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OCT 07 2010

L-PI-10-091
TS 5.6.5.d

U S Nuclear Regulatory Commission
ATTN: Document Control Desk
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Prairie Island Nuclear Generating Plant Unit 1
Docket 50-282
License No. DPR-42

Core Operating Limits Report (COLR) for Prairie Island Nuclear Generating Plant (PINGP) Unit 1, Cycle 26, Revision 1

Pursuant to the requirements of Technical Specification 5.6.5.d, the COLR for the PINGP Unit 1, Cycle 26, Revision 1, is attached. The limits specified in the attached COLR have been established using Nuclear Regulatory Commission (NRC) approved methodologies.

The COLR for the Unit 1, Cycle 26, Revision 1, has been updated to include the second set of W(z) factors. This resulted in changes to the following sections:

- Revised Section 3.2.1, Heat Flux Hot Channel Factor ($F_Q(Z)$)
- Revised Section 3.2.3, Axial Flux Difference (AFD)
- Revised the References section, item 28, to update the 50.59 Evaluation 1072 reference to Revision 1
- Revised Table 2 title to add "associated with Figure 5"
- Revised Table 3 title to add "associated with Figure 5 and Table 2"
- Added Table 4, W(z) Values associated with Figure 6
- Added Table 5, $F^W_Q(Z)$ Penalty Factor associated with Figure 6 and Table 4
- Revised Figure 5 title to add "associated with Table 2"
- Added Figure 6, Flux Difference Operating Envelope associated with Table 4

Summary of Commitments

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

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ENCLOSURE

PRAIRIE ISLAND NUCLEAR GENERATING PLANT
CORE OPERATING LIMITS REPORT
UNIT 1 – CYCLE 26
REVISION 1

Record of Revision (6 pages)

Unit 1 – Cycle 26, Revision 1 (21 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).

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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.

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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.

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Core Operating Limits Report

Record of Revision

Unit	Cycle	Revision No.	Approval Date	Remarks
2	21	1	10/02/02	Revised to support License Amendment 149 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.

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Core Operating Limits Report

Record of Revision

Unit	Cycle	Revision No.	Approval Date	Remarks
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 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.

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

Core Operating Limits Report

Record of Revision

Unit	Cycle	Revision No.	Approval Date	Remarks
2	24	3	2/11/08	Updated Table 1 to reflect correct Shutdown Margin Requirements and added Figures 6A through 6H.
1	25	0	2/24/08	Updated to Unit 1 Cycle 25
1	25	1	5/28/08	Updated Table 2 to reflect the correct W(z) at a burnup of 150 MWd/MTU and a core height of 6.20 feet
2	25	0	9/26/08	Updated for Unit 2 Cycle 25
1	26	0	9/24/09	Updated for Unit 1 Cycle 26
2	26	0	5/3/10	Updated for Unit 2 Cycle 26
2	26	1	5/17/10	Updated to include part power W(z) factors
1	26	1	9/2/10	Updated for second set of W(z) factors

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 1 – CYCLE 26

REVISION 1

Reviewed By: _____ Date: 8-25-10
Lynn Johnson
Supervisor, NSSS

Reviewed By: _____ Date: 8/23/10
Hank Hoelscher
Supervisor, PWR Analyses

Approved By: _____ Date: 9-2-10
Steve Skoyen
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 26
REVISION 1

This report provides the values of the limits for Unit 1 Cycle 26 as required by Technical Specification 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. 2.1.1 Reactor Core Safety Limits

Reactor Core Safety Limits are shown in Figure 1.

Reference Technical Specification section 2.1.1.

2. 3.1.1 Shutdown Margin Requirements

Minimum Shutdown Margin requirements are shown in Table 1.

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 a power level = 70% RTP to
   ii. -1.5 pcm/°F at a power level = 100% RTP

ITC Lower limit:

a. -43.15 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.

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.

The HFP W(Z) values are provided in Table 2 and Table 4.

The W(Z) values in Table 2 are only applicable to Figure 5.

The W(Z) values in Table 4 are only applicable to Figure 6.

The data in Tables 2 and 4 should be used independently; cross interpolation or extrapolation between W(Z) sets is prohibited.

The $F^W_Q(Z)$ Penalty Factors associated with Figure 5 and Table 2 are provided in Table 3.

The $F^W_Q(Z)$ Penalty Factors associated with Figure 6 and Table 4 are provided in Table 5.

The Axial Flux Difference (AFD) Band in Figure 6 is more restrictive than the AFD Band in Figure 5. Prior to switching from Figure 6 to Figure 5, $F^W_Q(Z)$ must be confirmed to meet Technical Specification requirements by one of the follow methods:

1. Confirm $F^W_Q(Z)$ meets the Technical Specification Limit with the Table 2 W(Z) values for the most recent surveillance performed.
2. Perform a new surveillance and confirm $F^W_Q(Z)$ meets the Technical Specification Limit with the Table 2 W(Z) values.

The HFP W(Z) values are generated assuming that they will be used for full power surveillance. When a part power surveillance is performed, the W(Z) values should be multiplied by the factor 1/P, when P > 0.5. When P is $\leq$ 0.5, the W(Z) values should be multiplied by the factor 1/(0.5), or 2.0. This is consistent with the adjustment in the $F_Q(Z)$ limit at part power conditions.

Reference 10 provides the basis for multiple sets of W(Z) curves.

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 limits:

$F_{\Delta H} \leq 1.77 \times [1 + 0.3(1- P)]$ for all 422V+ type fuel assemblies, and

$F_{\Delta H} \leq 1.712 \times [1 + 0.3(1- P)]$ for all OFA type fuel assemblies

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 shall be maintained within the allowed operational space defined by Figure 5 or the more restrictive operational space as defined by Figure 6.

Both Figures 5 and 6 can be used any time during the cycle.

Prior to switching to the more restrictive AFD envelope (Figure 6), it should be confirmed that the plant is within the specified AFD envelope.

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

Reference Technical Specification section 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(ΔI)	=	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(ΔI) = 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 ≤ T′
τ_3	=	10 seconds

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

The DNB Limits are:
Pressurizer pressure limit = 2190 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

Reference Technical Specification section 3.9.1.

REFERENCES
(NRC Approved Methodologies for COLR Parameters)

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.

7. WCAP-10924-P-A, Volume 1, Revision 1, and Volume 2, Revision 2, "Westinghouse Large Break LOCA Best Estimate Methodology," September 2005.

8. 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.

9. 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.

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

11. NAD-PI-003, "Prairie Island Nuclear Power Plant Required Shutdown Margin During Physics Tests," Revision 0, January 2001.

12. NAD-PI-004, "Prairie Island Nuclear Plant $F^W_Q(Z)$ Penalty With Increasing $[F^C_Q(Z)/K(Z)]$ Trend," Revision 0, January 2001.

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

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

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

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

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

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

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

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

21. WCAP-10965-P-A, "ANC: A Westinghouse Advanced Nodal Computer Code," September 1986.

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

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

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

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

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

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

28. 50.59 Evaluation 1072, Revision 1, "Unit 1 Cycle 26 Core Reload."

Table 1

Minimum Required Shutdown Margin, %Δρ

	Number of Charging Pumps Running**		
Mode 1*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 22000 MWd/MTU	-	-	-

Mode 2*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 22000 MWd/MTU	2.0	2.0	2.0

Physics Testing in Mode 2			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 22000 MWd/MTU	0.5	0.5	0.5

Mode 3	**Tave ≥ 520 °F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 – 22000 MWd/MTU	2.0	2.0	2.0

Mode 3	**350 °F ≤ Tave < 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
22000 MWd/MTU	2.0	2.0	2.0

Mode 4	**200 °F < Tave < 350°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU	2.0	4.0	6.5
12000 MWd/MTU	2.0	3.0	4.5
22000 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 ≤ Tave ≤ 200°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
22000 MWd/MTU	2.0	2.0	3.0

Mode 6	**68°F ≤ Tave < 200°F (ARI)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU***	5.129	5.129	7.0
12000 MWd/MTU	5.129	5.129	5.129
22000 MWd/MTU	5.129	5.129	5.129

Mode 6	**68°F ≤ Tave < 200°F (ARO)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU***	5.129	5.5	8.5
12000 MWd/MTU	5.129	5.129	7.0
22000 MWd/MTU	5.129	5.129	5.129

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 25 end of cycle.

Table 2 - W(z) Values associated with Figure 5 (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]						
	[ft]	150	4000	8000	13000	16000	18000	20000
		AO = 0.70	AO = -1.71	AO = -3.30	AO = -4.80	AO = -0.04	AO = 0.81	AO = -0.10
[BOTTOM] 1	0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0	1.2964	1.2134	1.1709	1.1640	1.2375	1.2516	1.2658
7	1.2	1.2842	1.2042	1.1626	1.1552	1.2283	1.2411	1.2540
8	1.4	1.2702	1.1938	1.1534	1.1455	1.2182	1.2297	1.2411
9	1.6	1.2549	1.1825	1.1437	1.1353	1.2078	1.2178	1.2278
10	1.8	1.2383	1.1708	1.1336	1.1250	1.1972	1.2057	1.2141
11	2.0	1.2226	1.1581	1.1236	1.1146	1.1864	1.1932	1.2001
12	2.2	1.2083	1.1468	1.1129	1.1043	1.1755	1.1805	1.1855
13	2.4	1.1944	1.1388	1.1033	1.0942	1.1646	1.1677	1.1707
14	2.6	1.1802	1.1312	1.0995	1.0843	1.1536	1.1547	1.1558
15	2.8	1.1662	1.1236	1.0973	1.0746	1.1430	1.1404	1.1378
16	3.0	1.1513	1.1159	1.0955	1.0664	1.1308	1.1313	1.1319
17	3.2	1.1430	1.1109	1.0946	1.0643	1.1254	1.1313	1.1372
18	3.4	1.1423	1.1108	1.0945	1.0675	1.1290	1.1377	1.1464
19	3.6	1.1409	1.1115	1.0994	1.0752	1.1344	1.1471	1.1599
20	3.8	1.1389	1.1135	1.1047	1.0827	1.1389	1.1560	1.1730
21	4.0	1.1363	1.1158	1.1091	1.0893	1.1427	1.1636	1.1845
22	4.2	1.1328	1.1172	1.1130	1.0955	1.1455	1.1701	1.1947
23	4.4	1.1288	1.1181	1.1161	1.1008	1.1472	1.1753	1.2033
24	4.6	1.1264	1.1184	1.1185	1.1053	1.1479	1.1791	1.2102
25	4.8	1.1243	1.1178	1.1203	1.1104	1.1476	1.1815	1.2153
26	5.0	1.1216	1.1181	1.1210	1.1160	1.1461	1.1825	1.2190
27	5.2	1.1187	1.1212	1.1221	1.1214	1.1447	1.1822	1.2198
28	5.4	1.1151	1.1264	1.1263	1.1260	1.1451	1.1807	1.2163
29	5.6	1.1120	1.1314	1.1321	1.1292	1.1507	1.1816	1.2125
30	5.8	1.1167	1.1378	1.1386	1.1390	1.1595	1.1893	1.2191
31	6.0	1.1275	1.1459	1.1470	1.1543	1.1684	1.2016	1.2348
32	6.2	1.1358	1.1544	1.1583	1.1700	1.1759	1.2109	1.2459
33	6.4	1.1438	1.1618	1.1713	1.1848	1.1823	1.2191	1.2559
34	6.6	1.1509	1.1680	1.1833	1.1985	1.1876	1.2258	1.2639
35	6.8	1.1570	1.1751	1.1942	1.2111	1.1915	1.2307	1.2699
36	7.0	1.1621	1.1827	1.2039	1.2224	1.1941	1.2339	1.2736
37	7.2	1.1659	1.1891	1.2122	1.2321	1.1959	1.2351	1.2742
38	7.4	1.1684	1.1946	1.2189	1.2400	1.1971	1.2342	1.2713
39	7.6	1.1708	1.1995	1.2237	1.2460	1.1965	1.2311	1.2657
40	7.8	1.1720	1.2030	1.2266	1.2497	1.1941	1.2257	1.2573
41	8.0	1.1713	1.2046	1.2272	1.2511	1.1897	1.2179	1.2462
42	8.2	1.1690	1.2042	1.2255	1.2500	1.1835	1.2078	1.2321
43	8.4	1.1648	1.2018	1.2213	1.2462	1.1753	1.1952	1.2152
44	8.6	1.1590	1.1976	1.2149	1.2391	1.1640	1.1806	1.1972
45	8.8	1.1502	1.1902	1.2047	1.2327	1.1573	1.1689	1.1805
46	9.0	1.1482	1.1882	1.1999	1.2311	1.1576	1.1581	1.1586
47	9.2	1.1564	1.1945	1.2018	1.2328	1.1603	1.1481	1.1359
48	9.4	1.1612	1.1972	1.2056	1.2364	1.1612	1.1473	1.1334
49	9.6	1.1695	1.2032	1.2073	1.2379	1.1608	1.1454	1.1300
50	9.8	1.1774	1.2089	1.2117	1.2381	1.1588	1.1406	1.1224
51	10.0	1.1839	1.2132	1.2194	1.2412	1.1562	1.1401	1.1240
52	10.2	1.1896	1.2166	1.2259	1.2480	1.1560	1.1470	1.1379
53	10.4	1.1900	1.2158	1.2311	1.2528	1.1602	1.1524	1.1446
54	10.6	1.1937	1.2170	1.2374	1.2582	1.1656	1.1599	1.1542
55	10.8	1.2010	1.2154	1.2436	1.2639	1.1711	1.1688	1.1666
56	11.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2 (cont.) - W(z) Values associated with Figure 5 (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]						
	[ft]	150	4000	8000	13000	16000	18000	20000
		AO = 0.70	AO = -1.71	AO = -3.30	AO = -4.80	AO = -0.04	AO = 0.81	AO = -0.10
57	11.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
[TOP] 61	12.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* **Linear extrapolation based on a line between 18,000 MWD/MTU and 20,000 MWD/MTU is adequate for addressing burnups beyond 20,000 MWD/MTU.**

Table 3

$F^W_Q(Z)$ Penalty Factor associated with Figure 5 and Table 2

Cycle Burnup (MWD/MTU)	$F^W_Q(Z)$ Penalty Factor
14632	1.0200
14779	1.0203
14925	1.0202
15071	1.0200

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

Table 4 - W(z) Values associated with Figure 6 (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]						
	[ft]	150	4000	8000	13000	16000	18000	20000
		AO = 0.70	AO = -1.71	AO = -3.30	AO = -4.80	AO = -0.04	AO = 0.81	AO = -0.10
[BOTTOM] 1	0.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0	1.2724	1.1878	1.1447	1.0798	1.1713	1.2067	1.1863
7	1.2	1.2607	1.1790	1.1369	1.0737	1.1631	1.1972	1.1758
8	1.4	1.2471	1.1690	1.1281	1.0670	1.1540	1.1869	1.1645
9	1.6	1.2324	1.1583	1.1189	1.0602	1.1447	1.1764	1.1531
10	1.8	1.2166	1.1470	1.1094	1.0536	1.1353	1.1658	1.1417
11	2.0	1.2000	1.1353	1.0998	1.0472	1.1259	1.1551	1.1303
12	2.2	1.1830	1.1233	1.0901	1.0410	1.1166	1.1444	1.1189
13	2.4	1.1657	1.1114	1.0807	1.0353	1.1073	1.1336	1.1077
14	2.6	1.1483	1.0996	1.0715	1.0303	1.0980	1.1230	1.0969
15	2.8	1.1315	1.0875	1.0619	1.0241	1.0909	1.1117	1.0843
16	3.0	1.1134	1.0779	1.0562	1.0270	1.0844	1.1028	1.0814
17	3.2	1.1033	1.0749	1.0565	1.0385	1.0823	1.1017	1.0886
18	3.4	1.1031	1.0769	1.0617	1.0488	1.0886	1.1094	1.0955
19	3.6	1.1027	1.0835	1.0706	1.0592	1.0966	1.1175	1.1025
20	3.8	1.1026	1.0899	1.0793	1.0692	1.1041	1.1248	1.1133
21	4.0	1.1036	1.0957	1.0873	1.0787	1.1109	1.1321	1.1250
22	4.2	1.1057	1.1009	1.0947	1.0876	1.1169	1.1402	1.1351
23	4.4	1.1070	1.1055	1.1014	1.0959	1.1220	1.1491	1.1442
24	4.6	1.1079	1.1095	1.1073	1.1033	1.1259	1.1566	1.1520
25	4.8	1.1084	1.1125	1.1126	1.1101	1.1312	1.1628	1.1585
26	5.0	1.1084	1.1163	1.1170	1.1160	1.1369	1.1677	1.1635
27	5.2	1.1079	1.1212	1.1212	1.1214	1.1413	1.1714	1.1678
28	5.4	1.1073	1.1264	1.1263	1.1260	1.1449	1.1738	1.1746
29	5.6	1.1093	1.1314	1.1320	1.1292	1.1507	1.1745	1.1866
30	5.8	1.1167	1.1378	1.1386	1.1384	1.1595	1.1787	1.1984
31	6.0	1.1273	1.1459	1.1463	1.1512	1.1684	1.1854	1.2083
32	6.2	1.1358	1.1544	1.1535	1.1633	1.1759	1.1912	1.2170
33	6.4	1.1438	1.1618	1.1598	1.1747	1.1823	1.1958	1.2242
34	6.6	1.1509	1.1680	1.1680	1.1851	1.1876	1.1991	1.2298
35	6.8	1.1570	1.1737	1.1760	1.1944	1.1915	1.2008	1.2336
36	7.0	1.1621	1.1778	1.1827	1.2023	1.1940	1.2014	1.2357
37	7.2	1.1659	1.1808	1.1883	1.2091	1.1950	1.2013	1.2358
38	7.4	1.1684	1.1830	1.1937	1.2157	1.1942	1.2001	1.2339
39	7.6	1.1694	1.1844	1.1979	1.2206	1.1917	1.1971	1.2297
40	7.8	1.1687	1.1842	1.2003	1.2235	1.1872	1.1921	1.2232
41	8.0	1.1662	1.1822	1.2010	1.2244	1.1806	1.1850	1.2143
42	8.2	1.1618	1.1782	1.1996	1.2232	1.1721	1.1760	1.2030
43	8.4	1.1553	1.1723	1.1961	1.2196	1.1614	1.1651	1.1894
44	8.6	1.1472	1.1647	1.1908	1.2135	1.1481	1.1515	1.1738
45	8.8	1.1353	1.1537	1.1818	1.2071	1.1361	1.1415	1.1577
46	9.0	1.1295	1.1504	1.1779	1.2055	1.1275	1.1336	1.1413
47	9.2	1.1320	1.1597	1.1801	1.2080	1.1222	1.1225	1.1267
48	9.4	1.1393	1.1660	1.1801	1.2071	1.1184	1.1097	1.1215
49	9.6	1.1447	1.1711	1.1812	1.2086	1.1118	1.1003	1.1259
50	9.8	1.1509	1.1743	1.1846	1.2107	1.1105	1.0993	1.1345
51	10.0	1.1545	1.1775	1.1909	1.2158	1.1144	1.1028	1.1416
52	10.2	1.1537	1.1825	1.2004	1.2260	1.1198	1.1043	1.1489
53	10.4	1.1564	1.1856	1.2088	1.2349	1.1326	1.1052	1.1556
54	10.6	1.1573	1.1902	1.2161	1.2426	1.1445	1.1074	1.1621
55	10.8	1.1597	1.1920	1.2232	1.2502	1.1541	1.1100	1.1682
56	11.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 4 (cont.) W(z) Values associated with Figure 6 (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]						
	[ft]	150	4000	8000	13000	16000	18000	20000
		AO = 0.70	AO = -1.71	AO = -3.30	AO = -4.80	AO = -0.04	AO = 0.81	AO = -0.10
57	11.2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
[TOP] 61	12.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* **Linear extrapolation based on a line between 18,000 MWD/MTU and 20,000 MWD/MTU is adequate for addressing burnups beyond 20,000 MWD/MTU.**

Table 5

$F^W_Q(Z)$ Penalty Factor associated with Figure 6 and Table 4

Cycle Burnup (MWD/MTU)	$F^W_Q(Z)$ Penalty Factor
15364	1.0200
15510	1.0215
15656	1.0232
15803	1.0212
15947	1.0200

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

Figure 1

Reactor Core Safety Limits

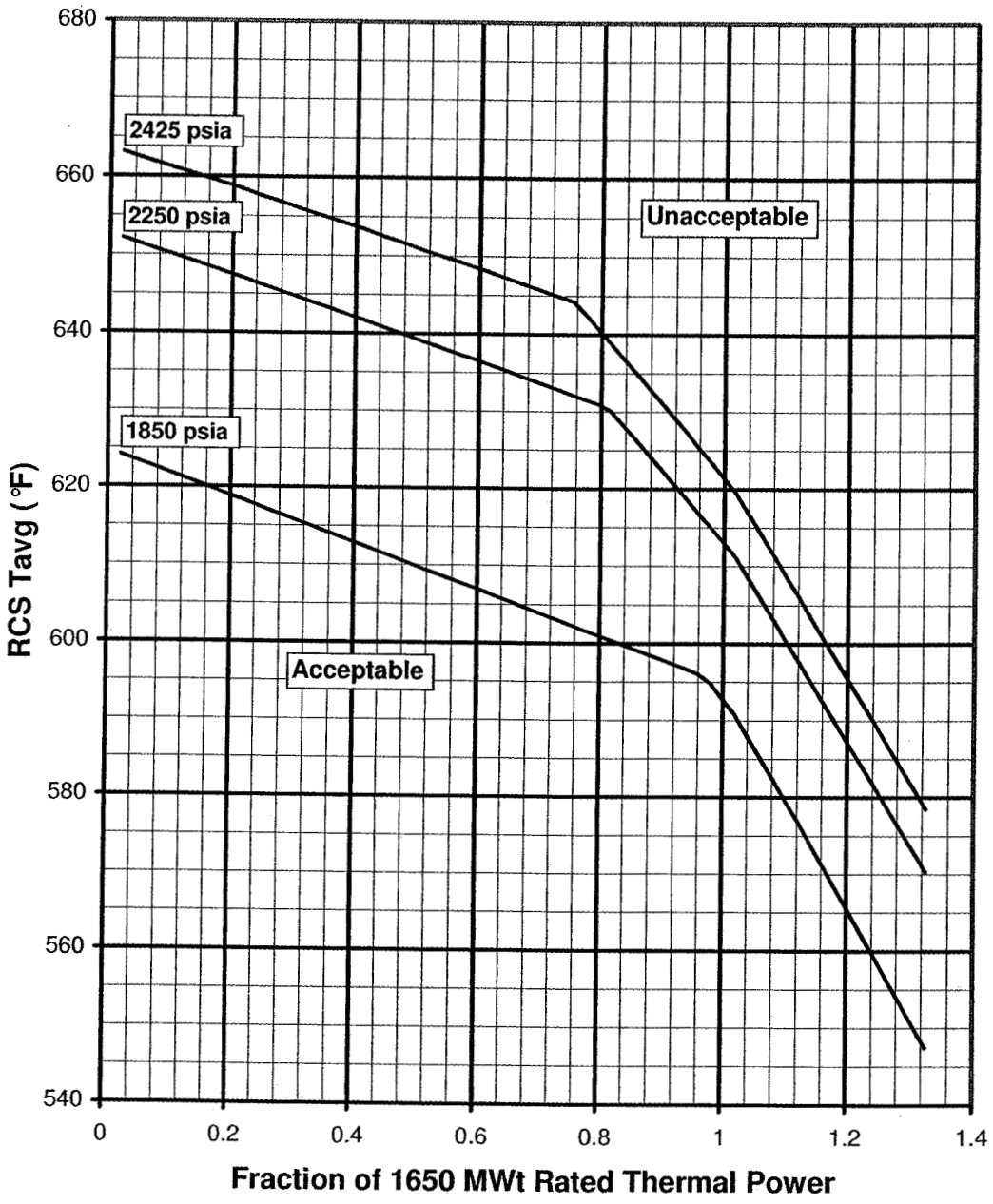
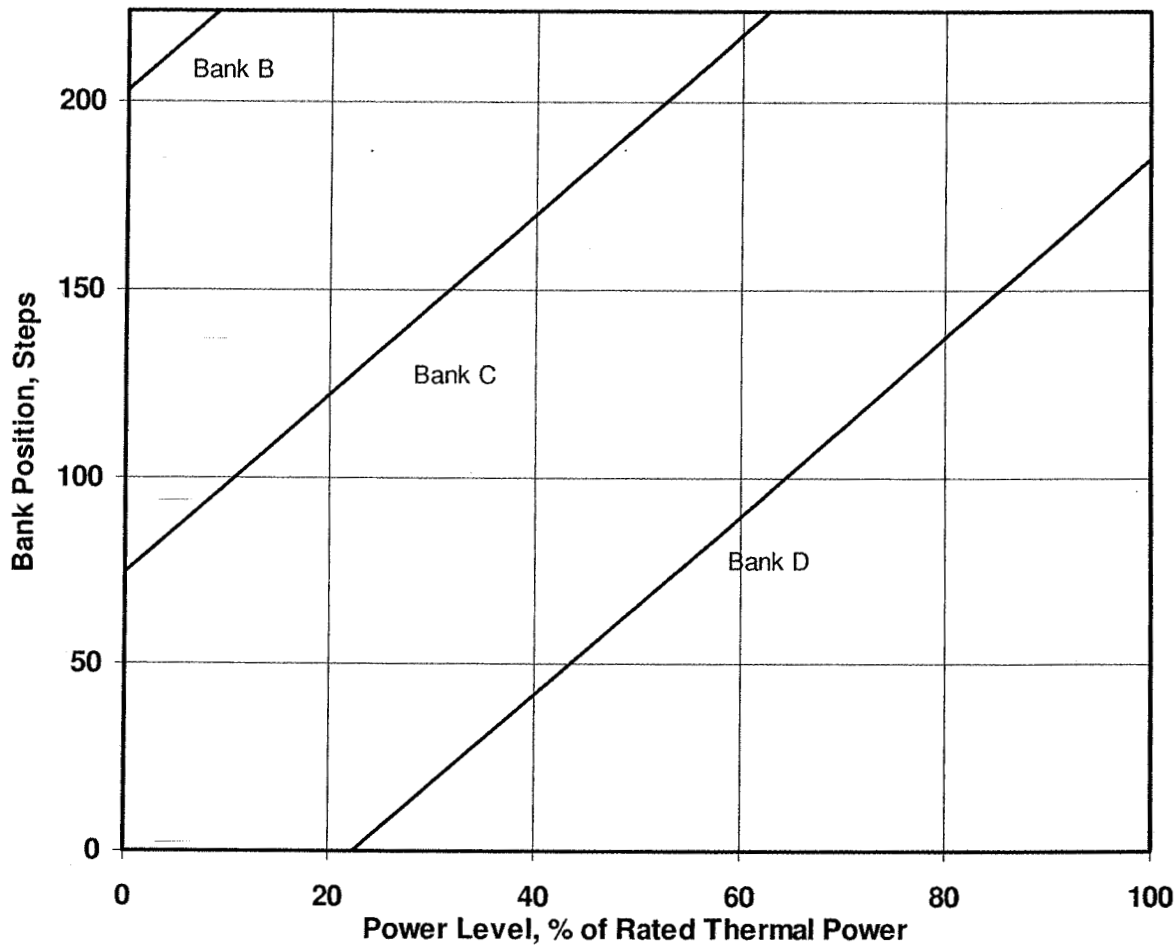


Figure 2
Rod Insertion Limit, 128 Step Tip-to-Tip

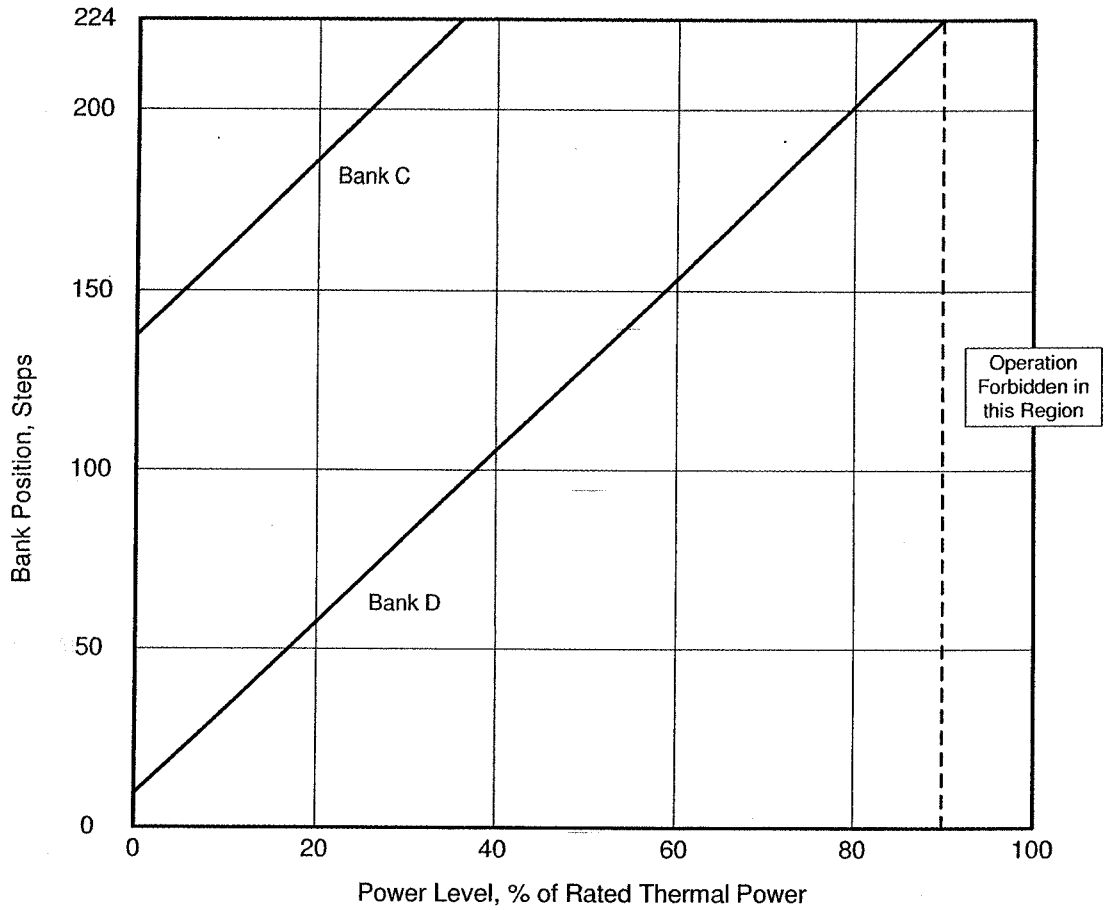


Bank Positions Given By:

- 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)

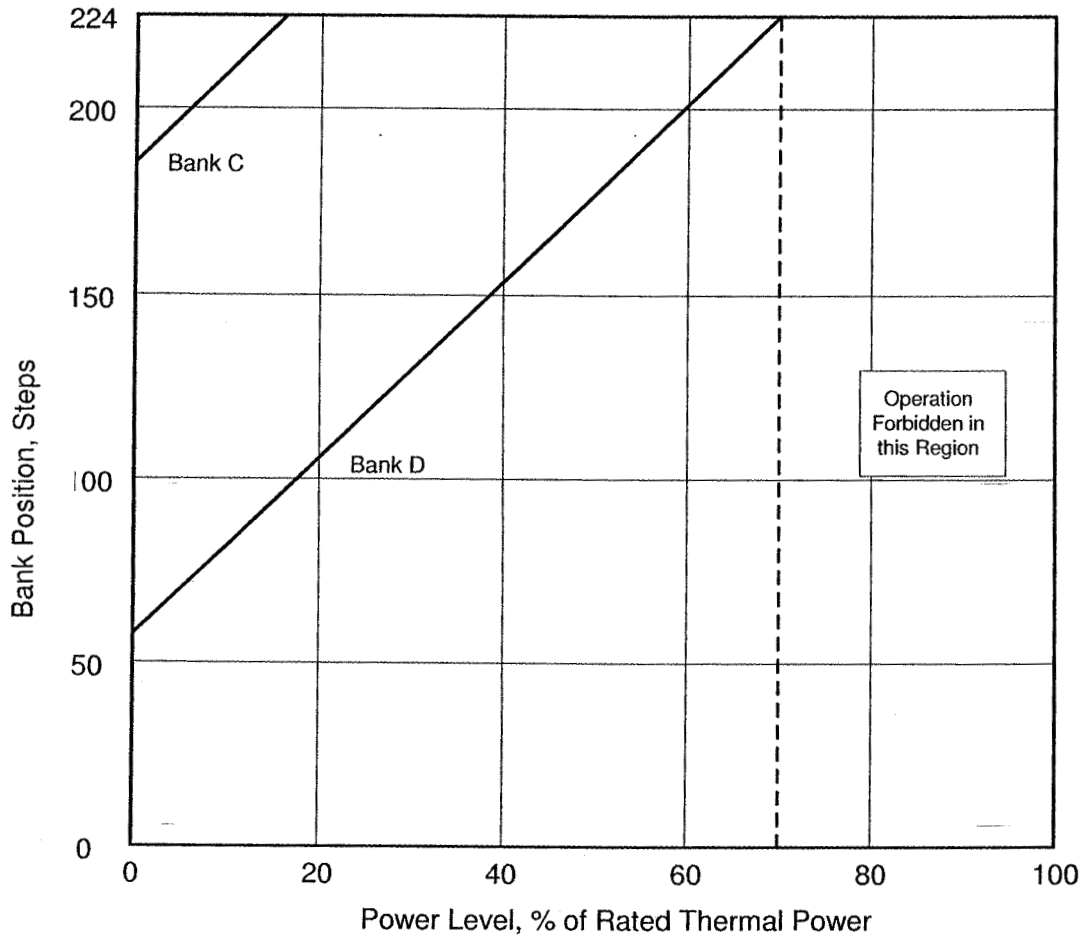


Bank Positions Given By:

- 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 associated with Table 2

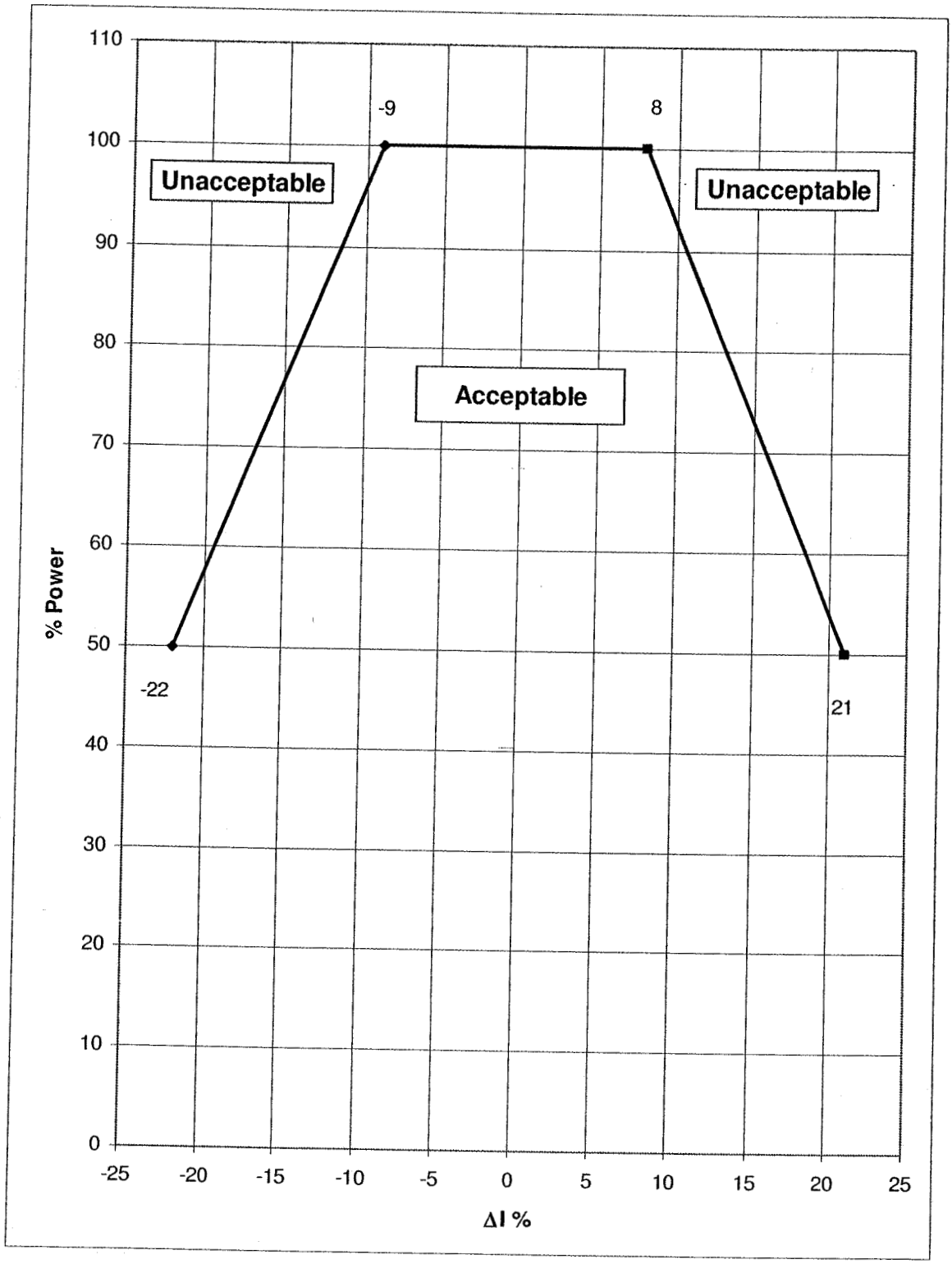
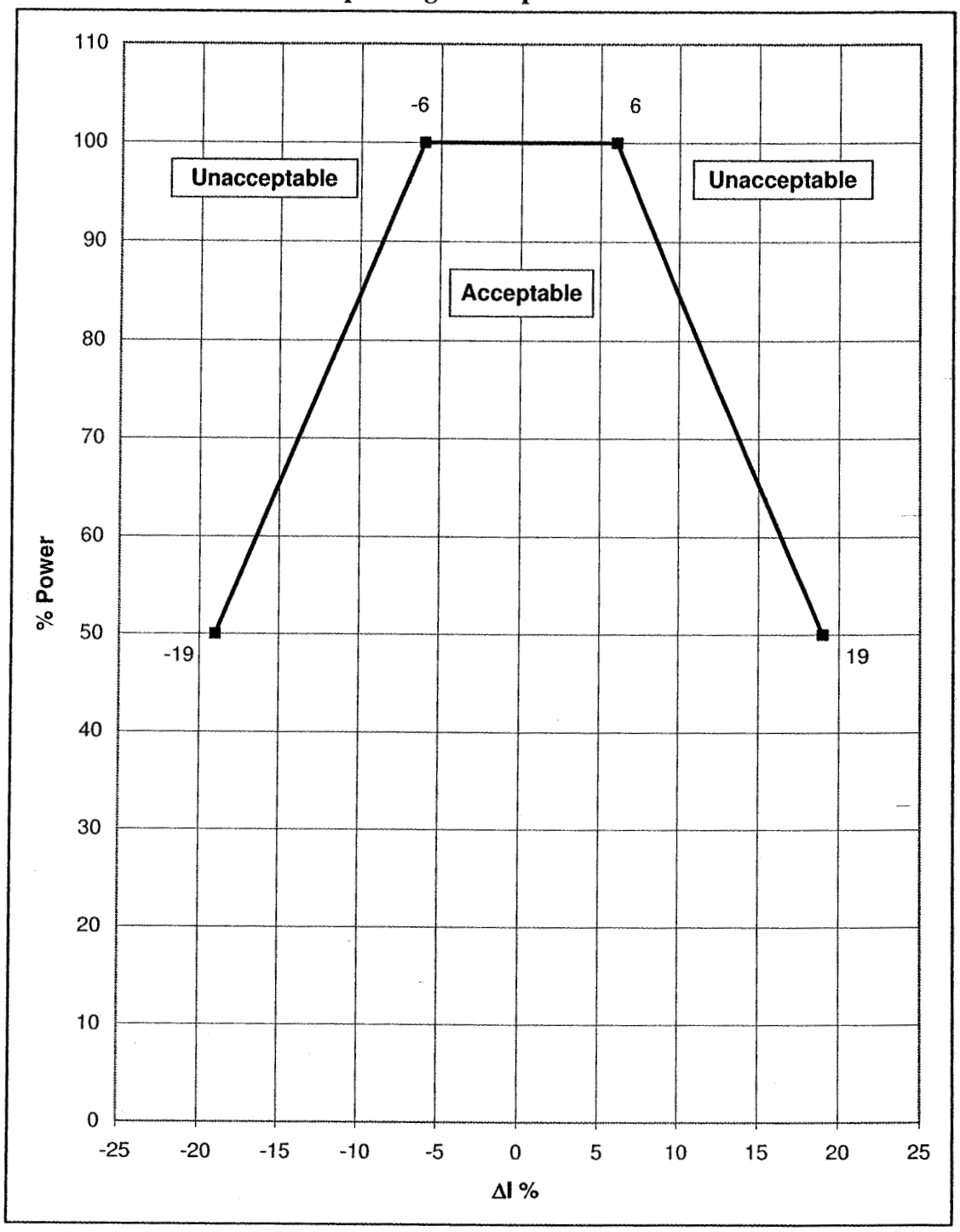



Figure 6
Flux Difference Operating Envelope associated with Table 4