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*A Member of the
Constellation Energy Group*

March 7, 2000

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit No. 1; Docket No. 50-317
Cycle 14, Core Operating Limits Report, Revision 5

Pursuant to Calvert Cliffs Nuclear Power Plant Technical Specification 5.6.5, the attached Revision 5 to the Unit 1, Cycle 14, Core Operating Limits Report is provided for your records.

Please replace the Unit 1 Core Operating Limits Report in its entirety, with the attached Revision 5.

Should you have questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,

A handwritten signature in black ink, appearing to read 'Charles H. Cruse', is written over a horizontal line. The signature is fluid and cursive.

CHC/DJM/bjd

Attachment: As Stated

cc: R. S. Fleishman, Esquire
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A001

CALVERT CLIFFS NUCLEAR POWER PLANT

CORE OPERATING LIMITS REPORT

for

UNIT 1, CYCLE 14

REVISION 5

Timothy A. Scheaver 2/19/00

RESPONSIBLE ENGINEER / DATE

J. Naushkin 2/20/2000

INDEPENDENT REVIEWER / DATE

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PRINCIPAL ENGINEER - NEU / DATE

CORE OPERATING LIMITS REPORT
CALVERT CLIFFS UNIT 1, CYCLE 14

The following limits are included in this Core Operating Limits Report:

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INTRODUCTION

This report provides the cycle-specific limits for operation of Calvert Cliffs Unit 1, Cycle 14. It contains the limits for:

- Shutdown Margin (SDM)
- Moderator Temperature Coefficient (MTC)
- Control Element Assembly (CEA) Alignment
- Regulating Control Element Assembly (CEA) Insertion Limits
- Linear Heat Rate (LHR)
- Total Planar Radial Peaking Factor (F_{xy}^T)
- Total Integrated Radial Peaking Factor (F_r^T)
- Axial Shape Index (ASI)
- Reactor Protective System (RPS) Instrumentation - Operating
- Boron Concentration

In addition, this report contains a number of figures which give limits on the parameters listed above. If any of the limits contained in this report are exceeded, corrective action will be taken as defined in the Technical Specifications.

This report has been prepared in accordance with the requirements of Technical Specifications. The cycle specific limits have been developed using the NRC-approved methodologies given in the "List of Approved Methodologies" section of this report and in the Technical Specifications.

COLR Revision 0

COLR Revision 0 was issued to support Unit 1 Cycle 14 Operation in Modes 6 and 5. Safety Evaluation SE00278 Rev. 0000 provided for this revision.

COLR Revision 1

COLR Revision 1 was issued to support Unit 1 Cycle 14 Operation in All Modes of Operation. Safety Evaluation SE00294 Rev. 0000 provided for this revision.

COLR Revision 2

COLR Revision 2 was issued to increase the F_{xy}^T and F_r^T limits to 1.70 for (up to) the first 1000 MWd/MTU of Cycle 14. This revision encompasses all values dependent upon these limits. Safety Evaluation SE00295 Rev. 0000 provided for this revision.

COLR Revision 3

COLR Revision 3 was issued to restore the F_{xy}^T and F_r^T limits to 1.67. This revision encompasses all values dependent upon these limits. Safety Evaluation SE00295 Rev. 0000 provided for this revision.

COLR Revision 4

Revision 4 to the Unit 1 Cycle 14 COLR implements changes associated with the approval and implementation of the Improved Technical Specifications (ITS). This revision constitutes a complete rerelease of the COLR without revision marks.

COLR Revision 5

Revision 5 implements two changes to the requirements for Refueling Boron Concentration. U1C14 has accumulated sufficient cycle burnup to now eliminate the requirement to credit the negative reactivity worth of 44 CEAs during the end-of-cycle core offload. Additionally, Issue Report IR3-022-300 will be resolved by restoring information to the COLR on assumed calculational uncertainties that was inadvertently deleted several cycles ago. Safety Evaluation SE00278 Rev. 0002 provided justification for this COLR revision.

DEFINITIONS

Axial Shape Index (ASI)

ASI shall be the power generated in the lower half of the core less the power generated in the upper half of the core, divided by the sum of the power generated in the lower and upper halves of the core.

$$\text{ASI} = \frac{\text{lower} - \text{upper}}{\text{lower} + \text{upper}} = Y_E$$

The Axial Shape Index (Y_I) used for the trip and pretrip signals in the Reactor Protection System (RPS) is the above value (Y_E) modified by an appropriate multiplier (A) and a constant (B) to determine the true core axial power distribution for that channel.

$$Y_I = AY_E + B$$

Total Integrated Radial Peaking Factor - F_r^T

The Total Integrated Radial Peaking Factor is the ratio of the peak pin power to the average pin power in an unrodded core.

Total Planar Radial Peaking Factor - F_{xy}^T

The Total Planar Radial Peaking Factor is the maximum ratio of the peak to average power density of the individual fuel rods in any of the unrodded horizontal planes.

CYCLE SPECIFIC LIMITS FOR UNIT 1, CYCLE 14

3.1.1 Shutdown Margin (SDM) (SR 3.1.1.1)

T_{avg} > 200 °F - Modes 3 and 4:

The shutdown margin shall be equal to or greater than the limit line of COLR Figure 3.1.1.

T_{avg} ≤ 200 °F - Mode 5:

The shutdown margin shall be $\geq 3.0\% \Delta\rho$.

3.1.3 Moderator Temperature Coefficient (MTC) (SR 3.1.3.2)

The Moderator Temperature Coefficient (MTC) shall be less negative than $-3.0 \times 10^{-4} \Delta\rho/^\circ\text{F}$ at rated thermal power.

3.1.4 Control Element Assembly (CEA) Alignment (Action 3.1.4.B.1)

The allowable time to realign a CEA may be provided by the full core power distribution monitoring system (Better Axial Shape Selection System - BASSS) or COLR Figure 3.1.4, "Allowable Time to Realign CEA Versus Initial Total Integrated Radial Peaking Factor (F_r^T)."

If COLR Figure 3.1.4 is used, the pre-misaligned F_r^T value used to determine the allowable time to realign the CEA shall be the latest measurement taken within 5 days prior to the CEA misalignment. If no measurements have been taken within 5 days prior to the misalignment and the full core power distribution monitoring system is unavailable then the time to realign is zero (0) minutes.

3.1.6 Regulating Control Element Assembly (CEA) Insertion Limits (SR 3.1.6.1 and SR 3.1.6.2)

The regulating CEA groups insertion limits are shown on COLR Figure 3.1.6.

3.2.1 Linear Heat Rate (LHR) (SR 3.2.1.2 and SR 3.2.1.4)

The linear heat rate shall not exceed the limits shown on COLR Figure 3.2.1-1.

The axial shape index power dependent control limits are given in COLR Figure 3.2.1-2.

When using the excore detector monitoring system (SR 3.2.1.2):

The alarm setpoints are equal to the ASI limits, therefore when the alarms are adjusted, they provide indication to the operator that ASI is not within the limits.

The maximum allowable fraction of rated thermal power vs. F_{xy}^T is shown in COLR Figure 3.2.1-3.

The axial shape index alarm setpoints are shown on COLR Figure 3.2.1-2.

When using the incore detector monitoring system (SR 3.2.1.4):

The alarm setpoints are adjusted to protect the Linear Heat Rate limits shown on COLR Figure 3.2.1-1 and uncertainty factors are appropriately included in the setting of these alarms.

CYCLE SPECIFIC LIMITS FOR UNIT 1, CYCLE 14

The uncertainty factors for the incore detector monitoring system are:

1. A measurement-calculational uncertainty factor of 1.062,
2. An engineering uncertainty factor of 1.03,
3. A linear heat rate uncertainty factor of 1.002 due to axial fuel densification and thermal expansion, and
- 4.a For measured thermal power less than or equal to 50 percent but greater than 20 percent of rated full core power a thermal power measurement uncertainty factor of 1.035.
- 4.b For measured thermal power greater than 50 percent of rated full core power a thermal power measurement uncertainty factor of 1.020.

3.2.2 Total Planar Radial Peaking Factor (F_{xy}^T) (SR 3.2.1.1 and SR 3.2.2.1)

The calculated value of F_{xy}^T shall be limited to ≤ 1.67 .

The allowable combination of thermal power and F_{xy}^T are shown on COLR Figure 3.2.2.

3.2.3 Total Integrated Radial Peaking Factor (F_r^T) (SR 3.2.3.1)

The calculated value of F_r^T shall be limited to ≤ 1.67 .

The allowable combinations of thermal power and F_r^T are shown on COLR Figure 3.2.3.

3.2.5 Axial Shape Index (ASI) (SR 3.2.5.1)

The axial shape index and thermal power shall be maintained within the limits established by the Better Axial Shape Selection System (BASSS) for CEA insertions of the lead bank of < 55% when BASSS is operable, or within the limits of COLR Figure 3.2.5 for CEA insertions specified by COLR Figure 3.1.6.

3.3.1 Reactor Protective System (RPS) Instrumentation - Operating (Reactor Trip Setpoints) (TS Table 3.3.1-1)

The Axial Power Distribution - High trip setpoint and allowable values are given in COLR Figure 3.3.1-1.

The Thermal Margin/Low Pressure (TM/LP) trip setpoint is given in COLR Figures 3.3.1-2 and 3.3.1-3. The allowable values are to be not less than the larger of (1) 1875 psia or (2) the value calculated from COLR Figures 3.3.1-2 and 3.3.1-3.

3.9.1 Boron Concentration (SR 3.9.1.1)

The refueling boron concentration will maintain the K_{eff} at 0.95 or less (including a 1% $\Delta K/K$ conservative allowance for uncertainties).

The refueling boron concentration shall be maintained uniform and sufficient to ensure that the boron concentration is > 2308 ppm. (See NEOP-13 for the refueling boron concentration Administrative Limit which includes additional conservatism). This refueling boron concentration credits zero control element assemblies and a boron concentration at 19.8 a/o B¹⁰.

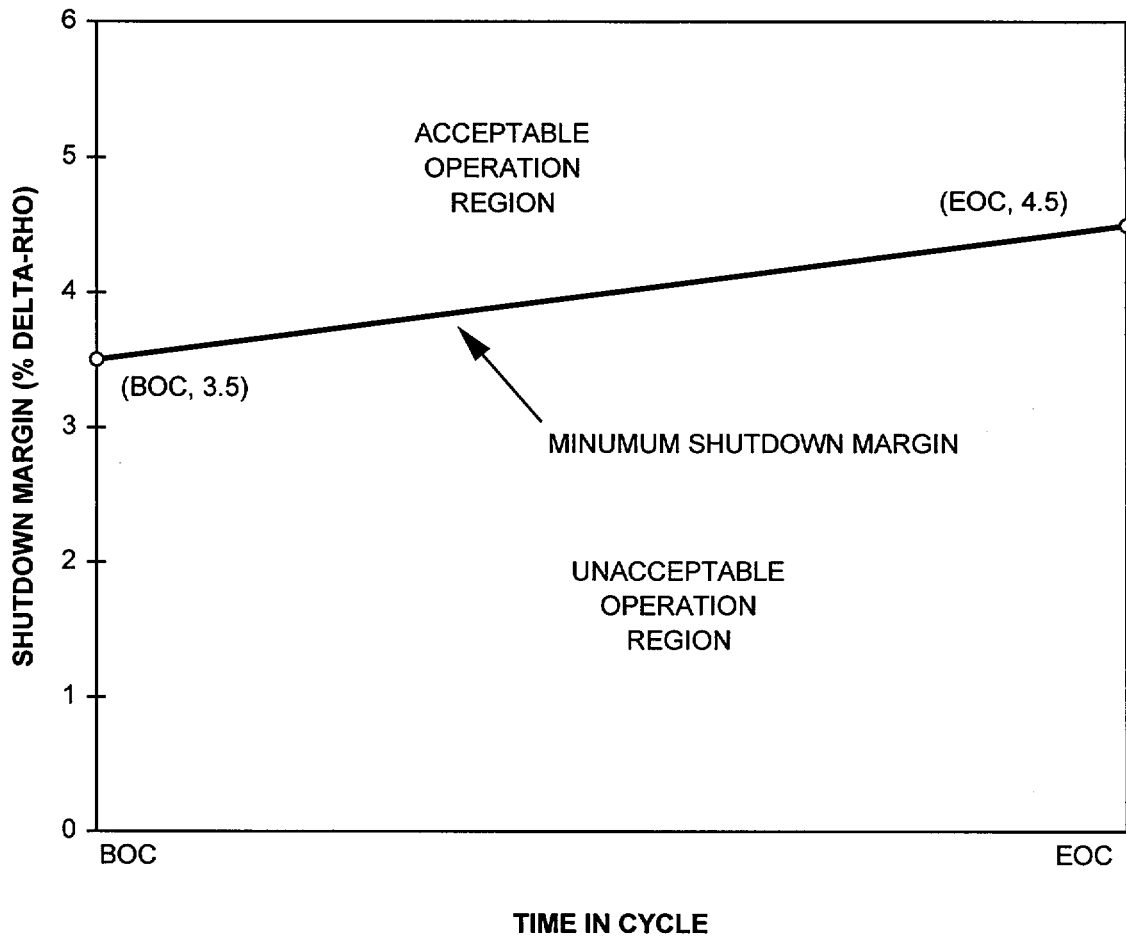


Figure 3.1.1
Shutdown Margin vs. Time in Cycle

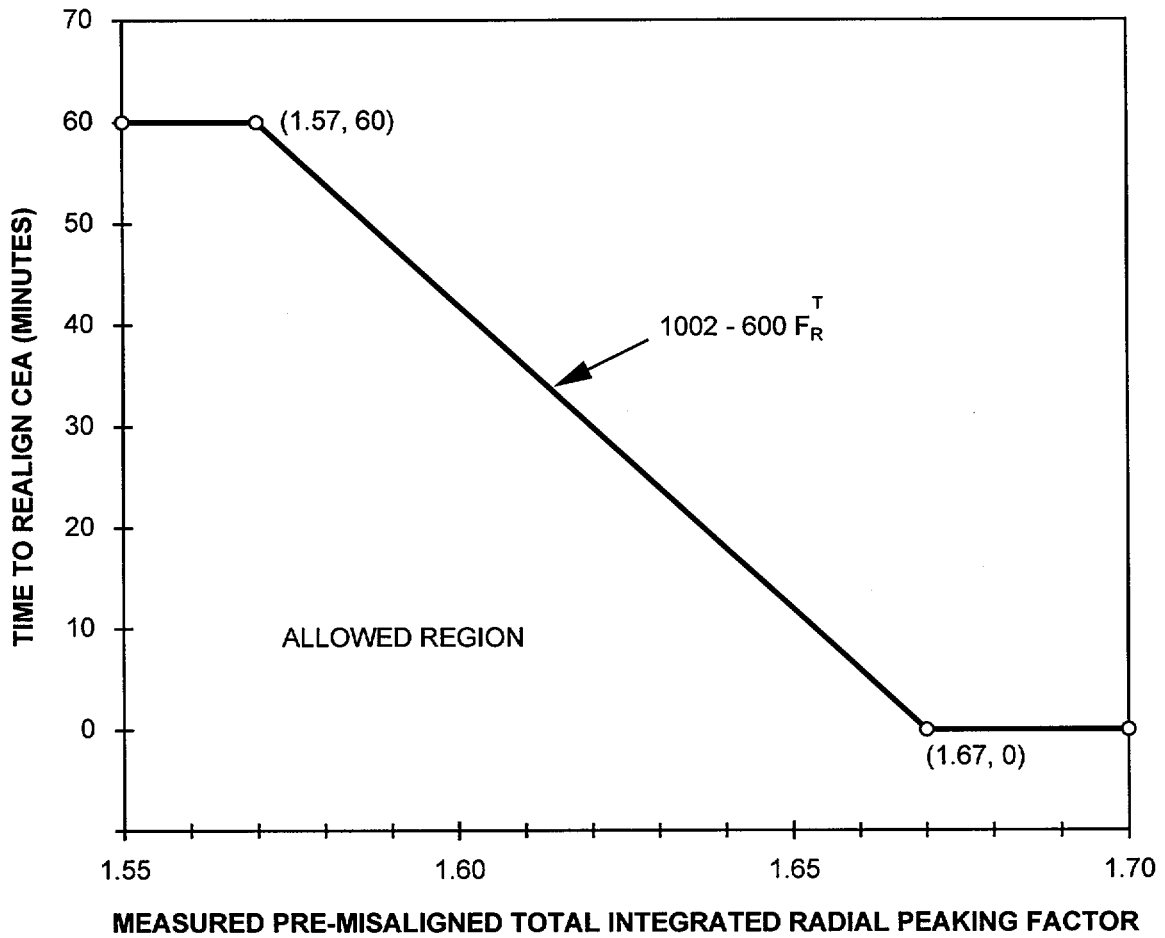


Figure 3.1.4
Allowable Time to Realign CEA Versus
Initial Total Integrated Radial Peaking Factor (F_R^T)

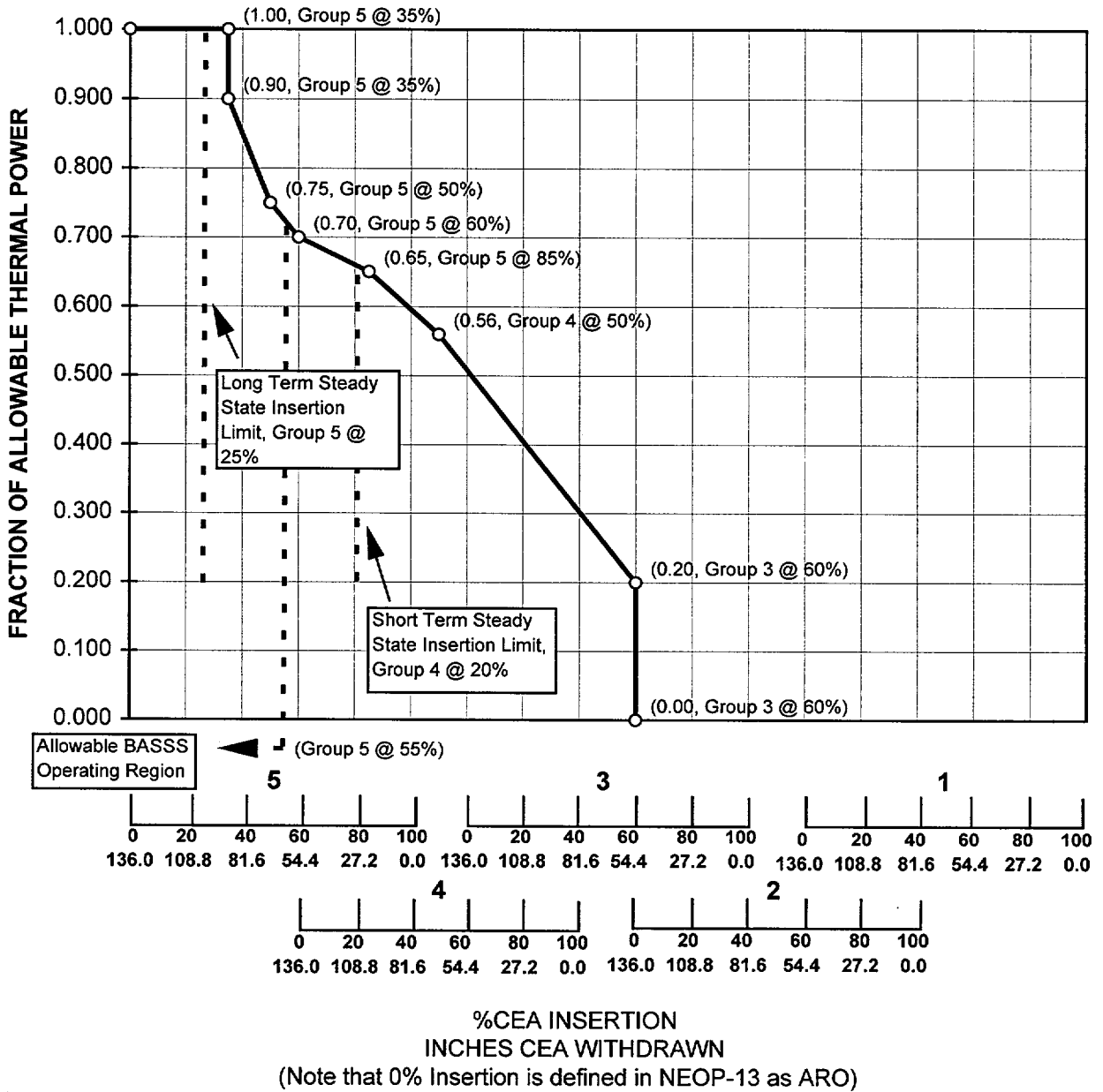


Figure 3.1.6

CEA Group Insertion Limits vs. Fraction of Rated Thermal Power

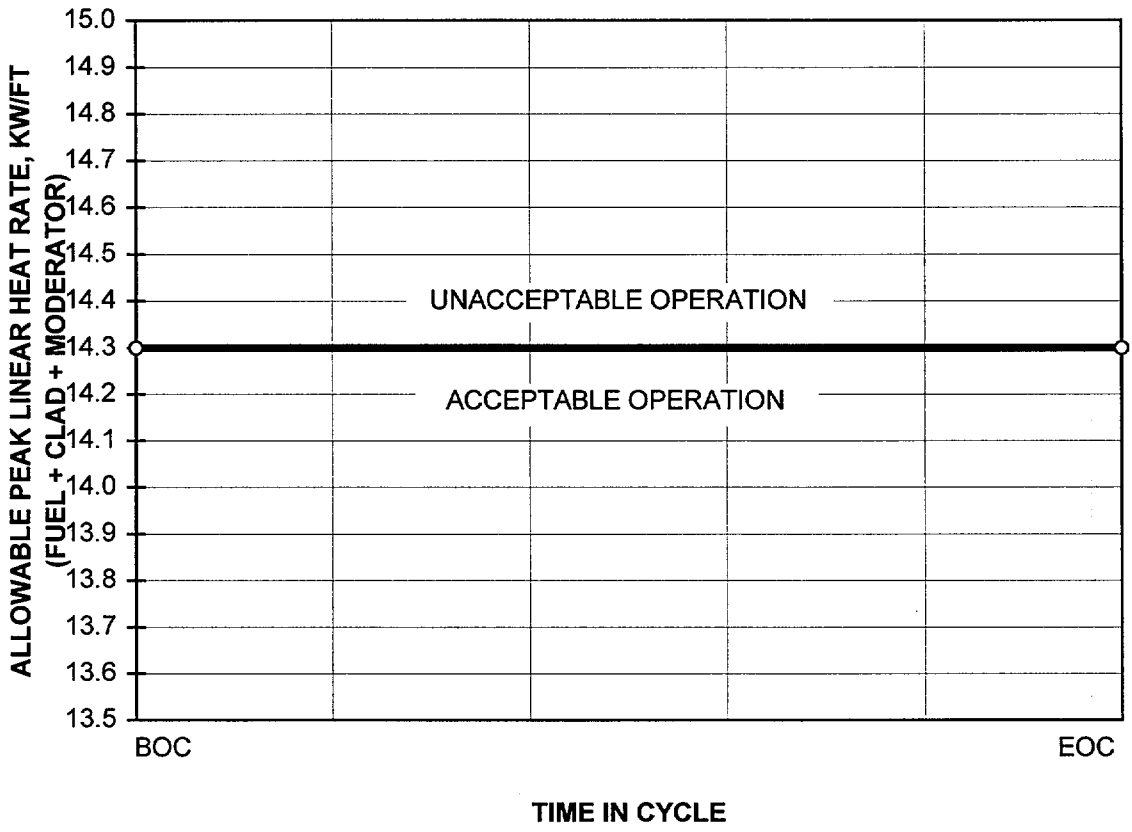


Figure 3.2.1-1
Allowable Peak Linear Heat Rate vs. Time in Cycle

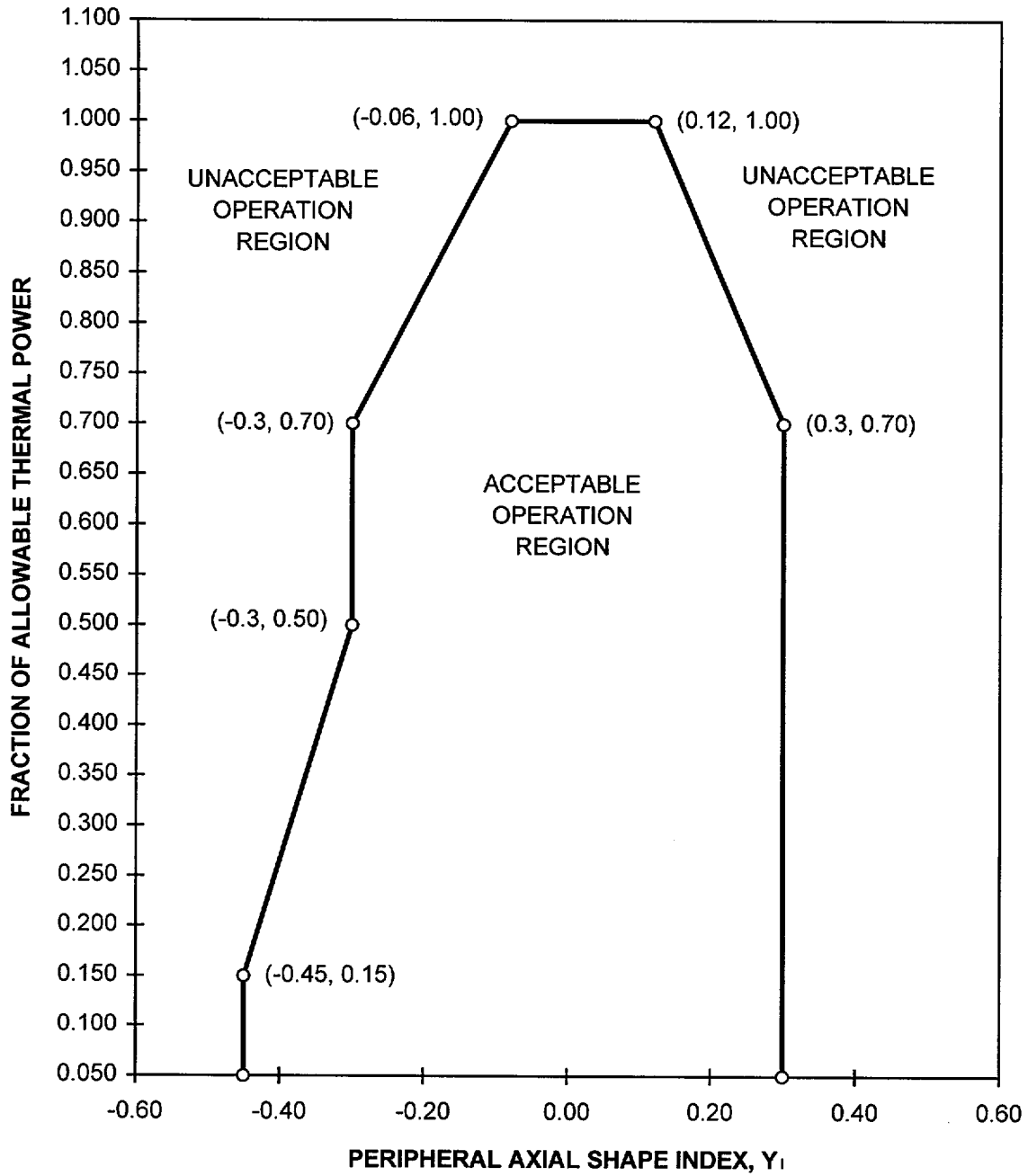


Figure 3.2.1-2
Linear Heat Rate Axial Flux Offset Control Limits

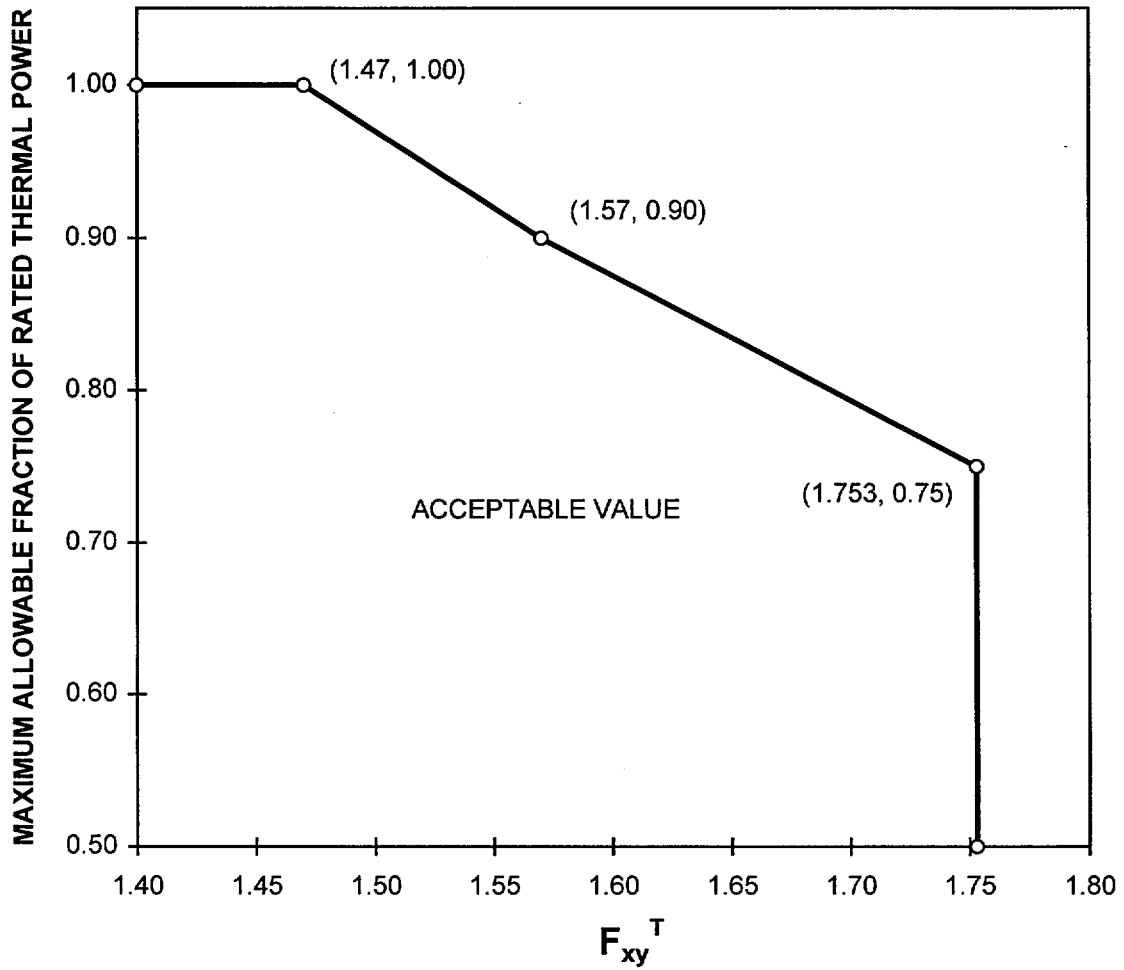


Figure 3.2.1-3

**Total Planar Radial Peaking Factor (F_{xy}^T) vs.
Maximum Allowable Fraction of Rated Thermal Power**

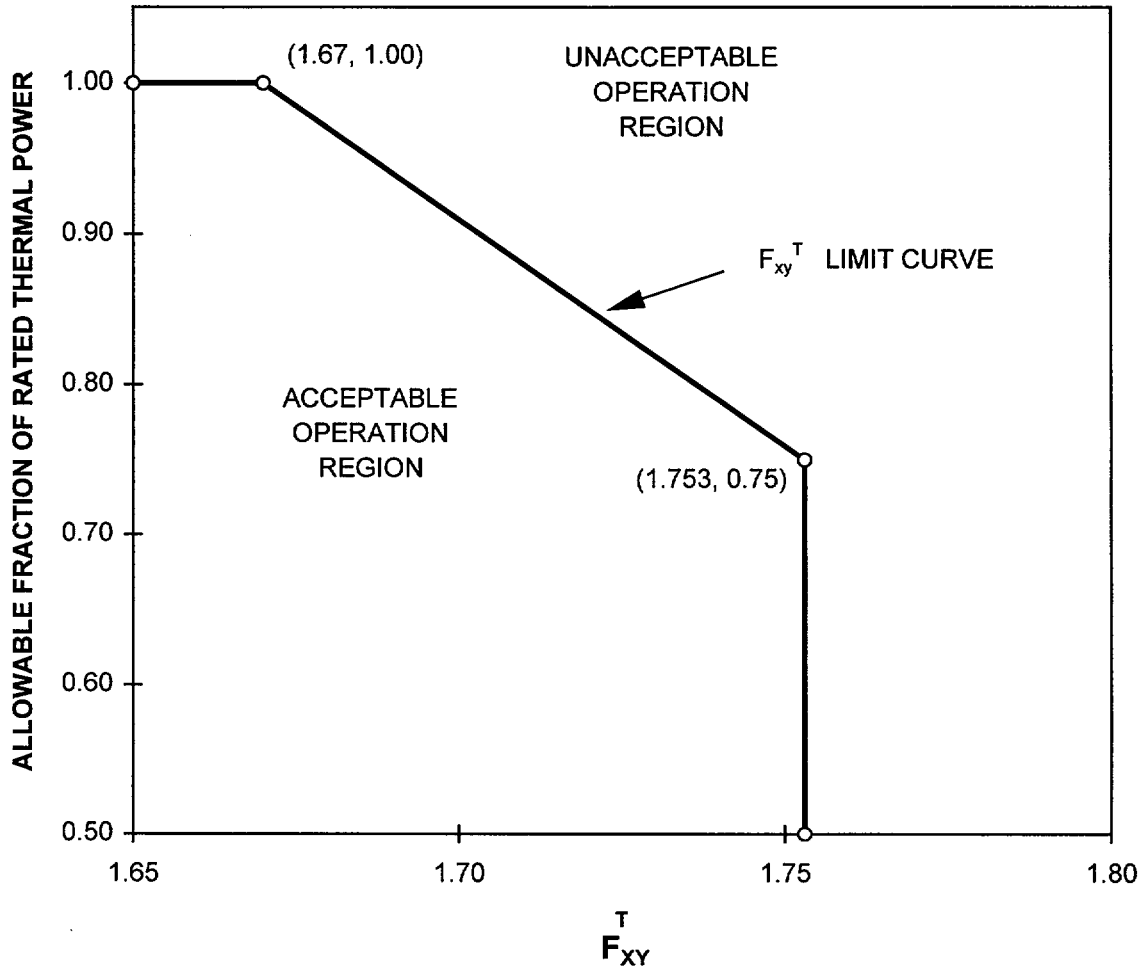


Figure 3.2.2

Total Planar Radial Peaking Factor (F_{xy}^T) vs. Allowable Fraction of Rated Thermal Power

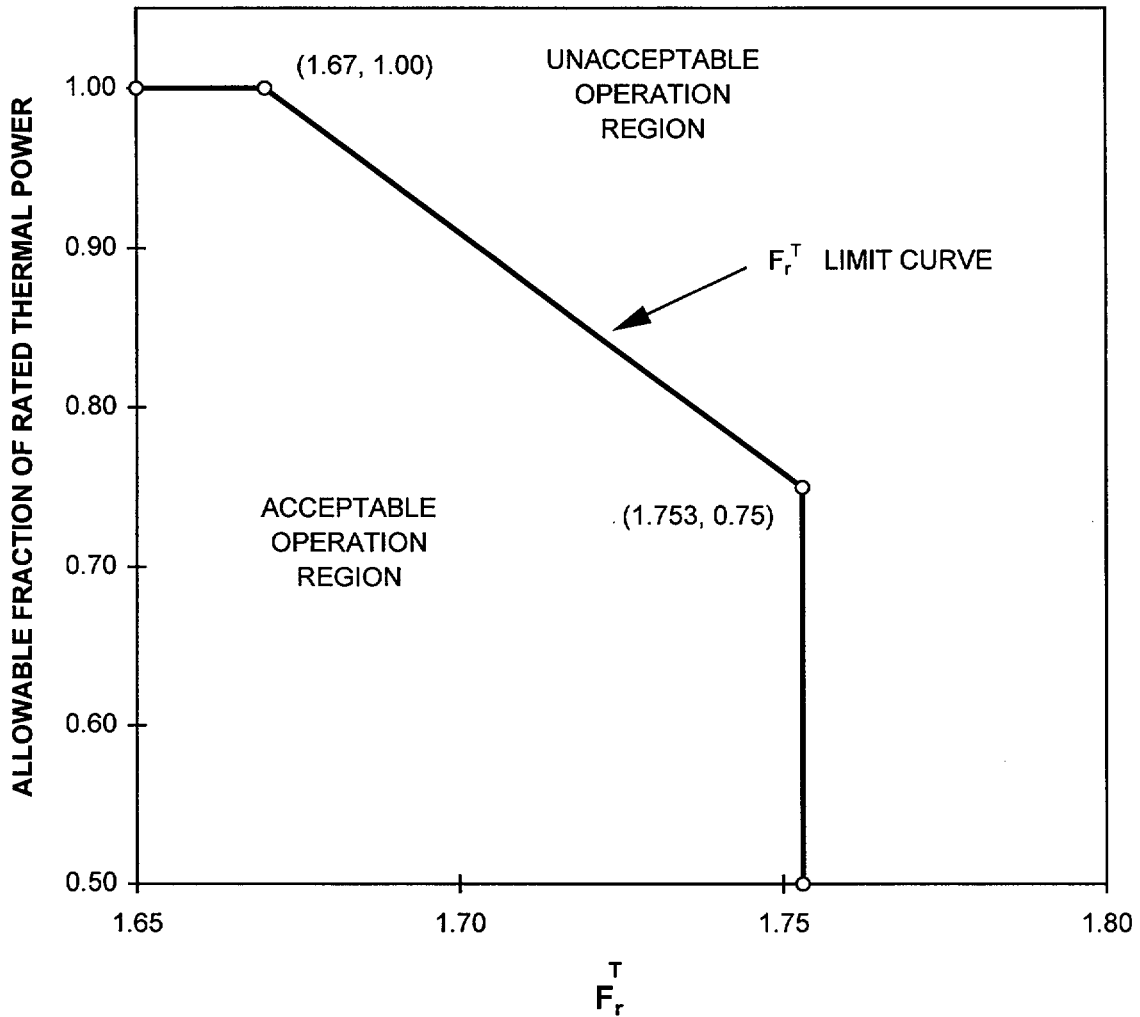


Figure 3.2.3

Total Integrated Radial Peaking Factor (F_r^T) vs.
Allowable Fraction of Rated Thermal Power

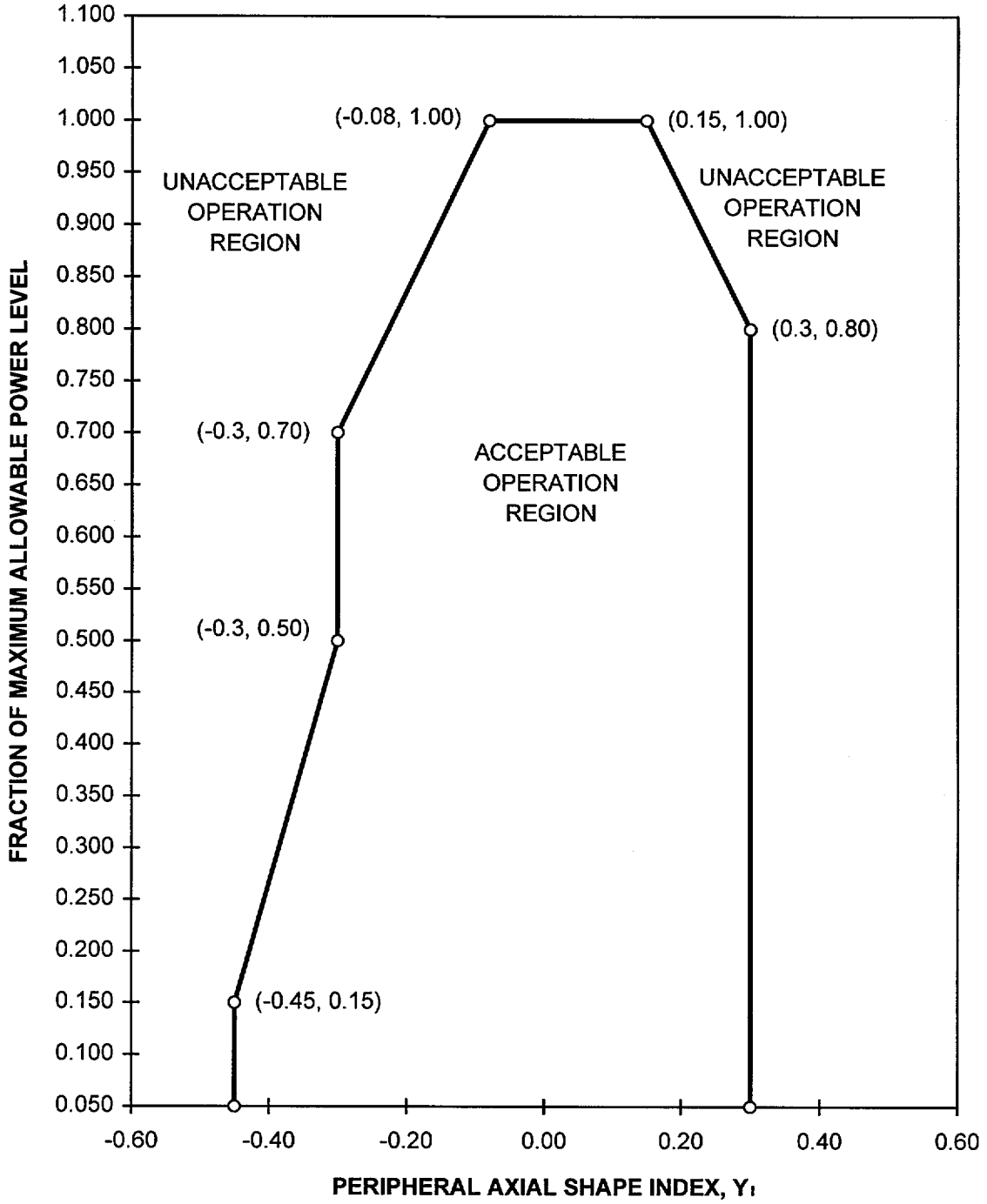


Figure 3.2.5
DNB Axial Flux Offset Control Limits

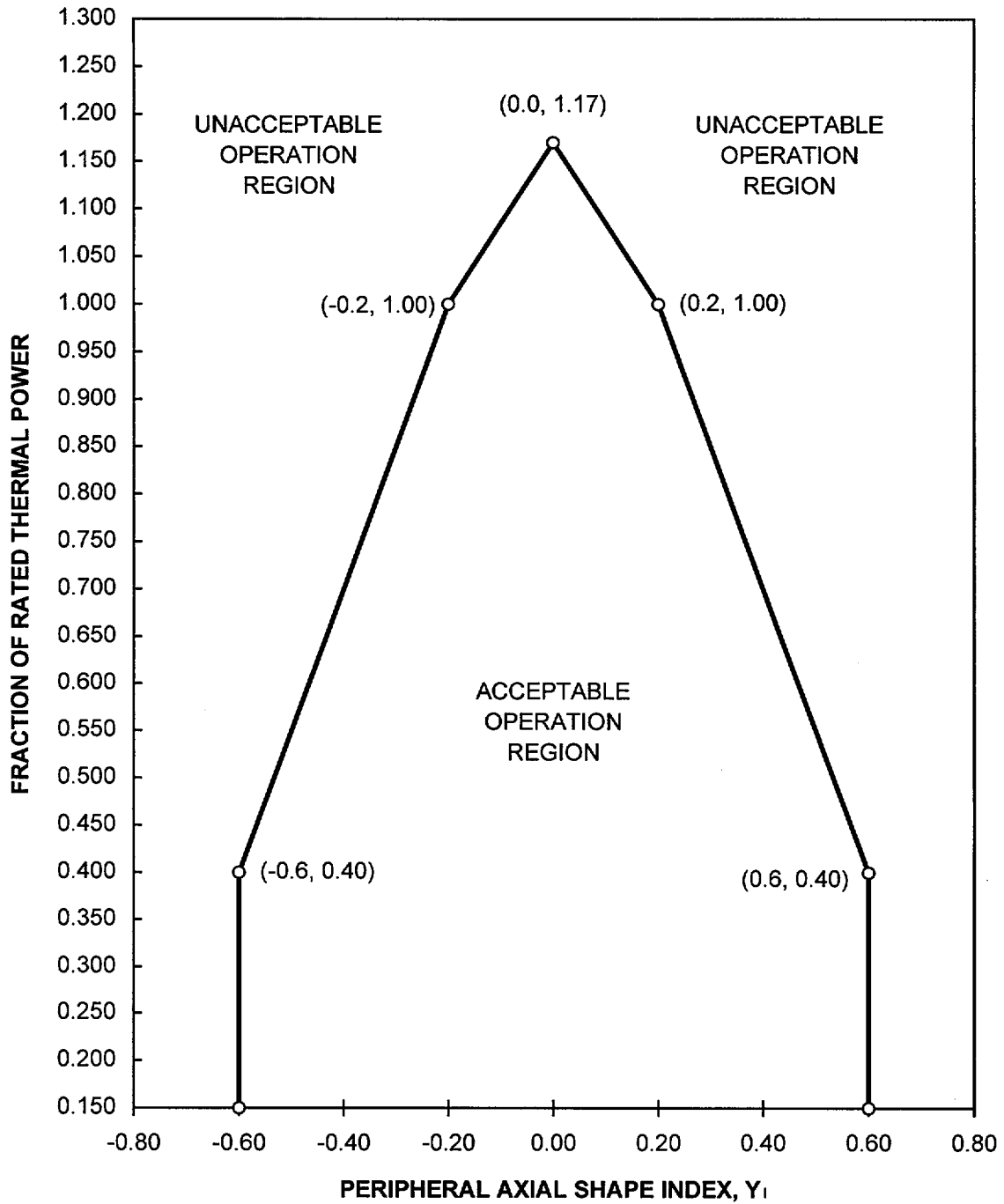


Figure 3.3.1-1

**Axial Power Distribution - High Trip Setpoint
Peripheral Axial Shape Index vs. Fraction of Rated Thermal Power**

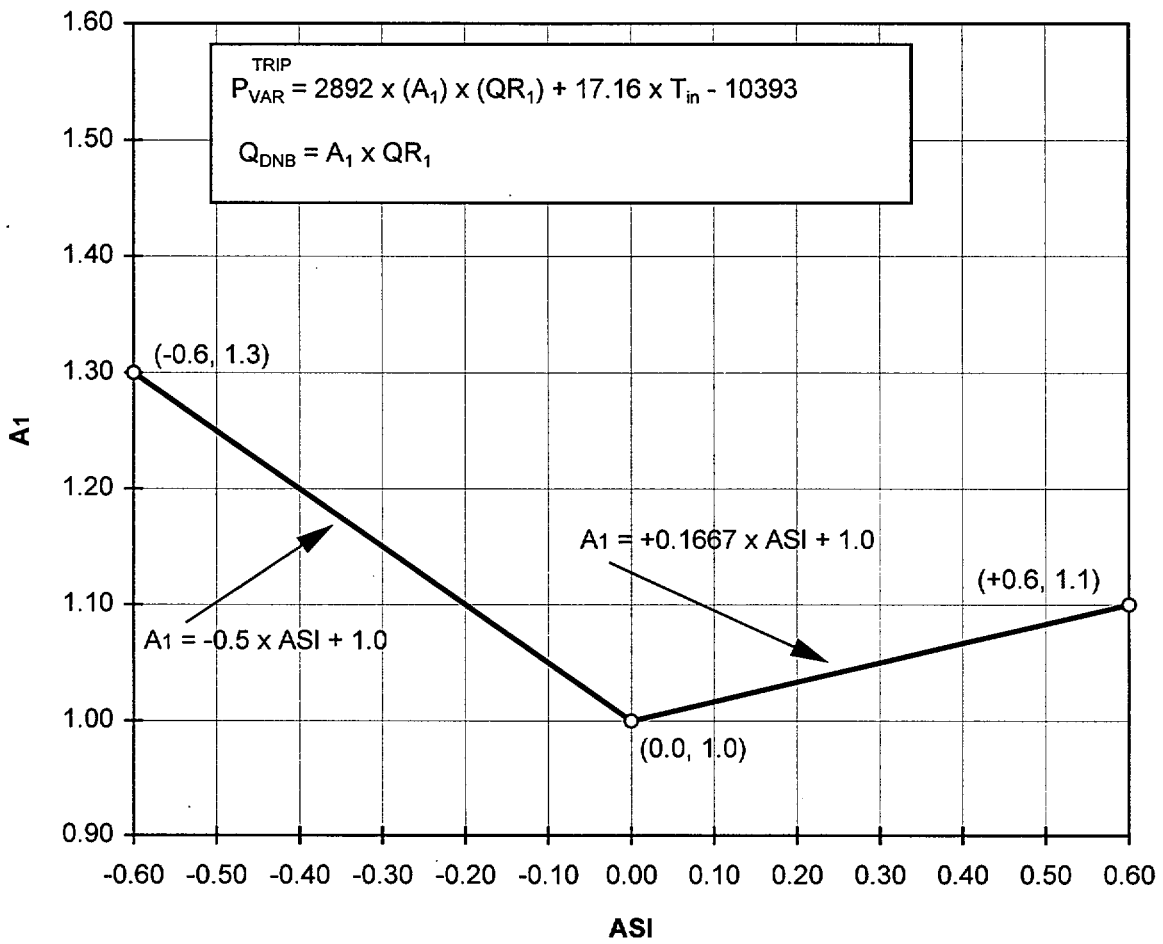


Figure 3.3.1-2
Thermal Margin/Low Pressure Trip Setpoint - Part 1
(ASI vs. A₁)

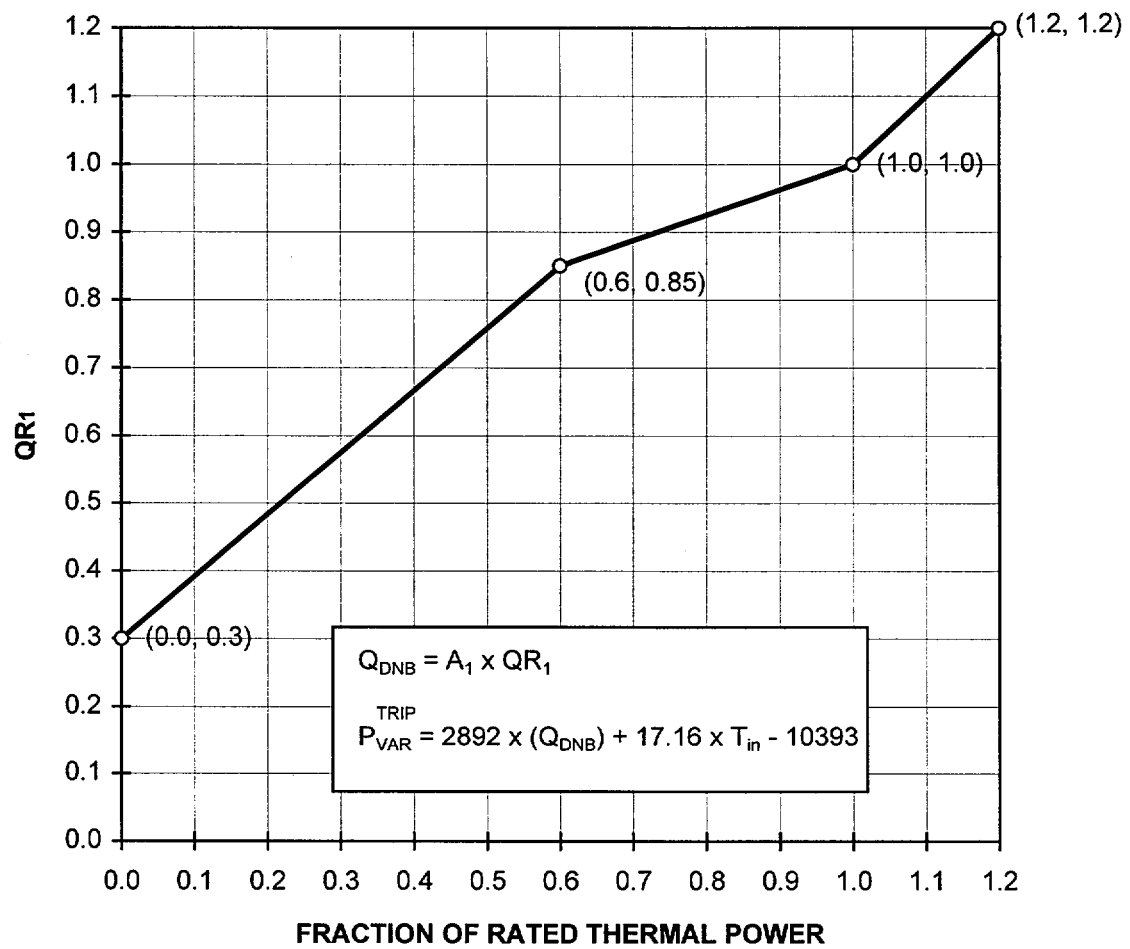


Figure 3.3.1-3

Thermal Margin/Low Pressure Trip Setpoint - Part 2
(Fraction of Rated Thermal Power vs. QR₁)

LIST OF APPROVED METHODOLOGIES

- (1) CENPD-199-P, Rev 1-P-A, "C-E Setpoint Methodology: C-E Local Power Density and DNB LSSS and LCO Setpoint Methodology for Analog Protection Systems," January 1986 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.2.5)
- (2) CEN-124(B)-P, "Statistical Combination of Uncertainties Methodology Part 1: C-E Calculated Local Power Density and Thermal Margin/Low Pressure LSSS for Calvert Cliffs Units I and II," December 1979 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.2, 3.2.3)
- (3) CEN-124(B)-P, "Statistical Combination of Uncertainties Methodology Part 2: Combination of System Parameter Uncertainties in Thermal Margin Analyses for Calvert Cliffs Units 1 and 2," January 1980 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)
- (4) CEN-124(B)-P, "Statistical Combination of Uncertainties Methodology Part 3: C-E Calculated Departure from Nucleate Boiling and Linear Heat Rate Limiting Conditions for Operation for Calvert Cliffs Units 1 and 2," March 1980 (Methodology for Specifications 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.2.5)
- (5) CEN-191(B)-P, "CETOP-D Code Structure and Modeling Methods for Calvert Cliffs Units 1 and 2," December 1981 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)
- (6) Letter from Mr. D. H. Jaffe (NRC) to Mr. A. E. Lundvall, Jr. (BG&E), dated June 24, 1982, Unit 1 Cycle 6 License Approval (Amendment No. 71 to DPR-53 and SER) [Approval to CEN-124(B)-P (three parts) and CEN-191(B)-P]
- (7) CEN-348(B)-P, "Extended Statistical Combination of Uncertainties," January 1987 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)
- (8) Letter from Mr. S. A. McNeil, Jr. (NRC) to Mr. J. A. Tiernan (BG&E), dated October 21, 1987, Docket Nos. 50-317 and 50-318, "Safety Evaluation of Topical Report CEN-348(B)-P, Extended Statistical Combination of Uncertainties"
- (9) CENPD-161-P-A, "TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core," April 1986 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)
- (10) CENPD-162-P-A, "Critical Heat Flux Correlation of C-E Fuel Assemblies with Standard Spacer Grids Part 1, Uniform Axial Power Distribution," April 1975 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)
- (11) CENPD-207-P-A, "Critical Heat Flux Correlation for C-E Fuel Assemblies with Standard Spacer Grids Part 2, Non-Uniform Axial Power Distribution," December 1984 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)
- (12) CENPD-206-P-A, "TORC Code, Verification and Simplified Modeling Methods," June 1981 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)
- (13) CENPD-225-P-A, "Fuel and Poison Rod Bowing," June 1983 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.3, 3.2.5)

- (14) CENPD-266-P-A, "The ROCS and DIT Computer Code for Nuclear Design," April 1983 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.2.5)
- (15) CENPD-275-P-A, "C-E Methodology for Core Designs Containing Gadolinia - Urania Burnable Absorbers," May 1988 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.2.5)
- (16) CENPD-382-P-A, "Methodology for Core Designs Containing Erbium Burnable Absorbers," August 1993 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.2.5)
- (17) CENPD-139-P-A, "C-E Fuel Evaluation Model Topical Report," July 1974 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2)
- (18) CEN-161-(B)-P-A, "Improvements to Fuel Evaluation Model," August 1989 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2)
- (19) CEN-161-(B)-P, Supplement 1-P, "Improvements to Fuel Evaluation Model," April 1986 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2)
- (20) Letter from Mr. S. A. McNeil, Jr. (NRC) to Mr. J. A. Tiernan (BG&E), dated February 4, 1987, Docket Nos. 50-317 and 50-318, "Safety Evaluation of Topical Report CEN-161-(B)-P, Supplement 1-P, Improvements to Fuel Evaluation Model" (Approval of CEN-161(B), Supplement 1-P)
- (21) CEN-372-P-A, "Fuel Rod Maximum Allowable Gas Pressure," May 1990 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2)
- (22) Letter from Mr. A. E. Scherer (CE) to Mr. J. R. Miller (NRC) dated December 15, 1981, LD-81-095, Enclosure 1-P, "C-E ECCS Evaluation Model Flow Blockage Analysis" (Methodology for Specifications 3.2.1, 3.2.2)
- (23) CENPD-132, Supplement 3-P-A, "Calculative Methods for the C-E Large Break LOCA Evaluation Model for the Analysis of C-E and W Designed NSSS," June 1985 (Methodology for Specifications 3.2.1, 3.2.2 and approval of Letter LD-81-095, dated December 15, 1981)
- (24) CENPD-133, Supplement 5, "CEFLASH-4A, a FORTRAN77 Digital Computer Program for Reactor Blowdown Analysis," June 1985 (Methodology for Specifications 3.2.1, 3.2.2)
- (25) CENPD-134, Supplement 2, "COMPERC-II, a Program for Emergency Refill-Reflood of the Core," June 1985 (Methodology for Specifications 3.2.1, 3.2.2)
- (26) Letter from Mr. D. M. Crutchfield (NRC) to Mr. A. E. Scherer (CE), dated July 31, 1986, "Safety Evaluation of Combustion Engineering ECCS Large Break Evaluation Model and Acceptance for Referencing of Related Licensing Topical Reports (Approval of CENPD-133, Supplement 5 and CENPD-134, Supplement 2)
- (27) CENPD-135, Supplement 5-P, "STRIKIN-II, A Cylindrical Geometry Fuel Rod Heat Transfer Program," April 1977 (Methodology for Specifications 3.2.1, 3.2.2)

- (28) Letter from Mr. R. L. Baer (NRC) to Mr. A. E. Scherer (CE) dated September 6, 1978, "Evaluation of Topical Report CENPD-135, Supplement 5"
- (29) CENPD-137, Supplement 1-P, "Calculative Methods for the C-E Small Break LOCA Evaluation Model," January 1977 (Methodology for Specifications 3.2.1, 3.2.2)
- (30) CENPD-133, Supplement 3-P, "CEFLASH-4AS, "A Computer Program for the Reactor Blowdown Analysis of the Small Break Loss of Coolant Accident," January 1977 (Methodology for Specifications 3.2.1, 3.2.2)
- (31) Letter from Mr. K. Kniel (NRC) to Mr. A. E. Scherer (CE), dated September 27, 1977, "Evaluation of Topical Reports CENPD-133, Supplement 3-P and CENPD-137, Supplement 1-P"
- (32) CENPD-138, Supplement 2-P, "PARCH, A FORTRAN-IV Digital Program to Evaluate Pool Boiling, Axial Rod and Coolant Heatup," January 1977 (Methodology for Specifications 3.2.1, 3.2.2)
- (33) Letter from Mr. C. Aniel (NRC) to Mr. A. E. Scherer, dated April 10, 1978. "Evaluation of Topical Report CENPD-138, Supplement 2-P"
- (34) Letter from Mr. A. E. Lundvall, Jr. (BG&E) to Mr. J. R. Miller (NRC) dated February 22, 1985, "Calvert Cliffs Nuclear Power Plant Unit 1; Docket No. 50-317, Amendment to Operating License DPR-53, Eighth Cycle License Application" (Section 7.3.2 contains Methodology for Specifications 3.1.1 and 3.1.3 and 3.1.6)
- (35) Letter from Mr. D. H. Jaffe (NRC) to Mr. A. E. Lundvall, Jr. (BG&E), dated May 20, 1985, "Safety Evaluation Report Approving Unit 1 Cycle 8 License Application"
- (36) Letter from Mr. A. E. Lundvall, Jr. (BG&E) to Mr. R. A. Clark (NRC), dated September 22, 1980, "Amendment to Operating License No. 50-317, Fifth Cycle License Application" (Section 7.1.2 contains Methodology for Specifications 3.1.1, 3.9.1)
- (37) Letter from Mr. R. A. Clark (NRC) to Mr. A. E. Lundvall, Jr. (BG&E), dated December 12, 1980, "Safety Evaluation Report Approving Unit 1, Cycle 5 License Application"
- (38) Letter from Mr. J. A. Tiernan (BG&E) to Mr. A. C. Thadani (NRC), dated October 1, 1986, "Calvert Cliffs Nuclear Power Plant Unit Nos. 1 & 2, Docket Nos. 50-317 & 50-318, Request for Amendment" (Methodology for Specifications 3.1.4)
- (39) Letter from S. A. McNeil, Jr. (NRC) to Mr. J. A. Tiernan (BG&E), dated July 7, 1987, Docket Nos. 50-317 and 50-318, Approval of Amendments 127 (Unit 1) and 109 (Unit 2) (Support for Specification 3.1.4)
- (40) CENPD-188-A, "HERMITE: A Multi-Dimensional Space-Time Kinetics Code for PWR Transients," July 1976 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.2.5)

- (41) The power distribution monitoring system referenced in various specifications and the BASES, is described in the following documents:
- i. CENPD-153-P, Revision 1-P-A, "Evaluation of Uncertainty in the Nuclear Power Peaking Measured by the Self-Powered, Fixed Incore Detector System," May 1980 (Methodology for Specifications 3.3.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.2.5)
 - ii. CEN-119(B)-P, "BASSS, Use of the Incore Detector System to Monitor the DNB-LCO on Calvert Cliffs Unit 1 and Unit 2," November 1979 (Referenced in Appendix B of Unit 2 Cycle 9 License Application)
 - iii. Letter from Mr. G. C. Creel (BG&E) to NRC Document Control Desk, dated February 7, 1989, "Calvert Cliffs Nuclear Power Plant Unit No. 2; Docket No. 50-318, Request for Amendment, Unit 2 Ninth Cycle License Application" (Appendix B contains Methodologies for Specifications 3.1.4, 3.2.2, 3.2.3, 3.2.5)
 - iv. Letter from Mr. S. A. McNeil, Jr. (NRC) to Mr. G. C. Creel (BG&E), dated January 10, 1990, "Safety Evaluation Report Approving Unit 2 Cycle 9 License Application"
- (42) Letter from Mr. D. G. McDonald, Jr. (NRC) to Mr. R. E. Denton (BGE), dated May 11, 1995, "Approval to Use Convolution Technique in Main Steam Line Break Analysis - Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (TAC Nos. M90897 and M90898)" (Methodology for Specification 3.2.3).