



U. S. Nuclear Regulatory Commission  
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**DOMINION ENERGY NUCLEAR CONNECTICUT, INC.**  
**MILLSTONE POWER STATION UNIT 2**  
**CORE OPERATING LIMITS REPORT, CYCLE 27**

**MAY 21 2020**

In accordance with the Millstone Power Station Unit 2 (MPS2) Technical Specifications (TSs), Section 6.9.1.8d, Dominion Energy Nuclear Connecticut, Inc., hereby submits, as an enclosure, the Cycle 27 Core Operating Limits Report (COLR).

The MPS2 COLR has been revised as follows:

- Revision of page headers to reflect Cycle 27

The Cycle 27 COLR has been incorporated into the MPS2 Technical Requirements Manual.

If you have any questions or require additional information, please contact Mr. Jeffry Langan at (860) 444-5544.

Sincerely,

A handwritten signature in black ink, appearing to read 'L. J. Armstrong', written in a cursive style.

L. J. Armstrong  
Director, Nuclear Station Safety and Licensing - Millstone

Enclosure: Core Operating Limits Report, Cycle 27

Commitments made in this letter: None

ADDI  
NRK

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**ENCLOSURE**

**CORE OPERATING LIMITS REPORT, CYCLE 27**

**DOMINION ENERGY NUCLEAR CONNECTICUT, INC.  
MILLSTONE POWER STATION UNIT 2**

# TECHNICAL REQUIREMENTS MANUAL

## APPENDIX 8.1 CORE OPERATING LIMITS REPORT, CYCLE 27

### 1. CORE OPERATING LIMITS REPORT

This CORE OPERATING LIMITS REPORT for Millstone 2 has been prepared in accordance with the requirements of Technical Specification 6.9.1.8 a through 6.9.1.8 d. The Technical Specifications affected by this report are listed below:

<u>Section</u>	<u>Specification</u>	
2.1	3/4.1.1.1	SHUTDOWN MARGIN – (SDM)
2.2		Deleted (Ref. License Amendment 280)
2.3	3/4.1.1.4	Moderator Temperature Coefficient (MTC)
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 UNRODDED INTEGRATED RADIAL PEAKING FACTOR -- $F_r^T$
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 – (SDM) (Specification 3/4.1.1.1)

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

#### 2.2 Deleted

#### 2.3 Moderator Temperature Coefficient (Specification 3/4.1.1.4)

The moderator temperature coefficient shall be:

- Less positive than  $0.7 \times 10^{-4} \Delta K/K/^\circ F$  whenever THERMAL POWER is  $\leq 70\%$  of RATED THERMAL POWER,
- Less positive than  $0.4 \times 10^{-4} \Delta K/K/^\circ F$  whenever THERMAL POWER is  $> 70\%$  of RATED THERMAL POWER,
- Less negative than  $-3.0 \times 10^{-4} \Delta K/K/^\circ F$  at RATED THERMAL POWER.

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**CORE OPERATING LIMITS REPORT, CYCLE 27**

2.4 Regulating CEA Insertion Limits (Technical 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.  $\leq 4$  hours per 24 hour interval,
- b.  $\leq 5$  Effective Full Power Days per 30 Effective Full Power Day interval, and
- c.  $\leq 14$  Effective Full Power Days per 365 Effective Full Power Day interval.

2.5 Linear Heat Rate (Technical 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 whenever the reactor coolant flow rate (determined per Technical Specification 3/4.2.1) is  $\geq 360,000$  gpm.
- b. 15.0 kw/ft whenever the reactor coolant flow rate (determined per Technical Specification 3/4.2.1) is  $< 360,000$  gpm and  $\geq 354,600$  gpm.
- c. 14.9 kw/ft whenever the reactor coolant flow rate (determined per Technical Specification 3/4.2.1) is  $< 354,600$  gpm and  $\geq 349,200$  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. A measurement-calculational uncertainty factor of 1.07,
- 2. An engineering uncertainty factor of 1.03, and
- 3. A THERMAL POWER measurement uncertainty factor of 1.02.

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### 2.6 TOTAL UNRODDED INTEGRATED RADIAL PEAKING FACTOR -- $F_r^T$ (Technical Specification 3/4.2.3)

The calculated value of  $F_r^T$  at RATED THERMAL POWER shall be:

$\leq 1.690$  whenever the reactor coolant flow rate is  $\geq 360,000$  gpm.

$\leq 1.664$  whenever the reactor coolant flow rate is  $< 360,000$  gpm and  $\geq 354,600$  gpm.

$\leq 1.639$  whenever the reactor coolant flow rate is  $< 354,600$  gpm and  $\geq 349,200$  gpm.

2.6.1 The Power Dependent  $F_r^T$  limits, whenever the reactor coolant flow rate is  $\geq 360,000$  gpm, are shown in Figure 2.6-1.

2.6.2 The Power Dependent  $F_r^T$  limits, whenever the reactor coolant flow rate is  $< 360,000$  gpm and  $\geq 354,600$  gpm, are shown in Figure 2.6-2.

2.6.3 The Power Dependent  $F_r^T$  limits, whenever the reactor coolant flow rate is  $< 354,600$  gpm and  $\geq 349,200$  gpm, are shown in Figure 2.6-3.

### 2.7 DNB Margin (Technical 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
	<u>Four Reactor Coolant Pumps Operations</u>
a. Cold Leg Temperature	$\leq 549^\circ\text{F}$
b. Pressurizer Pressure	$> 2225$ psia*
c. Reactor Coolant Flow Rate	$\geq 360,000$ gpm with Linear Heat Rate and $F_r^T$ limits as specified in Sections 2.5 and 2.6. or $\geq 354,600$ gpm with Linear Heat Rate and $F_r^T$ limit reductions as specified in Sections 2.5 and 2.6. or $\geq 349,200$ gpm with Linear Heat Rate and $F_r^T$ limit reductions as specified in Sections 2.5 and 2.6.
d. AXIAL SHAPE INDEX	Figure 2.7-1

\* Limit not applicable during either the 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.

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**CORE OPERATING LIMITS REPORT, CYCLE 27**

**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 EMF-96-029(P)(A) Volumes 1 and 2, "Reactor Analysis System for PWRs Volume 1 - Methodology Description, Volume 2 - Benchmarking Results," Siemens Power Corporation, January 1997.

Methodology for:

- TS 3.1.1.1 – Shutdown Margin – (SDM)
- TS 3.1.1.4 – Moderator Temperature Coefficient (MTC)
- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.2 ANF-84-73 Revision 5 Appendix B(P)(A), "Advanced Nuclear Fuels Methodology for Pressurized Water Reactors: Analysis of Chapter 15 Events," Advanced Nuclear Fuels, July 1990.

Methodology for:

- TS 3.1.1.1 – Shutdown Margin – (SDM)
- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.3 XN-NF-82-21(P)(A) Revision 1, "Application of Exxon Nuclear Company PWR Thermal Margin Methodology to Mixed Core Configurations," Exxon Nuclear Company, September 1983.

Methodology for:

- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.4 XN-75-32(P)(A) Supplements 1 through 4, "Computational Procedure for Evaluating Fuel Rod Bowing," Exxon Nuclear Company, October 1983.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

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- 3.5 EMF-2328(P)(A), Revision 0 and Supplement 1(P)(A), "PWR Small Break LOCA Evaluation Model S-RELAP5 Based," Framatome ANP, September 2015.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.6 EMF-2087(P)(A), "SEM/PWR-98: ECCS Evaluation Model for PWR LBLOCA Applications," Siemens Power Corporation, June 1999.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.7 XN-NF-78-44(NP)(A), "A Generic Analysis of the Control Rod Ejection Transient for Pressurized Water Reactors," Exxon Nuclear Company, October 1983.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.8 XN-NF-621(P)(A) Revision 1, "Exxon Nuclear DNB Correlation for PWR Fuel Designs," Exxon Nuclear Company, September 1983.

Methodology for:

- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.9 XN-NF-82-06(P)(A) Revision 1 and Supplements 2, 4, and 5, "Qualification of Exxon Nuclear Fuel for Extended Burnup," Exxon Nuclear Company, October 1986.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$



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- 3.10 ANF-88-133(P)(A) and Supplement 1, "Qualification of Advanced Nuclear Fuels PWR Design Methodology for Rod Burnups of 62 GWd/MTU," Advanced Nuclear Fuels Corporation, December 1991.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.11 XN-NF-85-92(P)(A) "Exxon Nuclear Uranium Dioxide/Gadolinia Irradiation Examination and Thermal Conductivity Results," Exxon Nuclear Company, November 1986.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.12 ANF-89-151(P)(A), "ANF-RELAP Methodology for Pressurized Water Reactors: Analysis of Non-LOCA Chapter 15 Events," Advanced Nuclear Fuels Corporation, May 1992.

Methodology for:

- TS 3.1.1.4 – Moderator Temperature Coefficient (MTC)
- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.13 EMF-1961(P)(A) Revision 0, "Statistical Setpoint/Transient Methodology for Combustion Engineering Type Reactors," Siemens Power Corporation, July 2000.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$
- TS 3.2.6 – DNB Margin

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- 3.14 EMF-2310(P)(A), Revision 1, "SRP Chapter 15 Non-LOCA Methodology for Pressurized Water Reactors," Framatome ANP, May 2004.

Methodology for:

- TS 3.1.1.4 – Moderator Temperature Coefficient (MTC)
- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.15 EMF-92-153(P)(A), Revision 1, "HTP: Departure from Nucleate Boiling Correlation for High Thermal Performance Fuel," Siemens Power Corporation, January 2005.

Methodology for:

- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.16 EMF-92-116(P)(A) Revision 0 and Supplement 1(P)(A), "Generic Mechanical Design Criteria for PWR Fuel Designs," Siemens Power Corporation, February 2015.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.17 BAW-10240(P)(A), Revision 0, "Incorporation of M5™ Properties in Framatome ANP Approved Methods," Framatome ANP, Inc., May 2004.

Methodology for:

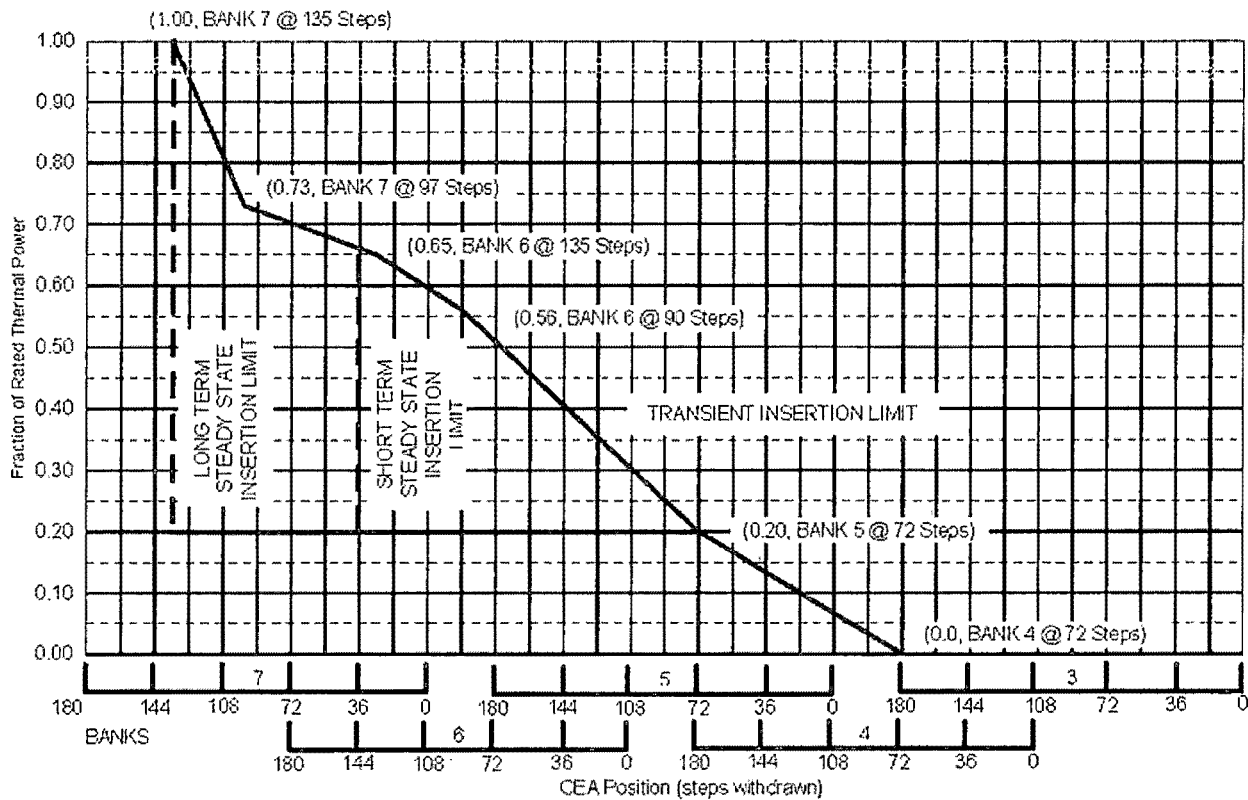
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

- 3.18 EMF-2103(P)(A), Revision 3, "Realistic Large Break LOCA Methodology for Pressurized Water Reactors," AREVA Inc., June 2016.

Methodology for:

- TS 3.1.3.6 – Regulating CEA Insertion Limits
- TS 3.2.1 – Linear Heat Rate
- TS 3.2.3 – Total Unrodded Integrated Radial Peaking Factor –  $F_r^T$

**APPENDIX 8.1**  
**CORE OPERATING LIMITS REPORT, CYCLE 27**



Note: Regulating CEAs that are  $\geq 176$  steps withdrawn are considered fully withdrawn and are acceptable per this figure.

**Figure 2.4-1**  
**CEA Insertion Limit vs. THERMAL POWER With**  
**Four Reactor Coolant Pumps Operating**

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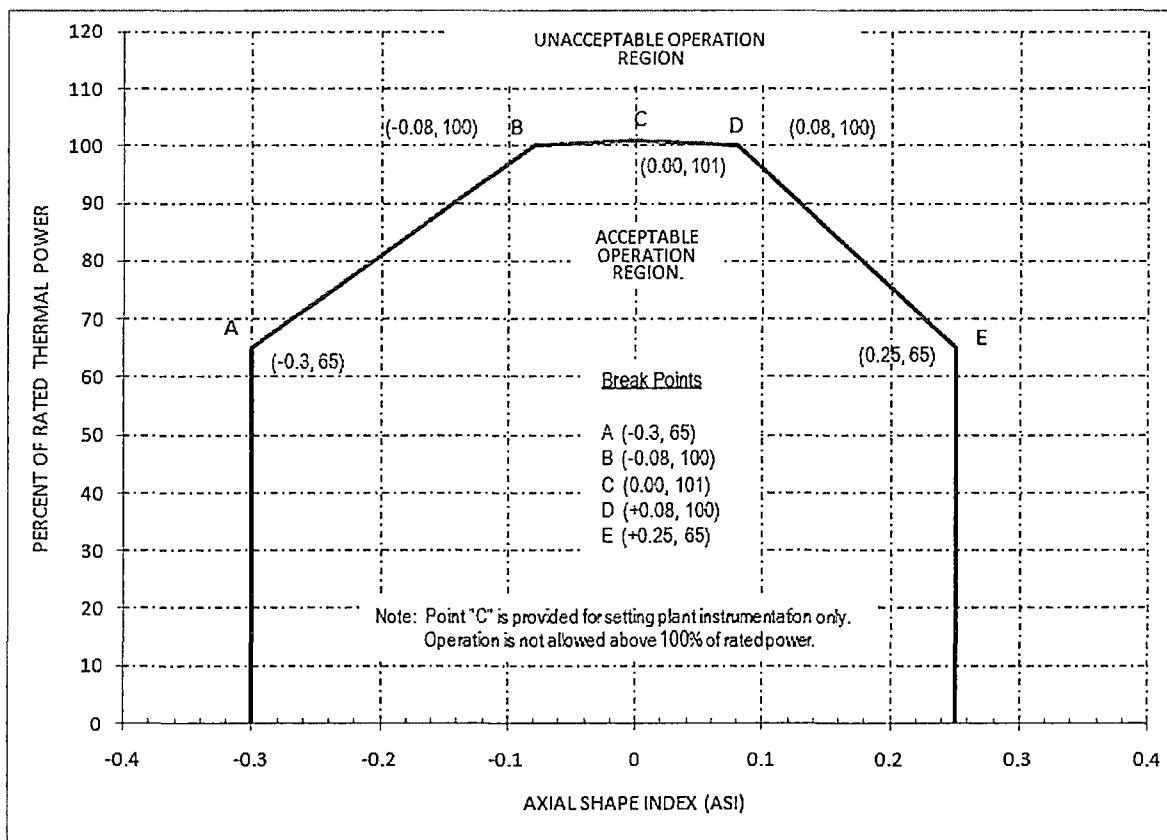
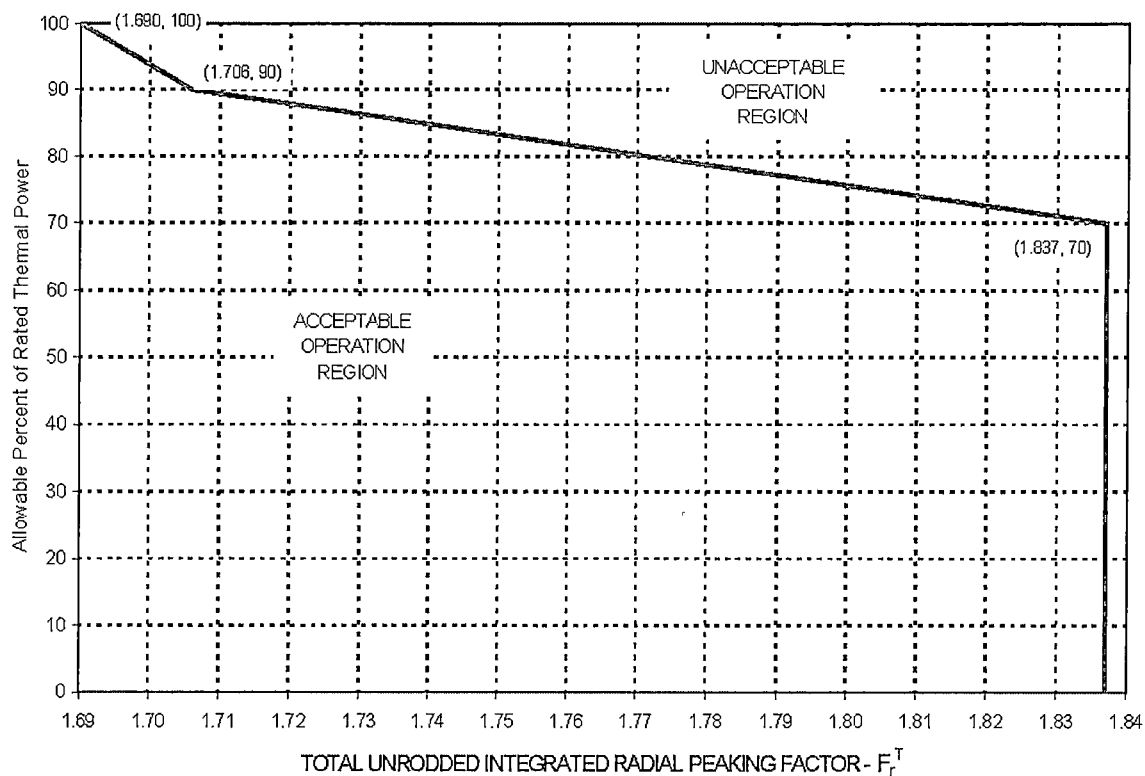


Figure 2.5-1  
AXIAL SHAPE INDEX vs.  
PERCENT OF ALLOWABLE POWER LEVEL

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Note: The  $F_r^T$  limit should be reduced for reactor coolant flow rates  $\geq 349,200$  gpm and  $< 360,000$  gpm (see Section 2.6).

**Figure 2.6-1**  
**TOTAL UNRODDED INTEGRATED RADIAL PEAKING FACTOR**  
**vs. Allowable RATED THERMAL POWER**  
**For Reactor Coolant Flow Rates  $\geq 360,000$  gpm**

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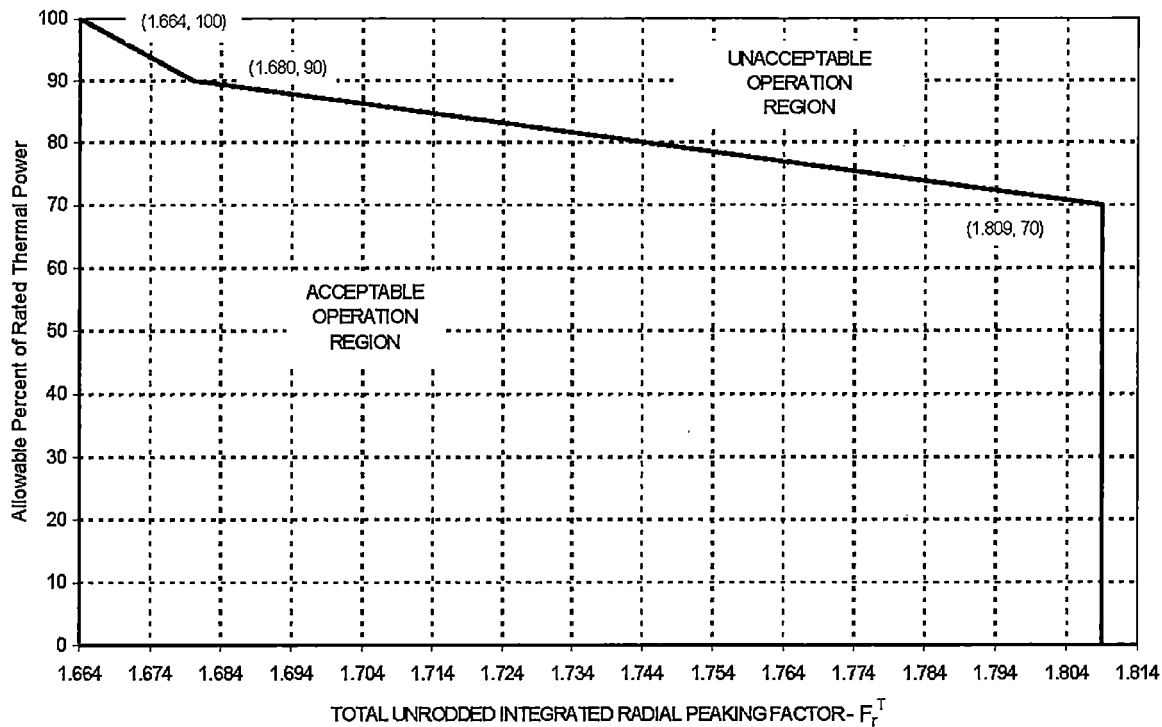
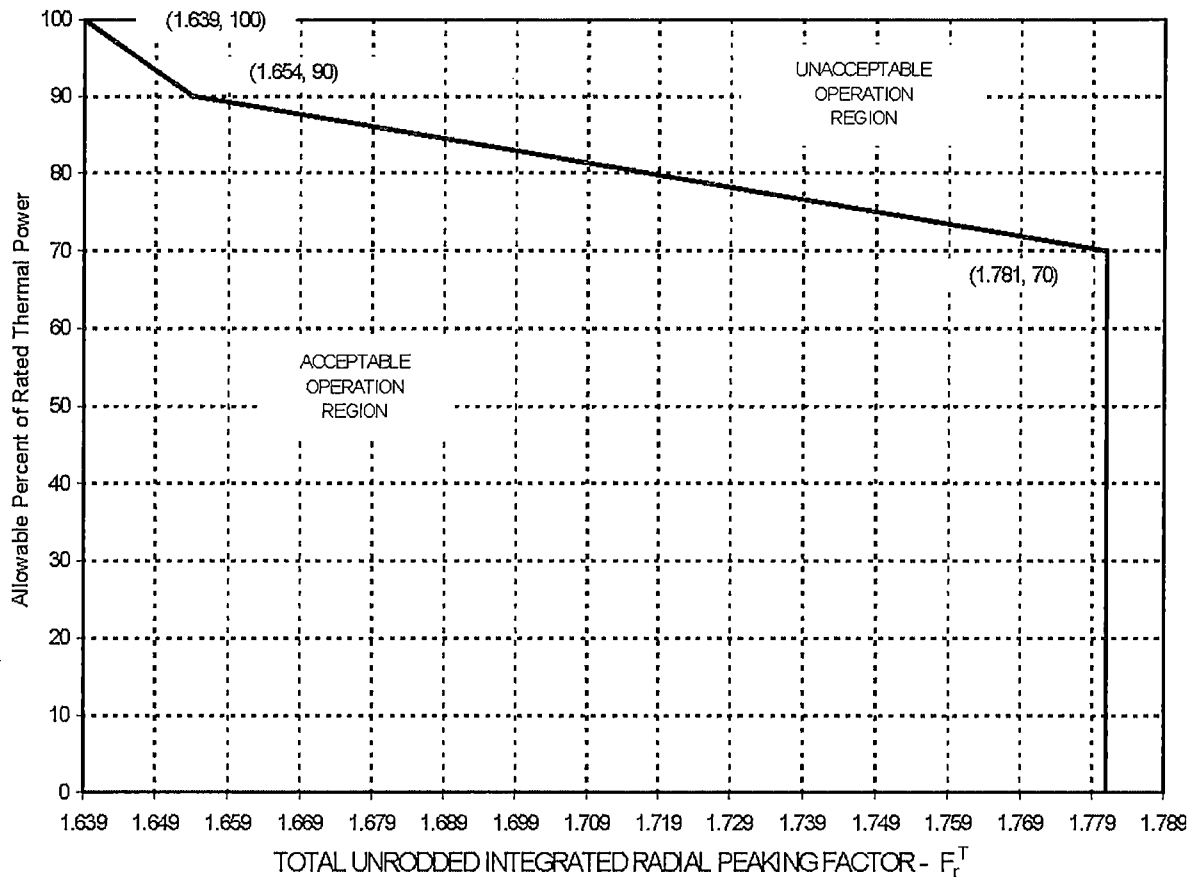


Figure 2.6-2  
TOTAL UNRODDED INTEGRATED RADIAL PEAKING FACTOR  
vs. Allowable RATED THERMAL POWER  
For Reactor Coolant Flow Rates  $< 360,000$  gpm and  $\geq 354,600$  gpm

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**Figure 2.6-3**  
**TOTAL UNRODDED INTEGRATED RADIAL PEAKING FACTOR**  
**vs. Allowable RATED THERMAL POWER**  
**For Reactor Coolant Flow Rates < 354,600 gpm and  $\geq$  349,200 gpm**

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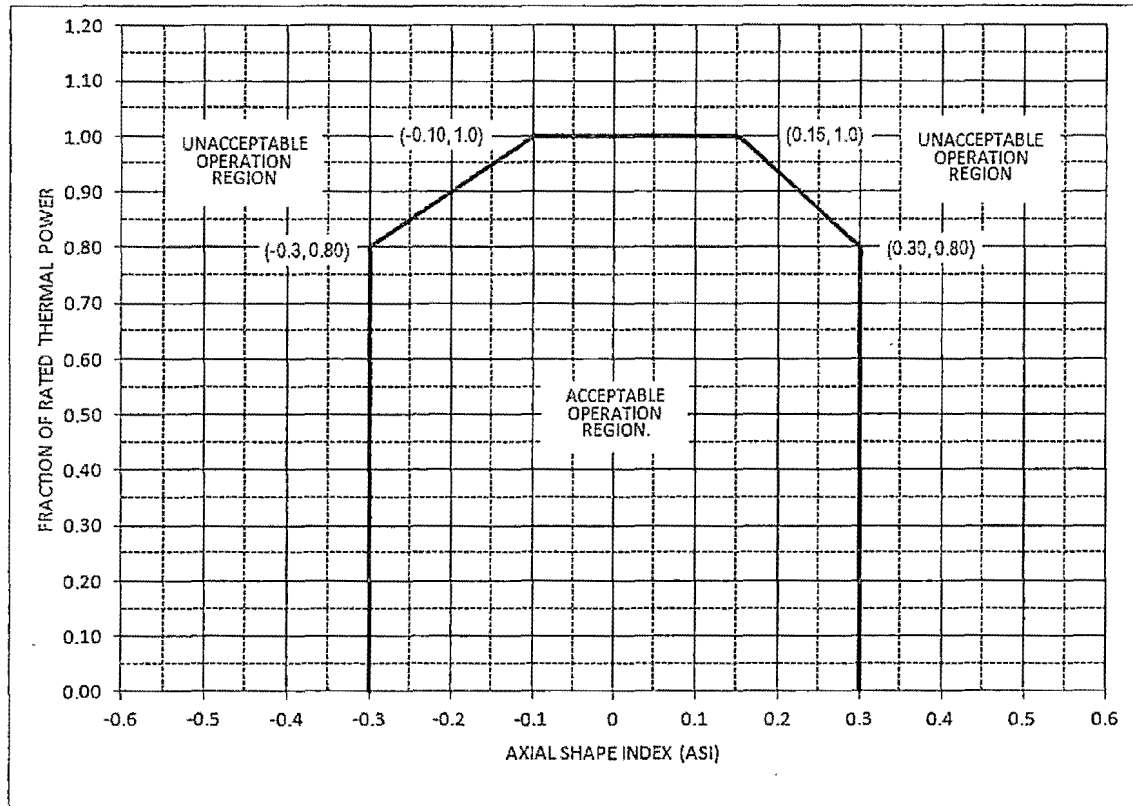


Figure 2.7-1  
AXIAL SHAPE INDEX Operating Limits With  
Four Reactor Coolant Pumps Operating