



**Palo Verde
Nuclear Generating Station**
5871 S. Wintersburg Road
Tonopah, AZ 85354

102-08379-KJG/MSC
January 26, 2022

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

Subject: **Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2, and 3
Docket Nos. STN 50-528, 50-529, and 50-530
Unit 1 Core Operating Limits Report Revision 30
Unit 2 Core Operating Limits Report Revision 24
Unit 3 Core Operating Limits Report Revision 29**

Pursuant to PVNGS Technical Specifications, Section 5.6.5(d), enclosed are the Units 1, 2, and 3 Core Operating Limits Report (COLR), Revisions 30, 24, and 29, respectively, which were made effective January 20, 2022.

The changes implemented by these revisions are to the table in the Analytical Methods section of each unit's COLR. Specifically, the table for each Unit reflects the adoption of an updated version of Framatome topical report BAW-10241P-A, *BHTP DNB Correlation Applied with LYNXT*, Revision 2. No technical changes were necessary. Revision bars have been applied to those pages which contain changes.

No commitments are being made to the Nuclear Regulatory Commission (NRC) by this letter. If you have any questions about this submittal please contact Matthew S. Cox, Licensing Section Leader, at (623) 393-5753.

Sincerely,

A handwritten signature in black ink that reads "Katherine J. Gil".

Digitally signed by Gil, Katherine
J(Z05492)
Date: 2022.01.26 08:03:47 -07'00'

Katherine J. Gil
Nuclear Regulatory Affairs Director

KJG/MSC/mg

Enclosure 1: Unit 1 Core Operating Limits Report, Revision 30
Enclosure 2: Unit 2 Core Operating Limits Report, Revision 24
Enclosure 3: Unit 3 Core Operating Limits Report, Revision 29

cc:

S. A. Morris
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NRC Region IV Regional Administrator
NRC NRR Project Manager for PVNGS
NRC Senior Resident Inspector for PVNGS

Enclosure 1

**Unit 1 Core Operating Limits Report
Revision 30**

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 1

CORE OPERATING LIMITS REPORT

Revision 30

Effective: January 20, 2022

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This Report has been prepared in accordance with the requirements of Technical Specifications 4.2.1 and 5.6.5. The Core Operating Limits have been developed using the NRC approved methodologies specified in Section 5.6.5 b of the Palo Verde Technical Specifications.

AFFECTED PVNGS TECHNICAL SPECIFICATIONS

- 3.1.1 Shutdown Margin (SDM) - Reactor Trip Breakers Open
- 3.1.2 Shutdown Margin (SDM) - Reactor Trip Breakers Closed
- 3.1.4 Moderator Temperature Coefficient (MTC)
- 3.1.5 Control Element Assembly (CEA) Alignment
- 3.1.7 Regulating CEA Insertion Limits
- 3.1.8 Part Strength CEA Insertion Limits
- 3.2.1 Linear Heat Rate (LHR)
- 3.2.3 Azimuthal Power Tilt (T_q)
- 3.2.4 Departure From Nucleate Boiling Ratio (DNBR)
- 3.2.5 Axial Shape Index (ASI)
- 3.3.12 Boron Dilution Alarm System (BDAS)
- 3.9.1 Boron Concentration
- 4.2.1 Fuel Assemblies

ANALYTICAL METHODS

The COLR contains the complete identification for each of the Technical Specification referenced topical reports (i.e., report number, title, revision, date, and any supplements) and correspondence that provide the NRC-approved analytical methods used to determine the core operating limits, described in the following documents:

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
1	CENPD-0190-A	N.A. / N.A.	January 1976	CE Method for Control Element Assembly Ejection Analysis (N001-1301-01204)	Westinghouse Framatome
2	CENPD-266-P-A	N.A. / N.A.	April 1983	The ROCS and DIT Computer Codes for Nuclear Design (N001-1900-01412)	Westinghouse Framatome
3	NUREG-0852	N.A. / N.A.	November 1981	Safety Evaluation Report related to the Final Design of the Standard Nuclear Steam Supply Reference Systems CESSAR System 80, Docket No. STN 50-470	Westinghouse Framatome
3		N.A. / 1	March 1983		Westinghouse Framatome
3		N.A. / 2	September 1983		Westinghouse Framatome
3		N.A. / 3	December 1987		Westinghouse Framatome
4	CEN-356(V)-P-A	01-P-A / N.A.	May 1988	Modified Statistical Combination of Uncertainties (N001-1303-01747)	Westinghouse Framatome
4	Enclosure 1-P to LD-82-054	N.A. / 1-P	February 1993	System 80 TM Inlet Flow Distribution (N001-1301-01228)	Westinghouse Framatome
5	CENPD-132 P	N.A. / N.A.	August 1974	Calculative Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132P	N.A./ 1	February 1975	Calculational Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132-P	N.A. / 2-P	July 1975	Calculational Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132	N.A. / 3-P-A	June 1985	Calculative Methods for the C-E Large Break LOCA Evaluation Model for the Analysis of C-E and <u>W</u> Designed NSSS	Westinghouse

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
5	CENPD-132	N.A. / 4-P-A Rev. 1	March 2001	Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model (N001-1900-01192)	Westinghouse
5	CENPD-132- P-A	N.A. / 4-P-A Addendum 1-P- A	August 2007	Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model (N001-0205-00046)	Westinghouse
5	CENPD-132	N.A. / SUPP 4-P-A APP A-Rev. 004	Decem- ber 2008	Revision 4 to the Supplement to Appen- dix A of CENPD-132 Supplement 4-P-A (N001-0205-00229)	Westinghouse
6	CENPD-137-P	N.A. / N.A.	August 1974	Calculative Methods for the C-E Small Break LOCA Evaluation Model	Westinghouse
6	CENPD-137	N.A. / 1-P	January 1977	Calculative Methods for the C-E Small Break LOCA Evaluation Model	Westinghouse
6	CENPD-137	N.A. / 2-P-A	April 1998	Calculative Methods for the ABB C-E Small Break LOCA Evaluation Model (N001-1900-01185)	Westinghouse
7	N.A.	N.A. / N.A.	June 13, 1975	Letter: O.D. Parr (NRC) to F. M. Stern (CE), (NRC Staff Review of the Combustion Engineering ECCS Evaluation Model). NRC approval for: 5.6.5.b.6.	Westinghouse
8	N.A.	N.A. / N.A.	Septem- ber 27, 1977	Letter: K. Kniel (NRC) to A. E. Scherer (CE), (Evaluation of Topical Reports CENPD 133, Supplement 3-P and CENPD-137, Supplement 1-P). NRC approval for 5.6.5.b.6.	Westinghouse
9	CEN-372-P-A	N.A. / N.A.	May 1990	Fuel Rod Maximum Allowable Pressure (N001-0201-00026)	Westinghouse
10	N.A.	N.A. / N.A.	April 10, 1990	Letter: A. C. Thadani (NRC) to A. E. Scherer (CE), ("Acceptance for Reference CE Topical Report CEN-372- P"). NRC approval for 5.6.5.b.9.	Westinghouse
11	NFM-005	1 / N.A.	August 2007	Arizona Public Service Company PWR Reactor Physics Methodology Using CASMO-4/SIMULATE-3 (NFM-005)	Westinghouse Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
12	CENPD-282-P-A Vols. 1	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 1 (CENTS-TD MANUAL-VOL 1)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 2	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 2 (CENTS-TD MANUAL-VOL 2)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 3	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 3 (CENTS-TD MANUAL-VOL 3)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 4	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 4 (CENTS-TD MANUAL-VOL 4)	Westinghouse Framatome
13	CENPD-404-P-A	0 / N.A.	November 2001	Implementation of ZIRLO™ Cladding Material in CE Nuclear Power Fuel Assembly Designs (N001-1900-01329)	Westinghouse
13	CENPD-404-P-A Addendum 1-A	0 / N.A.	July 2006	Optimized ZIRLO™ (N001-0203-00611)	Westinghouse
13	CENPD-404-P-A Addendum 2-A	0 / N.A.	October 2013	Westinghouse Clad Corrosion Model for ZIRLO and Optimized ZIRLO™ (N001-0205-00006)	Westinghouse
14	CENPD-188-A	N.A. / N.A.	July 1976	HERMITE, A Multi-Dimensional Space-Time Kinetics Code for PWR Transients (HERMITE-TOPICAL)	Westinghouse Framatome
15	CENPD-161-P-A	N.A. / N.A.	April 1986	TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core (N001-1301-01202)	Westinghouse
16	CEN-160(S)-P	1-P / N.A.	September 1981	CETOP-D Code Structures and Modeling Methods for San Onofre Nuclear Generating Station Units 2 and 3 (N001-1301-01185)	Westinghouse Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
17	N.A.	N.A. / N.A.	September 29, 2003	“Safety Evaluation related to Palo Verde Nuclear Generating Station, Unit 2 (PVNGS-2) Issuance of Amendment on Replacement of Steam Generators and Up-rated Power Operation, (September 29, 2003)	Westinghouse Framatome
17	N.A.	N.A. / N.A.	November 16, 2005	“Safety Evaluation related to Palo Verde Nuclear Generating Station, Units 1, 2, and 3 – Issuance of Amendments Re: Replacement of Steam Generators and Up-rated Power Operations and Associated Administrative Changes, (November 16, 2005).”	Westinghouse Framatome
18	CEN-310-P-A	0 / N.A.	April 1986	CPC Methodology Changes for the CPC Improvement Program (N001-1303-02283)	Westinghouse Framatome
19	CENPD-183-A	0 / N.A.	June 1984	Loss of Flow, C-E Methods for Loss of Flow Analysis (N001-1301-01203)	Westinghouse Framatome
20	CENPD-382-P-A	0 / N.A.	August 1993	Methodology for Core Designs Containing Erbium Burnable Absorbers (N001-0201-00035)	Westinghouse
21	CEN-386-P-A	0 / N.A.	August 1992	Verification of the Acceptability of a 1-Pin Burnup Limit of 60 MWD/kgU for Combustion Engineering 16 x 16 PWR Fuel (N001-0201-00042)	Westinghouse
22	WCAP-16500-P-A	0 / N.A.	August 2007	CE 16x16 Next Generation Fuel Core Reference Report (N001-0203-00614)	Westinghouse
22	WCAP-16500-P-A	0 / 1 Rev 1	December 2010	Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (N001-0205-00063)	Westinghouse Framatome
22	WCAP-16500-P-A	0 / 2-P-A	June 2016	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 Analysis (N001-0205-00048)	Westinghouse

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
23	WCAP-14565-P-A	0 / N.A.	October 1999	VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis (N001-0205-00002)	Westinghouse Framatome
23	WCAP-14565-P-A, Addendum 1-A	0 / N.A.	August 2004	Addendum 1 to WCAP-14565-P-A Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code (N001-0205-00003)	Westinghouse
23	WCAP-14565-P-A, Addendum 2-P-A	0 / N.A.	April 2008	Addendum 2 to WCAP-14565-P-A, Extended Applications of ABB-NV Correlation and Modified ABB-NV Correlation WLOP for PWR Low Pressure Applications (N001-0205-00004)	Westinghouse
24	CENPD-387-P-A	0 / N.A.	May 2000	ABB Critical Heat Flux Correlations for PWR Fuel (N001-0205-00042)	Westinghouse
25	WCAP-16523-P-A	0 / N.A.	August 2007	Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes (N001-0203-00615)	Westinghouse
26	WCAP-16072-P-A	0 / N.A.	August 2004	Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs (N001-0205-00226)	Westinghouse
27	EMF-2103P-A	3 / N.A.	June 2016	Realistic Large Break LOCA Methodology for Pressurized Water Reactors	Framatome
28	EMF-2328(P)(A)	0 / N.A.	March 2001	PWR Small Break LOCA Evaluation Model, S-RELAP5 Based	Framatome
28	EMF-2328(P)(A)	0 / 1(P)(A)	December 2016	PWR Small Break LOCA Evaluation Model, S-RELAP5 Based	Framatome
29	BAW-10231P-A	1 / N.A.	January 2004	COPERNIC Fuel Rod Design Computer Code	Framatome
30	BAW-10241P-A	2 / N.A.	September 2020	BHTP DNB Correlation Applied with LYNXT (N001-0206-00200)	Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
31	EPRI-NP-2511-CCM-A	Mod 02 / N.A.	Volume 1-4 (February 2017)	VIPRE-01: A Thermal Hydraulic Analysis Code for Reactor Cores	Westinghouse Framatome
31		Mod 02 / N.A.	Volume 5 (March 1988)	VIPRE-01: A Thermal Hydraulic Analysis Code for Reactor Cores	Westinghouse Framatome

a. Corresponds to the reference number specified in Technical Specification 5.6.5

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

3.1.1 - Shutdown Margin (SDM) - Reactor Trip Breakers Open

The Shutdown Margin shall be greater than or equal to that shown in Figure 3.1.1-1.

3.1.2 - Shutdown Margin (SDM) - Reactor Trip Breakers Closed

The Shutdown Margin shall be greater than or equal to that shown in Figure 3.1.2-1.

3.1.4 - Moderator Temperature Coefficient (MTC)

The moderator temperature coefficient (MTC) shall be within the area of Acceptable Operation shown in Figure 3.1.4-1.

3.1.5 - Control Element Assembly (CEA) Alignment

With one or more full-strength or part-strength CEAs misaligned from any other CEAs in its group by more than 6.6 inches, the minimum required MODES 1 and 2 core power reduction is specified in Figure 3.1.5-1. The required power reduction is based on the initial power before reducing power.

3.1.7 - Regulating CEA Insertion Limits

With COLSS IN SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits¹ shown in Figure 3.1.7-1²; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits¹ shown in Figure 3.1.7-2.² Regulating Groups 1 and 2 CEAs shall be maintained \geq fully withdrawn^{1, 3} while in Modes 1 and 2 (except while performing SR 3.1.5.3). When $\geq 20\%$ power Regulating Group 3 shall be maintained \geq fully withdrawn.^{1, 3}

¹ A reactor power cutback will cause either (Case 1) Regulating Group 5 or Regulating Group 4 and 5 to be dropped with no sequential insertion of additional Regulating Groups (Groups 1, 2, 3, and 4) or (Case 2) Regulating Group 5 or Regulating Group 4 and 5 to be dropped with all or part of the remaining Regulating Groups (Groups 1, 2, 3, and 4) being sequentially inserted. In either case, the Transient Insertion Limit and withdrawal sequence specified in the CORE OPERATING LIMITS REPORT can be exceeded for up to 2 hours.

² The Separation between Regulating Groups 4 and 5 may be reduced from the 90 inch value specified in Figures 3.1.7-1 and 3.1.7-2 provided that each of the following conditions are satisfied:

- a) Regulating Group 4 position is between 60 and 150 inches withdrawn.

- b) Regulating Group 5 position is maintained at least 10 inches lower than Regulating Group 4 position.
- c) Both Regulating Group 4 and Regulating Group 5 positions are maintained above the Transient Insertion Limit specified in Figure 3.1.7-1 (COLSS In Service) or Figure 3.1.7-2 (COLSS Out of Service).

³ Fully withdrawn (FW) is defined as $\geq 147.75''$ (Pulse Counter indication) and $\geq 145.25''$ (RSPT indication). No further CEA withdrawal above FW is required for CEAs' to meet the Transient Insertion Limit (TIL) requirements.

3.1.8 - Part Strength CEA Insertion Limits

The part strength CEA groups shall be limited to the insertion limits shown in Figure 3.1.8-1.

3.2.1 - Linear Heat Rate (LHR)

The linear heat rate limit shall be maintained in accordance with core burnup:

- 13.1 kW/ft for burnup < 400 EFPD
- 12.1 kW/ft for burnup \geq 400 EFPD

3.2.3 - Azimuthal Power Tilt (T_q)

The AZIMUTHAL POWER TILT (T_q) shall be less than or equal to 10% with COLSS IN SERVICE when power is greater than 20% and less than or equal to 50%. Additionally, the AZIMUTHAL POWER TILT (T_q) shall be less than or equal to 5% with COLSS IN SERVICE when power is greater than 50%. See Figure 3.2.3-1.

3.2.4 - Departure From Nucleate Boiling Ratio (DNBR)

COLSS IN SERVICE and Both CEACs INOPERABLE in Any OPERABLE CPC Channel - Maintain COLSS calculated core power less than or equal to COLSS calculated core power operation limit based on DNBR decreased by the allowance shown in Figure 3.2.4-1.

COLSS OUT OF SERVICE and CEAC(s) OPERABLE - Operate within the region of acceptable operation of Figure 3.2.4-2 using any operable CPC channel.

COLSS OUT OF SERVICE and Both CEACs INOPERABLE in Any OPERABLE CPC Channel - Operate within the region of acceptable operation of Figure 3.2.4-3 using any operable CPC channel with both CEACs INOPERABLE.

3.2.5 - Axial Shape Index (ASI)

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

COLSS OPERABLE

$-0.18 \leq \text{ASI} \leq 0.17$ for power $\geq 50\%$

$-0.28 \leq \text{ASI} \leq 0.17$ for power $>20\%$ and $< 50\%$

COLSS OUT OF SERVICE (CPC)

$-0.10 \leq \text{ASI} \leq 0.10$ for power $>20\%$

3.3.12 - Boron Dilution Alarm System (BDAS)

With one or both start-up channel high neutron flux alarms inoperable, the RCS boron concentration shall be determined at the applicable monitoring frequency specified in Tables 3.3.12-1 through 3.3.12-5.

3.9.1 - Boron Concentration

The boron concentration of all filled portions of the Reactor Coolant System and the refueling canal shall be maintained at a uniform concentration ≥ 3000 ppm.

4.2.1 - Fuel Assemblies

The Reactor Core contains the following fuel types:

- Westinghouse CE16STD with ZIRLO™ cladding
- Westinghouse CE16NGF with Optimized ZIRLO™ cladding
- No lead test assemblies

Refer to the ANALYTICAL METHODS Table for the methods applicable to a particular fuel type.

FIGURE 3.1.1-1
 SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
 REACTOR TRIP BREAKERS OPEN

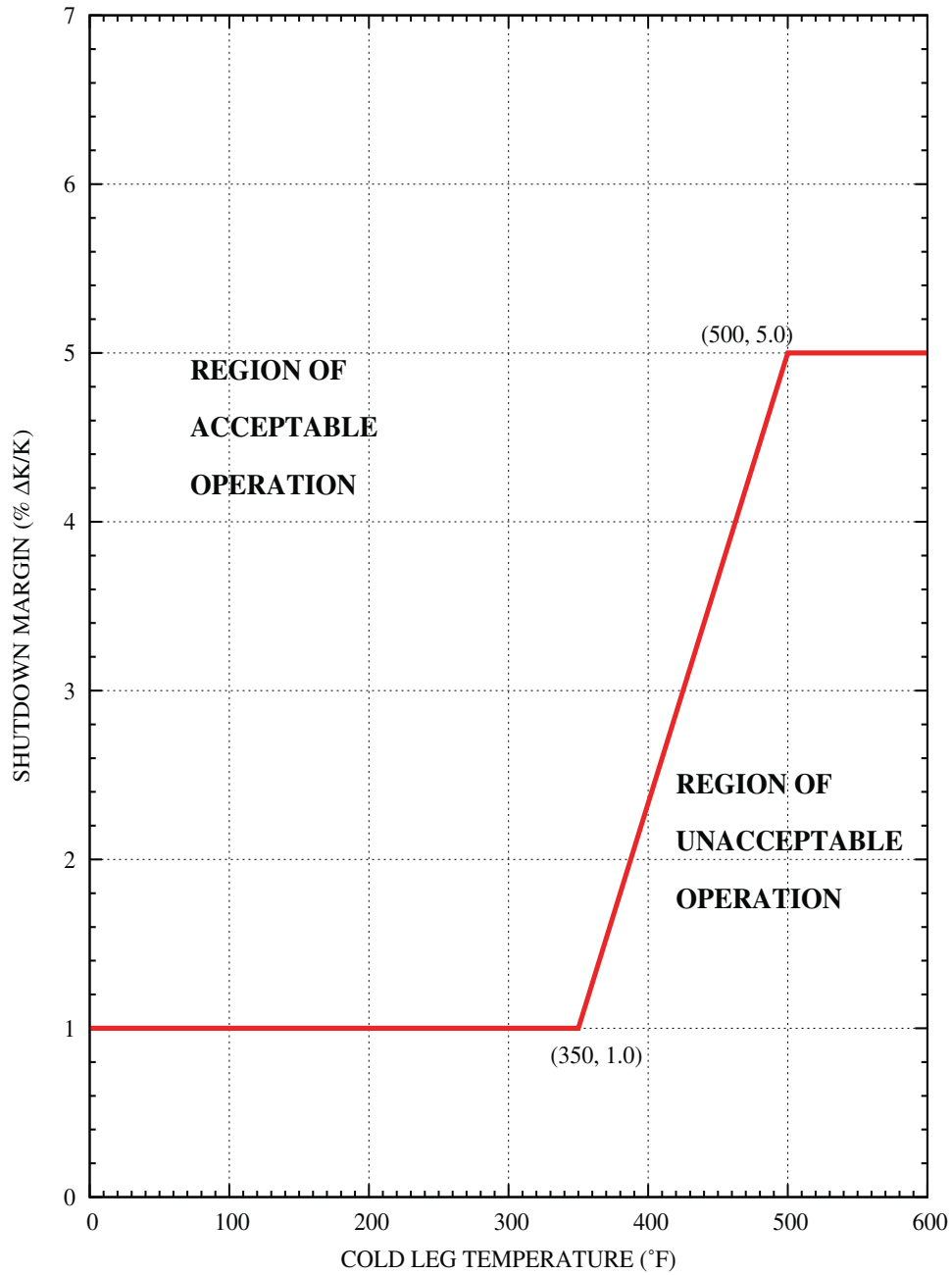


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

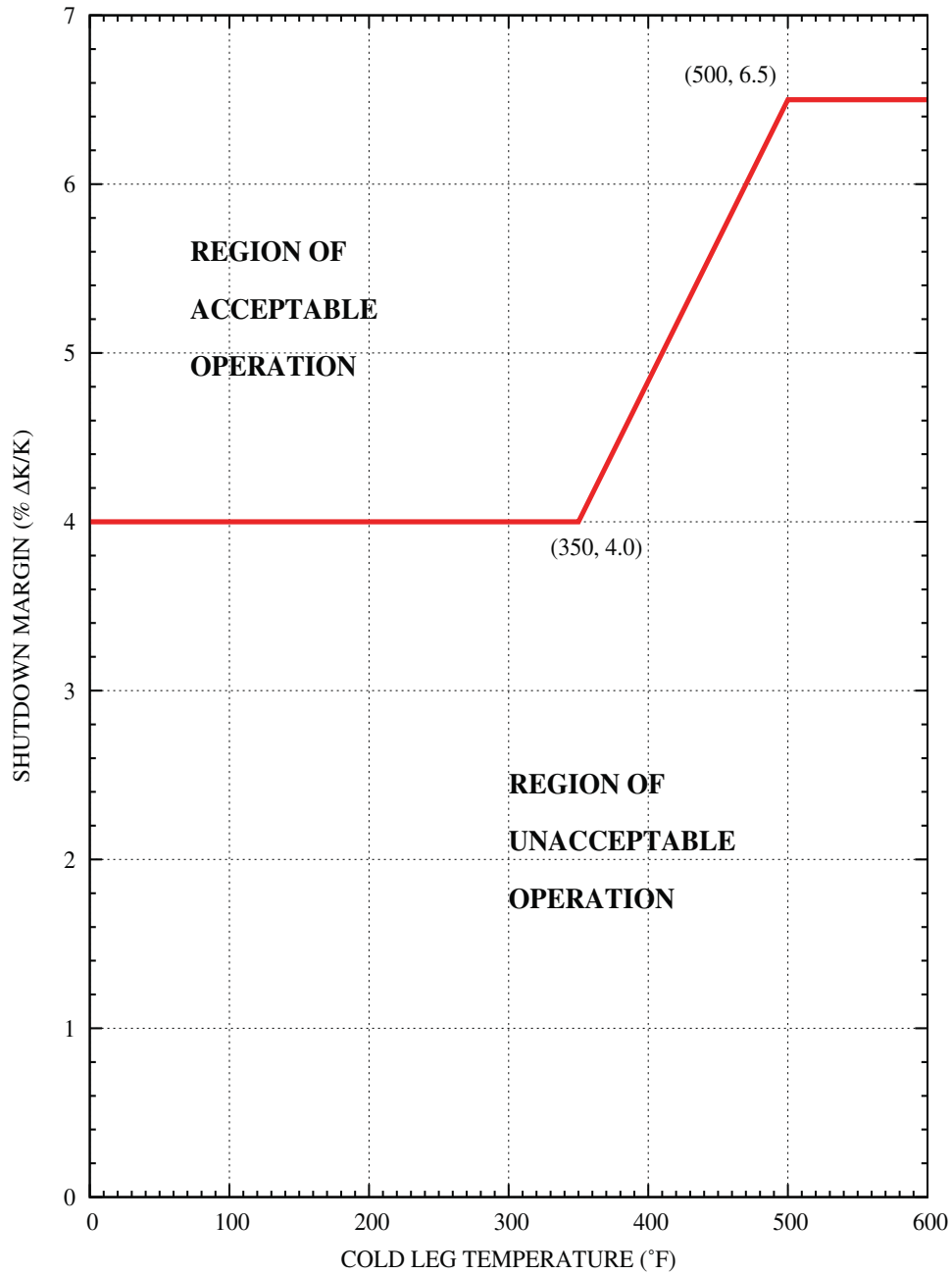


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

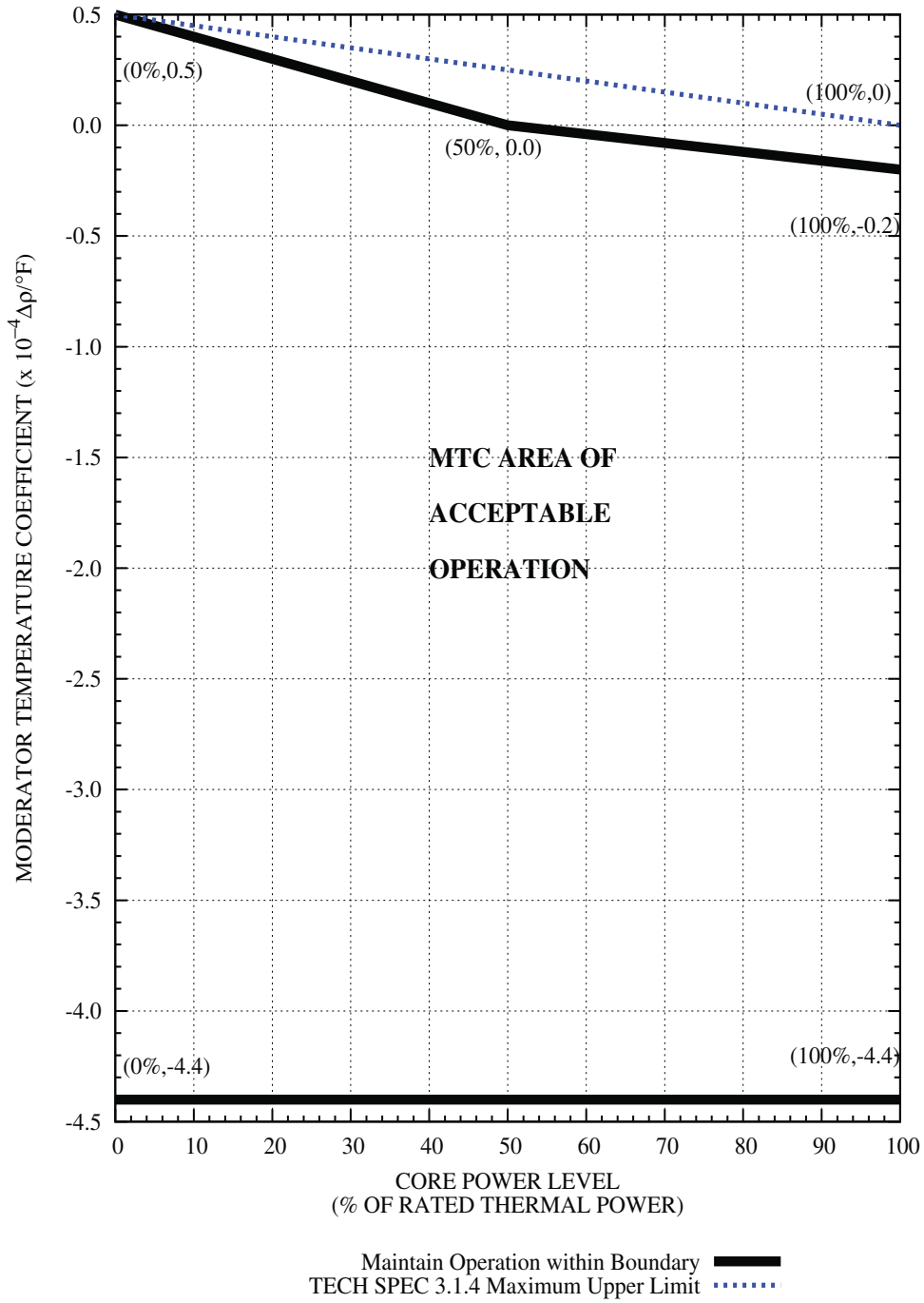
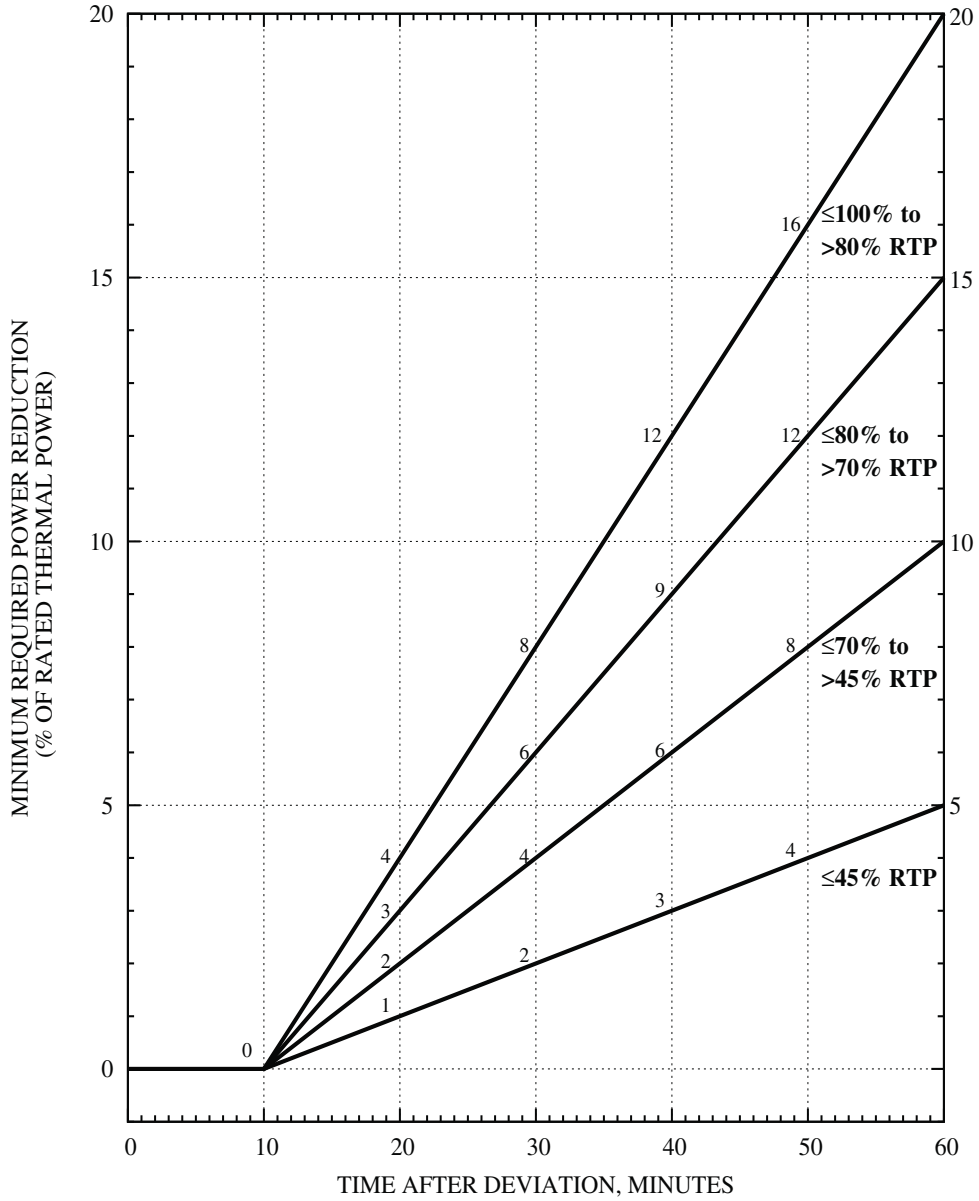


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

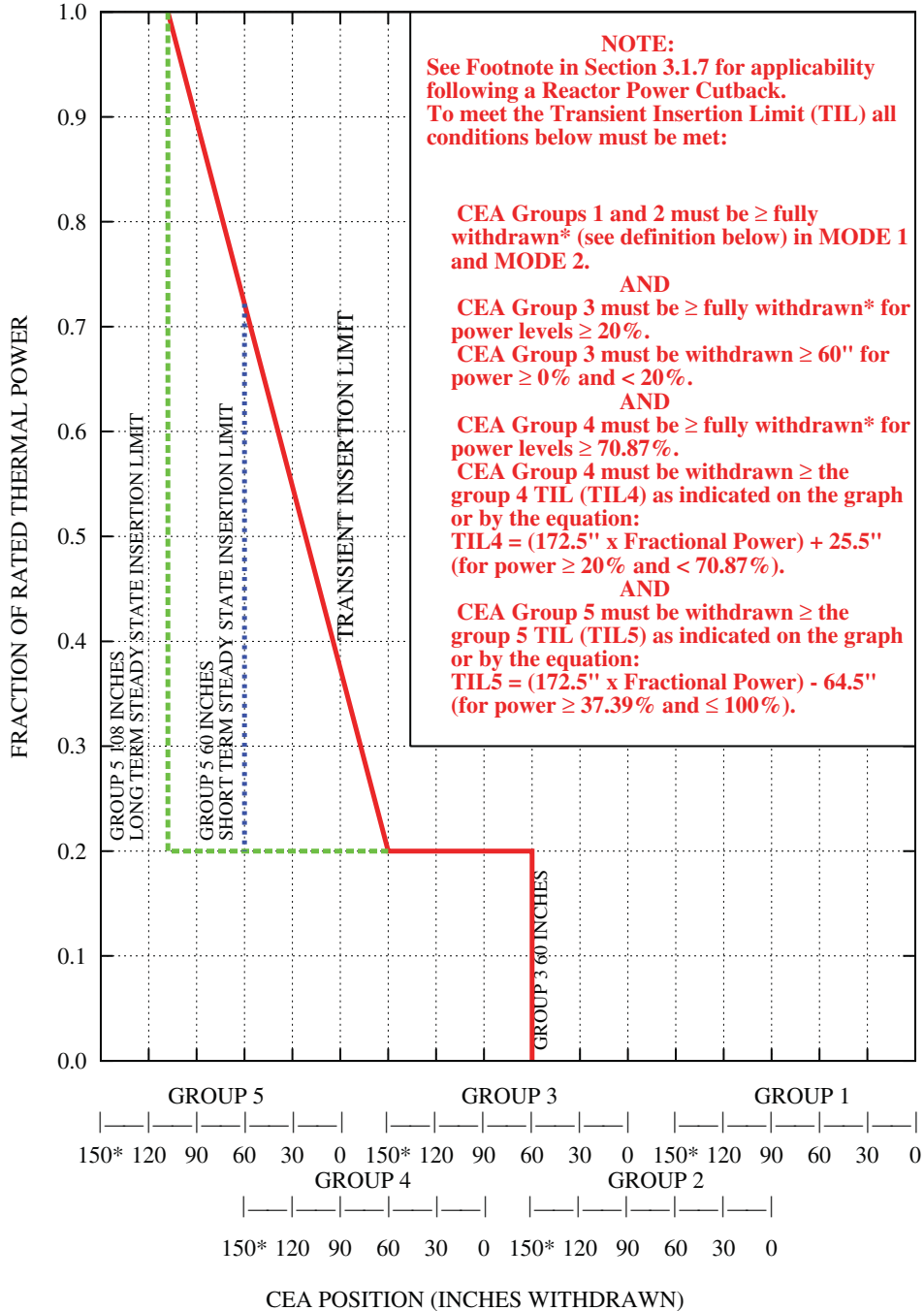


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

* NO POWER REDUCTION IS REQUIRED FOR A SINGLE CEA MISALIGNMENT IF THE FOLLOWING CONDITIONS ARE CONTINUOUSLY MET FROM THE TIME OF DEVIATION:

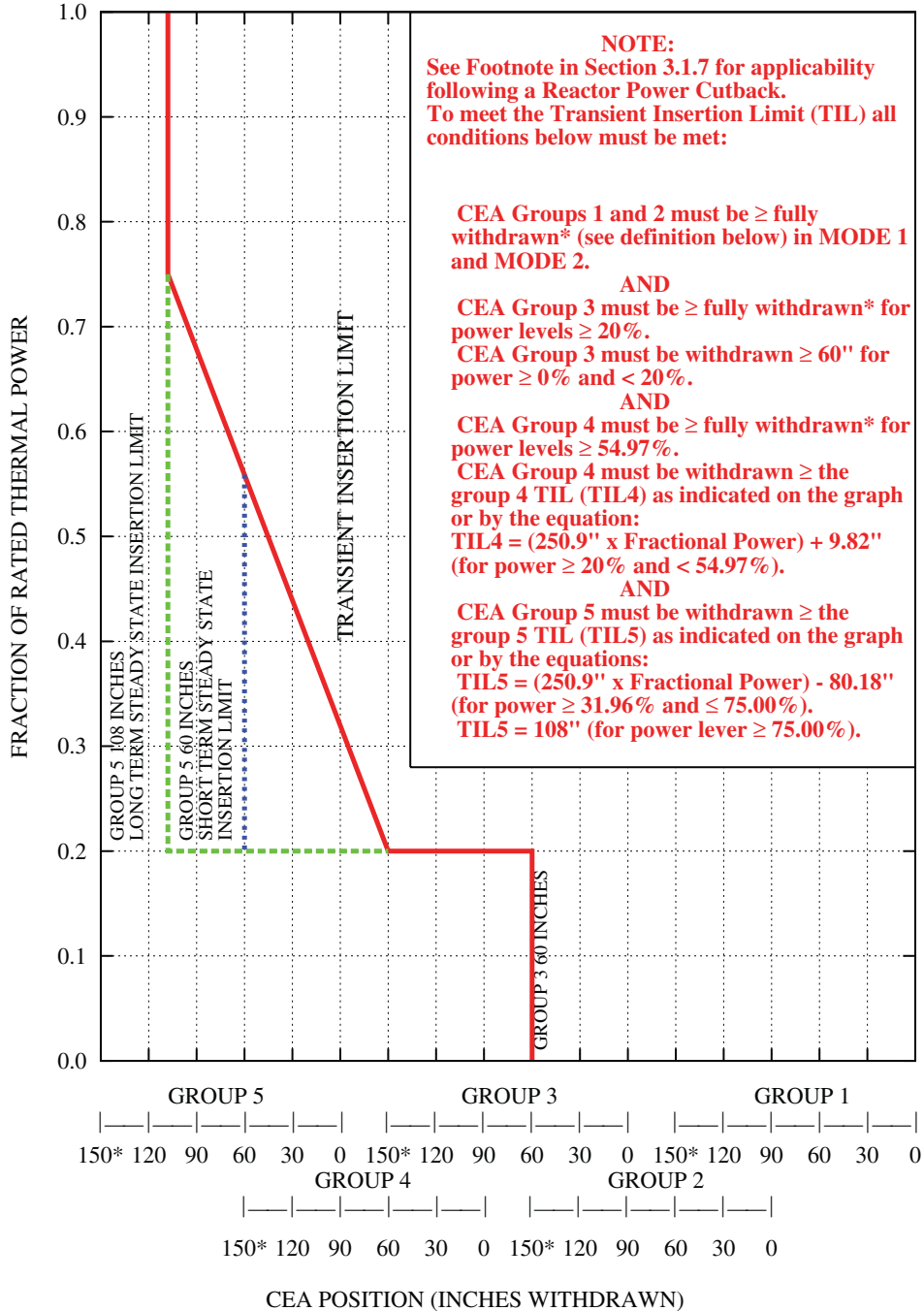
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

FIGURE 3.1.7-1
CEA INSERTION LIMITS VERSUS THERMAL POWER
(COLSS IN SERVICE)



* Fully Withdrawn (FW) is defined as ≥ 147.75" (Pulse Counter) and ≥ 145.25" (RSPT).
No further CEA withdrawal above FW is required for CEAs' to meet the TIL requirements.

FIGURE 3.1.7-2
CEA INSERTION LIMITS VERSUS THERMAL POWER
(COLSS OUT OF SERVICE)



* Fully Withdrawn (FW) is defined as \geq 147.75" (Pulse Counter) and \geq 145.25" (RSPT).
No further CEA withdrawal above FW is required for CEAs' to meet the TIL requirements.

FIGURE 3.1.8-1
PART STRENGTH CEA INSERTION LIMITS
VERSUS THERMAL POWER

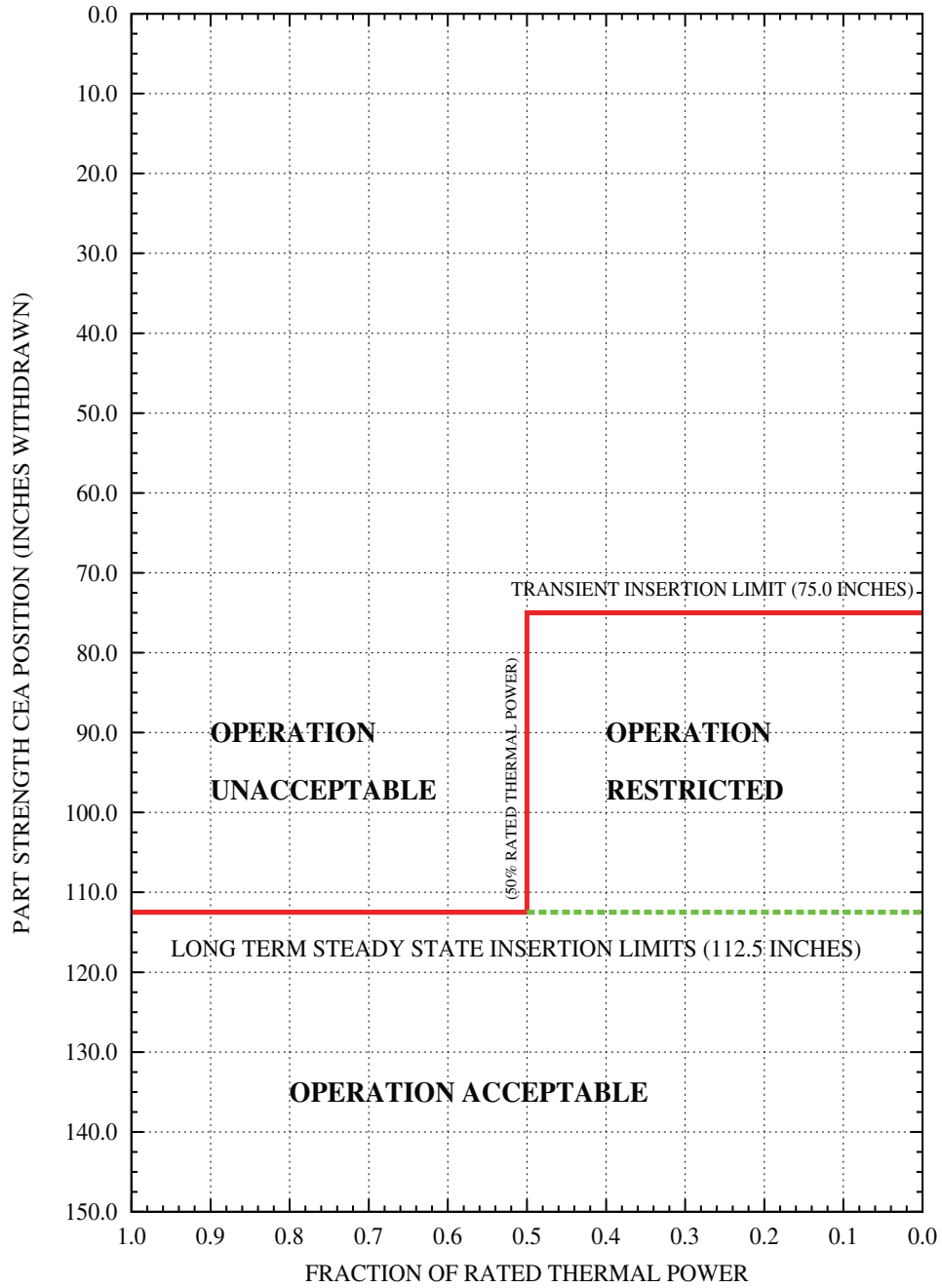


FIGURE 3.2.3-1
 AZIMUTHAL POWER TILT VERSUS THERMAL POWER
 (COLSS IN SERVICE)

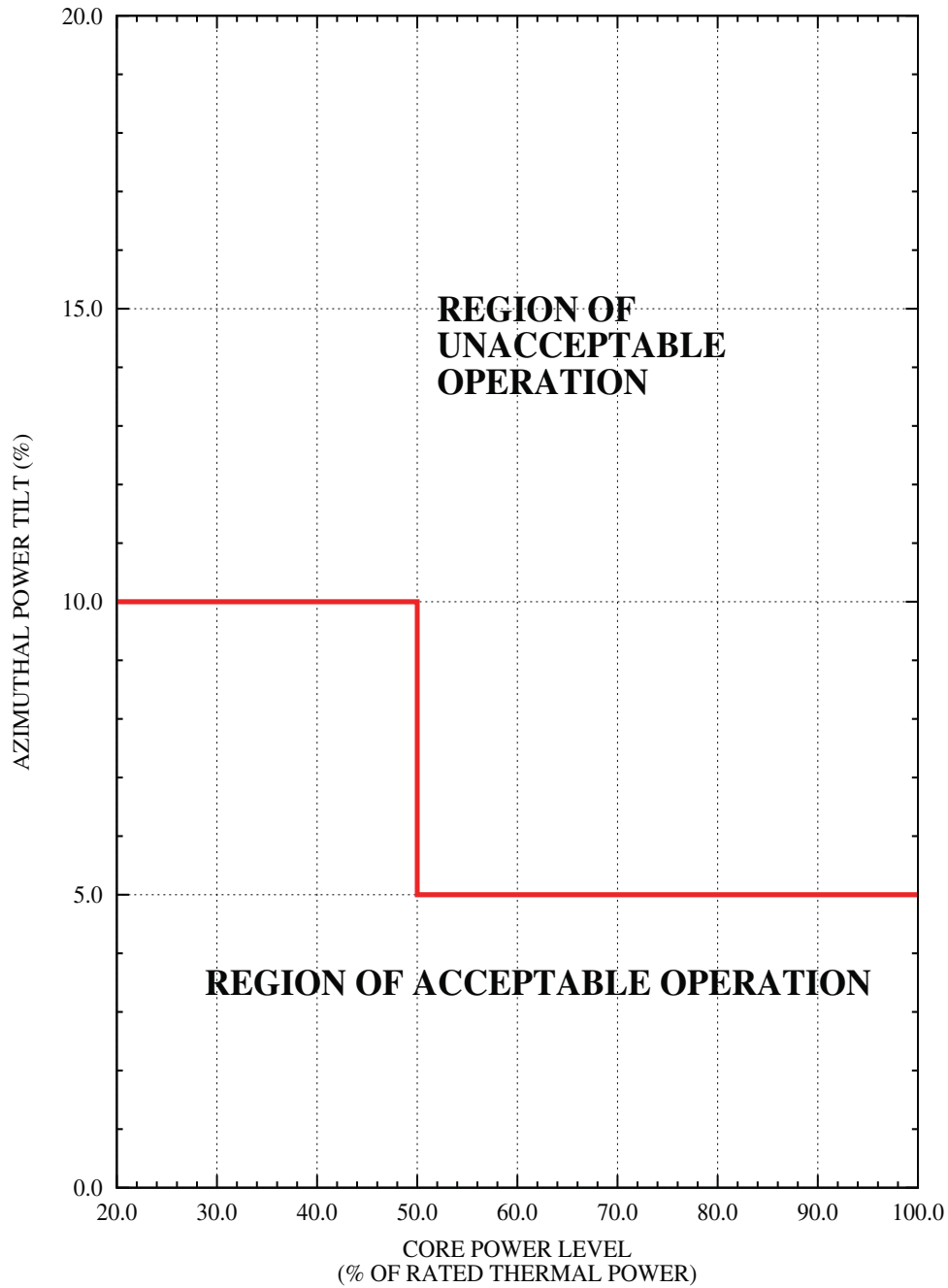


FIGURE 3.2.4-1
 COLSS DNBR OPERATING LIMIT
 ALLOWANCE FOR BOTH CEACs INOPERABLE
 IN ANY OPERABLE CPC CHANNEL

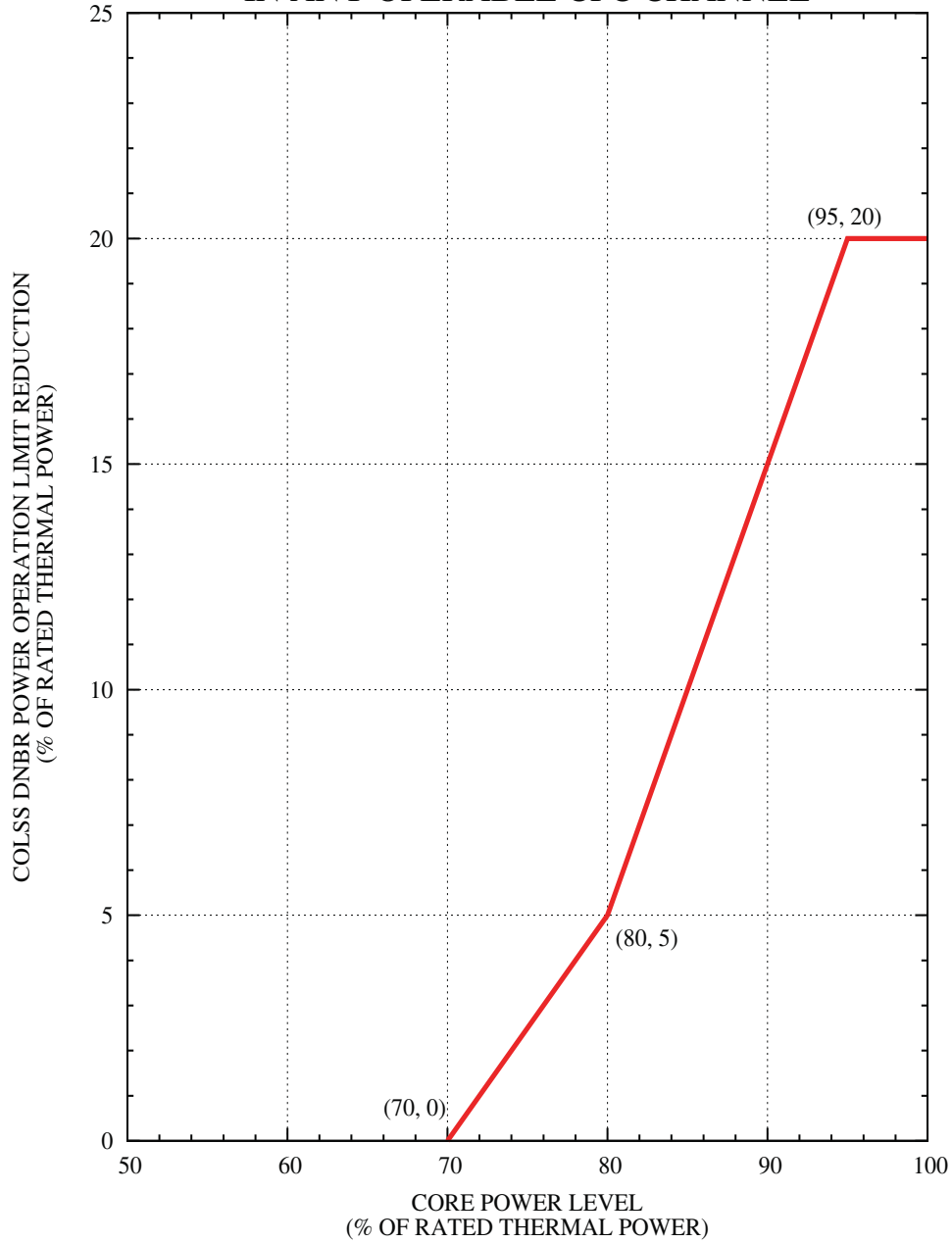


FIGURE 3.2.4-2
 DNBR MARGIN OPERATING LIMIT BASED ON
 THE CORE PROTECTION CALCULATORS
 (COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

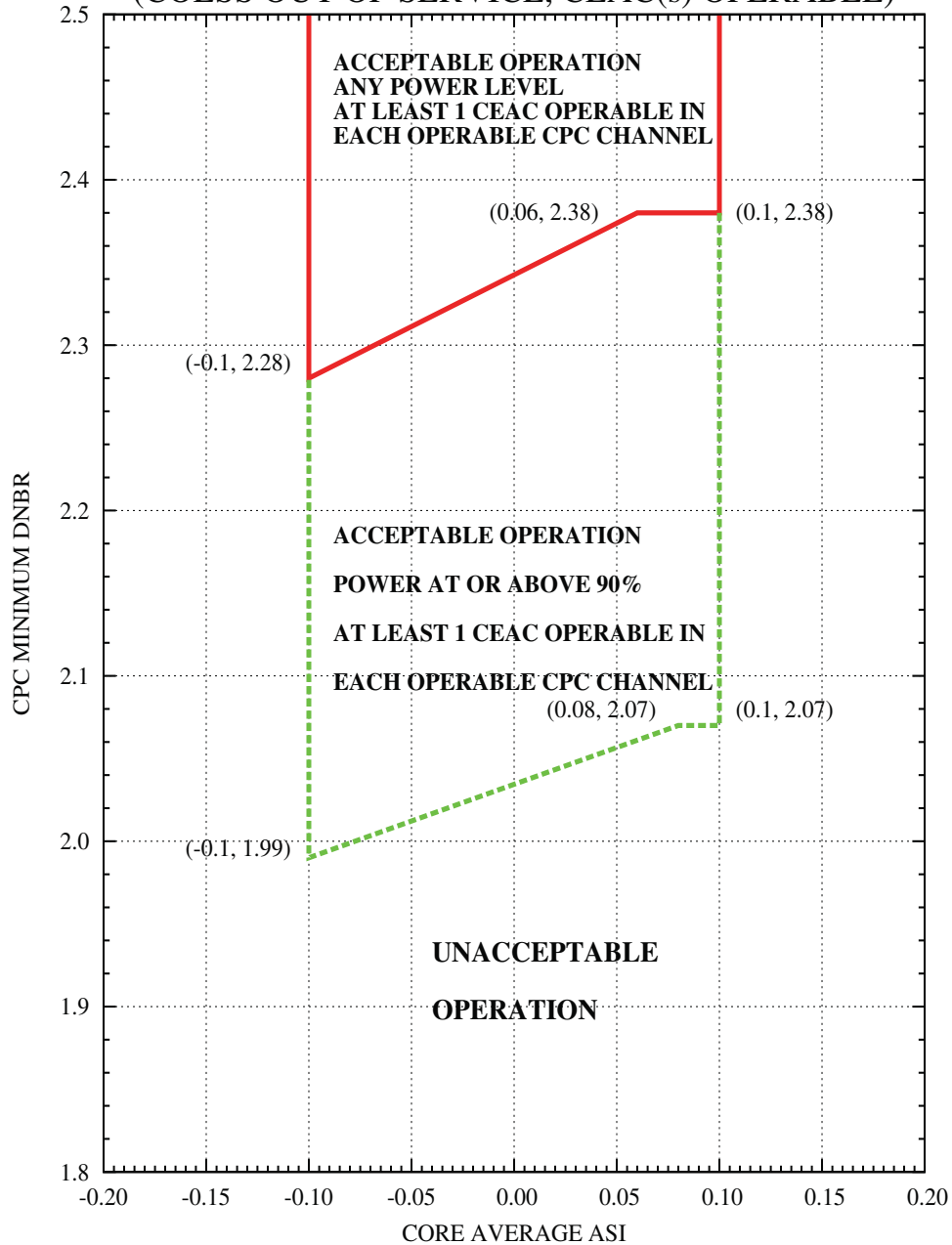


FIGURE 3.2.4-3
 DNBR MARGIN OPERATING LIMIT BASED ON
 THE CORE PROTECTION CALCULATORS
 (COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
 IN ANY OPERABLE CPC CHANNEL)

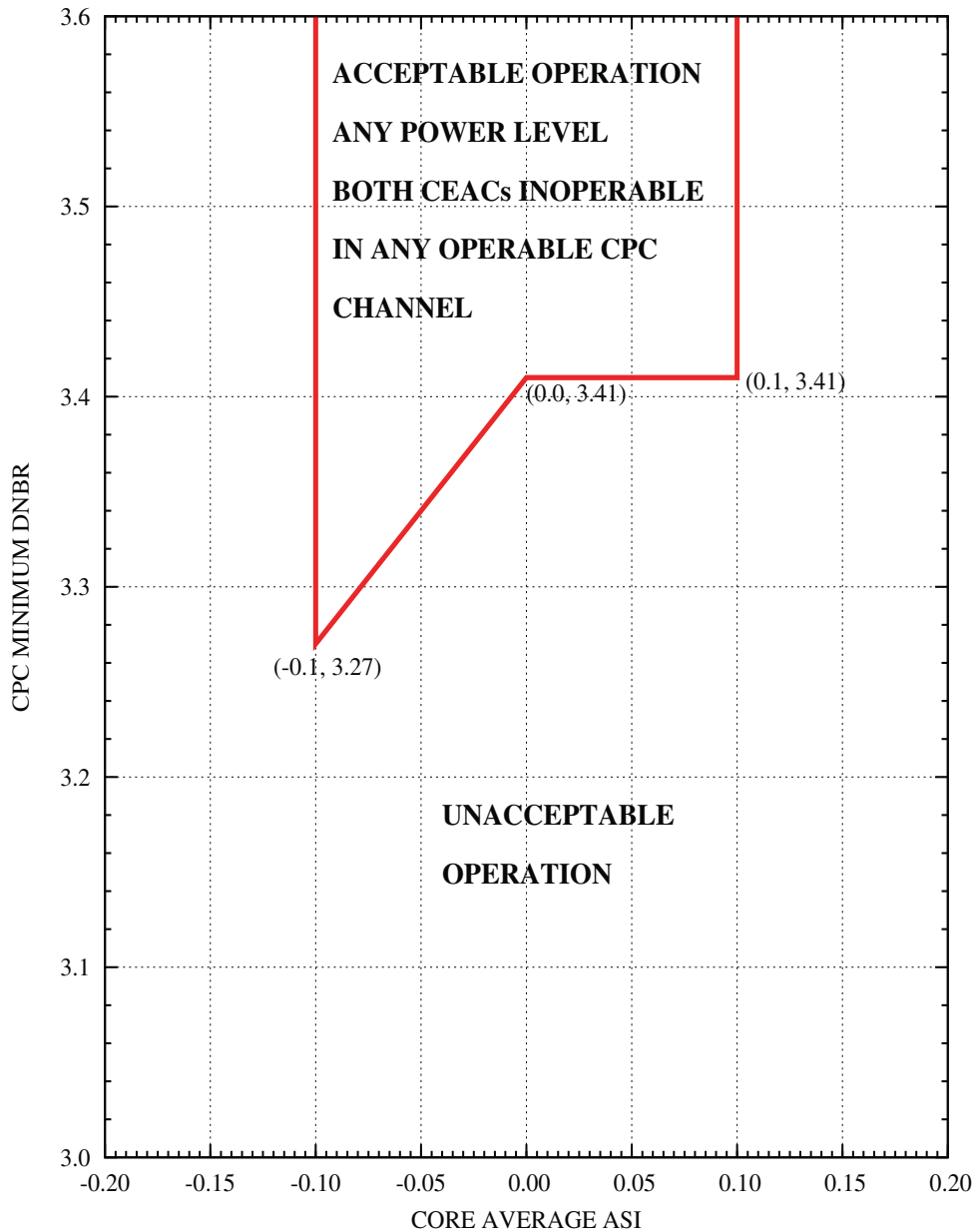


Table 3.3.12-1

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} > 0.98$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	0.5 hours	ONA	ONA
4 not on SCS	12 hours	0.5 hours	ONA	ONA
5 not on SCS	8 hours	0.5 hours	ONA	ONA
4 & 5 on SCS	ONA	ONA	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Table 3.3.12-2

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.98 \geq K_{\text{eff}} > 0.97$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	1 hour	0.5 hours	ONA
4 not on SCS	12 hours	1.5 hours	0.5 hours	ONA
5 not on SCS	8 hours	1.5 hours	0.5 hours	ONA
4 & 5 on SCS	8 hours	0.5 hours	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Table 3.3.12-3

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
 DILUTION DETECTION AS A FUNCTION OF OPERATING
 CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.97 \geq K_{eff} > 0.96$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	2.5 hours	1 hour	ONA
4 not on SCS	12 hours	2.5 hours	1 hour	0.5 hours
5 not on SCS	8 hours	2.5 hours	1 hour	0.5 hours
4 & 5 on SCS	8 hours	1 hour	ONA	ONA

Notes: SCS = Shutdown Cooling System
 ONA = Operation Not Allowed

Table 3.3.12-4

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.96 \geq K_{\text{eff}} > 0.95$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	3 hours	1 hour	0.5 hours
4 not on SCS	12 hours	3.5 hours	1.5 hours	0.75 hours
5 not on SCS	8 hours	3.5 hours	1.5 hours	0.75 hours
4 & 5 on SCS	8 hours	1.5 hours	0.5 hours	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Table 3.3.12-5

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} \leq 0.95$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	4 hours	1.5 hours	1 hour
4 not on SCS	12 hours	4.5 hours	2 hours	1 hour
5 not on SCS	8 hours	4.5 hours	2 hours	1 hour
4 & 5 on SCS	8 hours	2 hours	0.75 hours	ONA
6	24 hours	1.5 hours	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Enclosure 2

**Unit 2 Core Operating Limits Report
Revision 24**

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 2

CORE OPERATING LIMITS REPORT

Revision 24

Effective: January 20, 2022

Responsible Engineer Date	Gill, Shawn P(Z37857) Digitally signed by Gill, Shawn P(Z37857) Date: 2022.01.06 15:59:08 -07'00'
Design Verifier Date	Cowdin, Christopher r (Z12133) Digitally signed by Cowdin, Christopher (Z12133) Date: 2022.01.07 10:45:02 -07'00'
Responsible Section Leader Date	Karlson, Charles F(V55086) Digitally signed by Karlson, Charles F(V55086) Date: 2022.01.11 13:18:38 -07'00'

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This Report has been prepared in accordance with the requirements of Technical Specifications 4.2.1 and 5.6.5. The Core Operating Limits have been developed using the NRC approved methodologies specified in Section 5.6.5 b of the Palo Verde Technical Specifications.

AFFECTED PVNGS TECHNICAL SPECIFICATIONS

- 3.1.1 Shutdown Margin (SDM) - Reactor Trip Breakers Open
- 3.1.2 Shutdown Margin (SDM) - Reactor Trip Breakers Closed
- 3.1.4 Moderator Temperature Coefficient (MTC)
- 3.1.5 Control Element Assembly (CEA) Alignment
- 3.1.7 Regulating CEA Insertion Limits
- 3.1.8 Part Strength CEA Insertion Limits
- 3.2.1 Linear Heat Rate (LHR)
- 3.2.3 Azimuthal Power Tilt (T_q)
- 3.2.4 Departure From Nucleate Boiling Ratio (DNBR)
- 3.2.5 Axial Shape Index (ASI)
- 3.3.12 Boron Dilution Alarm System (BDAS)
- 3.9.1 Boron Concentration
- 4.2.1 Fuel Assemblies

ANALYTICAL METHODS

The COLR contains the complete identification for each of the Technical Specification referenced topical reports (i.e., report number, title, revision, date, and any supplements) and correspondence that provide the NRC-approved analytical methods used to determine the core operating limits, described in the following documents:

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
1	CENPD-0190-A	N.A. / N.A.	January 1976	CE Method for Control Element Assembly Ejection Analysis (N001-1301-01204)	Westinghouse Framatome
2	CENPD-266-P-A	N.A. / N.A.	April 1983	The ROCS and DIT Computer Codes for Nuclear Design (N001-1900-01412)	Westinghouse Framatome
3	NUREG-0852	N.A. / N.A.	November 1981	Safety Evaluation Report related to the Final Design of the Standard Nuclear Steam Supply Reference Systems CESSAR System 80, Docket No. STN 50-470	Westinghouse Framatome
3		N.A. / 1	March 1983		Westinghouse Framatome
3		N.A. / 2	September 1983		Westinghouse Framatome
3		N.A. / 3	December 1987		Westinghouse Framatome
4	CEN-356(V)-P-A	01-P-A / N.A.	May 1988	Modified Statistical Combination of Uncertainties (N001-1303-01747)	Westinghouse Framatome
4	Enclosure 1-P to LD-82-054	N.A. / 1-P	February 1993	System 80 TM Inlet Flow Distribution (N001-1301-01228)	Westinghouse Framatome
5	CENPD-132 P	N.A. / N.A.	August 1974	Calculative Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132P	N.A./ 1	February 1975	Calculational Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132-P	N.A. / 2-P	July 1975	Calculational Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132	N.A. / 3-P-A	June 1985	Calculative Methods for the C-E Large Break LOCA Evaluation Model for the Analysis of C-E and <u>W</u> Designed NSSS	Westinghouse

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
5	CENPD-132	N.A. / 4-P-A Rev. 1	March 2001	Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model (N001-1900-01192)	Westinghouse
5	CENPD-132- P-A	N.A. / 4-P-A Addendum 1-P- A	August 2007	Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model (N001-0205-00046)	Westinghouse
5	CENPD-132	N.A. / SUPP 4-P-A APP A-Rev. 004	Decem- ber 2008	Revision 4 to the Supplement to Appen- dix A of CENPD-132 Supplement 4-P-A (N001-0205-00229)	Westinghouse
6	CENPD-137-P	N.A. / N.A.	August 1974	Calculative Methods for the C-E Small Break LOCA Evaluation Model	Westinghouse
6	CENPD-137	N.A. / 1-P	January 1977	Calculative Methods for the C-E Small Break LOCA Evaluation Model	Westinghouse
6	CENPD-137	N.A. / 2-P-A	April 1998	Calculative Methods for the ABB C-E Small Break LOCA Evaluation Model (N001-1900-01185)	Westinghouse
7	N.A.	N.A. / N.A.	June 13, 1975	Letter: O.D. Parr (NRC) to F. M. Stern (CE), (NRC Staff Review of the Combustion Engineering ECCS Evaluation Model). NRC approval for: 5.6.5.b.6.	Westinghouse
8	N.A.	N.A. / N.A.	Septem- ber 27, 1977	Letter: K. Kniel (NRC) to A. E. Scherer (CE), (Evaluation of Topical Reports CENPD 133, Supplement 3-P and CENPD-137, Supplement 1-P). NRC approval for 5.6.5.b.6.	Westinghouse
9	CEN-372-P-A	N.A. / N.A.	May 1990	Fuel Rod Maximum Allowable Pressure (N001-0201-00026)	Westinghouse
10	N.A.	N.A. / N.A.	April 10, 1990	Letter: A. C. Thadani (NRC) to A. E. Scherer (CE), ("Acceptance for Reference CE Topical Report CEN-372- P"). NRC approval for 5.6.5.b.9.	Westinghouse
11	NFM-005	1 / N.A.	August 2007	Arizona Public Service Company PWR Reactor Physics Methodology Using CASMO-4/SIMULATE-3 (NFM-005)	Westinghouse Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
12	CENPD-282-P-A Vols. 1	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 1 (CENTS-TD MANUAL-VOL 1)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 2	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 2 (CENTS-TD MANUAL-VOL 2)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 3	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 3 (CENTS-TD MANUAL-VOL 3)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 4	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 4 (CENTS-TD MANUAL-VOL 4)	Westinghouse Framatome
13	CENPD-404-P-A	0 / N.A.	November 2001	Implementation of ZIRLO™ Cladding Material in CE Nuclear Power Fuel Assembly Designs (N001-1900-01329)	Westinghouse
13	CENPD-404-P-A Addendum 1-A	0 / N.A.	July 2006	Optimized ZIRLO™ (N001-0203-00611)	Westinghouse
13	CENPD-404-P-A Addendum 2-A	0 / N.A.	October 2013	Westinghouse Clad Corrosion Model for ZIRLO and Optimized ZIRLO™ (N001-0205-00006)	Westinghouse
14	CENPD-188-A	N.A. / N.A.	July 1976	HERMITE, A Multi-Dimensional Space-Time Kinetics Code for PWR Transients (HERMITE-TOPICAL)	Westinghouse Framatome
15	CENPD-161-P-A	N.A. / N.A.	April 1986	TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core (N001-1301-01202)	Westinghouse
16	CEN-160(S)-P	1-P / N.A.	September 1981	CETOP-D Code Structures and Modeling Methods for San Onofre Nuclear Generating Station Units 2 and 3 (N001-1301-01185)	Westinghouse Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
17	N.A.	N.A. / N.A.	September 29, 2003	“Safety Evaluation related to Palo Verde Nuclear Generating Station, Unit 2 (PVNGS-2) Issuance of Amendment on Replacement of Steam Generators and Up-rated Power Operation, (September 29, 2003)	Westinghouse Framatome
17	N.A.	N.A. / N.A.	November 16, 2005	“Safety Evaluation related to Palo Verde Nuclear Generating Station, Units 1, 2, and 3 – Issuance of Amendments Re: Replacement of Steam Generators and Up-rated Power Operations and Associated Administrative Changes, (November 16, 2005).”	Westinghouse Framatome
18	CEN-310-P-A	0 / N.A.	April 1986	CPC Methodology Changes for the CPC Improvement Program (N001-1303-02283)	Westinghouse Framatome
19	CENPD-183-A	0 / N.A.	June 1984	Loss of Flow, C-E Methods for Loss of Flow Analysis (N001-1301-01203)	Westinghouse Framatome
20	CENPD-382-P-A	0 / N.A.	August 1993	Methodology for Core Designs Containing Erbium Burnable Absorbers (N001-0201-00035)	Westinghouse
21	CEN-386-P-A	0 / N.A.	August 1992	Verification of the Acceptability of a 1-Pin Burnup Limit of 60 MWD/kgU for Combustion Engineering 16 x 16 PWR Fuel (N001-0201-00042)	Westinghouse
22	WCAP-16500-P-A	0 / N.A.	August 2007	CE 16x16 Next Generation Fuel Core Reference Report (N001-0203-00614)	Westinghouse
22	WCAP-16500-P-A	0 / 1 Rev 1	December 2010	Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (N001-0205-00063)	Westinghouse Framatome
22	WCAP-16500-P-A	0 / 2-P-A	June 2016	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 Analysis (N001-0205-00048)	Westinghouse

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
23	WCAP-14565-P-A	0 / N.A.	October 1999	VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis (N001-0205-00002)	Westinghouse Framatome
23	WCAP-14565-P-A, Addendum 1-A	0 / N.A.	August 2004	Addendum 1 to WCAP-14565-P-A Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code (N001-0205-00003)	Westinghouse
23	WCAP-14565-P-A, Addendum 2-P-A	0 / N.A.	April 2008	Addendum 2 to WCAP-14565-P-A, Extended Applications of ABB-NV Correlation and Modified ABB-NV Correlation WLOP for PWR Low Pressure Applications (N001-0205-00004)	Westinghouse
24	CENPD-387-P-A	0 / N.A.	May 2000	ABB Critical Heat Flux Correlations for PWR Fuel (N001-0205-00042)	Westinghouse
25	WCAP-16523-P-A	0 / N.A.	August 2007	Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes (N001-0203-00615)	Westinghouse
26	WCAP-16072-P-A	0 / N.A.	August 2004	Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs (N001-0205-00226)	Westinghouse
27	EMF-2103P-A	3 / N.A.	June 2016	Realistic Large Break LOCA Methodology for Pressurized Water Reactors	Framatome
28	EMF-2328(P)(A)	0 / N.A.	March 2001	PWR Small Break LOCA Evaluation Model, S-RELAP5 Based	Framatome
28	EMF-2328(P)(A)	0 / 1(P)(A)	December 2016	PWR Small Break LOCA Evaluation Model, S-RELAP5 Based	Framatome
29	BAW-10231P-A	1 / N.A.	January 2004	COPERNIC Fuel Rod Design Computer Code	Framatome
30	BAW-10241P-A	2 / N.A.	September 2020	BHTP DNB Correlation Applied with LYNXT (N001-0206-00200)	Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
31	EPRI-NP-2511-CCM-A	Mod 02 / N.A.	Volume 1-4 (February 2017)	VIPRE-01: A Thermal Hydraulic Analysis Code for Reactor Cores	Westinghouse Framatome
31		Mod 02 / N.A.	Volume 5 (March 1988)	VIPRE-01: A Thermal Hydraulic Analysis Code for Reactor Cores	Westinghouse Framatome

a. Corresponds to the reference number specified in Technical Specification 5.6.5

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

3.1.1 - Shutdown Margin (SDM) - Reactor Trip Breakers Open

The Shutdown Margin shall be greater than or equal to that shown in Figure 3.1.1-1.

3.1.2 - Shutdown Margin (SDM) - Reactor Trip Breakers Closed

The Shutdown Margin shall be greater than or equal to that shown in Figure 3.1.2-1.

3.1.4 - Moderator Temperature Coefficient (MTC)

The moderator temperature coefficient (MTC) shall be within the area of Acceptable Operation shown in Figure 3.1.4-1.

3.1.5 - Control Element Assembly (CEA) Alignment

With one or more full-strength or part-strength CEAs misaligned from any other CEAs in its group by more than 6.6 inches, the minimum required MODES 1 and 2 core power reduction is specified in Figure 3.1.5-1. The required power reduction is based on the initial power before reducing power.

3.1.7 - Regulating CEA Insertion Limits

With COLSS IN SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits¹ shown in Figure 3.1.7-1²; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits¹ shown in Figure 3.1.7-2.² Regulating Groups 1 and 2 CEAs shall be maintained \geq fully withdrawn^{1, 3} while in Modes 1 and 2 (except while performing SR 3.1.5.3). When \geq 20% power Regulating Group 3 shall be maintained \geq fully withdrawn.^{1, 3}

¹ A reactor power cutback will cause either (Case 1) Regulating Group 5 or Regulating Group 4 and 5 to be dropped with no sequential insertion of additional Regulating Groups (Groups 1, 2, 3, and 4) or (Case 2) Regulating Group 5 or Regulating Group 4 and 5 to be dropped with all or part of the remaining Regulating Groups (Groups 1, 2, 3, and 4) being sequentially inserted. In either case, the Transient Insertion Limit and withdrawal sequence specified in the CORE OPERATING LIMITS REPORT can be exceeded for up to 2 hours.

² The Separation between Regulating Groups 4 and 5 may be reduced from the 90 inch value specified in Figures 3.1.7-1 and 3.1.7-2 provided that each of the following conditions are satisfied:

- a) Regulating Group 4 position is between 60 and 150 inches withdrawn.

- b) Regulating Group 5 position is maintained at least 10 inches lower than Regulating Group 4 position.
- c) Both Regulating Group 4 and Regulating Group 5 positions are maintained above the Transient Insertion Limit specified in Figure 3.1.7-1 (COLSS In Service) or Figure 3.1.7-2 (COLSS Out of Service).

³ Fully withdrawn (FW) is defined as $\geq 147.75''$ (Pulse Counter indication) and $\geq 145.25''$ (RSPT indication). No further CEA withdrawal above FW is required for CEAs' to meet the Transient Insertion Limit (TIL) requirements.

3.1.8 - Part Strength CEA Insertion Limits

The part strength CEA groups shall be limited to the insertion limits shown in Figure 3.1.8-1.

3.2.1 - Linear Heat Rate (LHR)

The linear heat rate limit of 13.1 kW/ft shall be maintained.

3.2.3 - Azimuthal Power Tilt (T_q)

The AZIMUTHAL POWER TILT (T_q) shall be less than or equal to 10% with COLSS IN SERVICE when power is greater than 20% and less than or equal to 50%. Additionally, the AZIMUTHAL POWER TILT (T_q) shall be less than or equal to 5% with COLSS IN SERVICE when power is greater than 50%. See Figure 3.2.3-1.

3.2.4 - Departure From Nucleate Boiling Ratio (DNBR)

COLSS IN SERVICE and Both CEACs INOPERABLE in Any OPERABLE CPC Channel - Maintain COLSS calculated core power less than or equal to COLSS calculated core power operation limit based on DNBR decreased by the allowance shown in Figure 3.2.4-1.

COLSS OUT OF SERVICE and CEAC(s) OPERABLE - Operate within the region of acceptable operation of Figure 3.2.4-2 using any operable CPC channel.

COLSS OUT OF SERVICE and Both CEACs INOPERABLE in Any OPERABLE CPC Channel - Operate within the region of acceptable operation of Figure 3.2.4-3 using any operable CPC channel with both CEACs INOPERABLE.

3.2.5 - Axial Shape Index (ASI)

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

COLSS OPERABLE

$-0.18 \leq \text{ASI} \leq 0.17$ for power $\geq 50\%$

$-0.28 \leq \text{ASI} \leq 0.17$ for power $>20\%$ and $< 50\%$

COLSS OUT OF SERVICE (CPC)

$-0.10 \leq \text{ASI} \leq 0.10$ for power $>20\%$

3.3.12 - Boron Dilution Alarm System (BDAS)

With one or both start-up channel high neutron flux alarms inoperable, the RCS boron concentration shall be determined at the applicable monitoring frequency specified in Tables 3.3.12-1 through 3.3.12-5.

3.9.1 - Boron Concentration

The boron concentration of all filled portions of the Reactor Coolant System and the refueling canal shall be maintained at a uniform concentration ≥ 3000 ppm.

4.2.1 - Fuel Assemblies

The Reactor Core contains the following fuel types:

- Westinghouse CE16STD with ZIRLO™ cladding
- Framatome CE16HTP with M5® cladding
- No lead test assemblies

Refer to the ANALYTICAL METHODS Table for the methods applicable to a particular fuel type.

FIGURE 3.1.1-1
 SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
 REACTOR TRIP BREAKERS OPEN

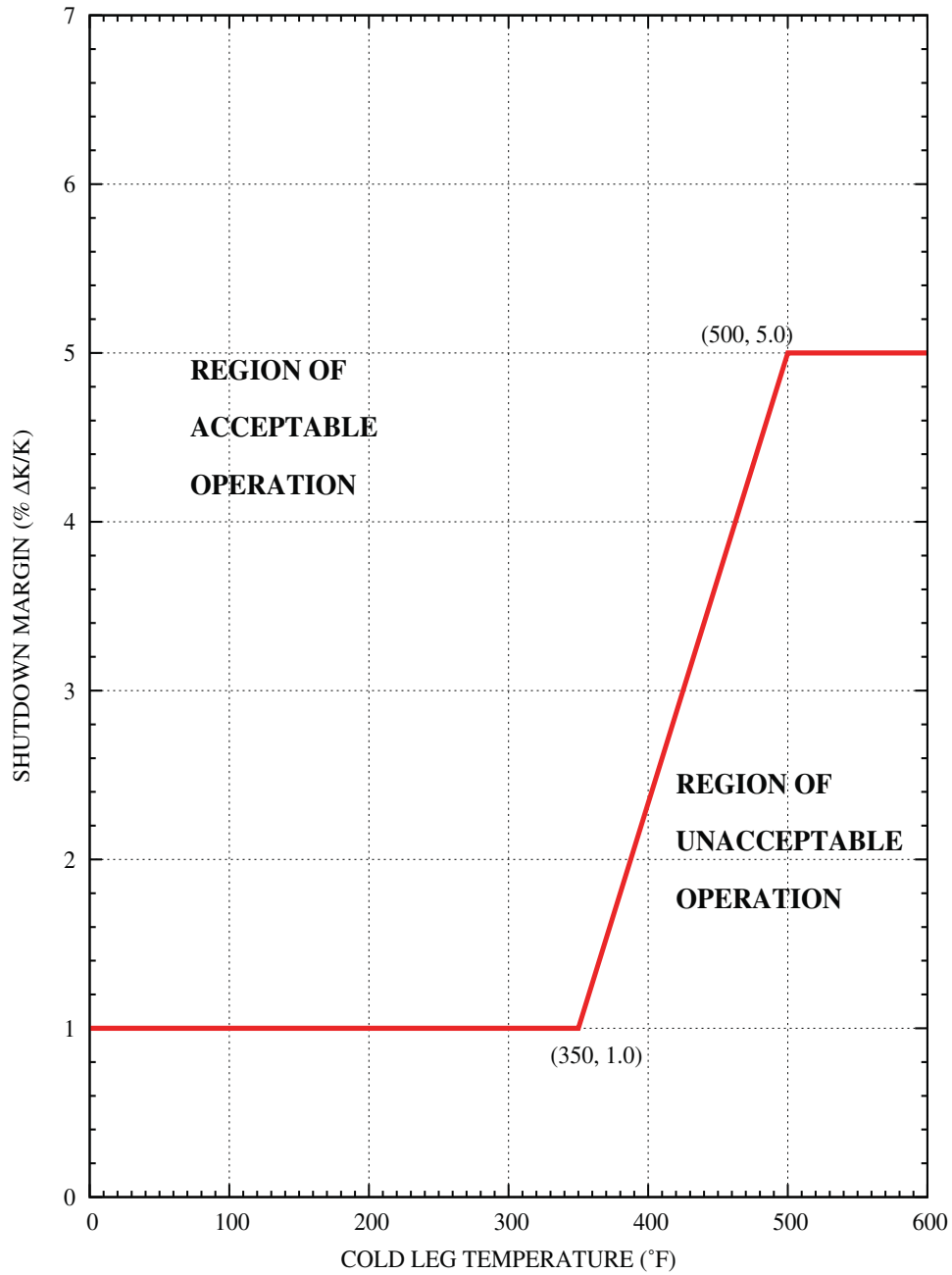


FIGURE 3.1.2-1
 SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
 REACTOR TRIP BREAKERS CLOSED

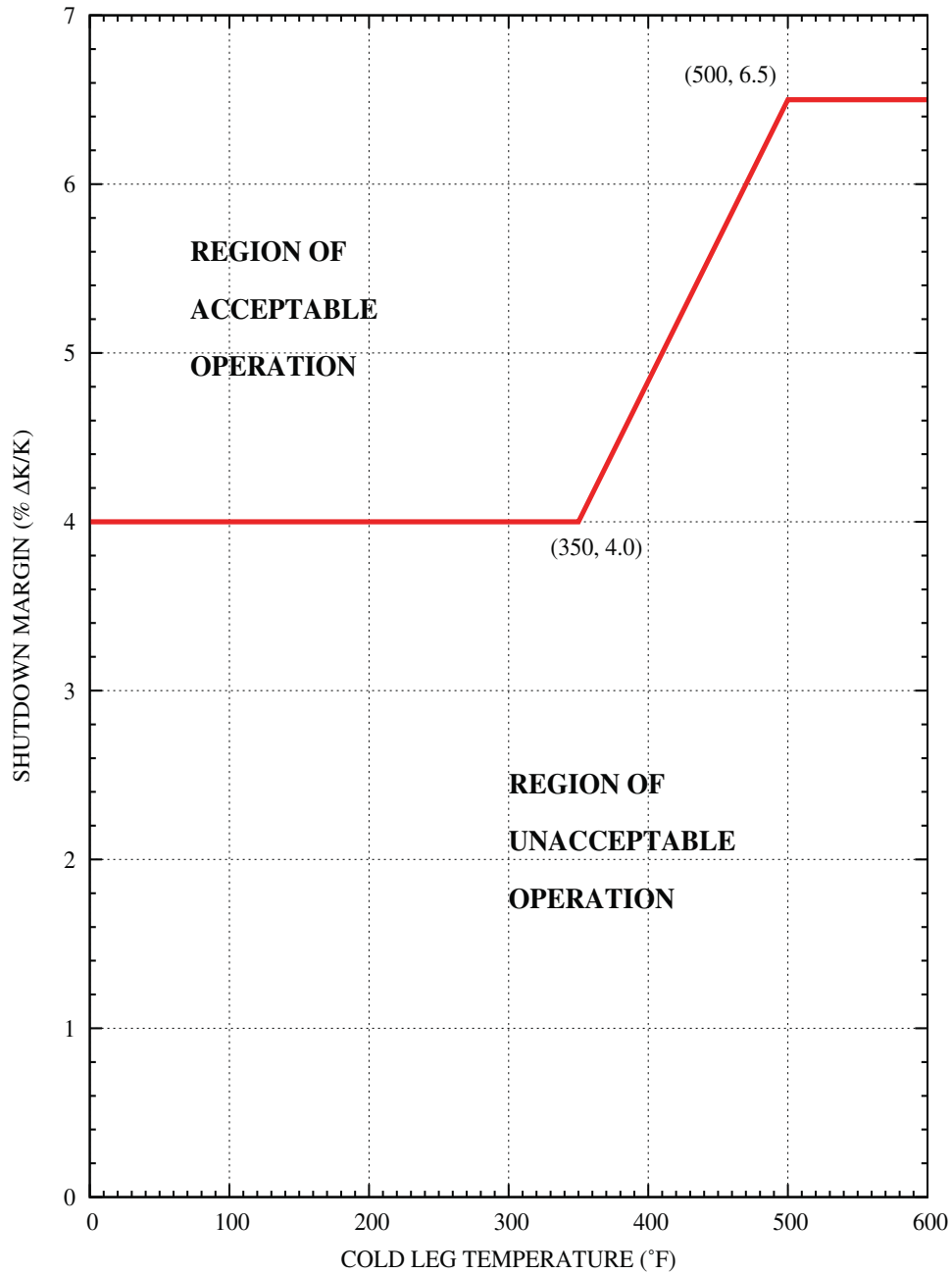


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

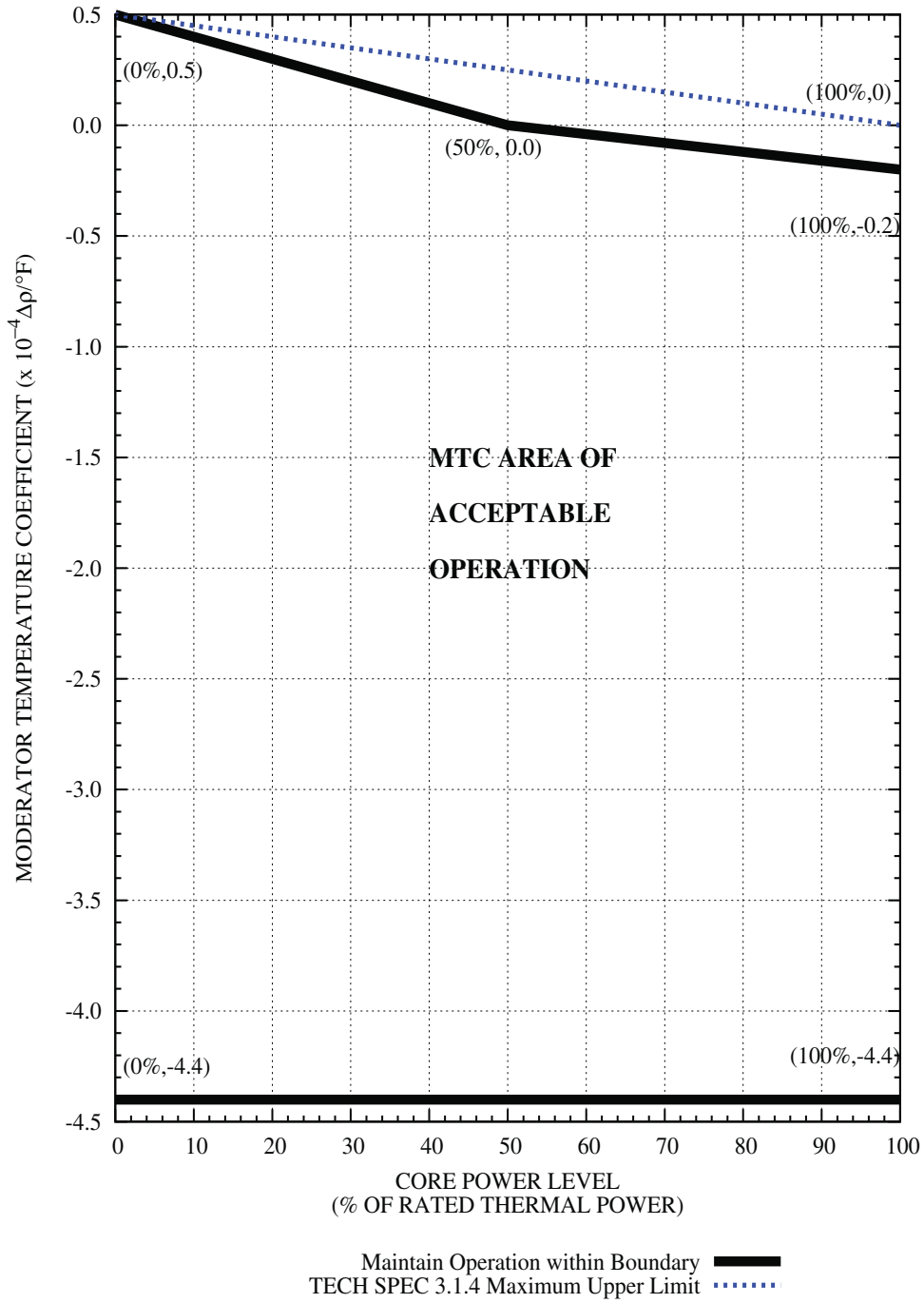
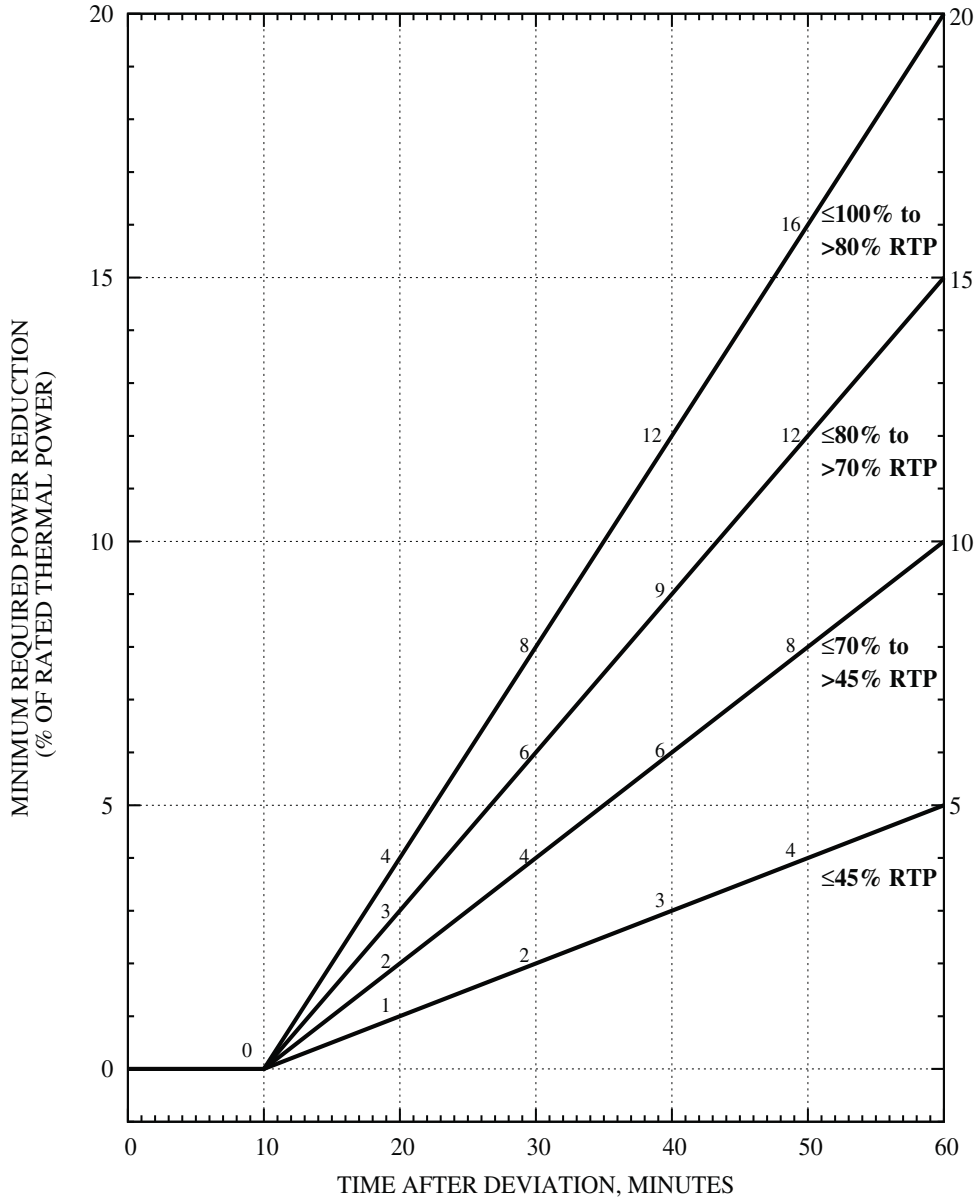


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

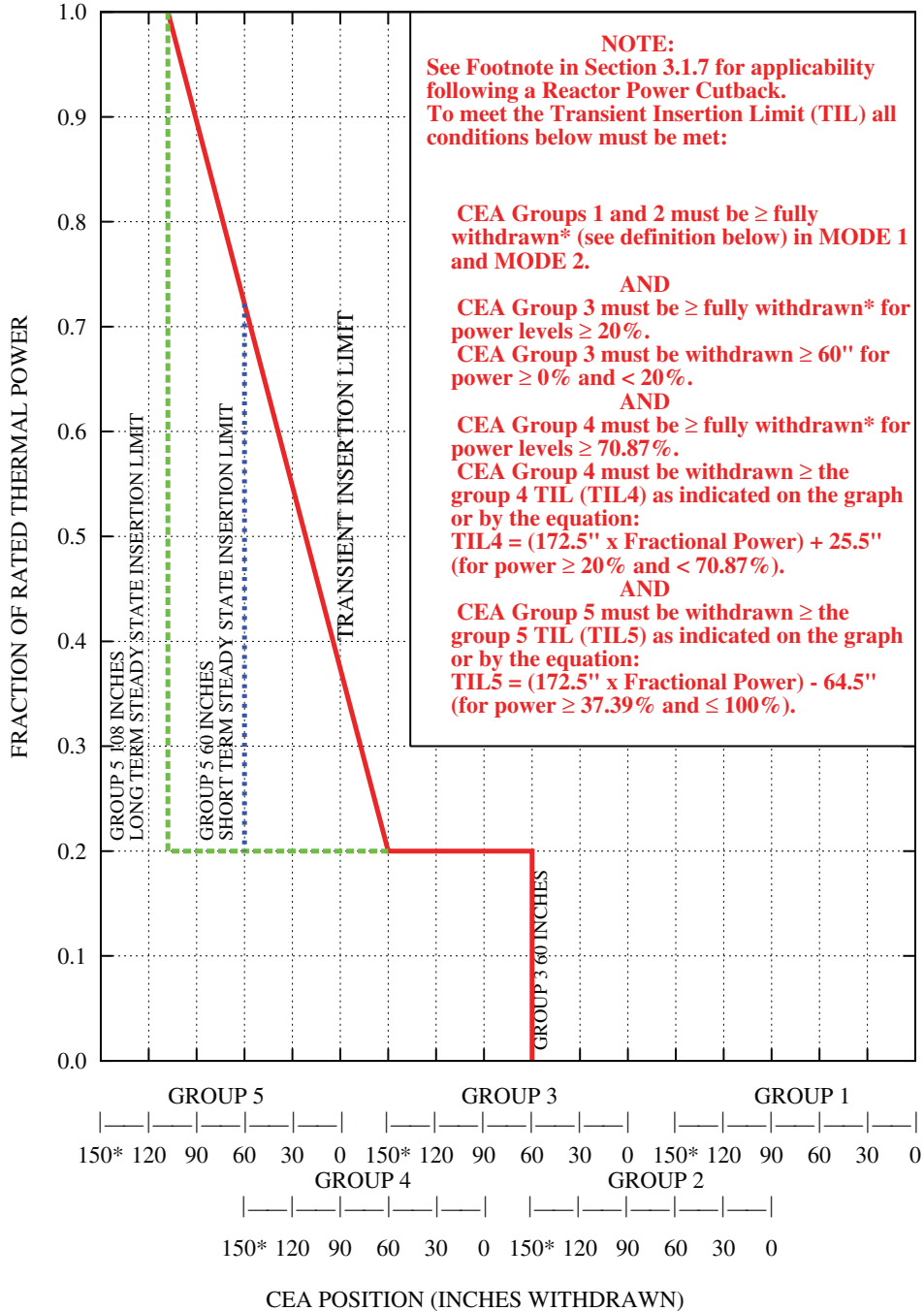


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

* NO POWER REDUCTION IS REQUIRED FOR A SINGLE CEA MISALIGNMENT IF THE FOLLOWING CONDITIONS ARE CONTINUOUSLY MET FROM THE TIME OF DEVIATION:

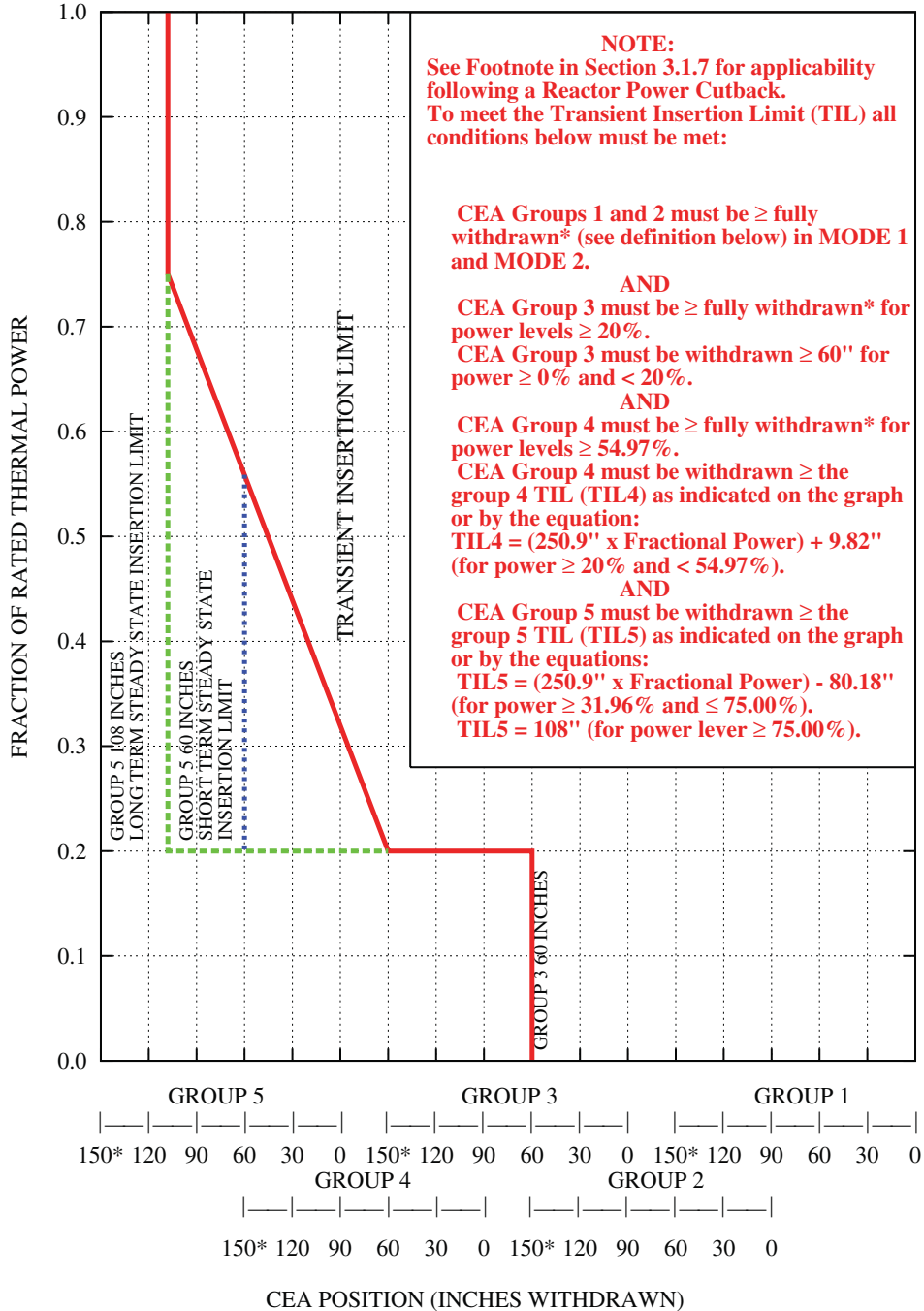
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

FIGURE 3.1.7-1
CEA INSERTION LIMITS VERSUS THERMAL POWER
(COLSS IN SERVICE)



* Fully Withdrawn (FW) is defined as \geq 147.75" (Pulse Counter) and \geq 145.25" (RSPT).
No further CEA withdrawal above FW is required for CEAs' to meet the TIL requirements.

FIGURE 3.1.7-2
CEA INSERTION LIMITS VERSUS THERMAL POWER
(COLSS OUT OF SERVICE)



* Fully Withdrawn (FW) is defined as ≥ 147.75" (Pulse Counter) and ≥ 145.25" (RSPT).
No further CEA withdrawal above FW is required for CEAs' to meet the TIL requirements.

FIGURE 3.1.8-1
PART STRENGTH CEA INSERTION LIMITS
VERSUS THERMAL POWER

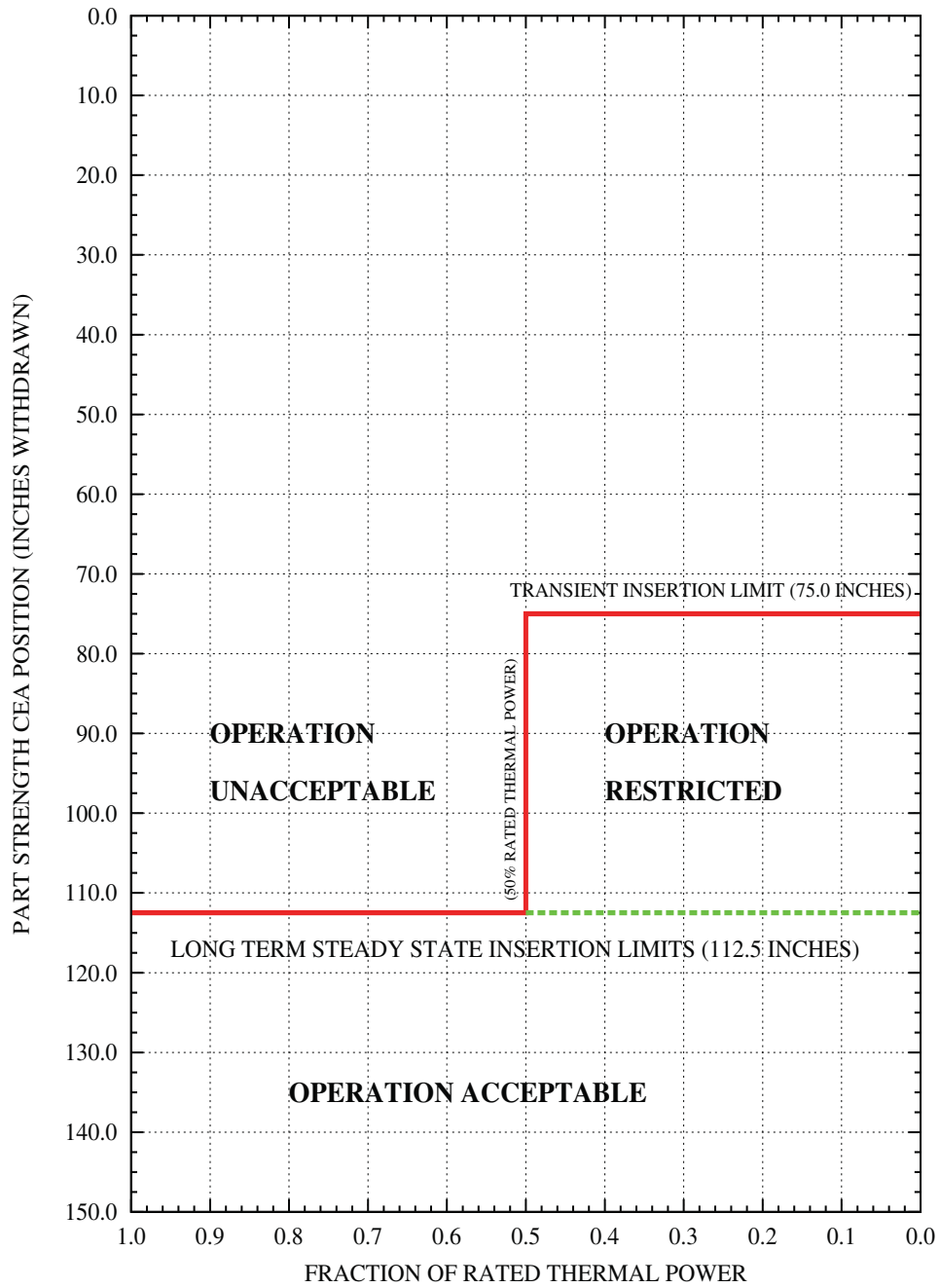


FIGURE 3.2.3-1
 AZIMUTHAL POWER TILT VERSUS THERMAL POWER
 (COLSS IN SERVICE)

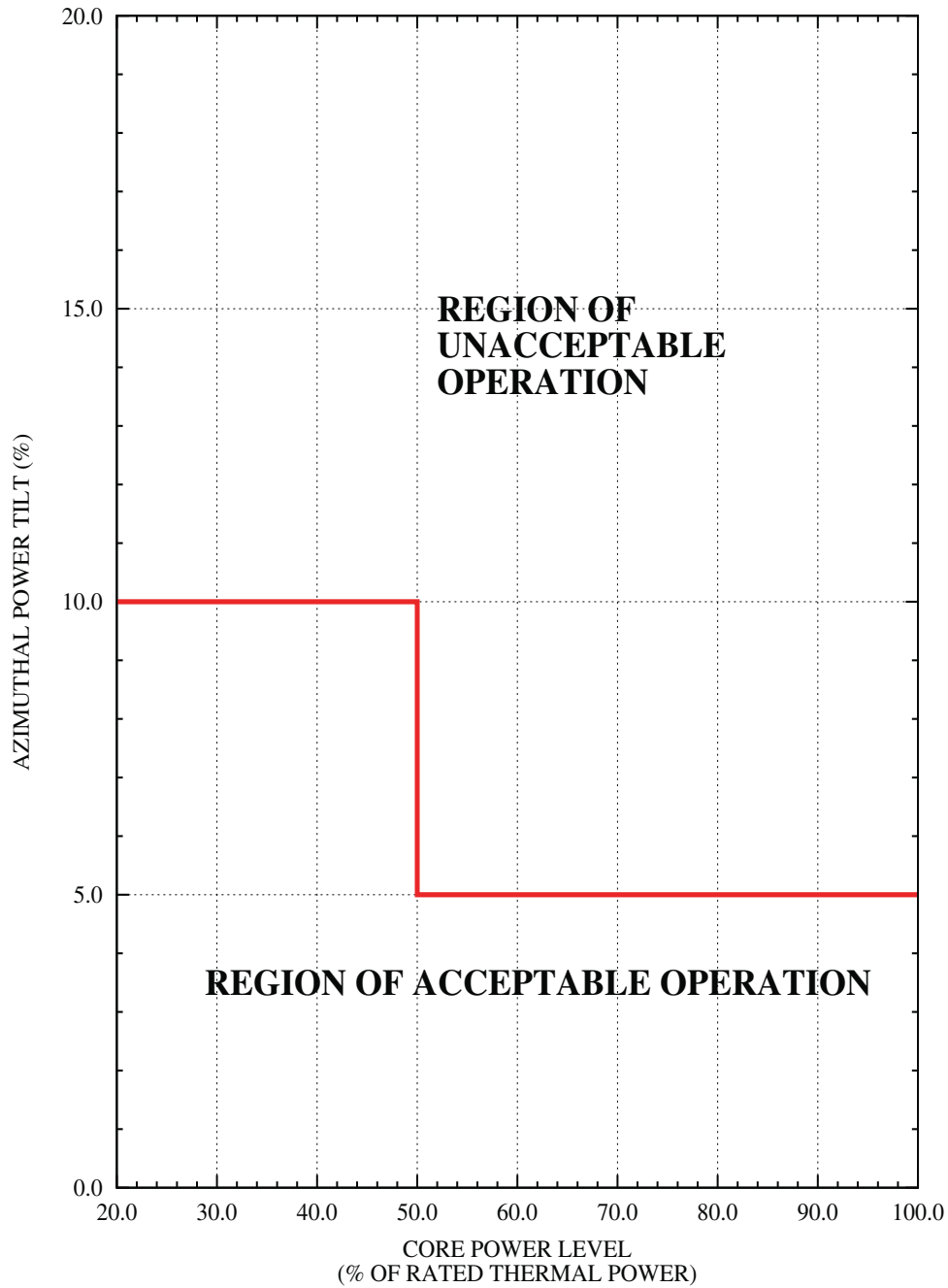


FIGURE 3.2.4-1
 COLSS DNBR OPERATING LIMIT
 ALLOWANCE FOR BOTH CEACs INOPERABLE
 IN ANY OPERABLE CPC CHANNEL

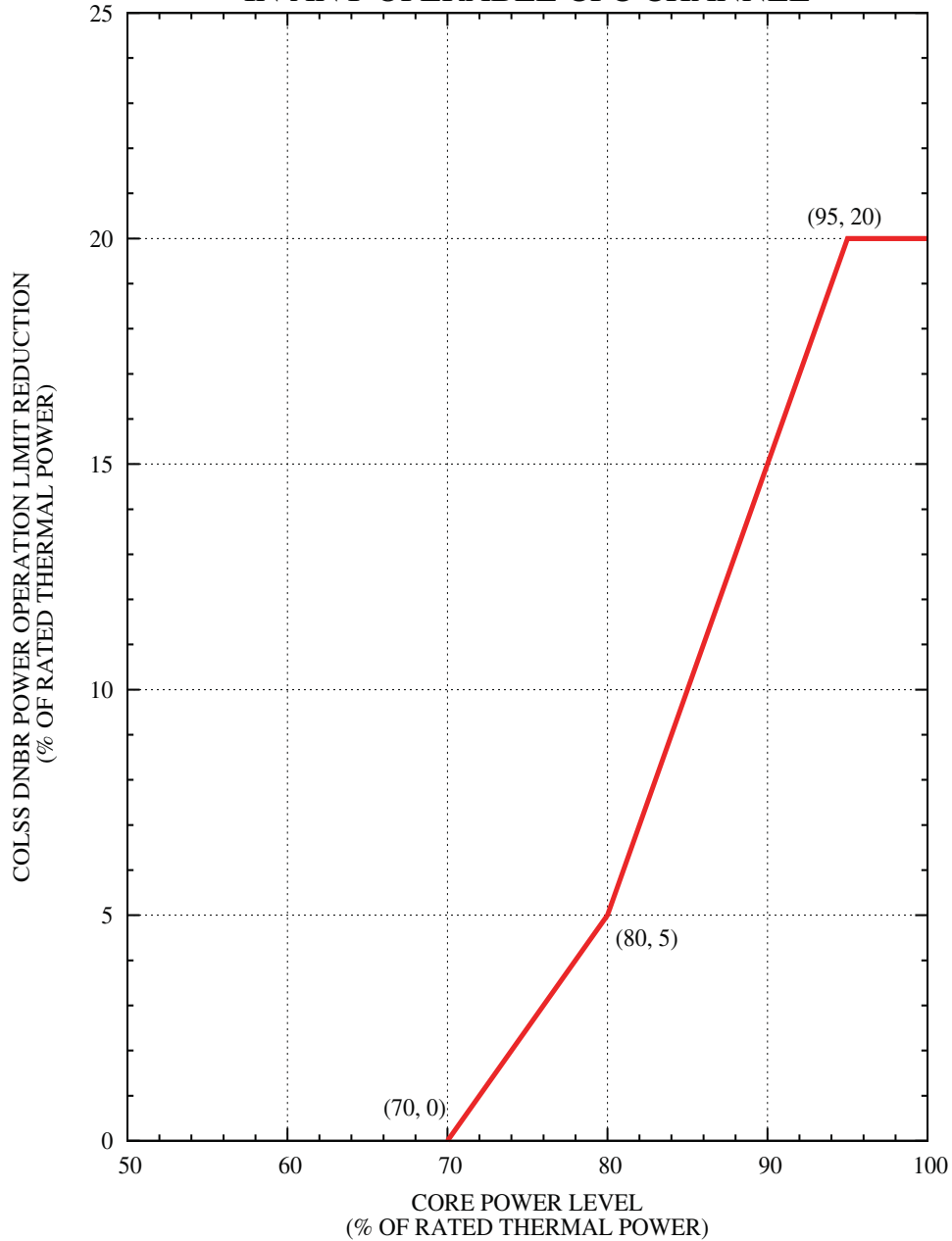


FIGURE 3.2.4-2
 DNBR MARGIN OPERATING LIMIT BASED ON
 THE CORE PROTECTION CALCULATORS
 (COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

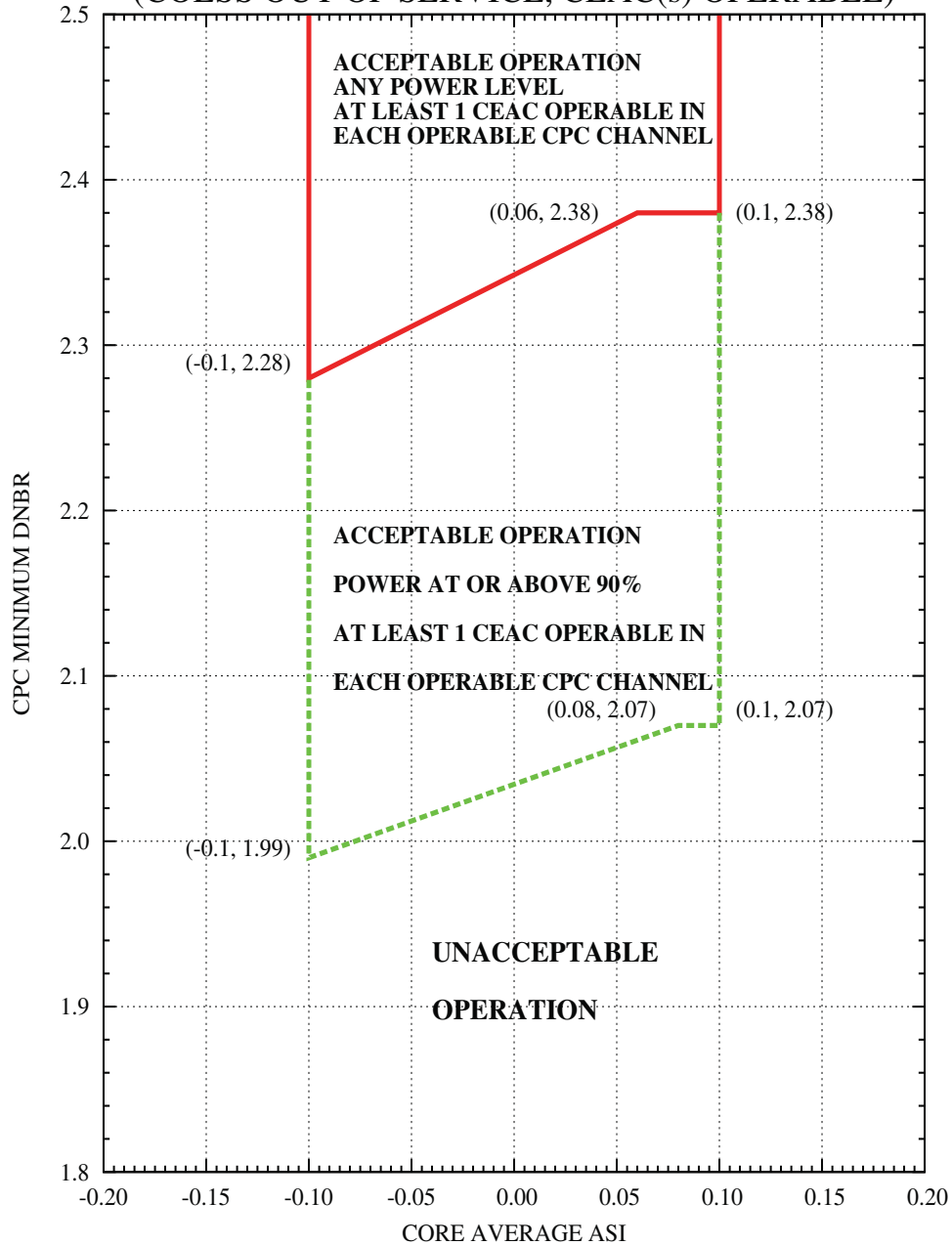


FIGURE 3.2.4-3
 DNBR MARGIN OPERATING LIMIT BASED ON
 THE CORE PROTECTION CALCULATORS
 (COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
 IN ANY OPERABLE CPC CHANNEL)

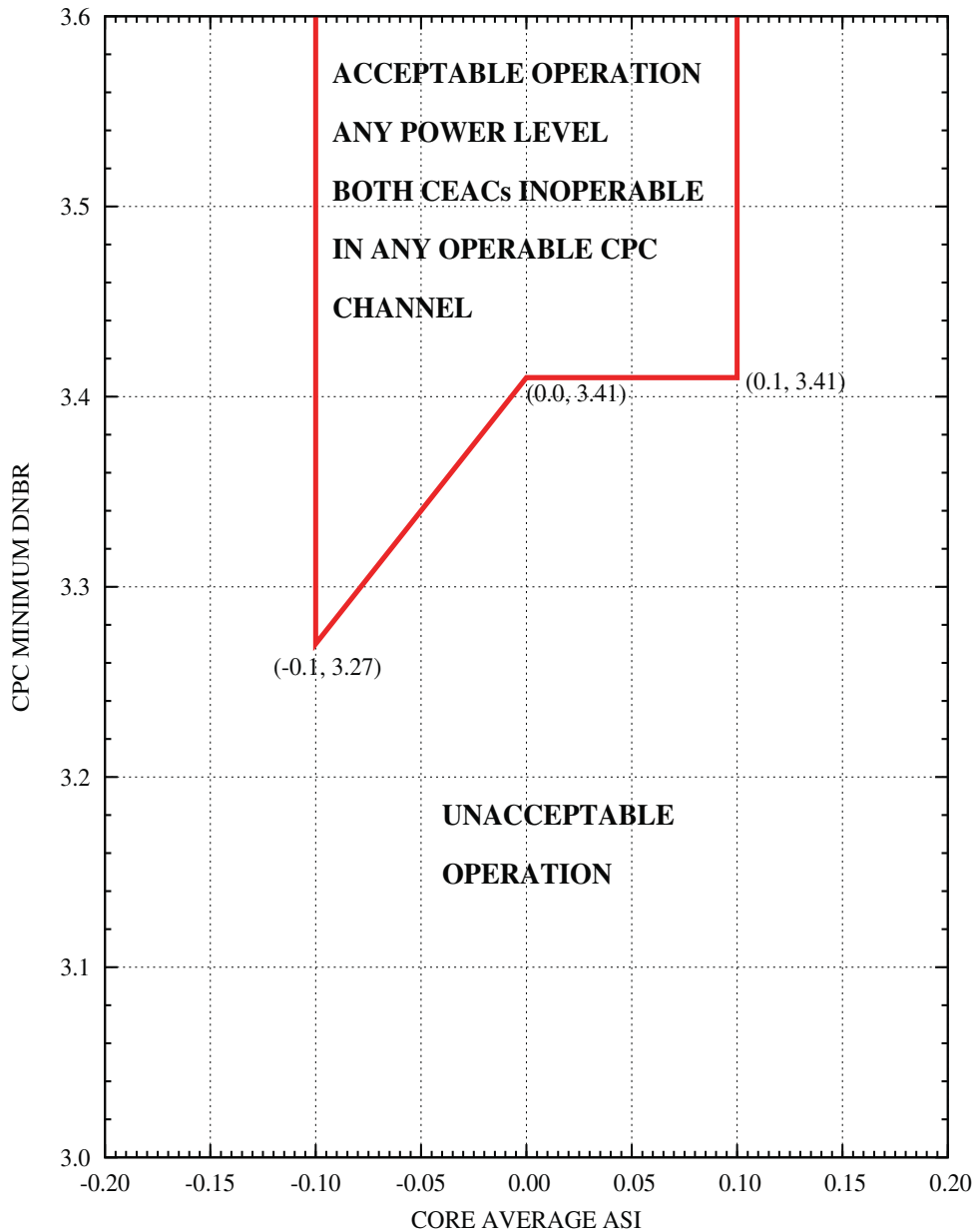


Table 3.3.12-1

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} > 0.98$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	0.5 hours	ONA	ONA
4 not on SCS	12 hours	0.5 hours	ONA	ONA
5 not on SCS	8 hours	0.5 hours	ONA	ONA
4 & 5 on SCS	ONA	ONA	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed



Table 3.3.12-2

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
 DILUTION DETECTION AS A FUNCTION OF OPERATING
 CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.98 \geq K_{eff} > 0.97$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	1 hour	0.5 hours	ONA
4 not on SCS	12 hours	1.5 hours	0.5 hours	ONA
5 not on SCS	8 hours	1.5 hours	0.5 hours	ONA
4 & 5 on SCS	8 hours	0.5 hours	ONA	ONA

Notes: SCS = Shutdown Cooling System
 ONA = Operation Not Allowed



Table 3.3.12-3

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
 DILUTION DETECTION AS A FUNCTION OF OPERATING
 CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.97 \geq K_{eff} > 0.96$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	2.5 hours	1 hour	ONA
4 not on SCS	12 hours	2.5 hours	1 hour	0.5 hours
5 not on SCS	8 hours	2.5 hours	1 hour	0.5 hours
4 & 5 on SCS	8 hours	1 hour	ONA	ONA

Notes: SCS = Shutdown Cooling System
 ONA = Operation Not Allowed



Table 3.3.12-4

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
 DILUTION DETECTION AS A FUNCTION OF OPERATING
 CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.96 \geq K_{eff} > 0.95$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	3 hours	1 hour	0.5 hours
4 not on SCS	12 hours	3.5 hours	1.5 hours	0.75 hours
5 not on SCS	8 hours	3.5 hours	1.5 hours	0.75 hours
4 & 5 on SCS	8 hours	1.5 hours	0.5 hours	ONA

Notes: SCS = Shutdown Cooling System
 ONA = Operation Not Allowed

Table 3.3.12-5

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} \leq 0.95$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	4 hours	1.5 hours	1 hour
4 not on SCS	12 hours	4.5 hours	2 hours	1 hour
5 not on SCS	8 hours	4.5 hours	2 hours	1 hour
4 & 5 on SCS	8 hours	2 hours	0.75 hours	ONA
6	24 hours	1.5 hours	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Enclosure 3

**Unit 3 Core Operating Limits Report
Revision 29**

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 3

CORE OPERATING LIMITS REPORT

Revision 29

Effective: January 20, 2022

Responsible Engineer Date	Gill, Shawn P(Z37857) Digitally signed by Gill, Shawn P(Z37857) Date: 2022.01.06 16:01:30 -07'00'
Design Verifier Date	Cowdin, Christophe r (Z12133) Digitally signed by Cowdin, Christopher (Z12133) Date: 2022.01.07 10:43:58 -07'00'
Responsible Section Leader Date	Karlson, Charles F(V55086) Digitally signed by Karlson, Charles F(V55086) Date: 2022.01.11 13:20:41 -07'00'

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This Report has been prepared in accordance with the requirements of Technical Specifications 4.2.1 and 5.6.5. The Core Operating Limits have been developed using the NRC approved methodologies specified in Section 5.6.5 b of the Palo Verde Technical Specifications.

AFFECTED PVNGS TECHNICAL SPECIFICATIONS

- 3.1.1 Shutdown Margin (SDM) - Reactor Trip Breakers Open
- 3.1.2 Shutdown Margin (SDM) - Reactor Trip Breakers Closed
- 3.1.4 Moderator Temperature Coefficient (MTC)
- 3.1.5 Control Element Assembly (CEA) Alignment
- 3.1.7 Regulating CEA Insertion Limits
- 3.1.8 Part Strength CEA Insertion Limits
- 3.2.1 Linear Heat Rate (LHR)
- 3.2.3 Azimuthal Power Tilt (T_q)
- 3.2.4 Departure From Nucleate Boiling Ratio (DNBR)
- 3.2.5 Axial Shape Index (ASI)
- 3.3.12 Boron Dilution Alarm System (BDAS)
- 3.9.1 Boron Concentration
- 4.2.1 Fuel Assemblies

ANALYTICAL METHODS

The COLR contains the complete identification for each of the Technical Specification referenced topical reports (i.e., report number, title, revision, date, and any supplements) and correspondence that provide the NRC-approved analytical methods used to determine the core operating limits, described in the following documents:

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
1	CENPD-0190-A	N.A. / N.A.	January 1976	CE Method for Control Element Assembly Ejection Analysis (N001-1301-01204)	Westinghouse Framatome
2	CENPD-266-P-A	N.A. / N.A.	April 1983	The ROCS and DIT Computer Codes for Nuclear Design (N001-1900-01412)	Westinghouse Framatome
3	NUREG-0852	N.A. / N.A.	November 1981	Safety Evaluation Report related to the Final Design of the Standard Nuclear Steam Supply Reference Systems CESSAR System 80, Docket No. STN 50-470	Westinghouse Framatome
3		N.A. / 1	March 1983		Westinghouse Framatome
3		N.A. / 2	September 1983		Westinghouse Framatome
3		N.A. / 3	December 1987		Westinghouse Framatome
4	CEN-356(V)-P-A	01-P-A / N.A.	May 1988	Modified Statistical Combination of Uncertainties (N001-1303-01747)	Westinghouse Framatome
4	Enclosure 1-P to LD-82-054	N.A. / 1-P	February 1993	System 80 TM Inlet Flow Distribution (N001-1301-01228)	Westinghouse Framatome
5	CENPD-132 P	N.A. / N.A.	August 1974	Calculative Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132P	N.A./ 1	February 1975	Calculational Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132-P	N.A. / 2-P	July 1975	Calculational Methods for the C-E Large Break LOCA Evaluation Model	Westinghouse
5	CENPD-132	N.A. / 3-P-A	June 1985	Calculative Methods for the C-E Large Break LOCA Evaluation Model for the Analysis of C-E and <u>W</u> Designed NSSS	Westinghouse

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
5	CENPD-132	N.A. / 4-P-A Rev. 1	March 2001	Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model (N001-1900-01192)	Westinghouse
5	CENPD-132- P-A	N.A. / 4-P-A Addendum 1-P- A	August 2007	Calculative Methods for the CE Nuclear Power Large Break LOCA Evaluation Model (N001-0205-00046)	Westinghouse
5	CENPD-132	N.A. / SUPP 4-P-A APP A-Rev. 004	Decem- ber 2008	Revision 4 to the Supplement to Appen- dix A of CENPD-132 Supplement 4-P-A (N001-0205-00229)	Westinghouse
6	CENPD-137-P	N.A. / N.A.	August 1974	Calculative Methods for the C-E Small Break LOCA Evaluation Model	Westinghouse
6	CENPD-137	N.A. / 1-P	January 1977	Calculative Methods for the C-E Small Break LOCA Evaluation Model	Westinghouse
6	CENPD-137	N.A. / 2-P-A	April 1998	Calculative Methods for the ABB C-E Small Break LOCA Evaluation Model (N001-1900-01185)	Westinghouse
7	N.A.	N.A. / N.A.	June 13, 1975	Letter: O.D. Parr (NRC) to F. M. Stern (CE), (NRC Staff Review of the Combustion Engineering ECCS Evaluation Model). NRC approval for: 5.6.5.b.6.	Westinghouse
8	N.A.	N.A. / N.A.	Septem- ber 27, 1977	Letter: K. Kniel (NRC) to A. E. Scherer (CE), (Evaluation of Topical Reports CENPD 133, Supplement 3-P and CENPD-137, Supplement 1-P). NRC approval for 5.6.5.b.6.	Westinghouse
9	CEN-372-P-A	N.A. / N.A.	May 1990	Fuel Rod Maximum Allowable Pressure (N001-0201-00026)	Westinghouse
10	N.A.	N.A. / N.A.	April 10, 1990	Letter: A. C. Thadani (NRC) to A. E. Scherer (CE), ("Acceptance for Reference CE Topical Report CEN-372- P"). NRC approval for 5.6.5.b.9.	Westinghouse
11	NFM-005	1 / N.A.	August 2007	Arizona Public Service Company PWR Reactor Physics Methodology Using CASMO-4/SIMULATE-3 (NFM-005)	Westinghouse Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
12	CENPD-282-P-A Vols. 1	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 1 (CENTS-TD MANUAL-VOL 1)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 2	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 2 (CENTS-TD MANUAL-VOL 2)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 3	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 3 (CENTS-TD MANUAL-VOL 3)	Westinghouse Framatome
12	CENPD-282-P-A Vols. 4	2 / N.A.	March 2005	Technical Description Manual for the CENTS Code Volume 4 (CENTS-TD MANUAL-VOL 4)	Westinghouse Framatome
13	CENPD-404-P-A	0 / N.A.	November 2001	Implementation of ZIRLO™ Cladding Material in CE Nuclear Power Fuel Assembly Designs (N001-1900-01329)	Westinghouse
13	CENPD-404-P-A Addendum 1-A	0 / N.A.	July 2006	Optimized ZIRLO™ (N001-0203-00611)	Westinghouse
13	CENPD-404-P-A Addendum 2-A	0 / N.A.	October 2013	Westinghouse Clad Corrosion Model for ZIRLO and Optimized ZIRLO™ (N001-0205-00006)	Westinghouse
14	CENPD-188-A	N.A. / N.A.	July 1976	HERMITE, A Multi-Dimensional Space-Time Kinetics Code for PWR Transients (HERMITE-TOPICAL)	Westinghouse Framatome
15	CENPD-161-P-A	N.A. / N.A.	April 1986	TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core (N001-1301-01202)	Westinghouse
16	CEN-160(S)-P	1-P / N.A.	September 1981	CETOP-D Code Structures and Modeling Methods for San Onofre Nuclear Generating Station Units 2 and 3 (N001-1301-01185)	Westinghouse Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
17	N.A.	N.A. / N.A.	September 29, 2003	“Safety Evaluation related to Palo Verde Nuclear Generating Station, Unit 2 (PVNGS-2) Issuance of Amendment on Replacement of Steam Generators and Up-rated Power Operation, (September 29, 2003)	Westinghouse Framatome
17	N.A.	N.A. / N.A.	November 16, 2005	“Safety Evaluation related to Palo Verde Nuclear Generating Station, Units 1, 2, and 3 – Issuance of Amendments Re: Replacement of Steam Generators and Up-rated Power Operations and Associated Administrative Changes, (November 16, 2005).”	Westinghouse Framatome
18	CEN-310-P-A	0 / N.A.	April 1986	CPC Methodology Changes for the CPC Improvement Program (N001-1303-02283)	Westinghouse Framatome
19	CENPD-183-A	0 / N.A.	June 1984	Loss of Flow, C-E Methods for Loss of Flow Analysis (N001-1301-01203)	Westinghouse Framatome
20	CENPD-382-P-A	0 / N.A.	August 1993	Methodology for Core Designs Containing Erbium Burnable Absorbers (N001-0201-00035)	Westinghouse
21	CEN-386-P-A	0 / N.A.	August 1992	Verification of the Acceptability of a 1-Pin Burnup Limit of 60 MWD/kgU for Combustion Engineering 16 x 16 PWR Fuel (N001-0201-00042)	Westinghouse
22	WCAP-16500-P-A	0 / N.A.	August 2007	CE 16x16 Next Generation Fuel Core Reference Report (N001-0203-00614)	Westinghouse
22	WCAP-16500-P-A	0 / 1 Rev 1	December 2010	Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (N001-0205-00063)	Westinghouse Framatome
22	WCAP-16500-P-A	0 / 2-P-A	June 2016	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 Analysis (N001-0205-00048)	Westinghouse

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
23	WCAP-14565-P-A	0 / N.A.	October 1999	VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis (N001-0205-00002)	Westinghouse Framatome
23	WCAP-14565-P-A, Addendum 1-A	0 / N.A.	August 2004	Addendum 1 to WCAP-14565-P-A Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code (N001-0205-00003)	Westinghouse
23	WCAP-14565-P-A, Addendum 2-P-A	0 / N.A.	April 2008	Addendum 2 to WCAP-14565-P-A, Extended Applications of ABB-NV Correlation and Modified ABB-NV Correlation WLOP for PWR Low Pressure Applications (N001-0205-00004)	Westinghouse
24	CENPD-387-P-A	0 / N.A.	May 2000	ABB Critical Heat Flux Correlations for PWR Fuel (N001-0205-00042)	Westinghouse
25	WCAP-16523-P-A	0 / N.A.	August 2007	Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes (N001-0203-00615)	Westinghouse
26	WCAP-16072-P-A	0 / N.A.	August 2004	Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs (N001-0205-00226)	Westinghouse
27	EMF-2103P-A	3 / N.A.	June 2016	Realistic Large Break LOCA Methodology for Pressurized Water Reactors	Framatome
28	EMF-2328(P)(A)	0 / N.A.	March 2001	PWR Small Break LOCA Evaluation Model, S-RELAP5 Based	Framatome
28	EMF-2328(P)(A)	0 / 1(P)(A)	December 2016	PWR Small Break LOCA Evaluation Model, S-RELAP5 Based	Framatome
29	BAW-10231P-A	1 / N.A.	January 2004	COPERNIC Fuel Rod Design Computer Code	Framatome
30	BAW-10241P-A	2 / N.A.	September 2020	BHTP DNB Correlation Applied with LYNXT (N001-0206-00200)	Framatome

<u>T.S Ref#^a</u>	<u>Report No.</u>	<u>Revision/ Supplement</u>	<u>Date</u>	<u>Title</u>	<u>Fuel Applicability</u>
31	EPRI-NP-2511-CCM-A	Mod 02 / N.A.	Volume 1-4 (February 2017)	VIPRE-01: A Thermal Hydraulic Analysis Code for Reactor Cores	Westinghouse Framatome
31		Mod 02 / N.A.	Volume 5 (March 1988)	VIPRE-01: A Thermal Hydraulic Analysis Code for Reactor Cores	Westinghouse Framatome

a. Corresponds to the reference number specified in Technical Specification 5.6.5

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

3.1.1 - Shutdown Margin (SDM) - Reactor Trip Breakers Open

The Shutdown Margin shall be greater than or equal to that shown in Figure 3.1.1-1.

3.1.2 - Shutdown Margin (SDM) - Reactor Trip Breakers Closed

The Shutdown Margin shall be greater than or equal to that shown in Figure 3.1.2-1.

3.1.4 - Moderator Temperature Coefficient (MTC)

The moderator temperature coefficient (MTC) shall be within the area of Acceptable Operation shown in Figure 3.1.4-1.

3.1.5 - Control Element Assembly (CEA) Alignment

With one or more full-strength or part-strength CEAs misaligned from any other CEAs in its group by more than 6.6 inches, the minimum required MODES 1 and 2 core power reduction is specified in Figure 3.1.5-1. The required power reduction is based on the initial power before reducing power.

3.1.7 - Regulating CEA Insertion Limits

With COLSS IN SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits¹ shown in Figure 3.1.7-1²; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits¹ shown in Figure 3.1.7-2.² Regulating Groups 1 and 2 CEAs shall be maintained \geq fully withdrawn^{1, 3} while in Modes 1 and 2 (except while performing SR 3.1.5.3). When \geq 20% power Regulating Group 3 shall be maintained \geq fully withdrawn.^{1, 3}

¹ A reactor power cutback will cause either (Case 1) Regulating Group 5 or Regulating Group 4 and 5 to be dropped with no sequential insertion of additional Regulating Groups (Groups 1, 2, 3, and 4) or (Case 2) Regulating Group 5 or Regulating Group 4 and 5 to be dropped with all or part of the remaining Regulating Groups (Groups 1, 2, 3, and 4) being sequentially inserted. In either case, the Transient Insertion Limit and withdrawal sequence specified in the CORE OPERATING LIMITS REPORT can be exceeded for up to 2 hours.

² The Separation between Regulating Groups 4 and 5 may be reduced from the 90 inch value specified in Figures 3.1.7-1 and 3.1.7-2 provided that each of the following conditions are satisfied:

- a) Regulating Group 4 position is between 60 and 150 inches withdrawn.

- b) Regulating Group 5 position is maintained at least 10 inches lower than Regulating Group 4 position.
- c) Both Regulating Group 4 and Regulating Group 5 positions are maintained above the Transient Insertion Limit specified in Figure 3.1.7-1 (COLSS In Service) or Figure 3.1.7-2 (COLSS Out of Service).

³ Fully withdrawn (FW) is defined as $\geq 147.75''$ (Pulse Counter indication) and $\geq 145.25''$ (RSPT indication). No further CEA withdrawal above FW is required for CEAs' to meet the Transient Insertion Limit (TIL) requirements.

3.1.8 - Part Strength CEA Insertion Limits

The part strength CEA groups shall be limited to the insertion limits shown in Figure 3.1.8-1.

3.2.1 - Linear Heat Rate (LHR)

The linear heat rate limit shall be maintained in accordance with core burnup:

- 13.1 kW/ft for burnup < 450 EFPD
- 12.3 kW/ft for burnup \geq 450 EFPD

3.2.3 - Azimuthal Power Tilt (T_q)

The AZIMUTHAL POWER TILT (T_q) shall be less than or equal to 10% with COLSS IN SERVICE when power is greater than 20% and less than or equal to 50%. Additionally, the AZIMUTHAL POWER TILT (T_q) shall be less than or equal to 5% with COLSS IN SERVICE when power is greater than 50%. See Figure 3.2.3-1.

3.2.4 - Departure From Nucleate Boiling Ratio (DNBR)

COLSS IN SERVICE and Both CEACs INOPERABLE in Any OPERABLE CPC Channel - Maintain COLSS calculated core power less than or equal to COLSS calculated core power operation limit based on DNBR decreased by the allowance shown in Figure 3.2.4-1.

COLSS OUT OF SERVICE and CEAC(s) OPERABLE - Operate within the region of acceptable operation of Figure 3.2.4-2 using any operable CPC channel.

COLSS OUT OF SERVICE and Both CEACs INOPERABLE in Any OPERABLE CPC Channel - Operate within the region of acceptable operation of Figure 3.2.4-3 using any operable CPC channel with both CEACs INOPERABLE.

3.2.5 - Axial Shape Index (ASI)

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

COLSS OPERABLE

$-0.18 \leq \text{ASI} \leq 0.17$ for power $\geq 50\%$

$-0.28 \leq \text{ASI} \leq 0.17$ for power $>20\%$ and $< 50\%$

COLSS OUT OF SERVICE (CPC)

$-0.10 \leq \text{ASI} \leq 0.10$ for power $>20\%$

3.3.12 - Boron Dilution Alarm System (BDAS)

With one or both start-up channel high neutron flux alarms inoperable, the RCS boron concentration shall be determined at the applicable monitoring frequency specified in Tables 3.3.12-1 through 3.3.12-5.

3.9.1 - Boron Concentration

The boron concentration of all filled portions of the Reactor Coolant System and the refueling canal shall be maintained at a uniform concentration ≥ 3000 ppm.

4.2.1 - Fuel Assemblies

The Reactor Core contains the following fuel types:

- Westinghouse CE16STD with ZIRLO™ cladding
- Westinghouse CE16NGF with Optimized ZIRLO™ cladding
- No lead test assemblies

Refer to the ANALYTICAL METHODS Table for the methods applicable to a particular fuel type.

FIGURE 3.1.1-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS OPEN

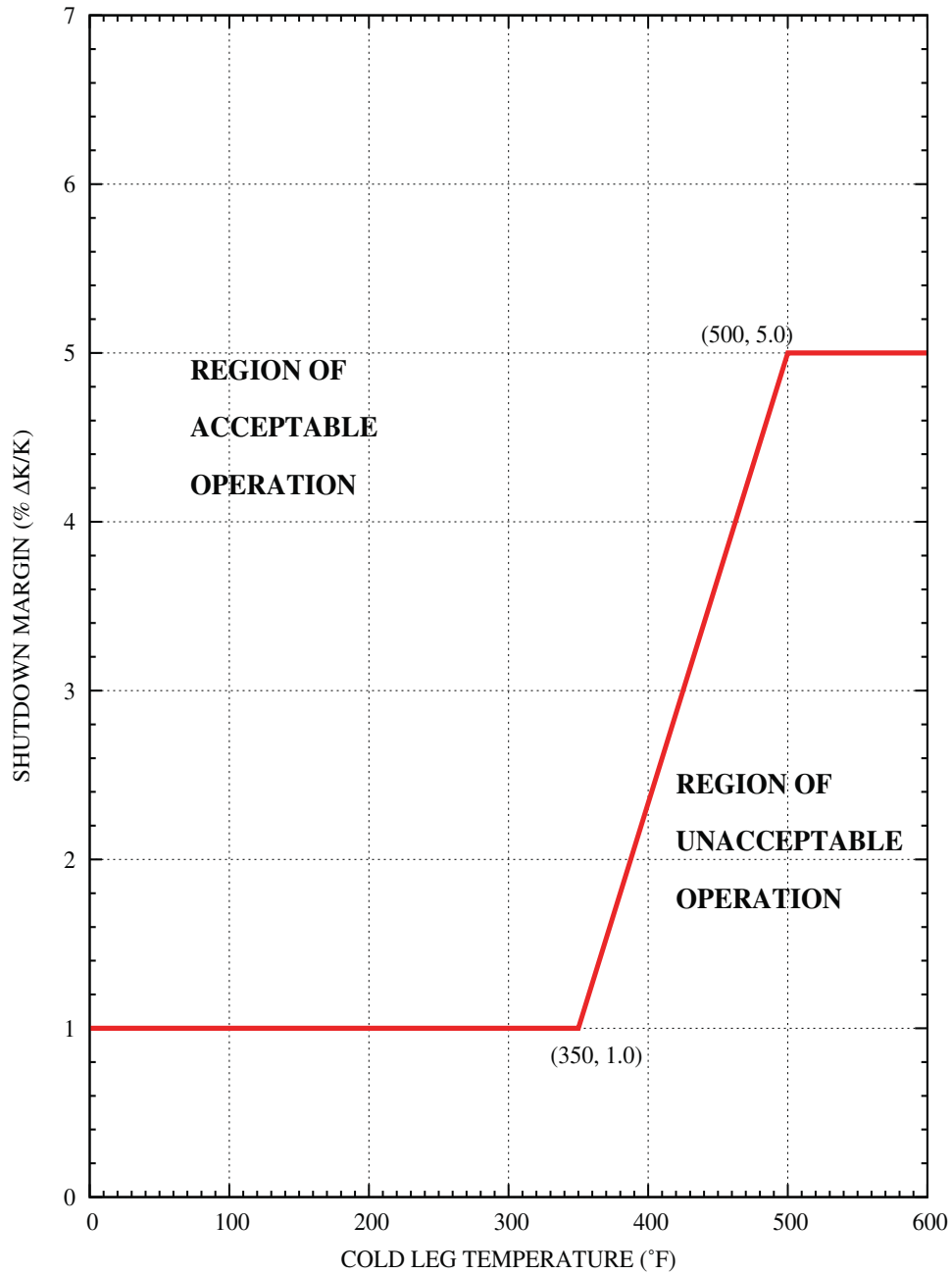


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

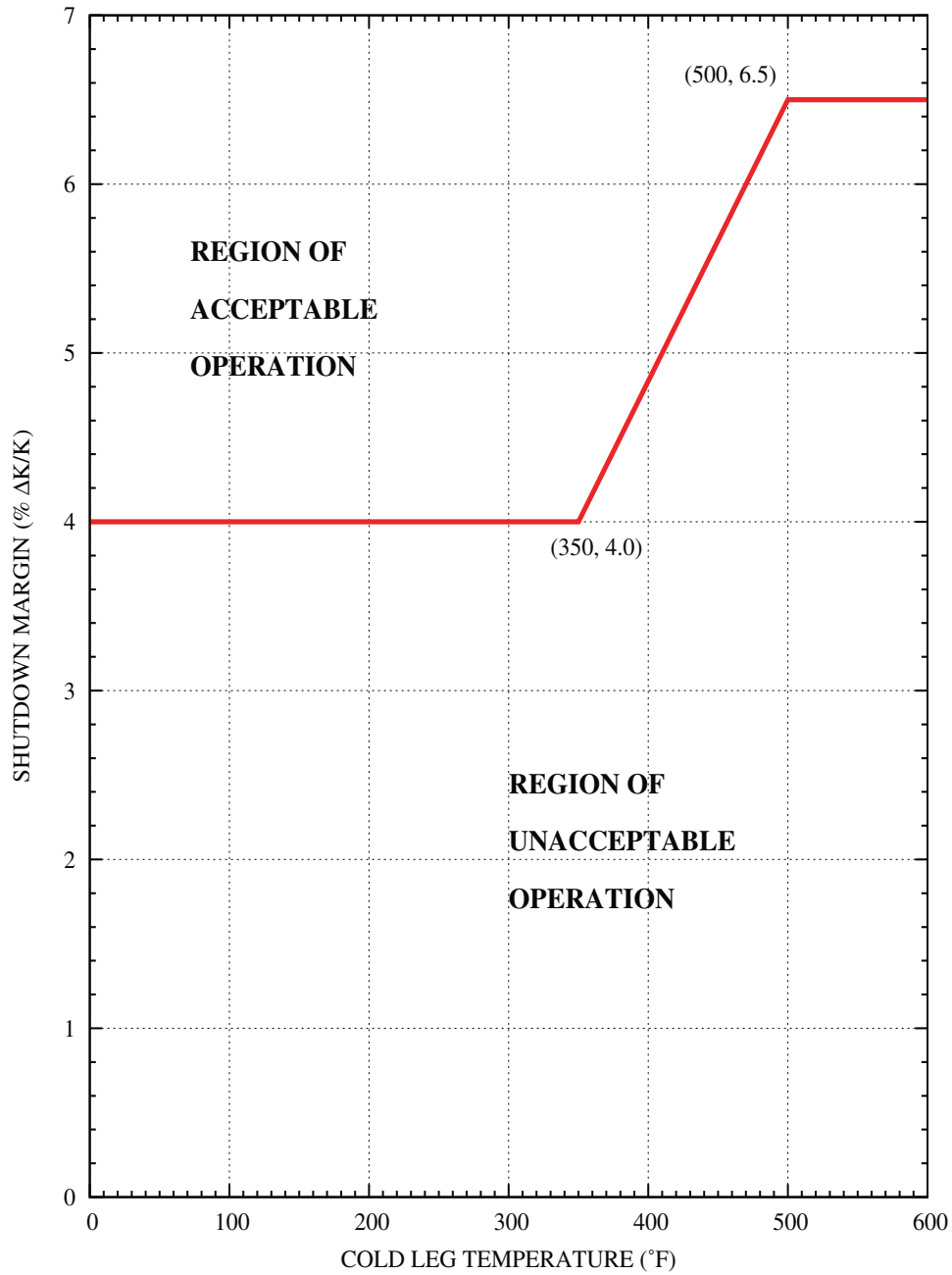


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

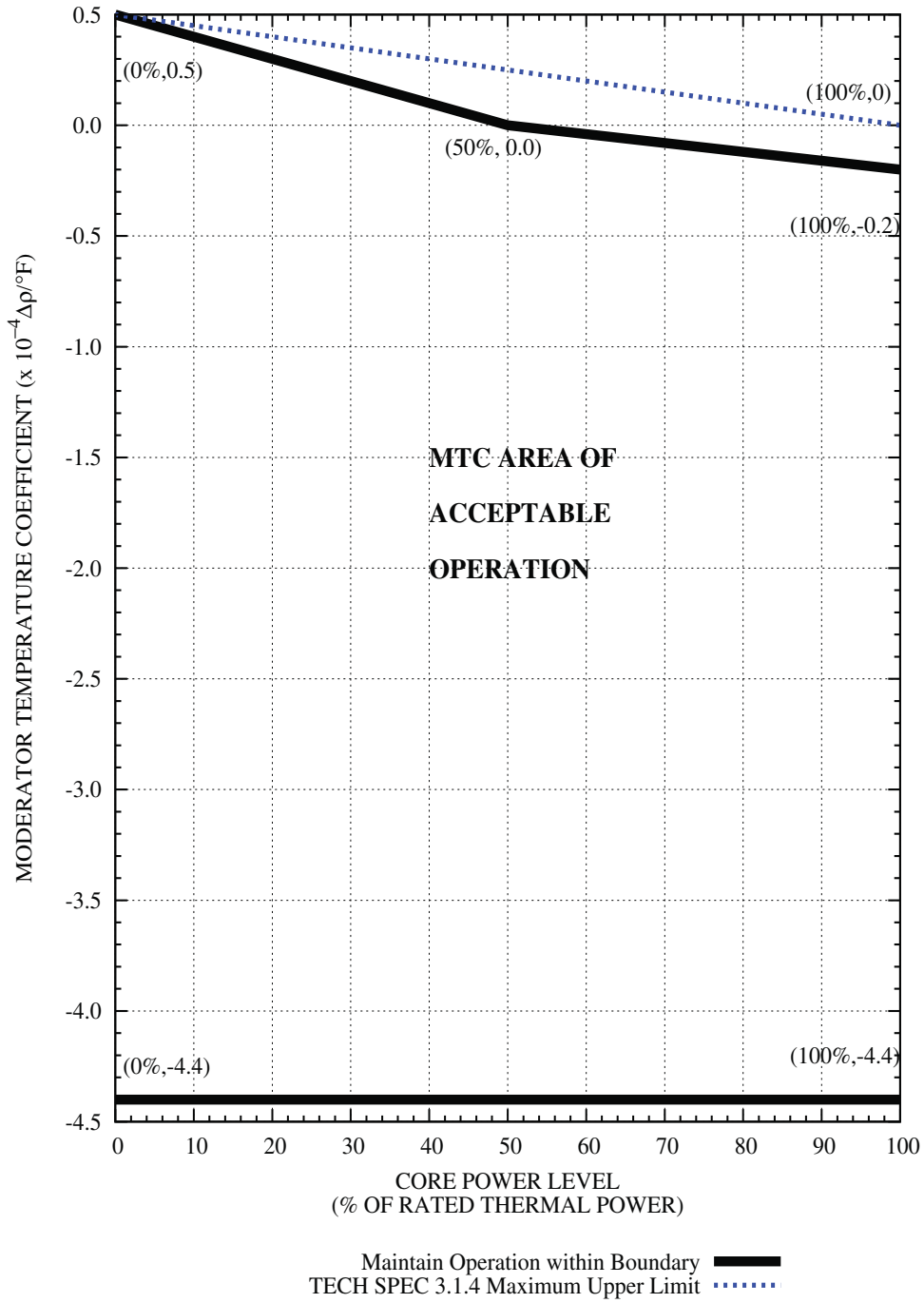
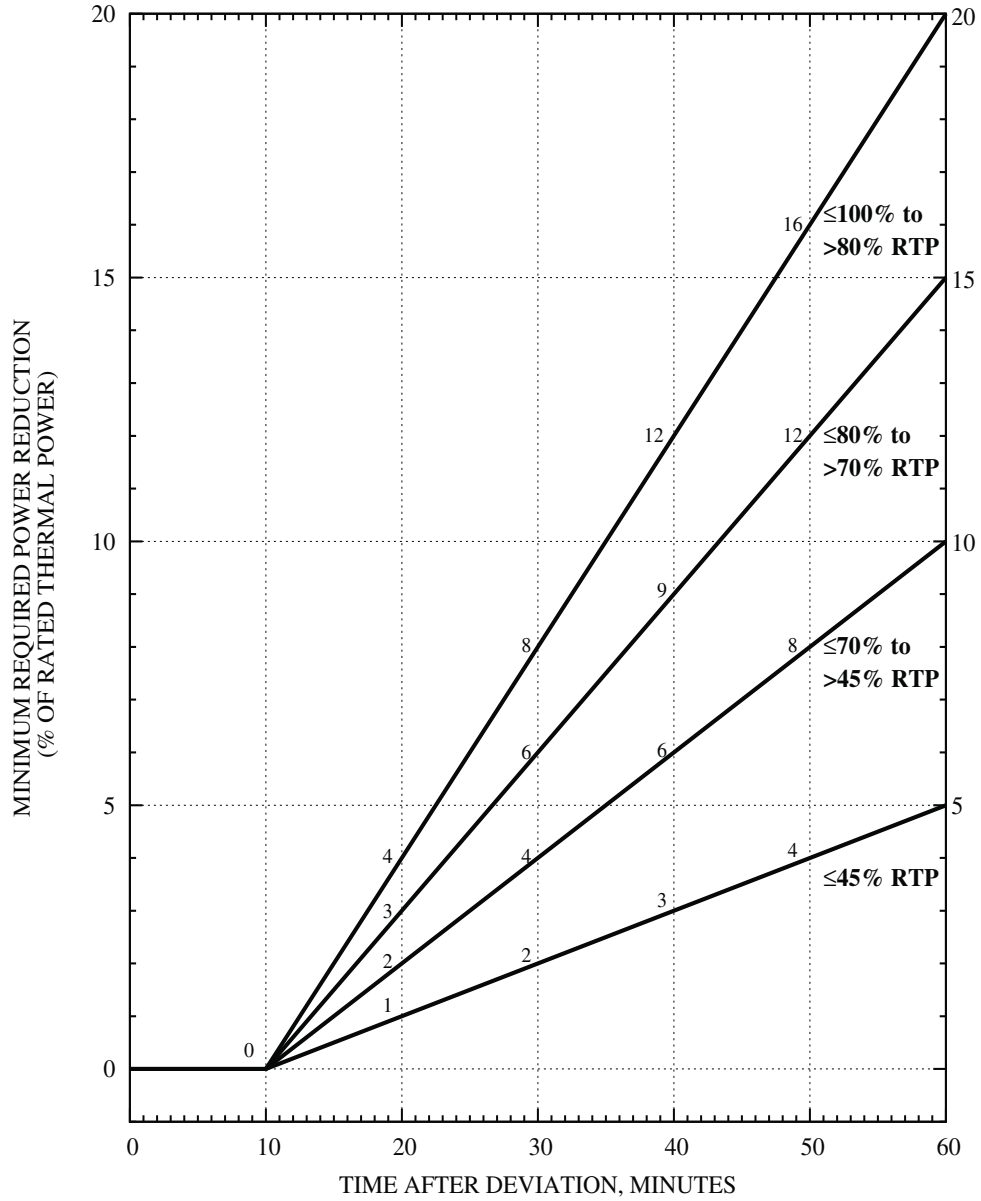


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

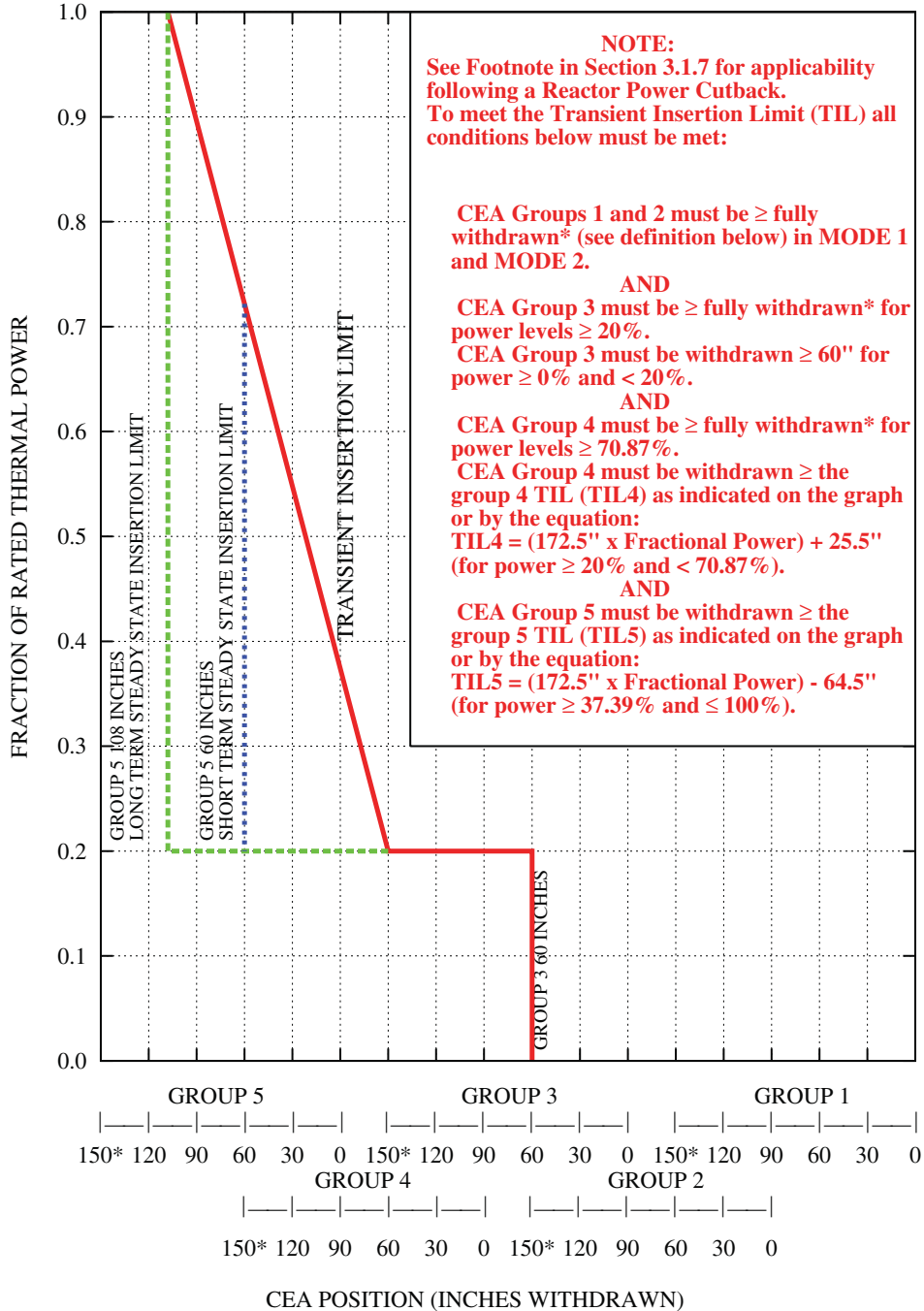


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

* NO POWER REDUCTION IS REQUIRED FOR A SINGLE CEA MISALIGNMENT IF THE FOLLOWING CONDITIONS ARE CONTINUOUSLY MET FROM THE TIME OF DEVIATION:

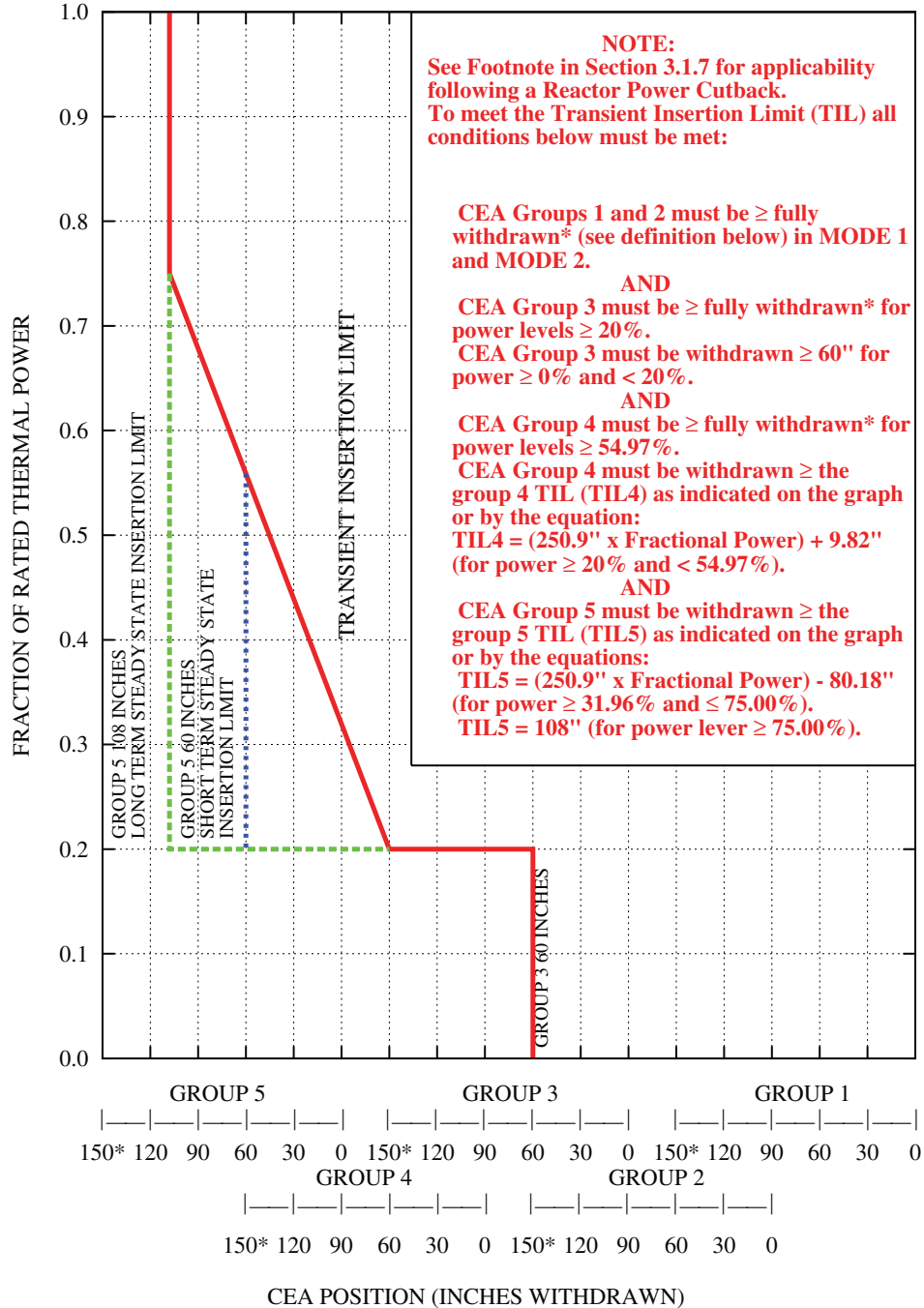
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

FIGURE 3.1.7-1
CEA INSERTION LIMITS VERSUS THERMAL POWER
(COLSS IN SERVICE)



* Fully Withdrawn (FW) is defined as ≥ 147.75" (Pulse Counter) and ≥ 145.25" (RSPT).
No further CEA withdrawal above FW is required for CEAs' to meet the TIL requirements.

FIGURE 3.1.7-2
CEA INSERTION LIMITS VERSUS THERMAL POWER
(COLSS OUT OF SERVICE)



* Fully Withdrawn (FW) is defined as ≥ 147.75" (Pulse Counter) and ≥ 145.25" (RSPT). No further CEA withdrawal above FW is required for CEAs' to meet the TIL requirements.

FIGURE 3.1.8-1
PART STRENGTH CEA INSERTION LIMITS
VERSUS THERMAL POWER

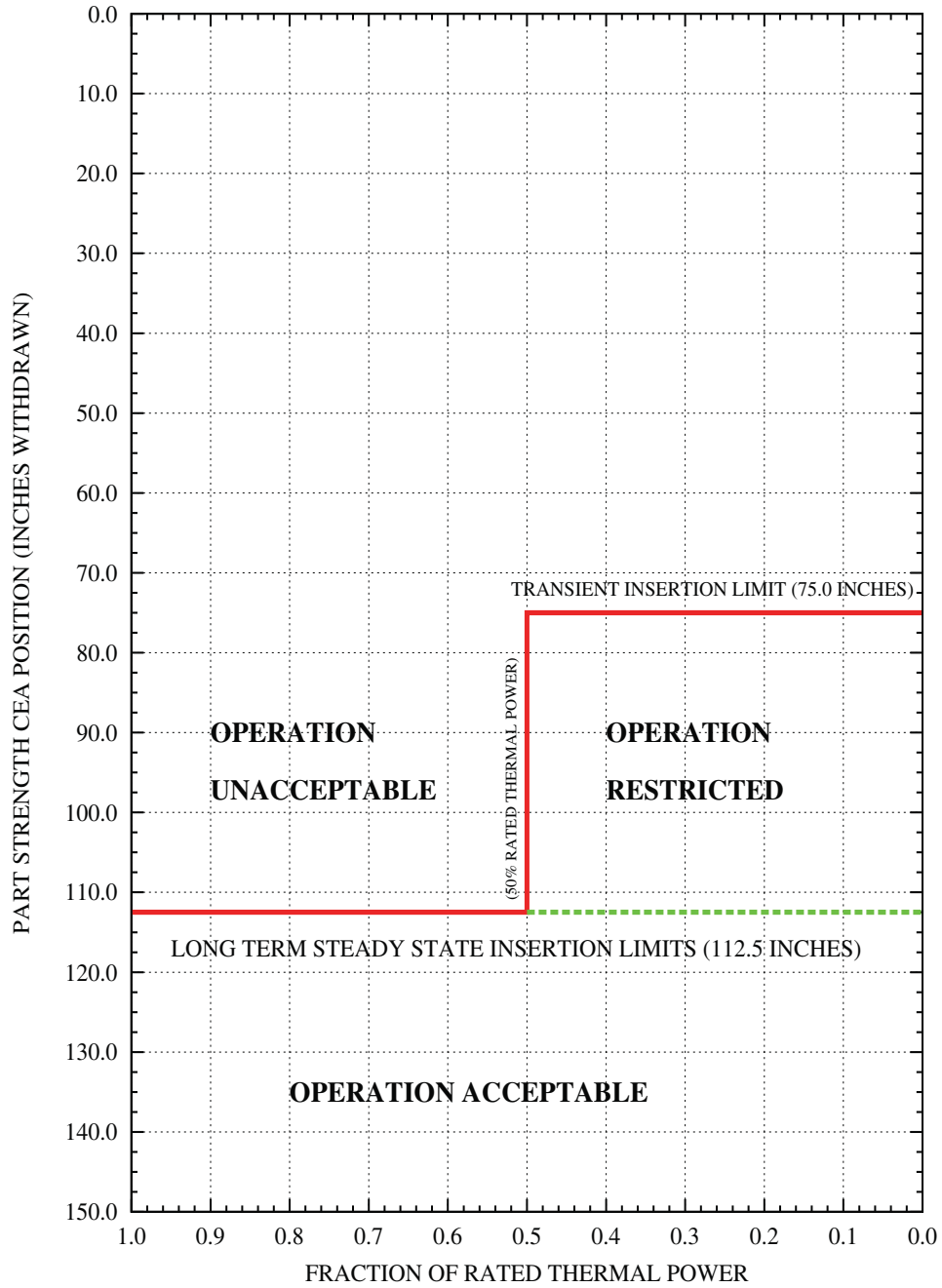


FIGURE 3.2.3-1
 AZIMUTHAL POWER TILT VERSUS THERMAL POWER
 (COLSS IN SERVICE)

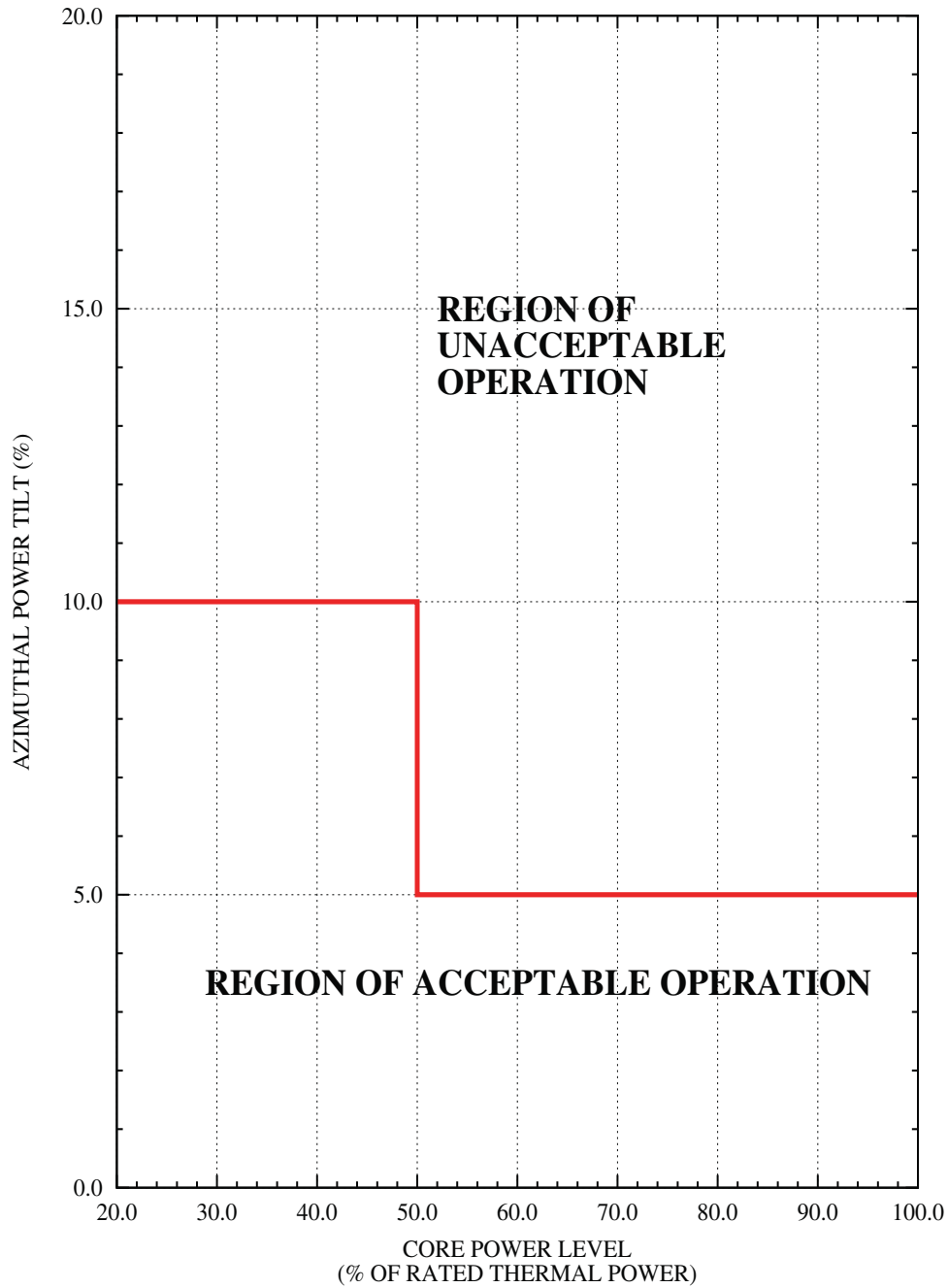


FIGURE 3.2.4-1
 COLSS DNBR OPERATING LIMIT
 ALLOWANCE FOR BOTH CEACs INOPERABLE
 IN ANY OPERABLE CPC CHANNEL

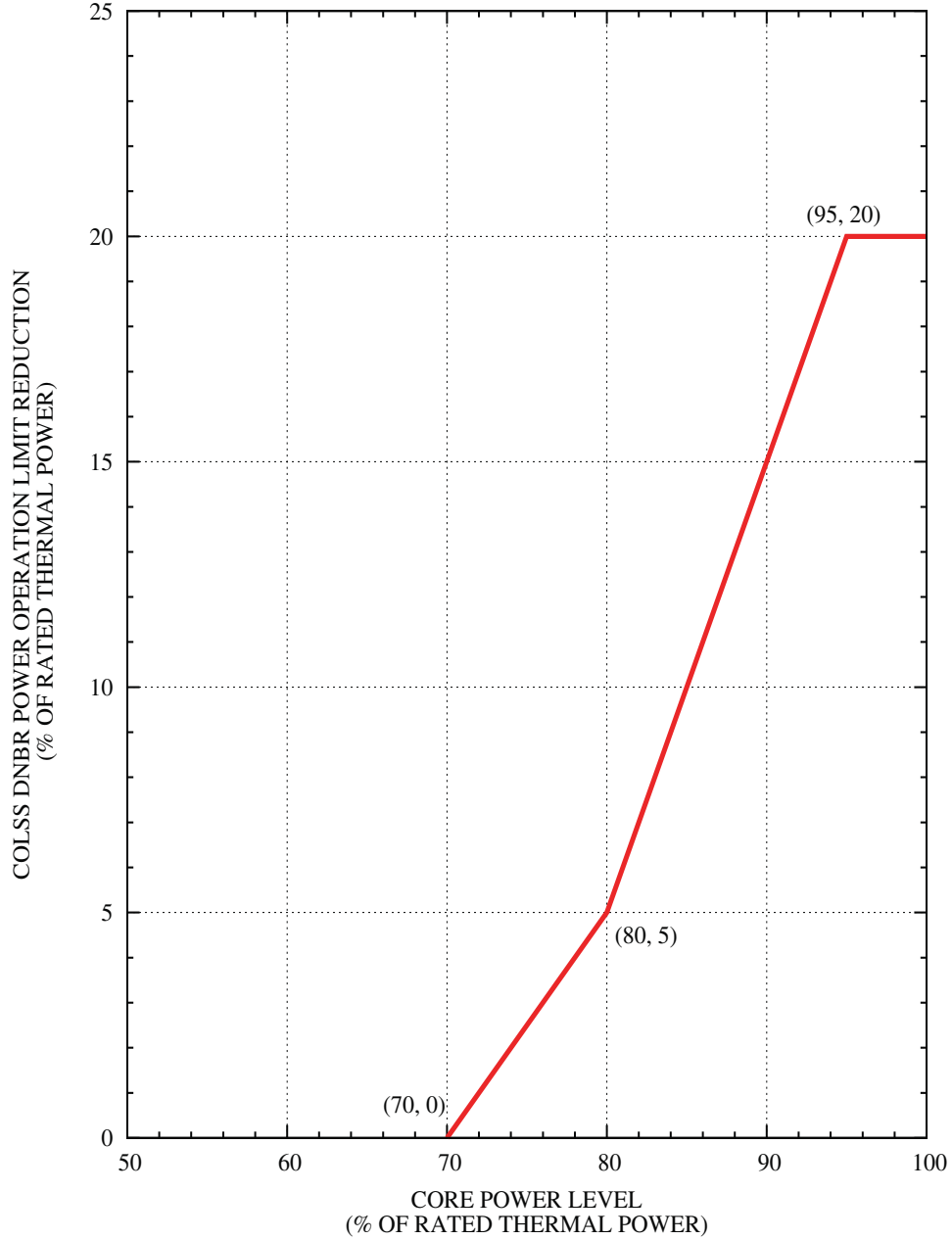


FIGURE 3.2.4-2
 DNBR MARGIN OPERATING LIMIT BASED ON
 THE CORE PROTECTION CALCULATORS
 (COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

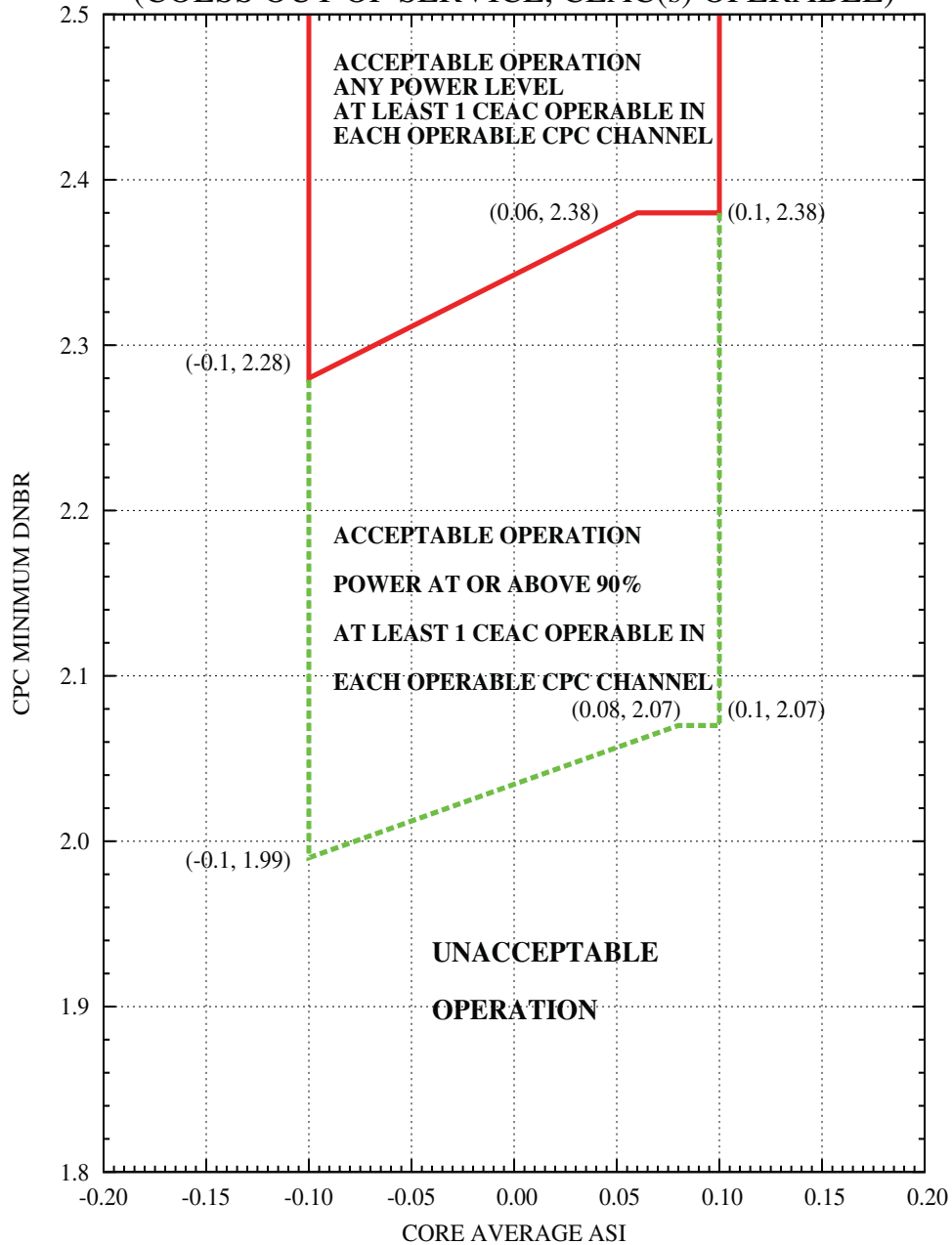


FIGURE 3.2.4-3
 DNBR MARGIN OPERATING LIMIT BASED ON
 THE CORE PROTECTION CALCULATORS
 (COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
 IN ANY OPERABLE CPC CHANNEL)

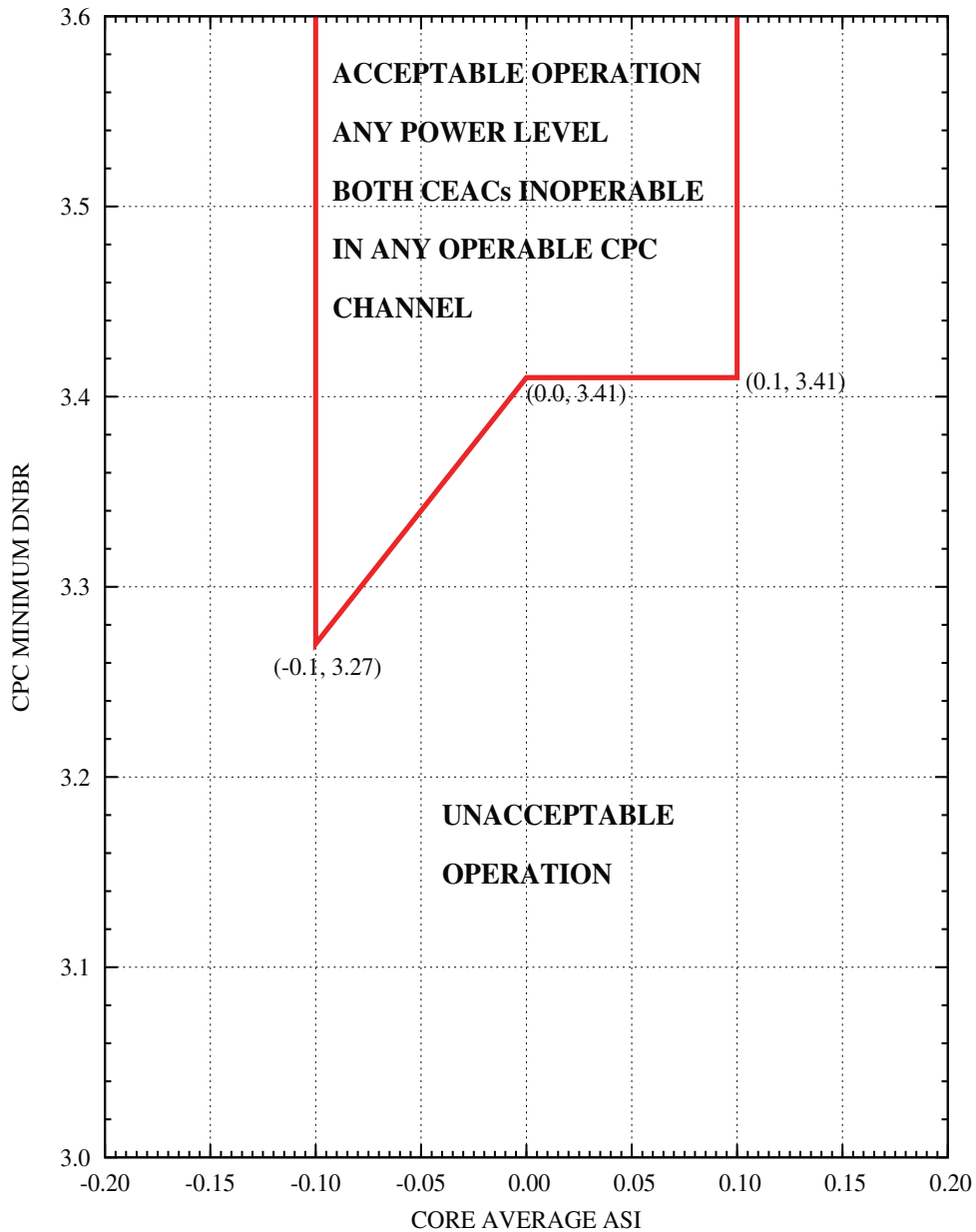


Table 3.3.12-1

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} > 0.98$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	0.5 hours	ONA	ONA
4 not on SCS	12 hours	0.5 hours	ONA	ONA
5 not on SCS	8 hours	0.5 hours	ONA	ONA
4 & 5 on SCS	ONA	ONA	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Table 3.3.12-2

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.98 \geq K_{\text{eff}} > 0.97$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	1 hour	0.5 hours	ONA
4 not on SCS	12 hours	1.5 hours	0.5 hours	ONA
5 not on SCS	8 hours	1.5 hours	0.5 hours	ONA
4 & 5 on SCS	8 hours	0.5 hours	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Table 3.3.12-3

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.97 \geq K_{\text{eff}} > 0.96$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	2.5 hours	1 hour	ONA
4 not on SCS	12 hours	2.5 hours	1 hour	0.5 hours
5 not on SCS	8 hours	2.5 hours	1 hour	0.5 hours
4 & 5 on SCS	8 hours	1 hour	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Table 3.3.12-4

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $0.96 \geq K_{\text{eff}} > 0.95$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	3 hours	1 hour	0.5 hours
4 not on SCS	12 hours	3.5 hours	1.5 hours	0.75 hours
5 not on SCS	8 hours	3.5 hours	1.5 hours	0.75 hours
4 & 5 on SCS	8 hours	1.5 hours	0.5 hours	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed

Table 3.3.12-5

REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON
DILUTION DETECTION AS A FUNCTION OF OPERATING
CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $K_{eff} \leq 0.95$

OPERATIONAL MODE	Number of Operating Charging Pumps			
	0	1	2	3
3	12 hours	4 hours	1.5 hours	1 hour
4 not on SCS	12 hours	4.5 hours	2 hours	1 hour
5 not on SCS	8 hours	4.5 hours	2 hours	1 hour
4 & 5 on SCS	8 hours	2 hours	0.75 hours	ONA
6	24 hours	1.5 hours	ONA	ONA

Notes: SCS = Shutdown Cooling System
ONA = Operation Not Allowed