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A001

TRM

APPROVED AMENDMENT TO

UNIT 2 TECHNICAL REQUIREMENTS MANUAL

EFFECTIVE DATE 03/10/2003

Replace the following pages of the Technical Requirements Manual with the enclosed pages. The revised pages are identified by Effective Date and contain vertical lines indicating the area of change.

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SUSQUEHANNA STEAM ELECTRIC STATION
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Susquehanna SES
Unit 2 Cycle 12

CORE OPERATING LIMITS REPORT

Nuclear Fuels
Engineering

March 2003

CORE OPERATING LIMITS REPORT
REVISION DESCRIPTION INDEX

Rev. No.	Affected Sections	Description/Purpose of Revision
0	ALL	Issuance of this COLR is in support of Unit 2 Cycle 12 operation.

SUSQUEHANNA STEAM ELECTRIC STATION
Unit 2 Cycle 12
CORE OPERATING LIMITS REPORT

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1.0 INTRODUCTION

This CORE OPERATING LIMITS REPORT for Susquehanna Unit 2 Cycle 12 is prepared in accordance with the requirements of Susquehanna Unit 2, Technical Specification 5.6.5. As required by Technical Specifications 5.6.5, core shutdown margin, the core operating limits and APRM setpoints presented herein were developed using NRC-approved methods and are established such that all applicable limits of the plant safety analysis are met.

2.0 DEFINITIONS

Terms used in this COLR but not defined in Section 1.0 of the Technical Specifications or Section 1.1 of the Technical Requirements Manual are provided below.

2.1 The AVERAGE BUNDLE EXPOSURE shall be equal to the total energy produced by the bundle divided by the total initial weight of uranium in the fuel bundle.

2.2 The AVERAGE PLANAR EXPOSURE at a specified height shall be equal to the total energy produced per unit length at the specified height divided by the total initial weight of uranium per unit length at that height.

2.3 The FRACTION OF LIMITING POWER DENSITY (FLPD) shall be the LHGR existing at a given height divided by the applicable LHGR for APRM Setpoint Limit for that bundle type.

2.4 The FRACTION OF RATED THERMAL POWER (FRTP) shall be the measured THERMAL POWER divided by the RATED THERMAL POWER.

2.5 FDLRX is the ratio of the maximum LHGR calculated by the core monitoring system for each fuel bundle divided by the LHGR limit for the applicable fuel bundle type.

2.6 MFLCPR is the ratio of the applicable MCPR operating limit for the applicable fuel bundle type divided by the MCPR calculated by the core monitoring system for each fuel bundle.

2.7 MAPRAT is the ratio of the maximum APLHGR calculated by the core monitoring system for each fuel bundle divided by the APLGHR limit for the applicable fuel bundle type.

2.8 FDLRC is the ratio of the maximum LHGR calculated by the core monitoring system for each fuel bundle divided by the LHGR for APRM Setpoint Limit for the applicable fuel bundle type.

3.0 SHUTDOWN MARGIN

3.1 Technical Specification Reference

Technical Specification 3.1.1

3.2 Description

The SHUTDOWN MARGIN shall be equal to or greater than:

a) 0.38% Δk/k with the highest worth rod analytically determined

OR

b) 0.28% Δk/k with the highest worth rod determined by test

Since core reactivity will vary during the cycle as a function of fuel depletion and poison burnup, Beginning of Cycle (BOC) SHUTDOWN MARGIN (SDM) tests must also account for changes in core reactivity during the cycle. Therefore, the SDM measured at BOC must be equal to or greater than the applicable requirement from either 3.2.a or 3.2.b plus an adder, "R". The adder, "R", is the difference between the calculated value of maximum core reactivity (that is, minimum SDM) during the operating cycle and the calculated BOC core reactivity. If the value of "R" is zero (that is, BOC is the most reactive point in the cycle) no correction to the BOC measured value is required.

The SHUTDOWN MARGIN limits provided in 3.2a and 3.2b are applicable in MODES 1, 2, 3, 4, and 5. This includes core shuffling.

4.0 AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)

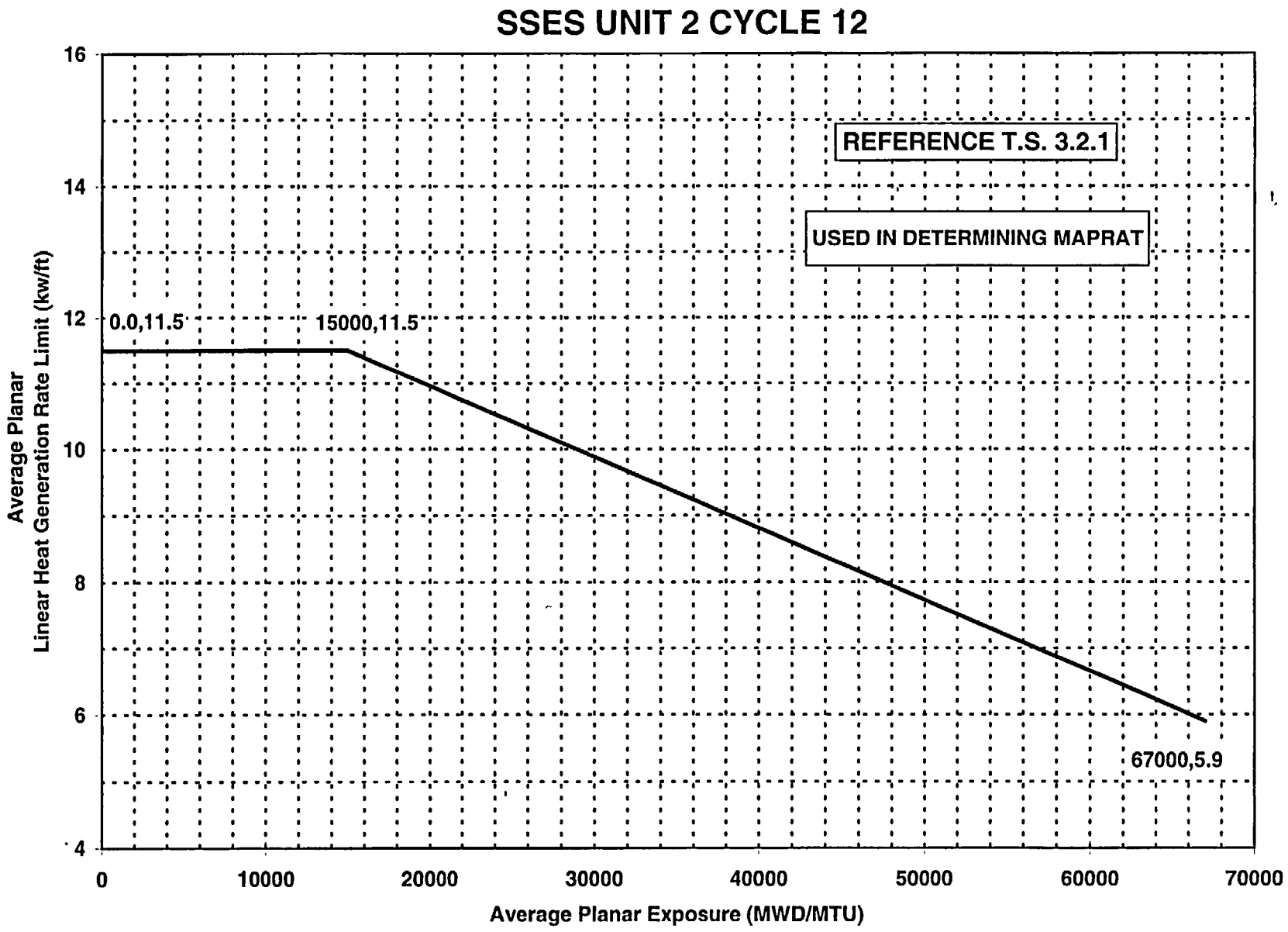
4.1 Technical Specification Reference

Technical Specification 3.2.1

4.2 Description

The APLHGRs for ATRIUM™-10 fuel shall not exceed the limit shown in Figure 4.2-1.

The APLHGR limits in Figure 4.2-1 are valid for Main Turbine Bypass Operable and Inoperable and EOC-RPT Operable and Inoperable in Two Loop operation. The APLHGR limits for Single Loop operation are provided in Section 8.0.



AVERAGE PLANAR LINEAR HEAT GENERATION RATE LIMIT VERSUS
AVERAGE PLANAR EXPOSURE TWO LOOP OPERATION
ATRIUM™-10 FUEL
FIGURE 4.2-1

5.0 MINIMUM CRITICAL POWER RATIO (MCPR)

5.1 Technical Specification Reference

Technical Specification 3.2.2, 3.7.6, and 3.3.4.1

5.2 Description

The MCPR limit is specified as a function of core power, core flow, average scram insertion time per Section 5.3 and plant equipment operability status. The MCPR limits for all fuel types (ATRIUM™-10) shall be the greater of the Flow-Dependent or the Power-Dependent MCPR, depending on the applicable equipment operability status.

a) EOC-RPT and Main Turbine Bypass Operable

Figure 5.2-1: Flow-Dependent MCPR value determined from BOC to EOC

Figure 5.2-2: Power-Dependent MCPR value determined from BOC to EOC

b) Main Turbine Bypass Inoperable / EOC-RPT Operable

Figure 5.2-3: Flow-Dependent MCPR value determined from BOC to EOC

Figure 5.2-4: Power-Dependent MCPR value determined from BOC to EOC

c) EOC-RPT Inoperable / Main Turbine Bypass Operable

Figure 5.2-5: Flow-Dependent MCPR value determined from BOC to EOC

Figure 5.2-6: Power-Dependent MCPR value determined from BOC to EOC

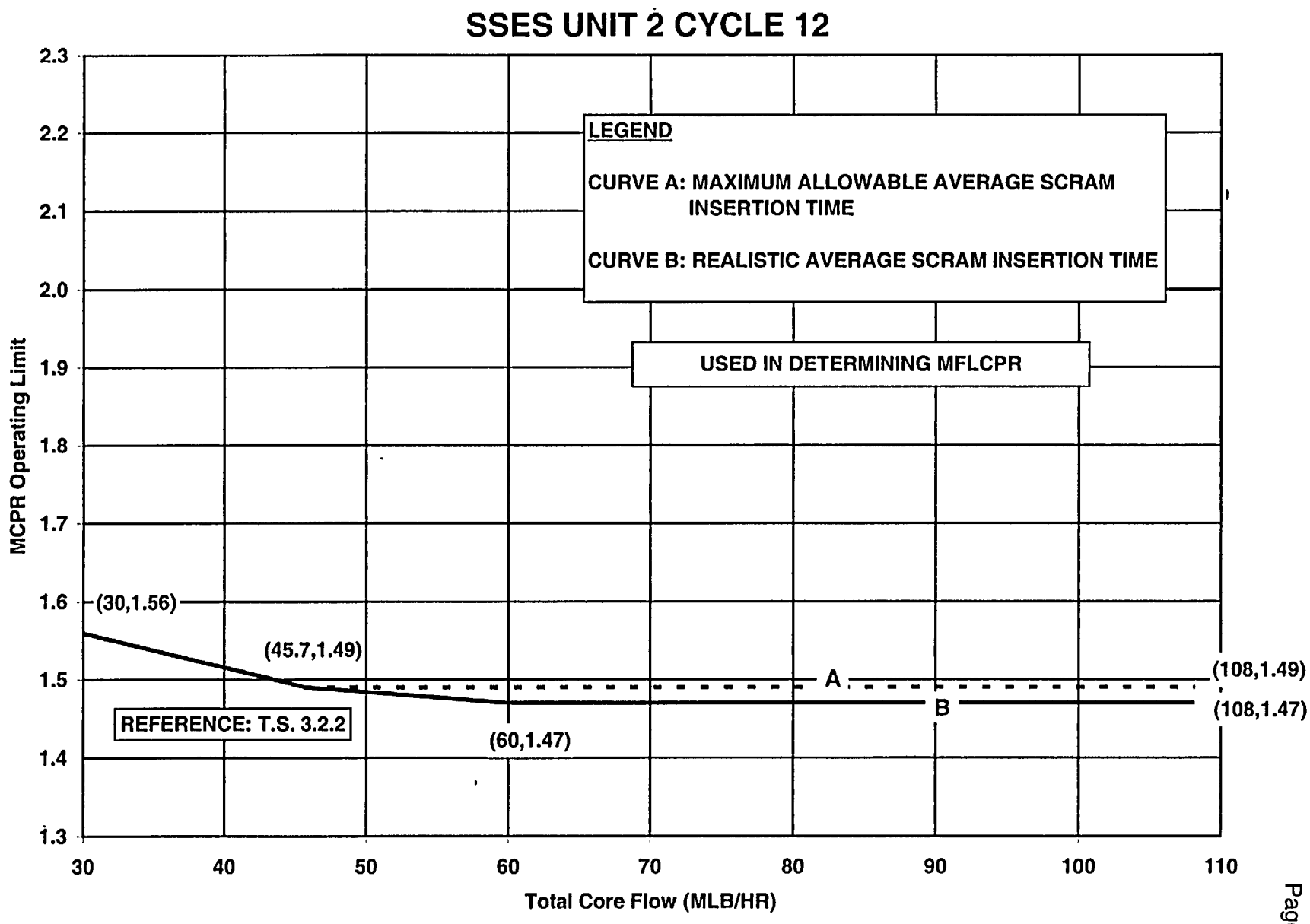
The MCPR limits in Figures 5.2-1 through 5.2-6 are valid for Two Loop operation.

The MCPR limits for Single Loop operation are provided in Section 8.0.

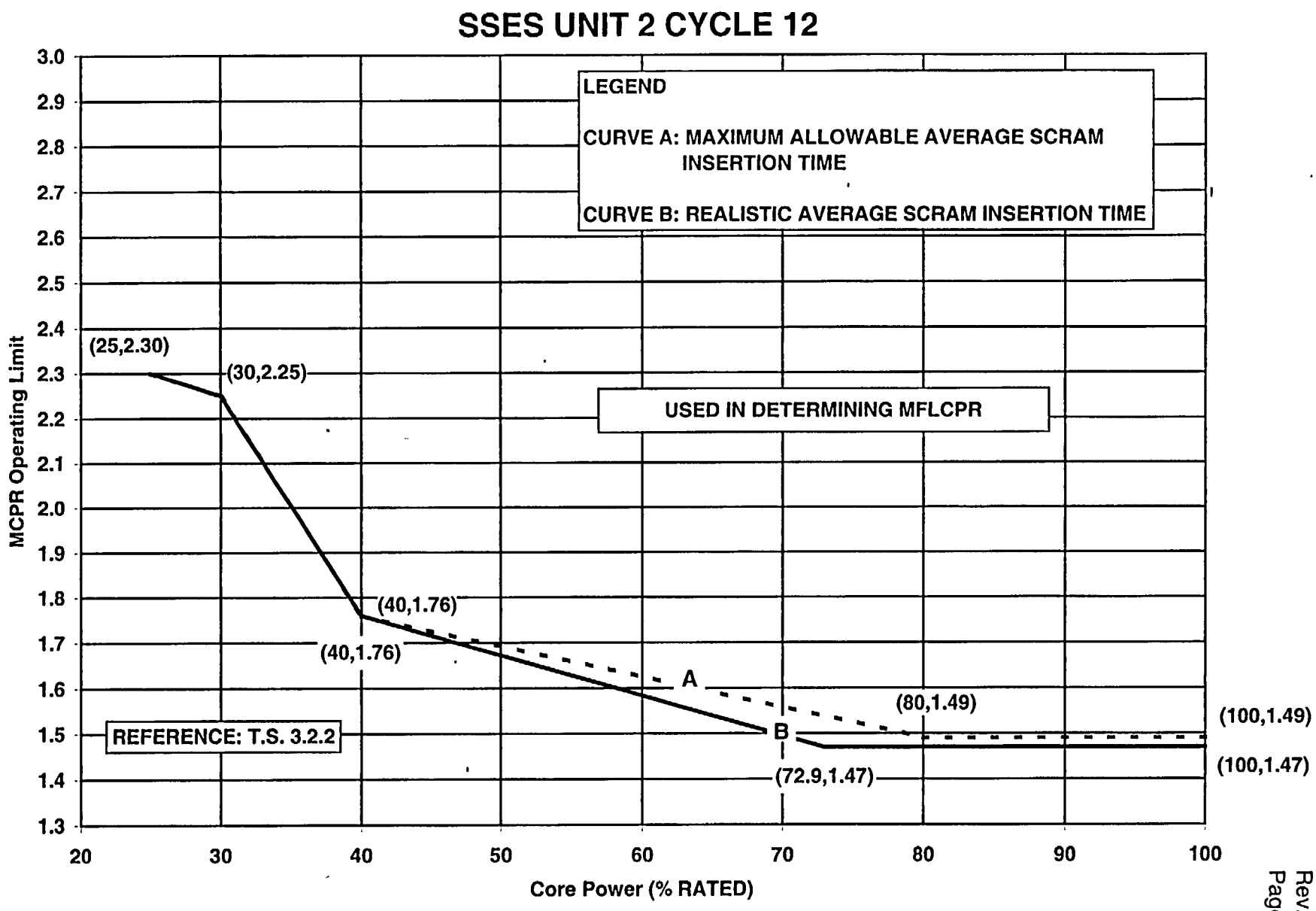
5.3 Average Scram Time Fraction

Table 5.3-1 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.

EOC-RPT and Main Turbine Bypass Operable

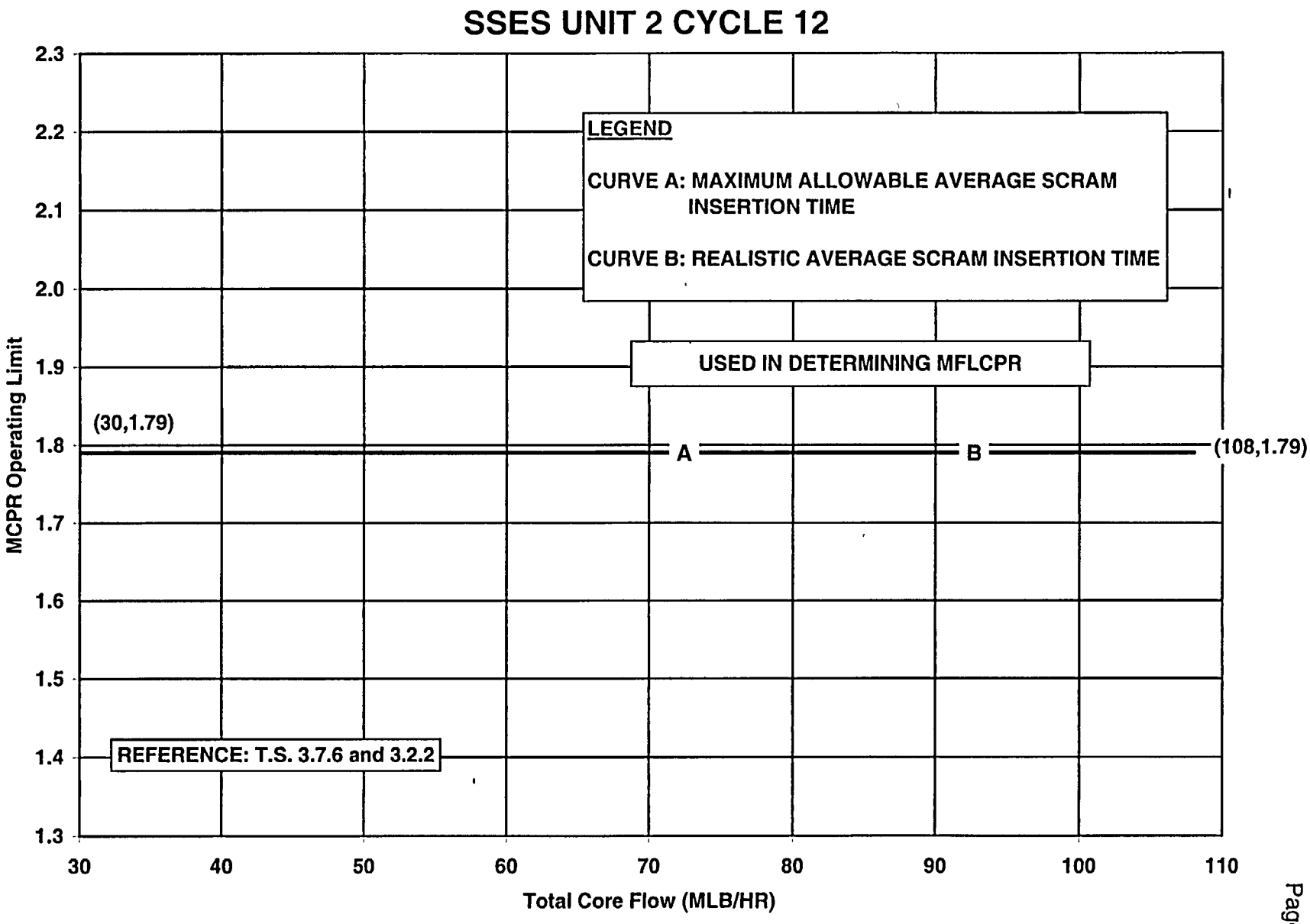


MCPR OPERATING LIMIT VERSUS TOTAL CORE FLOW
EOC-RPT AND MAIN TURBINE BYPASS OPERABLE
TWO LOOP OPERATION (BOC TO EOC)
FIGURE 5.2-1



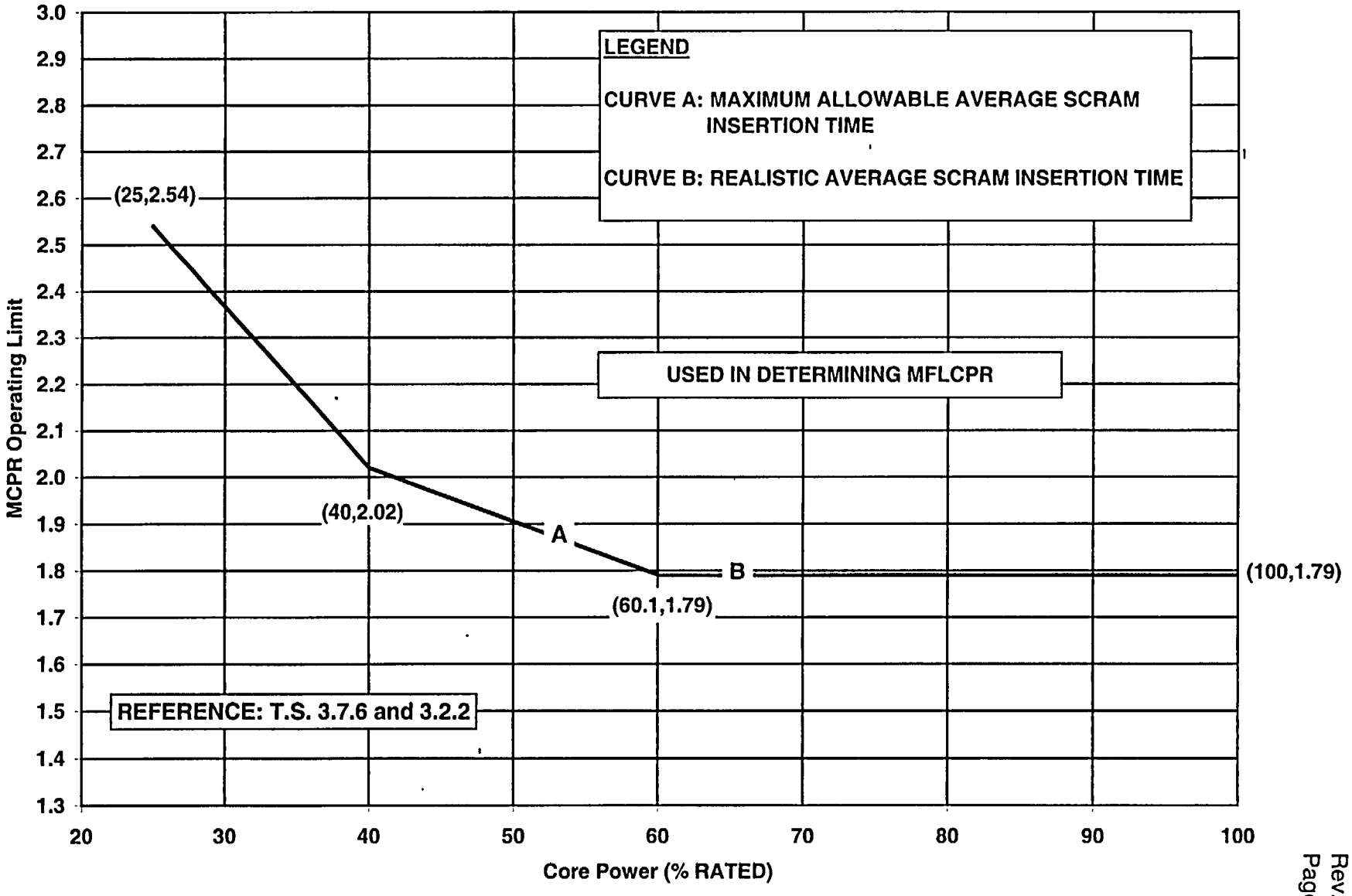
MCPR OPERATING LIMIT VERSUS CORE POWER
EOC-RPT AND MAIN TURBINE BYPASS OPERABLE
TWO LOOP OPERATION (BOC TO EOC)
FIGURE 5.2-2

Main Turbine Bypass Inoperable / EOC-RPT Operable



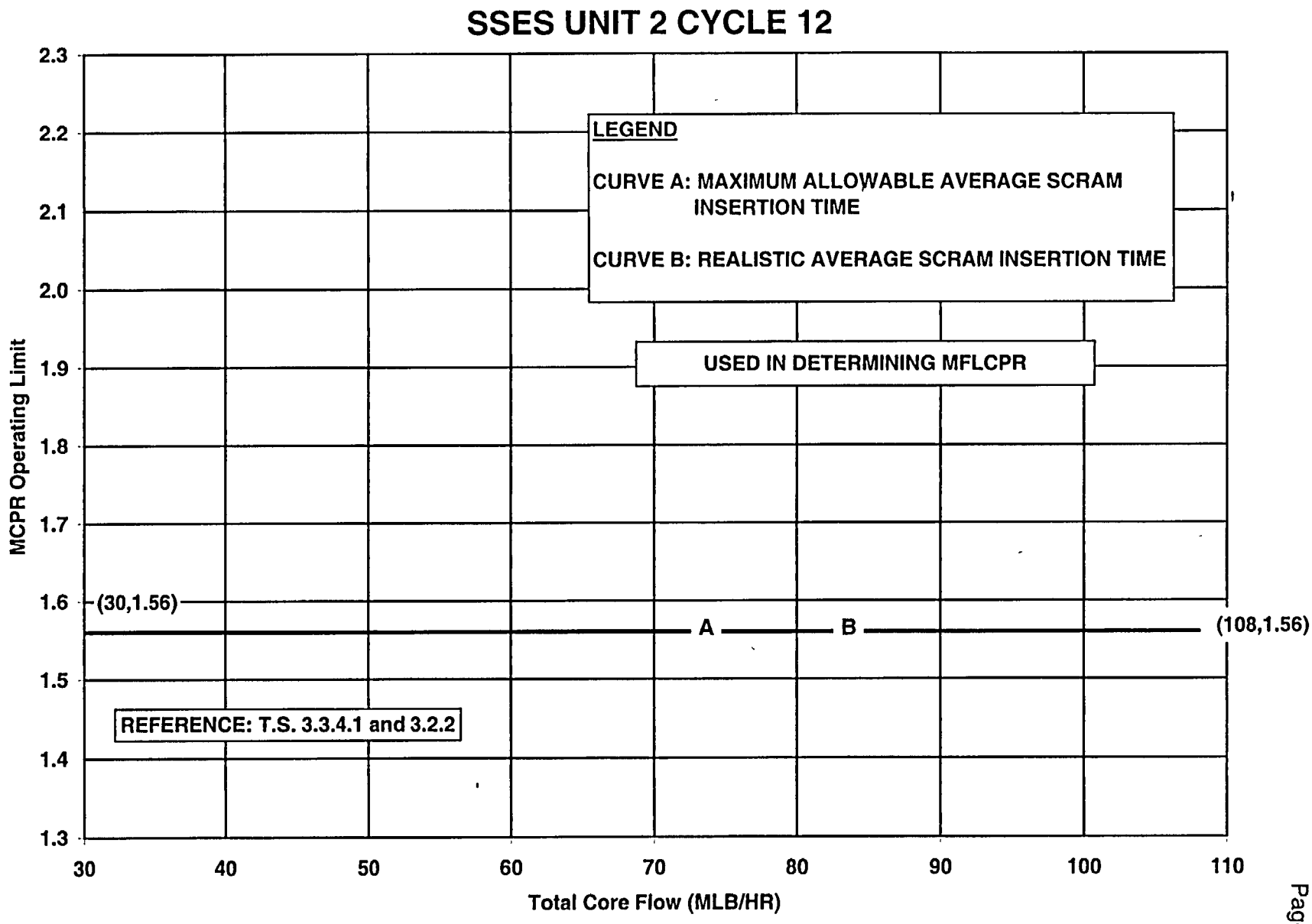
MCPR OPERATING LIMIT VERSUS TOTAL CORE FLOW
MAIN TURBINE BYPASS INOPERABLE / EOC-RPT OPERABLE
TWO LOOP OPERATION (BOC TO EOC)
FIGURE 5.2-3

SSES UNIT 2 CYCLE 12

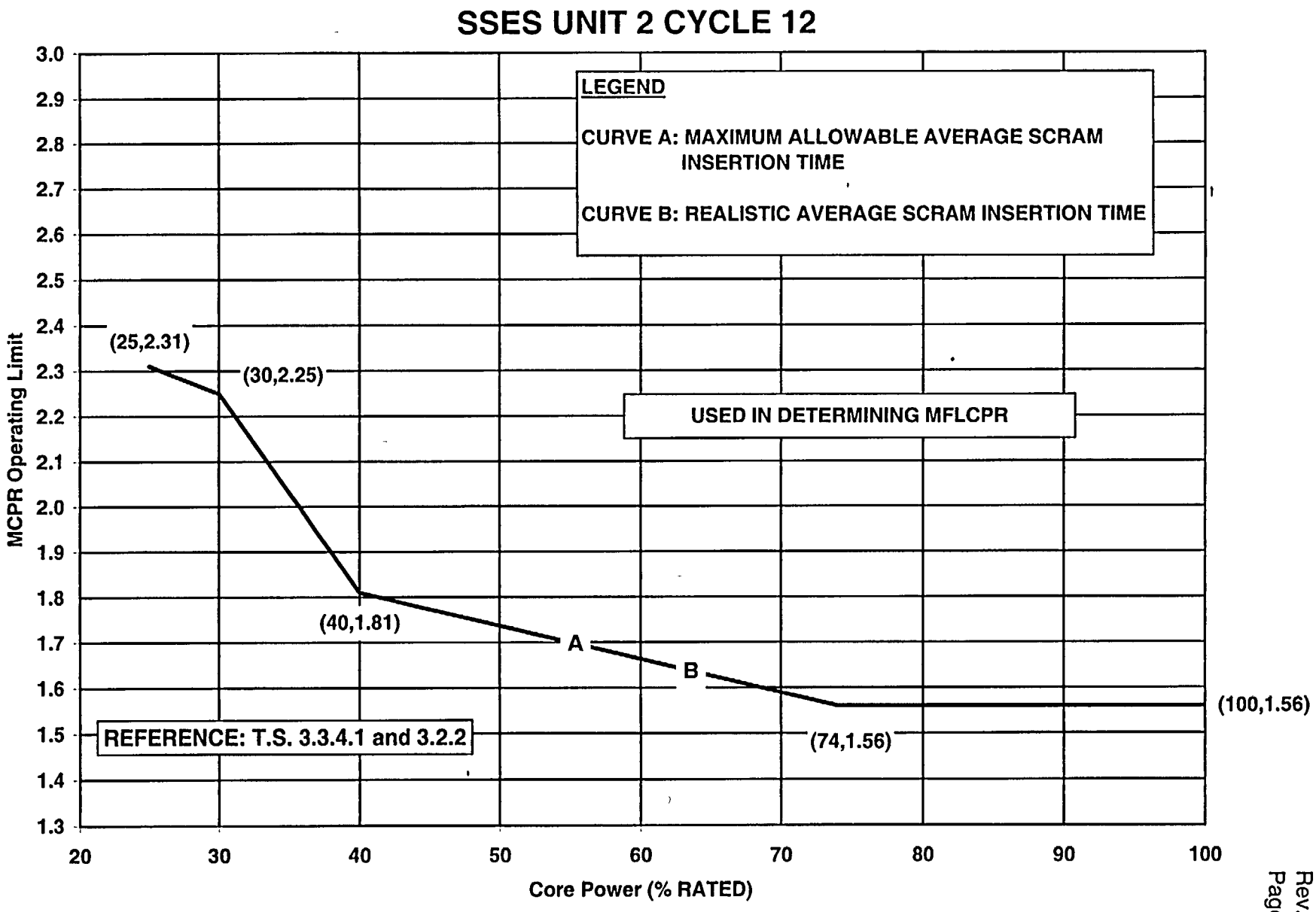


MCPR OPERATING LIMIT VERSUS CORE POWER
MAIN TURBINE BYPASS INOPERABLE / EOC-RPT OPERABLE
TWO LOOP OPERATION (BOC to EOC)
FIGURE 5.2-4

EOC-RPT Inoperable / Main Turbine Bypass Operable



MCPR OPERATING LIMIT VERSUS TOTAL CORE FLOW
EOC-RPT INOPERABLE / MAIN TURBINE BYPASS OPERABLE
TWO LOOP OPERATION (BOC TO EOC)
FIGURE 5.2-5



MCPR OPERATING LIMIT VERSUS CORE POWER
EOC-RPT INOPERABLE / MAIN TURBINE BYPASS OPERABLE
TWO LOOP OPERATION (BOC to EOC)
FIGURE 5.2-6

Table 5.3-1

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

Control Rod Position	Average Scram Time to Position (seconds)					
45	0.470	0.480	0.490	0.500	0.510	0.520
39	0.630	0.676	0.722	0.768	0.814	0.860
25	1.500	1.582	1.664	1.746	1.828	1.910
5	2.700	2.848	2.996	3.144	3.292	3.440
Scram Time Fraction	0.000	0.200	0.400	0.600	0.800	1.000
Average Scram Insertion Time	Realistic					Maximum Allowable

6.0 LINEAR HEAT GENERATION RATE (LHGR)

6.1 Technical Specification Reference

Technical Specification 3.2.3 and 3.7.6

6.2 Description

The LHGR limits are specified below as a function of Main Turbine Bypass operability for each fuel type as follows:

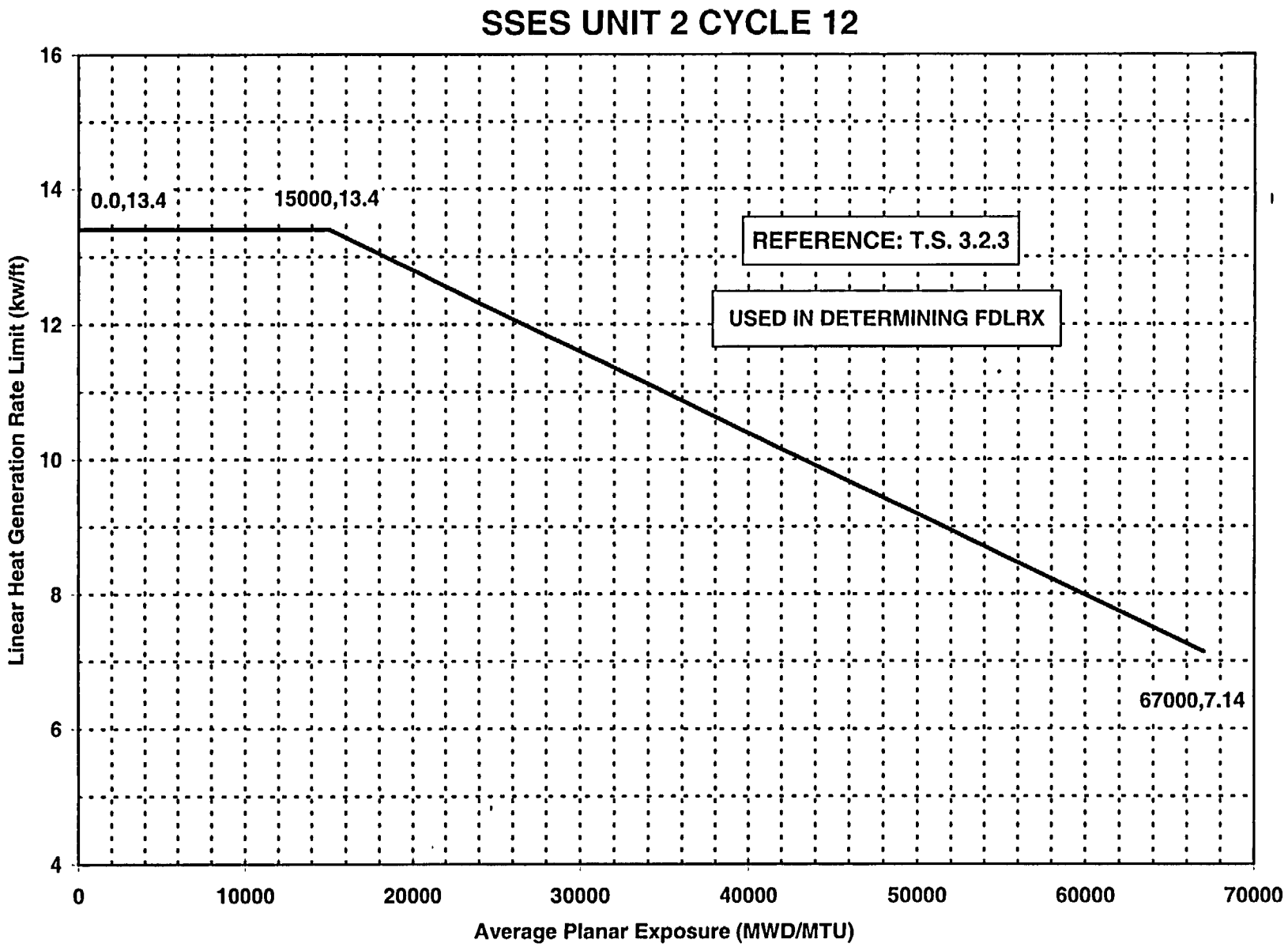
Main Turbine Bypass Operable

The LHGR for ATRIUM™-10 fuel shall not exceed the LHGR limit determined from Figure 6.2-1.

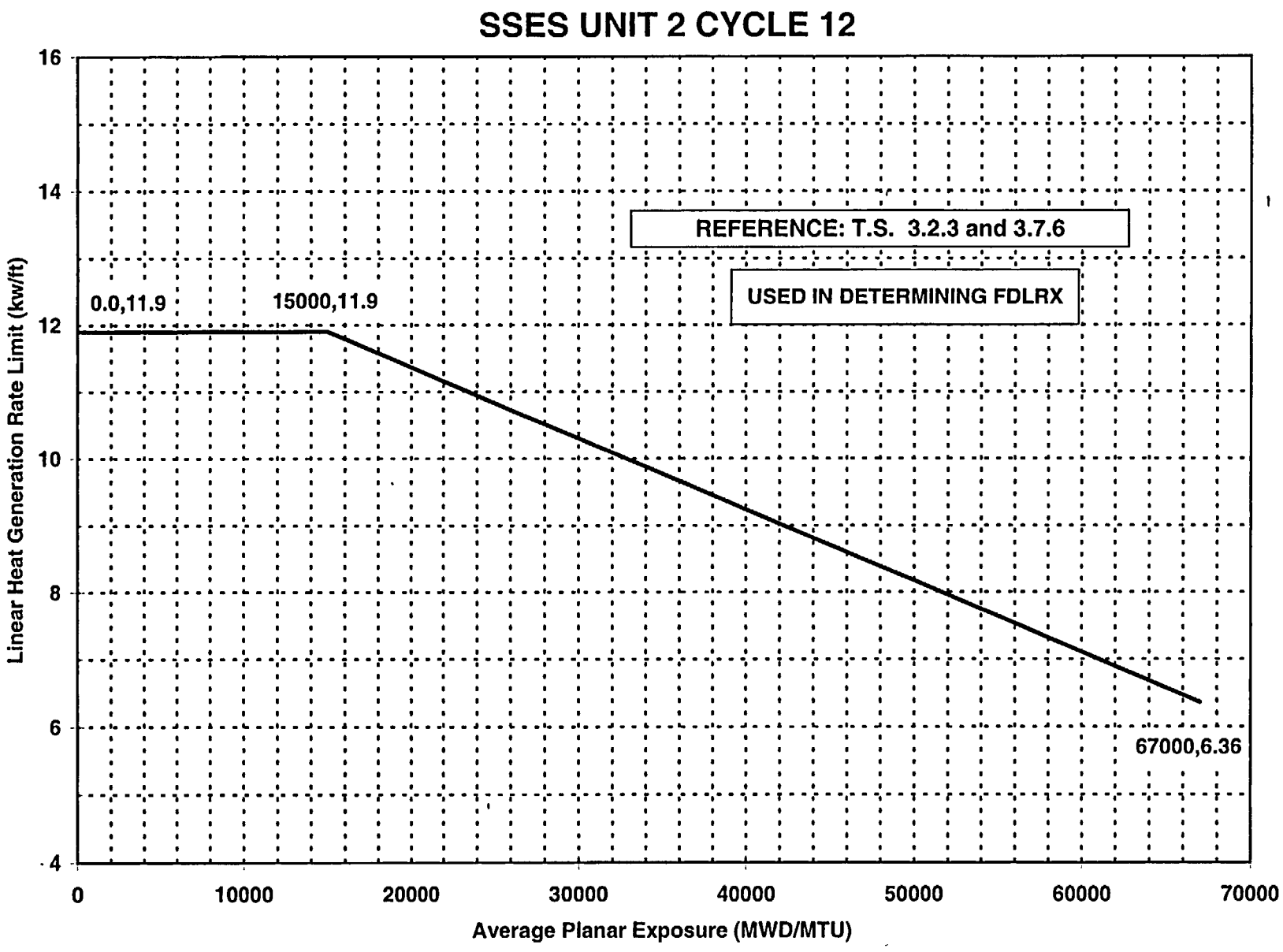
Main Turbine Bypass Inoperable

The LHGR for ATRIUM™-10 fuel shall not exceed the LHGR limit determined from Figure 6.2-2.

The LHGR limits in Figures 6.2-1 and 6.2-2 are valid for Two Loop and Single Loop operation.



LINEAR HEAT GENERATION RATE LIMIT VERSUS AVERAGE PLANAR EXPOSURE
MAIN TURBINE BYPASS OPERABLE
ATRIUM™-10 FUEL
FIGURE 6.2-1



LINEAR HEAT GENERATION RATE LIMIT VERSUS AVERAGE PLANAR EXPOSURE
MAIN TURBINE BYPASS INOPERABLE
ATRIUM™-10 FUEL
FIGURE 6.2-2

7.0 AVERAGE POWER RANGE MONITOR (APRM) GAIN AND SETPOINTS

7.1 Technical Specification Reference

Technical Specification 3.2.4 and 3.3.1.1

7.2 Description

The APRM flow biased simulated thermal power-upscale scram trip setpoint (S) and flow biased neutron flux-upscale control rod block trip setpoint (S_{RB}) shall be established as specified in Table 7.2-1 and Table 7.2-2, including any adjustments per Technical Specification LCO 3.2.4.

Technical Specification LCO 3.2.4 provides an option to adjust the APRM setpoints when MFLPD is greater than FRACTION OF RATED THERMAL POWER (FRTP). The adjustment applies to both the APRM flow biased simulated thermal power-upscale scram trip setpoint and flow biased neutron flux-upscale control rod block trip setpoint for Two Loop and Single Loop operation. The APRM setpoints for Specification 3.2.4 are established in Tables 7.2-1 and 7.2-2.

Table 7.2-1
APRM Setpoint for
Two Loop Operation

Trip Setpoint	Allowable Value
$S \leq (0.58W + 59\%)\ T$	$S \leq (0.58W + 62\%)\ T$[1]
$S_{RB} \leq (0.58W + 50\%)\ T$	$S_{RB} \leq (0.58W + 53\%)\ T$

Table 7.2-2
APRM Setpoint for
Single Loop Operation

Trip Setpoint	Allowable Value
$S \leq (0.58W + 54\%)\ T$	$S \leq (0.58W + 57\%)\ T$[1]
$S_{RB} \leq (0.58W + 45\%)\ T$	$S_{RB} \leq (0.58W + 48\%)\ T$

where: S and S_{RB} are in percent of RATED THERMAL POWER

W = Loop recirculation flow as a percentage of the loop recirculation flow which produces a core flow of 100 million lbs/hr

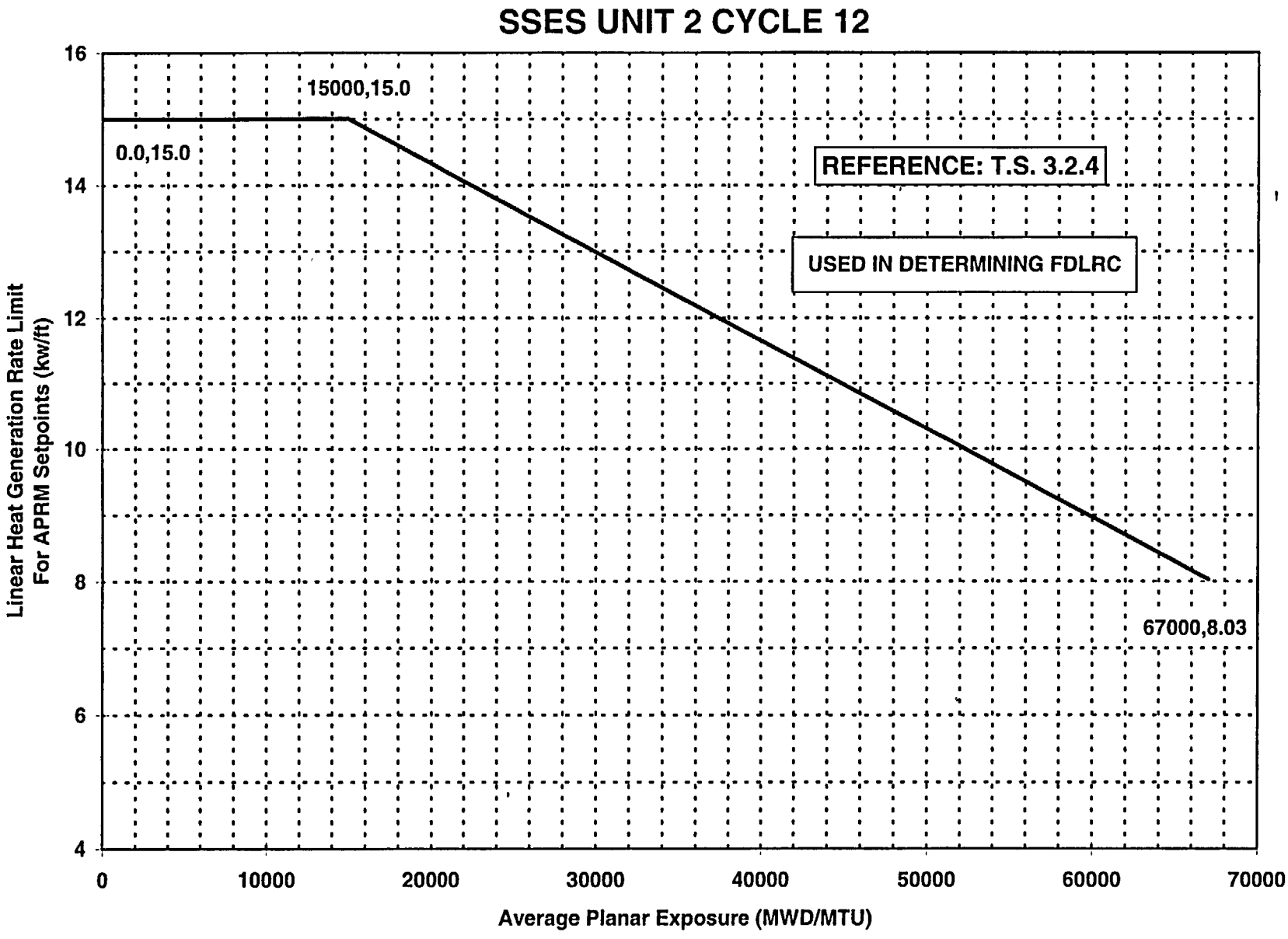
T = Lowest value of the ratio of FRTP divided by the MFLPD.[2] The FLPD is the actual LHGR divided by the applicable LHGR limit for APRM Setpoints. The LHGR limit for APRM setpoints for ATRIUM™-10 fuel shall be taken from Figure 7.2-1.

The LHGR for APRM setpoint limits in Figure 7.2-1 are valid for Main Turbine Bypass Operable and Inoperable and EOC-RPT Operable and Inoperable for both Two and Single Loop operation.

For calculated T-values greater than 1.0, a ratio of 1.0 is used in the above equations.

[1] APRM flow biased simulated thermal power-upscale scram allowable value in this table is equal to the value established in Technical Specification 3.3.1.1.

[2] For the calculation of T, the value of MFLPD shall be the maximum value of FDLRC.



LINEAR HEAT GENERATION RATE LIMIT FOR APRM SETPOINTS VERSUS AVERAGE PLANAR EXPOSURE
ATRIUM™ -10 FUEL
FIGURE 7.2-1

8.0 RECIRCULATION LOOPS - SINGLE LOOP OPERATION

8.1 Technical Specification Reference

Technical Specification 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.3.4.1, 3.4.1, and 3.7.6

8.2 Description

APLHGR

The APLHGR limit for ATRIUM™-10 fuel shall be equal to the APLHGR Limit from Figure 8.2-1.

The APLHGR limits in Figure 8.2-1 are valid for Main Turbine Bypass Operable and Inoperable and EOC-RPT Operable and Inoperable in Single Loop operation.

Minimum Critical Power Ratio Limit

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

a) Flow-Dependent MCPR value determined from Figure 8.2-2

OR

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

Figure 8.2-3 : EOC-RPT and Main Turbine Bypass Operable from BOC to EOC

Figure 8.2-4 : Main Turbine Bypass Inoperable / EOC-RPT Operable from BOC to EOC

Figure 8.2-5 : EOC-RPT Inoperable / Main Turbine Bypass Operable from BOC to EOC

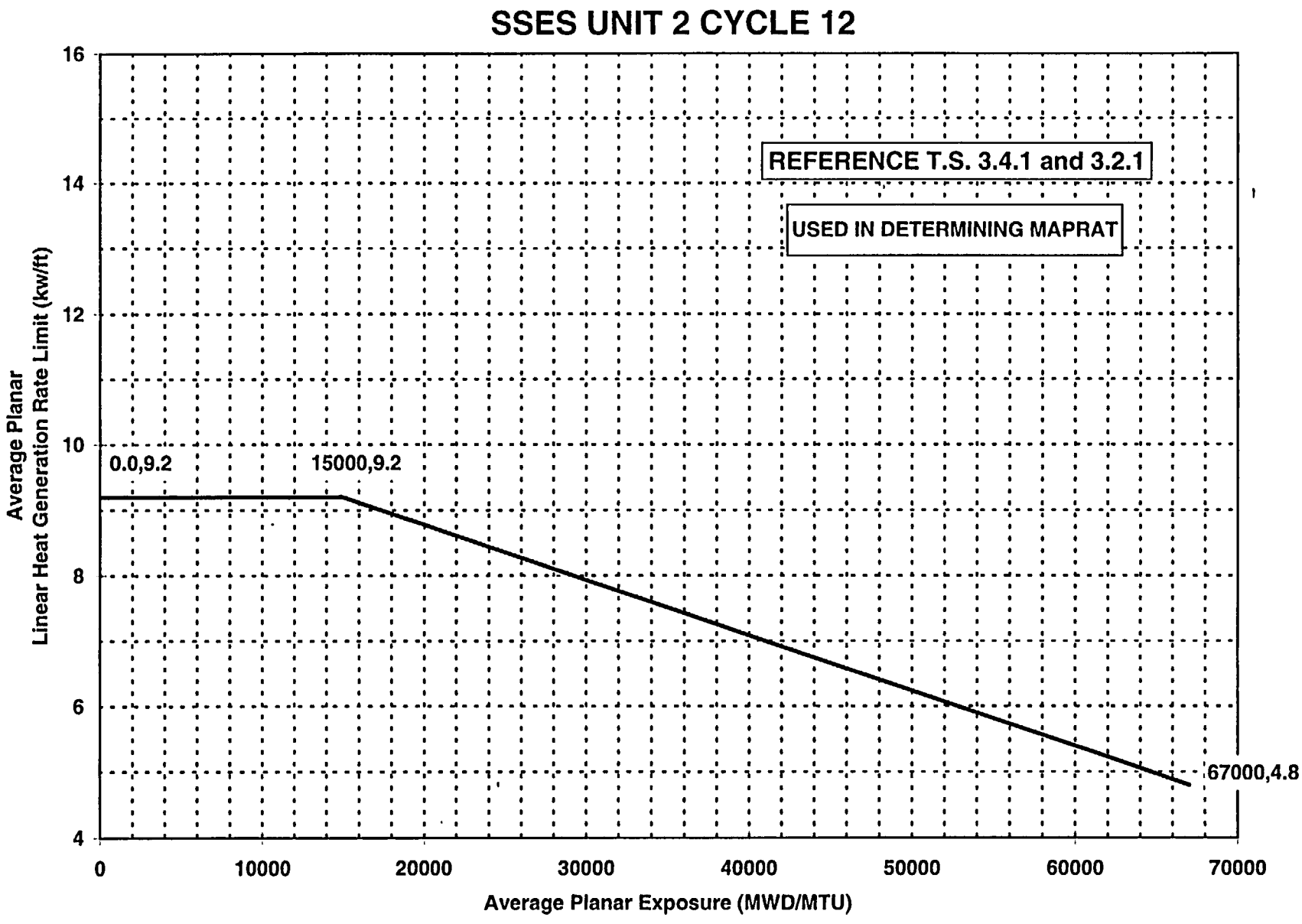
The MCPR limits in Figures 8.2-2 through 8.2-5 are valid only for Single Loop operation.

Linear Heat Generation Rate Limit

The LHGR limits for Single Loop Operation are defined in Section 6.0.

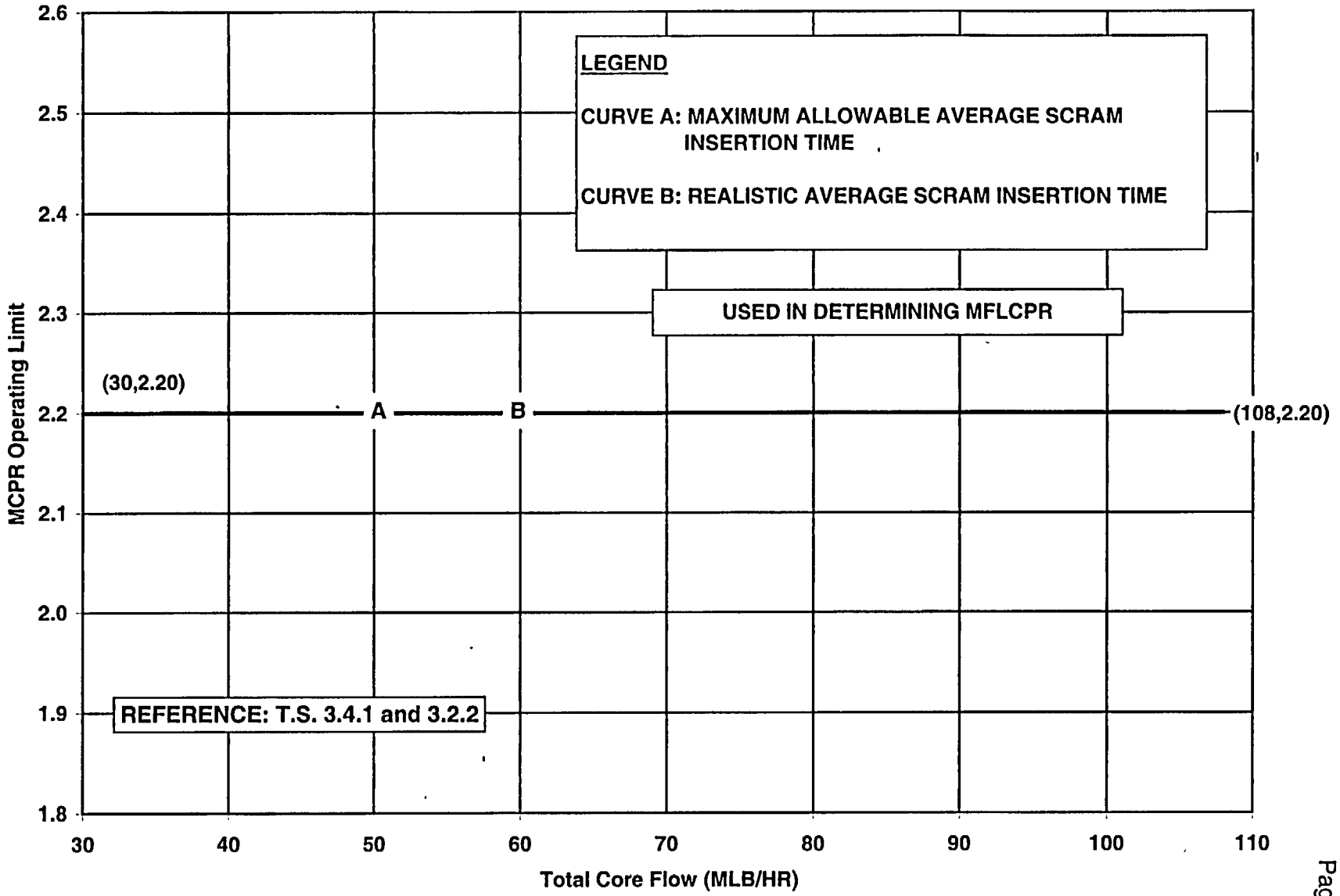
Average Power Range Monitor (APRM) Gain And Setpoints

APRM setpoints and the LHGR limit for APRM setpoints for Single Loop operation are defined in Section 7.0.

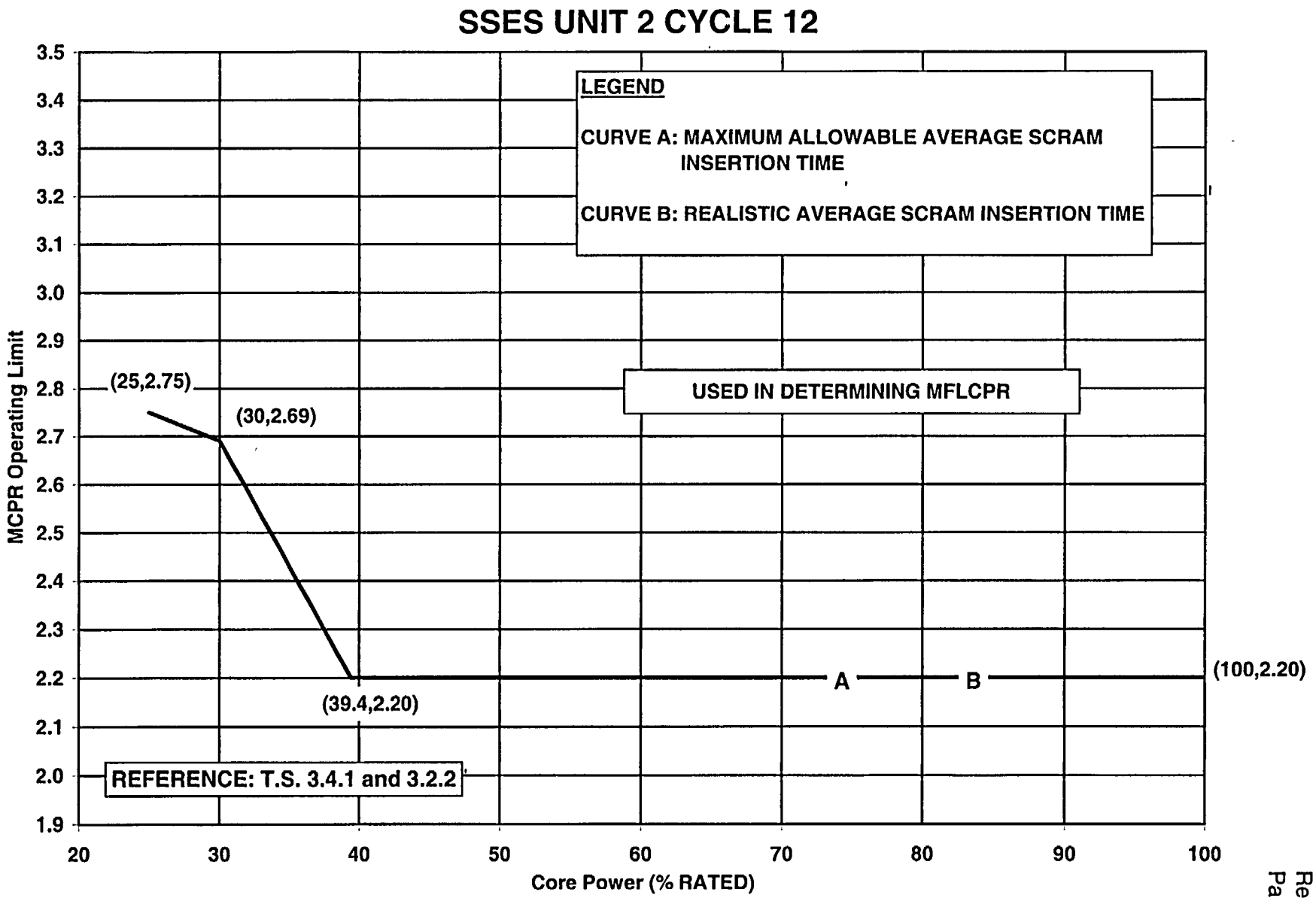


AVERAGE PLANAR LINEAR HEAT GENERATION RATE LIMIT VERSUS AVERAGE PLANAR EXPOSURE
SINGLE LOOP OPERATION
ATRIUM™-10 FUEL
FIGURE 8.2-1

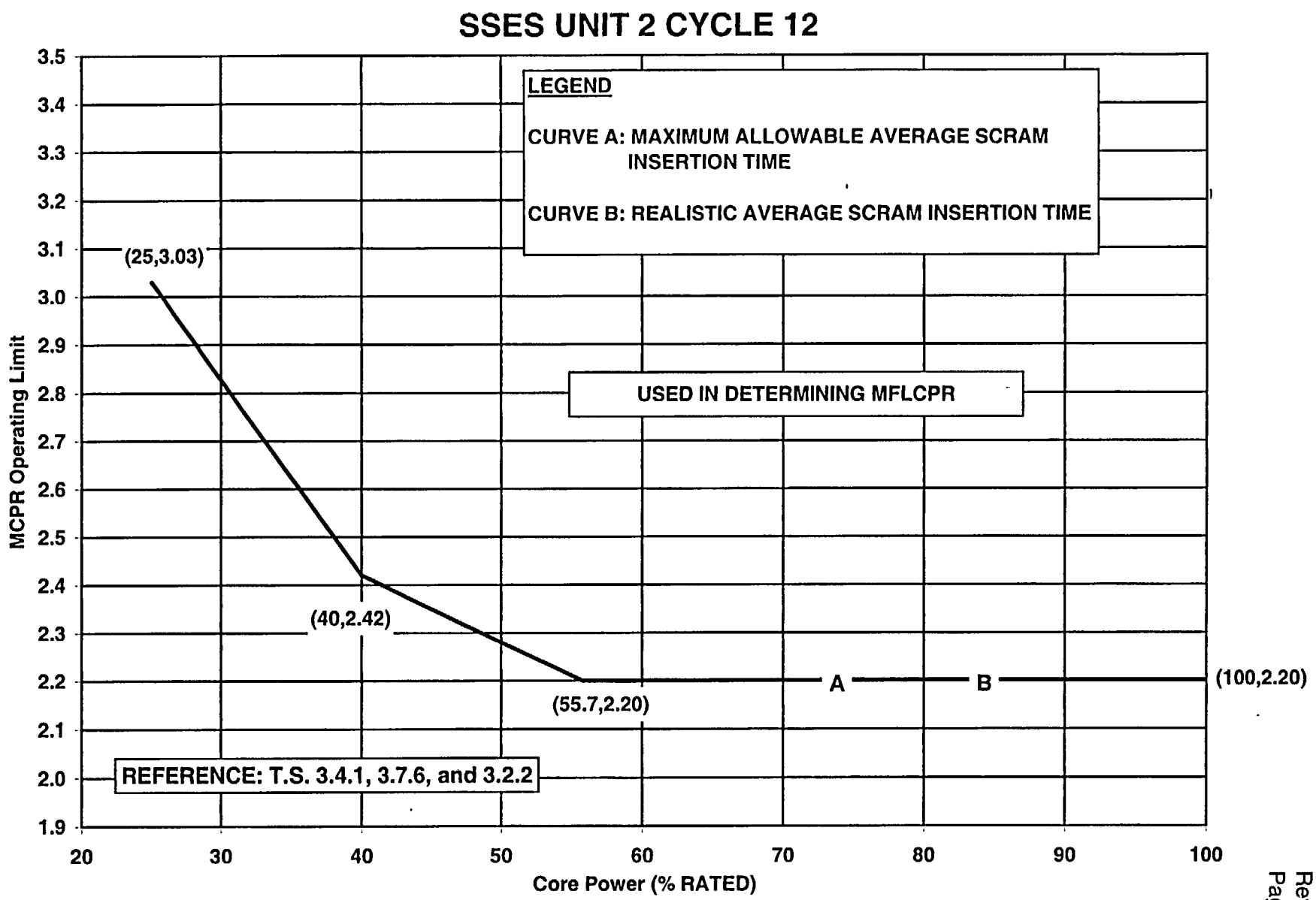
SSES UNIT 2 CYCLE 12



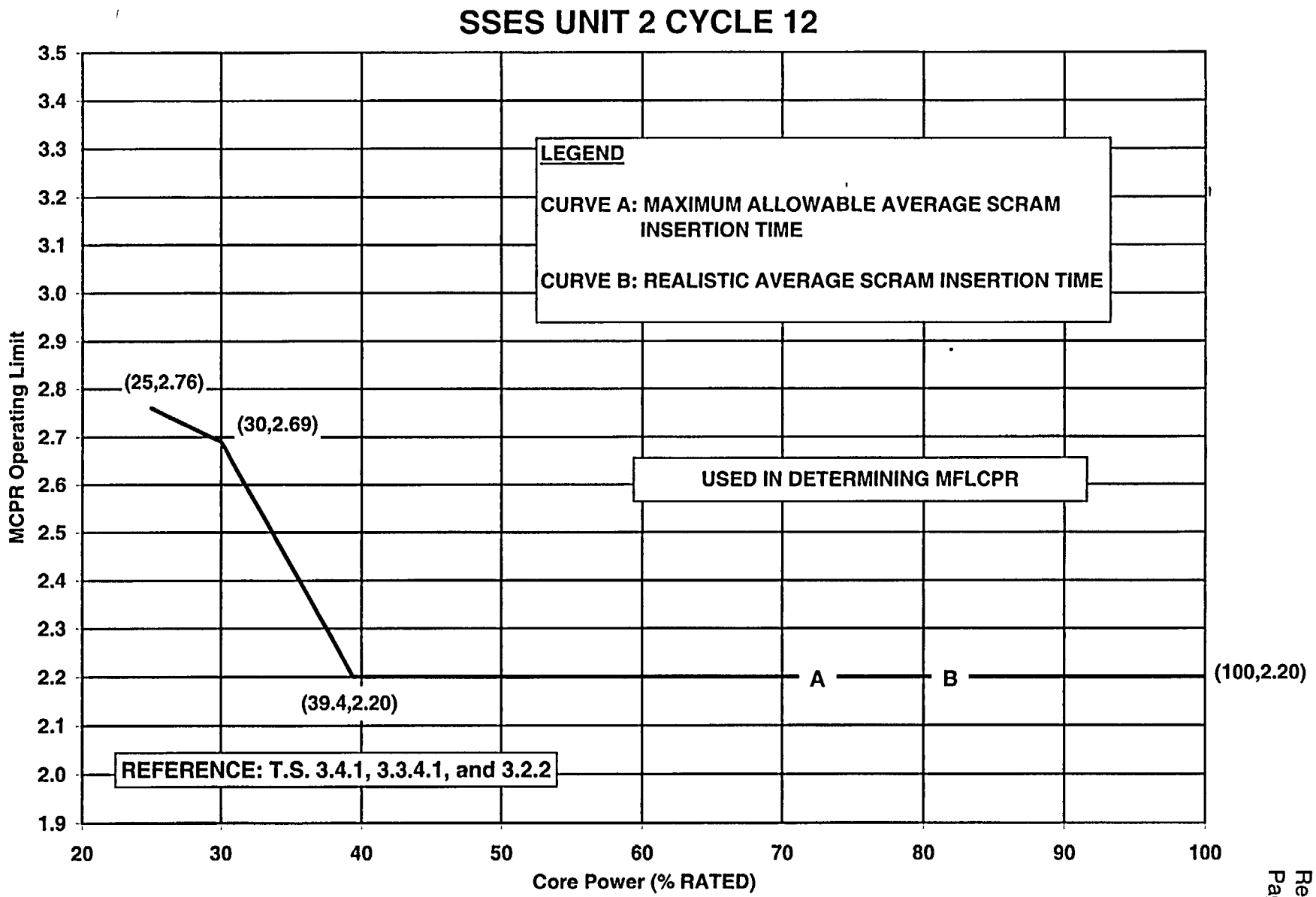
MCPR OPERATING LIMIT VERSUS TOTAL CORE FLOW
SINGLE LOOP OPERATION (BOC to EOC)
FIGURE 8.2-2



MCPR OPERATING LIMIT VERSUS CORE POWER
EOC-RPT AND MAIN TURBINE BYPASS OPERABLE
SINGLE LOOP OPERATION (BOC to EOC)
FIGURE 8.2-3



MCPR OPERATING LIMIT VERSUS CORE POWER
MAIN TURBINE BYPASS INOPERABLE / EOC-RPT OPERABLE
SINGLE LOOP OPERATION (BOC to EOC)
FIGURE 8.2-4



MCPR OPERATING LIMIT VERSUS CORE POWER
EOC-RPT INOPERABLE / MAIN TURBINE BYPASS OPERABLE
SINGLE LOOP OPERATION (BOC to EOC)
FIGURE 8.2-5

9.0 REFERENCES

9.1 The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC, specifically those described in the following documents:

1. PL-NF-90-001-A, "Application of Reactor Analysis Methods for BWR Design and Analysis," July 1992.

2. PL-NF-90-001, Supplement 1-A, "Application of Reactor Analysis Methods for BWR Design and Analysis: Loss of Feedwater Heating Changes and Use of RETRAN MOD 5.1," August 1995.

3. PL-NF-90-001, Supplement 2-A, "Application of Reactor Analysis Methods for BWR Design and Analysis: CASMO-3G Code and ANFB Critical Power Correlation," July 1996.

4. PL-NF-90-001, Supplement 3-A, "Application of Reactor Analysis Methods for BWR Design and Analysis: Application Enhancements," March 2001.

5. XN-NF-80-19(A), Volume 1, and Volume 1 Supplements 1 and 2 (March 1983), and Volume 1 Supplement 3 (November 1990), "Exxon Nuclear Methodology for Boiling Water Reactors: Neutronic Methods for Design and Analysis," Exxon Nuclear Company, Inc.

6. XN-NF-80-19(P)(A), Volumes 2, 2A, 2B, and 2C "Exxon Nuclear Methodology for Boiling Water Reactors: EXEM BWR ECCS Evaluation Model," September 1982.

7. XN-NF-80-19(P)(A), Volume 3 Revision 2 "Exxon Nuclear Methodology for Boiling Water Reactors Thermex: Thermal Limits Methodology Summary Description," January 1987.

8. XN-NF-80-19(P)(A), Volume 4, Revision 1, "Exxon Nuclear Methodology for Boiling Water Reactors: Application of the ENC Methodology to BWR Reloads," Exxon Nuclear Company, Inc. June 1986.

9. XN-NF-85-67(P)(A), Revision 1, "Generic Mechanical Design for Exxon Nuclear Jet Pump BWR Reload Fuel," Exxon Nuclear Company, Inc., September 1986.

10. ANF-524(P)(A), Revision 2 and Supplement 1, Revision 2, "Advanced Nuclear Fuels Corporation Critical Power Methodology for Boiling Water Reactors," November 1990.

11. NE-092-001A, Revision 1, "Licensing Topical Report for Power Uprate With Increased Core Flow," Pennsylvania Power & Light Company, December 1992 and NRC SER (November 30, 1993).

12. ANF-89-98(P)(A) Revision 1 and Revision 1 Supplement 1, "Generic Mechanical Design Criteria for BWR Fuel Designs," Advanced Nuclear Fuels Corporation, May 1995.

13. ANF-91-048(P)(A), "Advanced Nuclear Fuels Corporation Methodology for Boiling Water Reactors EXEM BWR Evaluation Model," January 1993.

14. XN-NF-79-71(P)(A) Revision 2, Supplements 1, 2, and 3, "Exxon Nuclear Plant Transient Methodology for Boiling Water Reactors," March 1986.

15. EMF-1997(P)(A) Revision 0, "ANFB-10 Critical Power Correlation," July 1998, and EMF-1997(P)(A) Supplement 1 Revision 0, "ANFB-10 Critical Power Correlation : High Local Peaking Results," July 1998.

16. Caldon, Inc., "TOPICAL REPORT: Improving Thermal Power Accuracy and Plant Safety While Increasing Operating Power Level Using the LEFM✓™ System," Engineering Report - 80P, March 1997.

17. Caldon, Inc., "Supplement to Topical Report ER-80P: Basis for a Power Uprate with the LEFM✓™ or LEFM CheckPlus™ System," Revision 0, Engineering Report ER-160P, May 2000.

18. EMF-85-74(P)(A), "RODEX2A (BWR) Fuel Rod Thermal-Mechanical Evaluation Model," Revision 0, Supplements 1 and 2, February 1998.

19. EMF-2158(P)(A), Revision 0, "Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/Microburn-B2," Siemens Power Corporation, October 1999.