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2CAN052301

May 3, 2023

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

Subject: ANO-2 Cycle 30 Core Operating Limits Report (COLR)

Arkansas Nuclear One, Unit 2
NRC Docket No. 50-368
Renewed Facility Operating License No. NPF-6

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. Attached is Revision 0 of the ANO-2 Cycle 30 COLR. This completes the reporting requirement for the referenced specification.

This submittal contains no commitments.

If there are any questions or if additional information is needed, please contact Riley Keele, Manager, Regulatory Assurance, Arkansas Nuclear One, at 479-858-7826.

Respectfully,

Riley Keele

Digitally signed by Riley Keele
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Reason: I am approving this document
Date: 2023.05.03 13:43:58 -05'00'

RDK/mar

Enclosure: ANO-2 Core Operating Limits Report (COLR) for Cycle 30

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector – Arkansas Nuclear One
NRC Project Manager – Arkansas Nuclear One
Designated Arkansas State Official

Enclosure

2CAN052301

ANO-2 Core Operating Limits Report (COLR) for Cycle 30

(13 pages)

ENTERGY OPERATIONS

ARKANSAS NUCLEAR ONE - UNIT 2

CORE OPERATING LIMITS REPORT

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CORE OPERATING LIMITS REPORT
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ARKANSAS NUCLEAR ONE - UNIT 2

**CORE OPERATING LIMITS REPORT
FOR CYCLE 30**

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 30. This is Revision 0 of the Cycle 30 COLR.

II. SUMMARY OF CHANGES

There were no changes to any limits from the latest revision of the Cycle 29 COLR. Supplement 2 of WCAP-16500 P-A was added to the list of References (Reference 23) for the approved Modified Outer Strap (MOS), additional anti-hangup Outer Strap Tab (OST), and longitudinal stamping (LS) for the Next Generation Fuel (NGF). Also, explanatory notes to COLR items 3/4.1.1.1 and 3/4.1.1.2 were added to indicate the required subcritical margin is in terms of absolute value. Both of these changes are purely editorial and do not impact any COLR limits.

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 Specifications 3.1.1.1, 3.1.1.2 for Shutdown Margins, 3.1.1.4 for MTC, 3.1.3.6 for Regulating and Group P CEA Insertion Limits; and 3.2.4.b for DNBR Margin)

2) "CE Method for Control Element Assembly Ejection Analysis," CENPD-0190-A, January 1976 (Methodology for Specification 3.1.3.6 for Regulating and Group P CEA Insertion Limits, and 3.2.3 for Azimuthal Power Tilt)

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

4) "Calculative Methods for the CE Large Break LOCA Evaluation Model," CENPD-132-P, August 1974 (Methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

5) "Calculational Methods for the CE Large Break LOCA Evaluation Model," CENPD-132-P, Supplement 1, February 1975 (Methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

6) "Calculational Methods for the CE Large Break LOCA Evaluation Model," CENPD-132-P, Supplement 2-P, July 1975 (Methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

7) "Calculative Methods for the CE Large Break LOCA Evaluation Model for the Analysis of CE and W Designed NSSS," CENPD-132, Supplement 3-P-A, June 1985 (Methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

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 Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

9) "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 MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

10) "Calculative Methods for the CE Small Break LOCA Evaluation Model," CENPD-137-P, August 1974 (Methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

11) "Calculative Methods for the CE Small Break LOCA Evaluation Model," CENPD-137, Supplement 1-P, January 1977 (Methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

12) "Calculative Methods for the CE Small Break LOCA Evaluation Model," CENPD-137, Supplement 2-P-A, April 1998 (Methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

13) "Technical Manual for the CENTS Code," WCAP-15996-P-A, Rev. 1, March 2005 (Methodology for Specifications 3.1.1.1 and 3.1.1.2 for Shutdown Margin, 3.1.1.4 for MTC, 3.1.3.1 for CEA Position, 3.1.3.6 for Regulating and Group P Insertion Limits, and 3.2.4.b for DNBR Margin)

14) "Implementation of ZIRLO Material Cladding in CE Nuclear Power Fuel Assembly Designs," CENPD-404-P-A, Revision 0, November 2001 (Modifies CENPD-132-P and CENPD-137-P as methodology for Specifications 3.1.1.4 for MTC, 3.2.1 for Linear Heat Rate, 3.2.3 for Azimuthal Power Tilt, and 3.2.7 for ASI)

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 Specifications 3.1.1.1 and 3.1.1.2 for Shutdown Margins, 3.1.1.4 for MTC, 3.1.3.6 for Regulating and Group P CEA Insertion Limits, and 3.2.4.b for DNBR Margin)

16) "Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs," WCAP-16072-P-A, Revision 0, August 2004 (Methodology for Specifications 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)

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-A, Revision 0, August 2007 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 Specifications 3.1.1.4 for 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) "Application of CE Setpoint Methodology for CE 16 x 16 Next Generation Fuel (NGF)," WCAP-16500-P-A, Supplement 1, Revision 1, December 2010, (Methodology for Specifications 3.2.4.b, 3.2.4.c, and 3.2.4.d for DNBR Margin)

23) "Evolutionary Design Changes to CE 16X16 Next Generation Fuel and Method for Addressing the Effects of End-of-Life Properties on Seismic and Loss of Coolant Accident Analyses," WCAP-16500-P-A, Supplement 2, June 2016.

24) "Optimized ZIRLO™," WCAP-12610-P-A and CENPD-404-P-A Addendum 1-A, July 2006 (Methodology for Specifications 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)

25) "Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes," WCAP-16523-P-A, Revision 0, August 2007 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 Specifications 3.2.4.b, 3.2.4.c, and 3.2.4.d for DNBR Margin)

26) "ABB Critical Heat Flux Correlations for PWR Fuel," CENPD-387-P-A Revision 0, May 2000 (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)

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% Δk/k in Modes 1, 2, 3, and 4.

NOTE: Above refers to required subcritical margin in terms of absolute value. Reactivity balance calculations that treat core excess reactivity as positive and boron reactivity as negative will satisfy the requirement when SHUTDOWN MARGIN is -5.0% Δk/k or more negative.

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% Δk/k in Mode 5.

NOTE: Above refers to required subcritical margin in terms of absolute value. Reactivity balance calculations that treat core excess reactivity as positive and boron reactivity as negative will satisfy the requirement when SHUTDOWN MARGIN is -5.0% Δk/k or more negative.

3) 3.1.1.4 - MODERATOR TEMPERATURE COEFFICIENT

The Moderator Temperature Coefficient (MTC) shall be in accordance with Figure 1 except as follows. The upper COLR MTC limit line of Figure 1 applies from BOC to 140.0 EFPD. From 380.0 EFPD to End of Cycle (EOC), the upper COLR MTC limit shall be linear between 0.0E-4 Δk/k/°F at 0% power and -1.0E-4 Δk/k/°F at 100% power. Between 140.0 EFPD and 380.0 EFPD, the upper MTC limit may be linearly interpolated with burnup between these two upper limits.

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 ≤ 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

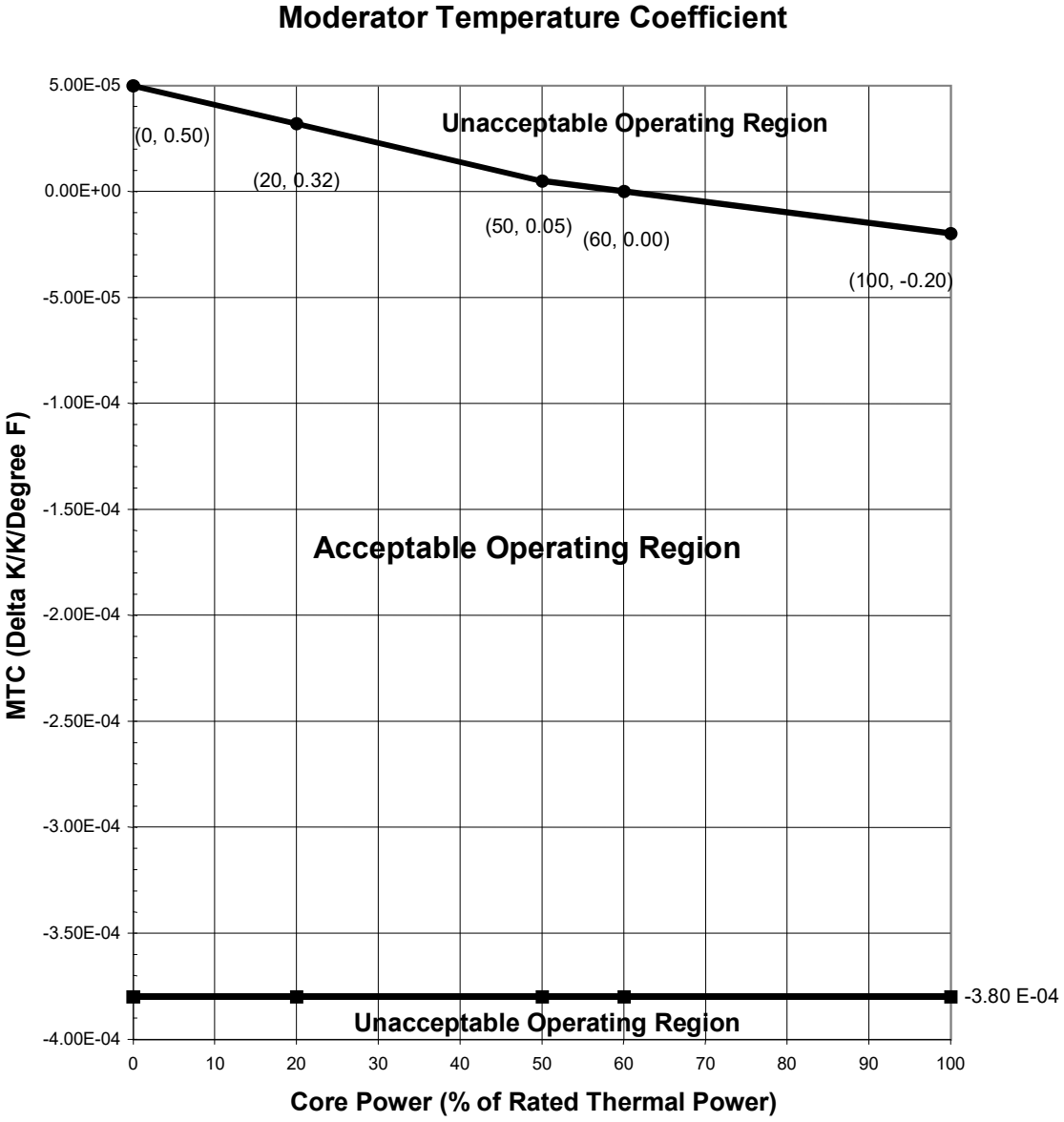
The core average AXIAL SHAPE INDEX (ASI) shall be maintained within the following limits:

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

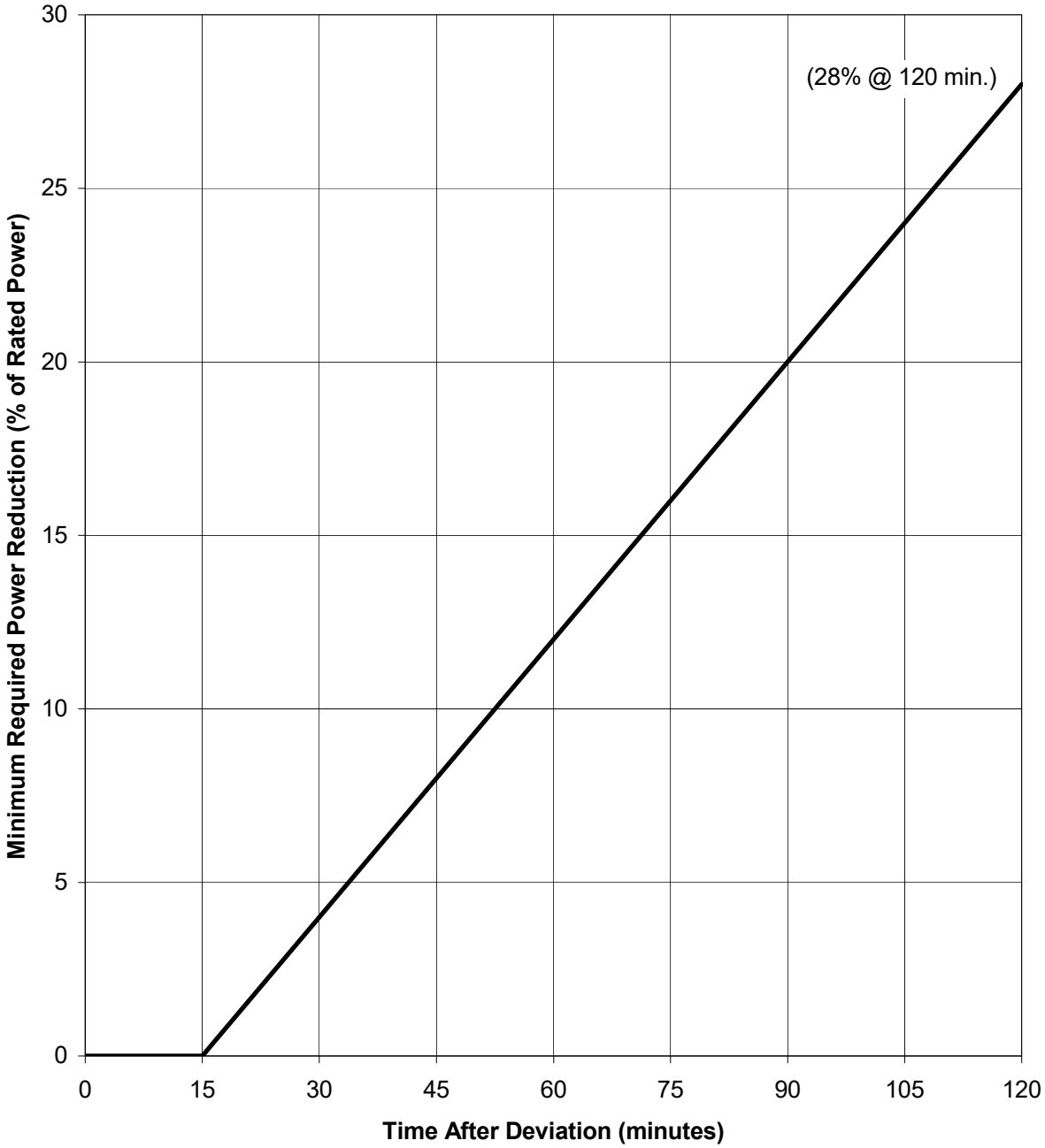


Note:

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

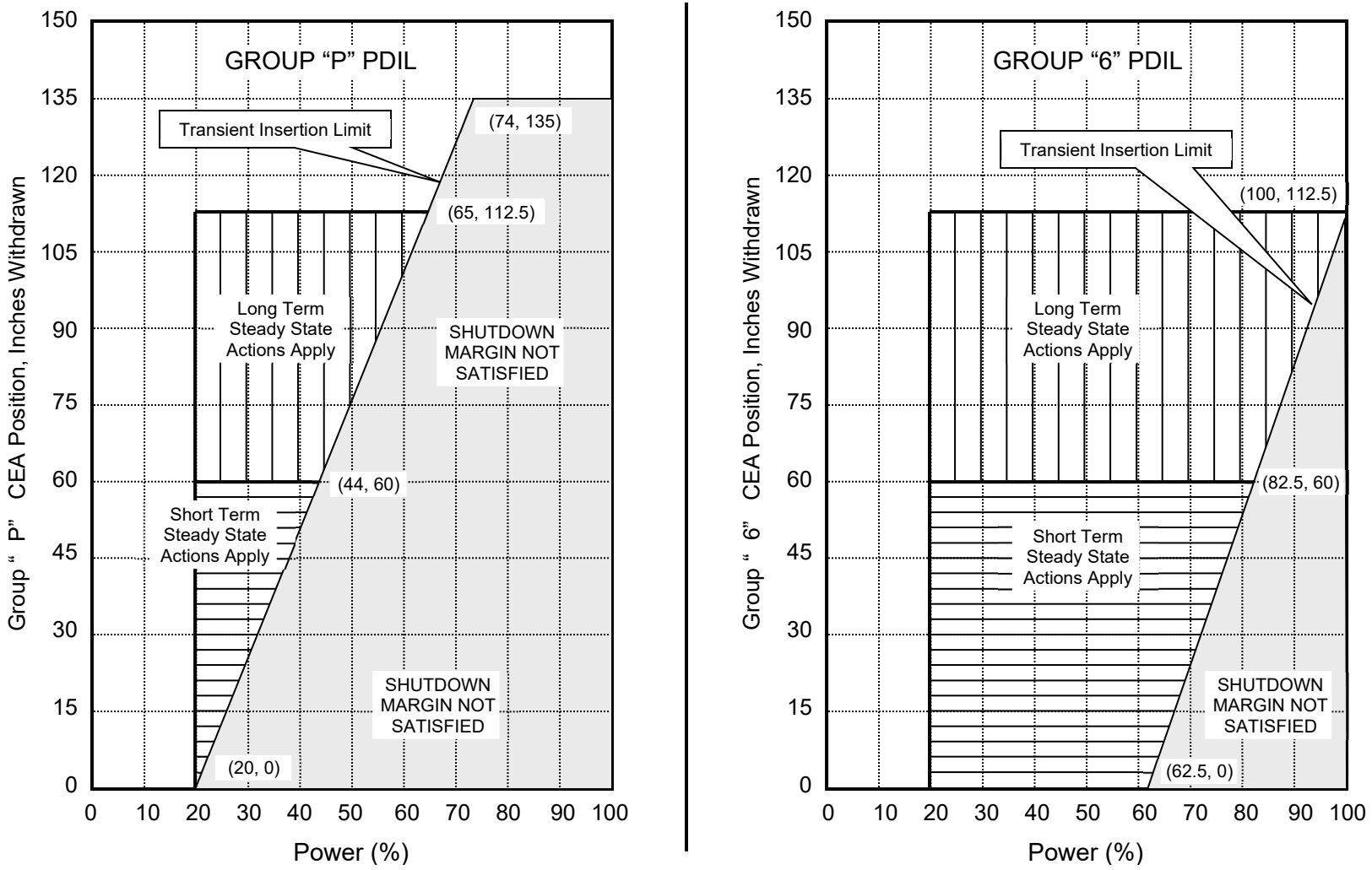
REQUIRED POWER REDUCTION AFTER INWARD CEA DEVIATION*



***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

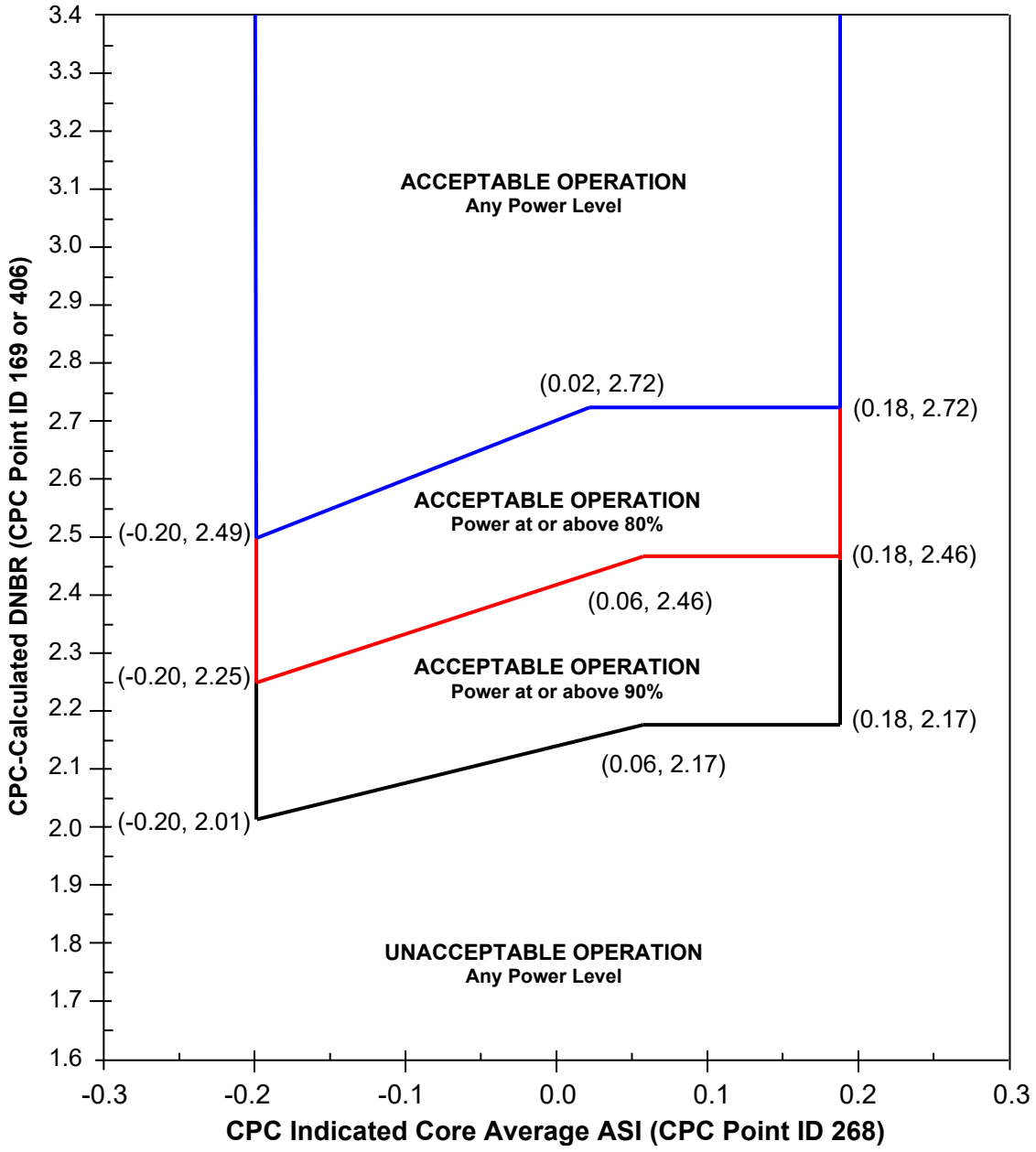


Note: Regulating Groups 1 through 5 at or above Programmed Insertion Limit

FIGURE 4

DNBR MARGIN OPERATING LIMIT BASED ON CORE PROTECTION CALCULATORS

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

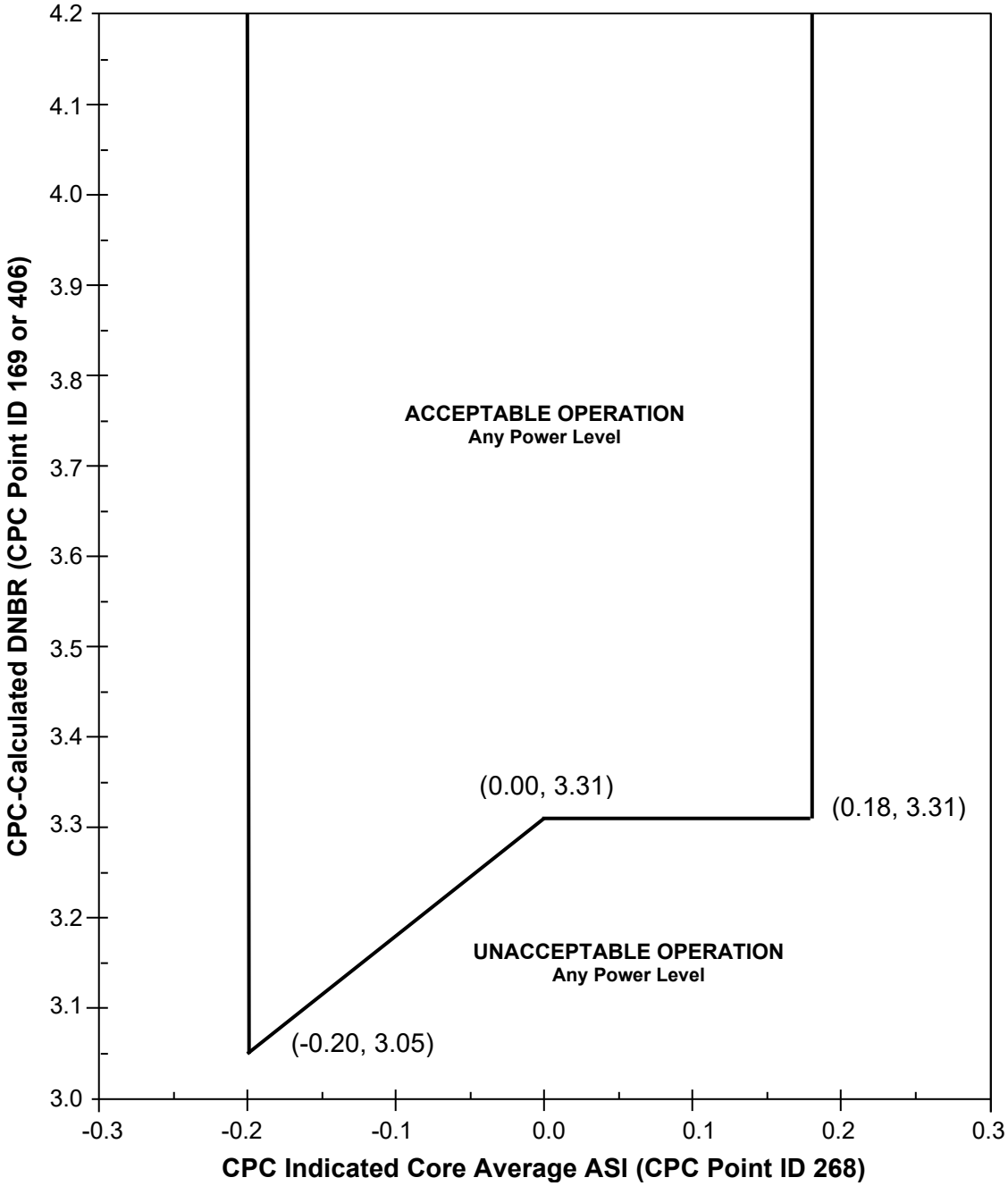


NOTE: DNBR greater than that indicated at the top of the figure is acceptable, provided the indicated ASI limits remain between the bounds that are shown for lower DNBR.

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.