

Docket No. 50-336

Millstone Unit No. 2

Cycle 11

Core Operating Limits Report

Revision 4

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1. CORE OPERATING LIMITS REPORT

This Core Operating Limits Report for Millstone 2 has been prepared in accordance with the requirements of Technical Specification 6.9.1.7. The Technical Specifications affected by this report are listed below:

Section	Specification
2.1	3/4.1.1.1 SHUTDOWN MARGIN - $T_{avg} > 200^{\circ}\text{F}$
2.2	3/4.1.1.2 SHUTDOWN MARGIN - $T_{avg} \leq 200^{\circ}\text{F}$
2.3	3/4.1.1.4 Moderator Temperature Coefficient
2.4	3/4.1.3.6 Regulating CEA Insertion Limits
2.5	3/4.2.1 Linear Heat Rate
2.6	3/4.2.3 Total Integrated Radial Peaking Factor - F_1^T
2.7	3/4.2.6 DNB Margin

Terms appearing in capitalized type are DEFINED TERMS as defined in Section 1.0 of the Technical Specifications.

2. OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC-approved methodologies specified in Section 3.

2.1 SHUTDOWN MARGIN - $T_{avg} > 200^{\circ}\text{F}$ (Specification 3/4.1.1.1)

The SHUTDOWN MARGIN shall be $\geq 3.6\% \Delta\text{K/K}$

2.2 SHUTDOWN MARGIN - $T_{avg} \leq 200^{\circ}\text{F}$ (Specification 3/4.1.1.2)

The SHUTDOWN MARGIN shall be $\geq 2.0\% \Delta\text{K/K}$

2.3 Moderator Temperature Coefficient (Specification 3/4.1.1.4)

The moderator temperature coefficient shall be:

- Less positive than $0.7 \times 10^{-4} \Delta\text{K/K/}^{\circ}\text{F}$ whenever THERMAL POWER is $\leq 70\%$ of RATED THERMAL POWER,
- Less positive than $0.4 \times 10^{-4} \Delta\text{K/K/}^{\circ}\text{F}$ whenever THERMAL POWER is $> 70\%$ of RATED THERMAL POWER,
- Less negative than $-2.8 \times 10^{-4} \Delta\text{K/K/}^{\circ}\text{F}$ at RATED THERMAL POWER.

2.4 Regulating CEA Insertion Limits (Specification 3/4.1.3.6)

The regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits shown in Figure 2.4-1. CEA insertion between the Long Term Steady State Insertion Limits and the Transient Insertion Limits is restricted to:

- a. ≤ 4 hours per 24 hour interval,
- b. ≤ 5 Effective Full Power Days per 30 Effective Full Power Day interval, and
- c. ≤ 14 Effective Full Power Days per calendar year.

2.5 Linear Heat Rate (Specification 3/4.2.1)

The Linear heat rate, including heat generated in the fuel, clad and moderator, shall not exceed:

- a. 15.1 kw/ft when the reactor coolant flow rate measured per Specification 4.2.6.1 $\geq 340,000$ gpm.
- b. 14.5 kw/ft when the reactor coolant flow rate measured per Specification 4.2.6.1 $\geq 325,000$ gpm and $< 340,000$ gpm.

During operation with the linear heat rate being monitored by the Excore Detector Monitoring System, the AXIAL SHAPE INDEX shall remain within the limits of Figure 2.5-1.

During operation with the linear heat rate being monitored by the Incore Detector Monitor System, the alarm setpoints shall be adjusted to less than or equal to the limit when the following factors are appropriately included in the setting of the alarms:

- 1.* Flux peaking augmentation factors as shown in Figure 2.5-2,
- 2. A measurement-calculational uncertainty factor of 1.07,
- 3. An engineering uncertainty factor of 1.03,
- 4.* A linear heat rate uncertainty factor of 1.01 due to axial fuel densification and thermal expansion, and
- 5. A THERMAL POWER measurement uncertainty factor of 1.02.

*These factors are only appropriate to fuel batches "A" through "L".

2.6 Total Integrated Radial Peaking Factor - $F_{r,T}$ (Specification 3/4.2.3)

The calculated value of $F_{r,T}$, defined as $F_{r,T} = F_r(1+T_q)$, shall be ≤ 1.64 .

2.6.1 If $F_{r,T} > 1.64$, then REFER to the ACTION statement for Specification 3.2.3. Refer to Figure 2.6-1 for the power dependent $F_{r,T}$ limits.

2.7 DNB Margin (Specification 3/4.2.6)

The DNB margin shall be preserved by maintaining the cold leg temperature, pressurizer pressure, reactor coolant flow rate, and AXIAL SHAPE INDEX within the following limits.

Parameter	Limits
	Four Reactor Coolant Pumps Operations
a. Cold Leg Temperature	$\leq 549^\circ\text{F}$
b. Pressurizer Pressure	$\geq 2225 \text{ psia}^*$
c. Reactor Coolant Flow Rate	$\geq 325,000 \text{ gpm}$
d. AXIAL SHAPE INDEX	FIGURE 2.7-1

* Limit not applicable during either a THERMAL POWER ramp increase in excess of 5% of RATED THERMAL POWER per minute or a THERMAL POWER step increase of greater than 10% of RATED THERMAL POWER.

3. ANALYTICAL METHODS

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:

- 3.1 XN-75-27(A), Rev. 0 and Supplements 1 through 5, "Exxon Nuclear Neutronics Design Methods for Pressurized Water Reactors," Exxon Nuclear Company. Rev. 0 dated June 1975, Supplement 1 dated September 1976, Supplement 2 dated December 1980, Supplement 3 dated September 1981, Supplement 4 dated December 1986, Supplement 5 dated February 1987.
- 3.2 ANF-84-73(P), Rev. 3, "Advanced Nuclear Fuels Methodology for Pressurized Water Reactors: Analysis of Chapter 15 Events," Advanced Nuclear Fuels Corporation, dated May 1988.
- 3.3 XN-NF-82-21(A), Rev. 1, "Application of Exxon Nuclear Company PWR Thermal Margin Methodology to Mixed Core Configurations," Exxon Nuclear Company, dated September 1983.
- 3.4 ANF-84-93(A), Rev. 0 and Supplement 1, "Steamline Break Methodology for PWR's," Advanced Nuclear Fuels Corporation. Rev. 0 dated March 1989, Supplement 1 dated March 1989.
- 3.5 XN-75-32(A), Supplements 1, 2, 3, and 4, "Computational Procedure for Evaluating Fuel Rod Bowing," Exxon Nuclear Company, dated October 1983.
- 3.6 XN-NF-82-49(A), Rev. 1 and Supplement 1, "Exxon Nuclear Company Evaluation Model EXEM PWR Small Break Model," Advanced Nuclear Fuels Corporation, both reports dated April 1989.
- 3.7 EXEM PWR Large Break LOCA Evaluation Model as defined by:
 - a. XN-NF-82-20(A), Rev. 1 and Supplements 1 through 4, "Exxon Nuclear Company Evaluation Model EXEM/PWR ECCS Model Updates," Exxon Nuclear Company. All reports dated January 1990.
 - b. XN-NF-82-07(A), Rev. 1, "Exxon Nuclear Company ECCS Cladding Swelling and Rupture Model," Exxon Nuclear Company, dated November 1982.
 - c. XN-NF-81-58(A), Rev. 2 and Supplements 1 through 4, "RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model," Exxon Nuclear Company. Rev. 2 and Supplements 1 and 2 dated March 1984, Supplements 3 and 4 dated June 1990.

- d. XN-NF-85-16(A), Volume 1 through Supplement 3; Volume 2, Rev. 1 and Supplement 1, "PWR 17x17 Fuel Cooling Tests Program," Exxon Nuclear Company. All reports dated February 1990.
 - e. XN-NF-85-105(A), Rev. 0 and Supplement 1, "Scaling of FCTF Based Reflood Heat Transfer Correlation for Other Bundle Designs," Exxon Nuclear Company. Both reports dated January 1990.
- 3.8 XN-NF-78-44(A), "A Generic Analysis of the Control Rod Ejection Transient for Pressurized Water Reactors," Exxon Nuclear Company, dated October 1983.
- 3.9 XN-NF-621(A), Rev. 1, "Exxon Nuclear DNB Correlation of PWR Fuel Design," Exxon Nuclear Company, dated September 1983.

An acceptable Millstone 2 specific application of these analytical methodologies is described in ANF-88-126, "Millstone Unit 2 Cycle 10 Safety Analysis Report," dated October 1988.

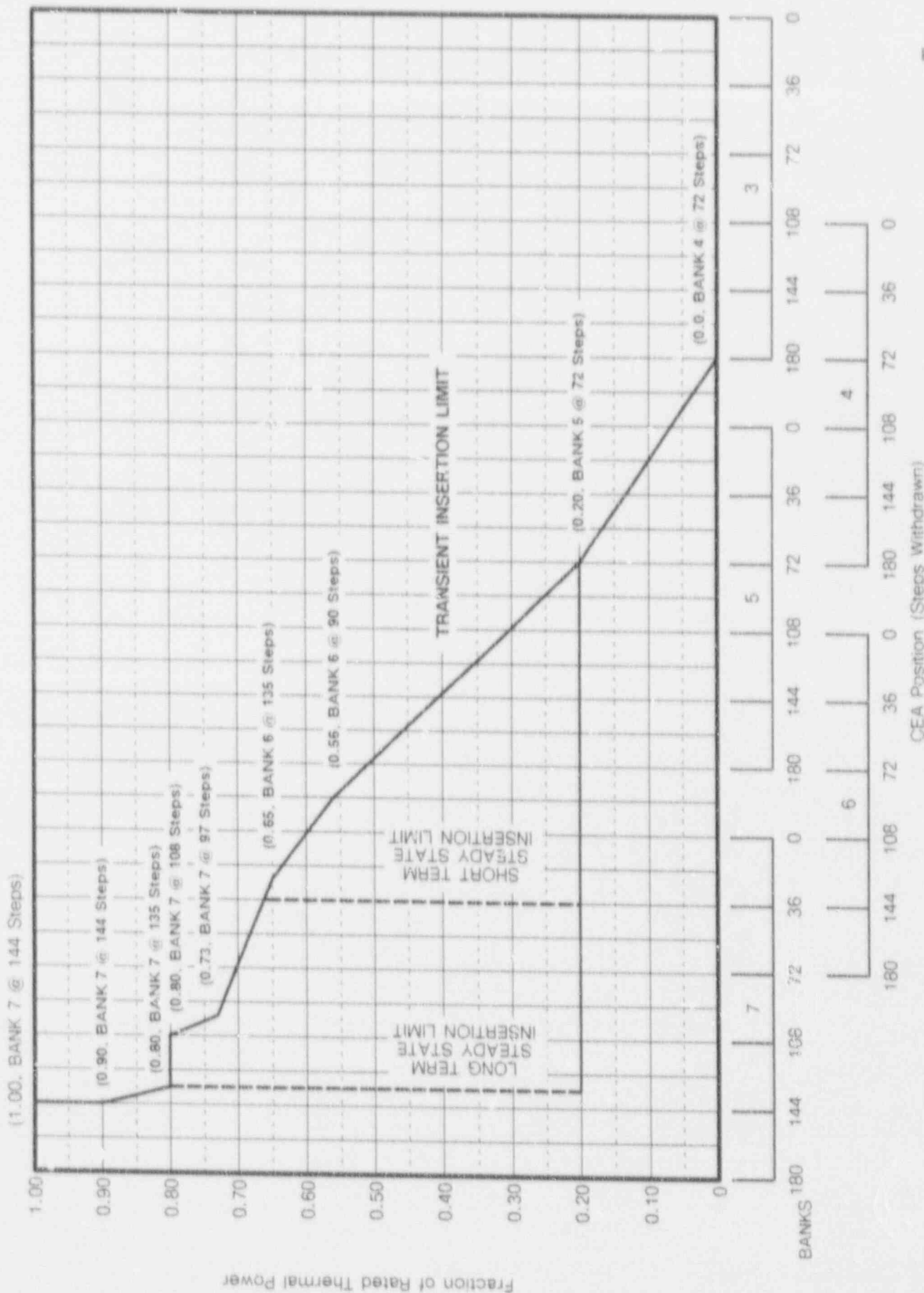


FIGURE 2.4-1 CEA Insertion Limit vs. THERMAL POWER with Four Reactor Coolant Pumps Operating

CEA Position (Steps Withdrawn)

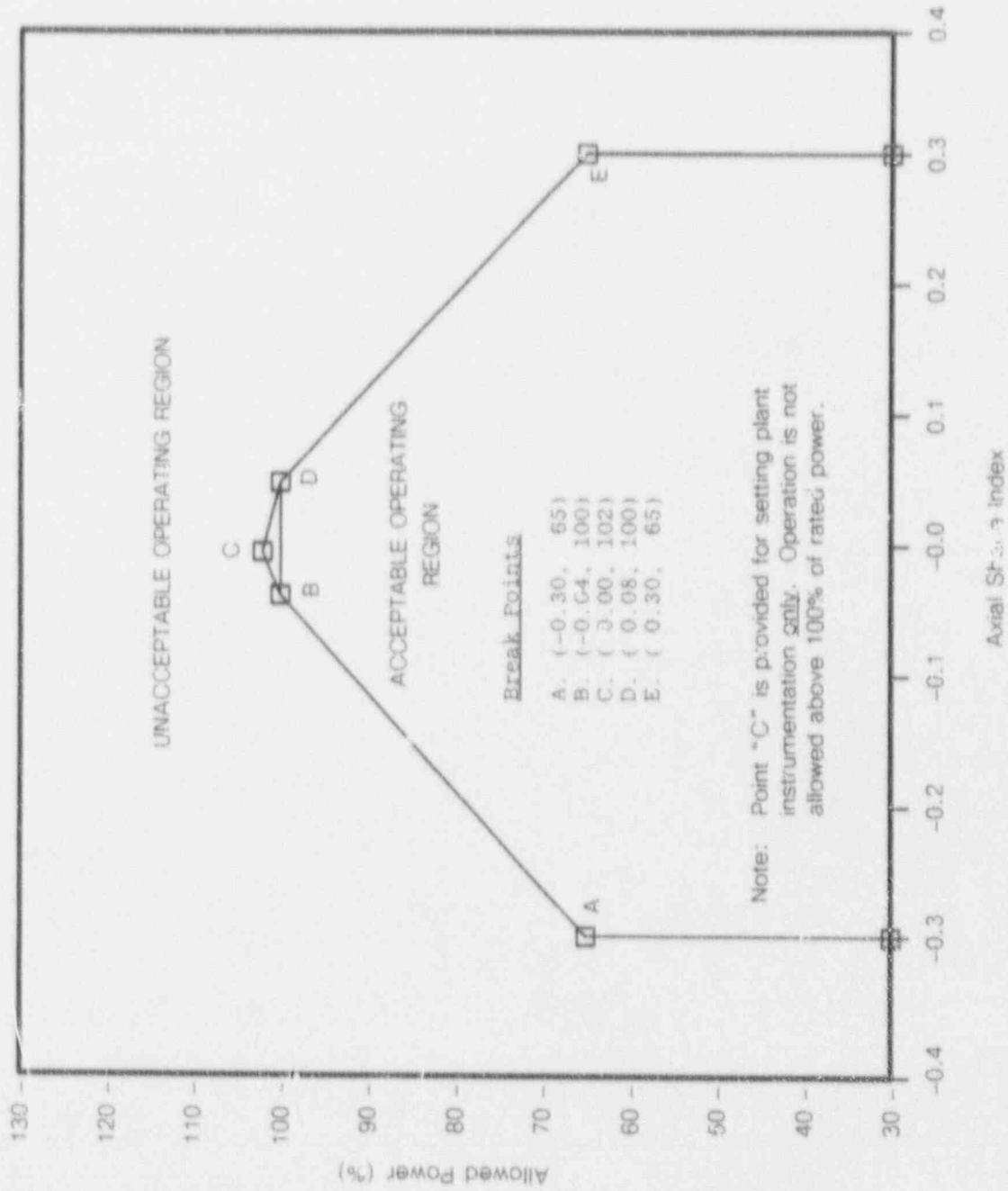


FIGURE 2.5-1 AXIAL SHAPE INDEX vs. PERCENT OF ALLOWABLE POWER LEVEL

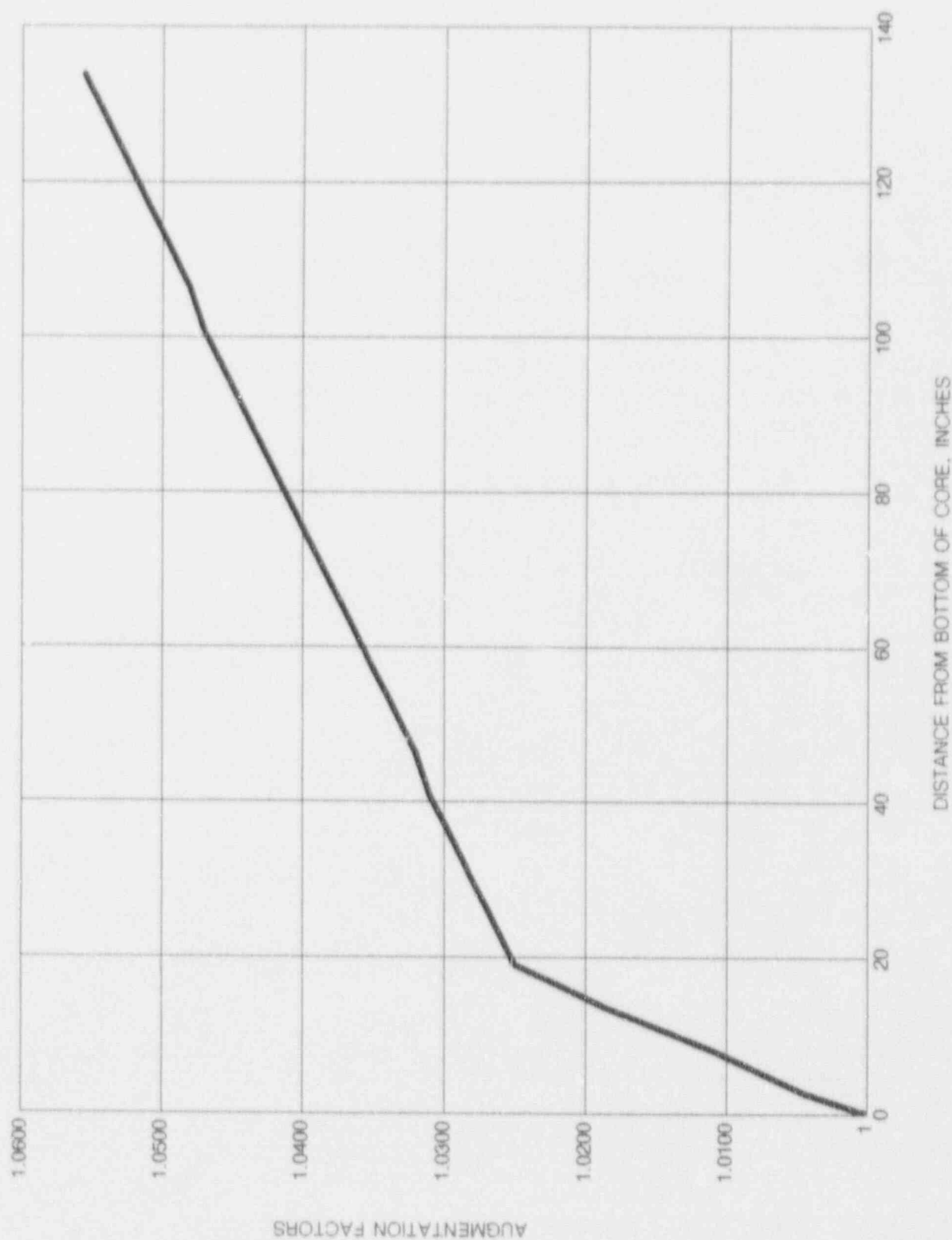


FIGURE 2.5-2 Augmentation Factor vs. Distance from Bottom of Core
(only applicable to fuel batches "A" through "L")

Allowable Percent of Rated Thermal Power

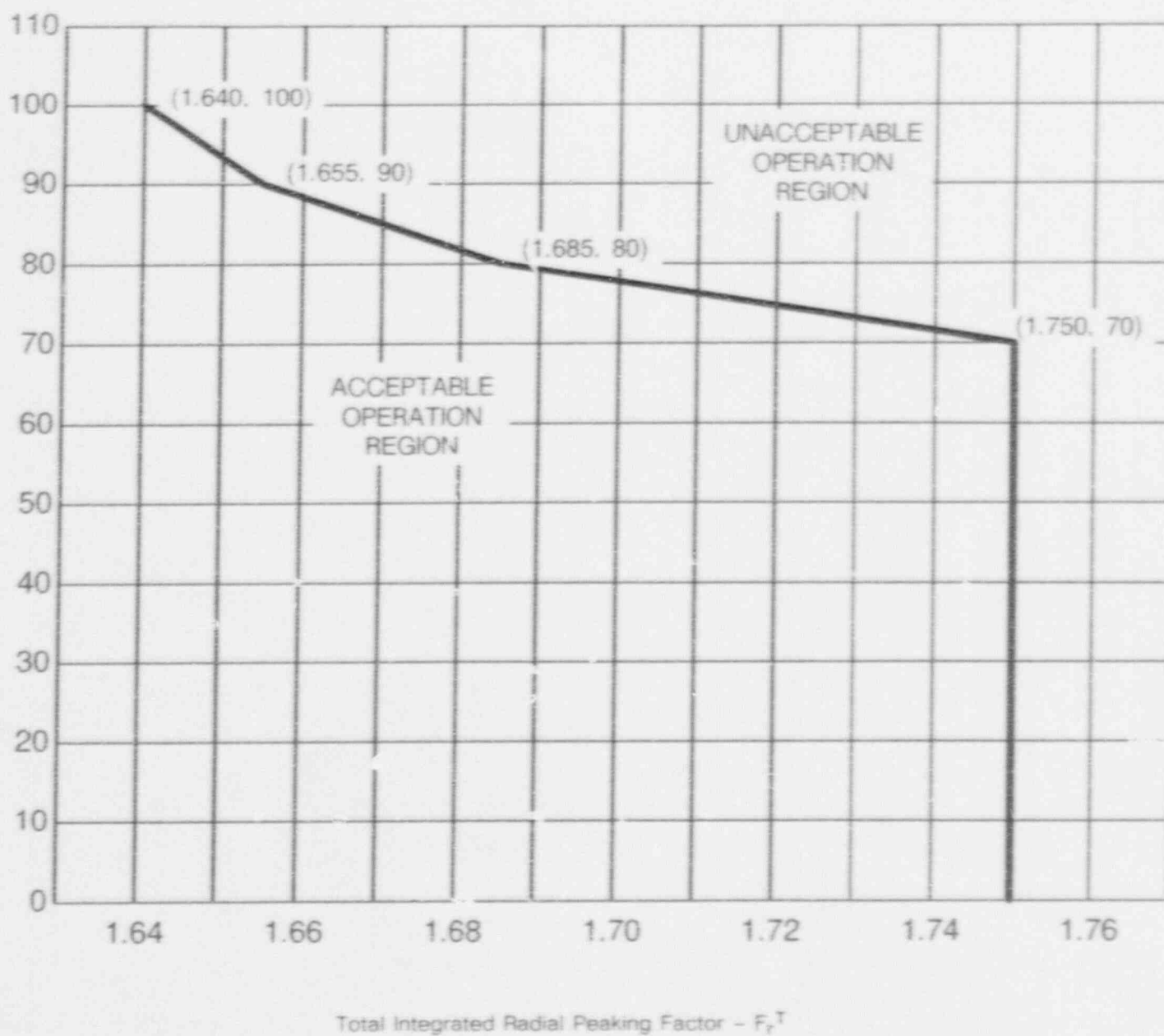


FIGURE 2.6-1 Total Integrated Radial Peaking Factor vs. Allowable Rated Thermal Power

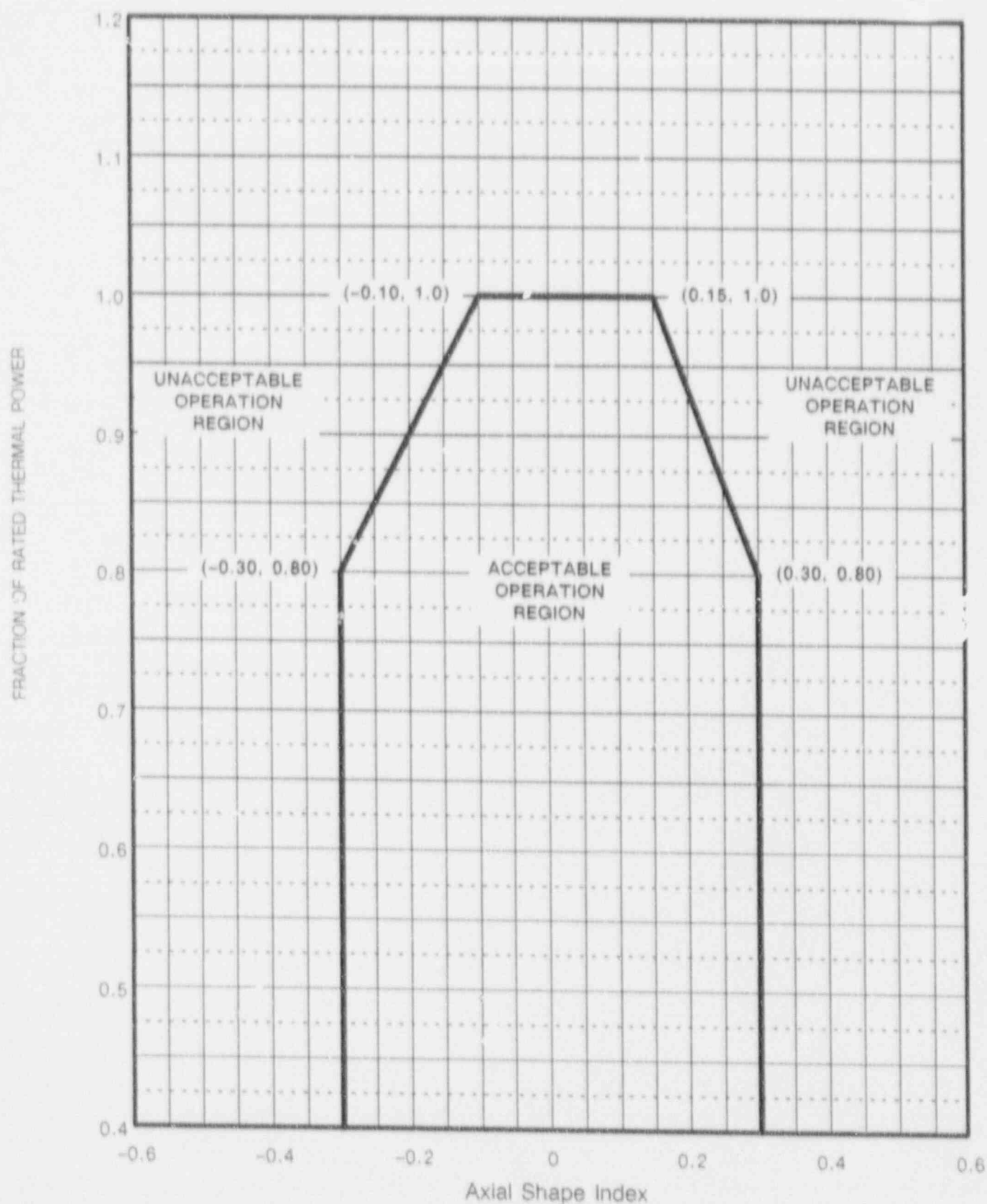


FIGURE 2.7-1 AXIAL SHAPE INDEX Operating Limits with Four Reactor Coolant Pumps Operating