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WNP-2

CYCLE 7

CORE OPERATING LIMITS REPORT

June 1991

WASHINGTON PUBLIC POWER SUPPLY SYSTEM

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WNP-2
CYCLE 7
CORE OPERATING LIMITS REPORT

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WNP-2 CYCLE 7
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 7 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 have been determined using NRC-approved methodology and are established such that all applicable limits of the plant safety analysis are met. The thermal limits given here are developed in the Cycle 7 Transient Analysis Report (Reference 1.0), and the Cycle 7 Reload Analysis Report (Reference 2.0).

Included in the WNP-2 Cycle 7 reload are four Advanced Nuclear Fuels (ANF), four General Electric (GE), and four ABB Atom (ABB) Lead Fuel Assemblies (LFA's). The four ANF LFA's were inserted at the beginning of Cycle 5 and were designed to be compatible with the reload utilized 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 for Cycle 6. The Supply System will load the LFA's in core locations which have been analyzed to have sufficient margin such that the LFA's are not expected to be the limiting assemblies in the core on either a nodal or an assembly power basis. This approach is intended to prevent the possibility of the LFA's from ever being the limiting fuel assemblies. 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 3.0). This reference describes the design goals of the GE11 LFA's, and provides support for monitoring the GE11 LFA's to thermal limits based on the ANF 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 4.0). The process for developing thermal limits for the SVEA-96 LFA fuel based upon the ANF 8x8 reload fuel thermal limits is described in this Reference.

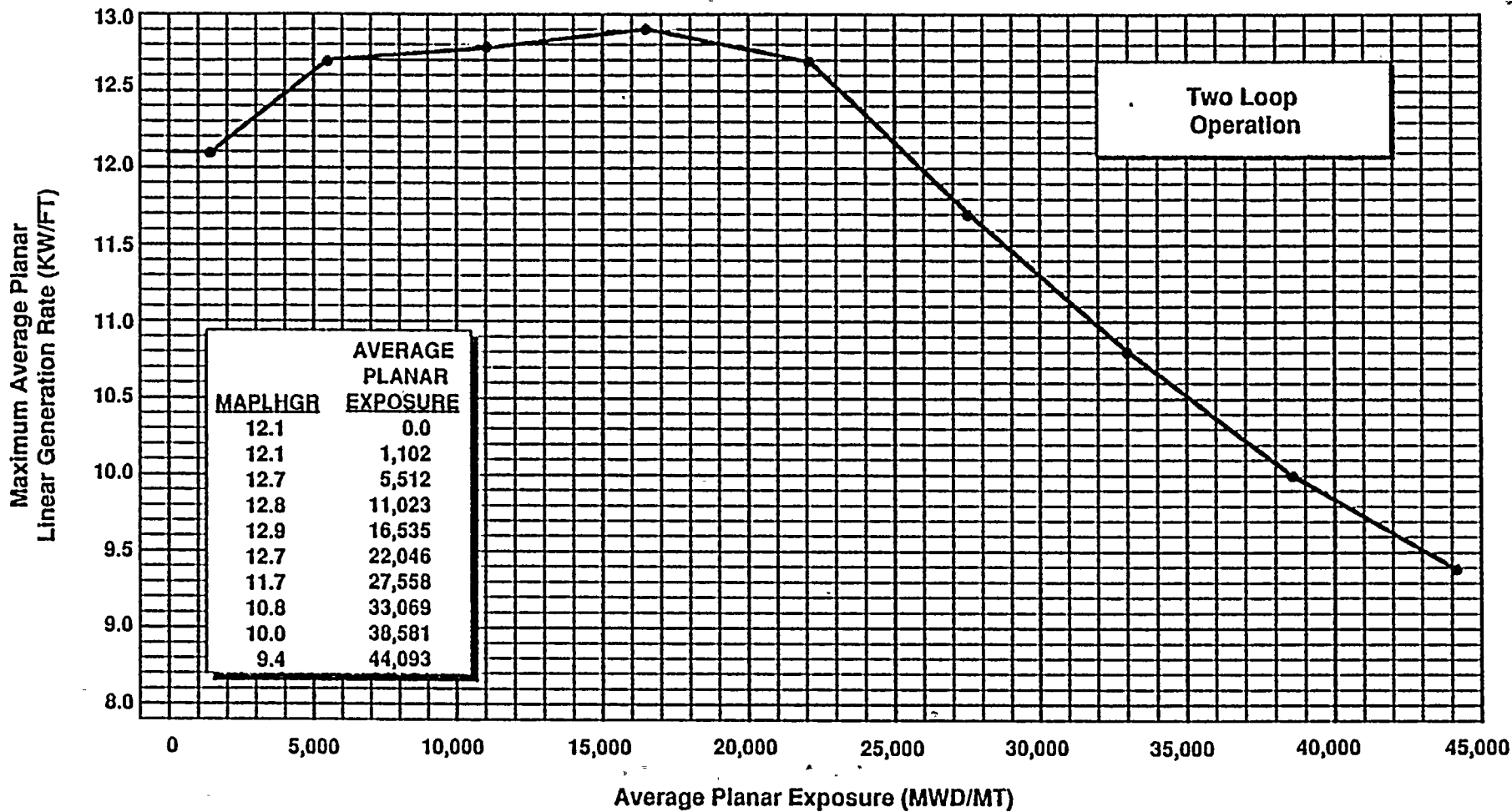
The MAPLHGR limit for the GE11 LFA's use the same values as the ANF 8x8 reload fuel, but a ratio $(64-2/81-7)$ is applied to account for the differing number of fuel pins in each assembly. The MAPLHGR limit for the SVEA-96 LFA's use the same values as the ANF 8x8 reload fuel, but a ratio $(64-2/100-4)$ is applied to account for the differing number of fuel pins in each assembly. Furthermore, the MAPLHGR limit on the SVEA-96 LFA's are multiplied by 1.04 to account for the underestimation of the local power in the output from POWERPLEX compared to the ABB Atom design. A multiplier of 1.02 is applied to the MAPLHGR limit to account for POWERPLEX underestimating exposure compared to ABB Atom methods.

A power dependent MCPR is specified in this report to define operating limits at other than rated power conditions. For this core, feedwater controller failure transients from reduced power are calculated to be more severe than from full power conditions, due to the greater change in feedwater flow. 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 is the maximum of the rated MCPR, the reduced power MCPR, and the reduced flow MCPR. This stipulation assures that the safety limit MCPR will not be violated throughout the WNP-2 operating regime.

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.

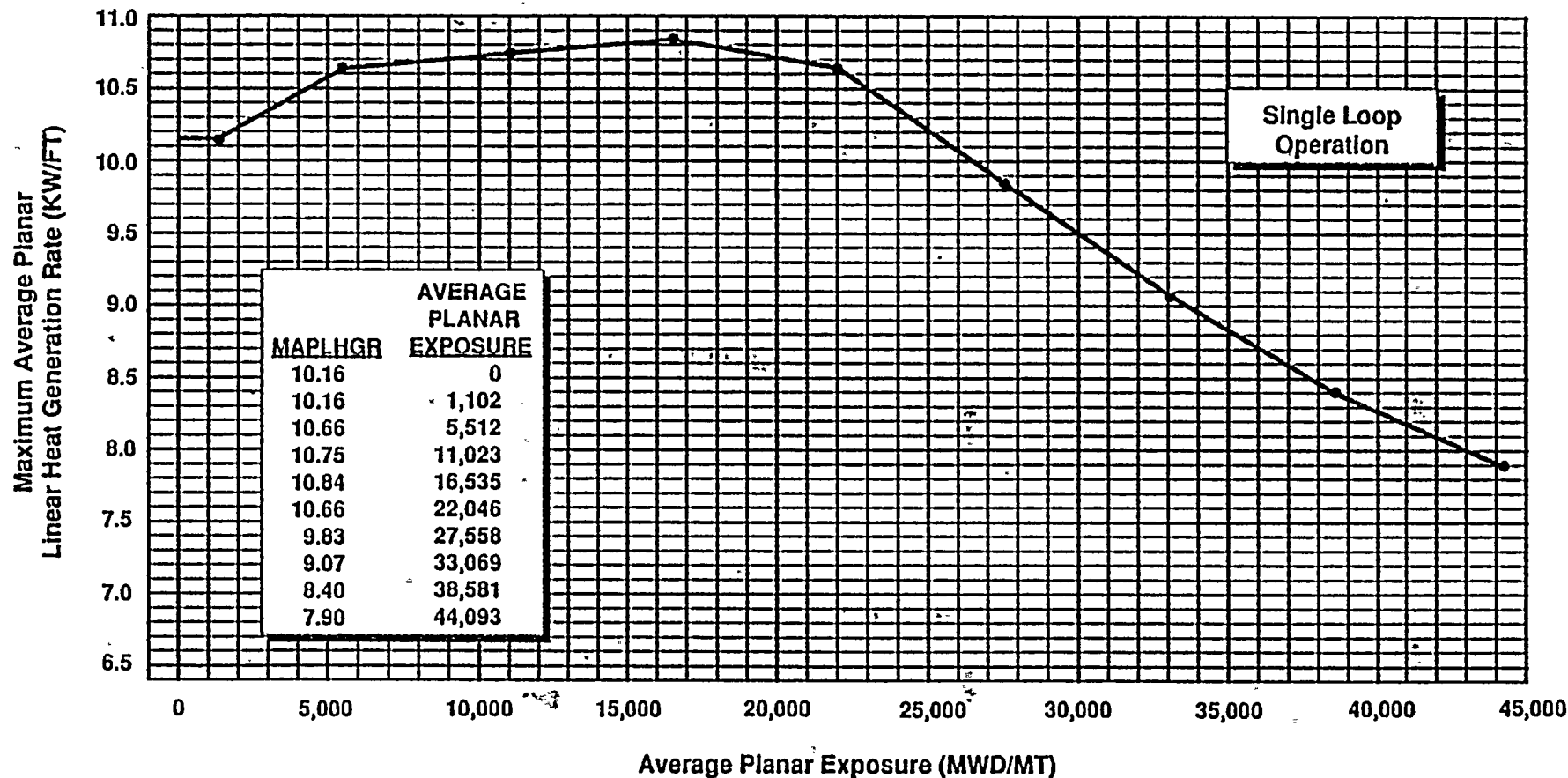
2.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR) LIMIT FOR USE IN TECHNICAL SPECIFICATION 3.2.1

The APLHGRs for use in Technical Specification 3.2.1 shall not exceed the limits shown in Figures 1, 3, 4, 6, and 7 when in two-loop operation and Figures 2, 3, 5, 6, and 7 when in single loop operation. The limits for each fuel type as a function of AVERAGE PLANAR EXPOSURE are provided for the General Electric initial core fuel, Advanced Nuclear Fuels fuel, including the ANF LFA's, SVEA-96 LFA fuel, and GE11 LFA fuel.



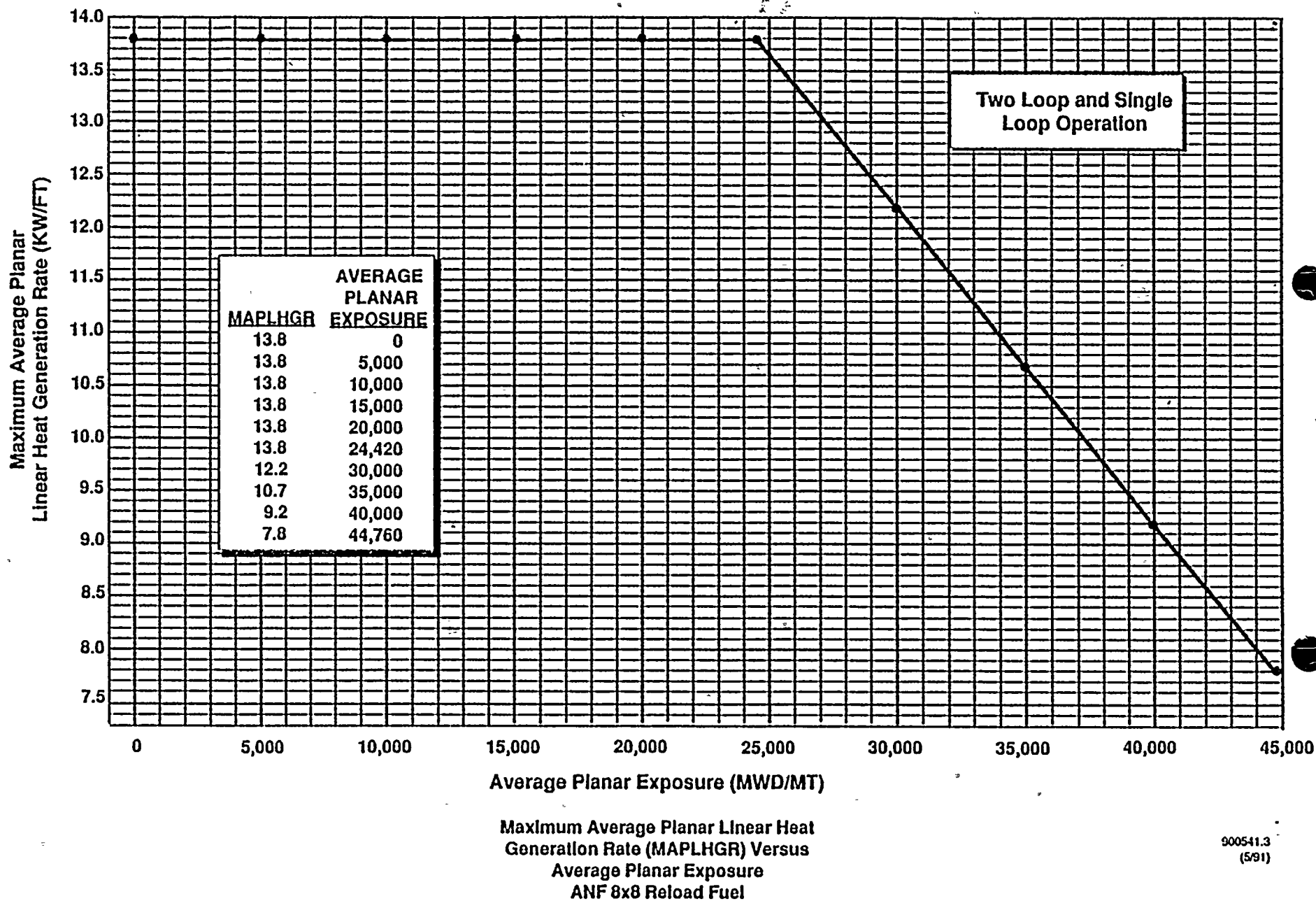
Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Versus Average Planar Exposure Initial Core Fuel Type 8CR183

Figure 1



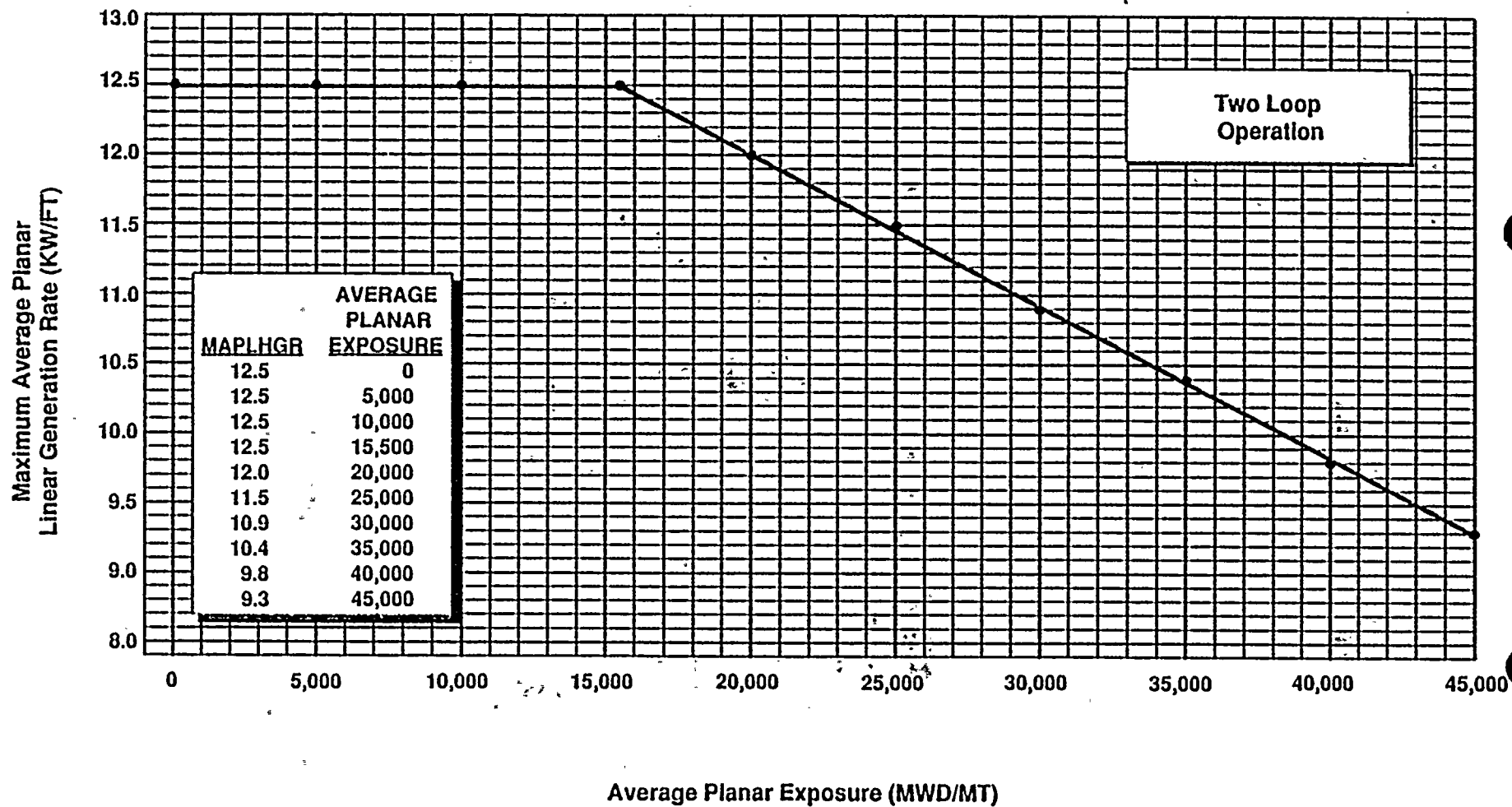
Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Versus Average Planar Exposure
Initial Core Fuel Type 8CR183

Figure 2

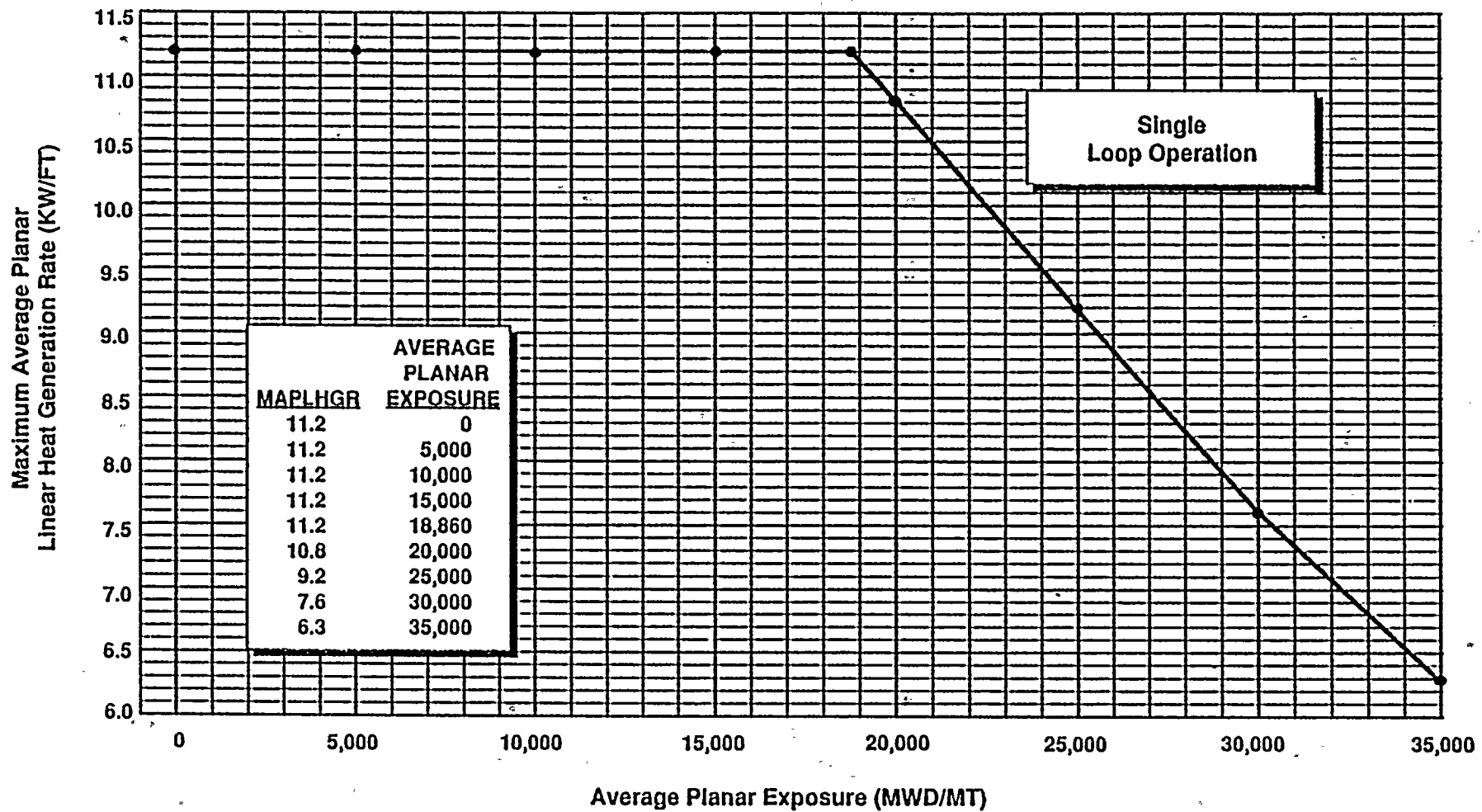


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Figure 3

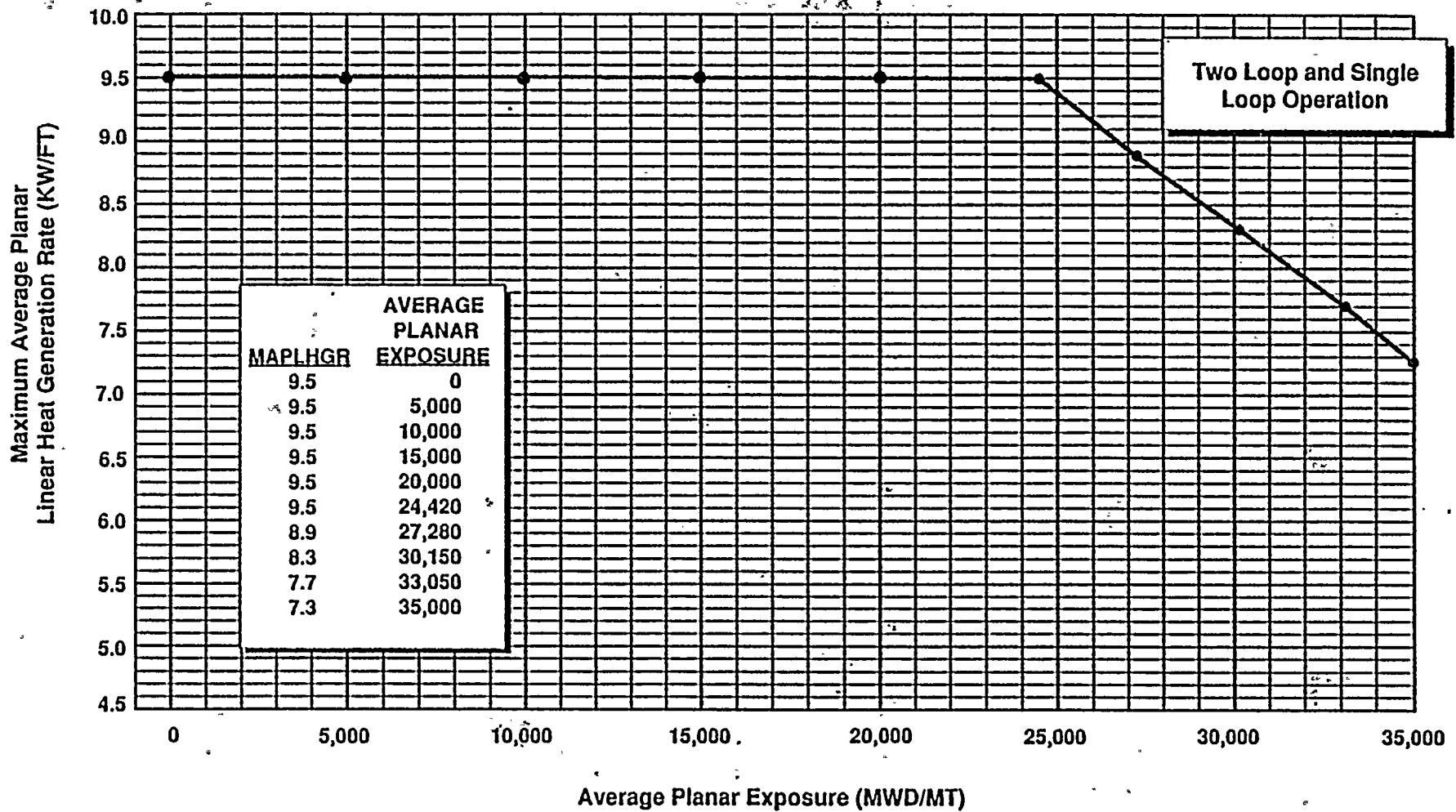


Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Versus Average Planar Exposure
9x9 - 9X Reload Fuel and ANF 9x9 LFA's
Figure 4



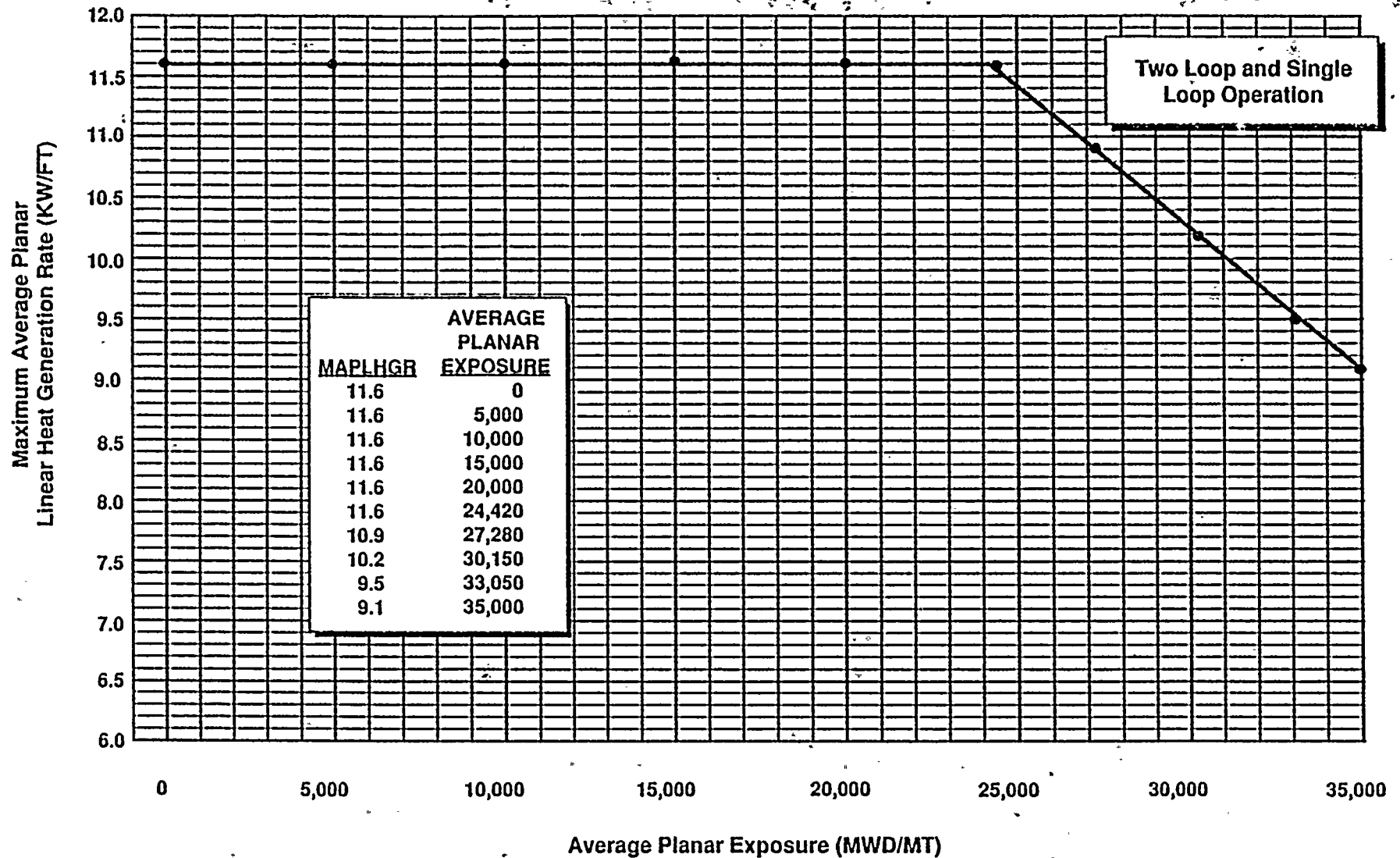
Maximum Average Planar Linear Heat
Generation Rate (MAPLHGR) Versus
Average Planar Exposure
9x9 - 9X Reload Fuel and ANF 9x9 LFA's

Figure 5



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

Figure 6



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

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Figure 7

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 Table 1 and Figures 8 through 27.

The MCPR limit is valid up to 104 percent power and up to 106 percent core flow.

Table 1
WNP-2 Cycle 7 MCPR Operating Conditions

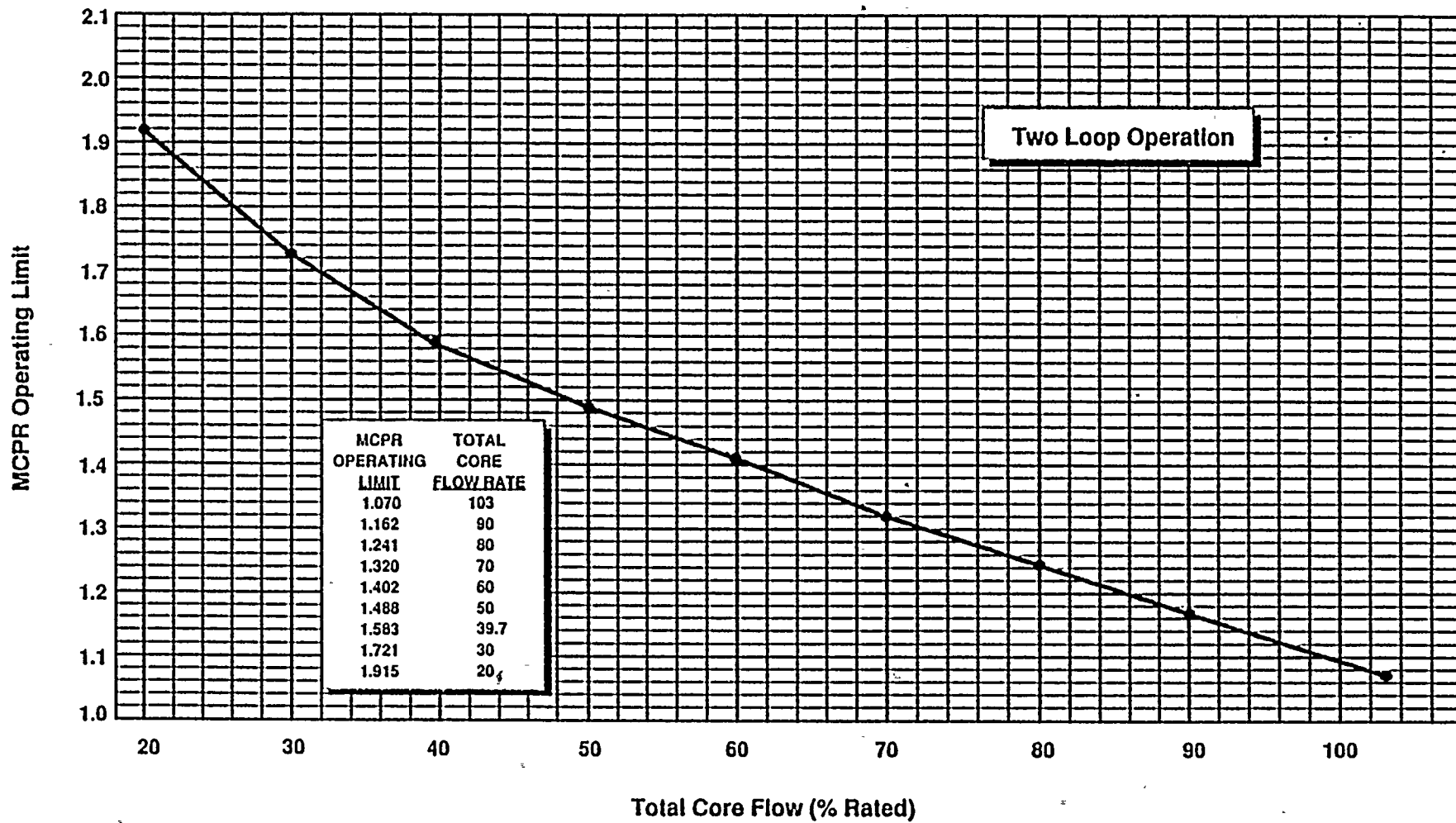
Condition	Limit	SLMCPR = 1.07 ≤4500 MWd/MTU				SLMCPR = 1.11 ≥4500 $\frac{\text{MWd}}{\text{MTU}}$ to EOC				SLMCPR = 1.11 FFTR			
		ANF 8x8 GE 8x8 GE11 LFA	ANF 9x9	ANF 9x9 LFA	SVEA 96 LFA	ANF 8x8 GE 8x8 GE11 LFA	ANF 9x9	ANF 9x9 LFA	SVEA 96 LFA	ANF 8x8 GE 8x8 GE11 LFA	ANF 9x9	ANF 9x9 LFA	SVEA 96 LFA
NSS ⁽¹⁾													
Full Power		1.23 ⁽²⁾	1.23 ⁽²⁾	1.23 ⁽²⁾	1.36	1.29	1.29	1.35	1.45	1.31	1.31	1.37	1.48
Flow Dependent		Figure 8				Figure 9				Figure 9			
Power Dependent		Fig. 10	Fig. 10	Fig. 11	Fig. 10	Fig. 14	Fig. 14	Fig. 15	Fig. 14	Fig. 18	Fig. 18	Fig. 19	Fig. 18
TSSS ⁽¹⁾													
Full Power		1.23 ⁽²⁾	1.23 ⁽²⁾	1.23 ⁽²⁾	1.36	1.34	1.35	1.42	1.52	Not analyzed			
Flow Dependent		Figure 8				Figure 9							
Power Dependent		Fig. 12	Fig. 12	Fig. 13	Fig. 12	Fig. 16	Fig. 16	Fig. 17	Fig. 16				
RPT Inoperable; NSS													
Full Power		1.23 ⁽²⁾	1.23 ⁽²⁾	1.23 ⁽²⁾	1.36	1.37	1.38	1.48	1.57	Not analyzed			
Flow Dependent		Figure 8				Figure 9							
Power Dependent		Fig. 20	Fig. 20	Fig. 21	Fig. 20	Fig. 22	Fig. 22	Fig. 23	Fig. 22				
Class Inoperable; NSS													
Full Power		1.23 ⁽²⁾	1.23 ⁽²⁾	1.23 ⁽²⁾	1.36	1.35	1.35	1.40	1.54	Not analyzed			
Flow Dependent		Figure 8				Figure 9							
Power Dependent		Fig. 24	Fig. 24	Fig. 25	Fig. 24	Fig. 26	Fig. 26	Fig. 27	Fig. 26				
SLO; NSS													
Full Power		1.56	1.36	1.36	1.85	1.56	1.36	1.36	1.85	1.56	1.36	1.37	1.85
Flow Dependent		None				None				None			
Power Dependent		Fig. 10	Fig. 10	Fig. 11	Fig. 10	Fig. 14	Fig. 14	Fig. 15	Fig. 14	Fig. 18	Fig. 18	Fig. 19	Fig. 18
SLO; TSSS													
Full Power		1.56	1.36	1.36	1.85	1.56	1.36	1.36	1.85	Not analyzed			
Flow Dependent		None				None							
Power Dependent		Fig. 12	Fig. 12	Fig. 13	Fig. 12	Fig. 16	Fig. 16	Fig. 17	Fig. 16				
SLO; RPT Inop.; NSS													
Full Power		1.56	1.36	1.36	1.85	1.56	1.38	1.48	1.85	Not analyzed			
Flow Dependent		None				None							
Power Dependent		Fig. 20	Fig. 20	Fig. 21	Fig. 20	Fig. 22	Fig. 22	Fig. 23	Fig. 22				
Class Inop.; Bypass Inop.; NSS													
Full Power		1.56	1.36	1.36	1.85	1.56	1.36	1.40	1.85	Not analyzed			
Flow Dependent		None				None							
Power Dependent		Fig. 24	Fig. 24	Fig. 25	Fig. 24	Fig. 26	Fig. 26	Fig. 27	Fig. 26				

NOTES FOR TABLE 1

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

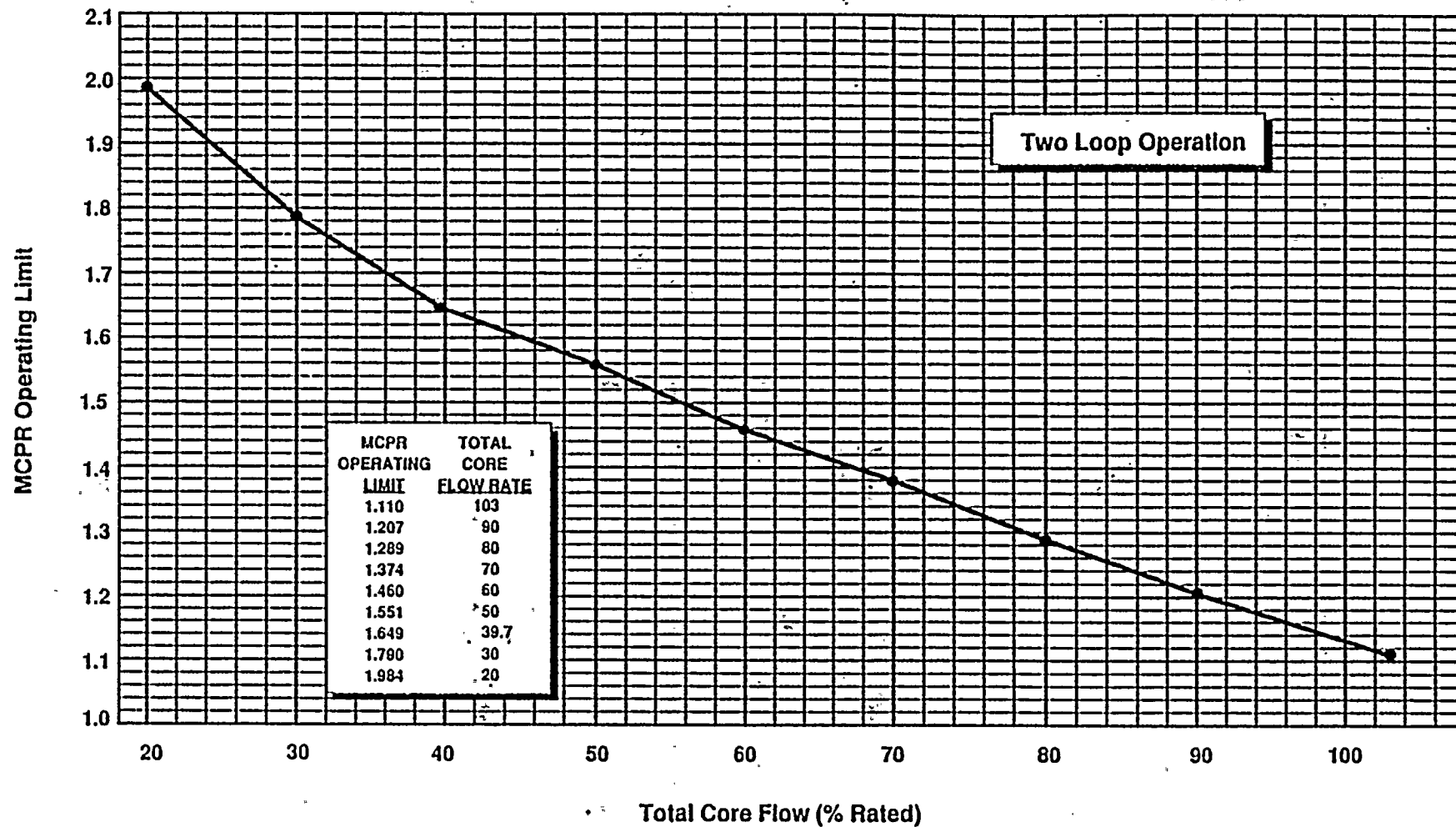
<u>Position Inserted From Fully Withdrawn</u>	<u>Slowest measured average control rod insertion times to specified notches for all operable control rods for each group of 4 control rods arranged in a two-by-two array (seconds)</u>
Notch 45	0:404
Notch 39	0.660
Notch 25	1.504
Notch 5	2.624

Note 2: The control rod withdrawal error analysis, which provides the limiting MCPR full power values for exposures less than 4500 MWD/MTU, 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 11.0, consistent with approved industry practice.



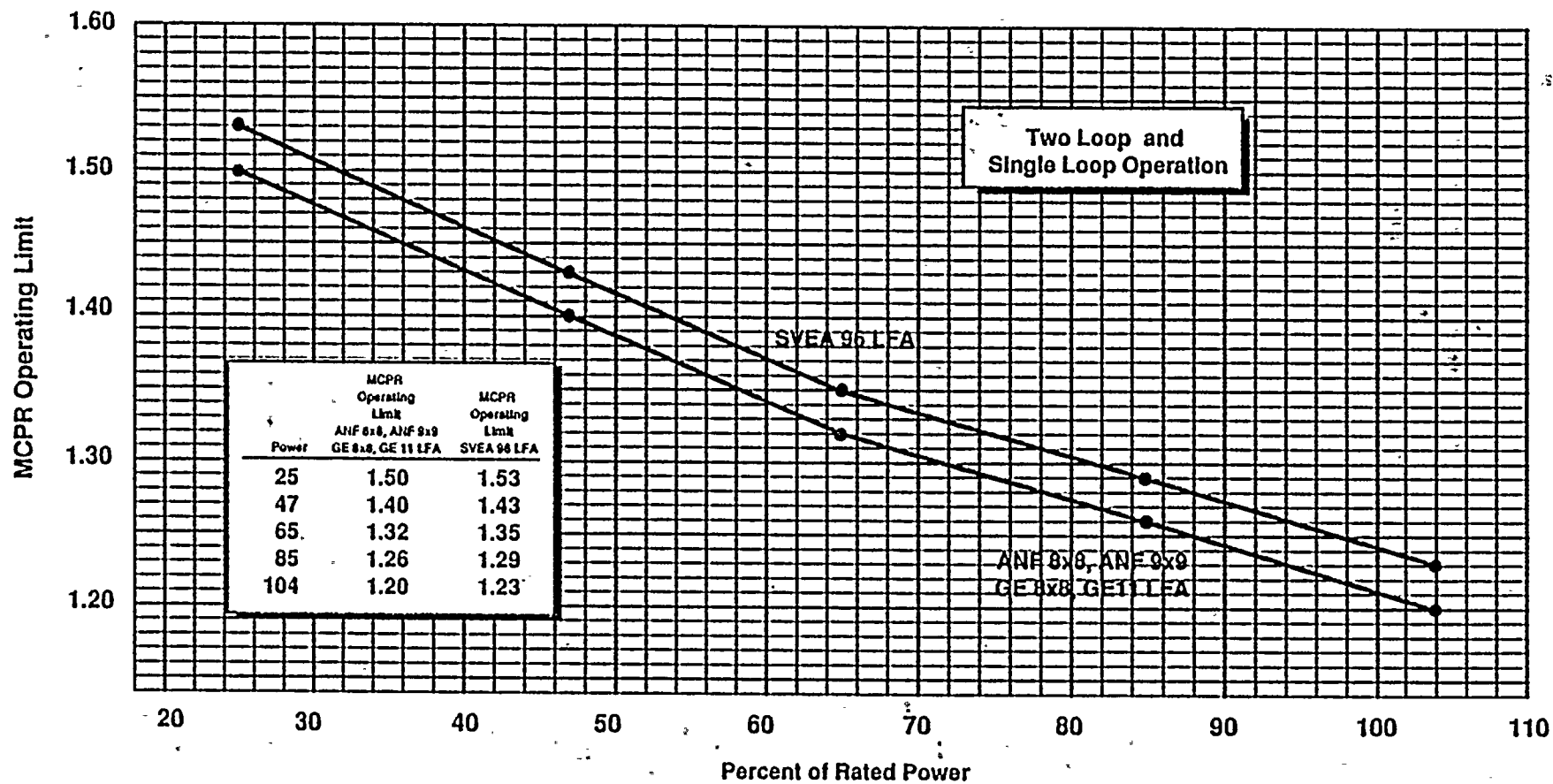
Reduced Flow MCPR Operating Limit
Versus Total Core Flow
All Fuel in WNP-2 Cycle 7
<4500 MWD/MTU

Figure 8



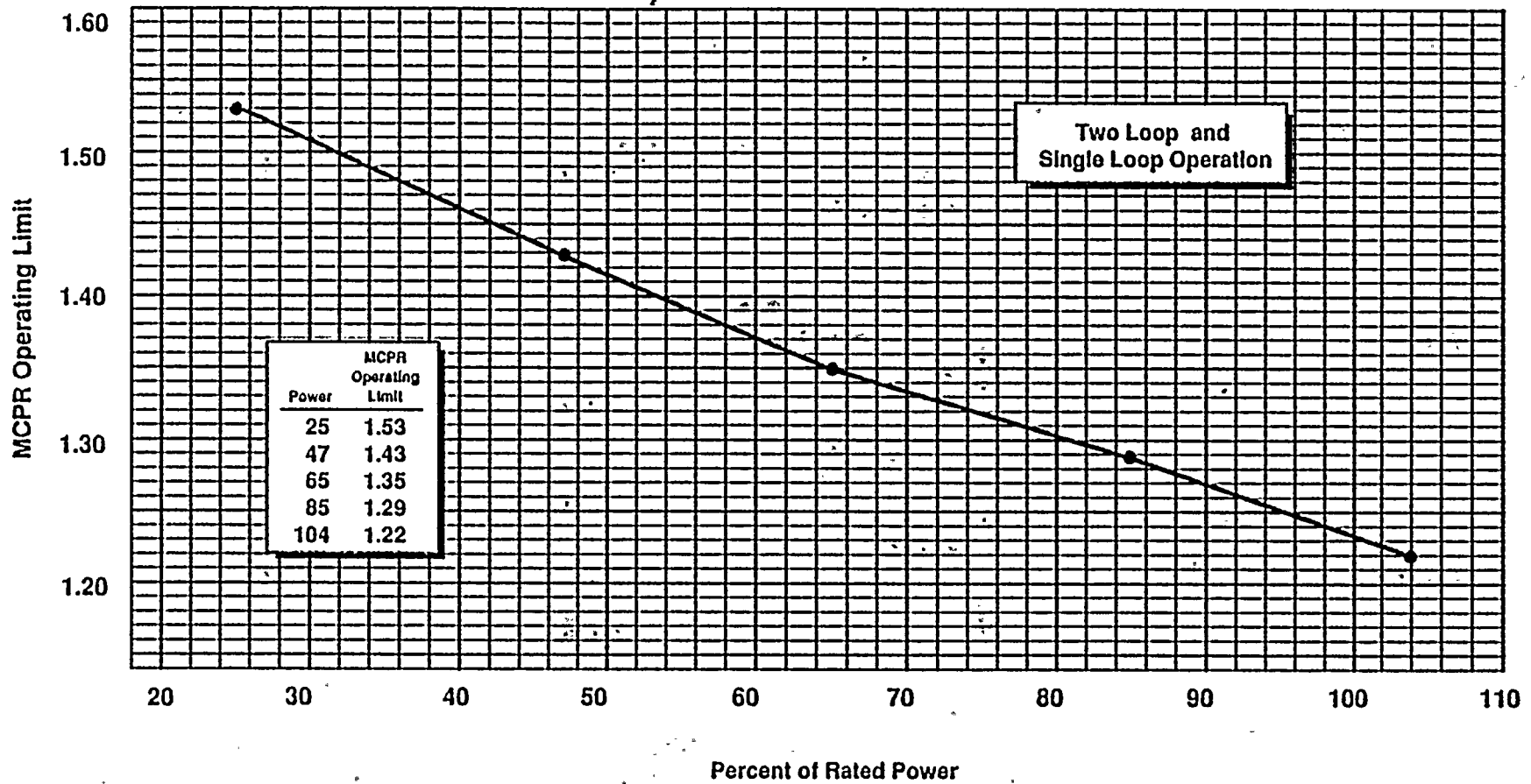
Reduced Flow MCPR Operating Limit
Versus Total Core Flow
All Fuel In WNP-2 Cycle 7
≥4500 MWD/MTU
Applicable to FFTR operation

Figure 9



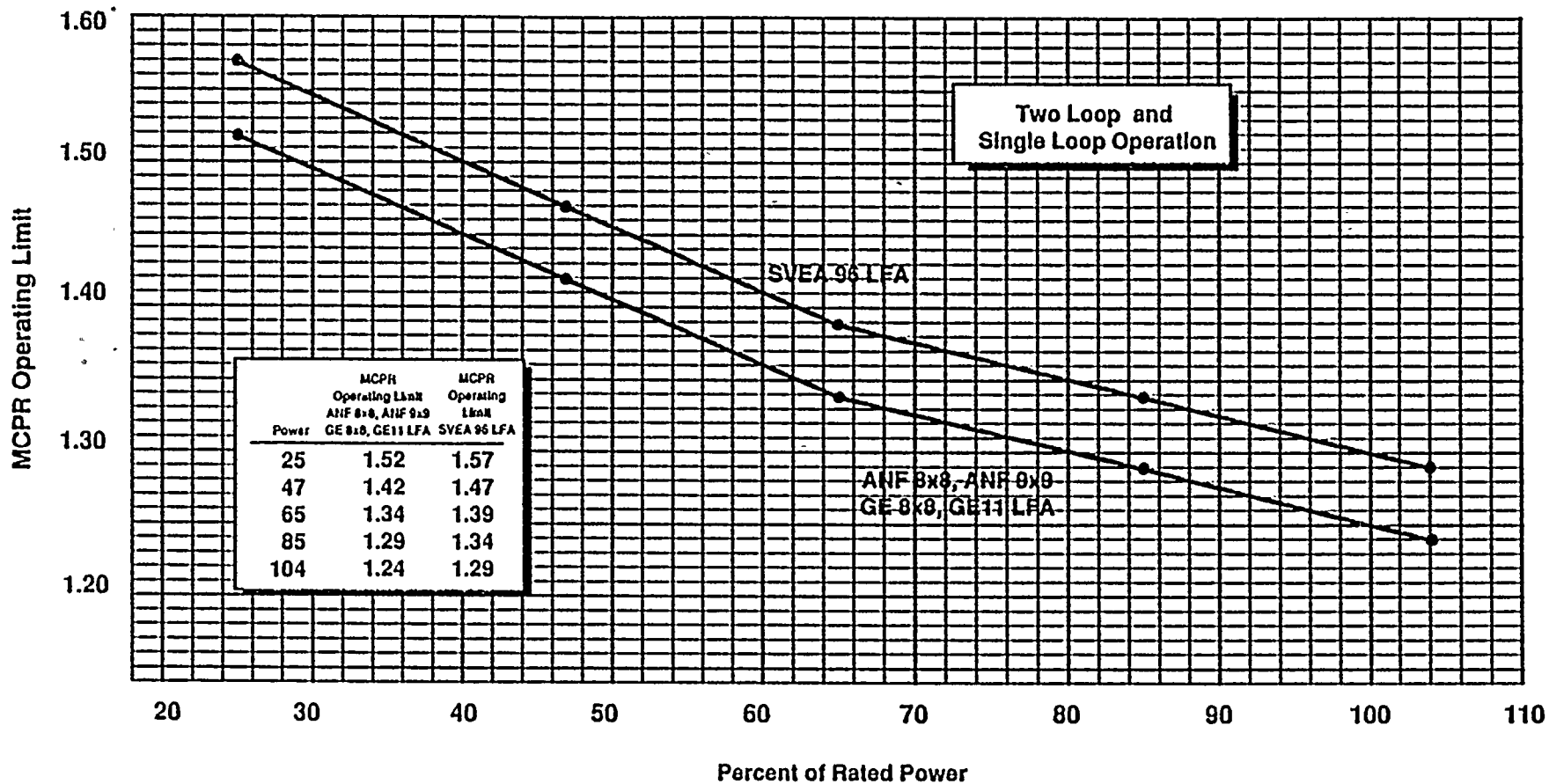
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Operable
ANF 8x8, ANF 9x9, GE 8x8, GE 11 LFA, SVEA 96 LFA
<4500 MWD/MTU

Figure 10



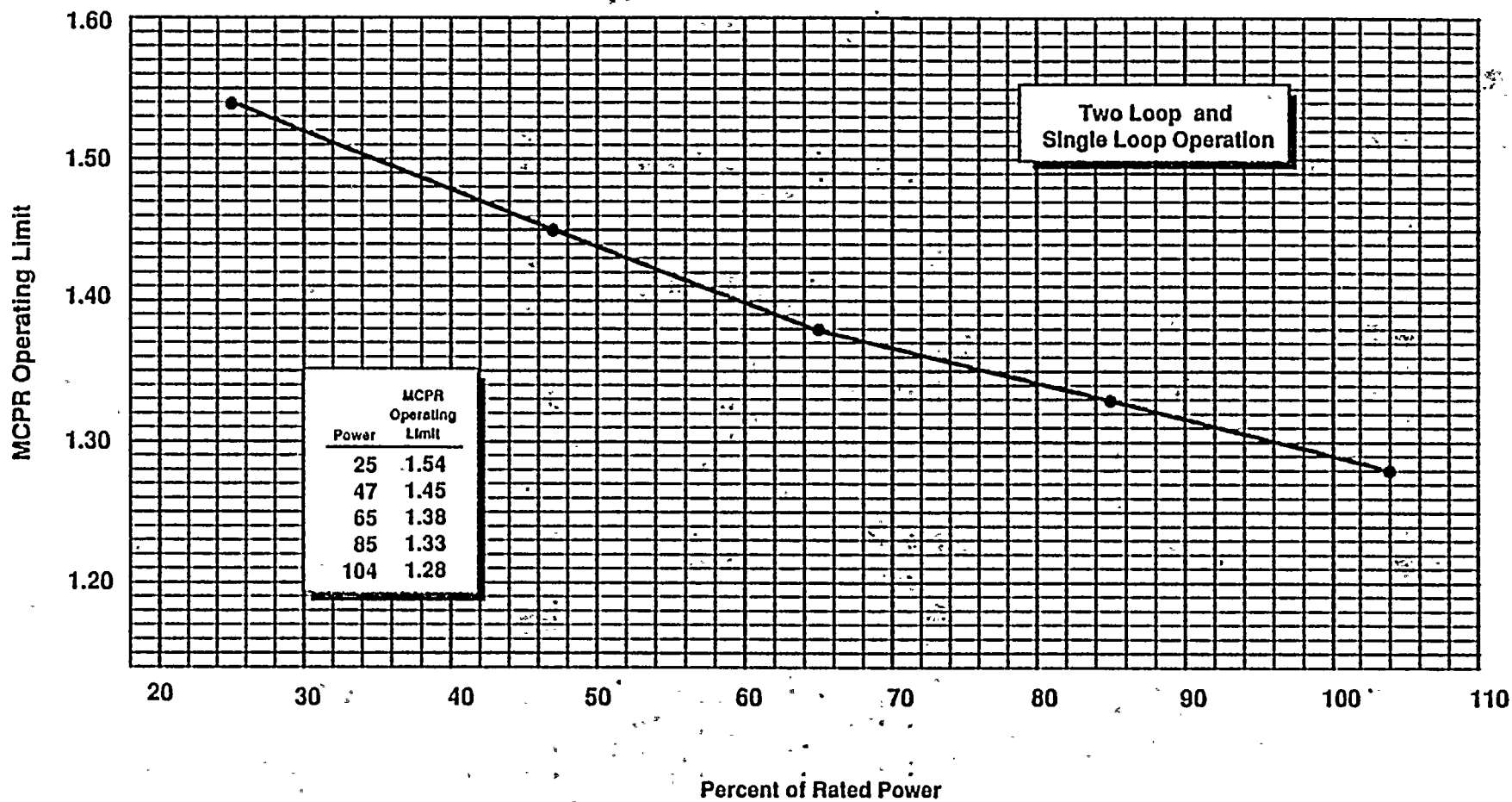
Reduced Power M CPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Operable
ANF 9x9 LFA
<4500 MWD/MTU

Figure 11



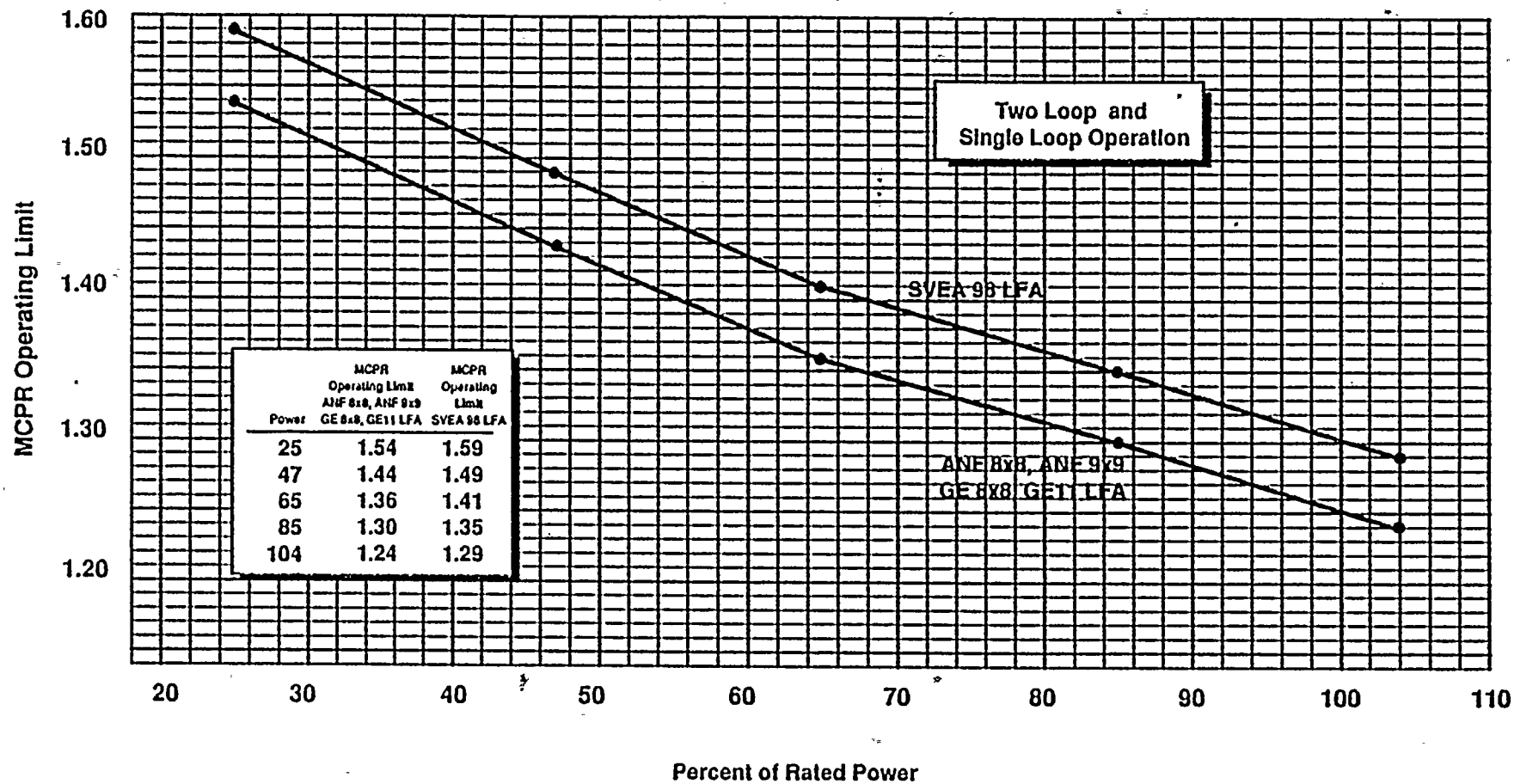
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable, Bypass Operable
ANF 8x8, ANF 9x9, GE 8x8, GE 11 LFA, SVEA 96 LFA
<4500 MWD/MTU

Figure 12



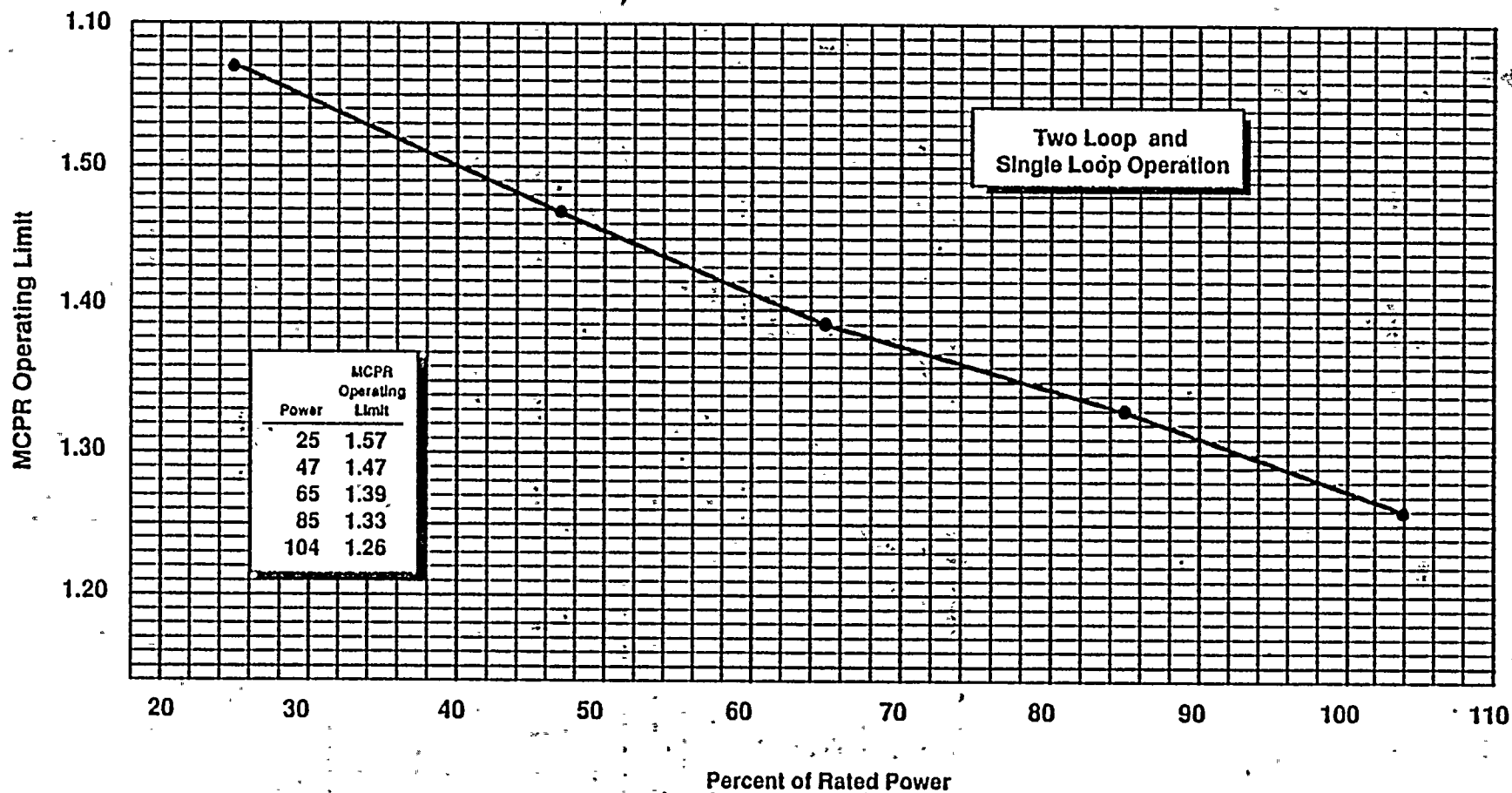
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable, Bypass Operable
ANF 9x9 LFA
<4500 MWD/MTU

Figure 13



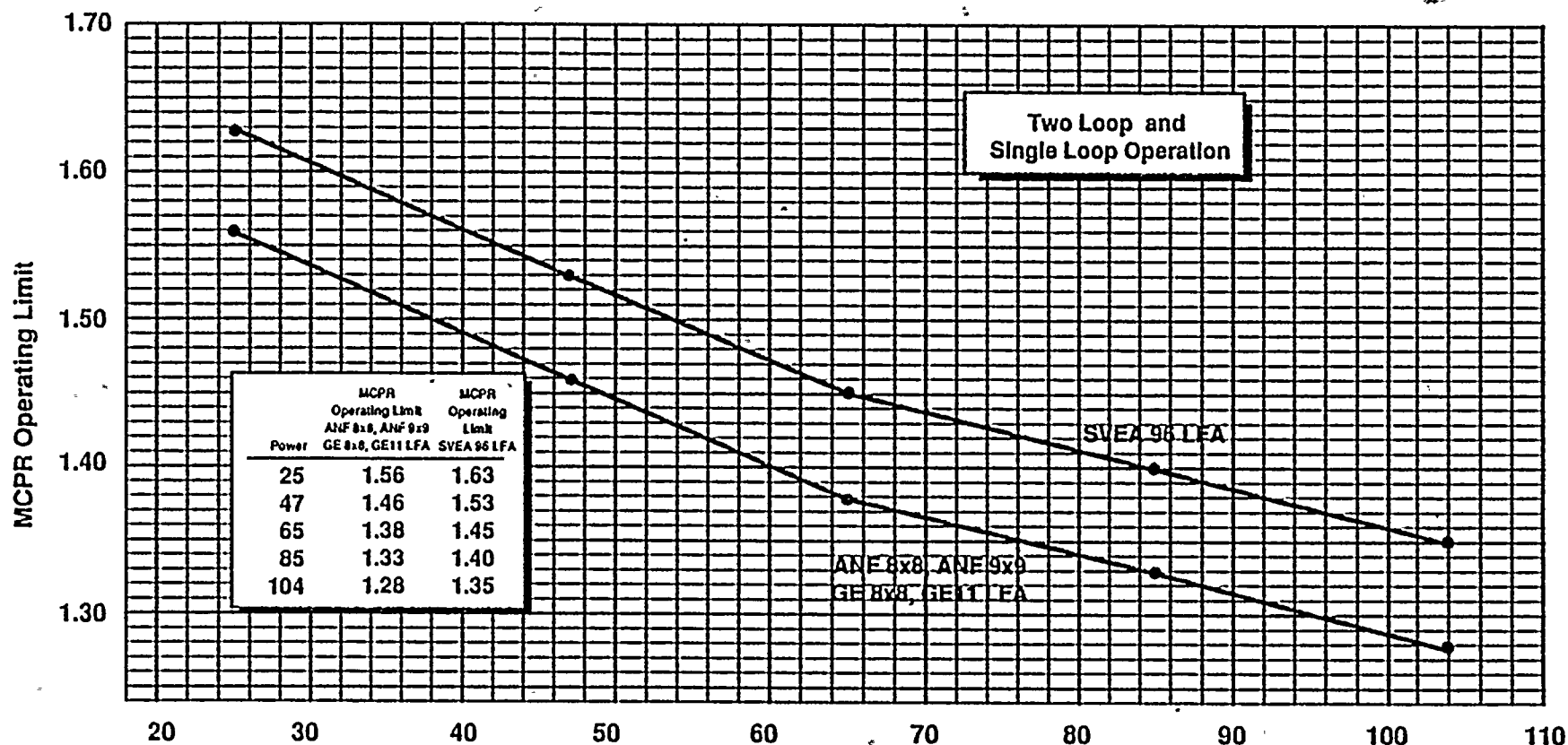
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Operable
ANF 8x8, ANF 9x9, GE 8x8, GE 11 LFA, SVEA 96 LFA
≥4500 MWD/MTU

Figure 14



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Operable
ANF 9x9 LFA
≥4500 MWD/MTU

Figure 15



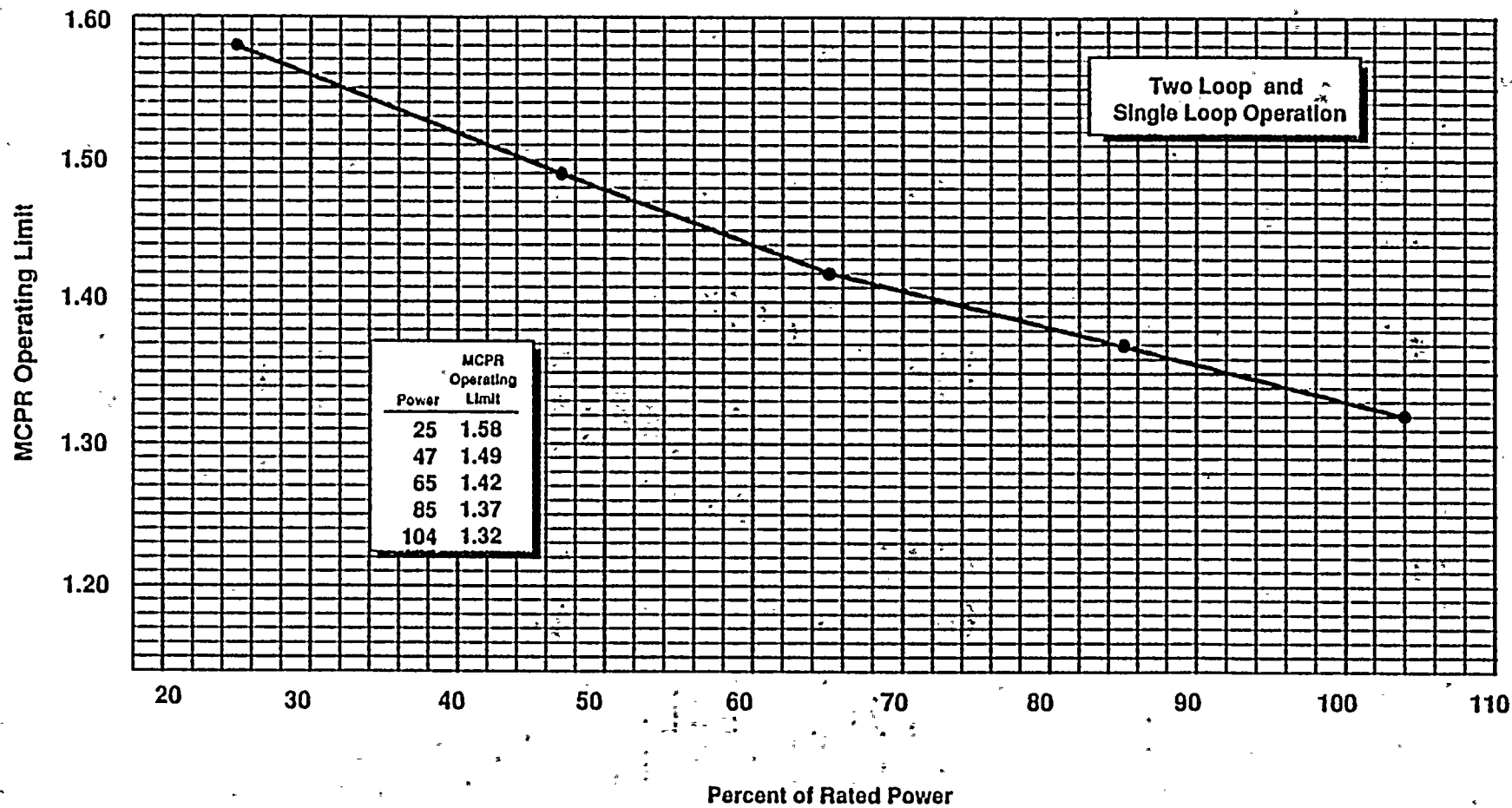
Percent of Rated Power

Reduced Power MCPR Operating Limit
 Versus Percent of Rated Power

TSSS, RPT Operable, Bypass Operable

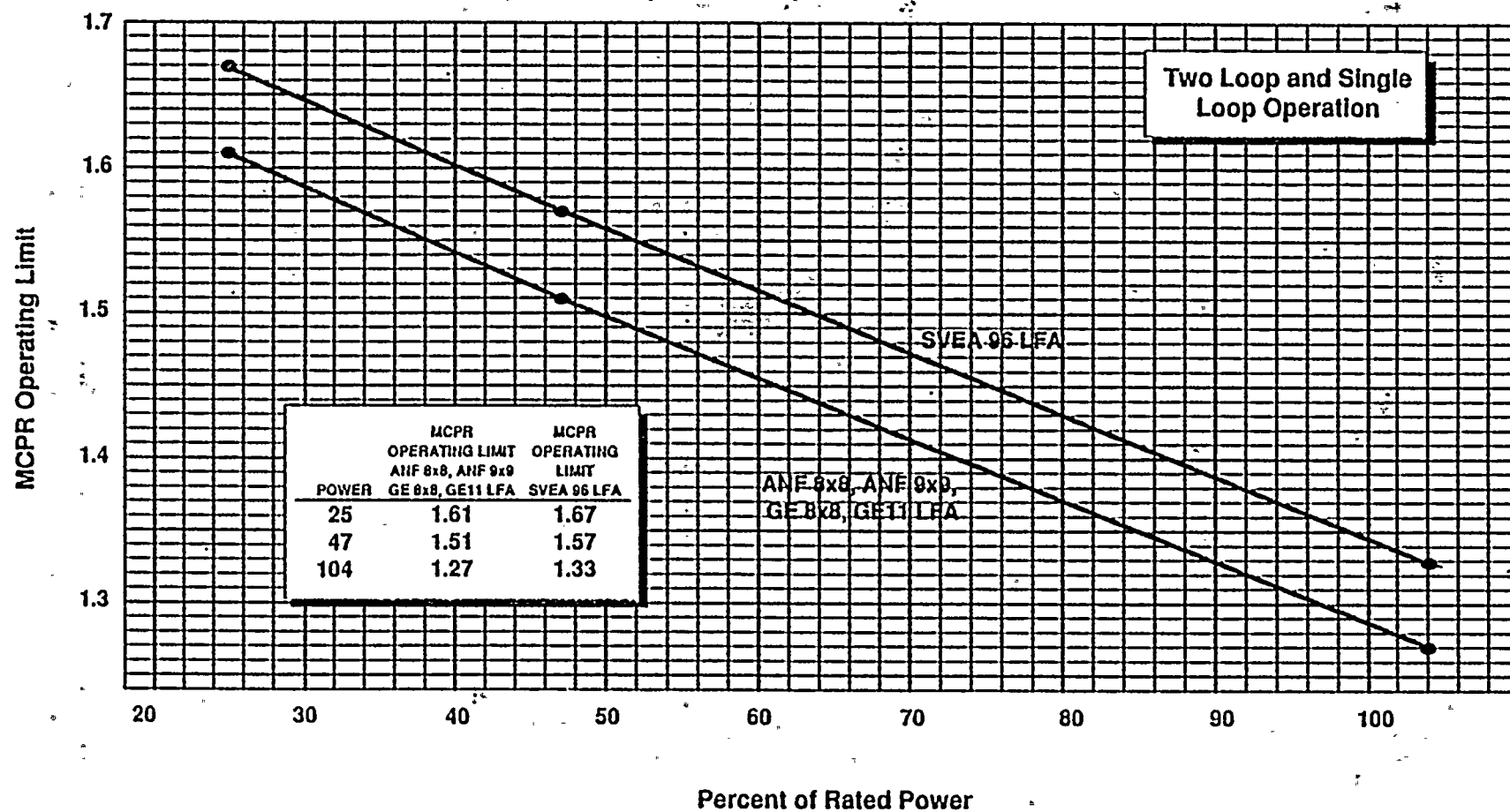
ANF 8x8, ANF 9x9, GE 8x8, GE11 LFA, SVEA 96 LFA
 ≥ 4500 MWD/MTU

Figure 16



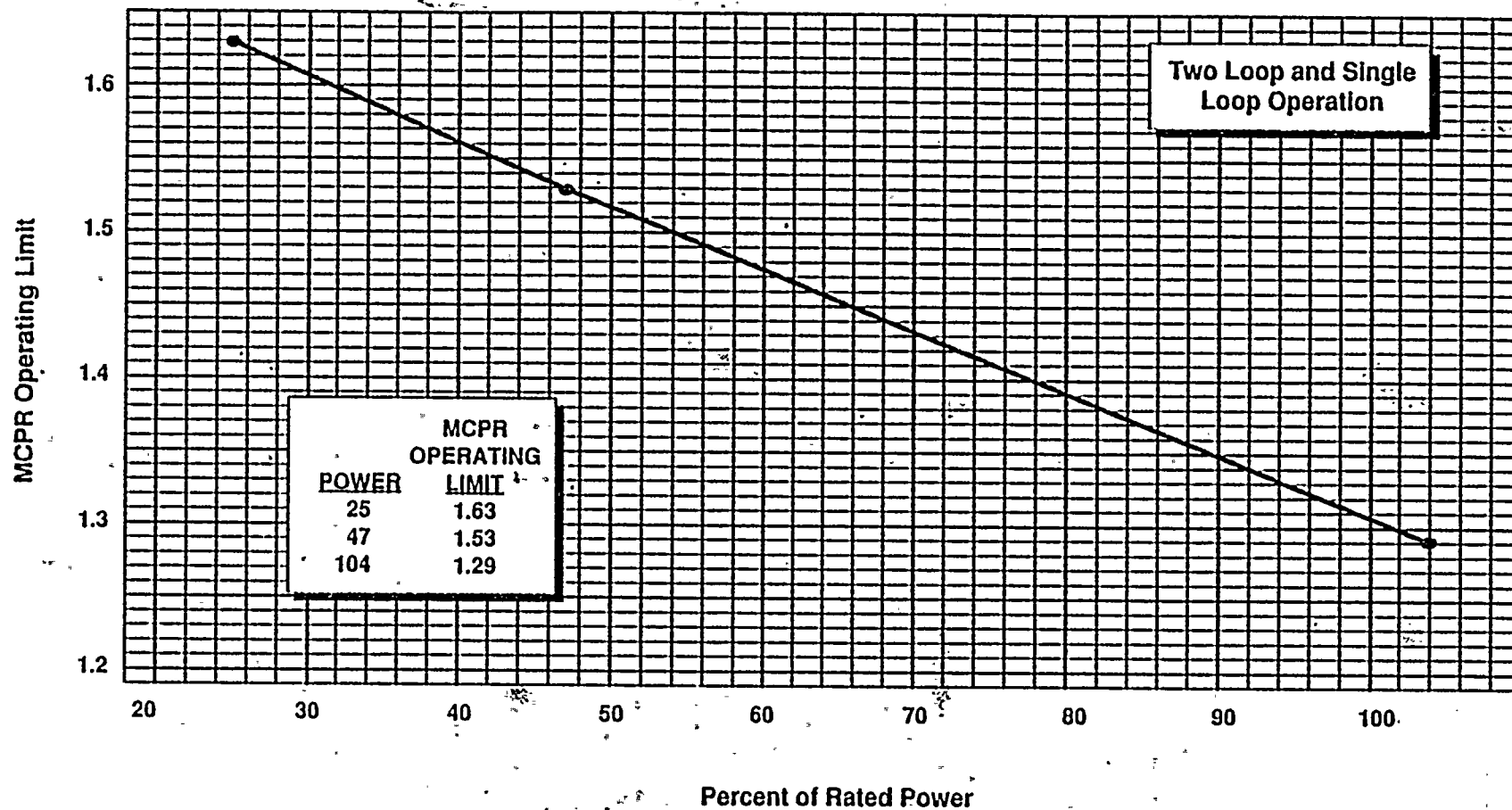
Reduced Power M CPR Operating Limit
Versus Percent of Rated Power
TSSS, RPT Operable, Bypass Operable
ANF 9x9 LFA
≥4500 MWD/MTU

Figure 17



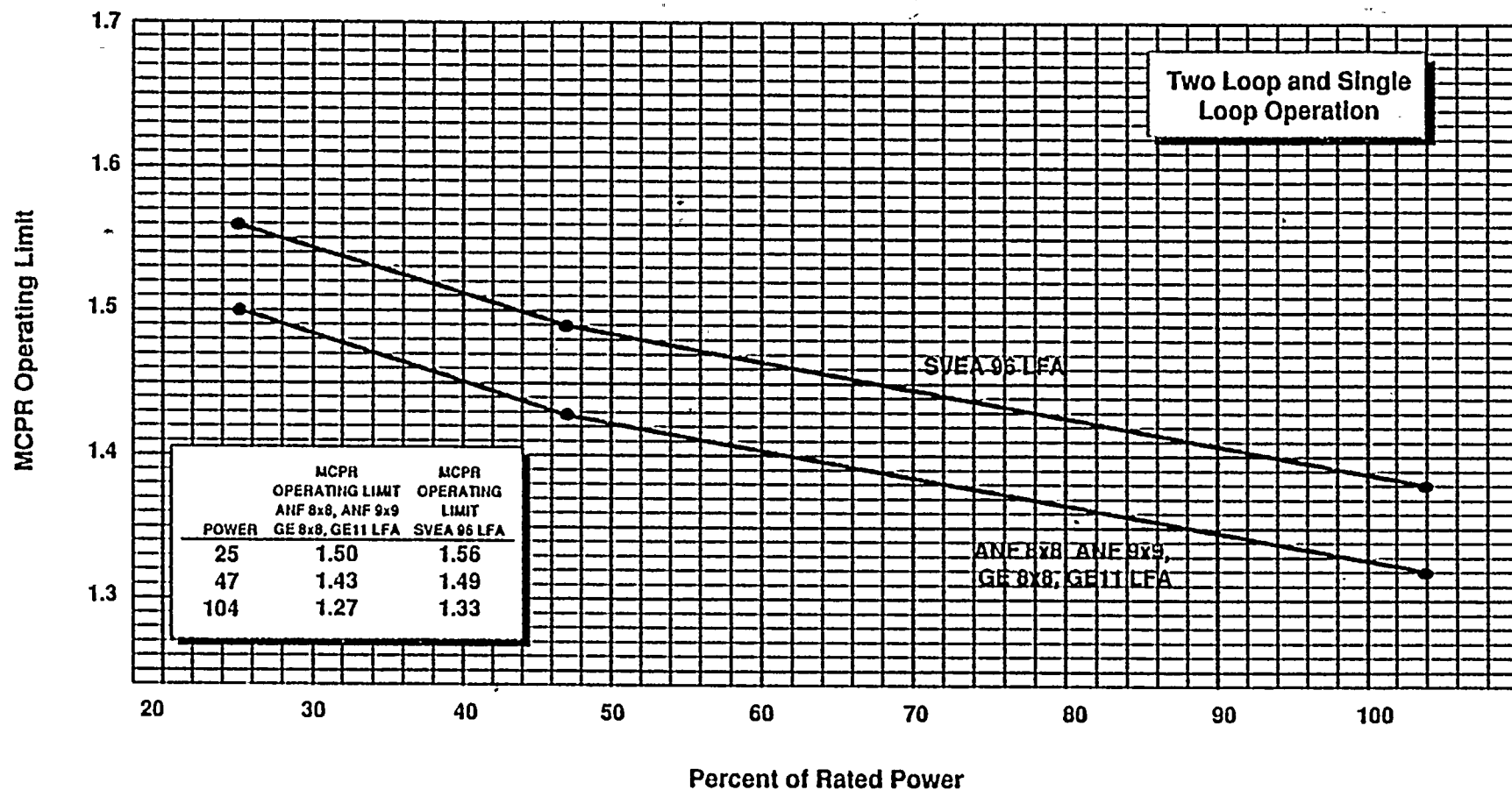
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
FFTR Operation
NSS, RPT Operable, Bypass Operable
ANF 8x8, ANF 9x9, GE 8x8, GE11 LFA, SVEA 96 LFA

Figure 18



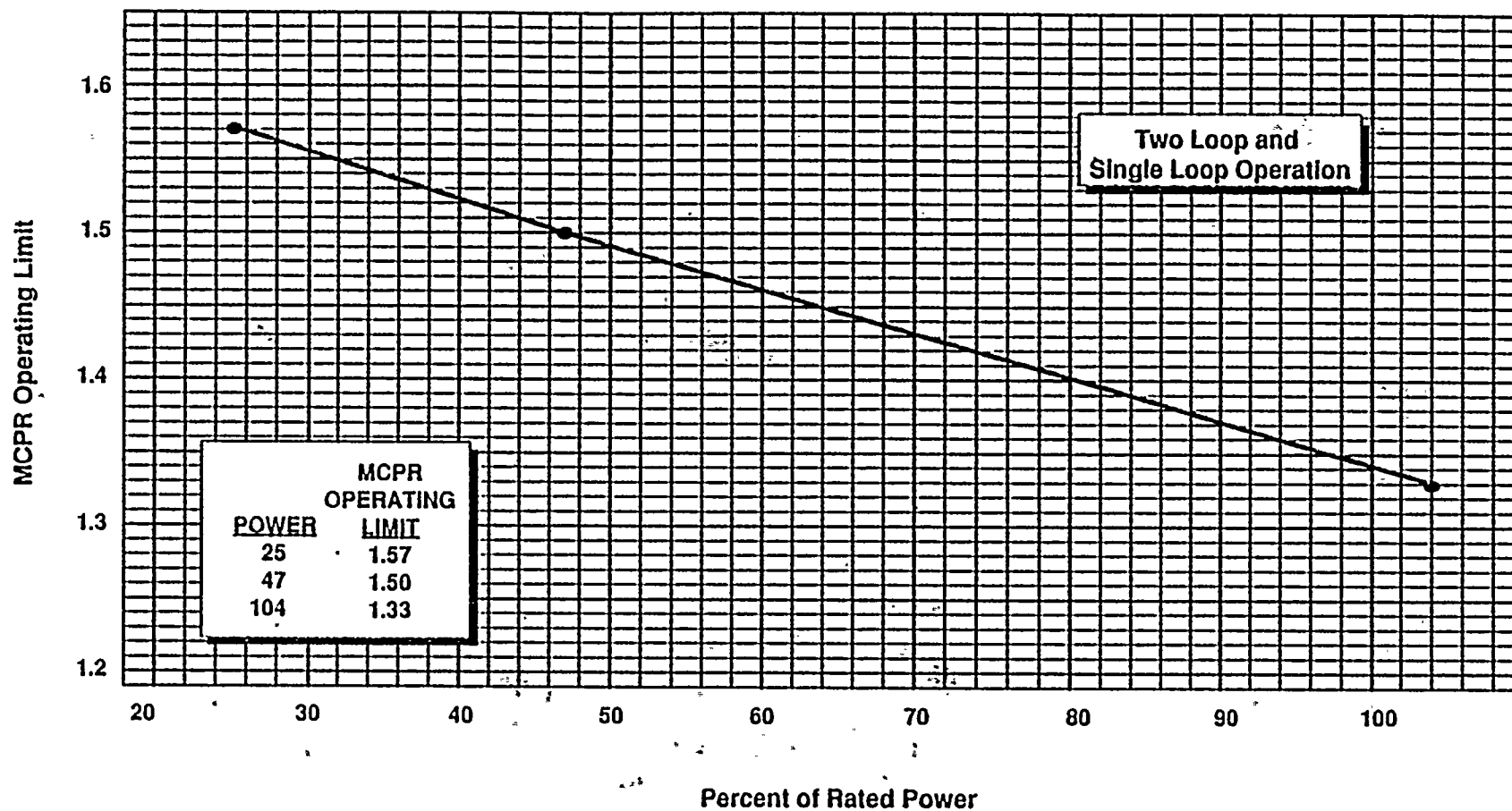
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
FFTR Operation
NSS, RPT Operable, Bypass Operable
ANF 9x9 LFA

Figure 19



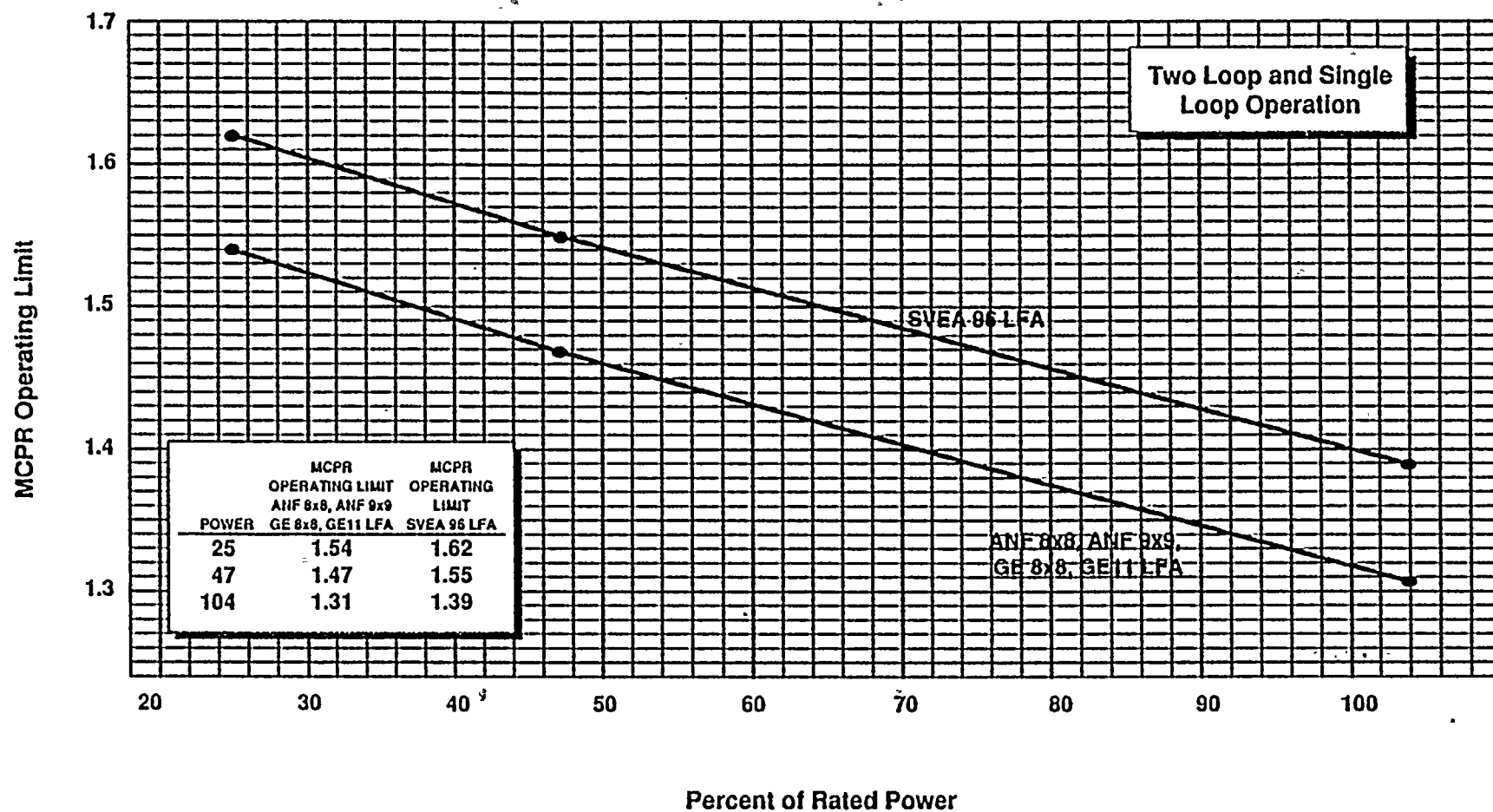
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
ANF 8x8, ANF 9x9, GE 8x8, GE 11 LFA, SVEA 96 LFA
<4500 MWD/MTU

Figure 20



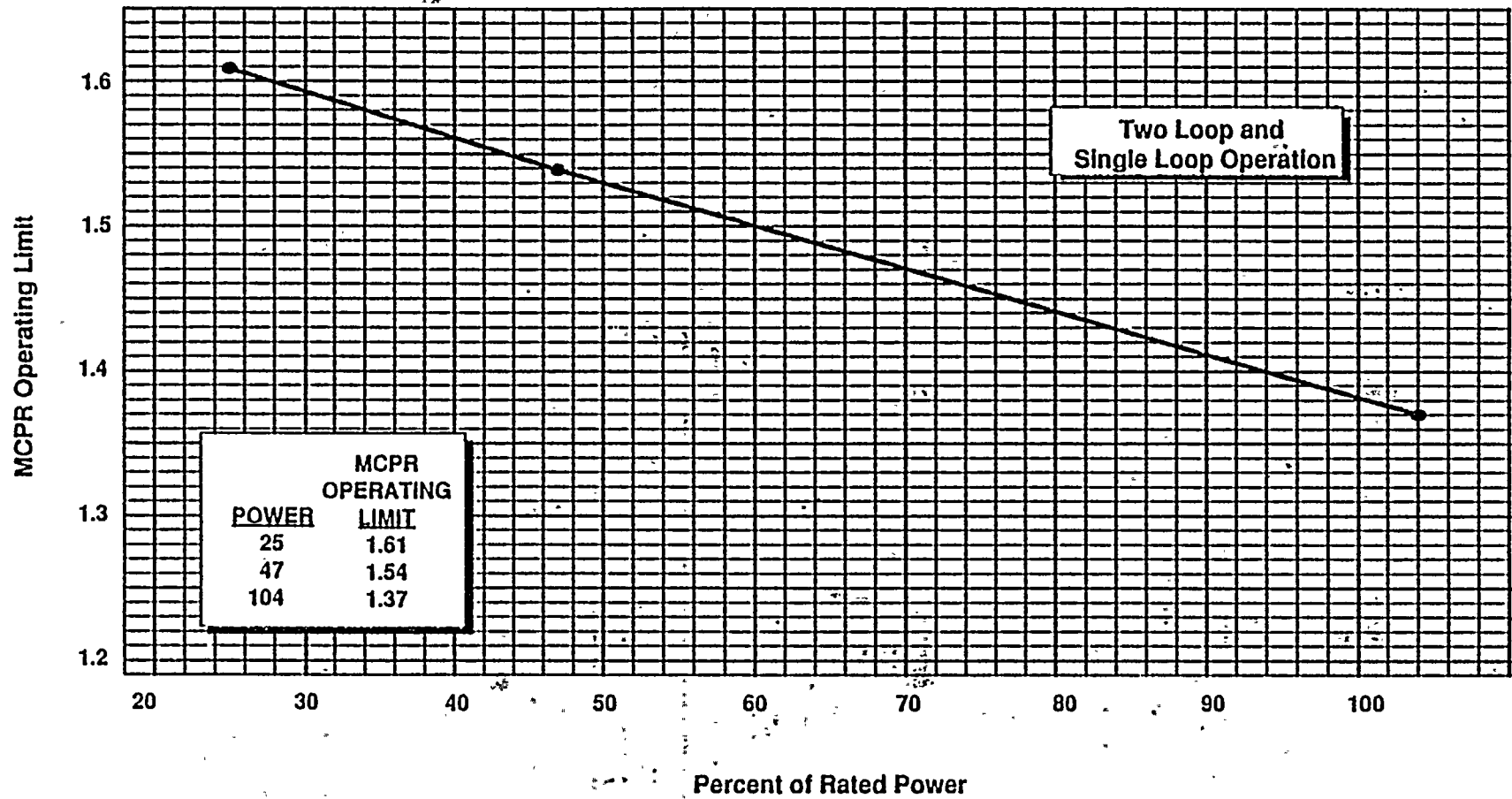
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
ANF 9x9 LFA
<4500 MWD/MTU

Figure 21



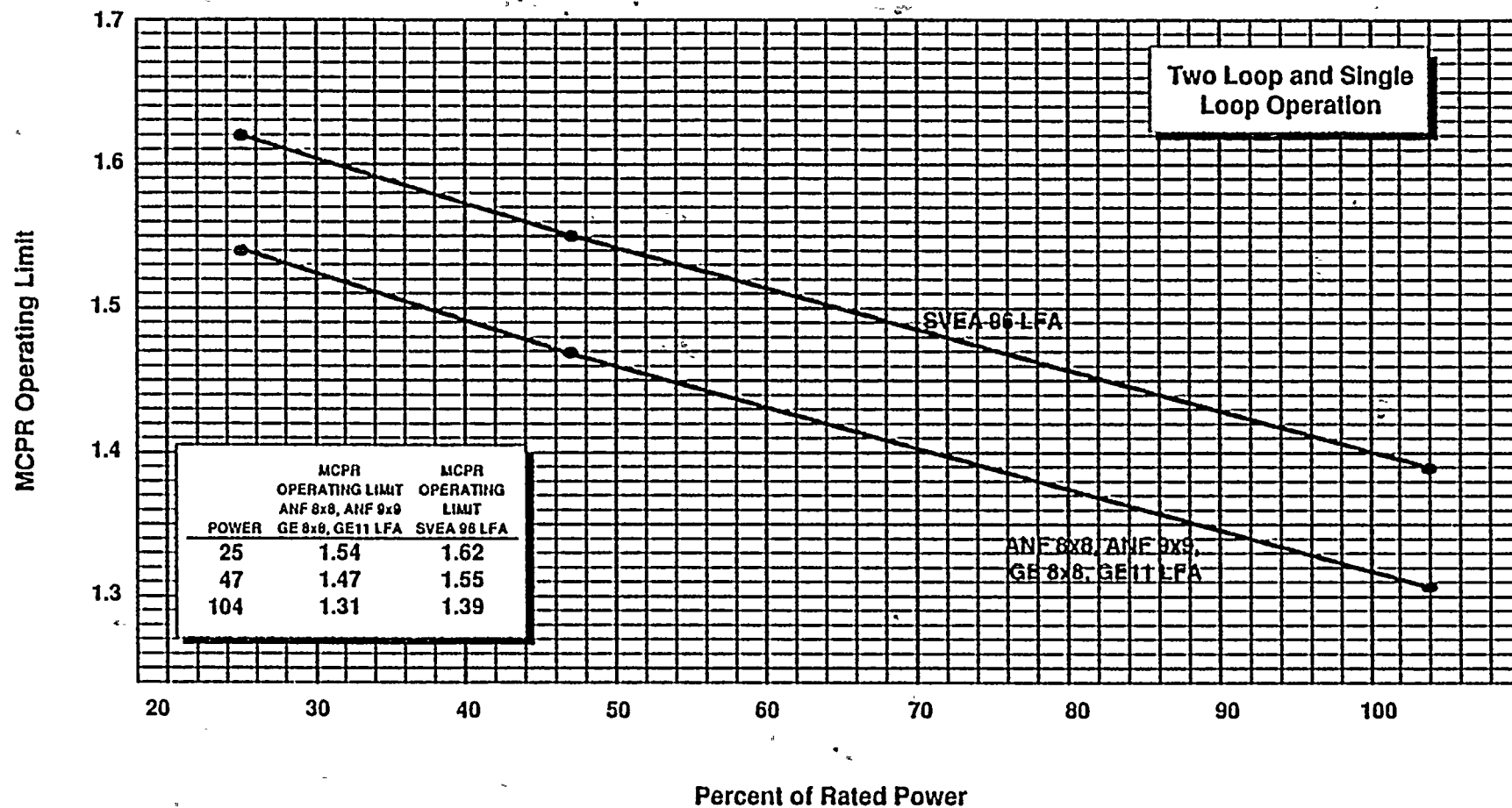
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
ANF 8x8, ANF 9x9, GE 8x8, GE11 LFA, SVEA 96 LFA
≥4500 MWD/MTU

Figure 22



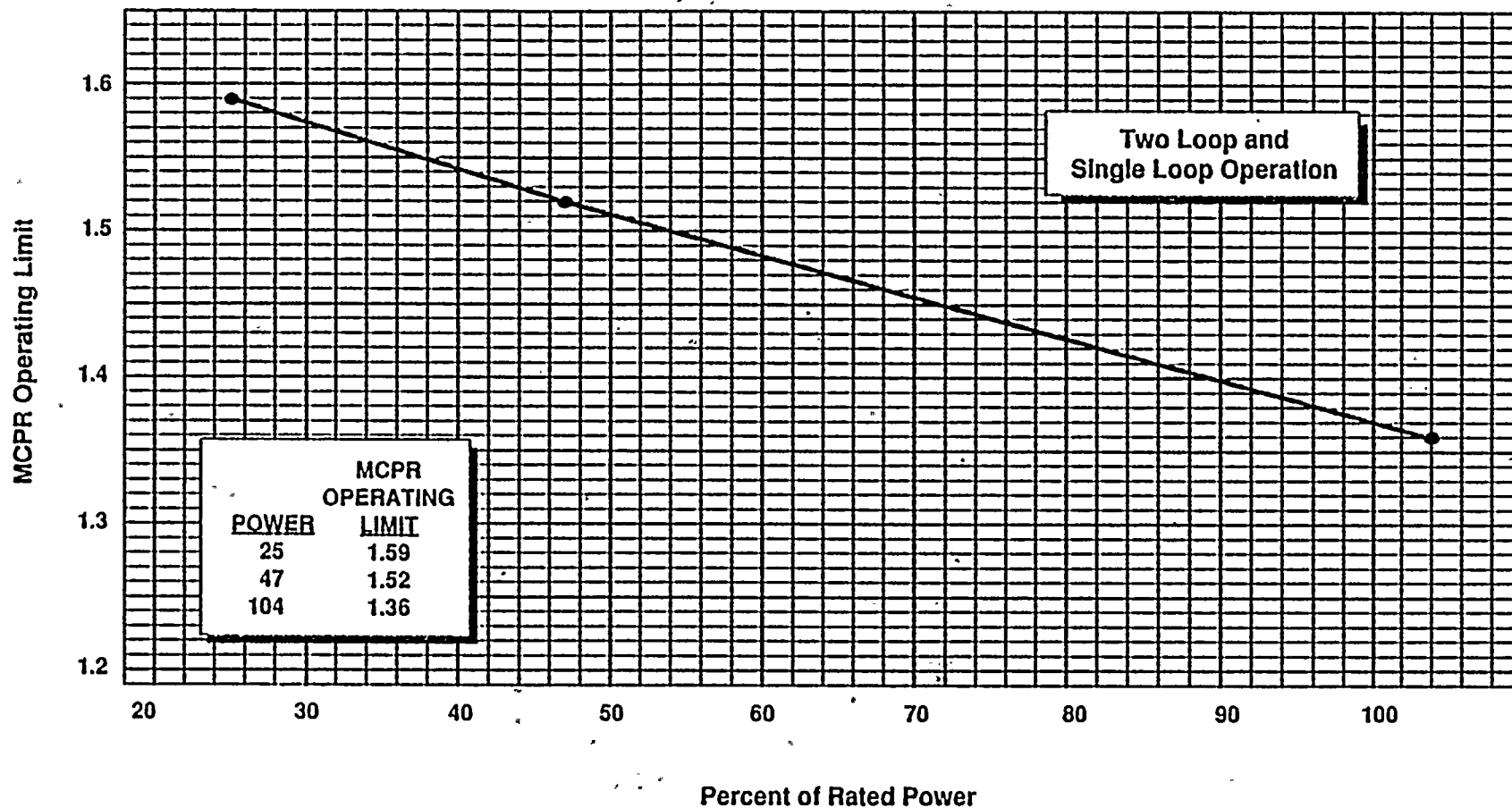
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Inoperable, Bypass Operable
ANF 9x9 LFA
≥4500 MWD/MTU

Figure 23



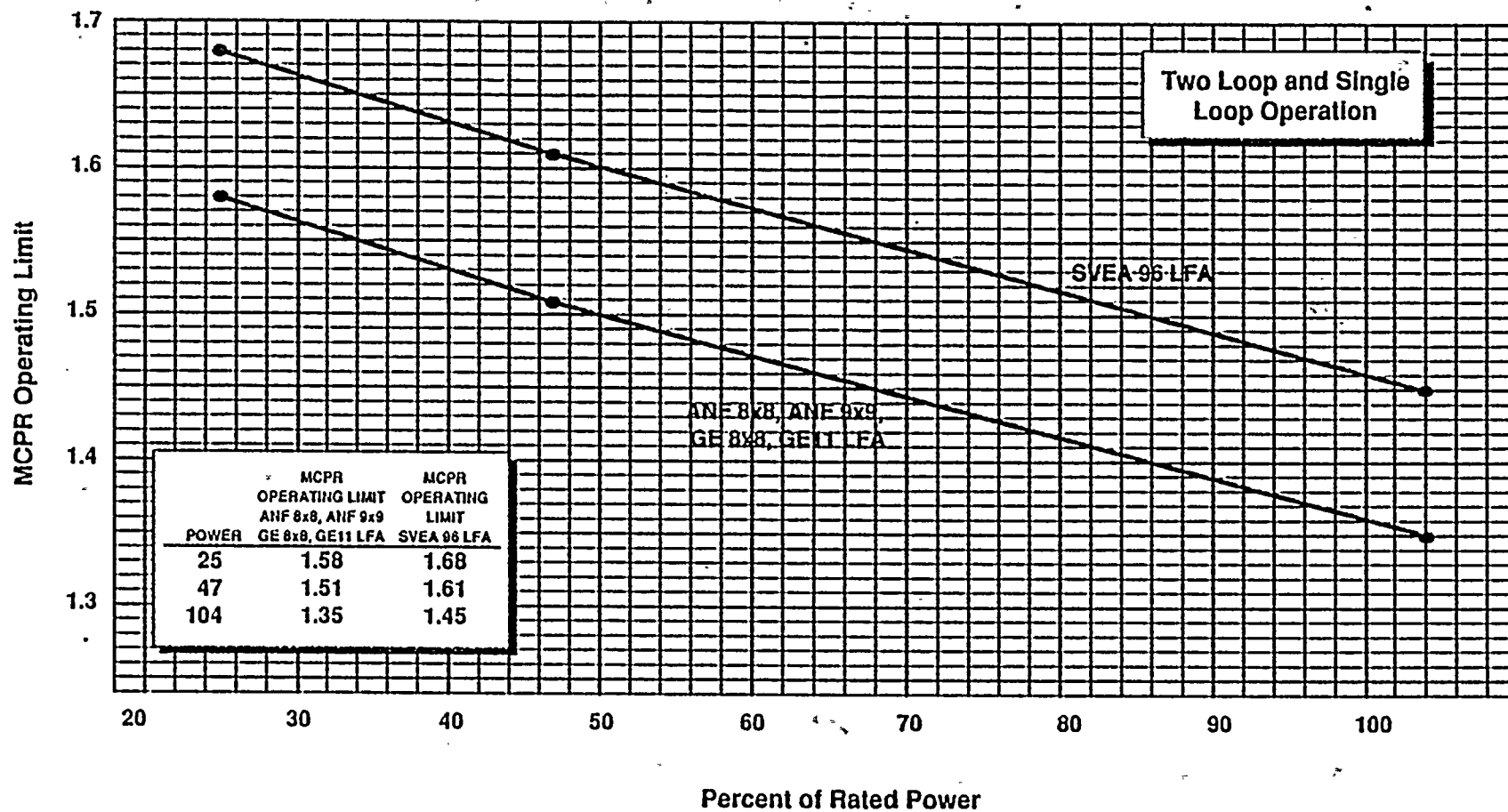
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Inoperable
ANF 8x8, ANF 9x9, GE 8x8, GE11 LFA, SVEA 96 LFA
<4500 MWD/MTU

Figure 24



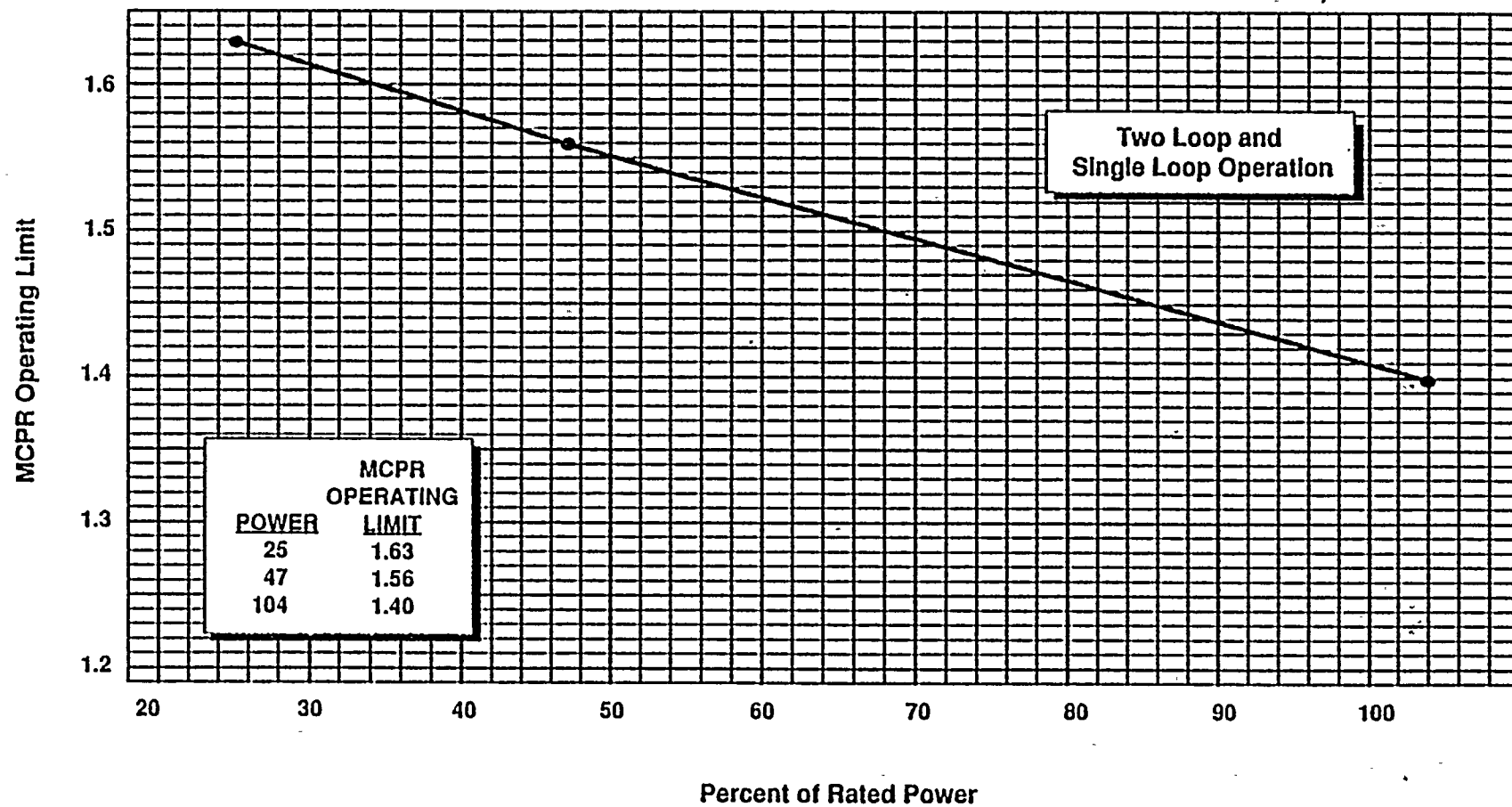
Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Inoperable
ANF 9x9 LFA
<4500 MWD/MTU

Figure 25



Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Inoperable
ANF 8x8, ANF 9x9, GE 8x8, GE 11 LFA, SVEA 96 LFA
≥4500 MWD/MTU

Figure 26

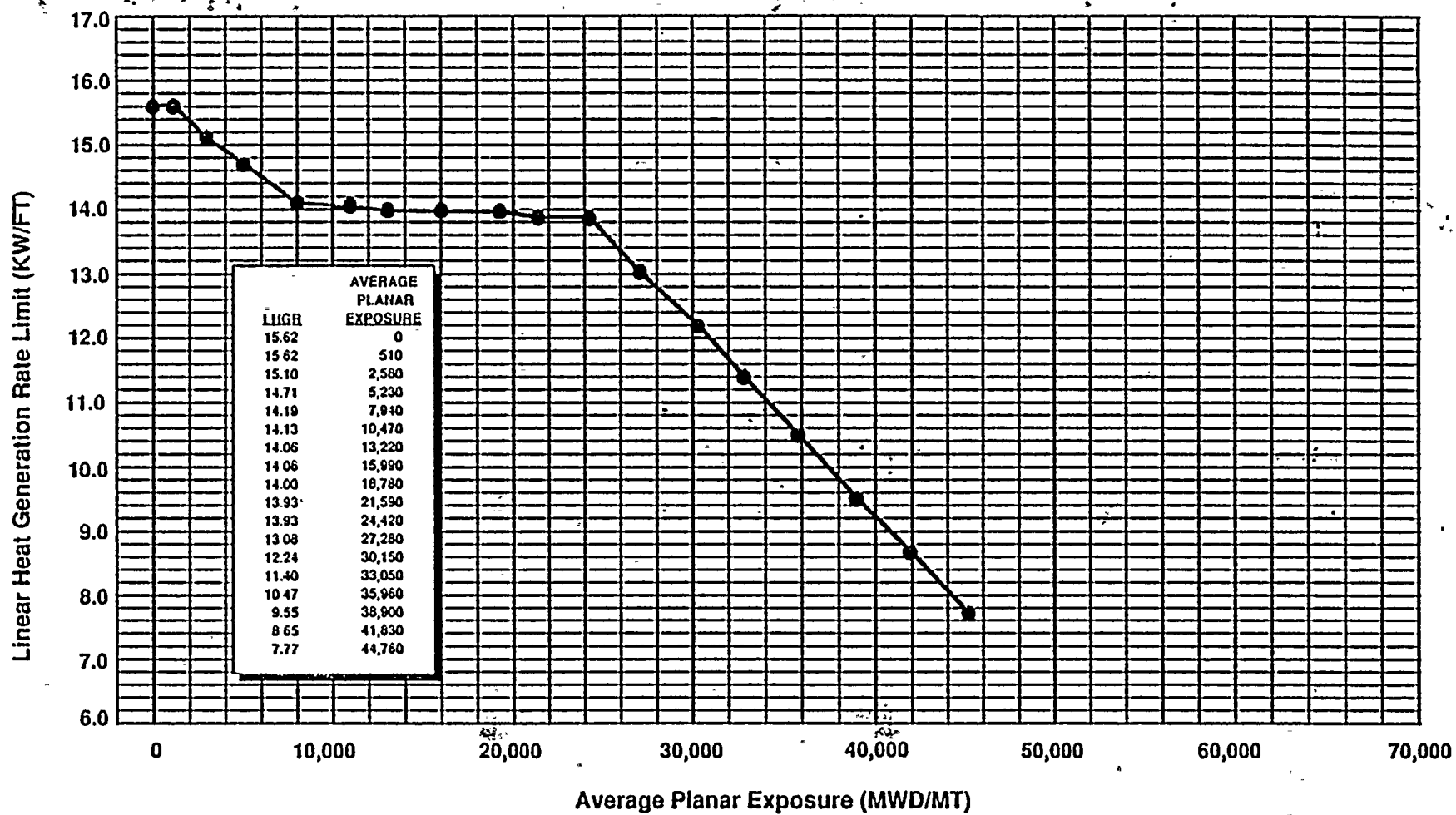


Reduced Power MCPR Operating Limit
Versus Percent of Rated Power
NSS, RPT Operable, Bypass Inoperable
ANF 9x9 LFA
≥4500 MWD/MTU

Figure 27

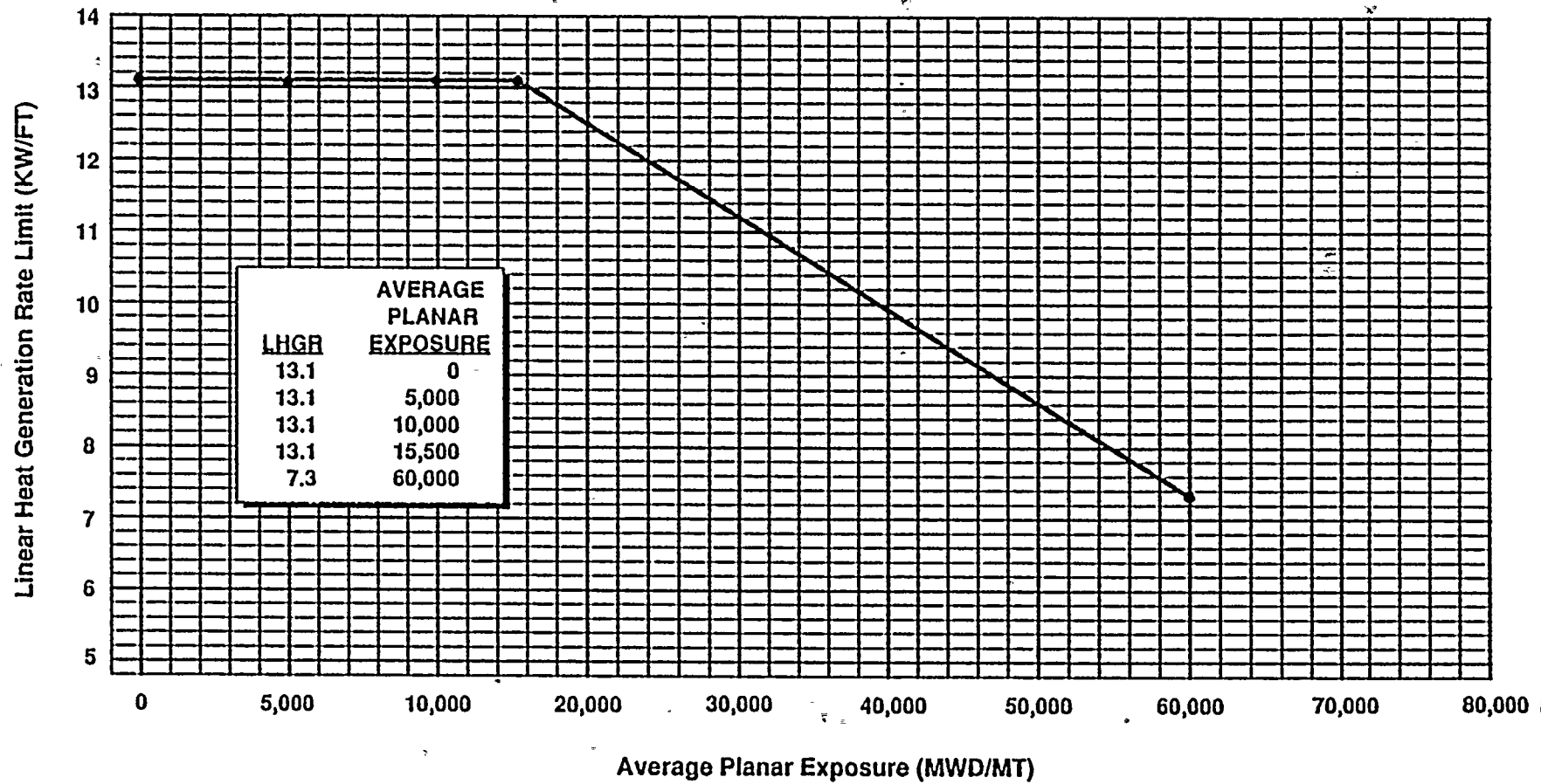
4.0 LINEAR HEAT GENERATION RATE (LHGR) LIMIT FOR USE IN TECHNICAL SPECIFICATION 3.2.4

The LHGR limit for use in Technical Specification 3.2.4 for GE initial core fuel shall not exceed 13.4 kw/ft. The LHGR limit for use in Technical Specification 3.2.4 for reload fuel shall not exceed the values shown in Figures 28, 29, 30, 31 and 32.



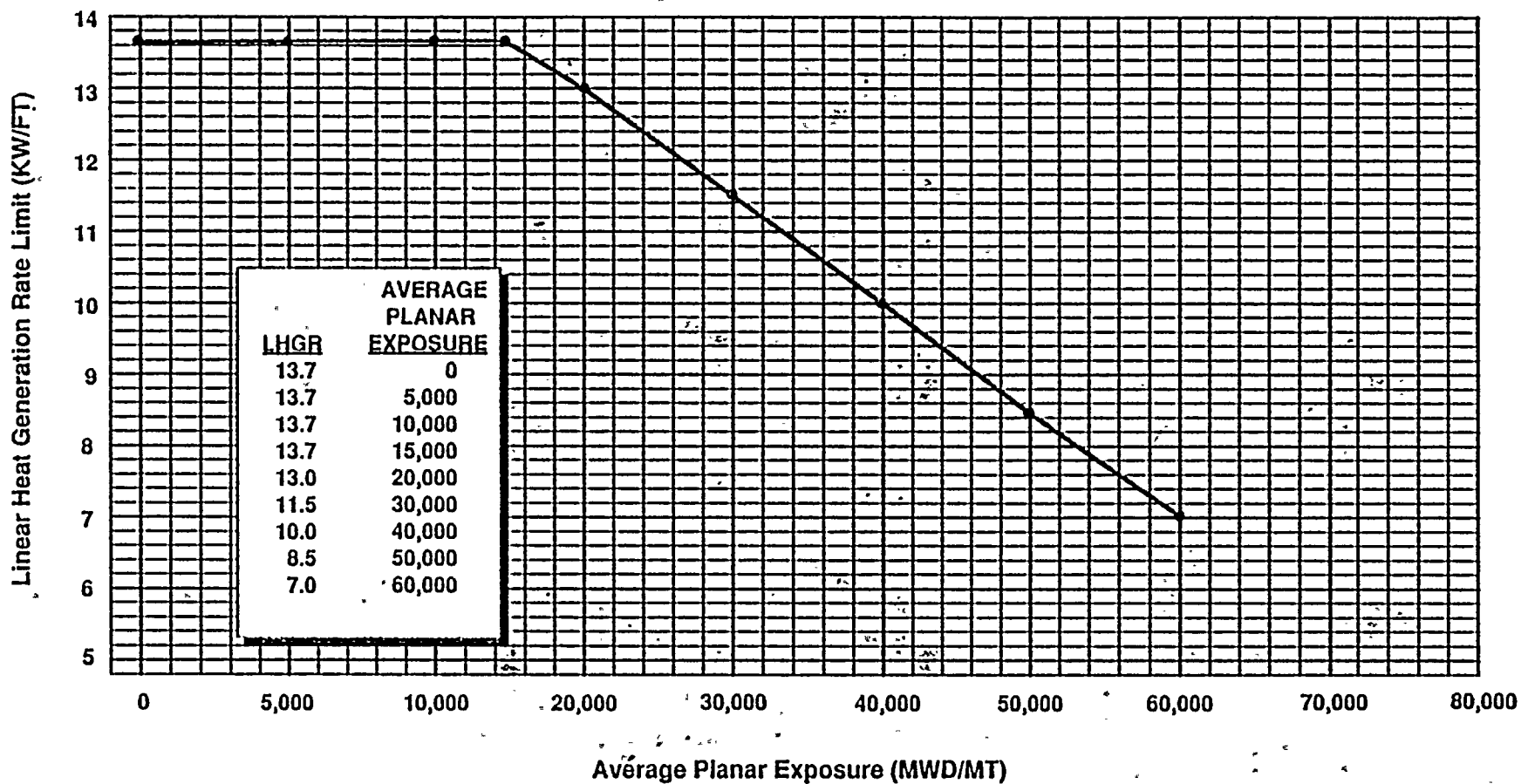
Linear Heat Generation Rate (LHGR) Limit
Versus Average Planar Exposure
ANF 8x8 Reload Fuel

Figure 28



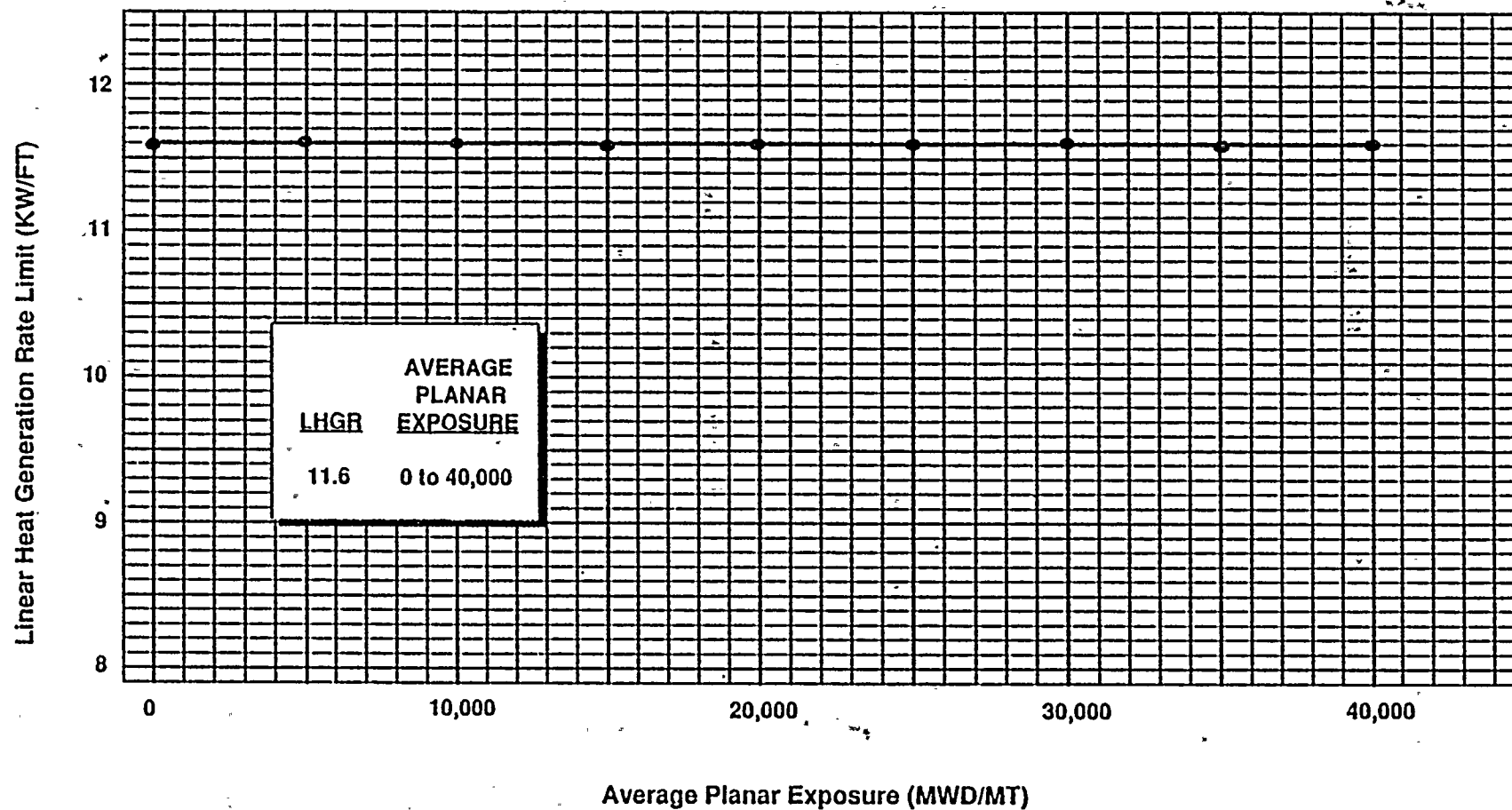
Linear Heat Generation Rate (LHGR) Limit
Versus Average Planar Exposure
ANF 9x9 - 9X Reload and ANF 9x9 - 9X LFA Fuel

Figure 29



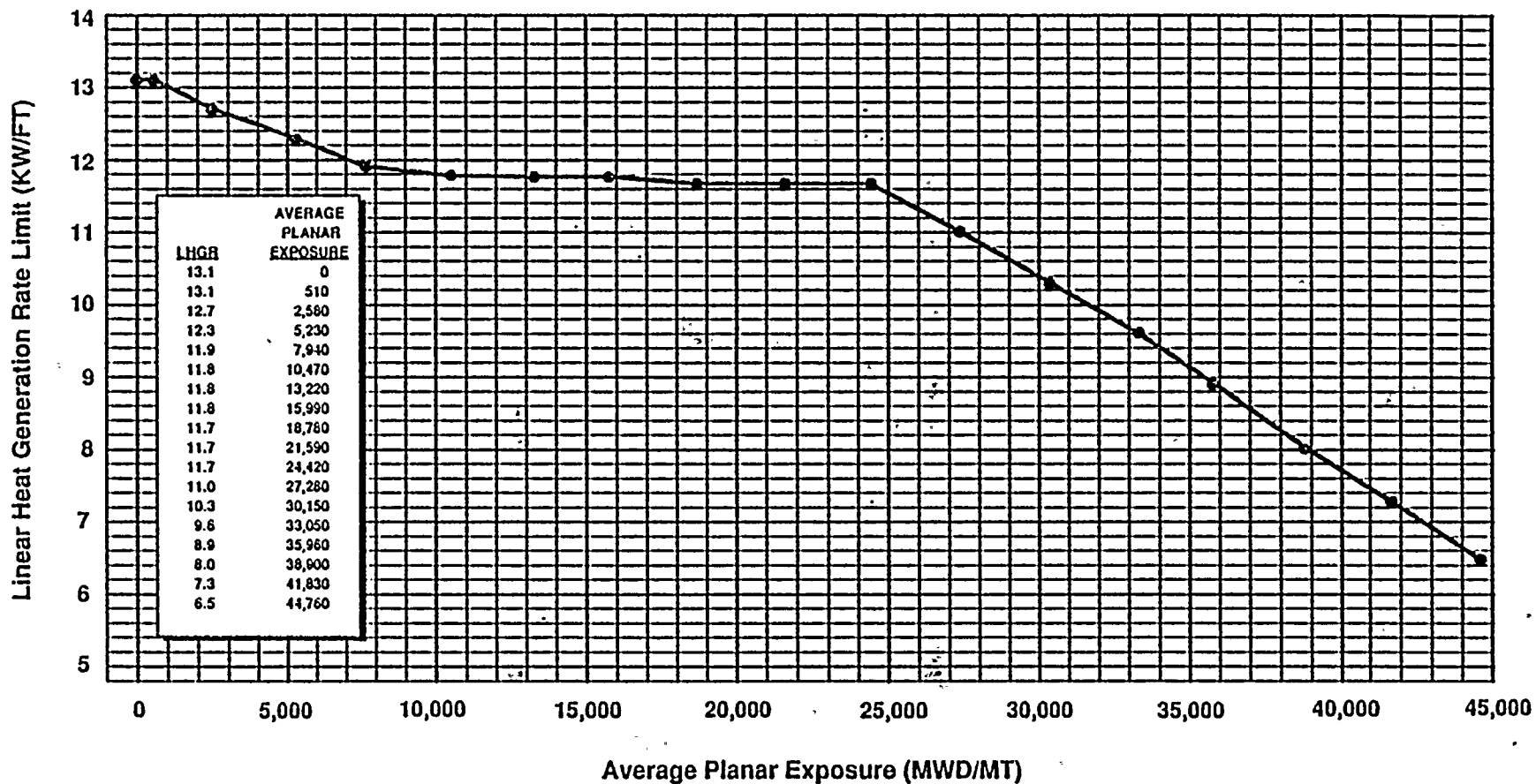
Linear Heat Generation Rate (LHGR) Limit
Versus Average Planar Exposure
ANF 9x9 - IX LFA Fuel

Figure 30



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

Figure 31



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

Figure 32

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- 1.0 ANF-91-01, Revision 1, "WNP-2 Cycle 7 Plant Transient Analysis Report", Advanced Nuclear Fuels Corporation, April 1991
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