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

102-08608-MSC/DD
April 29, 2023

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 32
Unit 2 Core Operating Limits Report Revision 25
Unit 3 Core Operating Limits Report Revision 31

Pursuant to Palo Verde Nuclear Generating Station (PVNGS) Technical Specifications (TS), Section 5.6.5(d), enclosed are the Units 1, 2, and 3, *Core Operating Limits Report* (COLR), Revisions 32, 25, and 31, respectively, which were made effective April 19, 2023.

The change implemented by these revisions is the relocation of the parameters of TS 3.4.1, *RCS [Reactor Coolant System] Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits*, to each of the COLRs. The relocation of information conforms with Renewed Facility Operating License Amendments number 220 [Agencywide Documents Access and Management System (ADAMS) Accession number ML22334A070], which adopted TS Task Force (TSTF) Traveler, TSTF-487-A.

In addition, the Unit 2 COLR removed the use of Westinghouse CE16STD with ZIRLO™ cladding fuel type for operating cycle 25. Revision bars have been applied to the pages which contain changes.

No commitments are being made by this letter. If you have any questions concerning the content of this letter, please contact me at (623) 393-5753.

Sincerely,

Cox, Matthew S(Z05628)

Digitally signed by Cox, Matthew S(Z05628)
Date: 2023.04.29 21:09:06 -07'00'

Matthew S. Cox
Department Leader, Nuclear Regulatory Affairs

MSC/DD/cr

Enclosure 1: Unit 1 Core Operating Limits Report, Revision 32
Enclosure 2: Unit 2 Core Operating Limits Report, Revision 25
Enclosure 3: Unit 3 Core Operating Limits Report, Revision 31

cc:

R. J. Lewis	Acting NRC Region IV Regional Administrator
S. P. Lingam	NRC NRR Project Manager for PVNGS
L. N. Merker	NRC Senior Resident Inspector for PVNGS

Enclosure 1

Unit 1 Core Operating Limits Report
Revision 32

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 1

CORE OPERATING LIMITS REPORT

Revision 32

Effective: April 19, 2023

Responsible Engineer Date	Swoope, Scott (ZD0940) Digitally signed by Swoope, Scott (ZD0940) Date: 2023.04.06 13:42:04 -07'00'
Design Verifier Date	Gill, Shawn P(Z37857) Digitally signed by Gill, Shawn P(Z37857) Date: 2023.04.06 15:08:54 -07'00'
Responsible Section Leader Date	Cowdin, Christopher (Z12133) Digitally signed by Cowdin, Christopher (Z12133) Reason: I am the acting Reload Analysis Section Leader. Date: 2023.04.07 12:38:23 -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
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3.1.8	Part Strength CEA Insertion Limits
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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:

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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™ 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 W Designed NSSS	Westinghouse

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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	December 2008	Revision 4 to the Supplement to Appendix 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.	September 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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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 Uprated 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 Uprated 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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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 limits[1] shown in Figure 3.1.7-1[2]; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits[1] shown in Figure 3.1.7-2.[2] Regulating Groups 1 and 2 CEAs shall be maintained ≥ fully withdrawn[1, 3] while in Modes 1 and 2 (except while performing SR 3.1.5.3). When ≥ 20% power Regulating Group 3 shall be maintained ≥ 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 ≥147.75” (Pulse Counter indication) and ≥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
$-0.18 \leq ASI \leq 0.17$ for power $\geq 50\%$
$-0.28 \leq ASI \leq 0.17$ for power $>20\%$ and $< 50\%$

COLSS OUT OF SERVICE (CPC)
$-0.10 \leq ASI \leq 0.10$ 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.

3.4.1 - RCS Pressure, Temperature and Flow Departure from Nucleate Boiling Limits

RCS DNB parameters for pressurizer pressure, cold leg temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure ≥ 2130 psia and ≤ 2295 psia; and

b. RCS cold leg temperature (T_c) shall be within the area of acceptable operation shown in Figure 3.4.1-1; and

c. RCS total flow rate ≥ 155.8 E6 lbm/hour

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

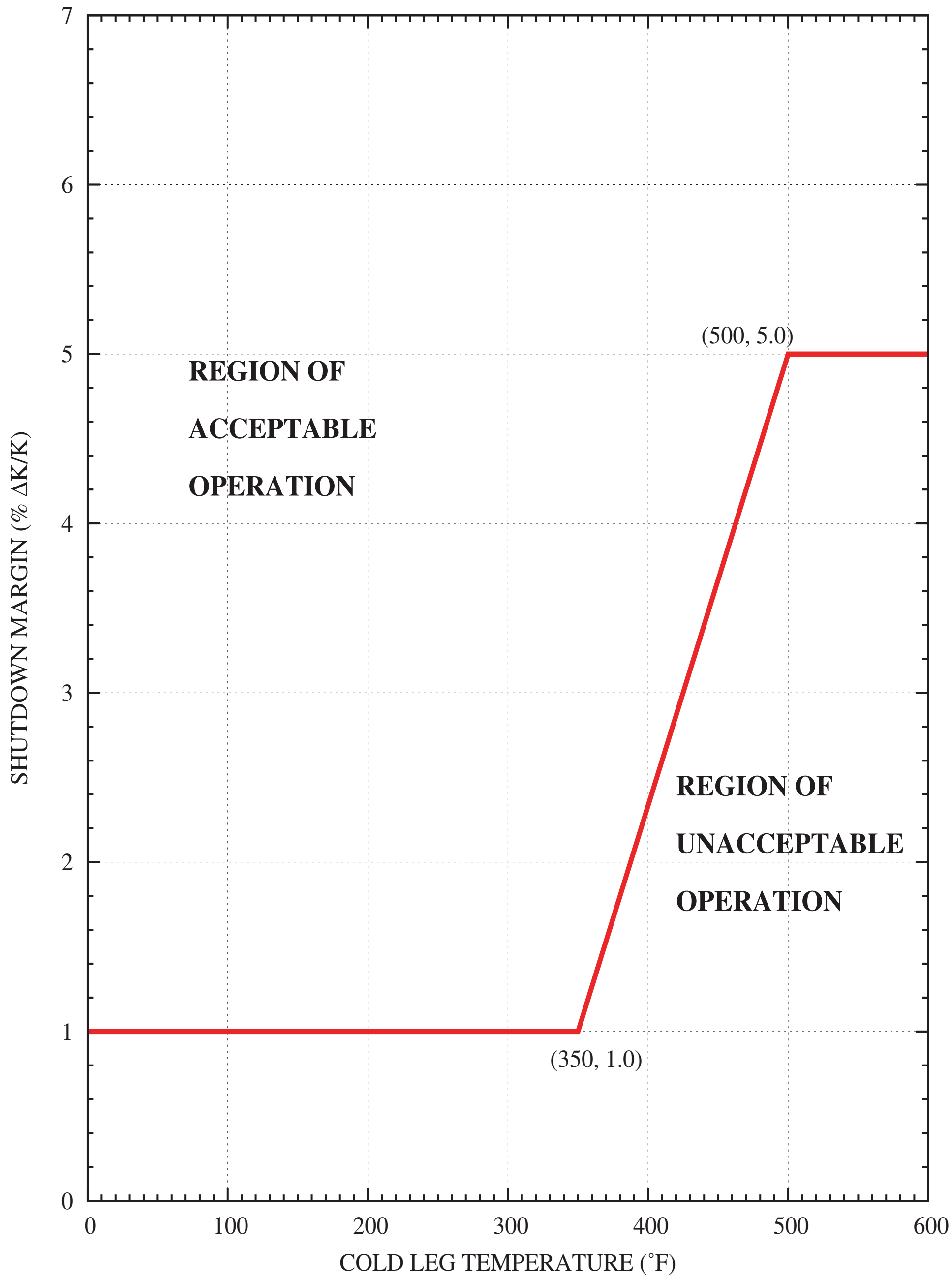


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

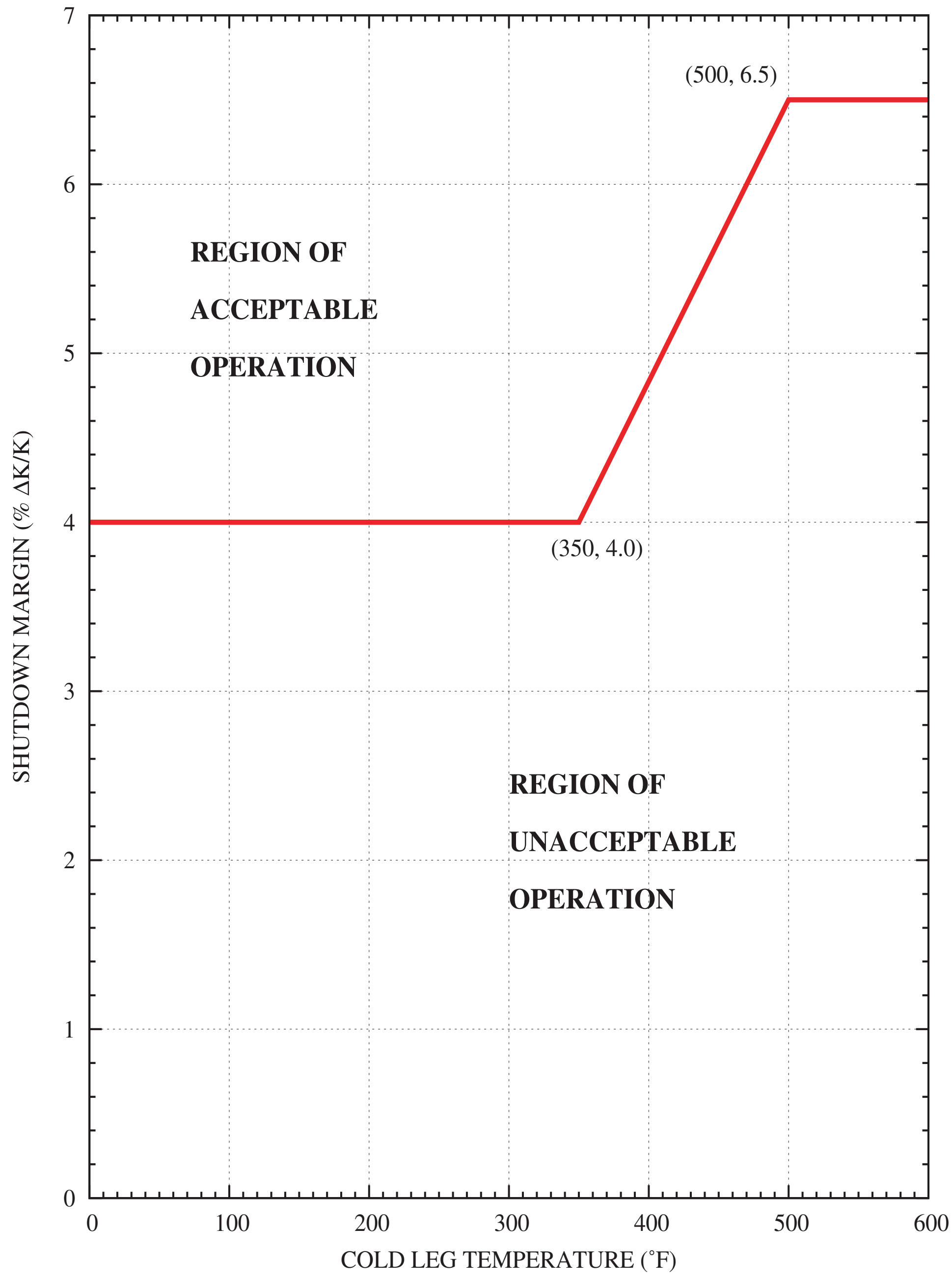


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

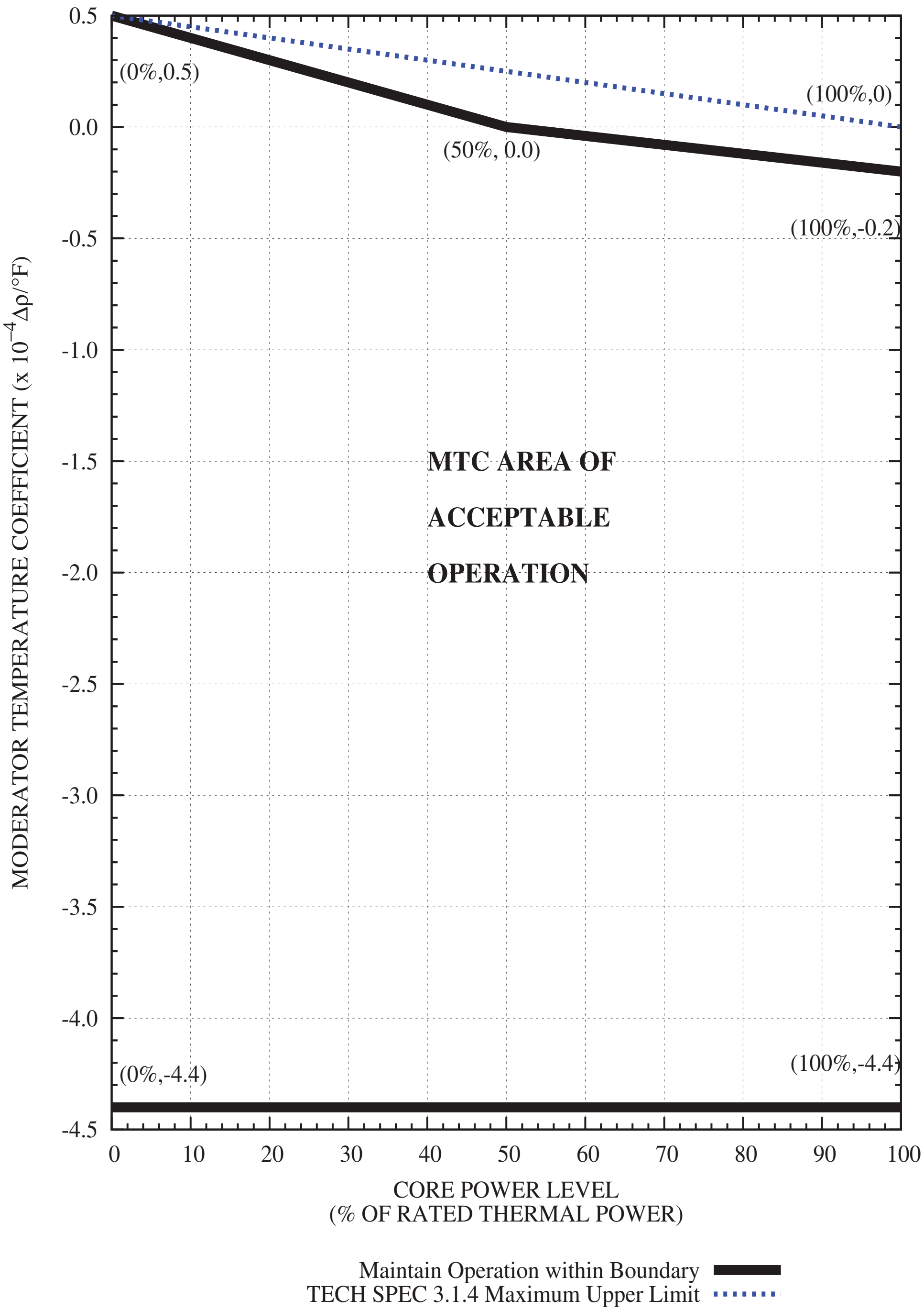
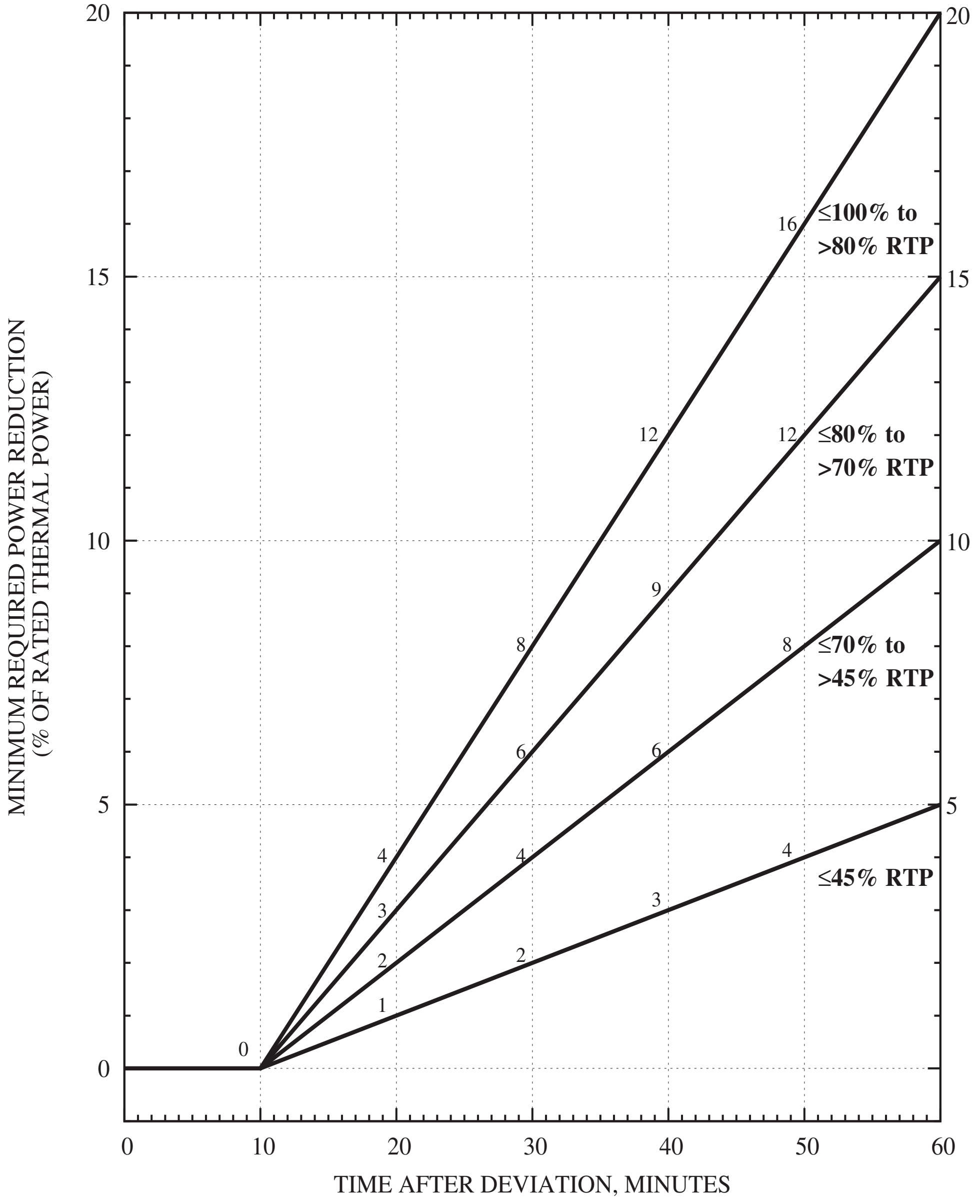


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

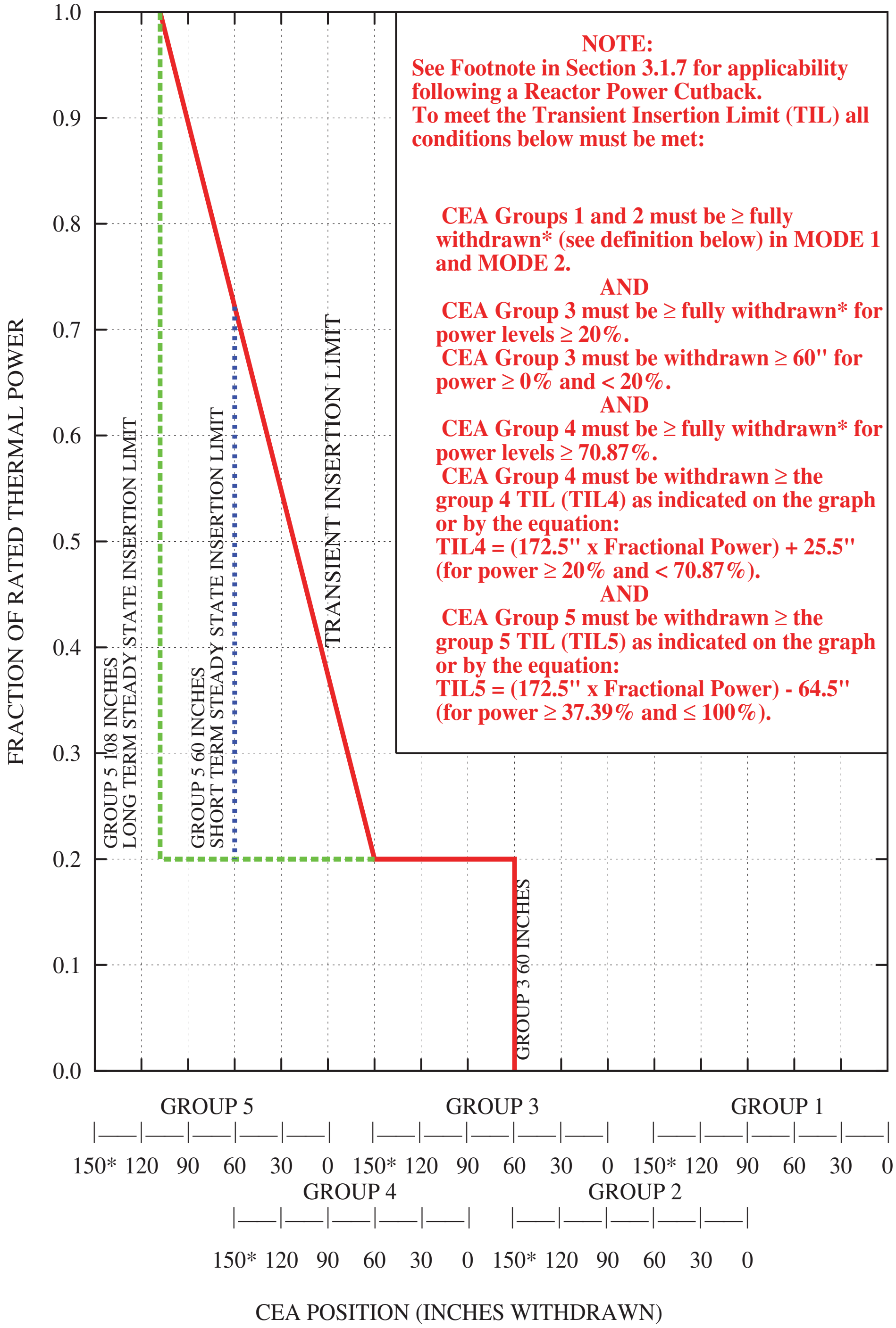


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

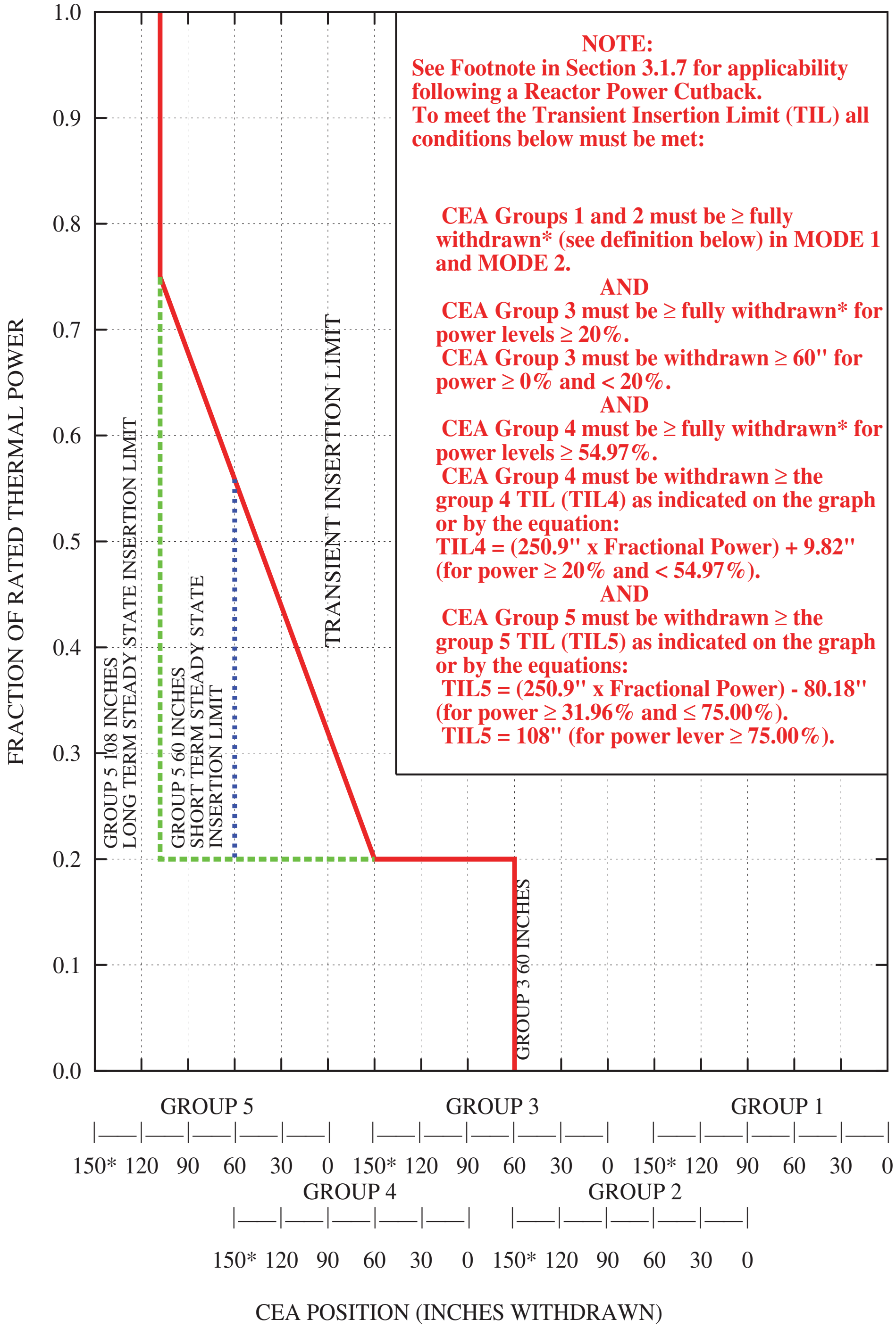
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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

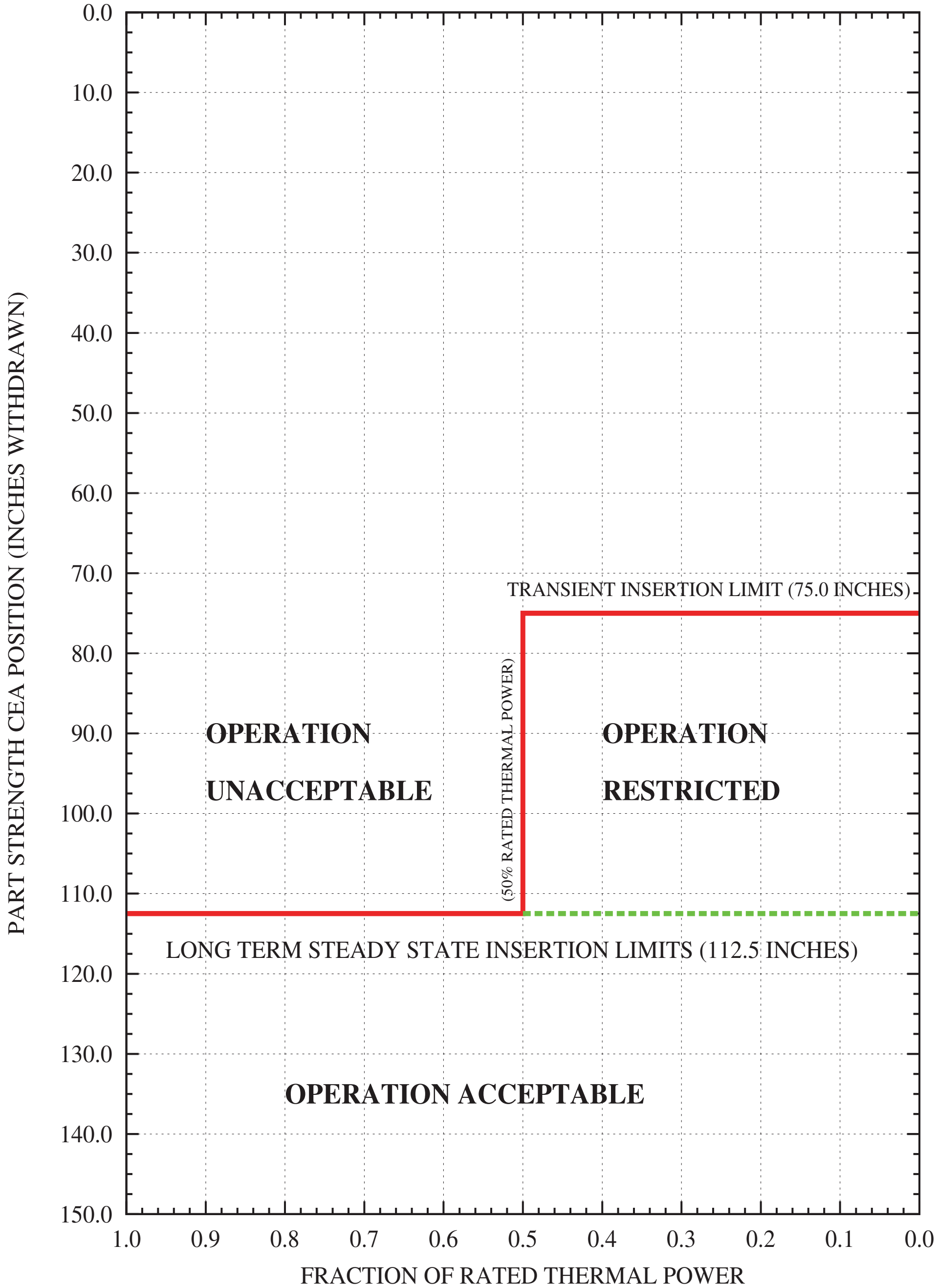


FIGURE 3.2.3-1
AZIMUTHAL POWER TILT VERSUS THERMAL POWER
(COLSS IN SERVICE)

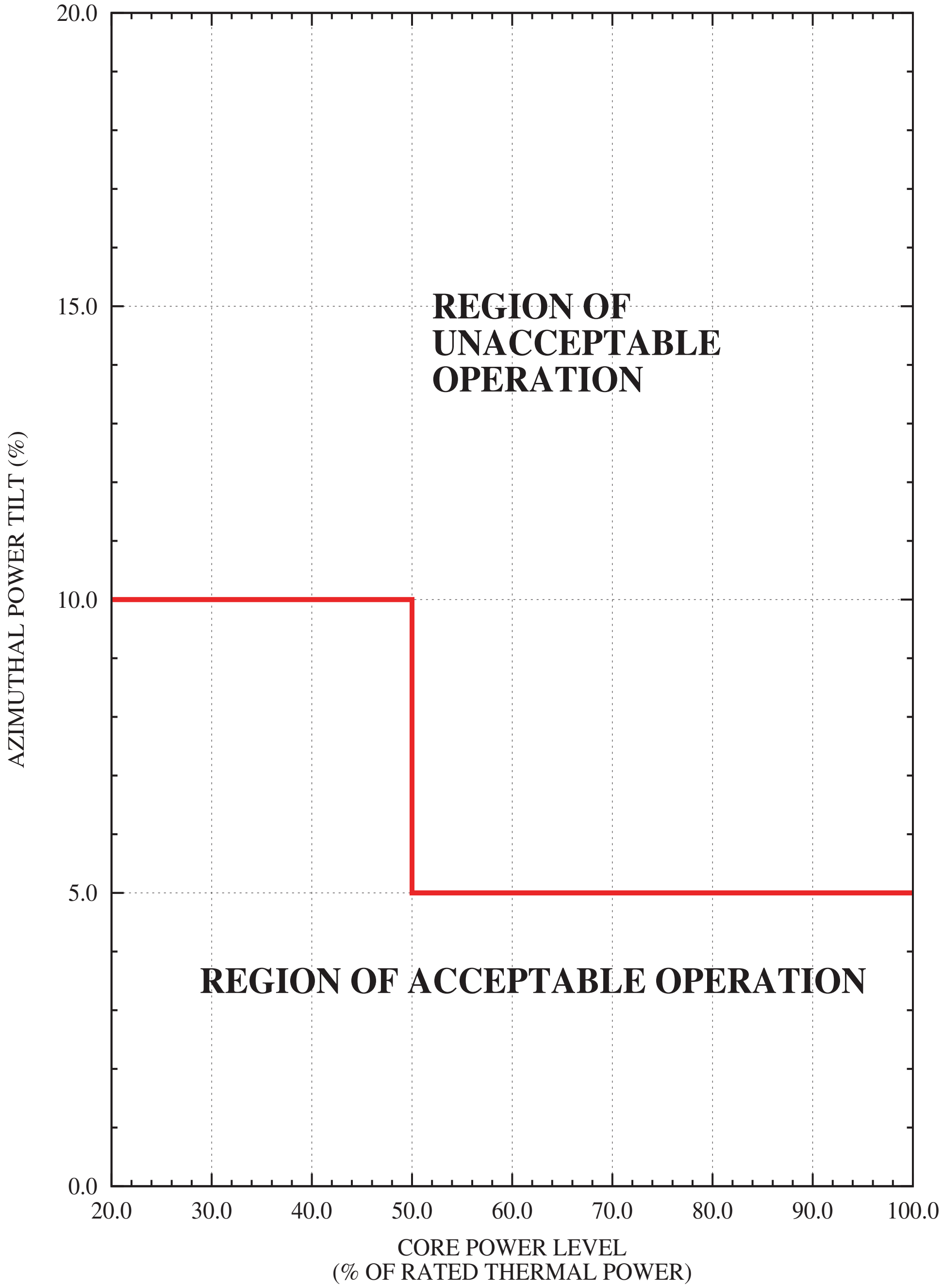


FIGURE 3.2.4-1
COLSS DNBR OPERATING LIMIT
ALLOWANCE FOR BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL

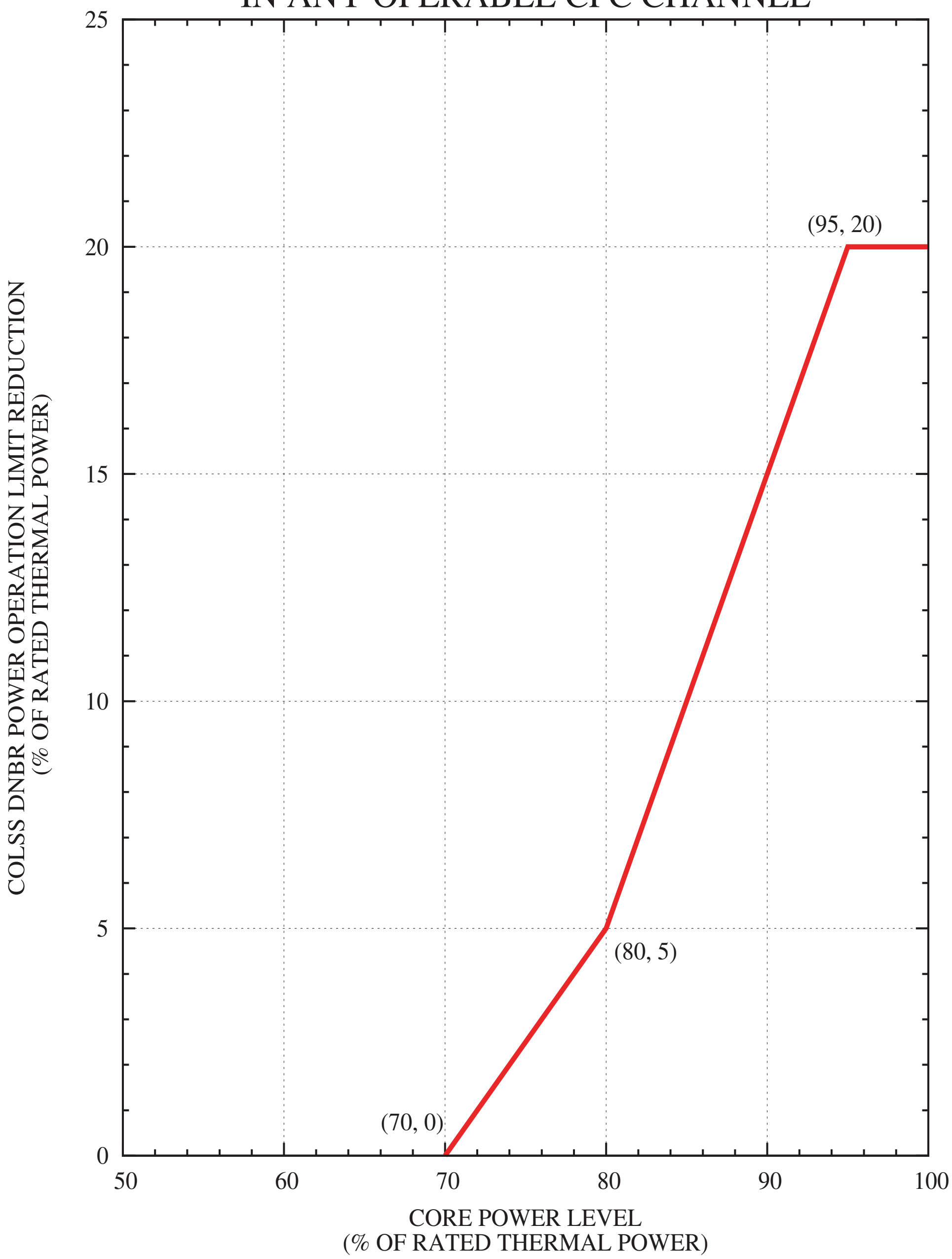


FIGURE 3.2.4-2
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

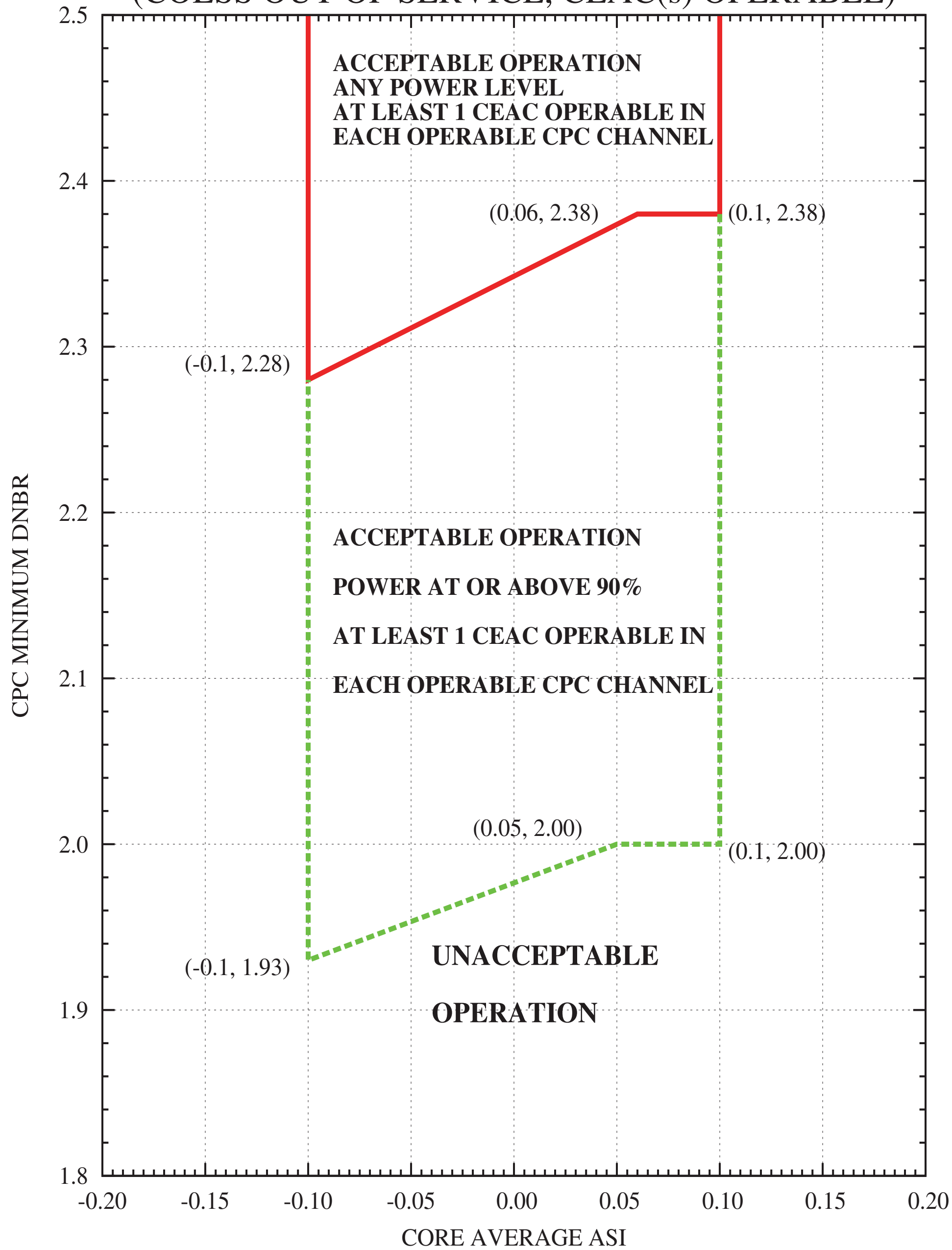


FIGURE 3.2.4-3
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL)

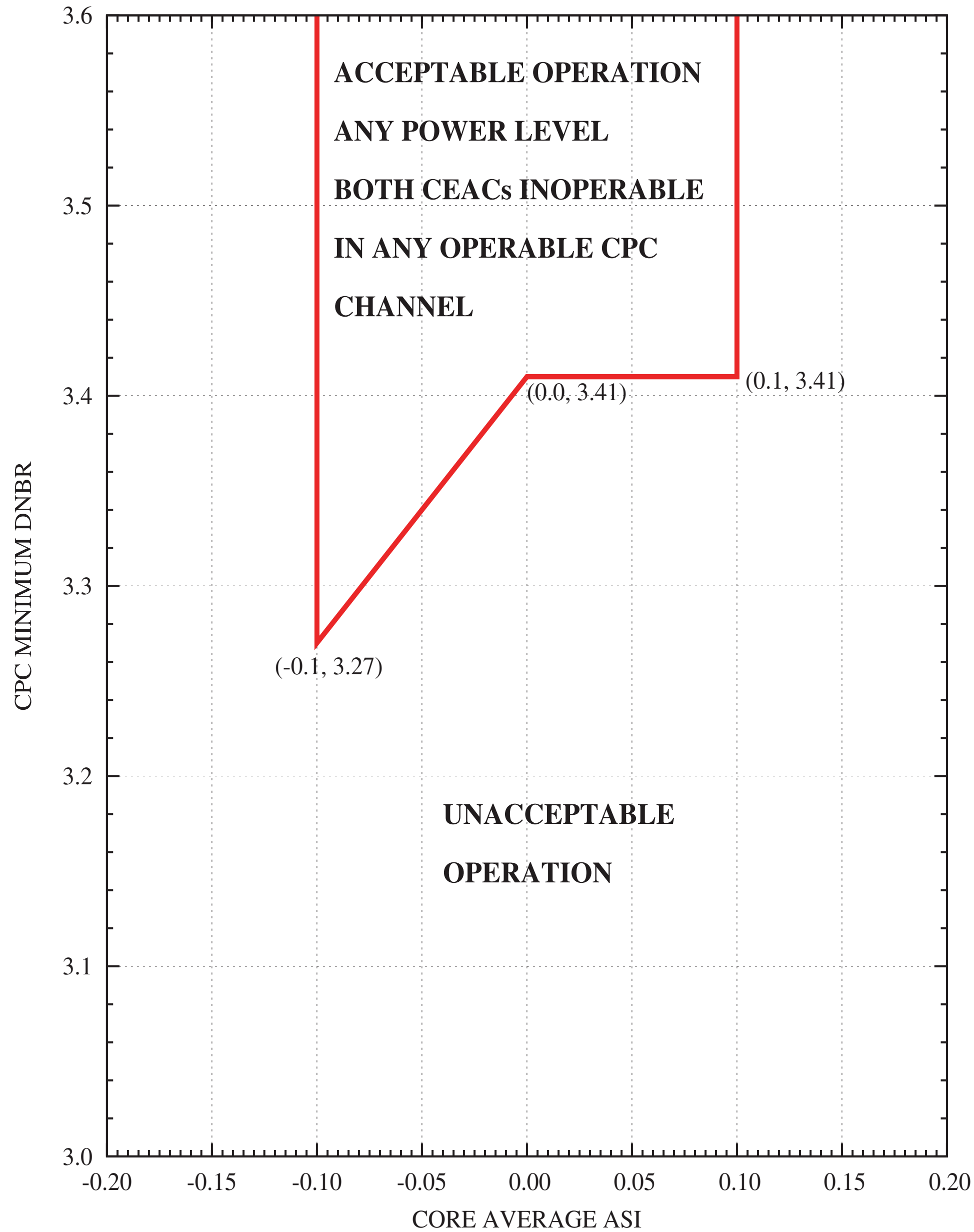


Table 3.3.12-1

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

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 $\mathbf{0.97 \geq K_{eff} > 0.96}$

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 $\mathbf{0.96 \geq K_{eff} > 0.95}$

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

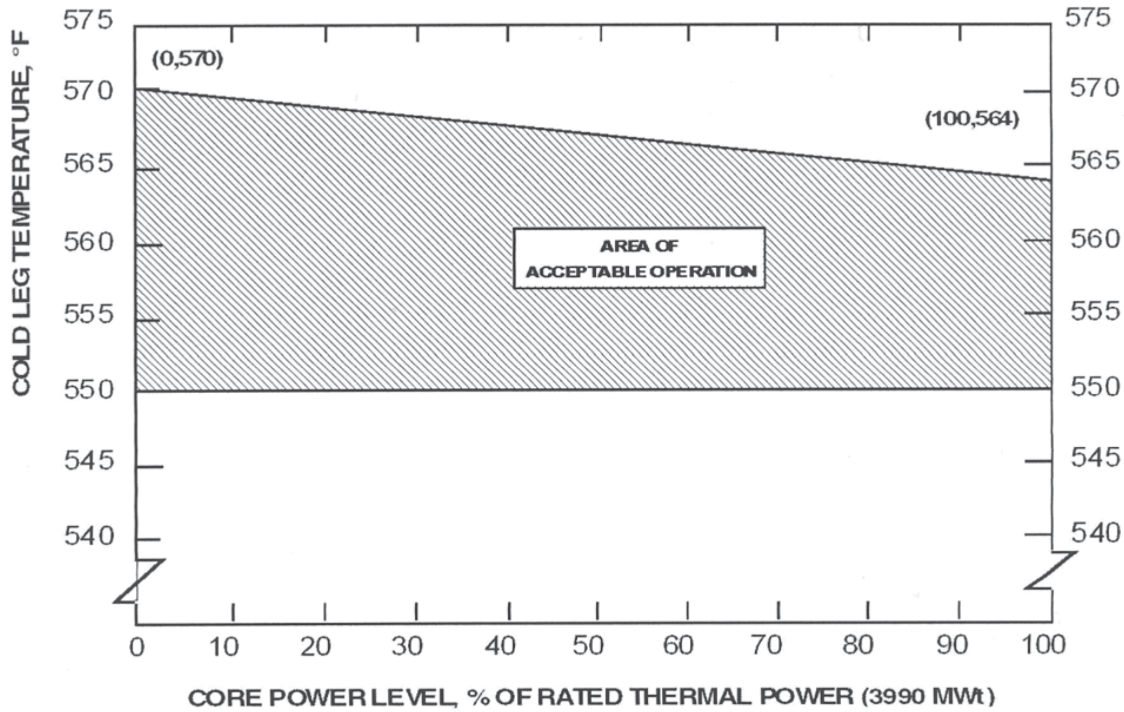
Table 3.3.12-5

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

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

Figure 3.4.1-1 Reactor Coolant Cold Leg Temperature vs Core Power Level



Enclosure 2

Unit 2 Core Operating Limits Report
Revision 25

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 2

CORE OPERATING LIMITS REPORT

Revision 25

Effective: April 19, 2023

Responsible Engineer Date	Swoope, Scott (ZD0940) Digitally signed by Swoope, Scott (ZD0940) Date: 2023.04.06 15:41:14 -07'00'
Design Verifier Date	Gill, Shawn P(Z37857) Digitally signed by Gill, Shawn P(Z37857) Date: 2023.04.06 16:06:55 -07'00'
Responsible Section Leader Date	Cowdin, Christopher (Z12133) Digitally signed by Cowdin, Christopher (Z12133) Reason: I am the acting Reload Analysis Section Leader. Date: 2023.04.07 14:06:43 -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)
3.4.1	RCS Pressure, Temperature and Flow DNB Limits
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:

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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™ 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 W Designed NSSS	Westinghouse

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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	December 2008	Revision 4 to the Supplement to Appendix 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.	September 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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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 Uprated 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 Uprated 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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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 limits[1] shown in Figure 3.1.7-1[2]; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits[1] shown in Figure 3.1.7-2.[2] Regulating Groups 1 and 2 CEAs shall be maintained ≥ fully withdrawn[1, 3] while in Modes 1 and 2 (except while performing SR 3.1.5.3). When ≥ 20% power Regulating Group 3 shall be maintained ≥ 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 ≥147.75" (Pulse Counter indication) and ≥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
$-0.18 \leq ASI \leq 0.17$ for power $\geq$ 50%
$-0.28 \leq ASI \leq 0.17$ for power >20% and < 50%

COLSS OUT OF SERVICE (CPC)
$-0.10 \leq ASI \leq 0.10$ 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.

3.4.1 - RCS Pressure, Temperature and Flow Departure from Nucleate Boiling Limits

RCS DNB parameters for pressurizer pressure, cold leg temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure $\geq$ 2130 psia and $\leq$ 2295 psia; and

b. RCS cold leg temperature (T_c) shall be within the area of acceptable operation shown in Figure 3.4.1-1; and

c. RCS total flow rate $\geq$ 155.8 E6 lbm/hour

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:
- 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

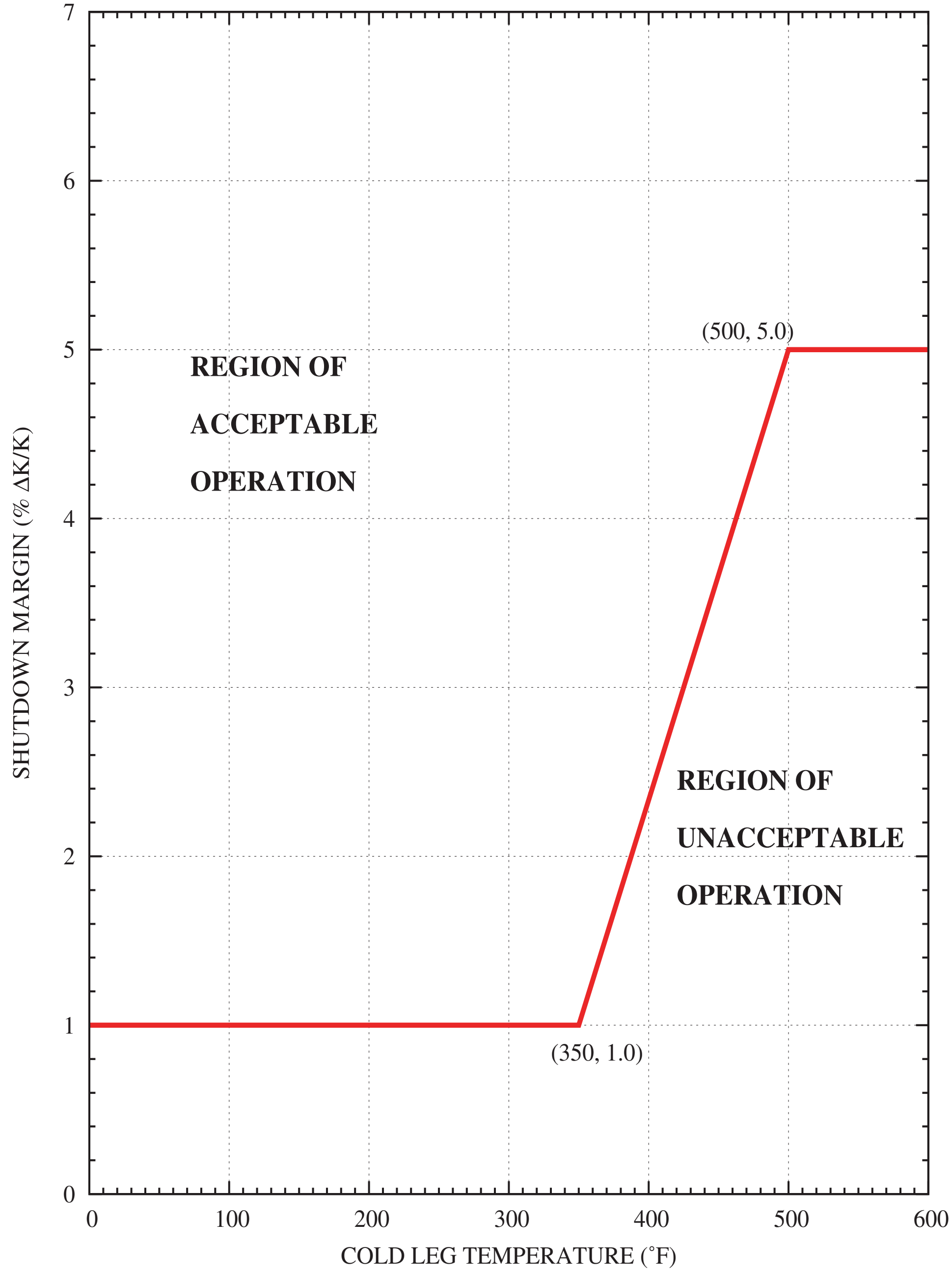


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

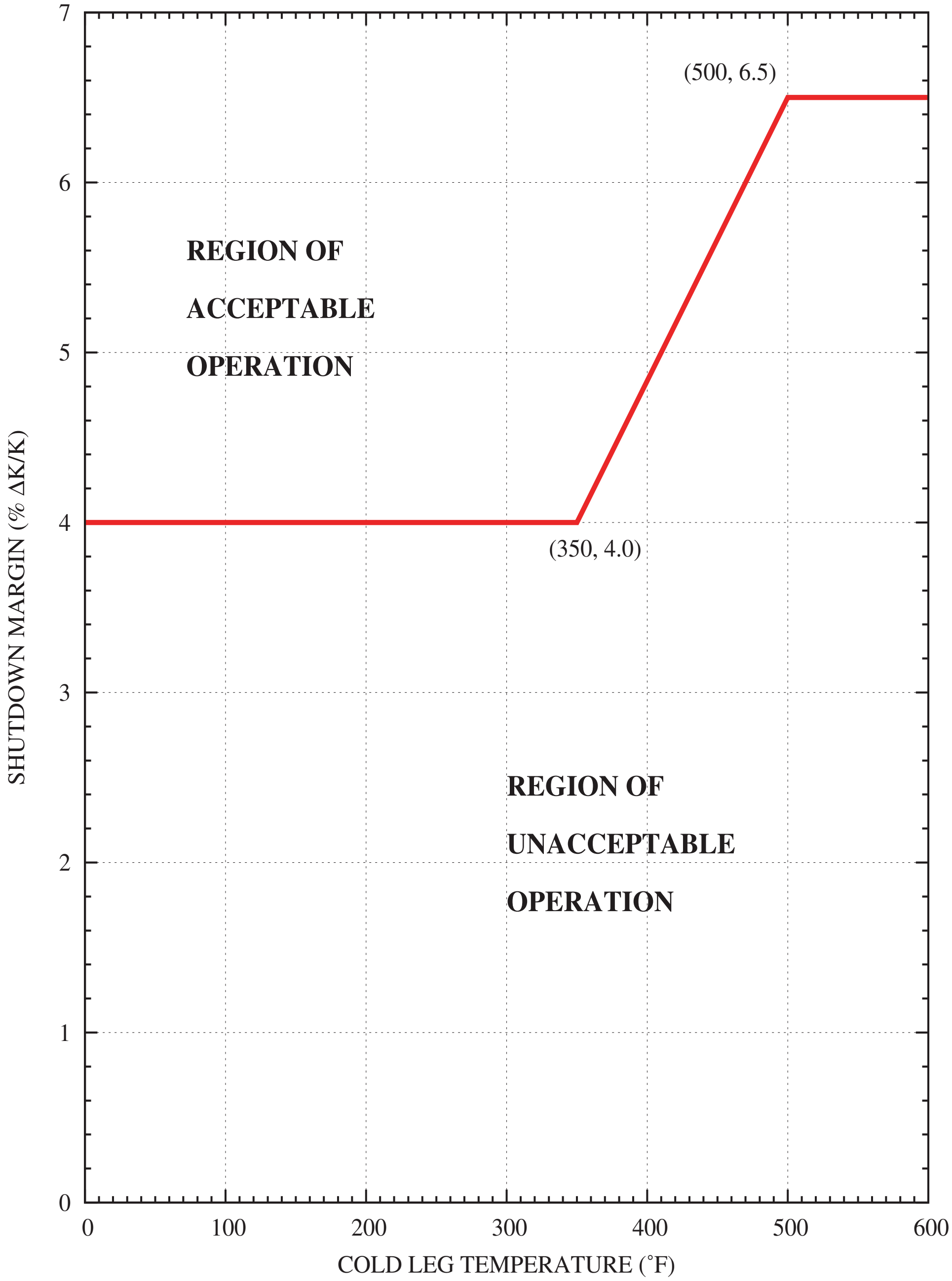


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

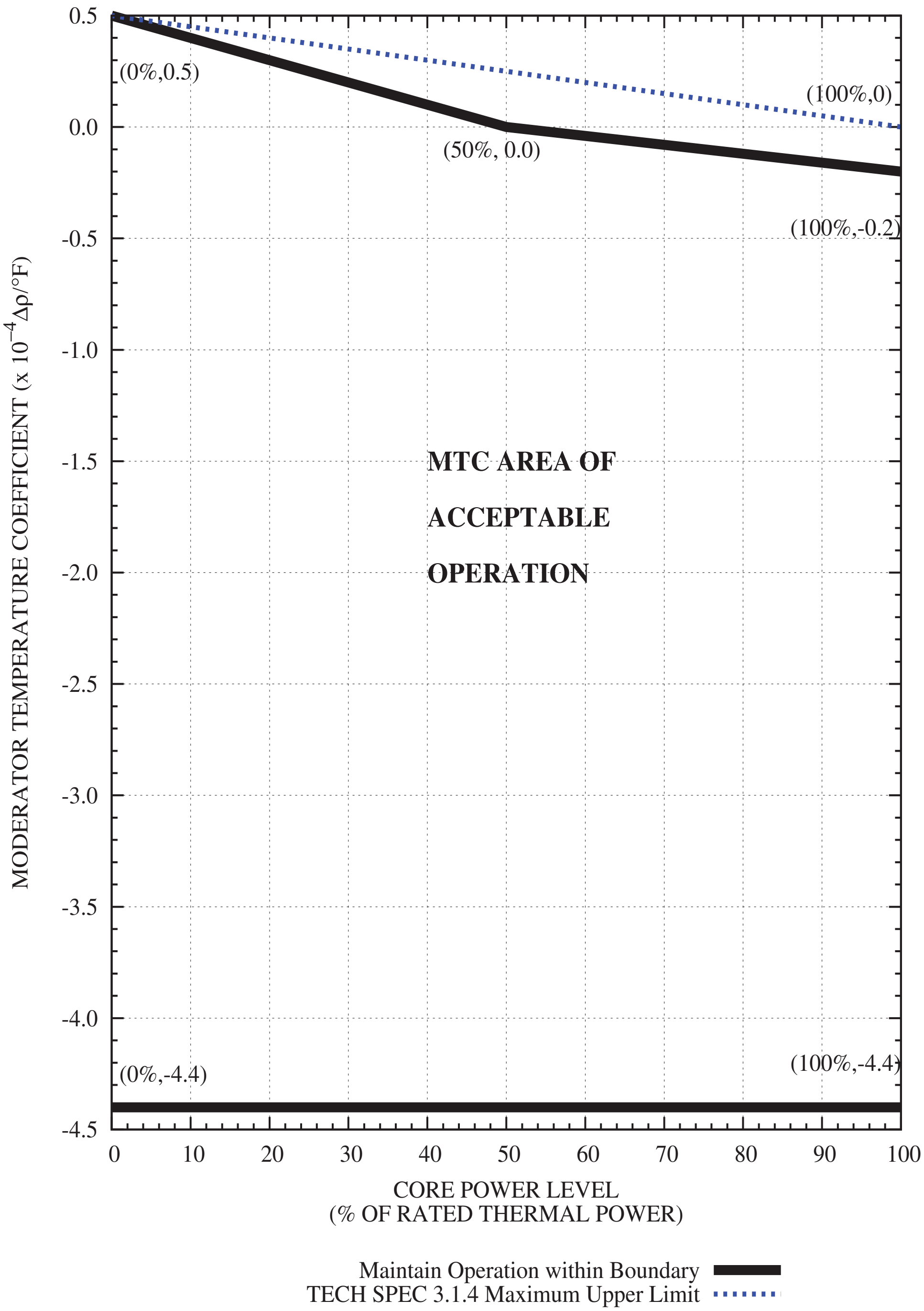
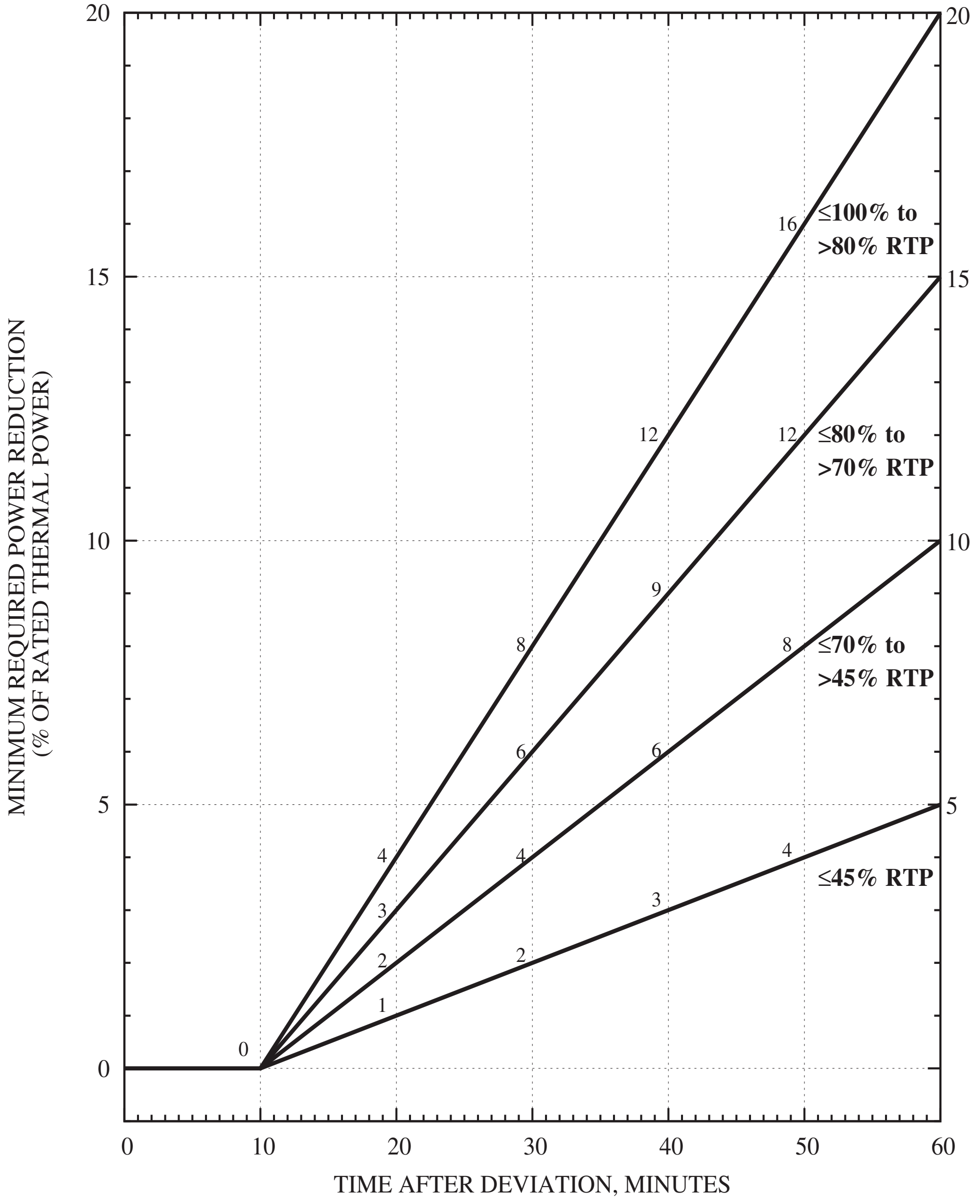


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

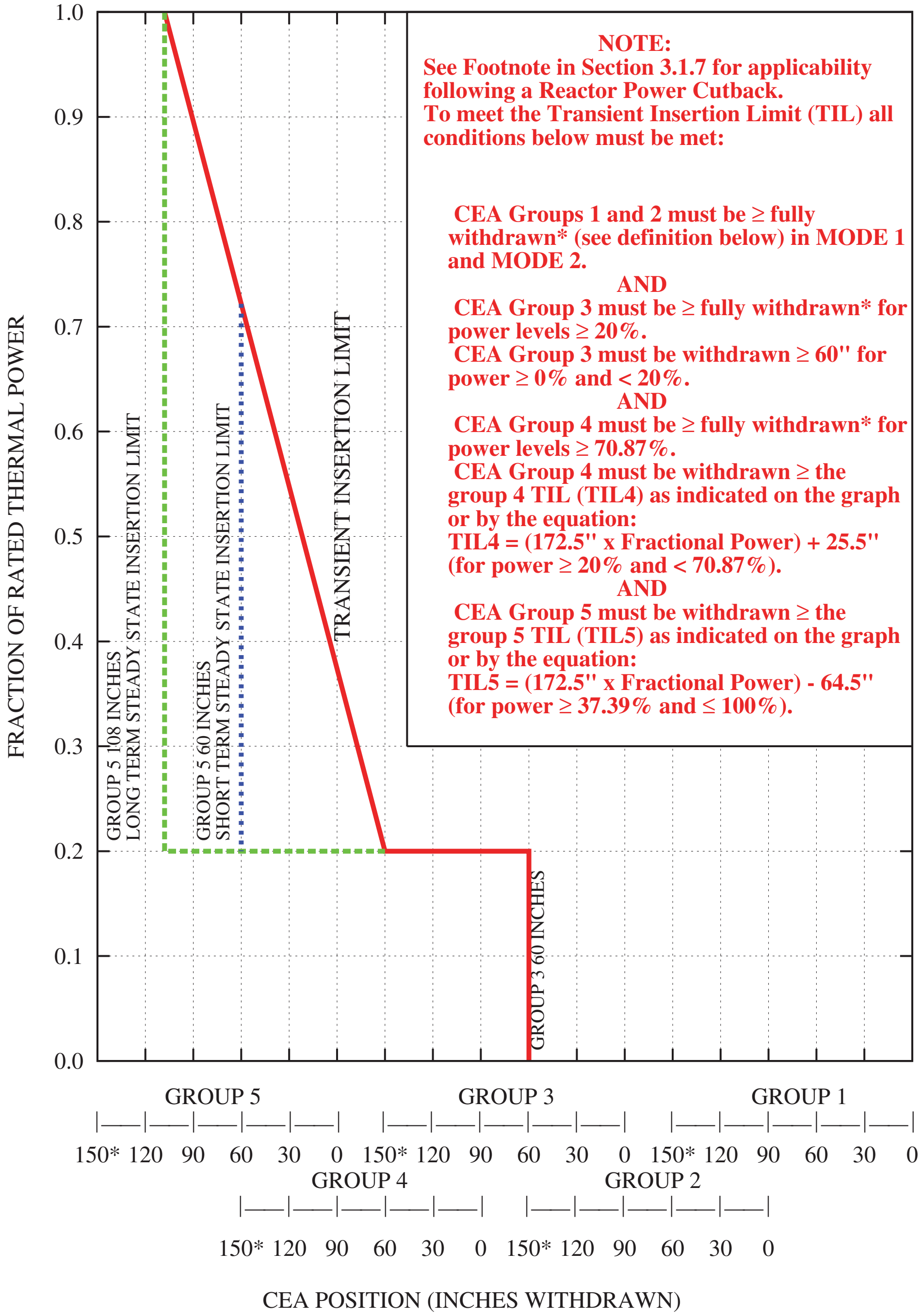


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

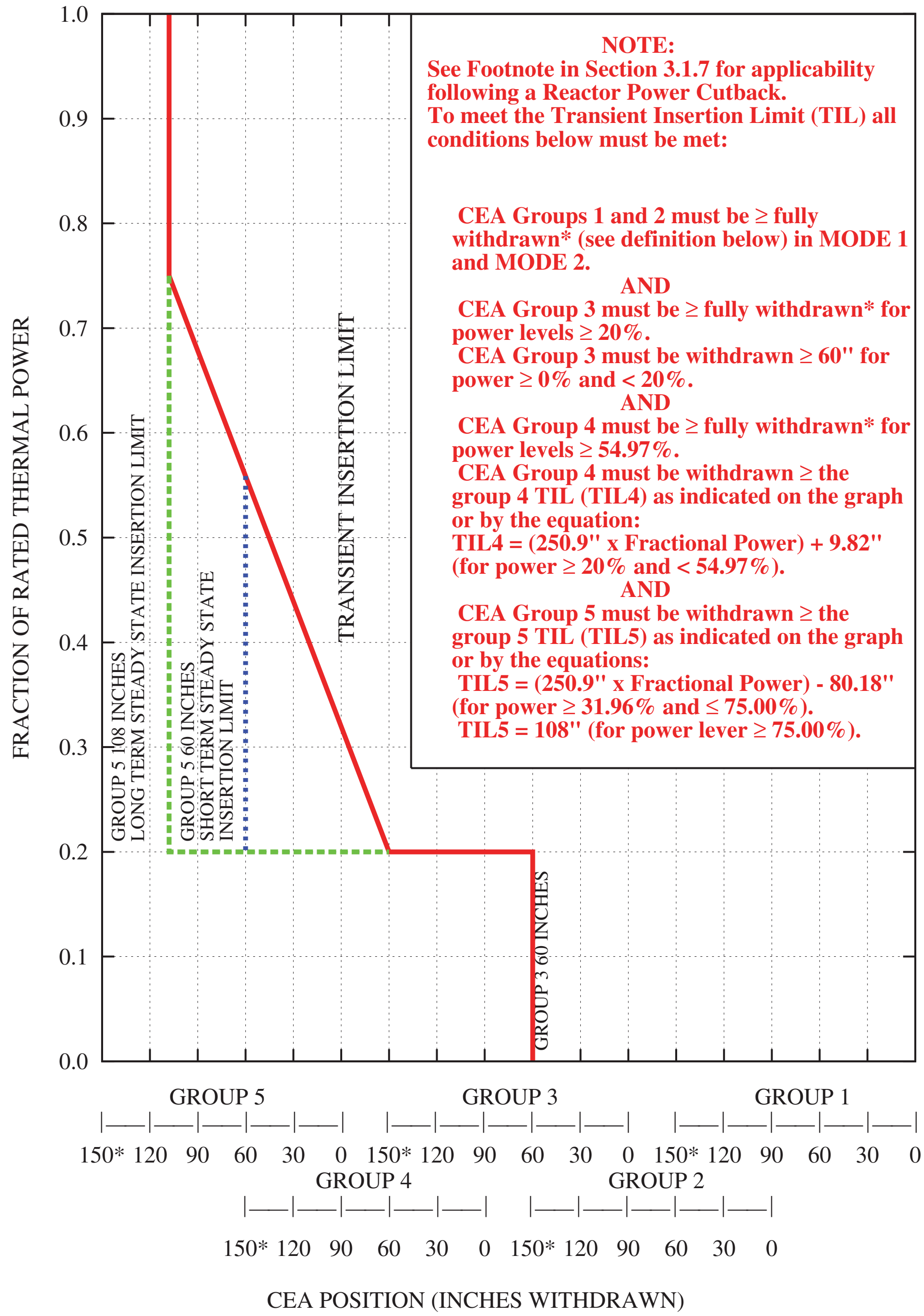
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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



* Fully Withdrawn (FW) is defined as ≥ 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

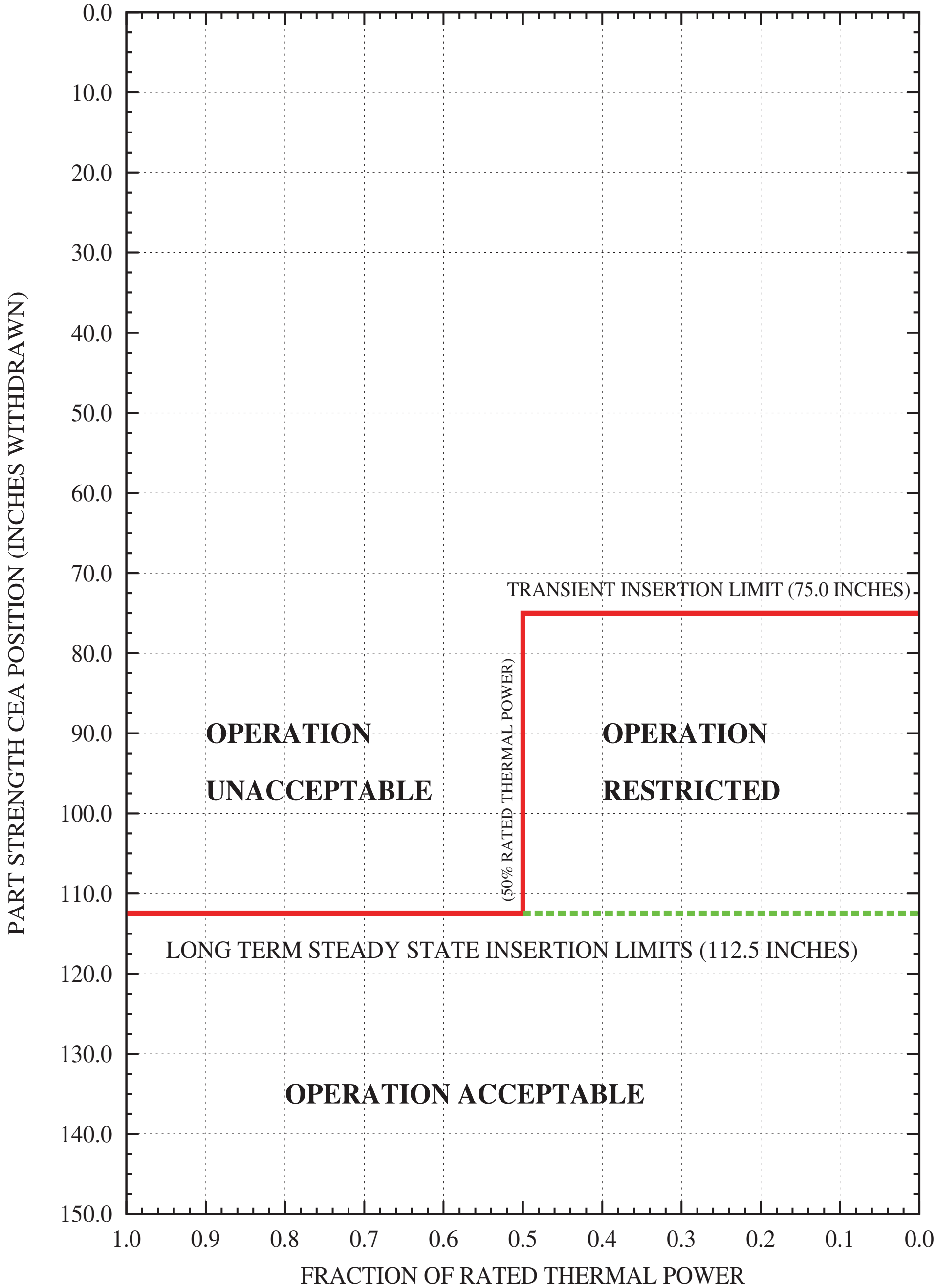


FIGURE 3.2.3-1
AZIMUTHAL POWER TILT VERSUS THERMAL POWER
(COLSS IN SERVICE)

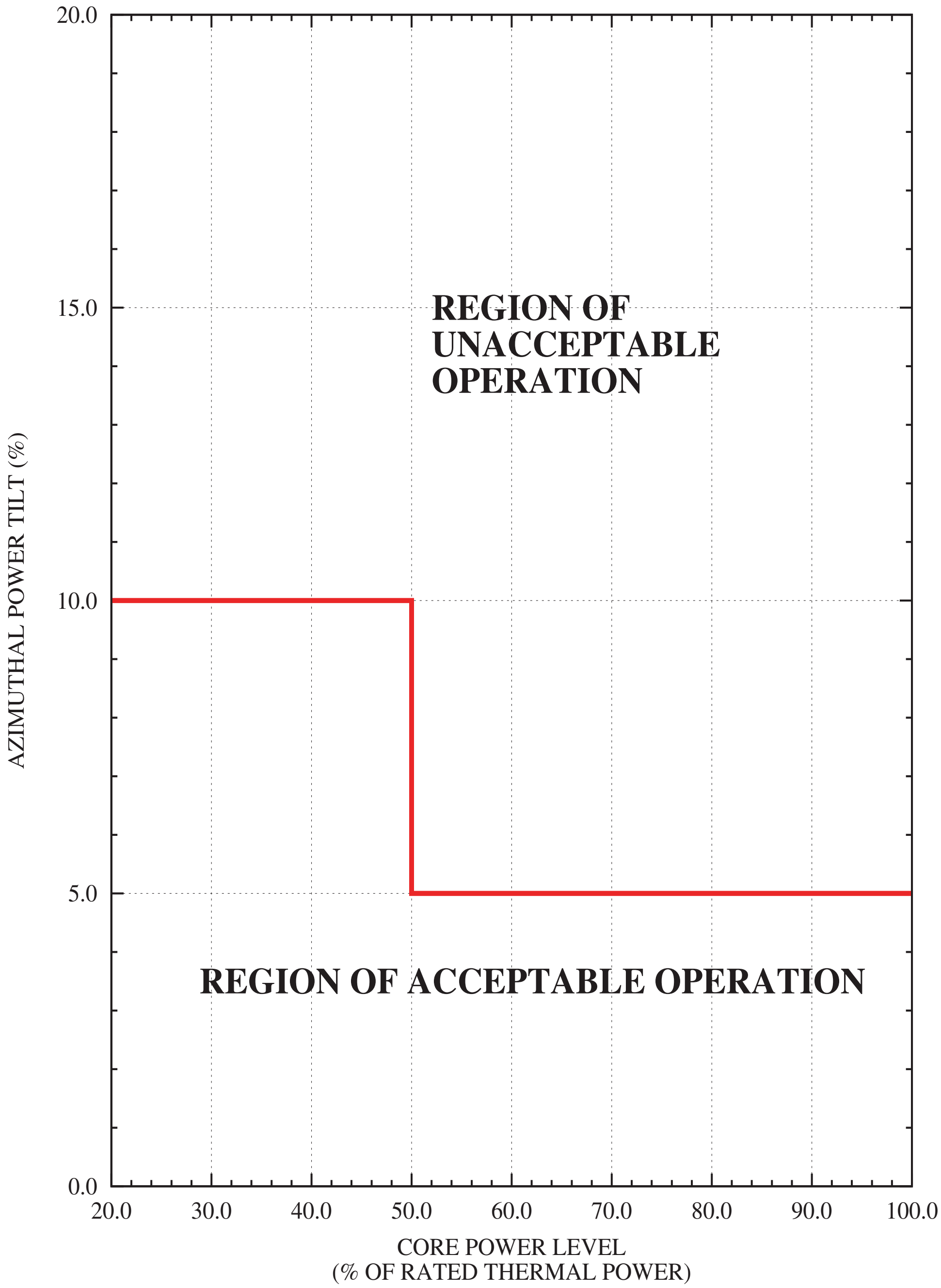


FIGURE 3.2.4-1
COLSS DNBR OPERATING LIMIT
ALLOWANCE FOR BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL

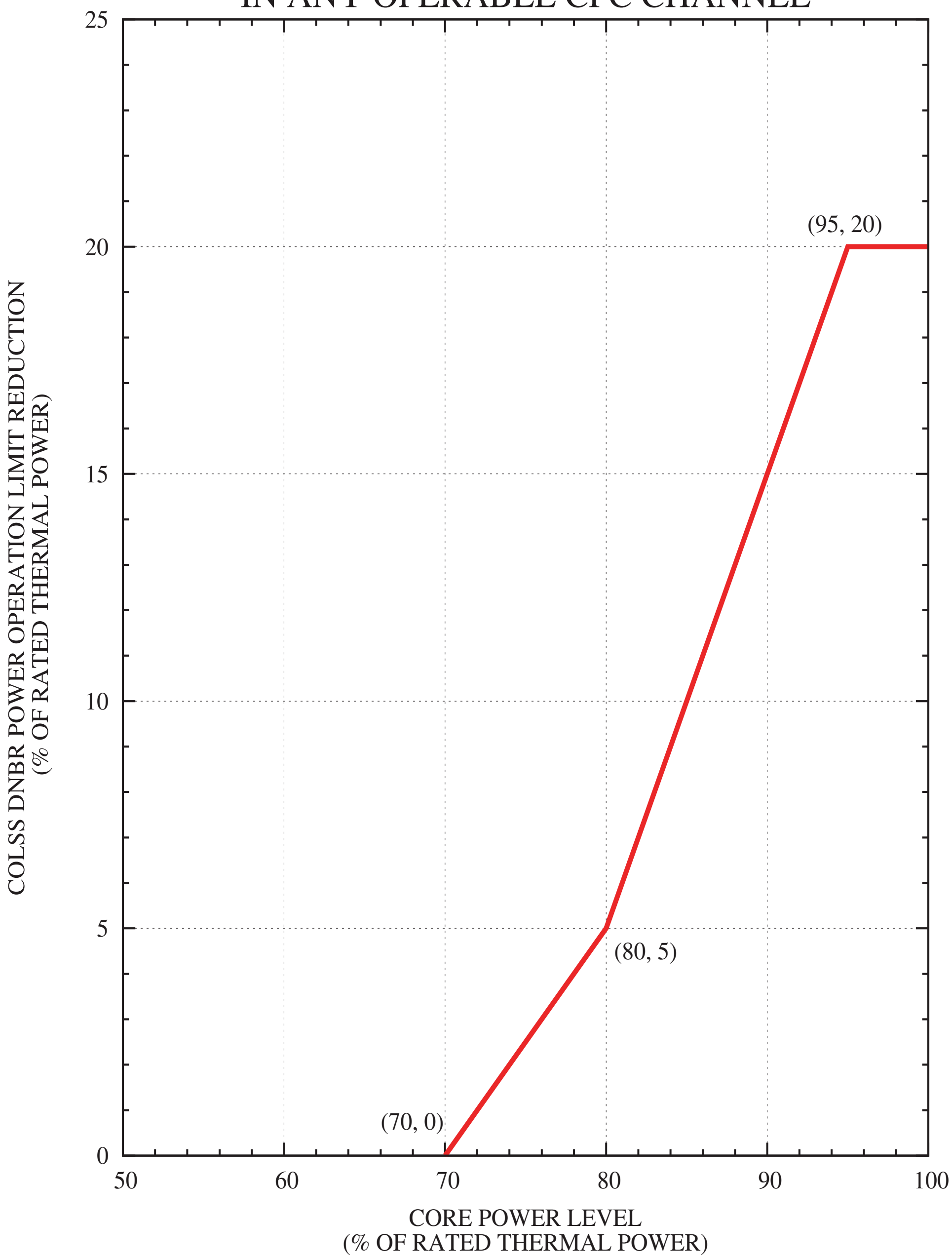


FIGURE 3.2.4-2
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

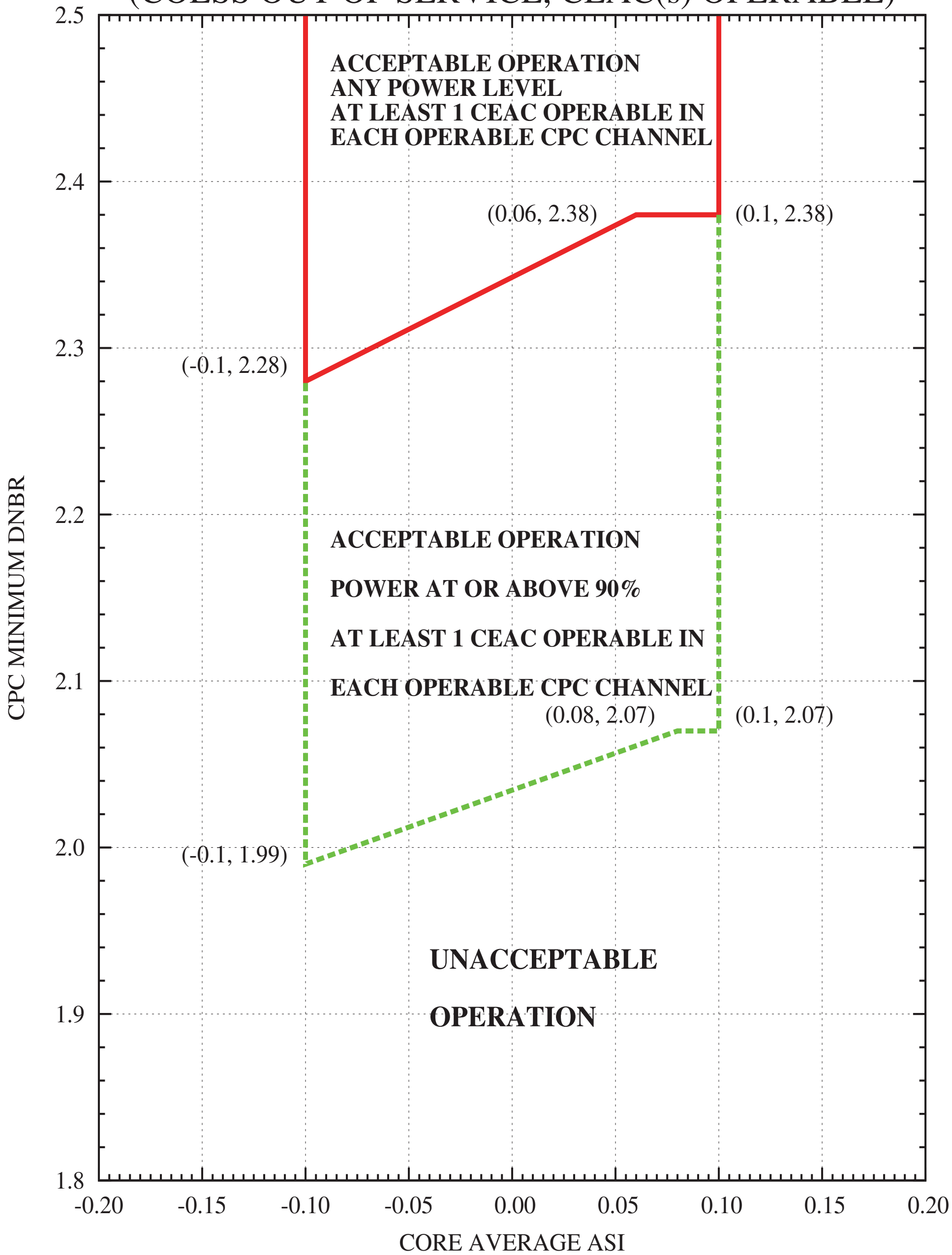


FIGURE 3.2.4-3
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL)

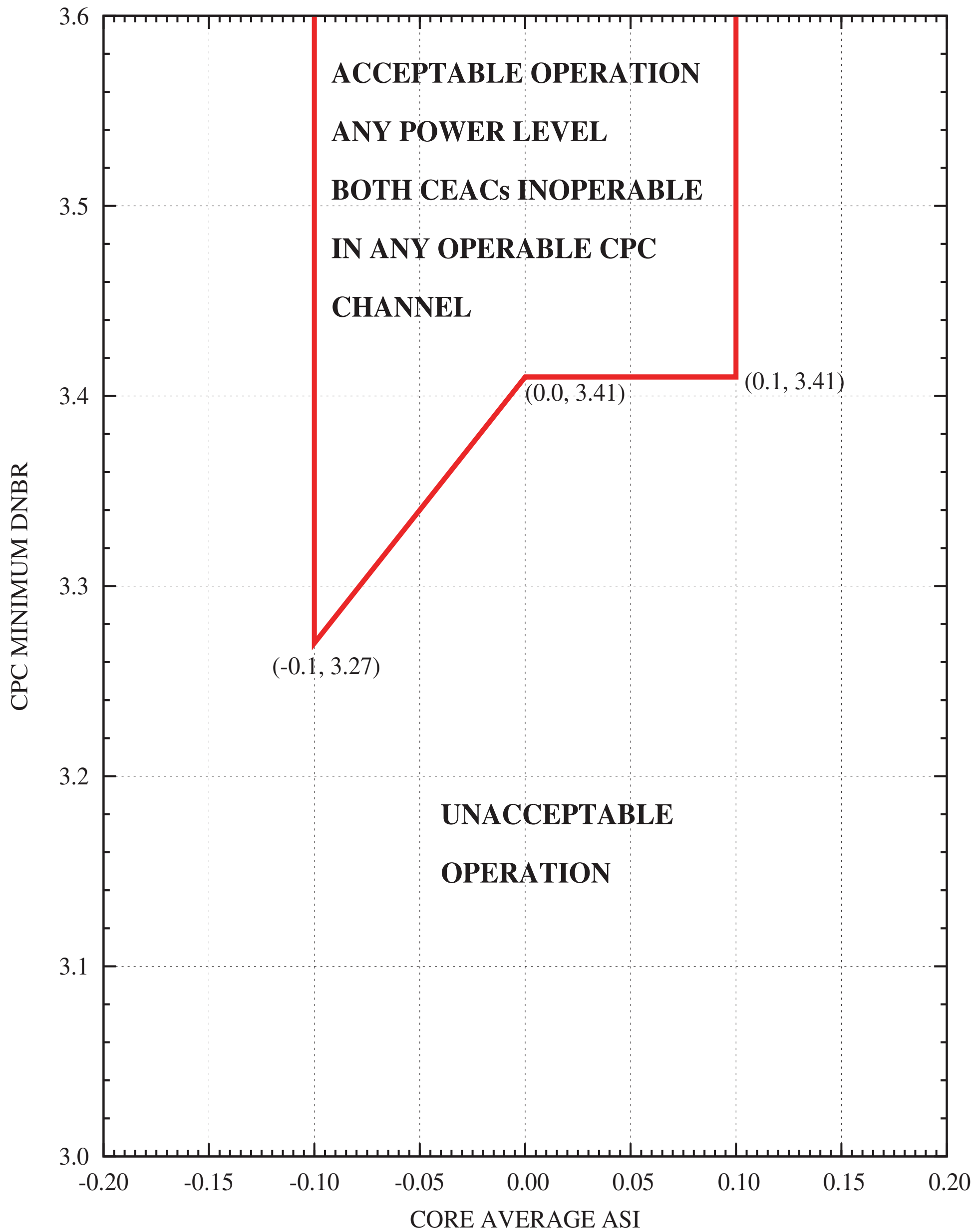


Table 3.3.12-1
REQUIRED MONITORING FREQUENCIES FOR BACKUP BORON DILUTION DETECTION AS A FUNCTION OF OPERATING CHARGING PUMPS AND PLANT OPERATIONAL MODES FOR $\mathbf{K_{eff} > 0.98}$

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 $\mathbf{0.98 \geq K_{eff} > 0.97}$

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 $\mathbf{0.97 \geq K_{eff} > 0.96}$

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 $\mathbf{0.96 \geq K_{eff} > 0.95}$

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

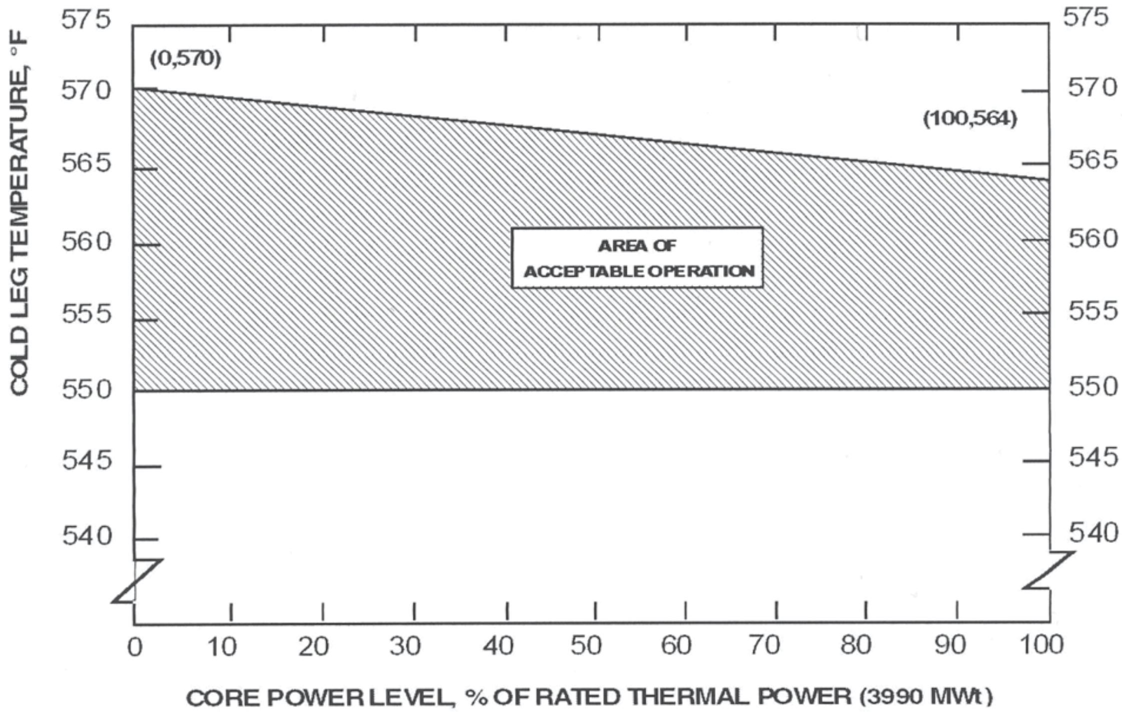
Table 3.3.12-5

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

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

Figure 3.4.1-1 Reactor Coolant Cold Leg Temperature vs Core Power Level



Enclosure 3

Unit 3 Core Operating Limits Report
Revision 31

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 3

CORE OPERATING LIMITS REPORT

Revision 31

Effective: April 19, 2023

Responsible Engineer Date	Swoope, Scott (ZD0940) Digitally signed by Swoope, Scott (ZD0940) Date: 2023.04.06 15:49:57 -07'00'
Design Verifier Date	Gill, Shawn P(Z37857) Digitally signed by Gill, Shawn P(Z37857) Date: 2023.04.06 16:08:29 -07'00'
Responsible Section Leader Date	Cowdin, Christopher (Z12133) Digitally signed by Cowdin, Christopher (Z12133) Reason: I am the acting Reload Analysis Section Leader. Date: 2023.04.07 14:22:44 -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)
3.4.1	RCS Pressure, Temperature and Flow DNB Limits
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:

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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™ 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 W Designed NSSS	Westinghouse
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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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	December 2008	Revision 4 to the Supplement to Appendix 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.	September 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
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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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^{TM} 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^{TM} (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^{TM} (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
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 Uprated Power Operation, (September 29, 2003)	Westinghouse Framatome

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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 Uprated 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
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

T.S Ref#[a]	Report No.	Revision / Supplement	Date	Title	Fuel Applicability
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
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 limits[1] shown in Figure 3.1.7-1[2]; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits[1] shown in Figure 3.1.7-2.[2] Regulating Groups 1 and 2 CEAs shall be maintained ≥ fully withdrawn[1, 3] while in Modes 1 and 2 (except while performing SR 3.1.5.3). When ≥ 20% power Regulating Group 3 shall be maintained ≥ 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 ≥147.75" (Pulse Counter indication) and ≥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

12.1 kW/ft for burnup ≥ 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 ≤ ASI ≤ 0.17 for power ≥ 50%
-0.28 ≤ ASI ≤ 0.17 for power >20% and < 50%

COLSS OUT OF SERVICE (CPC)
-0.10 ≤ ASI ≤ 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.

3.4.1 - RCS Pressure, Temperature and Flow Departure from Nucleate Boiling Limits

RCS DNB parameters for pressurizer pressure, cold leg temperature, and RCS total flow rate shall be within the limits specified below:

a. Pressurizer pressure ≥ 2130 psia and ≤ 2295 psia; and

b. RCS cold leg temperature (T_c) shall be within the area of acceptable operation shown in Figure 3.4.1-1; and

c. RCS total flow rate ≥ 155.8 E6 lbm/hour

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

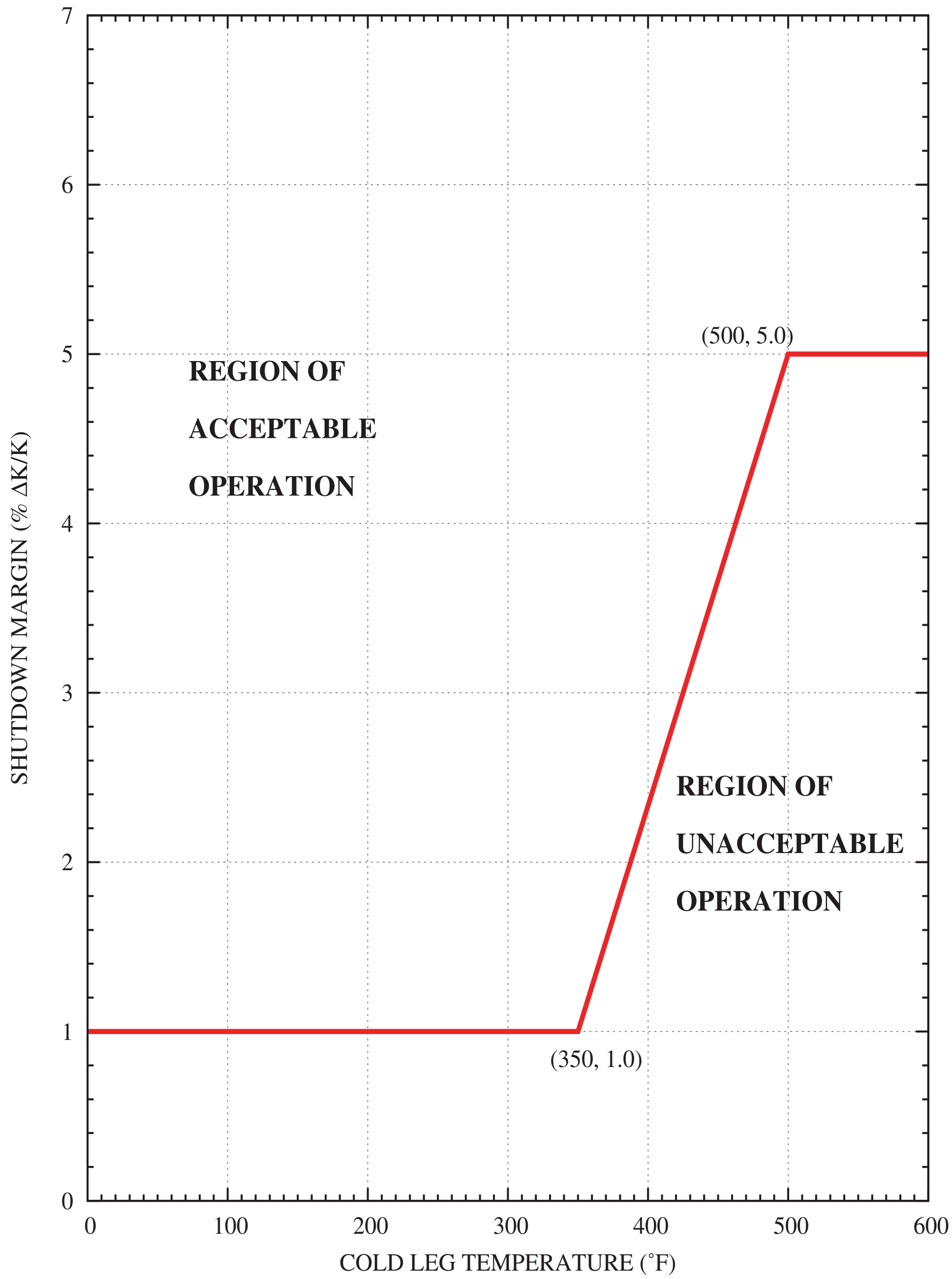


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

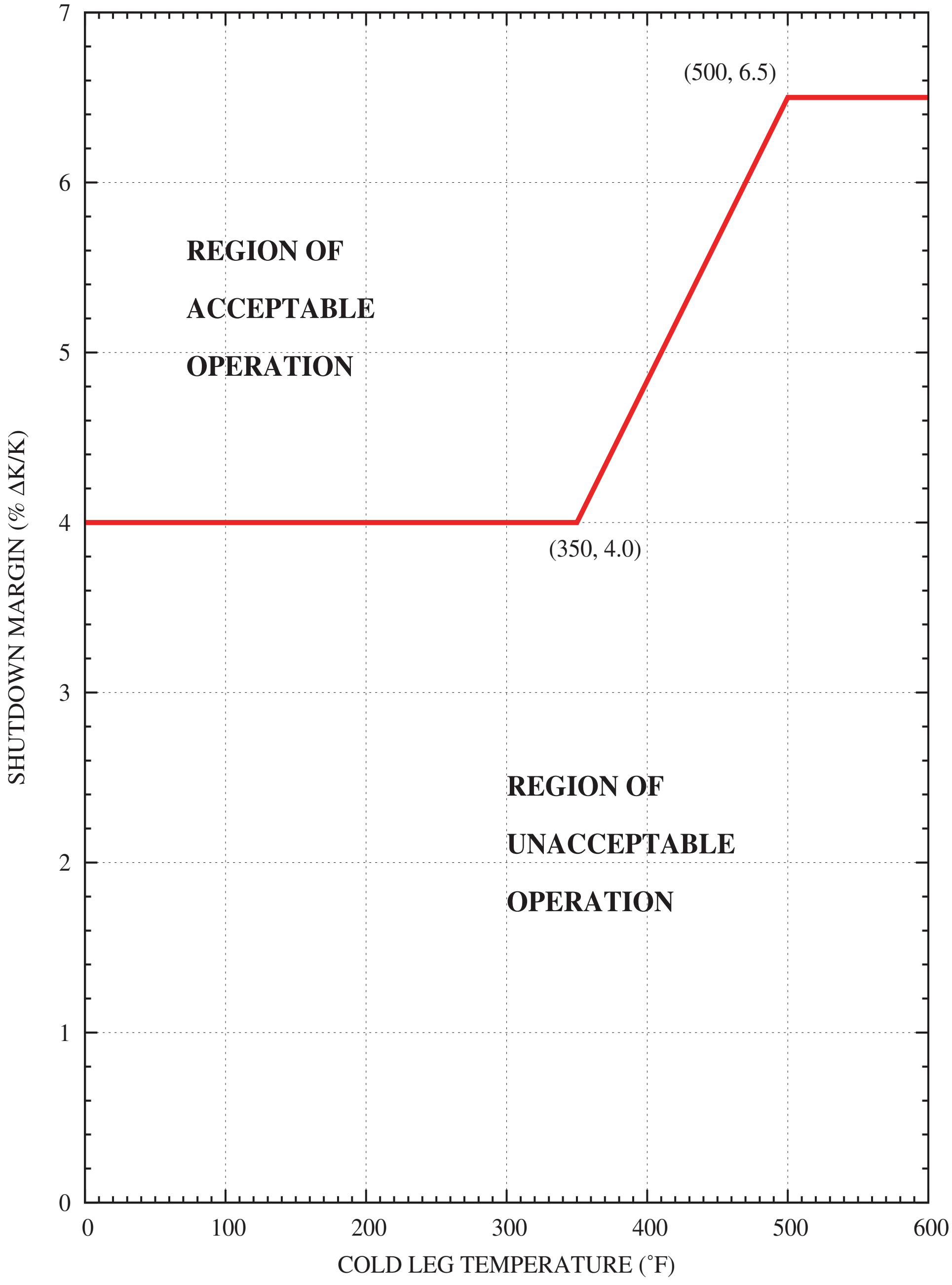


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

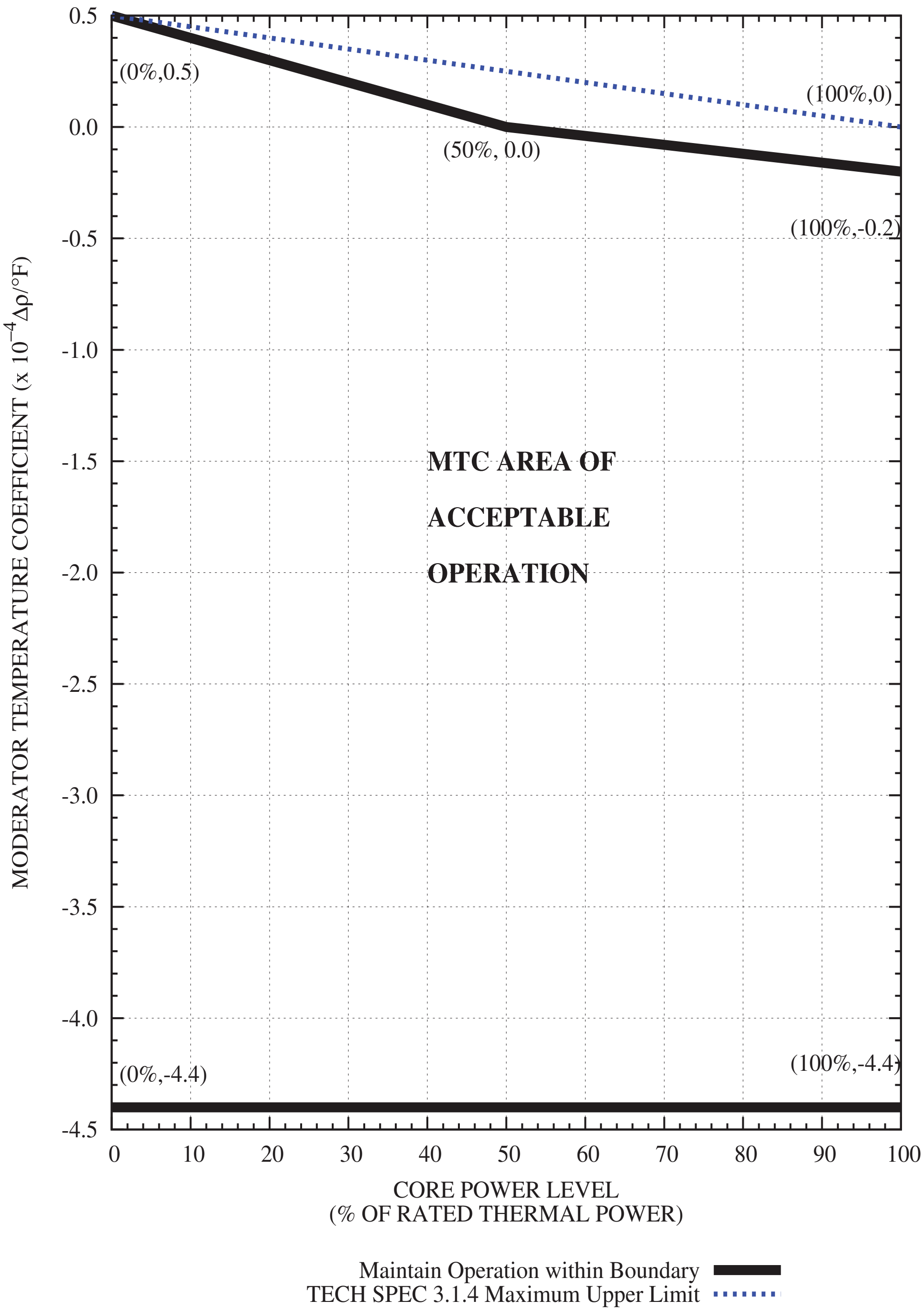
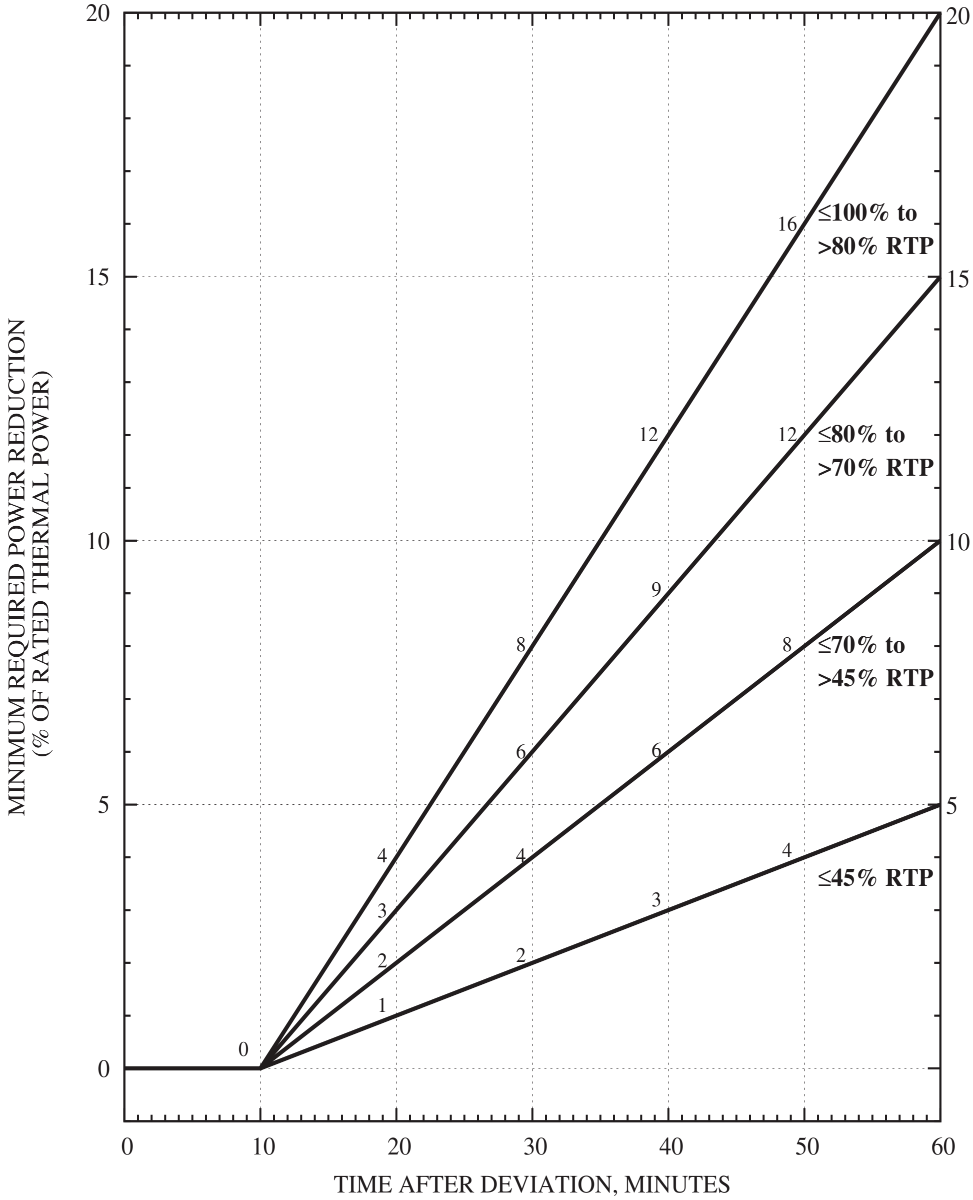


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

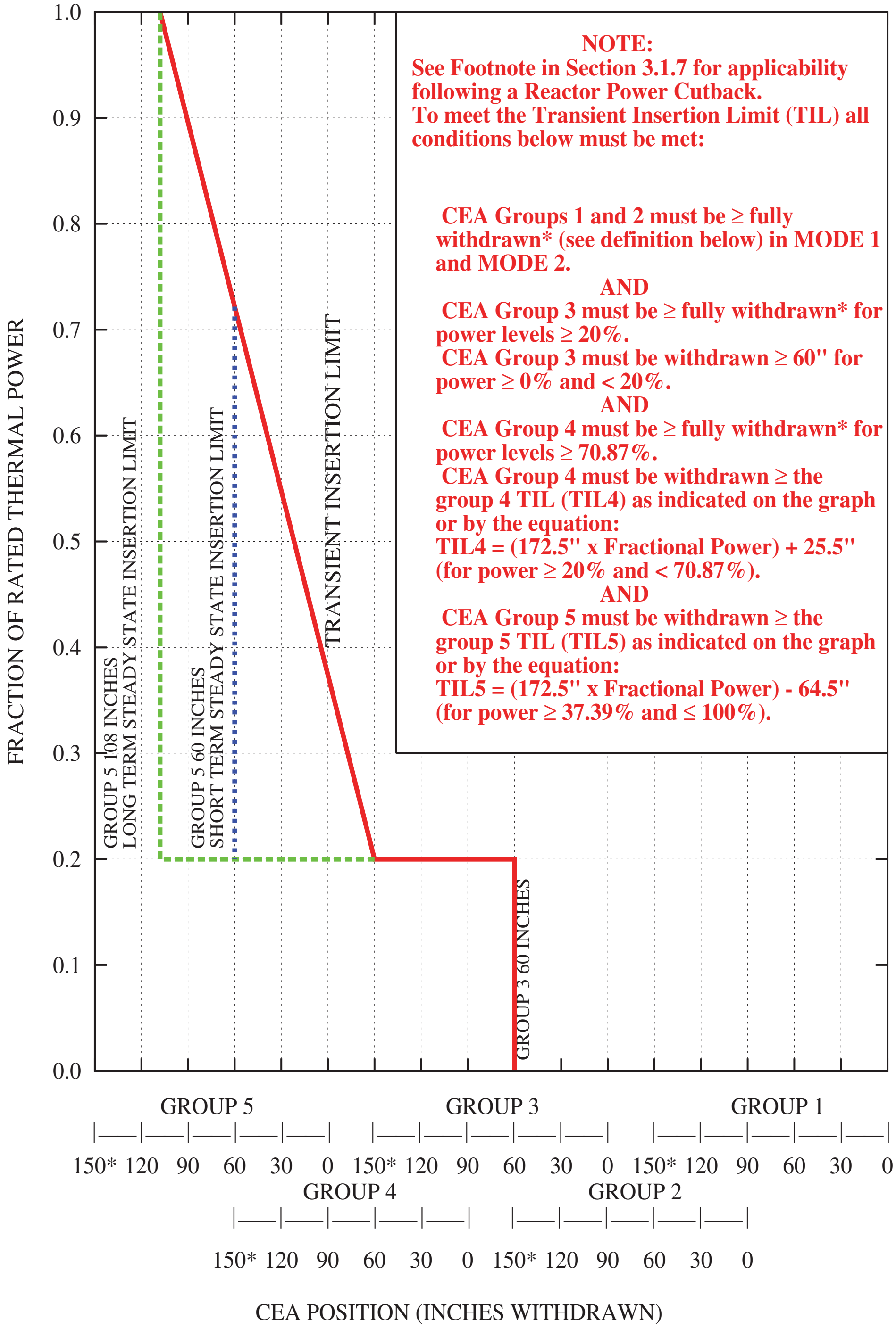


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

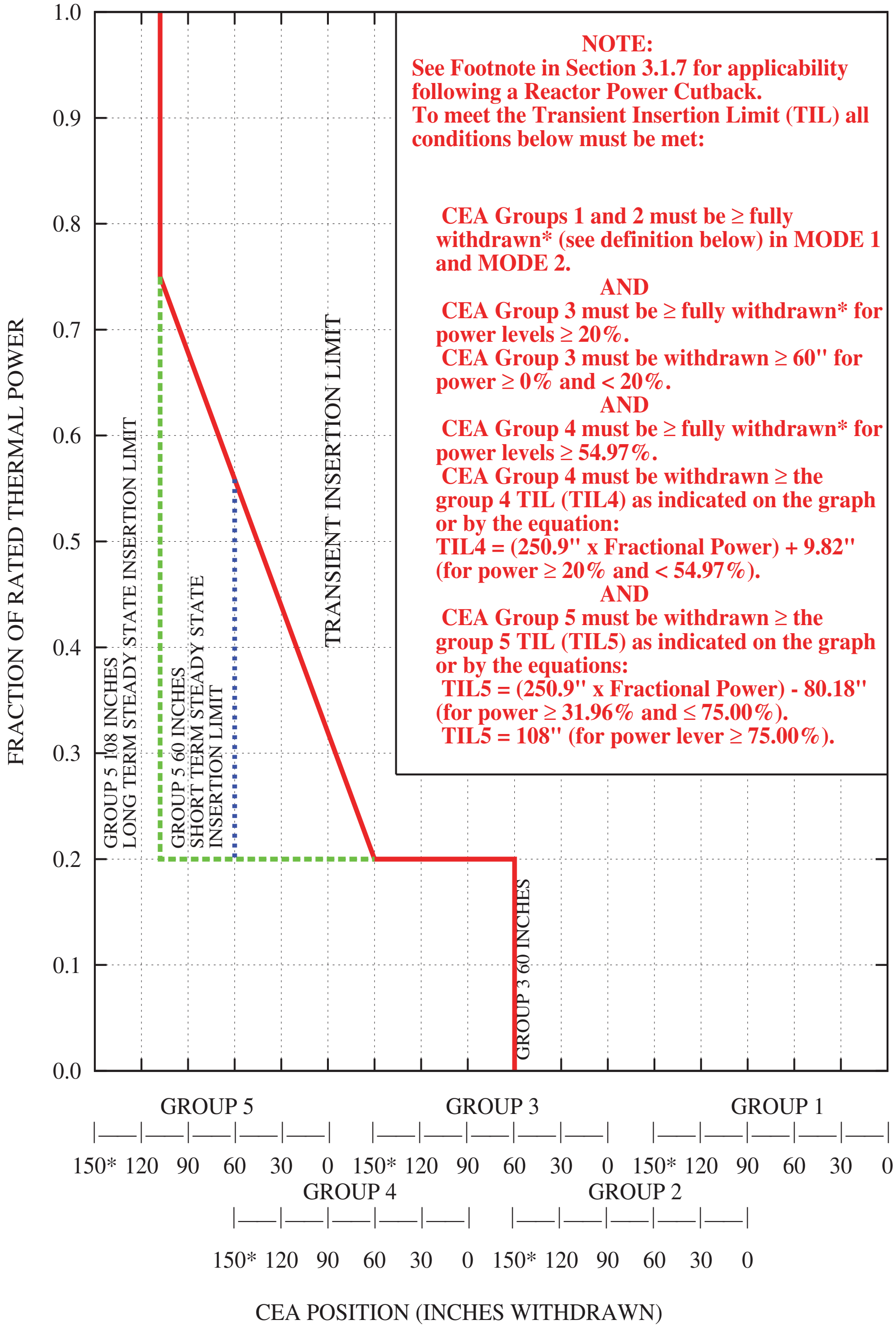
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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

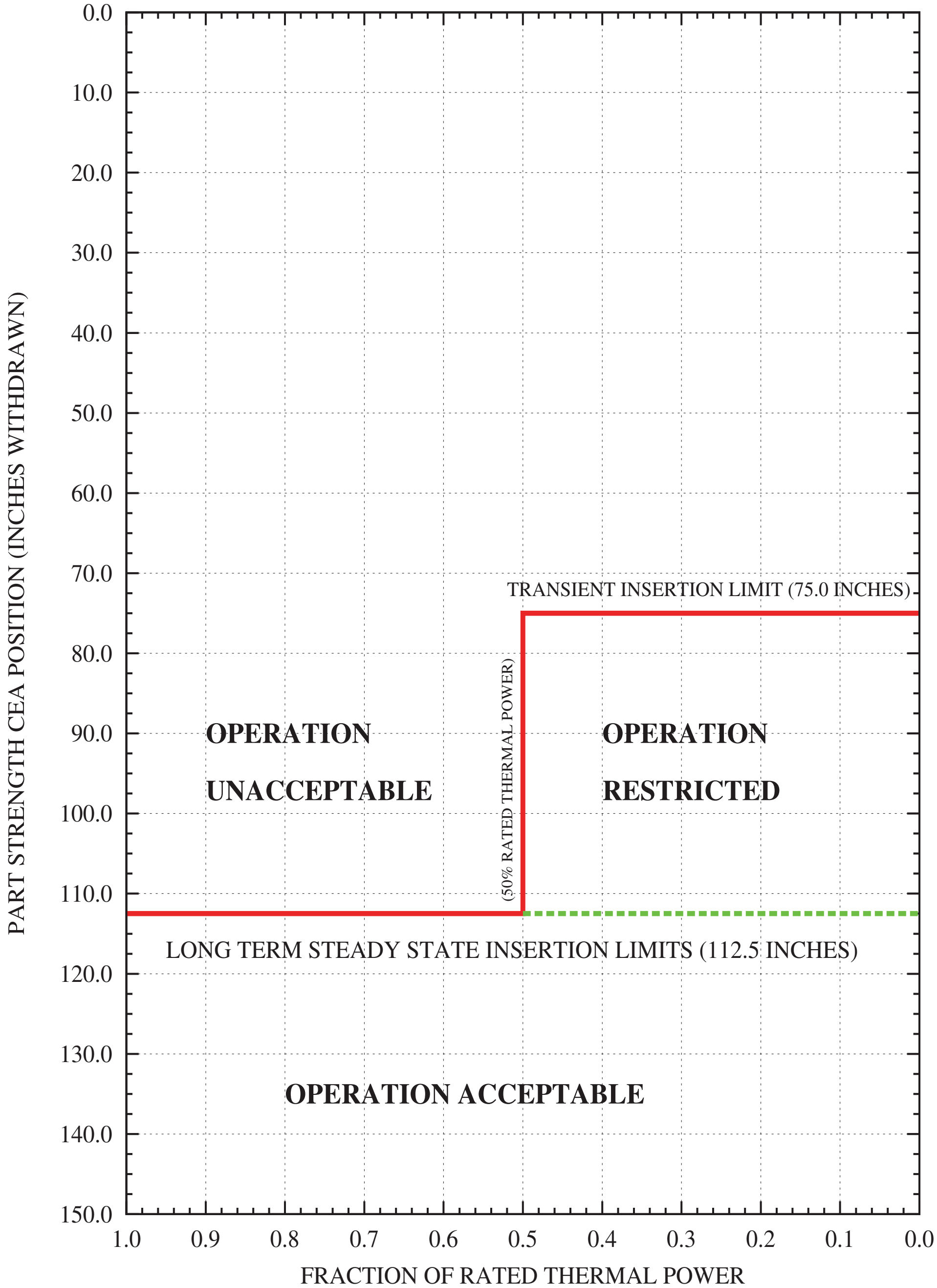


FIGURE 3.2.3-1
AZIMUTHAL POWER TILT VERSUS THERMAL POWER
(COLSS IN SERVICE)

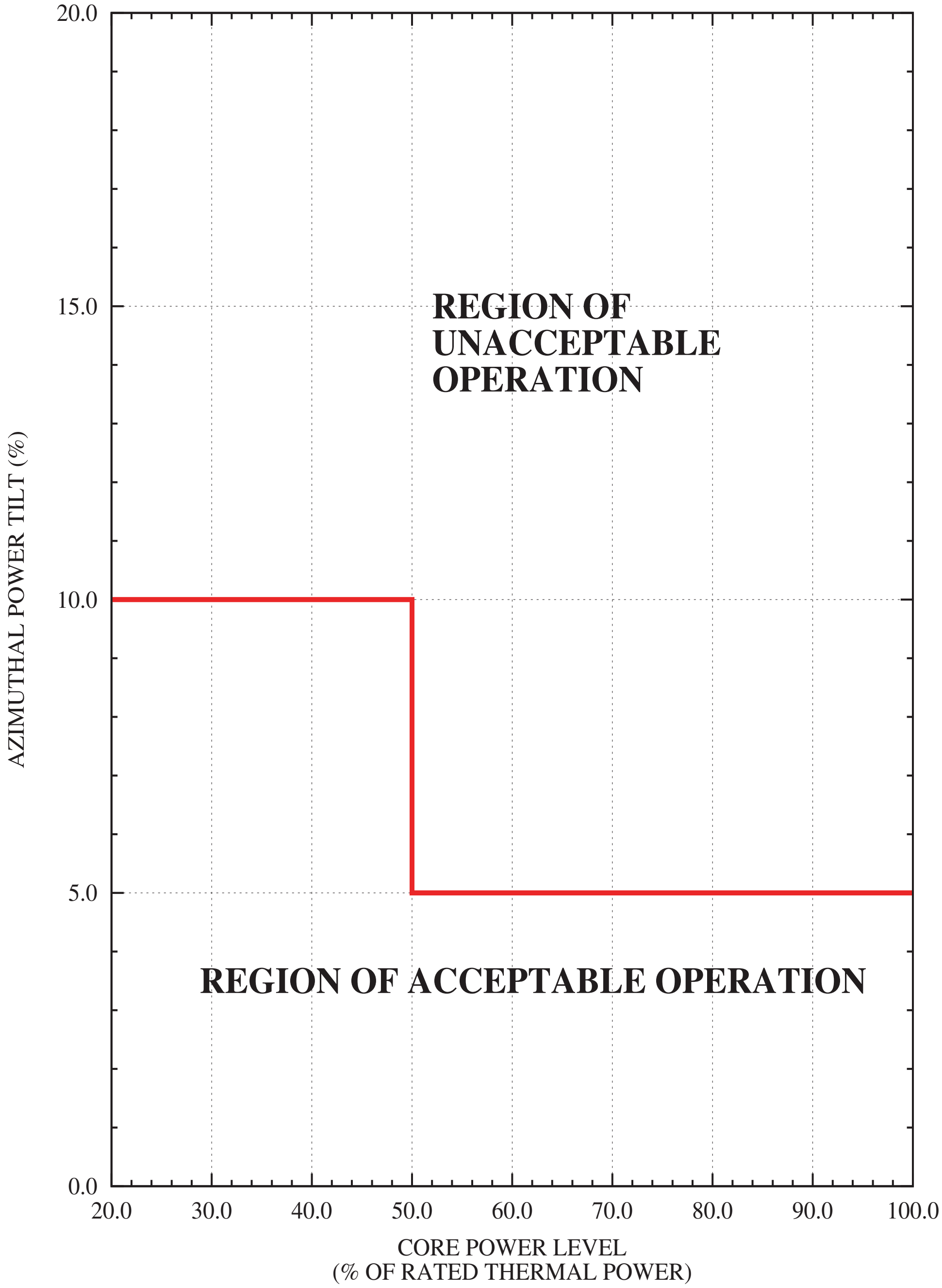


FIGURE 3.2.4-1
COLSS DNBR OPERATING LIMIT
ALLOWANCE FOR BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL

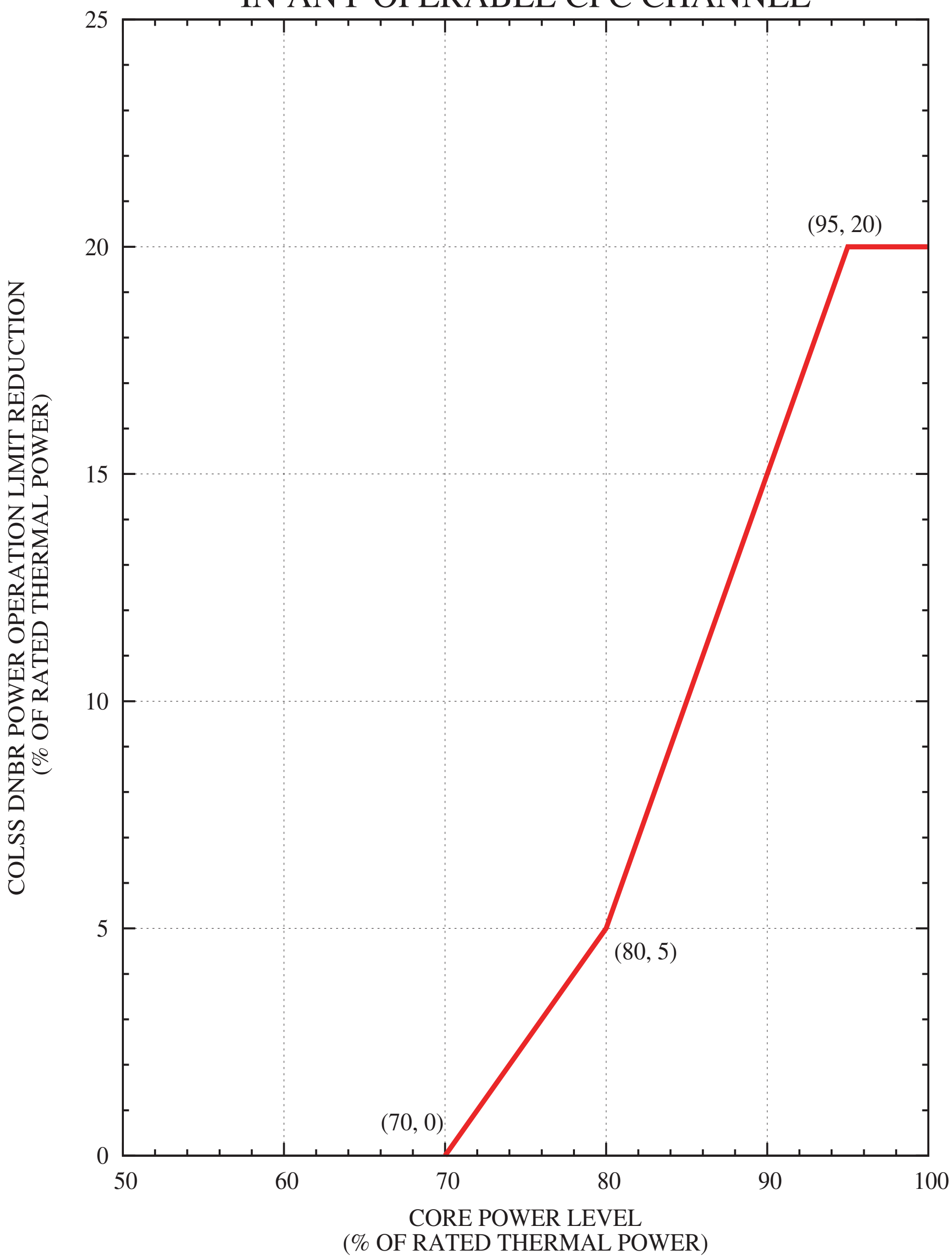


FIGURE 3.2.4-2
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

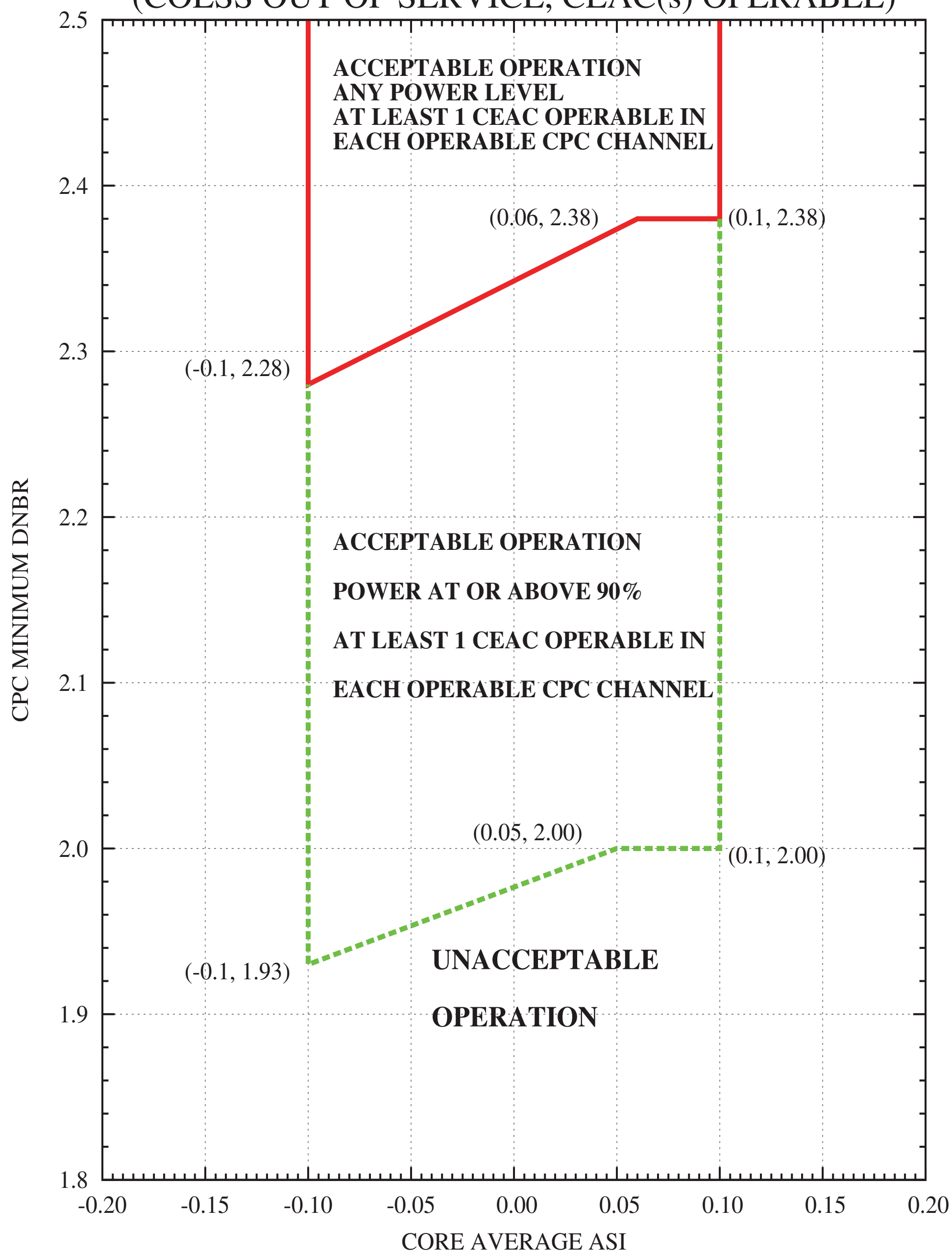


FIGURE 3.2.4-3
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL)

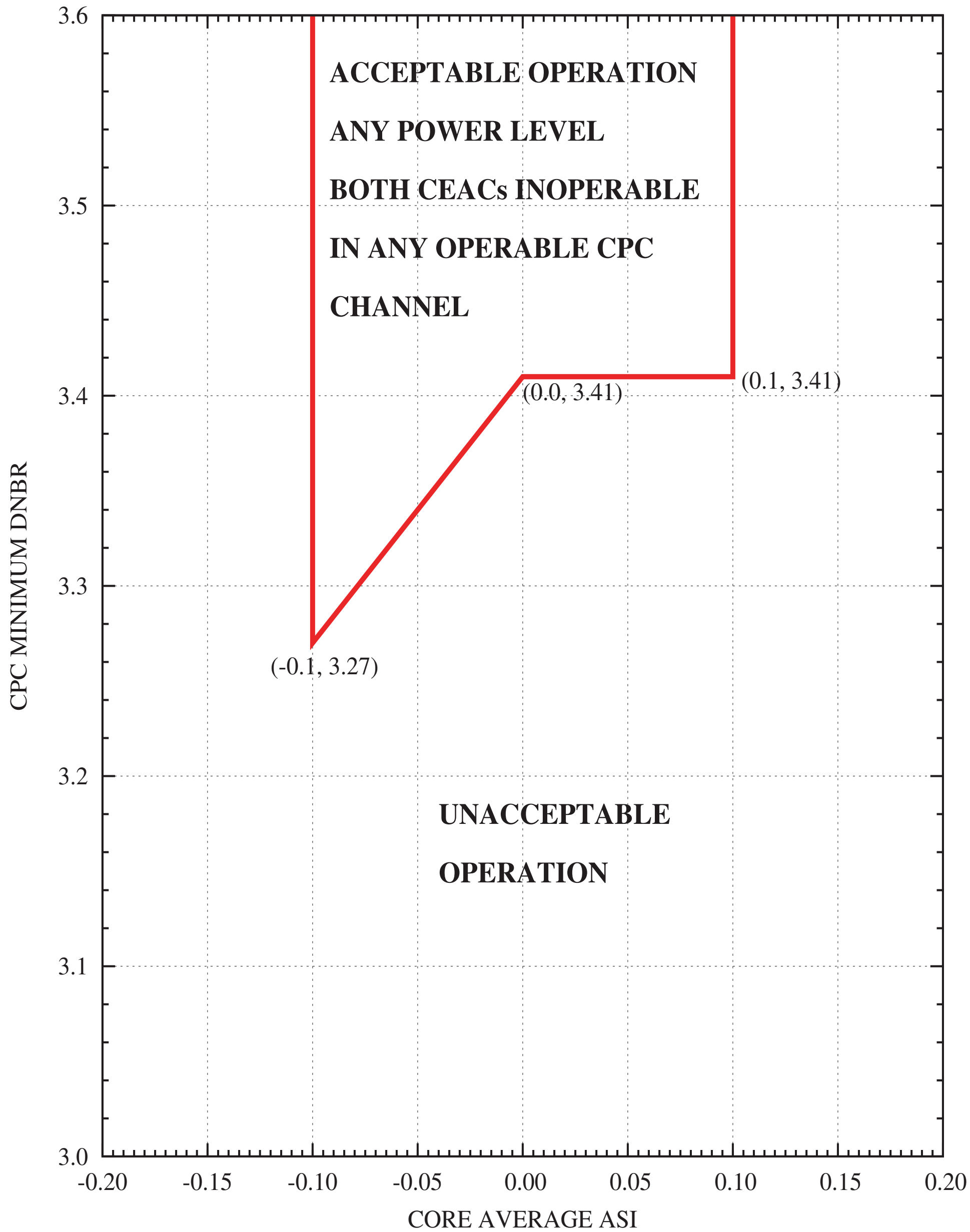


Table 3.3.12-1

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

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 $\mathbf{0.98 \geq K_{eff} > 0.97}$

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 $\mathbf{0.97 \geq K_{eff} > 0.96}$

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 $\mathbf{K_{eff} \leq 0.95}$

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

Figure 3.4.1-1 Reactor Coolant Cold Leg Temperature vs Core Power Level