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2CAN050802

May 22, 2008

U. S. Nuclear Regulatory Commission
Attn.: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Revision 1 to the ANO-2 Cycle 20 COLR
Arkansas Nuclear One, Unit 2
Docket No. 50-368
License No. NPF-6

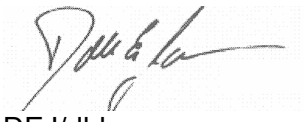
Dear Sir or Madam:

Arkansas Nuclear One – Unit 2 (ANO-2) Technical Specification 6.6.5 requires the submittal of the Core Operating Limits Report (COLR) for each reload cycle including any midcycle revisions or supplements. Attached is Revision 1 of the ANO-2 Cycle 20 COLR. This completes the reporting requirement for the referenced specification.

Figures 4 and 5, DNBR Margin Operating Limit Based on Core Protection Calculators (CPCs) Minimum 1 CEAC Operable and Both CEACs Inoperable, respectively, as well as Item V.9, 3.2.7 – Axial Shape Index (ASI), were revised to make the allowable CPC ASI range more restrictive on the positive side. The CPC ASI positive limit was changed to +0.18 to account for additional CPC ASI uncertainty introduced by the Shape Annealing matrix measurement.

This submittal contains no commitments. If you have any questions or require additional information, please contact me.

Sincerely,



DEJ/dbb

Attachment: ANO-2 Cycle 20 Core Operating Limits Report (COLR), Revision 1

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ATTACHMENT

2CAN050802

ANO-2 CYCLE 20 CORE OPERATING LIMITS REPORT (COLR), REVISION 1

ENTERGY OPERATIONS

ARKANSAS NUCLEAR ONE - UNIT 2

CORE OPERATING LIMITS REPORT

FOR CYCLE 20

CORE OPERATING LIMITS REPORT
FOR CYCLE 20

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ARKANSAS NUCLEAR ONE - UNIT 2

**CORE OPERATING LIMITS REPORT
FOR CYCLE 20**

I. INTRODUCTION

This CORE OPERATING LIMITS REPORT (COLR) has been prepared in accordance with the requirements of Arkansas Nuclear One - Unit 2 (ANO-2) Technical Specification 6.6.5 for ANO-2's Cycle 20. This is Revision 1 of the Cycle 20 COLR.

II. SUMMARY OF CHANGES

Listed below are the changes to the COLR from the latest revision of the Cycle 20 COLR.

- Figures 4 and 5, DNBR Margin Operating Limit Based on Core Protection Calculators, Minimum 1 CEAC Operable and Both CEACs Inoperable, respectively, as well as Item V.9, 3.2.7 – Axial Shape Index, were revised to make the allowable CPC ASI range more restrictive on the positive side. The CPC ASI positive limit was changed to +0.18 to account for additional CPC ASI uncertainty introduced by the Shape Annealing Matrix measurement.

III. AFFECTED TECHNICAL SPECIFICATIONS

1) 3.1.1.1 Shutdown Margin - $T_{avg} > 200°F$

2) 3.1.1.2 Shutdown Margin - $T_{avg} \leq 200°F$

3) 3.1.1.4 Moderator Temperature Coefficient

4) 3.1.3.1 CEA Position

5) 3.1.3.6 Regulating and Group P CEA Insertion Limits

6) 3.2.1 Linear Heat Rate

7) 3.2.3 Azimuthal Power Tilt - T_q

8) 3.2.4 DNBR Margin

9) 3.2.7 Axial Shape Index

IV. APPROVED METHODOLOGIES USED TO DETERMINE LIMITS

Provided below are the analytical methods used to determine the core operating limits addressed by the individual Technical Specifications. These methods have been reviewed and approved by the NRC.

1) "Qualification of the PHOENIX-P / ANC Nuclear Design System for Pressurized Water Reactor Cores," (WCAP-11596-P-A), June 1988, "ANC: A Westinghouse Advanced Nodal Computer Code" (WCAP-10965-P-A), September 1986, and "ANC: A Westinghouse Advanced Nodal Computer Code: Enhancements to ANC Rod Power Recovery" (WCAP-10965-P-A, Addendum 1), April 1989 (Methodology for Specification 3.1.1.1, 3.1.1.2, 3.1.1.4, 3.1.3.6; and 3.2.4.b)

2) "CE Method for Control Element Assembly Ejection Analysis," CENPD-0190-A, January 1976 (Methodology for Specification 3.1.3.6 and 3.2.3)

3) "Modified Statistical Combination of Uncertainties, CEN-356(V)-P-A, Revision 01-P-A, May 1988 (Methodology for 3.2.4.c, 3.2.4.d and 3.2.7)

4) "Calculative Methods for the CE Large Break LOCA Evaluation Model," CENPD-132-P, August 1974 (Methodology for 3.1.1.4, 3.2.1, 3.2.3 and 3.2.7)

5) "Calculational Methods for the CE Large Break LOCA Evaluation Model," CENPD-132-P, Supplement 1, February 1975 (Methodology for 3.1.1.4, 3.2.1; 3.2.3 and 3.2.7)

6) "Calculational Methods for the CE Large Break LOCA Evaluation Model," CENPD-132-P, Supplement 2-P, July 1975 (Methodology for 3.1.1.4, 3.2.1, 3.2.3 and 3.2.7)

7) "Calculative Methods for the CE Large Break LOCA Evaluation Model for the Analysis of CE and W Designed NSSS," CEN-132, Supplement 3-P-A, June 1985 (Methodology for 3.1.1.4, 3.2.1; 3.2.3 and 3.2.7)

8) "Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model," CENPD-132-P, Supplement 4-P-A, Revision 1, December 2000 (Methodology for 3.1.1.4, 3.2.1; 3.2.3 and 3.2.7)

9) "Calculative Methods for the CE Small Break LOCA Evaluation Model," CENPD-137-P, August 1974 (Methodology for 3.1.1.4, 3.2.1, 3.2.3, and 3.2.7)

10) "Calculative Methods for the CE Small Break LOCA Evaluation Model," CENPD-137, Supplement 1-P, January 1977 (Methodology for 3.1.1.4, 3.2.1, 3.2.3, and 3.2.7)

11) "Calculative Methods for the CE Small Break LOCA Evaluation Model," CENPD-137, Supplement 2-P-A, April 1998 (Methodology for 3.1.1.4, 3.2.1, 3.2.3, and 3.2.7)

12) "CESEC-Digital Simulation of a Combustion Engineering Nuclear Steam Supply System," December 1981 (Methodology for 3.1.1.1, 3.1.1.2, 3.1.1.4, 3.1.3.1, 3.1.3.6, and 3.2.4.b)

13) "Technical Manual for the CENTS Code," CENPD 282-P-A, February 1991 (Methodology for 3.1.1.1, 3.1.1.2, 3.1.1.4, 3.1.3.1, 3.1.3.6, 3.2.4.b)

14) "Implementation of ZIRLO Material Cladding in CE Nuclear Power Fuel Assembly Designs," CENPD-404-P-A, November 2001 (Modifies CENPD-132-P and CENPD-137-P as methodology for 3.1.1.4, 3.2.1, 3.2.3, and 3.2.7)

15) "Qualification of the Two-Dimensional Transport Code PARAGON," WCAP-16045-P-A, August 2004 (May be used as a replacement for the PHOENIX-P lattice code as methodology for 3.1.1.1, 3.1.1.2, 3.1.1.4, 3.1.3.6, and 3.2.4.b)

16) "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs," WCAP-16072-P-A, August 2004 (Methodology for 3.1.1.4, 3.2.1, 3.2.3, and 3.2.7)

17) Letter: O.D. Parr (NRC) to F.M. Stern (CE) dated June 13, 1975 (NRC Staff Review of Combustion Engineering ECCS Evaluation Model). NRC approval for items 4, 5 and 9 methodologies

18) Letter: O. D. Parr (NRC) to A.E. Scherer (CE), dated December 9, 1975 (NRC Staff Review of the Proposed Combustion Engineering ECCS Evaluation Model changes). NRC approval for item 6 methodology

19) Letter: K.Kniel (NRC) to A. E. Scherer (CE), dated September 27, 1977 (Evaluation of Topical Reports CENPD-133, Supplement 3-P and CENPD-137, Supplement 1-P). NRC approval for item 10 methodology

20) Letter: 2CNA038403, dated March 20, 1984, J.R. Miller (NRC) to J.M. Griffin (AP&L), "CESEC Code Verification." NRC approval for item 12 methodology

21) "CE 16 x 16 Next Generation Fuel Core Reference Report," WCAP-16500-P and Final Safety Evaluation for Westinghouse Electric Company (Westinghouse) Topical Report (TR) WCAP-16500-P, Revision 0, "CE [Combustion Engineering] 16 x 16 Next Generation [(NGF)] Core Reference Report," (Methodology for Specification 3.1.1.4 Moderator Temperature Coefficient (MTC), 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, 3.2.4.b, 3.2.4.c, and 3.2.4.d for DNBR Margin, and 3.2.7 for ASI)

22) "Optimized ZIRLO™," WCAP-12610-P-A and CENPD-404-P-A Addendum 1-A, (Methodology for Specification 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Tilt, and 3.2.7 for ASI)

23) "Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes," WCAP-16523-P and Final Safety Evaluation for Westinghouse Electric Company (Westinghouse) Topical Report (TR), WCAP-16523-P, "Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes," (Methodology for 3.2.4.b, 3.2.4.c, and 3.2.4.d for DNBR Margin and 3.2.7 for ASI)

24) "ABB Critical Heat Flux Correlations for PWR Fuel," CENPD-387-P-A (Methodology for Specifications 3.2.4.b, 3.2.4.c, and 3.2.4.d for DNBR Margin and 3.2.7 for ASI)

25) "Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model – Improvement to 1999 Large Break LOCA EM Steam Cooling Model for Less Than 1 in/sec Core Reflood," CENPD-132, Supplement 4-P-A, Addendum 1-P and Final Safety Evaluation for Westinghouse Electric Company (Westinghouse) Topical Report (TR) CENPD-132, Supplement 4-P-A, Addendum 1-P, "Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model – Improvement to 1999 Large Break LOCA EM Steam Cooling Model for Less Than 1 in/sec Core Reflood," (Methodology for Specification 3.1.1.4 Moderator Temperature Coefficient (MTC), 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

V. CORE OPERATING LIMITS

The cycle-specific operating limits for the specifications listed are presented below.

1) 3/4.1.1.1 - SHUTDOWN MARGIN- $T_{avg} > 200°F$

The SHUTDOWN MARGIN shall be greater than or equal to 5.0 % $\Delta k/k$ in Modes 1, 2, 3, and 4.

2) 3/4.1.1.2 - SHUTDOWN MARGIN - $T_{avg} \leq 200°F$

The SHUTDOWN MARGIN shall be greater than or equal to 5.0% $\Delta k/k$ in Mode 5.

3) 3.1.1.4 - MODERATOR TEMPERATURE COEFFICIENT

The Moderator Temperature Coefficient (MTC) shall be in accordance with Figure 1. The Beginning of Cycle (BOC) positive COLR MTC limit line of Figure 1 is from BOC to 140.0 EFPD. From 400.0 EFPD to End of Cycle (EOC) the positive COLR MTC limit line is linear from an MTC of 0.0 E-4 $\Delta k/k/°F$ at 0% power to an MTC of -1.0 E-4 $\Delta k/k/°F$ at 100% power, which is bounded by the BOC positive MTC limit. Between 140.0 EFPD and 400.0 EFPD the positive MTC limit may be interpolated linearly with burnup.

4) 3.1.3.1 - CEA POSITION

With one or more CEAs trippable but misaligned from any other CEAs in its group by more than the Technical Specification 3.1.3.1 allowed value, the minimum required core power reduction for Modes 1 and 2 is specified in Figure 2.

5) 3.1.3.6 - REGULATING CEA INSERTION LIMITS

The regulating CEA groups and Group P shall be limited to the withdrawal and insertion limits shown on Figure 3. Figure 3 assumes that Groups 1 through 5 are maintained at or above the Programmed Insertion Limit.

6) 3/4.2.1 - LINEAR HEAT RATE

With COLSS out of service, the linear heat rate shall be maintained $\leq$ 13.7 kW/ft.

7) 3.2.3 - AZIMUTHAL POWER TILT- T_q

The measured AZIMUTHAL POWER TILT shall be maintained ≤ 0.03.

8) 3/4.2.4 - DNBR MARGIN

The DNBR limit shall be maintained by one of the following methods:

a) With COLSS in service and neither CEAC operable - Maintain COLSS calculated core power less than or equal to COLSS calculated core power operating limit based on DNBR decreased by 10%.

b) With COLSS out of service and at least one CEAC operable - Operate within the Region of Acceptable Operation shown on Figure 4, using any operable CPC channel.

c) With COLSS out of service and neither CEAC operable - Operate within the Region of Acceptable Operation shown on Figure 5, using any operable CPC channel.

9) 3.2.7 - AXIAL SHAPE INDEX

The core average AXIAL SHAPE INDEX (ASI) shall be maintained within the following limits:

a) COLSS IN SERVICE
$-0.27 \leq ASI \leq +0.27$

b) COLSS OUT OF SERVICE (CPC)
$-0.20 \leq ASI \leq +0.18$

VI. LIST OF FIGURES

Figure 1 Moderator Temperature Coefficient

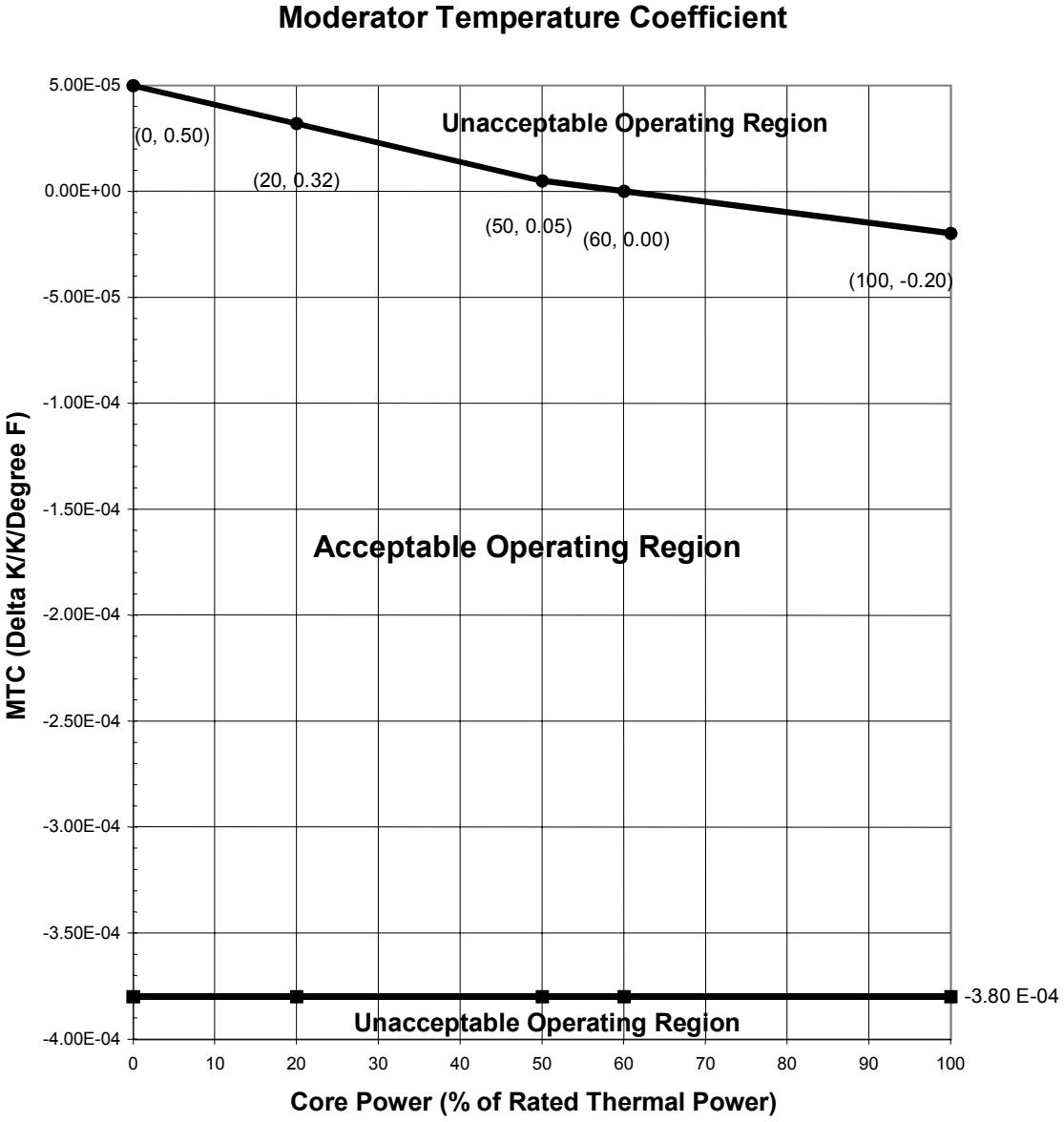
Figure 2 Required Power Reduction After Inward CEA Deviation

Figure 3 CEA Insertion Limits Versus Thermal Power

Figure 4 DNBR Margin Operating Limit Based on Core Protection Calculators (COLSS Out of Service, CEAC Operable)

Figure 5 DNBR Margin Operating Limit Based on Core Protection Calculators (COLSS Out of Service, Both CEACs Inoperable)

FIGURE 1

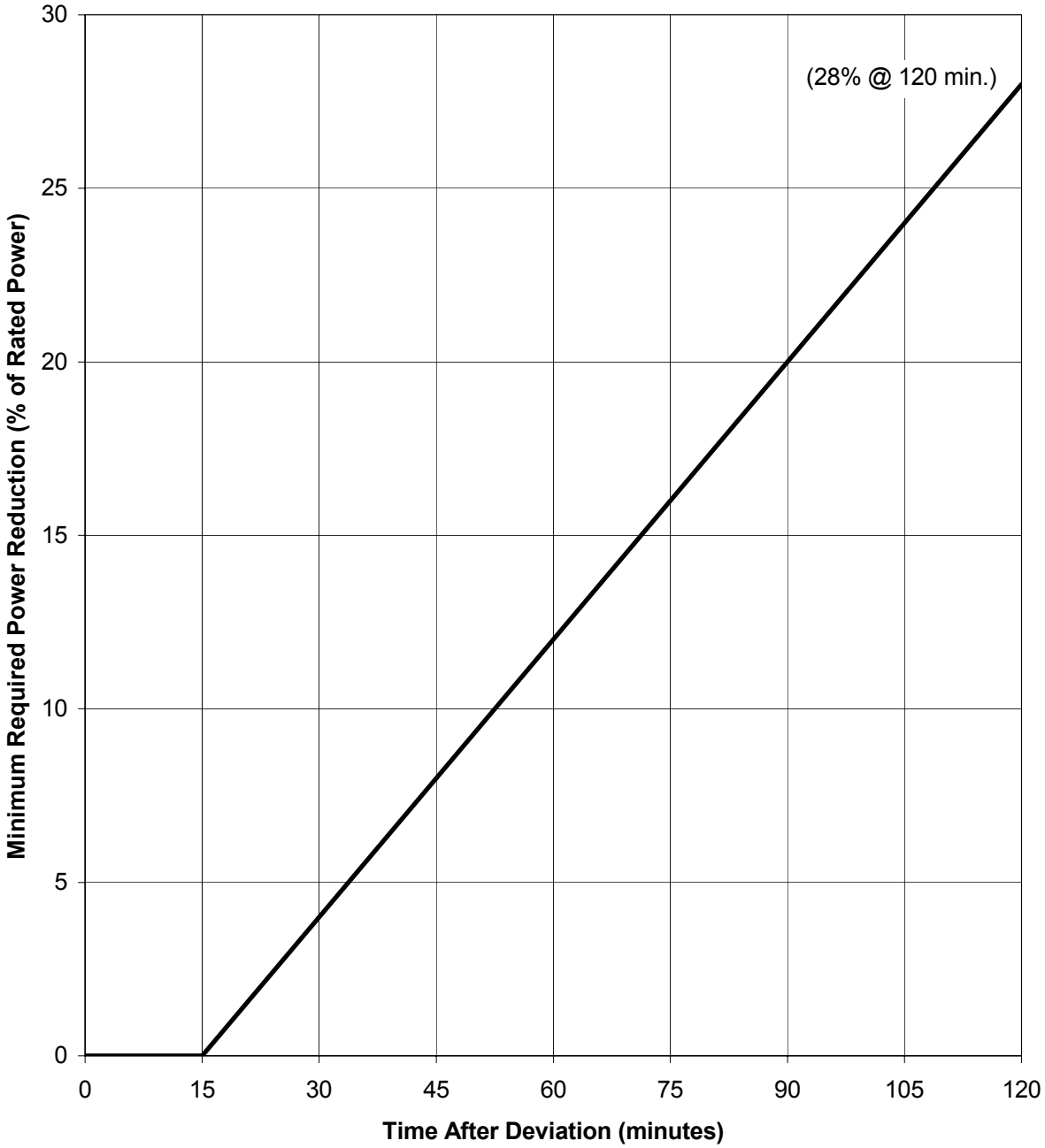


Note:

Per Technical Specification 3.1.1.4.a. and b., the Moderator Temperature Coefficient (MTC) maximum upper design limit shall be less positive than $+0.5 \times 10^{-4}$ $\Delta k/k/°F$ whenever THERMAL POWER is $\leq$ 70% of RATED THERMAL POWER and less positive than 0.0×10^{-4} $\Delta k/k/°F$ whenever THERMAL POWER is > 70% of RATED THERMAL POWER. Therefore, the actual MTC must be less than the COLR upper limit at zero power. At all other powers, the actual MTC may be equal to the COLR upper limit.

FIGURE 2

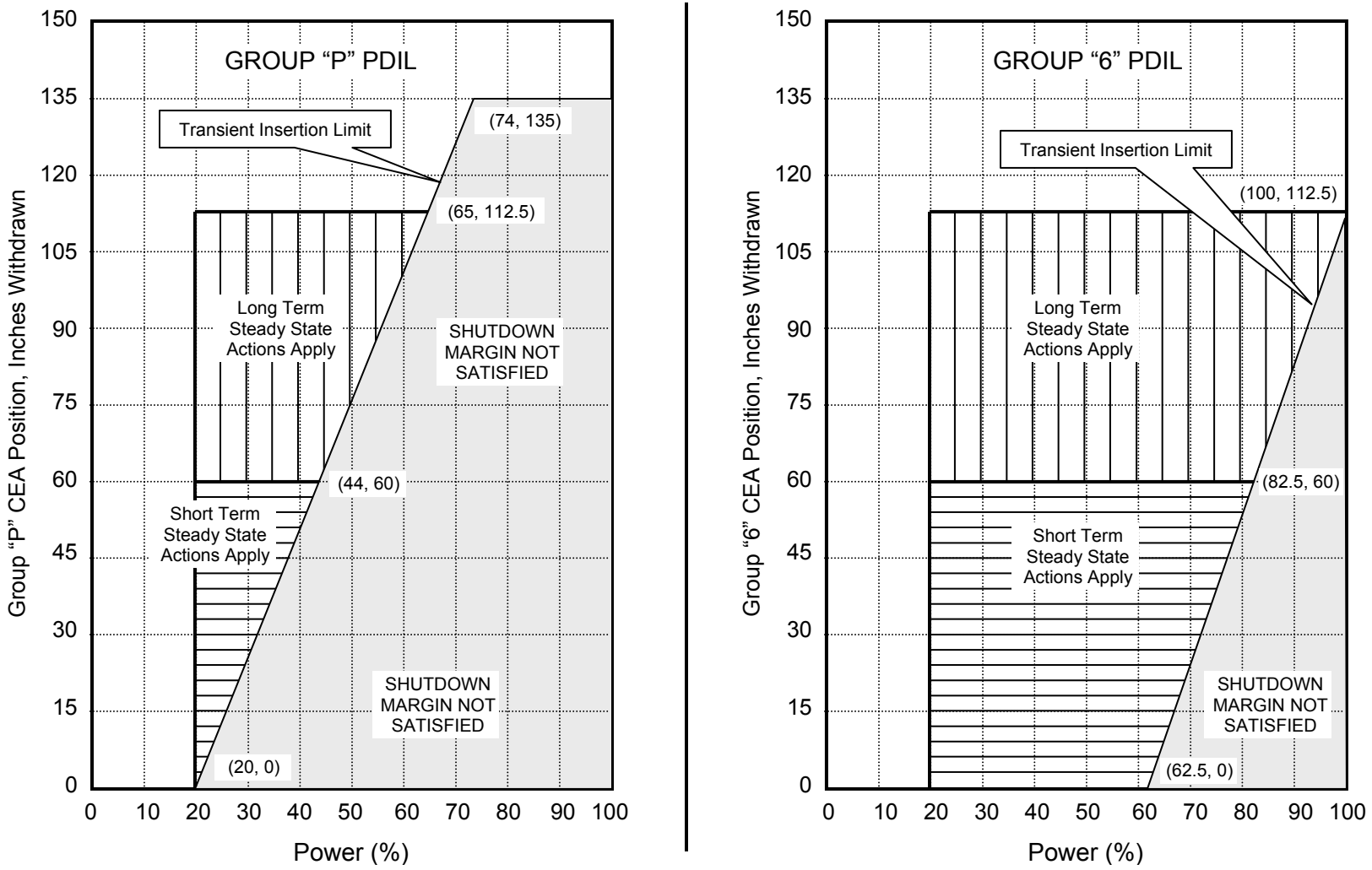
REQUIRED POWER REDUCTION AFTER INWARD CEA DEVIATION*



***When core power is reduced to 60% of rated power per this limit curve, further reduction is not required**

FIGURE 3

CEA INSERTION LIMITS VERSUS THERMAL POWER

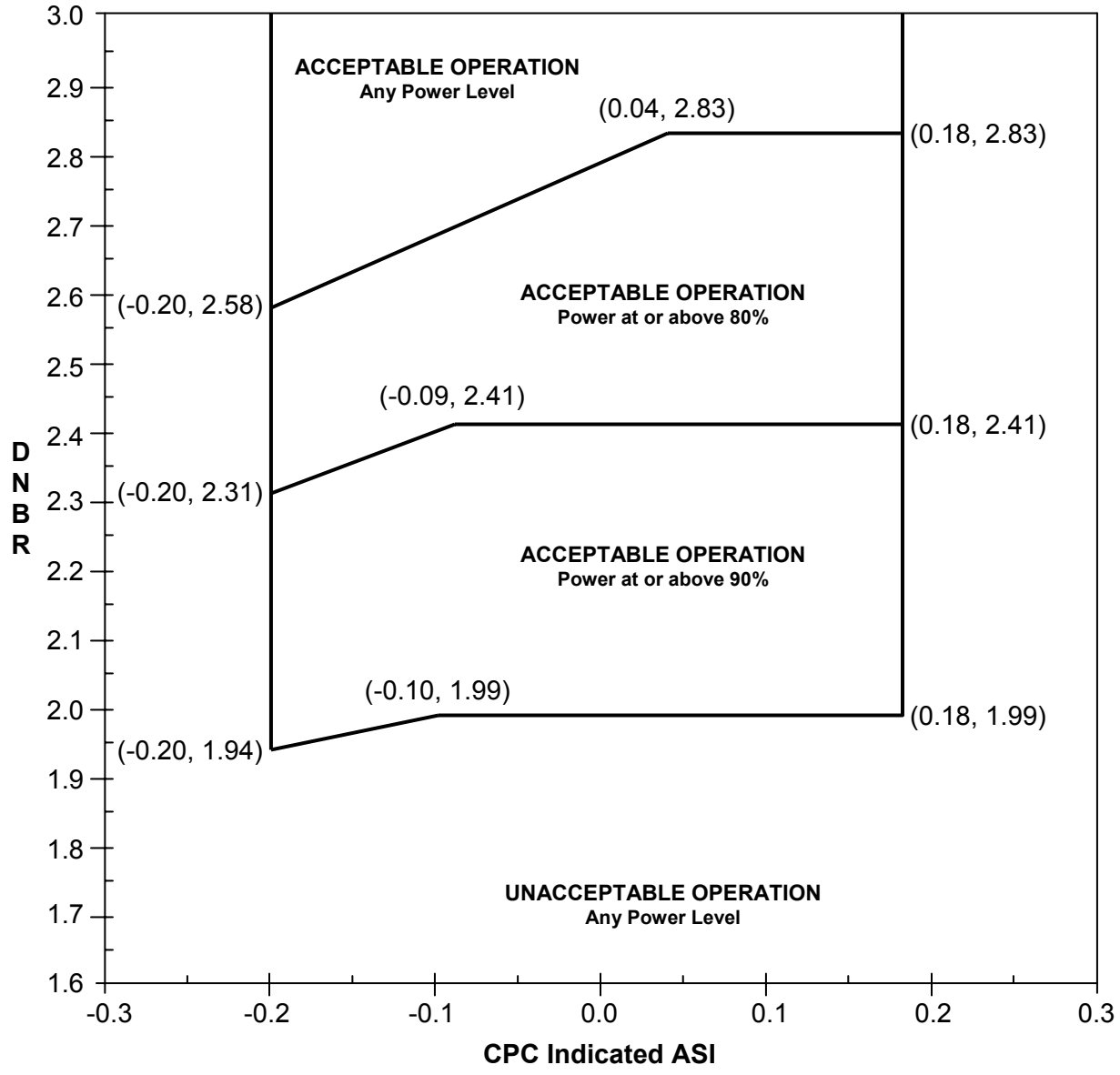


Note: Regulating Groups 1 through 5 at or above Programmed Insertion Limit

FIGURE 4

DNBR MARGIN OPERATING LIMIT BASED ON CORE PROTECTION CALCULATORS

ANO-2 Cycle Independent COLSS OOS Limit Lines
Minimum One CEAC Operable

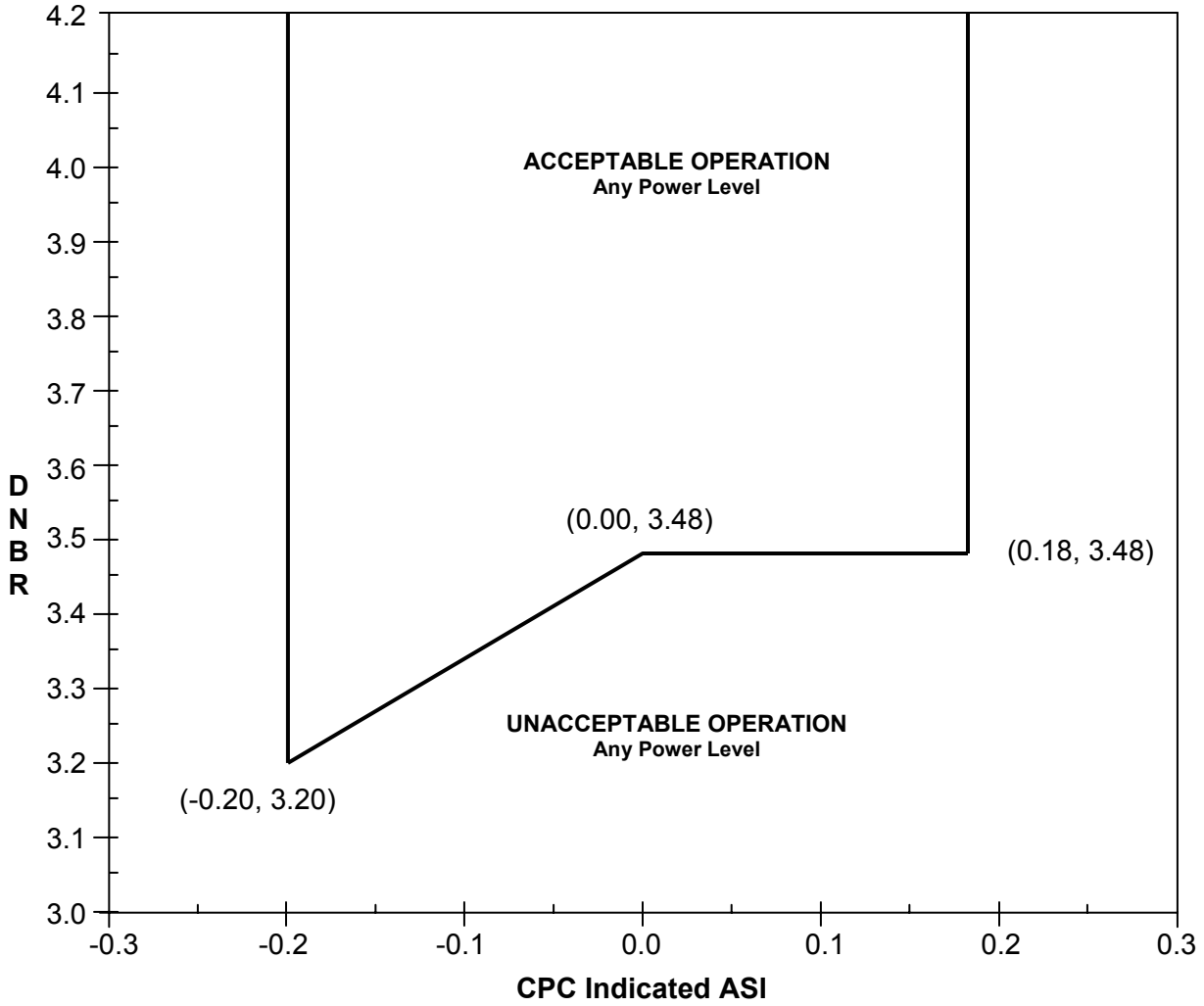


NOTE: DNBR greater than that indicated at the top of the figure is acceptable, provided the indicated ASI limits remain between the bounds that are shown for lower DNBR.

FIGURE 5

DNBR MARGIN OPERATING LIMIT BASED ON CORE PROTECTION CALCULATORS

ANO-2 Cycle Independent COLSS OOS Limit
Both CEACs Inoperable



NOTE: DNBR greater than that indicated at the top of the figure is acceptable, provided the indicated ASI limits remain between the bounds that are shown for lower DNBR.