

PL-NF-97-005

Rev. 2

# Susquehanna SES Unit 2 Cycle 9

## CORE OPERATING LIMITS REPORT

Nuclear Fuels  
Engineering

February 1998

**PP&L**

**Pennsylvania Power & Light Company**

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PP&L		CORE OPERATING LIMITS REPORT REVISION DESCRIPTION INDEX	
Rev. No.	Affected Sections	Description/Purpose of Revision	
2		<u>Revised MCPR Operating Limits</u>	
		The Two Loop and Single Loop flow dependent MCPR Operating Limits were revised. The revised operating limits are documented in Reference 1.	
	4.0	Revised MCPROL Figures 4.2-1A and 4.2-1B.	
	6.0	Revised MCPROL Figure 6.2-1.	
	7.0	Updated Reference 1.	

# SUSQUEHANNA SES UNIT 2 CYCLE 9 CORE OPERATING LIMITS REPORT

Prepared by: James M. Smith 2/5/98  
J. M. Smith  
Senior Engineer - Nuclear Fuels Engineering  
Date

Reviewed by: John J. Geosits 2/5/98  
J. J. Geosits  
Senior Engineer - Nuclear Fuels Engineering  
Date

Approved by: John P. Spadaro 2/6/98  
J. P. Spadaro  
Supervisor-Nuclear Fuels Engineering  
Date

Approved by: J. M. Kulick 2/6/98  
J. M. Kulick  
Manager-Nuclear Fuels  
Date

Approved PORC: 98-02-12 2/12/98  
PORC Meeting No. Date

Pennsylvania Power & Light Company

**SUSQUEHANNA STEAM ELECTRIC STATION  
Unit 2 Cycle 9  
CORE OPERATING LIMITS REPORT**

**1.0 INTRODUCTION**

This CORE OPERATING LIMITS REPORT for Susquehanna Unit 2 Cycle 9 is prepared in accordance with the requirements of Susquehanna Unit 2, Technical Specification 6.9.3. As required by Technical Specifications 6.9.3.2 and 6.9.3.3, the core operating limits presented herein were developed using NRC-approved methods and are established such that all applicable limits of the plant safety analysis are met. Results from the reload analysis for Unit 2 Cycle 9 are documented in Reference 1.

The following cycle specific core operating limits are included in this report:

- a. Average Planar Linear Heat Generation Rate (APLHGR)  
(Technical Specification 3.2.1)
- b. Linear Heat Generation Rate for Average Power  
Range Monitor (APRM) Setpoints  
(Technical Specification 3.2.2)
- c. Minimum Critical Power Ratio (MCPR)  
(Technical Specification 3.2.3)
- d. Linear Heat Generation Rate (LHGR)  
(Technical Specification 3.2.4)
- e. Recirculation Loops - Single Loop Operation  
(Technical Specification 3.4.1.1.2)

**2.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)**

**2.1 Technical Specification Reference**

Technical Specification 3.2.1

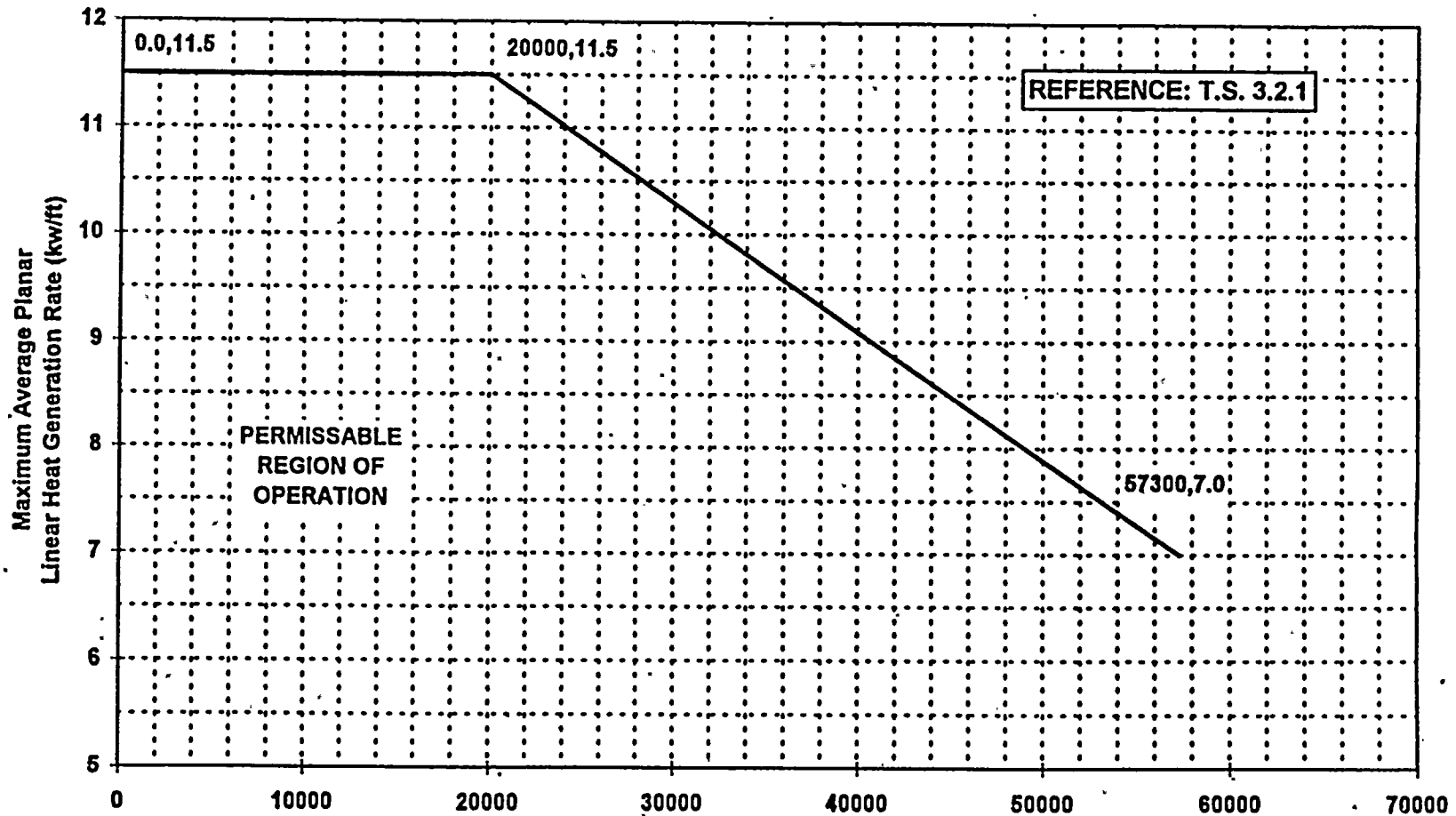
**2.2 Description**

The APLHGRs for SPC 9x9-2 fuel shall not exceed the limit shown in Figure 2.2-1.

The APLHGRs for SPC ATRIUM<sup>TM</sup>-10 fuel shall not exceed the limit shown in Figure 2.2-2

The APLHGRs for GE12 fuel shall not exceed the limit shown in Figure 2.2-3.

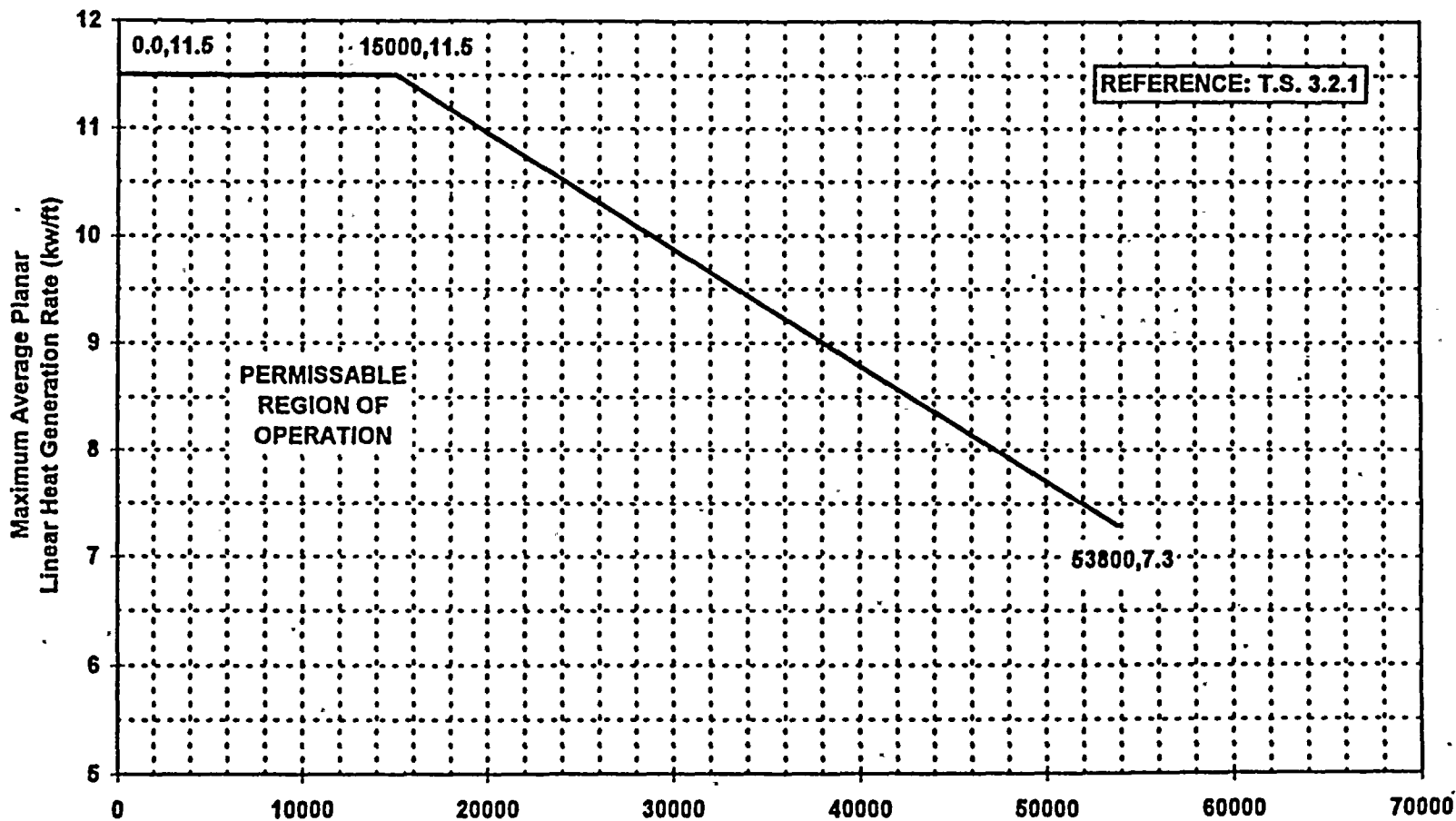
# SSES UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
MAXIMUM AVERAGE PLANAR LINEAR HEAT  
GENERATION RATE (MAPLHGR) VERSUS  
AVERAGE PLANAR EXPOSURE  
SPC 9X9-2 FUEL  
FIGURE 2.2-1



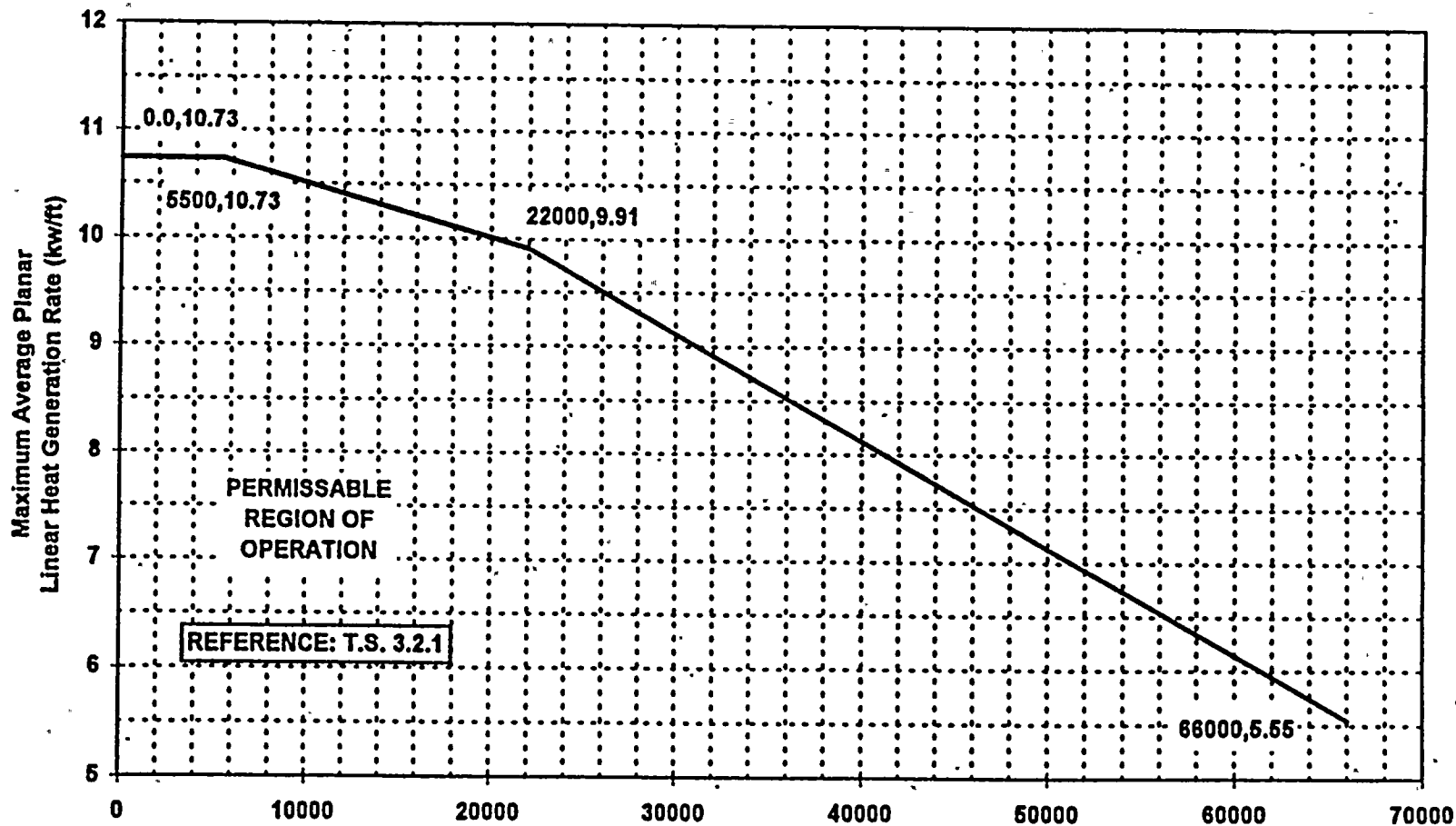
# SSSES UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
MAXIMUM AVERAGE PLANAR LINEAR HEAT  
GENERATION RATE (MAPLHGR) VERSUS  
AVERAGE PLANAR EXPOSURE  
SPC ATRIUM™ -10 FUEL  
FIGURE 2.2-2



# SSSES UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
MAXIMUM AVERAGE PLANAR LINEAR HEAT  
GENERATION RATE (MAPLHGR) VERSUS  
AVERAGE PLANAR EXPOSURE

GE12  
FIGURE 2.2-3

### 3.0 LINEAR HEAT GENERATION RATE FOR APRM SETPOINTS

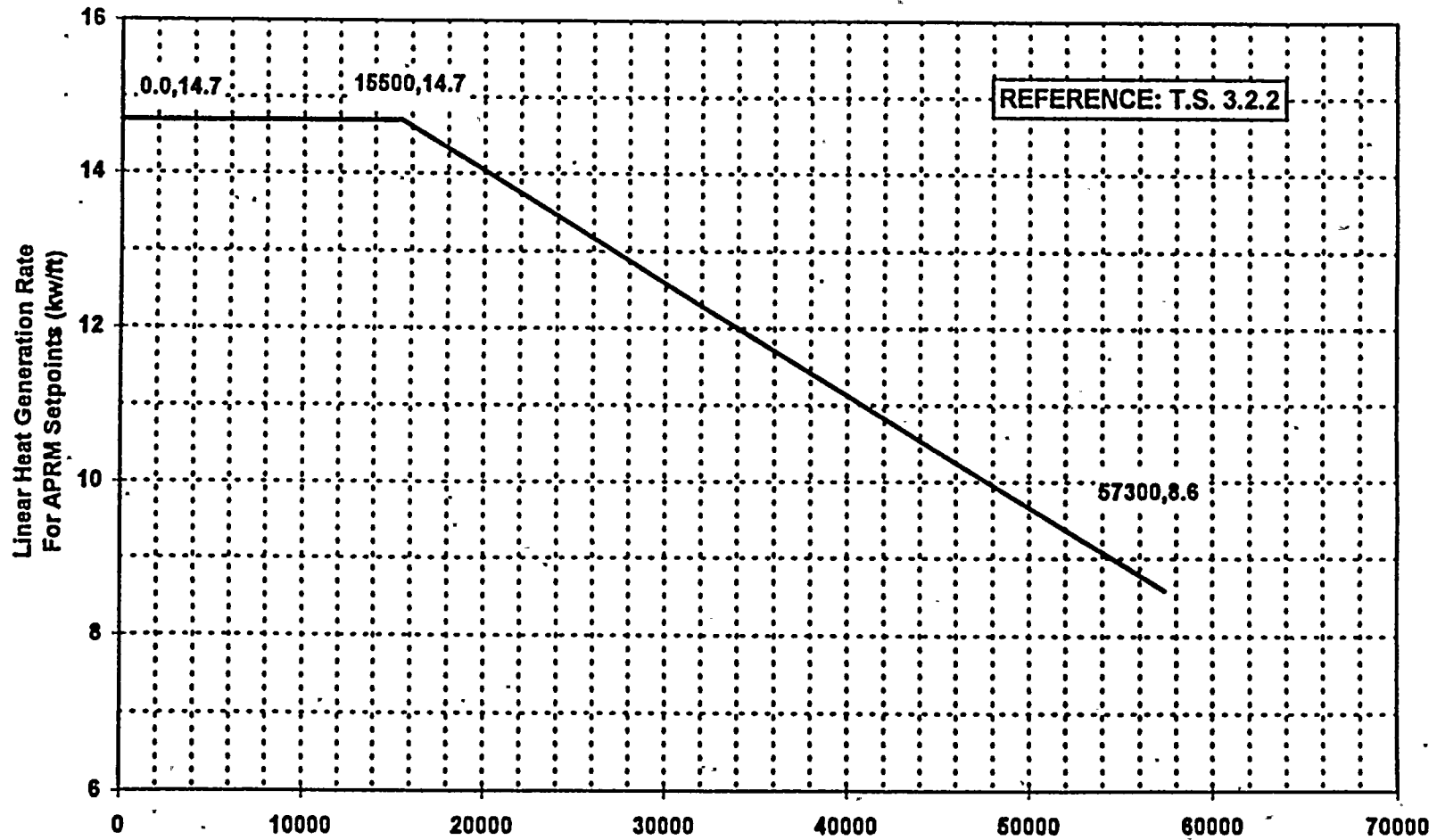
#### 3.1 Technical Specification Reference

Technical Specification 3.2.2.

#### 3.2 Description

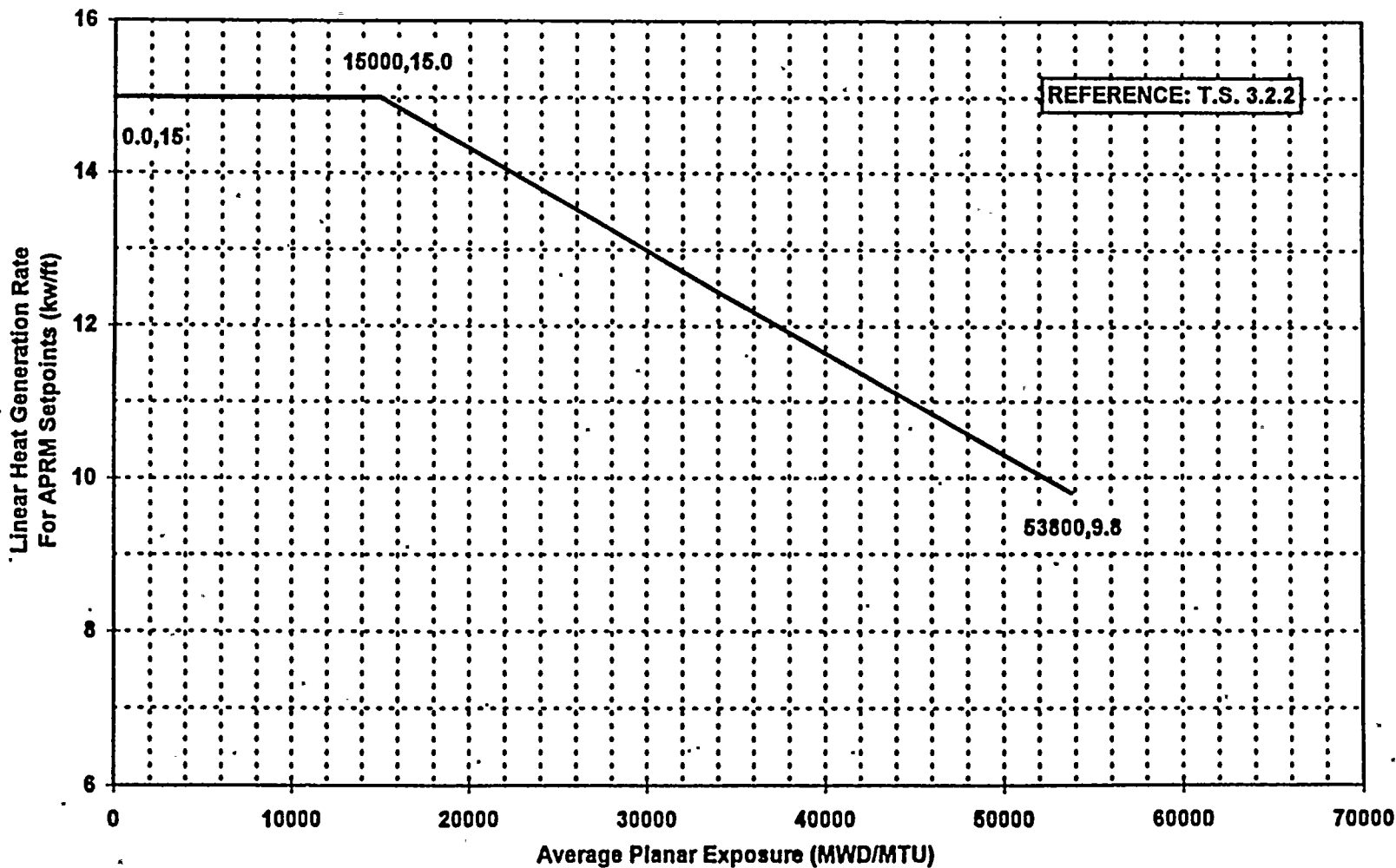
The APRM flow biased simulated thermal power-upscale scram trip setpoint and flow biased neutron flux-upscale control rod block trip setpoint shall be established according to the relationships specified in Technical Specification 3.2.2. For those relationships, the maximum Fraction of Limiting Power Density (FLPD) for use in determination of "T", is the actual LHGR divided by the LHGR limit. The LHGR limit for SPC 9x9-2 fuel shall be taken from Figure 3.2-1. The LHGR limit for SPC ATRIUM<sup>TM</sup>-10 fuel shall be taken from Figure 3.2-2. The LHGR limit for GE12 fuel shall be taken from Figure 3.2-3. The final value of "T" shall be the lesser of the "T" values calculated for each fuel type.

# SSSES UNIT 2 CYCLE 9



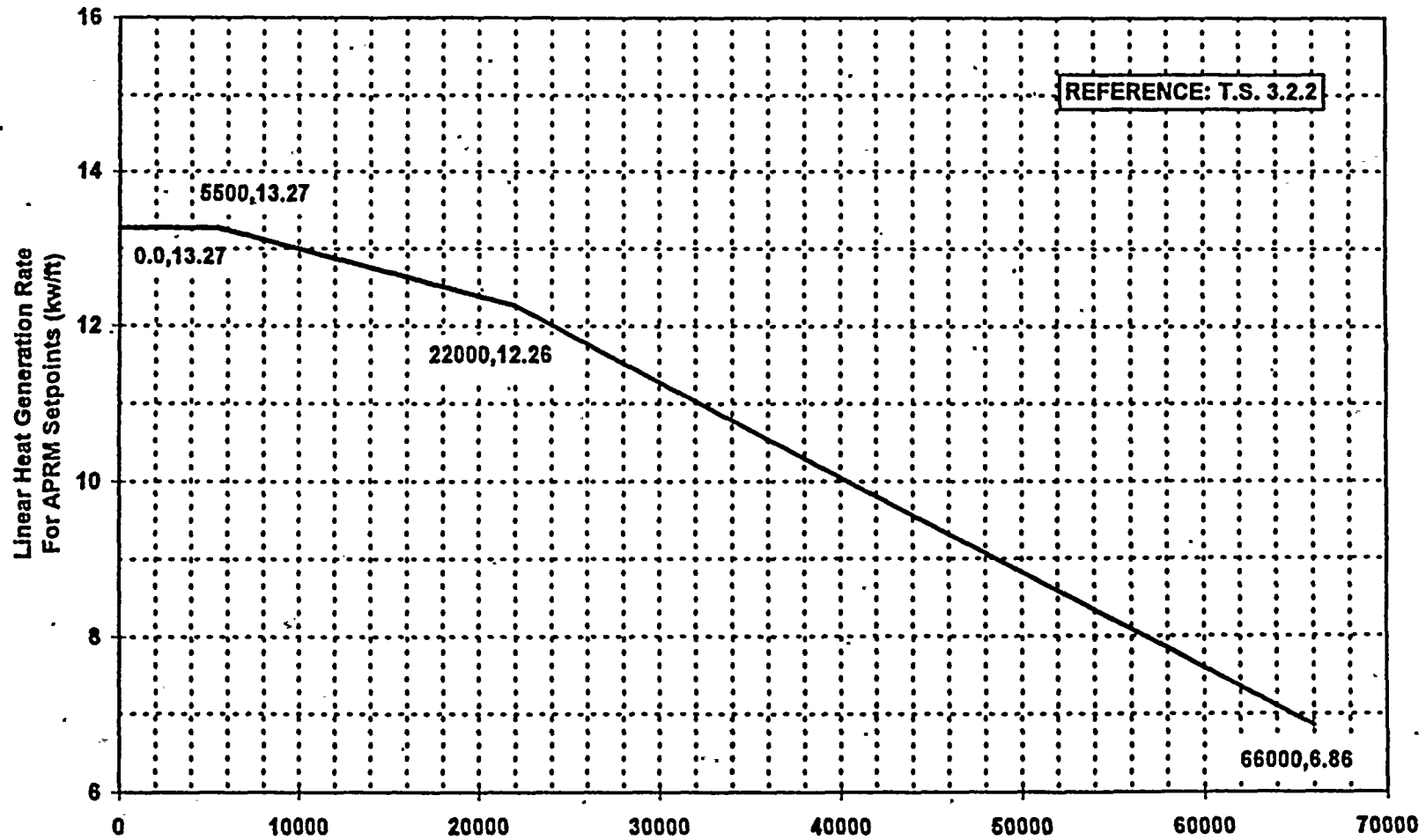
Average Planar Exposure (MWD/MTU)  
LINEAR HEAT GENERATION RATE FOR APRM SETPOINTS  
VERSUS AVERAGE PLANAR EXPOSURE  
SPC 9X9-2 FUEL  
FIGURE 3.2-1

# SSES UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
**LINEAR HEAT GENERATION RATE FOR APRM SETPOINTS  
VERSUS AVERAGE PLANAR EXPOSURE  
SPC ATRIUM™-10 FUEL  
FIGURE 3.2-2**

# SSSES UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
LINEAR HEAT GENERATION RATE FOR APRM SETPOINTS  
VERSUS AVERAGE PLANAR EXPOSURE  
GE12  
FIGURE 3.2-3

#### 4.0 MINIMUM CRITICAL POWER RATIO (MCPR)

##### 4.1 Technical Specification Reference

Technical Specification 3.2.3.

##### 4.2 Description

The MCPR limit is specified as a function of core power, core flow, cycle exposure, average scram insertion time per Section 4.3 and plant equipment operability status. The MCPR limits for all fuel types (SPC 9x9-2, SPC ATRIUM™-10, and GE12) shall be the greater of

- a) The Flow-Dependent MCPR value determined from one of the following figures as appropriate:

Figure 4.2-1A: BOC to EOC

Figure 4.2-1B: BOC to 10290 MWD/MTU

(Note that even though Figure 4.2-1A is more limiting than Figure 4.2-1B, Figure 4.2-1B may be used for cycle exposures between BOC and 10290 MWD/MTU.)

OR

- b) The Power-Dependent MCPR value determined from one of the following figures, as appropriate:

Figure 4.2-2A: EOC-RPT and Main Turbine Bypass Operable from BOC to EOC.

Figure 4.2-2B: EOC-RPT and Main Turbine Bypass Operable from BOC to 10290 MWD/MTU.

(Note that even though Figure 4.2-2A is more limiting than Figure 4.2-2B, Figure 4.2-2B may be used for cycle exposures between BOC and 10290 MWD/MTU.)

Figure 4.2-3A: EOC-RPT Operable / Main Turbine Bypass Inoperable from BOC to EOC

Figure 4.2-3B: EOC-RPT Operable / Main Turbine Bypass Inoperable from BOC to 10290 MWD/MTU.

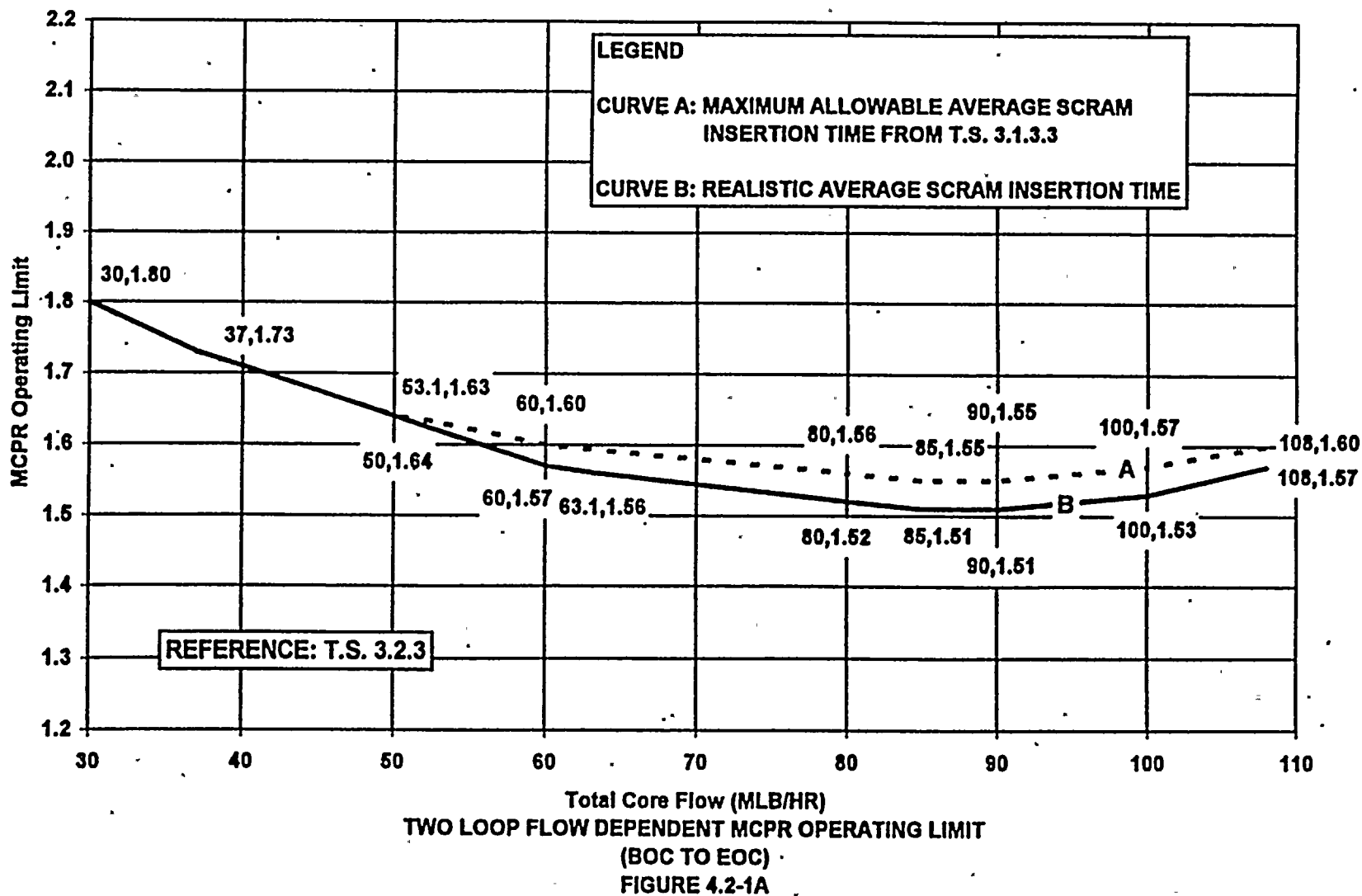
(Note that even though Figure 4.2-3A is more limiting than Figure 4.2-3B, Figure 4.2-3B may be used for cycle exposures between BOC and 10290 MWD/MTU.)

Figure 4.2-4: EOC-RPT Inoperable / Main Turbine Bypass Operable from BOC to EOC

4.3 Average Scram Time Fraction

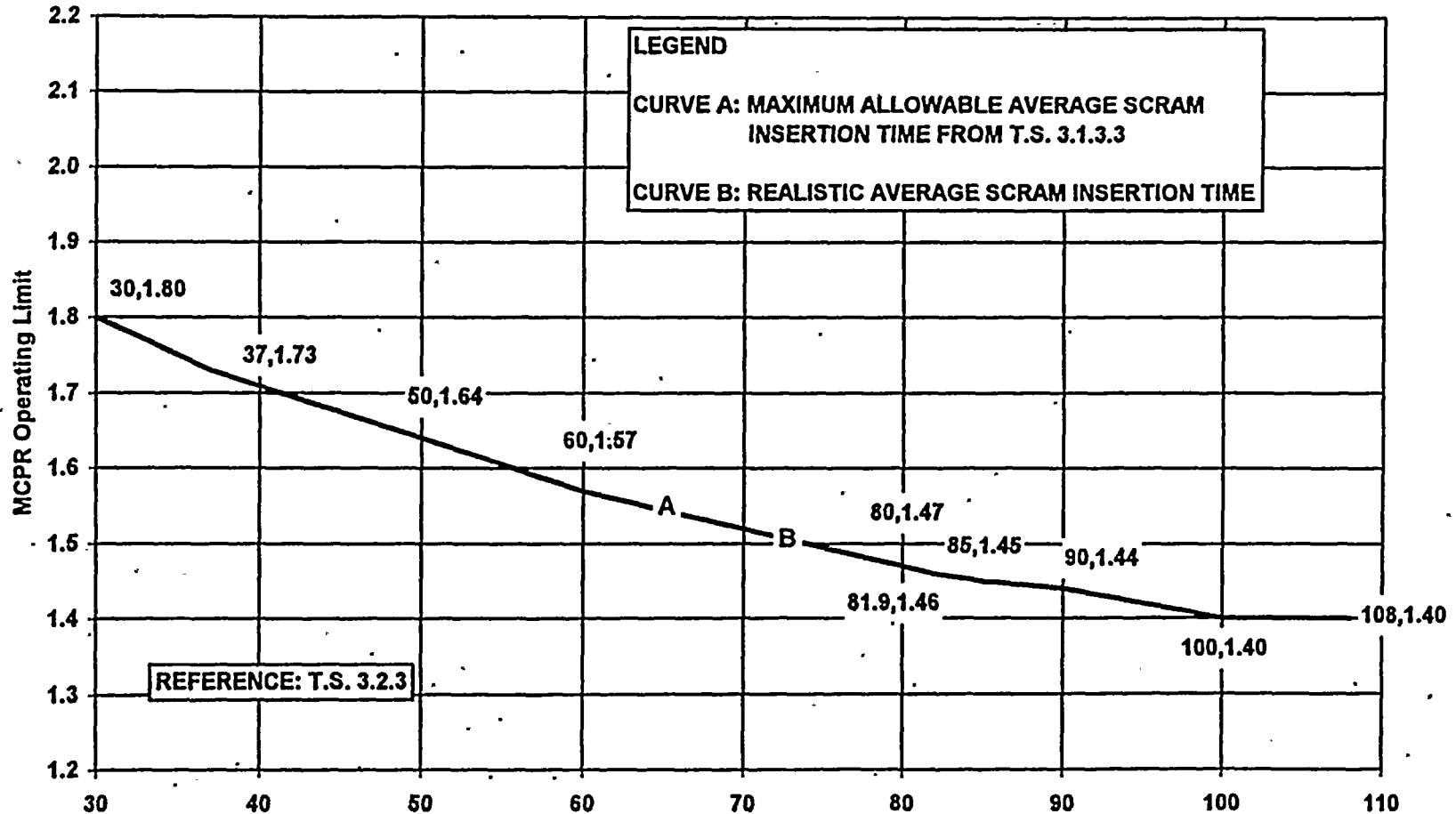
Table 4.3-1 provides the relationship between average scram time to control rod position and scram time fraction. The evaluation of scram insertion time data, as it relates to the attached table should be performed per Reactor Engineering procedures.

# SSES UNIT 2 CYCLE 9





# SSES UNIT 2 CYCLE 9

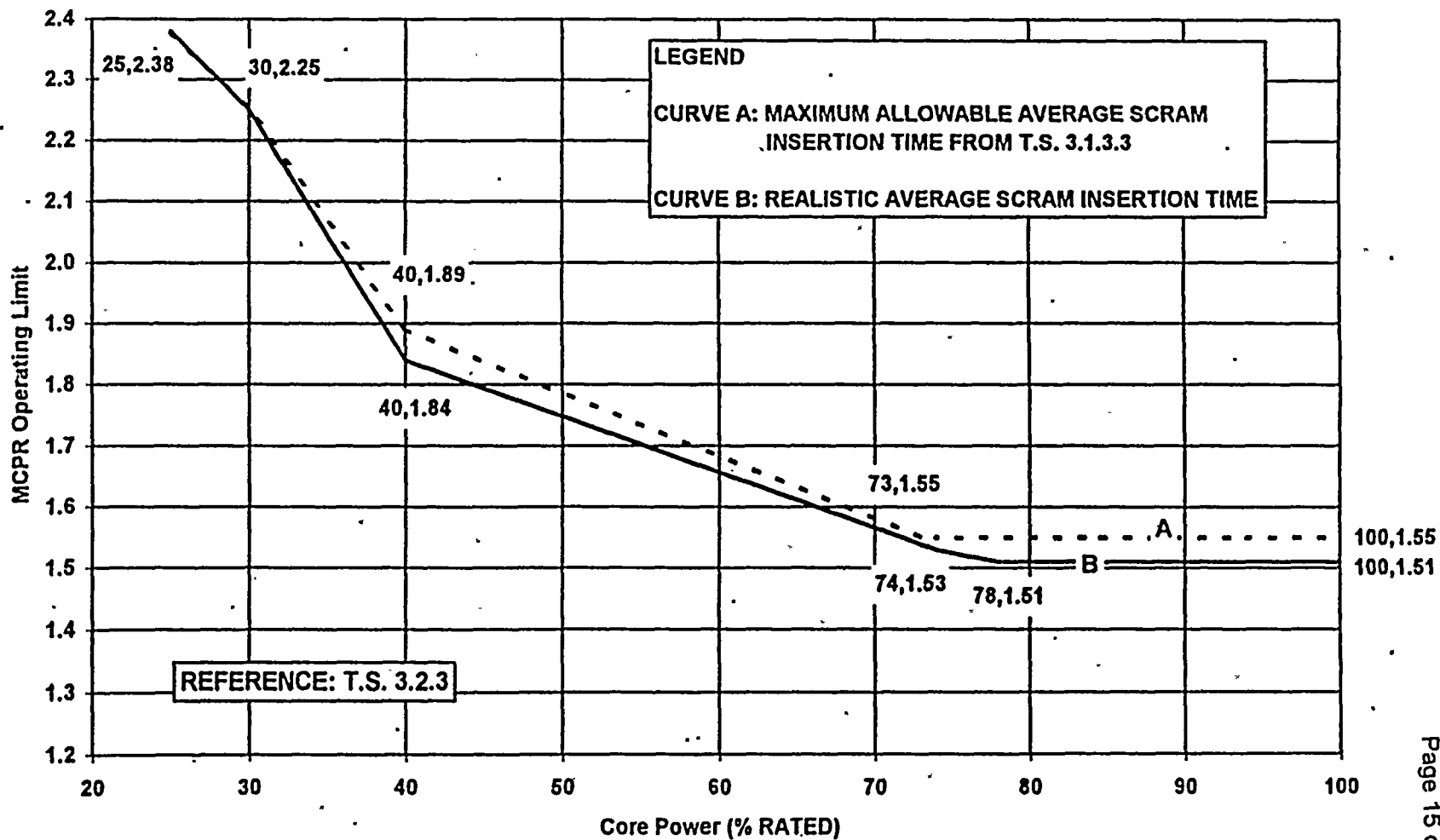


REFERENCE: T.S. 3.2.3

**LEGEND**  
 CURVE A: MAXIMUM ALLOWABLE AVERAGE SCRAM  
 INSERTION TIME FROM T.S. 3.1.3.3  
 CURVE B: REALISTIC AVERAGE SCRAM INSERTION TIME

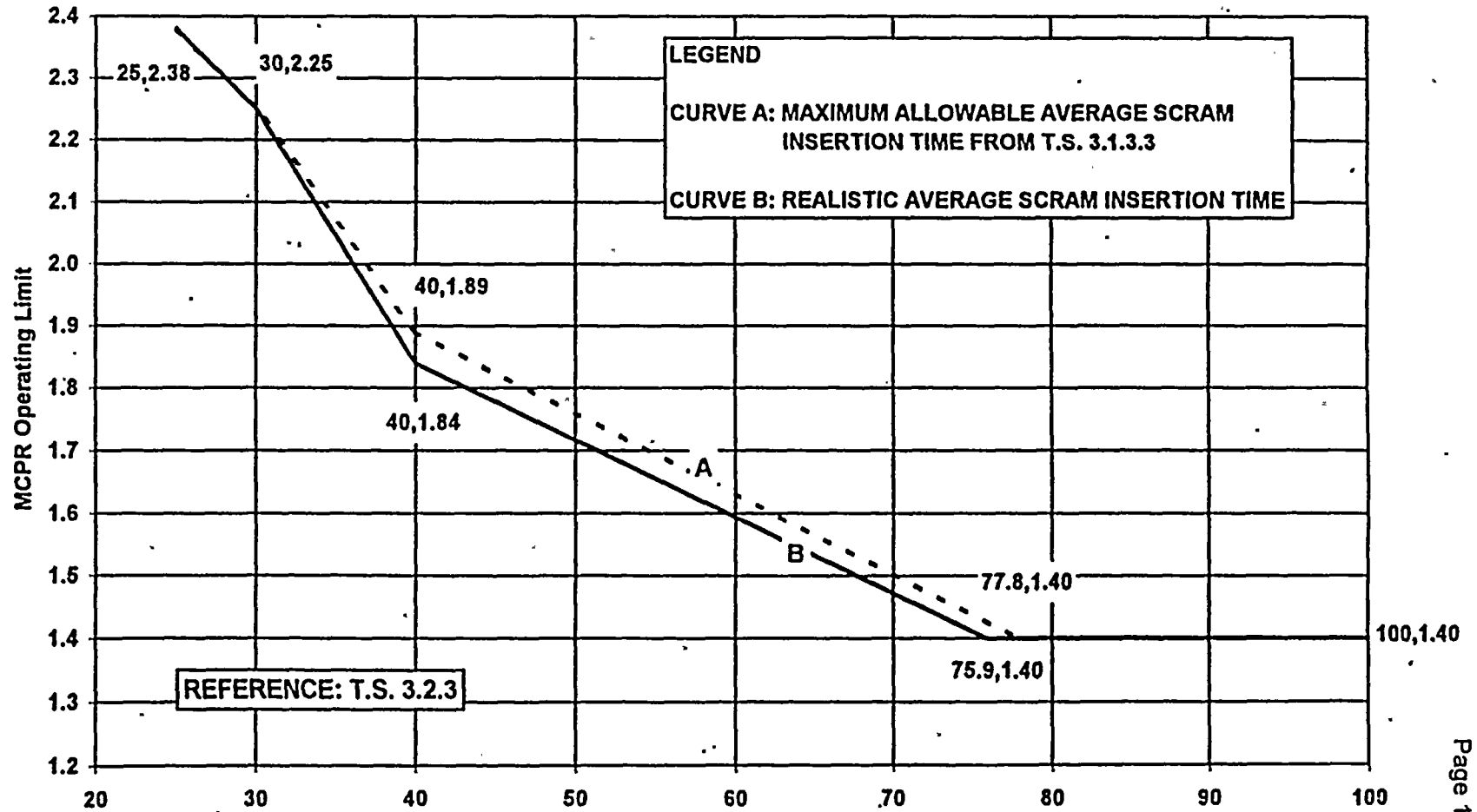
Total Core Flow (MLB/HR)  
 TWO LOOP FLOW DEPENDENT MCPR OPERATING LIMIT  
 (BOC TO 10290 MWD/MTU)  
 FIGURE 4.2-1B

# SSES UNIT 2 CYCLE 9



TWO LOOP POWER DEPENDENT MCPR OPERATING LIMIT  
 EOC-RPT AND MAIN TURBINE BYPASS OPERABLE  
 (BOC to EOC)  
 FIGURE 4.2-2A

# SSES UNIT 2 CYCLE 9

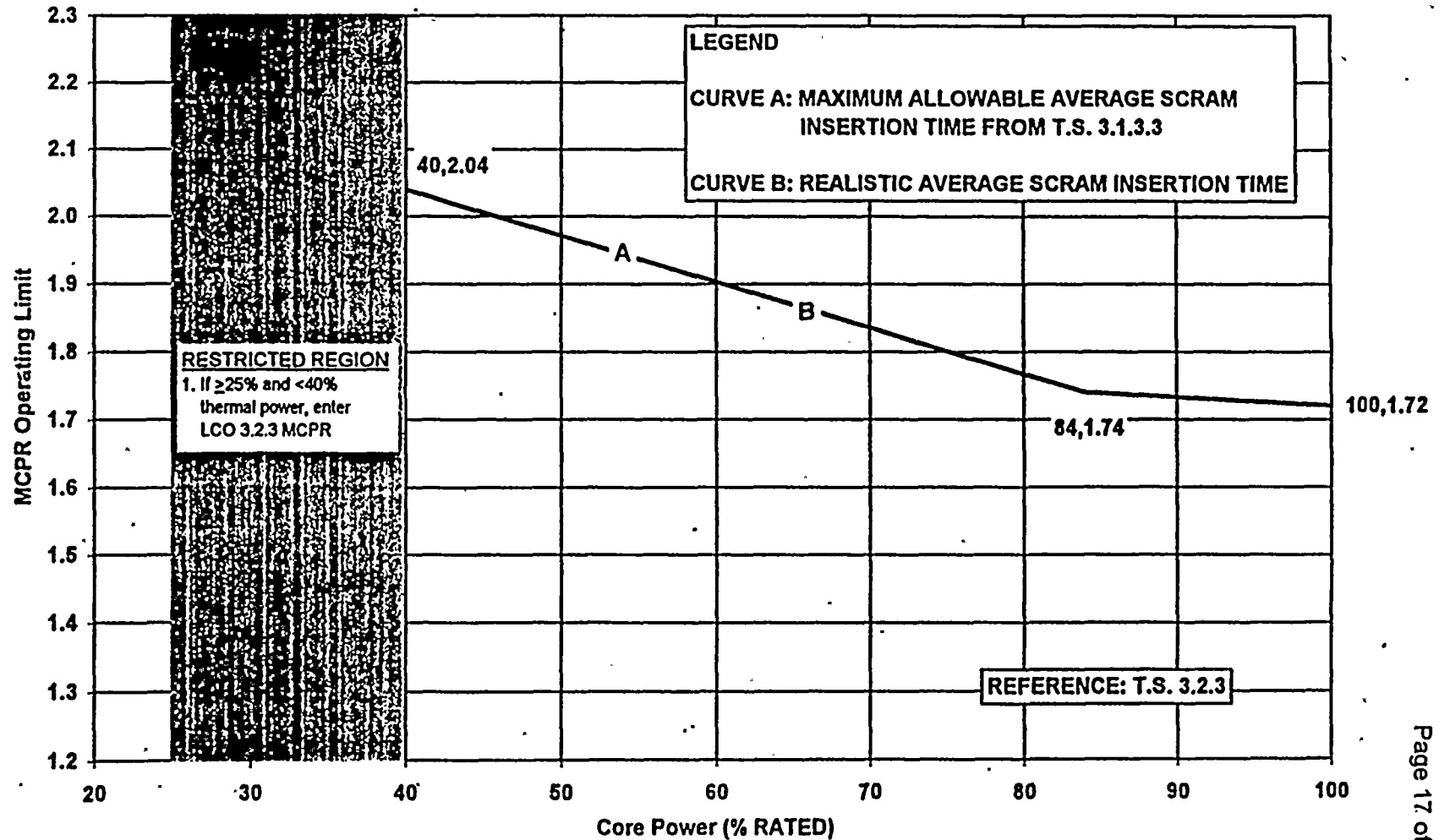


REFERENCE: T.S. 3.2.3

**LEGEND**  
 CURVE A: MAXIMUM ALLOWABLE AVERAGE SCRAM INSERTION TIME FROM T.S. 3.1.3.3  
 CURVE B: REALISTIC AVERAGE SCRAM INSERTION TIME

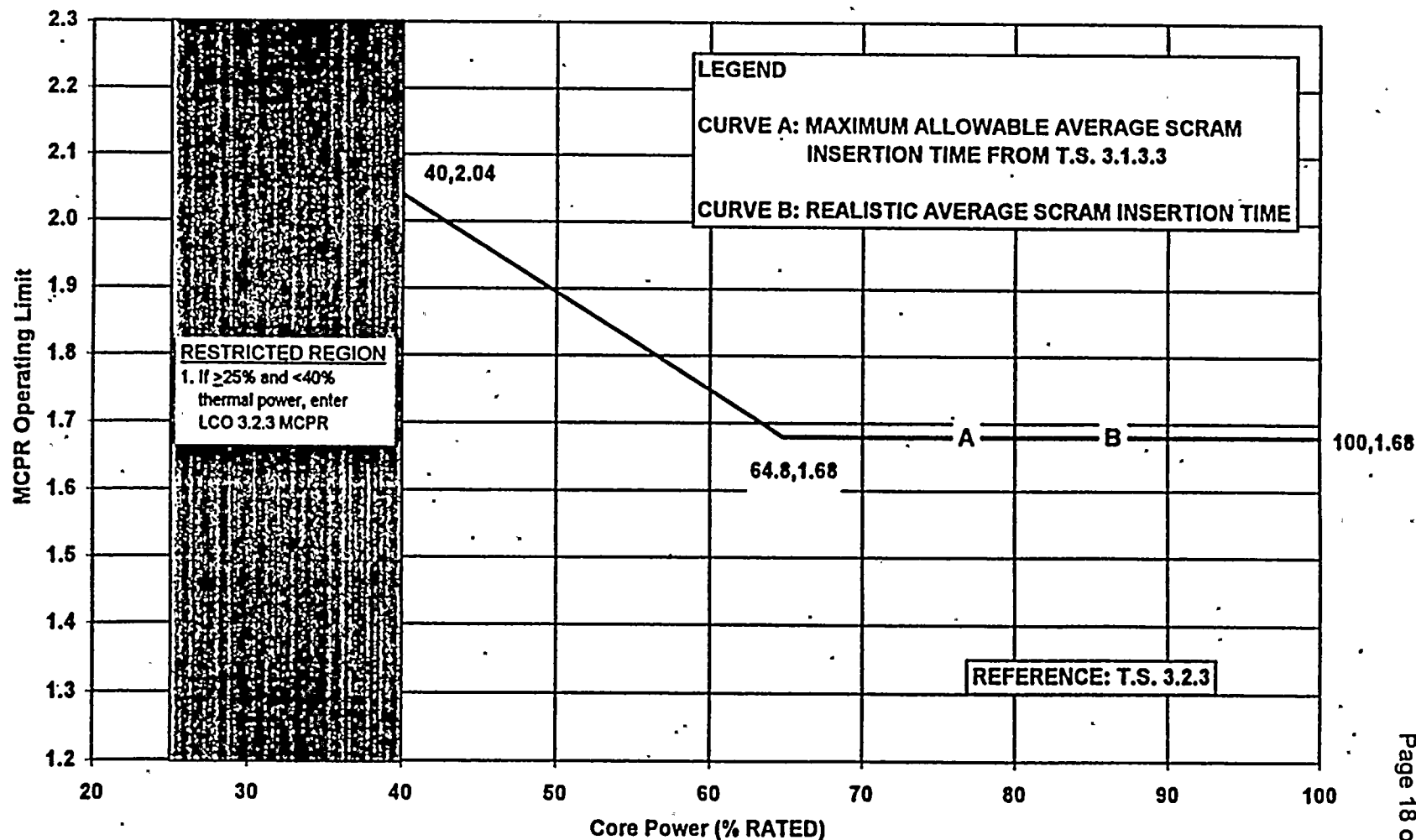
TWO LOOP POWER DEPENDENT MCPR OPERATING LIMIT  
 EOC-RPT AND MAIN TURBINE BYPASS OPERABLE  
 (BOC to 10290 MWD/MTU)  
 FIGURE 4.2-2B

# SSES UNIT 2 CYCLE 9



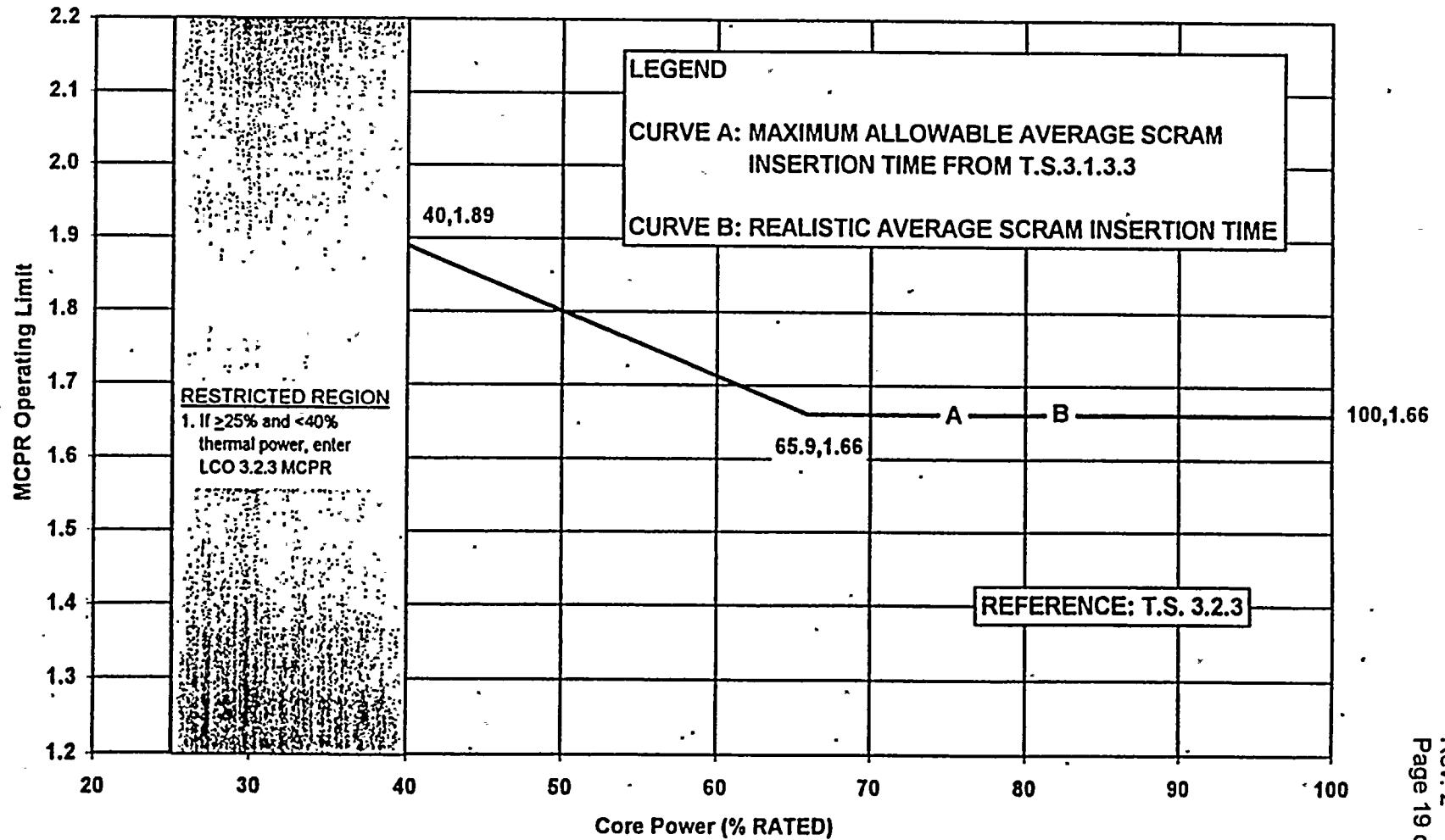
**TWO LOOP POWER DEPENDENT MCPR OPERATING LIMIT**  
**EOC-RPT OPERABLE / MAIN TURBINE BYPASS INOPERABLE**  
**(BOC to EOC)**  
**FIGURE 4.2-3A**

# SSES UNIT 2 CYCLE 9



**TWO LOOP POWER DEPENDENT MCPR OPERATING LIMIT**  
**EOC-RPT OPERABLE / MAIN TURBINE BYPASS INOPERABLE**  
**(BOC to 10290 MWD/MTU)**  
**FIGURE 4.2-3B**

# SSES UNIT 2 CYCLE 9



**Core Power (% RATED)**  
**TWO LOOP POWER DEPENDENT MCPR OPERATING LIMIT**  
**EOC-RPT INOPERABLE / MAIN TURBINE BYPASS OPERABLE**  
**(BOC to EOC)**  
**FIGURE 4.2-4**

Table 4.3-1

**Average Scram Time Fraction Table For Use With Scram Time Dependent  
MCPR Operating Limits**

<b>Control Rod Position</b>	<b>Average Scram Time to Position (seconds)</b>					
<b>45</b>	<b>0.430</b>	<b>0.430</b>	<b>0.430</b>	<b>0.430</b>	<b>0.430</b>	<b>0.430</b>
<b>39</b>	<b>0.711</b>	<b>0.740</b>	<b>0.770</b>	<b>0.800</b>	<b>0.830</b>	<b>0.860</b>
<b>25</b>	<b>1.507</b>	<b>1.591</b>	<b>1.676</b>	<b>1.760</b>	<b>1.845</b>	<b>1.930</b>
<b>5</b>	<b>2.643</b>	<b>2.812</b>	<b>2.981</b>	<b>3.151</b>	<b>3.320</b>	<b>3.490</b>
<b>Scram Time Fraction</b>	<b>0.000</b>	<b>0.200</b>	<b>0.400</b>	<b>0.600</b>	<b>0.800</b>	<b>1.000</b>
<b>Average Scram Insertion Time</b>	<b>Realistic</b>					<b>Maximum Allowable</b>

5.0 LINEAR HEAT GENERATION RATE (LHGR)

5.1 Technical Specification Reference

Technical Specification 3.2.4

5.2 Description

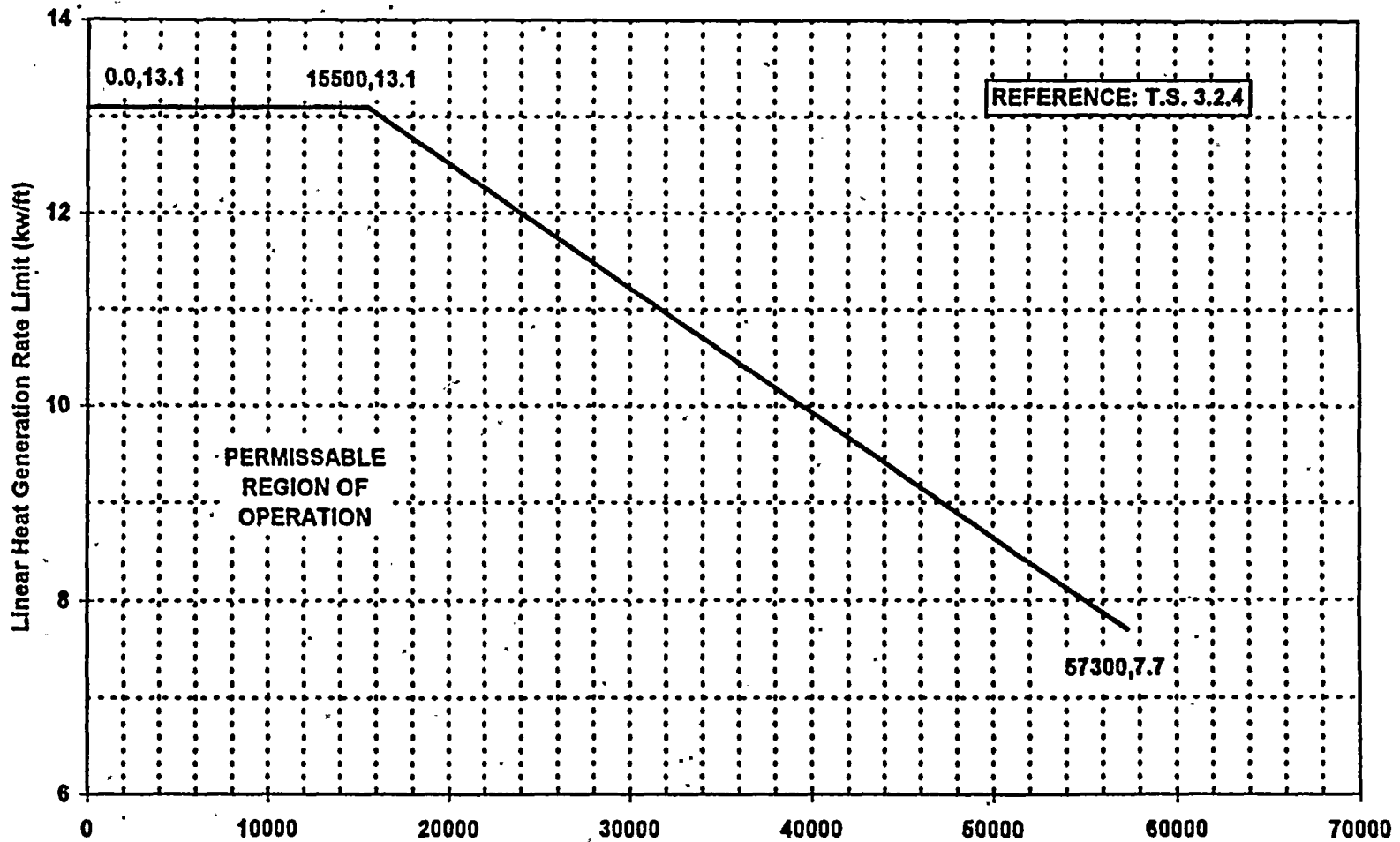
The LHGR for SPC 9x9-2 fuel shall not exceed the LHGR limit determined from Figure 5.2-1.

The LHGR for SPC ATRIUM™-10 fuel shall not exceed the LHGR limit determined from Figure 5.2-2.

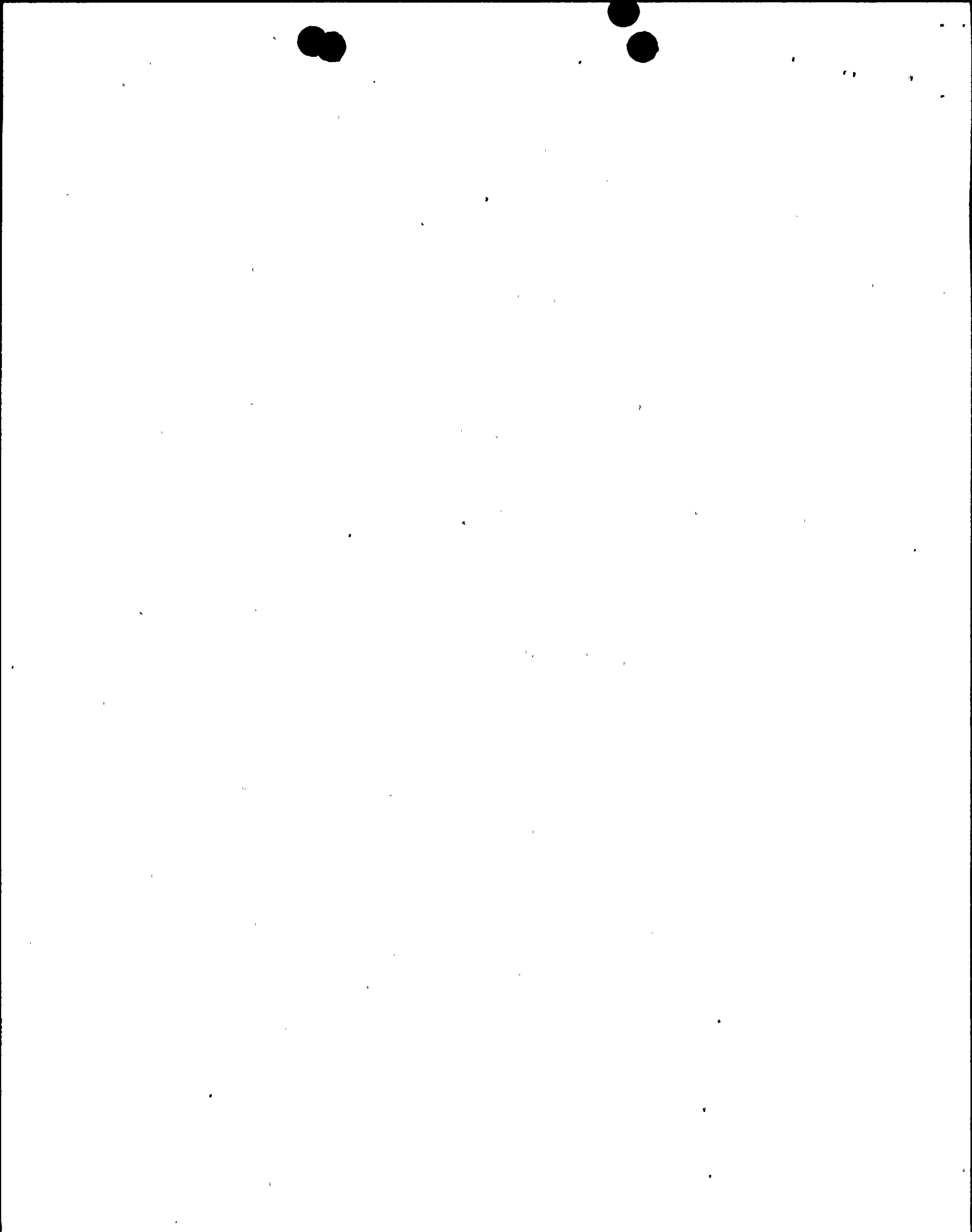
The LHGR for GE12 fuel shall not exceed the LHGR limit determined from Figure 5.2-3.



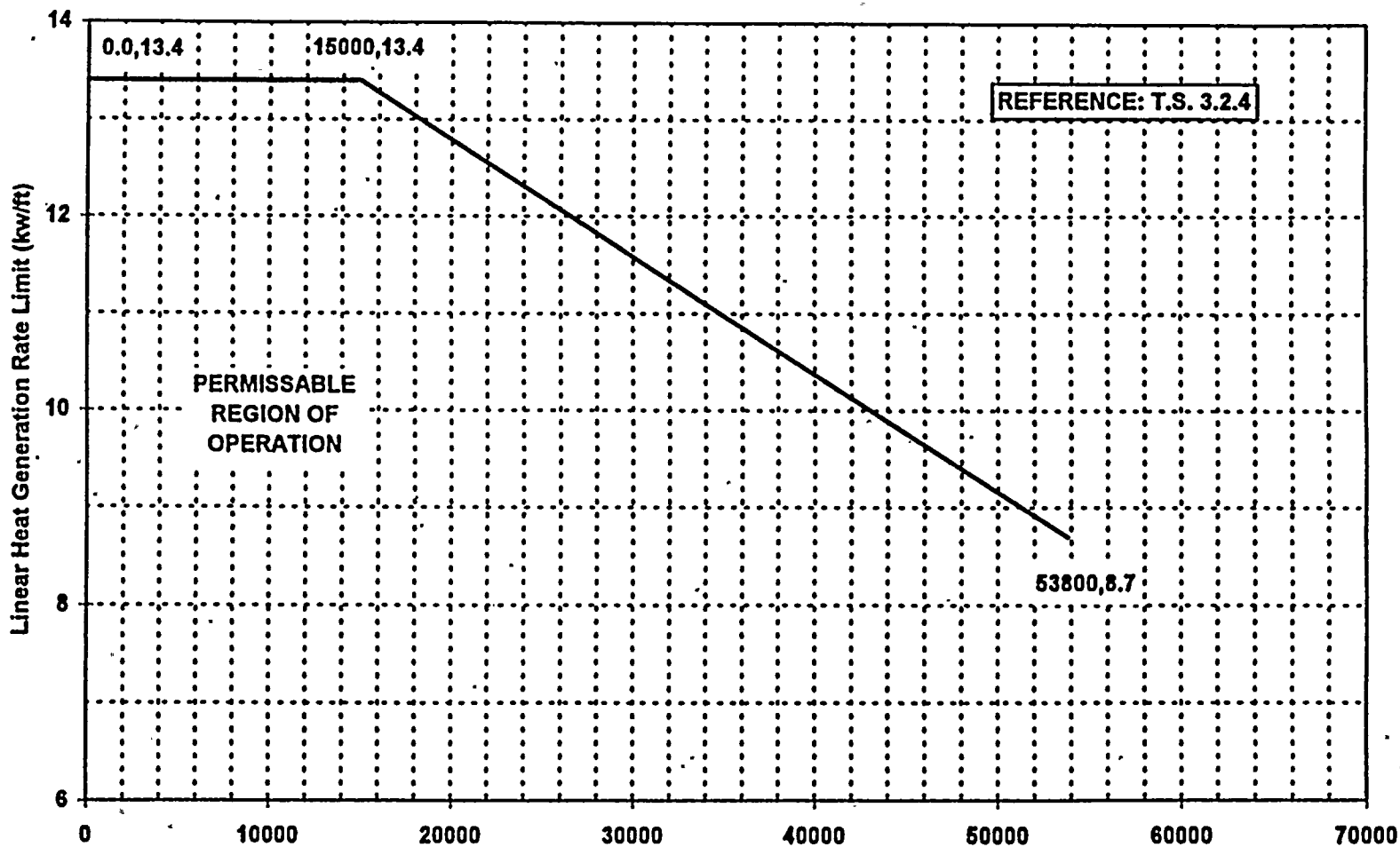
# SSS UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
LINEAR HEAT GENERATION RATE (LHGR) LIMIT  
VERSUS AVERAGE PLANAR EXPOSURE  
SPS 9X9-2 FUEL  
FIGURE 5.2-1

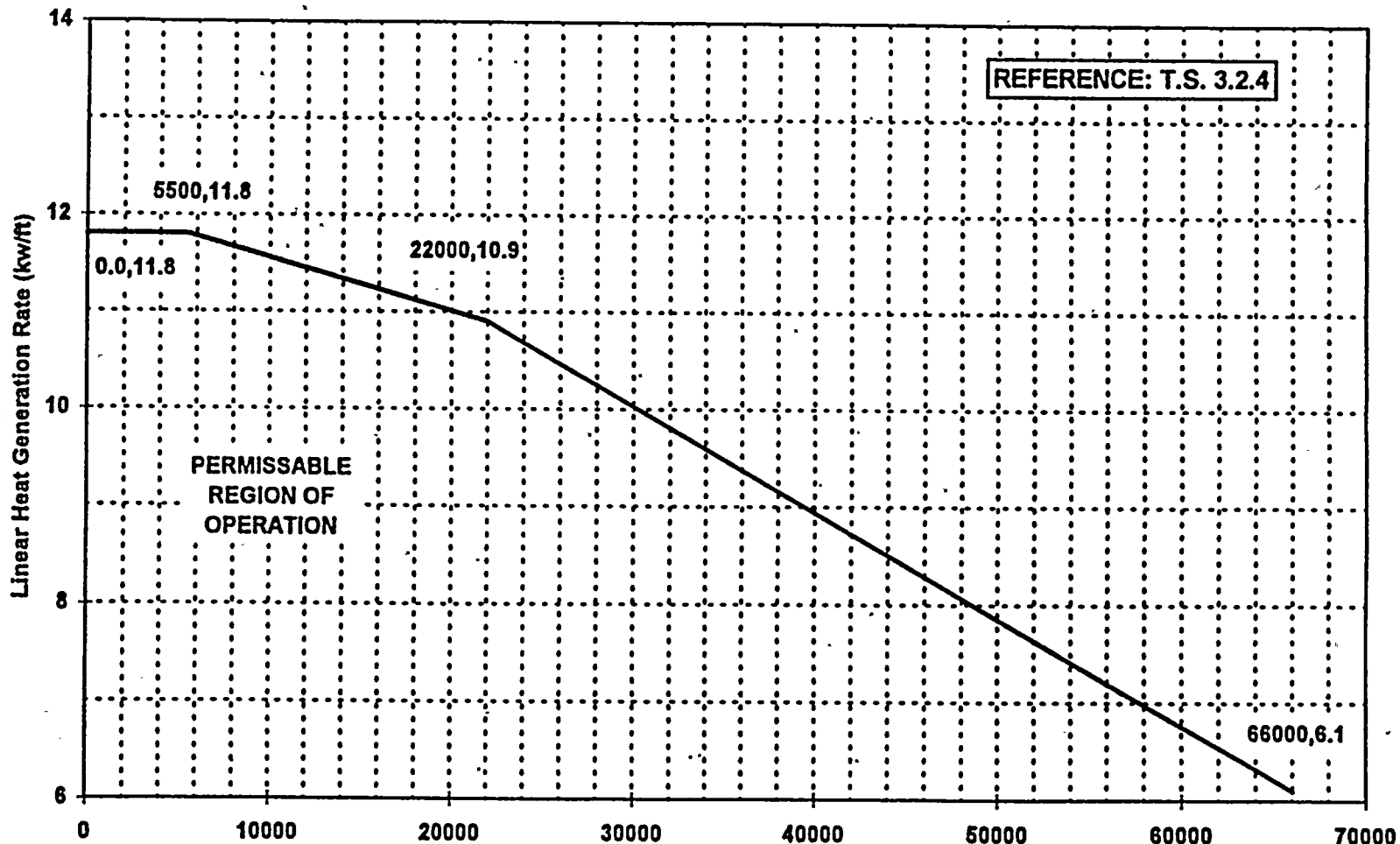


# SSES UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
LINEAR HEAT GENERATION RATE (LHGR) LIMIT  
VERSUS AVERAGE PLANAR EXPOSURE  
SPC ATRIUM™-10 FUEL  
FIGURE 5.2-2

# SSSES UNIT 2 CYCLE 9



Average Planar Exposure (MWD/MTU)  
LINEAR HEAT GENERATION RATE (LHGR) LIMIT  
VERSUS AVERAGE PLANAR EXPOSURE

GE12  
FIGURE 5.2-3

## 6.0 RECIRCULATION LOOPS - SINGLE LOOP OPERATION

### 6.1 Technical Specification Reference

Technical Specification 3.4.1.1.2

### 6.2 Description - SPC 9x9-2, SPC ATRIUM™-10 and GE12 Fuel

#### Minimum Critical Power Ratio Limit

The MCPR limit is specified as a function of core power, core flow, cycle exposure and plant equipment operability status. The MCPR limit for all fuel types (SPC 9x9-2, SPC ATRIUM™-10, and GE12) shall be the greater of:

- a) Flow-Dependent MCPR value determined from Figure 6.2-1.

OR

- b) The Power-Dependent MCPR value determined from one of the following figures, as appropriate:

Figure 6.2-2 : EOC-RPT and Main Turbine Bypass Operable from BOC to EOC

Figure 6.2-3 : EOC-RPT Operable / Main Turbine Bypass Inoperable from BOC to EOC

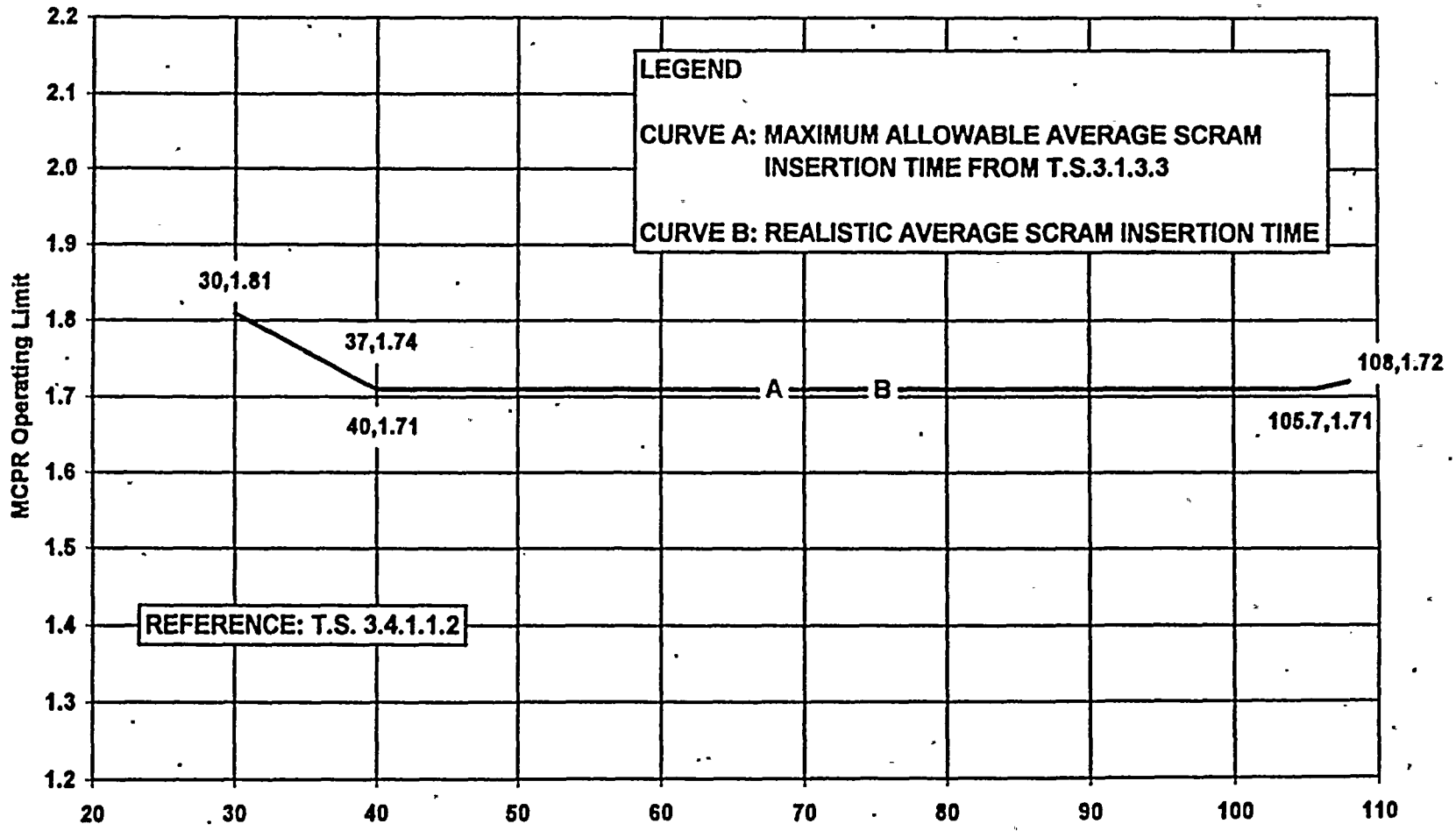
Figure 6.2-4 : EOC-RPT Inoperable / Main Turbine Bypass Operable from BOC to EOC

#### Linear Heat Generation Rate Limit

The LHGR limit for SPC 9x9-2 and GE12 fuel shall be equal to the LHGR Limit from Figure 5.2-1 and Figure 5.2-3, respectively, determined per Section 5.0 of this report multiplied by 0.7. The LHGR limit for SPC ATRIUM™-10 fuel shall be equal to the LHGR Limit from Figure 5.2-2 determined per Section 5.0 of this report.

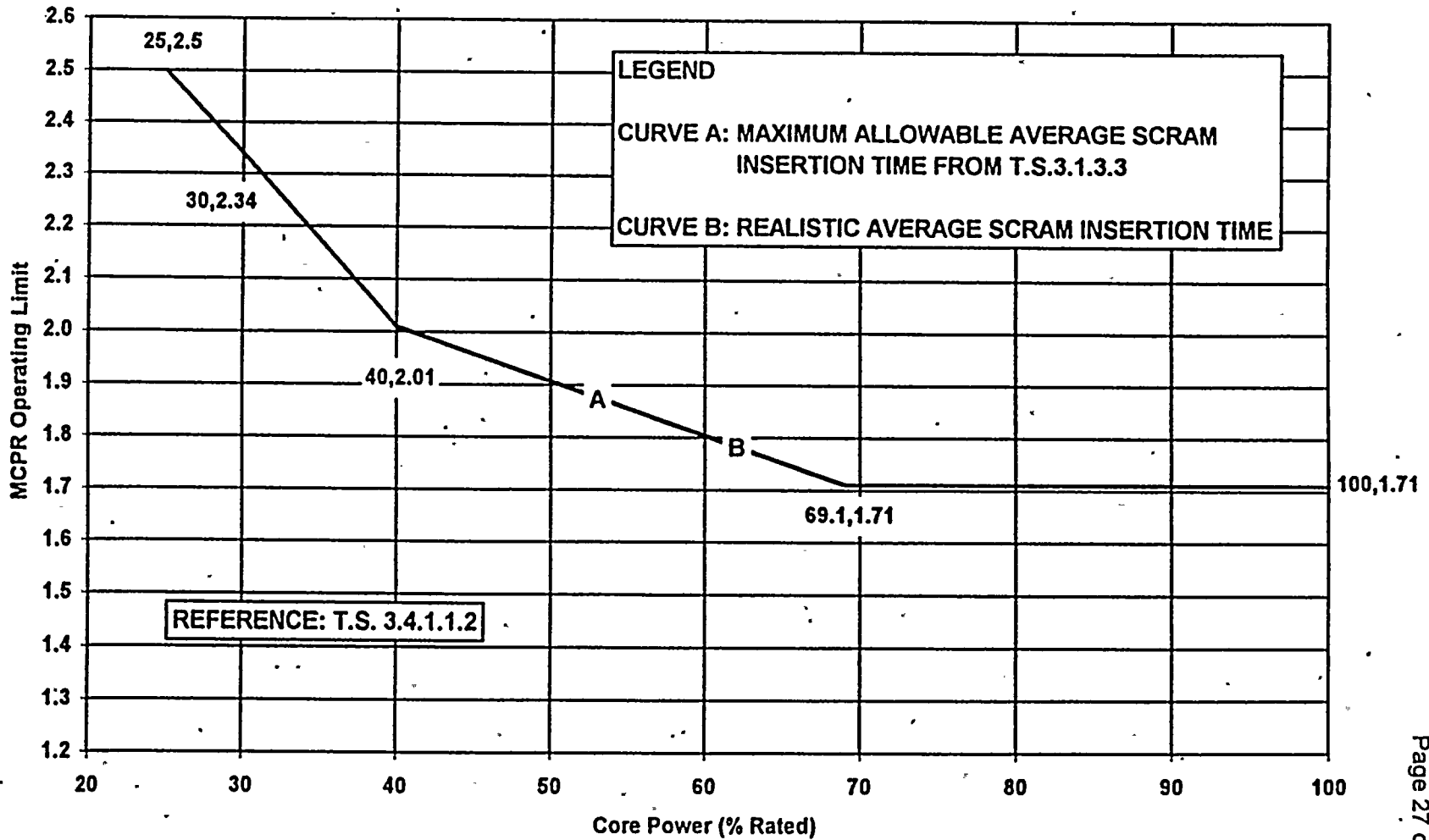
The APLHGR limit for SPC 9x9-2 and GE12 fuel shall be equal to the APLHGR Limit from Figure 2.2-1 and Figure 2.2-3, respectively, determined per Section 2.0 of this report. The APLHGR limit for SPC ATRIUM™-10 fuel shall be equal to the APLHGR Limit from Figure 2.2-2 determined per Section 2.0 of this report multiplied by 0.8.

# SSES UNIT 2 CYCLE 9



**Core Flow (Mlbm/hr)**  
**SINGLE LOOP FLOW DEPENDENT MCPR OPERATING LIMIT**  
**(BOC to EOC)**  
**FIGURE 6.2-1**

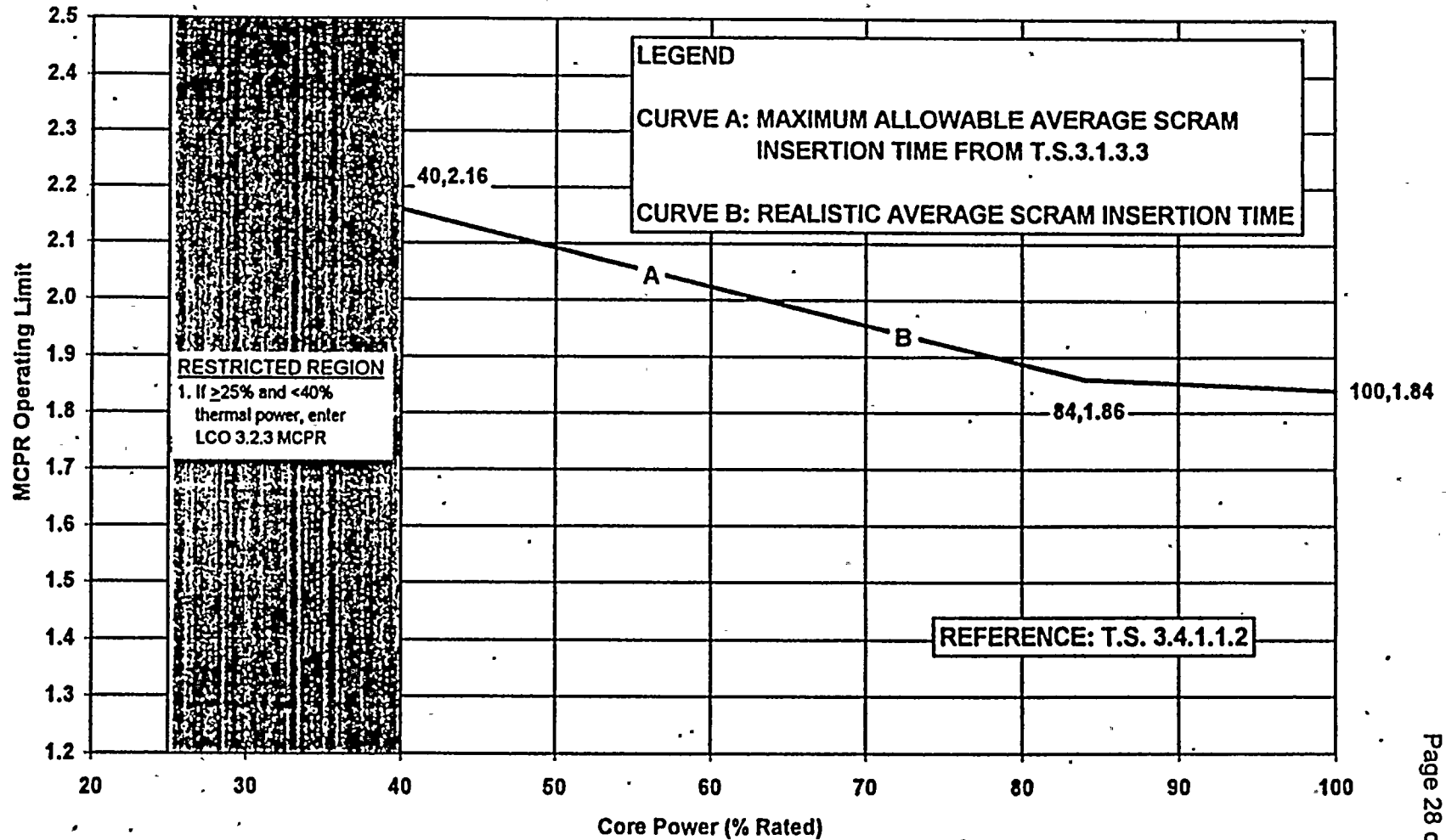
# SSSES UNIT 2 CYCLE 9



REFERENCE: T.S. 3.4.1.1.2

SINGLE LOOP POWER DEPENDENT MCPR OPERATING LIMIT  
 EOC-RPT and MAIN TURBINE BYPASS OPERABLE  
 (BOC to EOC)  
 FIGURE 6.2-2

# SSSES UNIT 2 CYCLE 9



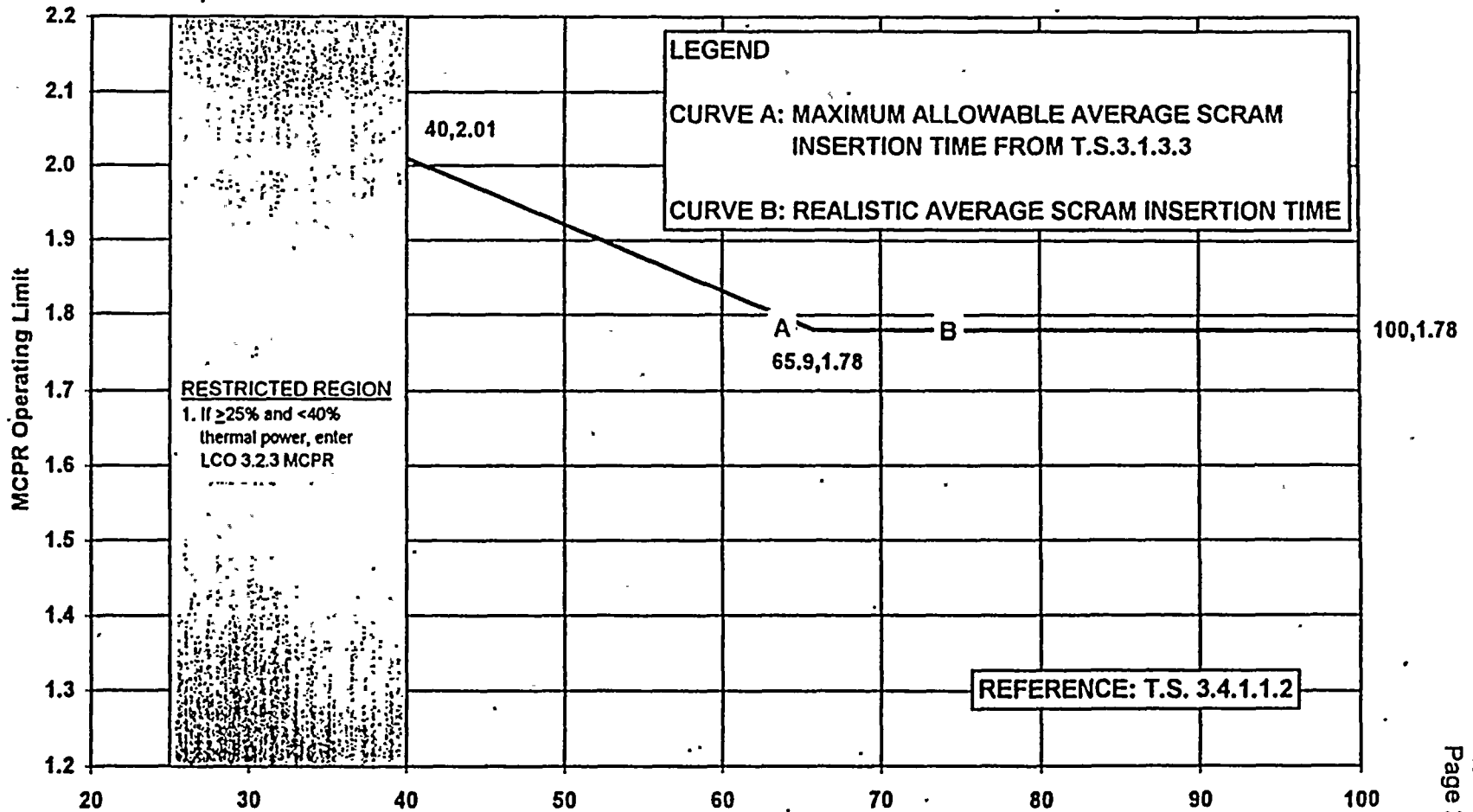
Core Power (% Rated)  
**SINGLE LOOP POWER DEPENDENT MCPR OPERATING LIMIT**  
**EOC-RPT OPERABLE / MAIN TURBINE BYPASS INOPERABLE**  
 (BOC to EOC)  
 FIGURE 6.2-3





1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

# SSES UNIT 2 CYCLE 9



**Core Power (% Rated)**  
**SINGLE LOOP POWER DEPENDENT MCPR OPERATING LIMIT**  
**EOC-RPT INOPERABLE / MAIN TURBINE BYPASS OPERABLE**  
**(BOC to EOC)**  
**FIGURE 6.2-4**

7.0 REFERENCE

1. PL-NF-97-003, Rev. 2, "Susquehanna SES Unit 2 Cycle 9 Reload Summary Report," February 1998.

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11  
12  
13  
14