Entergy

Entergy Operations, Inc.
1448 S.R. 333
Russellville, AR 72802
Tel 479-858-4888

Dale E. James
Manager, Licensing
Nuclear Safety Assurance

1CAN120503

December 1, 2005

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

Subject: ANO-1 Cycle 20 COLR
Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51

Dear Sir or Madam:

Arkansas Nuclear One – Unit 1 (ANO-1) Technical Specification 5.6.5 requires the submittal of the Core Operating Limits Report (COLR) for each reload cycle. Attached is Revision 0 of the ANO-1 Cycle 20 COLR. Please note that the approved revision number of the Babcock and Wilcox Topical Report BAW-10179P-A is identified in the COLR as Revision 6, August 2005. In addition, the approved revision number of the Entergy Reactor Physics Methods Report is identified in the COLR as Revision 0, December 1993. This completes the reporting requirement for the referenced specification. This submittal contains no commitments. Should you have any questions, please contact David Bice at 479-858-5338.

Sincerely,

Dale E. James

DEJ/dbb

Attachment: ANO-1 Cycle 20 Core Operating Limits Report (COLR)

A001

cc: Dr. Bruce S. Mallett
Regional Administrator
U. S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Drive, Suite 400
Arlington, TX 76011-8064

NRC Senior Resident Inspector
Arkansas Nuclear One
P. O. Box 310
London, AR 72847

U. S. Nuclear Regulatory Commission
Attn: Mr. Drew G. Holland
MS O-7D1
Washington, DC 20555-0001

Mr. Bernard R. Bevill
Director Division of Radiation
Control and Emergency Management
Arkansas Department of Health
4815 West Markham Street
Little Rock, AR 72205

Attachment 1

1CAN120503

ANO-1 Cycle 20 Core Operating Limits Report (COLR)

ENTERGY OPERATIONS

ARKANSAS NUCLEAR ONE
UNIT ONE

CYCLE 20

CORE OPERATING LIMITS REPORT

1.0 CORE OPERATING LIMITS

This Core Operating Limits Report for ANO-1 Cycle 20 has been prepared in accordance with the requirements of Technical Specification 5.6.5. The core operating limits have been developed using the methodology provided in the references.

The following cycle-specific core operating limits are included in this report:

1) 2.1.1 Variable Low RCS Pressure – Temperature Protective Limits,
2) 3.1.1 SHUTDOWN MARGIN (SDM),
3) 3.1.8 PHYSICS TESTS Exceptions – MODE 1,
4) 3.1.9 PHYSICS TEST Exceptions – MODE 2,
5) 3.2.1 Regulating Rod Insertion Limits,
6) 3.2.2 AXIAL POWER SHAPING RODS (APSR) Insertion Limits,
7) 3.2.3 AXIAL POWER IMBALANCE Operating Limits,
8) 3.2.4 QUADRANT POWER TILT (QPT),
9) 3.2.5 Power Peaking,
10) 3.3.1 Reactor Protection System (RPS) Instrumentation,
11) 3.4.1 RCS Pressure, Temperature, and Flow DNB limits,
12) 3.4.4 RCS Loops – MODES 1 and 2, and
13) 3.9.1 Boron Concentration.

2.0 REFERENCES

1. "Safety Criteria and Methodology for Acceptable Cycle Reload Analysis," BAW-10179P-A, Rev. 6, Framatome ANP, Lynchburg, Virginia, August 2005.

2. Letter dated 4/9/02 from L.W. Barnett, USNRC, to J.M. Mallay, FRA-ANP, "Safety Evaluation of Framatome Technologies Topical Report BAW-10164P Revision 4, 'RELAP5/MOD2- B&W, An Advanced Computer Program for Light Water Reactor LOCA and Non-LOCA Transient Analysis' (TAC Nos. MA8465 and MA8468)," USNRC ADAMS Accession Number ML013390204.

3. RELAP5/MOD2-B&W – An Advanced Computer Program for Light Water Reactor LOCA Transient Analysis, BAW-10164P, Rev. 4, Framatome Technologies, Inc., Lynchburg, Virginia, September 1999.

4. "Qualification of Reactor Physics Methods for the Pressurized Water Reactors of the Entergy System," ENEAD-01-P, Rev. 0, Entergy Operations, Inc., Jackson, Mississippi, December 1993.

5. "ANO-1 Cycle 20 Limits and Setpoints," Framatome ANP Doc. No. 86-5066742-02, September 14, 2005.

6. "Arkansas Nuclear One, Unit 1, Cycle 20 Reload Report," BAW-2493, Rev. 2, November 2005 (CALC-A1-NE-2005-001).

7. "ANO-1 Refueling Boron Concentration for 1R19," CALC-NEAD-SR-05/046, Rev. 0, September 13, 2005.

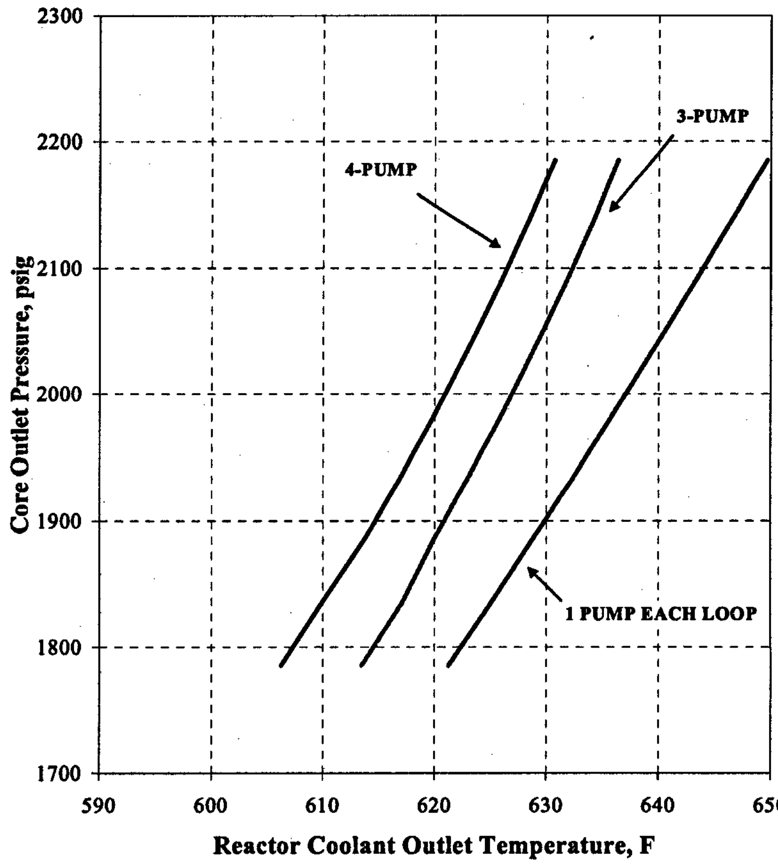
Table Of Contents

AXIAL POWER IMBALANCE OPERATING LIMITS (continued)

FIGURE 1

Variable Low RCS Pressure – Temperature Protective Limits

(Figure is referred to by Technical Specification 2.1.1.3)



PUMPS OPERATING (TYPE OF LIMIT)	GPM*	POWER**
FOUR PUMPS (DNBR LIMIT)	383,680 (100%)	110%
THREE PUMPS (DNBR LIMIT)	284,307 (74.1%)	89%
ONE PUMP IN EACH LOOP (DNBR LIMIT)	188,003 (49%)	62.2%

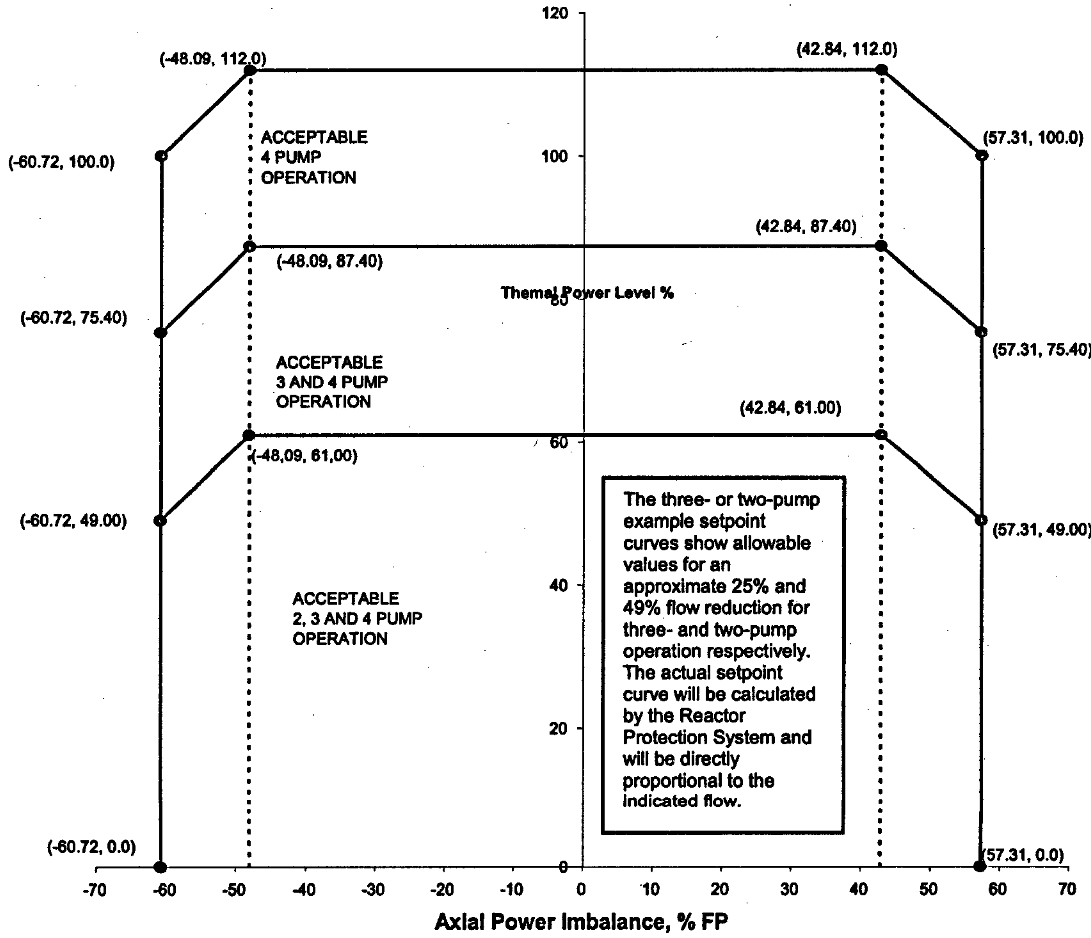
* 109% OF DESIGN FLOW (2.5% UNCERTAINTY INCLUDED IN STATISTICAL DESIGN LIMIT)

** AN ADDITIONAL 2% POWER UNCERTAINTY IS INCLUDED IN STATISTICAL DESIGN LIMIT

Figure 2

AXIAL POWER IMBALANCE Protective Limits
(measurement system independent)

(Figure is referred to by Technical Specification 2.1.1 Bases)



SHUTDOWN MARGIN (SDM)

(Limits are referred to by Technical Specifications 3.1.1, 3.1.4, 3.1.5, 3.1.8, 3.1.9, and 3.3.9)

Verify SHUTDOWN MARGIN per the table below.

APPLICABILITY	REQUIRED SHUTDOWN MARGIN	TECHNICAL SPECIFICATION REFERENCE
MODE 1*	≥ 1 %Δk/k	3.1.4, 3.1.5
MODE 2*	≥ 1 %Δk/k	3.1.4, 3.1.5, 3.3.9
MODE 3	≥ 1 %Δk/k	3.1.1, 3.3.9
MODE 4	≥ 1 %Δk/k	3.1.1, 3.3.9
MODE 5	≥ 1 %Δk/k	3.1.1, 3.3.9
MODE 1 PHYSICS TESTS Exceptions**	≥ 1 %Δk/k	3.1.8
MODE 2 PHYSICS TESTS Exceptions	≥ 1 %Δk/k	3.1.9

* The required Shutdown Margin capability of 1 %Δk/k in MODE 1 and MODE 2 is preserved by the Regulating Rod Insertion Limits specified in Figures 3-A&B, 4-A&B, and 5-A&B, as required by Technical Specification 3.2.1.

** Entry into Mode 1 Physics Tests Exceptions is not supported by existing analyses and as such requires <u>actual</u> shutdown margin to be ≥ 1 %Δk/k.

Figure 3-A

Regulating Rod Insertion Limits for Four-Pump Operation From 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.1)

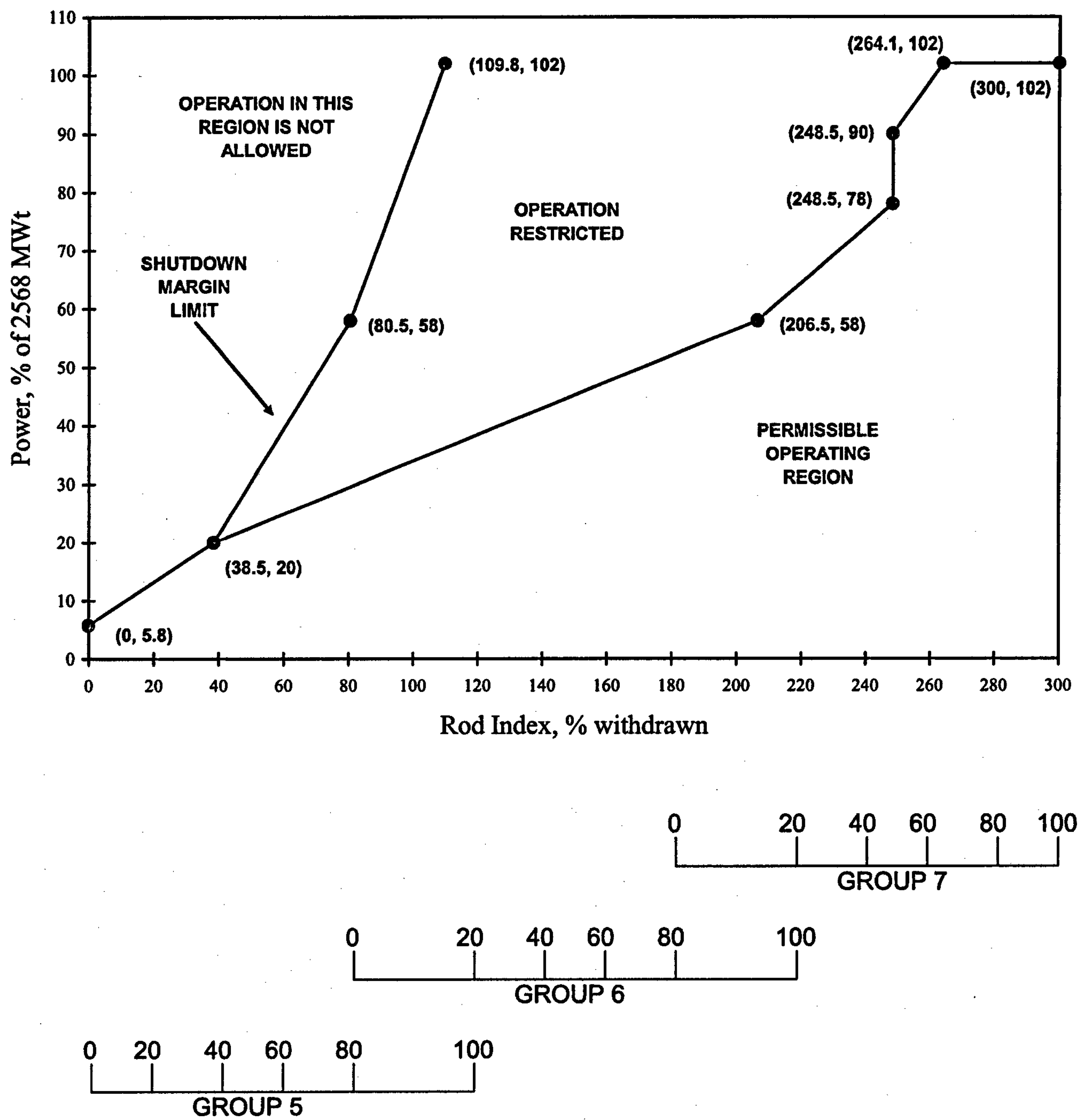


Figure 3-B

Regulating Rod Insertion Limits for Four-Pump Operation From 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.1)

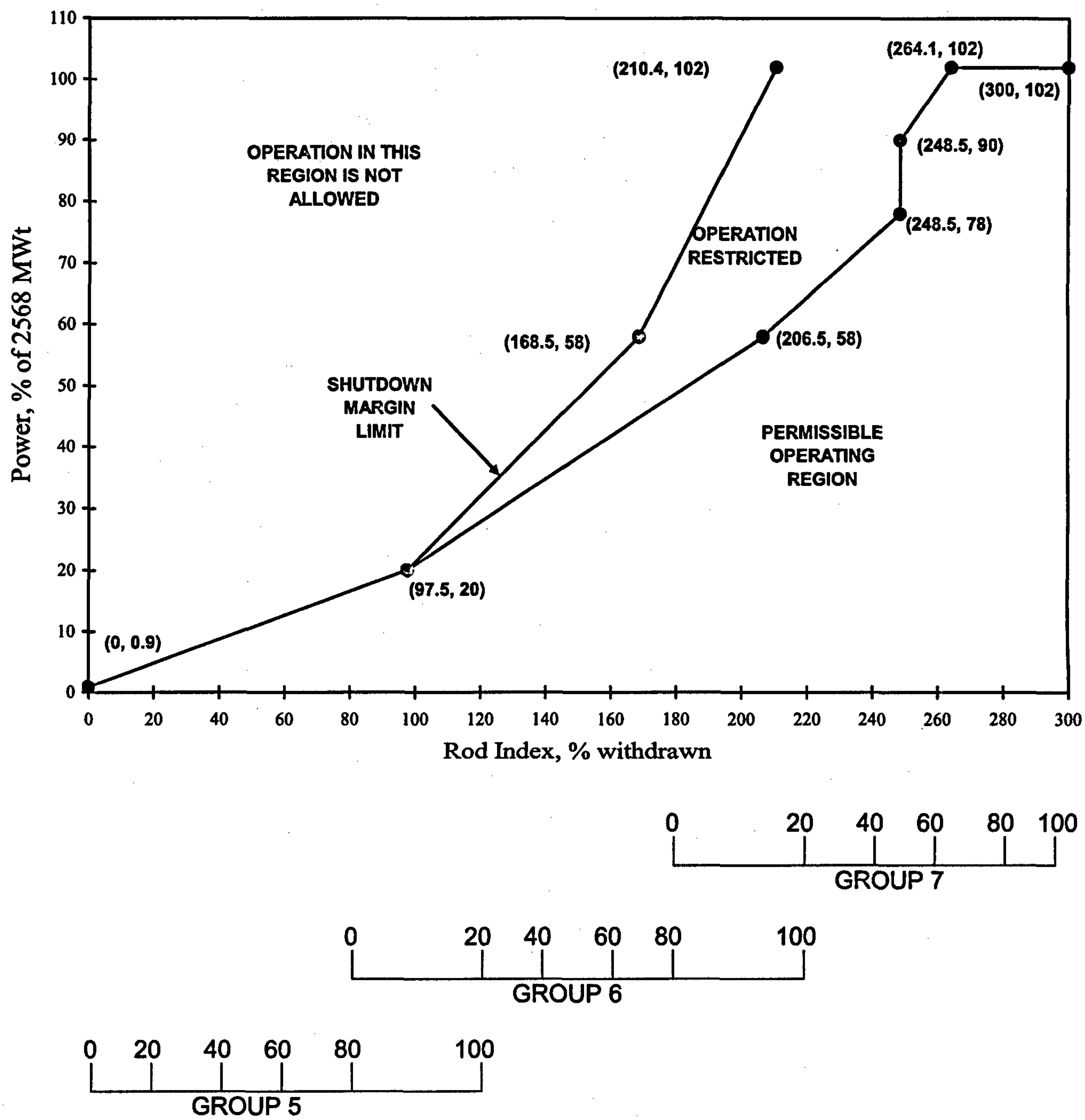


Figure 4-A

Regulating Rod Insertion Limits for Three-Pump Operation From 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.1)

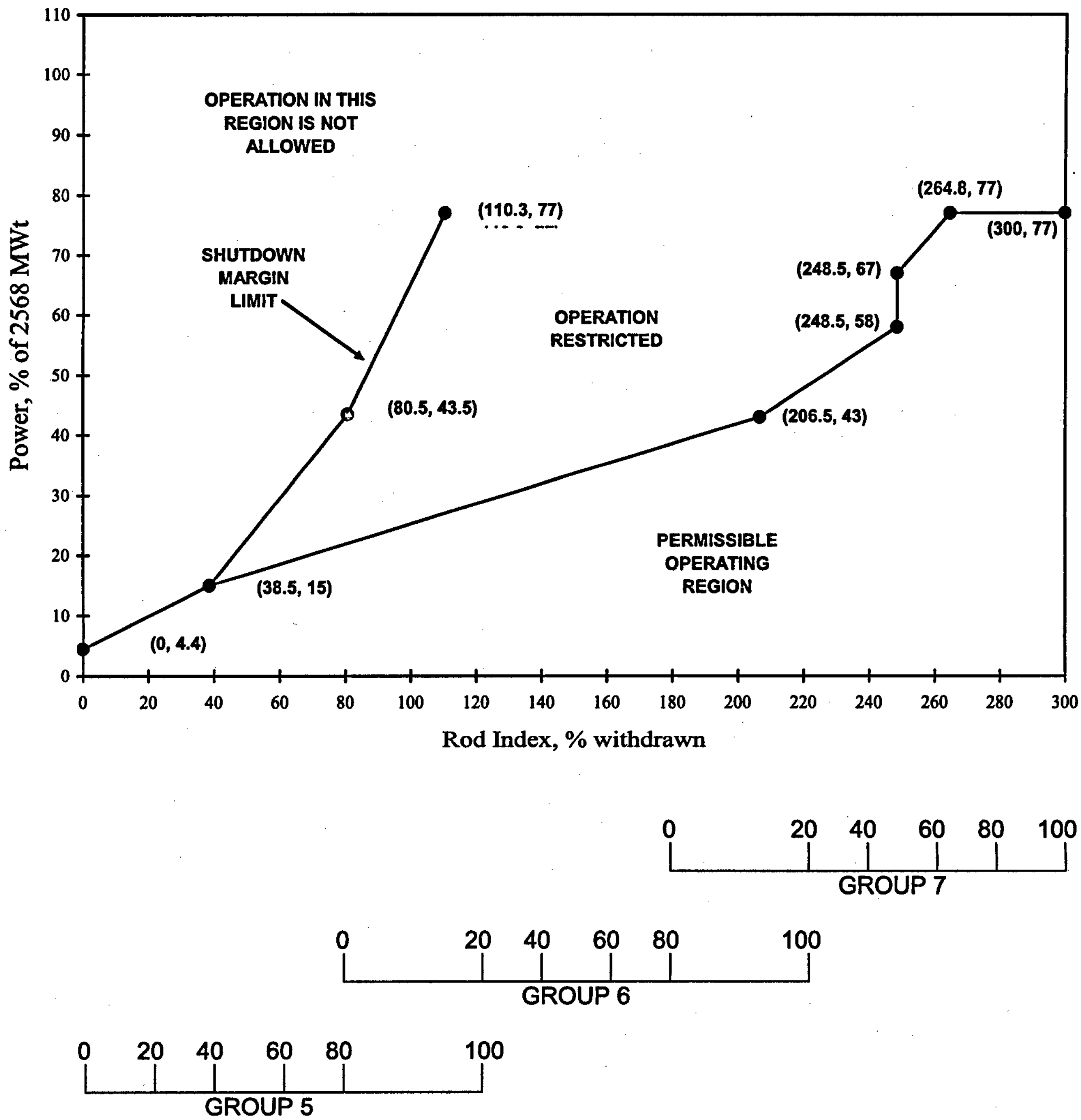


Figure 4-B

Regulating Rod Insertion Limits for Three-Pump Operation From 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.1)

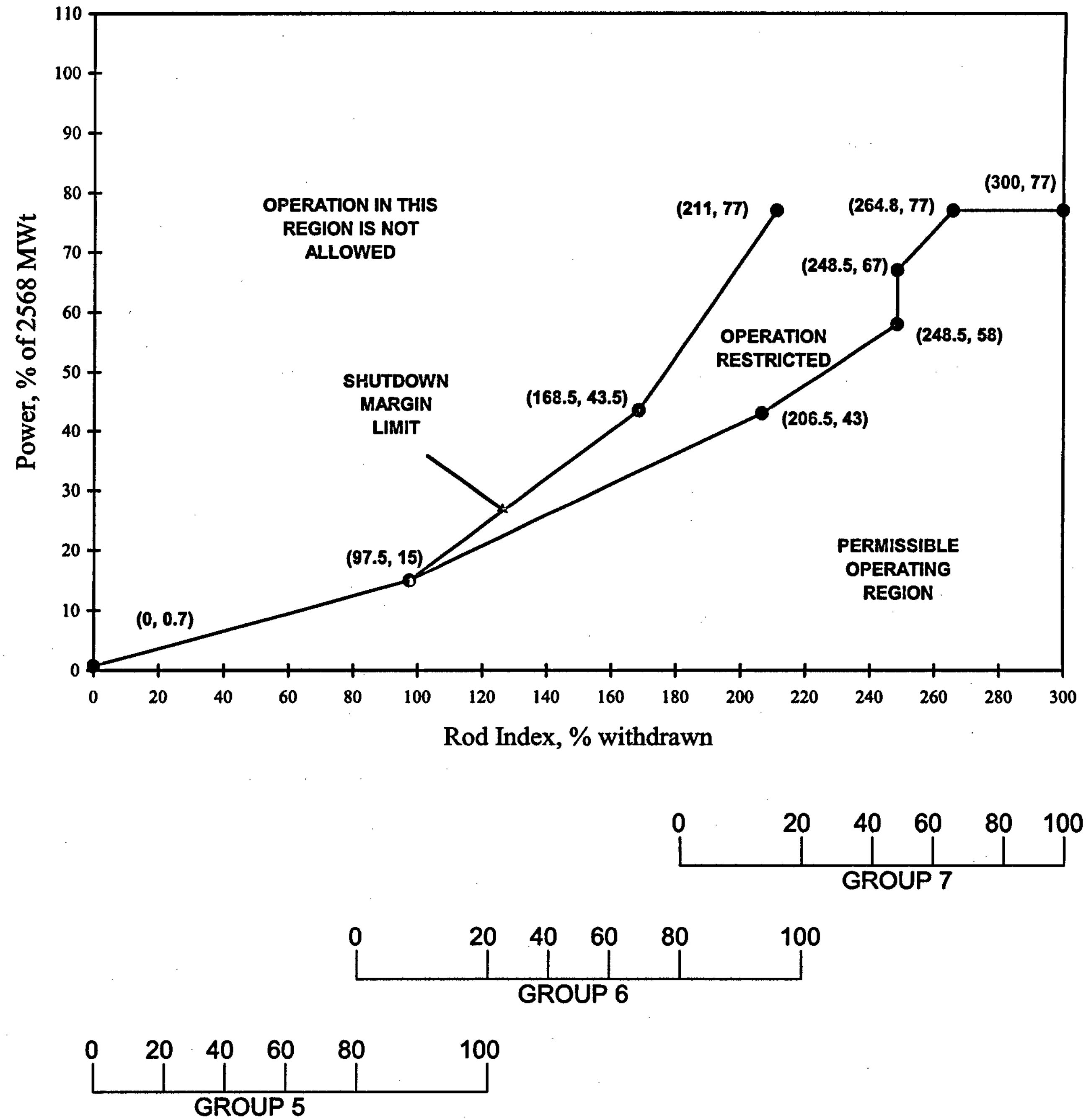


Figure 5-A

Regulating Rod Insertion Limits for Two-Pump Operation From 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.1)

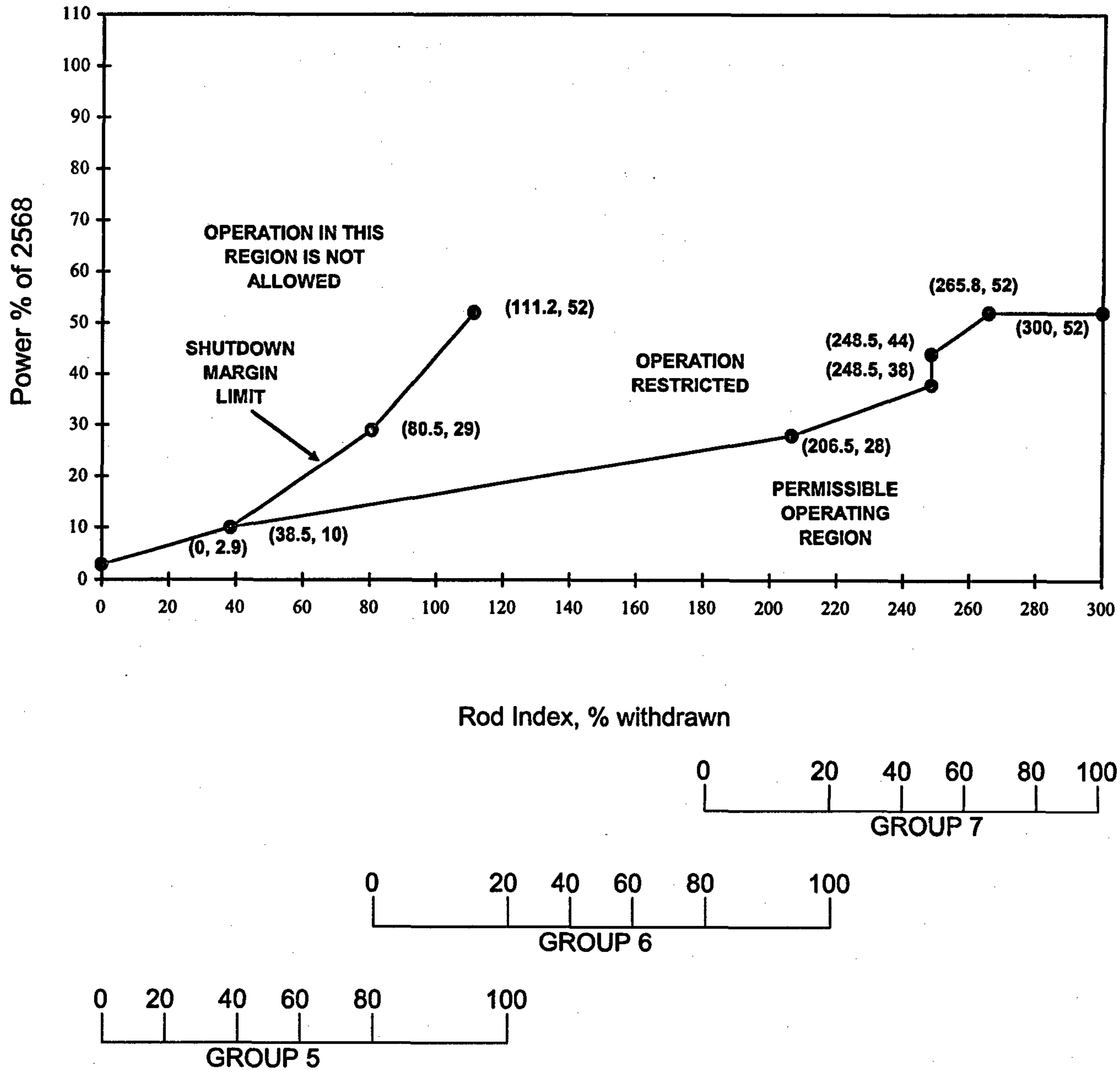
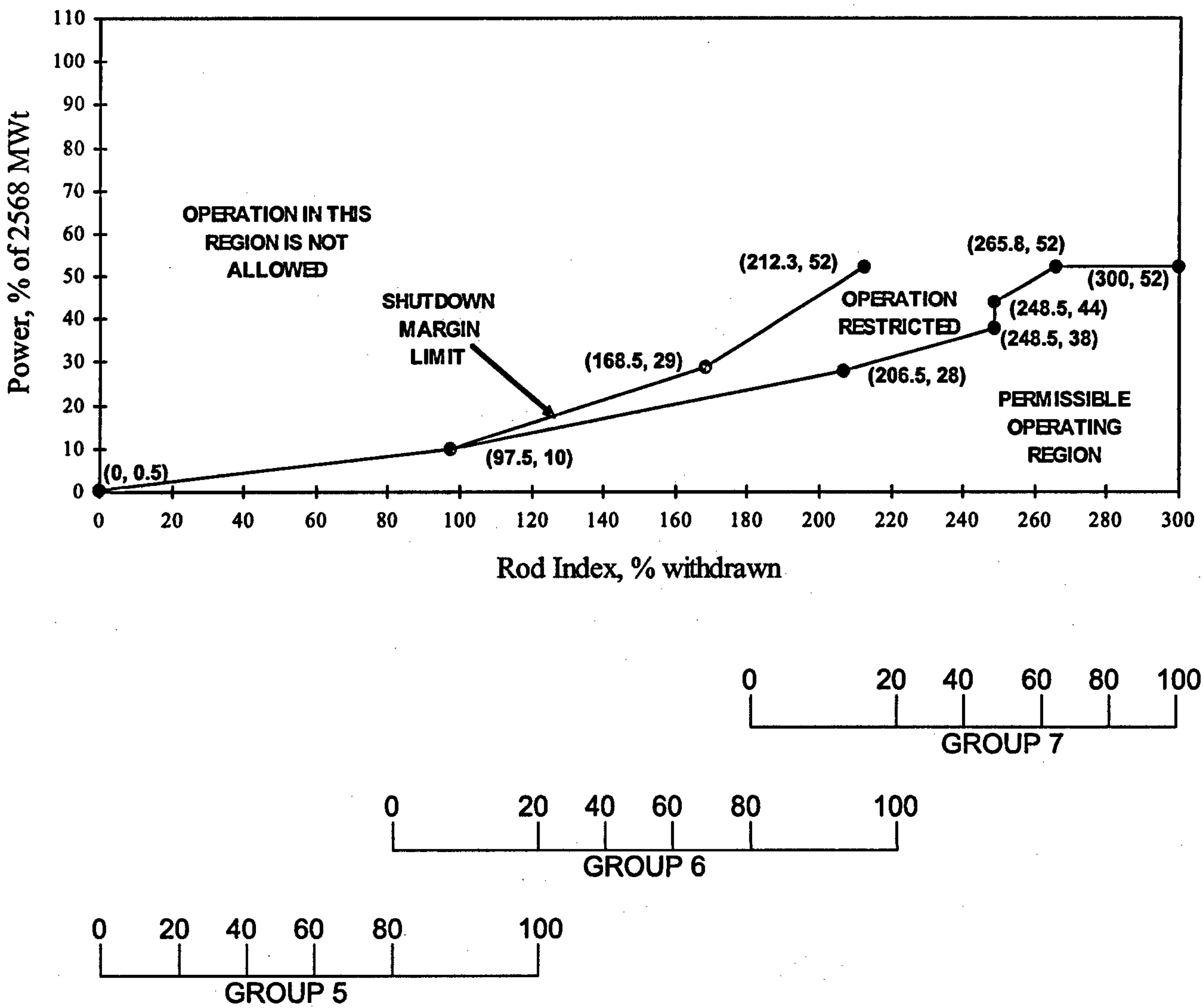


Figure 5-B

Regulating Rod Insertion Limits for Two-Pump Operation From 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.1)



AXIAL POWER SHAPING RODS (APSR) INSERTION LIMITS

(Figure is referred to by Technical Specification 3.2.2)

Up to 443 ± 10 EFPD, the APSRs may be positioned as necessary for transient imbalance control. However, the APSRs shall be fully withdrawn by 453 EFPD. After the APSR withdrawal at 443 ± 10 EFPD, the APSRs shall not be reinserted.

Figure 6-A(1)

AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Four-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

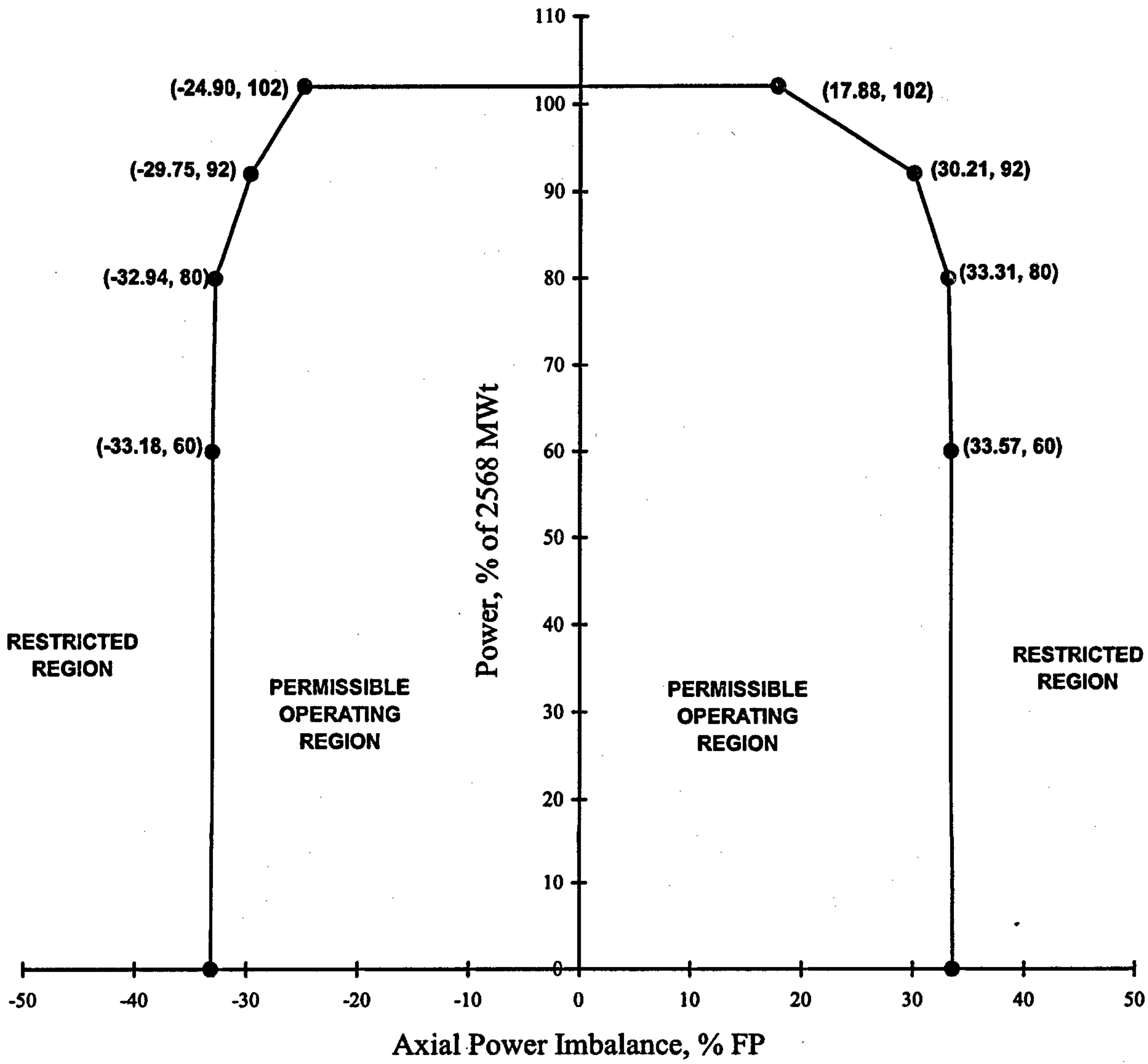


Figure 6-A(2)

AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Four-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)

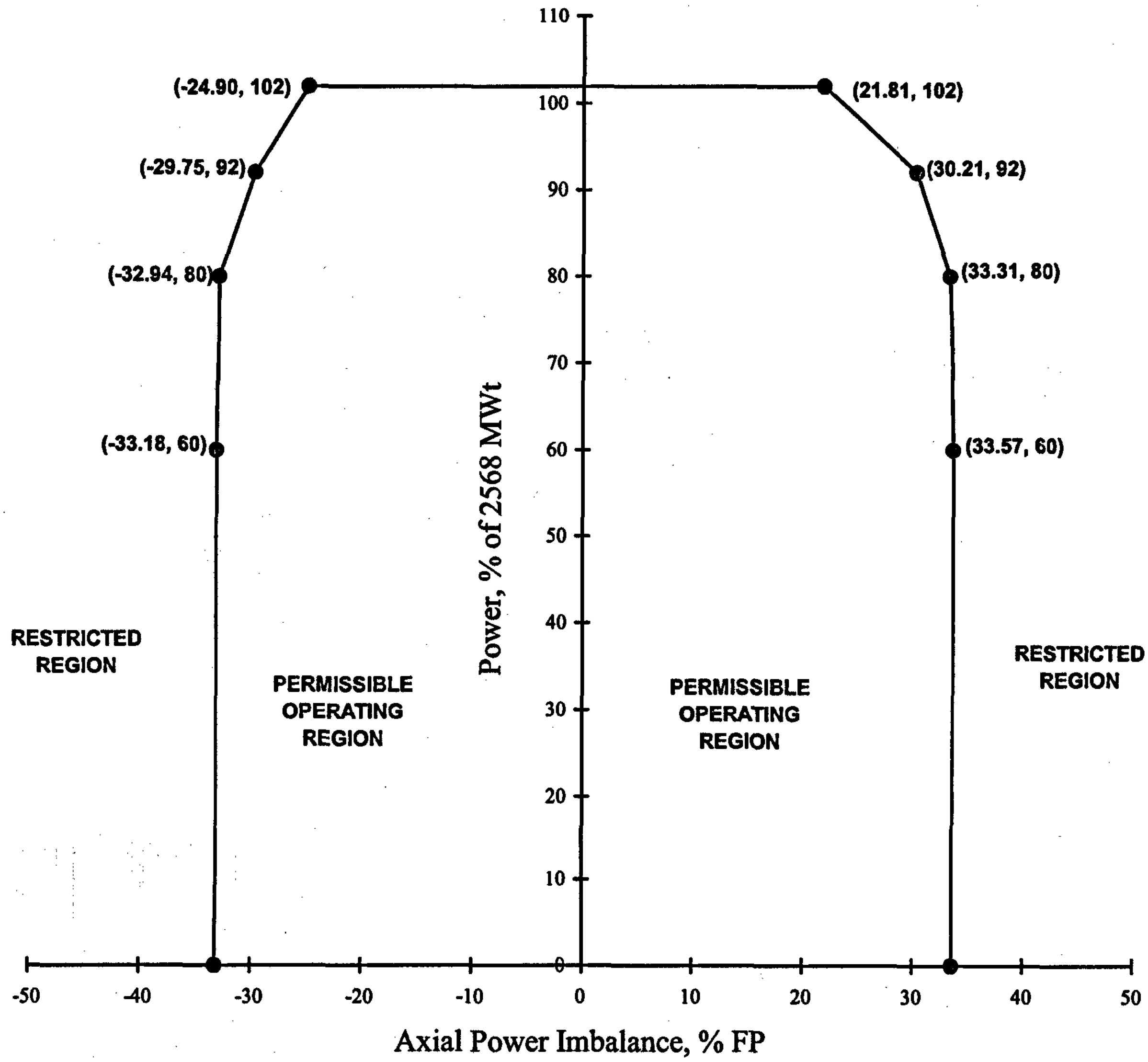
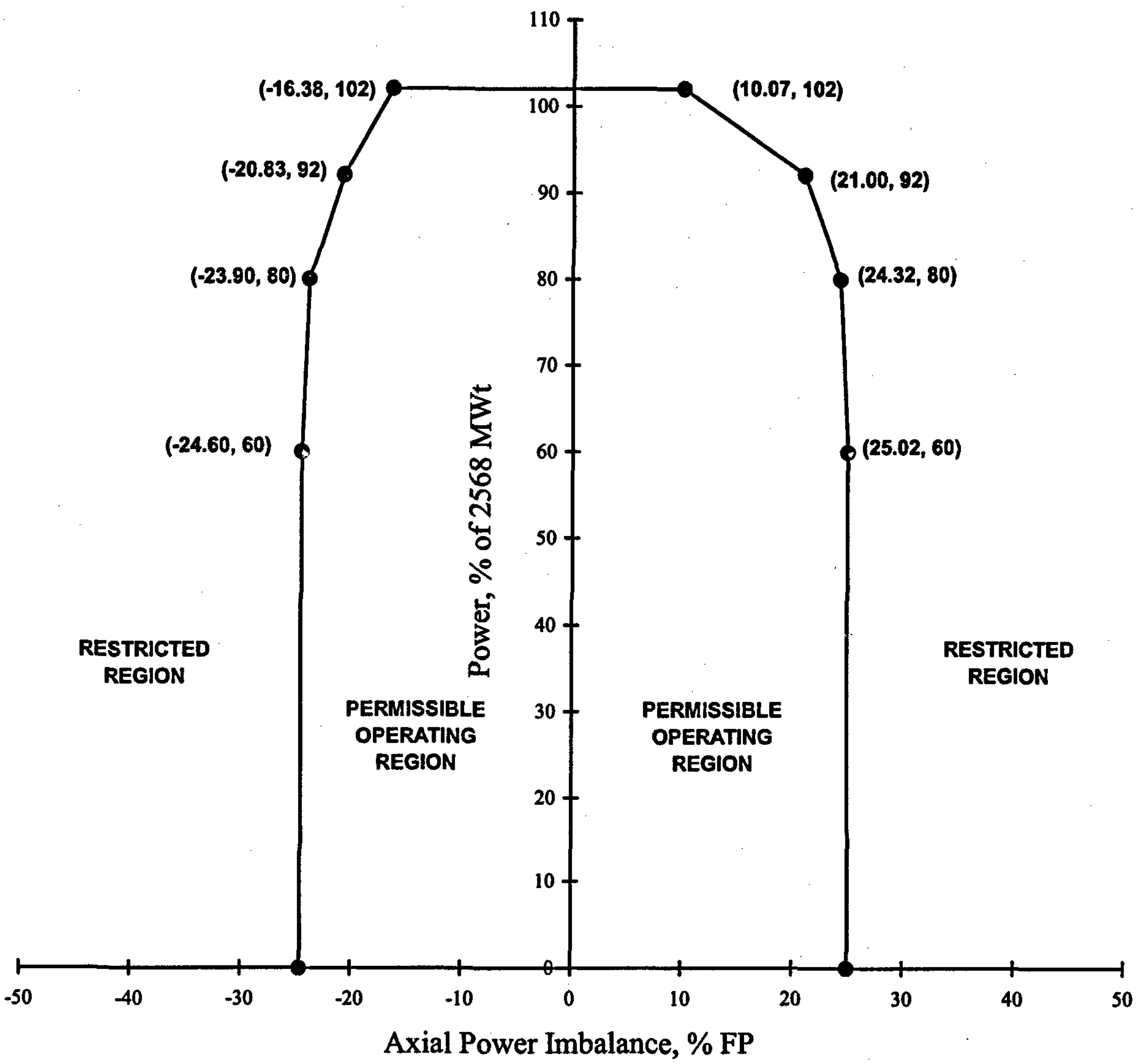


Figure 6-B(1)

AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions* for Four-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

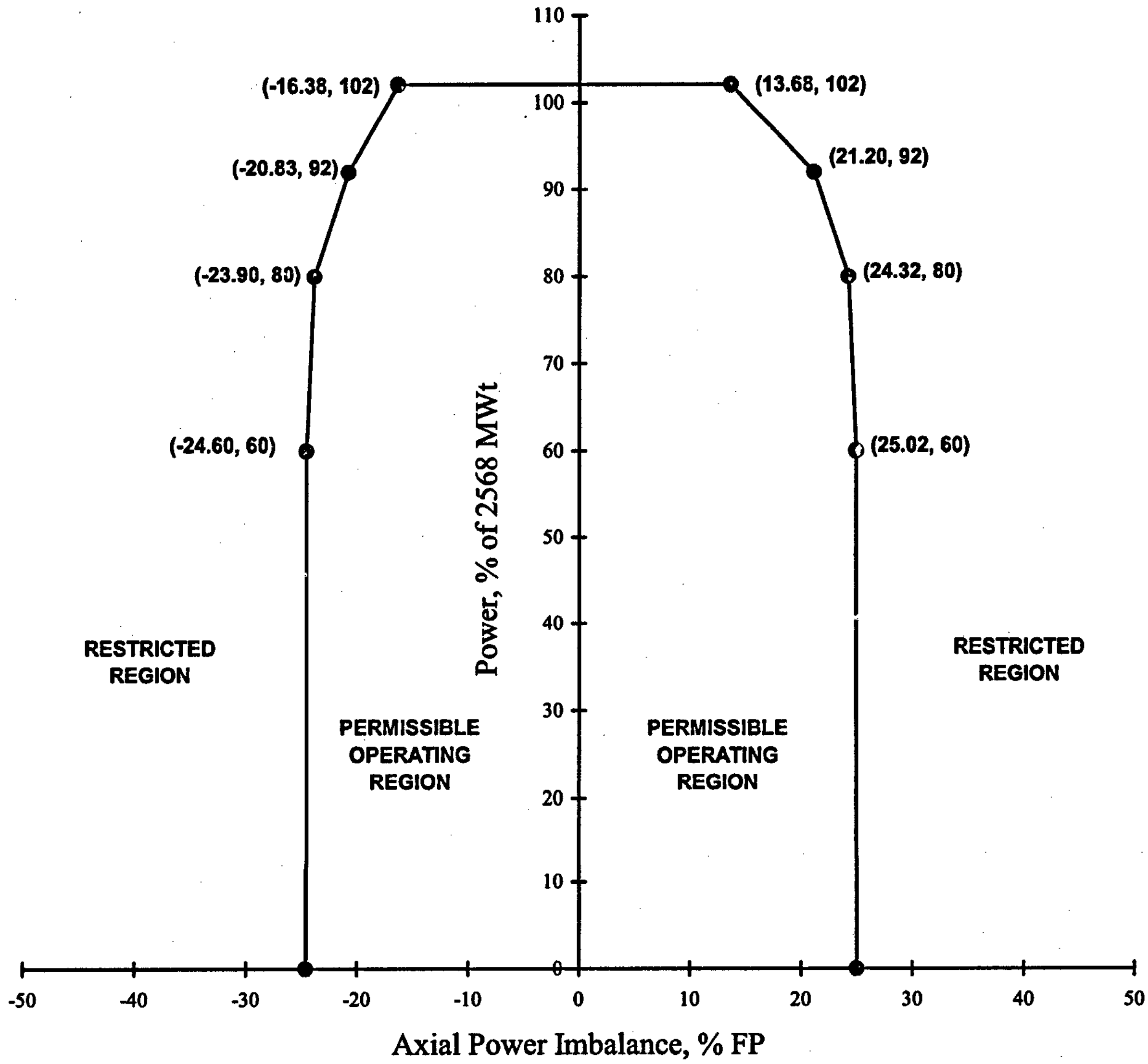


* Assumes that no individual short emitter detector affecting the minimum in-core imbalance calculation exceeds 60% sensitivity depletion, and that no individual long emitter detector exceeds 73% sensitivity depletion, or both. The imbalance setpoints for the minimum in-core system must be reduced by 2.80% FP at the earliest time-in-life that this assumption is no longer valid.

Figure 6-B(2)

AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions* for Four-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)



* Assumes that no individual short emitter detector affecting the minimum in-core imbalance calculation exceeds 60% sensitivity depletion, and that no individual long emitter detector exceeds 73% sensitivity depletion, or both. The imbalance setpoints for the minimum in-core system must be reduced by 2.80% FP at the earliest time-in-life that this assumption is no longer valid.

Figure 6-C(1)

AXIAL POWER IMBALANCE Setpoints for Excore Conditions for Four-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

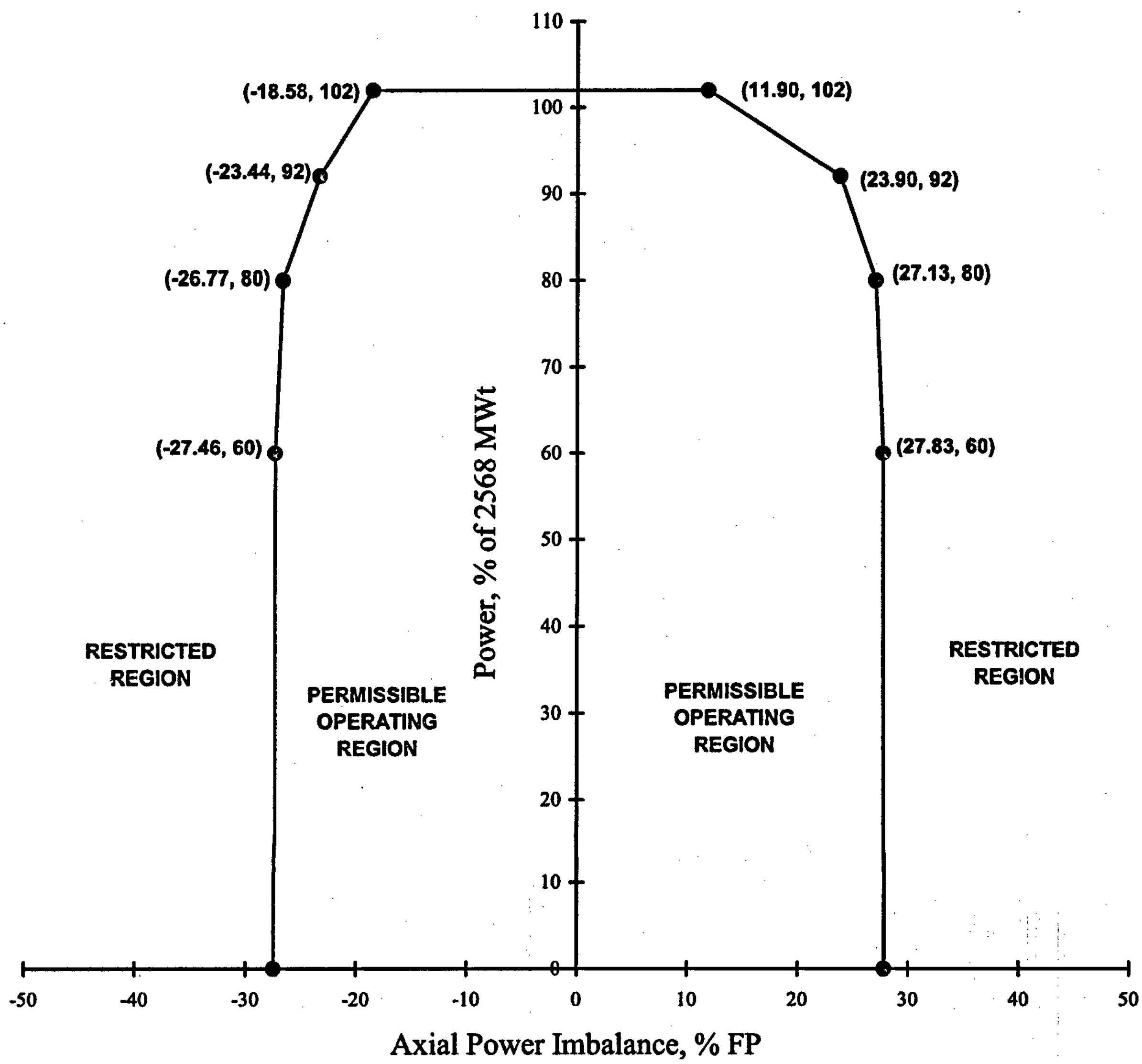


Figure 6-C(2)

AXIAL POWER IMBALANCE Setpoints for Excore Conditions for Four-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)

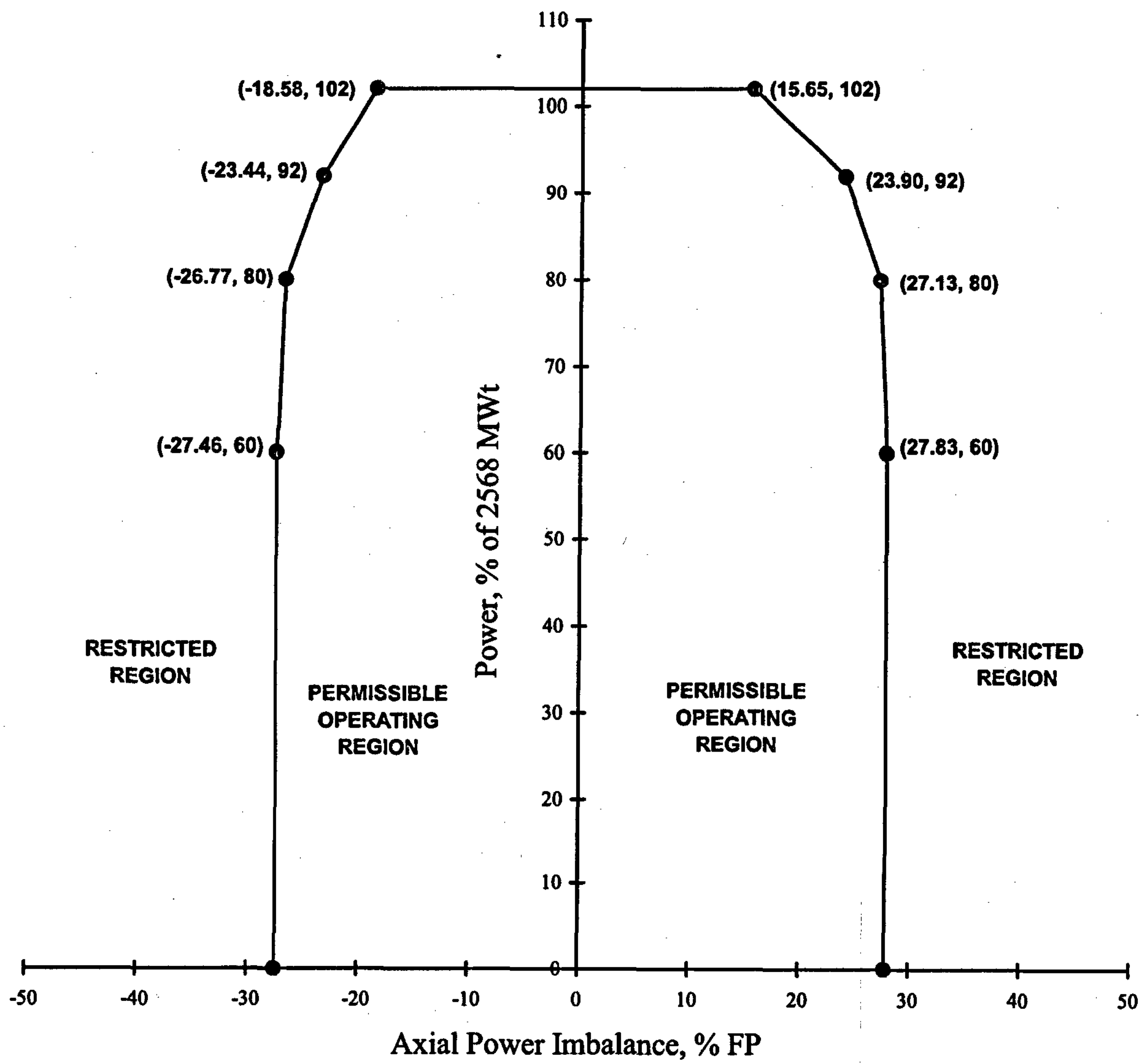


Figure 7-A(1)

AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Three-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

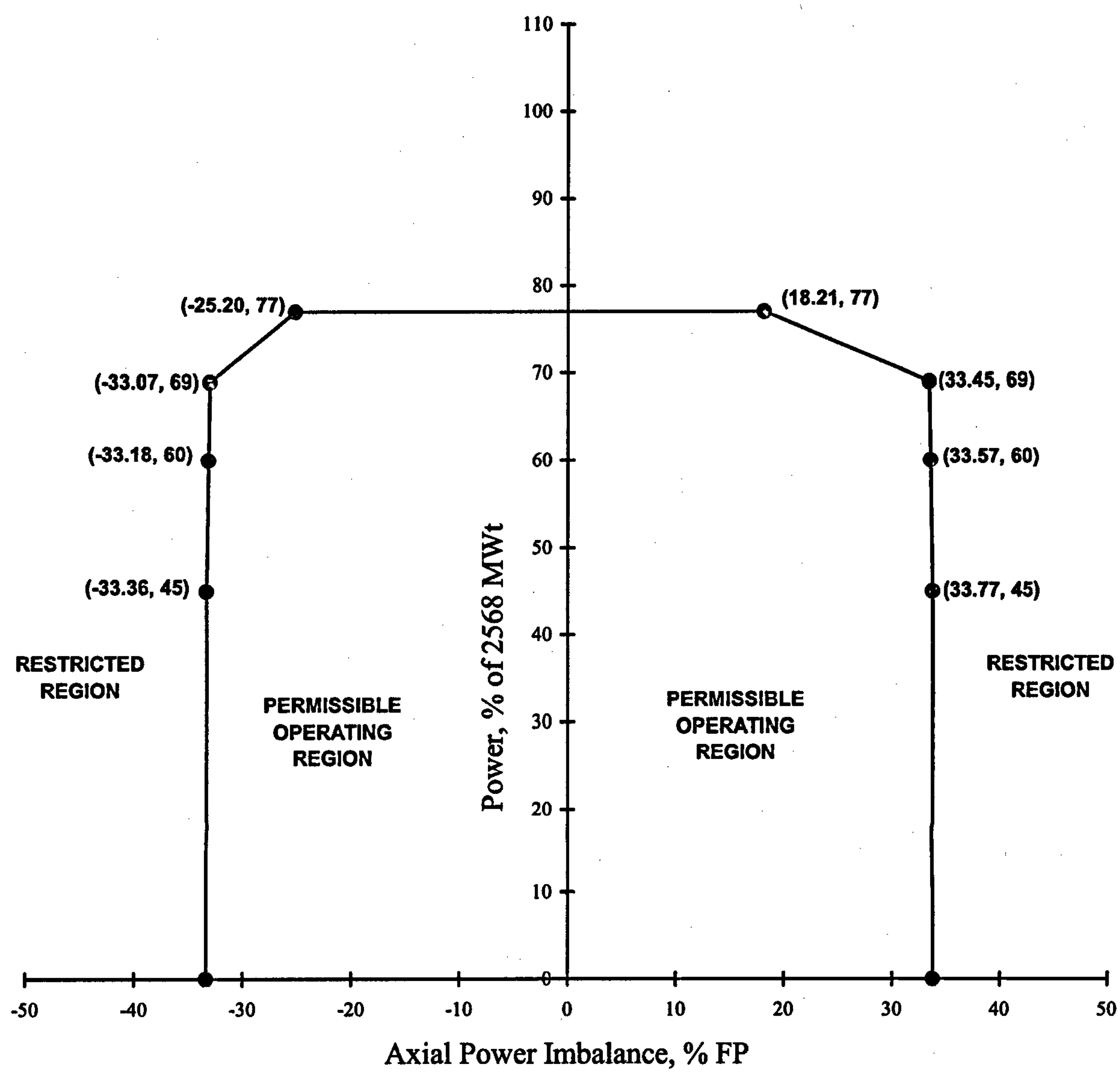


Figure 7-A(2)

AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Three-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)

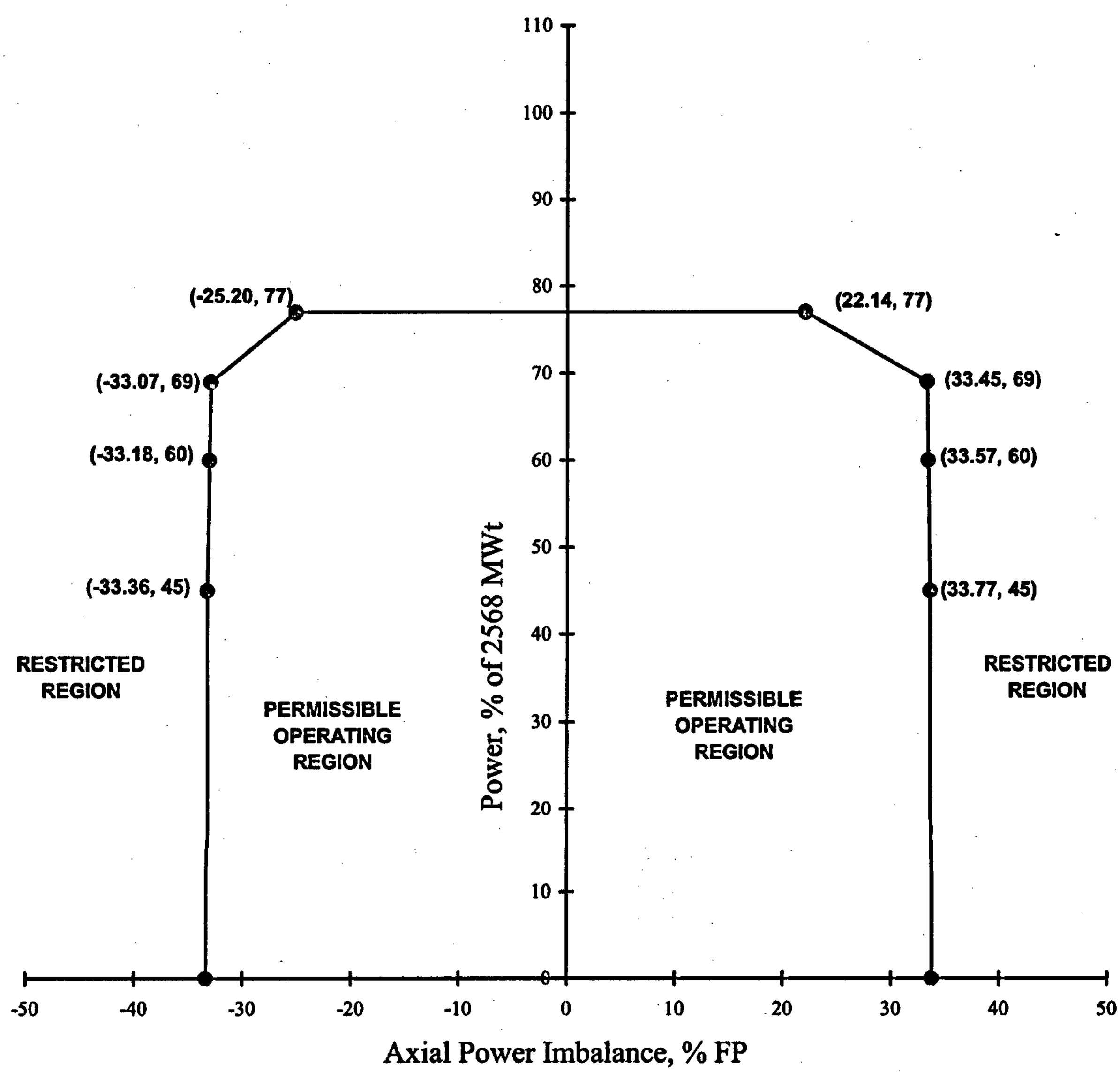
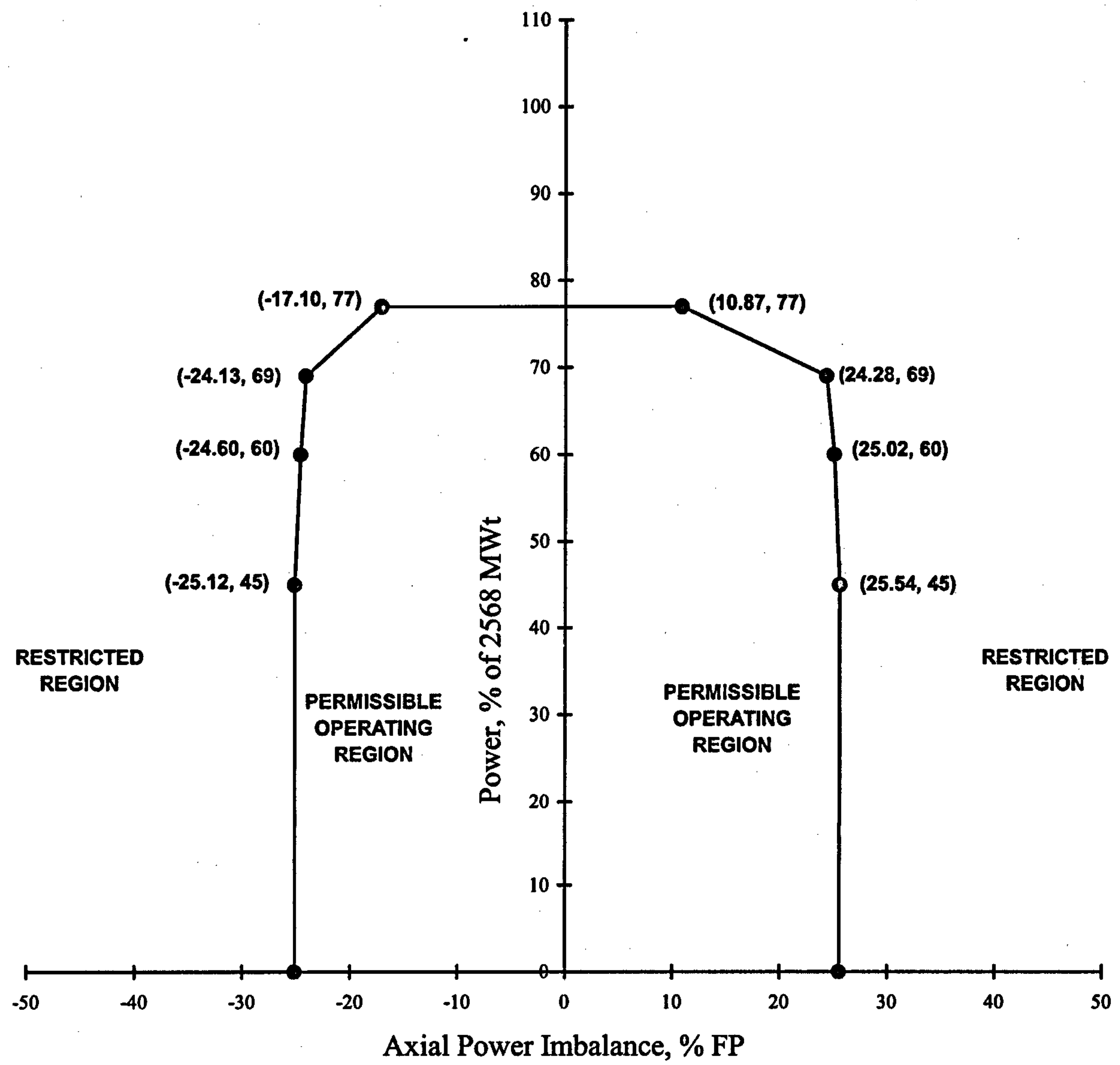


Figure 7-B(1)

AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions* for Three-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

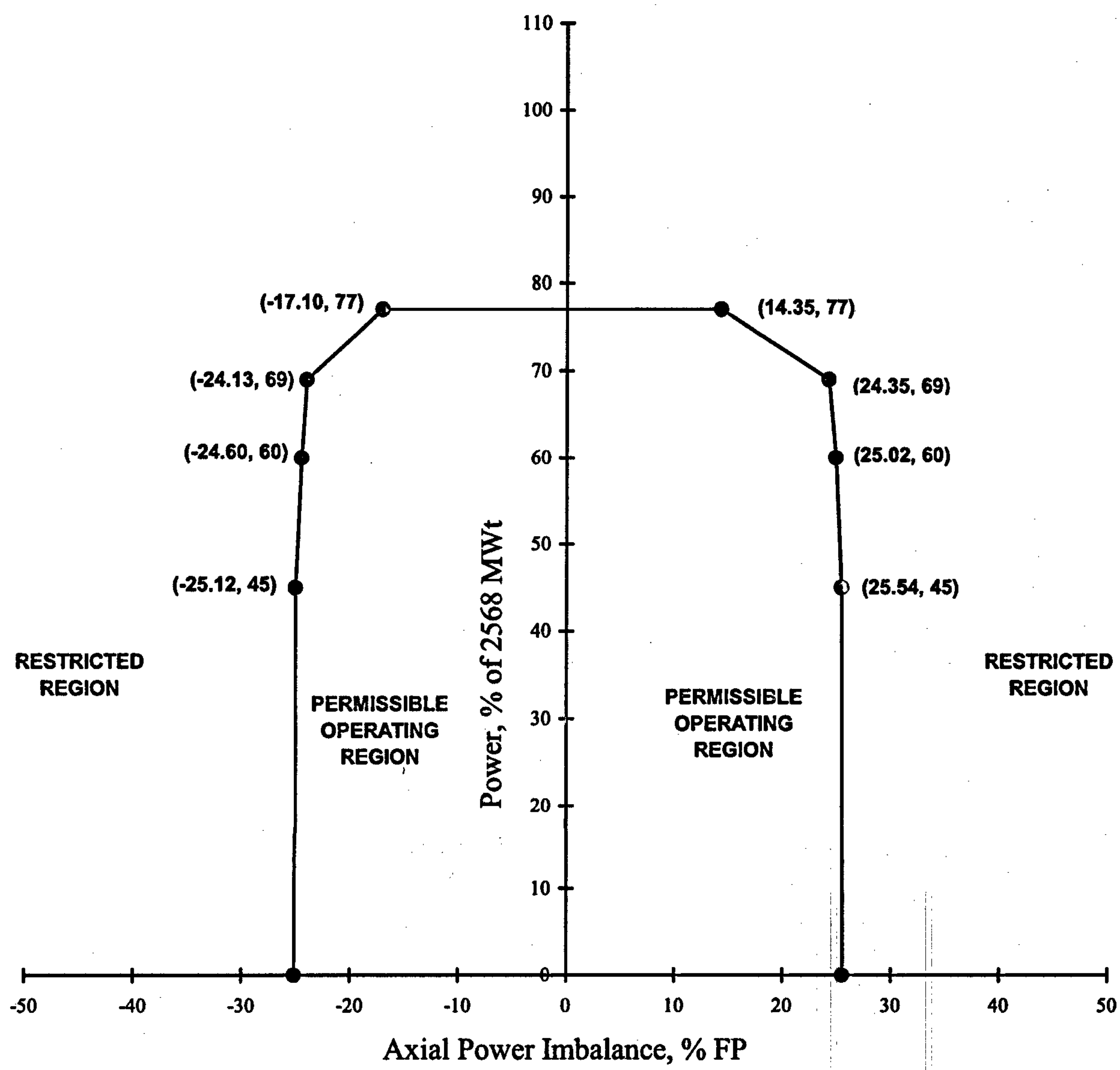


* Assumes that no individual short emitter detector affecting the minimum in-core imbalance calculation exceeds 60% sensitivity depletion, and that no individual long emitter detector exceeds 73% sensitivity depletion, or both. The imbalance setpoints for the minimum in-core system must be reduced by 2.80% FP at the earliest time-in-life that this assumption is no longer valid.

Figure 7-B(2)

AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions* for Three-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)



* Assumes that no individual short emitter detector affecting the minimum in-core imbalance calculation exceeds 60% sensitivity depletion, and that no individual long emitter detector exceeds 73% sensitivity depletion, or both. The imbalance setpoints for the minimum in-core system must be reduced by 2.80% FP at the earliest time-in-life that this assumption is no longer valid.

Figure 7-C(1)

AXIAL POWER IMBALANCE Setpoints for Ex-Core Conditions for Three-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

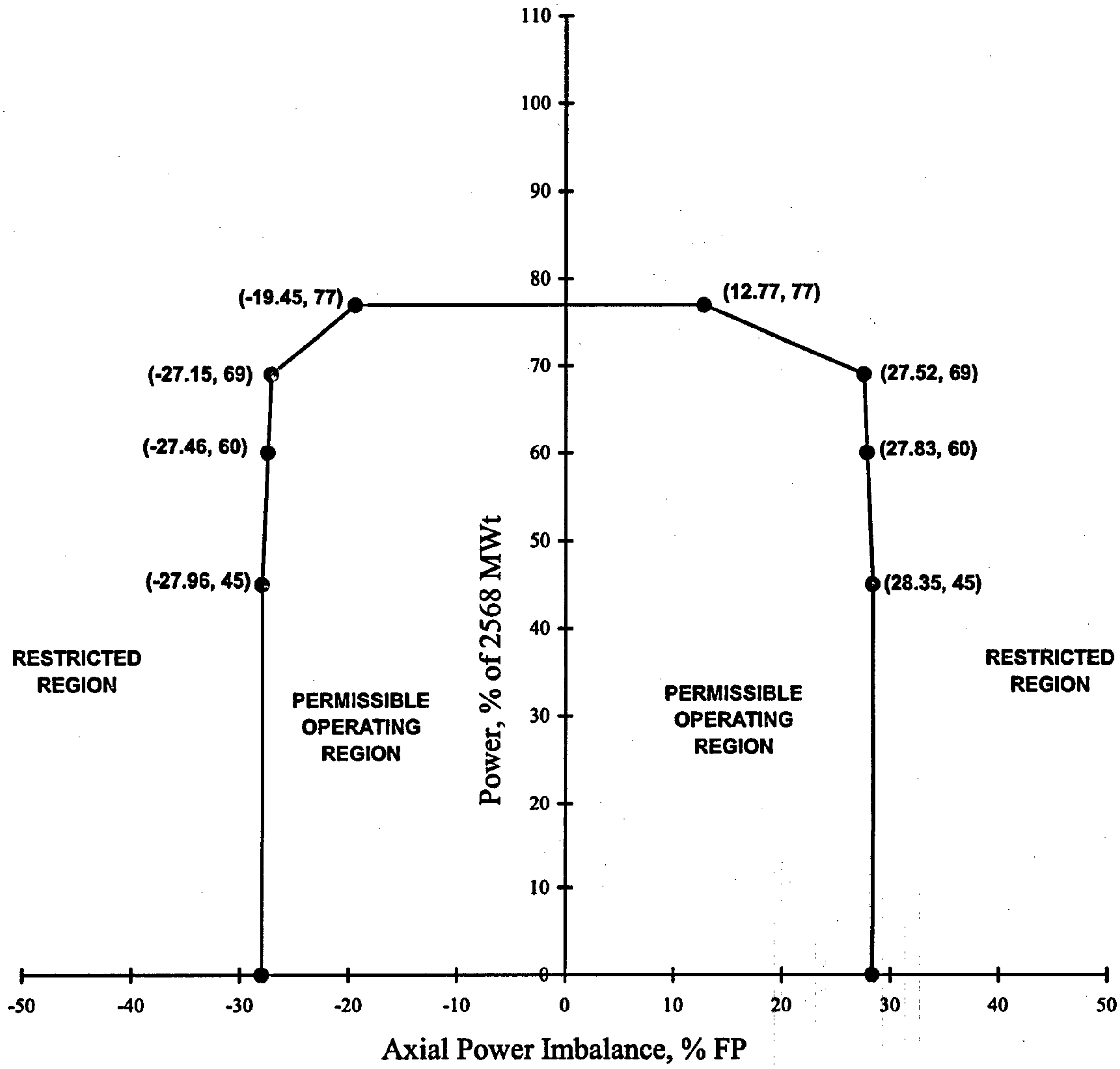


Figure 7-C(2)

AXIAL POWER IMBALANCE Setpoints for Ex-Core Conditions for Three-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)

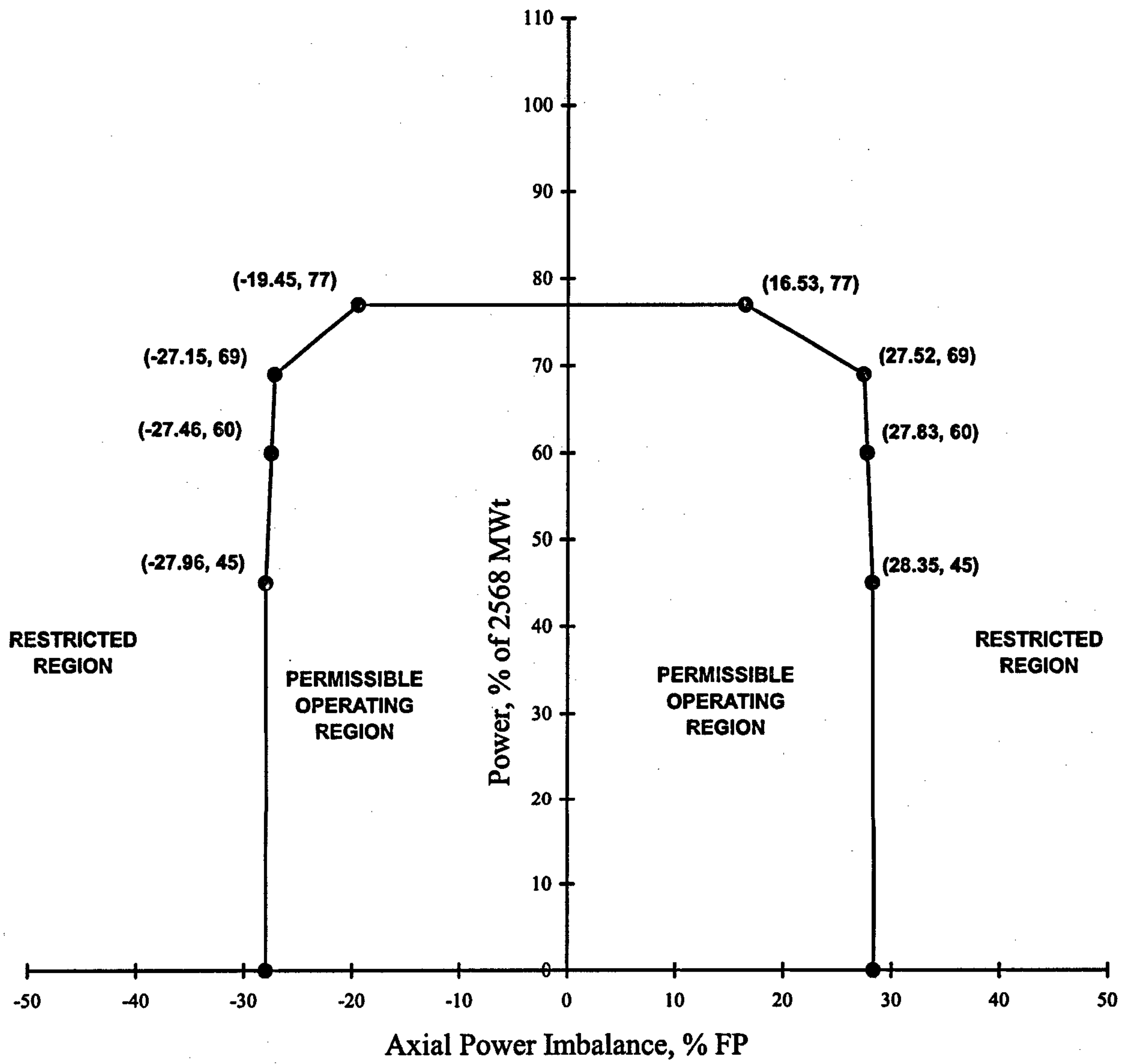


Figure 8-A(1)

AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Two-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

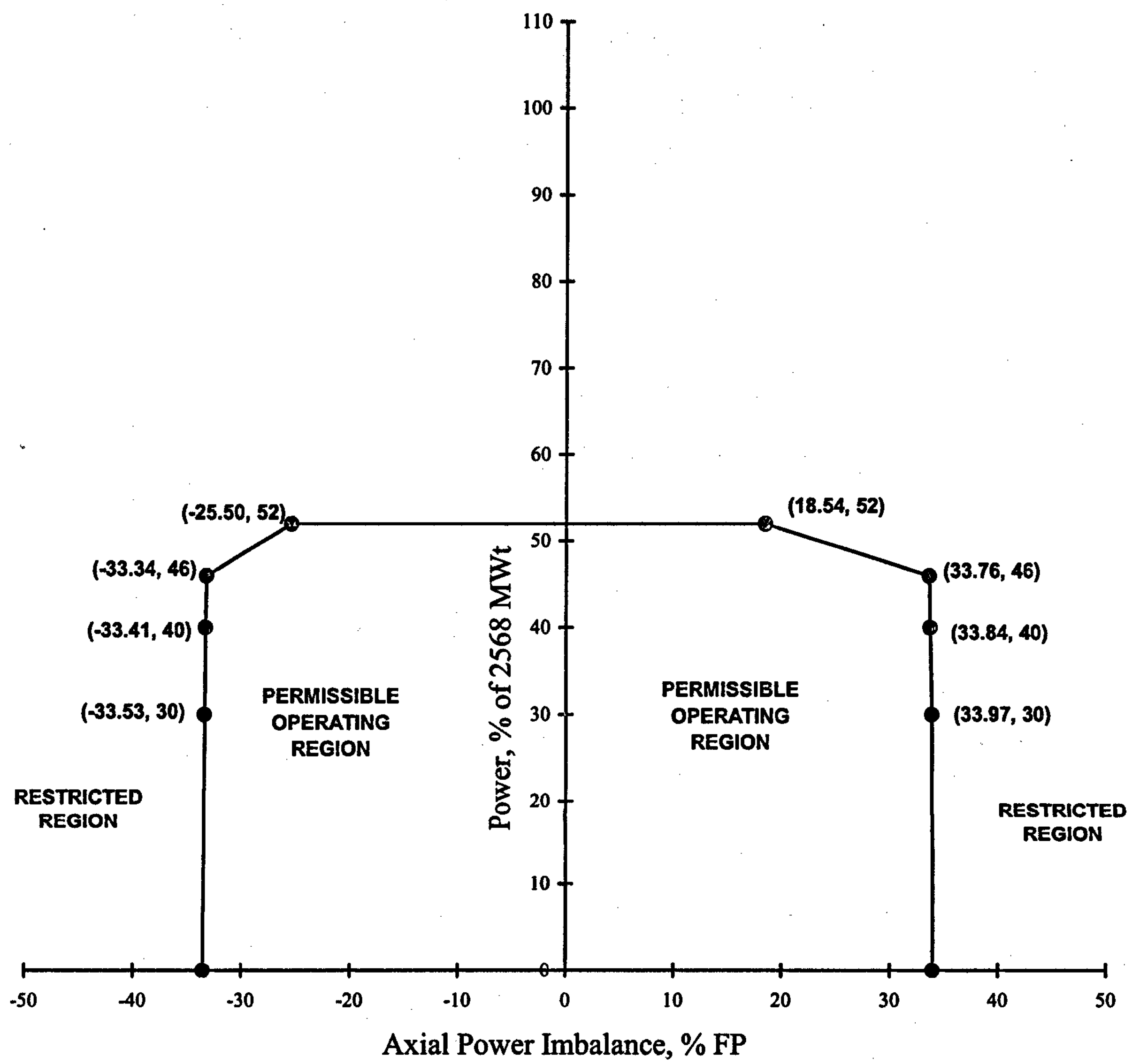


Figure 8-A(2)

AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Two-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)

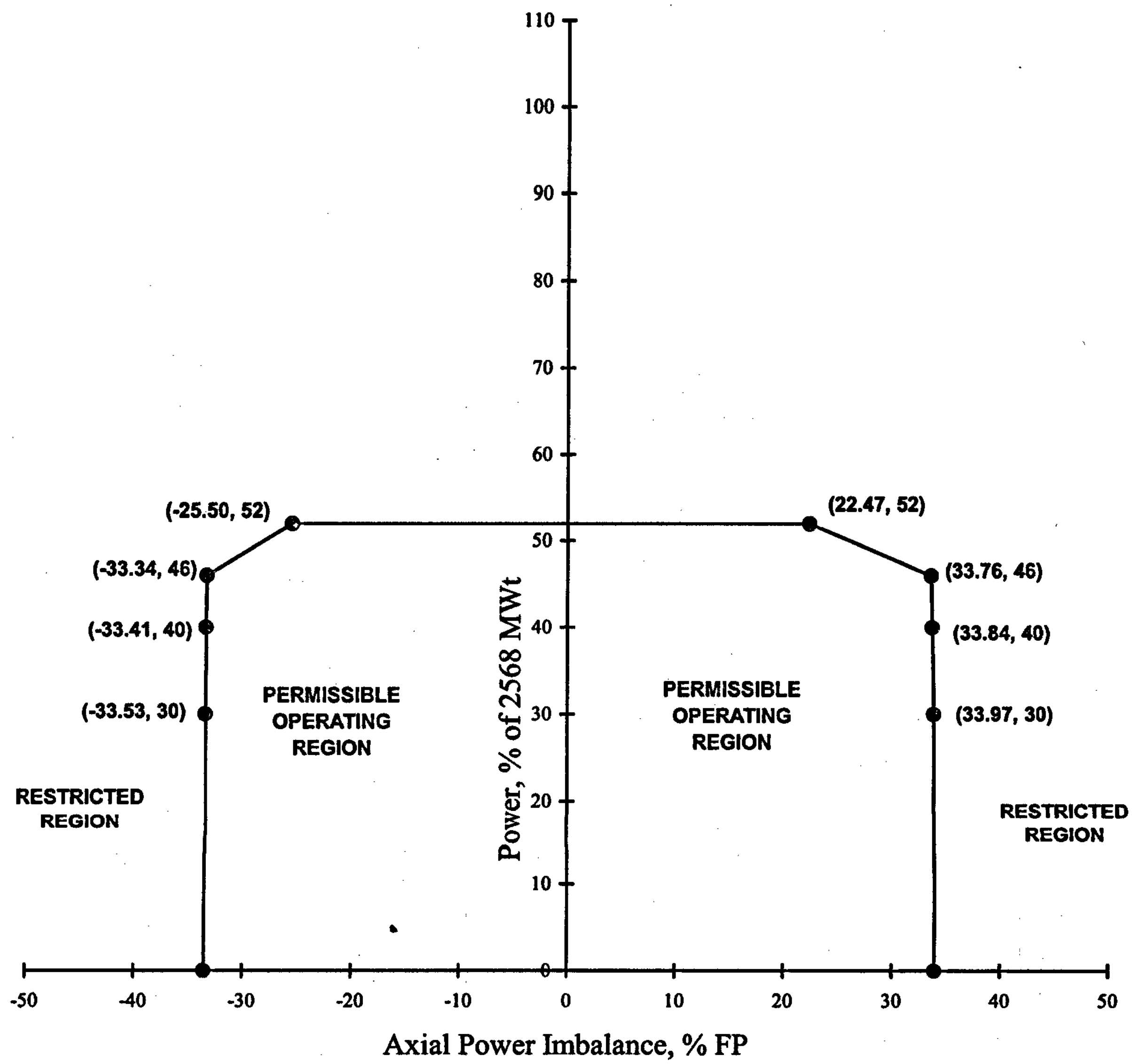
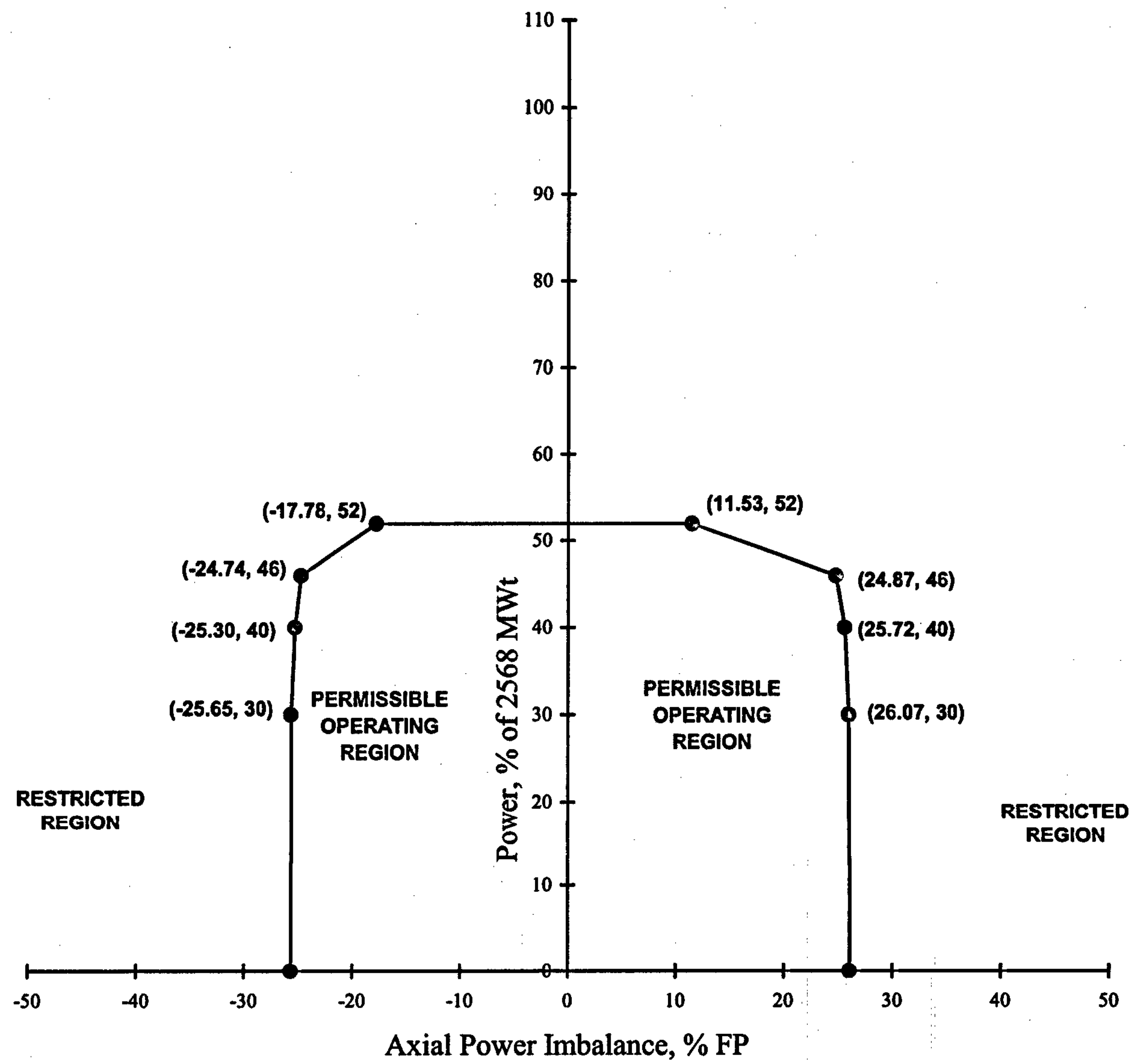


Figure 8-B(1)

AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions* for Two-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

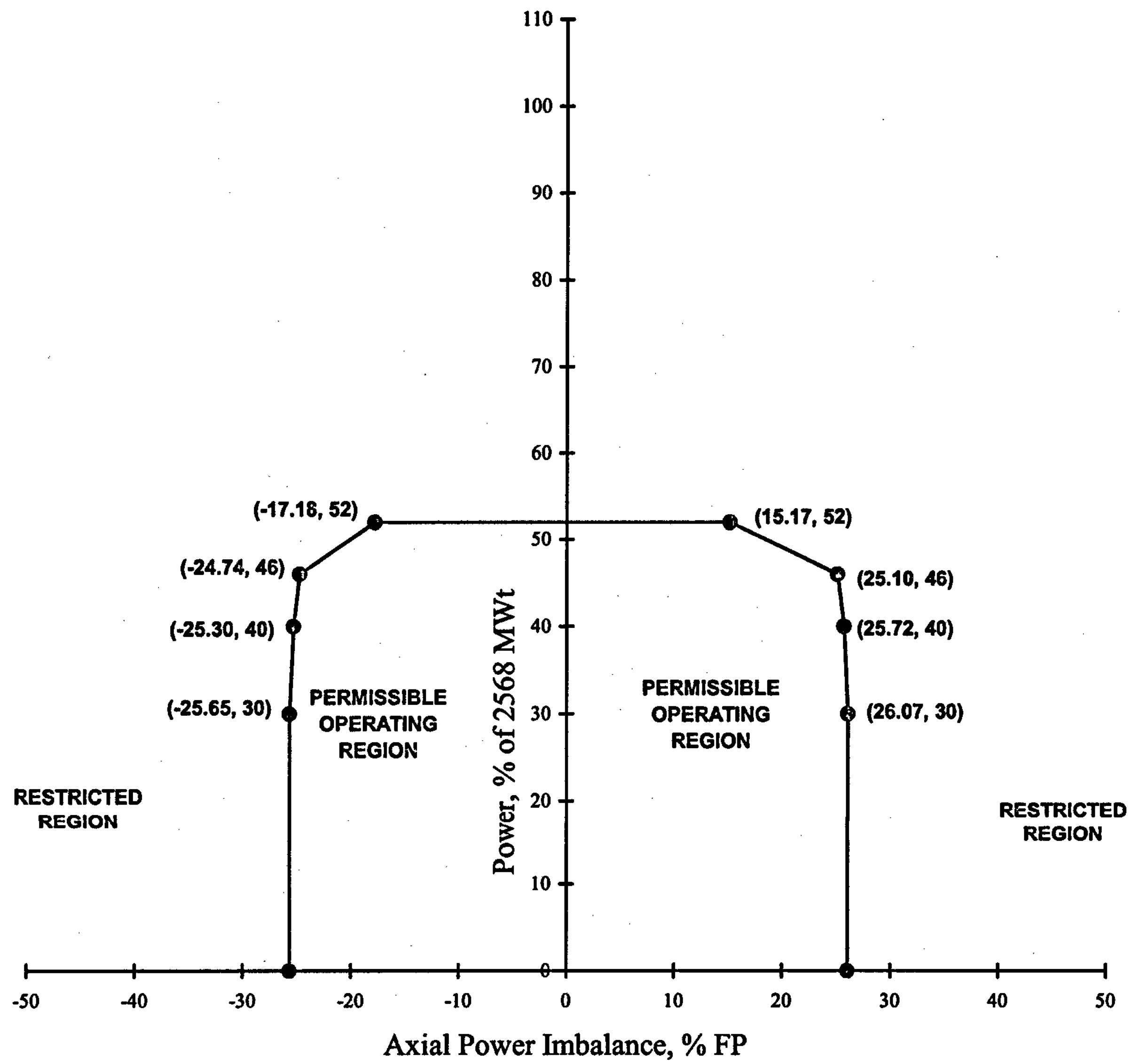


* Assumes that no individual short emitter detector affecting the minimum in-core imbalance calculation exceeds 60% sensitivity depletion, and that no individual long emitter detector exceeds 73% sensitivity depletion, or both. The imbalance setpoints for the *minimum in-core* system must be reduced by 2.80% FP at the earliest time-in-life that this assumption is no longer valid.

Figure 8-B(2)

AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions* for Two-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)



* Assumes that no individual short emitter detector affecting the minimum in-core imbalance calculation exceeds 60% sensitivity depletion, and that no individual long emitter detector exceeds 73% sensitivity depletion, or both. The imbalance setpoints for the minimum in-core system must be reduced by 2.80% FP at the earliest time-in-life that this assumption is no longer valid.

Figure 8-C(1)

AXIAL POWER IMBALANCE Setpoints for Ex-Core Conditions for Two-Pump Operation from 0 to 200 ± 10 EFPD

(Figure is referred to by Technical Specification 3.2.3)

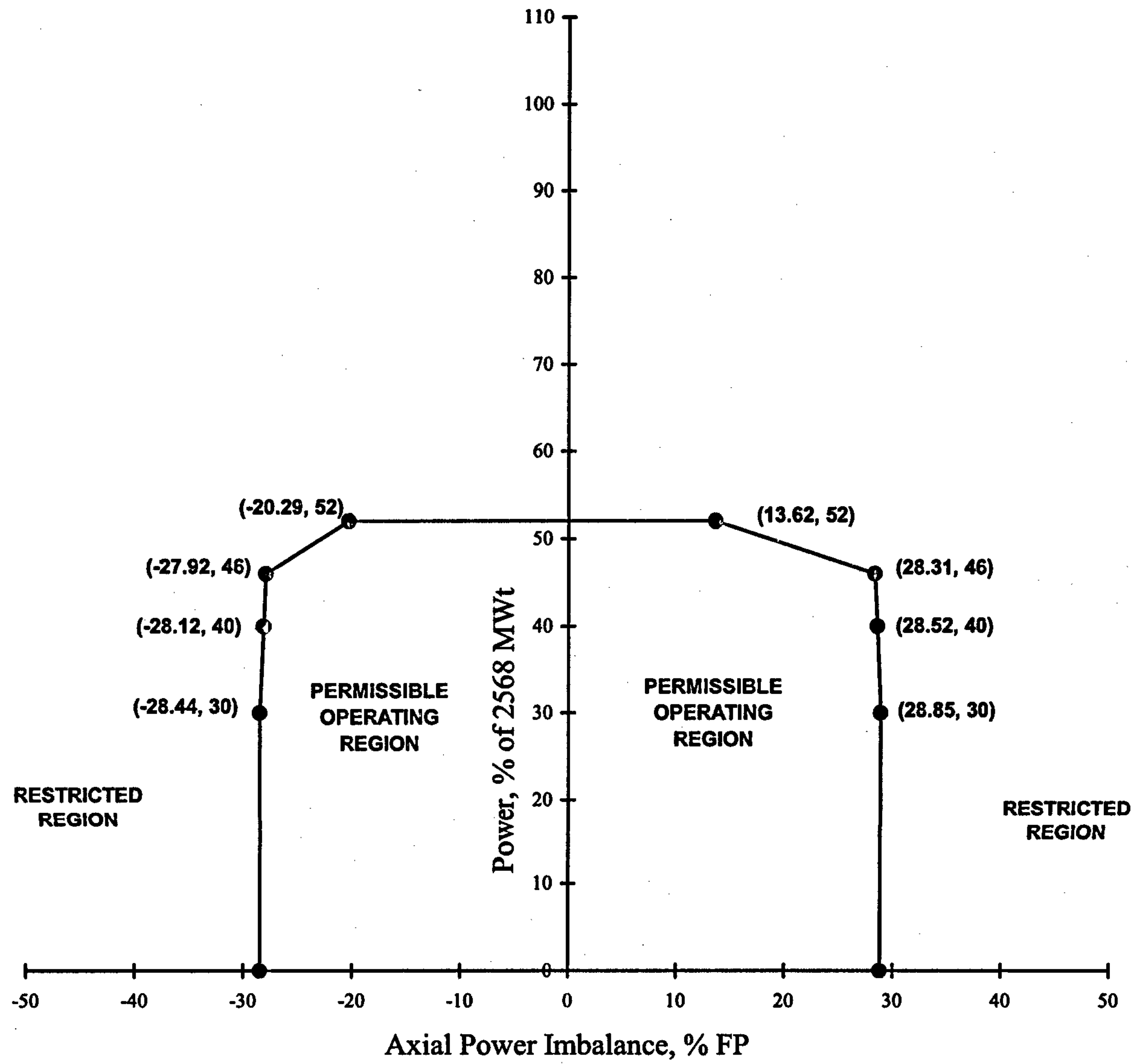


Figure 8-C(2)

AXIAL POWER IMBALANCE Setpoints for Ex-Core Conditions for Two-Pump Operation from 200 ± 10 EFPD to EOC

(Figure is referred to by Technical Specification 3.2.3)

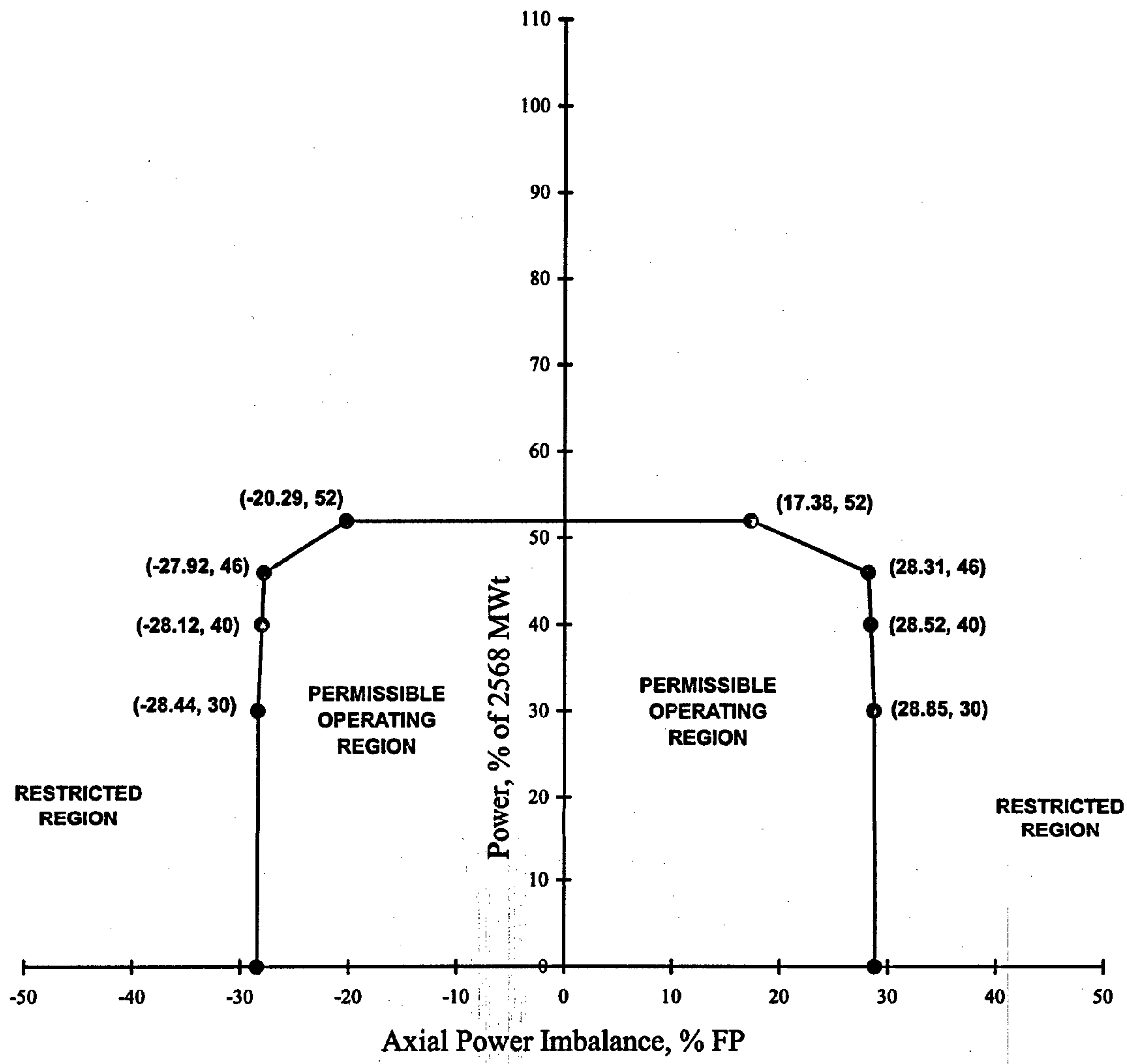


TABLE 3A-14

Quadrant Power Tilt Limits And Setpoints

(Limits are referred to by Technical Specification 3.2.4)

From 0 EFPD to EOC

Measurement System	Steady State Value (%)		Maximum Value (%)
	≤ 60 % FP	> 60 % FP	
Full In-core Detector System Setpoint	6.83	4.37	25.00
Minimum In-core Detector System Setpoint	2.78*	1.90*	25.00
Ex-core Power Range NI Channel Setpoint	4.05	1.96	25.00
Measurement System Independent Limit	7.50	4.92	25.00

* Assumes that no individual long emitter detector affecting the minimum in-core tilt calculation exceeds 73% sensitivity depletion. The setpoint must be reduced to 1.50% (power levels > 60% FP) and to 2.19% (power levels ≤ 60% FP) at the earliest time-in-life that this assumption is no longer valid.

Figure 9A

LOCA Linear Heat Rate Limits for Mark-B-HTP Fuel

(Figure is referred to by Technical Specification 3.1.8 and 3.2.5)

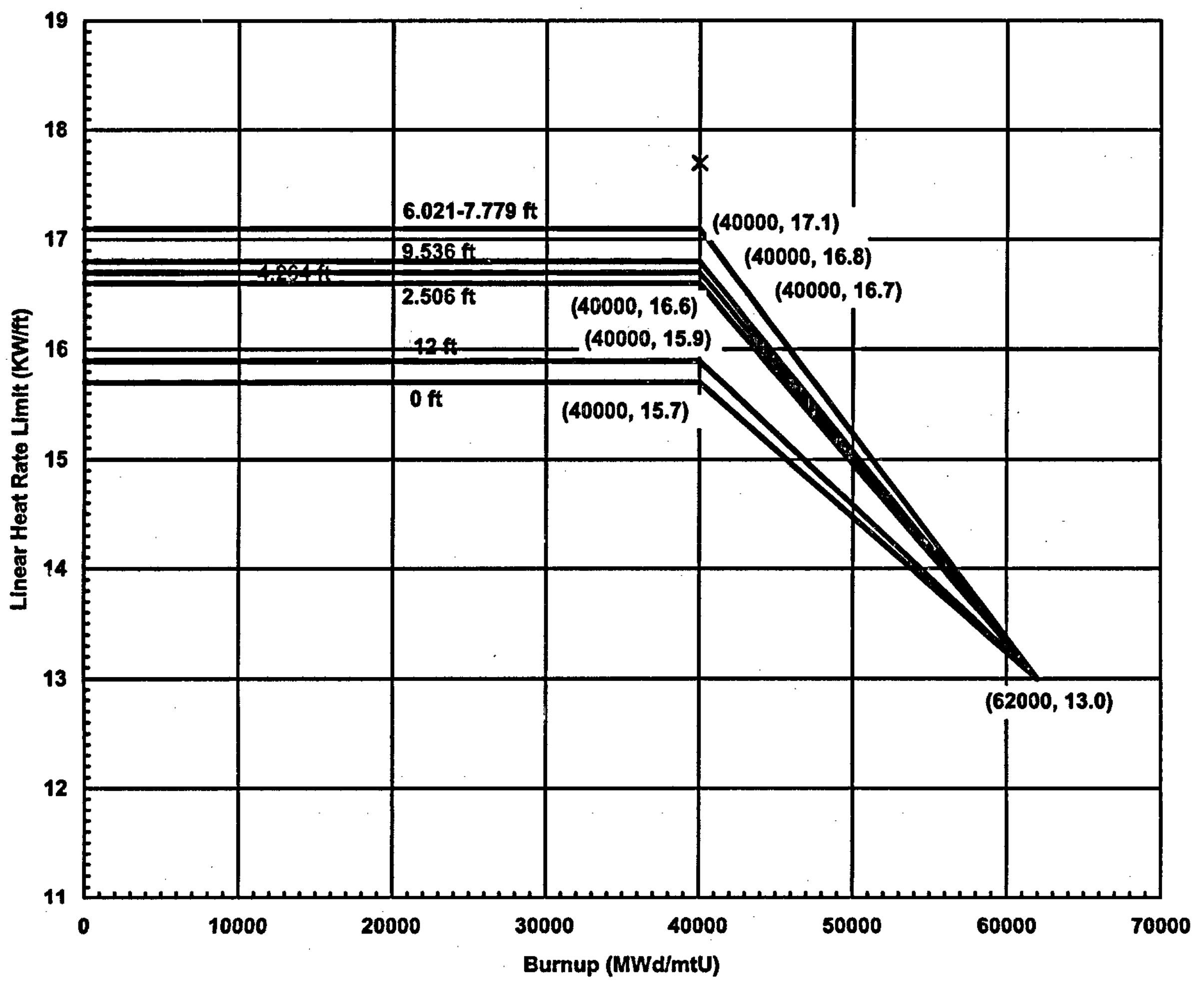
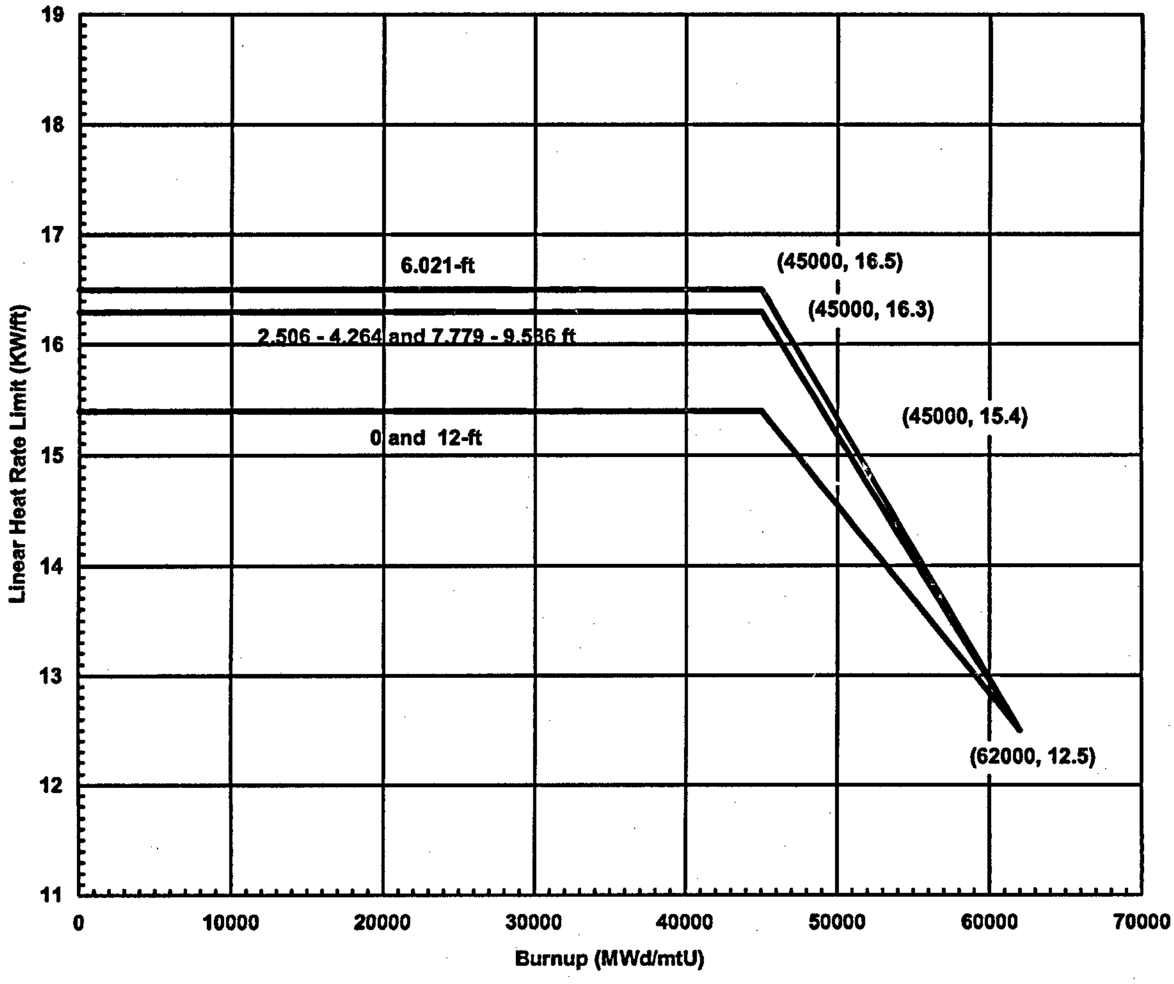


Figure 9B

LOCA Linear Heat Rate Limits for Mark-B9ZL Fuel

(Figure is referred to by Technical Specification 3.1.8 and 3.2.5)



DNB Power Peaking Factors

(Limits are referred to by Technical Specification 3.1.8 and 3.2.5)

The following total power peaking factors define the Maximum Allowable Peaking (MAP) limits to protect the initial conditions assumed in the DNB Loss of Flow transient analysis. The total power peaking factors for both the Mark-B9 and the Mark-B-HTP fuels are provided. The total power peaking factors for IC-DNB 4-pump and 3-pump are identical; hence one set of IC-DNB values are provided for both 4-pump and 3-pump operation.

Axial Peak	Axial Peak Location x/L	Mark-B-HTP IC MAP Limits	Mark-B9ZL IC MAP Limits
1.1	0.01	2.08970	---
	0.14	2.09061	---
	0.20	2.09081	2.036
	0.30	2.09080	---
	0.40	2.09048	2.029
	0.50	2.09030	---
	0.60	2.08995	2.016
	0.70	2.08979	---
	0.80	2.08866	1.988
	0.89	2.04041	---
	0.99	1.94602	---
1.2	0.01	2.38393	Axial Peak Not Evaluated
	0.14	2.38637	
	0.20	2.38711	
	0.30	2.38666	
	0.40	2.38616	
	0.50	2.38612	
	0.60	2.38553	
	0.70	2.30194	
	0.80	2.20190	
	0.89	2.13510	
	0.99	2.04448	
1.3	0.01	2.66050	---
	0.14	2.58201	---
	0.20	2.64238	2.535
	0.30	2.70551	---
	0.40	2.68966	2.506
	0.50	2.59373	---
	0.60	2.49505	2.411
	0.70	2.40470	---
	0.80	2.29341	2.252
	0.89	2.22210	---
	0.99	2.13400	---

IC-DNB Total Power Peaking Factors (Continued)

Axial Peak	Axial Peak Location x/L	Mark-B-HTP IC MAP Limits	Mark-B9ZL IC MAP Limits
1.4	0.01	2.68281	Axial Peak Not Evaluated
	0.14	2.58266	
	0.20	2.64487	
	0.30	2.74565	
	0.40	2.78466	
	0.50	2.69263	
	0.60	2.58415	
	0.70	2.49099	
	0.80	2.37534	
	0.89	2.30086	
	0.99	2.21159	
1.5	0.01	2.70611	---
	0.14	2.58407	---
	0.20	2.64723	2.973
	0.30	2.74950	---
	0.40	2.81333	2.786
	0.50	2.77586	---
	0.60	2.66315	2.596
	0.70	2.56832	---
	0.80	2.44935	2.422
	0.89	2.37414	---
	0.99	2.28275	---
1.6	0.01	2.72554	Axial Peak Not Evaluated
	0.14	2.58400	
	0.20	2.64915	
	0.30	2.75237	
	0.40	2.81854	
	0.50	2.84445	
	0.60	2.73470	
	0.70	2.63922	
	0.80	2.51853	
	0.89	2.44208	
	0.99	2.34902	
1.7	0.01	2.74462	---
	0.14	2.58449	---
	0.20	2.65108	3.117
	0.30	2.75329	---
	0.40	2.82309	2.921
	0.50	2.86702	---
	0.60	2.79623	2.727
	0.70	2.70161	---
	0.80	2.58298	2.560
	0.89	2.50578	---
	0.99	2.41376	---

IC-DNB Total Power Peaking Factors (Continued)

Axial Peak	Axial Peak Location x/L	Mark-B-HTP IC MAP Limits	Mark-B9ZL IC MAP Limits
1.8	0.01	2.76248	Axial Peak Not Evaluated
	0.14	2.58536	
	0.20	2.65100	
	0.30	2.75344	
	0.40	2.82636	
	0.50	2.87190	
	0.60	2.85278	
	0.70	2.75823	
	0.80	2.64208	
	0.89	2.56412	
	0.99	2.47374	
1.9	0.01	2.78038	---
	0.14	2.58548	---
	0.20	2.65223	3.237
	0.30	2.75356	---
	0.40	2.82802	3.024
	0.50	2.87614	---
	0.60	2.89110	2.841
	0.70	2.80738	---
	0.80	2.69523	2.675
	0.89	2.61744	---
	0.99	2.52919	---

Note - the values above are not error corrected.

The present T-H methodology allows for an increase in the design radial-local peak for power levels below 100% full power. The equations defining the multipliers are as follows:

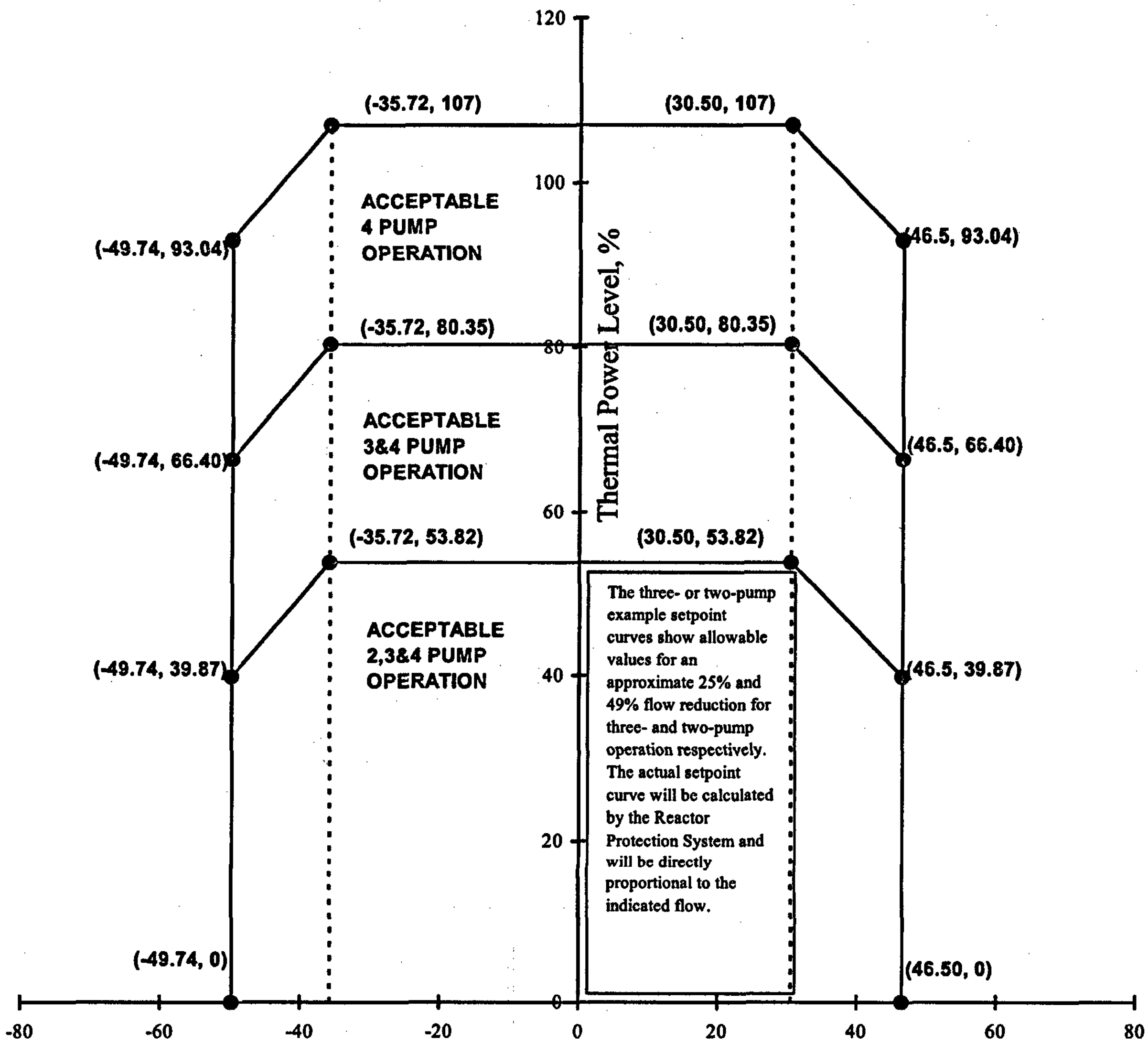
	$P/P_m = 1.00$	$P/P_m < 1.00$
MAP Multiplier	1.0	$1 + 0.3(1 - P/P_m)$

Where P = core power fraction, and
P_m = 1.00 for 4 pump operation, or
= 0.75 for 3 pump operation.

Figure 10

Reactor Protection System Maximum Allowable Setpoints for Axial Power Imbalance

(Figure is referred to by Technical Specification 2.1.1.1, 2.1.1.2, and 3.3.1)

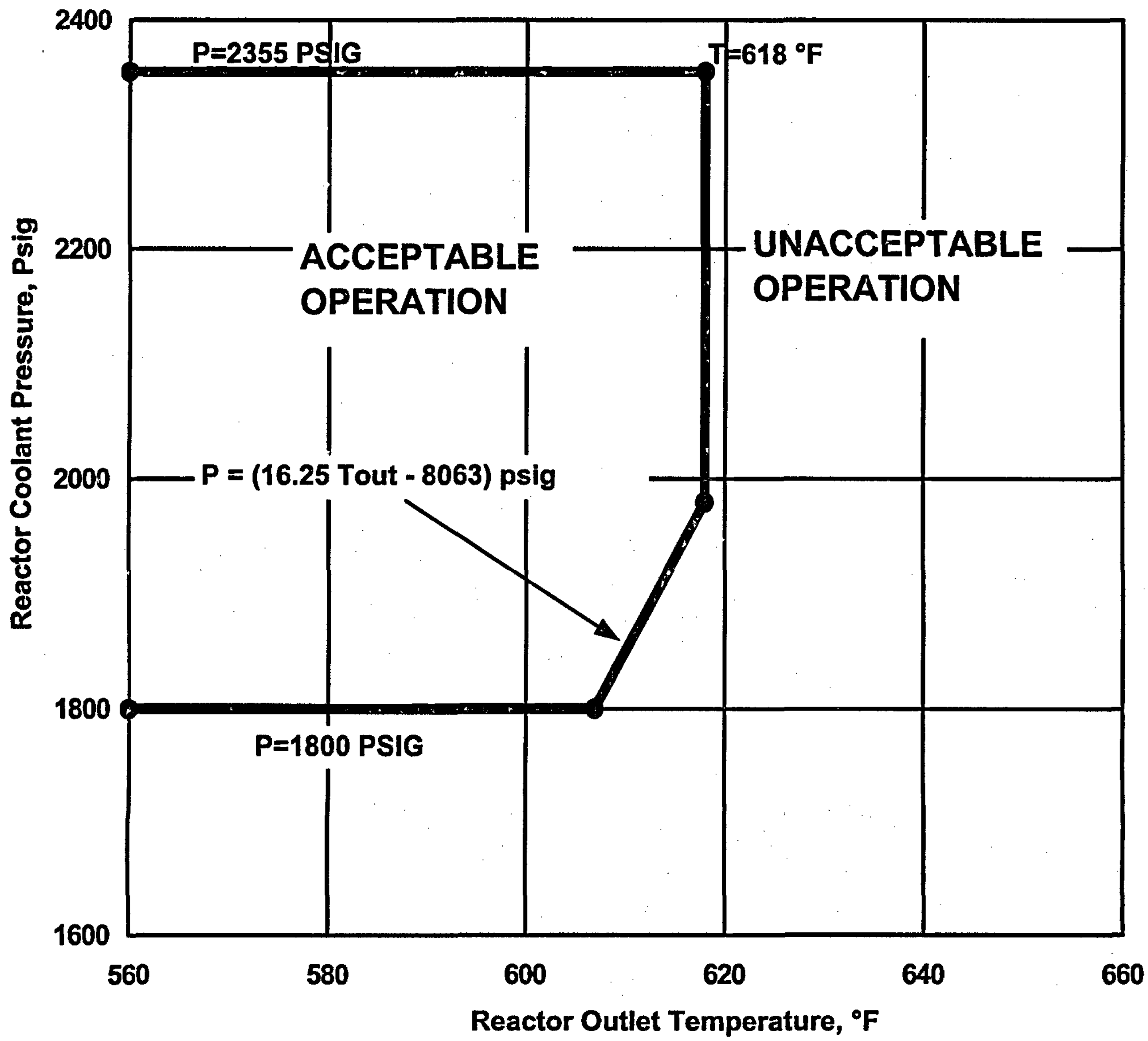


	Flux / Flow Setpoint (% Power / % Flow)
Four Pump Operation	1.07
Three Pump Operation	1.07
Two Pump Operation	1.07

Figure 11

Reactor Protection System Variable Low Pressure Temperature Envelope Setpoints

(Figure is referred to by Technical Specification 3.3.1)



RCS Pressure, Temperature, and Flow
DNB Surveillance Limits

(Limit is referred to by Technical Specification 3.4.1)

	Four-Pump Operation	Three-Pump Operation	Two-Pump Operation
Minimum RCS Hot Leg Pressure (psig) Note 1	2082.2	2081.2 Note 4 2120.4 Note 5	2118.1
Maximum RCS Hot Leg Temperature (°F) Note 2	602.85	603.15	603.4
Minimum RCS Total Flow (Mlb_m/hr) Note 3	143.36 Note 6 138.01 Note 9	106.46 Note 7 102.45 Note 9	70.64 Note 8 67.96 Note 9

Note 1 -- Using individual indications P1021, P1023, P1038 and P1039 (or equivalent) from the plant computer.

Note 2 -- Using individual indications T1011NR, T1014NR, T1039NR, T1042NR, T1012, T1013, T1040 and T1041 or averages TOUTA, XTOUTA, TOUTB, XTOUTB, TOUT, XTOUT from the plant computer.

Note 3 -- Using indication WRCFT (or equivalent) from the plant computer, and can be linearly interpolated between these values provided the T_{ave} versus Power level curve is followed.

Note 4 -- Applies to the RCS loop with two RCPs operating.

Note 5 -- Applies to the RCS loop with one RCP operating.

Note 6 -- For T_{cold} = 556.57° F.

Note 7 -- For T_{cold} = 556.3° F.

Note 8 -- For T_{cold} = 556.1° F.

Note 9 -- For T_{cold} = 580° F.

RCS Loops – Mode 1 and Mode 2

(Limit is referred to by Technical Specification 3.4.4)

	Nominal Operating Power Level (% Power)
Four Pump Operation	100
Three Pump Operation	75
Two Pump Operation*	49

* Technical Specification 3.4.4 does not allow indefinite operation in Modes 1 and 2 with only two pumps operating.

Refueling Boron Concentration

(Limit is referred to by Technical Specification 3.9.1)

The minimum required boron concentration (which includes uncertainties) for use during refueling as a function of EFPD is:

EOC 19 EFPD	ppm
488	2301
490	2297
492	2293
494	2289
496	2285
498	2281
500	2277
502	2273
504	2269