aps

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

102-07682-MSC/MDD
April 12, 2018

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

Subject: **Palo Verde Nuclear Generating Station Units 1, 2, and 3**
Docket Nos. STN 50-528, 50-529, and 50-530
Unit 1 Core Operating Limits Report (COLR), Revision 25
Unit 2 Core Operating Limits Report (COLR), Revision 21
Unit 3 Core Operating Limits Report (COLR), Revision 24

Dear Sirs:

Pursuant to Palo Verde Nuclear Generating Station (PVNGS) Technical Specifications, Section 5.6.5.d, enclosed are the Units 1, 2, and 3 Core Operating Limits Report (COLR), Revisions 25, 21, and 24, respectively, which were made effective April 6, 2018. The change implemented by these revisions includes the following:

- Revision to Analytical Methods to add the references associated with Westinghouse Next Generation Fuel (NGF).
- Administrative and editorial corrections made for clarity.

These changes affect several pages. Revision bars have been applied to the changes.

No commitments are being made to the NRC by this letter. Should you need further information regarding this submittal, please contact Matthew S. Cox, Licensing Section Leader at (623) 393-5753.

Sincerely,

Michael D. DiLorenzo
Nuclear Regulatory Affairs Department Leader

MSC/MDD/TMJ/sma

Enclosures:

Unit 1 Core Operating Limits Report, Revision 25
Unit 2 Core Operating Limits Report, Revision 21
Unit 3 Core Operating Limits Report, Revision 24

cc:

K. M. Kennedy	NRC Region IV Regional Administrator
S. P. Lingam	NRC NRR Project Manager for PVNGS
C. A. Peabody	NRC Senior Resident Inspector for PVNGS

Enclosure

PVNGS Unit 1 Core Operating Limits Report (COLR)
Revision 25

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 1

CORE OPERATING LIMITS REPORT

Revision 25

Effective April 6, 2018

Responsible Engineer Date	Wenzel, Richard R(Z99534) — Digitally signed by Wenzel, Richard R(Z99534) DN: cn=Wenzel, Richard R(Z99534) Reason: I am the author of this document Date: 2018.03.30 15:35:15 -07'00'
Independent Reviewer Date	Geiszler, Kelly J(Z07064) — Digitally signed by Geiszler, Kelly J(Z07064) DN: cn=Geiszler, Kelly J(Z07064) Reason: I have reviewed this document Date: 2018.04.03 08:13:04 -07'00'
Responsible Section Leader Date	Karlson, Charles F(V55086) — Digitally signed by Karlson, Charles F(V55086) DN: cn=Karlson, Charles F(V55086) Reason: I am approving this document Date: 2018.04.03 08:25:18 -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 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:

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
1	CE Method for Control Element Assembly Ejection Analysis (N001-1301-01204)	CENPD-0190-A	N.A.	January 1976	N.A.
2	The ROCS and DIT Computer Codes for Nuclear Design (N001-1900-01412)	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 (N001-1303-01747)	CEN-356(V)-P-A	01-P-A	May 1988	N.A.
4	System 80™ Inlet Flow Distribution (N001-1301-01228)	Enclosure 1-P to LD-82-054	N.A.	February 1993	1-P
5	Calculative Methods for the CE Large Break LOCA Evaluation Model (N001-1900-01192)	CENPD-132	N.A.	March 2001	4-P-A Rev. 1
6	Calculative Methods for the CE Small Break LOCA Evaluation Model (N001-1900-01185)	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.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
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 (N001-0201-00026)	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™ Cladding Material in CE Nuclear Power Fuel Assembly Designs (N001-1900-01329)	CENPD-404-P-A	0	November 2001	N.A.
13	Optimized ZIRLO™ (N001-0203-00611)	CENPD-404-P-A Addendum 1-A	0	July 2006	N.A.
13	Westinghouse Clad Corrosion Model for ZIRLO and Optimized ZIRLO™ (N001-0205-00006)	CENPD-404-P-A Addendum 2-A	0	October 2013	N.A.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
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.
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 Uprated 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 Uprated 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.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
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.
22	CE 16x16 Next Generation Fuel Core Reference Report (N001-0203-00614)	WCAP-16500-P-A	0	August 2007	N.A.
22	Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (N001-0205-00063)	WCAP-16500-P-A	1	December 2010	1
22	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)	WCAP-16500-P-A	1	June 2016	2-P-A
23	VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis (N001-0205-00002)	WCAP-14565-P-A	0	October 1999	N.A.
23	Addendum 1 to WCAP-14565-P-A Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code (N001-0205-00003)	WCAP-14565-P-A, Addendum 1-A	0	August 2004	N.A.
23	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)	WCAP-14565-P-A, Addendum 2-P-A	0	April 2008	N.A.
24	ABB Critical Heat Flux Correlations for PWR Fuel (N001-0205-00042)	CENPD-387-P-A	0	May 2000	N.A.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
25	Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes (N001-0203-00615)	WCAP-16523-P-A	0	August 2007	N.A
26	Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs (N001-0205-00226)	WCAP-16072-P-A	0	August 2004	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[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.

3.9.1 - 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

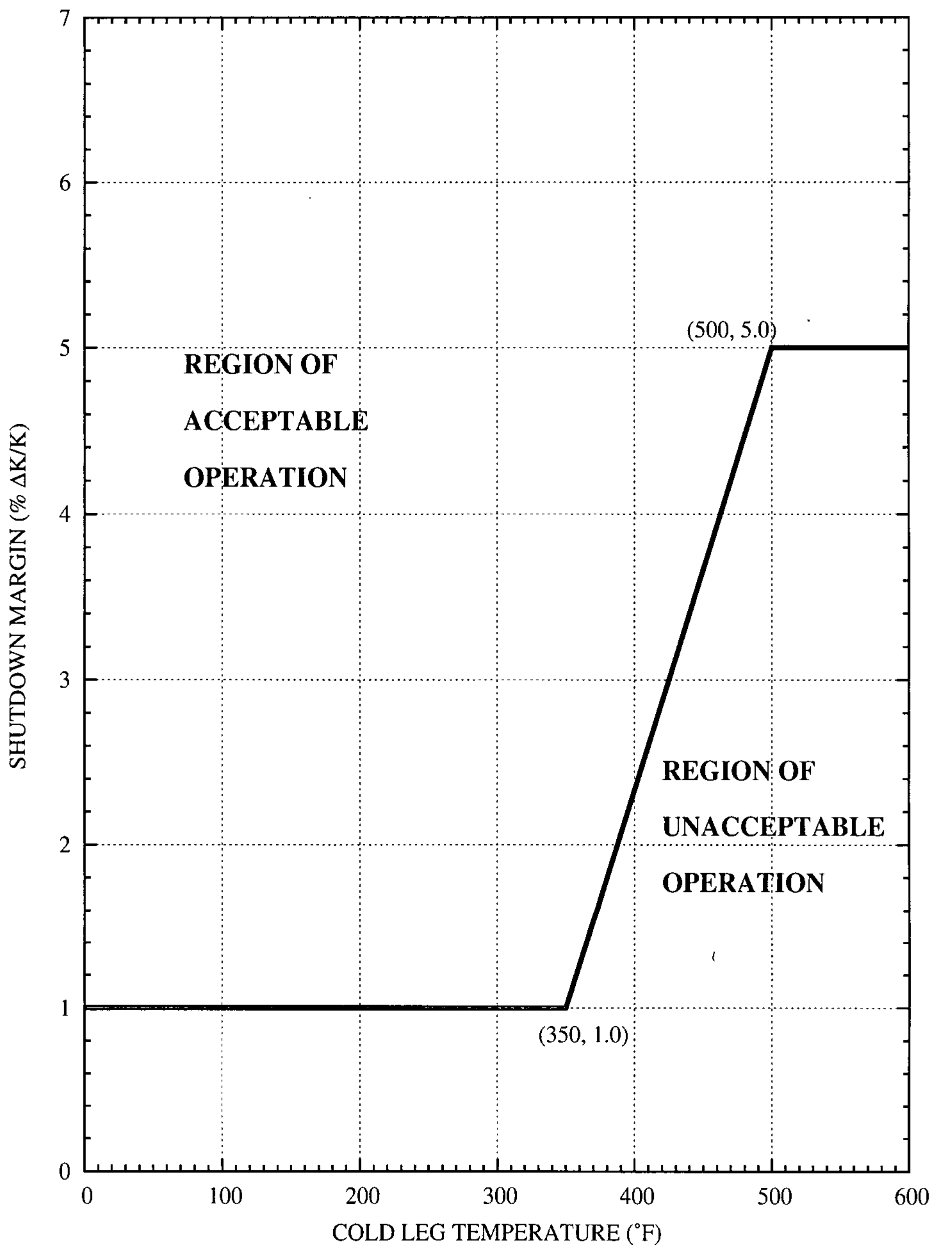


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

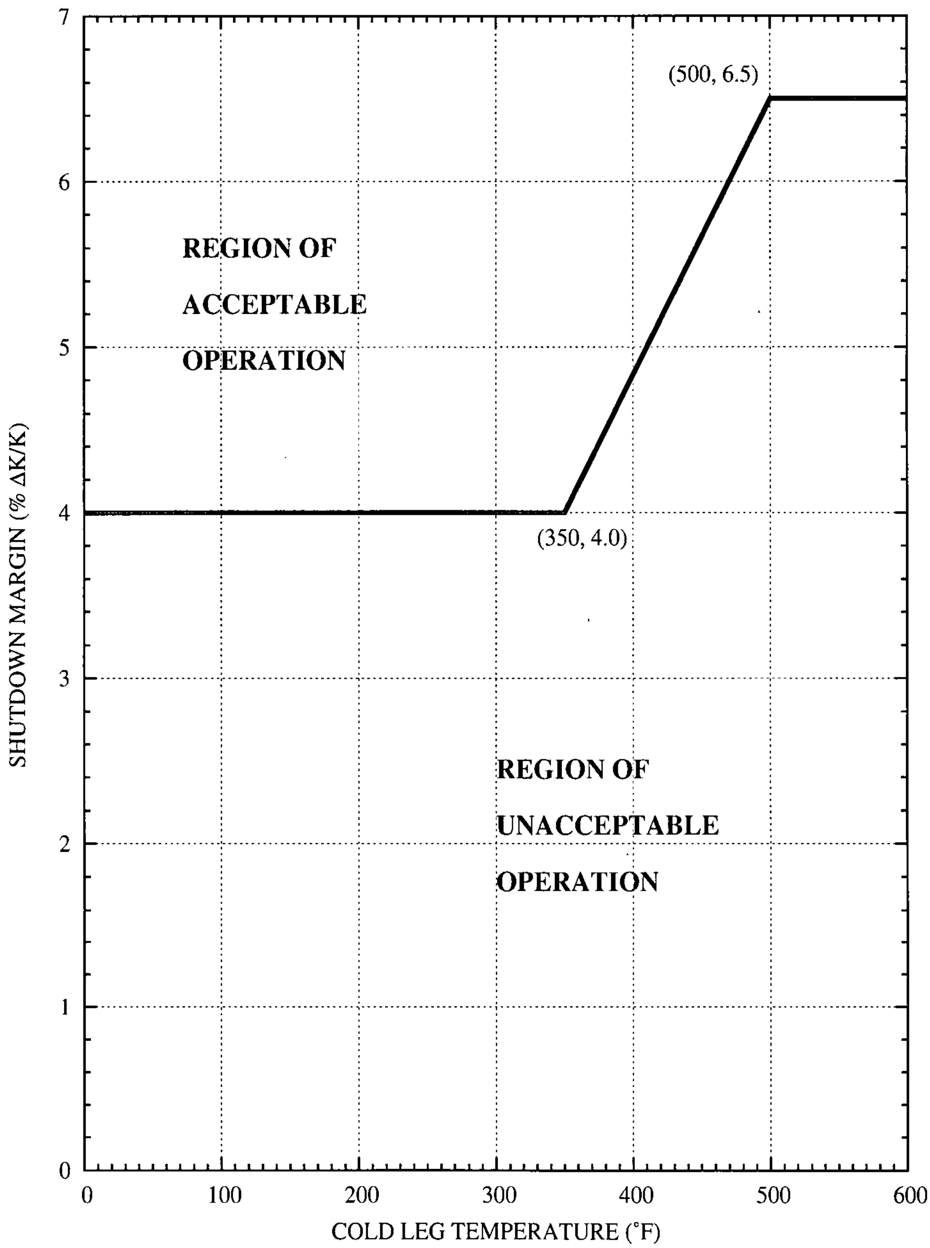


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

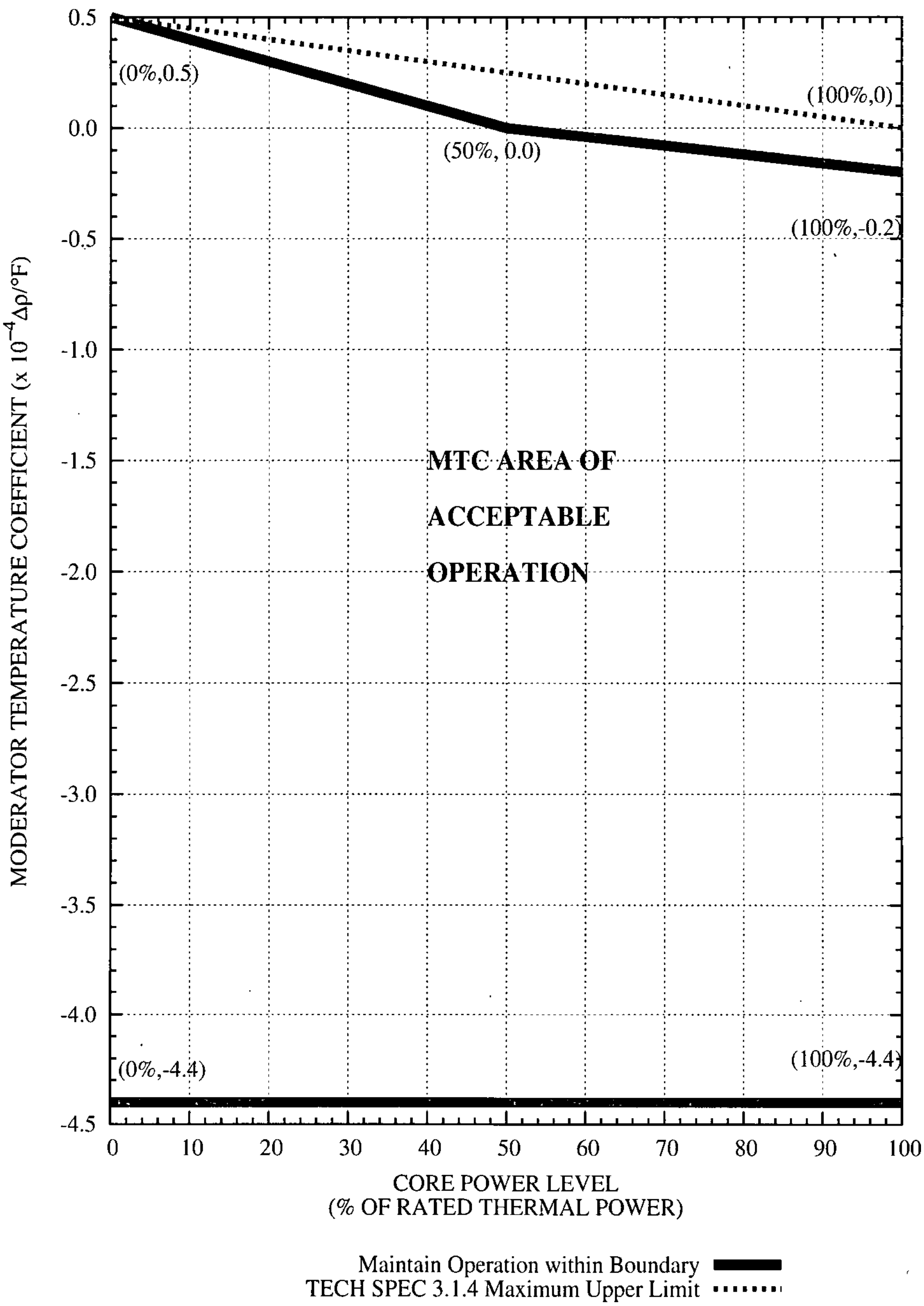
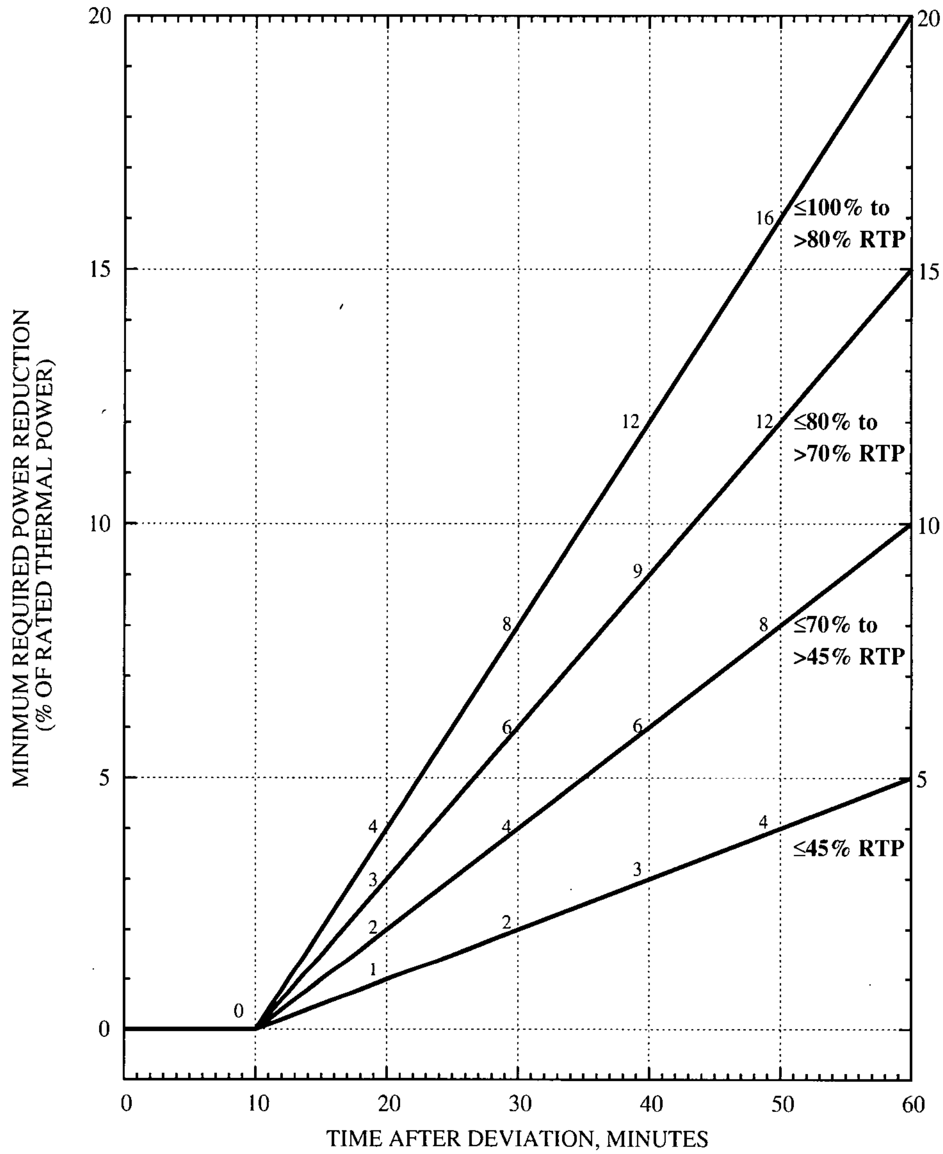


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

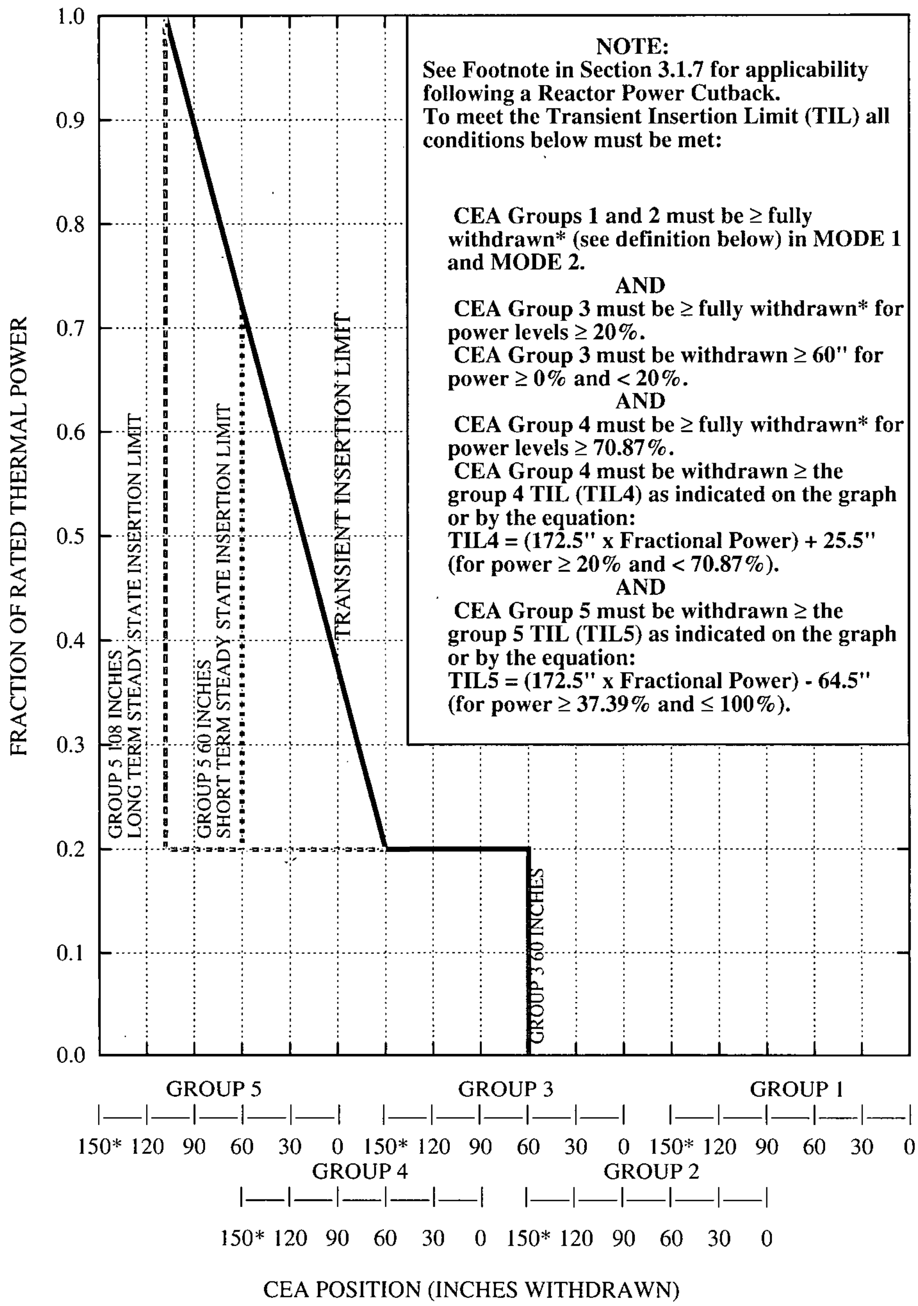


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

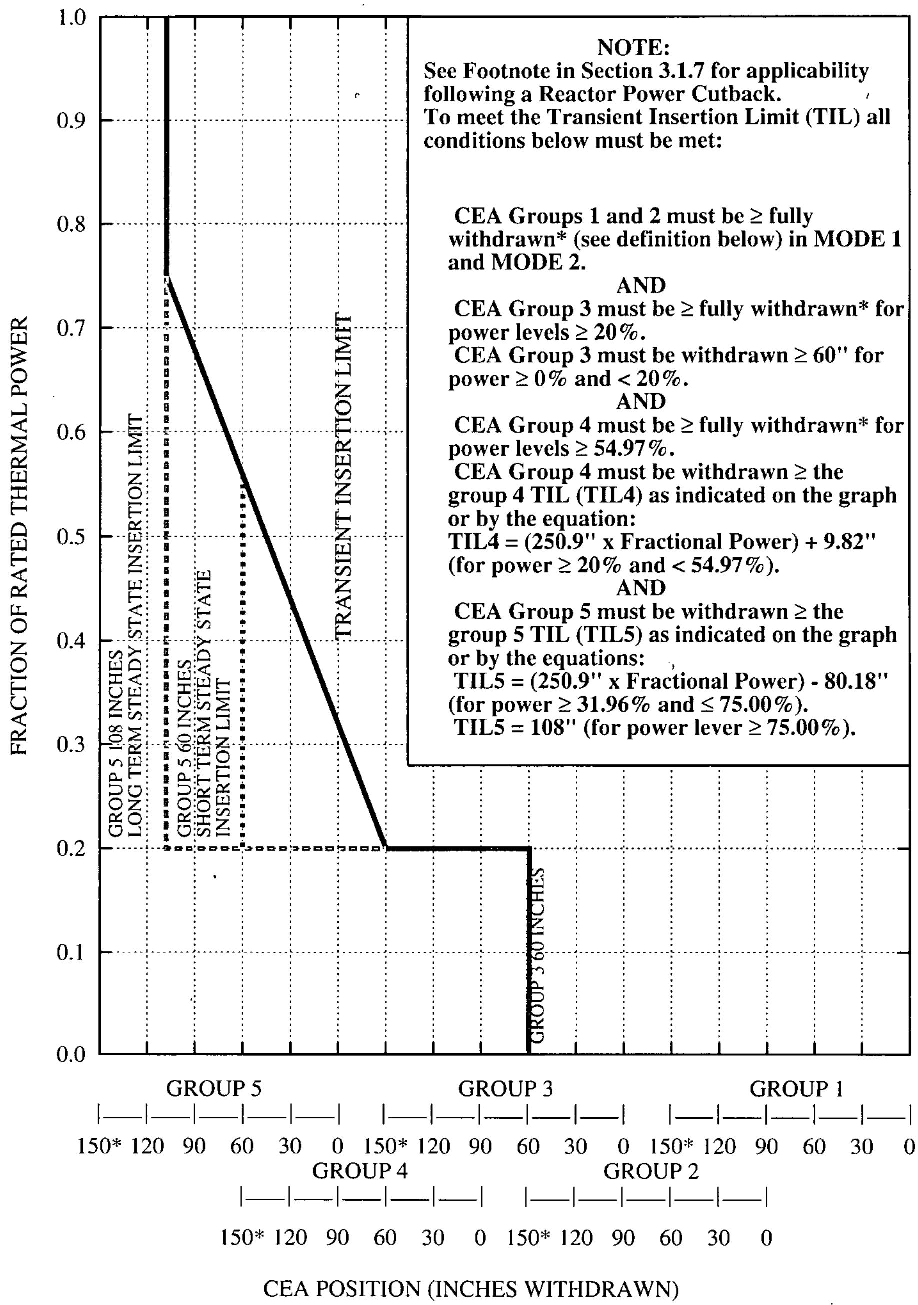
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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



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

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



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

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

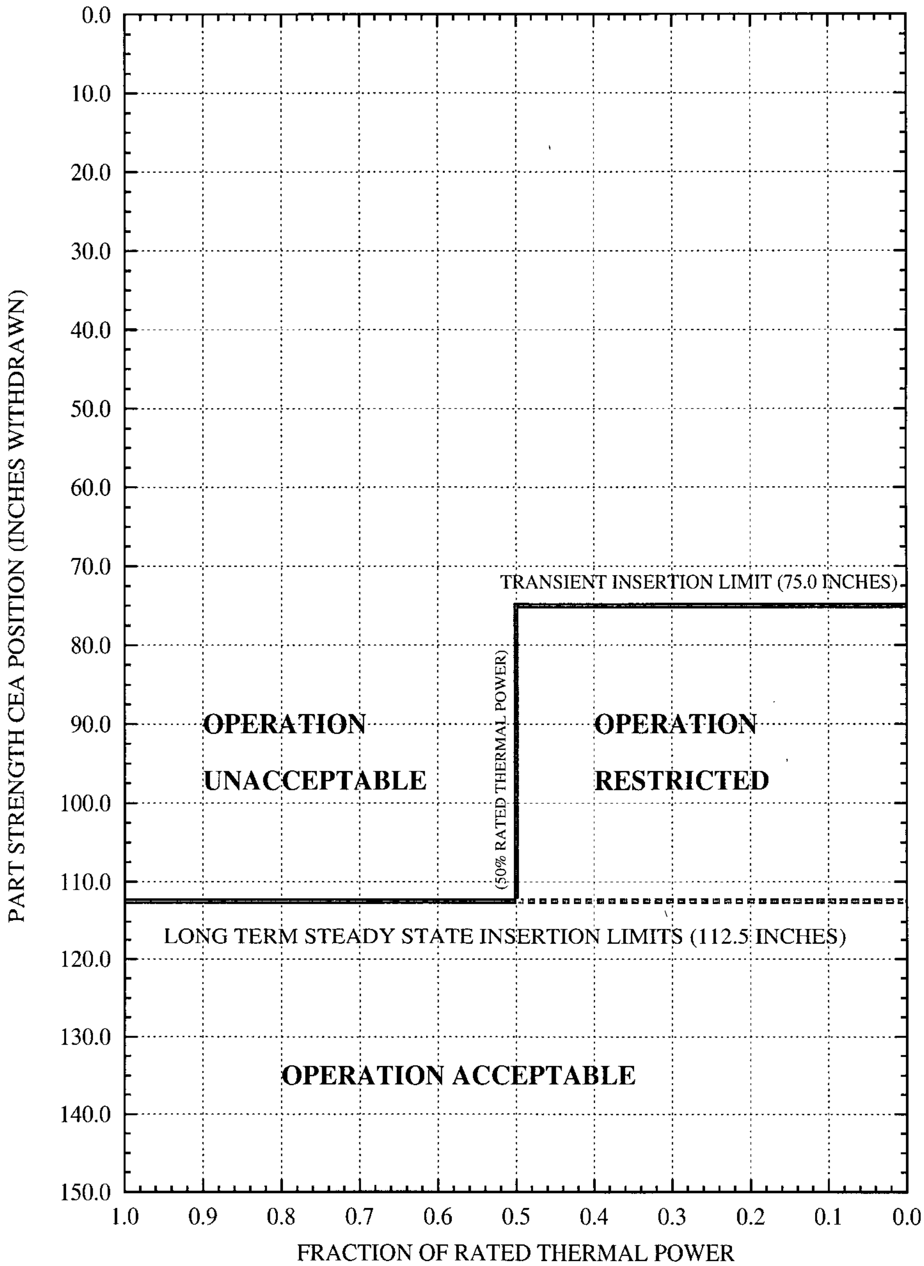


FIGURE 3.2.3-1
AZIMUTHAL POWER TILT VERSUS THERMAL POWER
(COLSS IN SERVICE)

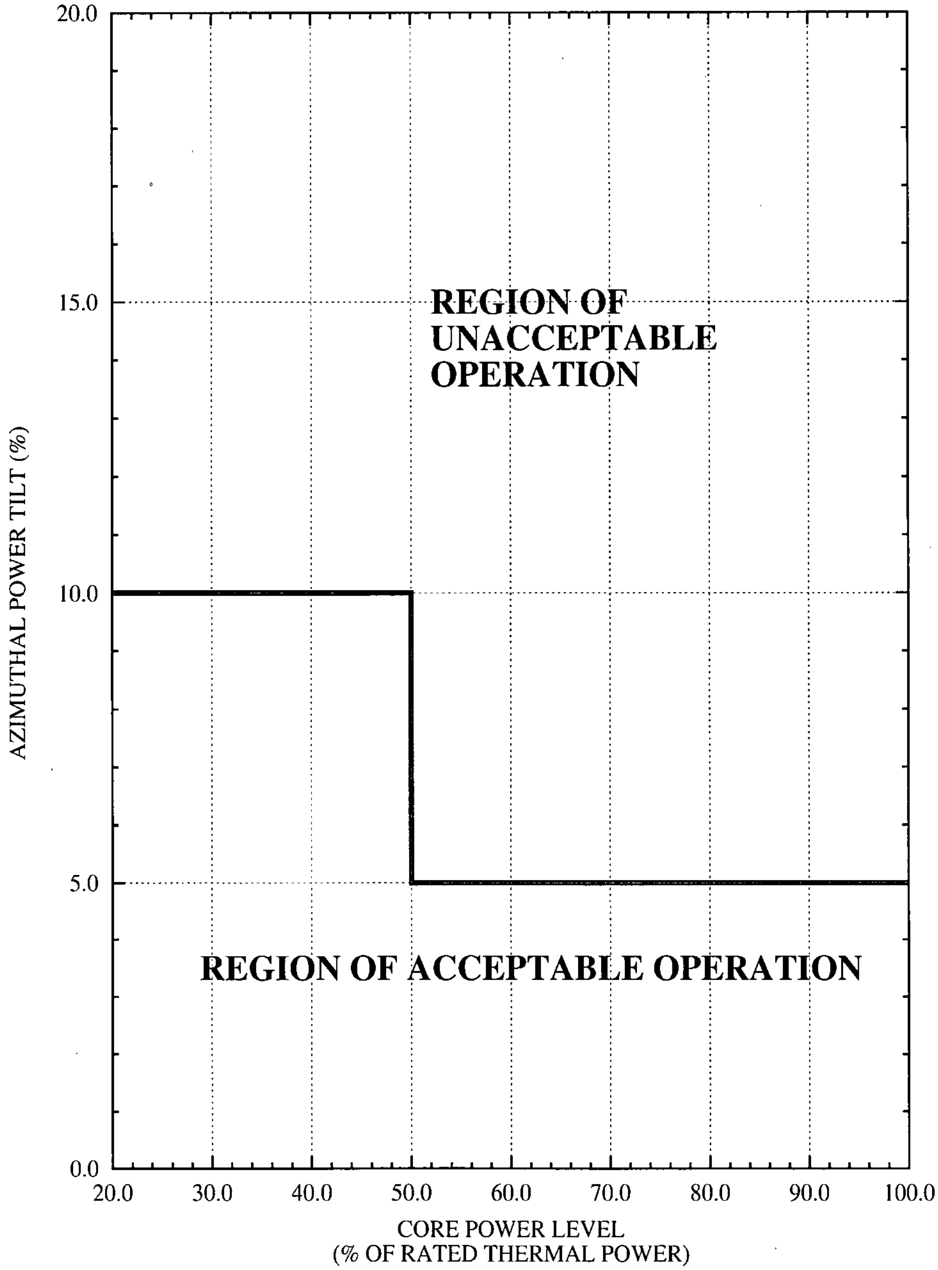


FIGURE 3.2.4-1
COLSS DNBR OPERATING LIMIT
ALLOWANCE FOR BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL

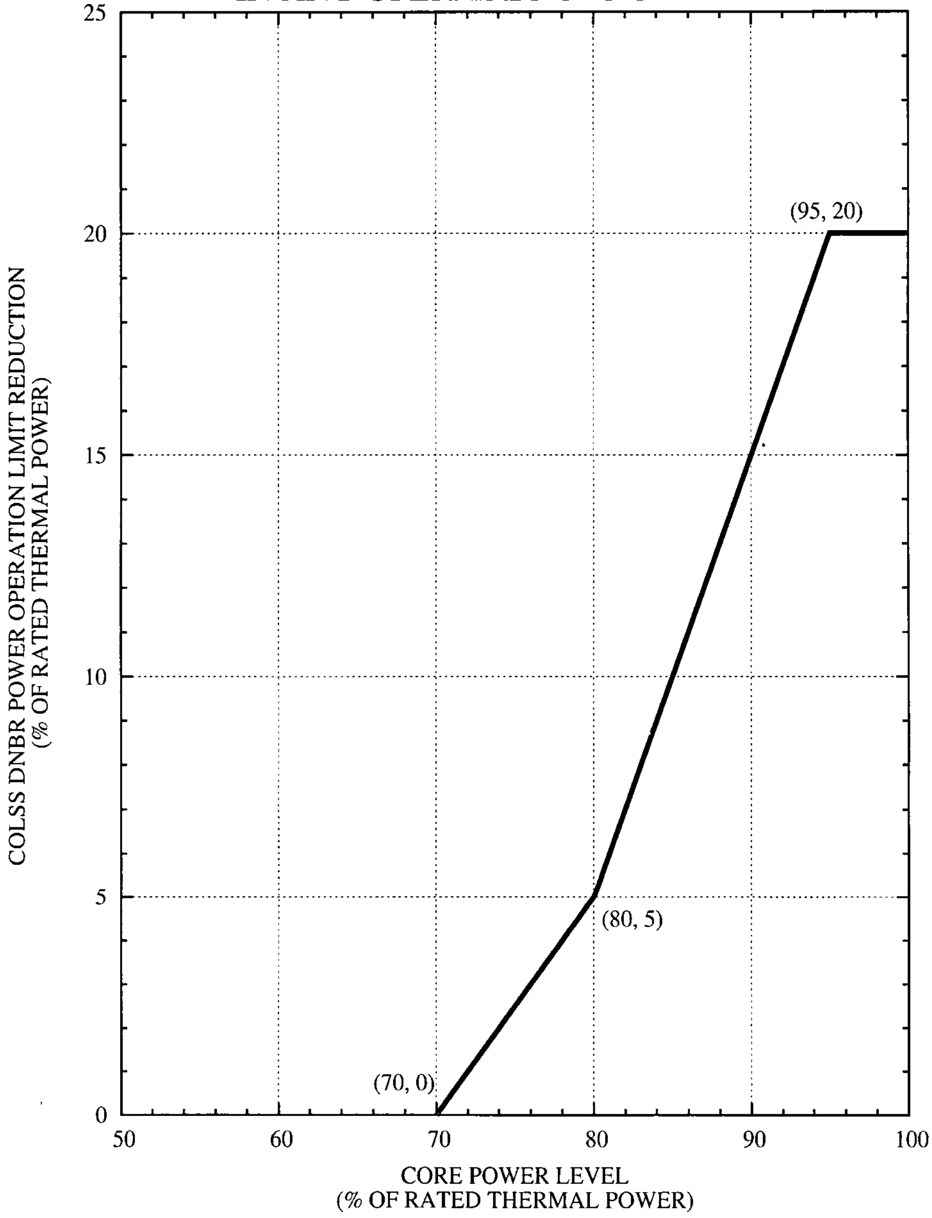


FIGURE 3.2.4-2
DNBR MARGIN OPERATING LIMIT BASED ON THE CORE PROTECTION CALCULATORS (COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

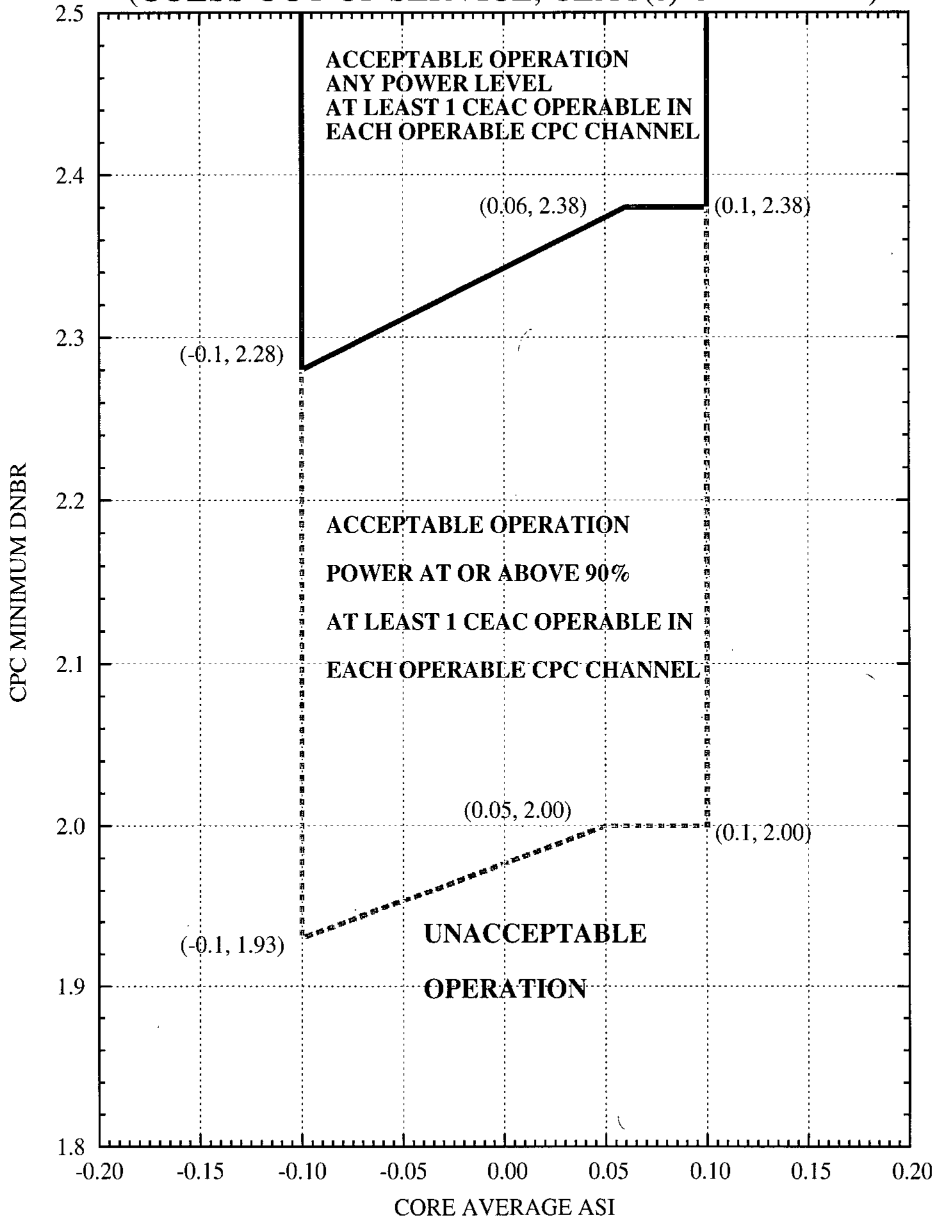


FIGURE 3.2.4-3
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL)

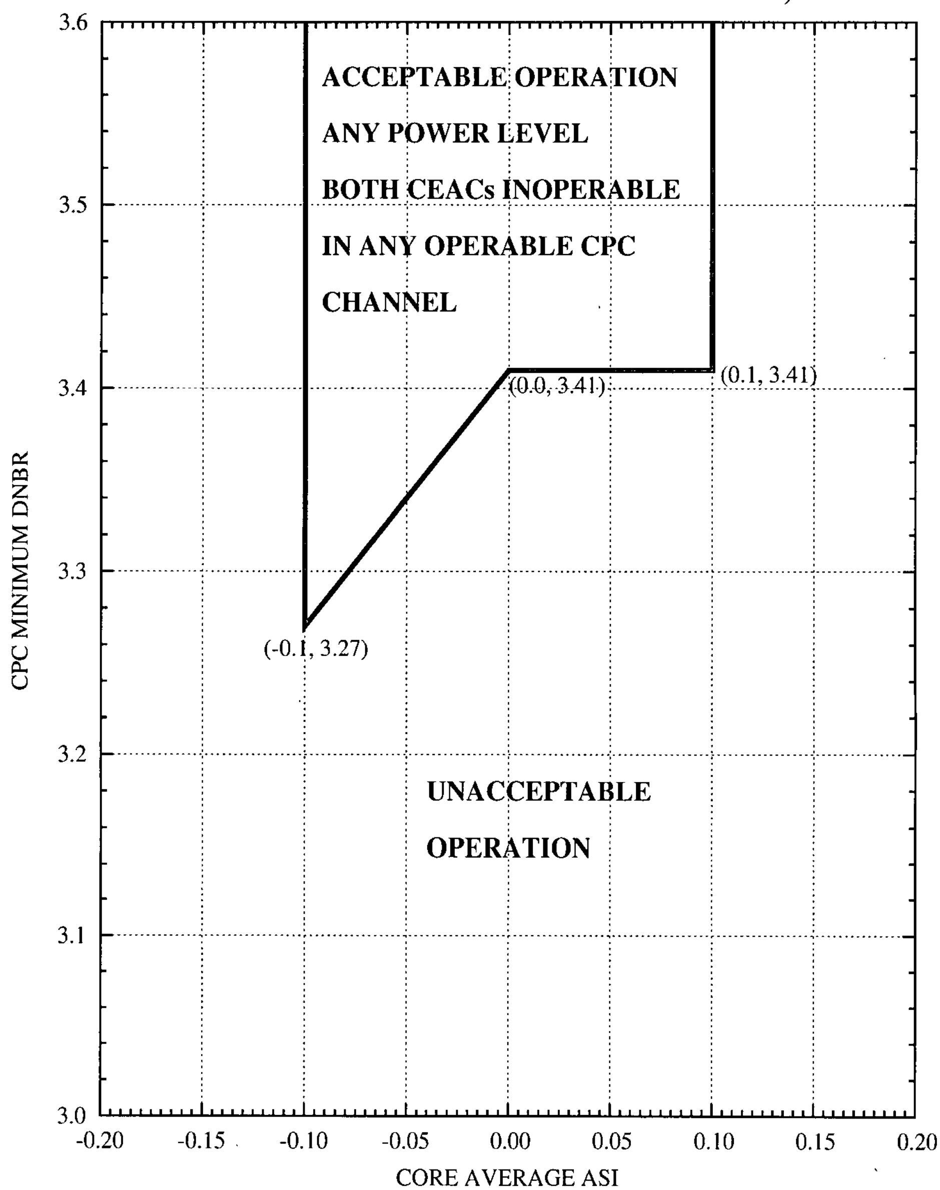


Table 3.3.12-1

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

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

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

Table 3.3.12-2

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

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

Enclosure

PVNGS Unit 2 Core Operating Limits Report (COLR)
Revision 21

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 2

CORE OPERATING LIMITS REPORT

Revision 21

Effective April 6, 2018

Responsible Engineer Date	Wenzel, Richard R(Z99534) Digitally signed by Wenzel, Richard R(Z99534) DN: cn=Wenzel, Richard R(Z99534) Reason: I am the author of this document Date: 2018.03.30 15:37:36 -07'00'
Independent Reviewer Date	Geiszler, Kelly J(Z07064) Digitally signed by Geiszler, Kelly J(Z07064) DN: cn=Geiszler, Kelly J(Z07064) Reason: I have reviewed this document Date: 2018.04.03 08:14:38 -07'00'
Responsible Section Leader Date	Karlson, Charles F(V55086) Digitally signed by Karlson, Charles F(V55086) DN: cn=Karlson, Charles F(V55086) Reason: I am approving this document Date: 2018.04.03 08:27:02 -07'00'

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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:

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
1	CE Method for Control Element Assembly Ejection Analysis (N001-1301-01204)	CENPD-0190-A	N.A.	January 1976	N.A.
2	The ROCS and DIT Computer Codes for Nuclear Design (N001-1900-01412)	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 (N001-1303-01747)	CEN-356(V)-P-A	01-P-A	May 1988	N.A.
4	System 80^{TM} Inlet Flow Distribution (N001-1301-01228)	Enclosure 1-P to LD-82-054	N.A.	February 1993	1-P
5	Calculative Methods for the CE Large Break LOCA Evaluation Model (N001-1900-01192)	CENPD-132	N.A.	March 2001	4-P-A Rev. 1
6	Calculative Methods for the CE Small Break LOCA Evaluation Model (N001-1900-01185)	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.

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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 (N001-0201-00026)	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™ Cladding Material in CE Nuclear Power Fuel Assembly Designs (N001-1900-01329)	CENPD-404-P-A	0	November 2001	N.A.
13	Optimized ZIRLO™ (N001-0203-00611)	CENPD-404-P-A Addendum 1-A	0	July 2006	N.A.
13	Westinghouse Clad Corrosion Model for ZIRLO and Optimized ZIRLO™ (N001-0205-00006)	CENPD-404-P-A Addendum 2-A	0	October 2013	N.A.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
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.
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 Uprated 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 Uprated 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.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
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.
22	CE 16x16 Next Generation Fuel Core Reference Report (N001-0203-00614)	WCAP-16500-P-A	0	August 2007	N.A.
22	Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (N001-0205-00063)	WCAP-16500-P-A	1	December 2010	1
22	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)	WCAP-16500-P-A	1	June 2016	2-P-A
23	VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis (N001-0205-00002)	WCAP-14565-P-A	0	October 1999	N.A.
23	Addendum 1 to WCAP-14565-P-A Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code (N001-0205-00003)	WCAP-14565-P-A, Addendum 1-A	0	August 2004	N.A.
23	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)	WCAP-14565-P-A, Addendum 2-P-A	0	April 2008	N.A.
24	ABB Critical Heat Flux Correlations for PWR Fuel (N001-0205-00042)	CENPD-387-P-A	0	May 2000	N.A.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
25	Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes (N001-0203-00615)	WCAP-16523-P-A	0	August 2007	N.A
26	Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs (N001-0205-00226)	WCAP-16072-P-A	0	August 2004	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[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.

3.9.1 - 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

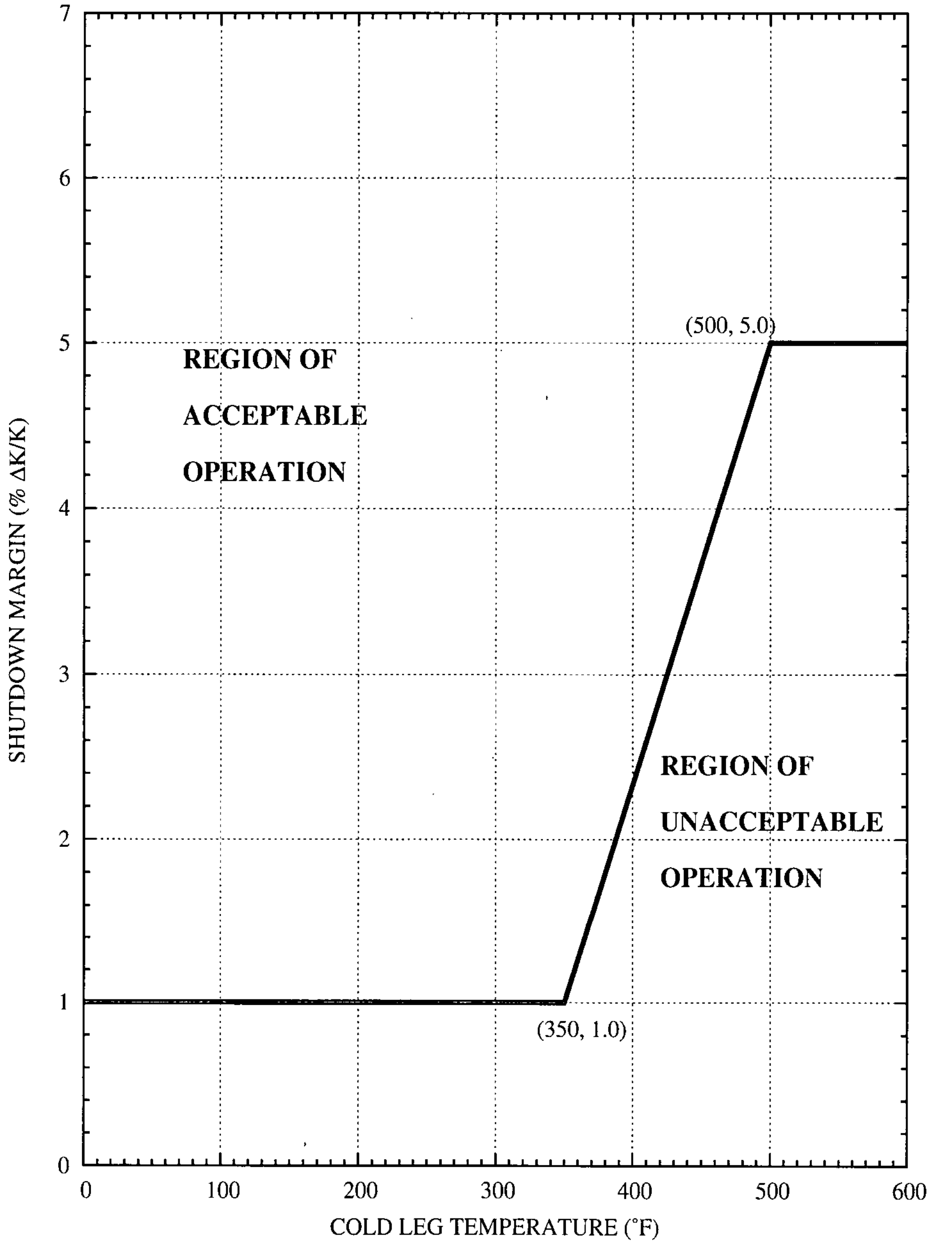


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

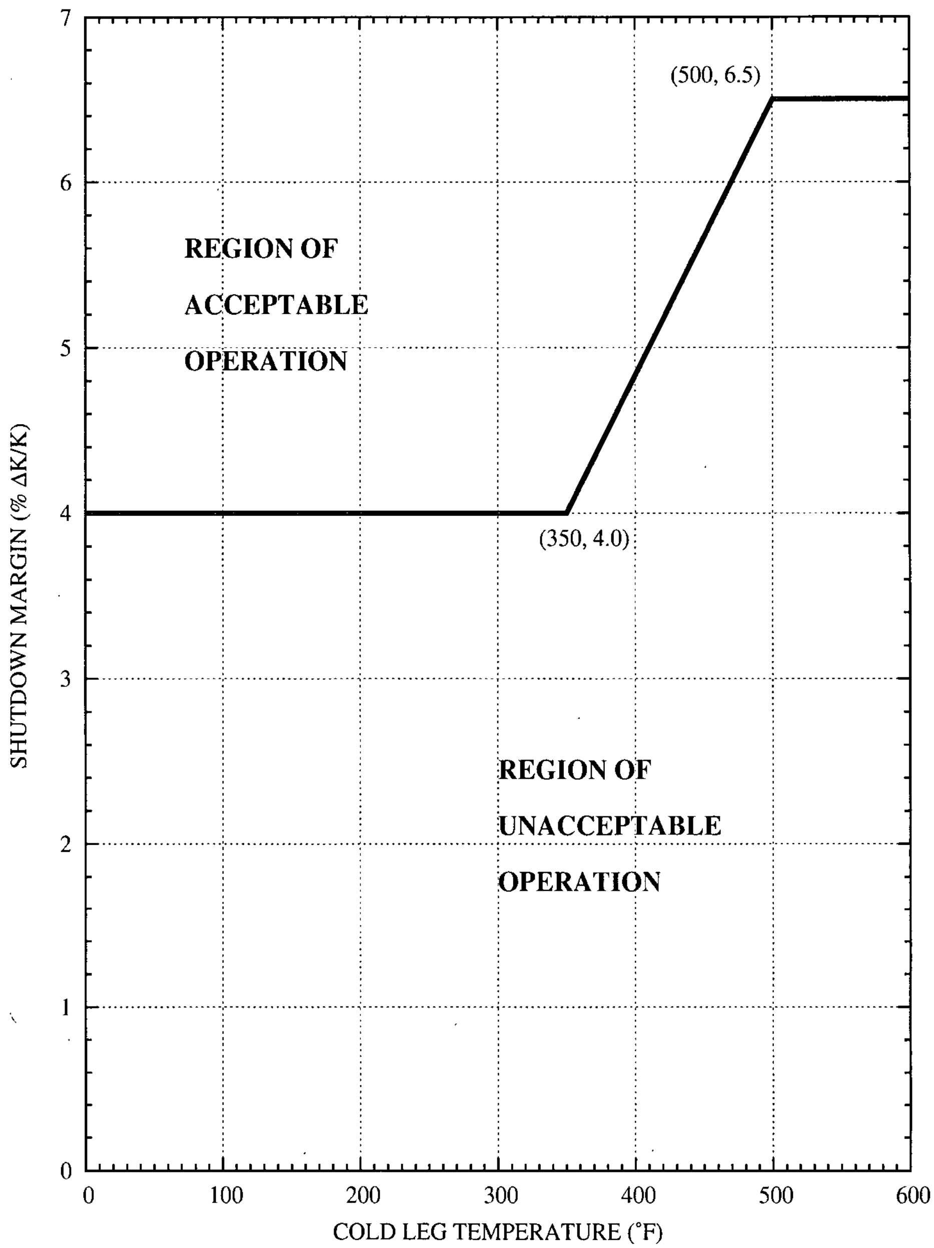


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

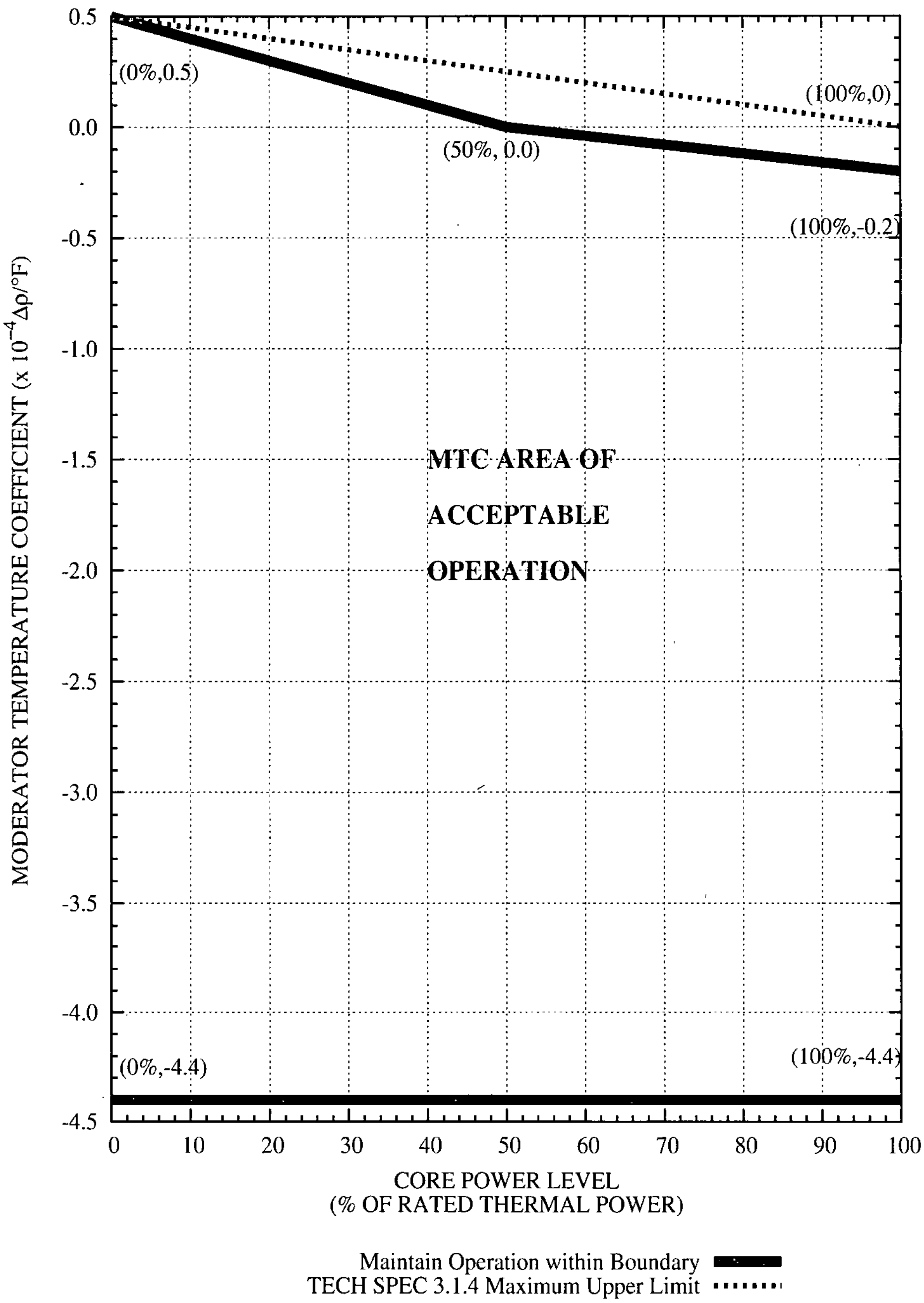
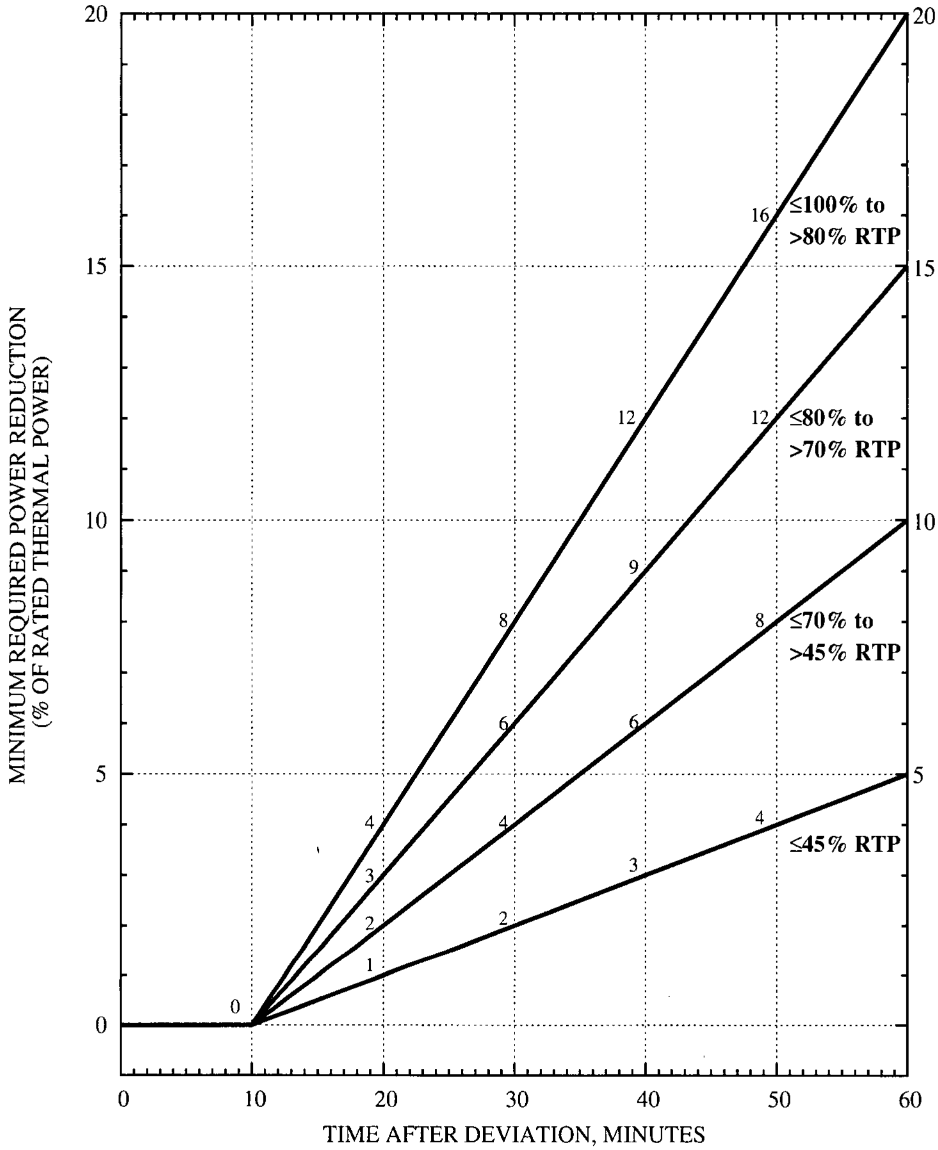


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

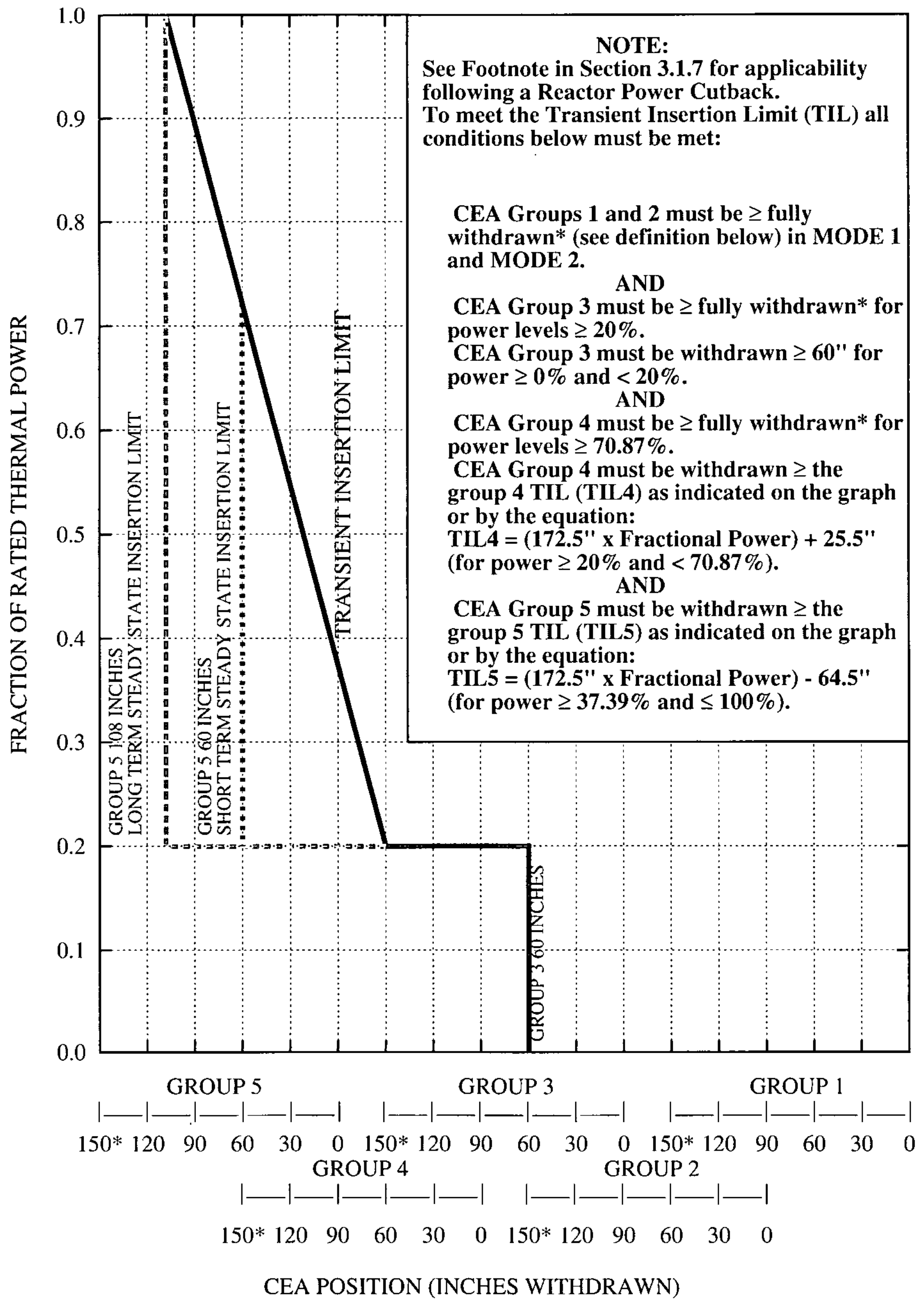


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

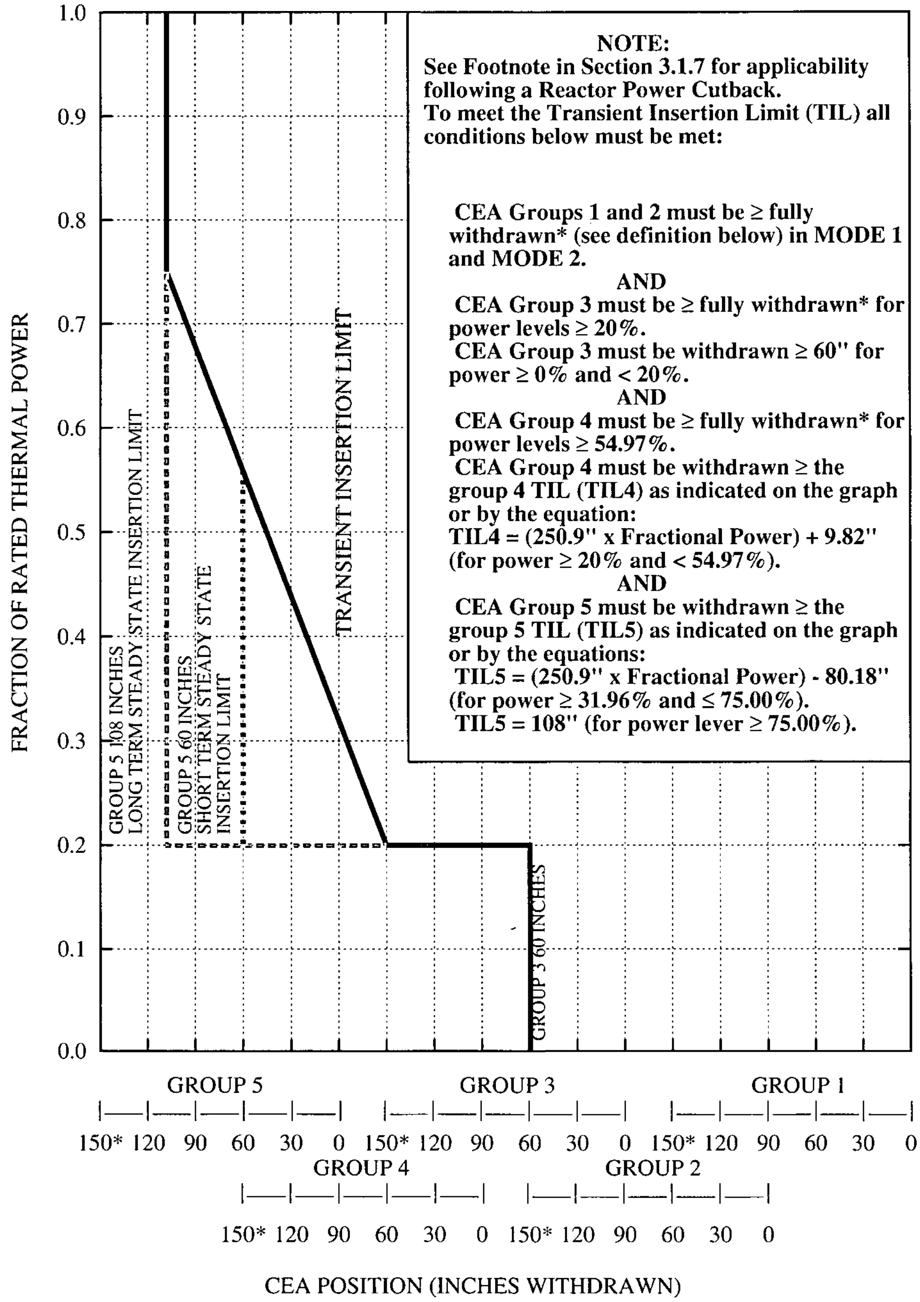
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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



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

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



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

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

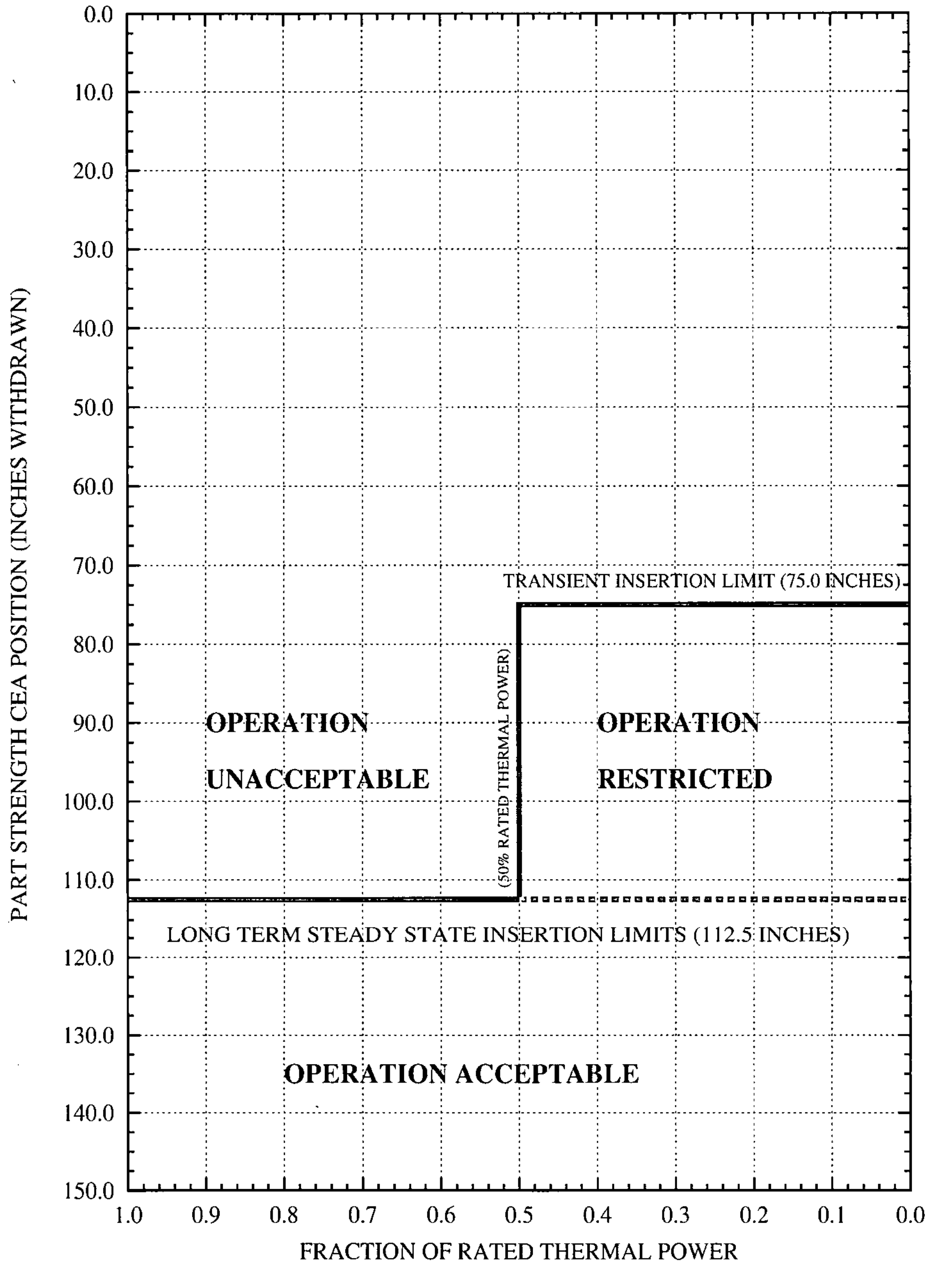


FIGURE 3.2.3-1
AZIMUTHAL POWER TILT VERSUS THERMAL POWER
(COLSS IN SERVICE)

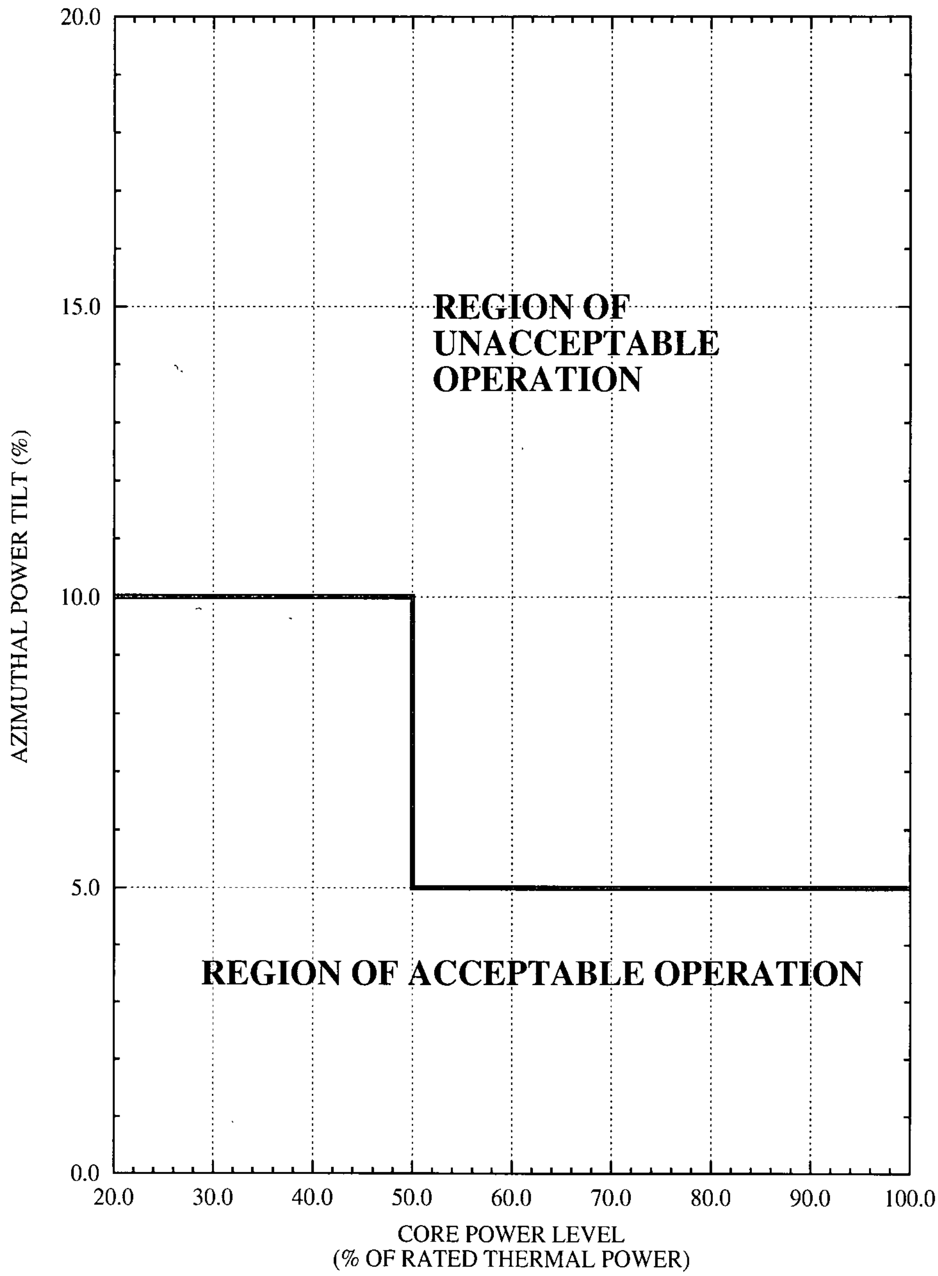


FIGURE 3.2.4-1
COLSS DNBR OPERATING LIMIT
ALLOWANCE FOR BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL

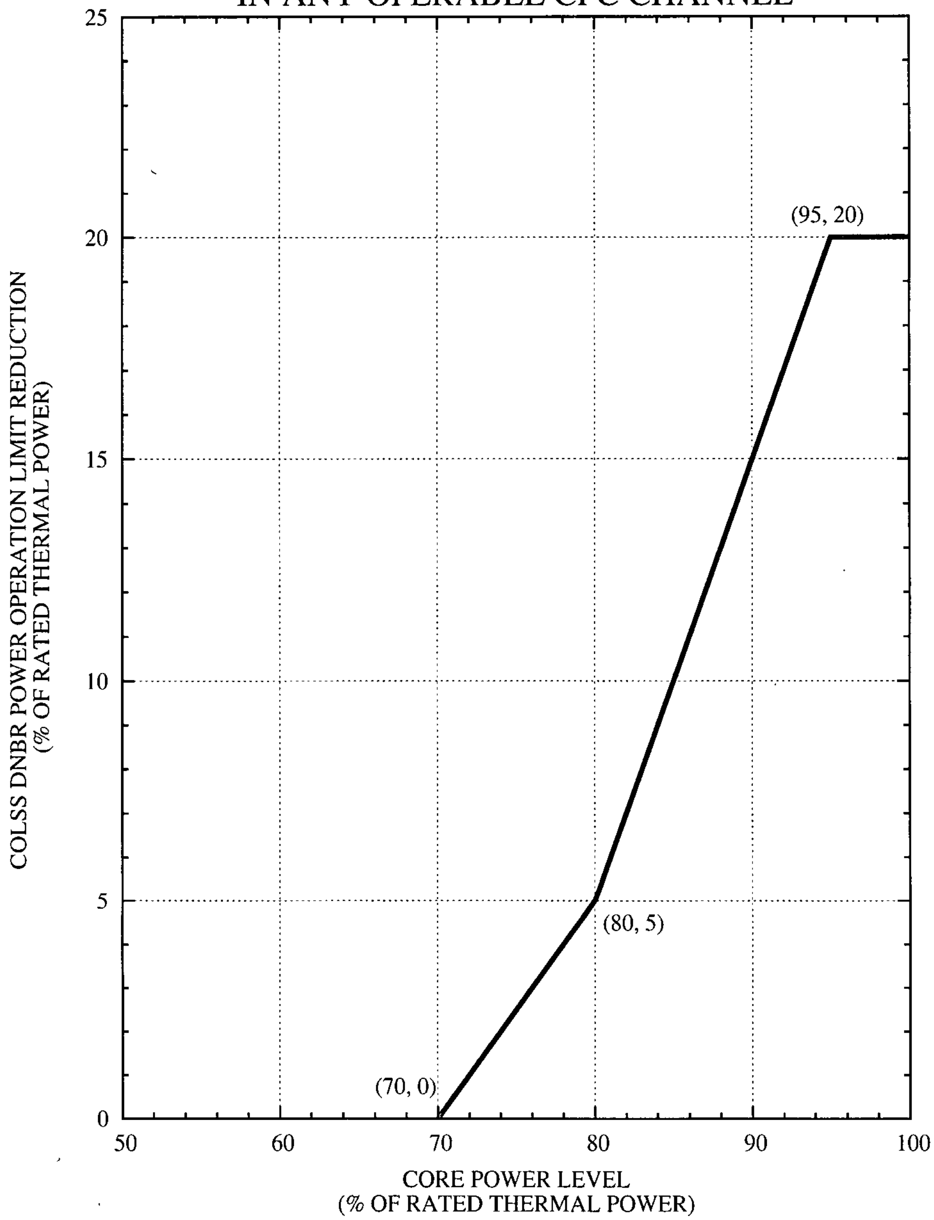


FIGURE 3.2.4-2
DNBR MARGIN OPERATING LIMIT BASED ON THE CORE PROTECTION CALCULATORS (COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

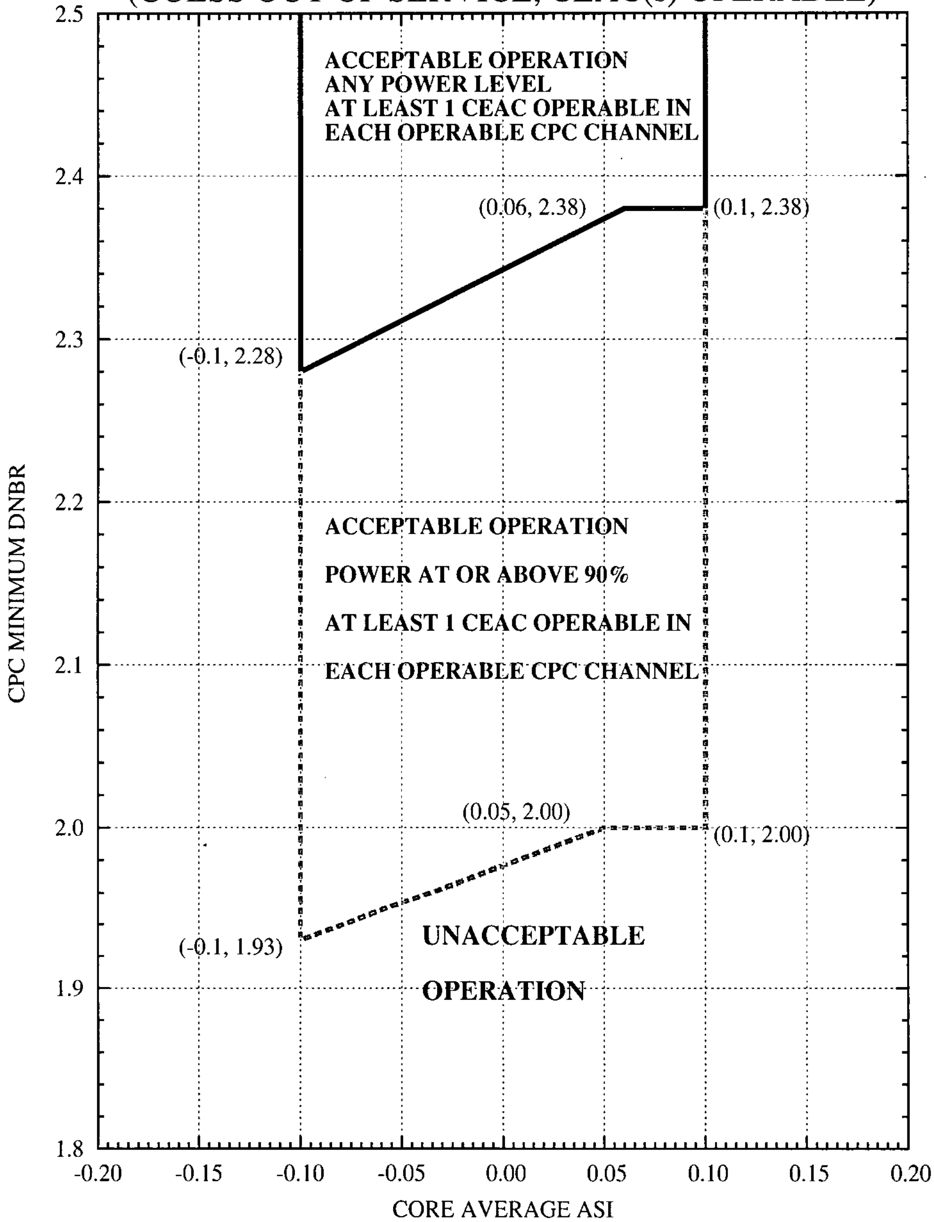


FIGURE 3.2.4-3
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL)

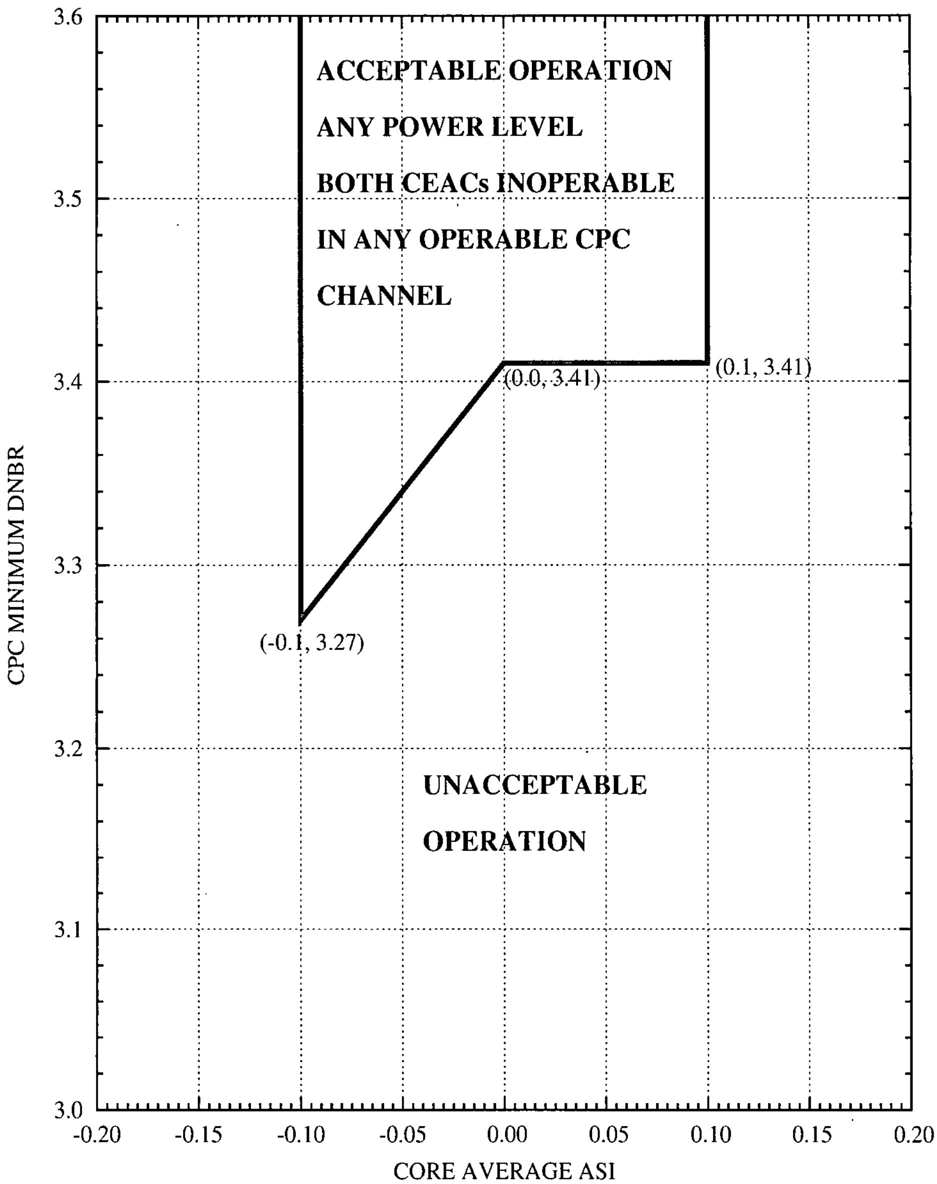


Table 3.3.12-1

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

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

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

Table 3.3.12-2

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

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

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

Enclosure

PVNGS Unit 3 Core Operating Limits Report (COLR)
Revision 24

PALO VERDE NUCLEAR GENERATING STATION (PVNGS)

UNIT 3

CORE OPERATING LIMITS REPORT

Revision 24

Effective April 6, 2018

Responsible Engineer Date	Wenzel, Richard R(Z99534) Digitally signed by Wenzel, Richard R(Z99534) DN: cn=Wenzel, Richard R(Z99534) Reason: I am the author of this document Date: 2018.03.30 15:38:32 -07'00'
Independent Reviewer Date	Geiszler, Kelly J(Z07064) Digitally signed by Geiszler, Kelly J(Z07064) DN: cn=Geiszler, Kelly J(Z07064) Reason: I have reviewed this document Date: 2018.04.03 08:16:51 -07'00'
Responsible Section Leader Date	Karlson, Charles F(V55086) Digitally signed by Karlson, Charles F(V55086) DN: cn=Karlson, Charles F(V55086) Reason: I am approving this document Date: 2018.04.03 08:27:28 -07'00'

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List of Tables

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 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)
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3.9.1	Boron Concentration

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4	System 80^{TM} Inlet Flow Distribution (N001-1301-01228)	Enclosure 1-P to LD-82-054	N.A.	February 1993	1-P
5	Calculative Methods for the CE Large Break LOCA Evaluation Model (N001-1900-01192)	CENPD-132	N.A.	March 2001	4-P-A Rev. 1
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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™ Cladding Material in CE Nuclear Power Fuel Assembly Designs (N001-1900-01329)	CENPD-404-P-A	0	November 2001	N.A.
13	Optimized ZIRLO™ (N001-0203-00611)	CENPD-404-P-A Addendum 1-A	0	July 2006	N.A.
13	Westinghouse Clad Corrosion Model for ZIRLO and Optimized ZIRLO™ (N001-0205-00006)	CENPD-404-P-A Addendum 2-A	0	October 2013	N.A.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
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.
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 Uprated 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 Uprated 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.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
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.
22	CE 16x16 Next Generation Fuel Core Reference Report (N001-0203-00614)	WCAP-16500-P-A	0	August 2007	N.A.
22	Application of CE Setpoint Methodology for CE 16x16 Next Generation Fuel (NGF) (N001-0205-00063)	WCAP-16500-P-A	1	December 2010	1
22	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)	WCAP-16500-P-A	1	June 2016	2-P-A
23	VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis (N001-0205-00002)	WCAP-14565-P-A	0	October 1999	N.A.
23	Addendum 1 to WCAP-14565-P-A Qualification of ABB Critical Heat Flux Correlations with VIPRE-01 Code (N001-0205-00003)	WCAP-14565-P-A, Addendum 1-A	0	August 2004	N.A.
23	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)	WCAP-14565-P-A, Addendum 2-P-A	0	April 2008	N.A.
24	ABB Critical Heat Flux Correlations for PWR Fuel (N001-0205-00042)	CENPD-387-P-A	0	May 2000	N.A.

T.S Ref#[a]	Title	Report No.	Rev	Date	Suppl
25	Westinghouse Correlations WSSV and WSSV-T for Predicting Critical Heat Flux in Rod Bundles with Side-Supported Mixing Vanes (N001-0203-00615)	WCAP-16523-P-A	0	August 2007	N.A
26	Implementation of Zirconium Diboride Burnable Absorber Coatings in CE Nuclear Power Fuel Assembly Designs (N001-0205-00226)	WCAP-16072-P-A	0	August 2004	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[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.

3.9.1 - 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

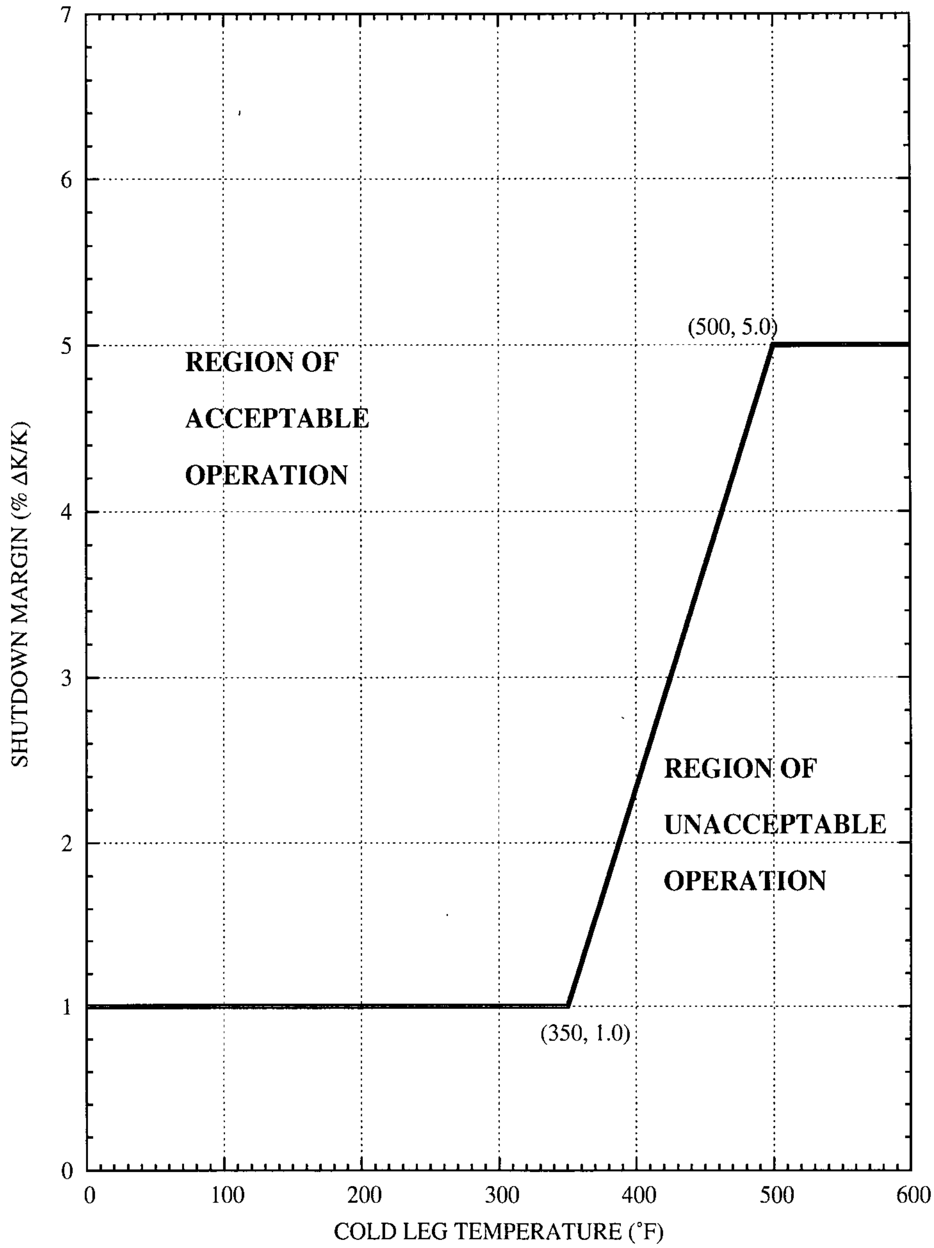


FIGURE 3.1.2-1
SHUTDOWN MARGIN VERSUS COLD LEG TEMPERATURE
REACTOR TRIP BREAKERS CLOSED

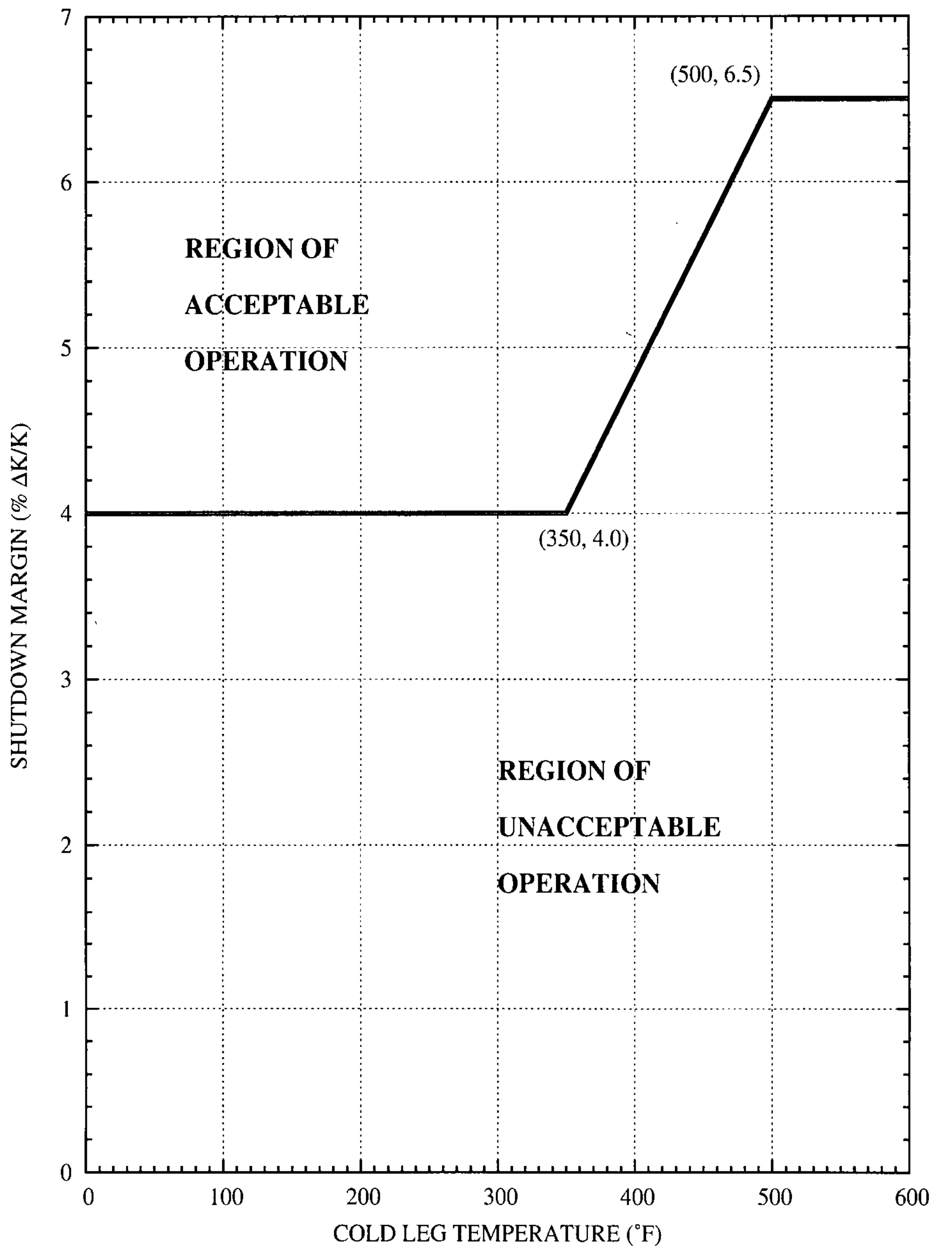


FIGURE 3.1.4-1
MTC ACCEPTABLE OPERATION, MODES 1 AND 2

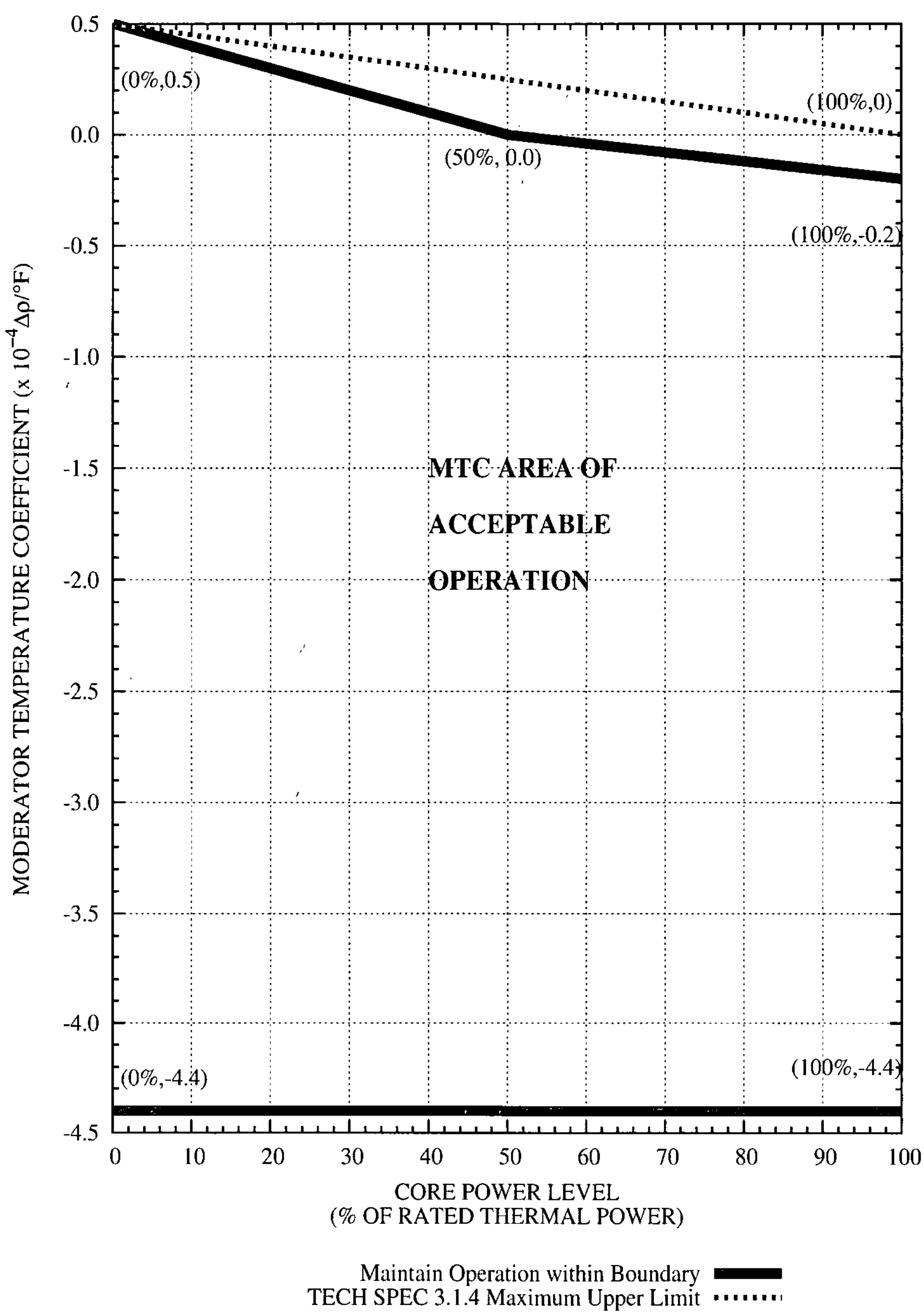
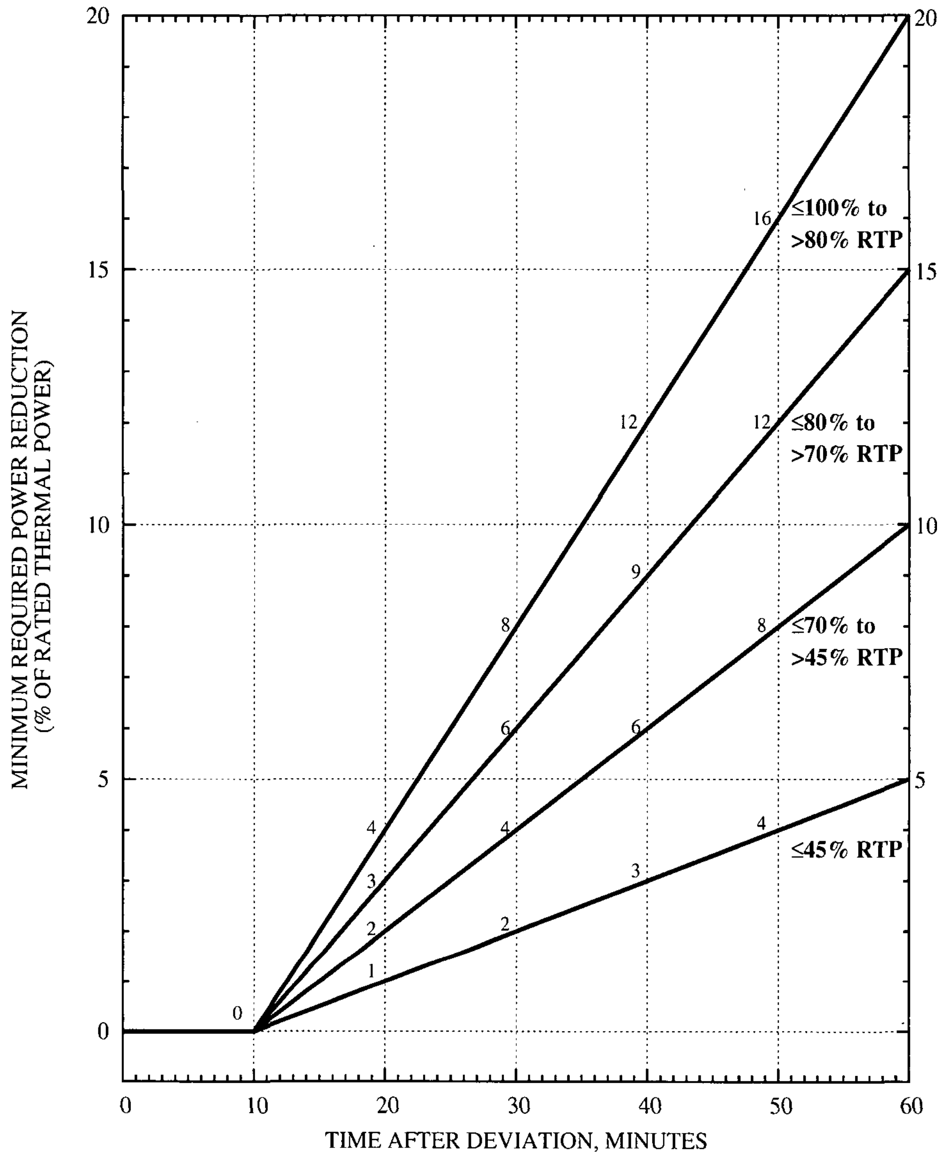


FIGURE 3.1.5-1
CORE POWER REDUCTION AFTER CEA DEVIATION*

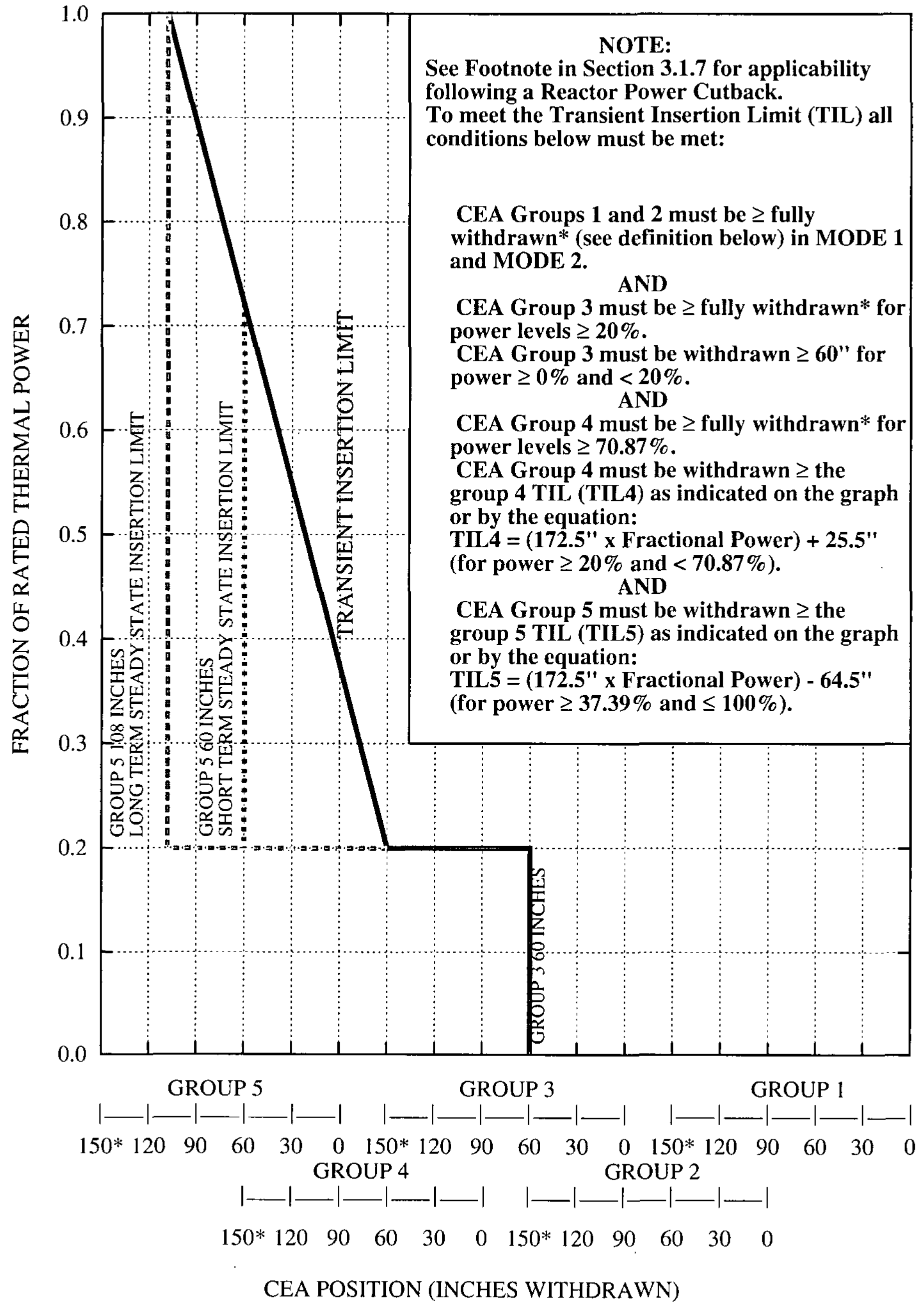


* WHEN CORE POWER IS REDUCED TO 35% OF RATED THERMAL POWER PER THIS LIMIT CURVE, FURTHER REDUCTION IS NOT REQUIRED.

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

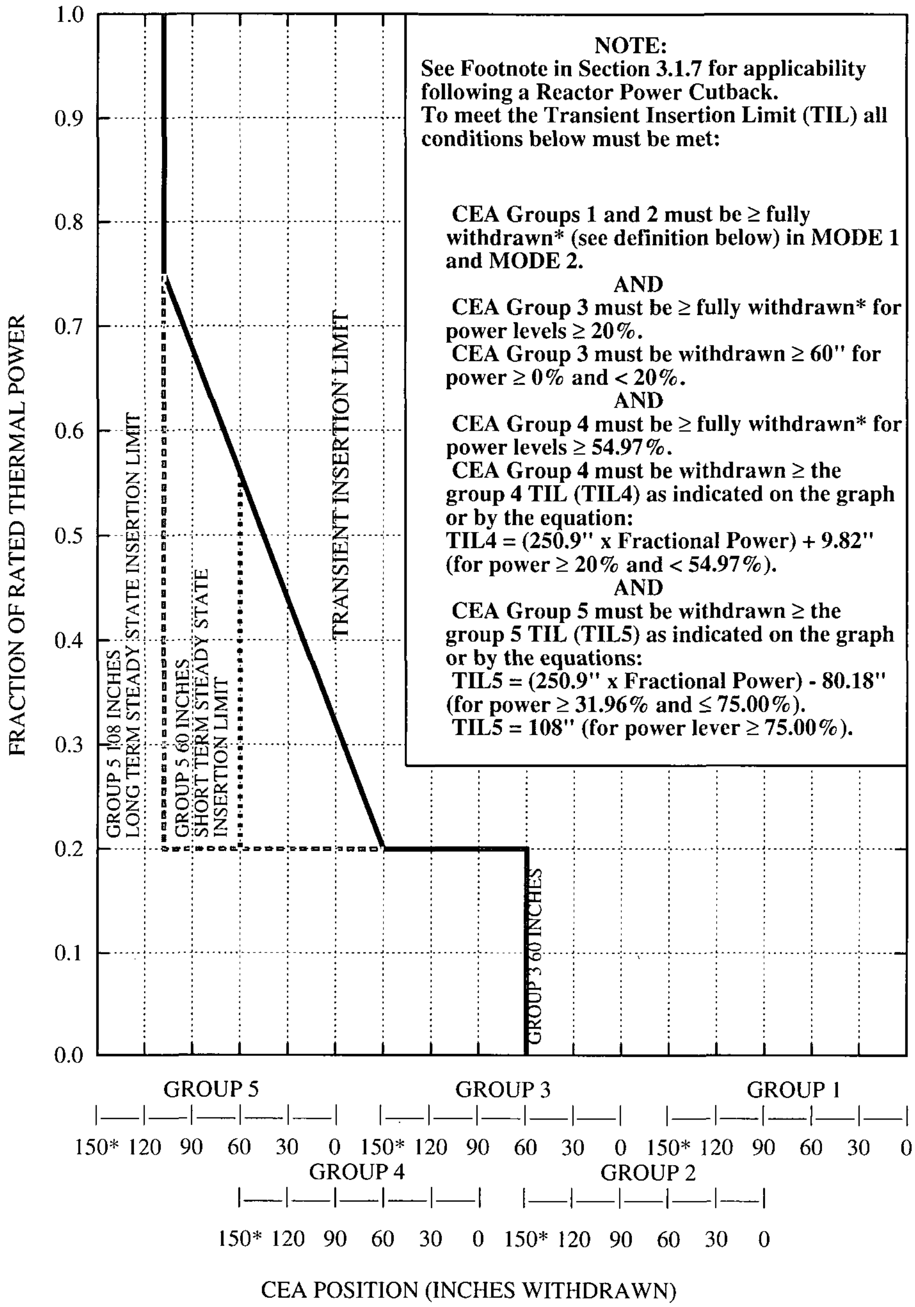
- > 95 % RATED THERMAL POWER
- COLSS IN SERVICE AND CEACS IN SERVICE
- AZIMUTHAL POWER TILT IS LESS THAN 3.0 %
- ALL CEAS REMAIN ABOVE 142.5" WITHDRAWN BY PULSE COUNTER AND ABOVE 140.1" WITHDRAWN BY RSPT INDICATION

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



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

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



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

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

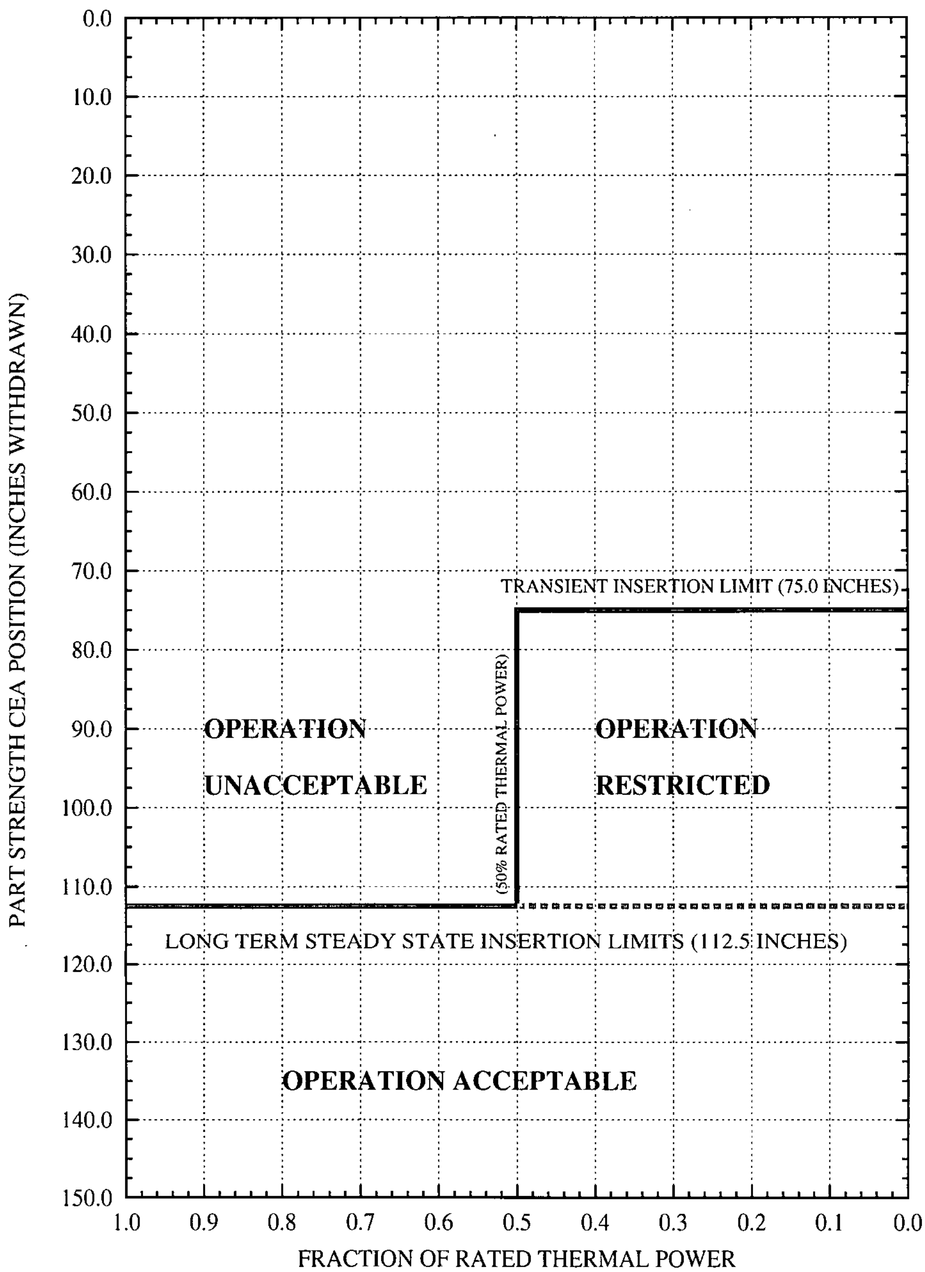


FIGURE 3.2.3-1
AZIMUTHAL POWER TILT VERSUS THERMAL POWER
(COLSS IN SERVICE)

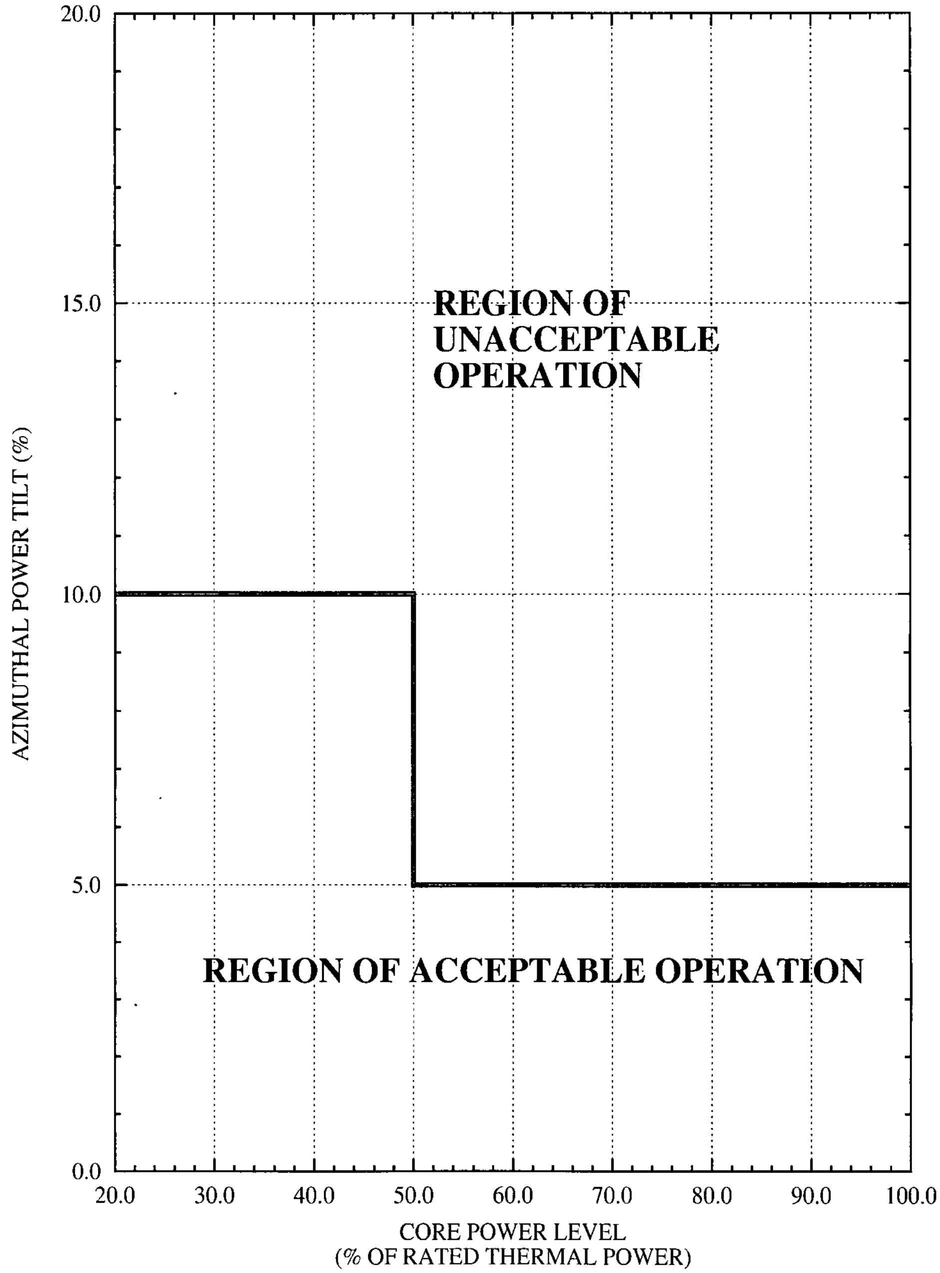


FIGURE 3.2.4-1
COLSS DNBR OPERATING LIMIT
ALLOWANCE FOR BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL

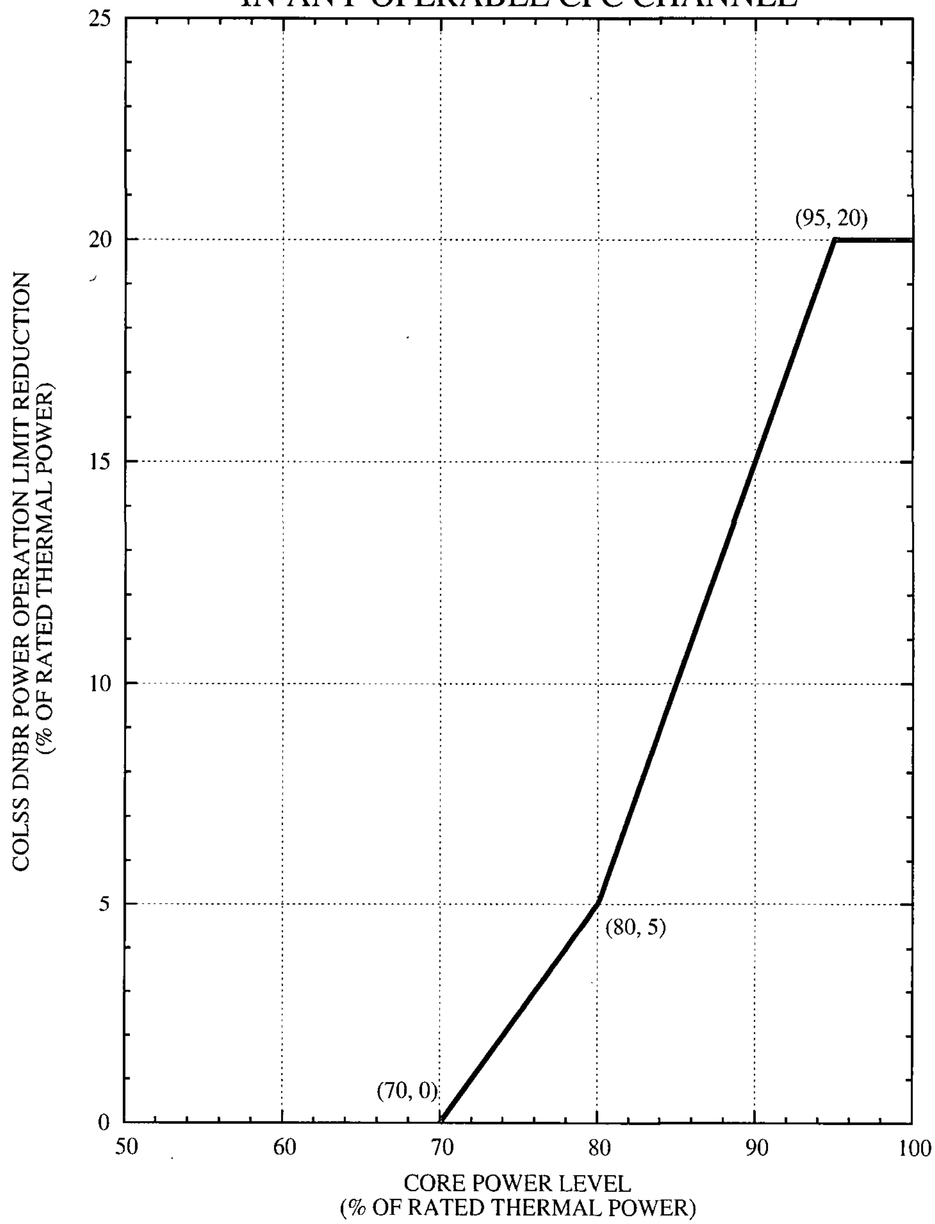


FIGURE 3.2.4-2
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, CEAC(s) OPERABLE)

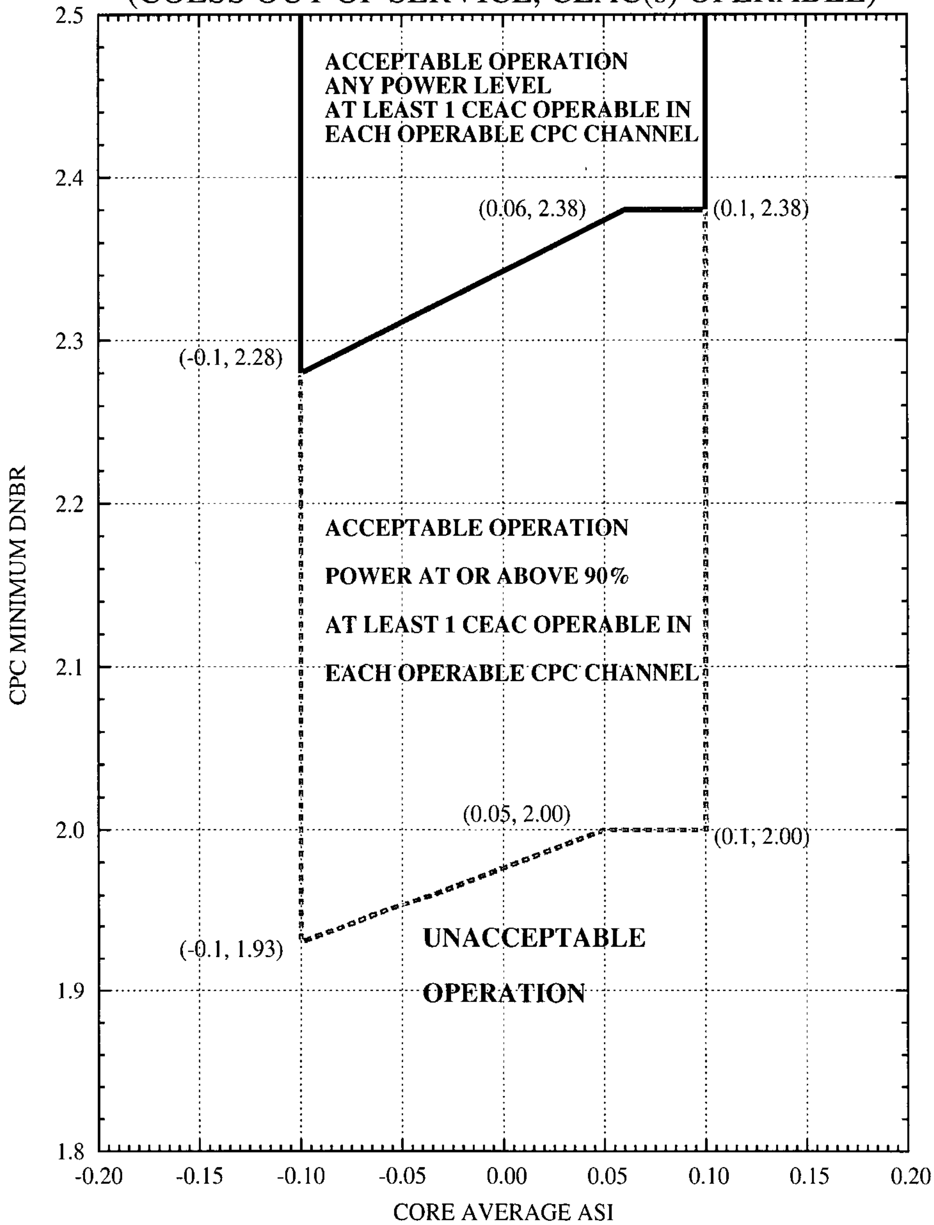


FIGURE 3.2.4-3
DNBR MARGIN OPERATING LIMIT BASED ON
THE CORE PROTECTION CALCULATORS
(COLSS OUT OF SERVICE, BOTH CEACs INOPERABLE
IN ANY OPERABLE CPC CHANNEL)

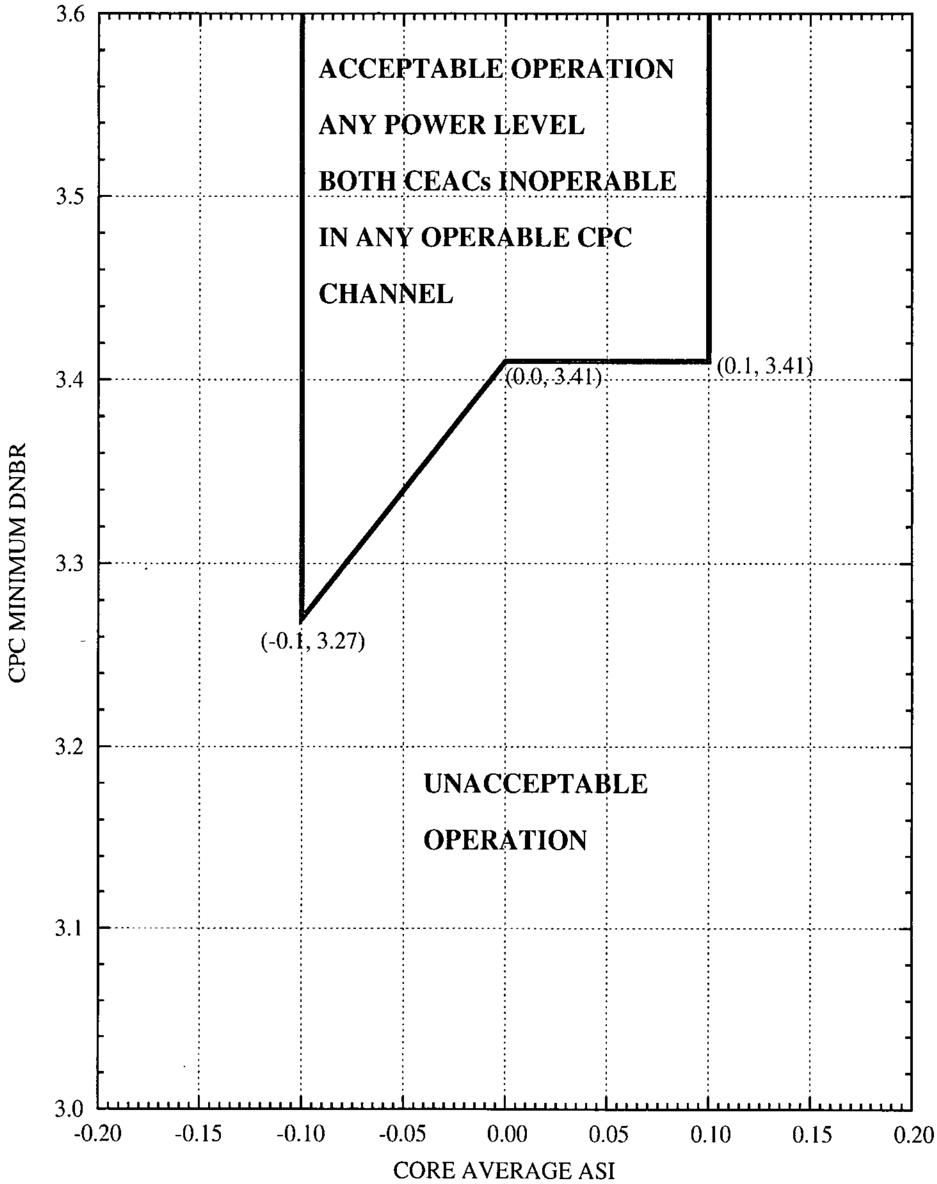


Table 3.3.12-1

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

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

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

Table 3.3.12-2

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

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

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