

Fort Calhoun Station  
Unit No. 1

## TDB-VI

### TECHNICAL DATA BOOK PROCEDURE

**Title:** CORE OPERATING LIMIT REPORT

---

Setpoint/Procedure  
Form Number (FC-68): 38867

Reason for Change: Update Section 6.0 and Figure 3 in  
COLR to reflect increase in peak  
linear heat rate to 14.4 kw/ft.

Contact Person: William Weber

ISSUED: 08-17-92 4:00 pm

R2

9209020342 920826  
PDR ADDCK 05000285  
P PDR

Fort Calhoun Station, Unit 1

Cycle 14 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 Production Engineering Division, Nuclear Engineering Department.

TABLE OF CONTENTS

<u>Item</u>	<u>Description</u>	<u>Page</u>
1.0	Introduction	5
2.0	Core Operating Limits	5
3.0	TM/LP Limit	6
4.0	Maximum Core Inlet Temperature	6
5.0	Power Dependent Insertion Limit	6
6.0	Linear Heat Rate	6
7.0	Excore Monitoring of LHR	7
8.0	Peaking Factor ( $F_{xy}^T$ , $F_R^T$ ) Limits	7
9.0	DNB Monitoring	7
10.0	$F_R^T$ , $F_{xy}^T$ and Core Power Limitations	7
11.0	Refueling Boron Concentration	7

LIST OF TABLE

<u>Table No.</u>	<u>Title</u>	<u>Page</u>
1	TM/LP Coefficients	6
2	Maximum $F_R$ and $F_{xy}$ Limits	7

LISTS OF FIGURES

<u>Figure No.</u>	<u>Title</u>	<u>Page</u>
1	Thermal Margin/Low Pressure 4 Pump Operation	8
2	Power Dependent Insertion Limit	9
3	Allowable Peak Linear Heat Rate vs. Burnup	10
4	Excure Monitoring of LHR	11
5	DNB Monitoring	12
6	$F_{xy}^T$ , $F_R^T$ and Core Power Limitations	13

CYCLE 14 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 14 operation. It includes limits for:

- 1.1 TM/LP LSSS 4 Pump Operation ( $P_{VAR}$ )
- 1.2 Core Inlet Temperature ( $T_{IN}$ )
- 1.3 Power Dependent Insertion Limit (PDIL)
- 1.4 Allowable Peak Linear Heat Rate
- 1.5 Excore Monitoring of LHR
- 1.6 Planar Radial Peaking Factor ( $F_{xy}^T$ )
- 1.7 Integrated Radial Peaking Factor ( $F_R^T$ )
- 1.8 DNB Monitoring
- 1.9  $F_R^T/F_{xy}^T$  versus Power Trade off curve
- 1.10 Refueling Boron Concentration

These limits are applicable for the duration of Cycle 14. 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.

This report has been prepared in accordance with the requirements of Technical Specification 5.9.5. The core operating limits have been developed using the NRC methodologies listed in Technical Specification 5.9.5.b.

2.0 CORE OPERATING LIMITS

The values and limits presented within this section have been derived using the NRC - approved methodologies listed in Technical Specification 5.9.5. All values and limits in this section apply to Cycle 14 operation. Cycle 14 must be operated within the bounds of these limits and all others specified in the Technical Specifications.



### 3.0 TM/LP LIMIT

The TM/LP coefficients for Cycle 14 are shown below:

Table 1

<u>Coefficient</u>	<u>Value</u>
$\alpha$	29.73
$\beta$	18.44
$\gamma$	-11325

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

$$P_{VAR} = 29.73 PF(B)A1(Y)B + 18.44T_{IN} - 11325$$

$$\begin{aligned} PF(B) &= 1.0 & B \geq 100\% \\ &= -0.008B + 1.8 & 50\% < B < 100\% \\ &= 1.4 & B \leq 50\% \end{aligned}$$

$$\begin{aligned} A1(Y) &= -0.35294Y_1 + 1.08824 & Y_1 \leq 0.25 \\ &= 0.57143Y_1 + 0.875 & Y_1 > 0.25 \end{aligned}$$

Where:

B = High Auctioneered thermal ( $\Delta T$ ) or Nuclear Power, % of rated power  
Y = Axial Shape Index, asi  
 $T_{IN}$  = 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 14 shall not exceed 543°F.

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 for Cycle 14 operation.

### 6.0 LINEAR HEAT RATE

The allowable peak linear heat rate vs. burnup is 14.4 kw/ft for Cycle 14 for all burnup points as shown on 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 14 is shown in Figure 4.

#### 8.0 PEAKING FACTOR LIMITS

The maximum full power values for the unrodded planar radial peaking factor ( $F_{xy}^T$ ) and integrated radial peaking factor ( $F_R^T$ ) are shown in Table 2.

Table 2

##### Maximum Full Power $F_R$ and $F_{xy}$ Limits

<u>Peaking Factor</u>	<u>Limits</u>
$F_{xy}^T$	1.85
$F_R^T$	1.79

#### 9.0 DNB MONITORING

The limits for DNB as a function of axial shape index and core power is shown in Figure 5.

Core power shall be maintained within the limits established by the Better Axial Shape Selection System (BASSS) for CEA insertion of the lead bank of <65% (i.e., greater than or equal to 44.1 inches withdrawn) when BASSS is operable, or within the limits of Figure 5.

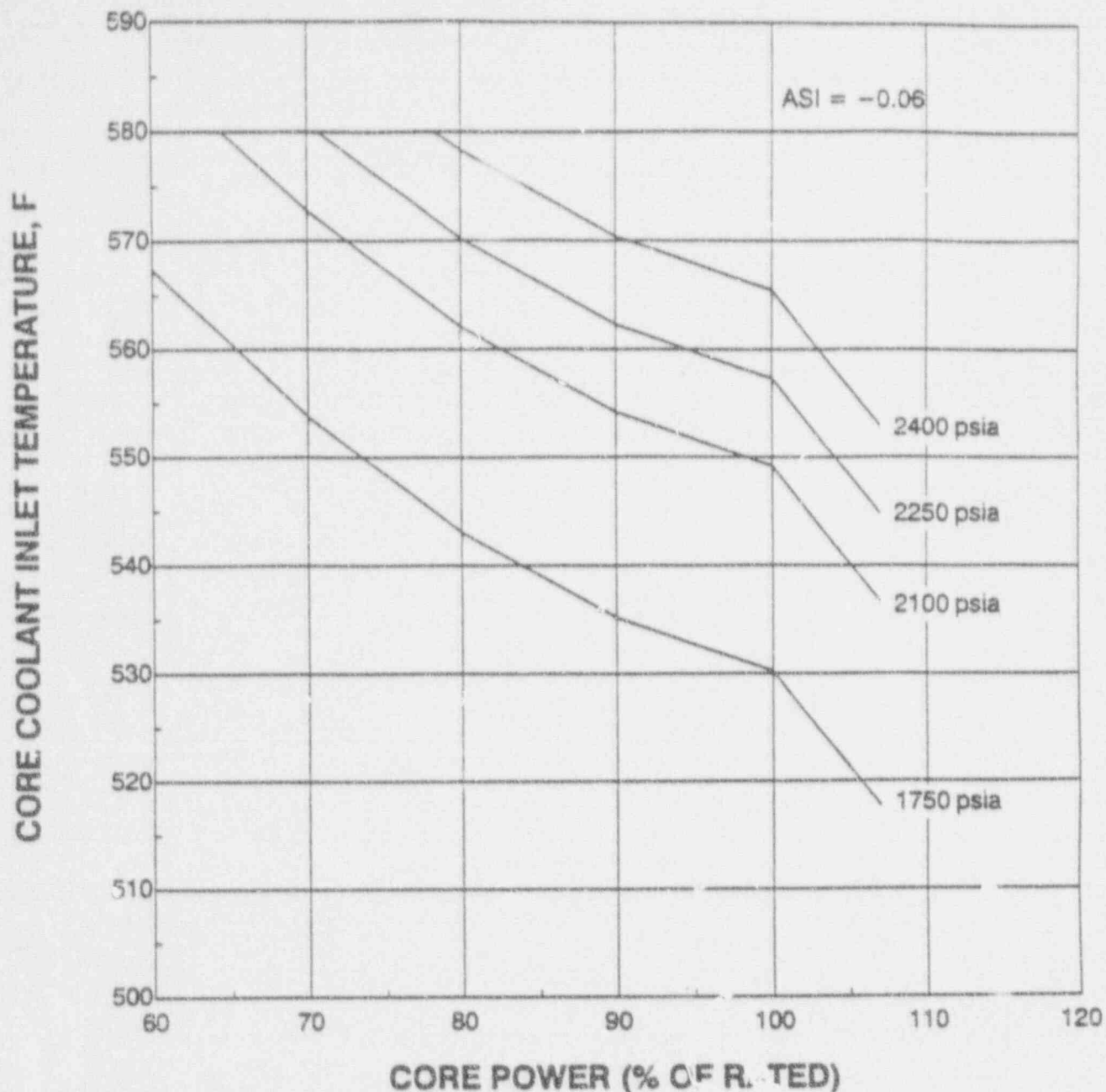
#### 10.0 $F_{xy}^T$ , $F_R^T$ AND CORE POWER LIMITATIONS

Core power limitations versus  $F_R^T$  and  $F_{xy}^T$  are shown in Figure 6.

#### 11.0 REFUELING BORON CONCENTRATION

The refueling boron concentration must be maintained with a boron concentration of at least 1700 ppm in the Reactor Coolant System to ensure a shutdown margin of not less than 5% with all CEAs withdrawn.



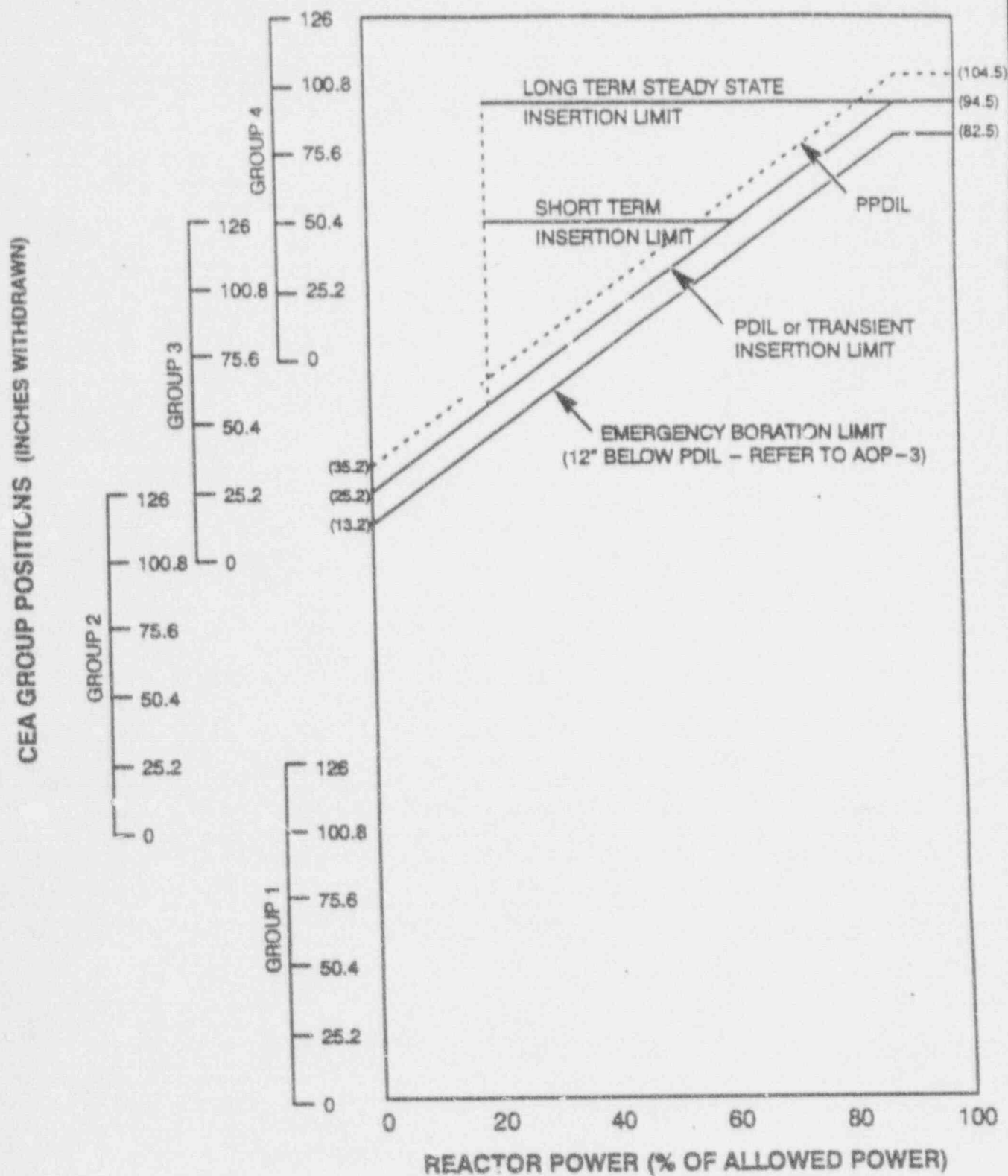


$$P_{VAR} = 29.73PF(B)A1(Y)B + 18.44T_{IN} - 11325$$

$$\begin{aligned} PF(B) &= 1.0 & B \geq 100\% \\ &= -.008B + 1.8 & 50\% < B < 100\% \\ &= 1.4 & B \leq 50\% \end{aligned}$$

$$\begin{aligned} A1(Y) &= -.35294Y_1 + 1.08824 & Y_1 \leq .25 \\ &= 0.57143Y_1 + 0.875 & Y_1 > .25 \end{aligned}$$

R2

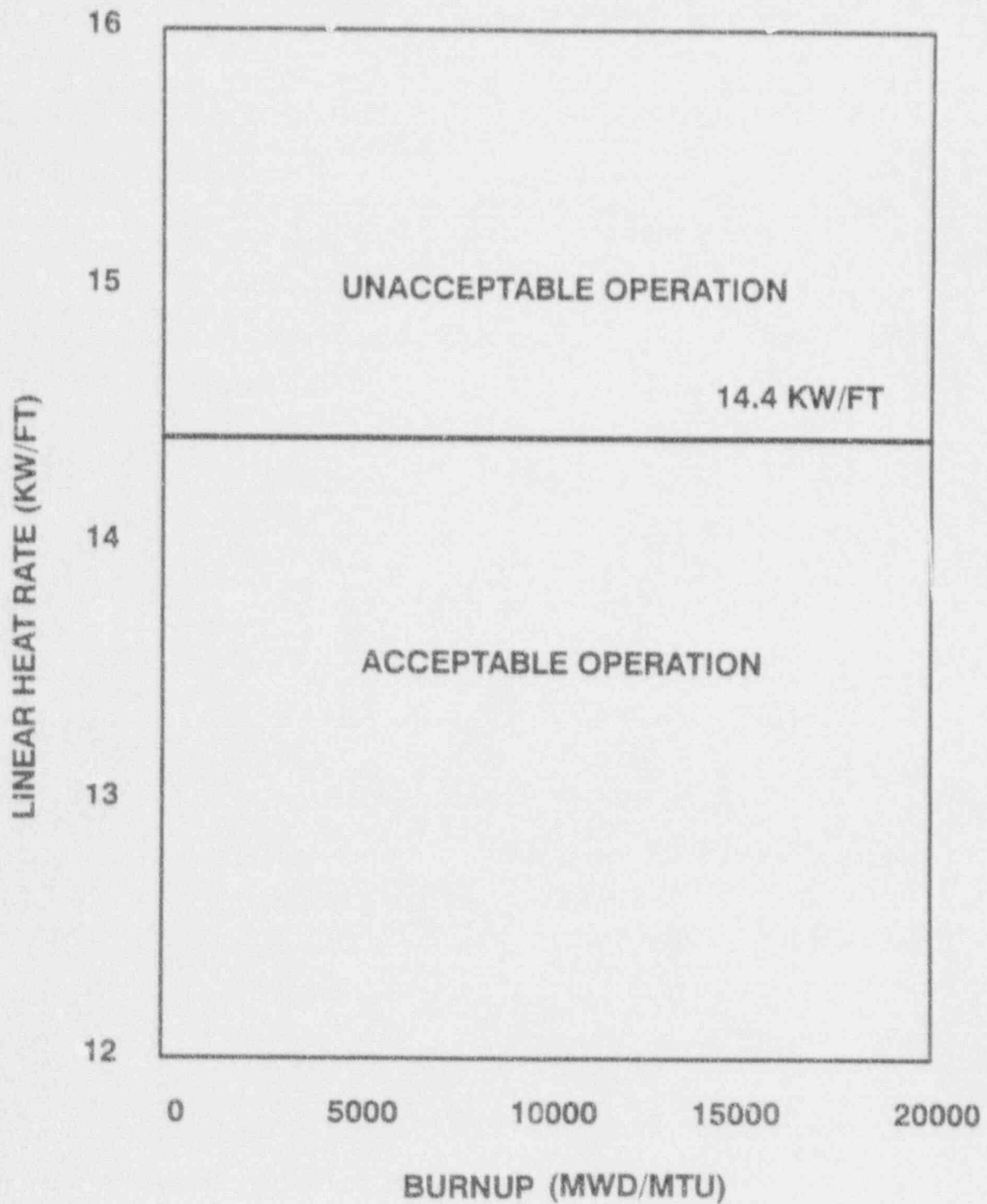


R2

CYCLE 14  
COLR

POWER DEPENDENT INSERTION LIMIT

FIGURE  
2



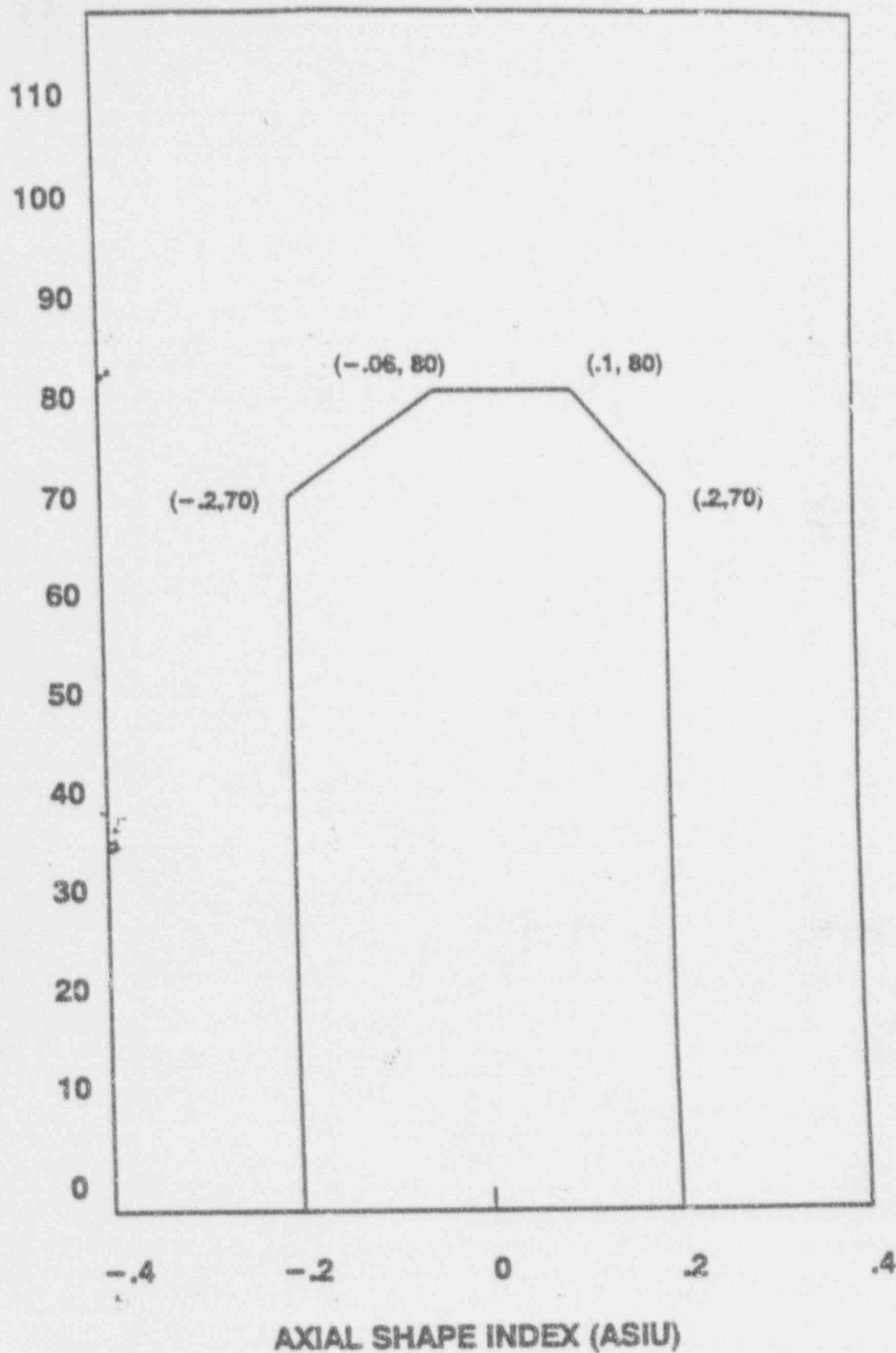
R2

CYCLE 14  
COLR

ALLOWABLE PEAK LINEAR HEAT RATE  
VS. BURNUP

FIGURE  
3

PERCENT OF ALLOWED CORE POWER



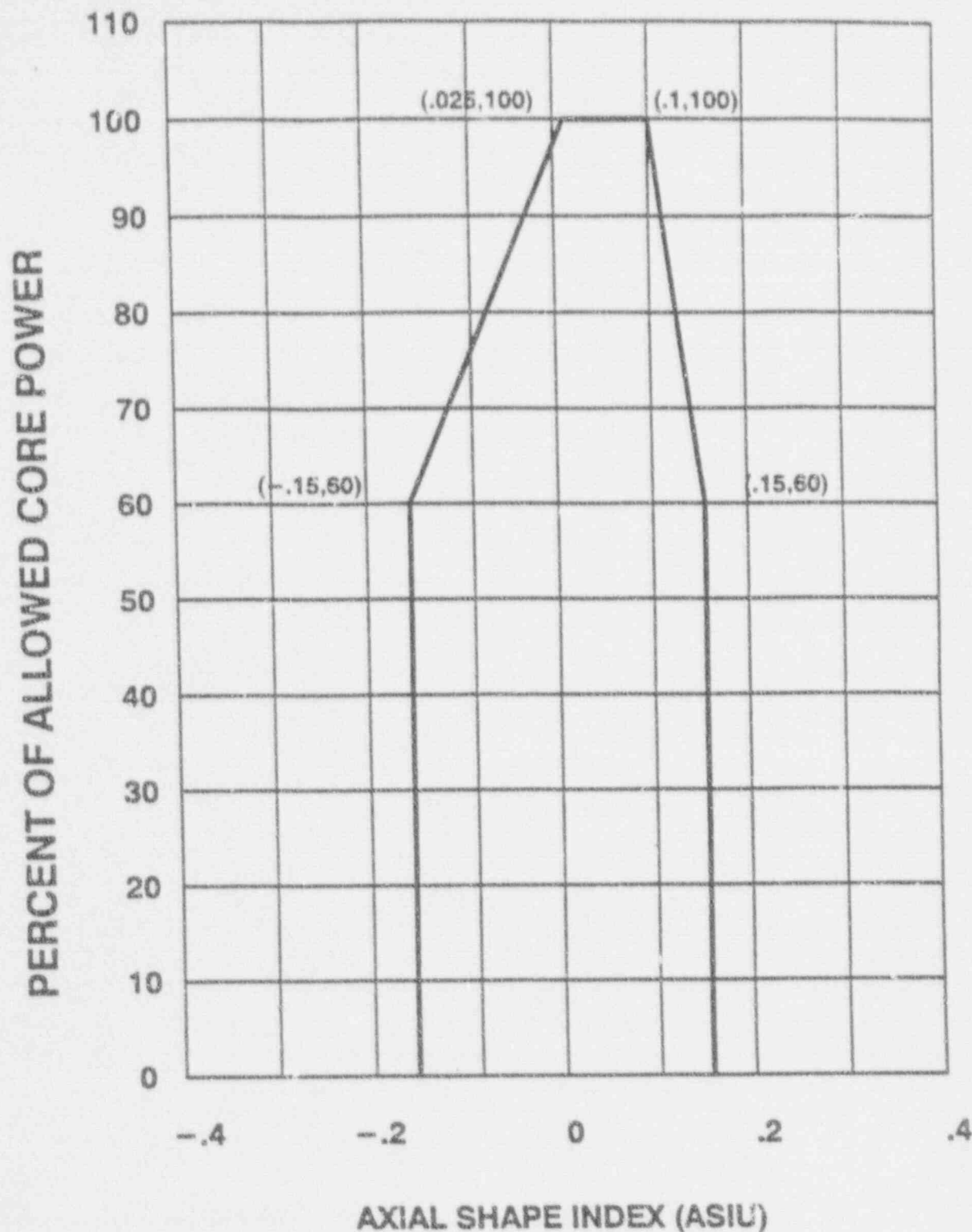
R2

CYCLE 14  
COLR

EXCORE MONITORING OF LHR

FIGURE  
4





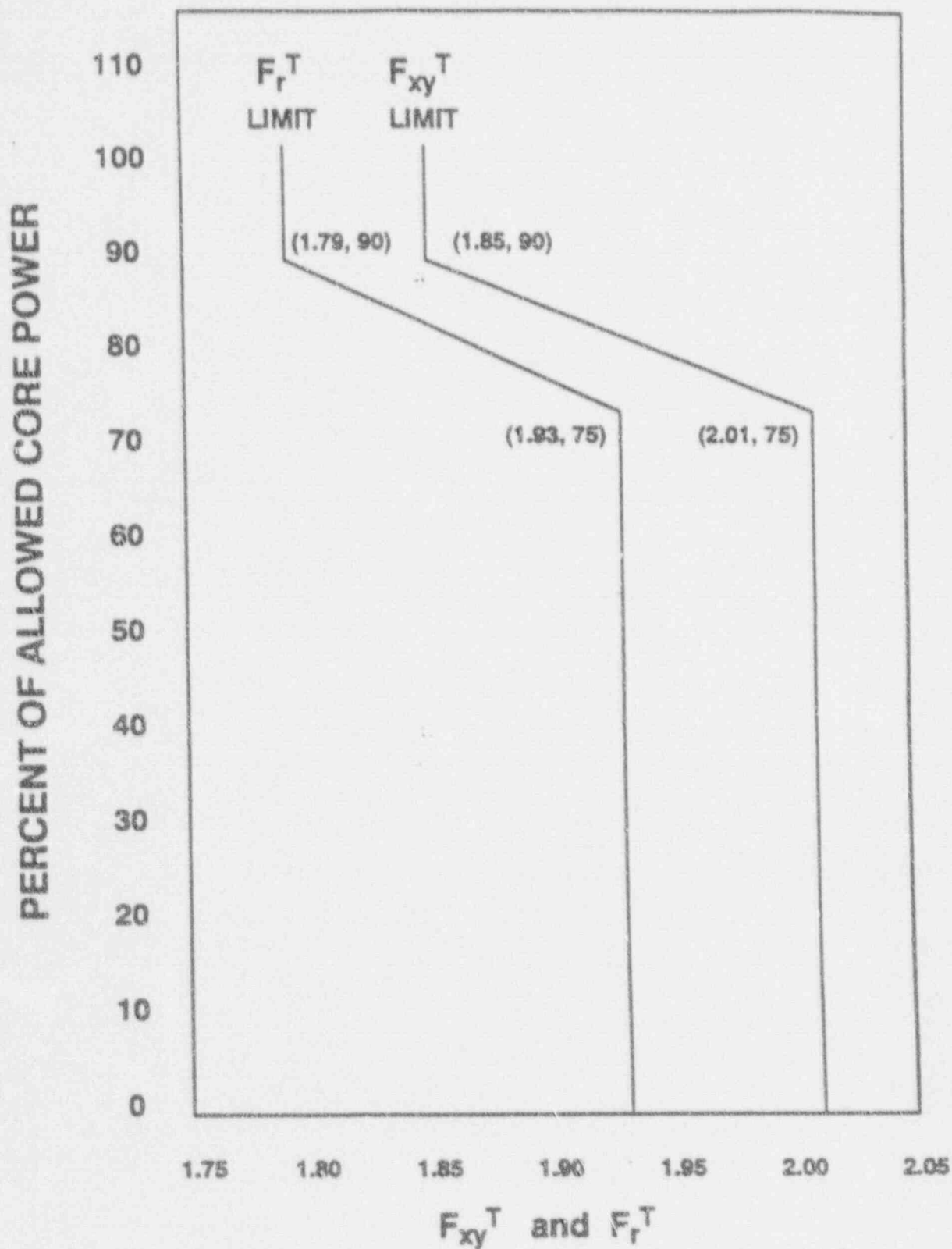
NOTE: WHEN BASSS IS OPERABLE THIS FIGURE IS  
SUPERSEDED BY THE BASSS DNB ALLOW-  
ABLE POWER VALUE

R2

CYCLE 14  
COLR

DNB MONITORING

FIGURE  
5



R2

CYCLE 14  
COLR

$F_{xy}^T$ ,  $F_r^T$ , AND CORE POWER LIMITATIONS

FIGURE  
6