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February 12, 2002
LIC-02-0020

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Reference: Docket No. 50-285

SUBJECT: Transmittal of Fort Calhoun Station (FCS) Core Operating Limit Report (COLR) Revision 25

Pursuant to FCS Unit No. 1 Technical Specification 5.9.5.c, Omaha Public Power District is transmitting Revision 25 (dated January 7, 2002) of the FCS COLR. The COLR was updated to allow for operation in the presence of a hot leg flow streaming event of up to 6% deviation.

Please contact me if you have any questions.

Sincerely,

R. T. Ridenoure
Division Manager
Nuclear Operations

SKG/RLJ/rlj

Attachment: TDB-VI – Technical Data Book – Core Operating Limit Report – Revision 25

c: E. W. Merschoff, NRC Regional Administrator, Region IV
A. B. Wang, NRC Project Manager
W. C. Walker, NRC Senior Resident Inspector
Winston & Strawn (w/o attachments)

A001

Fort Calhoun Station
Unit No. 1

TDB-VI

TECHNICAL DATA BOOK

Title: CORE OPERATING LIMIT REPORT

FC-68 Number: EC 29235

Reason for Change: To allow for operating in the presence of a hot leg flow streaming event of up to 6% deviation.

Requestor: Tom Heng

Preparer: Tom Heng

Fort Calhoun Station, Unit 1

Cycle 20 Core Operating Limits Report

Due to the critical aspects of the safety analysis inputs contained in this report, changes may not be made to this report without concurrence of the Nuclear Engineering Department.

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Cycle 20 Core Operating Limits Report

1.0 Introduction

This report provides the cycle–specific limits for operation of the Fort Calhoun Station Unit 1 for Cycle 20 operation. It includes limits for:

- TM/LP LSSS for 4 Pump Operation (P_{VAR})
- Core Inlet Temperature (T_{IN})
- Power Dependent Insertion Limit (PDIL)
- Allowable Peak Linear Heat Rate
- Excore Monitoring of LHR
- Integrated Radial Peaking Factor (F_R^T)
- DNB Monitoring
- F_R^T versus Power Trade–off Curve
- Refueling Boron Concentration
- Axial Power Distribution
- Shutdown Margin With T_{cold} >210°F
- Most Negative Moderator Temperature Coefficient

These limits are applicable for the duration of Cycle 20. For subsequent cycles the limits will be reviewed and revised as necessary. In addition, this report includes a number of cycle–specific coefficients used in the generation of certain reactor protective system trip setpoints or allowable increases in radial peaking factors.

2.0 Core Operating Limits

All values and limits in this TDB section apply to Cycle 20 operation. Cycle 20 must be operated within the bounds of these limits and all others specified in the Technical Specifications. This report has been prepared in accordance with the requirements of Technical Specification 5.9.5. The values and limits presented within this TDB section have been derived using the NRC approved methodologies listed below:

- OPPD–NA–8301, "Reload Core Analysis Methodology Overview," Rev. 6, dated December 1994. (TAC No. M89455)
- OPPD–NA–8302, "Reload Core Analysis Methodology, Neutronics Design Methods and Verification," Rev. 4, dated December 1994. (TAC No. M89456)
- OPPD–NA–8303, "Reload Core Analysis Methodology, Transient and Accident Methods and Verification," Rev. 4, dated January 1993. (TAC No. M85845)

- XN−75−32(P)(A) Supplements 1, 2, 3, & 4, "Computational Procedure for Evaluating Fuel Rod Bowing," October 1983.
- XN−NF−82−06(P)(A) and Supplements 2, 4, and 5, "Qualification of Exxon Nuclear Fuel for Extended Burnup," Revision 1, October 1986.
- XN−NF−85−92(P)(A), "Exxon Nuclear Uranium Dioxide/Gadolinia Irradiation Examination and Thermal Conductivity Results," August 1985.
- ANF−88−133(P)(A) and Supplement 1, "Qualification of Advanced Nuclear Fuels PWR Design Methodology for Rod Burnups of 62 GWd/MTU," December 1991.
- EMF−92−116(P)(A), "Generic Mechanical Design Criteria for PWR Fuel Designs," Revision 0, February 1999.
- XN−NF−78−44(P)(A), "A Generic Analysis of the Control Rod Ejection Transient for Pressurized Water Reactors," October 1983.
- XN−NF−82−21(P)(A), "Application of Exxon Nuclear Company PWR Thermal Margin Methodology to Mixed Core Configurations," Revision 1, September 1983.
- EMF−1961(P)(A), "Statistical Setpoint/Transient Methodology for Combustion Engineering Type Reactors," Revision 0, July 2000.
- XN−NF−621(P)(A), "Exxon Nuclear DNB Correlation for PWR Fuel Designs," Revision 1, September 1983.
- ANF−89−151(P)(A), "ANF−RELAP Methodology for Pressurized Water Reactors: Analysis of Non−LOCA Chapter 15 Events," Revision 0, May 1992.
- EMF−92−153(P)(A) and Supplement 1, "HTP: Departure from Nucleate Boiling Correlation for High Thermal Performance Fuel," March 1994.
- XN−NF−82−49(P)(A), Supplement 1, "Exxon Nuclear Company Evaluation Model Revised EXEM PWR Small Break Model," Revision 1, December 1994.
- EMF−2087(P)(A), "SEM/PWR−98: ECCS Evaluation Model for PWR LBLOCA Applications," Revision 0, June 1999.
- ANF−84−73 Appendix B (P)(A), "Advanced Nuclear Fuels Methodology for Pressurized Water Reactors: Analysis of Chapter 15 Events," Advanced Nuclear Fuels Corporation, Revision 5, July 1990.
- EMF−84−093(P)(A), "Steam Line Break Methodology for PWRs," Siemens Power Corporation, Revision 1, February 1999.

3.0 TM/LP Limit

The TM/LP coefficients for Cycle 20 are shown below:

Table 1
TM/LP Coefficients

Coefficient	Value
α	29.6
β	20.63
γ	−12372

The TM/LP setpoint is calculated by the P_{VAR} equation, shown below and in Figure 1:

$$P_{VAR} = 29.6\ PF(B)\ A1(Y)B + 20.63T_{IN} - 12372$$

PF(B)	= 1.0	for $B \geq 100\%$
	= −0.008(B) + 1.8	for $50\% < B < 100\%$
	= 1.4	for $B \leq 50\%$
A1(Y)	= $-0.6666(Y_1) + 1.000$	for $Y_1 \leq 0.00$
	= $+0.3333(Y_1) + 1.000$	for $Y_1 > 0.00$

Where:

B = High Auctioneered thermal (ΔT) or Nuclear Power, % of rated power
Y = Axial Shape Index, asiu
T_{IN} = Core Inlet Temperature, °F
P_{VAR} = Reactor Coolant System Pressure, psia

4.0 Maximum Core Inlet Temperature

The maximum core inlet temperature (T_{IN}) for Cycle 20 shall not exceed **545°F**. This value includes instrumentation uncertainty of ±2°F (Ref: FCS Calculation FC06292, 6/9/95).

This limit is not applicable during either a thermal power ramp in excess of 5% of rated thermal power per minute or a thermal power step greater than 10% of rated thermal power.

5.0 Power Dependent Insertion Limit

The power dependent insertion limit is defined in Figure 2.

6.0 Linear Heat Rate

The allowable peak linear heat rate for Cycle 20 is shown in Figure 3.

7.0 Excore Monitoring of LHR

The allowable operation for power versus axial shape index for monitoring of LHR with excore detectors for Cycle 20 is shown in Figure 4.

8.0 Peaking Factor Limits

The Cycle 20 maximum full power value for the integrated radial peaking factor (F_R^T) is 1.732. An additional dotted line exists on Figure 7 to allow operation in the presence of a hot leg flow streaming event with less than a 6% power difference between actual power and ΔT power indication.

9.0 DNB Monitoring

The core operating limits for monitoring of DNB are provided in Figures 5 and 6. These figures provide the allowable power versus axial shape index for Cycle 20 operation. When the Better Axial Shape Selection System (BASSS) is operable, the limits in Figure 6 apply. If BASSS becomes inoperable, the limits in Figure 5 apply. Note that for Cycle 20, the DNB limits are identical whether BASSS is operable or inoperable.

10.0 F_R^T and Core Power Limitations

Core power limitations versus F_R^T are shown in Figure 7 for Cycle 20.

11.0 Refueling Boron Concentration

The refueling boron concentration is required to ensure a shutdown margin of not less than 5% with all CEAs withdrawn. The refueling boron concentration must be at least **1,900 ppm** through the end of Cycle 19 operation and is valid until the beginning of core reload for Cycle 20.

Listed below in Table 2 are the refueling boron concentration values for Cycle 20 operations:

Table 2
Refueling Boron Concentrations

Cycle 20 Average Burnup (MWD/MTU)	Refueling Boron Concentration (ppm)
BOC	2,155
$\geq$ 2,000	2,023
$\geq$ 4,000	1,900

12.0 Axial Power Distribution

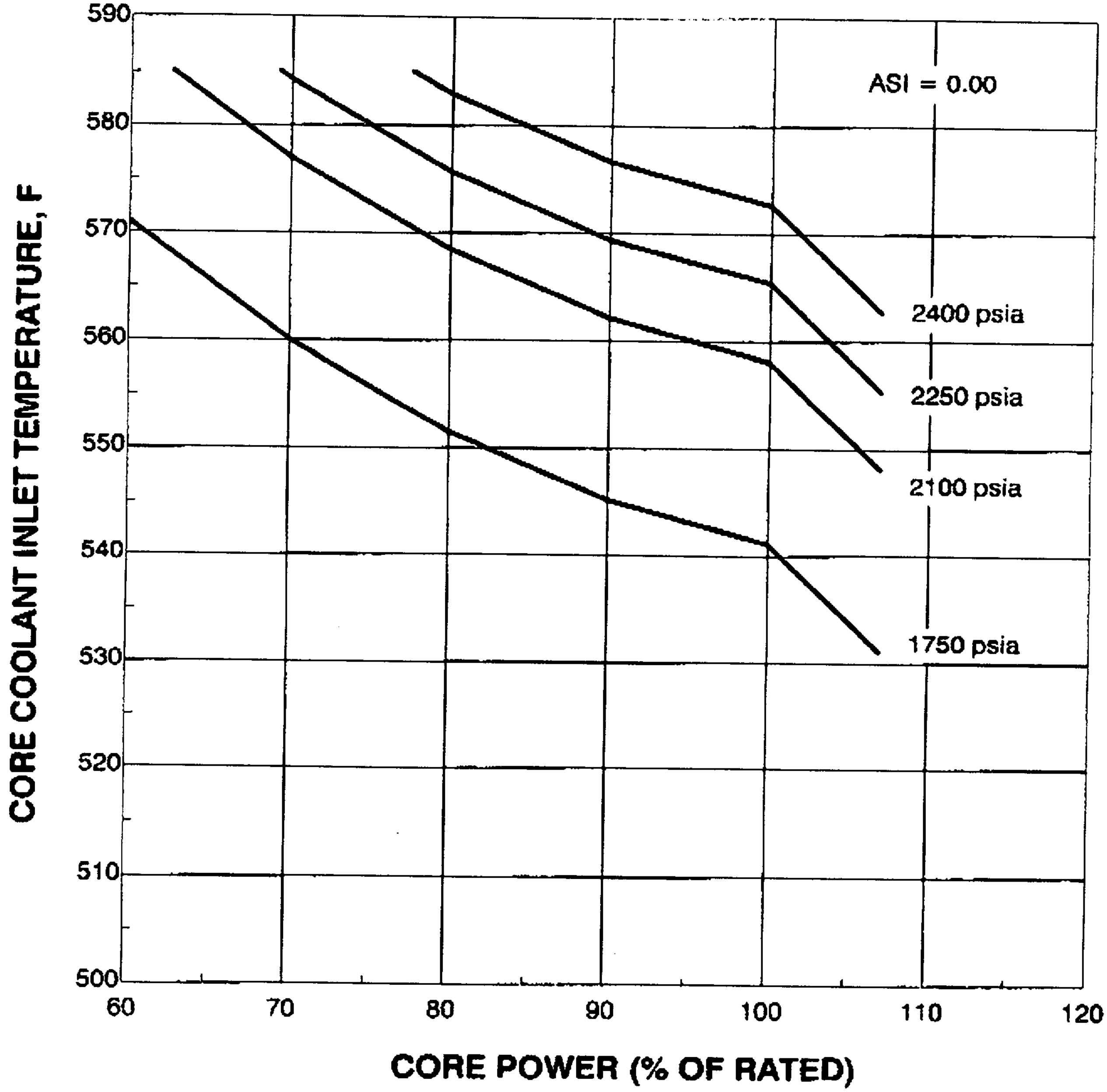
The axial power trip is provided to ensure that excessive axial peaking will not cause fuel damage. The Axial Shape Index is determined from the axially split excore detectors. The setpoint functions, shown in Figure 8 ensure that neither a DNBR of less than the minimum DNBR safety limit nor a maximum linear heat rate of more than 22 kW/ft (deposited in the fuel) will exist as a consequence of axial power maldistributions. Allowances have been made for instrumentation inaccuracies and uncertainties associated with the excore symmetric offset – incore axial peaking relationship. Figure 9 combines the LHR LCO tent from Figure 4, the DNB LCO tent from Figure 5, and the APD LSSS tent from Figure 8 into one figure for a visual comparison of the different limits.

13.0 Shutdown Margin With T_{cold} >210°F

Whenever the reactor is in hot shutdown, hot standby or power operation conditions, the shutdown margin shall be **$\geq$4.0% Δk/k**. With the shutdown margin <4.0% Δk/k, initiate and continue boration until the required shutdown margin is achieved.

14.0 Most Negative Moderator Temperature Coefficient

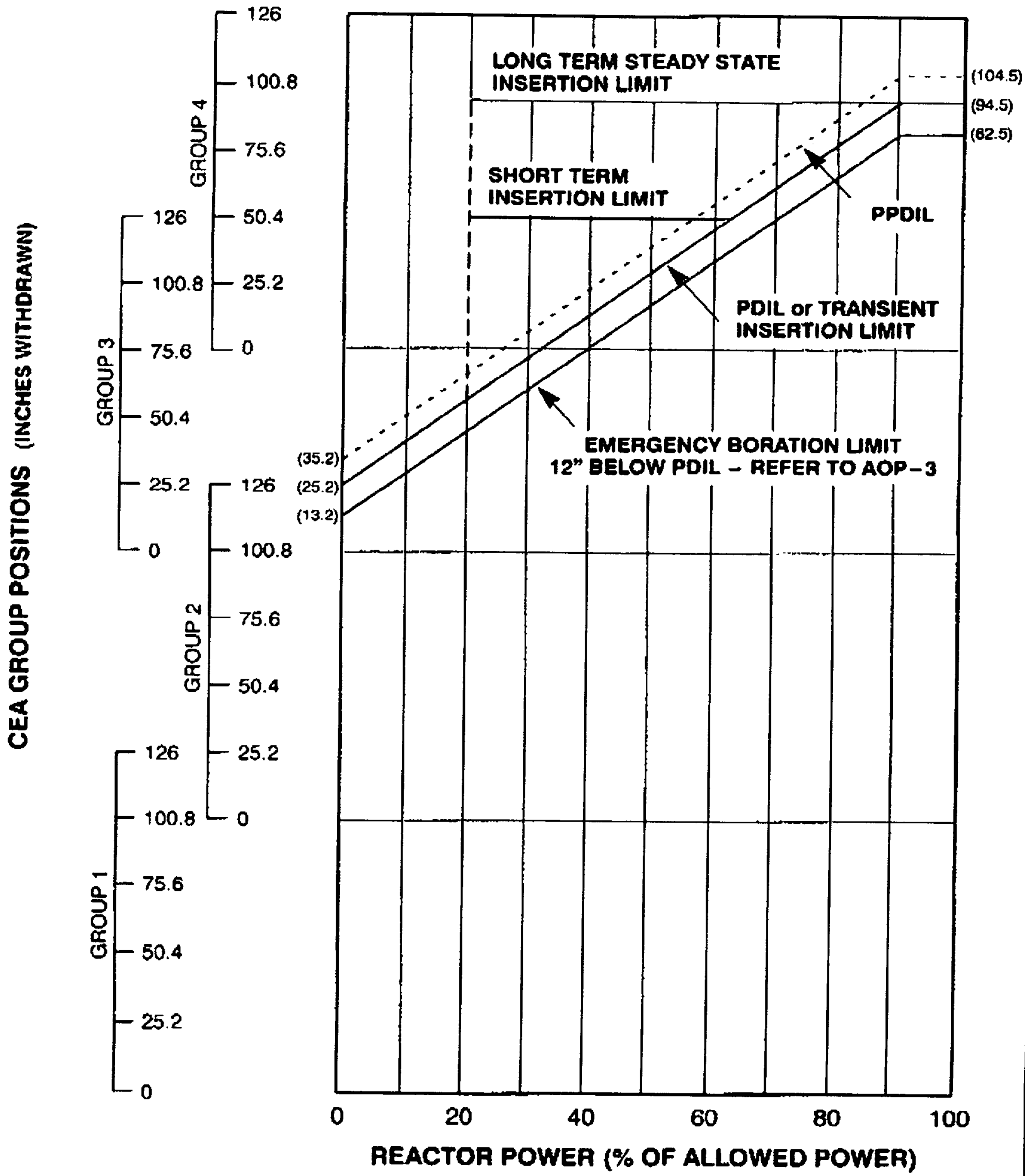
The moderator temperature coefficient (MTC) shall be more positive than **-3.05×10^{-4}** $\Delta\rho$/°F, including uncertainties, at rated power.



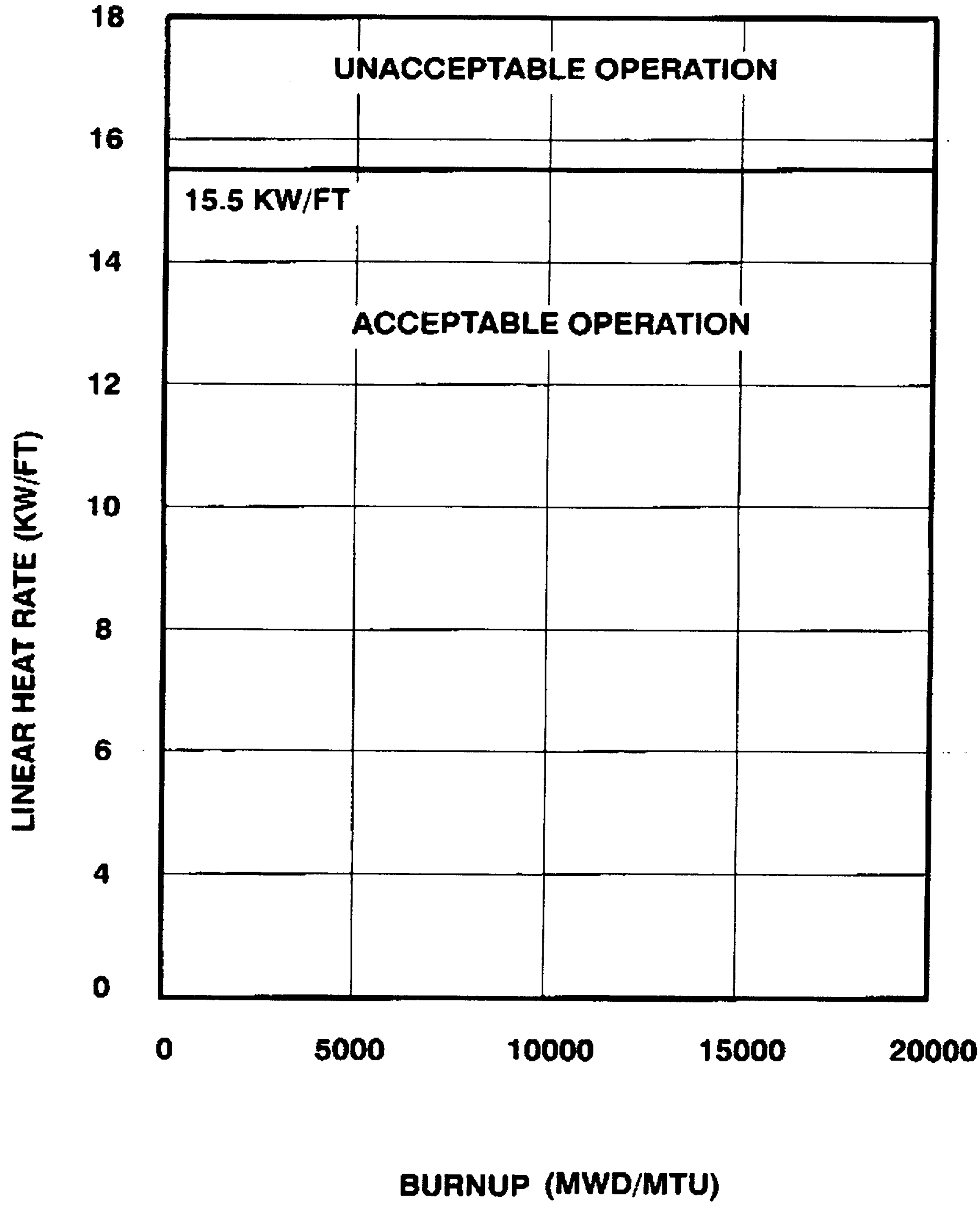
$P_{VAR} = 29.6PF(B)A1(Y)B + 20.63T_{IN} - 12372$

PF(B)	= 1.0	$B \geq 100\%$	A1(Y)	$= -0.6666Y_I + 1.000$	$Y_I \leq 0.00$
	= −.008B + 1.8	$50\% < B < 100\%$		$= +0.3333Y_I + 1.000$	$Y_I > 0.00$
	= 1.4	$B \leq 50\%$			

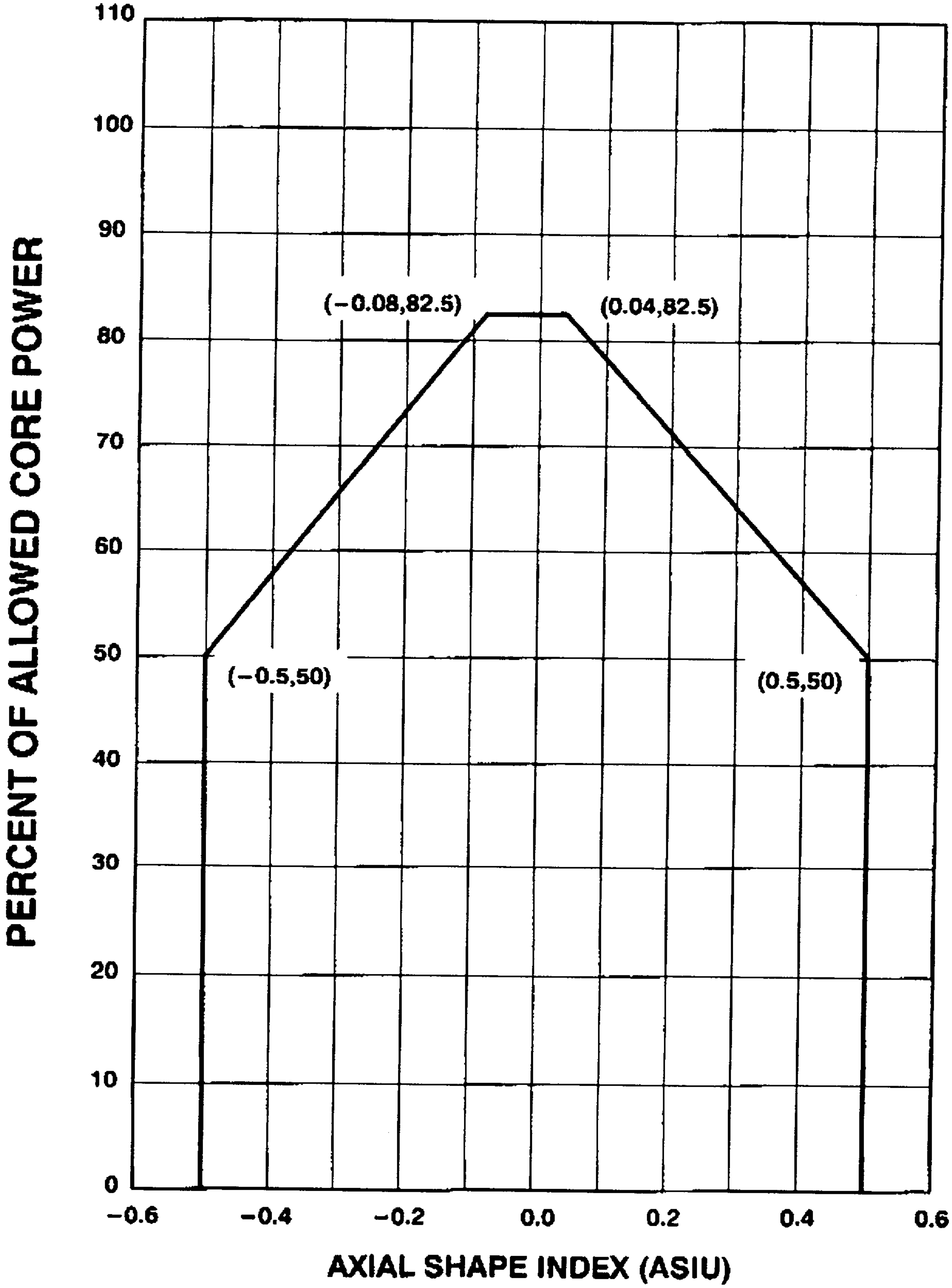
CYCLE 20 COLR	THERMAL MARGIN / LOW PRESSURE FOR 4 PUMP OPERATION	FIGURE 1



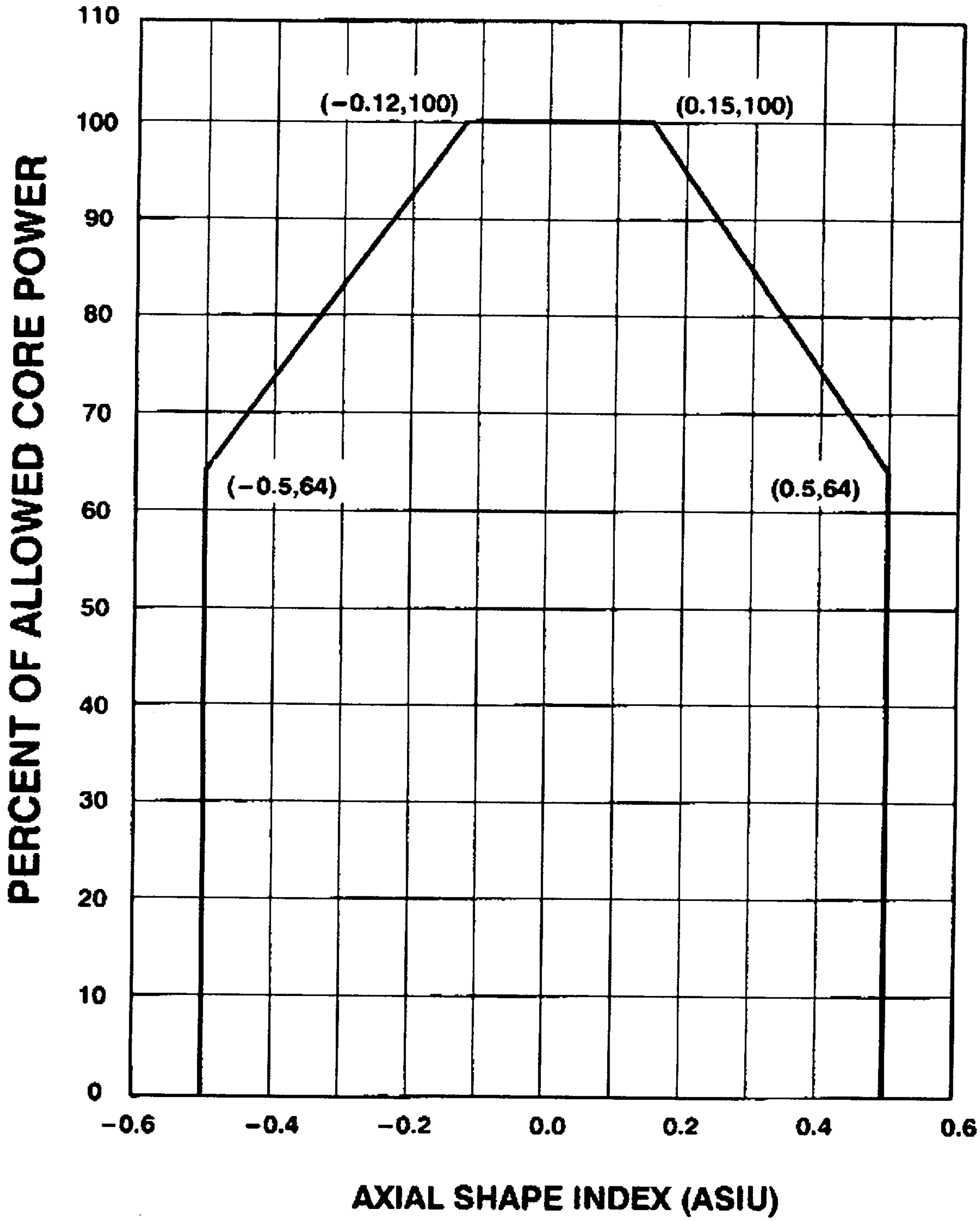
CYCLE 20 COLR	POWER DEPENDENT INSERTION LIMIT	FIGURE 2



CYCLE 20 COLR	ALLOWABLE PEAK LINEAR HEAT RATE VS. BURNUP	FIGURE 3

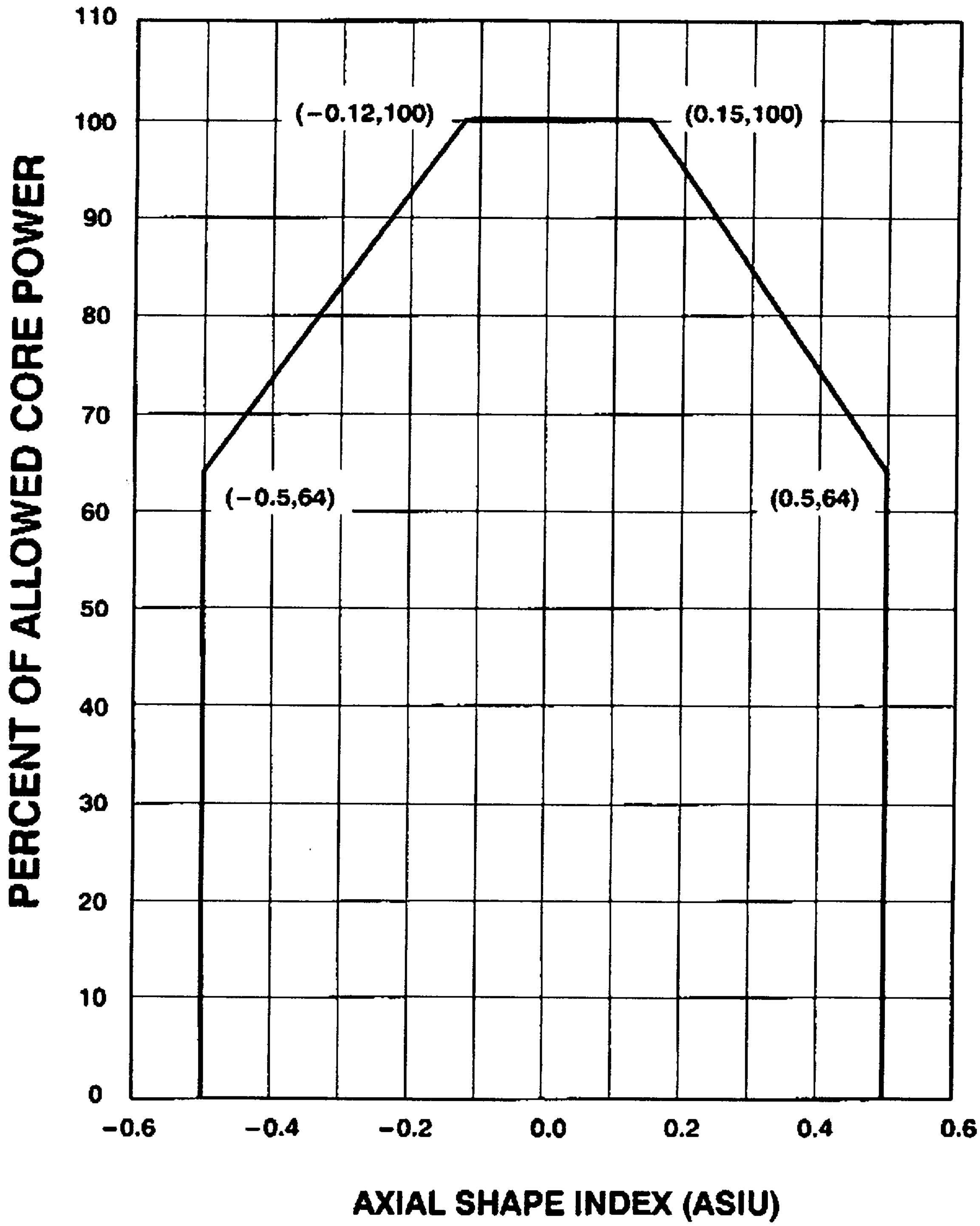


CYCLE 20 COLR	EXCORE MONITORING OF LHR	FIGURE 4

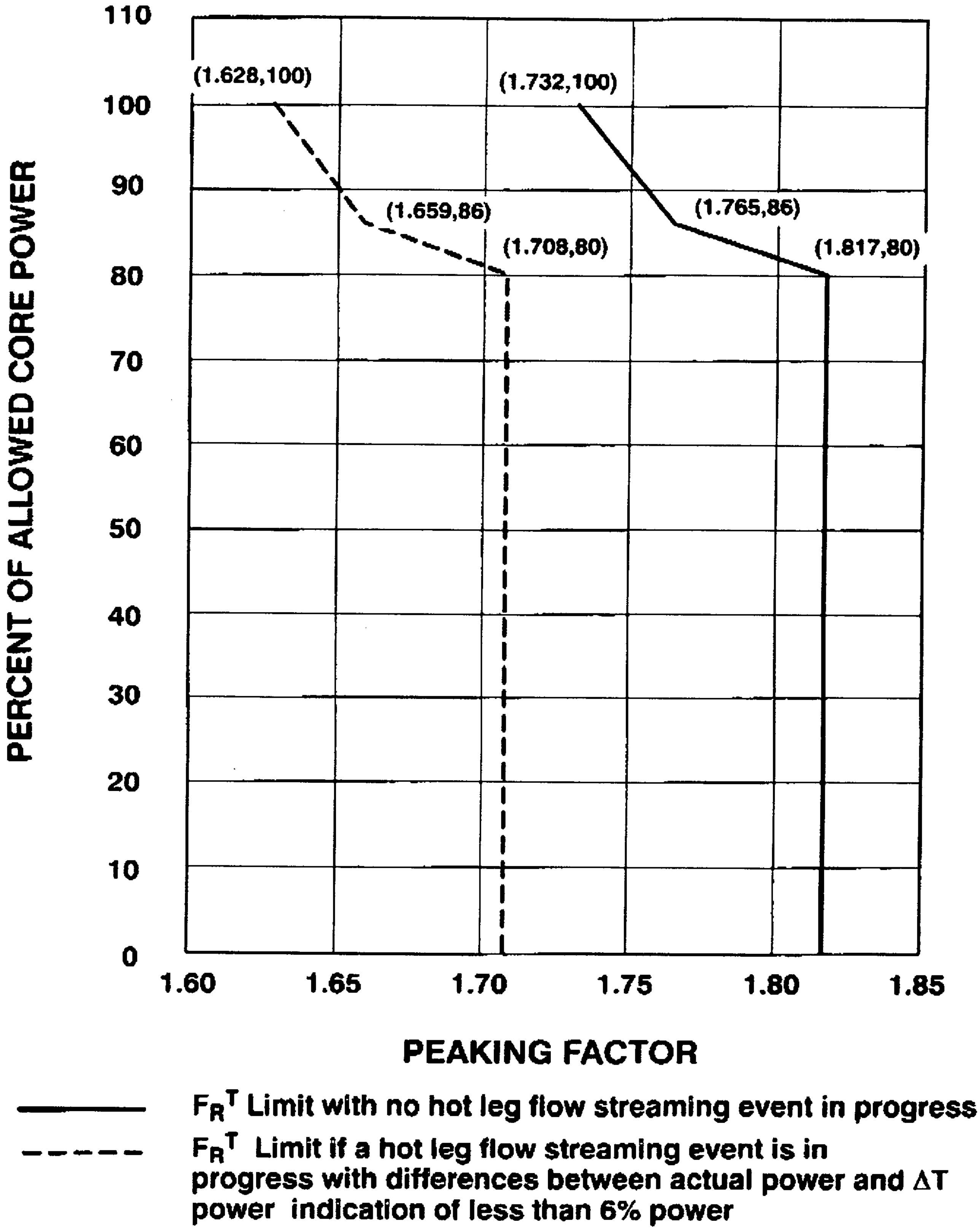


NOTE: **WHEN BASSS IS OPERABLE, THIS FIGURE IS SUPERCEDED BY FIGURE 6 – BASSS DNB ALLOWABLE POWER**

CYCLE 20 COLR	DNB MONITORING	FIGURE 5



CYCLE 20 COLR	BASSS DNB ALLOWABLE POWER LCO	FIGURE 6



CYCLE 20 COLR	F_R^T AND CORE POWER LIMITATIONS	FIGURE 7

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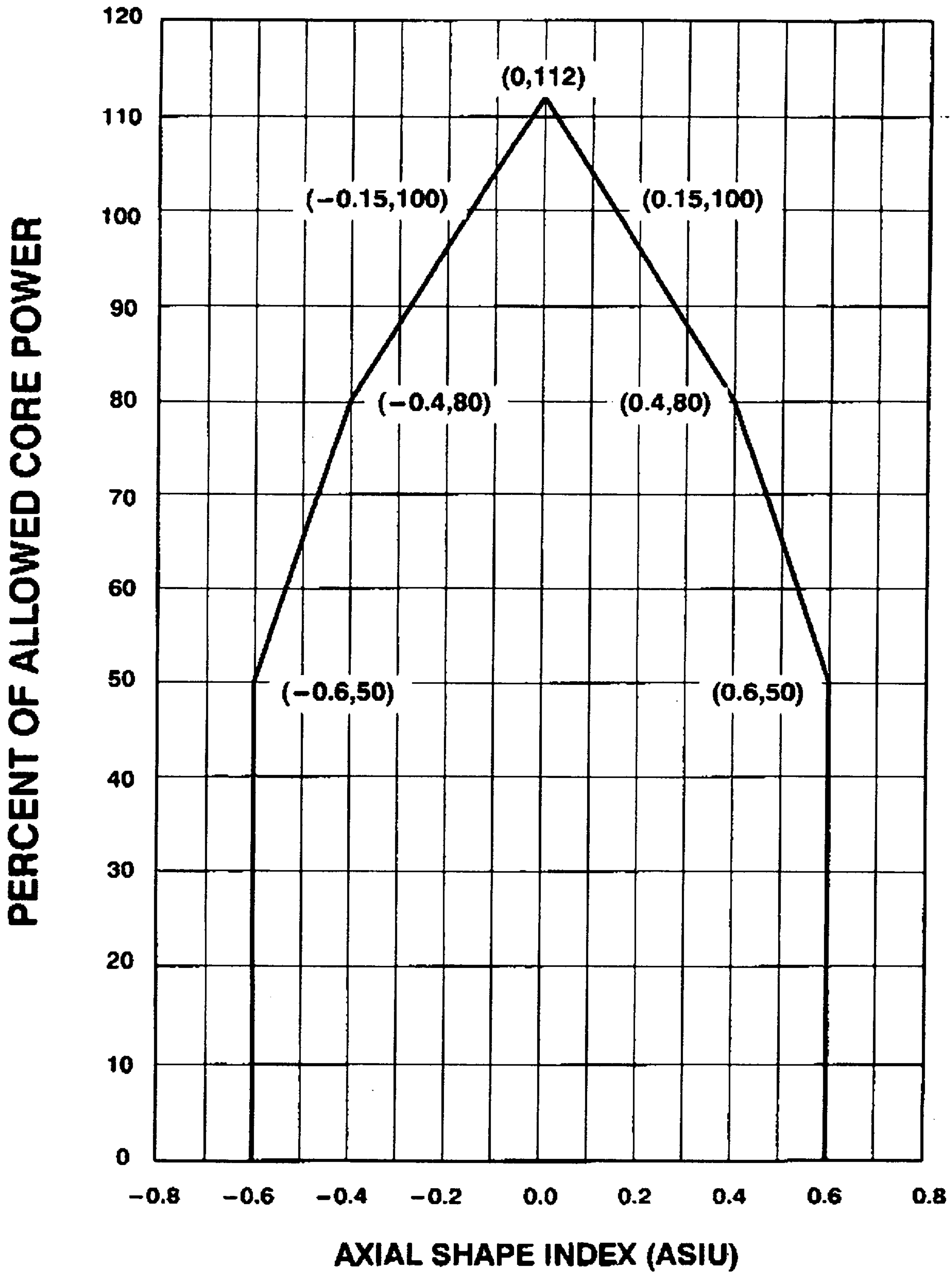

CYCLE 20 COLR	AXIAL POWER DISTRIBUTION LSSS FOR 4 PUMP OPERATION	FIGURE 8

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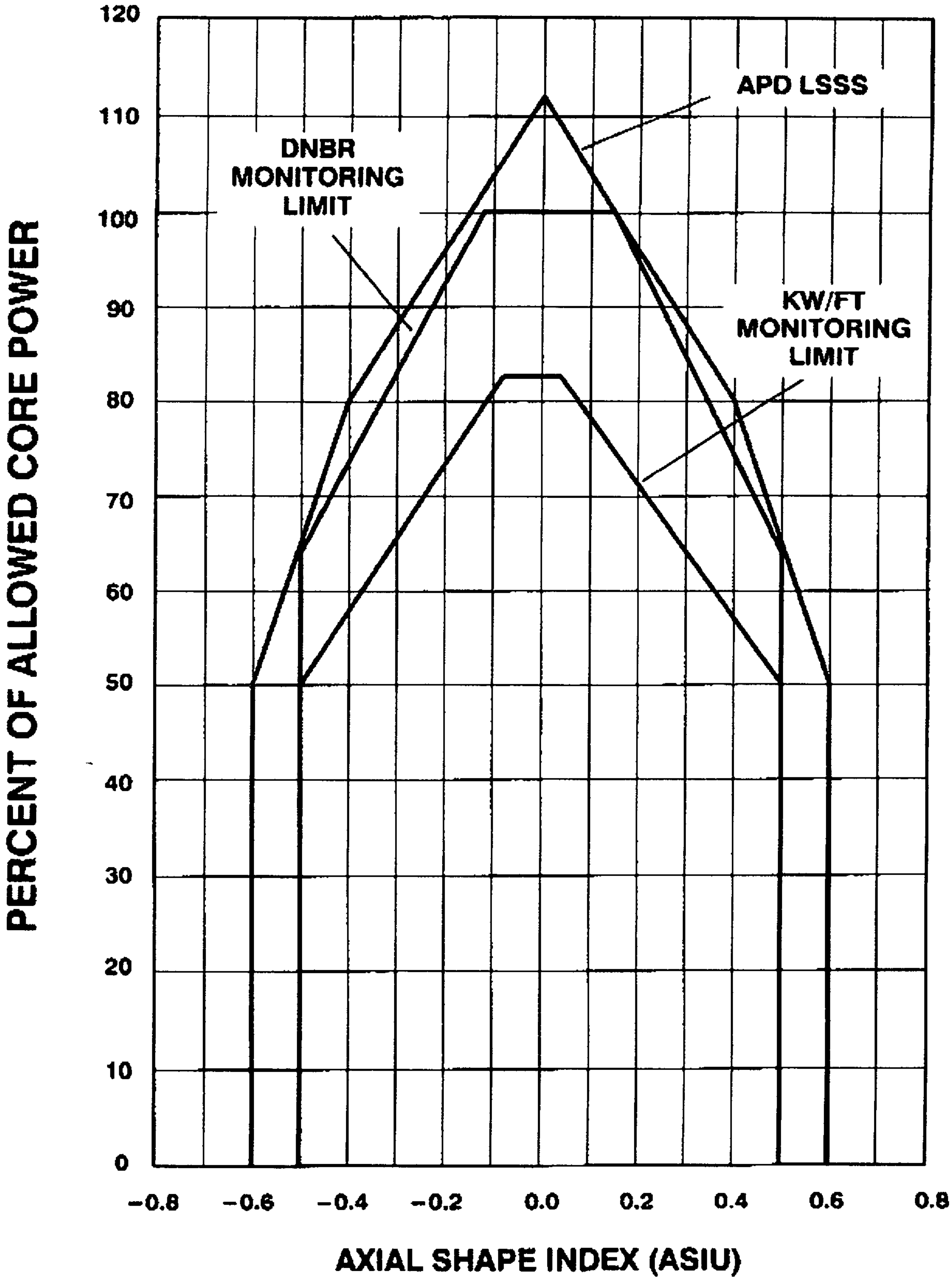

CYCLE 20 COLR	AXIAL POWER DISTRIBUTION LIMITS FOR 4 PUMP OPERATION WITH INCORES INOPERABLE	FIGURE 9

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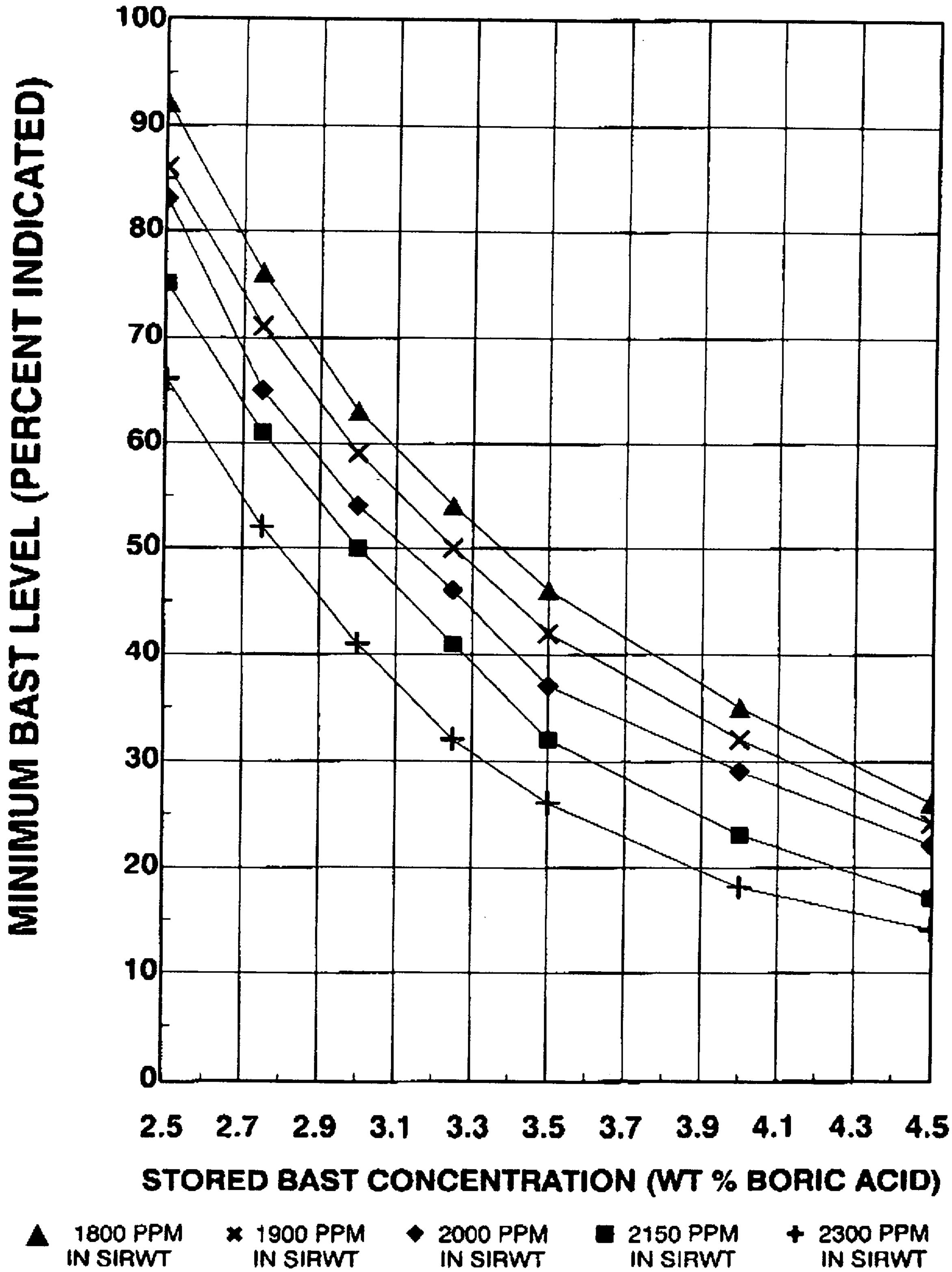

CYCLE 20 COLR	MINIMUM BAST LEVEL vs. STORED BAST CONCENTRATION	FIGURE 10