



Entergy

Entergy Operations, Inc.  
1448 S R 333  
Russellville, AR 72802  
Tel 501 858 5000

1CAN100201

October 10, 2002

U. S. Nuclear Regulatory Commission  
Document Control Desk  
Mail Station OP1-17  
Washington, DC 20555

Subject: Arkansas Nuclear One - Unit 1  
Docket No. 50-313  
License No. DPR-51  
ANO-1 Cycle 18 COLR

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 18 COLR. Please note that the approved revision number of the Babcock and Wilcox Topical Report BAW-10179P-A is identified in the COLR as August 2001. 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,

Sherrie R. Cotton  
Director, Nuclear Safety Assurance

SRC/dbb

Attachment: ANO-1 Cycle 18 Core Operating Limits Report (COLR)

A001

cc: Mr. Ellis W. Merschoff  
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

Mr. William Reckley  
NRR Project Manager Region IV/ANO-1  
U. S. Nuclear Regulatory Commission  
NRR Mail Stop O-7 D1  
One White Flint North  
11555 Rockville Pike  
Rockville, MD 20852

**Attachment**

**ANO-1 Cycle 18 Core Operating Limits Report (COLR)**

# ENTERGY OPERATIONS

ARKANSAS NUCLEAR ONE  
UNIT ONE

CYCLE 18

## **CORE OPERATING LIMITS REPORT**

## 1.0 CORE OPERATING LIMITS

This Core Operating Limits Report for ANO-1 Cycle 18 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 reference.

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

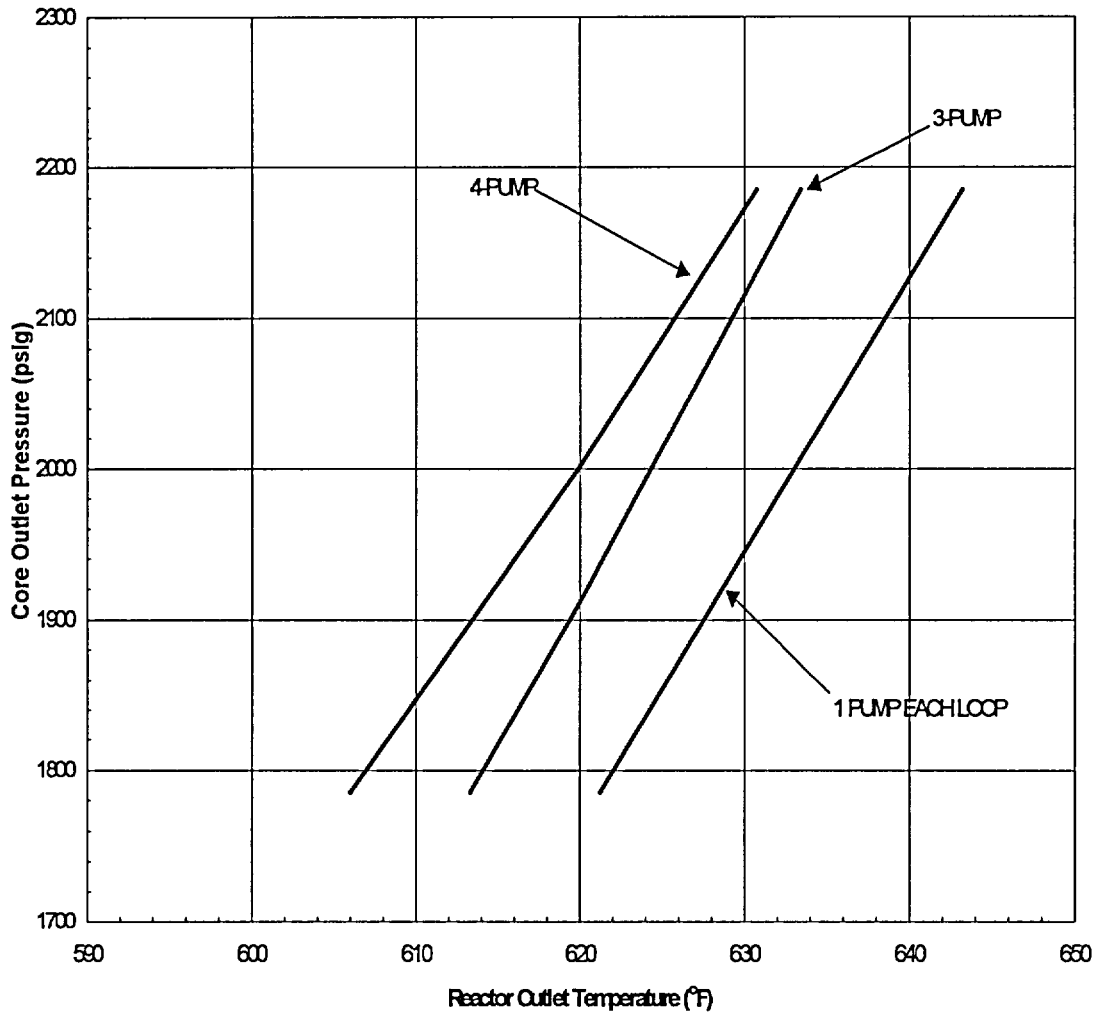
1. "Safety Criteria and Methodology for Acceptable Cycle Reload Analysis," BAW-10179P-A, Rev. 4, Framatome ANP, Lynchburg, Virginia, August 2001.
2. Letter dated 4/9/02 from L W. Barnett USNRC to J.M. Mallay FRA-ANP, "Safety Evaluation of Framatome Technologies Topical Report BAW-10164P Revision 4, 'RELAP5/MOD2- 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.

Table Of Contents

	<u>Page</u>
<b>REACTOR CORE SAFETY LIMITS</b>	
Fig 1 Variable Low RCS Pressure-Temperature Protective Limits .....	4
Fig 2 AXIAL POWER IMBALANCE protective Limits .....	5
<b>SHUTDOWN MARGIN (SDM) .....</b>	<b>6</b>
<b>REGULATING ROD INSERTION LIMITS</b>	
Fig 3-A Regulating Rod Insertion Limits for Four-Pump Operation From 0 to 200 ± 10 EFPD .....	7
Fig 3-B Regulating Rod Insertion Limits for Four-Pump Operation From 200 ± 10 EFPD to EOC .....	8
Fig 4-A Regulating Rod Insertion Limits for Three-Pump Operation From 0 to 200 ± 10 EFPD .....	9
Fig 4-B Regulating Rod Insertion Limits for Three-Pump Operation From 200 ± 10 EFPD to EOC .....	10
Fig 5-A Regulating Rod Insertion Limits for Two-Pump Operation From 0 to 200 ± 10 EFPD .....	11
Fig. 5-B Regulating Rod Insertion Limits for Two-Pump Operation From 200 ± 10 EFPD to EOC .....	12
<b>AXIAL POWER SHAPING RODS (APSR) INSERTION LIMITS .....</b>	<b>13</b>
<b>AXIAL POWER IMBALANCE OPERATING LIMITS</b>	
Fig 6-A AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Four-Pump Operation .....	14
Fig 6-B AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions for Four-Pump Operation .....	15
Fig. 6-C AXIAL POWER IMBALANCE Setpoints for Ex-Core Conditions for Four-Pump Operation .....	16
Fig. 7-A AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Three-Pump Operation .....	17
Fig 7-B AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions for Three-Pump Operation .....	18
Fig 7-C AXIAL POWER IMBALANCE Setpoints for Ex-Core Conditions for Three-Pump Operation .....	19
Fig 8-A AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Two-Pump Operation .....	20
Fig 8-B AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions for Two-Pump Operation .....	21
Fig 8-C AXIAL POWER IMBALANCE Setpoints for Ex-Core Conditions for Two-Pump Operation .....	22
<b>QUADRANT POWER TILT LIMITS AND SETPOINTS .....</b>	<b>23</b>
<b>POWER PEAKING FACTORS</b>	
Fig 9 LOCA Linear Heat Rate Limits .....	24
DNB Power Peaking Factors .....	25
<b>REACTOR PROTECTION SYSTEM (RPS) INSTRUMENTATION</b>	
Fig. 10 RPS Maximum Allowable Setpoints for Axial Power Imbalance .....	26
Fig. 11 RPS Variable Low Pressure Temperature Envelope Setpoints .....	27
<b>RCS PRESSURE, TEMPERATURE, AND FLOW DNB SURVEILLANCE LIMITS .....</b>	<b>28</b>
<b>RCS LOOPS MODE 1 AND 2 .....</b>	<b>29</b>
<b>REFUELING BORON CONCENTRATION .....</b>	<b>30</b>

Figure is referred to by  
 Technical Specification 2.1.1.3

Figure 1. Variable Low RCS Pressure--Temperature Protective Limits

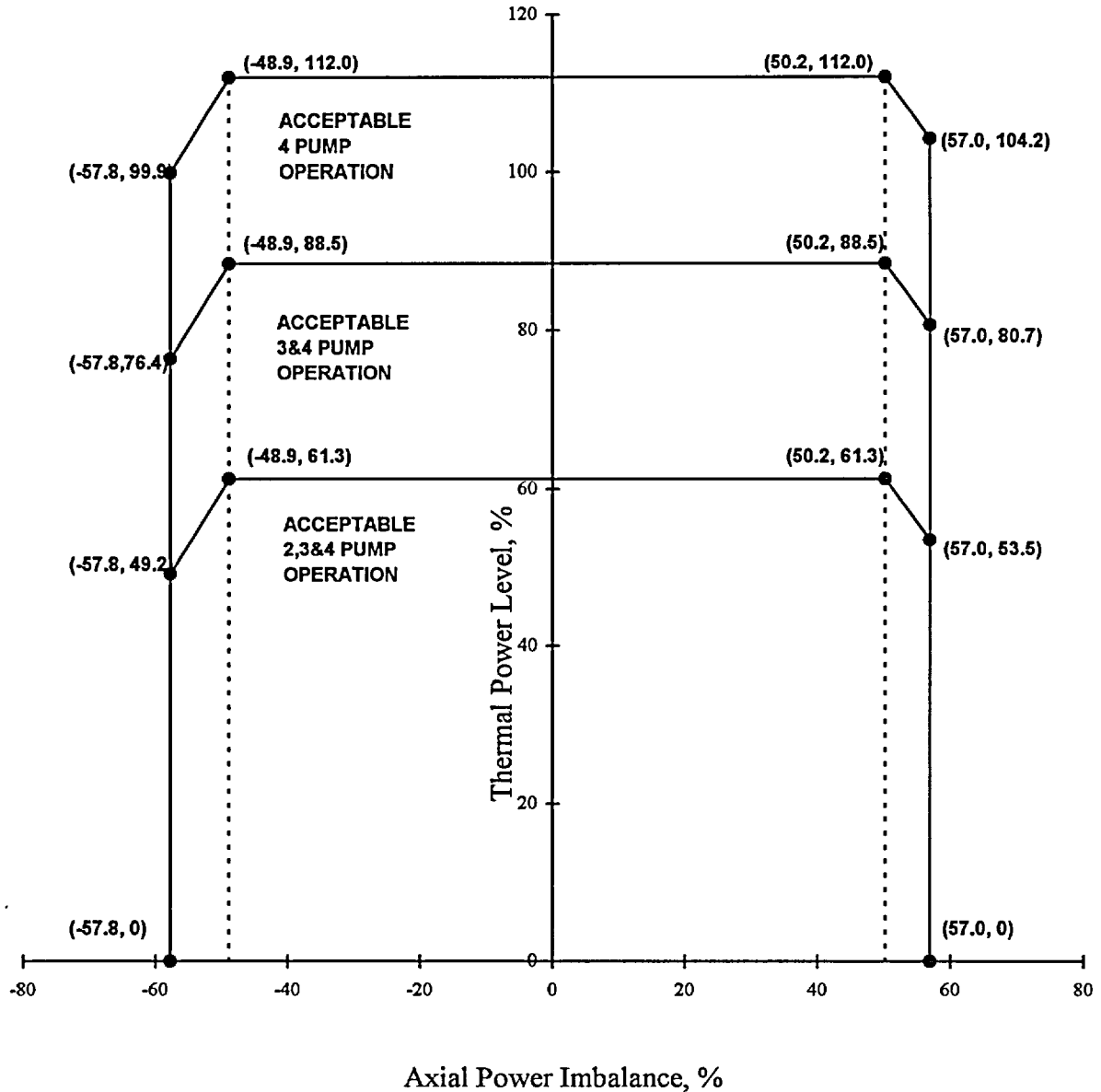


<u>PUMPS OPERATING (TYPE OF LIMIT)</u>	<u>GPM*</u>	<u>POWER**</u>
Four Pumps (DNBR Limit)	369,600 (100%)	110%
Three Pumps (DNBR Limit)	276,091 (74.7%)	89%
One Pump in Each Loop (DNBR Limit)	181,104 (49%)	62.2%

\* 105% of Design Flow (2.5% UNCERTAINTY INCLUDED IN STATISTICAL DESIGN LIMIT)  
 \*\*AN ADDITIONAL 2% POWER UNCERTAINTY IS INCLUDED IN STATISTICAL DESIGN LIMIT

Figure is referred to by  
Technical Specification 2.1.1 Bases

Figure 2. AXIAL POWER IMBALANCE Protective Limits  
(measurement system independent)





**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**

**SHUTDOWN MARGIN (SDM)**

Verify SHUTDOWN MARGIN per the table below.

<b>APPLICABILITY</b>	<b>REQUIRED SHUTDOWN MARGIN</b>	<b>TECHNICAL SPECIFICATION REFERENCE</b>
MODE 1	$\geq 1 \% \Delta k/k$	3.1.4, 3.1.5
MODE 2	$\geq 1 \% \Delta k/k$	3.1.4, 3.1.5, 3.3.9
MODE 3*	$\geq 1 \% \Delta k/k$	3.1.1, 3.3.9
MODE 4*	$\geq 1 \% \Delta k/k$	3.1.1, 3.3.9
MODE 5*	$\geq 1 \% \Delta k/k$	3.1.1, 3.3.9
MODE 1 PHYSICS TESTS Exceptions*	$\geq 1 \% \Delta k/k$	3.1.8
MODE 2 PHYSICS TESTS Exceptions	$\geq 1 \% \Delta k/k$	3.1.9

\*Requires actual shutdown margin to be  $\geq 1 \% \Delta k/k$ .

Figure is referred to by  
Technical Specification 3.2.1

Figure 3-A. Regulating Rod Insertion Limits for Four-Pump Operation From 0 to  $200 \pm 10$  EFPD

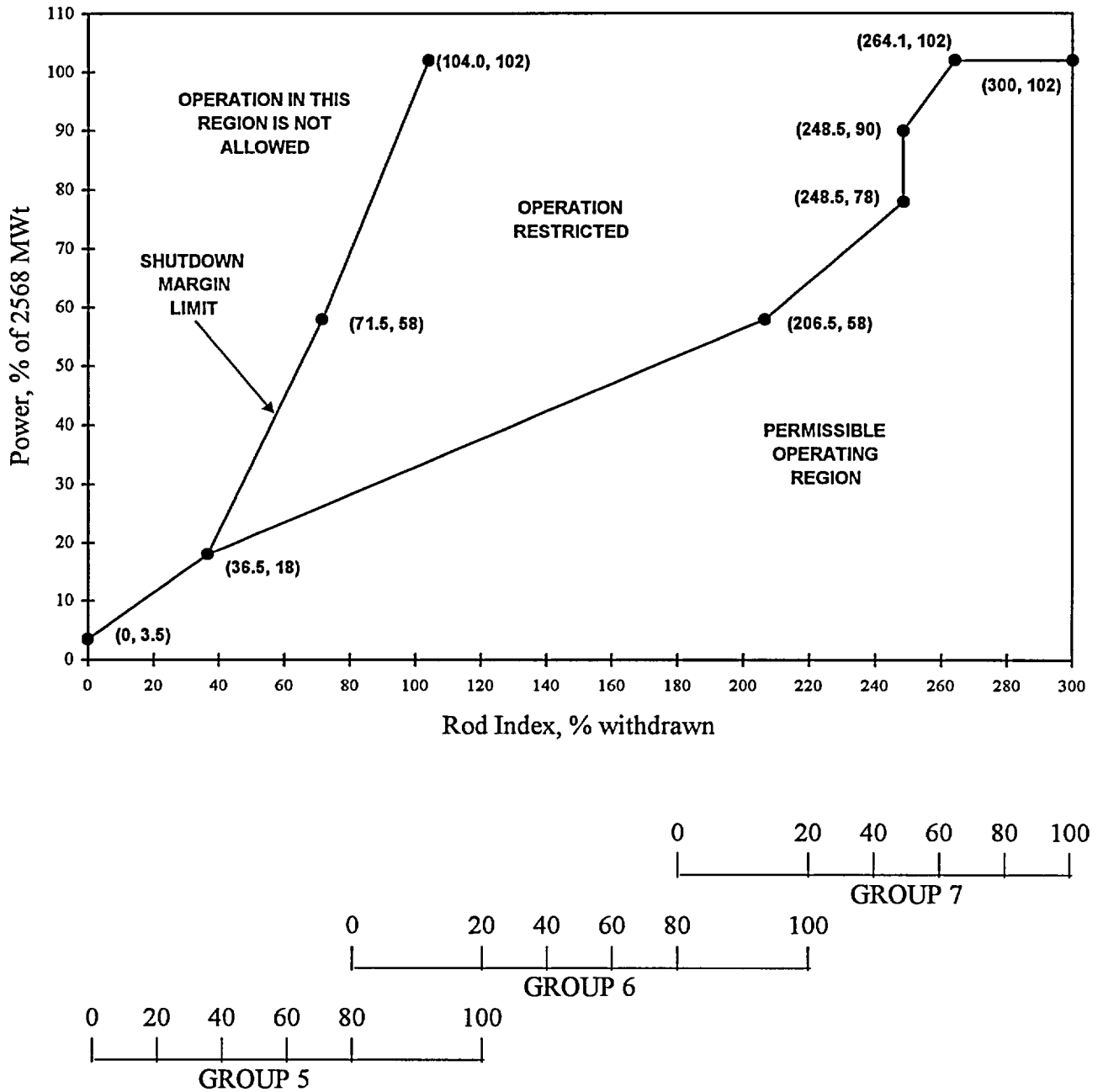


Figure is referred to by  
 Technical Specification 3.2.1

Figure 3-B. Regulating Rod Insertion Limits for Four-Pump Operation From  $200 \pm 10$  EFPD to EOC

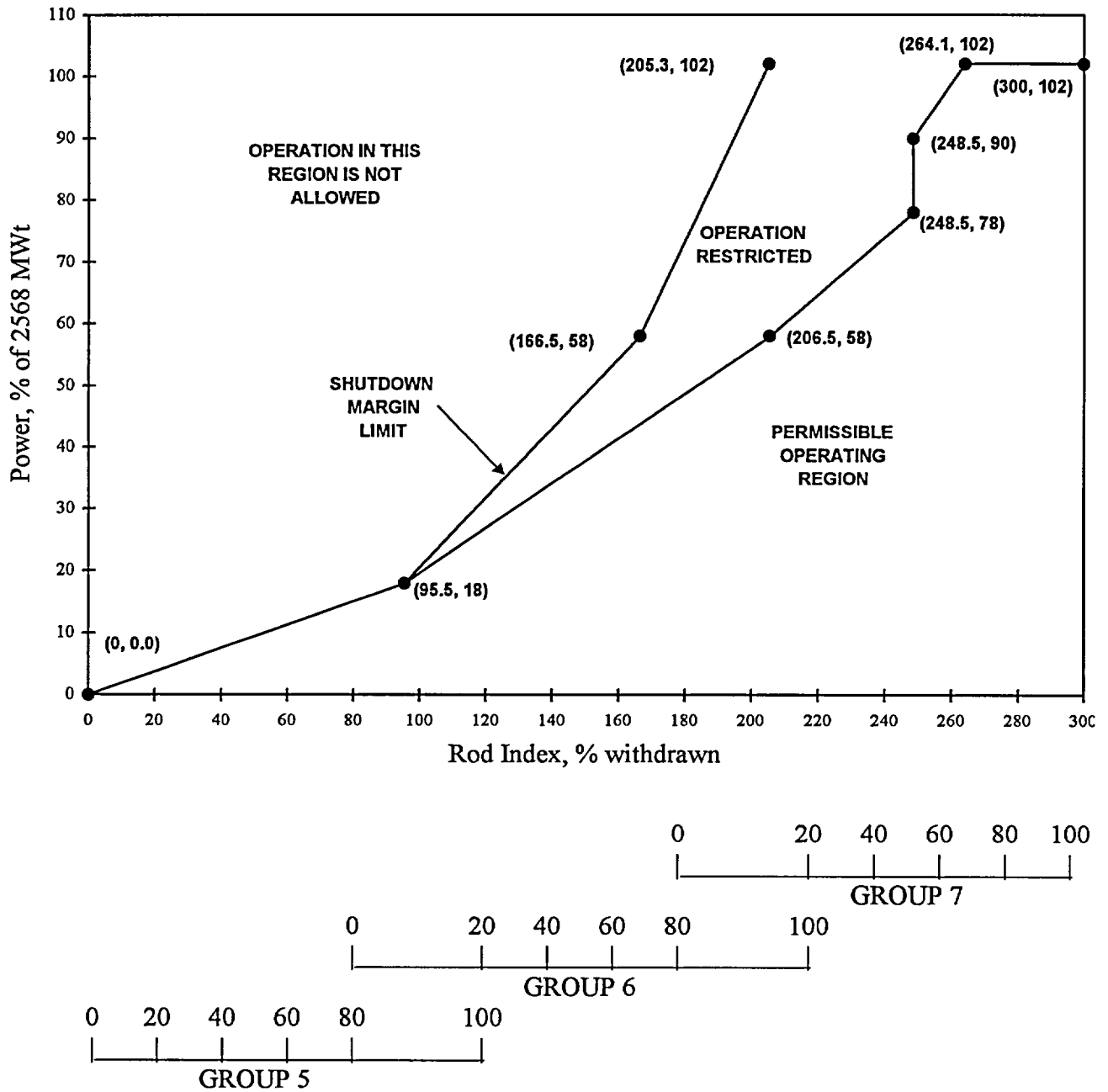


Figure is referred to by  
 Technical Specification 3.2.1

Figure 4-A. Regulating Rod Insertion Limits for Three-Pump Operation  
 From 0 to  $200 \pm 10$  EFPD

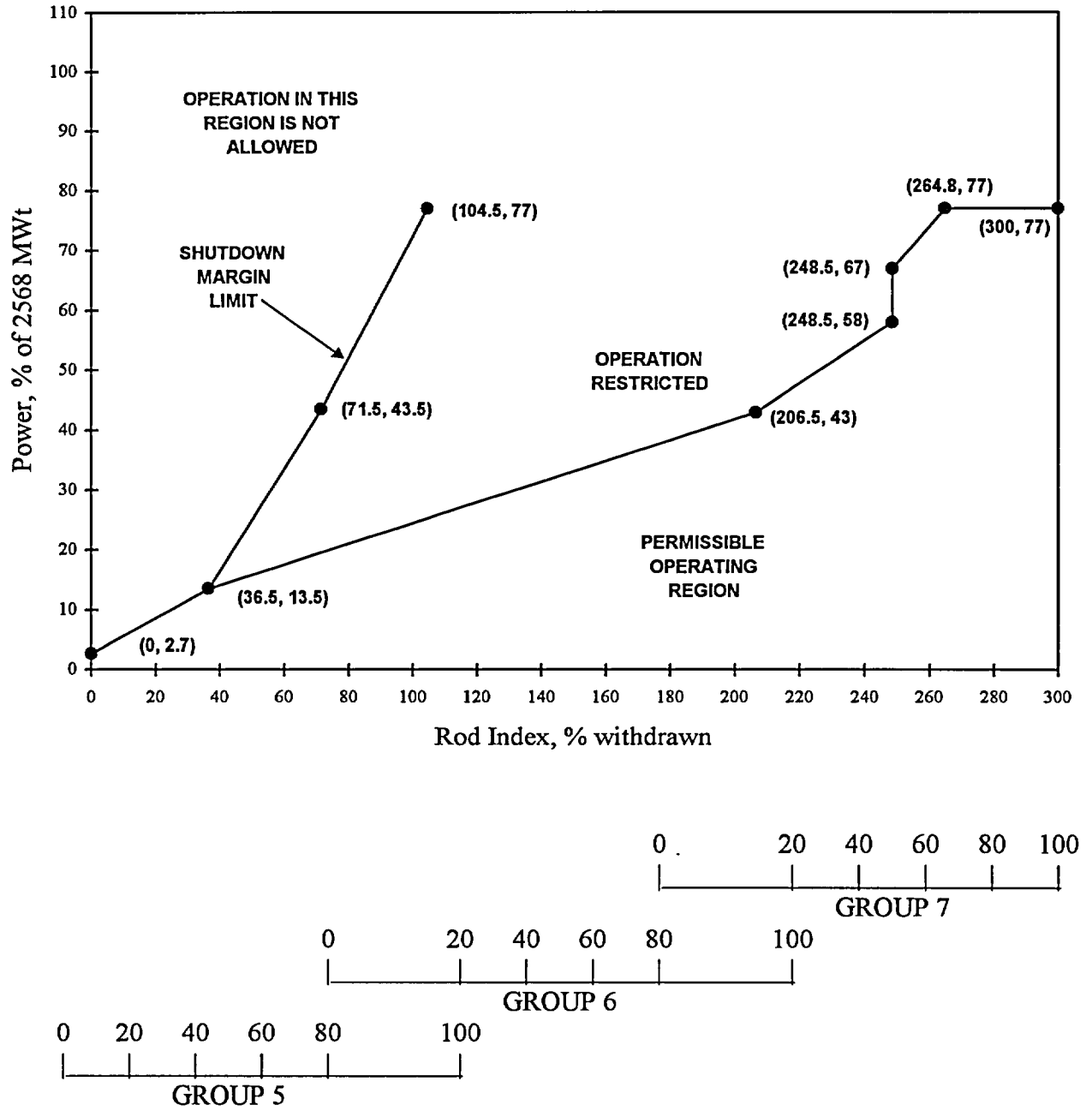


Figure is referred to by  
Technical Specification 3.2.1

Figure 4-B. Regulating Rod Insertion Limits for Three-Pump Operation  
From  $200 \pm 10$  EFPD to EOC

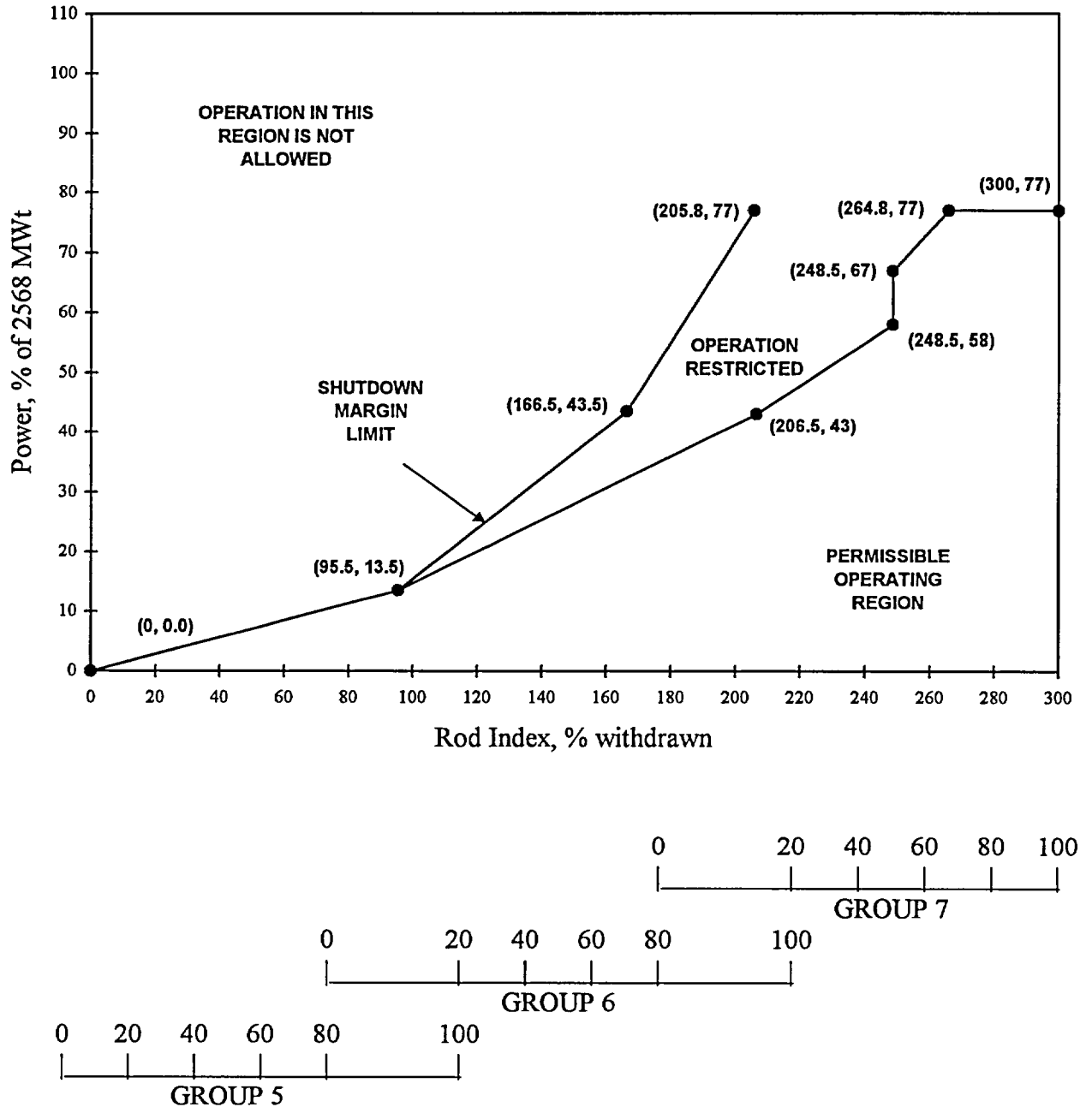


Figure is referred to by  
 Technical Specification 3.2.1

Figure 5-A. Regulating Rod Insertion Limits for Two-Pump Operation  
 From 0 to  $200 \pm 10$  EFPD

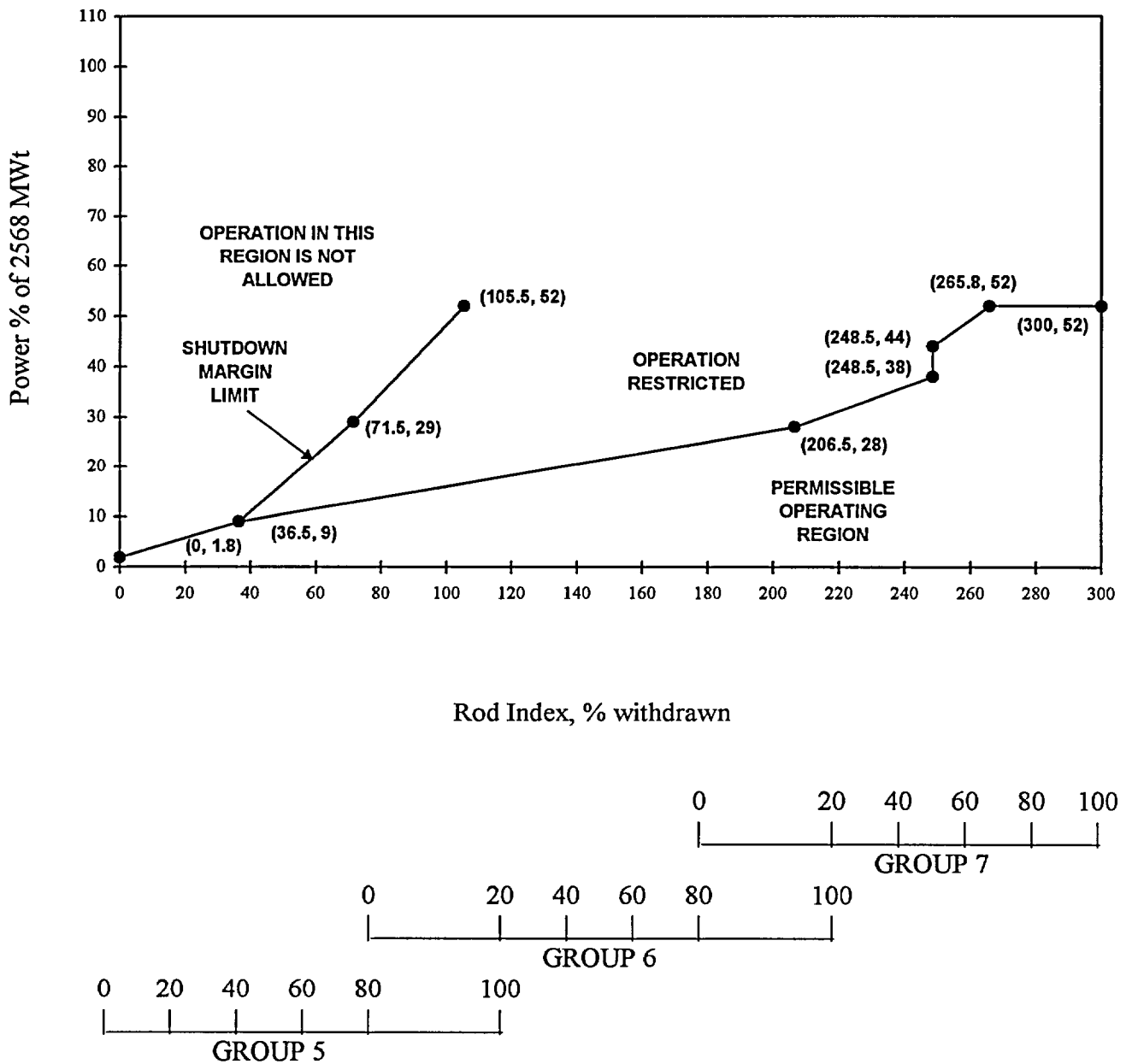
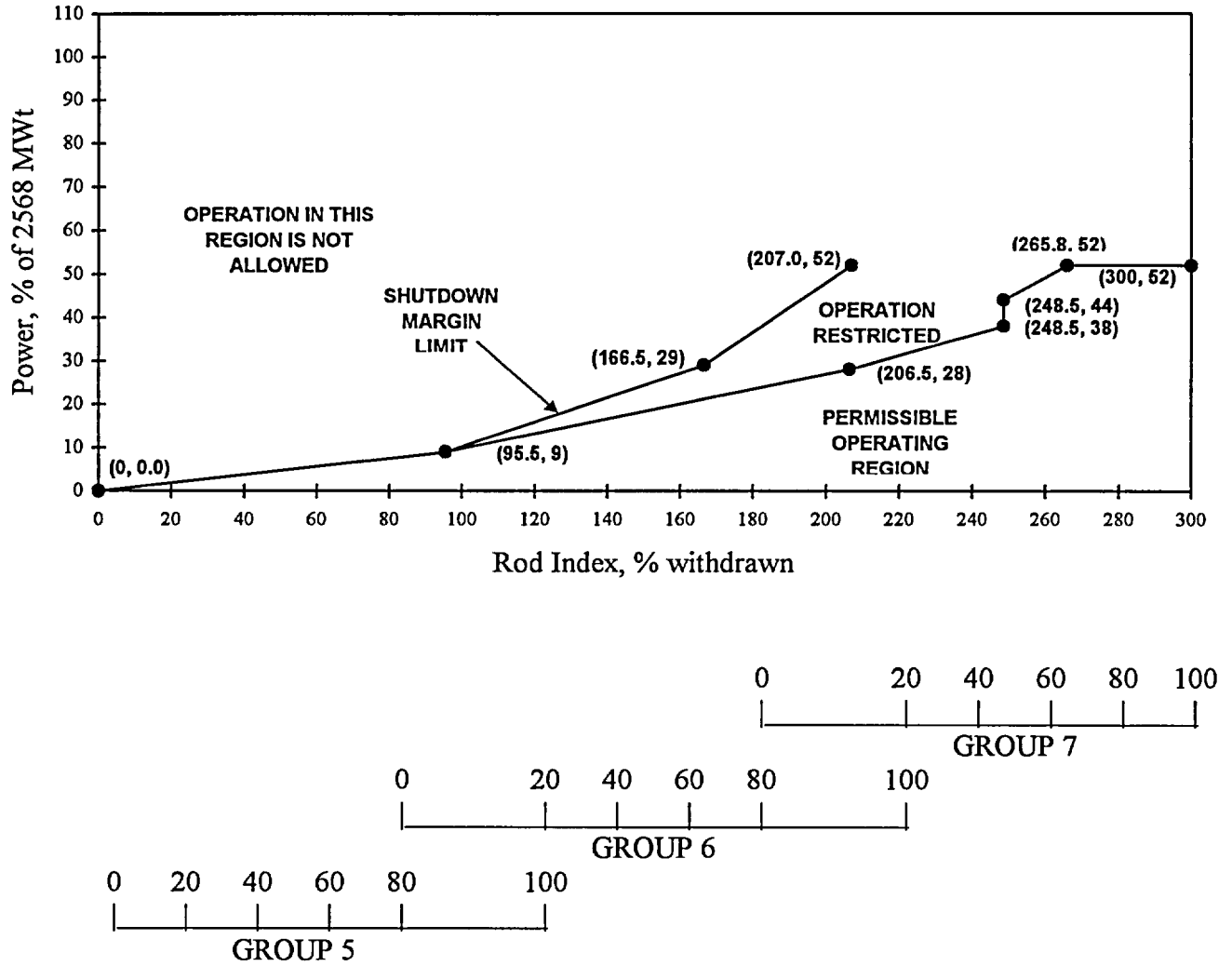


Figure is referred to by  
Technical Specification 3.2.1

Figure 5-B. Regulating Rod Insertion Limits for Two-Pump Operation  
From  $200 \pm 10$  EFPD to EOC



**LIMITS ARE REFERRED TO BY  
TECHNICAL SPECIFICATION 3.2.2**

**AXIAL POWER SHAPING RODS (APSR) Insertion Limits**

Up to  $470 \pm 10$  EFPD, the APSRs may be positioned as necessary for transient imbalance control, however, the APSRs shall be fully withdrawn by 480 EFPD. After the APSR withdrawal at  $470 \pm 10$  EFPD, the APSRs shall not be reinserted.



Figure is referred to by  
Technical Specification 3.2.3

Figure 6-A. AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Four-Pump Operation

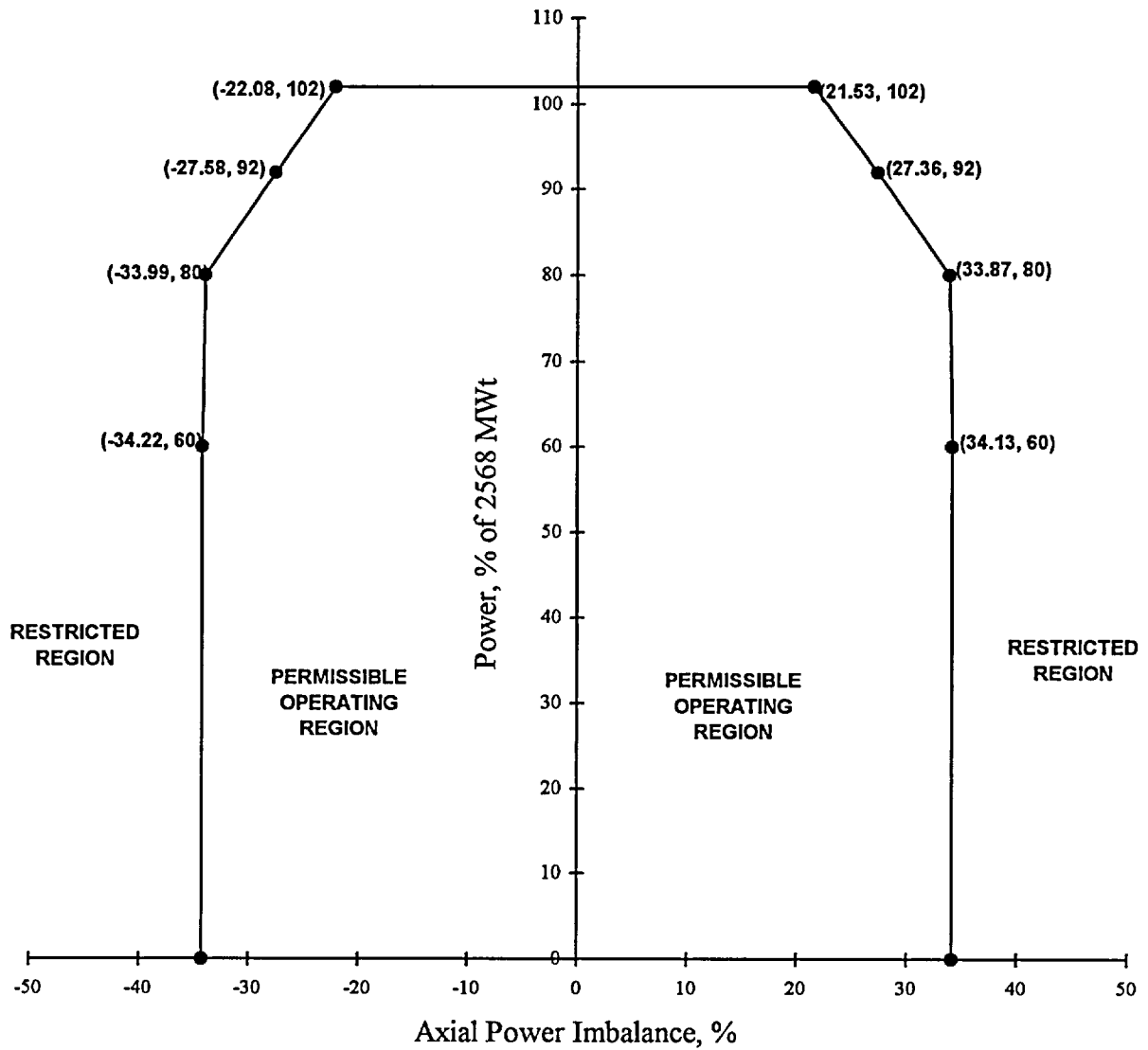
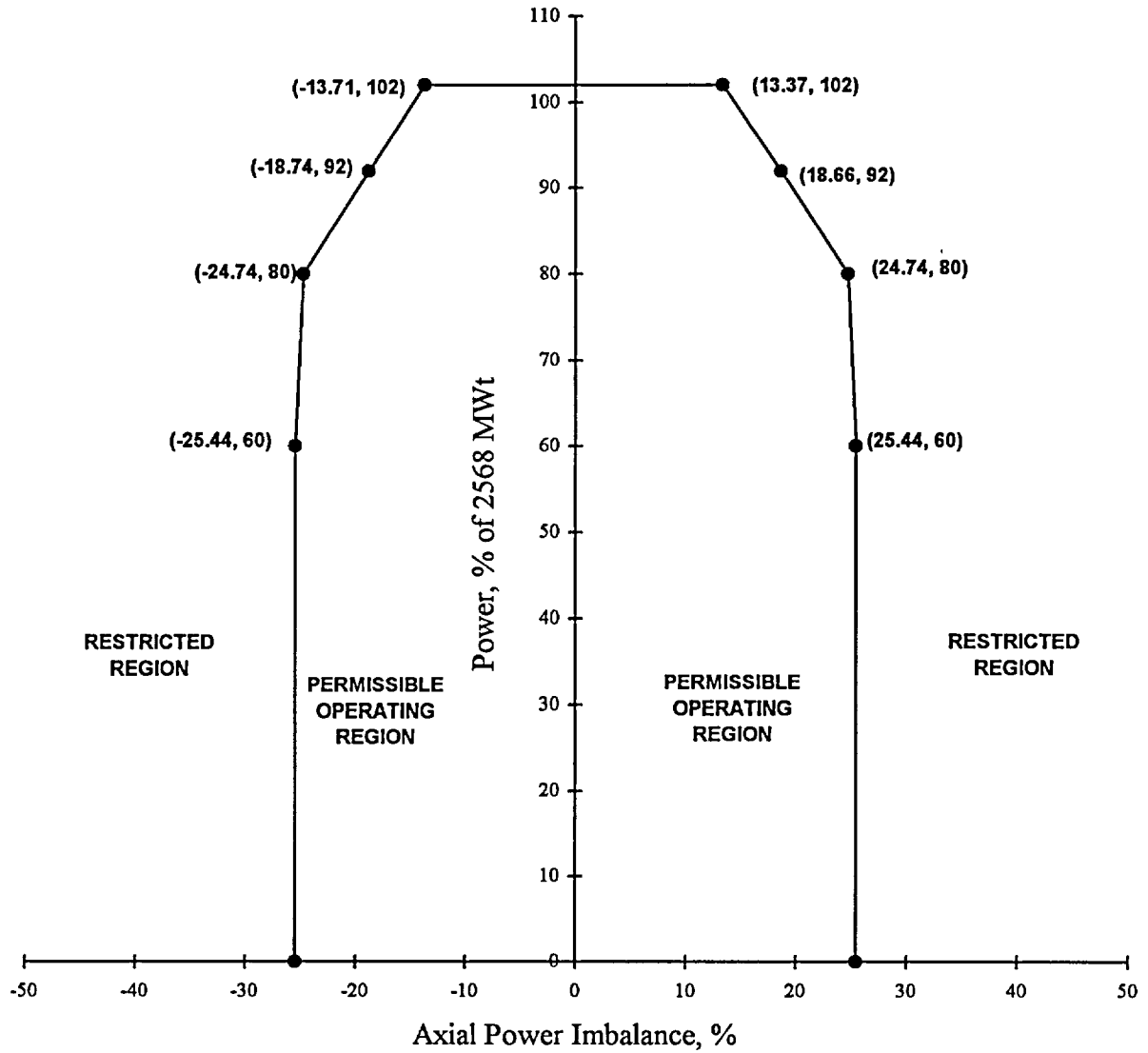


Figure is referred to by  
Technical Specification 3.2.3

Figure 6-B. AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions\* for Four-Pump Operation



\* 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 is referred to by  
Technical Specification 3.2.3

Figure 6-C. AXIAL POWER IMBALANCE Setpoints for Excore  
Conditions for Four-Pump Operation

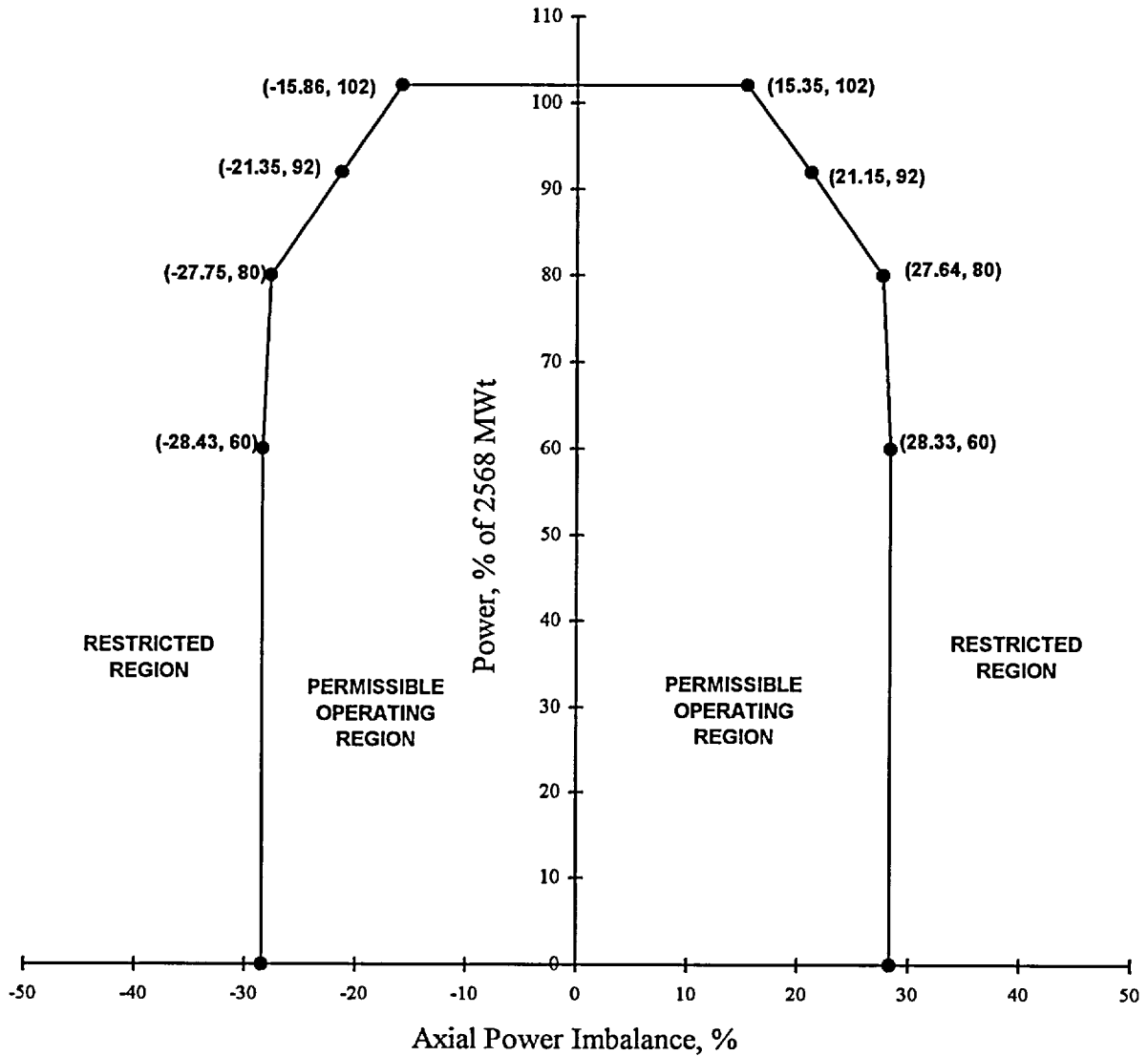


Figure is referred to by  
Technical Specification 3.2.3

Figure 7-A. AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Three-Pump Operation

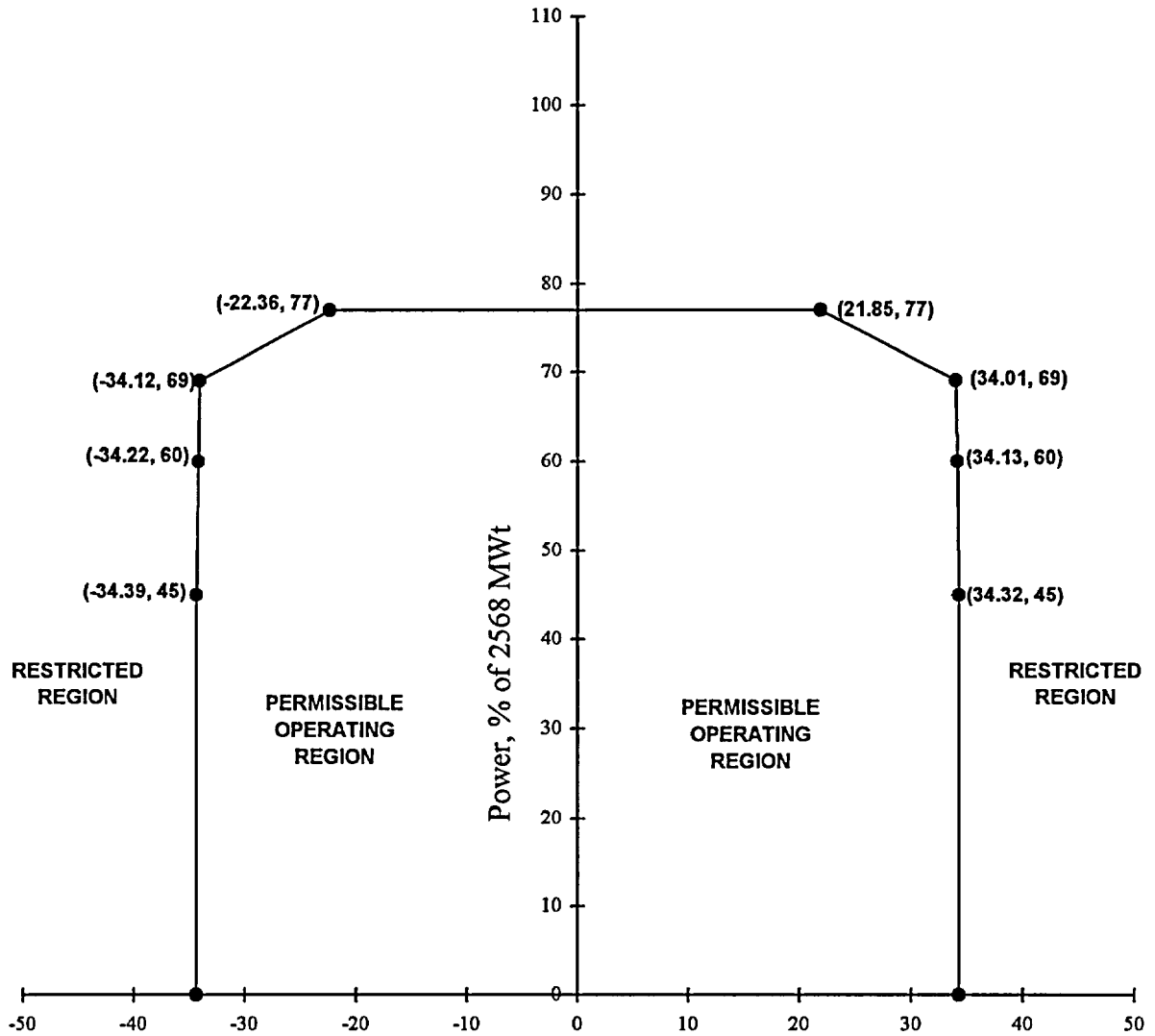
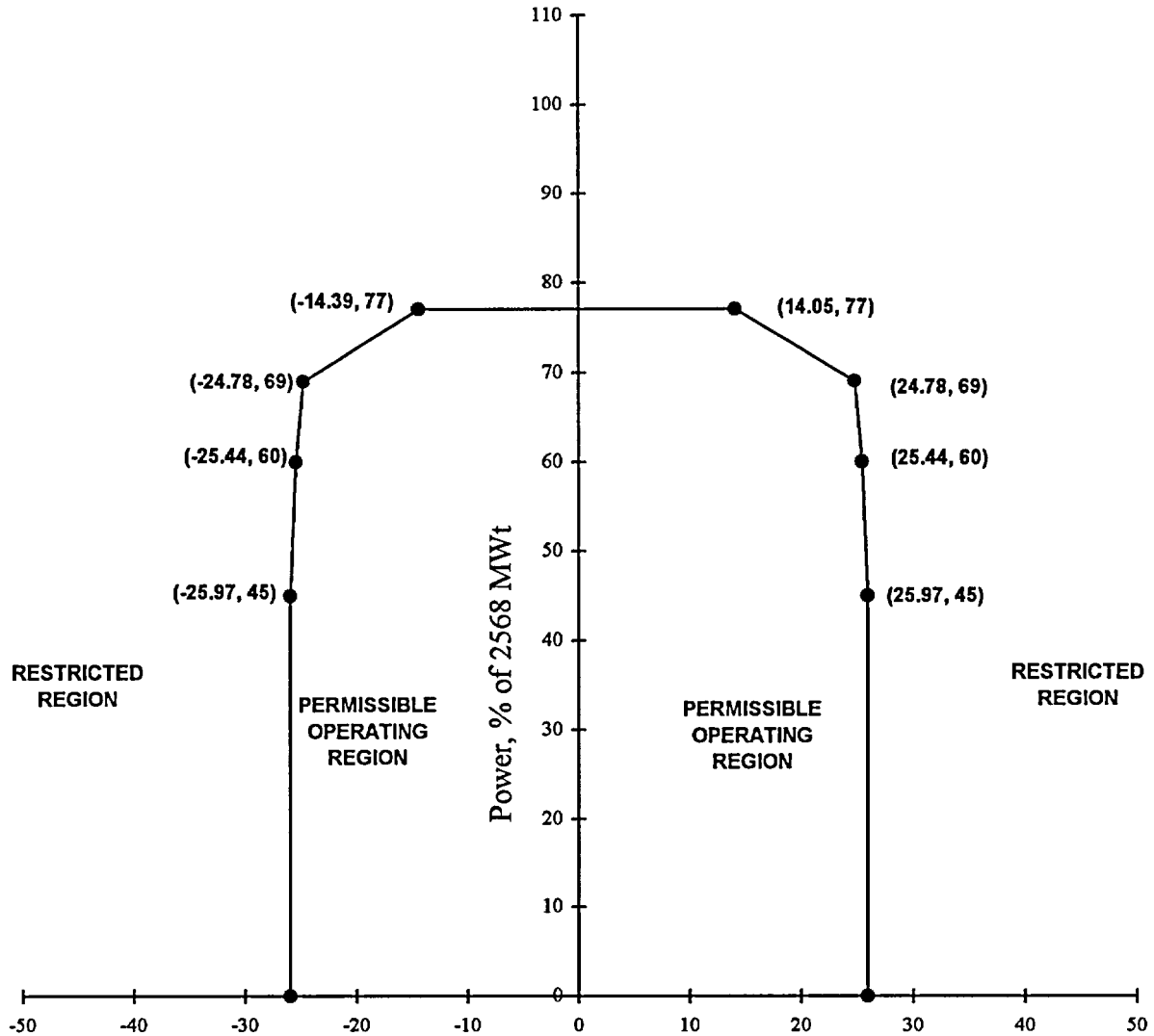


Figure is referred to by  
Technical Specification 3.2.3

Figure 7-B. AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions\* for Three-Pump Operation



\* 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 is referred to by  
Technical Specification 3.2.3

Figure 7-C. AXIAL POWER IMBALANCE Setpoints for Ex-Core  
Conditions for Three-Pump Operation

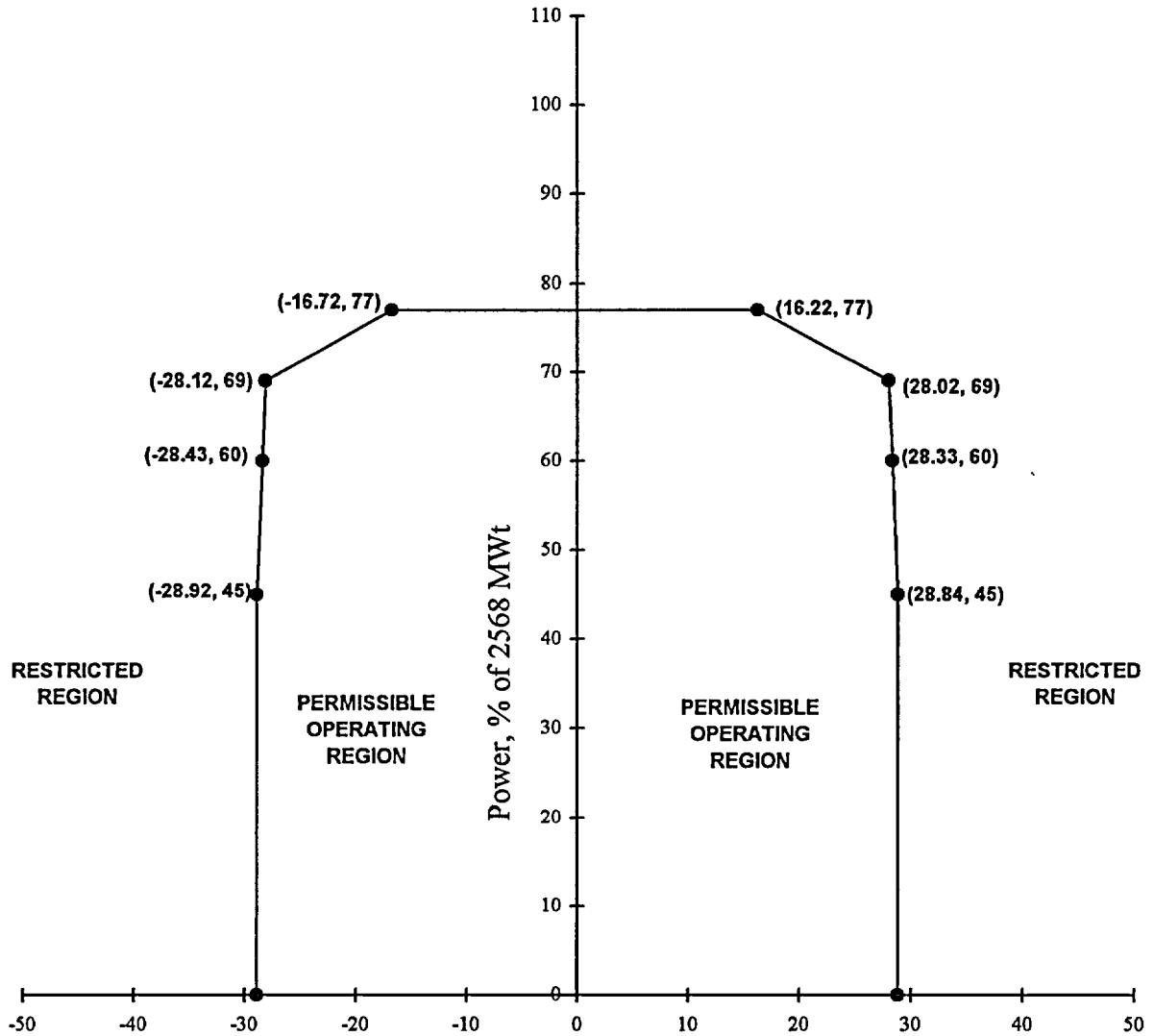


Figure is referred to by  
Technical Specification 3.2.3

Figure 8-A. AXIAL POWER IMBALANCE Setpoints for Full In-Core Conditions for Two-Pump Operation

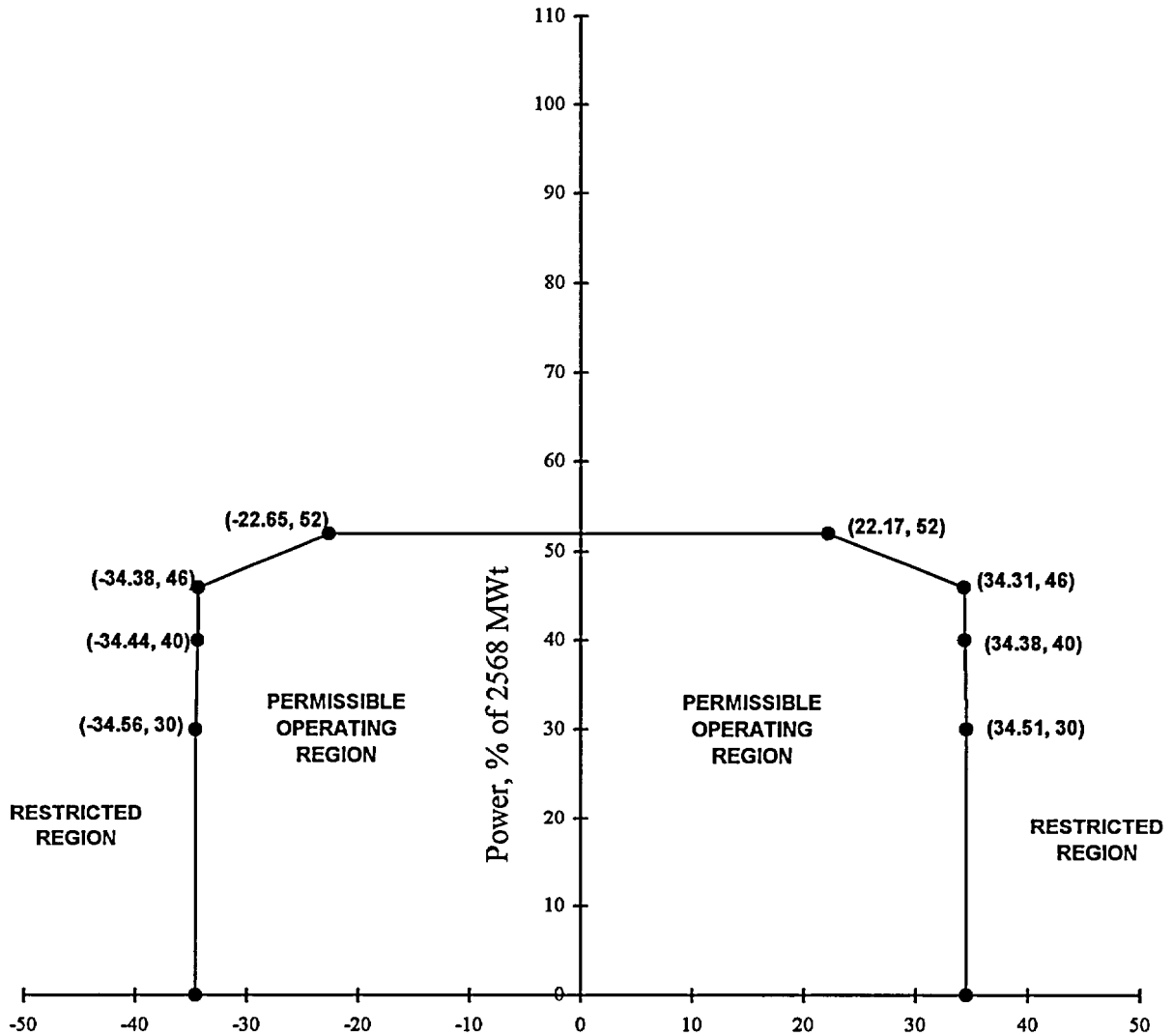
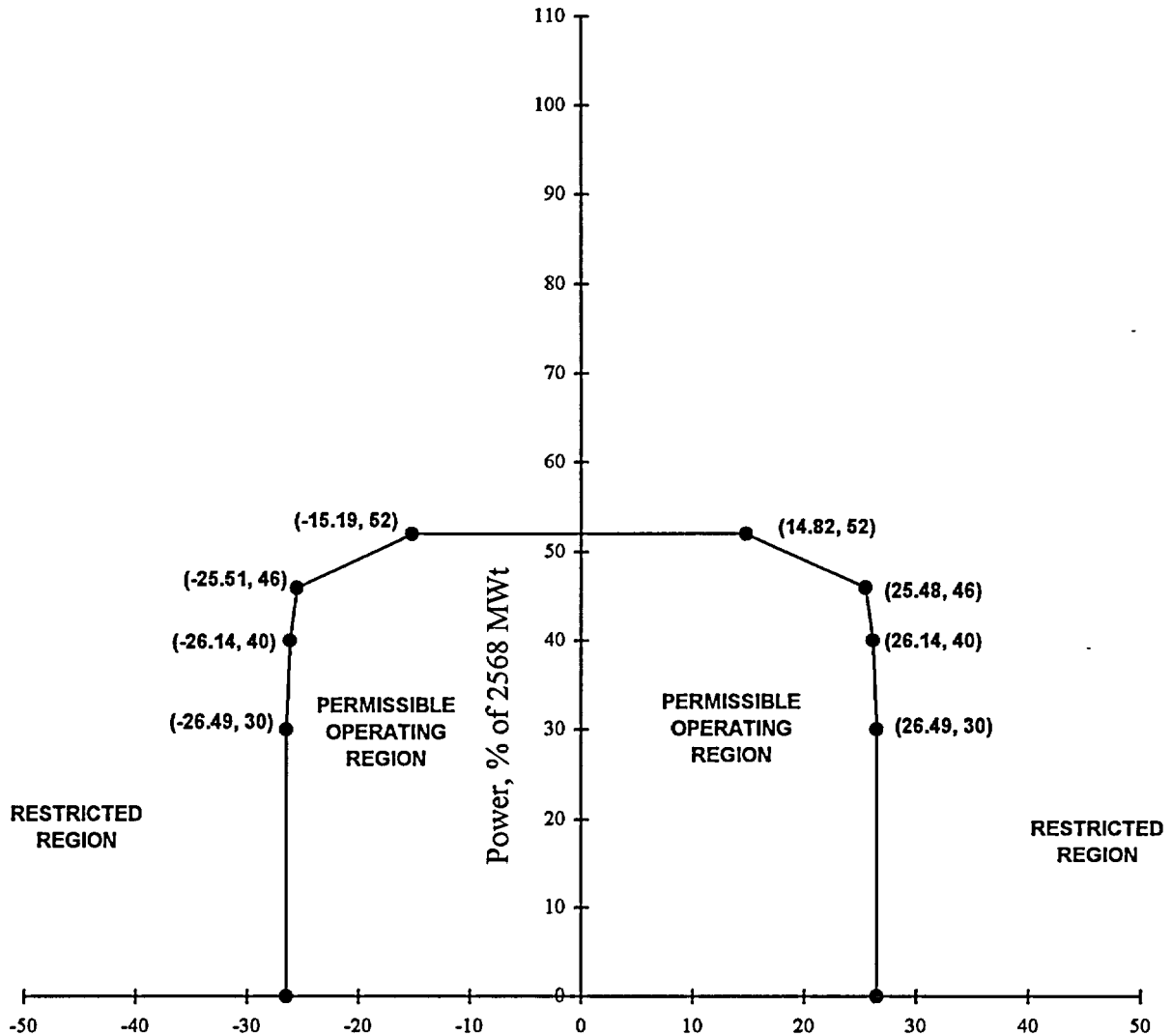


Figure is referred to by  
Technical Specification 3.2.3

Figure 8-B. AXIAL POWER IMBALANCE Setpoints for Minimum In-Core Conditions\* for Two-Pump Operation

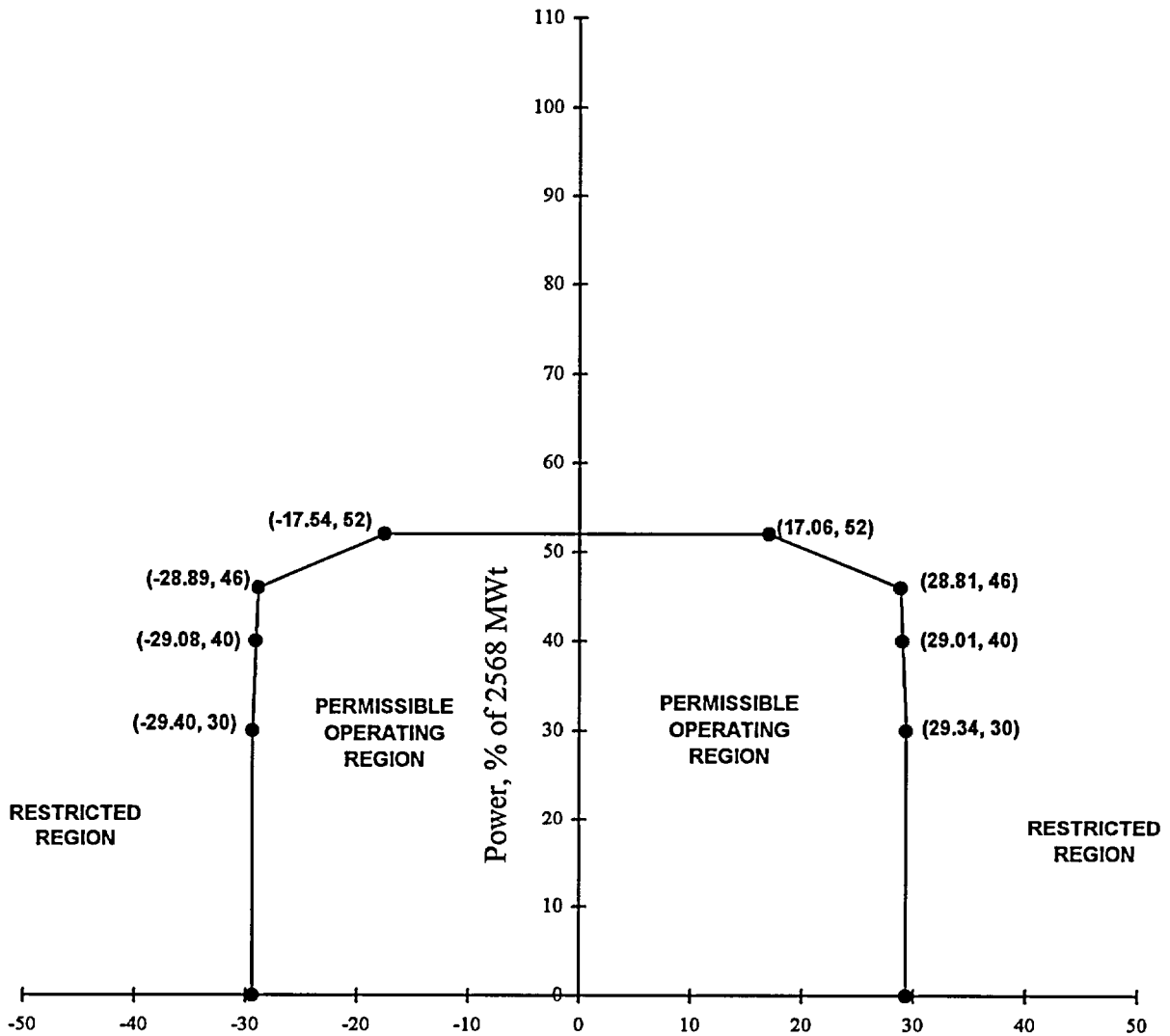


\* Assumes that no individual short emitter detector affecting the minimum in-core imbalance calculation exceeds 60% sensitivity depletion, and that no individual long emitter detector exceeds 73% sensitivity depletion, or both. The imbalance setpoints for the minimum in-core system must be reduced by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



Figure is referred to by  
Technical Specification 3.2.3

Figure 8-C. AXIAL POWER IMBALANCE Setpoints for Ex-Core  
Conditions for Two-Pump Operation



**LIMITS ARE REFERRED TO BY  
 TECHNICAL SPECIFICATION 3.2.4**

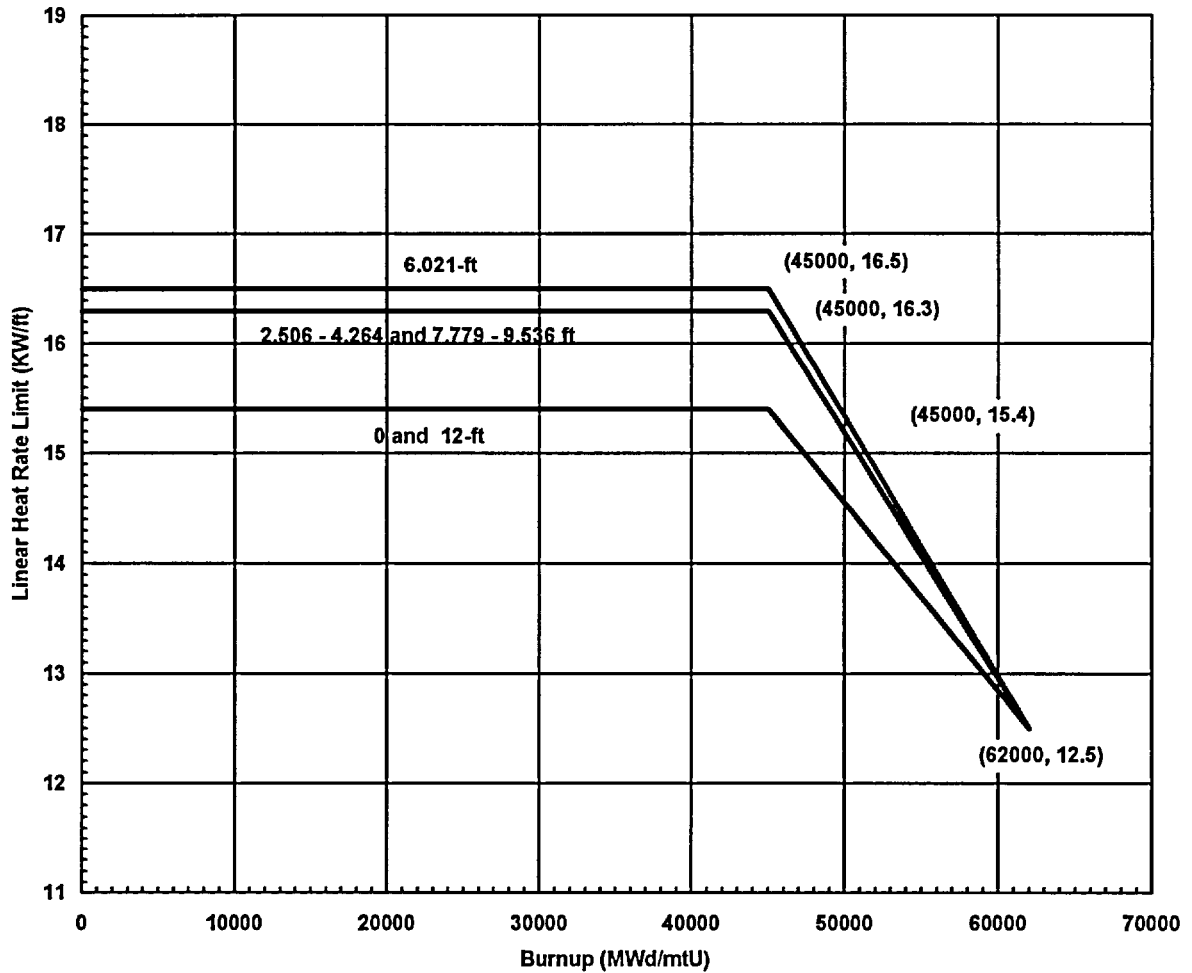
**Quadrant Power Tilt Limits And Setpoints**

<u>Measurement System</u>	<u>From 0 EFPD to EOC</u>		<u>Maximum Value (%)</u>
	<u>Steady State Value (%)</u>		
	<u>≤60 % RTP</u>	<u>&gt;60 % RTP</u>	
Full In-core Detector System Setpoint	6.83	4.44	25.0
Minimum In-core Detector System Setpoint	2.78*	1.90*	25.0
Ex-core Power Range NI Channel Setpoint	4.05	1.96	25.0
Measurement System Independent Limit	7.50	4.92	25.0

\* 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 is referred to by  
Technical Specification 3.1.8 and 3.2.5

Figure 9. LOCA Linear Heat Rate Limits



**LIMIT IS REFERRED TO BY  
 TECHNICAL SPECIFICATION 3.1.8 and 3.2.5**

**DNB Power Peaking Factors**

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

Axial Peak	Axial Peak Location X/L	Total Peak	
		4 - Pump Operation	3 - Pump Operation
1.1	0.2	2.028	2.028
1.1	0.4	2.021	2.021
1.1	0.6	2.008	2.008
1.1	0.8	1.985	1.985
1.3	0.2	2.515	2.515
1.3	0.4	2.486	2.486
1.3	0.6	2.411	2.411
1.3	0.8	2.252	2.252
1.5	0.2	2.973	2.973
1.5	0.4	2.786	2.786
1.5	0.6	2.596	2.596
1.5	0.8	2.422	2.422
1.7	0.2	3.117	3.117
1.7	0.4	2.921	2.921
1.7	0.6	2.727	2.727
1.7	0.8	2.560	2.560
1.9	0.2	3.237	3.237
1.9	0.4	3.024	3.024
1.9	0.6	2.841	2.841
1.9	0.8	2.675	2.675

Note - the values above have not been error corrected

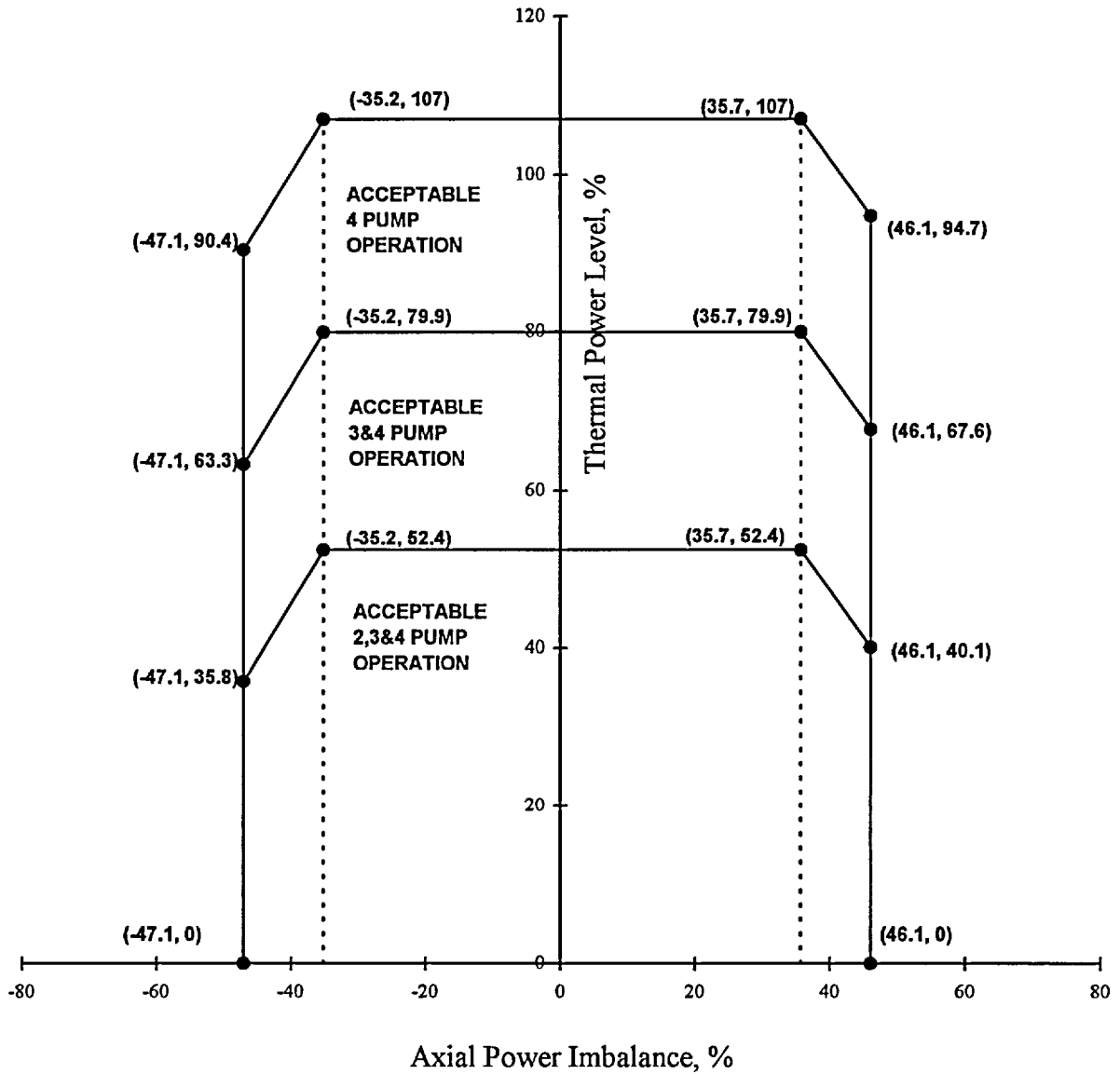
The present T-H methodology allows for an increase in the design radial-local peak for power levels under 100% full power. The equations defining the multipliers are as follows:

	$P/P_m = 1.00$	$P/P_m < 1.00$
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 is referred to by  
 Technical Specification 2.1.1.1, 2.1.1.2, and 3.3.1

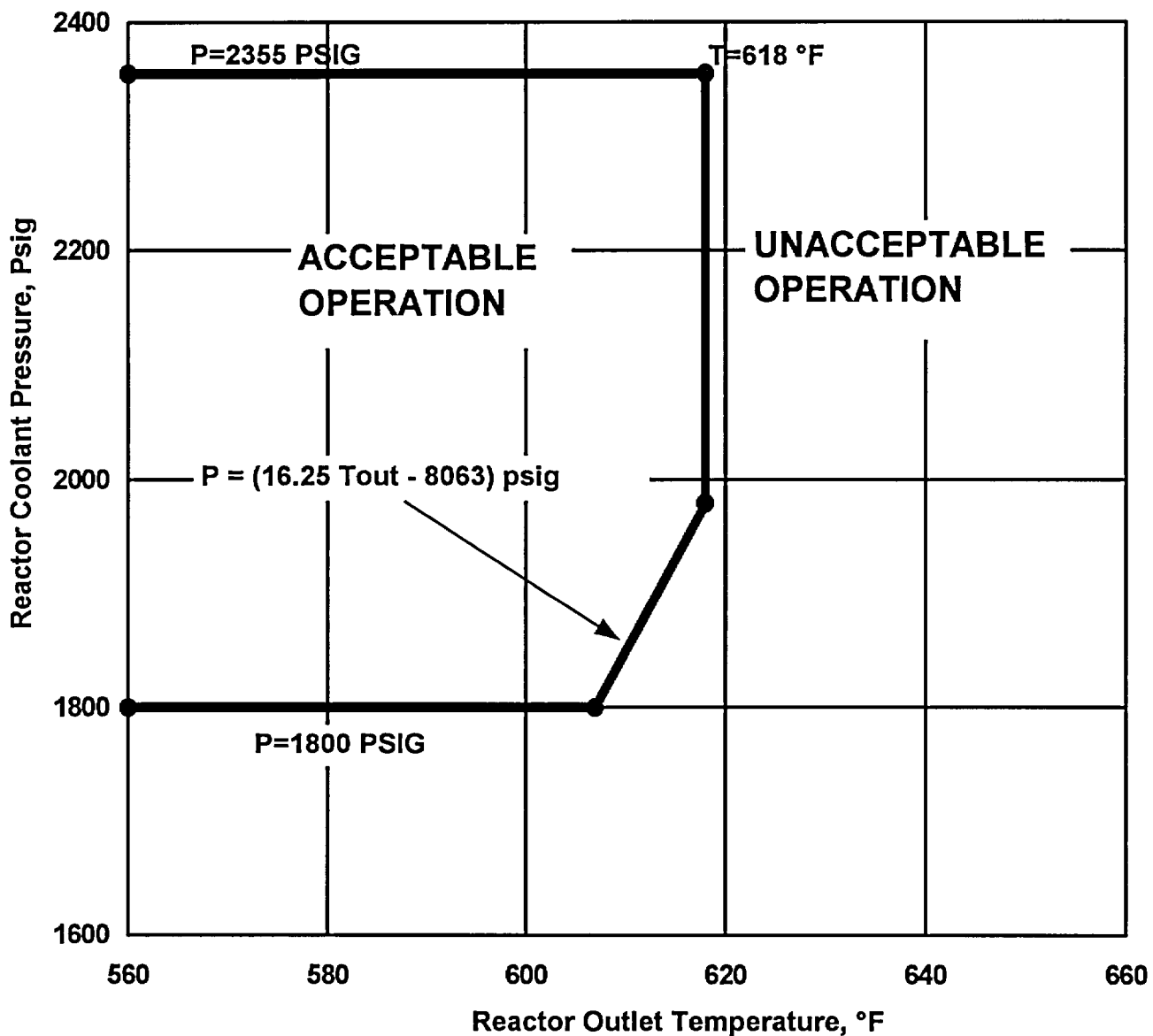
Figure 10. Reactor Protection System Maximum Allowable Setpoints for Axial Power Imbalance



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

Figure is referred to by  
Technical Specification 3.3.1

Figure 11. Reactor Protection System Variable Low Pressure  
Temperature Envelope Setpoints



**LIMIT IS REFERRED TO BY  
 TECHNICAL SPECIFICATION 3.4.1**

**RCS Pressure, Temperature, and Flow  
 DNB Surveillance Limits**

	Four-Pump Operation	Three-Pump Operation	Two-Pump Operation
Minimum RCS Hot Leg Pressure (psig) <sup>Note 1</sup>	2065.7	2063.9 <sup>Note 4</sup> 2100.9 <sup>Note 5</sup>	2099.1
Maximum RCS Hot Leg Temperature (°F) <sup>Note 2</sup>	603.45	603.55	604.00
Minimum RCS Total Flow (Mlb <sub>m</sub> /hr) <sup>Note 3</sup>	138.10 <sup>Note 6</sup> 132.96 <sup>Note 9</sup>	103.36 <sup>Note 7</sup> 99.50 <sup>Note 9</sup>	68.06 <sup>Note 8</sup> 65.48 <sup>Note 9</sup>

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<sub>ave</sub> 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 Tcold = 555.79°F.

Note 7 -- For Tcold = 555.69°F.

Note 8 -- For Tcold = 555.31°F.

Note 9 -- For Tcold = 580°F.

**LIMIT IS REFERRED TO BY  
TECHNICAL SPECIFICATION 3.4.4**

**RCS Loops – Mode 1 and Mode 2**

	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.



**LIMIT IS REFERRED TO BY  
TECHNICAL SPECIFICATION 3.9.1**

**Refueling Boron Concentration**

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

<b>EOC 17 EFPD</b>	<b>ppm</b>
<b>520</b>	<b>2433</b>
<b>522</b>	<b>2430</b>
<b>524</b>	<b>2427</b>
<b>526</b>	<b>2424</b>
<b>528</b>	<b>2421</b>
<b>530</b>	<b>2418</b>
<b>532</b>	<b>2415</b>
<b>534</b>	<b>2412</b>
<b>536</b>	<b>2409</b>