



**Palo Verde**  
**Nuclear Generating Station**  
5801 S. Wintersburg Road  
Tonopah, AZ 85354

102-06813 TNW/RKR  
January 2, 2014

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

Dear Sirs:

Subject: **Palo Verde Nuclear Generating Station (PVNGS) Units 1, 2, 3**  
**Docket Nos. STN 50-528, 50-529 and 50-530**  
**Unit 1 Core Operating Limits Report (COLR), Revision 23**  
**Unit 2 Core Operating Limits Report (COLR), Revision 19**  
**Unit 3 Core Operating Limits Report (COLR), Revision 22**

Pursuant to PVNGS Technical Specifications, Section 5.6.5d, enclosed are the Units 1, 2 and 3 Core Operating Limits Report (COLR), Revisions 23, 19 and 22, respectively, which were made effective December 20, 2013. The following change was implemented in these COLR revisions:

Figure 3.1.5-1 revised to include an exemption to the immediate downpower requirement, allowed if certain prerequisites are met, for a single small CEA misalignment (greater than 6.6 inches but less than 9.9 inches) in the top 9.9 inches of the active fuel region.

No commitments are being made to the NRC by this letter. Should you need further information regarding this submittal, please contact Robert K. Roehler, Licensing Section Leader, at (623) 393-5241.

Sincerely,

A handwritten signature in black ink that reads "Thomas N. Weber".

Thomas N. Weber  
Department Leader, Regulatory Affairs

TNW/RKR/KAR/hsc

Enclosures: PVNGS Unit 1 Core Operating Limits Report (COLR), Revision 23  
PVNGS Unit 2 Core Operating Limits Report (COLR), Revision 19  
PVNGS Unit 3 Core Operating Limits Report (COLR), Revision 22

cc:	M. L. Dapas	NRC Region IV Regional Administrator
	J. K. Rankin	NRC NRR Project Manager for PVNGS
	A. E. George	NRC NRR Project Manager
	M. A. Brown	NRC Senior Resident Inspector for PVNGS

ADD  
NRR

**Enclosure**

**PVNGS Unit 1 Core Operating Limits Report (COLR)  
Revision 23**


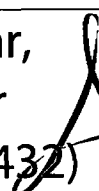
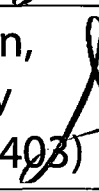
# **PALO VERDE NUCLEAR GENERATING STATION (PVNGS)**

## **UNIT 1**

### **CORE OPERATING LIMITS REPORT**

**Revision 23**

**Effective December 20, 2013**

Responsible Engineer Date	Sutton, Bradley J(Z06308)  <small>Digitally signed by Sutton, Bradley J(Z06308) DN: cn=Sutton, Bradley J(Z06308) Reason: I am the author of this document Date: 2013.12.18 15:31:54 -07'00'</small>
Independent Reviewer Date	Bodnar, Walter S(Z06432)  <small>Digitally signed by Bodnar, Walter S(Z06432) DN: cn=Bodnar, Walter S(Z06432) Reason: I have reviewed this document Date: 2013.12.18 16:15:01 -07'00'</small>
Responsible Section Leader Date	Ashton, Jeffrey C(Z03403)  <small>Digitally signed by Ashton, Jeffrey C(Z03403) DN: cn=Ashton, Jeffrey C(Z03403) Reason: I am approving this document Date: 2013.12.18 22:23:06 -07'00'</small>

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This Report has been prepared in accordance with the requirements of Technical Specification 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 Unit 1 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

### 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#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
1	CE Method for Control Element Assembly Ejection Analysis (13-N001-1301-01204-1)	CENPD-0190-A	N.A.	January 1976	N.A.
2	The ROCS and DIT Computer Codes for Nuclear Design (13-N001-1900-01412-0)	CENPD-266-P-A	N.A.	April 1983	N.A.
3	Safety Evaluation Report related to the Final Design of the Standard Nuclear Steam Supply Reference Systems CESSAR System 80, Docket No. STN 50-470	NUREG-0852	N.A.	March 1983  September 1983  December 1987	1  2  3
4	Modified Statistical Combination of Uncertainties (13-N001-1303-01747-2)	CEN-356(V)-P-A	01-P-A	May 1988	N.A.
4	System 80 <sup>TM</sup> Inlet Flow Distribution (13-N001-1301-01228-0)	Enclosure 1-P to LD-82-054	N.A.	February 1993	1-P
5	Calculative Methods for the CE Large Break LOCA Evaluation Model for the Analysis of CE and W Designed NSSS (13-N001-1900-01192-3)	CENPD-132	N.A.	March 2001	4-P-A Rev. 1
6	Calculative Methods for the CE Small Break LOCA Evaluation Model (13-N001-1900-01185-3)	CENPD-137-P	N.A.	April 1998	2-P-A
7	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.	N.A.	N.A.	June 13, 1975	N.A.



<u>T.S Ref#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
8	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.	N.A.	N.A.	September 27, 1977	N.A.
9	Fuel Rod Maximum Allowable Pressure (13-N001-0201-00026-1)	CEN-372-P-A	N.A.	May 1990	N.A.
10	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.	N.A.	N.A.	April 10, 1990	N.A.
11	Arizona Public Service Company PWR Reactor Physics Methodology Using CASMO-4/SIMULATE-3 (NFM-005)	NFM-005	1	August 2007	N.A.
12	Technical Description Manual for the CENTS Code Volume 1 (CENTS-TD MANUAL-VOL 1)	CE-NPD 282-P-A Vols. 1	2	March 2005	N.A.
12	Technical Description Manual for the CENTS Code Volume 2 (CENTS-TD MANUAL-VOL 2)	CE-NPD 282-P-A Vols. 2	2	March 2005	N.A.
12	Technical Description Manual for the CENTS Code Volume 3 (CENTS-TD MANUAL-VOL 3)	CE-NPD 282-P-A Vols. 3	2	March 2005	N.A.
13	Implementation of ZIRLO <sup>TM</sup> Cladding Material in CE Nuclear Power Fuel Assembly Designs (13-N001-1900-01329-0)	CENPD-404-P-A	0	November 2001	N.A.
14	HERMITE, A Multi-Dimensional Space-Time Kinetics Code for PWR Transients (HERMITE-TOPICAL)	CENPD-188-A	N.A.	July 1976	N.A.
15	TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core (N001-1301-01202)	CENPD-161-P-A	N.A.	April 1986	N.A.

**PVNGS UNIT 1 CORE OPERATING LIMITS REPORT      Revision 23**

<u>T.S Ref#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
16	CETOP-D Code Structures and Modeling Methods for San Onofre Nuclear Generating Station Units 2 and 3, (N001-1301-01185)	CEN-160(S)-P	1-P	September 1981	N.A.
17	“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) and “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).”	N.A.	N.A.	September 29, 2003  November 16, 2005	N.A.
18	CPC Methodology Changes for the CPC Improvement Program, (N001-1303-02283)	CEN-310-P-A	0	April 1986	N.A.
19	Loss of Flow, C-E Methods for Loss of Flow Analysis, (N001-1301-01203)	CENPD-183-A	0	June 1984	N.A.
20	Methodology for Core Designs Containing Erbium Burnable Absorbers (N001-0201-00035)	CENPD-382-P-A	0	August 1993	N.A.
21	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)	CEN-386-P-A	0	August 1992	N.A.

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<sup>1</sup> shown in Figure 3.1.7-1<sup>2</sup>; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits<sup>1</sup> shown in Figure 3.1.7-2.<sup>2</sup> Regulating Groups 1 and 2 CEAs shall be maintained  $\geq$  fully withdrawn<sup>1, 3</sup> 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.<sup>1, 3</sup>

<sup>1</sup> 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.

<sup>2</sup> 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).

<sup>3</sup> 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  $\geq 3000$  ppm.

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

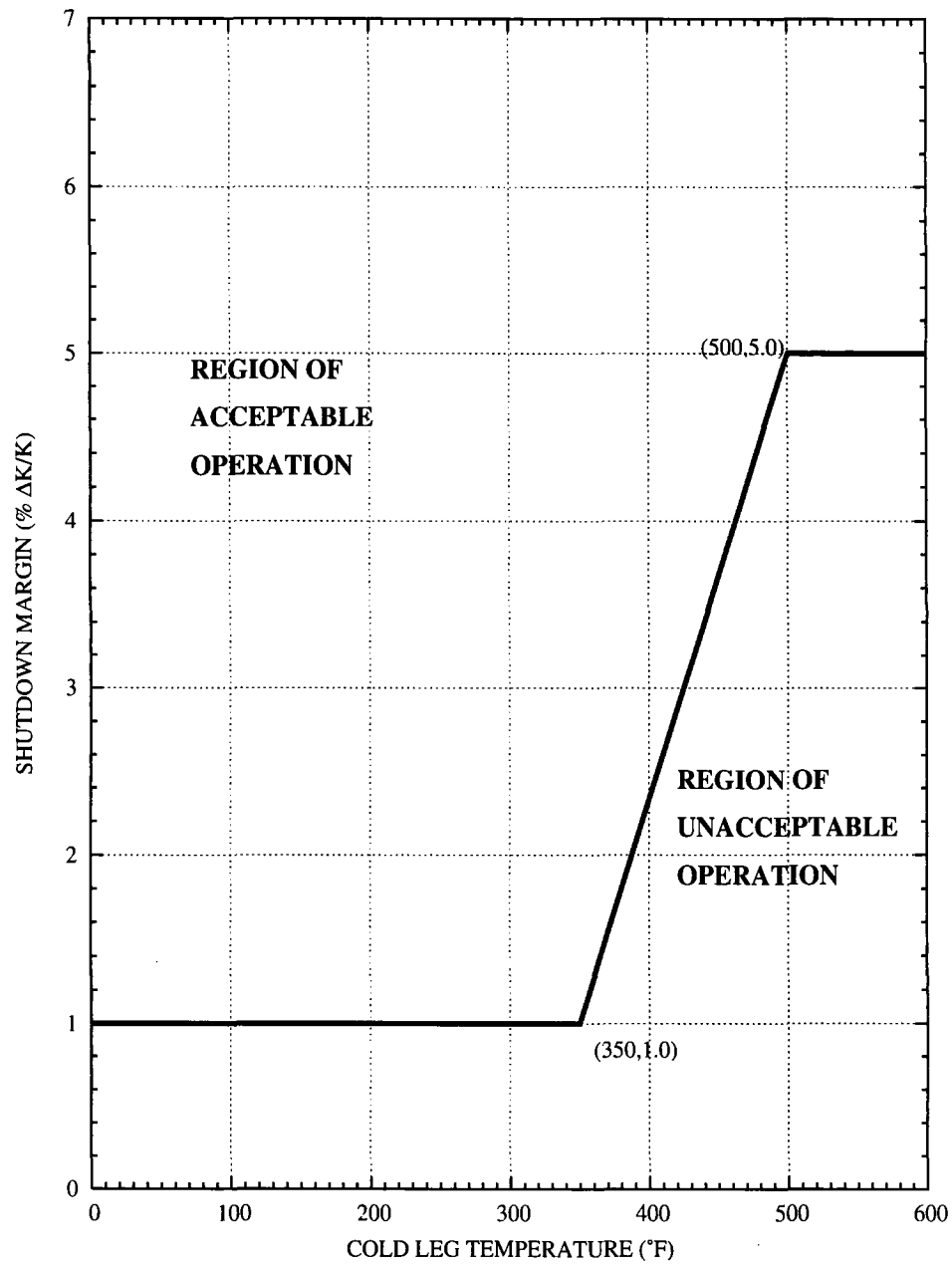


FIGURE 3.1.2-1  
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE  
REACTOR TRIP BREAKERS CLOSED

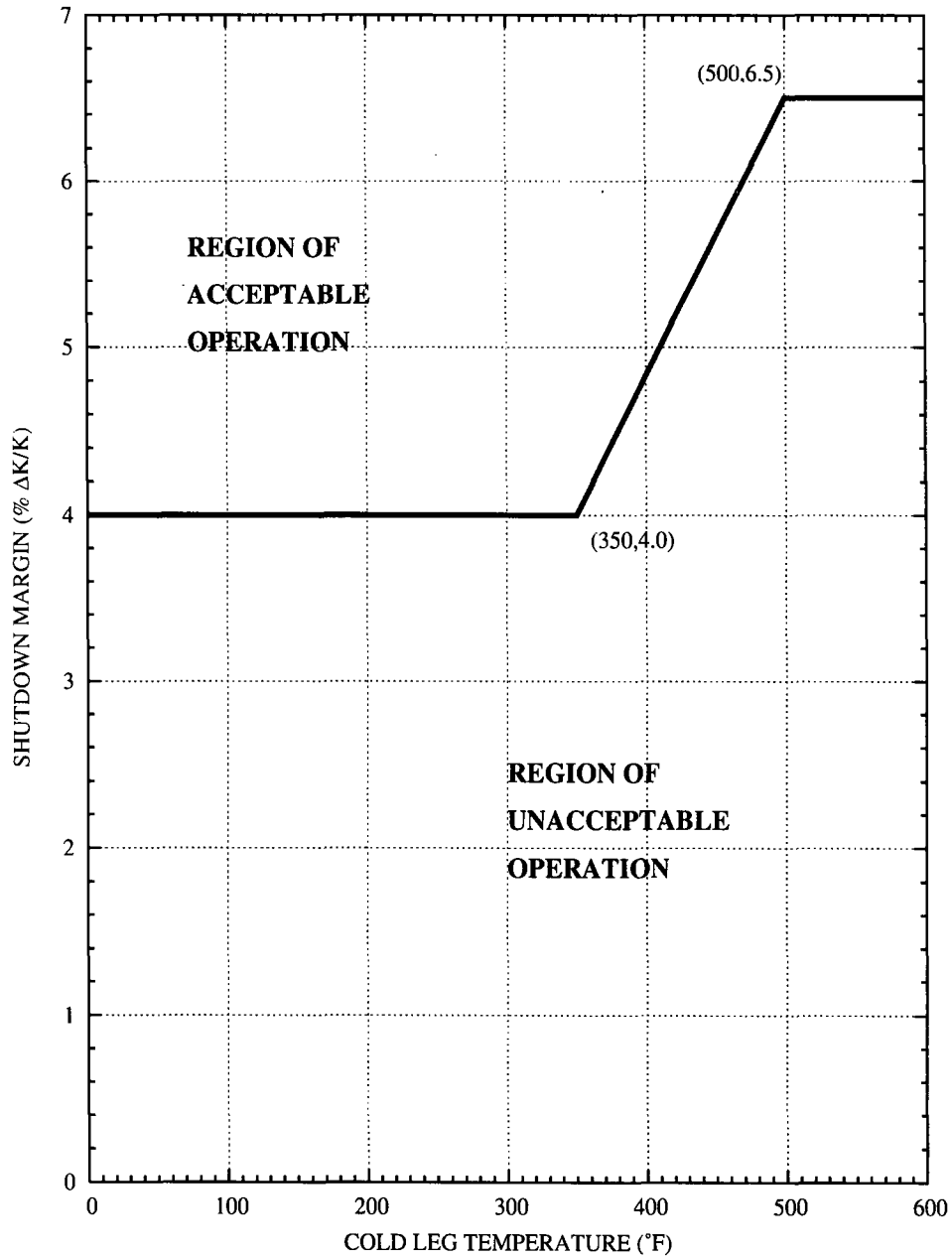


FIGURE 3.1.4-1

MTC ACCEPTABLE OPERATION, MODES 1 AND 2

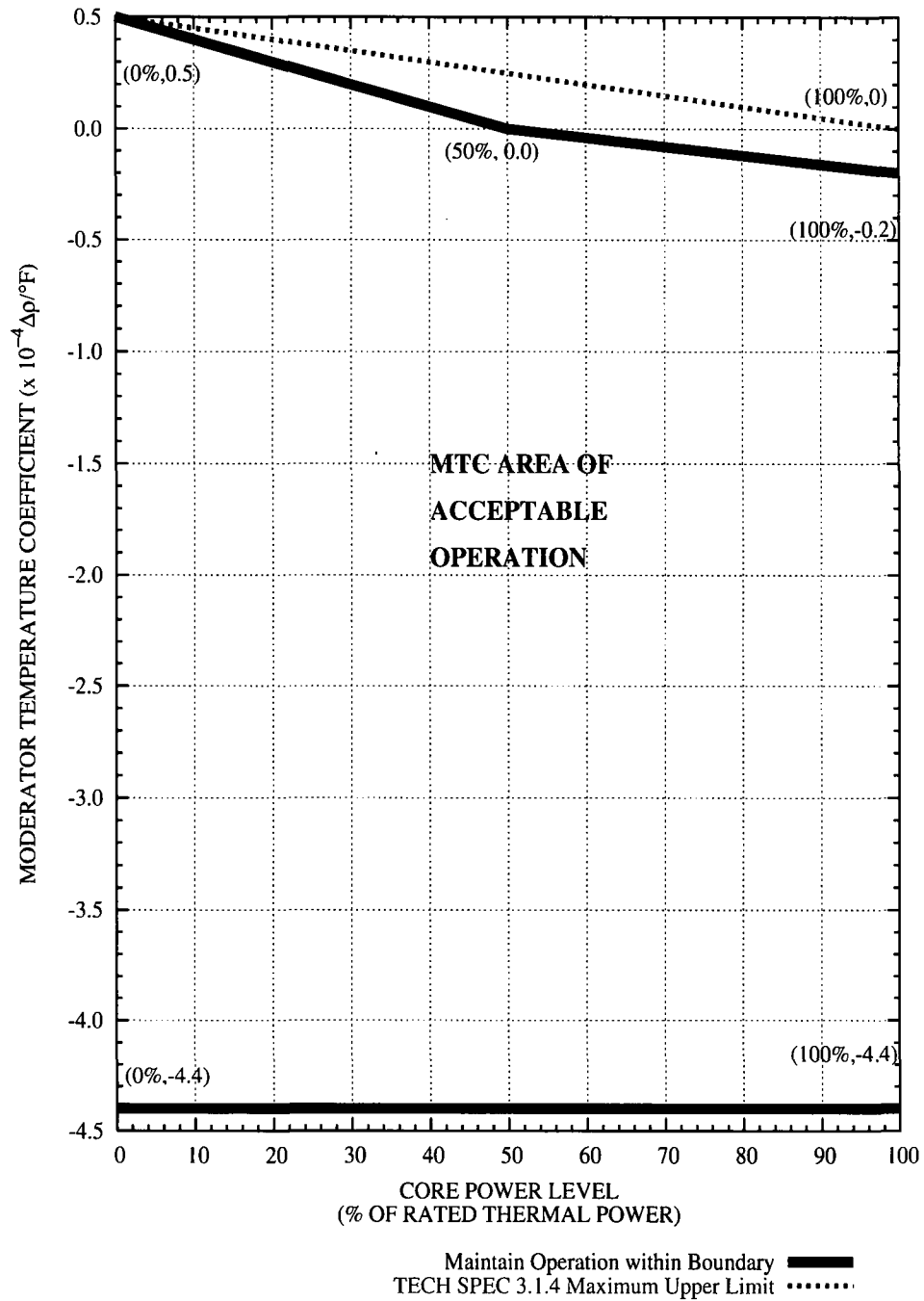
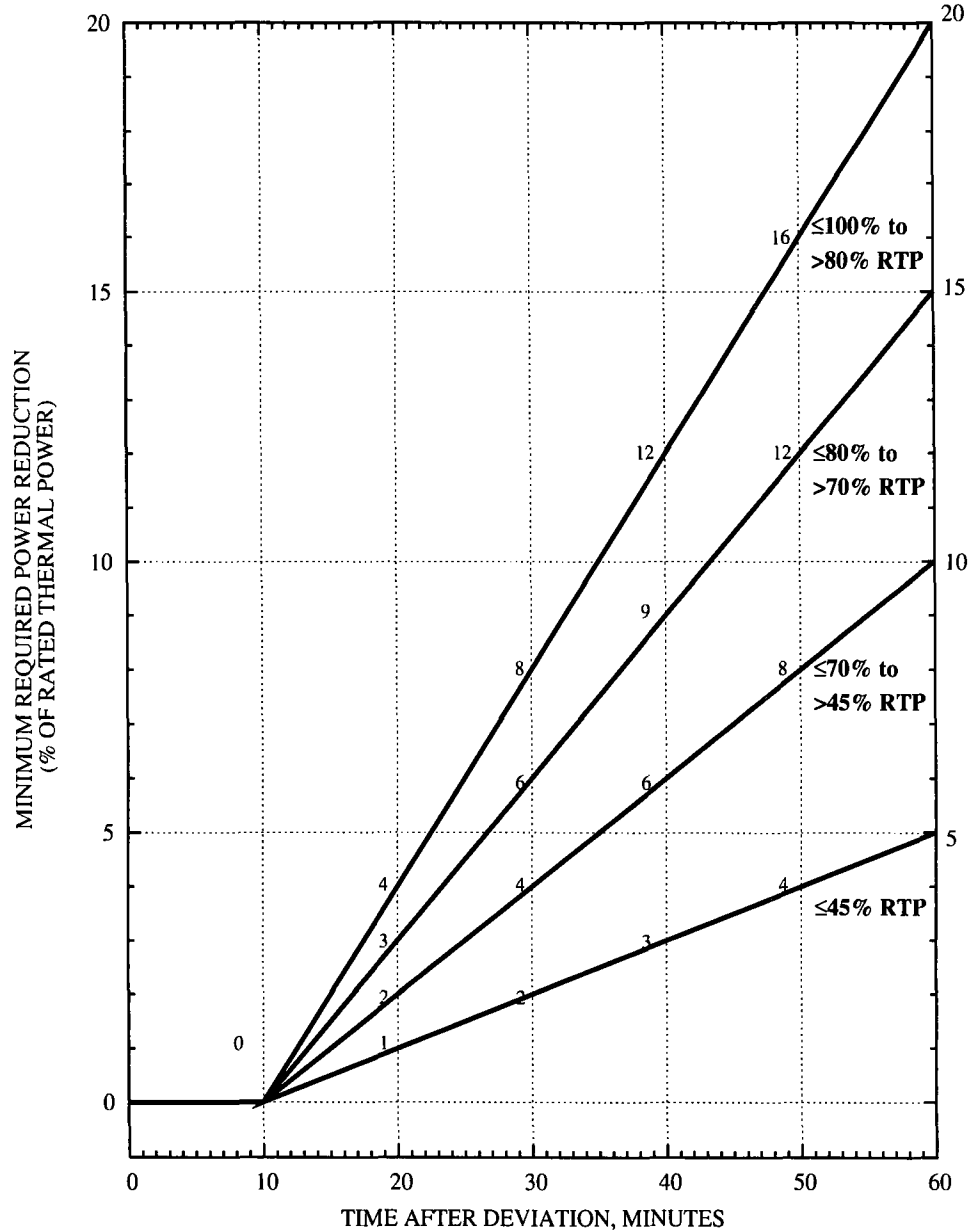




FIGURE 3.1.5-1

## CORE POWER REDUCTION AFTER CEA DEVIATION\*

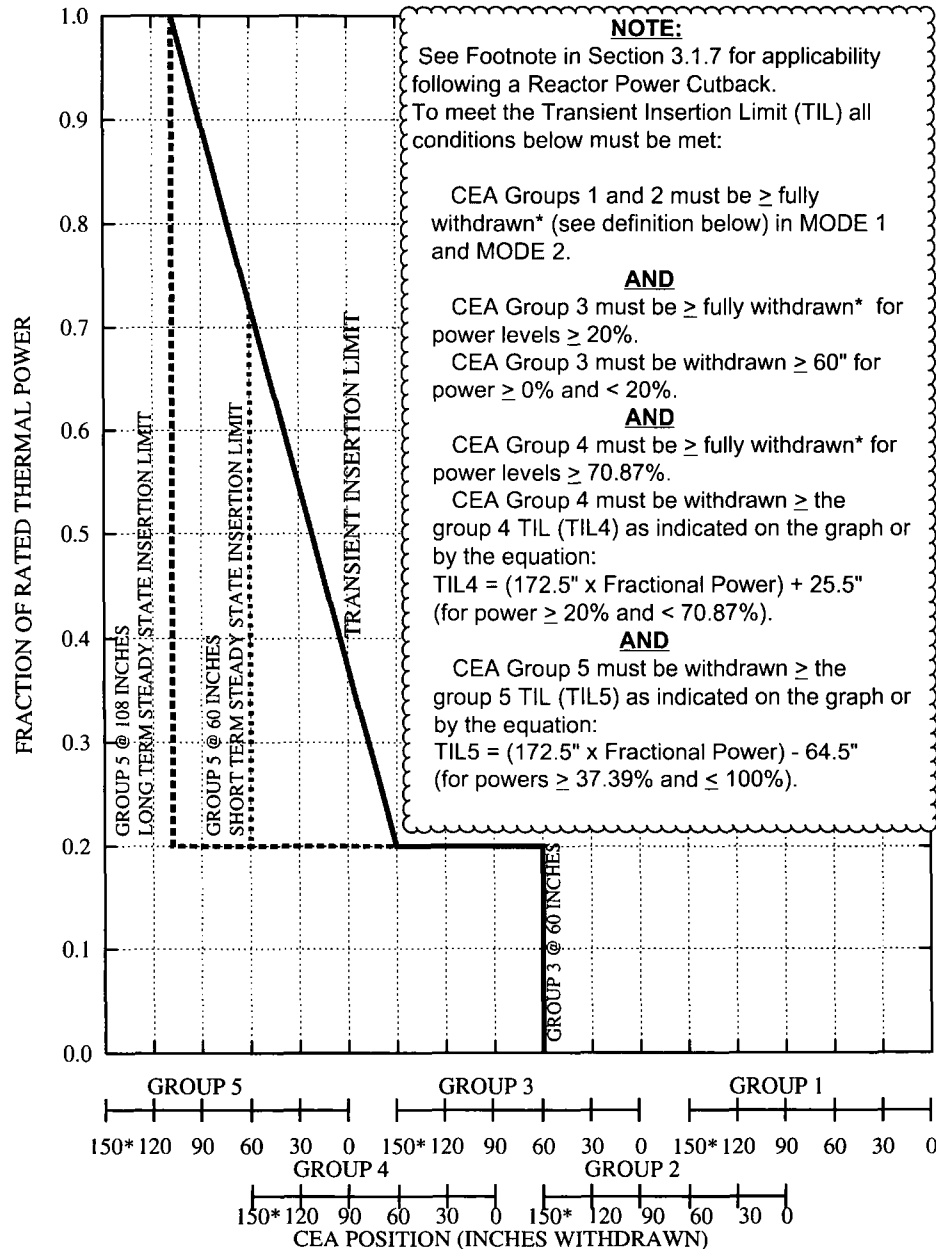


\* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

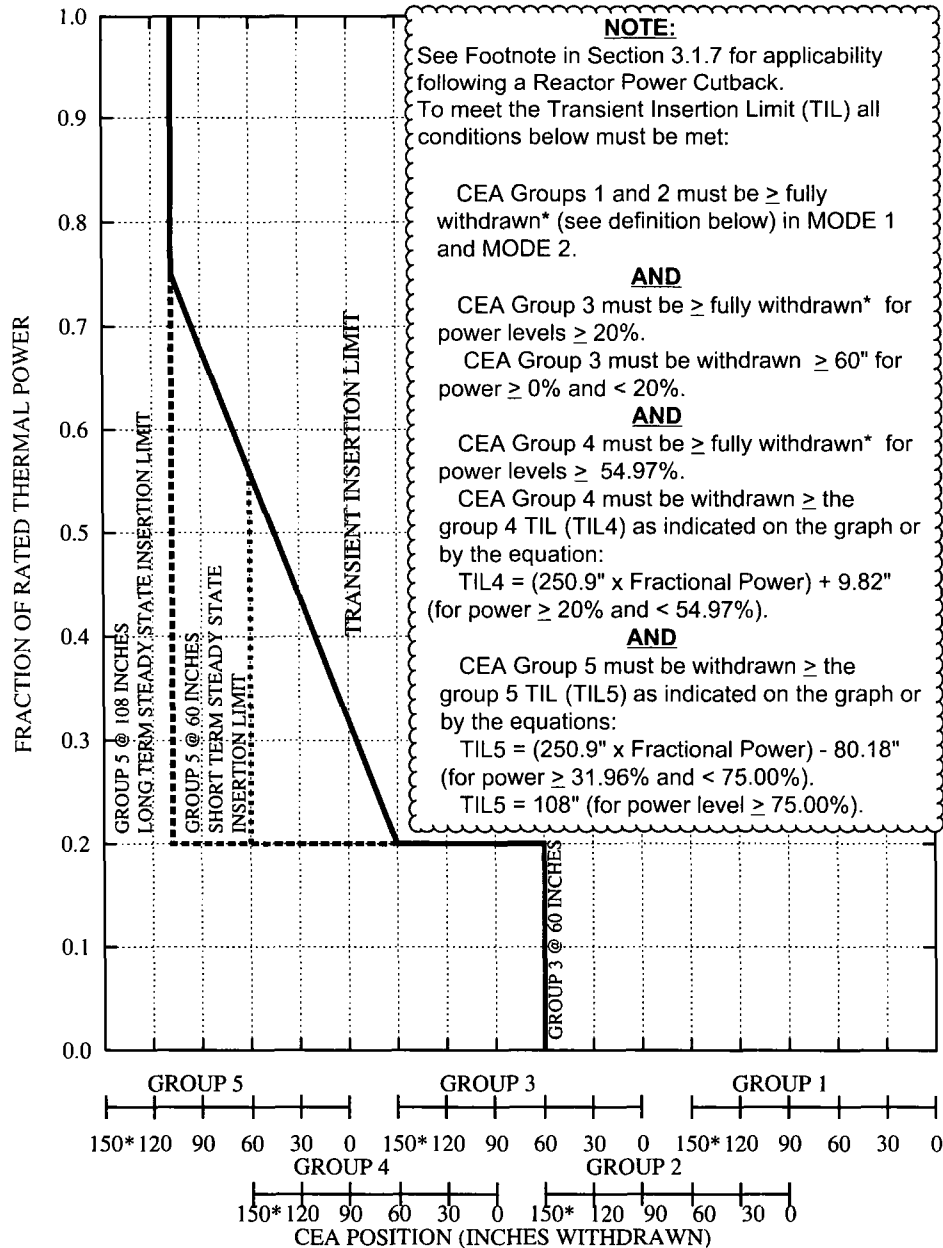
- RATED THERMAL POWER IS ABOVE 95 %
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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  $\geq 147.75"$  (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

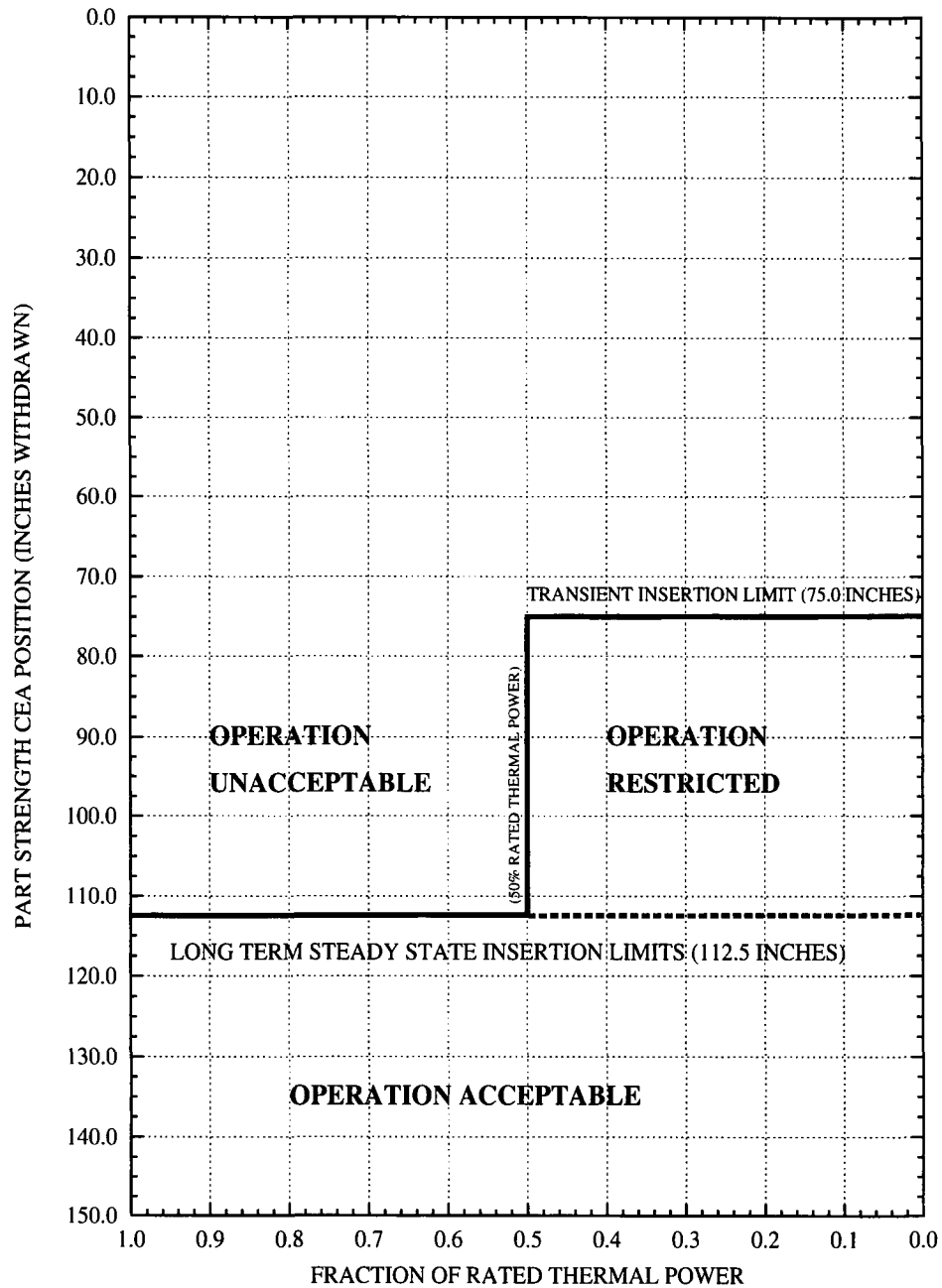


FIGURE 3.2.3-1  
AZIMUTHAL POWER TILT VERSUS THERMAL POWER  
(COLSS IN SERVICE)

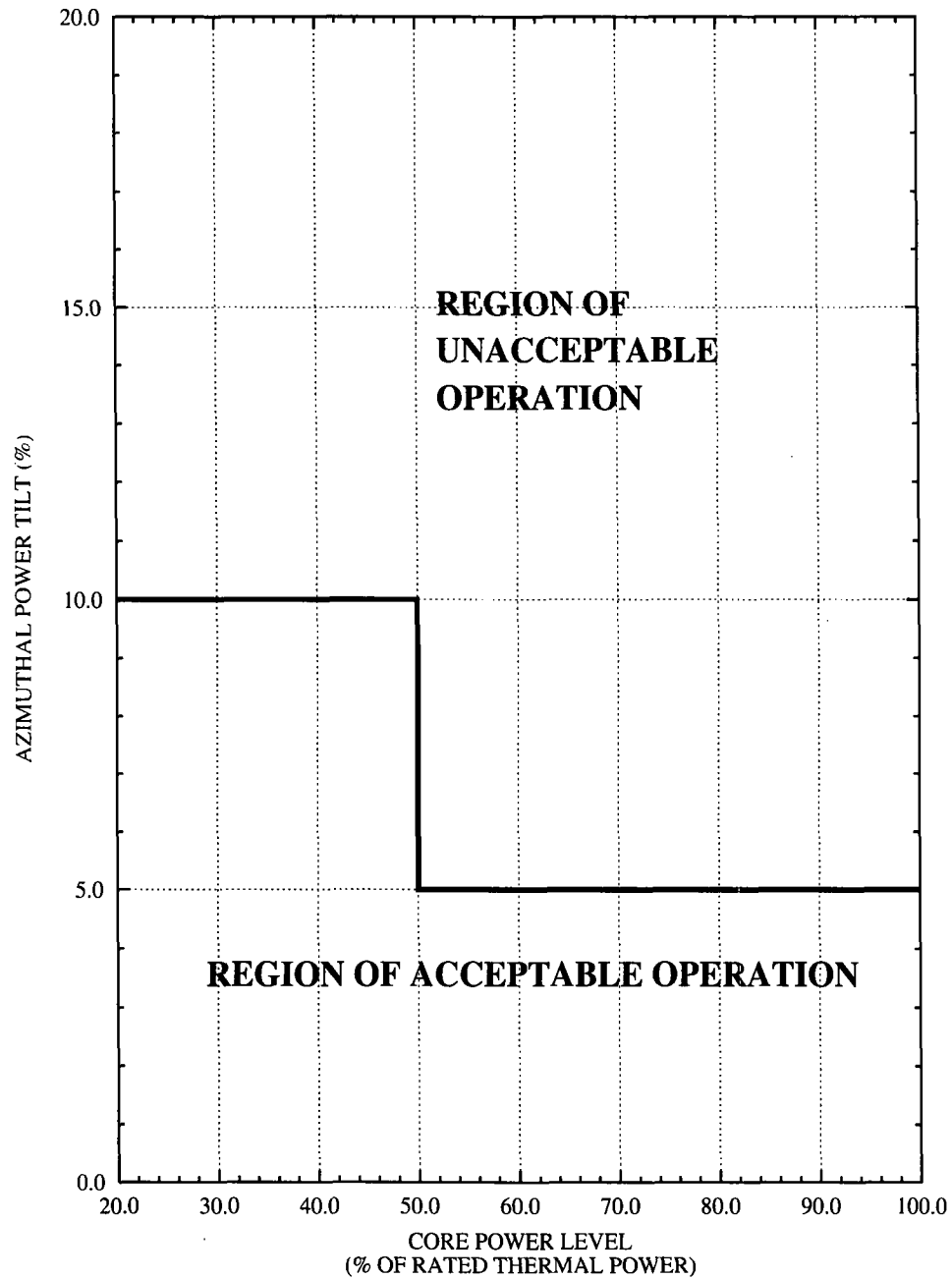


FIGURE 3.2.4-1  
COLSS DNBR OPERATING LIMIT  
ALLOWANCE FOR BOTH CEACs INOPERABLE  
IN ANY OPERABLE CPC CHANNEL

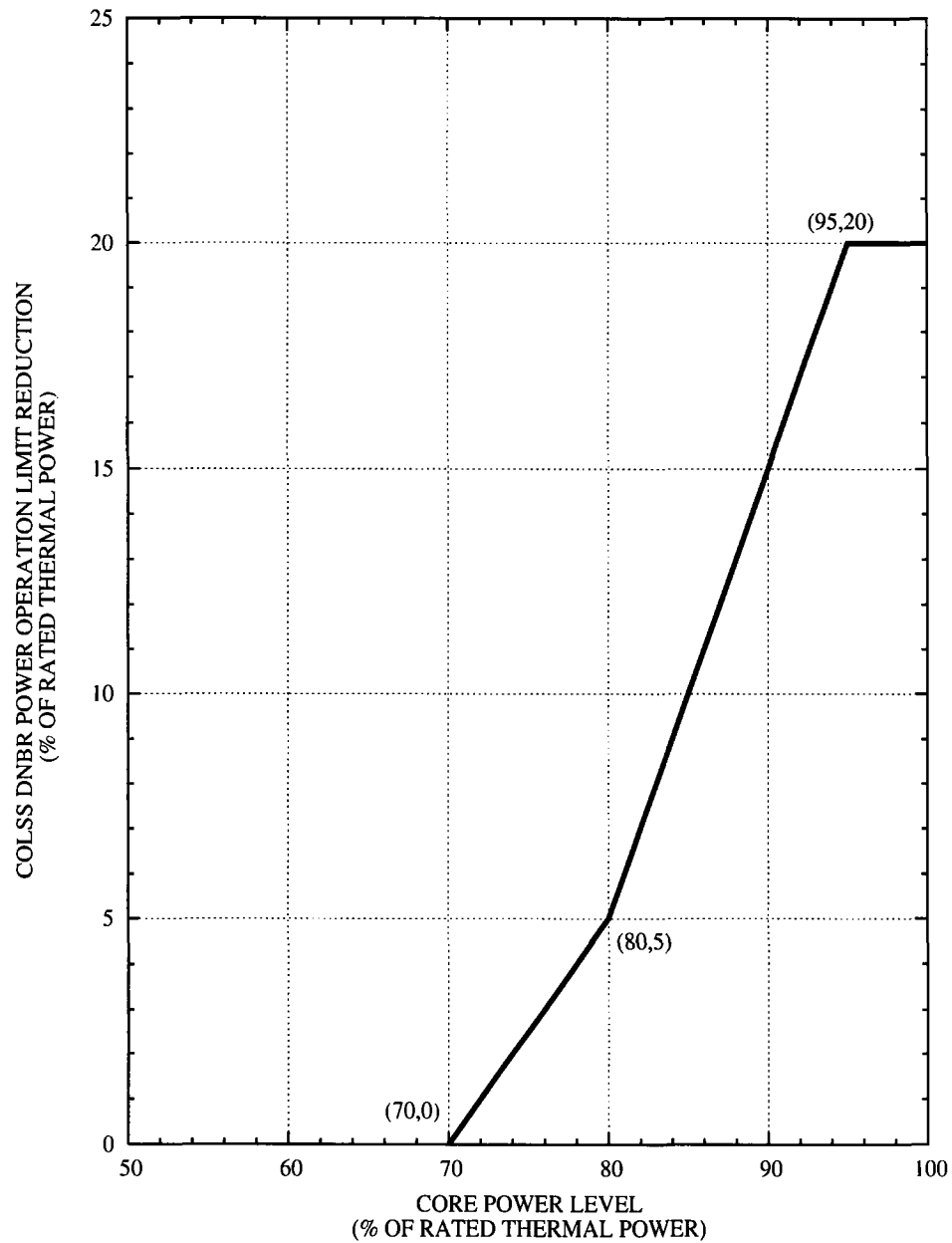


FIGURE 3.2.4-2  
DNBR MARGIN OPERATING LIMIT BASED ON  
THE CORE PROTECTION CALCULATORS  
(COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

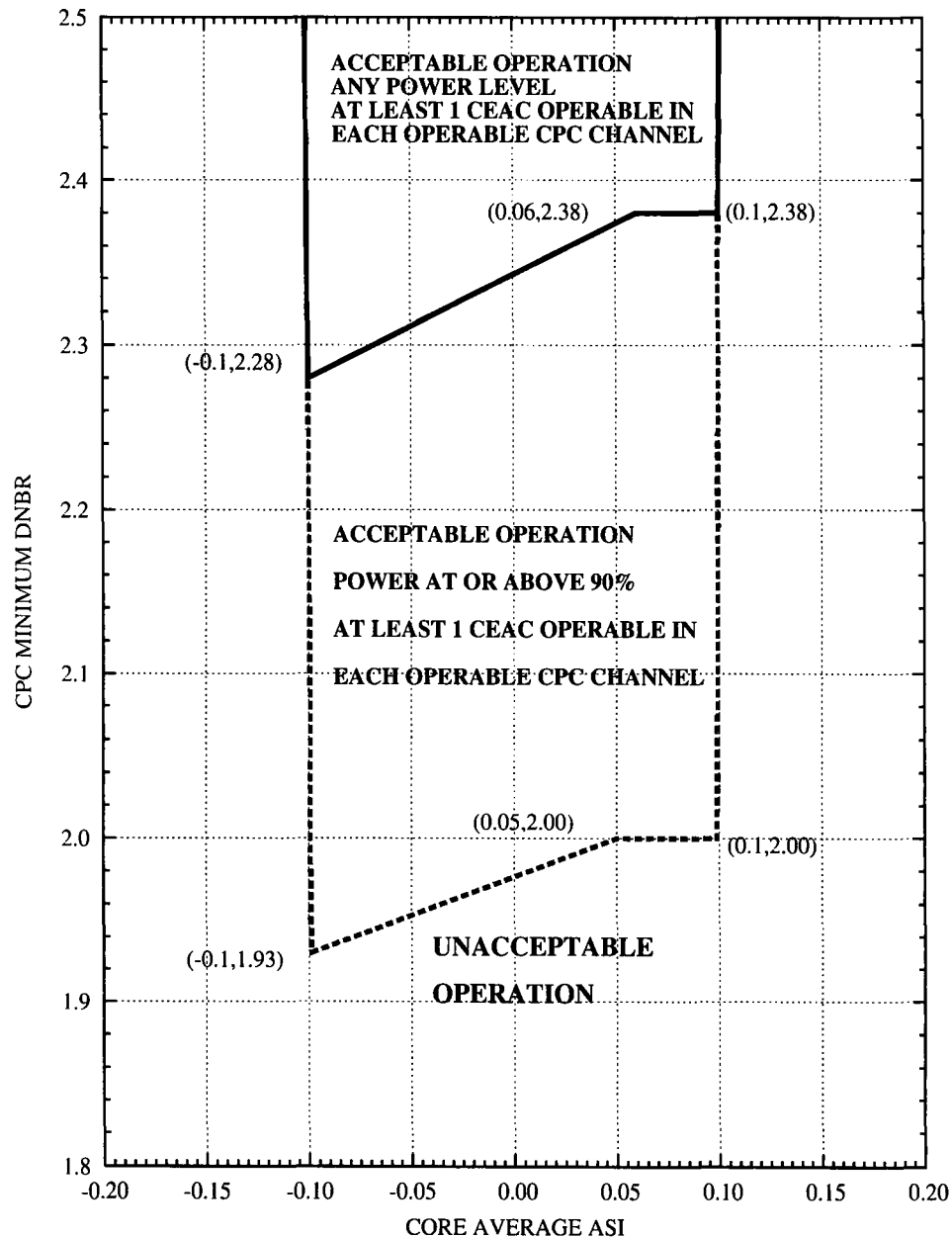


FIGURE 3.2.4-3  
DNBR MARGIN OPERATING LIMIT BASED ON  
THE CORE PROTECTION CALCULATORS  
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE  
IN ANY OPERABLE CPC CHANNEL)

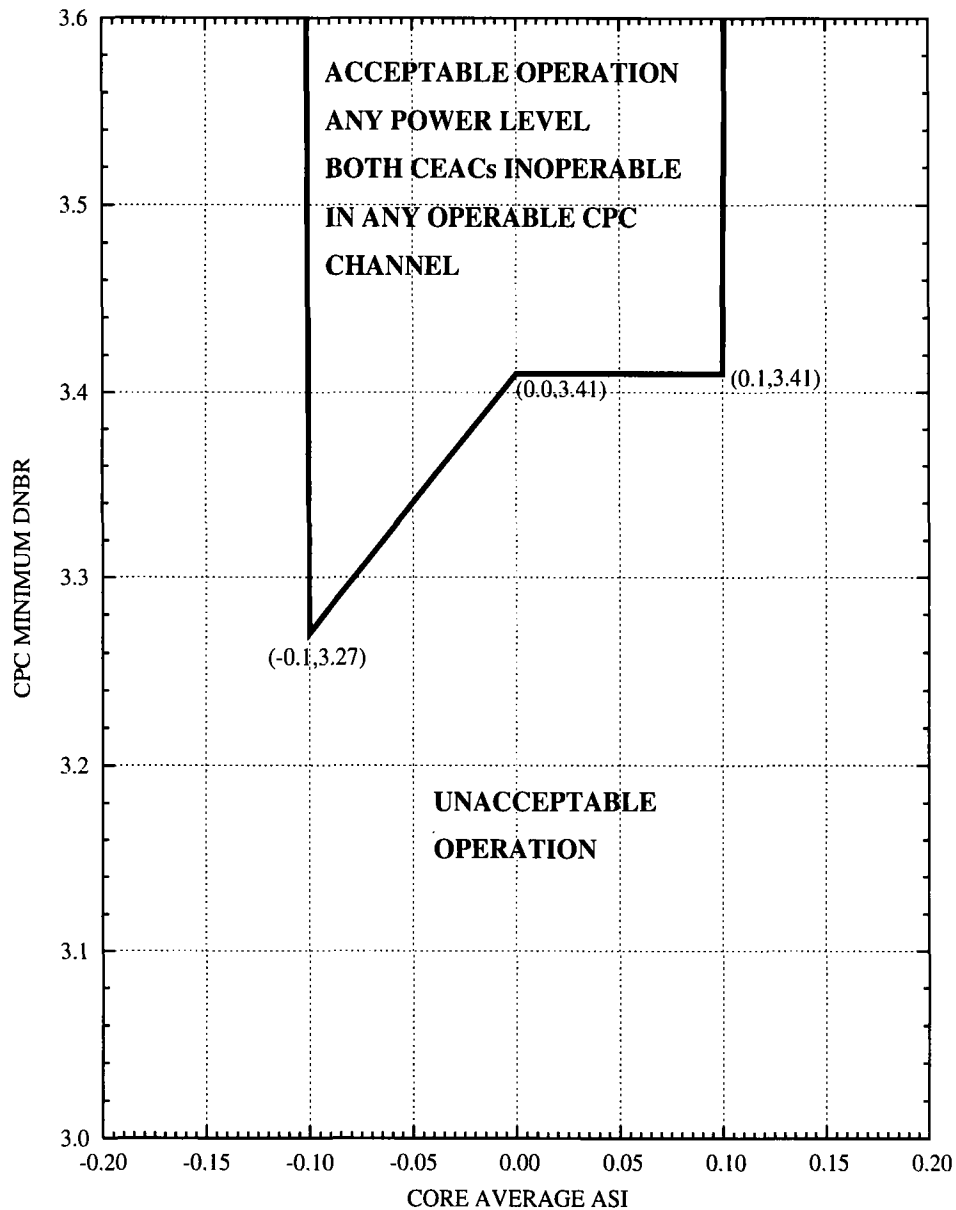




Table 3.3.12-1

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  $0.96 \geq K_{eff} > 0.95$

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**

**PVNGS Unit 2 Core Operating Limits Report (COLR)  
Revision 19**




# **PALO VERDE NUCLEAR GENERATING STATION (PVNGS)**

## **UNIT 2**

### **CORE OPERATING LIMITS REPORT**

**Revision 19**

**Effective December 20, 2013**

Responsible Engineer Date	Sutton, Bradley J(Z06308)  <small>Digitally signed by Sutton, Bradley J(Z06308) DN: cn=Sutton, Bradley J(Z06308) Reason: I am the author of this document Date: 2013.12.18 15:49:50 -07'00'</small>
Independent Reviewer Date	Bodnar, Walter S(Z06432)  <small>Digitally signed by Bodnar, Walter S(Z06432) DN: cn=Bodnar, Walter S(Z06432) Reason: I have reviewed this document Date: 2013.12.18 16:16:10 -07'00'</small>
Responsible Section Leader Date	Ashton, Jeffrey C(Z03403)  <small>Digitally signed by Ashton, Jeffrey C(Z03403) DN: cn=Ashton, Jeffrey C(Z03403) Reason: I am approving this document Date: 2013.12.18 22:24:41 -07'00'</small>

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This Report has been prepared in accordance with the requirements of Technical Specification 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 Unit 1 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

### 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#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
1	CE Method for Control Element Assembly Ejection Analysis (13-N001-1301-01204-1)	CENPD-0190-A	N.A.	January 1976	N.A.
2	The ROCS and DIT Computer Codes for Nuclear Design (13-N001-1900-01412-0)	CENPD-266-P-A	N.A.	April 1983	N.A.
3	Safety Evaluation Report related to the Final Design of the Standard Nuclear Steam Supply Reference Systems CESSAR System 80, Docket No. STN 50-470	NUREG-0852	N.A.	March 1983  September 1983  December 1987	1  2  3
4	Modified Statistical Combination of Uncertainties (13-N001-1303-01747-2)	CEN-356(V)-P-A	01-P-A	May 1988	N.A.
4	System 80 <sup>TM</sup> Inlet Flow Distribution (13-N001-1301-01228-0)	Enclosure 1-P to LD-82-054	N.A.	February 1993	1-P
5	Calculative Methods for the CE Large Break LOCA Evaluation Model for the Analysis of CE and W Designed NSSS (13-N001-1900-01192-3)	CENPD-132	N.A.	March 2001	4-P-A Rev. 1
6	Calculative Methods for the CE Small Break LOCA Evaluation Model (13-N001-1900-01185-3)	CENPD-137-P	N.A.	April 1998	2-P-A
7	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.	N.A.	N.A.	June 13, 1975	N.A.

<u>T.S</u> <u>Ref#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
8	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.	N.A.	N.A.	September 27, 1977	N.A.
9	Fuel Rod Maximum Allowable Pressure (13-N001-0201-00026-1)	CEN-372-P-A	N.A.	May 1990	N.A.
10	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.	N.A.	N.A.	April 10, 1990	N.A.
11	Arizona Public Service Company PWR Reactor Physics Methodology Using CASMO-4/SIMULATE-3 (NFM-005)	NFM-005	1	August 2007	N.A.
12	Technical Description Manual for the CENTS Code Volume 1 (CENTS-TD MANUAL-VOL 1)	CE-NPD 282-P-A Vols. 1	2	March 2005	N.A.
12	Technical Description Manual for the CENTS Code Volume 2 (CENTS-TD MANUAL-VOL 2)	CE-NPD 282-P-A Vols. 2	2	March 2005	N.A.
12	Technical Description Manual for the CENTS Code Volume 3 (CENTS-TD MANUAL-VOL 3)	CE-NPD 282-P-A Vols. 3	2	March 2005	N.A.
13	Implementation of ZIRLO <sup>TM</sup> Cladding Material in CE Nuclear Power Fuel Assembly Designs (13-N001-1900-01329-0)	CENPD-404-P-A	0	November 2001	N.A.
14	HERMITE, A Multi-Dimensional Space-Time Kinetics Code for PWR Transients (HERMITE-TOPICAL)	CENPD-188-A	N.A.	July 1976	N.A.
15	TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core (N001-1301-01202)	CENPD-161-P-A	N.A.	April 1986	N.A.

<u>T.S Ref#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
16	CETOP-D Code Structures and Modeling Methods for San Onofre Nuclear Generating Station Units 2 and 3, (N001-1301-01185)	CEN-160(S)-P	1-P	September 1981	N.A.
17	“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) and “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).”	N.A.	N.A.	September 29, 2003  November 16, 2005	N.A.
18	CPC Methodology Changes for the CPC Improvement Program, (N001-1303-02283)	CEN-310-P-A	0	April 1986	N.A.
19	Loss of Flow, C-E Methods for Loss of Flow Analysis, (N001-1301-01203)	CENPD-183-A	0	June 1984	N.A.
20	Methodology for Core Designs Containing Erbium Burnable Absorbers (N001-0201-00035)	CENPD-382-P-A	0	August 1993	N.A.
21	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)	CEN-386-P-A	0	August 1992	N.A.

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<sup>1</sup> shown in Figure 3.1.7-1<sup>2</sup>; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits<sup>1</sup> shown in Figure 3.1.7-2.<sup>2</sup> Regulating Groups 1 and 2 CEAs shall be maintained  $\geq$  fully withdrawn<sup>1,3</sup> 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.<sup>1,3</sup>

<sup>1</sup> 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.

<sup>2</sup> 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).

<sup>3</sup> 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  $\geq 3000$  ppm.

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

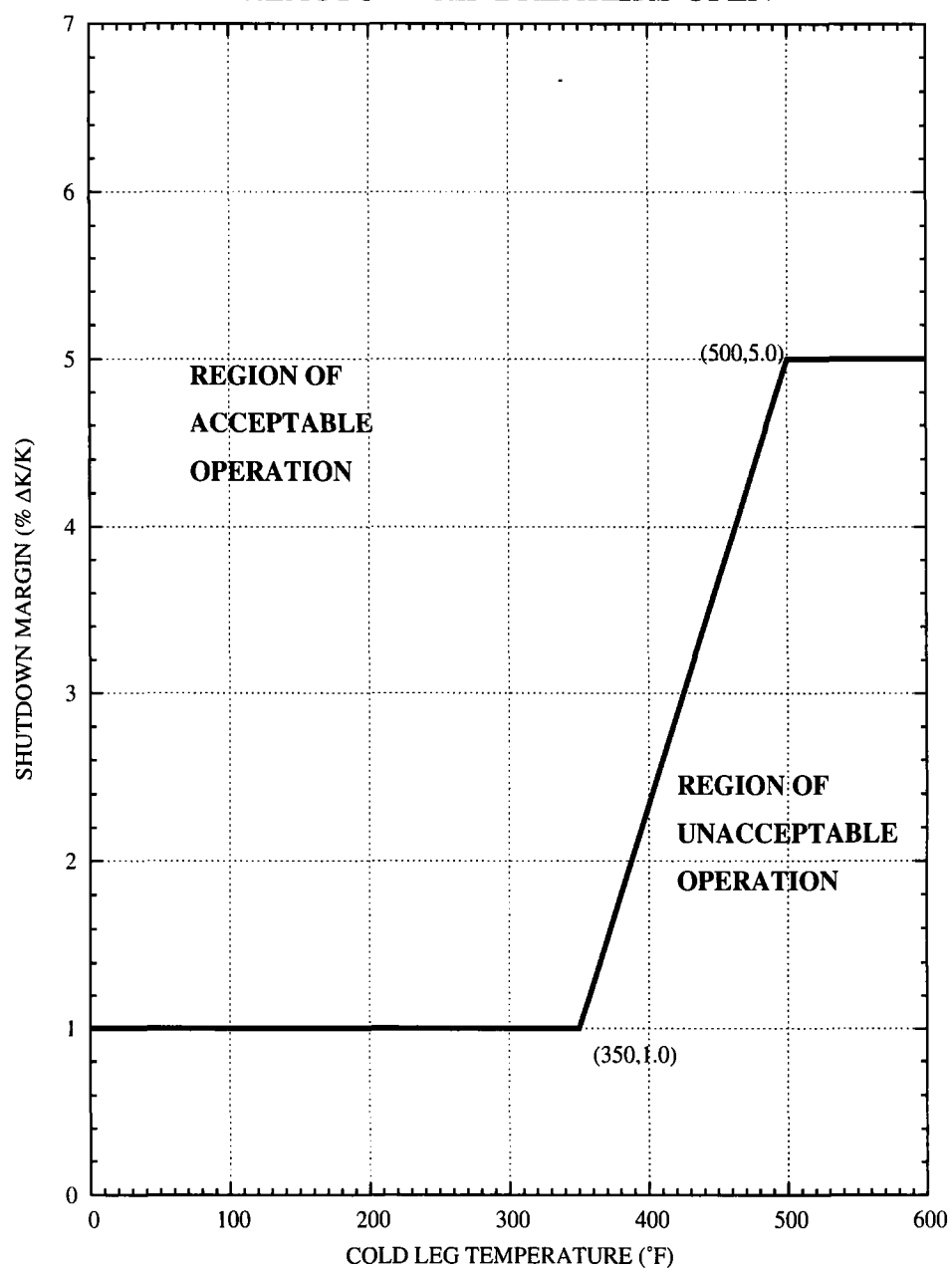
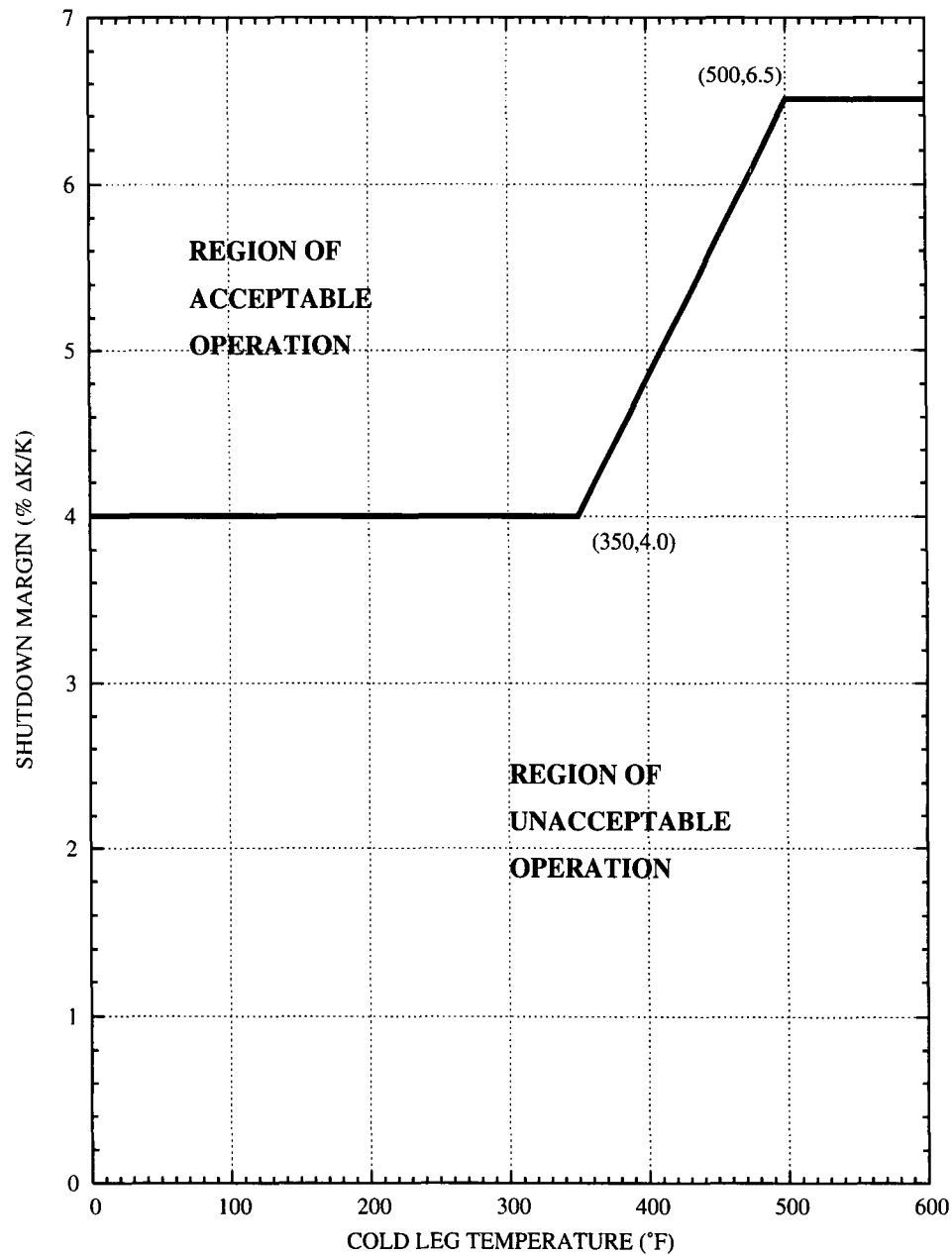


FIGURE 3.1.2-1  
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE  
REACTOR TRIP BREAKERS CLOSED



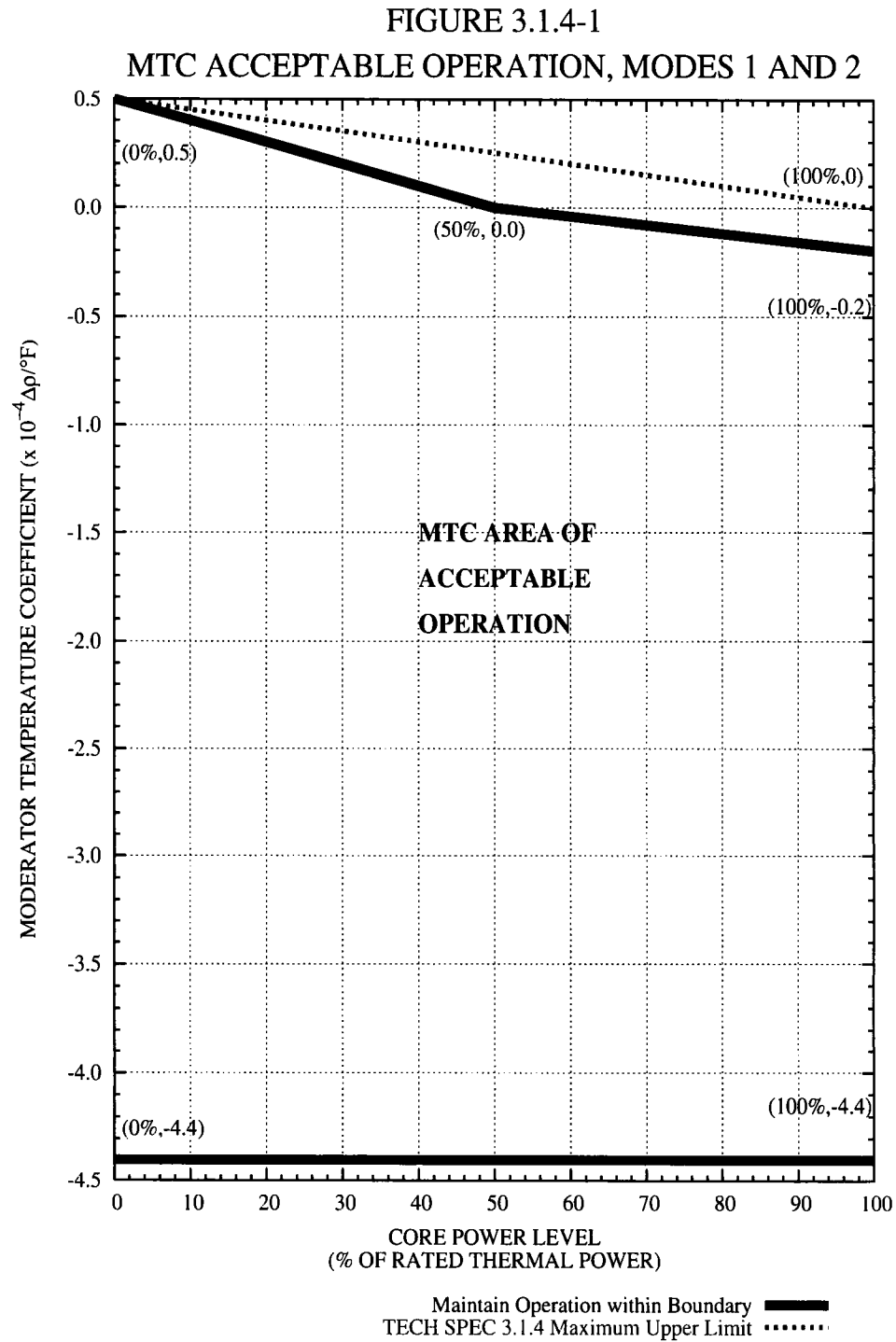
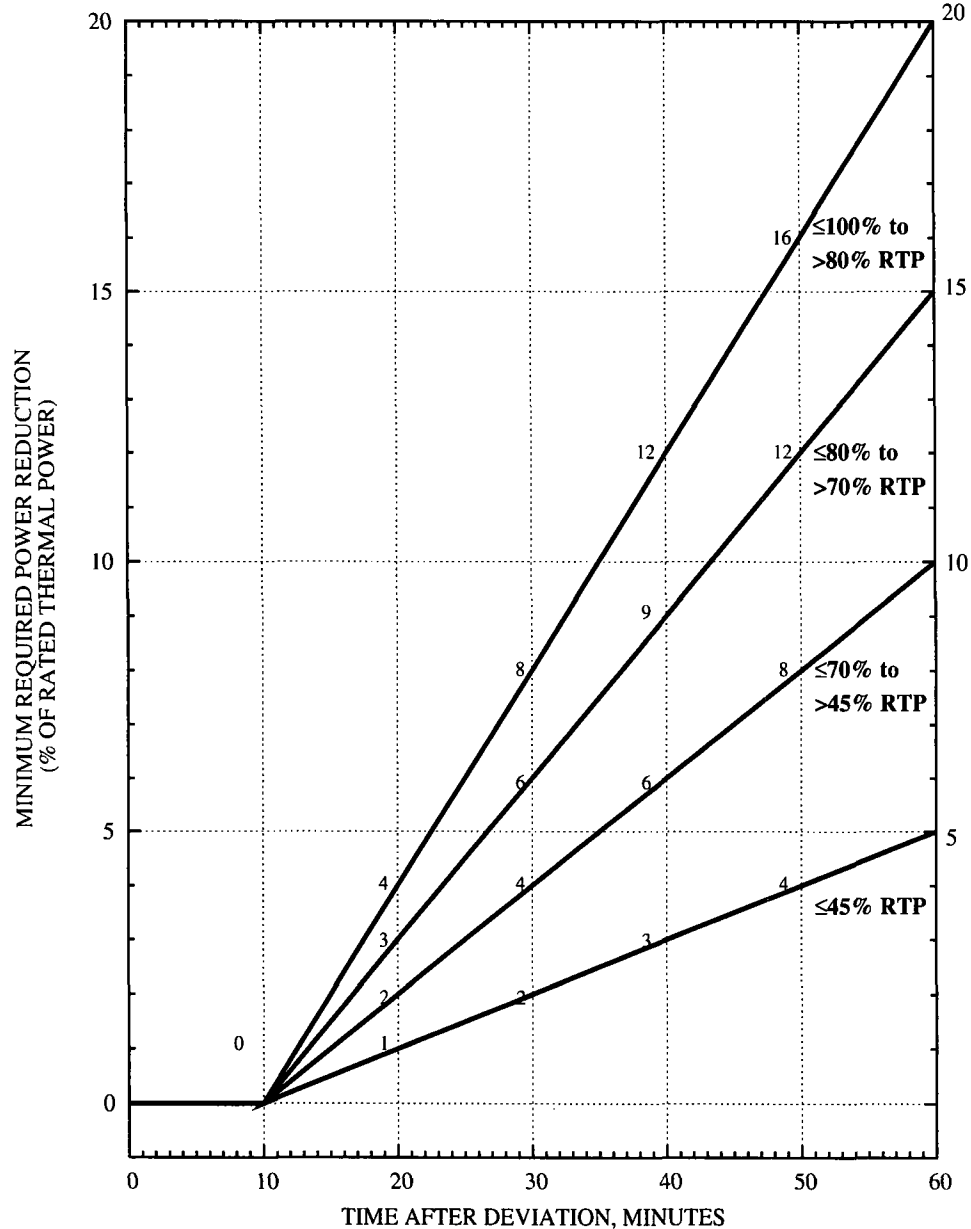


FIGURE 3.1.5-1

## CORE POWER REDUCTION AFTER CEA DEVIATION\*

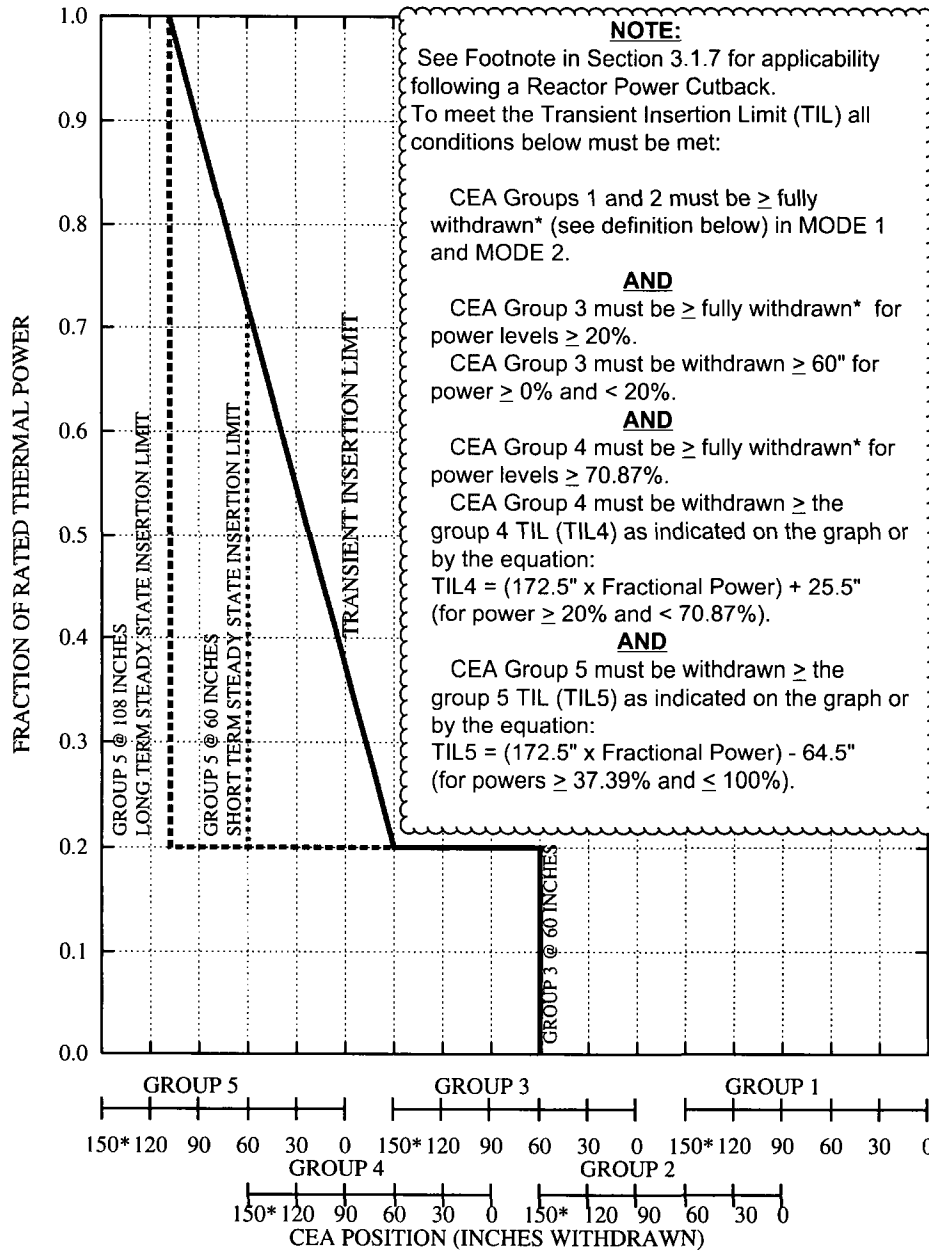


\* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

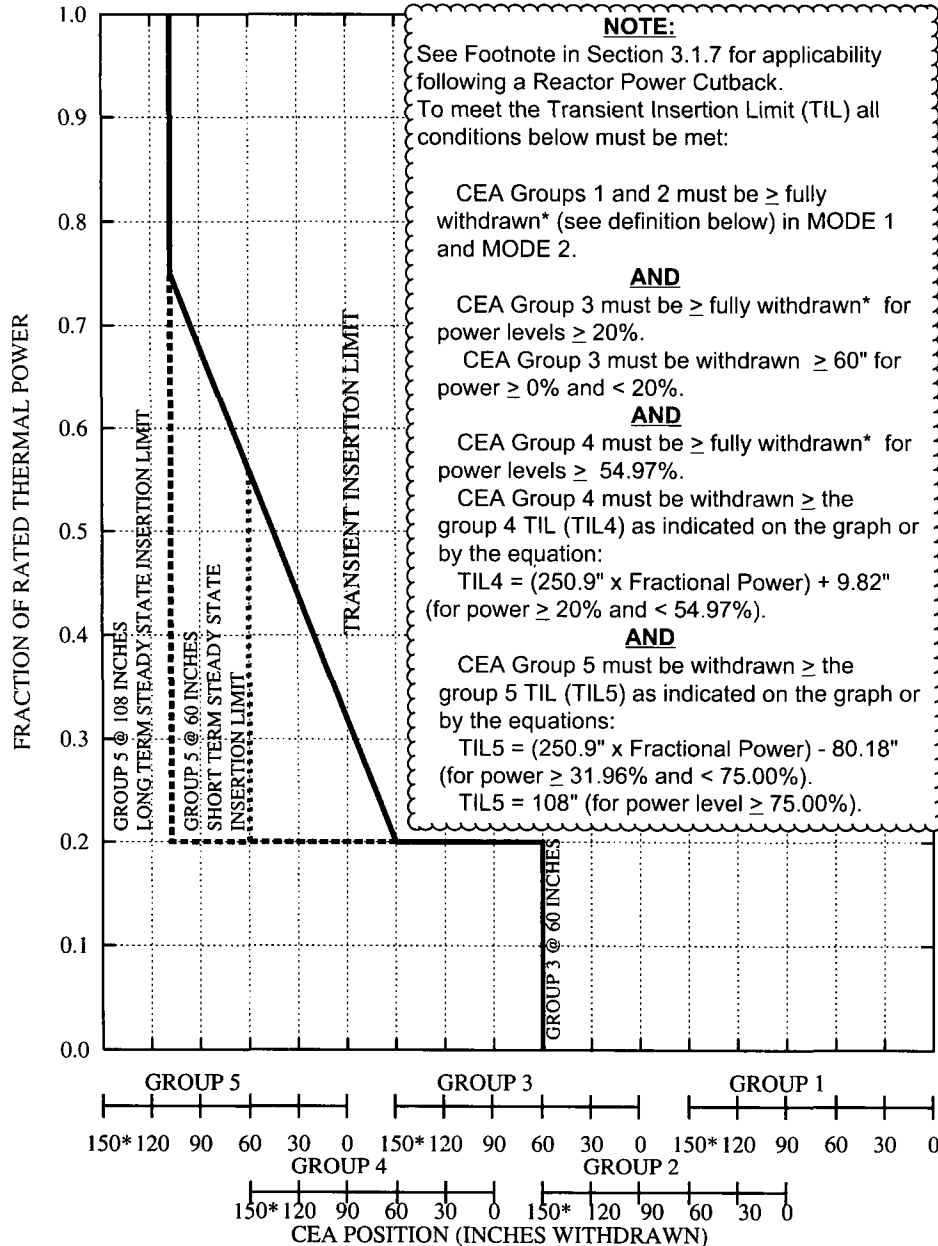
- RATED THERMAL POWER IS ABOVE 95 %
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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  $\geq 147.75"$  (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

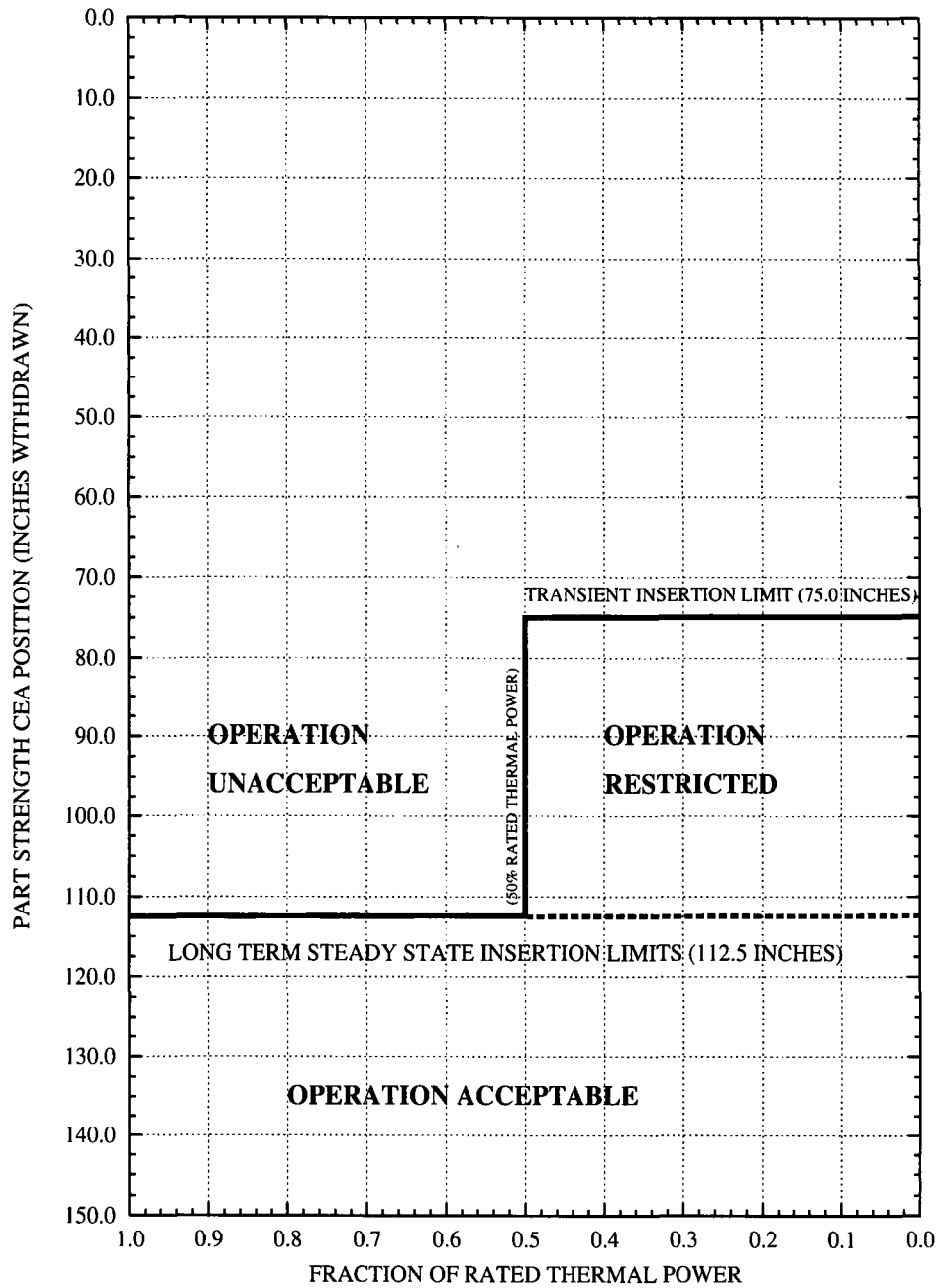




FIGURE 3.2.3-1  
AZIMUTHAL POWER TILT VERSUS THERMAL POWER  
(COLSS IN SERVICE)

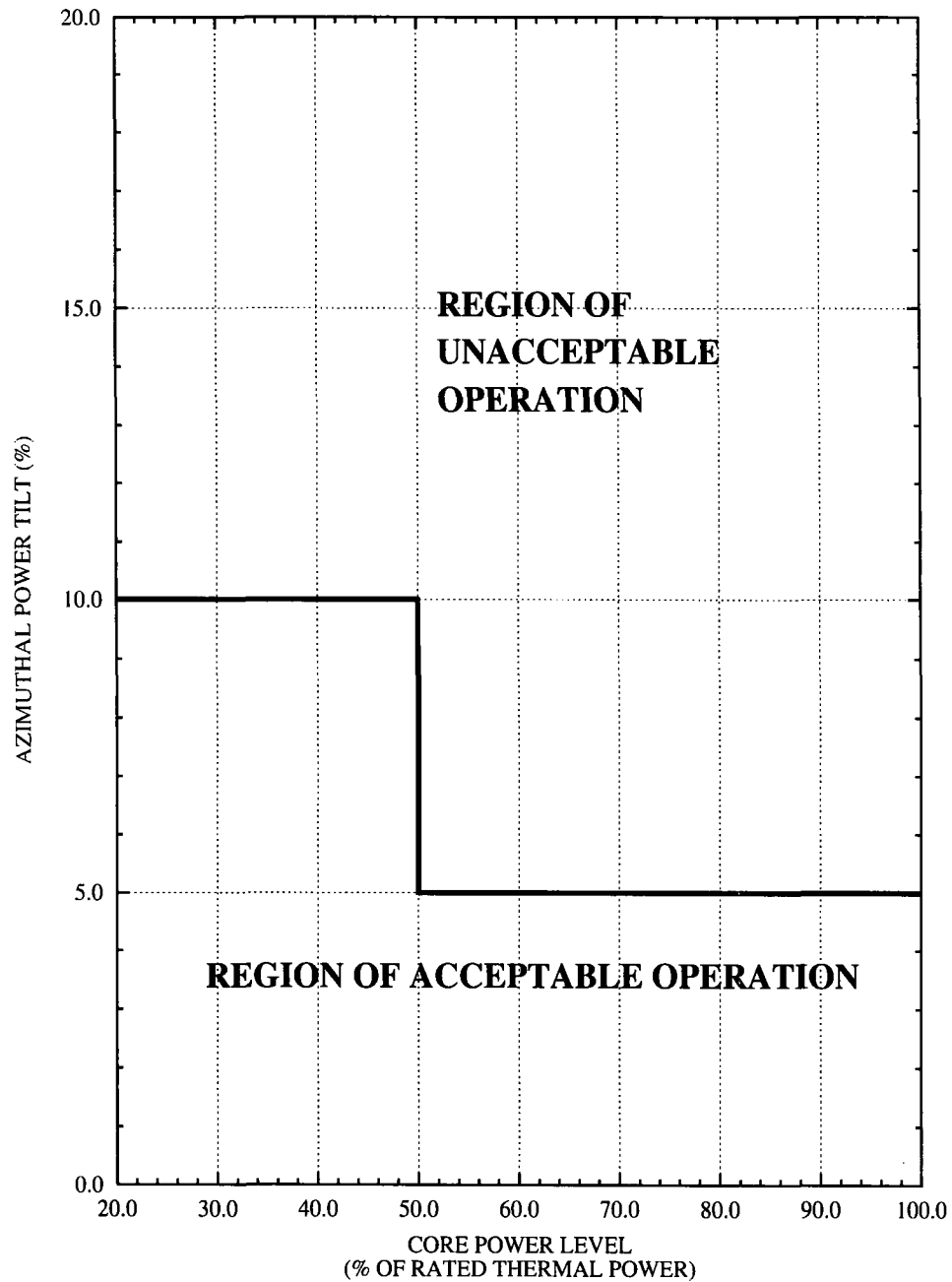


FIGURE 3.2.4-1  
COLSS DNBR OPERATING LIMIT  
ALLOWANCE FOR BOTH CEACs INOPERABLE  
IN ANY OPERABLE CPC CHANNEL

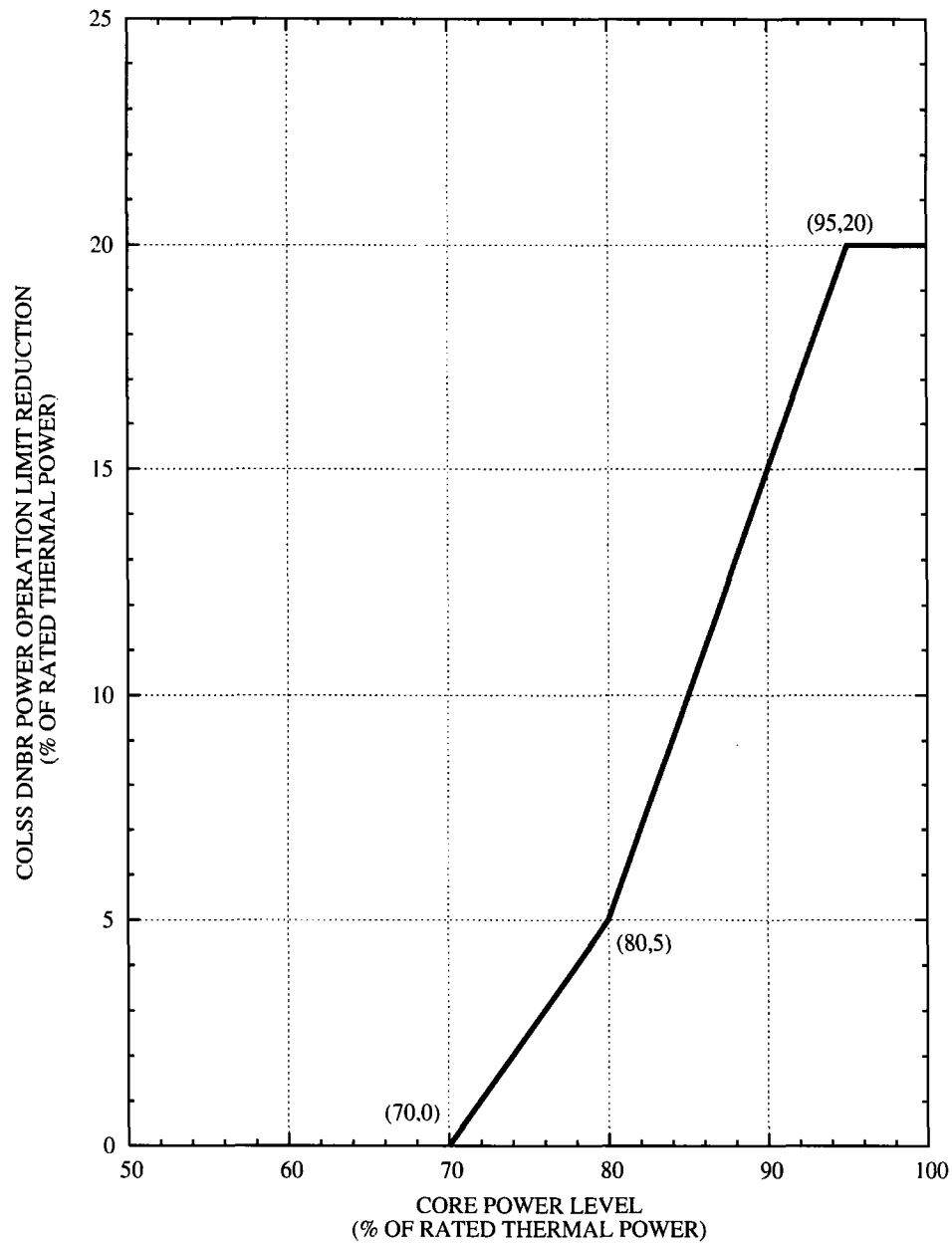


FIGURE 3.2.4-2  
DNBR MARGIN OPERATING LIMIT BASED ON  
THE CORE PROTECTION CALCULATORS  
(COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

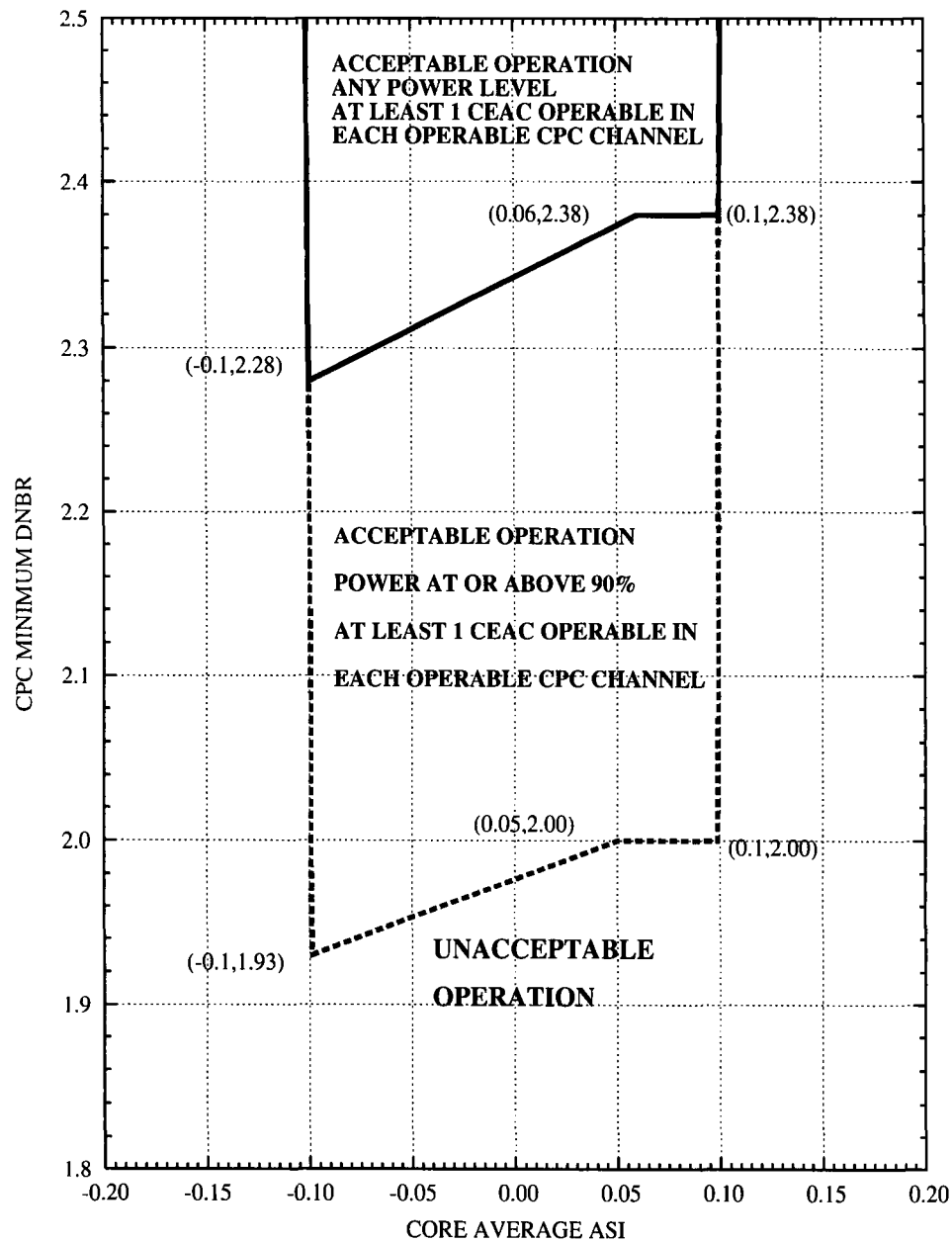


FIGURE 3.2.4-3  
DNBR MARGIN OPERATING LIMIT BASED ON  
THE CORE PROTECTION CALCULATORS  
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE  
IN ANY OPERABLE CPC CHANNEL)

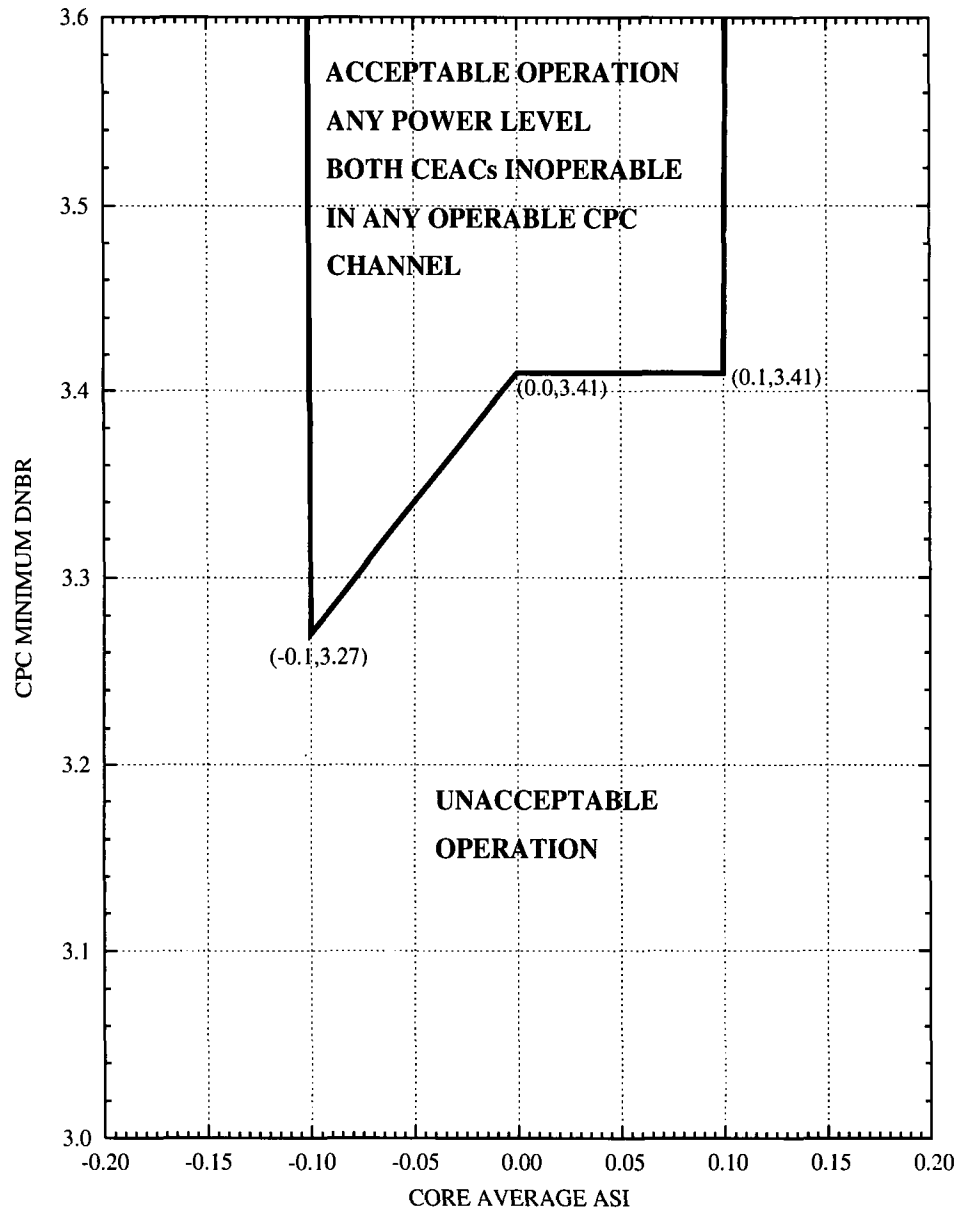


Table 3.3.12-1

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**

**PVNGS Unit 3 Core Operating Limits Report (COLR)  
Revision 22**

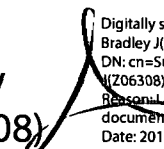
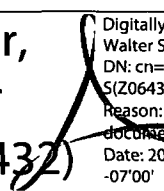
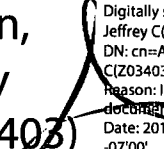
# **PALO VERDE NUCLEAR GENERATING STATION (PVNGS)**

## **UNIT 3**

### **CORE OPERATING LIMITS REPORT**

**Revision 22**

**Effective December 20, 2013**

Responsible Engineer Date	Sutton, Bradley J(Z06308)  Digitally signed by Sutton, Bradley J(Z06308) DN: cn=Sutton, Bradley J(Z06308) Reason: I am the author of this document Date: 2013.12.18 15:51:37 -07'00'
Independent Reviewer Date	Bodnar, Walter S(Z06432)  Digitally signed by Bodnar, Walter S(Z06432) DN: cn=Bodnar, Walter S(Z06432) Reason: I have reviewed this document Date: 2013.12.18 16:16:54 -07'00'
Responsible Section Leader Date	Ashton, Jeffrey C(Z03403)  Digitally signed by Ashton, Jeffrey C(Z03403) DN: cn=Ashton, Jeffrey C(Z03403) Reason: I am approving this document Date: 2013.12.18 22:26:00 -07'00'

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This Report has been prepared in accordance with the requirements of Technical Specification 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 Unit 1 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

### 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#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
1	CE Method for Control Element Assembly Ejection Analysis (13-N001-1301-01204-1)	CENPD-0190-A	N.A.	January 1976	N.A.
2	The ROCS and DIT Computer Codes for Nuclear Design (13-N001-1900-01412-0)	CENPD-266-P-A	N.A.	April 1983	N.A.
3	Safety Evaluation Report related to the Final Design of the Standard Nuclear Steam Supply Reference Systems CESSAR System 80, Docket No. STN 50-470	NUREG-0852	N.A.	March 1983  September 1983  December 1987	1  2  3
4	Modified Statistical Combination of Uncertainties (13-N001-1303-01747-2)	CEN-356(V)-P-A	01-P-A	May 1988	N.A.
4	System 80 <sup>TM</sup> Inlet Flow Distribution (13-N001-1301-01228-0)	Enclosure 1-P to LD-82-054	N.A.	February 1993	1-P
5	Calculative Methods for the CE Large Break LOCA Evaluation Model for the Analysis of CE and W Designed NSSS (13-N001-1900-01192-3)	CENPD-132	N.A.	March 2001	4-P-A Rev. 1
6	Calculative Methods for the CE Small Break LOCA Evaluation Model (13-N001-1900-01185-3)	CENPD-137-P	N.A.	April 1998	2-P-A
7	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.	N.A.	N.A.	June 13, 1975	N.A.



<u>T.S</u> <u>Ref#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
8	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.	N.A.	N.A.	September 27, 1977	N.A.
9	Fuel Rod Maximum Allowable Pressure (13-N001-0201-00026-1)	CEN-372-P-A	N.A.	May 1990	N.A.
10	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.	N.A.	N.A.	April 10, 1990	N.A.
11	Arizona Public Service Company PWR Reactor Physics Methodology Using CASMO-4/SIMULATE-3 (NFM-005)	NFM-005	1	August 2007	N.A.
12	Technical Description Manual for the CENTS Code Volume 1 (CENTS-TD MANUAL-VOL 1)	CE-NPD 282-P-A Vols. 1	2	March 2005	N.A.
12	Technical Description Manual for the CENTS Code Volume 2 (CENTS-TD MANUAL-VOL 2)	CE-NPD 282-P-A Vols. 2	2	March 2005	N.A.
12	Technical Description Manual for the CENTS Code Volume 3 (CENTS-TD MANUAL-VOL 3)	CE-NPD 282-P-A Vols. 3	2	March 2005	N.A.
13	Implementation of ZIRLO <sup>TM</sup> Cladding Material in CE Nuclear Power Fuel Assembly Designs (13-N001-1900-01329-0)	CENPD-404-P-A	0	November 2001	N.A.
14	HERMITE, A Multi-Dimensional Space-Time Kinetics Code for PWR Transients (HERMITE-TOPICAL)	CENPD-188-A	N.A.	July 1976	N.A.
15	TORC Code, A Computer Code for Determining the Thermal Margin of a Reactor Core (N001-1301-01202)	CENPD-161-P-A	N.A.	April 1986	N.A.

<u>T.S Ref#<sup>a</sup></u>	<u>Title</u>	<u>Report No.</u>	<u>Rev</u>	<u>Date</u>	<u>Suppl</u>
16	CETOP-D Code Structures and Modeling Methods for San Onofre Nuclear Generating Station Units 2 and 3, (N001-1301-01185)	CEN-160(S)-P	1-P	September 1981	N.A.
17	“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) and “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).”	N.A.	N.A.	September 29, 2003  November 16, 2005	N.A.
18	CPC Methodology Changes for the CPC Improvement Program, (N001-1303-02283)	CEN-310-P-A	0	April 1986	N.A.
19	Loss of Flow, C-E Methods for Loss of Flow Analysis, (N001-1301-01203)	CENPD-183-A	0	June 1984	N.A.
20	Methodology for Core Designs Containing Erbium Burnable Absorbers (N001-0201-00035)	CENPD-382-P-A	0	August 1993	N.A.
21	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)	CEN-386-P-A	0	August 1992	N.A.

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<sup>1</sup> shown in Figure 3.1.7-1<sup>2</sup>; with COLSS OUT OF SERVICE, regulating CEA groups shall be limited to the withdrawal sequence and to the insertion limits<sup>1</sup> shown in Figure 3.1.7-2.<sup>2</sup> Regulating Groups 1 and 2 CEAs shall be maintained  $\geq$  fully withdrawn<sup>1,3</sup> 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.<sup>1,3</sup>

<sup>1</sup> 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.

<sup>2</sup> 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).

<sup>3</sup> 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  $\geq 3000$  ppm.

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

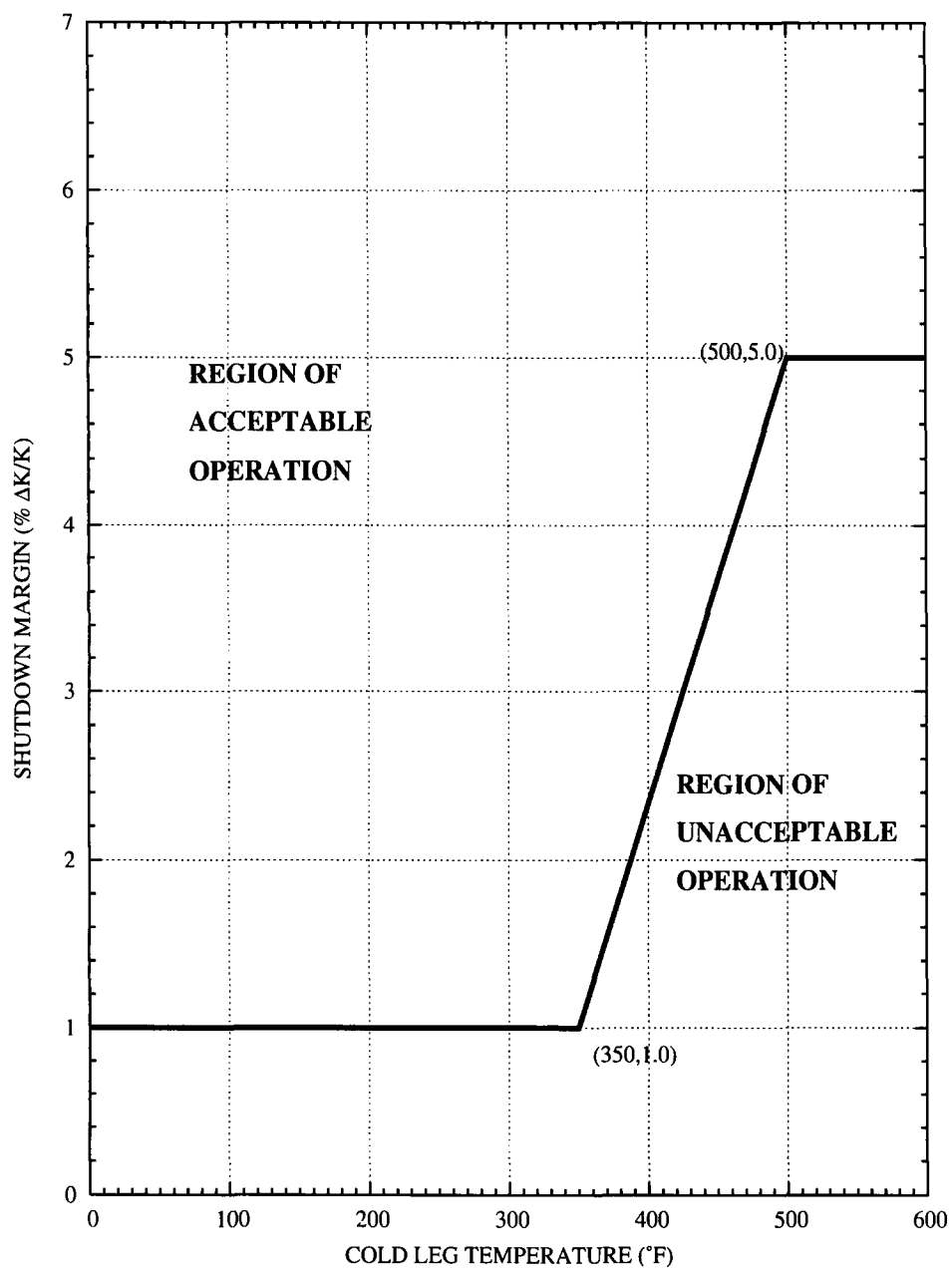
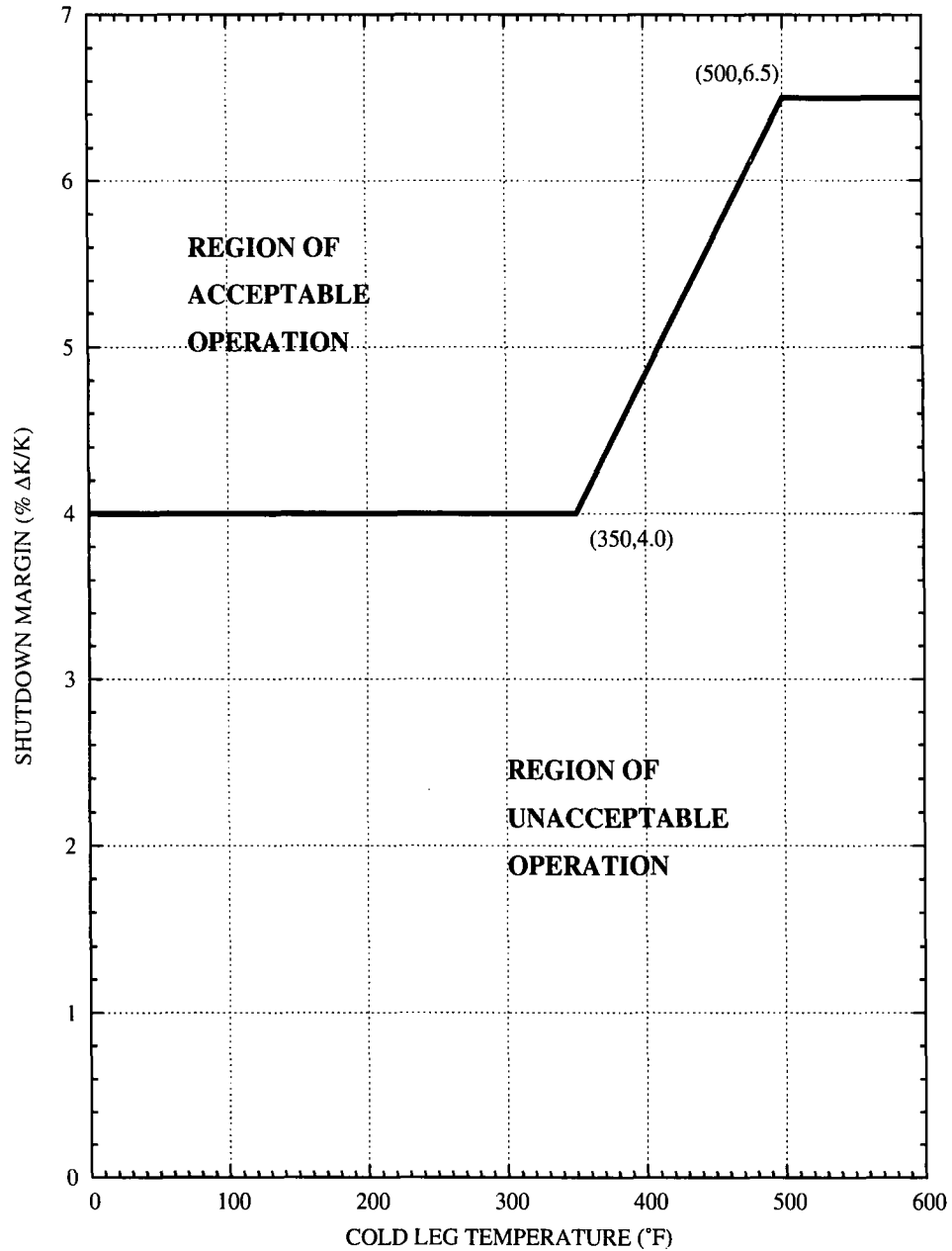


FIGURE 3.1.2-1  
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE  
REACTOR TRIP BREAKERS CLOSED



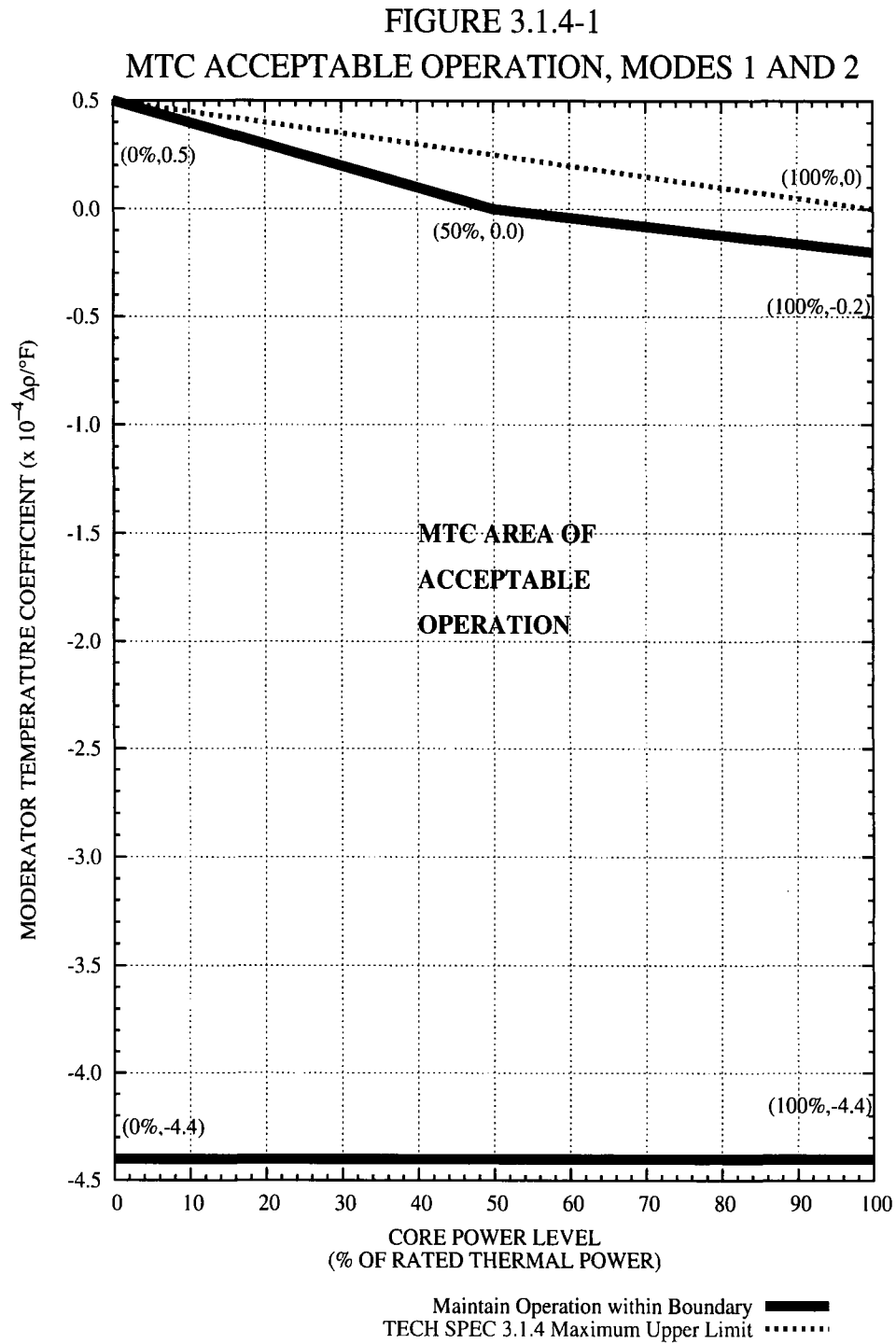
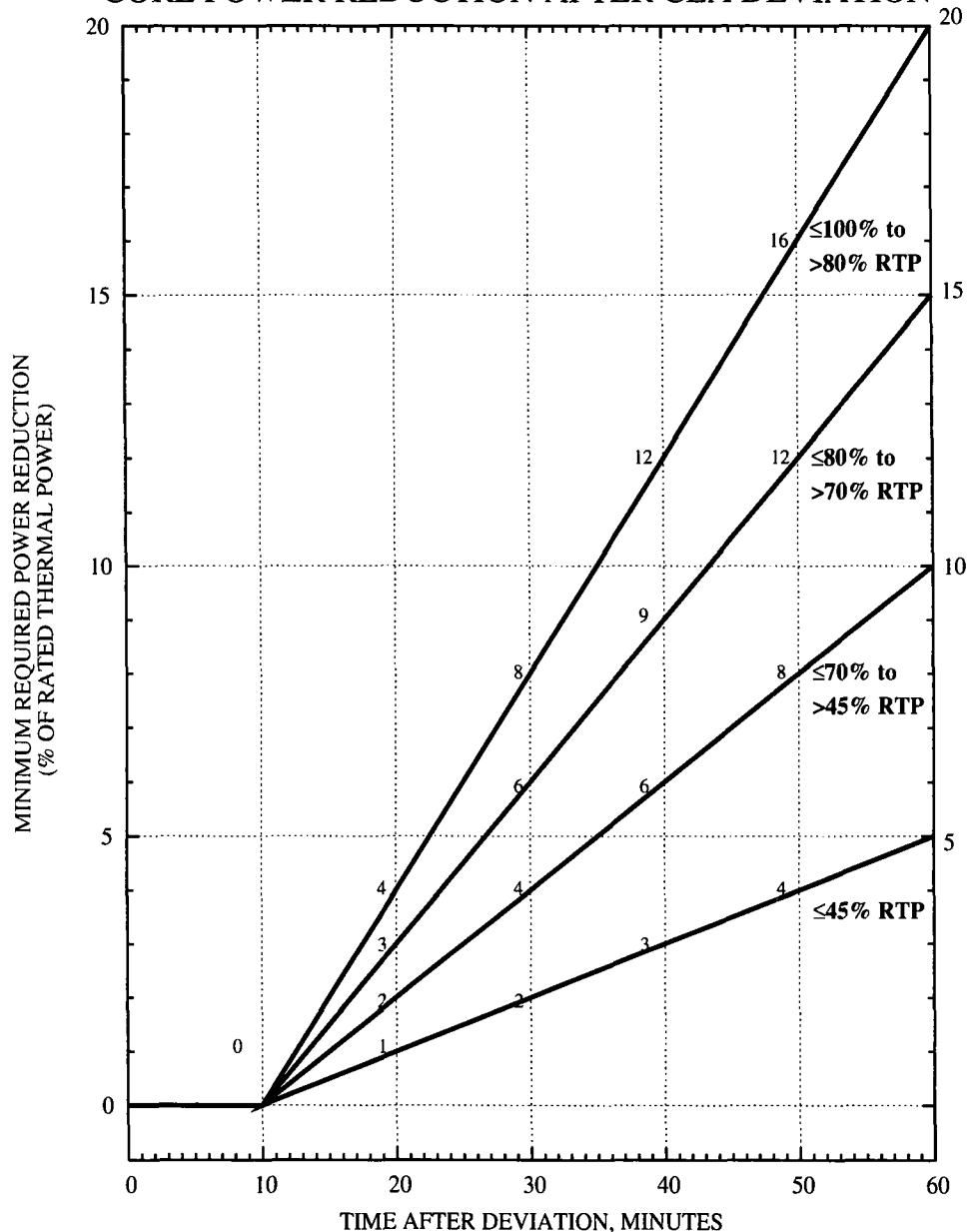




FIGURE 3.1.5-1

## CORE POWER REDUCTION AFTER CEA DEVIATION\*

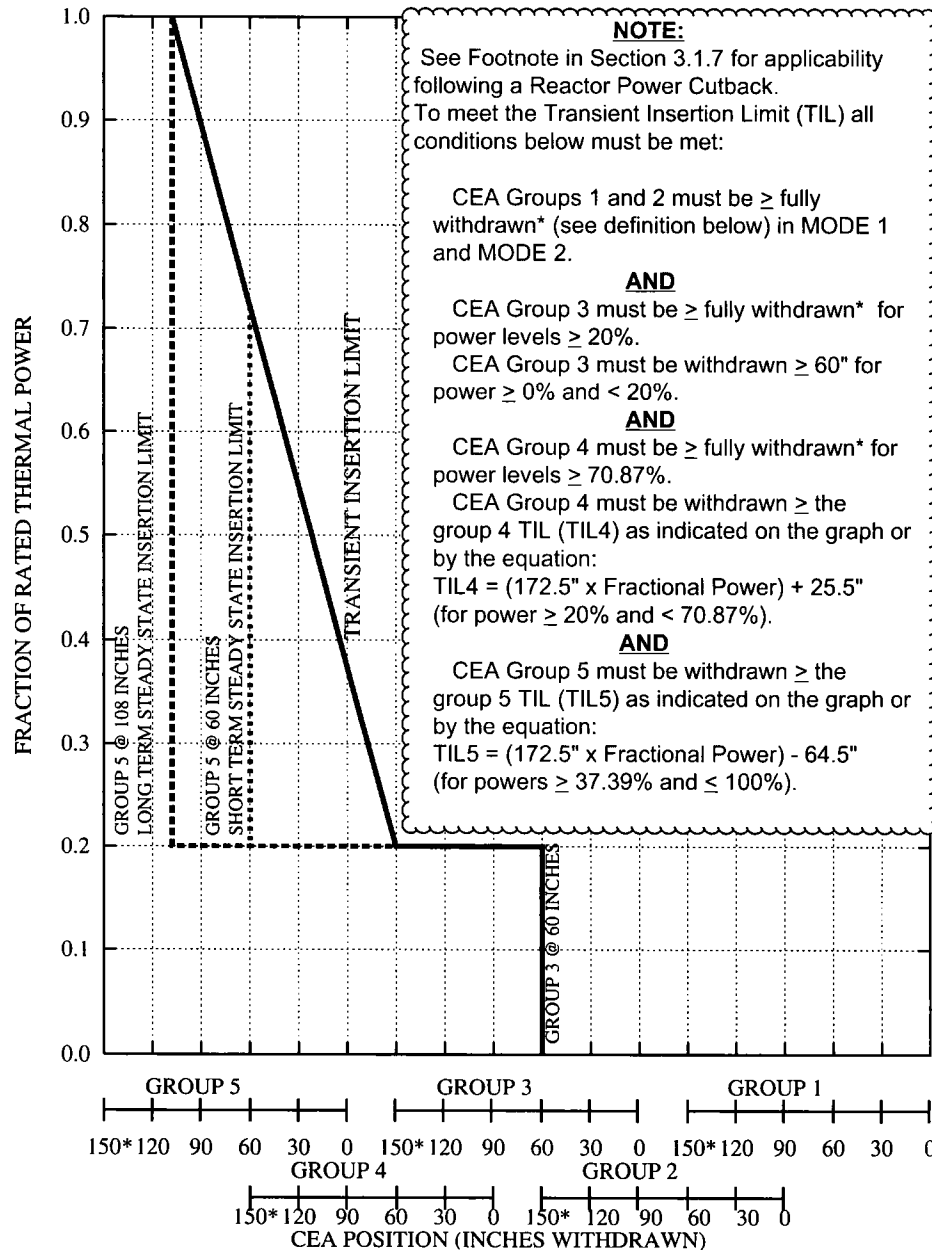


\* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

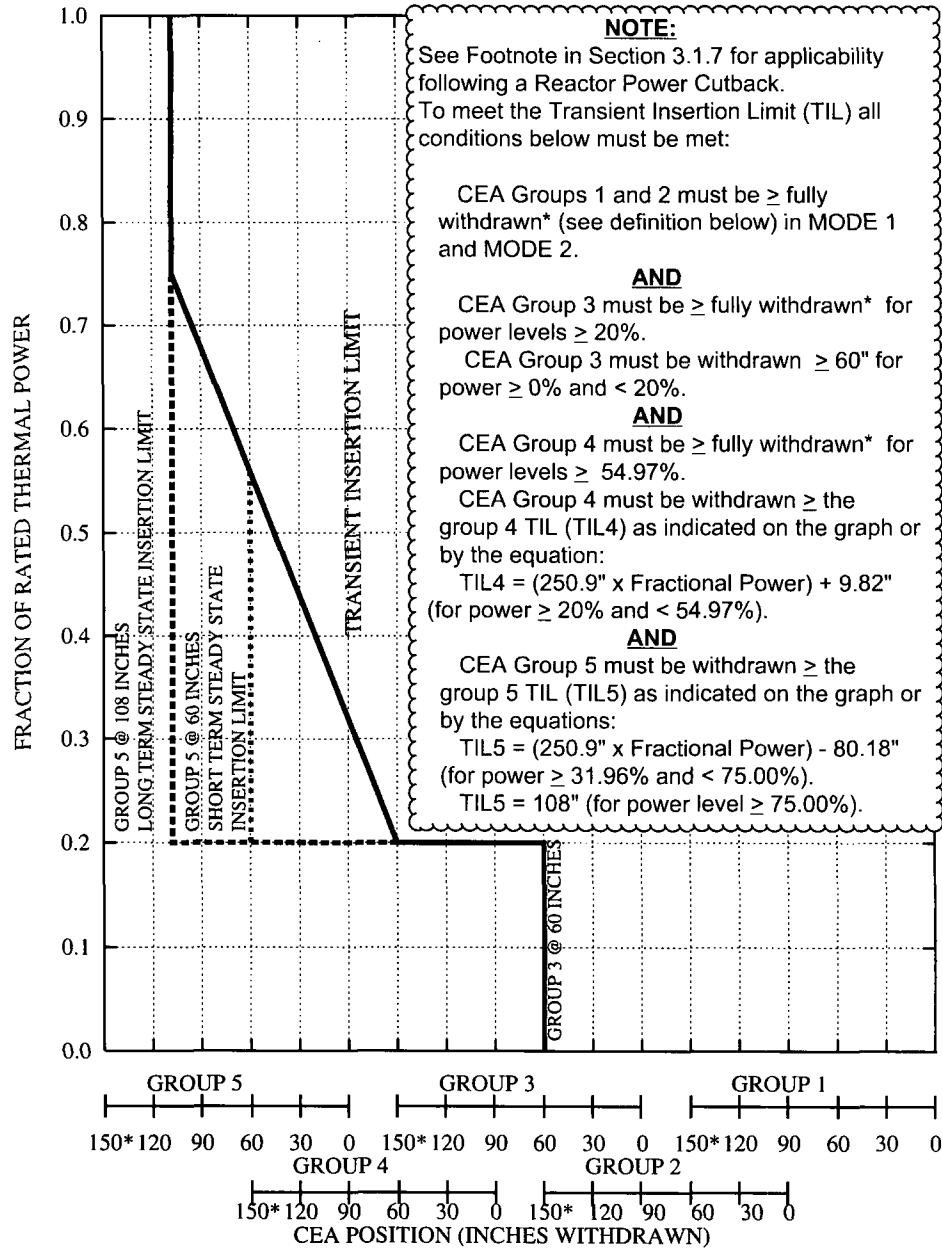
- RATED THERMAL POWER IS ABOVE 95 %
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

**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  $\geq 147.75"$  (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

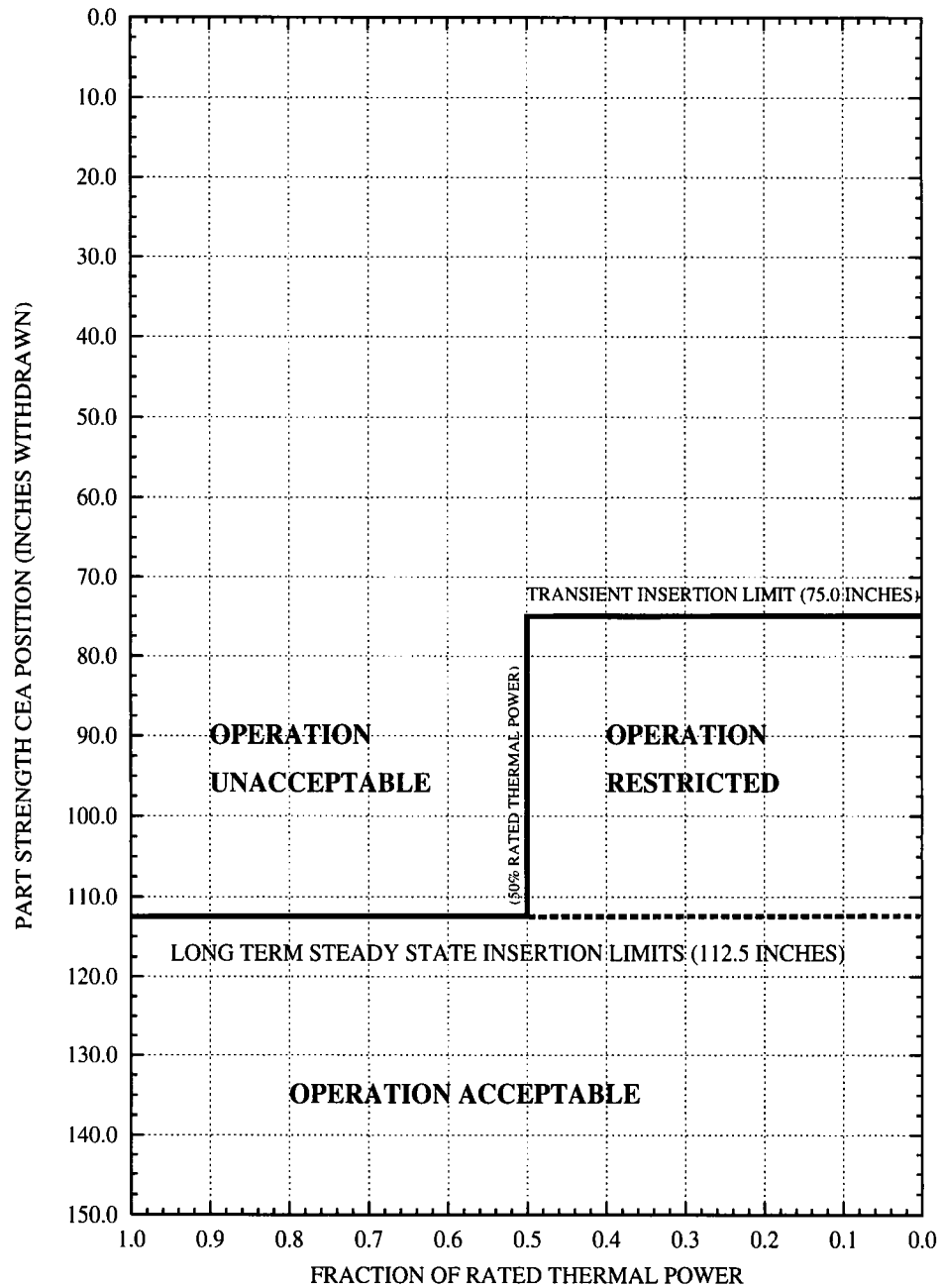


FIGURE 3.2.3-1  
AZIMUTHAL POWER TILT VERSUS THERMAL POWER  
(COLSS IN SERVICE)

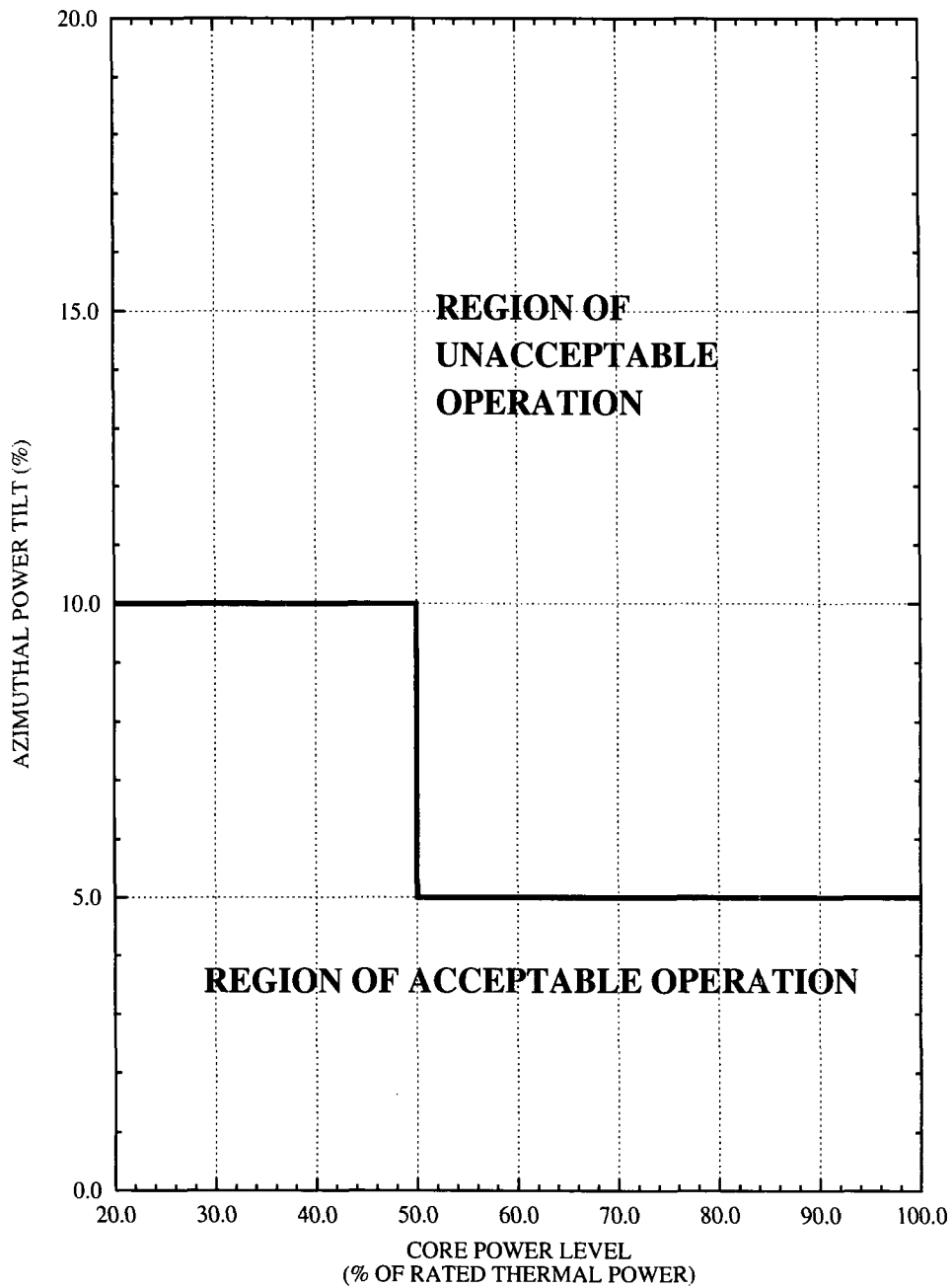


FIGURE 3.2.4-1  
COLSS DNBR OPERATING LIMIT  
ALLOWANCE FOR BOTH CEACs INOPERABLE  
IN ANY OPERABLE CPC CHANNEL

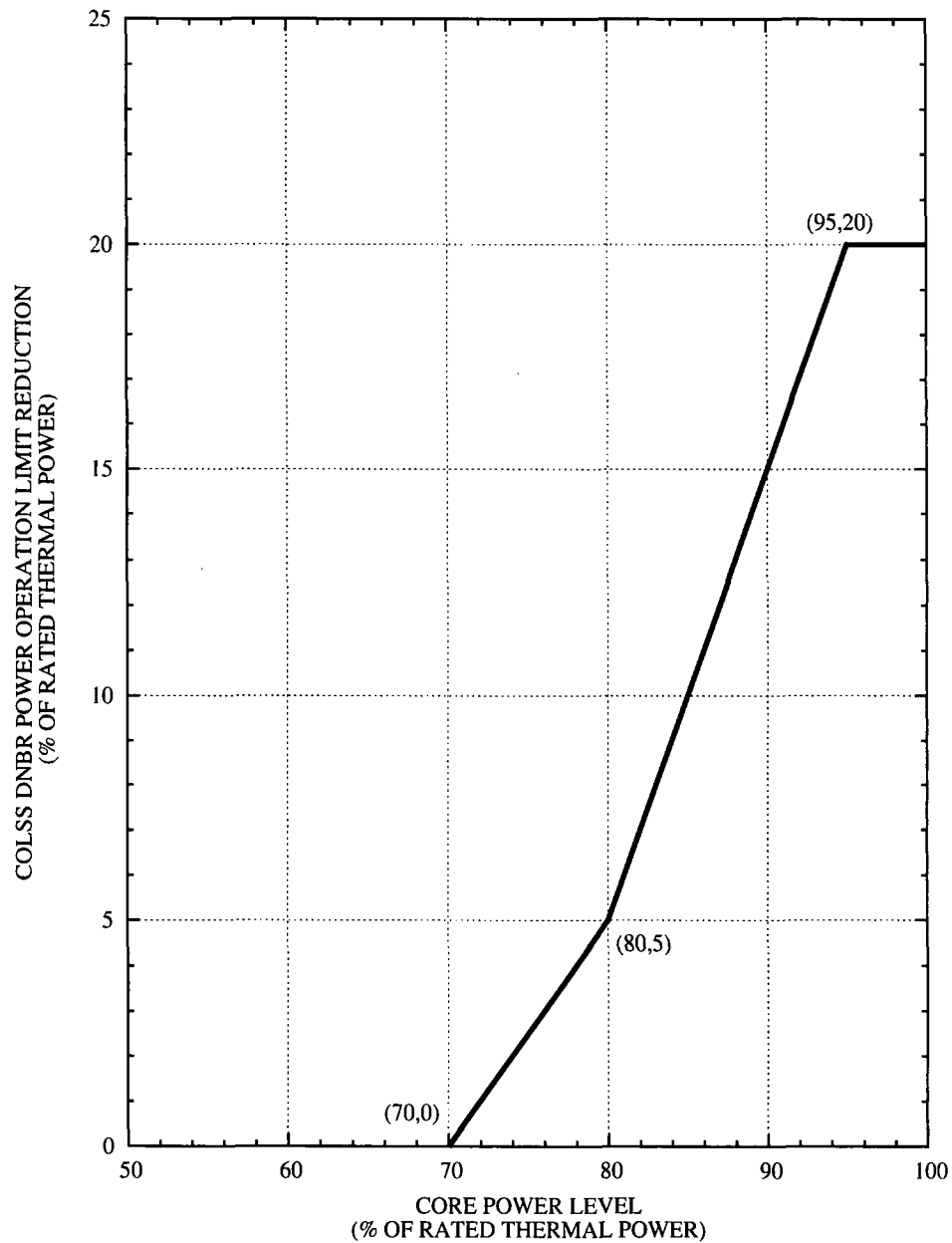


FIGURE 3.2.4-2  
DNBR MARGIN OPERATING LIMIT BASED ON  
THE CORE PROTECTION CALCULATORS  
(COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

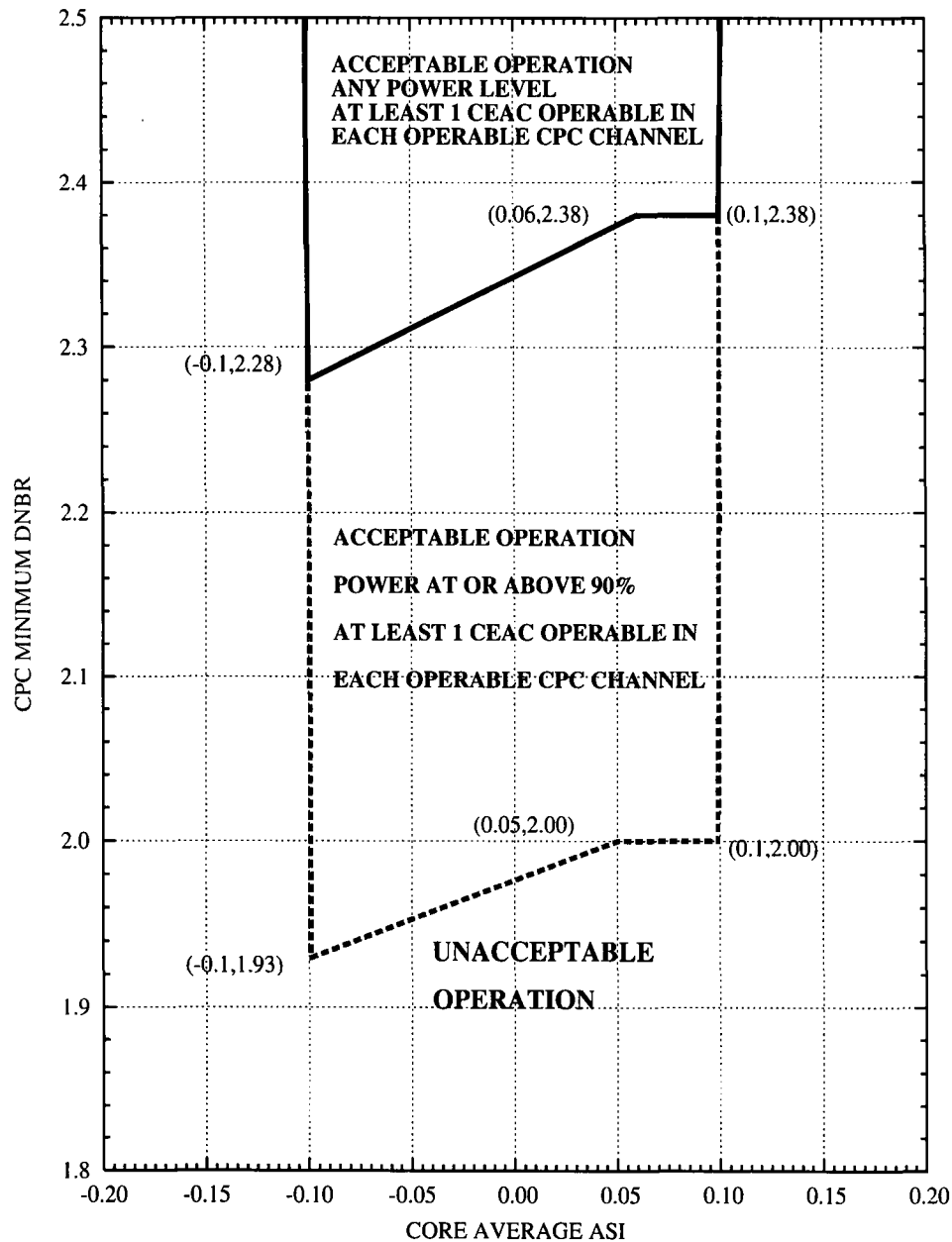


FIGURE 3.2.4-3  
DNBR MARGIN OPERATING LIMIT BASED ON  
THE CORE PROTECTION CALCULATORS  
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE  
IN ANY OPERABLE CPC CHANNEL)

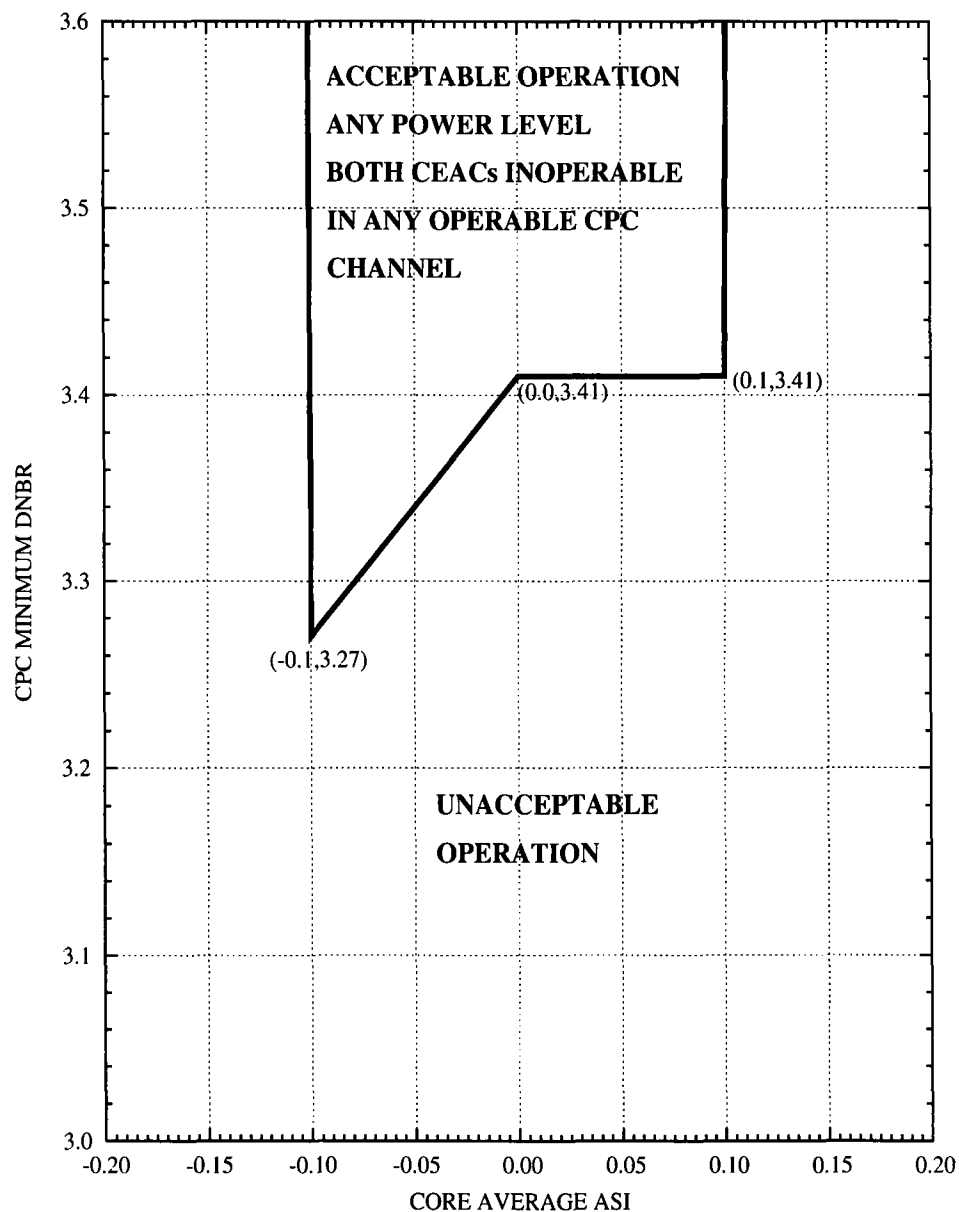




Table 3.3.12-1

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  $0.96 \geq K_{eff} > 0.95$

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