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WNP-2
Cycle 10
Core Operating Limits Report

June 1994

Washington Public Power Supply System

WNP-2
Cycle 10
Core Operating Limits Report

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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 10 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 SPC fuel given in this report are documented in the "Cycle 10 Plant Transient Analysis" (Reference 5.1.1) and the "Cycle 10 Reload Analysis" (Reference 5.1.2). The thermal limits determined through the approved methodology are modified for the GE11 and SVEA-96 LFAs as discussed below.

The WNP-2 Cycle 10 core includes four Siemens Power Corporation (SPC), four GE Nuclear Energy (GE), and four ABB Combustion Engineering Nuclear Operations (ABB CENO) Lead Fuel Assemblies (LFAs). The SPC LFAs were inserted during the reload for Cycle 5. The GE and ABB CENO LFAs were inserted at the beginning of Cycle 6 and were designed to be compatible with the reload fuel utilized in Cycle 6. The LFAs are loaded in core locations which analysis has shown to have sufficient thermal margin such that the LFAs are not expected to be the most limiting fuel assemblies on either a nodal or an assembly power basis. The GE Nuclear Energy GE11 LFAs are described in the "GE11 Lead Fuel Assembly Report for Washington Public Power Supply System Nuclear Project No. 2, Reload 5, Cycle 6" (Reference 5.3.1). This reference describes the design goals of the GE11 LFAs and provides support for monitoring the GE11 LFAs at thermal limits based on the SPC 8x8 reload fuel thermal limits. The ABB CENO SVEA-96 LFAs are described in the "Supplemental Lead Fuel Assembly Licensing Report—SVEA-96 LFAs for WNP-2—Summary" (Reference 5.3.2). The process for developing thermal limits for the SVEA-96 LFAs based upon the SPC 8x8 reload fuel thermal limits is described in References 5.3.2 through 5.3.4

The MAPLHGR limits for the GE11 LFAs are the same as for the SPC 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 LFAs are the same as for the SPC 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 LFAs are multiplied by the following constants: (a) 1.04 to account for a different estimation of the local power in the output from POWERPLEX compared to ABB CENO methods and (b) 1.02 to account for a different estimation of exposure in the output from POWERPLEX compared to ABB CENO methods.

The MCPR limit is the maximum of (a) the applicable exposure dependent, full power and full flow MCPR limit, (b) the applicable exposure and power dependent MCPR limit, and (c) the flow dependent MCPR limit specified in this report. This stipulation assures that the safety limit MCPR will not be violated throughout the WNP-2 operating regime. Full power MCPR limits are specified to define operating limits at rated power and flow. For the WNP-2 core, the Turbine Trip without Bypass event is limiting for operation at rated power and flow. Power dependent MCPR limits are specified to define operating limits at other than rated power conditions. For the WNP-2 core, the Feedwater Controller Failure event from reduced power

is calculated to be more severe than from full power conditions. A flow dependent MCPR is specified to define operating limits at other than rated flow conditions. The reduced flow MCPR limit provides bounding protection for the limiting Recirculation Flow Increase event.

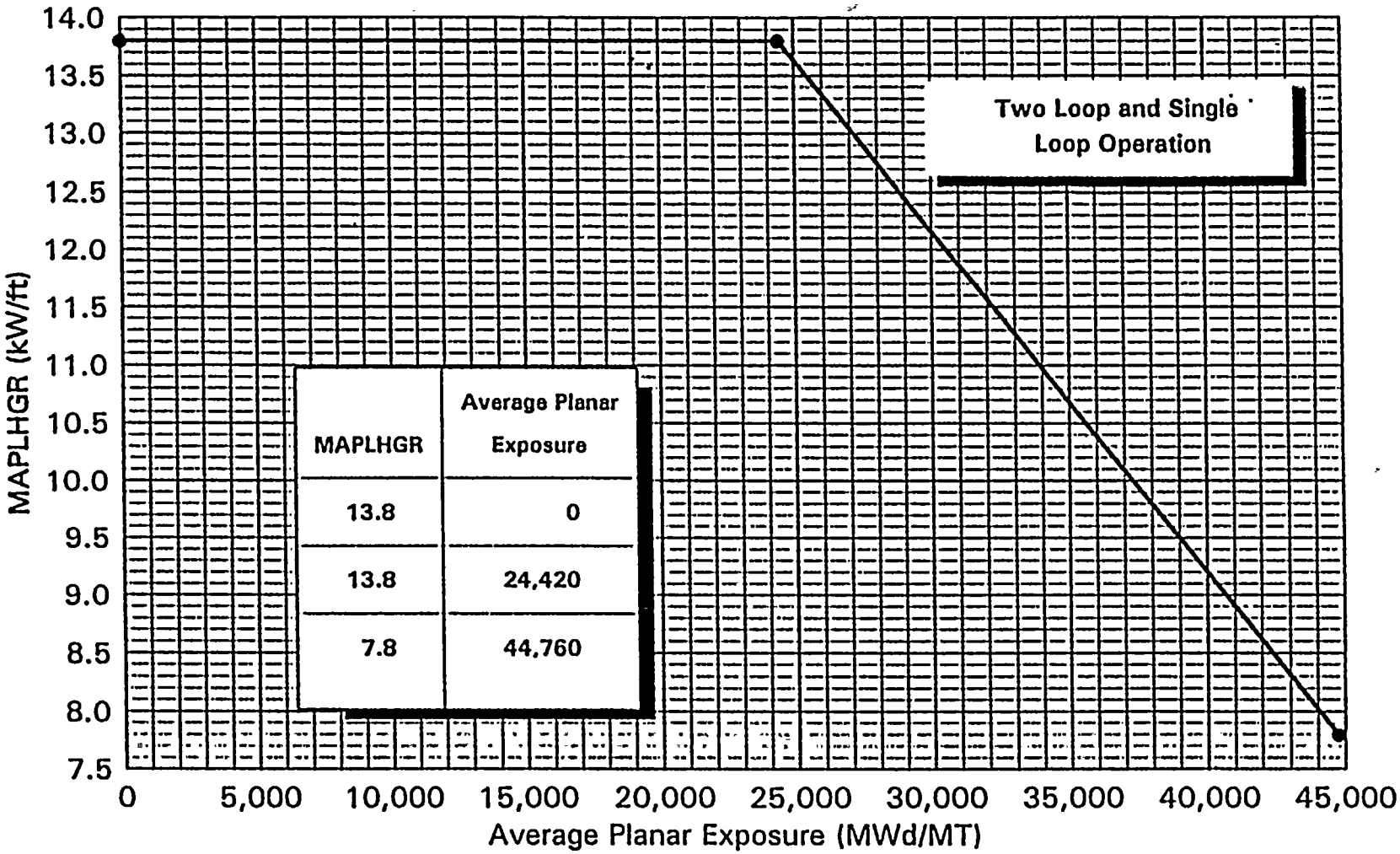
The LHGR limits for the GE11 LFAs are the same as for the SPC 8x8 reload fuel, except that a ratio ([64-2]/[81-7]) is applied to account for the different number of fuel pins in the two designs. The LHGR limits for the SVEA-96 LFAs are taken directly from Reference 5.3.2.

The reload licensing analyses for this cycle provide operating limits for Extended Load Line (ELLLA) operation which extends the power and flow operating regime for WNP-2 up to the 109% rod line which at full power corresponds to 87% of rated flow. The MCPR limits defined in this report are applicable up to 100% of rated thermal power along and below the 109% rod line. The minimum flow for operation at rated power is 87% of rated flow; the maximum is 106%. References 5.1.1 and 5.1.2 and the references in Section 5.4 document the analyses in support of ELLLA operation.

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 5.2.

2.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR) LIMITS FOR USE IN TECHNICAL SPECIFICATION 3.2.1

The APLHGRs for use in Technical Specification 3.2.1 shall not exceed the limits shown in Figures 2.1, 2.2, 2.4, and 2.5 when in two-loop operation and in Figures 2.1, 2.3, 2.4, and 2.5 when in single loop operation. The limits for each fuel type as a function of Average Planar Exposure are provided for the SPC reload fuel, the SPC LFAs, the SVEA-96 LFAs, and the GE11 LFAs.



Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Versus Average Planar Exposure SPC 8x8 Reload Fuel

Figure 2.1

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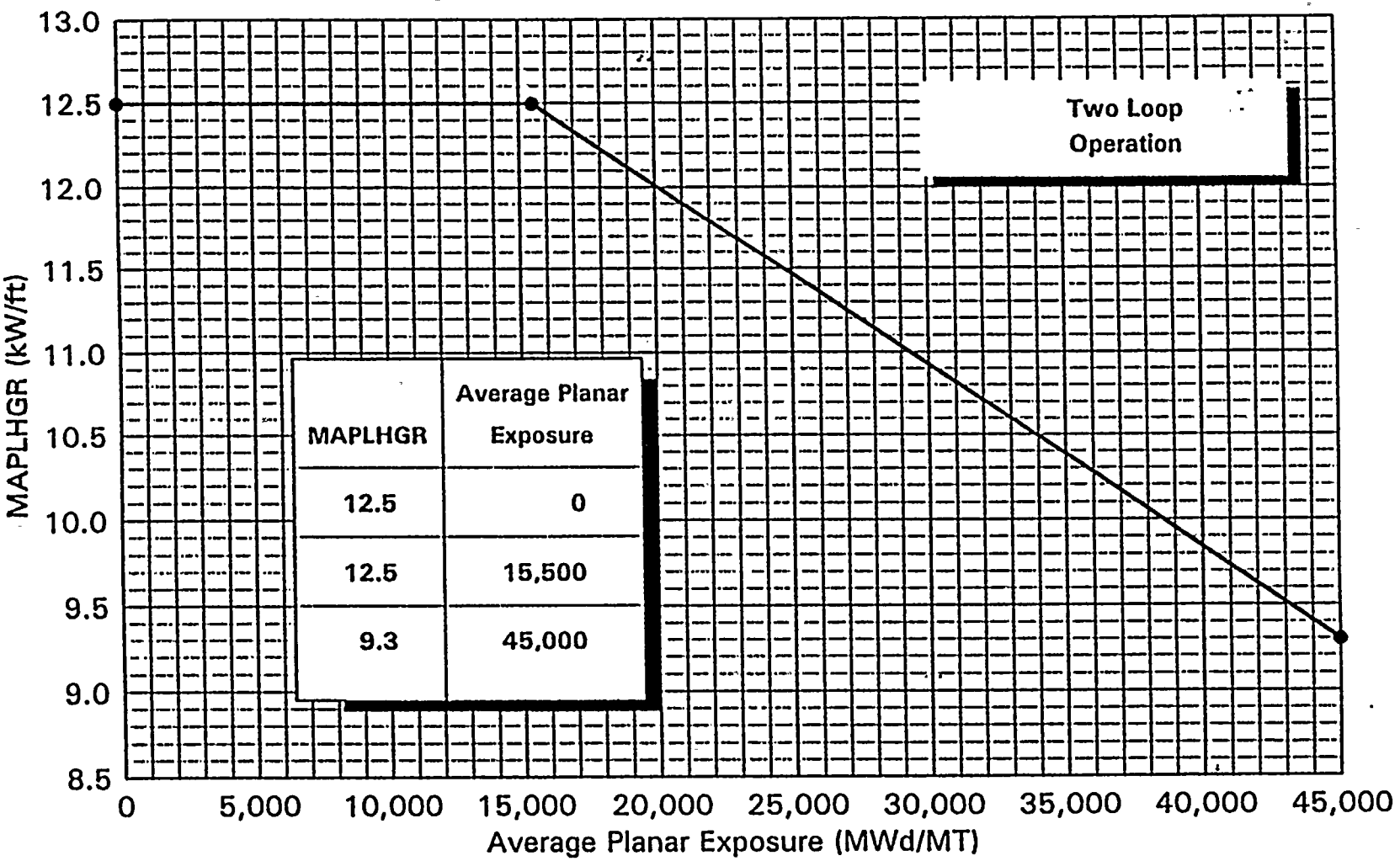
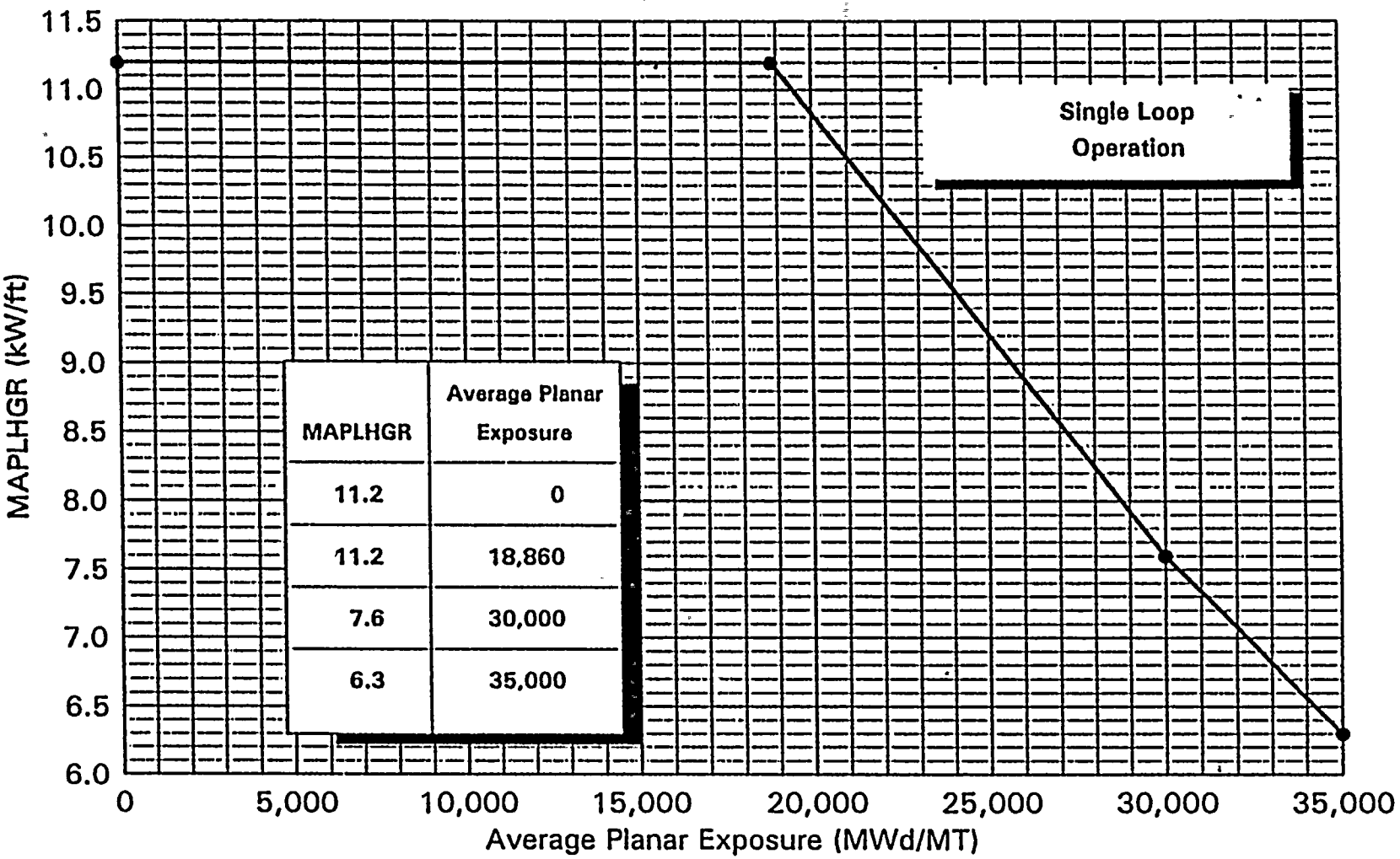


Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Versus Average Planar Exposure SPC 9x9-9X Reload Fuel and SPC 9x9 LFA's

Figure 2.2



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

Figure 2.3

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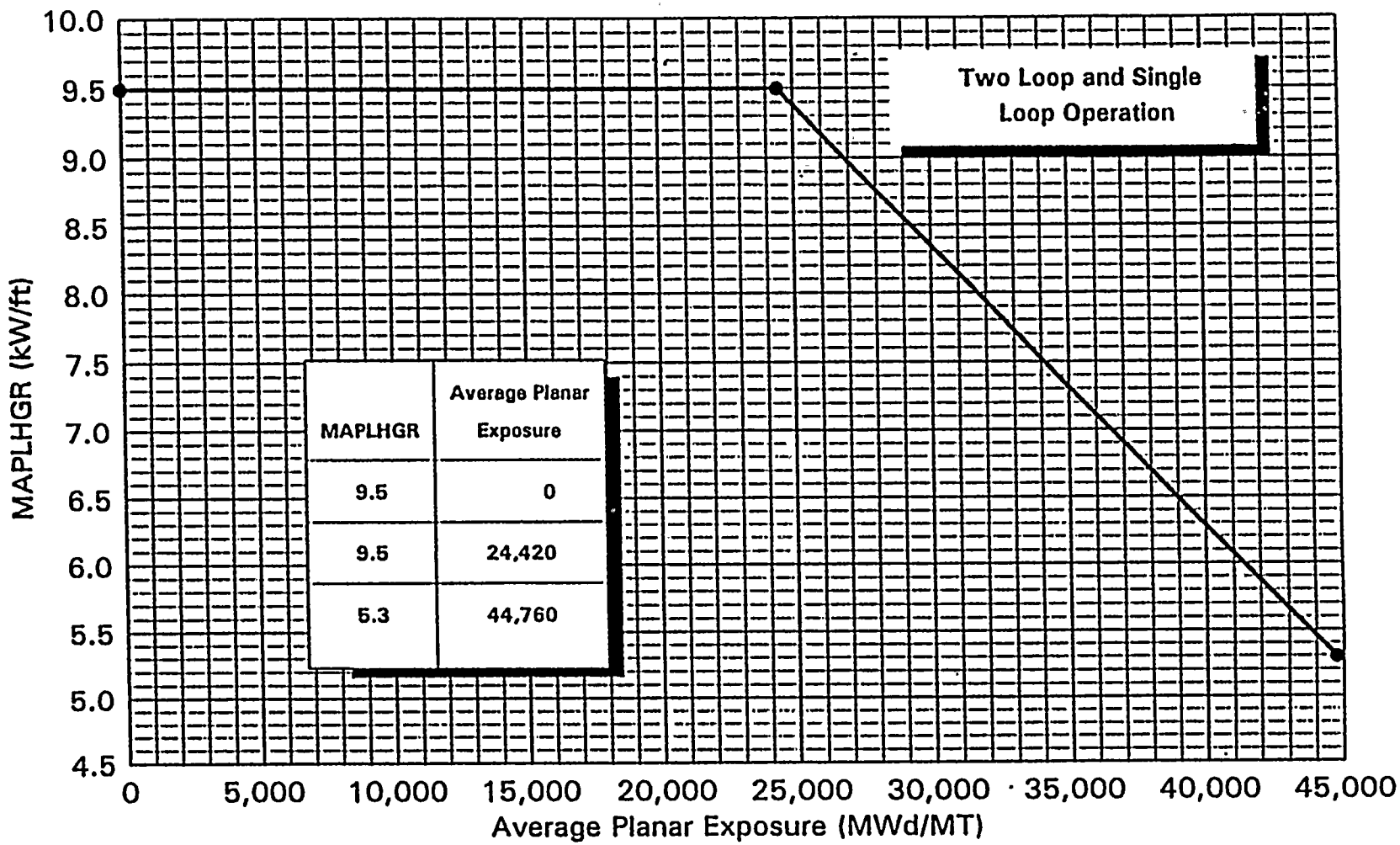
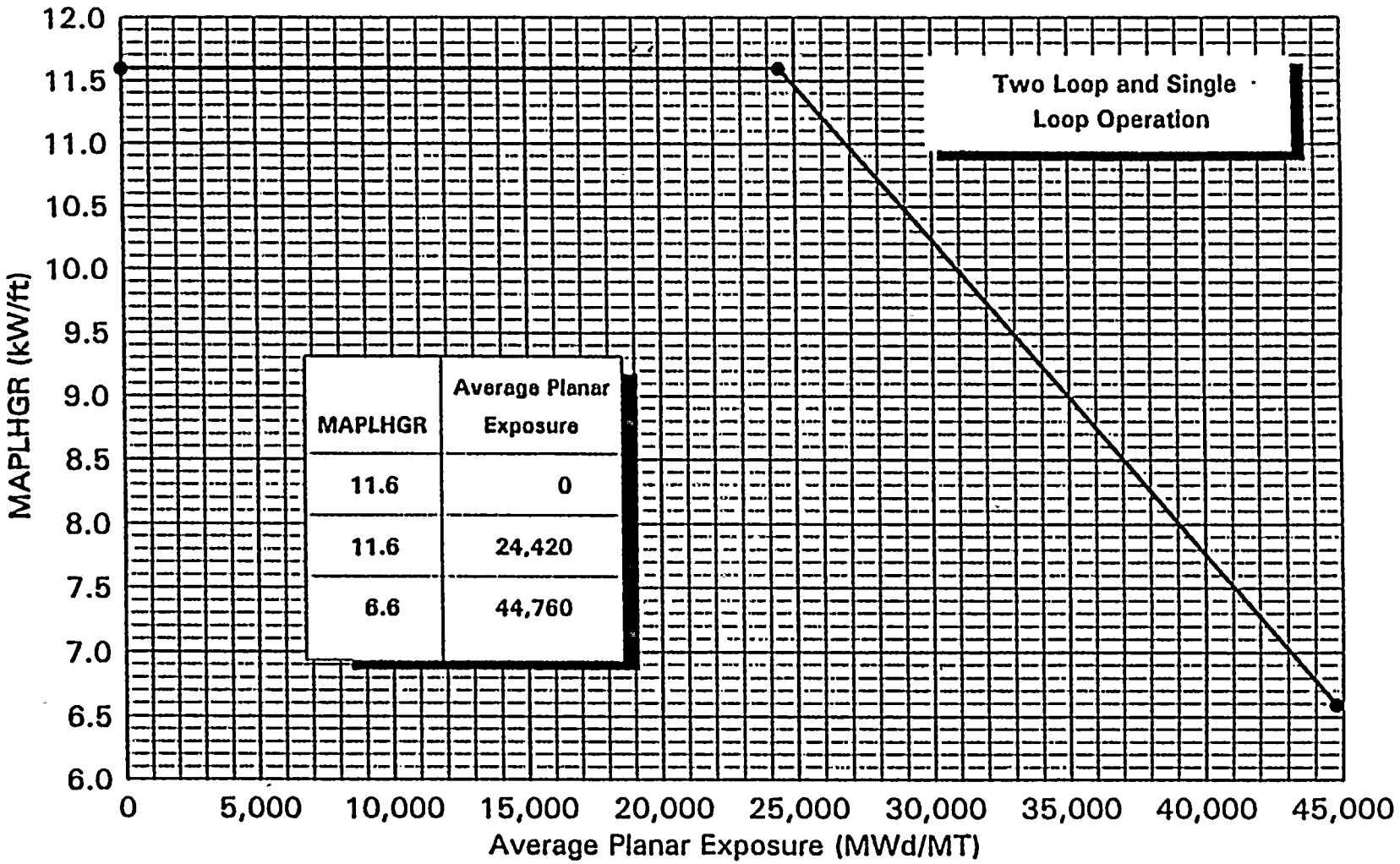


Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Versus Average Planar Exposure SVEA-96 Lead Fuel Assemblies

Figure 2.4



Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Versus Average Planar Exposure GE11 Lead Fuel Assemblies

Figure 2.5

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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:

Greater than or equal to the greater of the limits determined from Tables 3.1a and 3.1b and Figures 3.1 and 3.2a through 3.11b.

Table 3.1a
WNP-2 Cycle 10 MCPR Operating Conditions
Cycle Exposures ≤ 4500 MWd/MTU

Condition	Limit	SLMCPR = 1.07[2]			
		SPC 8x8 GE11 LFA	SPC 9x9	SPC 9x9 LFA	SVEA-96
NSS[1]					
	Full Power	1.24[3]	1.24[3]	1.28	1.44[3]
	Flow Dependent	Figure 3.1			
	Power Dependent[4]	Fig. 3.2a	Fig. 3.3a	Fig. 3.3a	Fig. 3.2a
TSSS[1]					
	Full Power	1.26	1.24	1.35	1.48
	Flow Dependent	Figure 3.1			
	Power Dependent[4]	Fig. 3.4a	Fig. 3.5a	Fig. 3.5a	Fig. 3.4a
NSS[1]					
RPT Inoperable	Full Power	1.28	1.27	1.43	1.51
	Flow Dependent	Figure 3.1			
	Power Dependent[4]	Fig. 3.10a	Fig. 3.11a	Fig. 3.11a	Fig. 3.10a
SLO[2] NSS					
	Full Power	1.56	1.36	1.36	1.98
	Flow Dependent	None			
	Power Dependent[4]	Fig. 3.2a	Fig. 3.3a	Fig. 3.3a	Fig. 3.2a
SLO[2] TSSS					
	Full Power	1.56	1.36	1.36	1.98
	Flow Dependent	None			
	Power Dependent[4]	Fig. 3.4a	Fig. 3.5a	Fig. 3.5a	Fig. 3.4a
SLO[2] NSS					
RPT Inoperable	Full Power	1.56	1.36	1.36	1.98
	Flow Dependent	None			
	Power Dependent[4]	Fig. 3.10a	Fig. 3.11a	Fig. 3.11a	Fig. 3.10a

Table 3.1b
WNP-2 Cycle 10 MCPR Operating Conditions
Cycle Exposures > 4500 MWd/MTU

Condition	Limit	SLMCPR = 1.07[2]				SLMCPR = 1.07[2] FFTR			
		SPC 8x8 GE11 LFA	SPC 9x9 LFA	SPC 9x9 LFA	SVEA-96	SPC 8x8 GE11 LFA	SPC 9x9 LFA	SPC 9x9 LFA	SVEA-96
NSS[1]									
	Full Power	1.30	1.27	1.44	1.54	1.32	1.29	1.46	1.58
	Flow Dependent	Figure 3.1				Figure 3.1			
	Power Dependent[4]	Fig. 3.2b	Fig. 3.3b	Fig. 3.3b	Fig. 3.2b	Fig. 3.6	Fig. 3.7	Fig. 3.7	Fig. 3.6
TSSS[1]									
	Full Power	1.33	1.30	1.49	1.60	1.35	1.32	1.51	1.63
	Flow Dependent	Figure 3.1				Figure 3.1			
	Power Dependent[4]	Fig. 3.4b	Fig. 3.5b	Fig. 3.5b	Fig. 3.4b	Fig. 3.8	Fig. 3.9	Fig. 3.9	Fig. 3.8
NSS[1] RPT Inoperable	Full Power	1.38	1.35	1.61	1.68	Not Analyzed			
	Flow Dependent	Figure 3.1							
	Power Dependent[4]	Fig. 3.10b	Fig. 3.11b	Fig. 3.11b	Fig. 3.10b				
SLO[2] NSS									
	Full Power	1.56	1.36	1.36	1.98	1.56	1.36	1.36	1.98
	Flow Dependent	None				None			
	Power Dependent[4]	Fig. 3.2b	Fig. 3.3b	Fig. 3.3b	Fig. 3.2b	Fig. 3.6	Fig. 3.7	Fig. 3.7	Fig. 3.6
SLO[2] TSSS									
	Full Power	1.56	1.36	1.36	1.98	1.56	1.36	1.36	1.98
	Flow Dependent	None				None			
	Power Dependent[4]	Fig. 3.4b	Fig. 3.5b	Fig. 3.5b	Fig. 3.4b	Fig. 3.8	Fig. 3.9	Fig. 3.9	Fig. 3.8
SLO[2] NSS RPT Inoperable	Full Power	1.56	1.36	1.36	1.98	Not Analyzed			
	Flow Dependent	None							
	Power Dependent[4]	Fig. 3.10b	Fig. 3.11b	Fig. 3.11b	Fig. 3.10b				

Notes for Tables 3.1a and 3.1b

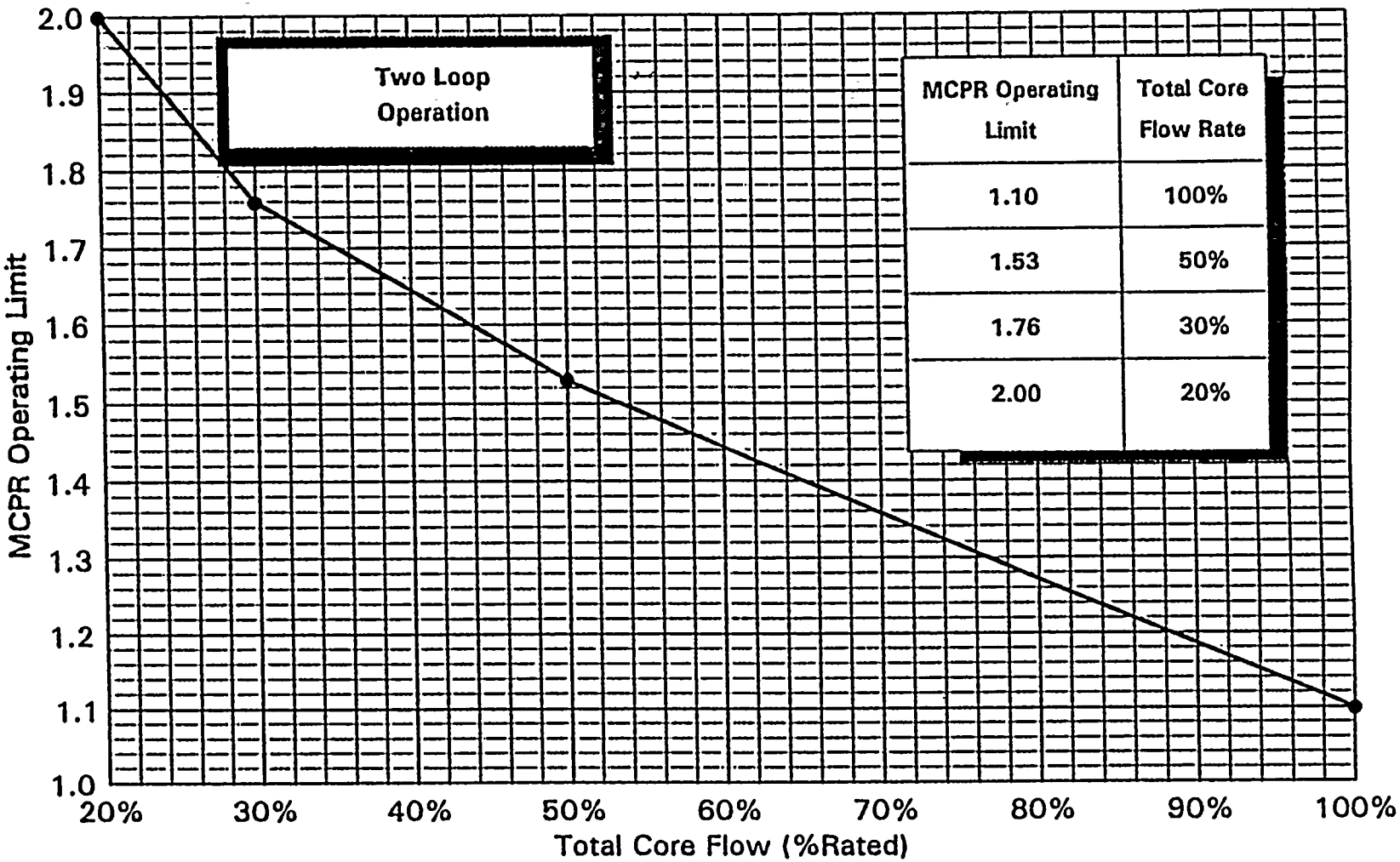
Note 1: The scram insertion times must meet the requirements of Technical Specification 3.1.3.4. The NSS MCPR values are based on the SPC transient analysis performed using the control rod insertion times shown below (defined as normal scram speed: NSS). In the event that Surveillance 4.1.3.2 shows these scram insertion times have been exceeded, the MCPR limit shall be determined from the applicable Technical Specification Scram Speed (TSSS) MCPR limits in Tables 3.1a and b.

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	0.720
Notch 25	1.600
Notch 5	2.950

Note 2: For Single Loop Operation (SLO), the SLMCPR increases by 0.01. The increase is included in the MCPR limits for SLO.

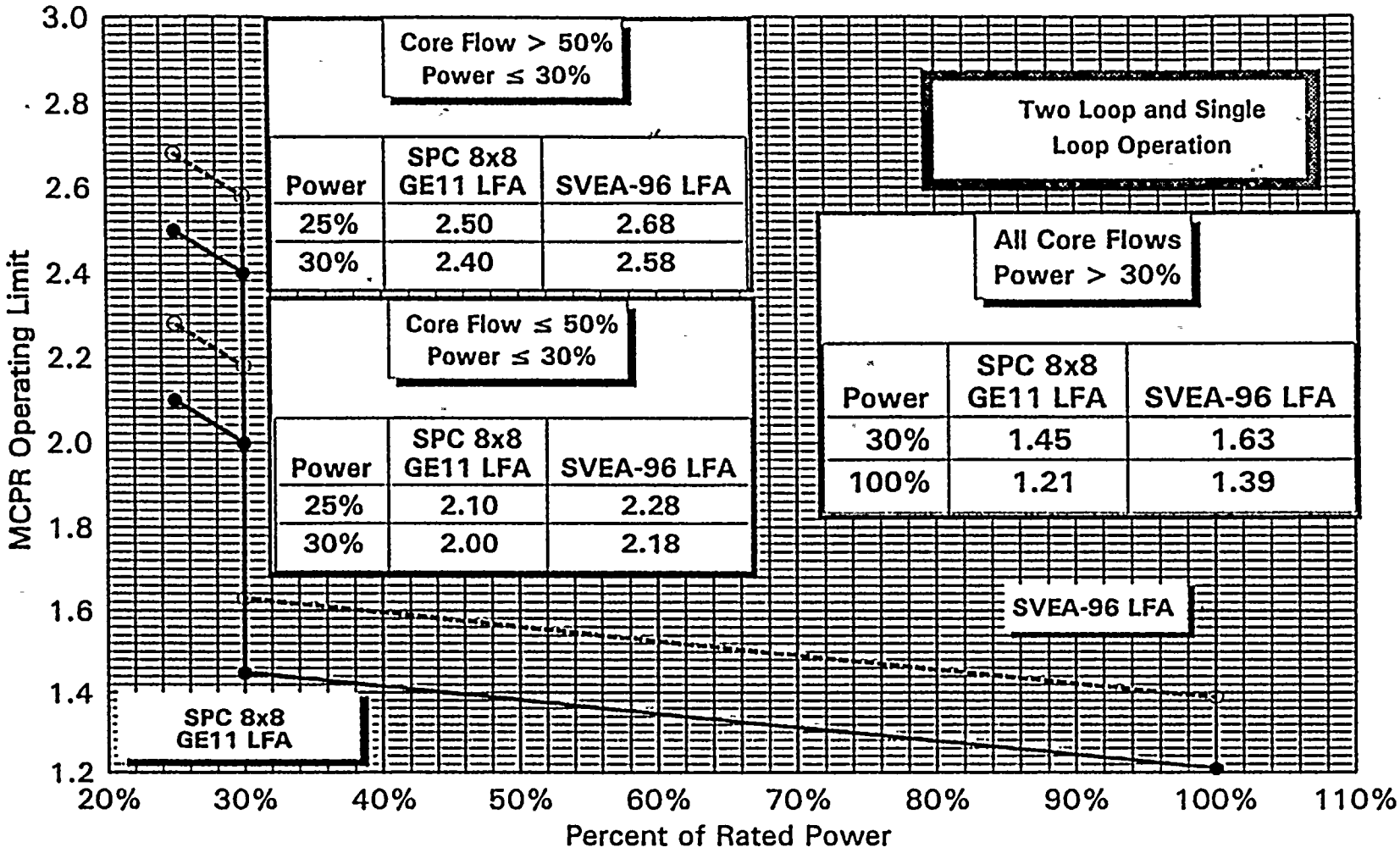
Note 3: For the noted full power MCPR limits, the control rod withdrawal error (CRWE) event is limiting. The turbine trip without bypass (TTNB) event is limiting for the remaining full power limits. CRWE analysis was performed with a nominal rod block monitor (RBM) setpoint of 1.06. Use of the nominal setpoint is in accordance with the methodology described in Reference 5.2.6, consistent with approved industry practice.

Note 4: Power dependent MCPR limits are provided for core thermal powers greater than or equal to 25% of rated power at all core flows. The power dependent MCPR limits for core thermal powers less than or equal to 30% of rated power are subdivided by core flow. Limits are provided for core flows greater than 50% of rated flow and less than or equal to 50% of rated flow, respectively. A step change in the power dependent MCPR limits occurs at 30% of rated power because direct scram on turbine throttle valve closure is automatically bypassed per Technical Specification 3.3.1.



Reduced Flow MCPR Operating Limit
Versus Total Core Flow
All Fuel

Figure 3.1



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable
SPC 8x8, GE11 LFA, SVEA-96 LFA
Cycle Exposures ≤ 4500 MWd/MT

Figure 3.2a

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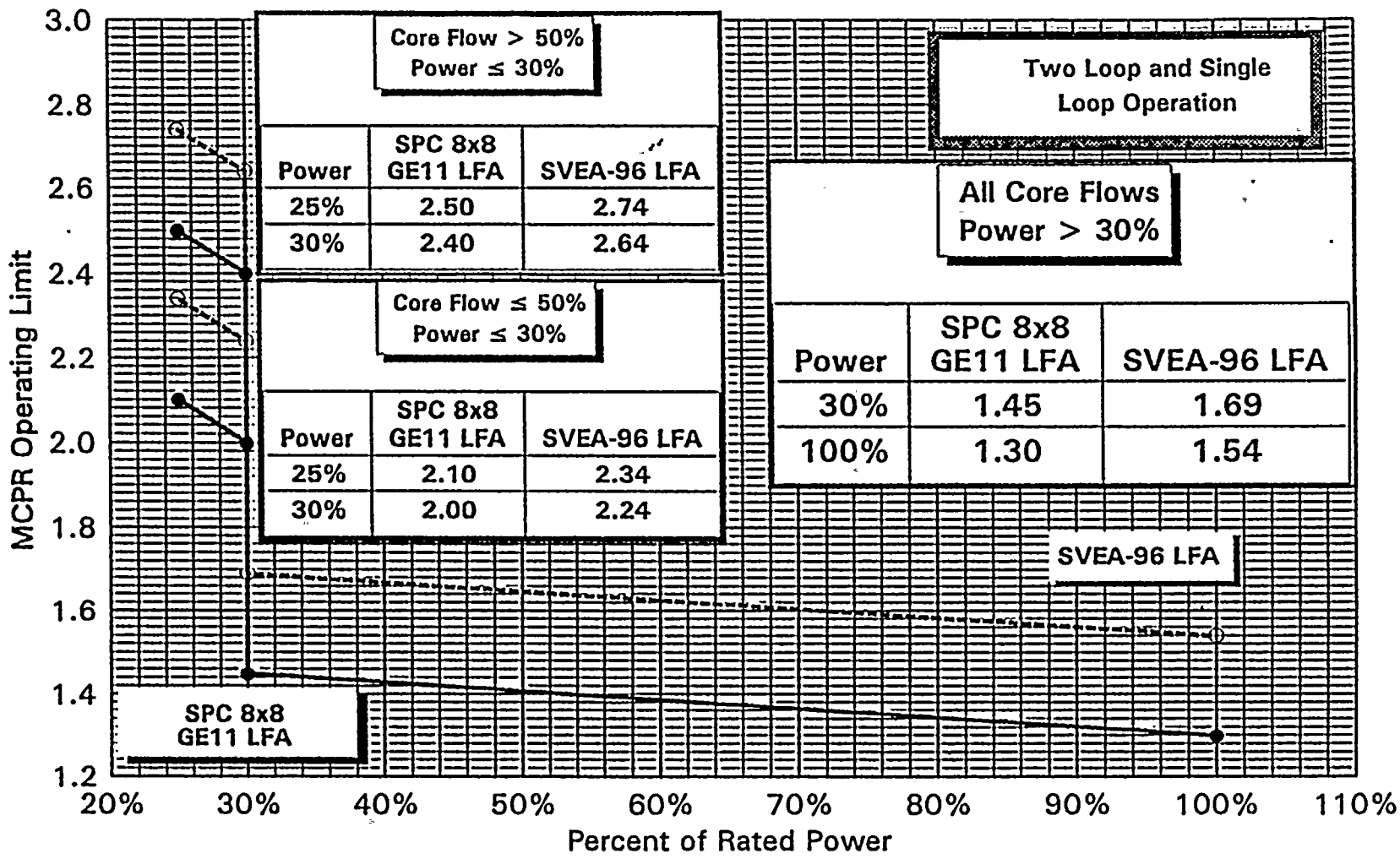
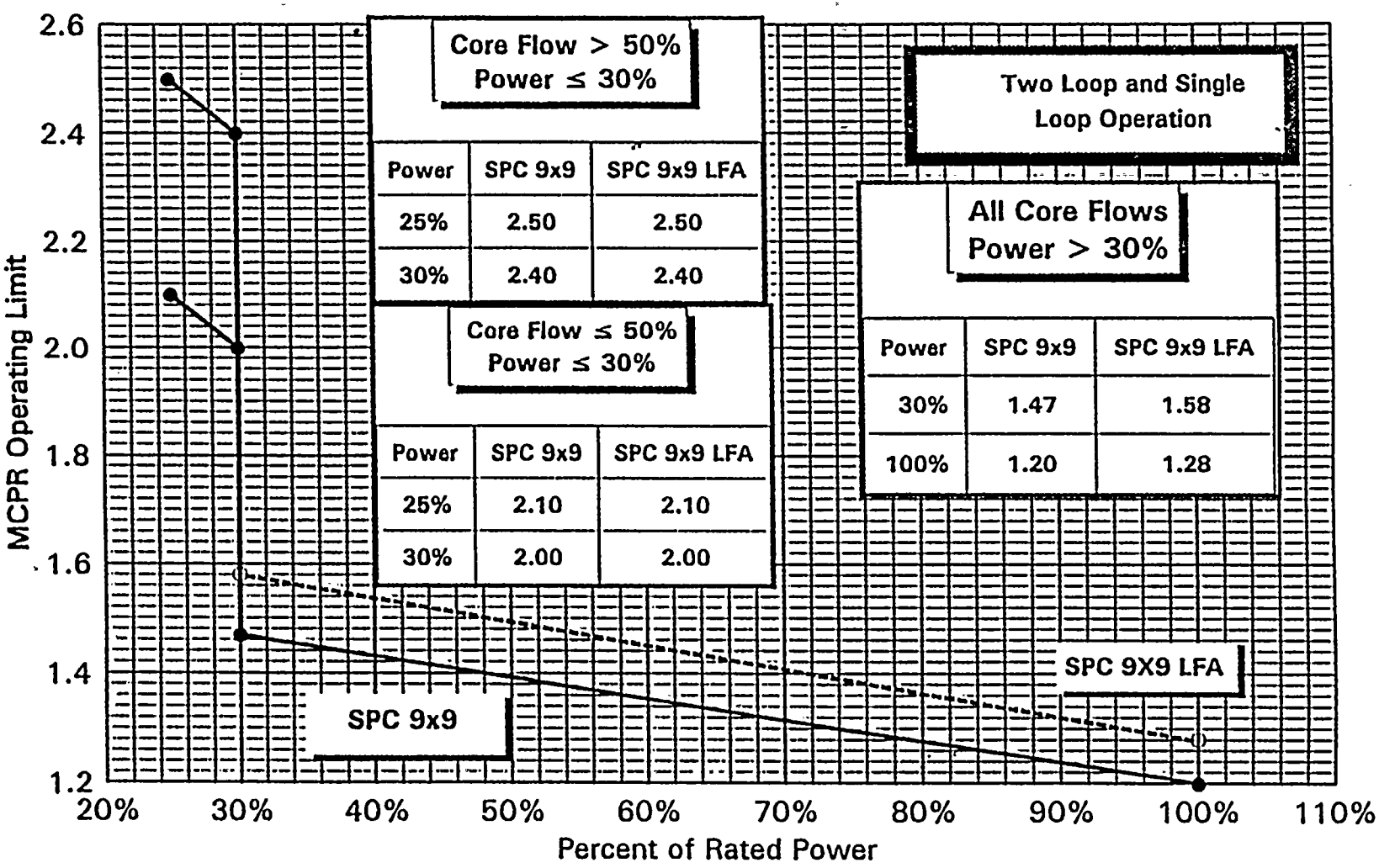


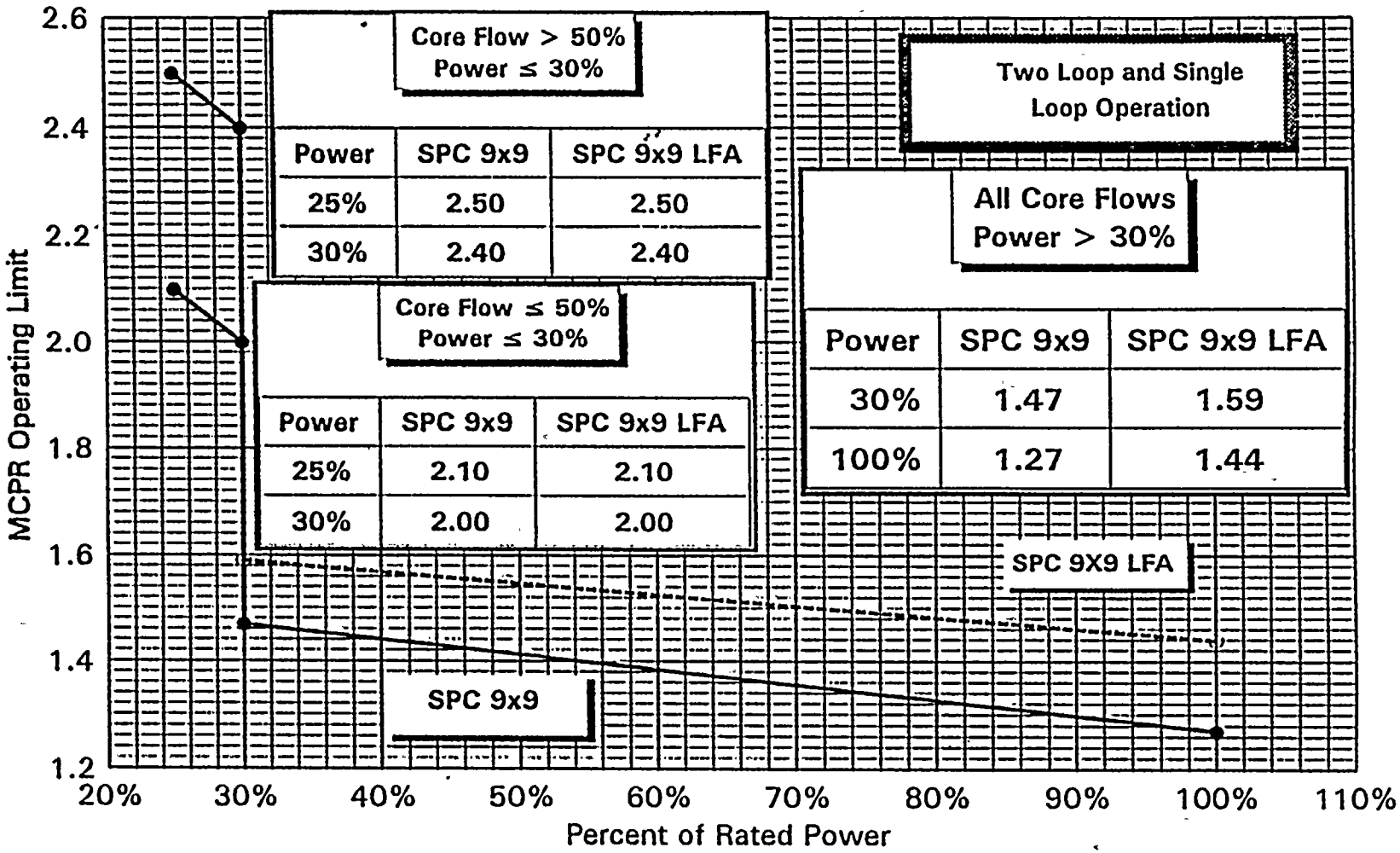
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable
SPC 8x8, GE11 LFA, SVEA-96 LFA
Cycle Exposures > 4500 MWd/MT

Figure 3.2b



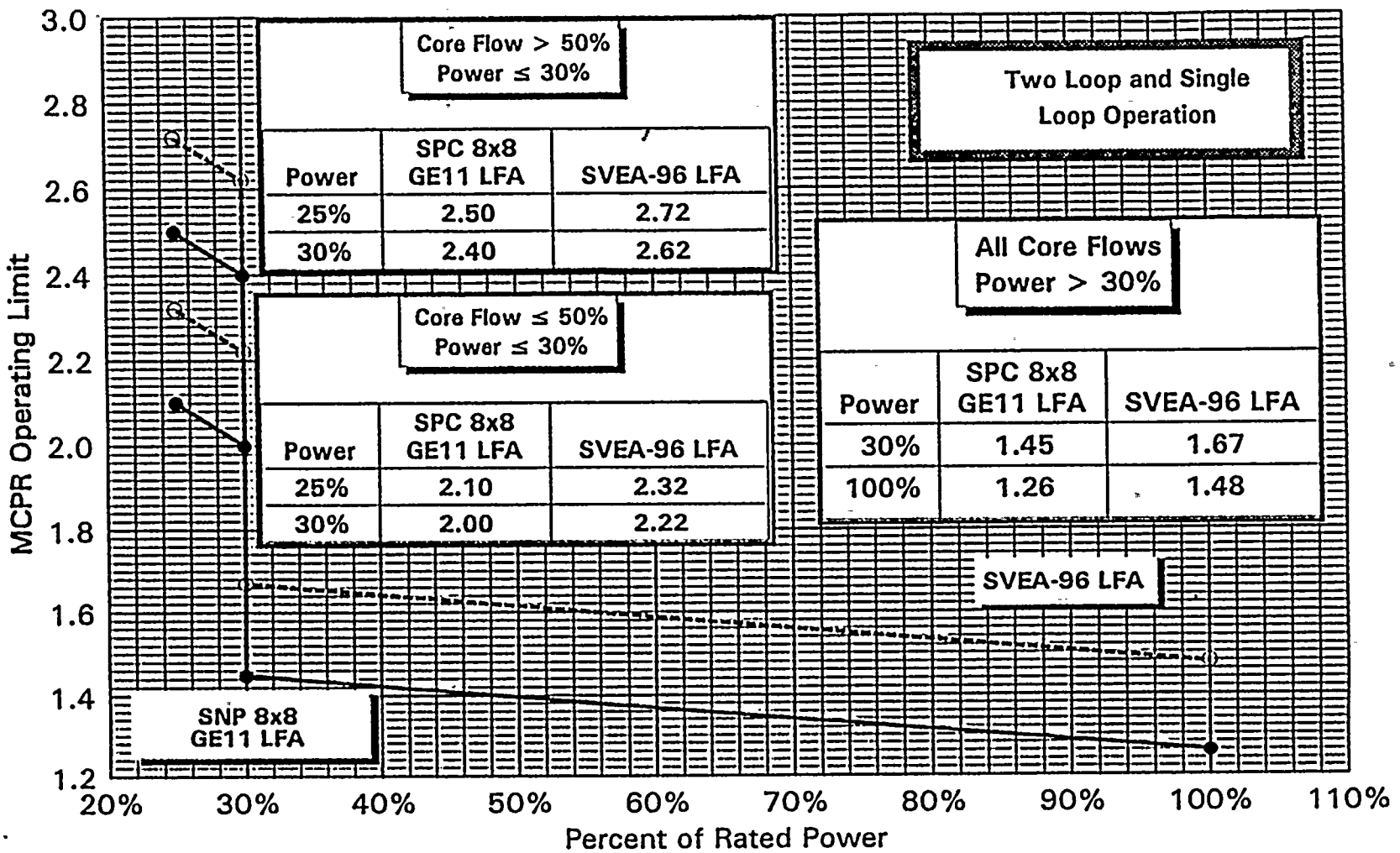
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable
SPC 9x9, SPC 9x9 LFA
Cycle Exposures ≤ 4500 MWd/MT

Figure 3.3a



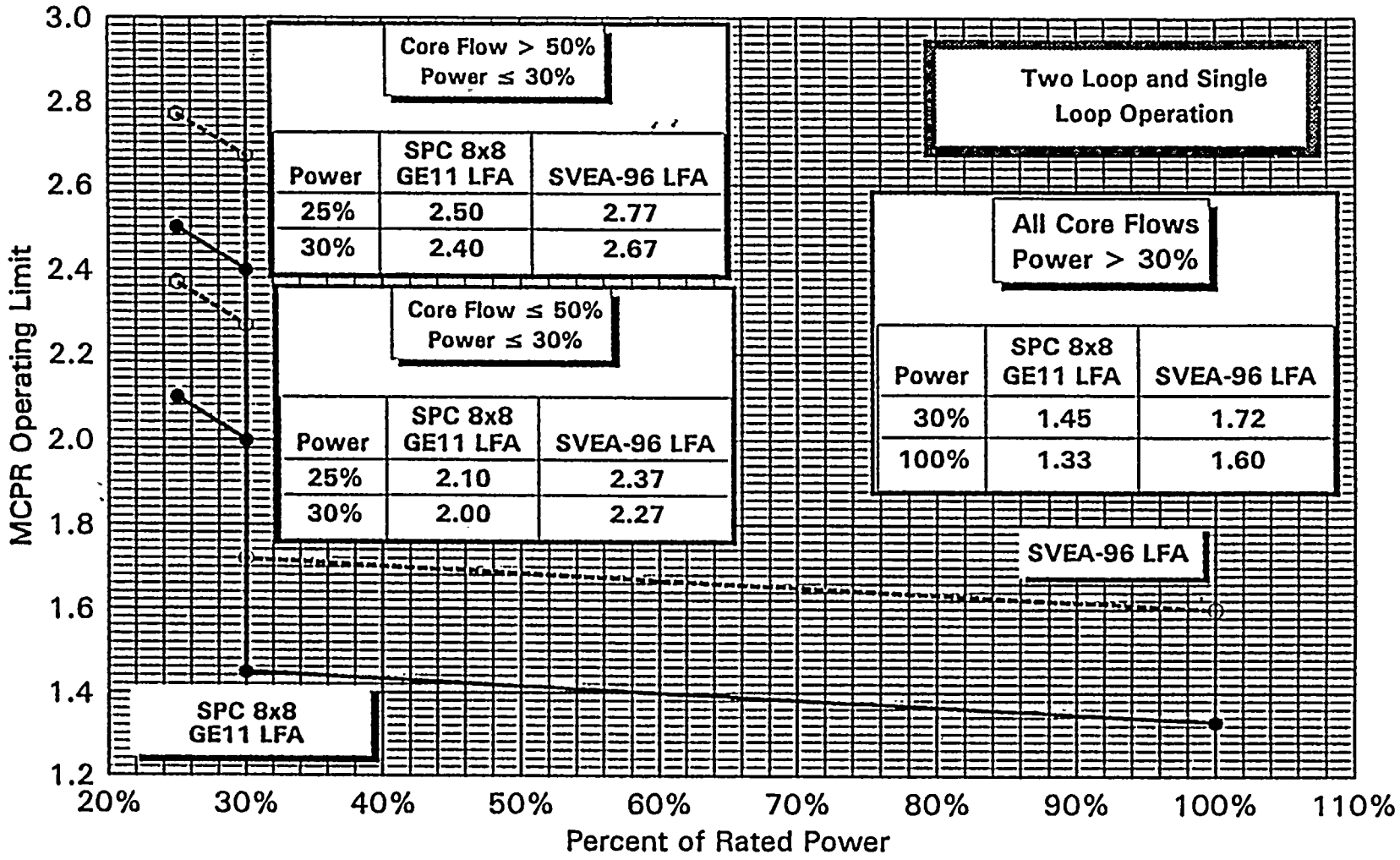
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable
SPC 9x9, SPC 9x9 LFA
Cycle Exposures > 4500 MWd/MT

Figure 3.3b



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable
SPC 8x8, GE11 LFA, SVEA-96 LFA
Cycle Exposures ≤ 4500 MWd/MT

Figure 3.4a



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable
SPC 8x8, GE11 LFA, SVEA-96 LFA
Cycle Exposures > 4500 MWd/MT

Figure 3.4b

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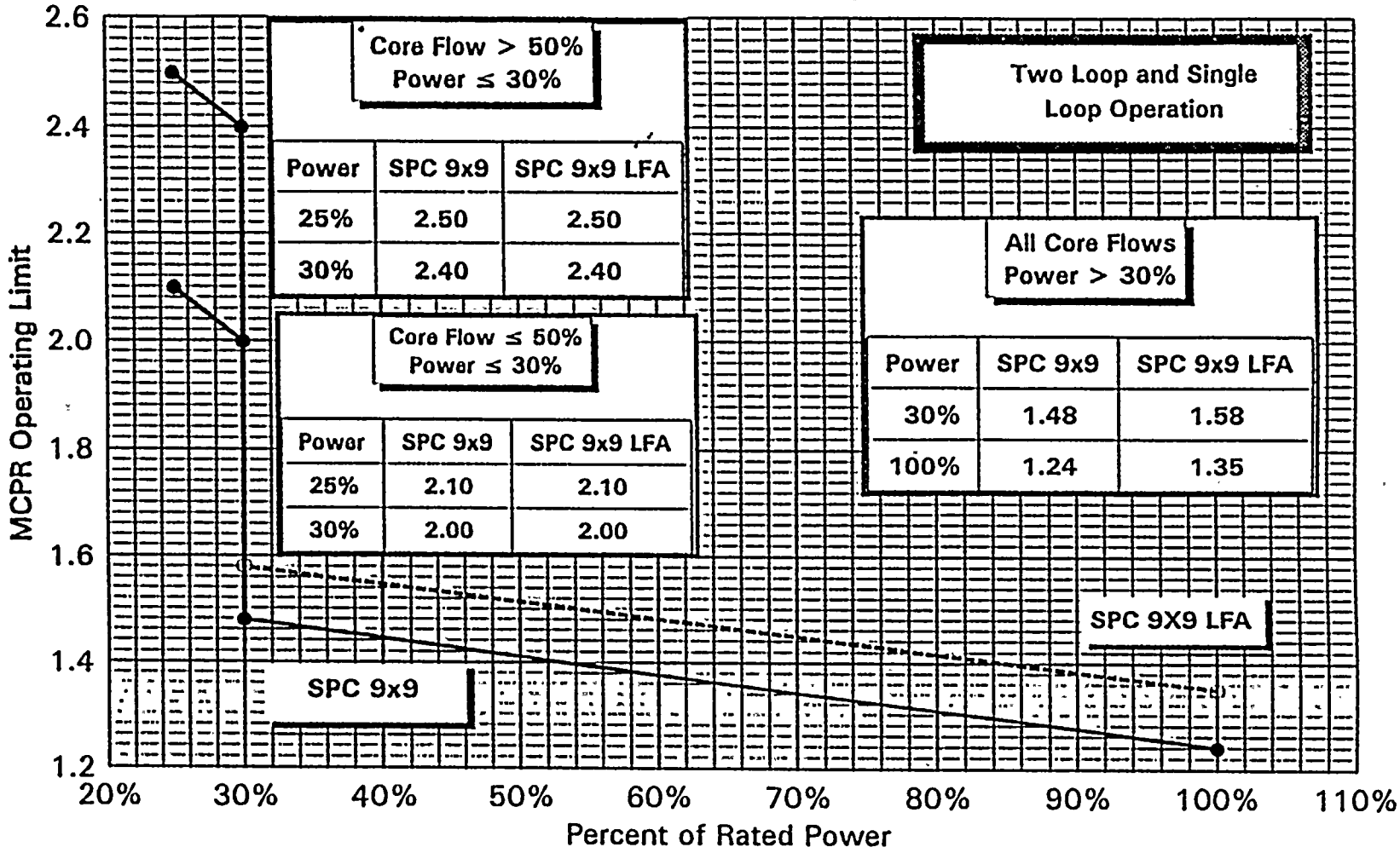
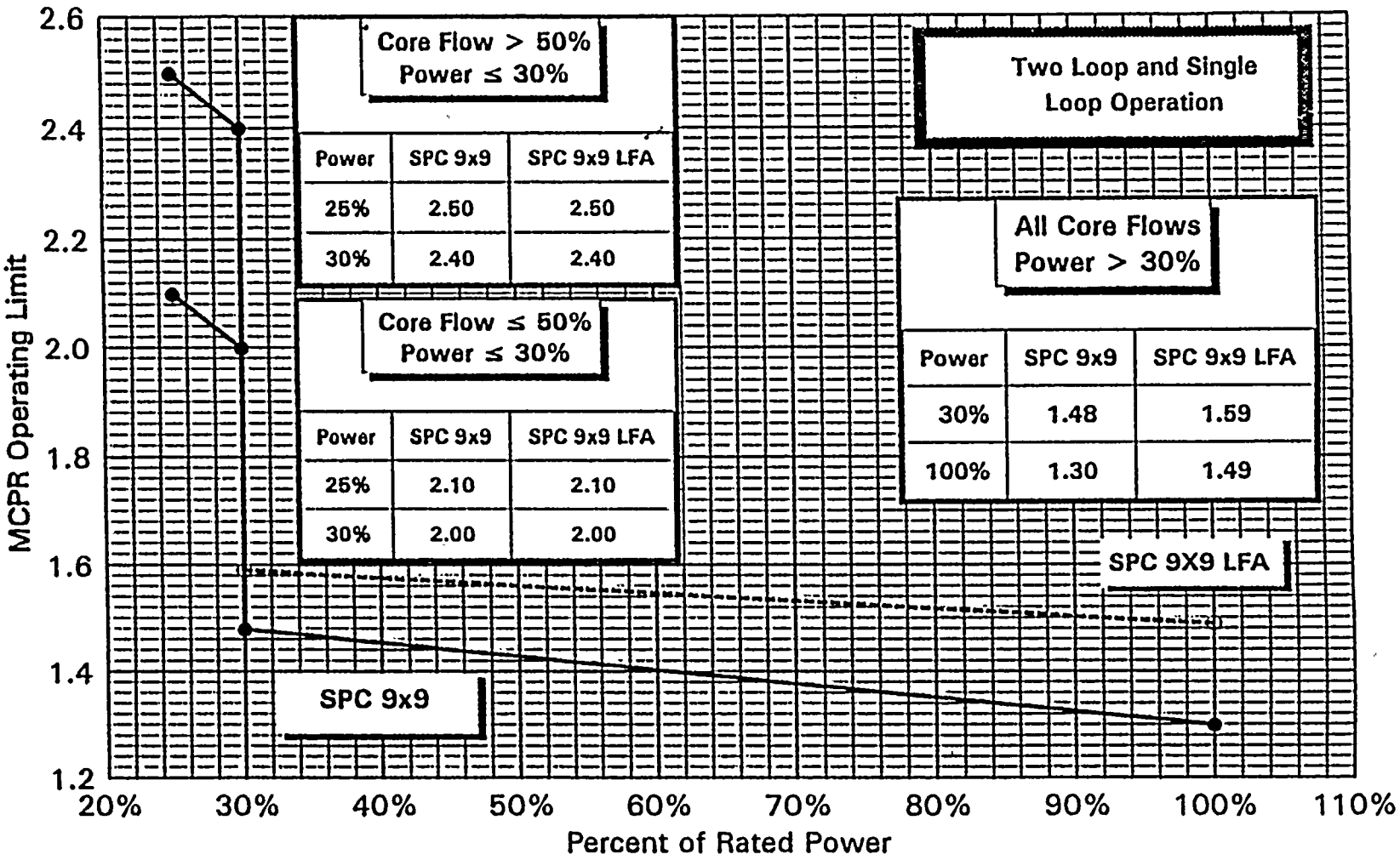


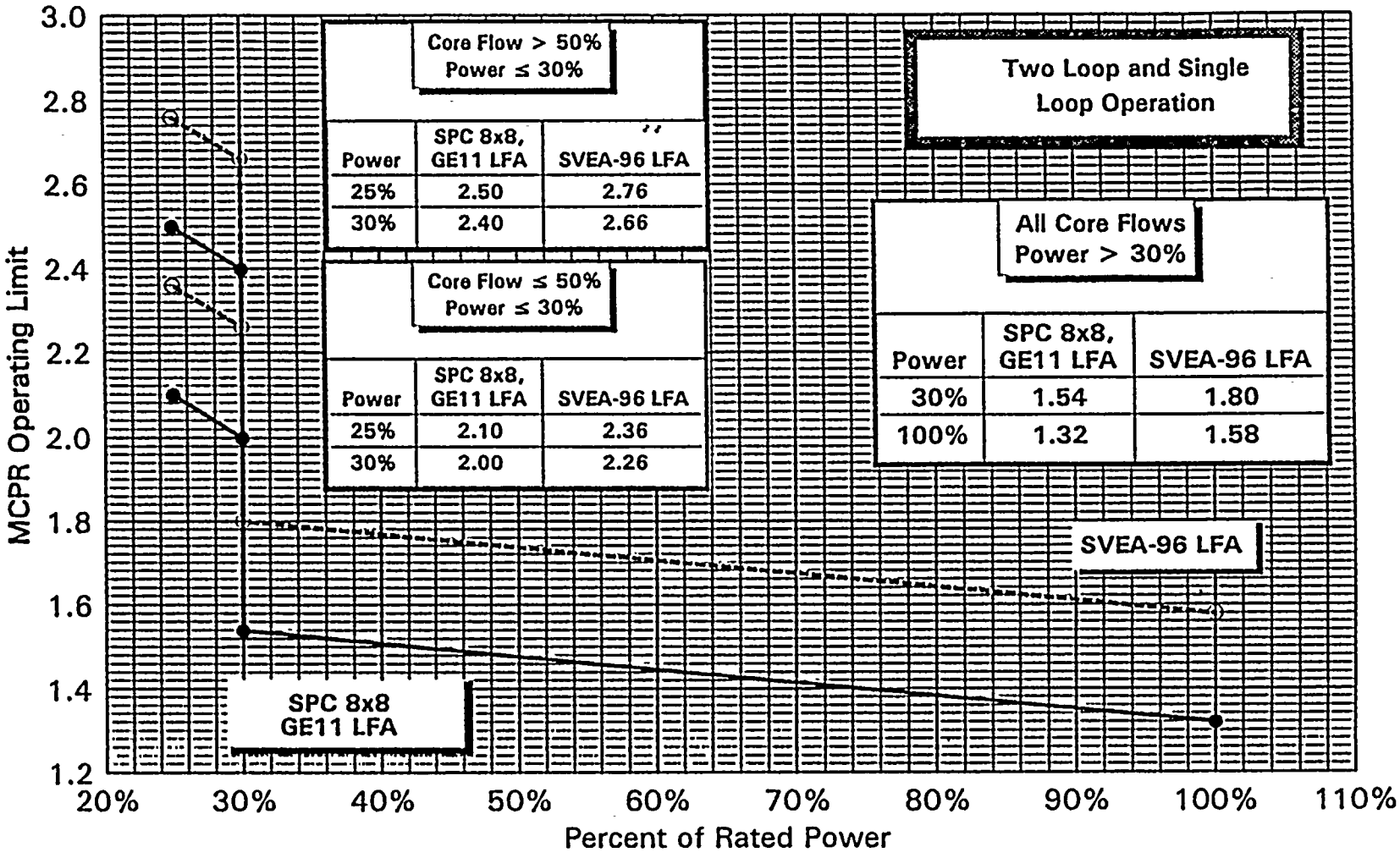
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable
SPC 9x9, SPC 9x9 LFA
Cycle Exposures ≤ 4500 MWd/MT

Figure 3.5a



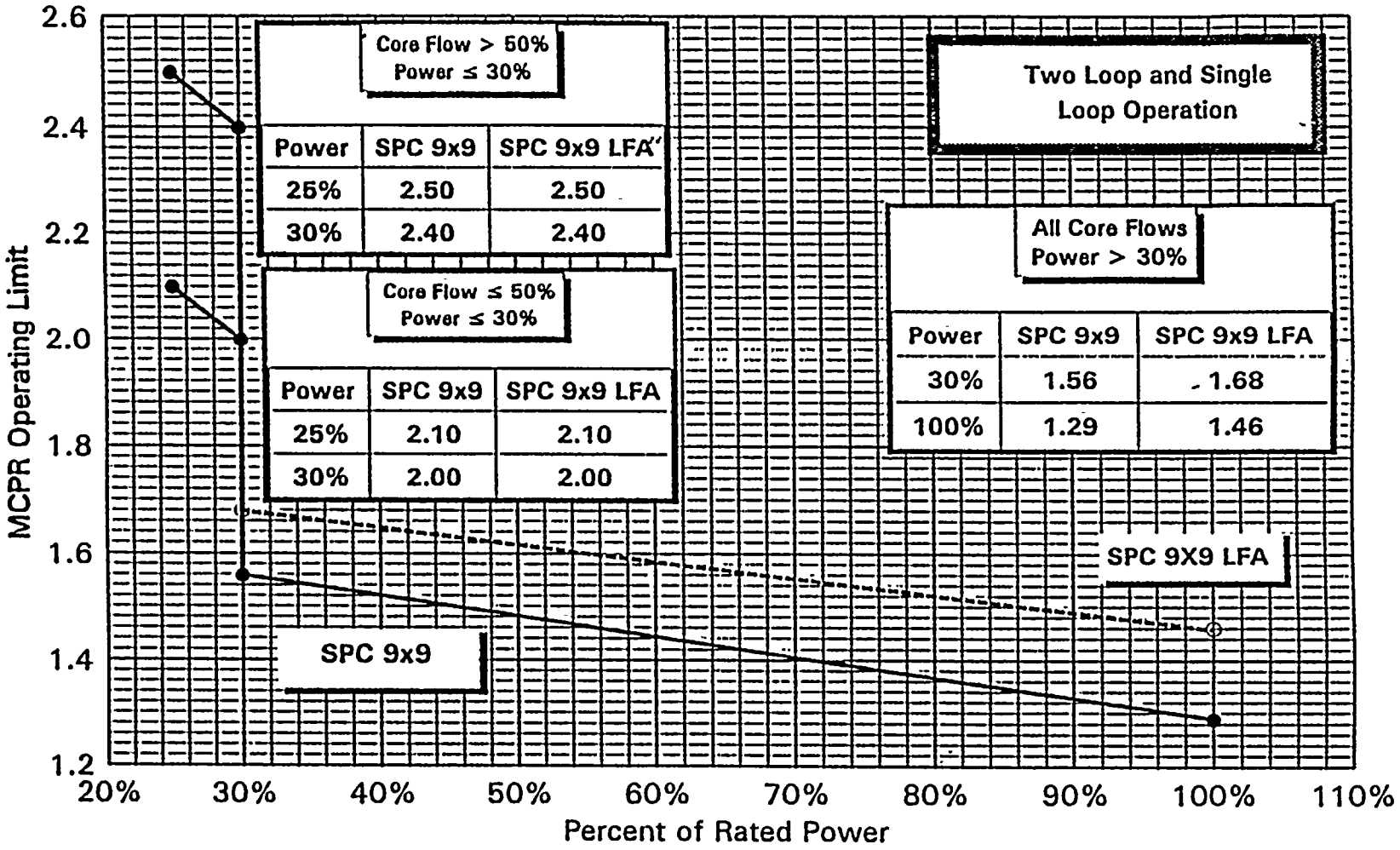
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable
SPC 9x9, SPC 9x9 LFA
Cycle Exposures > 4500 MWd/MT

Figure 3.5b



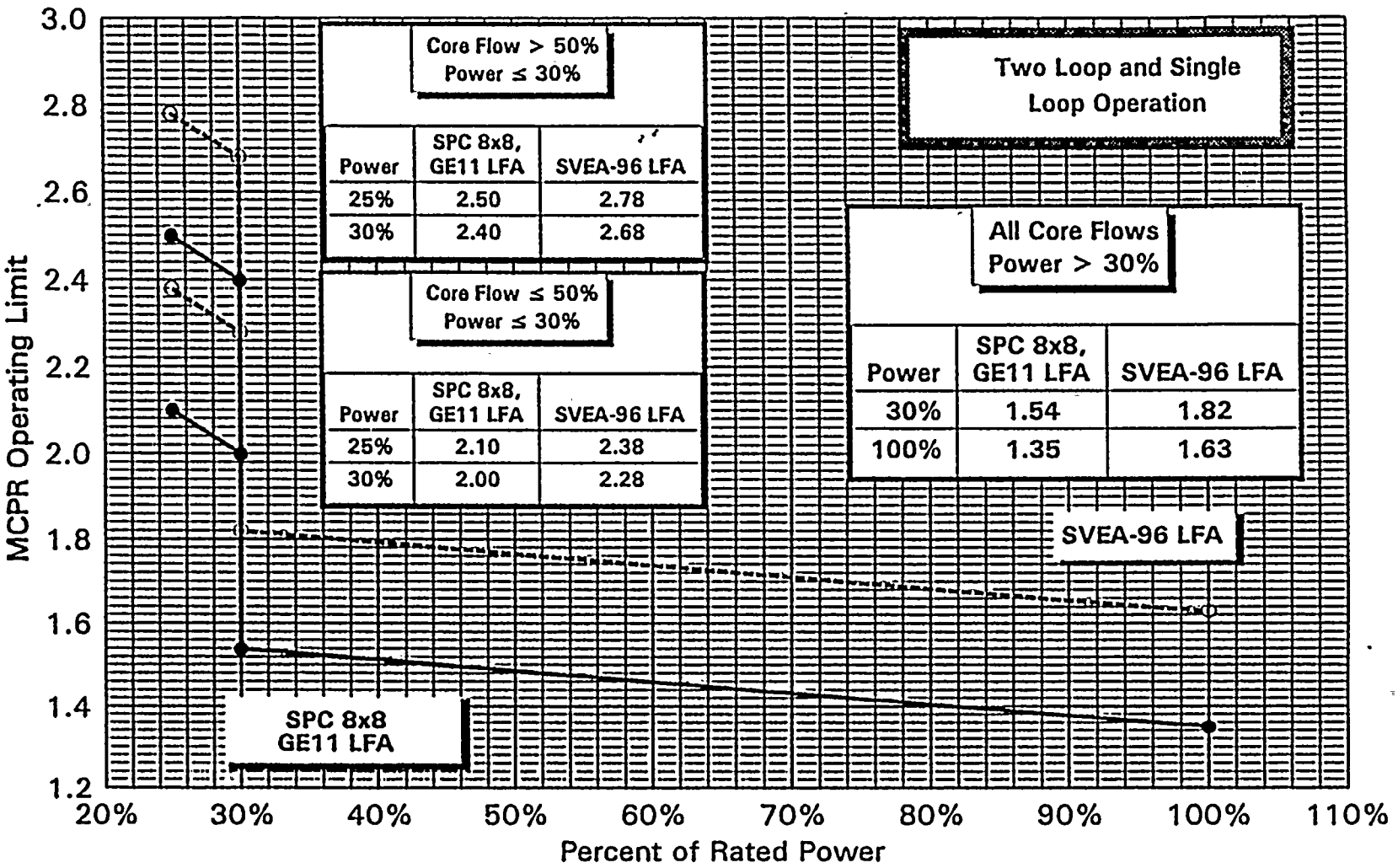
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable
SPC 8x8, GE11 LFA, SVEA-96 LFA
FFTR Operation

Figure 3.6



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable
SPC 9x9, SPC 9x9 LFA
FFTR Operation

Figure 3.7



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable
SPC 8x8, GE11 LFA, SVEA-96 LFA
FFTR Operation

Figure 3.8

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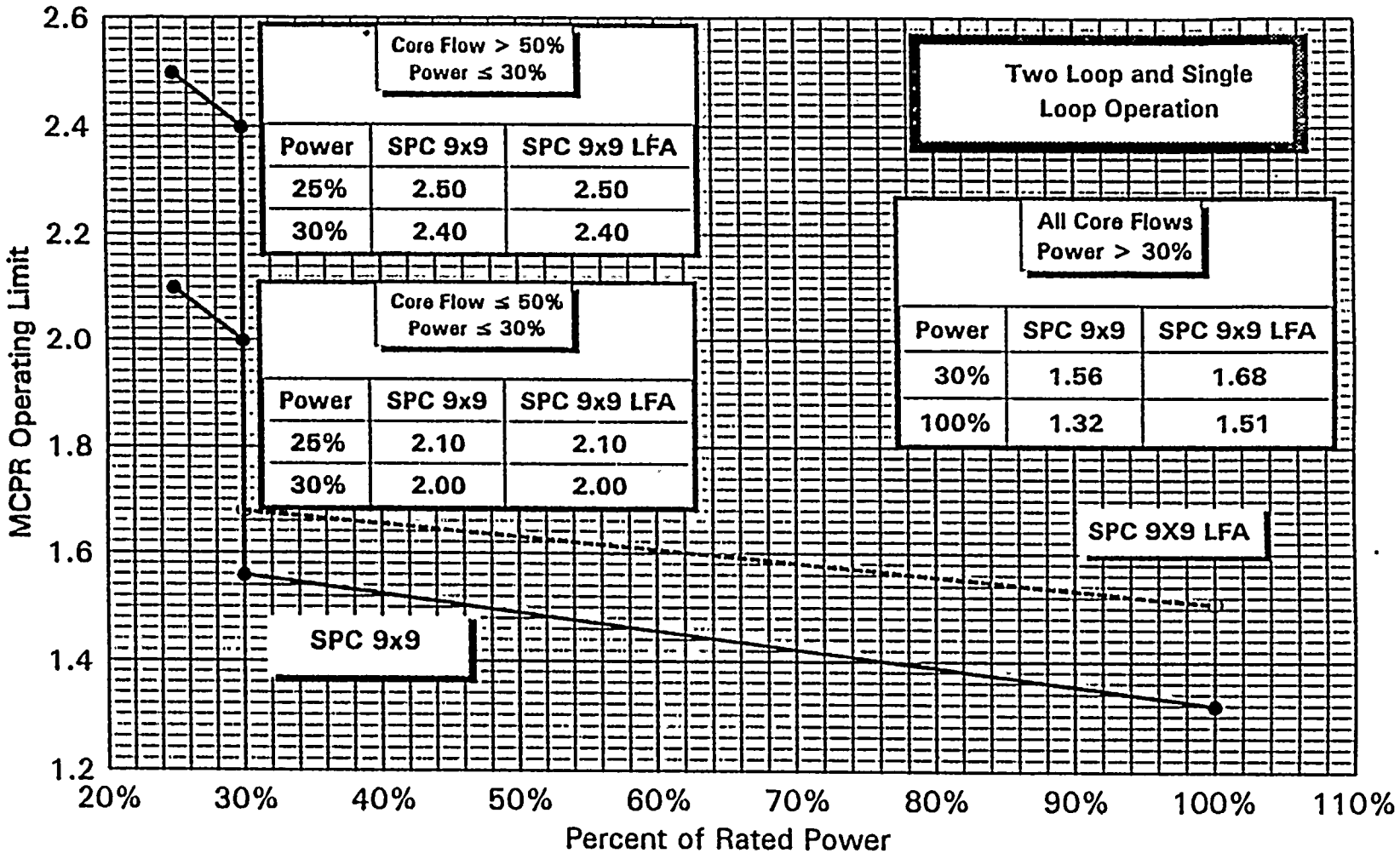
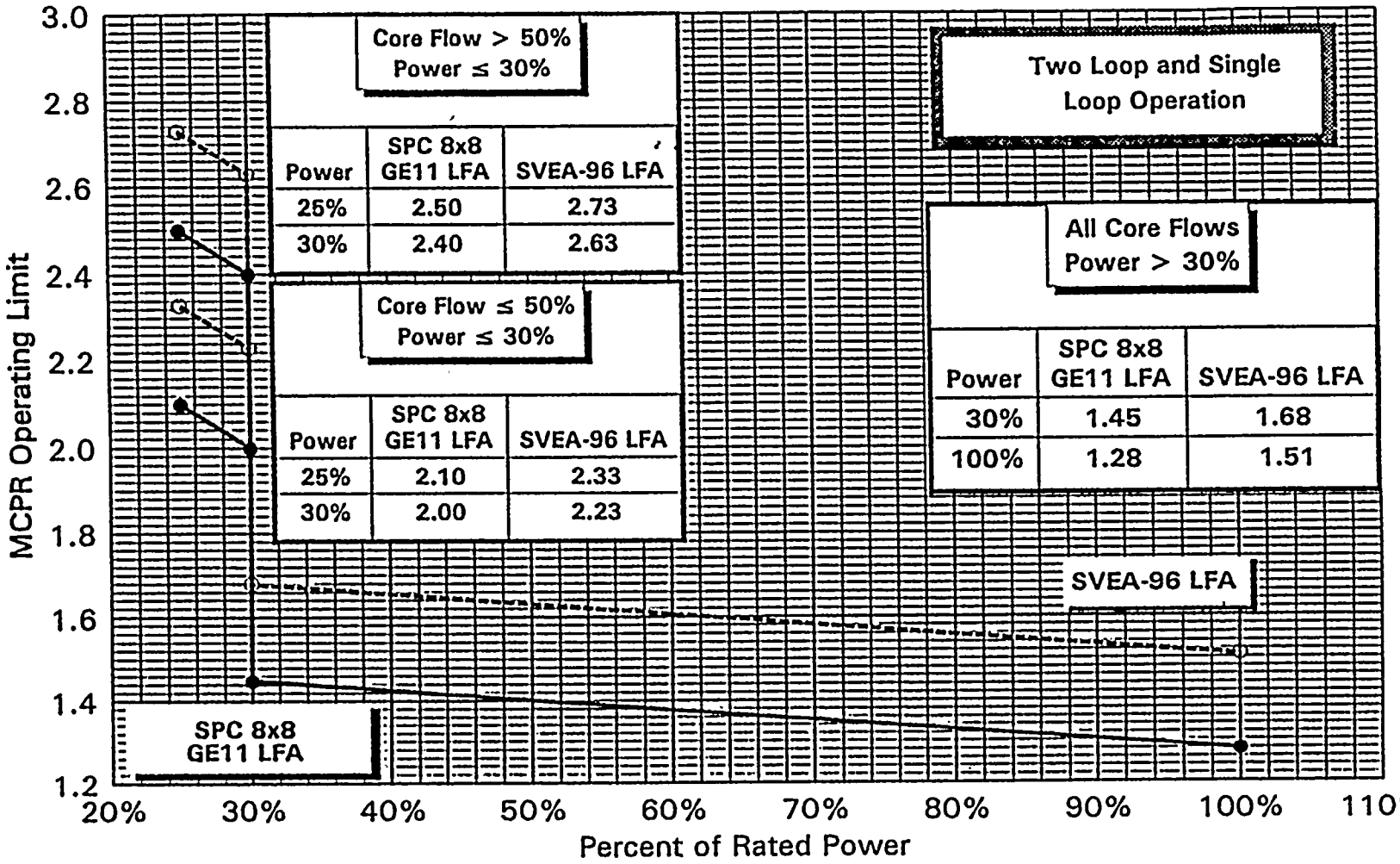


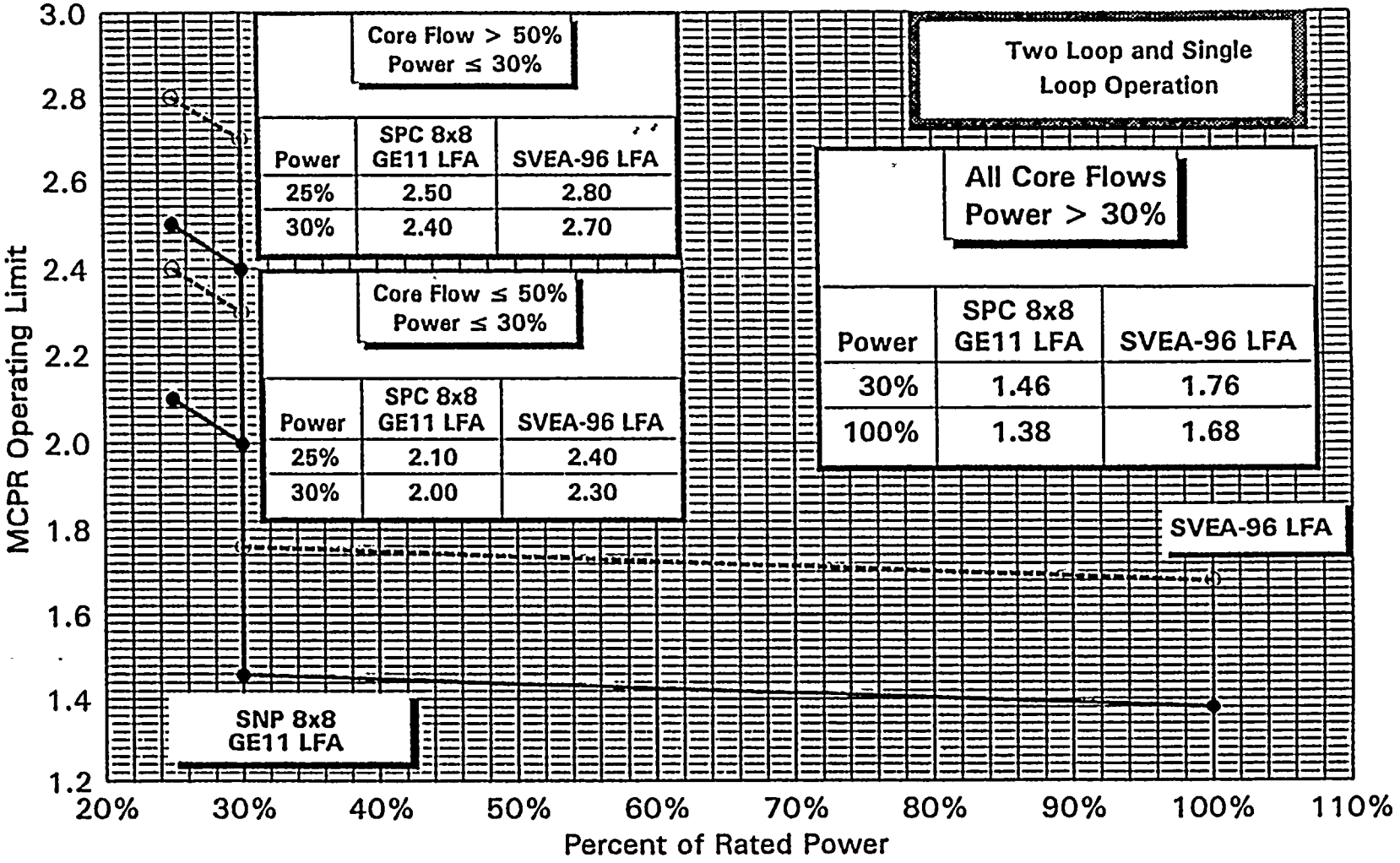
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable
SPC 9x9, SPC 9x9 LFA
FFTR Operation

Figure 3.9



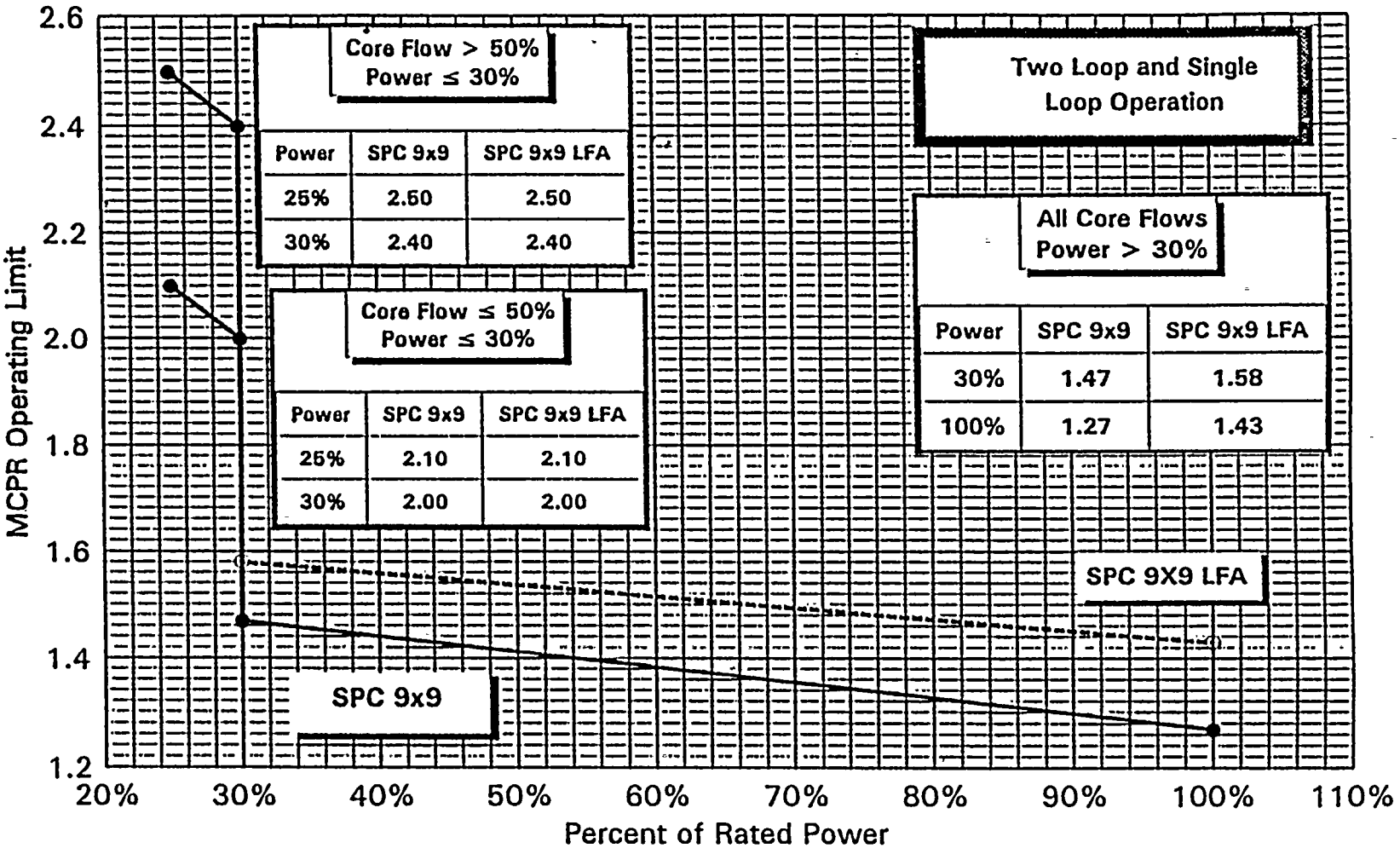
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable
SPC 8x8, GE11 LFA, SVEA-96 LFA
Cycle Exposures ≤ 4500 MWd/MT

Figure 3.10a



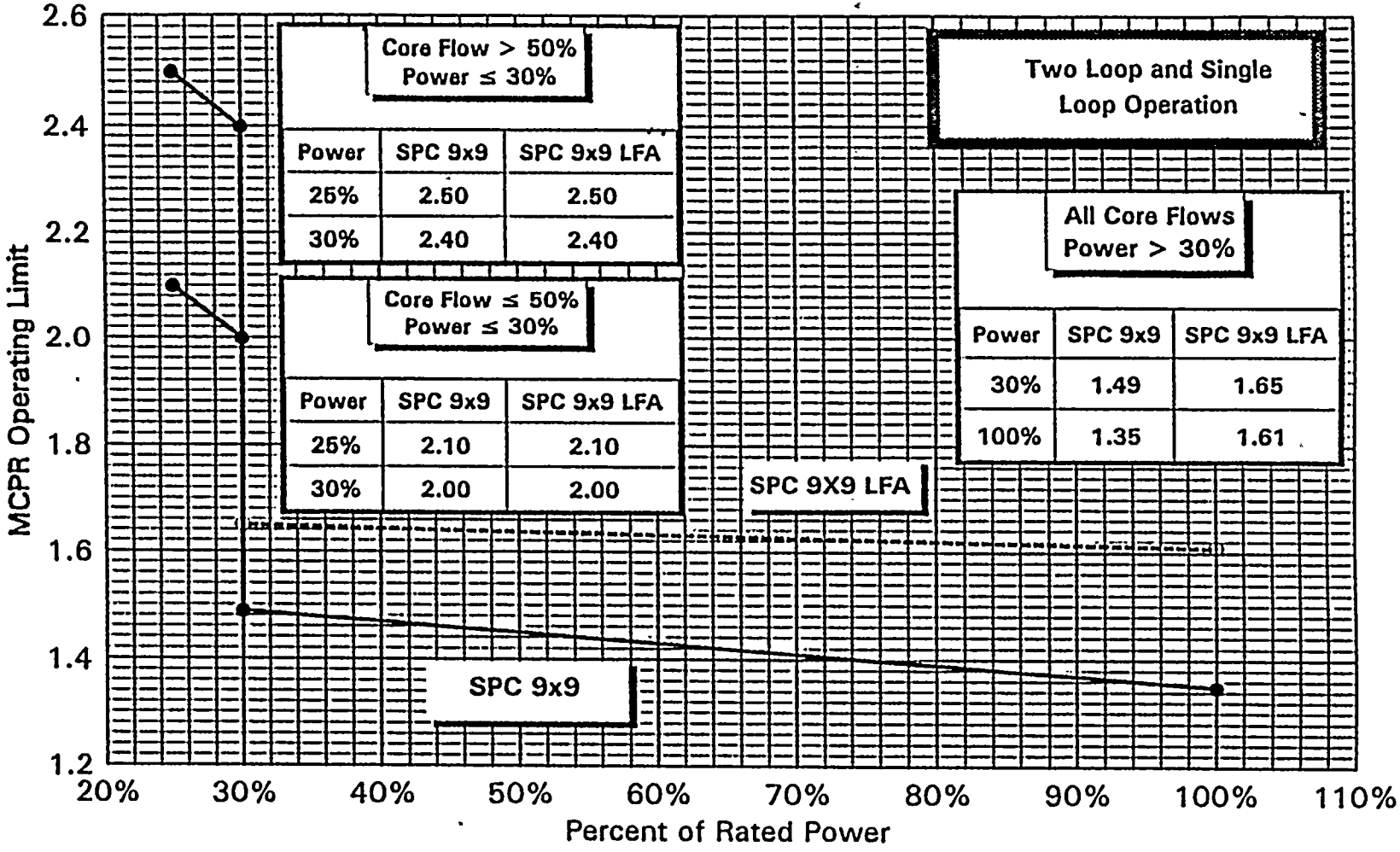
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable
SPC 8x8, GE11 LFA, SVEA-96 LFA
Cycle Exposures > 4500 MWd/MT

Figure 3.10b



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable
SPC 9x9, SPC 9x9 LFA
Cycle Exposures ≤ 4500 MWd/MT

Figure 3.11a



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable
SPC 9x9, SPC 9x9 LFA
Cycle Exposures > 4500 MWd/MT

Figure 3.11b

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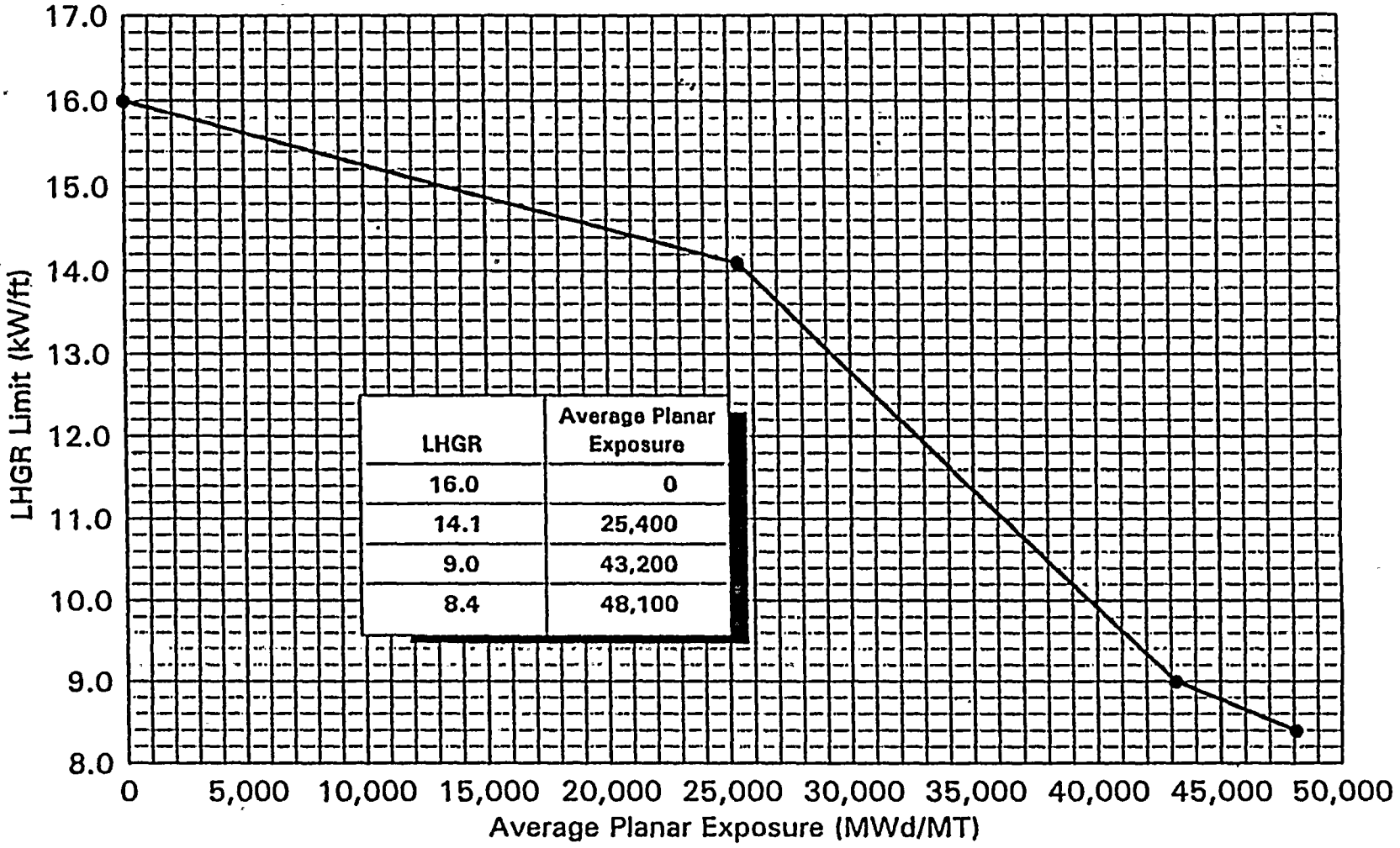
4.0 LINEAR HEAT GENERATION RATE (LHGR) LIMIT FOR USE IN TECHNICAL SPECIFICATION 3.2.4

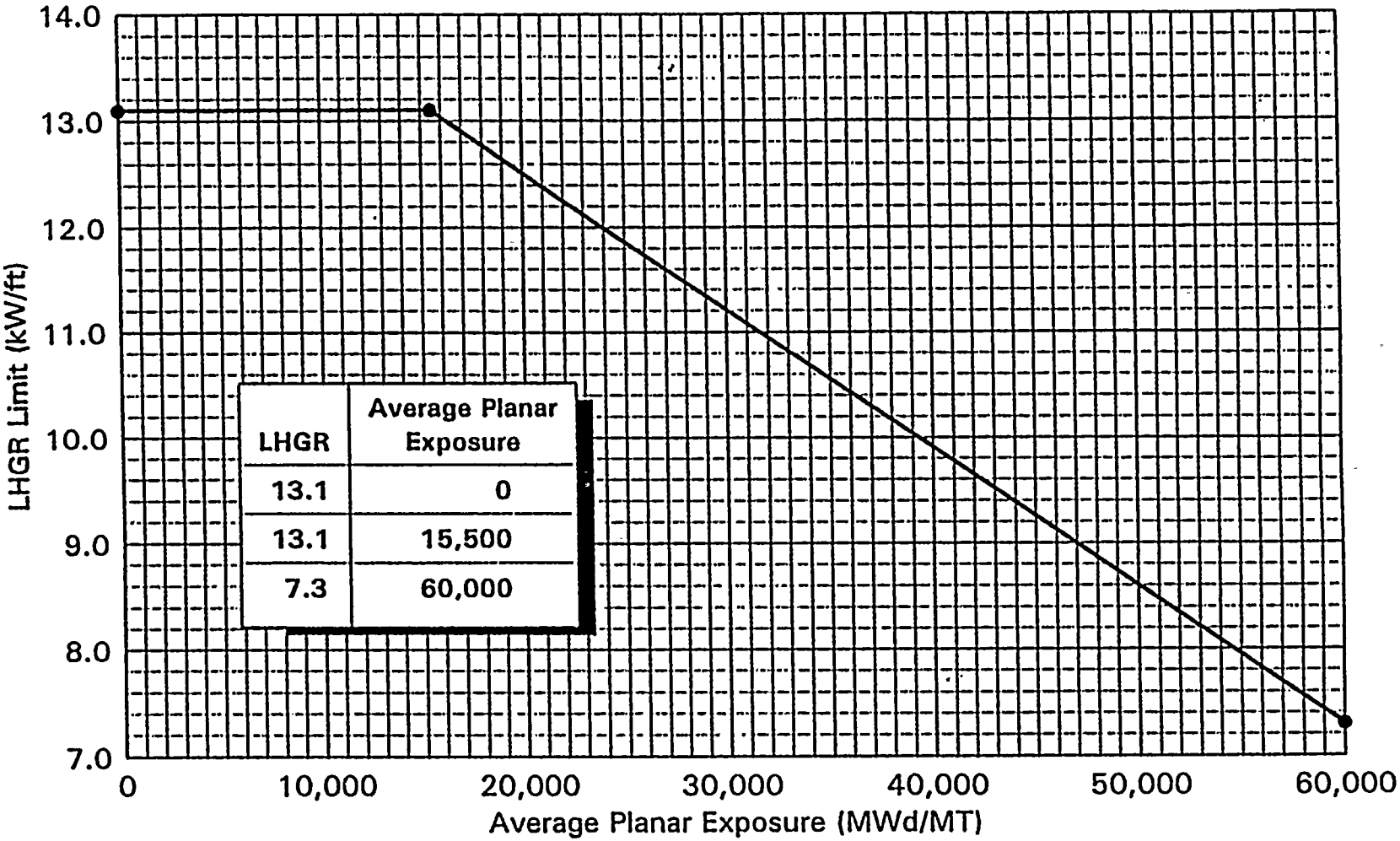
The LHGR limit for use in Technical Specification 3.2.4 shall not exceed the values shown in Figures 4.1 through 4.5.



LHGR	Average Planar Exposure
16.0	0
14.1	25,400
9.0	43,200
8.4	48,100

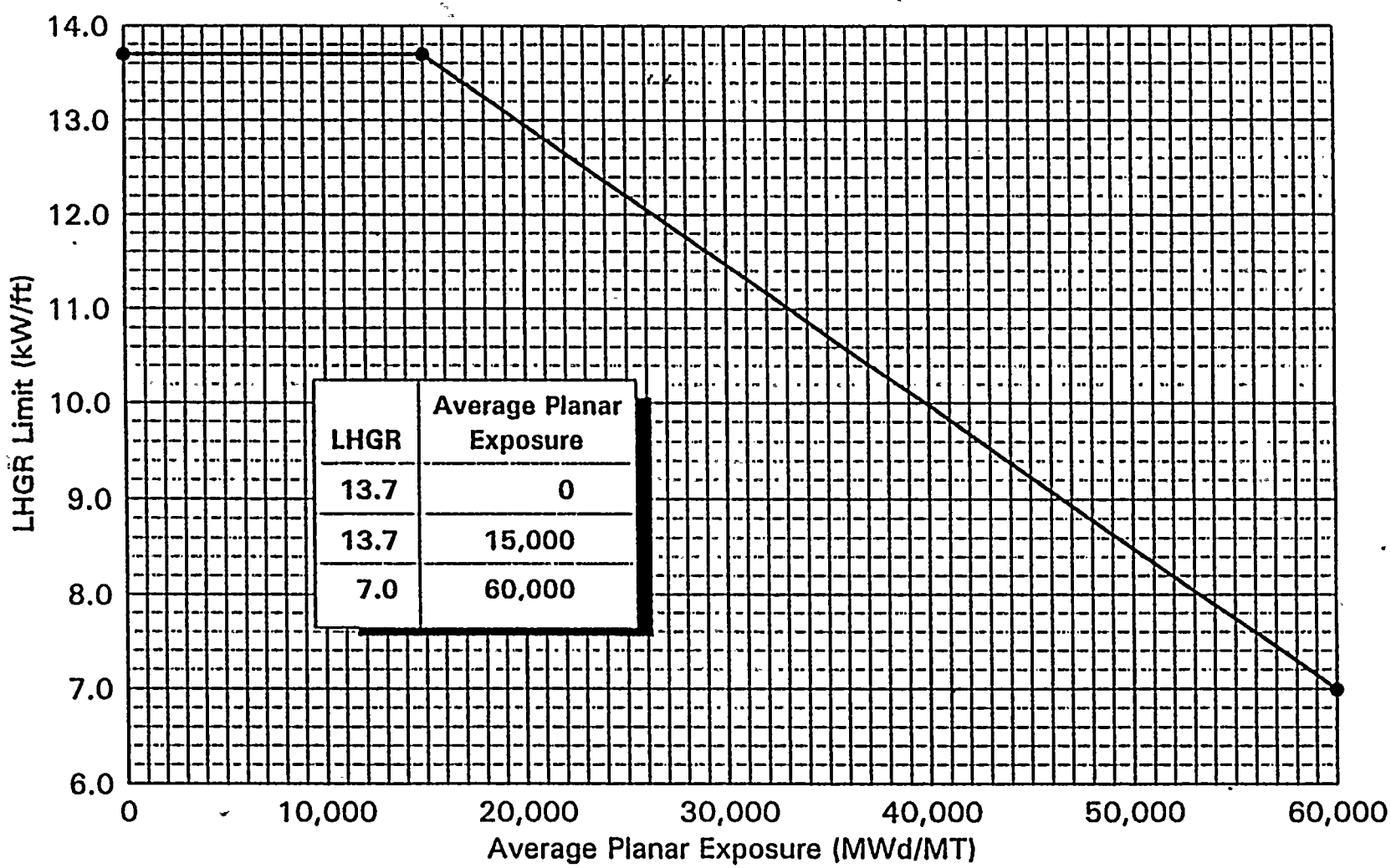
Linear Heat Generation Rate (LHGR) Limit Versus Average Planar Exposure SPC 8x8 Reload Fuel

Figure 4.1



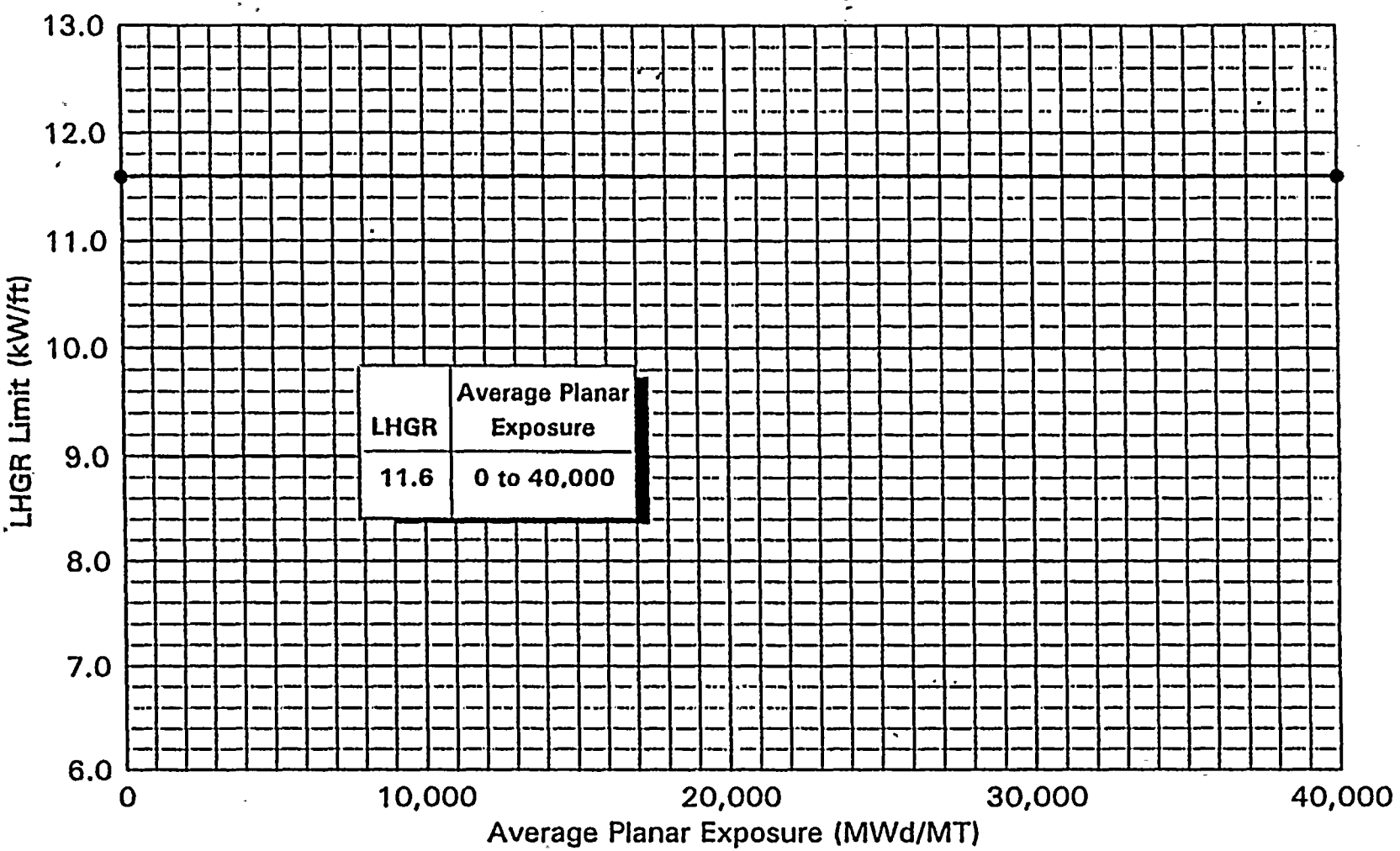
Linear Heat Generation Rate (LHGR) Limit Versus Average Planar Exposure SPC 9x9-9X Reload Fuel and SPC 9x9-9X LFA Fuel

Figure 4.2



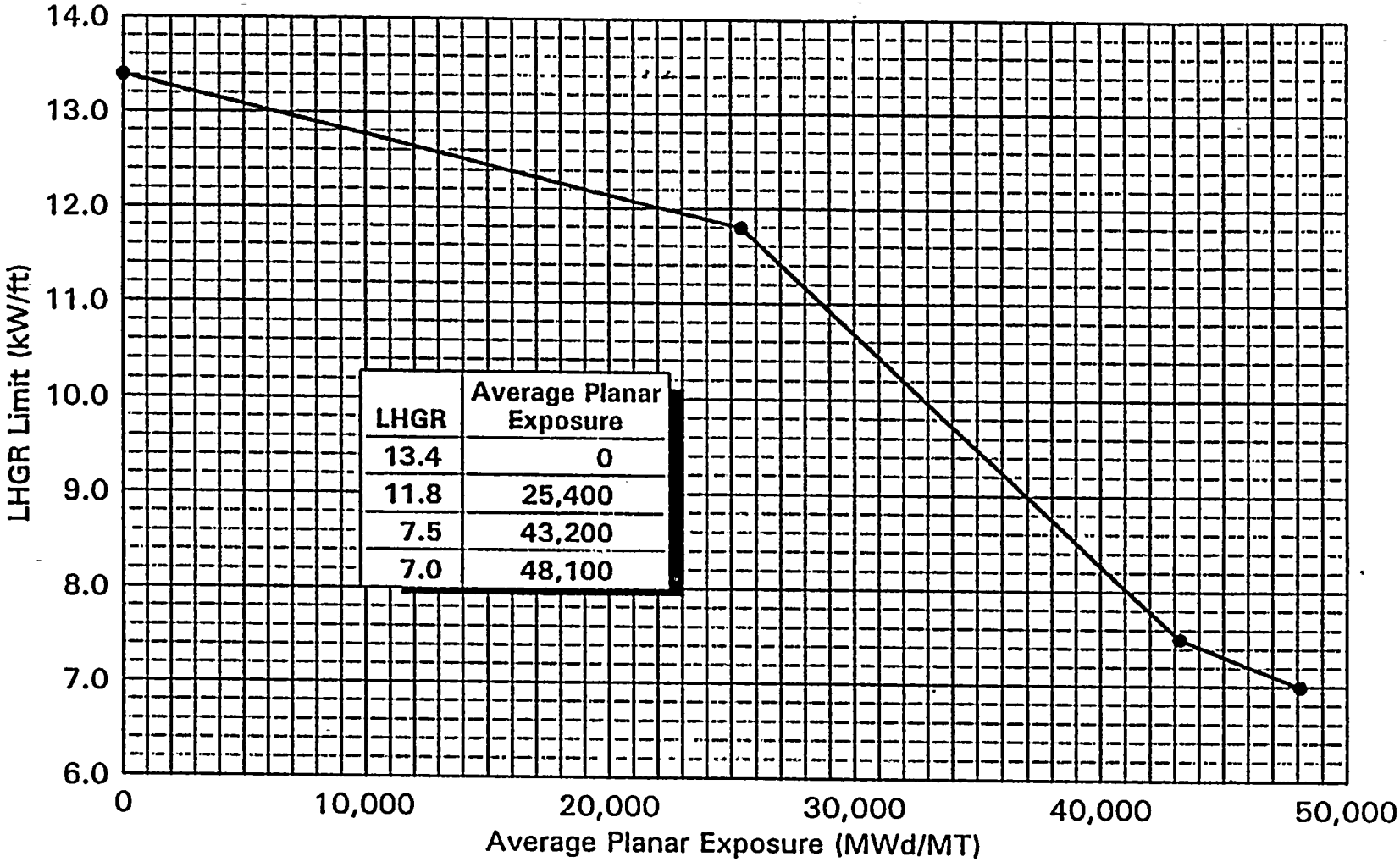
Linear Heat Generation Rate (LHGR) Limit Versus Average Planar Exposure SPC 9x9-IX LFA Fuel

Figure 4.3



Linear Heat Generation Rate (LHGR) Limit Versus Average Planar Exposure SVEA-96 LFA Fuel

Figure 4.4



Linear Heat Generation Rate (LHGR) Limit Versus Average Planar Exposure GE11 LFA Fuel

940610 13:46

Figure 4.5

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