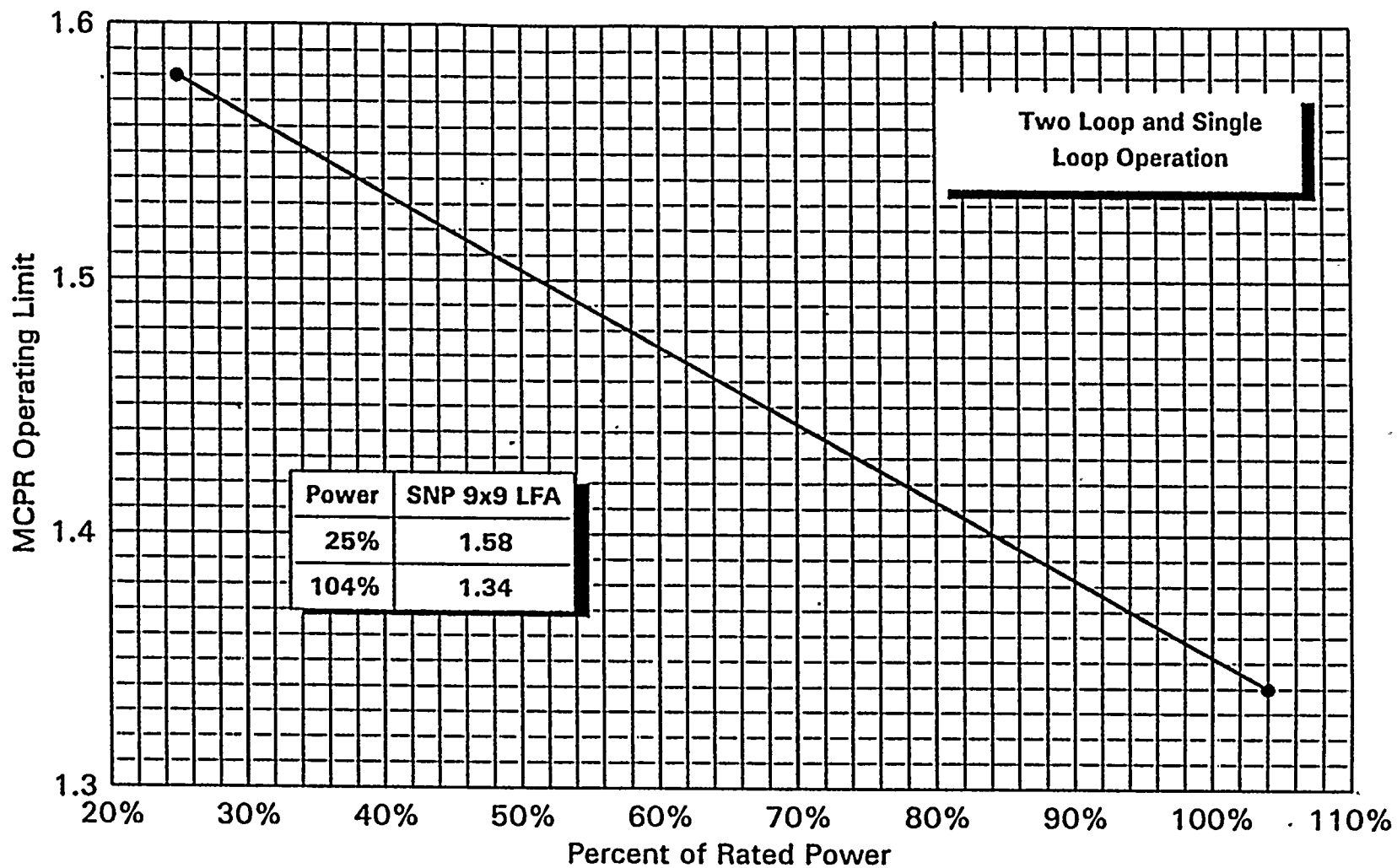
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
SNP 8x8, SNP 9x9, GE11 LFA, SVEA-96 LFA
Cycle Exposures < 4244 MWd/MT

Figure 13a



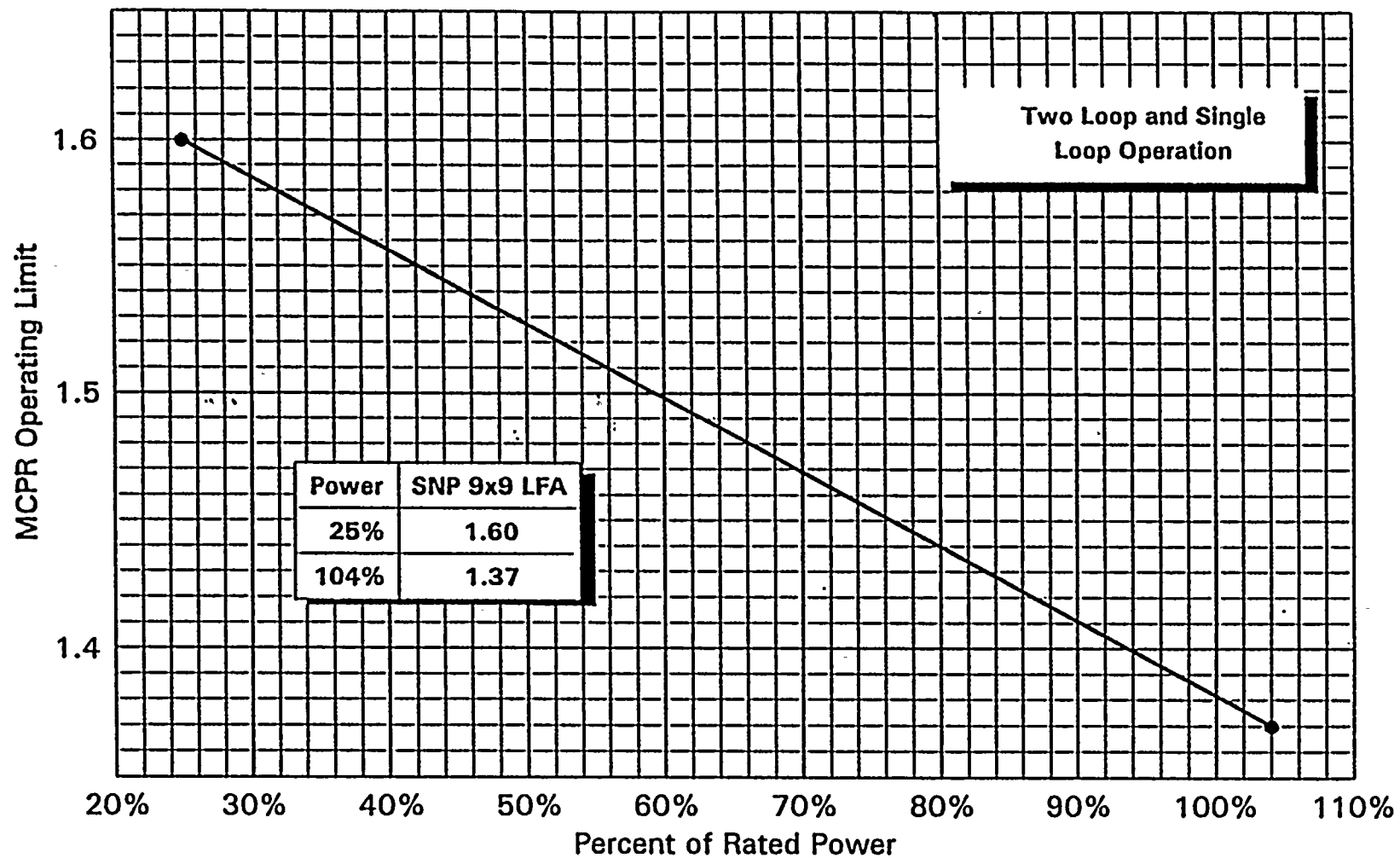
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
SNP 8x8, SNP 9x9, GE11 LFA, SVEA-96 LFA
Cycle Exposures ≥ 4244 MWd/MT

Figure 13b



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
SNP 9x9 LFA
Cycle Exposures < 4244 MWd/MT

Figure 14a



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
SNP 9x9 LFA
Cycle Exposures ≥ 4244 MWd/MT

Figure 14b

4.0 Linear Heat Generation Rate (LHGR) Limit for Use in Technical Specification 3.2.4

The LHGR limit for use in Technical Specification 3.2.4 shall not exceed the values shown in Figures 15, 16, 17, 18, and 19.

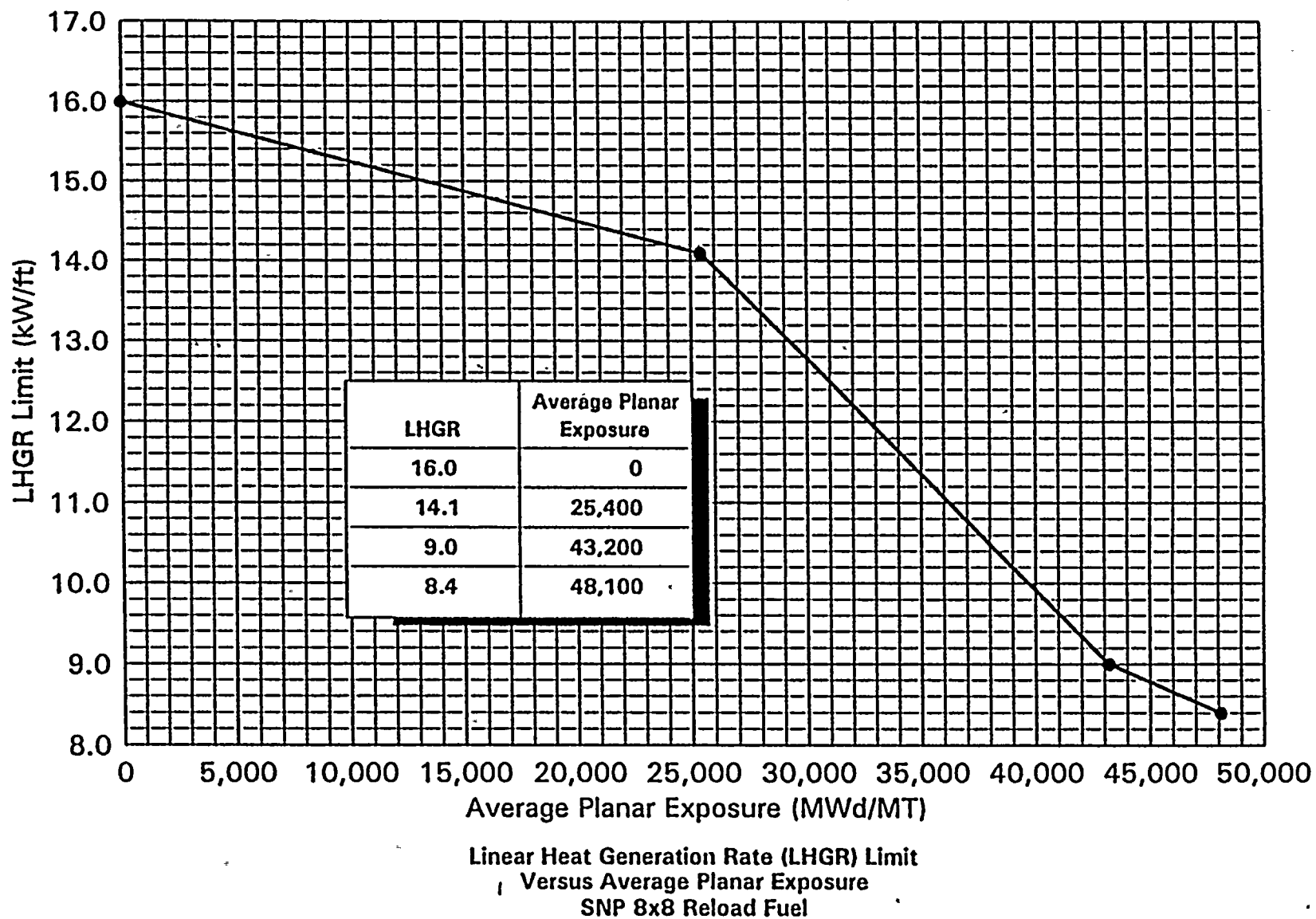


Figure 15

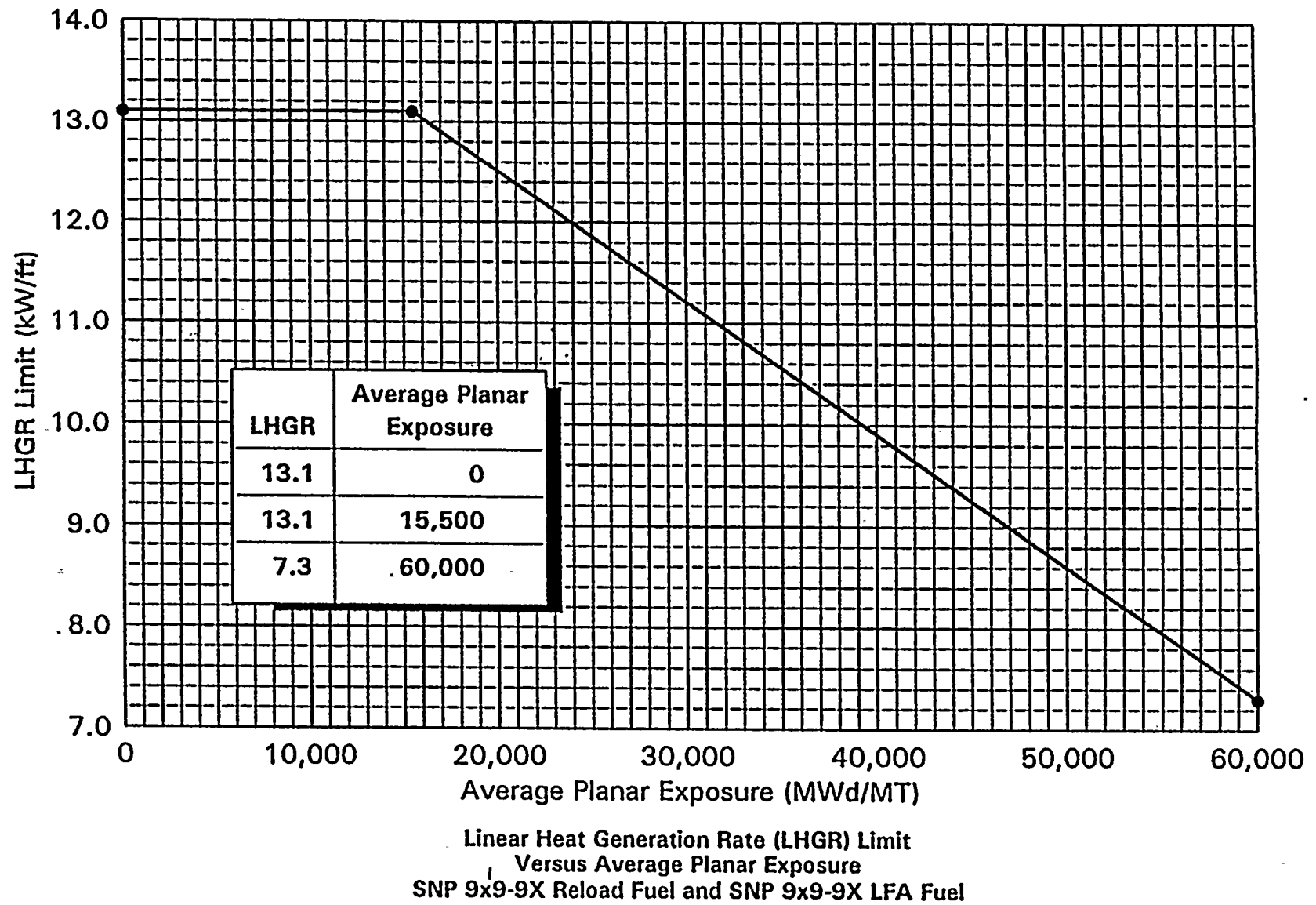


Figure 16

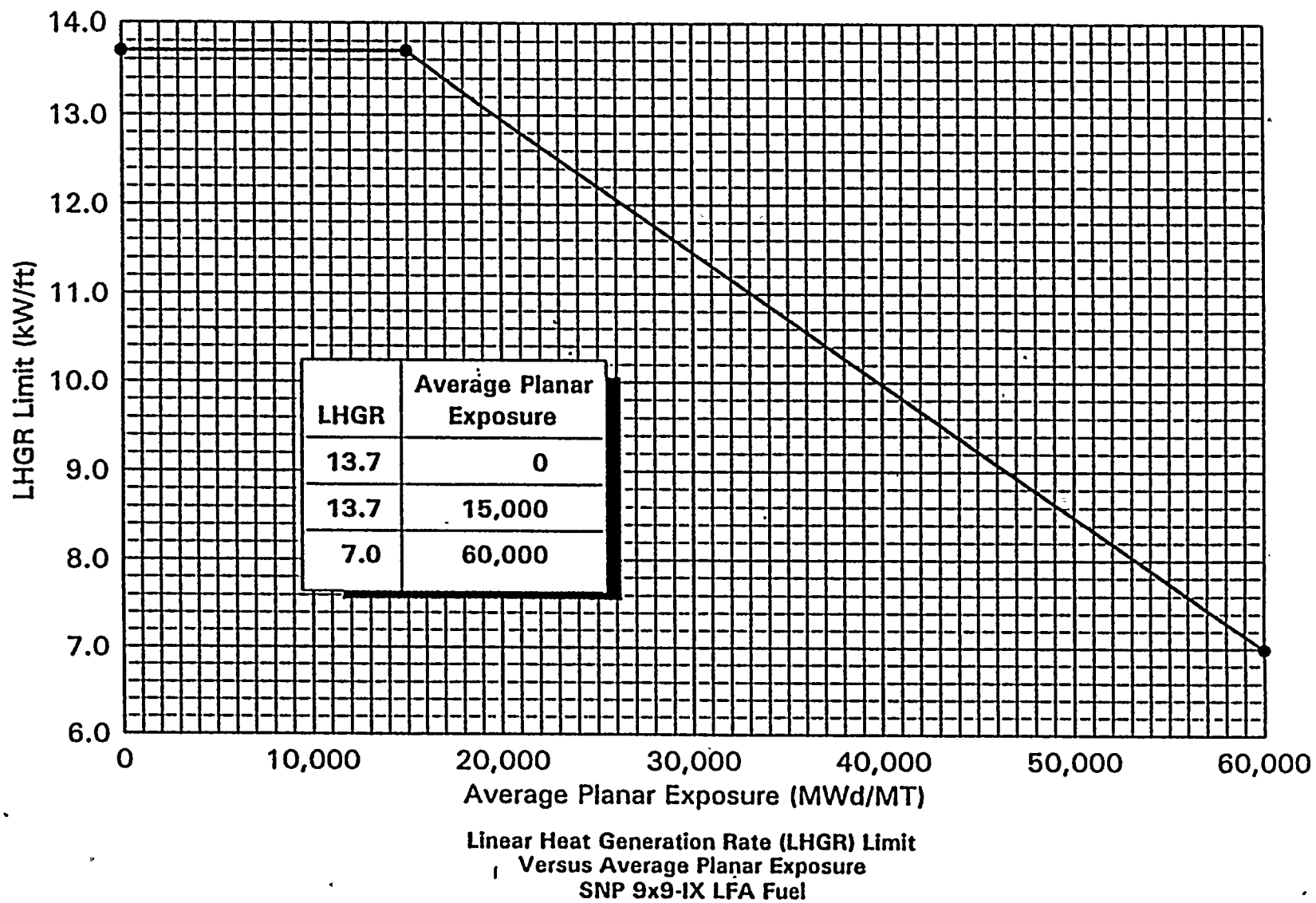


Figure 17

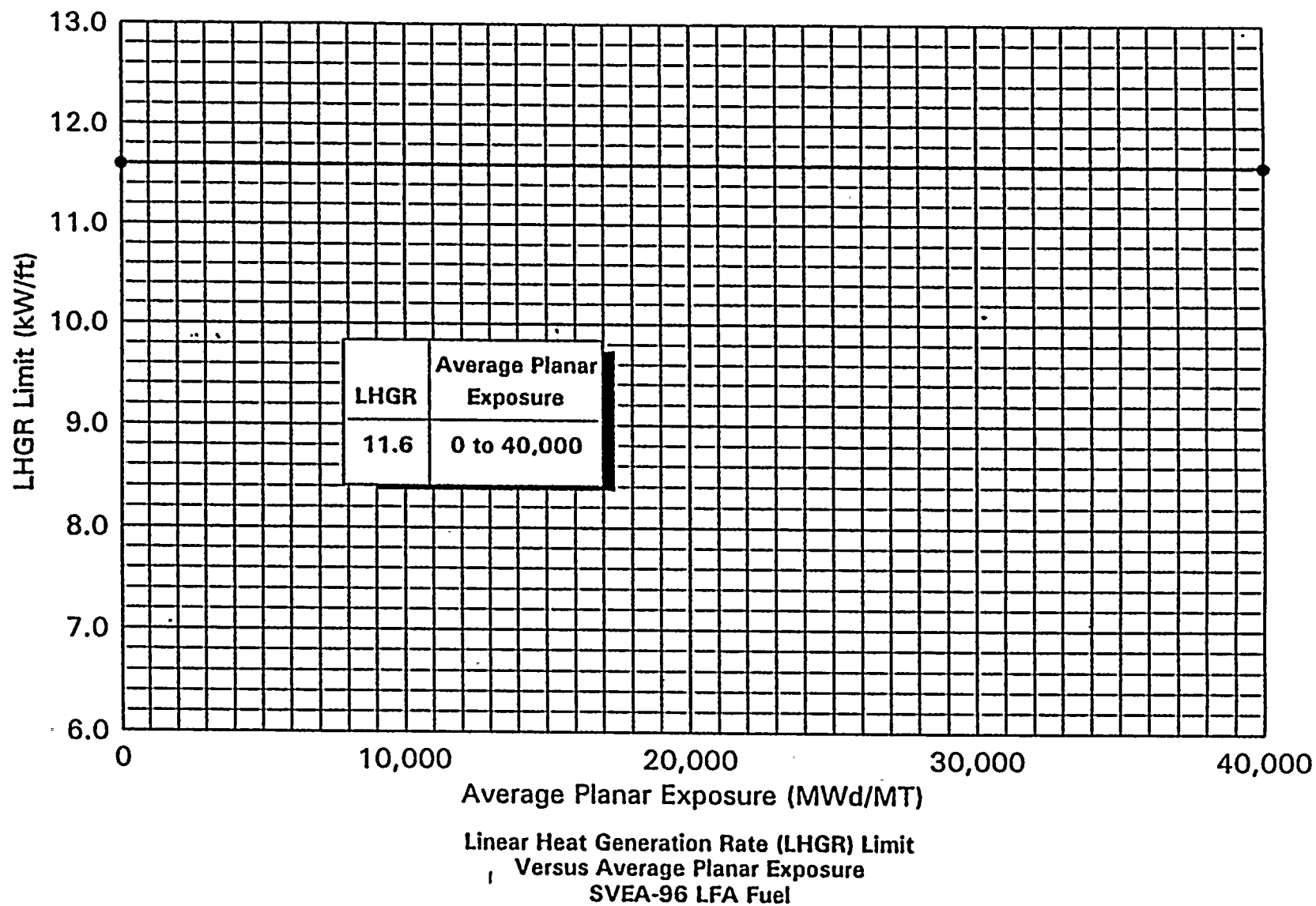


Figure 18

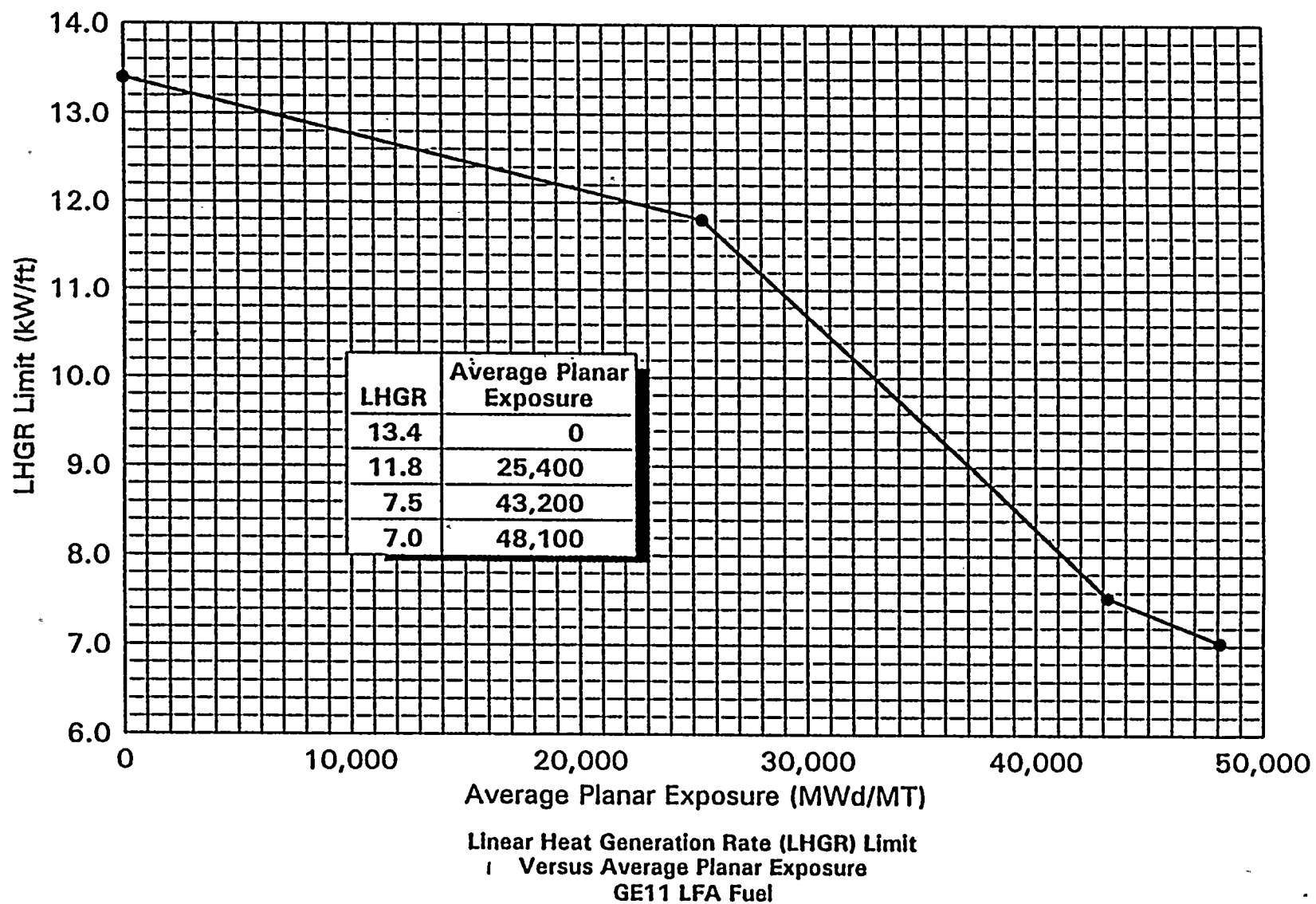


Figure 19

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