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L-PI-16-088
TS 5.6.5.d

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U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Prairie Island Nuclear Generating Plant, Unit 1
Docket No. 50-282
Renewed Facility Operating License No. DPR-42

Core Operating Limits Report (COLR) for Prairie Island Nuclear Generating Plant (PINGP) Unit 1, Cycle 30, Revision 0

Pursuant to the requirements of Technical Specification 5.6.5.d, Northern States Power Company, a Minnesota Corporation (NSPM), doing business as Xcel Energy, hereby submits the COLR for the PINGP Unit 1, Cycle 30, Revision 0. The COLR provides the cycle-specific values of the limits established using NRC approved methodologies such that the applicable limits of the plant safety analysis are met.

The COLR for PINGP Unit 1 Cycle 30, Revision 0, is provided in Enclosure 1.

Summary of Commitments

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

Scott Northard
Site Vice President, Prairie Island Nuclear Generating Plant
Northern States Power Company – Minnesota

Enclosure (1)

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 30
REVISION 0

Record of Revision (7 pages)

Unit 1 – Cycle 30, Revision 0 (26 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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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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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
2	26	2	9/30/10	Updated for Measurement Uncertainty Recapture power uprate to 1677 MWth and for a second set of W(z) factors
1	26	2	9/30/10	Updated for Measurement Uncertainty Recapture power uprate to 1677 MWth
1	26	3	12/17/10	Updated SDM in Table 1 for Mode 2 to say 1.9.
1	27	0	5/5/11	Updated for Unit 1 Cycle 27
1	27	1	6/2/11	Updated for Unit 1 Cycle 27 Modes 1 through 6
2	27	0	3/28/12	Updated for Unit 2 Cycle 27
1	28	0	11/29/12	Updated for Unit 1 Cycle 28

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Core Operating Limits Report

Record of Revision

Unit	Cycle	Revision No.	Approval Date	Remarks
2	28	0	11/23/13	Updated for Unit 2 Cycle 28
1	29	0	10/23/14	Updated for Unit 1 Cycle 29
2	29	0	11/05/15	Updated for Unit 2 Cycle 29
1	30	0	10/25/16	Updated for Unit 1 Cycle 30

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 1 - CYCLE 30

REVISION 0

Reviewed By: Mark A. Brossart Date: 10/20/16
Mark Brossart
Supervisor, Reactor Systems

Reviewed By: Date: 10/20/2016
Darius Ahrar
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Approved By: Date: 10/25/16
John Bjorseth
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 30
REVISION 0

This report provides the values of the limits for Unit 1 Cycle 30 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 Safety Limits
2. 3.1.1 Shutdown Margin Requirements
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 Technical Specification Table 3.3.1-1 (Note 1 and Note 2)
11. 3.4.1 RCS Pressure, Temperature, and Flow - Departure from Nucleate Boiling (DNB) Limits
12. 3.9.1 Refueling Boron Concentration

1. 2.1.1 Reactor Core Safety Limits

Reactor Core Safety Limits are shown in Figure 1.

Reference Technical Specification 2.1.1.

2. 3.1.1 Shutdown Margin Requirements

Minimum Shutdown Margin requirements are shown in Table 1.

Reference Technical Specification 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. 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 3.1.3.

4. 3.1.5 Shutdown Bank Insertion Limits

The shutdown rods shall be fully withdrawn.

Reference Technical Specification 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 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 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 Part Power W(Z) values for $75\% \leq P < 85\%$ and Part Power W(Z) values for $85 \leq P < 95\%$ are provided in Table 6.

The W(Z) values in Table 6 are only applicable to Figure 5.

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 following 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. Part power W(Z) values are only required to be used when the part power surveillance is performed using the moveable incore detector system. When a part power surveillance is performed from BOC through 150 MWd/MTU

and at a power level specified for Table 6, the W(Z) values provided in Table 6 should be used. When a part power surveillance is performed after 150 MWD/MTU, or at a power level other than those specified for Table 6, the HFP W(Z) values in Table 2 or Table 4 should be used.

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 Technical Specification 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:

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

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

Reference Technical Specification 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.

Reference Technical Specification 3.2.3.

10. 3.3.1 Reactor Trip System (RTS) Instrumentation

Overtemperature ΔT and Overpower ΔT Parameter Values for Technical Specification Table 3.3.1-1 (Note 1 and Note 2):

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

Reference Technical Specification 3.3.1.

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 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 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. WCAP-16045-P-A Addendum 1-A, "Qualification of the NEXUS Nuclear Data Methodology," August 2007.

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 Power 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/ FQ 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-16045-P-A, "Qualification of the Two-Dimensional Transport Code PARAGON," August 2004.

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. Caldon, Inc. Engineering Report-80P, "Improving Thermal Power Accuracy and Plant Safety While Increasing Operating Power Level Using the LEFM √™ System," Revision 0, March 1997.

29. Caldon, Inc. Engineering Report-157P, "Supplement to Topical Report ER-80P: Basis for a Power Uprate With the LEFM √™ Check or CheckPlus™ System," Revision 5, October 2001.

30. WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995.

31. WCAP-12610-P-A and CENPD-404-P-A, Addendum 1-A, "**Optimized ZIRLO™**," July 2006.

32. 50.59 Evaluation 1132, Revision 0, "Unit 1 Cycle 30 Core Reload Modification."

Table 1

Minimum Required Shutdown Margin, %Δρ

Number of Charging Pumps Running**			
Mode 1*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 - 24000 MWd/MTU	-	-	-

Mode 2*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 - 24000 MWd/MTU	1.7	1.7	1.7

Physics Testing in Mode 2			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 - 24000 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 - 24000 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	2.0
14000 MWd/MTU	2.0	2.0	2.0
24000 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	4.0	6.0
14000 MWd/MTU	2.0	3.0	4.5
24000 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 Keff ≥ 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	4.5	7.0
14000 MWd/MTU	2.0	3.5	5.5
24000 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	7.0
14000 MWd/MTU	5.129	5.129	5.129
24000 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	5.5	8.5
14000 MWd/MTU	5.129	5.129	7.0
24000 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 29 end of cycle.

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

	Height	BU [MWd/MTU]									
	[ft]	150	3000	4000	5000	6000	7000	8000	9000	10000	11000
		AO = 1.18%	AO = 0.40%	AO = -0.04%	AO = -0.47%	AO = -0.98%	AO = -1.50%	AO = -2.05%	AO = -2.64%	AO = -3.27%	AO = -3.93%
[BOTTOM]1	0.00	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.40	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.80	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.00	1.2518	1.2211	1.2342	1.2415	1.2287	1.2147	1.2130	1.2022	1.1905	1.1789
7	1.20	1.2443	1.2138	1.2277	1.2335	1.2209	1.2072	1.2053	1.1944	1.1829	1.1713
8	1.40	1.2357	1.2056	1.2203	1.2246	1.2121	1.1988	1.1967	1.1859	1.1744	1.1630
9	1.60	1.2258	1.1961	1.2118	1.2143	1.2021	1.1891	1.1868	1.1761	1.1648	1.1536
10	1.80	1.2146	1.1853	1.2019	1.2026	1.1909	1.1784	1.1759	1.1654	1.1543	1.1434
11	2.00	1.2024	1.1744	1.1912	1.1901	1.1788	1.1669	1.1643	1.1540	1.1433	1.1327
12	2.20	1.1902	1.1658	1.1804	1.1774	1.1666	1.1553	1.1526	1.1426	1.1322	1.1220
13	2.40	1.1784	1.1572	1.1692	1.1644	1.1540	1.1433	1.1405	1.1307	1.1207	1.1109
14	2.60	1.1697	1.1481	1.1583	1.1516	1.1416	1.1314	1.1285	1.1188	1.1091	1.0996
15	2.80	1.1614	1.1405	1.1468	1.1387	1.1296	1.1203	1.1174	1.1084	1.0992	1.0903
16	3.00	1.1529	1.1356	1.1381	1.1299	1.1217	1.1133	1.1108	1.1025	1.0939	1.0856
17	3.20	1.1474	1.1335	1.1351	1.1276	1.1196	1.1116	1.1095	1.1016	1.0932	1.0855
18	3.40	1.1456	1.1324	1.1313	1.1245	1.1169	1.1091	1.1074	1.1000	1.0917	1.0847
19	3.60	1.1436	1.1311	1.1278	1.1216	1.1143	1.1070	1.1046	1.0976	1.0898	1.0830
20	3.80	1.1409	1.1293	1.1241	1.1186	1.1117	1.1047	1.1022	1.0960	1.0896	1.0828
21	4.00	1.1376	1.1270	1.1204	1.1151	1.1086	1.1025	1.1009	1.0960	1.0912	1.0846
22	4.20	1.1335	1.1240	1.1181	1.1121	1.1061	1.1019	1.1009	1.0968	1.0929	1.0872
23	4.40	1.1290	1.1207	1.1153	1.1098	1.1043	1.1009	1.1004	1.0972	1.0942	1.0893
24	4.60	1.1243	1.1170	1.1120	1.1070	1.1021	1.0994	1.0991	1.0967	1.0945	1.0903
25	4.80	1.1194	1.1131	1.1084	1.1040	1.0994	1.0974	1.0975	1.0959	1.0944	1.0908
26	5.00	1.1140	1.1088	1.1047	1.1005	1.0971	1.0959	1.0955	1.0945	1.0940	1.0911
27	5.20	1.1080	1.1037	1.1000	1.0971	1.0963	1.0952	1.0937	1.0937	1.0932	1.0910
28	5.40	1.1015	1.0986	1.0962	1.0960	1.0968	1.0950	1.0935	1.0941	1.0925	1.0910
29	5.60	1.0960	1.0972	1.0979	1.0983	1.0975	1.0961	1.0949	1.0965	1.0936	1.0927
30	5.80	1.0978	1.0994	1.1010	1.1016	1.1005	1.0987	1.0980	1.0986	1.0961	1.0961
31	6.00	1.1028	1.1040	1.1056	1.1051	1.1050	1.1023	1.1016	1.1017	1.0989	1.0998
32	6.20	1.1070	1.1080	1.1105	1.1085	1.1089	1.1074	1.1044	1.1057	1.1013	1.1028
33	6.40	1.1106	1.1114	1.1146	1.1113	1.1127	1.1145	1.1078	1.1098	1.1049	1.1059
34	6.61	1.1139	1.1145	1.1185	1.1140	1.1183	1.1210	1.1150	1.1153	1.1115	1.1115
35	6.81	1.1164	1.1188	1.1234	1.1176	1.1228	1.1262	1.1209	1.1196	1.1202	1.1224
36	7.01	1.1188	1.1228	1.1280	1.1208	1.1266	1.1308	1.1260	1.1236	1.1298	1.1333
37	7.21	1.1216	1.1260	1.1319	1.1236	1.1296	1.1345	1.1342	1.1308	1.1394	1.1436
38	7.41	1.1246	1.1287	1.1353	1.1273	1.1333	1.1390	1.1442	1.1400	1.1487	1.1540
39	7.61	1.1272	1.1309	1.1380	1.1324	1.1394	1.1451	1.1528	1.1481	1.1575	1.1638
40	7.81	1.1288	1.1319	1.1397	1.1380	1.1463	1.1505	1.1606	1.1554	1.1654	1.1727
41	8.01	1.1295	1.1335	1.1399	1.1434	1.1524	1.1549	1.1673	1.1618	1.1723	1.1805
42	8.21	1.1285	1.1370	1.1409	1.1479	1.1574	1.1584	1.1730	1.1671	1.1780	1.1872
43	8.41	1.1279	1.1410	1.1430	1.1512	1.1611	1.1607	1.1772	1.1713	1.1826	1.1927
44	8.61	1.1299	1.1434	1.1438	1.1531	1.1635	1.1620	1.1801	1.1740	1.1856	1.1968
45	8.81	1.1321	1.1452	1.1438	1.1541	1.1650	1.1630	1.1820	1.1759	1.1878	1.2000
46	9.01	1.1362	1.1469	1.1469	1.1577	1.1656	1.1650	1.1812	1.1825	1.1951	1.2081
47	9.21	1.1434	1.1472	1.1531	1.1642	1.1681	1.1695	1.1813	1.1883	1.2016	1.2152
48	9.41	1.1500	1.1499	1.1599	1.1698	1.1695	1.1764	1.1836	1.1953	1.2092	1.2233
49	9.61	1.1564	1.1574	1.1663	1.1753	1.1715	1.1830	1.1885	1.2028	1.2171	1.2317
50	9.81	1.1635	1.1678	1.1729	1.1814	1.1780	1.1888	1.1967	1.2094	1.2242	1.2391
51	10.01	1.1690	1.1771	1.1806	1.1859	1.1882	1.1962	1.2077	1.2168	1.2322	1.2477
52	10.21	1.1754	1.1858	1.1873	1.1929	1.1982	1.1993	1.2184	1.2203	1.2361	1.2520
53	10.41	1.1845	1.1925	1.1946	1.2022	1.2074	1.2041	1.2283	1.2245	1.2404	1.2563
54	10.61	1.1947	1.2003	1.2021	1.2117	1.2162	1.2120	1.2378	1.2319	1.2458	1.2626
55	10.81	1.2024	1.2093	1.2071	1.2191	1.2232	1.2175	1.2453	1.2380	1.2497	1.2685
56	11.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
57	11.21	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.41	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.61	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.81	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
[TOP] 61	12.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* Linear extrapolation based on a line between 20,000 MWD/MTU and 21,000 MWD/MTU is adequate for addressing burnups beyond 21,000 MWD/MTU.

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

	Height	BU [MWd/MTU]									
	[ft]	12000	13000	14000	15000	16000	17000	18000	19000	20000	21000
		AO = -4.61%	AO = -4.64%	AO = -3.67%	AO = -2.00%	AO = -0.61%	AO = 0.23%	AO = 0.59%	AO = 0.75%	AO = 0.75%	AO = 0.63%
[BOTTOM]1	0.00	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.40	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.80	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.00	1.1596	1.1629	1.1698	1.2071	1.2252	1.2286	1.2351	1.2264	1.2355	1.2458
7	1.20	1.1520	1.1550	1.1620	1.1990	1.2173	1.2210	1.2273	1.2186	1.2273	1.2370
8	1.40	1.1437	1.1463	1.1534	1.1901	1.2089	1.2129	1.2191	1.2104	1.2188	1.2281
9	1.60	1.1344	1.1366	1.1438	1.1801	1.1994	1.2038	1.2100	1.2014	1.2096	1.2183
10	1.80	1.1242	1.1261	1.1335	1.1693	1.1891	1.1941	1.2003	1.1919	1.2000	1.2081
11	2.00	1.1137	1.1153	1.1230	1.1583	1.1786	1.1842	1.1904	1.1823	1.1904	1.1979
12	2.20	1.1032	1.1044	1.1124	1.1470	1.1677	1.1741	1.1802	1.1724	1.1805	1.1873
13	2.40	1.0922	1.0931	1.1013	1.1348	1.1556	1.1626	1.1686	1.1609	1.1689	1.1750
14	2.60	1.0808	1.0805	1.0890	1.1225	1.1434	1.1511	1.1567	1.1493	1.1577	1.1622
15	2.80	1.0729	1.0763	1.0841	1.1110	1.1313	1.1387	1.1439	1.1404	1.1460	1.1492
16	3.00	1.0703	1.0766	1.0838	1.1038	1.1232	1.1295	1.1342	1.1349	1.1375	1.1393
17	3.20	1.0700	1.0768	1.0863	1.1028	1.1209	1.1270	1.1318	1.1327	1.1360	1.1344
18	3.40	1.0716	1.0771	1.0885	1.1027	1.1176	1.1245	1.1289	1.1350	1.1368	1.1303
19	3.60	1.0749	1.0770	1.0904	1.1024	1.1167	1.1224	1.1262	1.1374	1.1373	1.1308
20	3.80	1.0784	1.0779	1.0921	1.1019	1.1162	1.1204	1.1256	1.1390	1.1368	1.1324
21	4.00	1.0815	1.0811	1.0935	1.1011	1.1154	1.1187	1.1263	1.1403	1.1368	1.1336
22	4.20	1.0844	1.0843	1.0947	1.1002	1.1143	1.1182	1.1263	1.1412	1.1388	1.1370
23	4.40	1.0869	1.0871	1.0954	1.0992	1.1125	1.1182	1.1257	1.1412	1.1402	1.1398
24	4.60	1.0882	1.0887	1.0948	1.0990	1.1129	1.1168	1.1234	1.1393	1.1395	1.1404
25	4.80	1.0890	1.0896	1.0936	1.0984	1.1133	1.1145	1.1201	1.1366	1.1378	1.1398
26	5.00	1.0896	1.0903	1.0923	1.0974	1.1131	1.1119	1.1173	1.1332	1.1355	1.1386
27	5.20	1.0899	1.0907	1.0908	1.0962	1.1124	1.1090	1.1156	1.1295	1.1328	1.1371
28	5.40	1.0902	1.0910	1.0898	1.0948	1.1114	1.1056	1.1134	1.1249	1.1293	1.1346
29	5.60	1.0923	1.0913	1.0908	1.0946	1.1108	1.1029	1.1117	1.1194	1.1256	1.1311
30	5.80	1.0944	1.0929	1.0931	1.0967	1.1112	1.1070	1.1170	1.1199	1.1262	1.1330
31	6.00	1.0974	1.0954	1.0952	1.0999	1.1112	1.1145	1.1257	1.1244	1.1331	1.1412
32	6.20	1.1014	1.0993	1.0985	1.1039	1.1124	1.1202	1.1325	1.1305	1.1428	1.1519
33	6.40	1.1060	1.1061	1.1071	1.1109	1.1210	1.1266	1.1393	1.1384	1.1514	1.1616
34	6.61	1.1140	1.1171	1.1192	1.1209	1.1311	1.1347	1.1453	1.1454	1.1592	1.1706
35	6.81	1.1255	1.1291	1.1295	1.1290	1.1391	1.1406	1.1488	1.1498	1.1644	1.1765
36	7.01	1.1368	1.1404	1.1387	1.1359	1.1459	1.1452	1.1511	1.1530	1.1681	1.1810
37	7.21	1.1476	1.1515	1.1480	1.1429	1.1521	1.1500	1.1533	1.1562	1.1710	1.1845
38	7.41	1.1584	1.1625	1.1570	1.1498	1.1575	1.1544	1.1550	1.1589	1.1727	1.1868
39	7.61	1.1687	1.1729	1.1653	1.1557	1.1618	1.1576	1.1555	1.1603	1.1731	1.1877
40	7.81	1.1779	1.1823	1.1725	1.1605	1.1648	1.1596	1.1546	1.1604	1.1719	1.1868
41	8.01	1.1862	1.1905	1.1786	1.1641	1.1664	1.1602	1.1523	1.1590	1.1690	1.1840
42	8.21	1.1932	1.1976	1.1835	1.1665	1.1666	1.1597	1.1490	1.1562	1.1644	1.1795
43	8.41	1.1991	1.2035	1.1871	1.1677	1.1653	1.1575	1.1435	1.1520	1.1585	1.1733
44	8.61	1.2035	1.2079	1.1893	1.1675	1.1625	1.1545	1.1383	1.1488	1.1541	1.1655
45	8.81	1.2070	1.2113	1.1910	1.1669	1.1598	1.1529	1.1391	1.1500	1.1540	1.1558
46	9.01	1.2154	1.2180	1.1957	1.1689	1.1598	1.1495	1.1373	1.1481	1.1501	1.1438
47	9.21	1.2227	1.2233	1.2006	1.1705	1.1616	1.1443	1.1343	1.1439	1.1467	1.1372
48	9.41	1.2313	1.2300	1.2073	1.1741	1.1625	1.1405	1.1312	1.1410	1.1429	1.1342
49	9.61	1.2403	1.2369	1.2143	1.1781	1.1633	1.1379	1.1307	1.1384	1.1377	1.1297
50	9.81	1.2480	1.2429	1.2203	1.1814	1.1651	1.1368	1.1350	1.1356	1.1356	1.1262
51	10.01	1.2568	1.2528	1.2291	1.1890	1.1664	1.1412	1.1409	1.1344	1.1427	1.1296
52	10.21	1.2620	1.2641	1.2404	1.1983	1.1708	1.1454	1.1468	1.1289	1.1500	1.1338
53	10.41	1.2698	1.2749	1.2516	1.2072	1.1746	1.1478	1.1525	1.1339	1.1567	1.1381
54	10.61	1.2806	1.2852	1.2620	1.2159	1.1795	1.1522	1.1587	1.1441	1.1640	1.1440
55	10.81	1.2884	1.2935	1.2707	1.2231	1.1863	1.1583	1.1638	1.1475	1.1704	1.1522
56	11.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
57	11.21	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.41	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.61	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.81	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	12.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* Linear extrapolation based on a line between 20,000 MWD/MTU and 21,000 MWD/MTU is adequate for addressing burnups beyond 21,000 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
0	1.0200
13557	1.0200
13693	1.0235
13830	1.0312
13967	1.0365
14104	1.0365
14241	1.0354
14377	1.0338
14514	1.0315
14651	1.0286
14788	1.0251
14925	1.0202
15061	1.0200
24000	1.0200

**Linear interpolation is adequate for intermediate cycle burnups.

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

	BU [MWd/MTU]	150	3000	4000	5000	6000	7000	8000	9000	10000	11000
	Height [ft]	AO = 1.18%	AO = 0.40%	AO = -0.04%	AO = -0.47%	AO = -0.98%	AO = -1.50%	AO = -2.05%	AO = -2.64%	AO = -3.27%	AO = -3.93%
[BOTTOM]1	0.00	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
2	0.20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
3	0.40	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
4	0.60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
5	0.80	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
6	1.00	1.2109	1.2000	1.1876	1.1746	1.1617	1.1694	1.1462	1.135	1.124	1.113
7	1.20	1.2040	1.1931	1.1809	1.1680	1.1552	1.1628	1.1399	1.129	1.118	1.107
8	1.40	1.1960	1.1853	1.1732	1.1606	1.1480	1.1555	1.1328	1.122	1.111	1.100
9	1.60	1.1867	1.1762	1.1643	1.1519	1.1396	1.1470	1.1246	1.114	1.103	1.092
10	1.80	1.1761	1.1659	1.1542	1.1422	1.1303	1.1377	1.1156	1.105	1.094	1.084
11	2.00	1.1645	1.1546	1.1433	1.1318	1.1203	1.1278	1.1061	1.096	1.085	1.075
12	2.20	1.1528	1.1433	1.1323	1.1212	1.1103	1.1178	1.0966	1.086	1.076	1.067
13	2.40	1.1409	1.1317	1.1211	1.1105	1.1000	1.1076	1.0868	1.077	1.067	1.058
14	2.60	1.1297	1.1201	1.1098	1.0995	1.0894	1.0976	1.0766	1.067	1.058	1.048
15	2.80	1.1174	1.1099	1.1004	1.0910	1.0817	1.0874	1.0697	1.060	1.052	1.043
16	3.00	1.1088	1.1039	1.0956	1.0873	1.0788	1.0791	1.0680	1.060	1.051	1.043
17	3.20	1.1083	1.1025	1.0946	1.0868	1.0786	1.0768	1.0680	1.064	1.055	1.046
18	3.40	1.1066	1.1003	1.0928	1.0856	1.0782	1.0801	1.0678	1.069	1.060	1.052
19	3.60	1.1049	1.0974	1.0916	1.0858	1.0800	1.0836	1.0701	1.073	1.065	1.057
20	3.80	1.1035	1.0959	1.0916	1.0872	1.0829	1.0865	1.0740	1.077	1.070	1.062
21	4.00	1.1015	1.0956	1.0920	1.0884	1.0849	1.0891	1.0770	1.081	1.074	1.068
22	4.20	1.0990	1.0946	1.0918	1.0892	1.0867	1.0913	1.0799	1.084	1.078	1.072
23	4.40	1.0963	1.0937	1.0918	1.0898	1.0882	1.0932	1.0825	1.087	1.082	1.077
24	4.60	1.0949	1.0941	1.0930	1.0903	1.0896	1.0943	1.0842	1.089	1.085	1.081
25	4.80	1.0937	1.0945	1.0942	1.0918	1.0918	1.0950	1.0860	1.091	1.087	1.083
26	5.00	1.0916	1.0944	1.0947	1.0931	1.0940	1.0955	1.0885	1.092	1.089	1.086
27	5.20	1.0909	1.0941	1.0951	1.0942	1.0956	1.0952	1.0911	1.093	1.091	1.088
28	5.40	1.0932	1.0943	1.0962	1.0960	1.0968	1.0950	1.0933	1.094	1.092	1.091
29	5.60	1.0951	1.0962	1.0977	1.0983	1.0975	1.0961	1.0949	1.096	1.093	1.092
30	5.80	1.0978	1.0994	1.1009	1.1015	1.1005	1.0987	1.0980	1.098	1.096	1.096
31	6.00	1.1027	1.1039	1.1056	1.1051	1.1050	1.1023	1.1016	1.101	1.098	1.099
32	6.20	1.1070	1.1080	1.1105	1.1085	1.1089	1.1074	1.1044	1.105	1.101	1.102
33	6.40	1.1106	1.1114	1.1146	1.1113	1.1127	1.1145	1.1078	1.109	1.104	1.105
34	6.61	1.1139	1.1145	1.1185	1.1140	1.1183	1.1210	1.1150	1.115	1.111	1.109
35	6.81	1.1164	1.1188	1.1234	1.1176	1.1228	1.1262	1.1209	1.119	1.116	1.115
36	7.01	1.1188	1.1228	1.1280	1.1208	1.1265	1.1307	1.1259	1.123	1.121	1.123
37	7.21	1.1216	1.1260	1.1319	1.1234	1.1296	1.1345	1.1308	1.130	1.126	1.131
38	7.41	1.1243	1.1287	1.1353	1.1264	1.1327	1.1384	1.1351	1.138	1.132	1.139
39	7.61	1.1257	1.1309	1.1380	1.1301	1.1347	1.1411	1.1390	1.145	1.139	1.147
40	7.81	1.1262	1.1319	1.1397	1.1326	1.1357	1.1427	1.1438	1.151	1.144	1.153
41	8.01	1.1255	1.1320	1.1399	1.1340	1.1359	1.1446	1.1481	1.156	1.149	1.158
42	8.21	1.1236	1.1308	1.1395	1.1343	1.1371	1.1469	1.1512	1.160	1.153	1.163
43	8.41	1.1203	1.1284	1.1373	1.1333	1.1384	1.1485	1.1531	1.163	1.156	1.166
44	8.61	1.1151	1.1241	1.1335	1.1306	1.1380	1.1485	1.1534	1.164	1.158	1.168
45	8.81	1.1088	1.1189	1.1286	1.1268	1.1367	1.1475	1.1528	1.164	1.160	1.171
46	9.01	1.1091	1.1212	1.1277	1.1275	1.1382	1.1472	1.1553	1.163	1.164	1.174
47	9.21	1.1144	1.1252	1.1269	1.1325	1.1432	1.1489	1.1611	1.163	1.166	1.179
48	9.41	1.1201	1.1308	1.1273	1.1372	1.1478	1.1502	1.1663	1.166	1.171	1.186
49	9.61	1.1253	1.1365	1.1301	1.1416	1.1519	1.1509	1.1711	1.169	1.178	1.193
50	9.81	1.1317	1.1416	1.1375	1.1468	1.1572	1.1550	1.1768	1.172	1.186	1.199
51	10.01	1.1375	1.1483	1.1446	1.1506	1.1620	1.1649	1.1809	1.182	1.198	1.210
52	10.21	1.1434	1.1512	1.1513	1.1555	1.1671	1.1746	1.1838	1.193	1.209	1.221
53	10.41	1.1502	1.1548	1.1562	1.1625	1.1741	1.1834	1.1896	1.202	1.219	1.232
54	10.61	1.1572	1.1595	1.1624	1.1684	1.1807	1.1921	1.1983	1.212	1.229	1.242
55	10.81	1.1611	1.1610	1.1699	1.1708	1.1842	1.1989	1.2053	1.219	1.237	1.250
56	11.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
57	11.21	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
58	11.41	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
59	11.61	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
60	11.81	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000
61	12.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.000	1.000	1.000

* **Linear extrapolation based on a line between 20,000 MWD/MTU and 21,000 MWD/MTU is adequate for addressing burnups beyond 21,000 MWD/MTU.**

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

	Height	BU [MWd/MTU]									
	[ft]	12000	13000	14000	15000	16000	17000	18000	19000	20000	21000
		AO = -4.61%	AO = -4.64%	AO = -3.67%	AO = -2.00%	AO = -0.61%	AO = 0.23%	AO = 0.59%	AO = 0.75%	AO = 0.75%	AO = 0.63%
[BOTTOM]1	0.00	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	0.20	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	0.40	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
4	0.60	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	0.80	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.00	1.1137	1.1163	1.1143	1.1572	1.1729	1.1748	1.1824	1.1689	1.1768	1.1883
7	1.20	1.1071	1.1094	1.1081	1.1501	1.1661	1.1682	1.1755	1.1622	1.1698	1.1807
8	1.40	1.0999	1.1019	1.1015	1.1423	1.1589	1.1613	1.1683	1.1553	1.1627	1.1729
9	1.60	1.0918	1.0934	1.0940	1.1337	1.1507	1.1536	1.1604	1.1478	1.1549	1.1644
10	1.80	1.0830	1.0843	1.0860	1.1244	1.1420	1.1454	1.1519	1.1399	1.1470	1.1558
11	2.00	1.0742	1.0752	1.0781	1.1151	1.1331	1.1373	1.1436	1.1322	1.1394	1.1473
12	2.20	1.0653	1.0660	1.0702	1.1056	1.1241	1.1290	1.1349	1.1242	1.1316	1.1385
13	2.40	1.0561	1.0564	1.0616	1.0953	1.1140	1.1196	1.1249	1.1159	1.1224	1.1281
14	2.60	1.0463	1.0462	1.0532	1.0848	1.1036	1.1101	1.1148	1.1091	1.1138	1.1171
15	2.80	1.0409	1.0403	1.0468	1.0759	1.0943	1.1000	1.1040	1.1028	1.1046	1.1070
16	3.00	1.0407	1.0398	1.0452	1.0722	1.0890	1.0942	1.0980	1.0992	1.1000	1.1020
17	3.20	1.0425	1.0415	1.0491	1.0725	1.0884	1.0942	1.0979	1.0994	1.1018	1.1015
18	3.40	1.0477	1.0454	1.0540	1.0726	1.0869	1.0943	1.0976	1.1038	1.1053	1.1007
19	3.60	1.0537	1.0510	1.0587	1.0723	1.0879	1.0940	1.0982	1.1083	1.1084	1.1022
20	3.80	1.0593	1.0569	1.0631	1.0726	1.0916	1.0940	1.1008	1.1123	1.1110	1.1061
21	4.00	1.0648	1.0625	1.0674	1.0754	1.0960	1.0948	1.1043	1.1162	1.1136	1.1101
22	4.20	1.0701	1.0680	1.0717	1.0801	1.0999	1.0972	1.1072	1.1197	1.1169	1.1147
23	4.40	1.0751	1.0732	1.0755	1.0841	1.1031	1.0999	1.1096	1.1225	1.1211	1.1204
24	4.60	1.0789	1.0770	1.0780	1.0867	1.1048	1.1011	1.1103	1.1234	1.1233	1.1239
25	4.80	1.0821	1.0802	1.0798	1.0886	1.1054	1.1014	1.1101	1.1234	1.1243	1.1261
26	5.00	1.0850	1.0833	1.0816	1.0902	1.1062	1.1015	1.1095	1.1228	1.1249	1.1278
27	5.20	1.0878	1.0861	1.0841	1.0917	1.1077	1.1013	1.1086	1.1219	1.1249	1.1291
28	5.40	1.0902	1.0888	1.0875	1.0929	1.1094	1.1008	1.1083	1.1203	1.1246	1.1297
29	5.60	1.0923	1.0911	1.0905	1.0941	1.1105	1.1021	1.1103	1.1177	1.1251	1.1296
30	5.80	1.0944	1.0929	1.0931	1.0967	1.1112	1.1070	1.1170	1.1197	1.1262	1.1304
31	6.00	1.0974	1.0952	1.0951	1.0999	1.1112	1.1144	1.1256	1.1244	1.1315	1.1356
32	6.20	1.1014	1.0993	1.0985	1.1039	1.1119	1.1202	1.1325	1.1305	1.1380	1.1434
33	6.40	1.1060	1.1060	1.1071	1.1109	1.1165	1.1260	1.1393	1.1384	1.1436	1.1502
34	6.61	1.1116	1.1119	1.1192	1.1209	1.1208	1.1310	1.1453	1.1454	1.1485	1.1562
35	6.81	1.1182	1.1211	1.1295	1.1290	1.1245	1.1339	1.1488	1.1498	1.1507	1.1595
36	7.01	1.1265	1.1302	1.1387	1.1359	1.1288	1.1357	1.1511	1.1530	1.1519	1.1614
37	7.21	1.1353	1.1388	1.1476	1.1425	1.1335	1.1375	1.1526	1.1554	1.1528	1.1625
38	7.41	1.1437	1.1475	1.1557	1.1483	1.1379	1.1389	1.1531	1.1568	1.1532	1.1625
39	7.61	1.1515	1.1554	1.1629	1.1530	1.1413	1.1392	1.1523	1.1570	1.1523	1.1611
40	7.81	1.1584	1.1624	1.1689	1.1566	1.1437	1.1383	1.1501	1.1557	1.1500	1.1582
41	8.01	1.1643	1.1683	1.1736	1.1589	1.1448	1.1361	1.1464	1.1529	1.1463	1.1536
42	8.21	1.1690	1.1731	1.1771	1.1599	1.1448	1.1328	1.1416	1.1486	1.1412	1.1474
43	8.41	1.1725	1.1767	1.1791	1.1595	1.1436	1.1280	1.1346	1.1428	1.1347	1.1398
44	8.61	1.1748	1.1789	1.1796	1.1576	1.1413	1.1226	1.1274	1.1358	1.1296	1.1337
45	8.81	1.1775	1.1806	1.1788	1.1543	1.1380	1.1202	1.1257	1.1271	1.1292	1.1323
46	9.01	1.1841	1.1853	1.1781	1.1540	1.1337	1.1188	1.1218	1.1149	1.1256	1.1271
47	9.21	1.1904	1.1905	1.1791	1.1566	1.1276	1.1160	1.1188	1.1105	1.1199	1.1225
48	9.41	1.1957	1.1974	1.1827	1.1590	1.1241	1.1145	1.1153	1.1083	1.1156	1.1172
49	9.61	1.2010	1.2048	1.1884	1.1614	1.1239	1.1147	1.1120	1.1070	1.1116	1.1123
50	9.81	1.2078	1.2110	1.1959	1.1644	1.1247	1.1188	1.1117	1.1104	1.1090	1.1114
51	10.01	1.2181	1.2190	1.2047	1.1658	1.1286	1.1254	1.1147	1.1164	1.1128	1.1152
52	10.21	1.2298	1.2301	1.2130	1.1712	1.1334	1.1321	1.1175	1.1225	1.1165	1.1215
53	10.41	1.2409	1.2412	1.2193	1.1761	1.1367	1.1383	1.1189	1.1284	1.1186	1.1281
54	10.61	1.2515	1.2516	1.2270	1.1820	1.1417	1.1450	1.1223	1.1348	1.1229	1.1353
55	10.81	1.2601	1.2602	1.2360	1.1896	1.1483	1.1504	1.1278	1.1404	1.1292	1.1417
56	11.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
57	11.21	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
58	11.41	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
59	11.61	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
60	11.81	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
61	12.01	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* **Linear extrapolation based on a line between 20,000 MWD/MTU and 21,000 MWD/MTU is adequate for addressing burnups beyond 21,000 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
0	1.0200
14651	1.0200
14788	1.0205
14925	1.0200
24000	1.0200

**Linear interpolation is adequate for intermediate cycle burnups.

Table 6 - W(z) Values Associated with Figure 5 for Part Power Surveillances*
(Top 10% and Bottom 8% excluded)

	Height	Part Power W(z) Functions (% of Hot Full Power)	
		80†	90††
		D-Bank @ 195 Steps‡	D-Bank @ 204 Steps‡
	[ft]	HFP AO = 1.18%	HFP AO = 1.18%
[BOTTOM] 1	0.00	1.0000	1.0000
2	0.20	1.0000	1.0000
3	0.40	1.0000	1.0000
4	0.60	1.0000	1.0000
5	0.80	1.0000	1.0000
6	1.00	1.2831	1.2688
7	1.20	1.2723	1.2600
8	1.40	1.2611	1.2504
9	1.60	1.2472	1.2381
10	1.80	1.2337	1.2256
11	2.00	1.2185	1.2123
12	2.20	1.2032	1.1983
13	2.40	1.1878	1.1849
14	2.60	1.1774	1.1753
15	2.80	1.1662	1.1655
16	3.00	1.1549	1.1556
17	3.20	1.1474	1.1494
18	3.40	1.1424	1.1456
19	3.60	1.1385	1.1430
20	3.80	1.1327	1.1383
21	4.00	1.1269	1.1338
22	4.20	1.1203	1.1285
23	4.40	1.1133	1.1228
24	4.60	1.1063	1.1162
25	4.80	1.1000	1.1114
26	5.00	1.0924	1.1049
27	5.20	1.0848	1.0978
28	5.40	1.0767	1.0902
29	5.60	1.0685	1.0829
30	5.80	1.0691	1.0841

* W(z) values only valid for core average burnups ≤ 150 MWd/MTU.

† 80% of full power W(z) values are applicable for powers 75% ≤ P < 85%.

†† 90% of full power W(z) values are applicable for powers 85% ≤ P < 95%.

‡ Rod insertion is given as a target value. Use control rods as necessary to control to target AO.

**Table 6 (cont.) - W(z) Values Associated with Figure 5 for Part Power Surveillances*
(Top 10% and Bottom 8% excluded)**

	Height	Part Power W(z) Functions (% of Hot Full Power)	
		80†	90††
		D-Bank @ 195 Steps‡	D-Bank @ 204 Steps‡
	[ft]	HFP AO = 1.18%	HFP AO = 1.18%
31	6.00	1.0722	1.0885
32	6.20	1.0747	1.0914
33	6.40	1.0781	1.0942
34	6.61	1.0785	1.0966
35	6.81	1.0812	1.0974
36	7.01	1.0839	1.0999
37	7.21	1.0861	1.1027
38	7.41	1.0889	1.1055
39	7.61	1.0920	1.1081
40	7.81	1.0934	1.1096
41	8.01	1.0958	1.1109
42	8.21	1.0960	1.1105
43	8.41	1.0970	1.1110
44	8.61	1.1011	1.1140
45	8.81	1.1063	1.1180
46	9.01	1.1130	1.1232
47	9.21	1.1251	1.1328
48	9.41	1.1374	1.1420
49	9.61	1.1503	1.1516
50	9.81	1.1649	1.1628
51	10.01	1.1784	1.1726
52	10.21	1.1941	1.1843
53	10.41	1.2119	1.1992
54	10.61	1.2304	1.2161
55	10.81	1.2444	1.2316
56	11.01	1.0000	1.0000
57	11.21	1.0000	1.0000
58	11.41	1.0000	1.0000
59	11.61	1.0000	1.0000
60	11.81	1.0000	1.0000
[TOP] 61	12.01	1.0000	1.0000

* W(z) values only valid for core average burnups ≤ 150 MWd/MTU.

† 80% of full power W(z) values are applicable for powers 75% ≤ P < 85%.

†† 90% of full power W(z) values are applicable for powers 85% ≤ P < 95%.

‡ Rod insertion is given as a target value. Use control rods as necessary to control to target AO.

Figure 1

Reactor Core Safety Limits

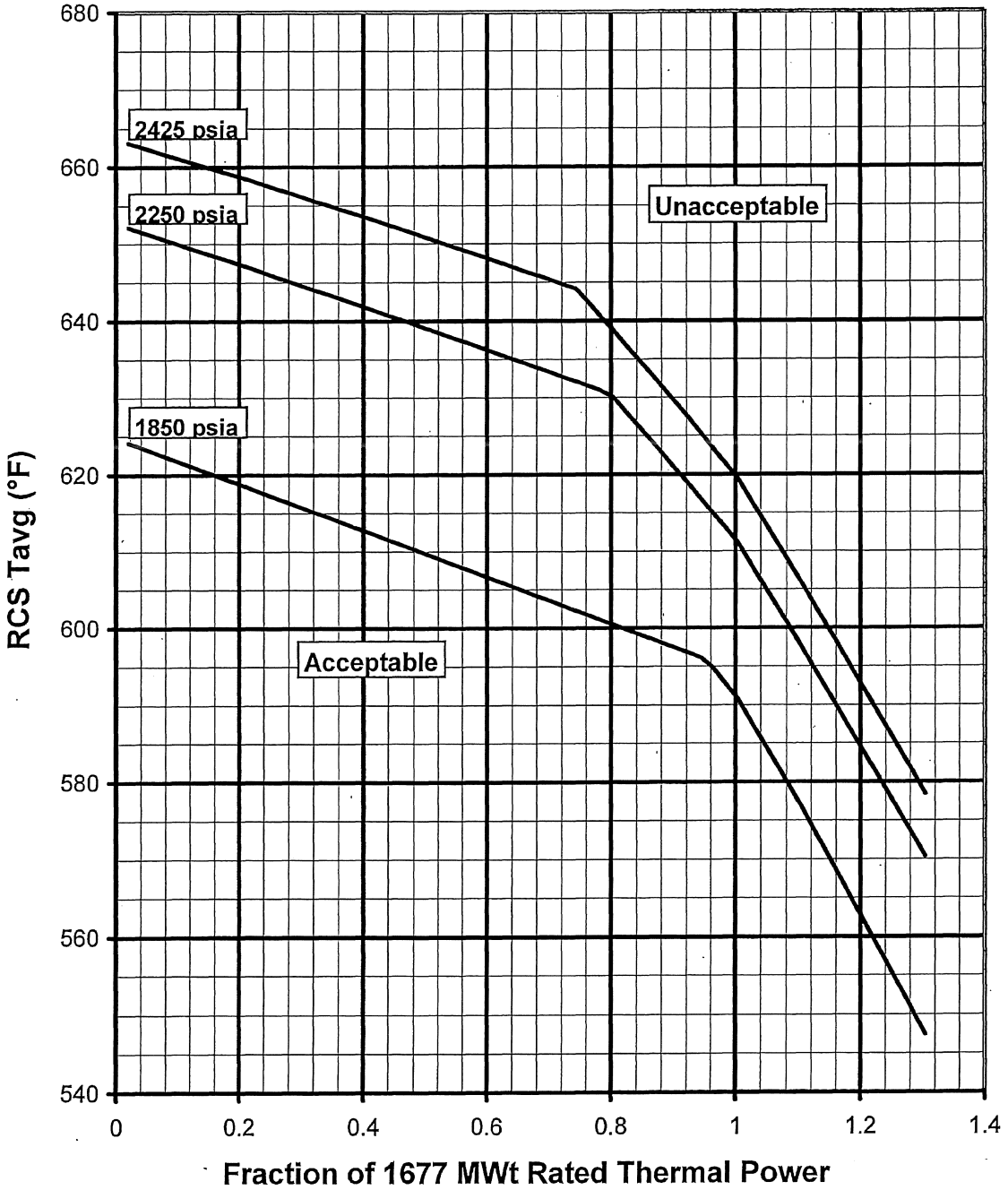
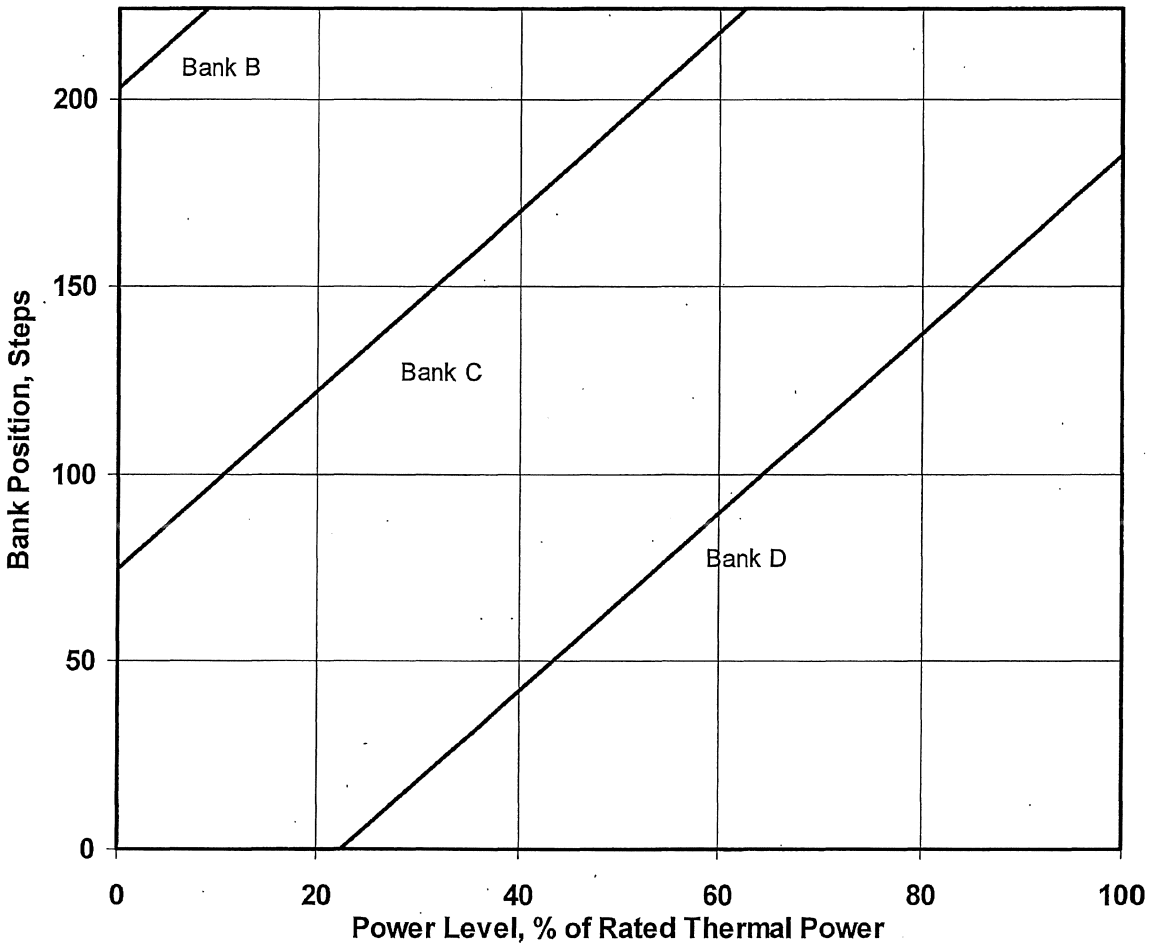


Figure 2
Rod Insertion Limit, 128 Step Tip-to-Tip

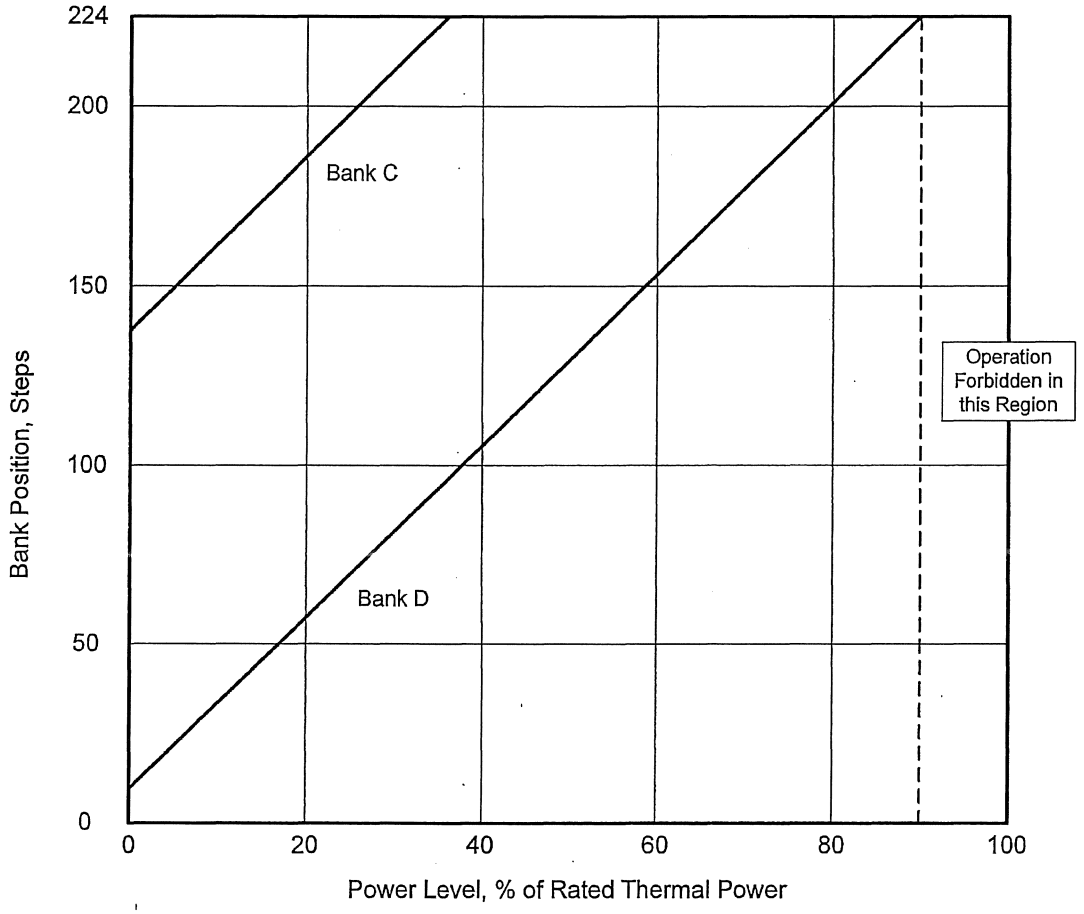


Bank Positions Given By:

- 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)

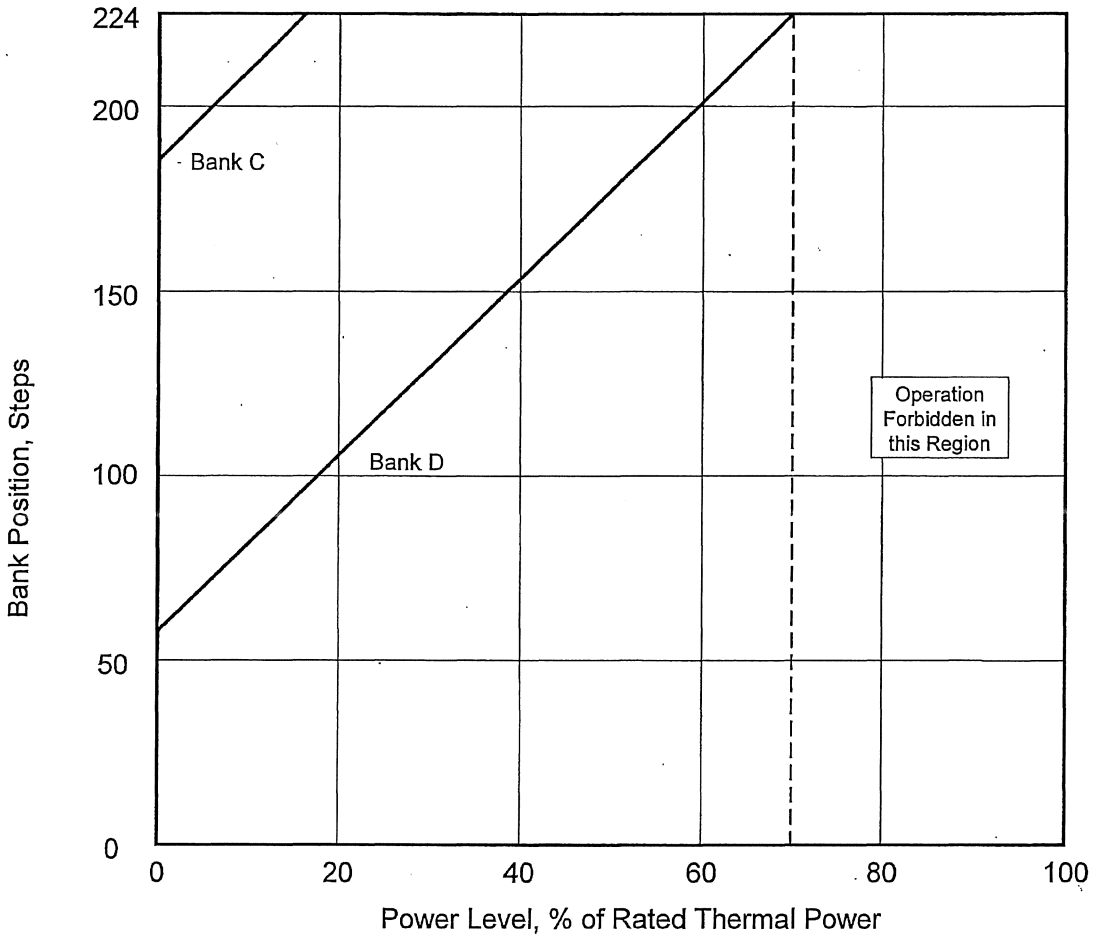


Bank Positions Given By:

- 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 and Table 6

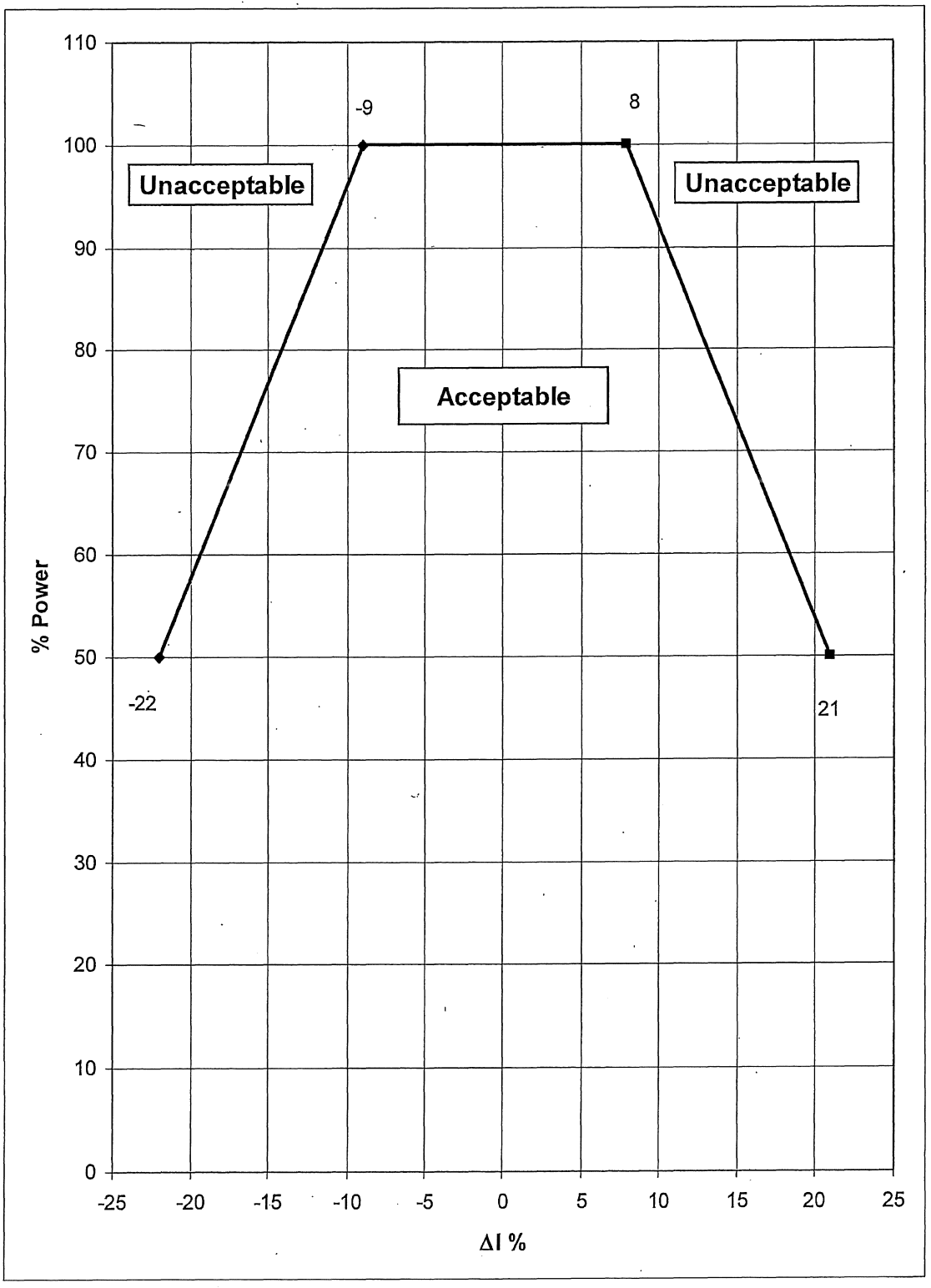


Figure 6
Flux Difference Operating Envelope associated with Table 4