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TS 5.6.5.d

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

Prairie Island Nuclear Generating Plant Units 1 and 2
Dockets 50-282 and 50-306
License Nos. DPR-42 and DPR-60

Core Operating Limits Report (COLR) for Prairie Island Nuclear Generating Plant (PINGP) Unit 1 Cycle 24, Revision 2 and Unit 2 Cycle 24, Revision 3

Pursuant to PINGP Technical Specification 5.6.5.d, the Nuclear Management Company LLC (NMC) is submitting the COLR for PINGP Unit 1, Cycle 24, Revision 2 and Unit 2, Cycle 24, Revision 3.

The enclosed revisions to the Unit 1 and 2, Cycle 24, COLRs correct errors between COLR Table 1 and the shutdown boron concentrations used to meet the Table 1 requirements, identified on 1/29/08. The Unit 1 Cycle 24 revision also corrects an error in Table 1 where shutdown margins (SDMs) reported were non-conservative to the boron dilution accident, identified on 2/1/08. The first error resulted in the shutdown boron concentrations (in ppm) given to site Operations by the vendor not always meeting the shutdown margin percentages given in Table 1 of both COLRs. PINGP Technical Specification 3.1.1 requires that the shutdown margins specified in the COLR be met. The modifications to the COLRs align the COLRs with the vendor supplied shutdown boron concentrations (in ppm). The second error impacts the Unit 1 Cycle 24 COLR only. Three of the shutdown margin percentages reported in Table 1 were non-conservative to the boron dilution accident 24 minute requirement. The shutdown margin percentages reported in Table 1 are for the most reactive time in the cycle. The shutdown boron concentrations (in ppm) given to site Operations by the vendor that correspond to the most reactive time in the Unit 1 Cycle 24 (COLR SDMs) were conservative to the boron dilution accident.

As a result the following changes have been made to the Unit 1 and Unit 2, Cycle 24 COLRs:

- Revised Section 3.1.1 Shutdown Margin Requirements, to include a reference to Figures 6A through 6H.
- Revised Section 3.1.8 Physics Test Exceptions – MODE 2, to include a reference to Figure 6B.
- Revised item c) of Section 3.9.1 Refueling Boron Concentration, to include a reference to Figures 6A through 6H.
- Updated Table 1 to reflect the correct Shutdown Margin Requirements.
- Added Figures 6A through 6H.

Summary of Commitments

This letter contains no new commitments and no revisions to existing commitments.

Michael D. Wadley

Michael D. Wadley
Site Vice President, Prairie Island Nuclear Generating Plant
Nuclear Management Company, LLC

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Prairie Island, USNRC
Resident Inspector, Prairie Island, USNRC
State of Minnesota

ENCLOSURE 1

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
CORE OPERATING LIMITS REPORT

UNIT 1 – CYCLE 24, REVISION 2

UNIT 2 – CYCLE 24, REVISION 3

Record of Revision (5 pages)

Unit 1 – Cycle 24, Revision 2 (25 pages)

Unit 2 – Cycle 24, Revision 3 (25 pages)

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Core Operating Limits Report

Record of Revision

Unit	Cycle	Revision No.	Approval Date	Remarks
2	13	0	3/22/90	Original Unit 2 Core Operating Limits Report, distributed with Technical Specification Revision 92.
1	14	0	3/22/90	Original Unit 1 Core Operating Limits Report, distributed with Technical Specification Revision 92.
		1	7/27/90	Incorporated expanded V(z) curves.
		2	9/27/90	Clarified rod insertion limit curve applicability.
		3	2/11/91	Incorporated revised F_Q of 2.45 as a result of NRC approval of Westinghouse Topical Report WCAP-10924-P-A, Volume 1, Addendum 4, October 1990.
2	14	0	-	Not used.
		1	9/27/90	Updated to Unit 2 Cycle 14, incorporated expanded V(z) curves and clarified rod insertion limit curve applicability.
		2	2/11/91	Incorporated revised F_Q of 2.45 as a result of NRC approval of Westinghouse Topical Report WCAP-10924-P-A, Volume 1, Addendum 4, October 1990.
1	15	0	6/25/91	Updated to Unit 1 Cycle 15.
2	15	0	3/9/92	Updated to Unit 2 Cycle 15 and clarified labeling of Figure 4. Clarified the actions to be taken if the nuclear enthalpy rise hot channel factor exceeds the Technical Specification limit.
1	16	0	12/28/92	Updated to Unit 1 Cycle 16, removed V(z) curves and replaced them with list of bounding V(z) values for three ranges of exposures.
2	16	0	12/8/93	Updated to Unit 2 Cycle 16. Removed the multiple V(z) curves and replaced them with a single figure with bounding V(z) curves for four ranges of exposures. Incorporated additional discussion related to V(z) and K(z).

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Core Operating Limits Report

Record of Revision

Unit	Cycle	Revision No.	Approval Date	Remarks
2	16	1	11/3/94	The table containing the bounding V(z) values and Figure 2 updated to incorporate revised bounding V(z) values for the exposure range of 14-21.5 GWD/MTU. Figures 3 through 6 re-formatted.
1	17	0	6/17/94	Updated to Unit 1 Cycle 17. Removed the list of bounding V(z) values and replaced it with multiple V(z) curves. Incorporated additional discussion related to V(z) and K(z).
2	17	0	6/2/95	Updated to Unit 2 Cycle 17. Incorporated Table 1 and expanded Figure 2 with updated bounding V(z) values.
1	18	0	2/7/96	Updated to Unit 1 Cycle 18. Incorporated revised $F_{\Delta H}$ limit of 1.77. Incorporated Table 1 and updated Figure 2 with revised bounding V(z) values.
2	18	0	2/27/97	Updated to Unit 2 Cycle 18. Revised $F_{\Delta H}$ limit to 1.77. Updated Table 1 and Figures 2a through 2e with revised bounding V(z) values. Incorporated new Figures 2f and 2g with additional bounding V(z) values.
1	19	0	9/25/97	Updated to Unit 1 Cycle 19. Updated Table 1 and Figures 2a through 2f with revised bounding V(z) values.
2	19	0	12/17/98	Updated to Unit 2 Cycle 19. Updated Table 1 and Figures 2a through 2d with revised bounding V(z) values. Deleted Figures 2e, 2f and 2g.
1	20	0	5/13/99	Updated to Unit 1 Cycle 20. Updated Table 1 and Figures 2a through 2f with revised bounding V(z) values.
		1	8/4/00	Technical Specification Amendment 151: Relocate shutdown margin (SDM) requirements from Tech Specs and incorporate additional SDM requirements for Modes 3-6 from revised analysis of Uncontrolled Dilution event.

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Core Operating Limits Report

Record of Revision

Unit	Cycle	Revision No.	Approval Date	Remarks
2	20	0	5/31/00	Updated to Unit 2 Cycle 20. Updated Table 1 and Figures 2a through 2d with revised bounding V(z) values. Added new Table 2 and Figures 2e, 2f and 2g with additional bounding V(z) values. Added references to Tables 1 and 2 and to Figures 2e, 2f and 2g to discussion of heat flux hot channel factor limits. Added discussion clarifying applicability of axial flux difference limits when using Tables 1 and 2 and Figures 2a through 2g. Added discussion of two tier V(z) curve presented in Table 2 and Figure 2g.
		1	8/4/00	Technical Specification Amendment 142: Relocate shutdown margin (SDM) requirements from Tech Specs and incorporate additional SDM requirements for Modes 3-6 from revised analysis of Uncontrolled Dilution event.
1	20	2	9/1/00	Revised to change axial flux difference target band.
1	21	0	1/31/01	Updated to support refueling activities associated with Unit 1 Cycle 21. Revision 0 of the Unit 1 Cycle 21 COLR had to be issued prior to confirming the applicability of the LOCA analysis. Therefore, Revision 0 of the Unit 1 Cycle 21 COLR does not contain all of the operating limits necessary to support operation of Unit 1 Cycle 21.
1	21	1	2/19/01	Updated to Unit 1 Cycle 21. Updated Tables 1 and 2 and Figures 2a through 2f with revised bounding V(z) values.
1	21	2	10/02/02	Revised to support License Amendment 158 changes, including revision of all references to TS, revision of F_Q symbols, addition of Table 4, ITC limits, DNB limits and refueling boron concentrations.
2	21	0	2/06/02	Updated to Unit 2 Cycle 21.
2	21	1	10/02/02	Revised to support License Amendment 149

Unit	Cycle	Revision No.	Approval Date	Remarks
				changes, including revision of all references to TS, revision of F_Q symbols, addition of Table 4, ITC limits, DNB limits and refueling boron concentrations. Also revised to include an additional V(z) curve to give greater F_Q margin between 13.0 and 16.0 GWd/MTU.
1	22	0	11/25/02	Updated to Unit 1 Cycle 22. Updated Tables 1 and 2 and Figures 2a through 2f with revised bounding V(z) values. Incorporated new Figure 2g with additional bounding V(z) values. Updated Table 3 with revised minimum shutdown margin limits. Deleted and revised text to eliminate duplication with the Technical Specifications and the Bases.
2	22	0	9/19/03	Updated to Unit 2 Cycle 22. Updated Tables 1 and 2. A reduced number of exposure ranges were calculated in Table 1, therefore new Figures 2a through 2e with revised bounding V(z) values replaced Figures 2a through 2f. New Figure 2f replaced Figure 2g for the 2 tier band bounding V(z) values. Updated Table 3 with revised minimum shutdown margin limits. Deleted and revised text to eliminate duplication with the Technical Specifications and the Bases.
1	22	1	7/6/04	Revision to incorporate Westinghouse Safety Analysis Transition per LA 162/153. Revision 1 contains transitional values for the OP/OT ΔT Trip setpoints that will be used while the physical changes are implemented.
2	22	1	7/6/04	Revision to incorporate Westinghouse Safety Analysis transition per LA 162/153. Revision 1 contains transitional values for the OP/OT ΔT Trip setpoints that will be used while the physical changes are implemented.
2	22	2	7/12/04	Revised Fq limit from 2.4 to 2.5. Removed OP and OT delta-T setpoints based on NMC methodology and replaced with Westinghouse developed setpoints.
1	22	2	7/16/04	Revised Fq limit form 2.4 to 2.5. Removed OP and OT delta-T setpoints based on NMC

Unit	Cycle	Revision No.	Approval Date	Remarks
				methodology and replaced with Westinghouse developed setpoints.
1	23	0	10/20/04	Updated to Unit 1 Cycle 23.
2	23	0	-	Not used due to core redesign.
2	23	1	5/19/05	Updated to Unit 2 Cycle 23 and to support redesign of Unit 2 Cycle 23 core.
1	23	1	7/11/05	Revised ITC upper limit from < 0 pcm/°F for power levels > 70% RTP to less than a line that slopes linearly from 0 pcm/°F at 70% RTP to -2.9 pcm/°F at 100% RTP. Revised the title of Figure 3 to reference T.S. 3.1.4 Condition B and revised the title of Figure 4 to reference T.S. 3.1.4 Condition A. Added references 24 and 25 to include the 50.59 screenings written to issue revision 1.
1	24	0	5/10/06	Updated to Unit 1 Cycle 24.
1	24	1	8/7/06	Updated Table 3 to reflect the correct $F_q^W(z)$ penalty factors.
2	24	0	11/26/06	Updated to Unit 2 Cycle 24 Modes 5 and 6.
2	24	1	12/6/06	Updated to Unit 2 Cycle 24 for Modes 1-6.
2	24	2	9/4/07	Revised to support LA-179/169. Revised reference 24 to include the revision number (revision 0) and the correct date of the report (January 2005). Revised references 6a, 6b, 6c, and 8 to say 'Deleted.' These references referred to the old LBLOCA methodology and model.
1	24	2	2/11/08	Updated Table 1 to reflect correct Shutdown Margin Requirements and added Figures 6A through 6H.
2	24	3	2/11/08	Updated Table 1 to reflect correct Shutdown Margin Requirements and added Figures 6A through 6H.

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 1 – CYCLE 24

REVISION 2

Reviewed By: Lynn K Johnson Date: 2/8/08
Lynn Johnson
Supervisor, NSSS

Reviewed By: ______________ Date: 2/11/08
Hank Hoelscher
Supervisor, PWR Analyses

Approved By: Michael Carlson Date: 2/11/08
Mike Carlson
Director, Site Engineering

Note: This report is not part of the Technical Specifications
This report is referenced in the Technical Specifications

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 1 - CYCLE 24

REVISION 2

This report provides the values of the limits for Unit 1 Cycle 24 as required by Technical Specification Section 5.6.5. These values have been established using NRC approved methodology and are established such that all applicable limits of the plant safety analysis are met. The Technical Specifications affected by this report are listed below:

1. 2.1.1 Reactor Core SLs
2. 3.1.1 Shutdown Margin (SDM)
3. 3.1.3 Isothermal Temperature Coefficient (ITC)
4. 3.1.5 Shutdown Bank Insertion Limits
5. 3.1.6 Control Bank Insertion Limits
6. 3.1.8 Physics Tests Exceptions - MODE 2
7. 3.2.1 Heat Flux Hot Channel Factor ($F_Q(z)$)
8. 3.2.2 Nuclear Enthalpy Rise Hot Channel Factor $\left(F^N_{\Delta H}\right)$
9. 3.2.3 Axial Flux Difference (AFD)
10. 3.3.1 Reactor Trip System (RTS) Instrumentation
    Overtemperature ΔT and Overpower ΔT Parameter Values for Table 3.3.1-1
11. 3.4.1 RCS Pressure, Temperature, and Flow - Departure from Nucleate
    Boiling (DNB) Limits
12. 3.9.1 Boron Concentration

1. <u>2.1.1 Reactor Core Safety Limits</u>

    Reactor Core Safety Limits are shown in Figure 1.

    Reference Technical Specification section 2.1.1.

2. <u>3.1.1 Shutdown Margin Requirements</u>

    Minimum Shutdown Margin requirements are shown in Table 1 and Figures 6A through 6H.

    Reference Technical Specification section 3.1.1.

3. 3.1.3 Isothermal Temperature Coefficient (ITC)

ITC Upper limit:

a. < 5 pcm/°F for power levels < 70% RTP; and
b. less than a line which slopes linearly from
   i) 0 pcm/°F at power level = 70% RTP to
   ii) -1.5pcm/°F at power level = 100% RTP

ITC Lower limit:

a. -32.7 pcm/°F

Reference Technical Specification section 3.1.3.

4. 3.1.5 Shutdown Bank Insertion Limits

The shutdown rods shall be fully withdrawn.

Reference Technical Specification section 3.1.5.

5. 3.1.6 Control Bank Insertion Limits

The control rod banks shall be limited in physical insertion as shown in Figures 2, 3, and 4.

The control rod banks withdrawal sequence shall be Bank A, Bank B, Bank C, and finally Bank D.

The control rod banks shall be withdrawn maintaining 128 step tip-to-tip distance.

Reference Technical Specification section 3.1.6.

6. 3.1.8 Physics Tests Exceptions - MODE 2

Minimum Shutdown Margin requirements during physics testing are shown in Table 1 and Figure 6B.

Reference Technical Specification section 3.1.8.

7. 3.2.1 Heat Flux Hot Channel Factor ($F_Q(Z)$)

The Heat Flux Hot Channel Factor shall be within the following limits:

CFQ = 2.50

K(Z) is a constant value = 1.0 at all elevations.

W(Z) values are provided in Table 2.

$F^W{}_Q(Z)$ Penalty Factors are provided in Table 3.

Applicability: MODE 1.

Reference Technical Specification section 3.2.1

8. 3.2.2 Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}{}^N$)

The Nuclear Enthalpy Rise Hot Channel Factor shall be within the following limit:

$$F_{\Delta H} \leq 1.77 \text{ x } [1 + 0.3(1- P)]$$

where: P is the fraction of RATED THERMAL POWER at which the core is operating.

Applicability: MODE 1.

Reference Technical Specification section 3.2.2

9. 3.2.3 Axial Flux Difference (AFD)

The indicated axial flux difference, in % flux difference units, shall be maintained within the allowed operational space defined by Figure 5.

Applicability: MODE 1 with RATED THERMAL POWER $\geq$ 50% RTP.

Reference Technical Specification sections 3.2.3.

10. 3.3.1 Reactor Trip System (RTS) Instrumentation

Overtemperature ΔT and Overpower ΔT Parameter Values for Table 3.3.1-1;

Overtemperature ΔT Setpoint

Overtemperature ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED THERMAL POWER, %
T	=	Average temperature, °F
T'	=	560.0 °F
P	=	Pressurizer Pressure, psig
P'	=	2235 psig
K_1	$\leq$	1.17
K_2	=	0.014 /°F
K_3	=	0.00100 /psi
τ_1	=	30 seconds
τ_2	=	4 seconds
$f(\Delta I)$	=	A function of the indicated difference between top and bottom detectors of the power range nuclear ion chambers. Selected gains are based on measured instrument response during plant startup tests, where q_t and q_b are the percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of RATED THERMAL POWER, such that (a) For $q_t - q_b$ within –13, +8 % $f(\Delta I) = 0$ (b) For each percent that the magnitude of $q_t - q_b$ exceeds +8% the ΔT trip setpoint shall be automatically reduced by an equivalent of 1.73 % of RATED THERMAL POWER. (c) For each percent that the magnitude of $q_t - q_b$ exceeds -13 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 3.846 % of RATED THERMAL POWER.

Overpower ΔT Setpoint

Overpower ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED THERMAL POWER, %
T	=	Average temperature, °F
T'	=	560.0 °F
K_4	$\leq$	1.11
K_5	=	0.0275/°F for increasing T; 0 for decreasing T
K_6	=	0.002/°F for $T > T'$; 0 for $T \leq T'$
τ_3	=	10 seconds

11. 3.4.1 RCS Pressure, Temperature, and Flow - Departure from Nucleate Boiling (DNB) Limits

Pressurizer pressure limit = 2205 psia
RCS average temperature limit = 564°F
RCS total flow rate limit = 178,000 gpm

Reference Technical Specification section 3.4.1.

12. 3.9.1 Refueling Boron Concentration.

The boron concentration of the reactor coolant system and the refueling cavity shall be sufficient to ensure that the more restrictive of the following conditions is met:

a) $K_{eff} \leq 0.95$
b) 2000 ppm
c) The Shutdown Margin specified in Table 1 and Figures 6A through 6H

Reference Technical Specification section 3.9.1.

REFERENCES

1. NSPNAD-8101-A, "Qualification of Reactor Physics Methods for Application to Prairie Island," Revision 2, October 2000.

2. NSPNAD-8102-PA, "Prairie Island Nuclear Power Plant Reload Safety Evaluation Methods for Application to PI Units," Revision 7, July 1999.

3. NSPNAD-97002-PA, "Northern States Power Company's "Steam Line Break Methodology," Revision 1, October 2000.

4. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July, 1985.

5.a WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model using the NOTRUMP Code," August, 1985.

5.b WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model using the NOTRUMP Code," Addendum 2 Revision 1, July 1997.

6.a WCAP-10924-P-A, "Westinghouse Large Break LOCA Best Estimate Methodology," Revision 1, Volume 1 Addendum 1,2,3, December 1988.

6.b WCAP-10924-P-A, "Westinghouse Large Break LOCA Best Estimate Methodology," Revision 2 , Volume 2 Addendum 1, December 1988.

6.c WCAP-10924-P-A, "Westinghouse Large Break LOCA Best Estimate Methodology," Revision 1, Volume 1 Addendum 4, March 1991.

7. XN-NF-77-57-(A), XN-NF-77-57, Supplement 1 (A), "Exxon Nuclear Power Distribution Control for Pressurized Water Reactors Phase II," May 1981.

8. WCAP-13677-P-A, "10 CFR 50.46 Evaluation Model Report: W-COBRA/TRAC 2-Loop Upper Plenum Injection Model Update to Support ZIRLO™ Cladding Options," February 1994.

9. NSPNAD-93003-A, "Prairie Island Units 1 and 2 Transient Power Distribution Methodology," Revision 0, April 1993.

10. WCAP-10216-P-A, Revision 1A, "Relaxation of Constant Axial Offset Control/ FQ Surveillance Technical Specification," February 1994.

11. WCAP-8745-P-A, "Design Bases for the Thermal Overpower ΔT and Thermal Overtemperature ΔT Trip Functions," September 1986.

12. WCAP-11397-P-A, "Revised Thermal Design Procedure," April 1989.

13. WCAP-14483-A, "Generic Methodology for Expanded Core Operating Limits Report," January 1999.

14. WCAP-7588 Rev. 1-A, "An Evaluation of the Rod Ejection Accident in Westinghouse Pressurized Water Reactors Using Spatial Kinetics Methods," January 1975.

15. WCAP-7908-A, "FACTRAN – A FORTRAN IV Code for Thermal Transients in a UO_2 Fuel Rod," December 1989.

16. WCAP-7907-P-A, "LOFTRAN Code Description," April 1984.

17. WCAP-7979-P-A, "TWINKLE – A Multidimensional Neutron Kinetics Computer Code," January 1975.

18. WCAP-10965-P-A, "ANC: A Westinghouse Advanced Nodal Computer Code," December 1985.

19. WCAP-11394-P-A, "Methodology for the Analysis of the Dropped Rod Event," January 1990.

20 WCAP-11596-P-A, "Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores," June 1988.

21. WCAP-12910 Rev. 1-A, "Pressurizer Safety Valve Set Pressure Shift," May 1993.

22. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis," October 1999.

23. WCAP-14882-P-A, "RETRAN-02 Modeling and Qualification for Westinghouse Pressurized Water Reactor Non-LOCA Safety Analyses," April 1999.

24. 50.59 Evaluation 1054, "Unit 1 Cycle 24 Core Reload."

Table 1

Minimum Required Shutdown Margin, %$\Delta\rho$

	Number of Charging Pumps Running**		
Mode 1*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 23000 MWd/MTU	-	-	-

Mode 2*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 23000 MWd/MTU	2.0	2.0	2.0

Physics Testing in Mode 2			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 23000 MWd/MTU	0.5	0.5	0.5

Mode 3	**$T_{ave} \geq 520$ °F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 23000 MWd/MTU	2.0	2.0	2.0

Mode 3	**350 °F $\leq T_{ave} <$ 520°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU	2.0	2.0	2.5
12000 MWd/MTU	2.0	2.0	2.0
23000 MWd/MTU	2.0	2.0	2.0

Mode 4	**200 °F < $T_{ave} <$ 350°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU	2.5	4.5	7.0
12000 MWd/MTU	2.0	3.5	5.0
23000 MWd/MTU	2.0	2.0	2.5

Operational Mode Definitions, as per TS Table 1.1-1.

* For Mode 1 and Mode 2 with $K_{eff} \geq 1.0$, the minimum shutdown margin requirements are provided by the Rod Insertion Limits.

** Charging pump(s) in service only pertains to steady state operations. It does not include transitory operations. For example, operations such as starting a second charging pump in order to secure the operating pump would fall under the one pump in service column.

Table 1, Continued

Minimum Required Shutdown Margin, %Δρ

	Number of Charging Pumps Running**		
Mode 5	68°F ≤ T_{ave} ≤ 200°F (Most Reactive Rod Out)		
	0-1 Pump	2 Pumps	3 Pumps
0 MWd/MTU***	2.5	5.5	8.5
12000 MWd/MTU	2.0	4.0	6.0
23000 MWd/MTU	2.0	2.0	3.0

Mode 6	68°F ≤ T_{ave} < 200°F (ARI)		
	0-1 Pump	2 Pumps	3 Pumps
0 MWd/MTU***	5.129	5.5	8.0
12000 MWd/MTU	5.129	5.129	6.0
23000 MWd/MTU	5.129	5.129	5.129

Mode 6	68°F ≤ T_{ave} < 200°F (ARO)		
	0-1 Pump	2 Pumps	3 Pumps
0 MWd/MTU***	5.129	6.5	10.0
12000 MWd/MTU	5.129	5.5	8.5
23000 MWd/MTU	5.129	5.129	5.5

Operational Mode Definitions, as per TS Table 1.1-1.

** Charging pump(s) in service only pertains to steady state operations. It does not include transitory operations. For example, operations such as starting a second charging pump in order to secure the operating pump would fall under the one pump in service column.

*** These values are also applicable for the Unit 1 Cycle 23 end of cycle.

Table 2 - W(z) Values(Top 10% and Bottom 8% excluded)

	Height [ft]	BU [MWd/MTU] 150	6000	12000	20000
		AO = 3.26	AO = -1.66	AO =-3.51	AO =-1.03
[BOTTOM] 1	0.00	1.0000	1.0000	1.0000	1.0000
2	0.20	1.0000	1.0000	1.0000	1.0000
3	0.40	1.0000	1.0000	1.0000	1.0000
4	0.60	1.0000	1.0000	1.0000	1.0000
5	0.80	1.0000	1.0000	1.0000	1.0000
6	1.00	1.3879	1.2397	1.1747	1.1918
7	1.20	1.3736	1.2294	1.1659	1.1821
8	1.40	1.3572	1.2177	1.1562	1.1719
9	1.60	1.3391	1.2052	1.1460	1.1619
10	1.80	1.3197	1.1920	1.1356	1.1520
11	2.00	1.2992	1.1783	1.1251	1.1423
12	2.20	1.2779	1.1643	1.1147	1.1327
13	2.40	1.2561	1.1504	1.1045	1.1233
14	2.60	1.2341	1.1367	1.0946	1.1142
15	2.80	1.2124	1.1212	1.0848	1.1040
16	3.00	1.1897	1.1164	1.0768	1.1043
17	3.20	1.1705	1.1169	1.0741	1.1156
18	3.40	1.1620	1.1164	1.0781	1.1281
19	3.60	1.1622	1.1155	1.0842	1.1414
20	3.80	1.1621	1.1140	1.0900	1.1538
21	4.00	1.1607	1.1117	1.0950	1.1650
22	4.20	1.1588	1.1099	1.0995	1.1748
23	4.40	1.1560	1.1097	1.1032	1.1831
24	4.60	1.1524	1.1087	1.1062	1.1898
25	4.80	1.1480	1.1069	1.1086	1.1949
26	5.00	1.1428	1.1069	1.1103	1.1983
27	5.20	1.1372	1.1105	1.1116	1.2004
28	5.40	1.1308	1.1167	1.1137	1.2009
29	5.60	1.1227	1.1231	1.1185	1.1998
30	5.80	1.1237	1.1287	1.1259	1.2020
31	6.00	1.1312	1.1371	1.1348	1.2090
32	6.20	1.1387	1.1489	1.1448	1.2180
33	6.40	1.1466	1.1591	1.1558	1.2281
34	6.60	1.1536	1.1686	1.1674	1.2381
35	6.80	1.1595	1.1772	1.1782	1.2468
36	7.00	1.1643	1.1846	1.1878	1.2535
37	7.20	1.1679	1.1907	1.1963	1.2582
38	7.40	1.1701	1.1958	1.2041	1.2607
39	7.60	1.1707	1.2003	1.2110	1.2608
40	7.80	1.1698	1.2032	1.2161	1.2582
41	8.00	1.1670	1.2041	1.2193	1.2529
42	8.20	1.1624	1.2030	1.2204	1.2448
43	8.40	1.1559	1.1998	1.2192	1.2338
44	8.60	1.1475	1.1950	1.2163	1.2206
45	8.80	1.1370	1.1853	1.2089	1.2092
46	9.00	1.1340	1.1821	1.2067	1.1957
47	9.20	1.1441	1.1930	1.2161	1.1818
48	9.40	1.1564	1.2031	1.2261	1.1817
49	9.60	1.1675	1.2121	1.2352	1.1840
50	9.80	1.1813	1.2189	1.2413	1.1872
51	10.00	1.1954	1.2264	1.2496	1.1905
52	10.20	1.2076	1.2373	1.2630	1.1928
53	10.40	1.2241	1.2472	1.2736	1.1942
54	10.60	1.2361	1.2605	1.2881	1.1978
55	10.80	1.2462	1.2736	1.3041	1.2028
56	11.00	1.0000	1.0000	1.0000	1.0000
57	11.20	1.0000	1.0000	1.0000	1.0000
58	11.40	1.0000	1.0000	1.0000	1.0000
59	11.60	1.0000	1.0000	1.0000	1.0000
60	11.80	1.0000	1.0000	1.0000	1.0000
[TOP] 61	12.00	1.0000	1.0000	1.0000	1.0000

Table 3

$F^W_Q(Z)$ Penalty Factor

Cycle Burnup (MWD/MTU)	$F^W_Q(Z)$ Penalty Factor
0	1.020
13281	1.020
13432	1.023
13583	1.027
13734	1.027
13885	1.027
14036	1.025
14187	1.023
14338	1.021
14488	1.020

$F^W_Q(Z)$ = 1.020 for all burnups except those listed above. Linear interpolation is adequate for intermediate cycle burnups.

Figure 1

Reactor Core Safety Limits

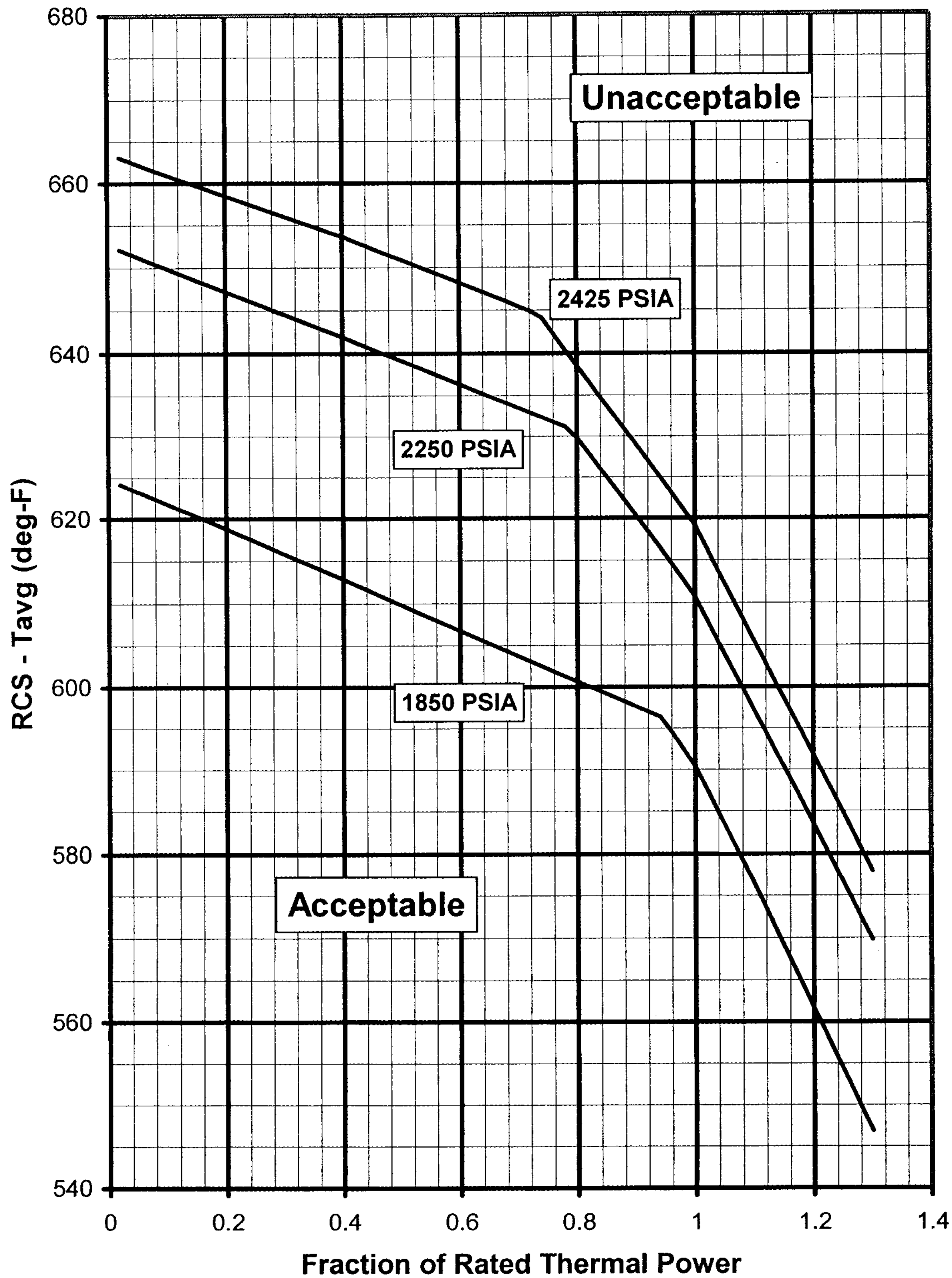
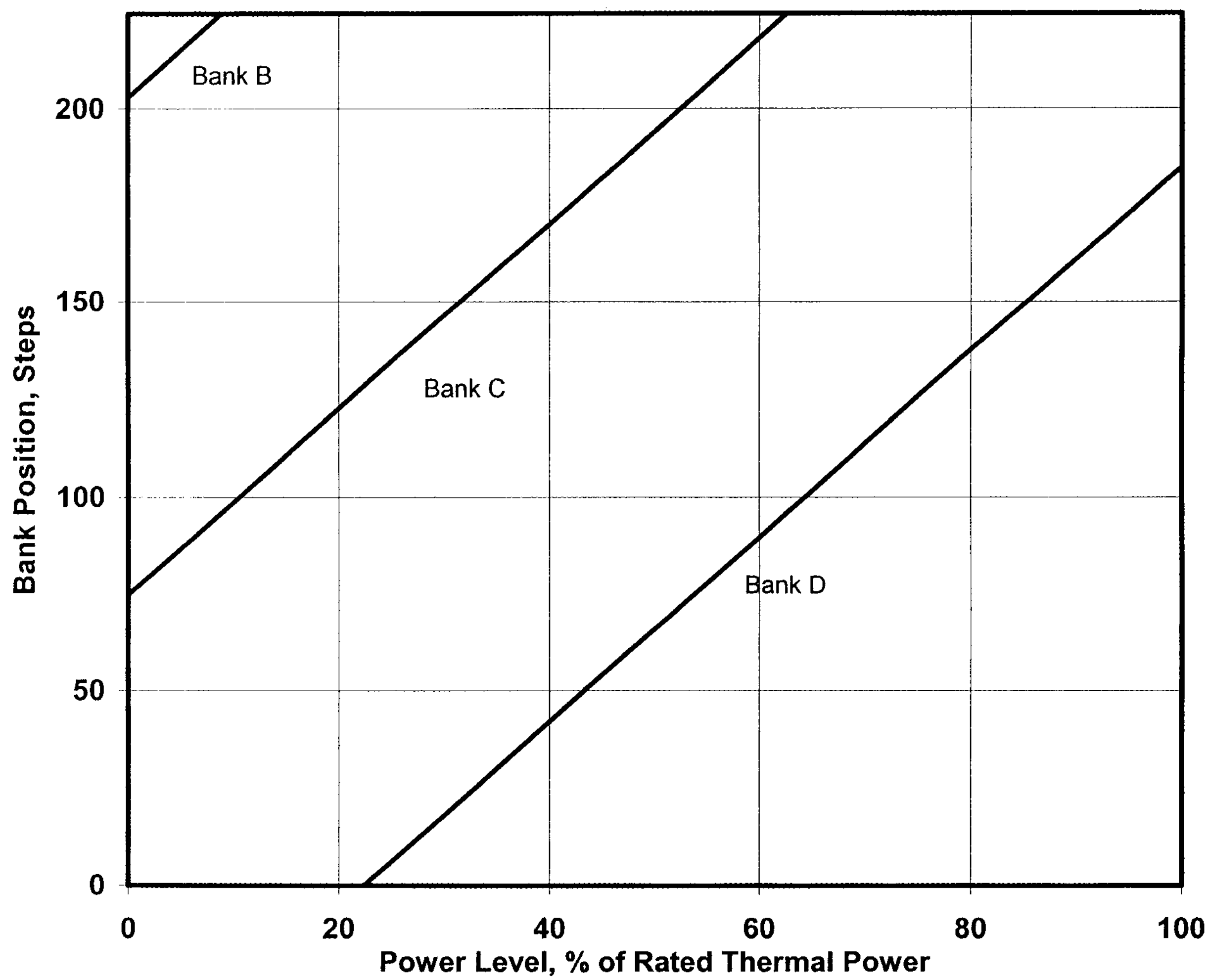


Figure 2
Rod Insertion Limit, 128 Step Tip-to-Tip

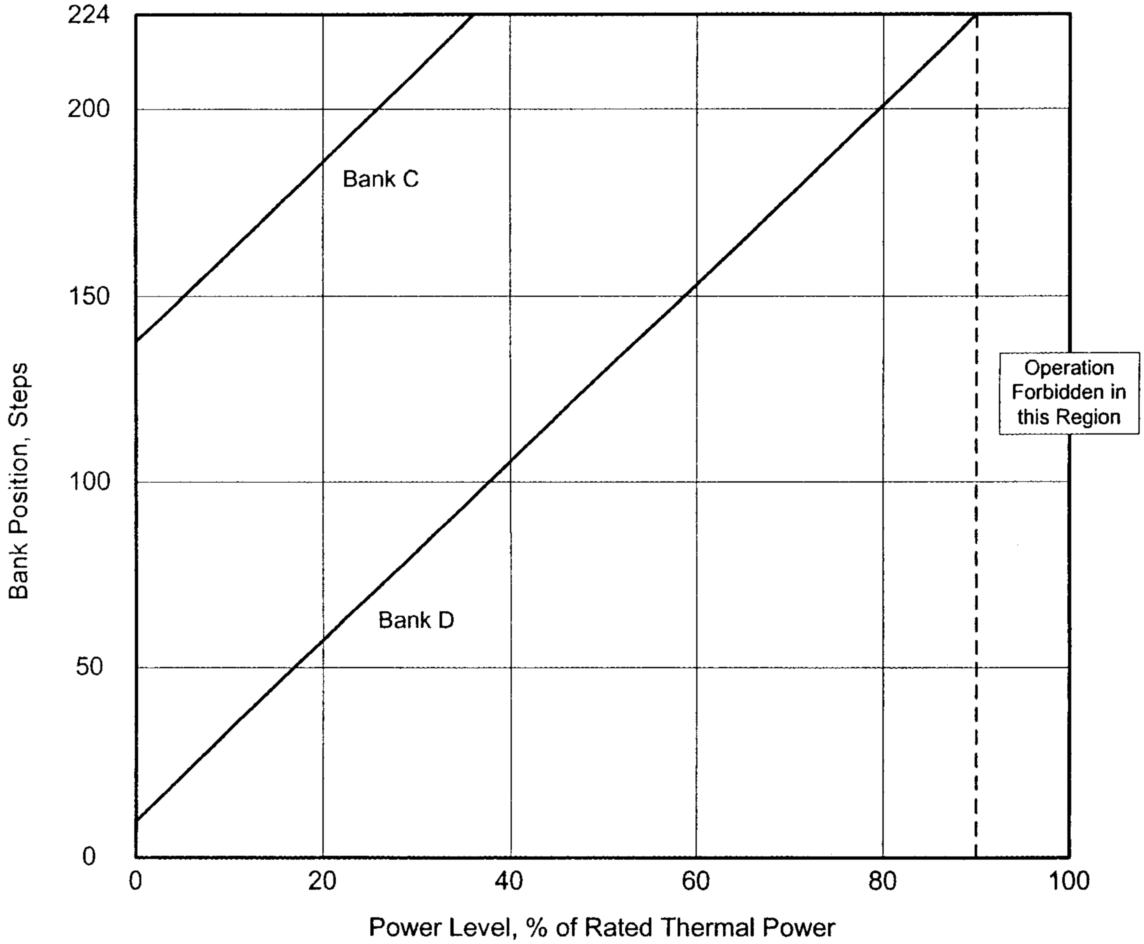


Bank Positions Given By:

- Bank D = (150 / 63) * (P – 100) + 185
- Bank C = (150 / 63) * (P – 100) + 185 + 128
- Bank B = (150 / 63) * (P – 100) + 185 + 128 + 128

NOTE: The top of the active fuel height corresponds to 224 steps. The ARO parking position may be any position above 224 steps.

Figure 3
Rod Insertion Limit, 128 Step Tip-to-Tip, One Bottomed Rod
(Technical Specification 3.1.4 Condition B)

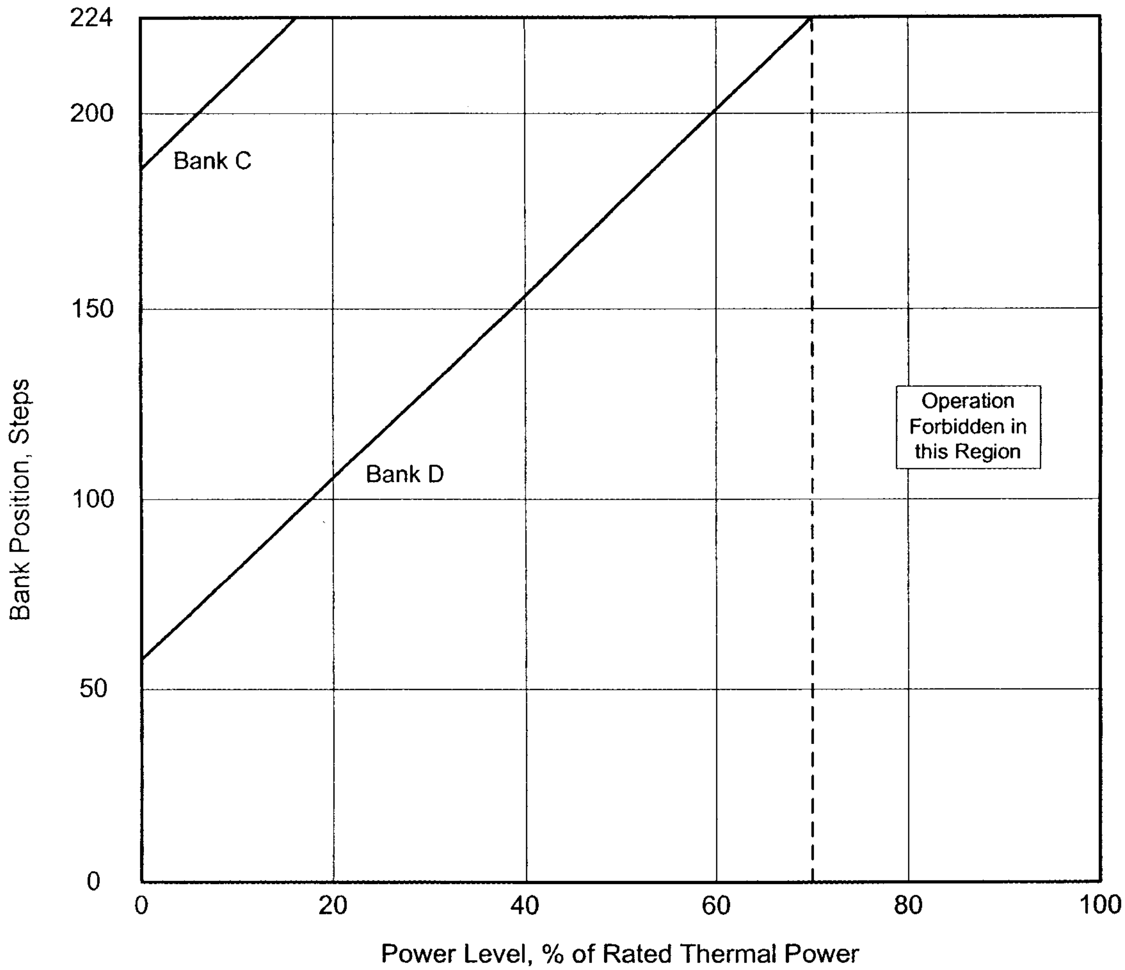


Bank Positions Given By:

- Bank D = (150 / 63) * (P – 90) + 224
- Bank C = (150 / 63) * (P – 90) + 224 + 128

NOTE: The top of the active fuel height corresponds to 224 steps. The ARO parking position may be any position above 224 steps.

Figure 4
Rod Insertion Limit, 128 Step Tip-to-Tip, One Inoperable Rod
(Technical Specification 3.1.4 Condition A)



Bank Positions Given By:

- Bank D = (150 / 63) * (P – 70) + 224
- Bank C = (150 / 63) * (P – 70) + 224 + 128

NOTE: The top of the active fuel height corresponds to 224 steps. The ARO parking position may be any position above 224 steps.

Figure 5
Flux Difference Operating Envelope

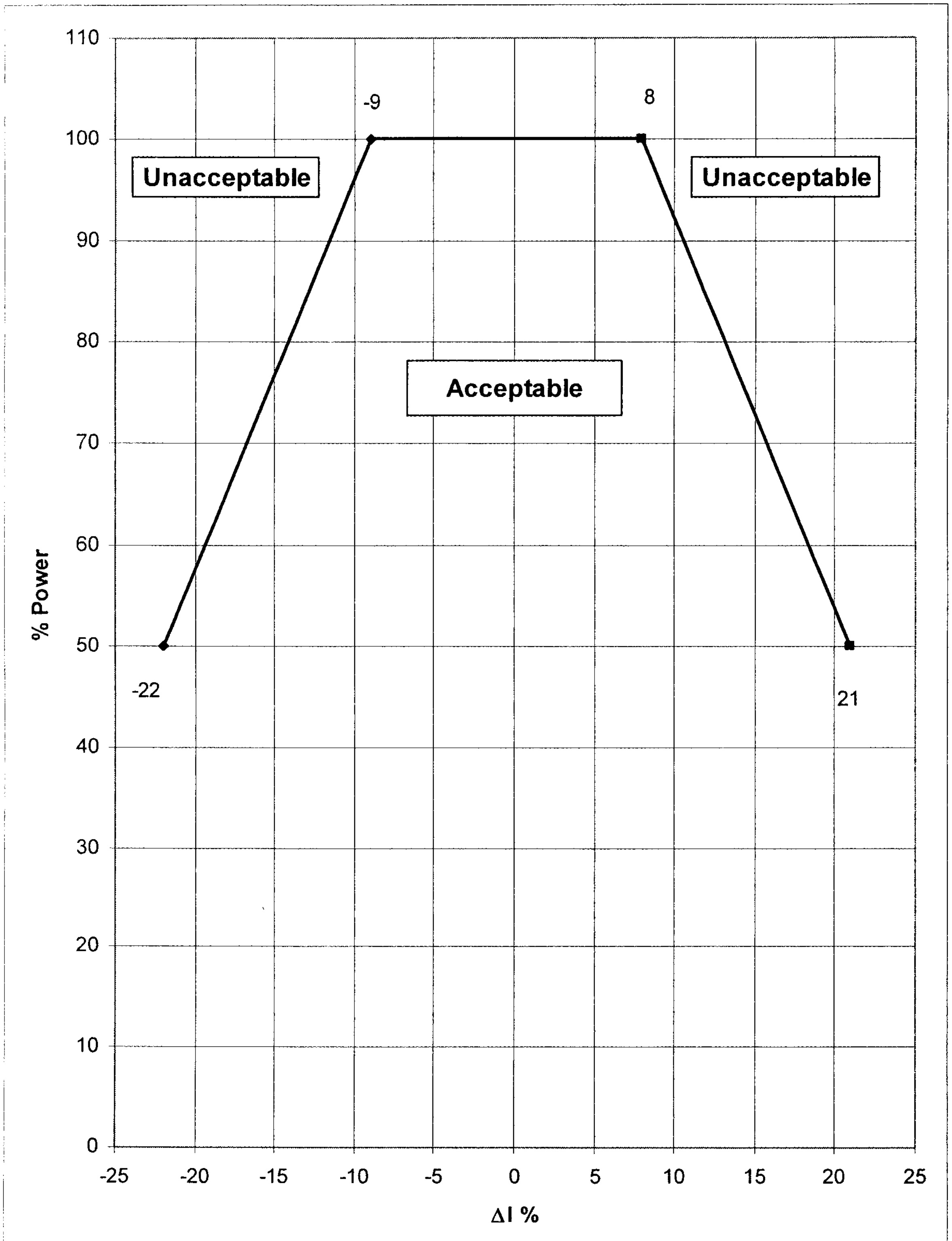


Figure 6A

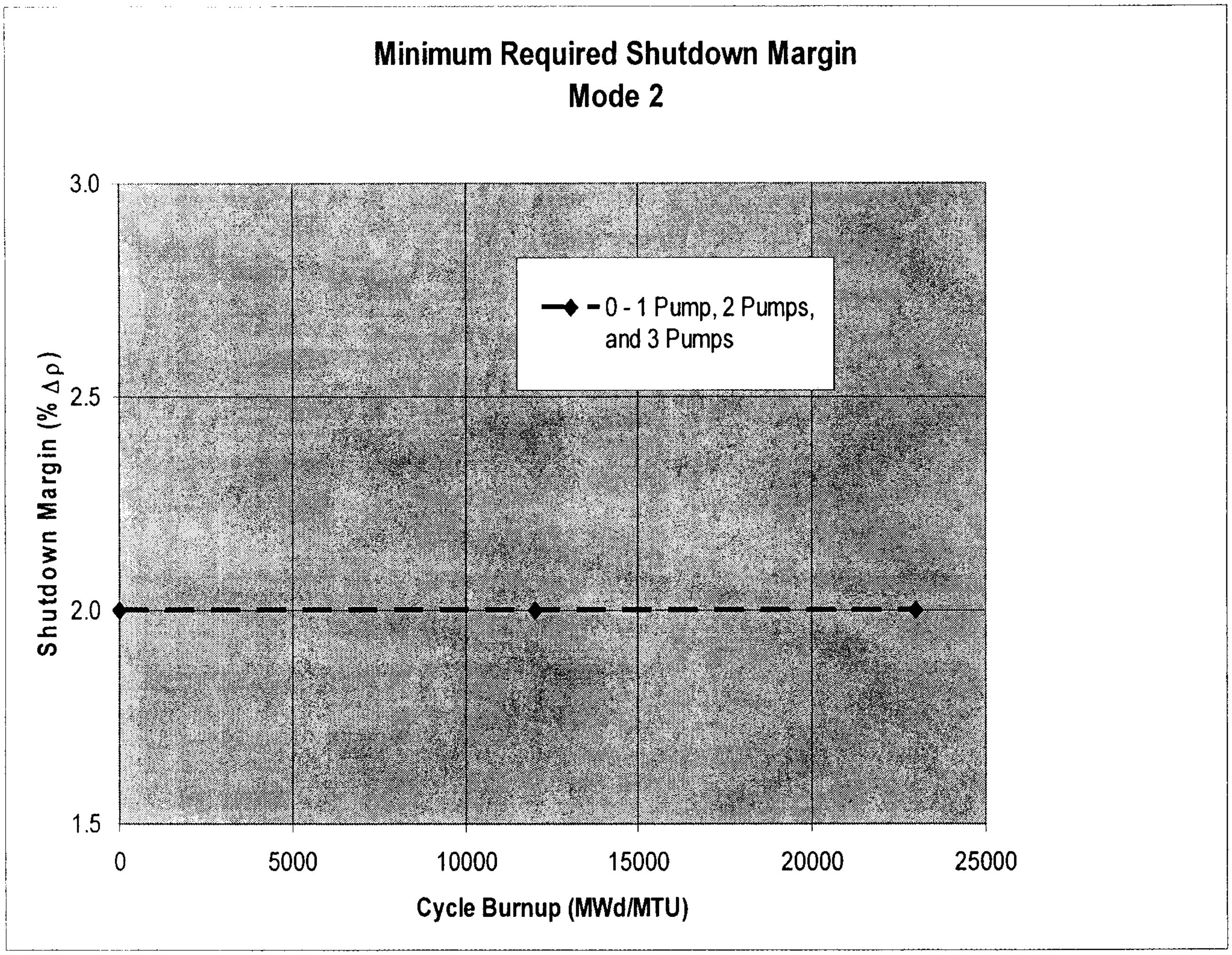

Minimum Required Shutdown Margin
Mode 2
0 - 1 Pump, 2 Pumps, and 3 Pumps
Shutdown Margin (% Δρ)
3.0
2.5
2.0
1.5
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)

Figure 6B

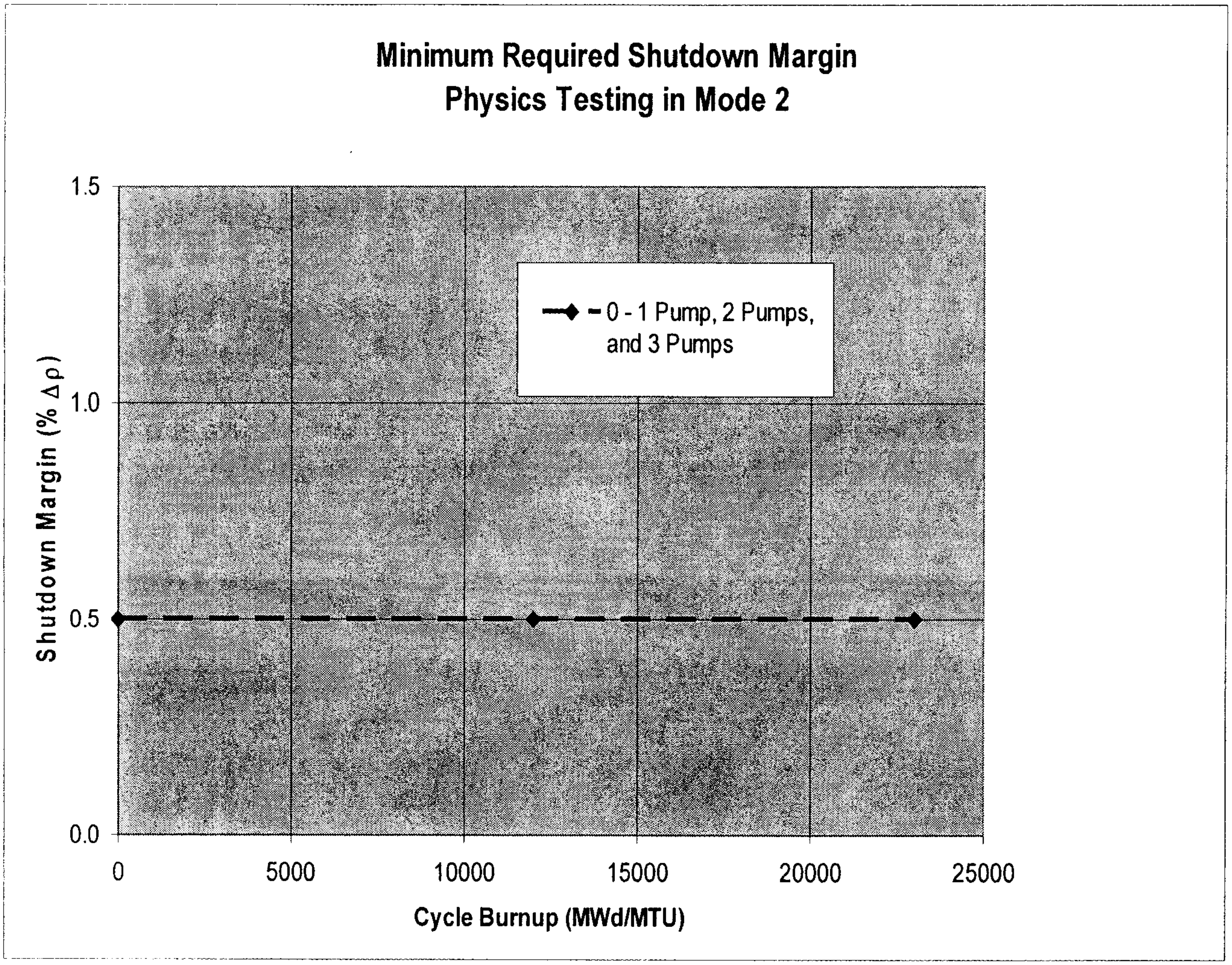
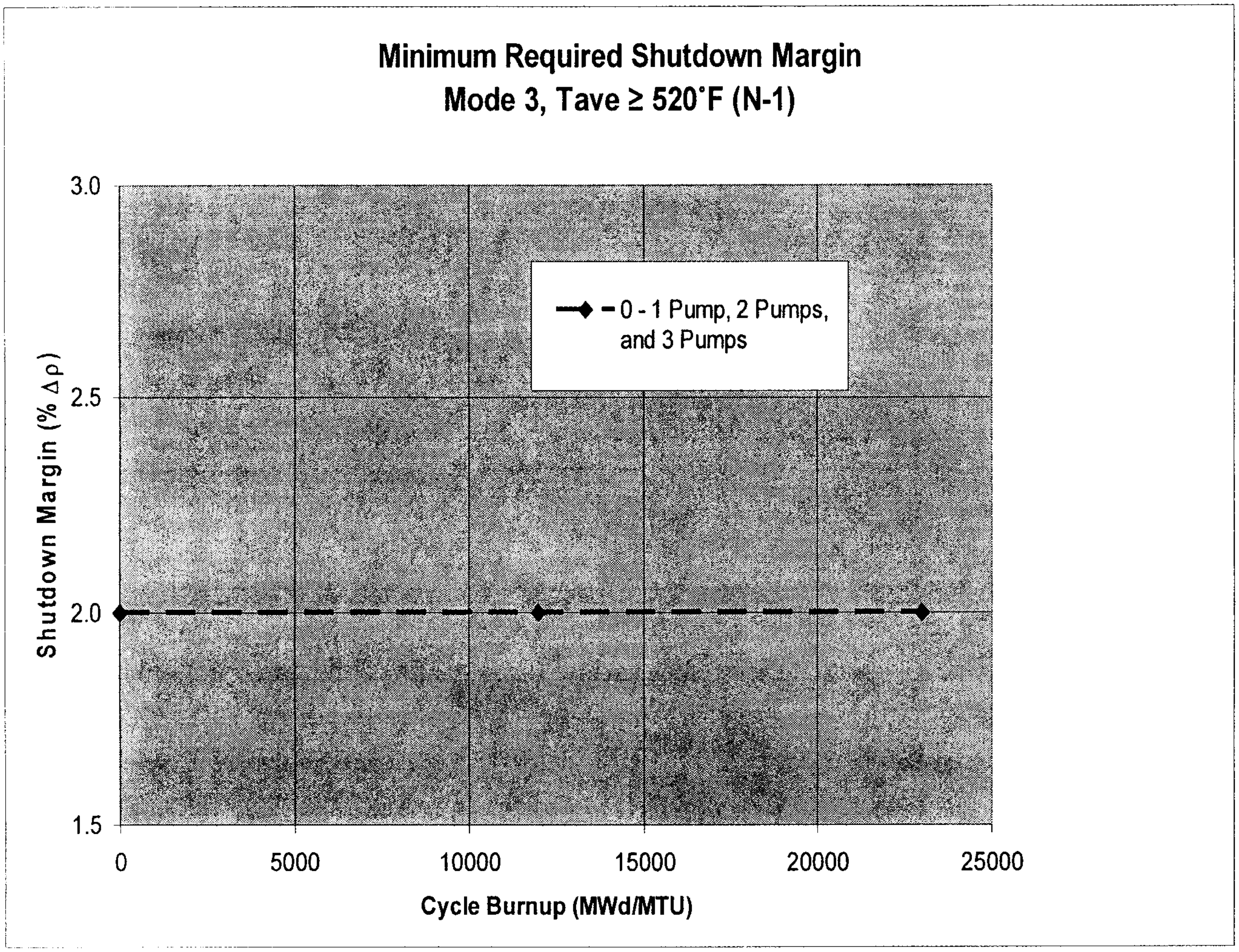
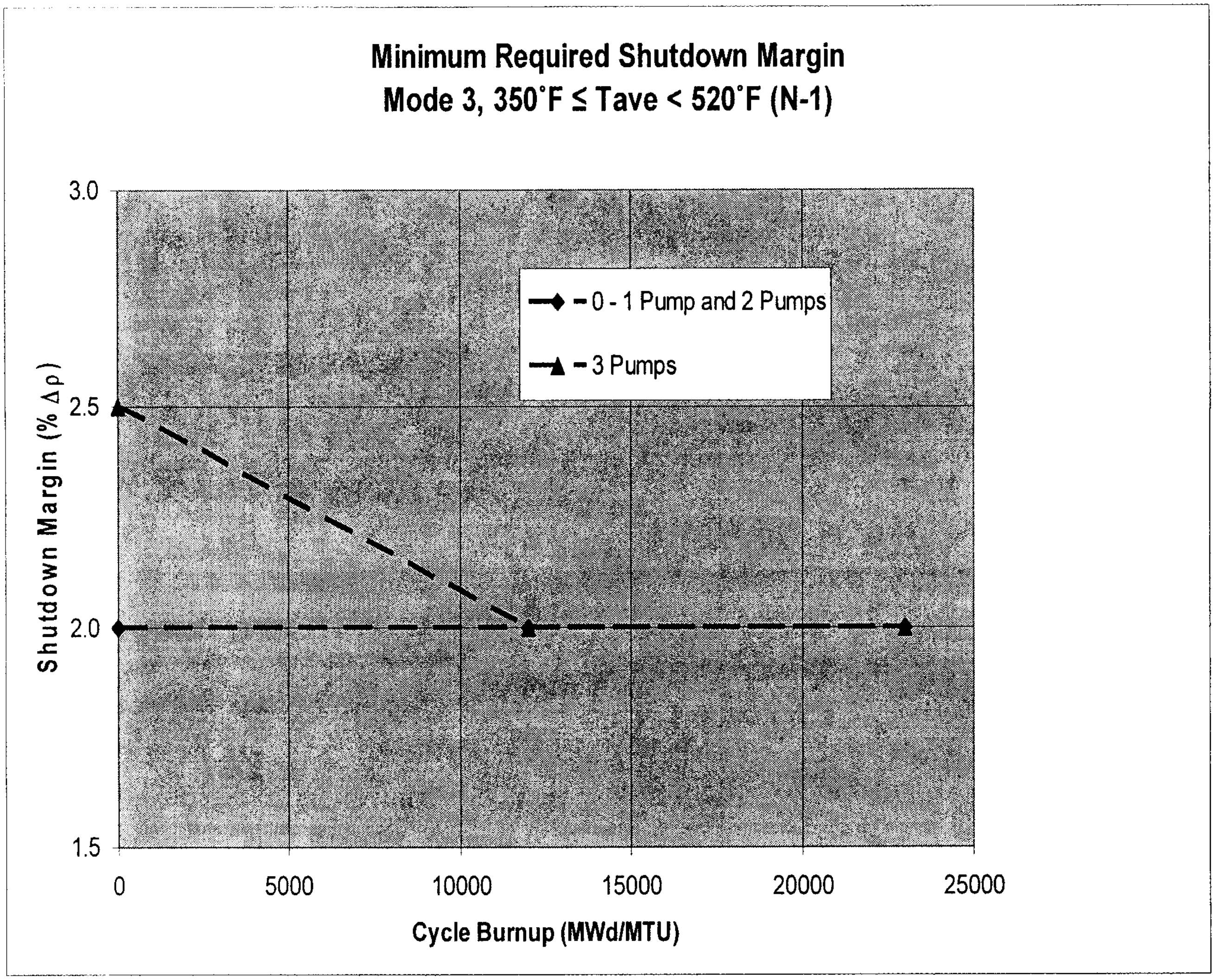

Minimum Required Shutdown Margin
Physics Testing in Mode 2
0 - 1 Pump, 2 Pumps, and 3 Pumps
Shutdown Margin (% Δρ)
1.5
1.0
0.5
0.0
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)

Figure 6C



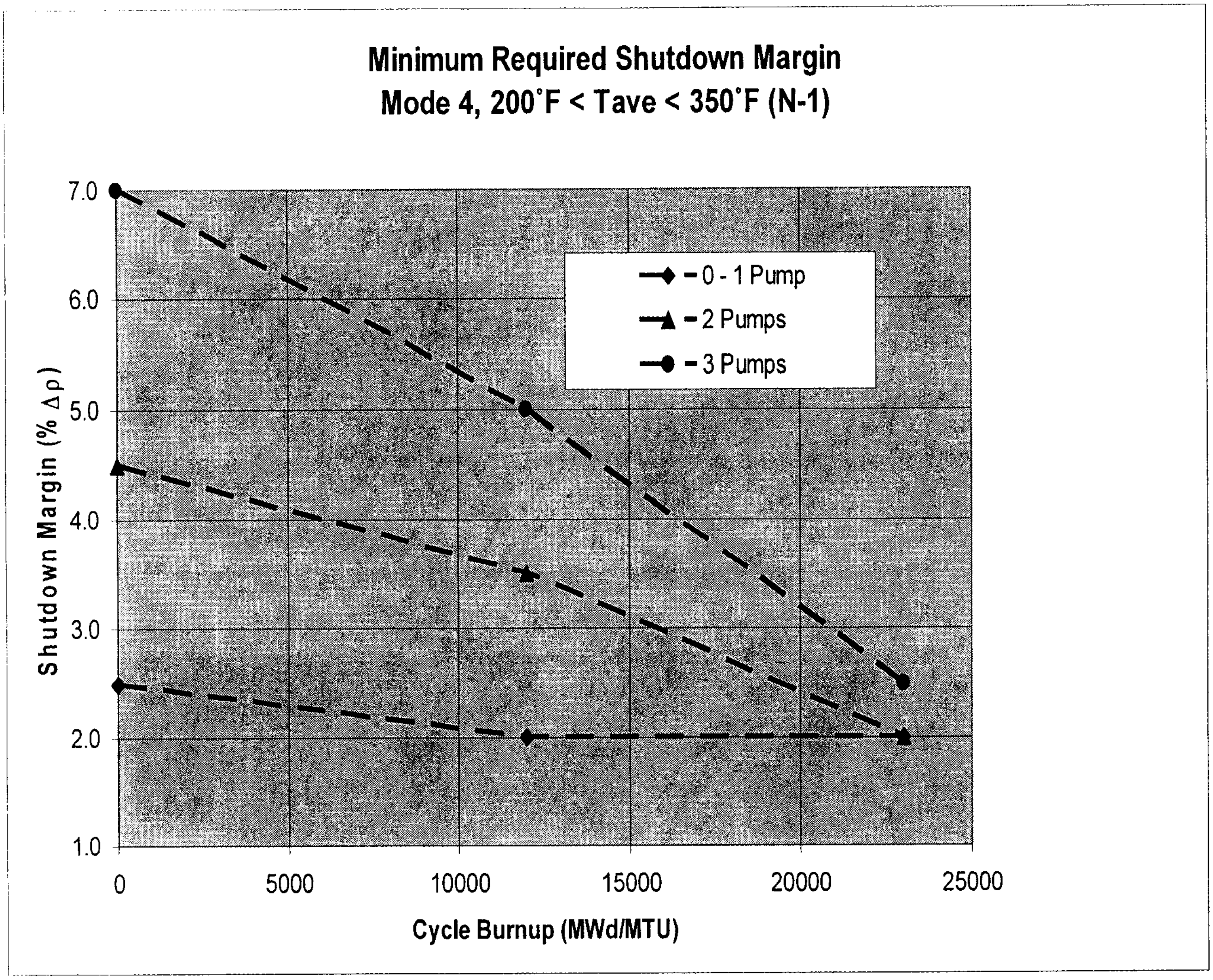
N-1 means all the rods are in except for the most reactive rod is out.

Figure 6D



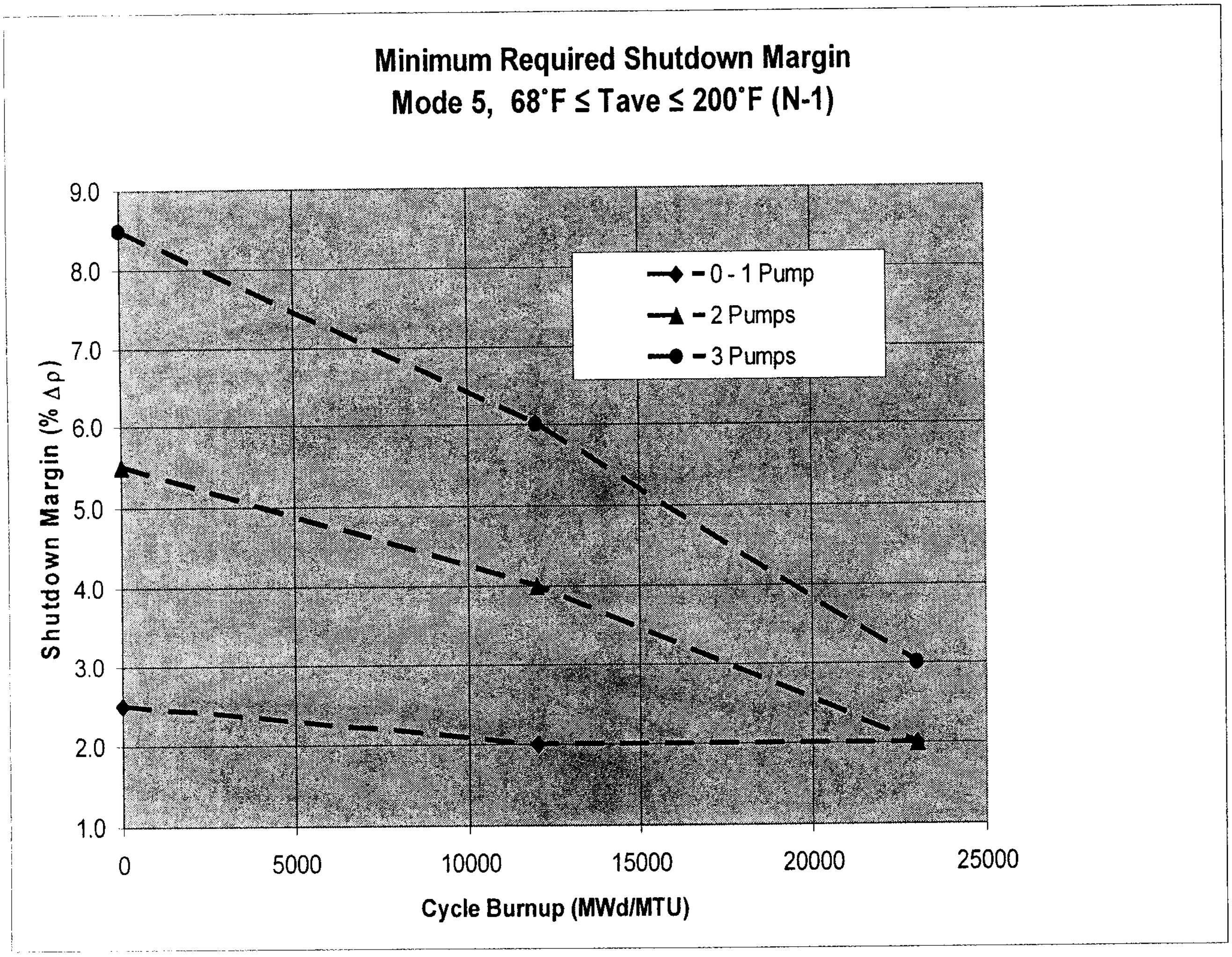
N-1 means all the rods are in except for the most reactive rod is out.

Figure 6E



N-1 means all the rods are in except for the most reactive rod is out.

Figure 6F



N-1 means all the rods are in except for the most reactive rod is out.

Figure 6G

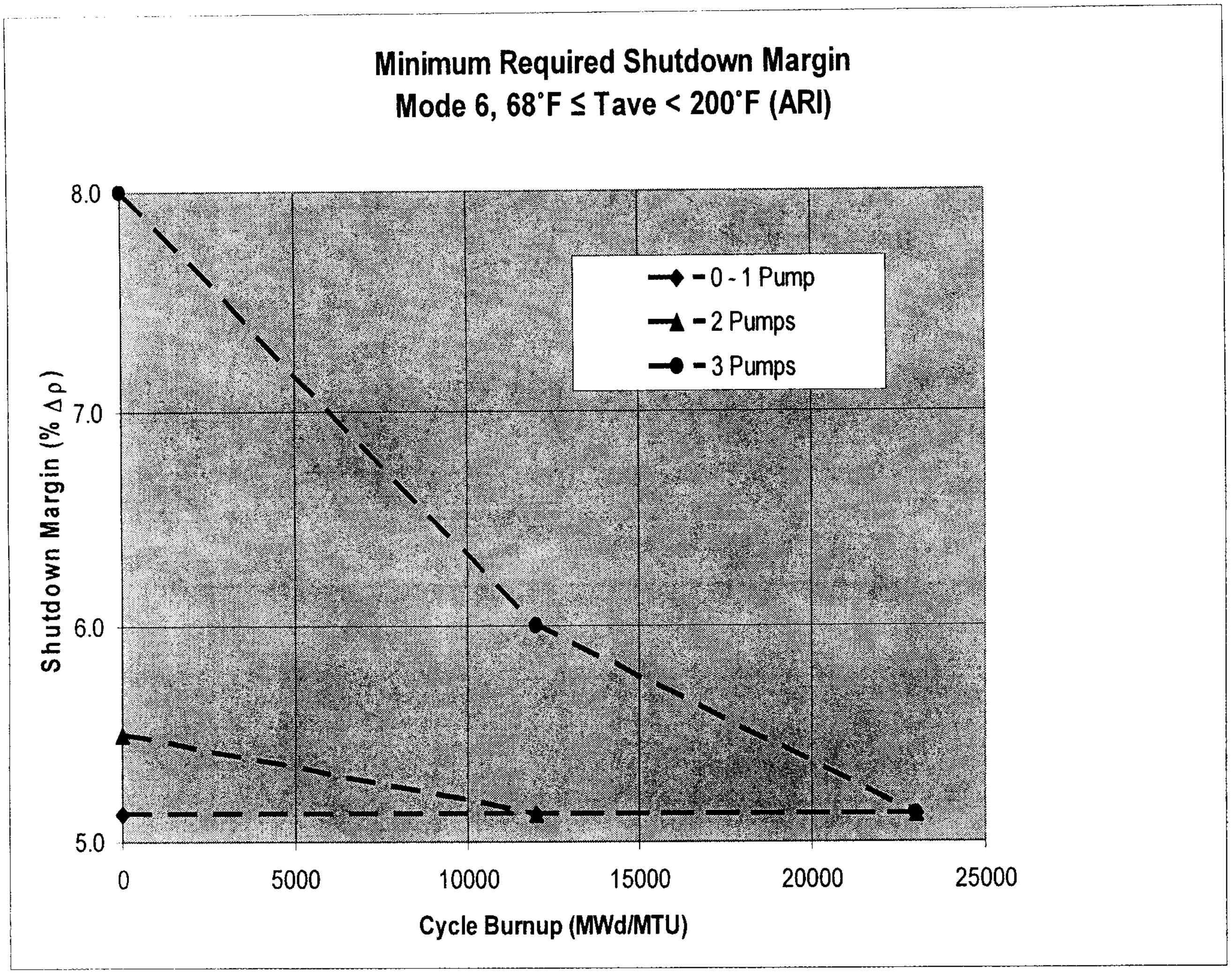
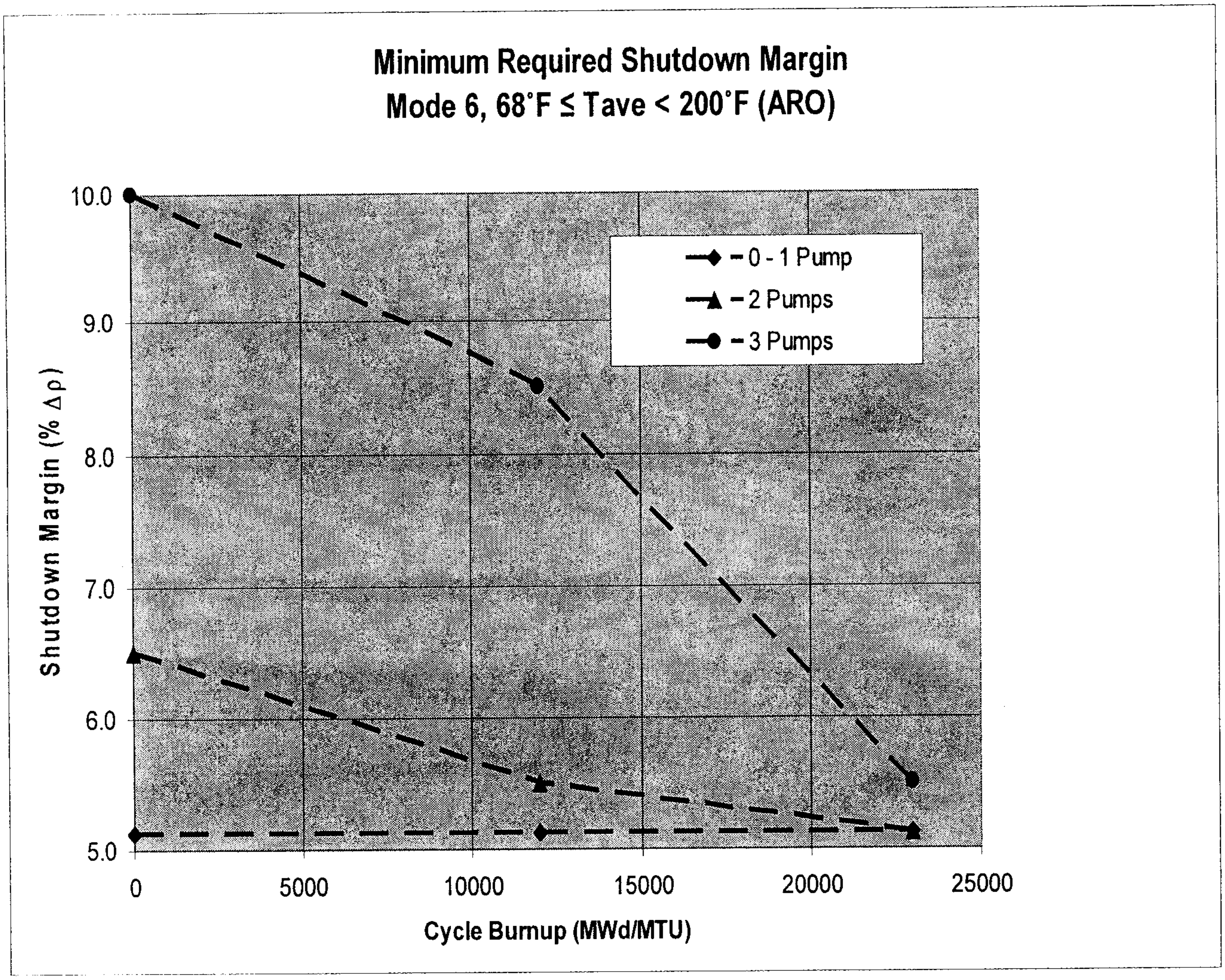

Minimum Required Shutdown Margin
Mode 6, 68°F ≤ Tave < 200°F (ARI)
8.0
7.0
6.0
5.0
Shutdown Margin (% Δρ)
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)
0 - 1 Pump
2 Pumps
3 Pumps

Figure 6H


Minimum Required Shutdown Margin
Mode 6, 68˚F ≤ Tave < 200˚F (ARO)
0 - 1 Pump
2 Pumps
3 Pumps
Shutdown Margin (% Δρ)
10.0
9.0
8.0
7.0
6.0
5.0
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 2 – CYCLE 24

REVISION 3

Reviewed By: Lynn R Johnson Date: 2/8/08
Lynn Johnson
Supervisor, NSSS

Reviewed By: A. T. H Date: 2/11/08
Hank Hoelscher
Supervisor, PWR Analyses

Approved By: Michael Carlson Date: 2/11/08
Mike Carlson
Director, Site Engineering

Note: This report is not part of the Technical Specifications
This report is referenced in the Technical Specifications

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 2 - CYCLE 24

REVISION 3

This report provides the values of the limits for Unit 2 Cycle 24 as required by Technical Specification Section 5.6.5. These values have been established using NRC approved methodology and are established such that all applicable limits of the plant safety analysis are met. The Technical Specifications affected by this report are listed below:

1. 2.1.1 Reactor Core SLs
2. 3.1.1 Shutdown Margin (SDM)
3. 3.1.3 Isothermal Temperature Coefficient (ITC)
4. 3.1.5 Shutdown Bank Insertion Limits
5. 3.1.6 Control Bank Insertion Limits
6. 3.1.8 Physics Tests Exceptions - MODE 2
7. 3.2.1 Heat Flux Hot Channel Factor ($F_Q(z)$)
8. 3.2.2 Nuclear Enthalpy Rise Hot Channel Factor $\left(F_{\Delta H}^{N}\right)$
9. 3.2.3 Axial Flux Difference (AFD)
10. 3.3.1 Reactor Trip System (RTS) Instrumentation
    Overtemperature ΔT and Overpower ΔT Parameter Values for Table 3.3.1-1
11. 3.4.1 RCS Pressure, Temperature, and Flow - Departure from Nucleate
    Boiling (DNB) Limits
12. 3.9.1 Boron Concentration

1. <u>2.1.1 Reactor Core Safety Limits</u>

   Reactor Core Safety Limits are shown in Figure 1.

   Reference Technical Specification section 2.1.1.

2. <u>3.1.1 Shutdown Margin Requirements</u>

   Minimum Shutdown Margin requirements are shown in Table 1 and Figures 6A through 6H.

   Reference Technical Specification section 3.1.1.

3. 3.1.3 Isothermal Temperature Coefficient (ITC)

ITC Upper limit:

a. < 5 pcm/°F for power levels < 70% RTP; and
b. less than a line which slopes linearly from
   i) 0 pcm/°F at power level = 70% RTP to
   ii) -1.5pcm/°F at power level = 100% RTP

ITC Lower limit:

a. -32.7 pcm/°F

Reference Technical Specification section 3.1.3.

4. 3.1.5 Shutdown Bank Insertion Limits

The shutdown rods shall be fully withdrawn.

Reference Technical Specification section 3.1.5.

5. 3.1.6 Control Bank Insertion Limits

The control rod banks shall be limited in physical insertion as shown in Figures 2, 3, and 4.

The control rod banks withdrawal sequence shall be Bank A, Bank B, Bank C, and finally Bank D.

The control rod banks shall be withdrawn maintaining 128 step tip-to-tip distance.

Reference Technical Specification section 3.1.6.

6. 3.1.8 Physics Tests Exceptions - MODE 2

Minimum Shutdown Margin requirements during physics testing are shown in Table 1 and Figure 6B.

Reference Technical Specification section 3.1.8.

7. <u>3.2.1 Heat Flux Hot Channel Factor ($F_Q(Z)$)</u>

The Heat Flux Hot Channel Factor shall be within the following limits:

CFQ = 2.50

K(Z) is a constant value = 1.0 at all elevations.

W(Z) values are provided in Table 2.

$F^W_Q(Z)$ Penalty Factors are provided in Table 3.

Applicability: MODE 1.

Reference Technical Specification section 3.2.1

8. <u>3.2.2 Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}^N$)</u>

The Nuclear Enthalpy Rise Hot Channel Factor shall be within the following limit:

$$F_{\Delta H} \leq 1.77 \times [1 + 0.3(1 - P)]$$

where: P is the fraction of RATED THERMAL POWER at which the core is operating.

Applicability: MODE 1.

Reference Technical Specification section 3.2.2

9. <u>3.2.3 Axial Flux Difference (AFD)</u>

The indicated axial flux difference, in % flux difference units, shall be maintained within the allowed operational space defined by Figure 5.

Applicability: MODE 1 with RATED THERMAL POWER $\geq$ 50% RTP.

Reference Technical Specification sections 3.2.3.

10. 3.3.1 Reactor Trip System (RTS) Instrumentation

Overtemperature ΔT and Overpower ΔT Parameter Values for Table 3.3.1-1;

Overtemperature ΔT Setpoint

Overtemperature ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED THERMAL POWER, %
T	=	Average temperature, °F
T'	=	560.0 °F
P	=	Pressurizer Pressure, psig
P'	=	2235 psig
K_1	≤	1.17
K_2	=	0.014 /°F
K_3	=	0.00100 /psi
τ_1	=	30 seconds
τ_2	=	4 seconds
$f(\Delta I)$	=	A function of the indicated difference between top and bottom detectors of the power range nuclear ion chambers. Selected gains are based on measured instrument response during plant startup tests, where q_t and q_b are the percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of RATED THERMAL POWER, such that (a) For q_t - q_b within −13, +8 % $f(\Delta I) = 0$ (b) For each percent that the magnitude of q_t - q_b exceeds +8% the ΔT trip setpoint shall be automatically reduced by an equivalent of 1.73 % of RATED THERMAL POWER. (c) For each percent that the magnitude of q_t - q_b exceeds -13 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 3.846 % of RATED THERMAL POWER.

Overpower ΔT Setpoint

Overpower ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED THERMAL POWER, %
T	=	Average temperature, °F
T'	=	560.0 °F
K_4	≤	1.11
K_5	=	0.0275/°F for increasing T; 0 for decreasing T
K_6	=	0.002/°F for $T > T'$; 0 for $T \le T'$
τ_3	=	10 seconds

11. 3.4.1 RCS Pressure, Temperature, and Flow - Departure from Nucleate Boiling (DNB) Limits

Pressurizer pressure limit = 2205 psia
RCS average temperature limit = 564°F
RCS total flow rate limit = 178,000 gpm

Reference Technical Specification section 3.4.1.

12. 3.9.1 Refueling Boron Concentration.

The boron concentration of the reactor coolant system and the refueling cavity shall be sufficient to ensure that the more restrictive of the following conditions is met:

a) $K_{eff} \leq 0.95$
b) 2000 ppm
c) The Shutdown Margin specified in Table 1 and Figures 6A through 6H

Reference Technical Specification section 3.9.1.

REFERENCES

1. NSPNAD-8101-A, "Qualification of Reactor Physics Methods for Application to Prairie Island," Revision 2, October 2000.

2. NSPNAD-8102-PA, "Prairie Island Nuclear Power Plant Reload Safety Evaluation Methods for Application to PI Units," Revision 7, July 1999.

3. NSPNAD-97002-PA, "Northern States Power Company's "Steam Line Break Methodology," Revision 1, October 2000.

4. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July, 1985.

5.a WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model using the NOTRUMP Code," August, 1985.

5.b WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model using the NOTRUMP Code," Addendum 2 Revision 1, July 1997.

6.a Deleted.

6.b Deleted.

6.c Deleted.

7. XN-NF-77-57-(A), XN-NF-77-57, Supplement 1 (A), "Exxon Nuclear Power Distribution Control for Pressurized Water Reactors Phase II," May 1981.

8. Deleted.

9. NSPNAD-93003-A, "Prairie Island Units 1 and 2 Transient Power Distribution Methodology," Revision 0, April 1993.

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12. WCAP-11397-P-A, "Revised Thermal Design Procedure," April 1989.

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19. WCAP-11394-P-A, "Methodology for the Analysis of the Dropped Rod Event," January 1990.

20 WCAP-11596-P-A, "Qualification of the PHOENIX-P/ANC Nuclear Design System for Pressurized Water Reactor Cores," June 1988.

21. WCAP-12910 Rev. 1-A, "Pressurizer Safety Valve Set Pressure Shift," May 1993.

22. WCAP-14565-P-A, "VIPRE-01 Modeling and Qualification for Pressurized Water Reactor Non-LOCA Thermal-Hydraulic Safety Analysis," October 1999.

23. WCAP-14882-P-A, "RETRAN-02 Modeling and Qualification for Westinghouse Pressurized Water Reactor Non-LOCA Safety Analyses," April 1999.

24. WCAP-16009-P-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment of Uncertainty Method (ASTRUM)," Revision 0, January 2005.

25. 50.59 Evaluation 1055, "Unit 2 Cycle 24 Core Reload."

Table 1

Minimum Required Shutdown Margin, %$\Delta\rho$

	Number of Charging Pumps Running**		
Mode 1*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 24700 MWd/MTU	-	-	-

Mode 2*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 24700 MWd/MTU	2.0	2.0	2.0

Physics Testing in Mode 2			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 24700 MWd/MTU	0.5	0.5	0.5

Mode 3	**$T_{ave} \geq 520$ °F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 24700 MWd/MTU	2.0	2.0	2.0

Mode 3	**350 °F $\leq T_{ave} <$ 520°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU	2.0	2.0	2.5
12000 MWd/MTU	2.0	2.0	2.0
24700 MWd/MTU	2.0	2.0	2.0

Mode 4	**200 °F $< T_{ave} <$ 350°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU	2.0	4.5	6.5
12000 MWd/MTU	2.0	3.5	5.5
24700 MWd/MTU	2.0	2.0	2.5

Operational Mode Definitions, as per TS Table 1.1-1.

* For Mode 1 and Mode 2 with $K_{eff} \geq 1.0$, the minimum shutdown margin requirements are provided by the Rod Insertion Limits.

** Charging pump(s) in service only pertains to steady state operations. It does not include transitory operations. For example, operations such as starting a second charging pump in order to secure the operating pump would fall under the one pump in service column.

Table 1, Continued

Minimum Required Shutdown Margin, %$\Delta\rho$

Number of Charging Pumps Running**			
Mode 5	**68°F ≤ T_{ave} ≤ 200°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU* **	2.5	5.5	8.0
12000 MWd/MTU	2.0	4.5	6.5
24700 MWd/MTU	2.0	2.0	3.0

Mode 6	**68°F ≤ T_{ave} < 200°F (ARI)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU* **	5.129	5.129	8.0
12000 MWd/MTU	5.129	5.129	6.5
24700 MWd/MTU	5.129	5.129	5.129

Mode 6	**68°F ≤ T_{ave} < 200°F (ARO)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU* **	5.129	6.5	10.0
12000 MWd/MTU	5.129	5.5	8.5
24700 MWd/MTU	5.129	5.129	5.5

Operational Mode Definitions, as per TS Table 1.1-1.

** Charging pump(s) in service only pertains to steady state operations. It does not include transitory operations. For example, operations such as starting a second charging pump in order to secure the operating pump would fall under the one pump in service column.

*** These values are also applicable for the Unit 2 Cycle 23 end of cycle.

Table 2 - W(z) Values(Top 10% and Bottom 8% excluded)

	Height	BU [MWd/MTU]				
	[ft]	150	4000	12000	18000	22000
		AO = 1.84	AO = -0.60	AO =-2.76	AO =-0.56	AO =-1.71
[BOTTOM] 1	0.00	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.20	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.40	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.60	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.80	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.00	1.3164	1.2648	1.2415	1.2135	1.1767
7	1.20	1.3052	1.2536	1.2299	1.2054	1.1671
8	1.40	1.2932	1.2409	1.2169	1.1966	1.1570
9	1.60	1.2798	1.2269	1.2029	1.1877	1.1471
10	1.80	1.2653	1.2121	1.1883	1.1787	1.1373
11	2.00	1.2501	1.1966	1.1733	1.1697	1.1275
12	2.20	1.2342	1.1807	1.1580	1.1607	1.1182
13	2.40	1.2180	1.1645	1.1428	1.1516	1.1087
14	2.60	1.2016	1.1490	1.1277	1.1423	1.0988
15	2.80	1.1846	1.1385	1.1129	1.1335	1.0988
16	3.00	1.1699	1.1280	1.0991	1.1219	1.1042
17	3.20	1.1613	1.1223	1.0928	1.1164	1.1149
18	3.40	1.1594	1.1242	1.0934	1.1256	1.1243
19	3.60	1.1597	1.1260	1.0946	1.1357	1.1340
20	3.80	1.1594	1.1271	1.0956	1.1451	1.1440
21	4.00	1.1582	1.1278	1.0971	1.1538	1.1529
22	4.20	1.1562	1.1278	1.0984	1.1613	1.1607
23	4.40	1.1534	1.1272	1.0991	1.1676	1.1690
24	4.60	1.1498	1.1259	1.0999	1.1727	1.1785
25	4.80	1.1455	1.1239	1.1022	1.1760	1.1866
26	5.00	1.1404	1.1215	1.1044	1.1793	1.1930
27	5.20	1.1348	1.1181	1.1066	1.1832	1.1979
28	5.40	1.1285	1.1153	1.1109	1.1860	1.2014
29	5.60	1.1218	1.1197	1.1155	1.1871	1.2036
30	5.80	1.1151	1.1269	1.1221	1.1893	1.2044
31	6.00	1.1170	1.1353	1.1311	1.1956	1.2103
32	6.20	1.1271	1.1451	1.1408	1.2051	1.2219
33	6.40	1.1348	1.1540	1.1496	1.2138	1.2317
34	6.60	1.1419	1.1621	1.1574	1.2211	1.2402
35	6.80	1.1482	1.1692	1.1670	1.2266	1.2471
36	7.00	1.1535	1.1752	1.1772	1.2303	1.2521
37	7.20	1.1577	1.1798	1.1857	1.2321	1.2557
38	7.40	1.1607	1.1832	1.1935	1.2318	1.2585
39	7.60	1.1622	1.1863	1.2006	1.2293	1.2590
40	7.80	1.1622	1.1880	1.2064	1.2245	1.2568
41	8.00	1.1605	1.1879	1.2102	1.2173	1.2521
42	8.20	1.1571	1.1859	1.2121	1.2079	1.2446
43	8.40	1.1517	1.1819	1.2120	1.1963	1.2343
44	8.60	1.1448	1.1764	1.2095	1.1810	1.2217
45	8.80	1.1340	1.1667	1.2057	1.1714	1.2055
46	9.00	1.1301	1.1628	1.1973	1.1656	1.1903
47	9.20	1.1352	1.1697	1.1905	1.1590	1.1816
48	9.40	1.1451	1.1747	1.2009	1.1570	1.1773
49	9.60	1.1536	1.1846	1.2132	1.1526	1.1701
50	9.80	1.1624	1.1949	1.2285	1.1558	1.1682
51	10.00	1.1706	1.2047	1.2443	1.1683	1.1721
52	10.20	1.1777	1.2153	1.2561	1.1816	1.1743
53	10.40	1.1887	1.2220	1.2690	1.1935	1.1758
54	10.60	1.1988	1.2306	1.2752	1.2026	1.1791
55	10.80	1.2082	1.2378	1.2801	1.2109	1.1835
56	11.00	1.0000	1.0000	1.0000	1.0000	1.0000
57	11.20	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.40	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.60	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.80	1.0000	1.0000	1.0000	1.0000	1.0000
[TOP] 61	12.00	1.0000	1.0000	1.0000	1.0000	1.0000

Table 3

$F^W_Q(Z)$ Penalty Factor

Cycle Burnup (MWD/MTU)	$F^W_Q(Z)$ Penalty Factor
0	1.020
12983	1.020
13134	1.021
13285	1.028
13436	1.031
13587	1.029
13738	1.029
13889	1.028
14040	1.027
14191	1.025
14342	1.024
14493	1.022
14644	1.021
14795	1.021
14946	1.020

$F^W_Q(Z)$ = 1.020 for all burnups except those listed above. Linear interpolation is adequate for intermediate cycle burnups.

Figure 1

Reactor Core Safety Limits

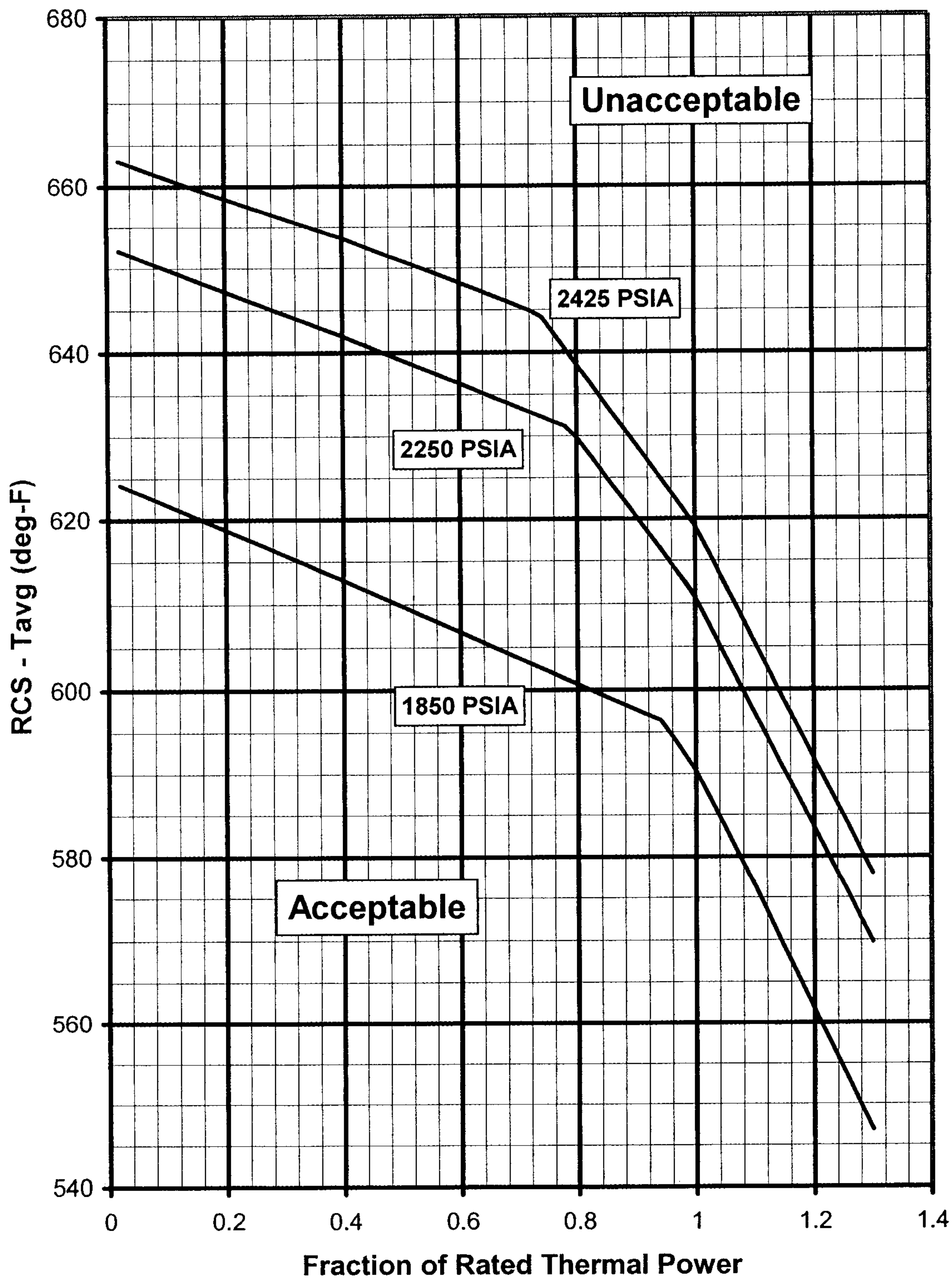
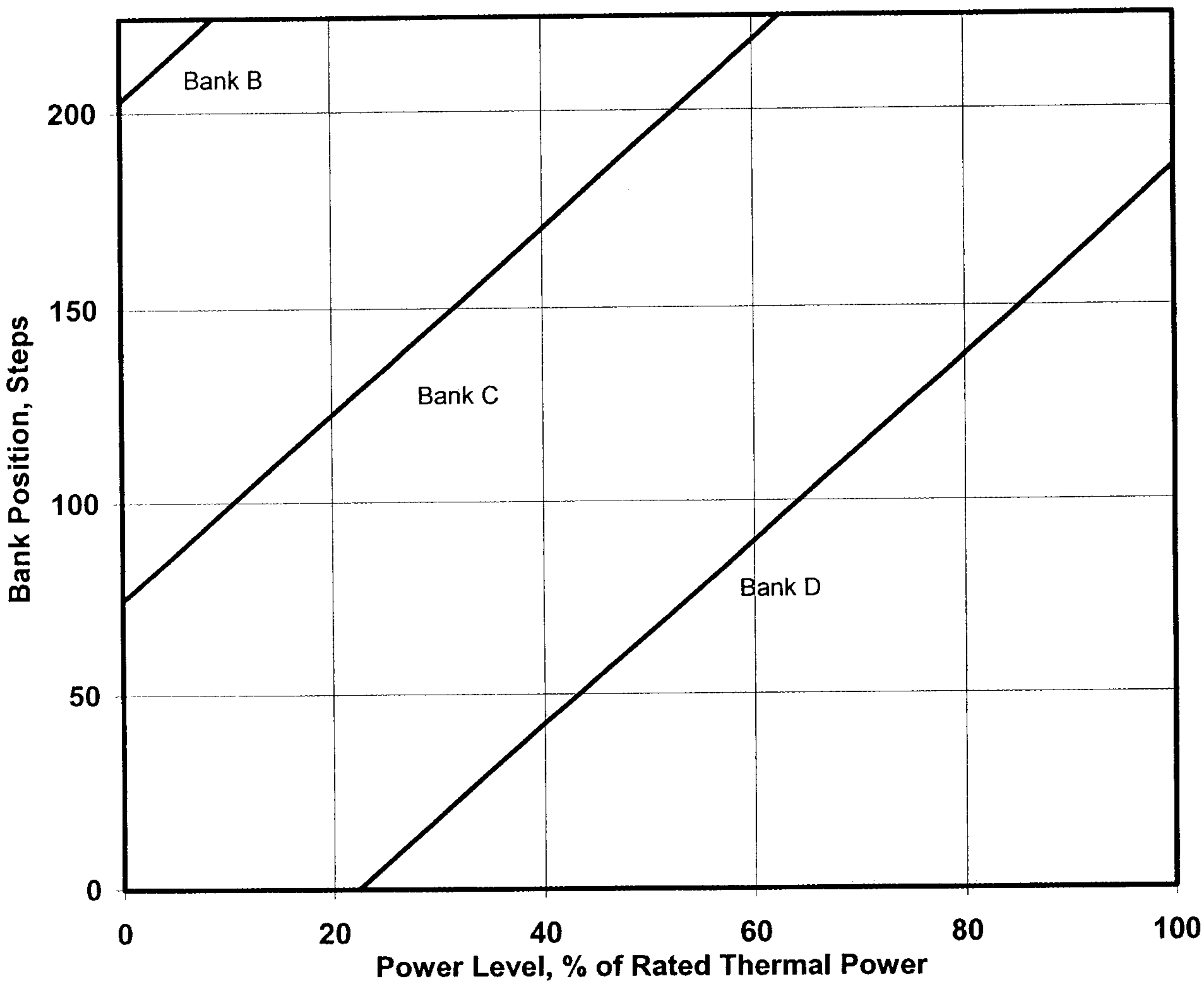


Figure 2
Rod Insertion Limit, 128 Step Tip-to-Tip

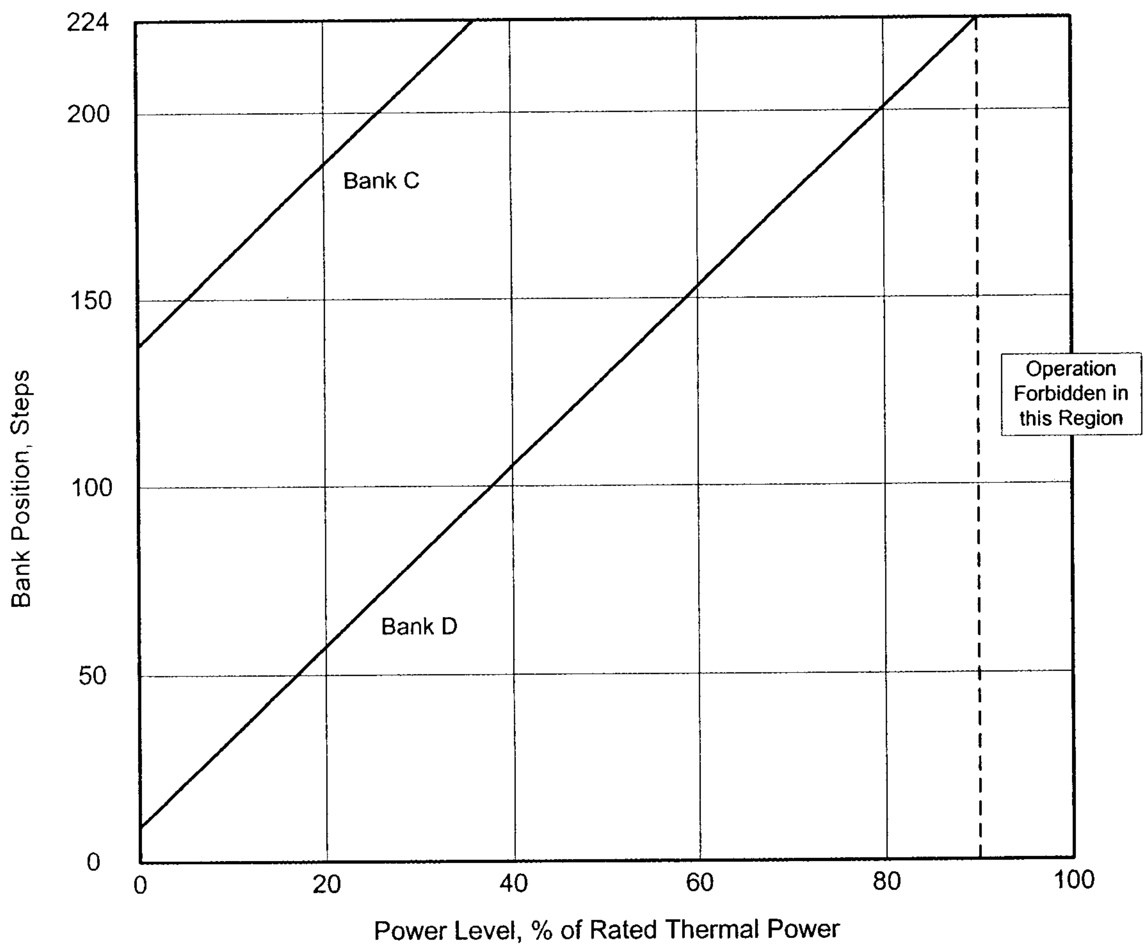


Bank Positions Given By:

- Bank D = (150 / 63) * (P – 100) + 185
- Bank C = (150 / 63) * (P – 100) + 185 + 128
- Bank B = (150 / 63) * (P – 100) + 185 + 128 + 128

NOTE: The top of the active fuel height corresponds to 224 steps. The ARO parking position may be any position above 224 steps.

Figure 3
Rod Insertion Limit, 128 Step Tip-to-Tip, One Bottomed Rod
(Technical Specification 3.1.4 Condition B)

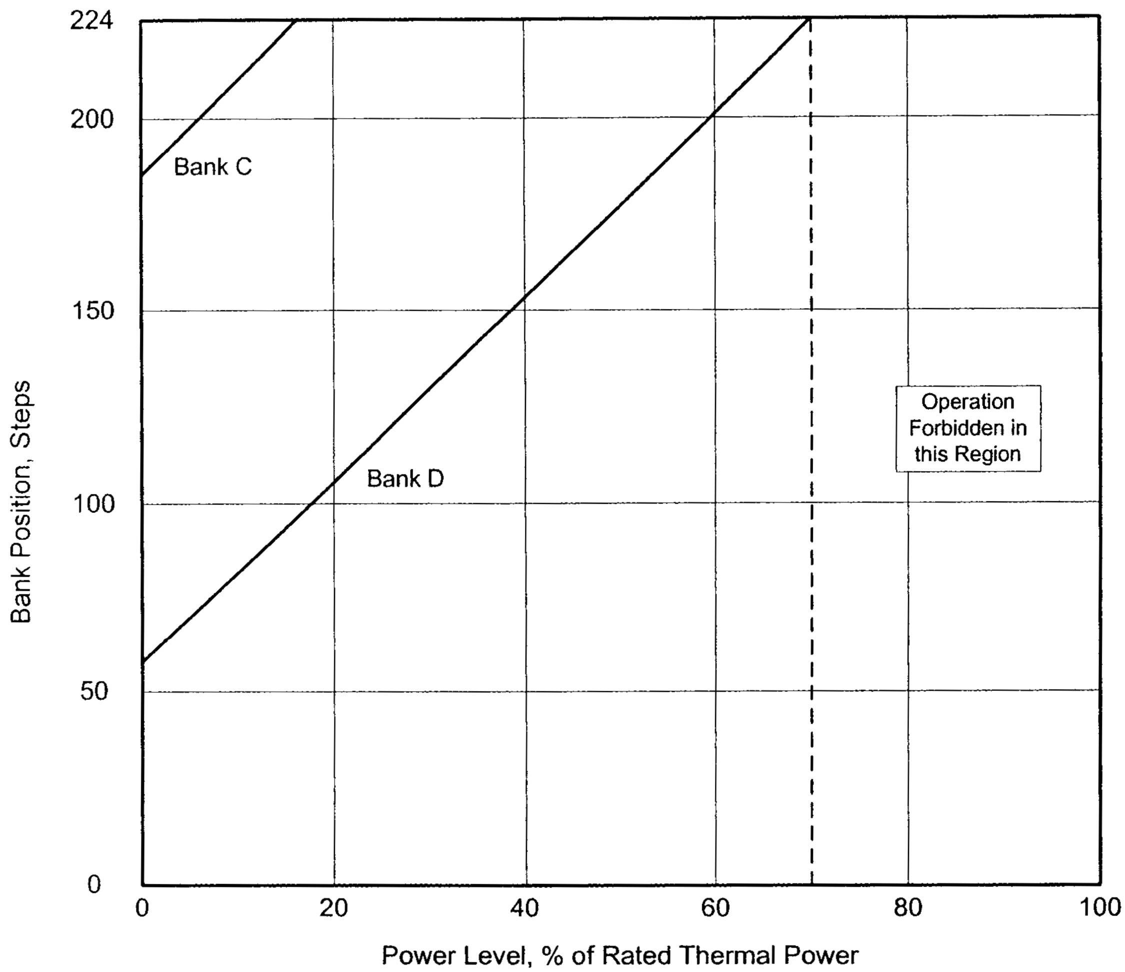


Bank Positions Given By:

- Bank D = (150 / 63) * (P – 90) + 224
- Bank C = (150 / 63) * (P – 90) + 224 + 128

NOTE: The top of the active fuel height corresponds to 224 steps. The ARO parking position may be any position above 224 steps.

Figure 4
Rod Insertion Limit, 128 Step Tip-to-Tip, One Inoperable Rod
(Technical Specification 3.1.4 Condition A)



Bank Positions Given By:

- Bank D = (150 / 63) * (P – 70) + 224
- Bank C = (150 / 63) * (P – 70) + 224 + 128

NOTE: The top of the active fuel height corresponds to 224 steps. The ARO parking position may be any position above 224 steps.

Figure 5
Flux Difference Operating Envelope

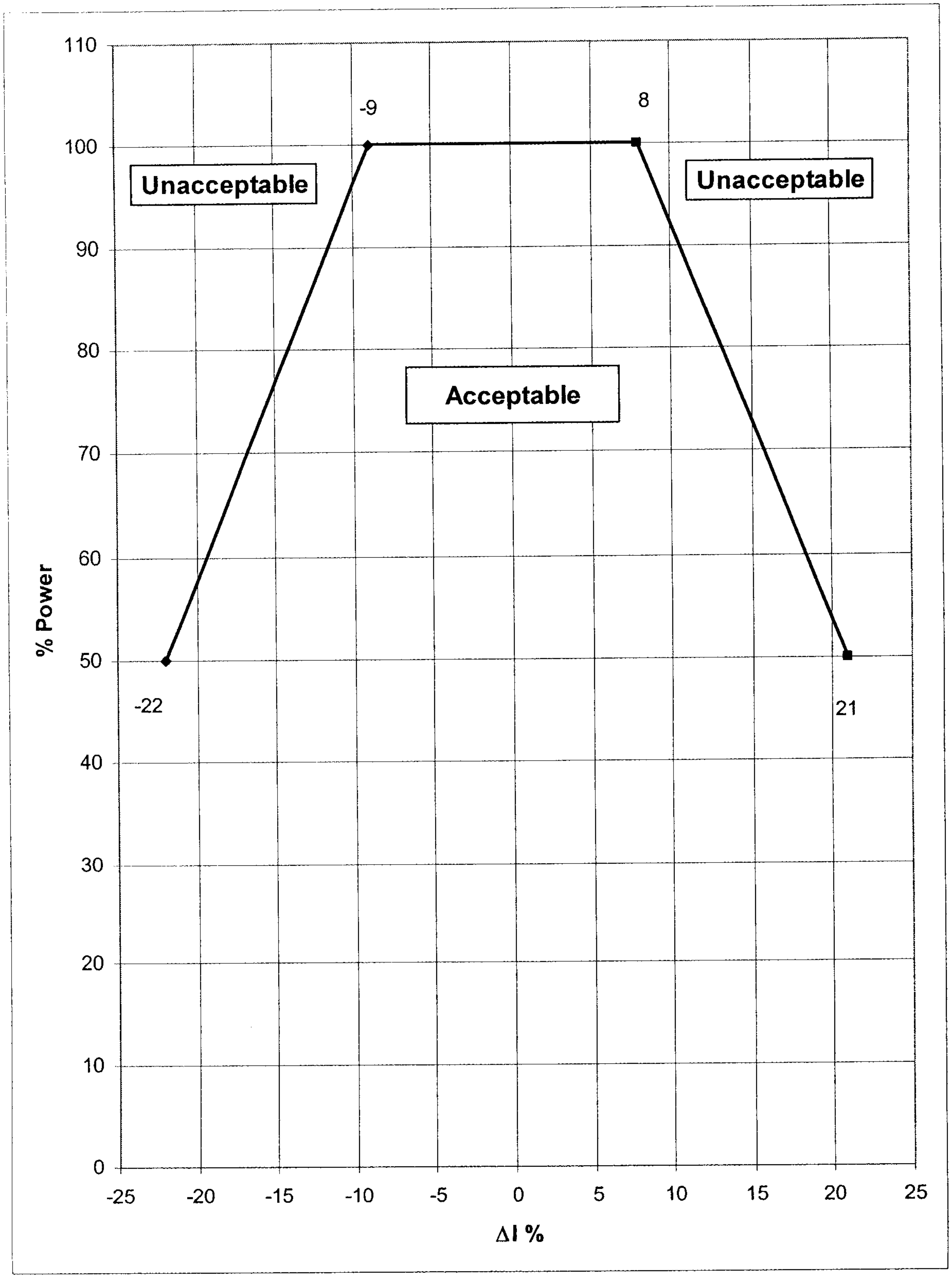


Figure 6A

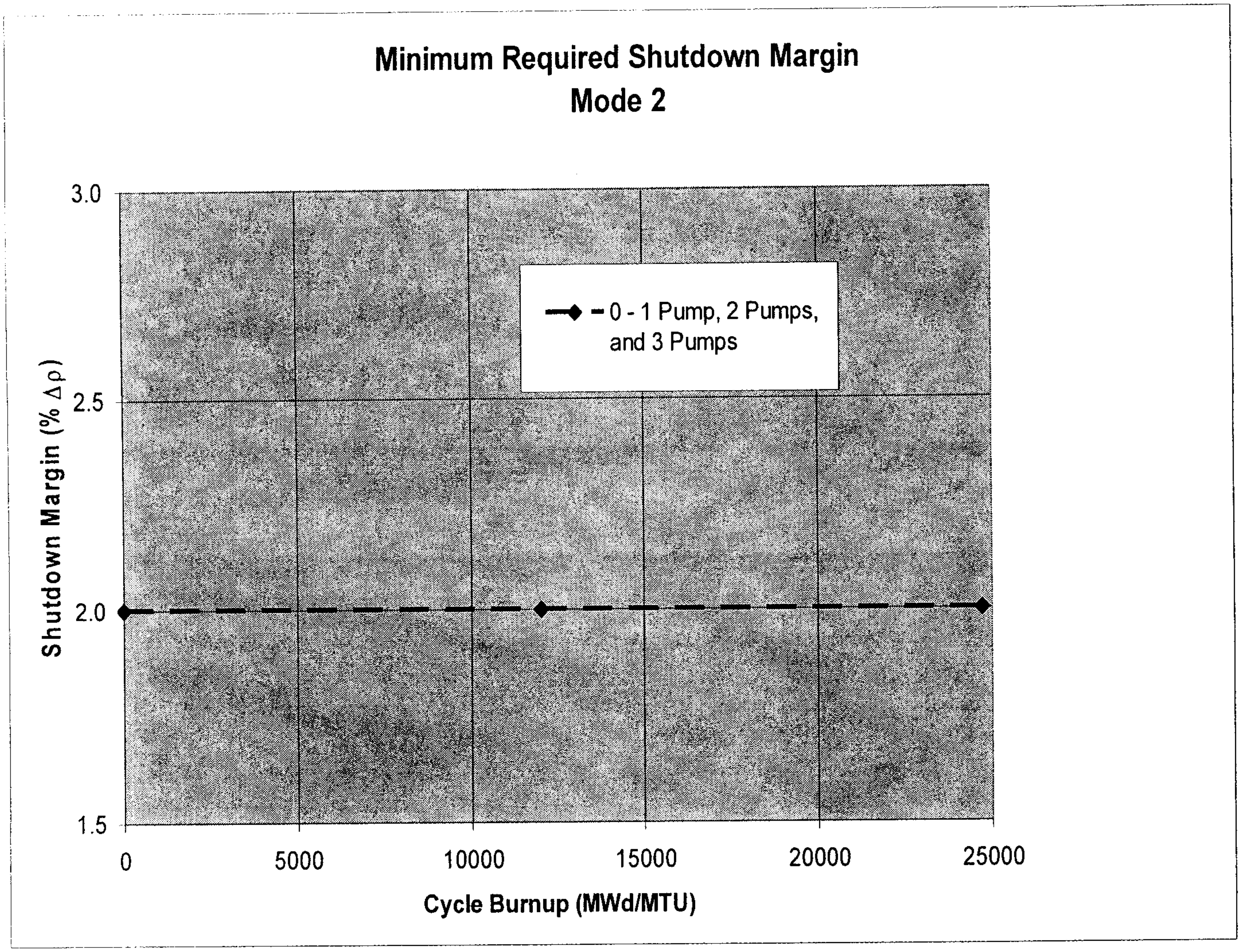

Minimum Required Shutdown Margin
Mode 2
0 - 1 Pump, 2 Pumps, and 3 Pumps
Shutdown Margin (% Δρ)
3.0
2.5
2.0
1.5
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)

Figure 6B

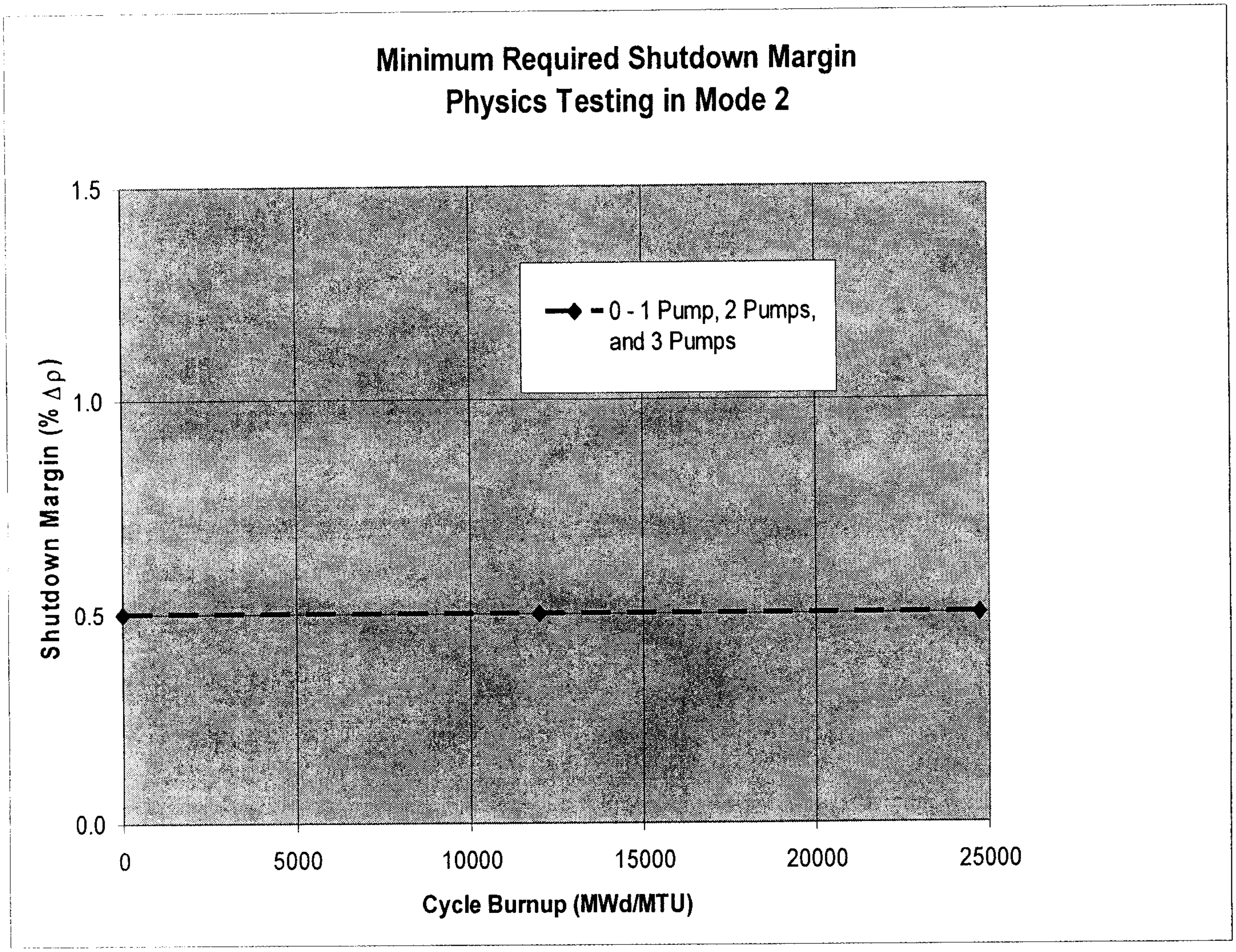
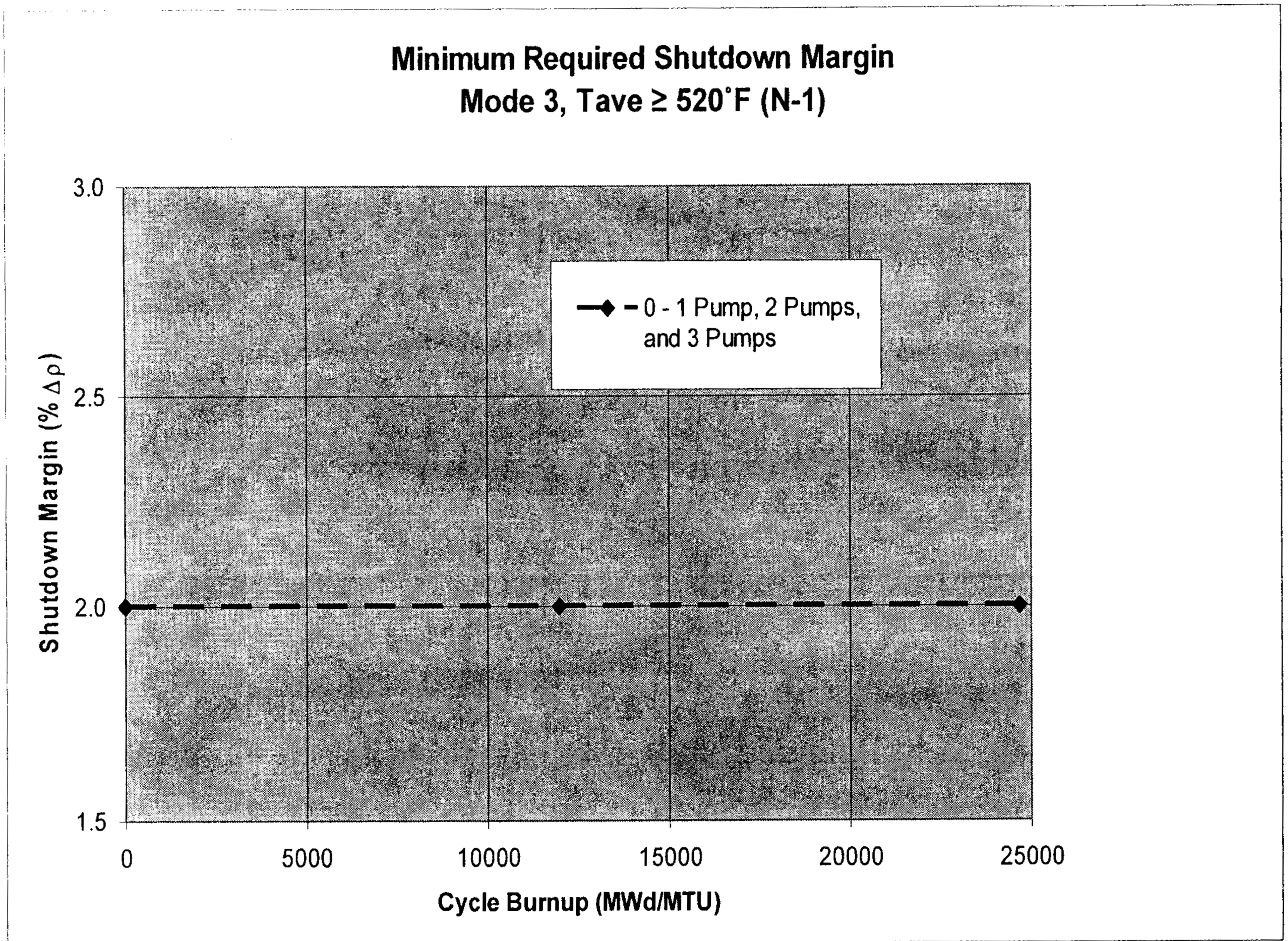
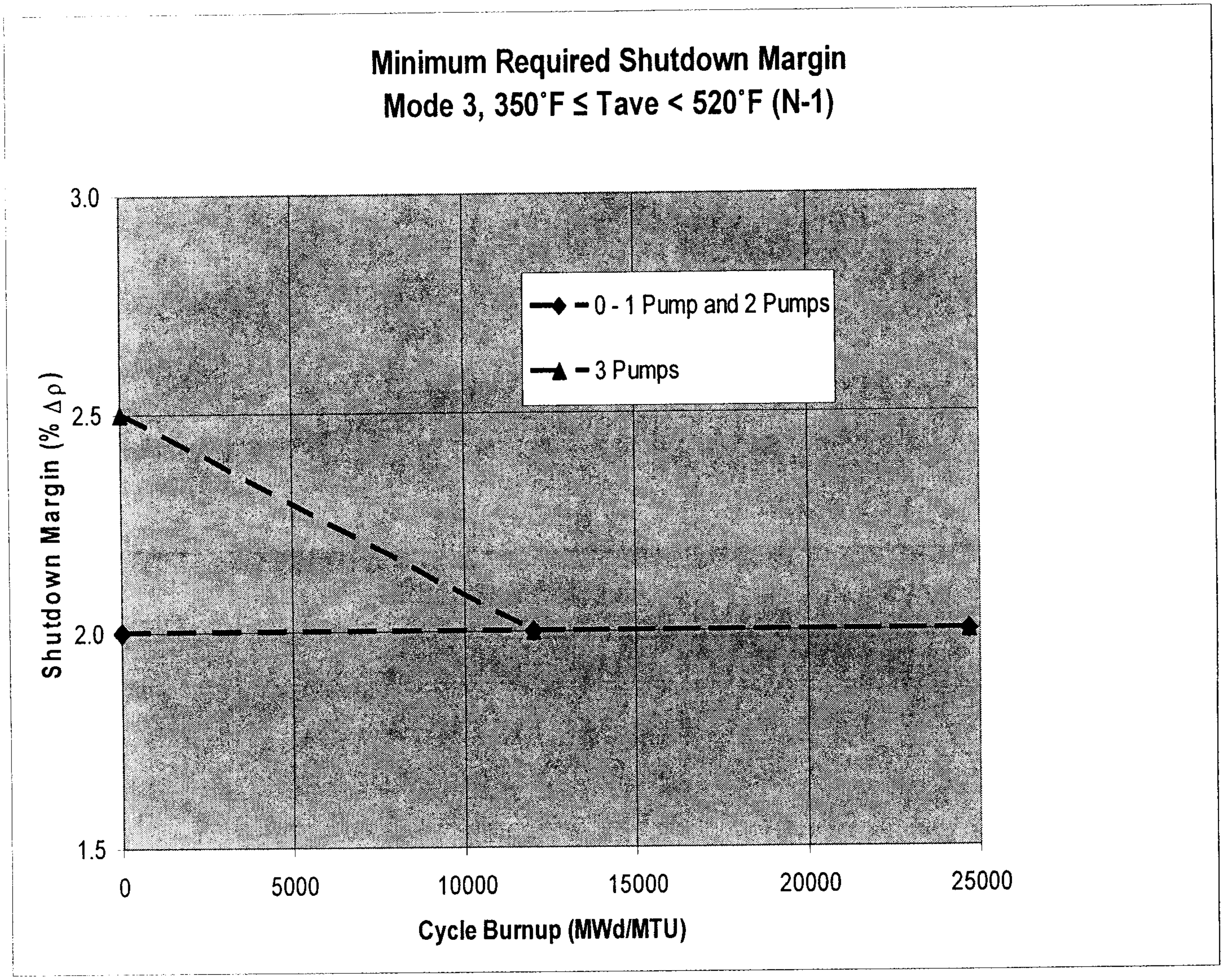

Minimum Required Shutdown Margin
Physics Testing in Mode 2
0 - 1 Pump, 2 Pumps, and 3 Pumps
Shutdown Margin (% Δρ)
1.5
1.0
0.5
0.0
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)

Figure 6C



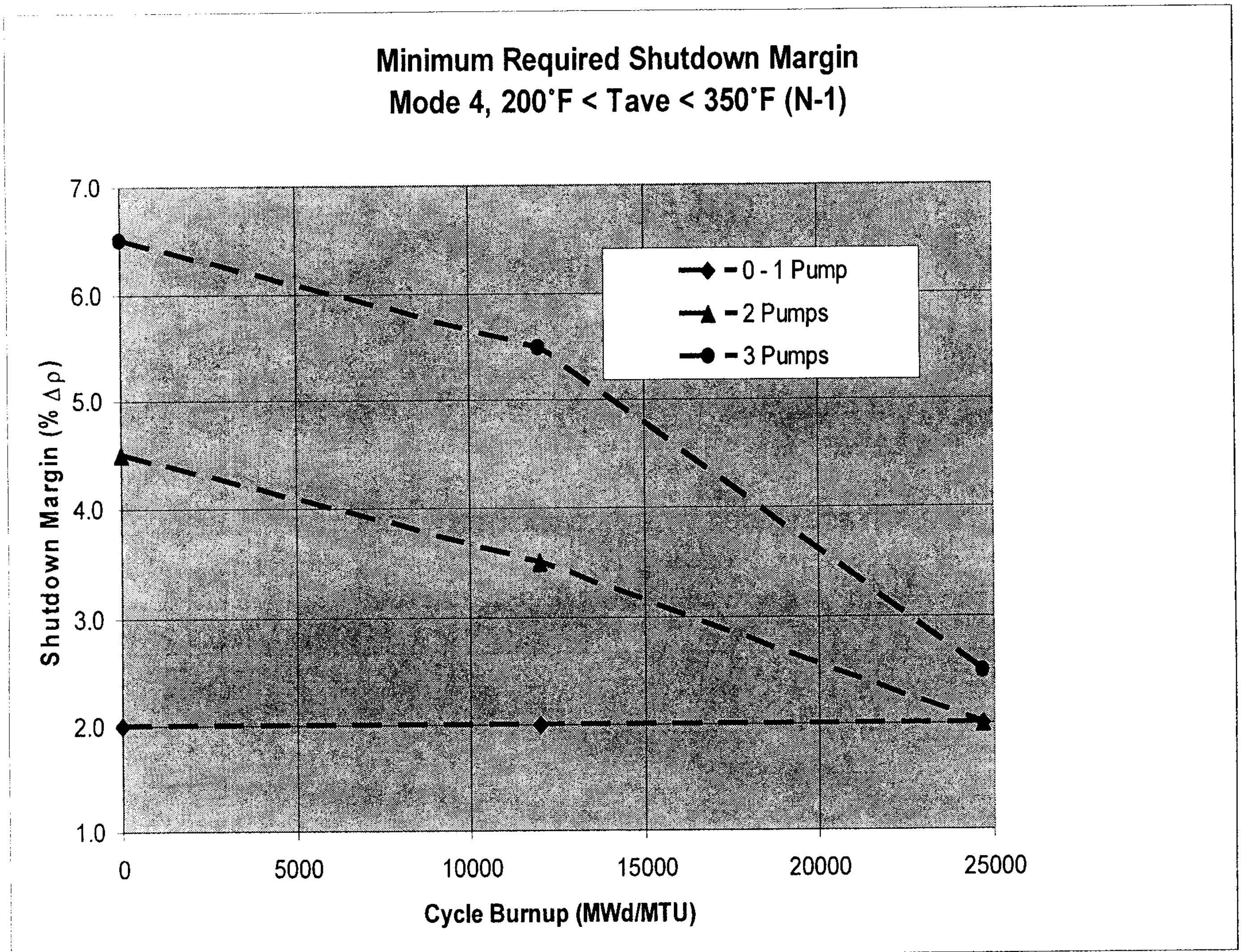
N-1 means all the rods are in except the most reactive rod is out.

Figure 6D



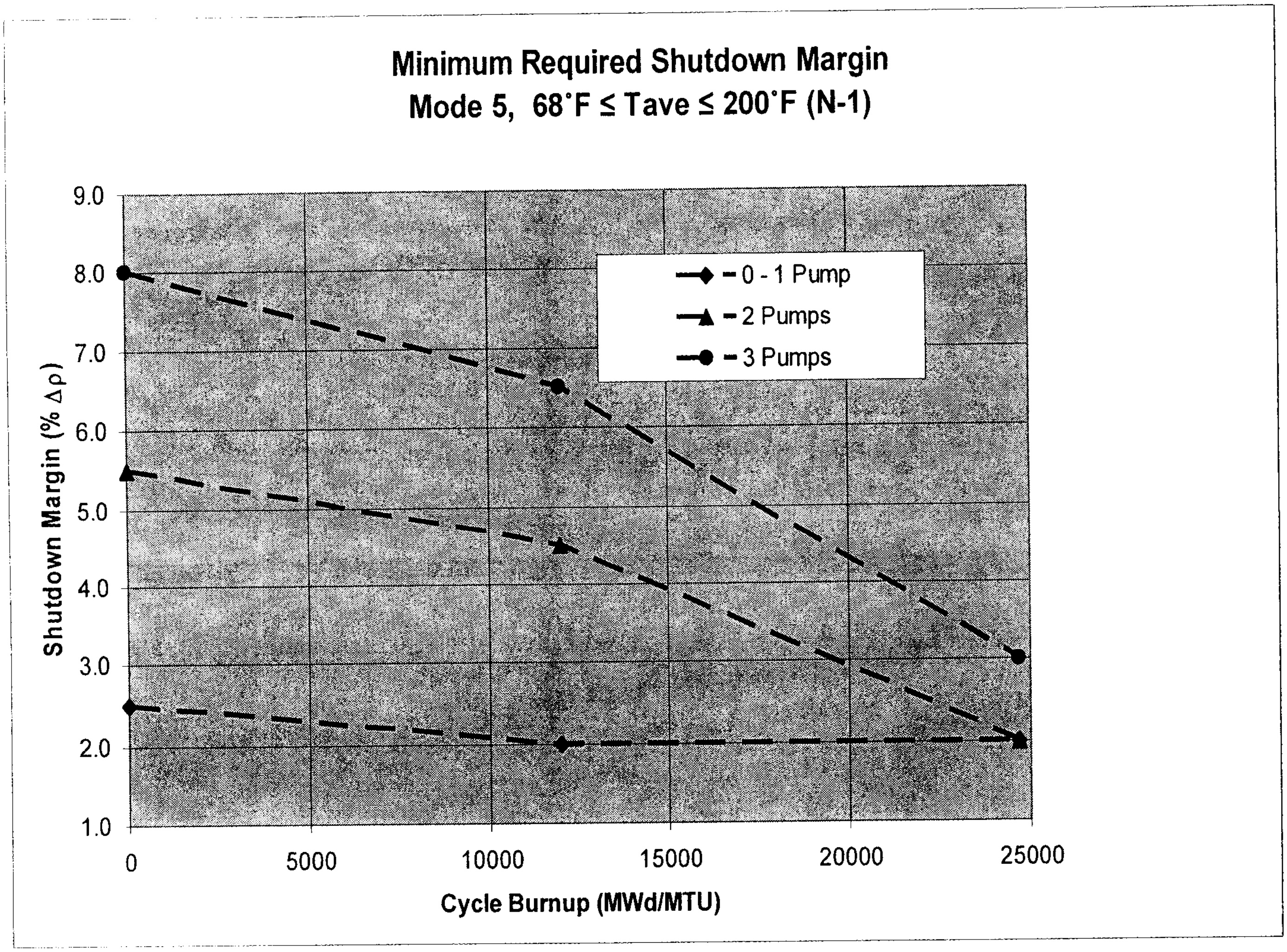
N-1 means all the rods are in except the most reactive rod is out.

Figure 6E



N-1 means all the rods are in except the most reactive rod is out.

Figure 6F



N-1 means all the rods are in except the most reactive rod is out.

Figure 6G

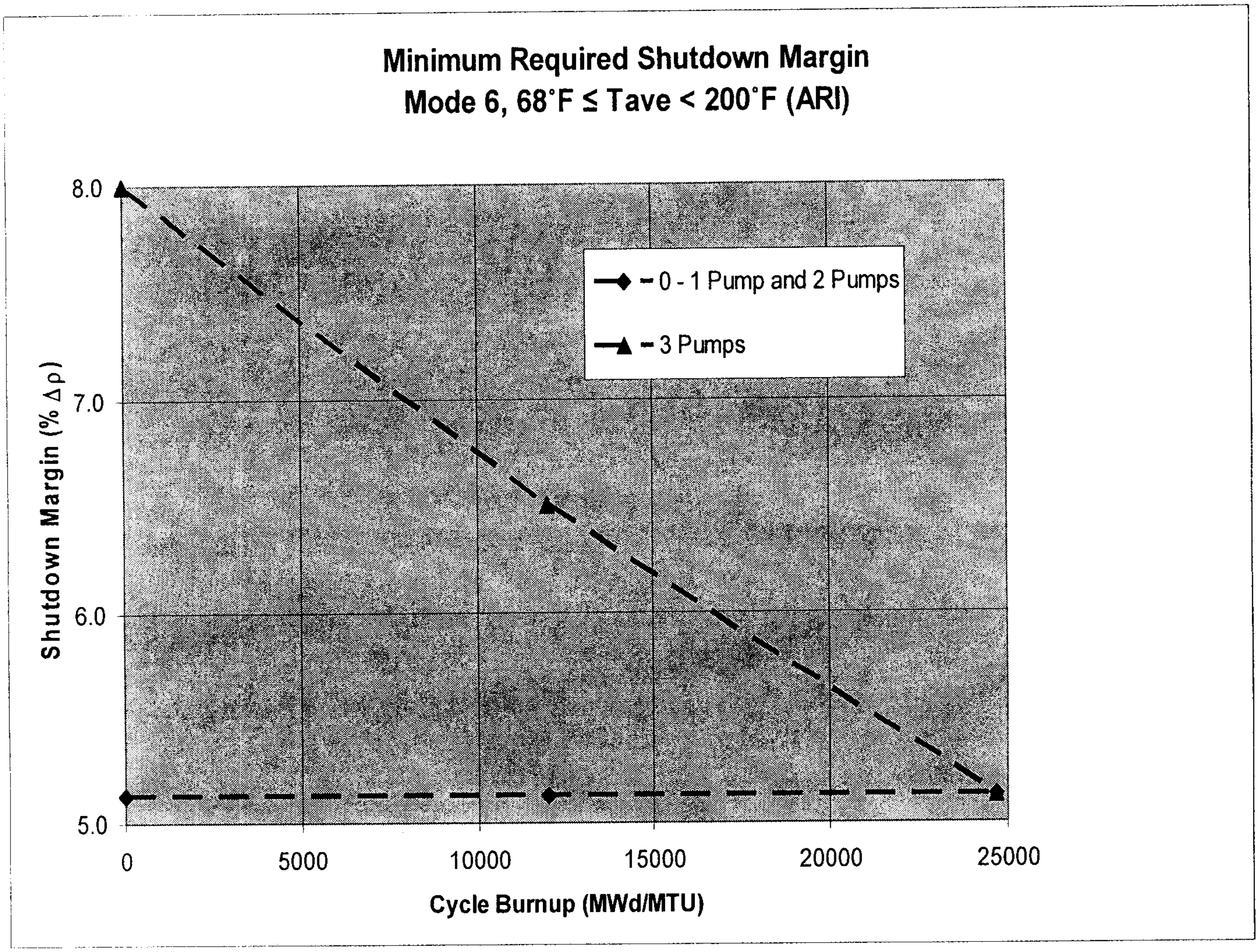
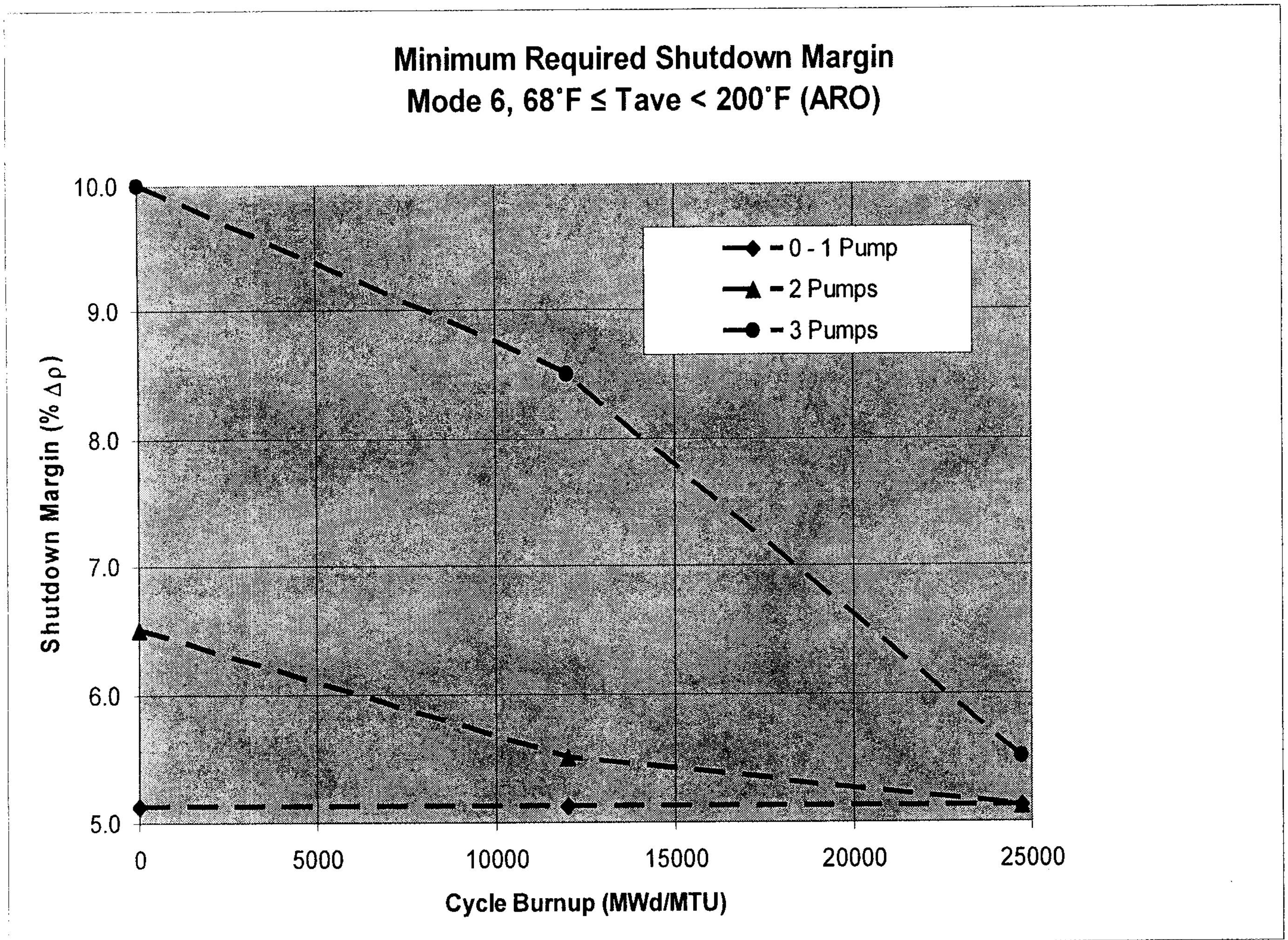

Minimum Required Shutdown Margin
Mode 6, 68°F ≤ Tave < 200°F (ARI)
0 - 1 Pump and 2 Pumps
3 Pumps
Shutdown Margin (% Δρ)
8.0
7.0
6.0
5.0
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)

Figure 6H


Minimum Required Shutdown Margin
Mode 6, 68°F ≤ Tave < 200°F (ARO)
0 - 1 Pump
2 Pumps
3 Pumps
10.0
9.0
8.0
7.0
6.0
5.0
Shutdown Margin (% Δρ)
0
5000
10000
15000
20000
25000
Cycle Burnup (MWd/MTU)