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November 5, 2024

L-PI-24-049
TS 5.6.5.d

ATTN: Document Control Desk
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 34, Revision 0

Pursuant to the requirements of Technical Specification 5.6.5.d, Northern States Power Company, a Minnesota corporation, doing business as Xcel Energy (hereafter "NSPM"), hereby submits the COLR for the PINGP Unit 1, Cycle 34, 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.

If you have any questions about this submittal, please contact Carrie Seipp, Senior Regulatory Engineer, at 612-330-5576.

Summary of Commitments

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

Bryan Currier
Plant Manager, Prairie Island Nuclear Generating Plant
Northern States Power Company – Minnesota

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 34
REVISION 0

35 pages follow

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).

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.

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.

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.

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

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

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
2	30	0	10/24/17	Updated for Unit 2 Cycle 30
1	31	0	09/06/18	Updated for Unit 1 Cycle 31
2	31	0	10/14/19	Updated for Unit 2 Cycle 31
2	31	1	09/14/20	Updated to revise Table 2 and Table 3 due to Flexible Power Operation
1	32	0	09/21/20	Updated for Unit 1 Cycle 32
2	32	0	10/11/21	Updated for Unit 2 Cycle 32
2	32	1	10/25/21	Updated to clarify power value used in calculation of $F_Q^W(Z)$
1	33	0	10/13/22	Updated for Unit 1 Cycle 33
2	33	0	10/26/23	Updated for Unit 2 Cycle 33
1	34	0	10/22/24	Updated for Unit 1 Cycle 34

PRAIRIE ISLAND NUCLEAR GENERATING PLANT

CORE OPERATING LIMITS REPORT

UNIT 1 - CYCLE 34

REVISION 0

Reviewed By: *Reviewed per 600001214712*
Troy Lassle
Manager, Engineering

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David Mienke
Manager, Nuclear Analysis & Design-Acting

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 34
REVISION 0

This report provides the values of the limits for Unit 1 Cycle 34 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/ºF at a power level = 70% RTP to
   ii. -1.5 pcm/ºF 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:

$$F_Q^W(z) \leq \frac{CFQ}{P} * K(z) \quad for\ P > 0.5$$

$$F_Q^W(z) \leq \frac{CFQ}{0.5} * K(z) \quad for\ P \leq 0.5$$

$F_Q^W(z) = [F_{XY}(z)]_{Surv}^M * \frac{[T(z)]^{COLR}}{P} * A_{XY}(z) * [R_j]^{COLR} * 1.0815$ for $P > 0.5$

$F_Q^W(z) = [F_{XY}(z)]_{Surv}^M * \frac{[T(z)]^{COLR}}{0.5} * A_{XY}(z) * [R_j]^{COLR} * 1.0815$ for $P \leq 0.5$

$[F_{XY}(z)]_{Surv}^M$ is the measured planar radial peaking factor.

P is the ratio of thermal power at the time of surveillance to rated thermal power.

CFQ = 2.50

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

The T(Z) values are provided in Tables 2 and 4.

The T(Z) values in Table 2 are applicable to Figure 5, which represents "RAOC Operation Space #1 (ROS1).

The T(Z) values in Table 4 are applicable to Figure 6, which represents "RAOC Operating Space #2 (ROS2). Through Table 6, Table 4 is also associated with Figures 7 and 8.

The R_j Penalty Factors associated with Figure 5 and Table 2 (ROS1) are provided in Table 3.

The R_j Penalty Factors associated with Figure 6 and Table 4 (ROS2) are provided in Table 5. Through Table 6, Table 5 is also associated with Figures 7 and 8.

The $A_{XY}(Z)$ factors adjust the surveillance to the reference conditions assumed in generating the T(z) factors. $A_{XY}(Z)$ may be assumed to equal 1.0 or may be determined for specific surveillance conditions using the approved methods listed in TS 5.6.5.

Either ROS1 or ROS2 may be implemented at any time during Cycle 34.

If ROS1 is implemented and entering LCO 3.2.1 Condition B for $F^{W}_{Q}(Z)$ not within limits, EITHER take Action B.1.1 by implementing ROS2, OR take Action B.2.1 by using Table 6 to determine required THERMAL POWER and AFD limits based on Required $F^{W}_{Q}(Z)$ margin improvement available in ROS1.

If ROS2 is implemented and entering LCO 3.2.1 Condition B for $F^{W}_{Q}(Z)$ not within limits, take Action B.2.1 by using Table 6 to determine required THERMAL POWER and AFD limits based on Required $F^{W}_{Q}(Z)$ margin improvement available in ROS2.

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 either Figure 5, if ROS1 is implemented, or Figure 6 if ROS2 is implemented. If implementing TS 3.2.1 Required Action B.2.1. the AFD shall be maintained within the allowed spaced defined by Figure 7 or 8, as determined by Table 6 and the condition that led to the required action.

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. Design Equivalent Change 601000004850 Rev. 0 "1R34 Core Reload."

33. WCAP-17661-P-A, "Improved RAOC and CAOC FQ Surveillance Technical Specifications", February 2019.

Table 1
Minimum Required Shutdown Margin, %Δρ

Number of Charging Pumps Running**			
Mode 1*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 - 24400 MWd/MTU	-	-	-

Mode 2*			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 - 24400 MWd/MTU	1.7	1.7	1.7

Physics Testing in Mode 2			
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 - 24400 MWd/MTU	0.5	0.5	0.5

Mode 3	**T_{ave} ≥ 520°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 - 24400 MWd/MTU	2.0	2.0	2.0

Mode 3	**350°F ≤ T_{ave} < 520°F (Most Reactive Rod Out)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWD/MTU	2.0	2.0	2.0
3000 MWd/MTU	2.0	2.0	2.0
6000 MWd/MTU	2.0	2.0	2.0
11000 MWd/MTU	2.0	2.0	2.0
16000 MWd/MTU	2.0	2.0	2.0
24400 MWd/MTU	2.0	2.0	2.0

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.

Note: Linear interpolation between burnup steps is allowed. Extrapolation is not allowed.

Table 1, Continued

Minimum Required Shutdown Margin, %Δρ

Number of Charging Pumps Running**			
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
3000 MWd/MTU	2.0	4.0	6.0
6000 MWd/MTU	2.0	4.0	6.0
11000 MWd/MTU	2.0	3.5	5.5
16000 MWd/MTU	2.0	3.0	4.5
24400 MWd/MTU	2.0	2.0	2.5

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* **	2.0	4.5	6.5
3000 MWd/MTU	2.0	4.5	6.5
6000 MWd/MTU	2.0	4.0	6.5
11000 MWd/MTU	2.0	4.0	6.0
16000 MWd/MTU	2.0	3.5	5.5
24400 MWd/MTU	2.0	2.0	3.0

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 33 end of cycle.

Note: Linear interpolation between burnup steps is allowed. Extrapolation is not allowed.

Table 1, Continued

Minimum Required Shutdown Margin, %Δρ

Number of Charging Pumps Running**			
Mode 6	**68°F ≤ T_{ave} < 200°F (ARI)**		
	0-1 Pump	**2 Pumps**	**3 Pumps**
0 MWd/MTU* **	5.129	5.129	6.5
3000 MWd/MTU	5.129	5.129	6.5
6000 MWd/MTU	5.129	5.129	6.5
11000 MWd/MTU	5.129	5.129	6.0
16000 MWd/MTU	5.129	5.129	5.129
24400 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
3000 MWd/MTU	5.129	5.5	8.5
6000 MWd/MTU	5.129	5.5	8.0
11000 MWd/MTU	5.129	5.129	8.0
16000 MWd/MTU	5.129	5.129	7.0
24400 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 33 end of cycle.

Note: Linear interpolation between burnup steps is allowed. Extrapolation is not allowed.

Table 2 - T(z) Factors associated with Figure 5 (ROS1) (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]									
	[ft]	150	1000	2000	2500	3000	4000	5000	6000	7000	8000
[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	1.1332	1.1109	1.1064	1.1014	1.0969	1.0828	1.0981	1.0865	1.0934	1.1211
7	1.20	1.1744	1.1580	1.1551	1.1517	1.1482	1.1347	1.1514	1.1407	1.1493	1.1785
8	1.40	1.2012	1.1901	1.1886	1.1865	1.1837	1.1705	1.1880	1.1776	1.1863	1.2151
9	1.60	1.2269	1.2205	1.2202	1.2193	1.2169	1.2050	1.2220	1.2115	1.2198	1.2474
10	1.80	1.2323	1.2302	1.2310	1.2311	1.2292	1.2200	1.2348	1.2245	1.2322	1.2584
11	2.00	1.1965	1.1984	1.2001	1.2013	1.2000	1.1937	1.2060	1.1965	1.2040	1.2283
12	2.20	1.1564	1.1618	1.1644	1.1666	1.1657	1.1623	1.1720	1.1628	1.1699	1.1920
13	2.40	1.1815	1.1894	1.1925	1.1953	1.1943	1.1931	1.2002	1.1926	1.1954	1.2157
14	2.60	1.2233	1.2335	1.2370	1.2403	1.2390	1.2400	1.2443	1.2402	1.2413	1.2544
15	2.80	1.2389	1.2456	1.2489	1.2527	1.2512	1.2547	1.2560	1.2570	1.2588	1.2622
16	3.00	1.2319	1.2347	1.2377	1.2418	1.2405	1.2457	1.2449	1.2492	1.2510	1.2484
17	3.20	1.2221	1.2301	1.2339	1.2379	1.2369	1.2418	1.2410	1.2438	1.2446	1.2415
18	3.40	1.2210	1.2343	1.2382	1.2425	1.2409	1.2464	1.2454	1.2461	1.2452	1.2417
19	3.60	1.2282	1.2447	1.2486	1.2532	1.2527	1.2569	1.2557	1.2542	1.2514	1.2474
20	3.80	1.2400	1.2578	1.2617	1.2664	1.2661	1.2697	1.2684	1.2641	1.2598	1.2572
21	4.00	1.2317	1.2504	1.2544	1.2592	1.2592	1.2624	1.2611	1.2553	1.2492	1.2502
22	4.20	1.1888	1.2079	1.2119	1.2168	1.2173	1.2202	1.2191	1.2154	1.2075	1.2107
23	4.40	1.1502	1.1688	1.1726	1.1773	1.1780	1.1805	1.1789	1.1779	1.1717	1.1730
24	4.60	1.1796	1.1988	1.2025	1.2071	1.2078	1.2097	1.2065	1.2060	1.2000	1.1981
25	4.80	1.2248	1.2450	1.2484	1.2530	1.2537	1.2552	1.2508	1.2493	1.2436	1.2384
26	5.00	1.2398	1.2598	1.2630	1.2674	1.2681	1.2688	1.2669	1.2648	1.2574	1.2496
27	5.20	1.2330	1.2525	1.2555	1.2597	1.2605	1.2599	1.2605	1.2583	1.2482	1.2386
28	5.40	1.2301	1.2498	1.2527	1.2569	1.2580	1.2560	1.2552	1.2528	1.2414	1.2309
29	5.60	1.2350	1.2539	1.2568	1.2609	1.2622	1.2607	1.2594	1.2566	1.2435	1.2332
30	5.80	1.2485	1.2684	1.2711	1.2749	1.2756	1.2736	1.2716	1.2683	1.2542	1.2430
31	6.00	1.2667	1.2864	1.2890	1.2926	1.2922	1.2910	1.2869	1.2837	1.2693	1.2561
32	6.20	1.2641	1.2836	1.2861	1.2896	1.2888	1.2881	1.2826	1.2787	1.2649	1.2499
33	6.40	1.2258	1.2448	1.2473	1.2507	1.2506	1.2499	1.2465	1.2395	1.2274	1.2122
34	6.61	1.1935	1.2119	1.2144	1.2154	1.2182	1.2174	1.2171	1.2039	1.1936	1.1824
35	6.81	1.2280	1.2464	1.2487	1.2499	1.2525	1.2514	1.2516	1.2360	1.2276	1.2125
36	7.01	1.2800	1.2982	1.3003	1.3007	1.3038	1.3022	1.3025	1.2835	1.2751	1.2579
37	7.21	1.2988	1.3165	1.3184	1.3189	1.3220	1.3202	1.3207	1.2999	1.2921	1.2735
38	7.41	1.2914	1.3085	1.3103	1.3106	1.3140	1.3122	1.3131	1.2911	1.2846	1.2671
39	7.61	1.2838	1.2997	1.3014	1.3016	1.3053	1.3034	1.3048	1.2821	1.2773	1.2631
40	7.81	1.2838	1.2989	1.3004	1.3006	1.3045	1.3025	1.3042	1.2818	1.2808	1.2680
41	8.01	1.2900	1.3039	1.3053	1.3053	1.3093	1.3072	1.3093	1.2912	1.2918	1.2799
42	8.21	1.2969	1.3094	1.3102	1.3100	1.3144	1.3121	1.3145	1.3031	1.3042	1.2932
43	8.41	1.2796	1.2905	1.2919	1.2917	1.2956	1.2936	1.2962	1.2916	1.2939	1.2847
44	8.61	1.2273	1.2368	1.2393	1.2394	1.2426	1.2415	1.2441	1.2451	1.2492	1.2427
45	8.81	1.1847	1.1932	1.1942	1.1944	1.1991	1.1977	1.2015	1.2029	1.2087	1.2051
46	9.01	1.2140	1.2214	1.2219	1.2214	1.2267	1.2247	1.2289	1.2304	1.2330	1.2330
47	9.21	1.2561	1.2624	1.2626	1.2616	1.2673	1.2648	1.2694	1.2719	1.2697	1.2726
48	9.41	1.2625	1.2665	1.2667	1.2654	1.2721	1.2695	1.2749	1.2792	1.2788	1.2843
49	9.61	1.2452	1.2456	1.2452	1.2436	1.2497	1.2471	1.2525	1.2589	1.2635	1.2724
50	9.81	1.2317	1.2281	1.2263	1.2243	1.2281	1.2254	1.2300	1.2363	1.2445	1.2560
51	10.01	1.2228	1.2163	1.2139	1.2117	1.2153	1.2125	1.2172	1.2198	1.2339	1.2453
52	10.21	1.2179	1.2079	1.2049	1.2021	1.2054	1.2024	1.2072	1.2094	1.2254	1.2360
53	10.41	1.2070	1.1929	1.1890	1.1857	1.1884	1.1850	1.1897	1.1918	1.2086	1.2209
54	10.61	1.1663	1.1484	1.1439	1.1401	1.1422	1.1388	1.1434	1.1457	1.1633	1.1769
55	10.81	1.0852	1.0631	1.0583	1.0544	1.0562	1.0531	1.0578	1.0605	1.0782	1.0901
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 18,500 MWD/MTU and 21,500 MWD/MTU is adequate for addressing burnups beyond 21,500 MWD/MTU.**

Table 2 (cont.) - T(z) Factors associated with Figure 5 (ROS1) (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]									
	[ft]	9000	10000	10500	11500	12500	14000	14500	16500	18500	21500
[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	1.1286	1.1427	1.1476	1.1485	1.1657	1.2036	1.2079	1.2204	1.2610	1.2832
7	1.20	1.1864	1.2010	1.2062	1.2067	1.2238	1.2598	1.2631	1.2712	1.3077	1.3230
8	1.40	1.2223	1.2360	1.2408	1.2400	1.2554	1.2867	1.2885	1.2909	1.3220	1.3301
9	1.60	1.2536	1.2659	1.2700	1.2675	1.2807	1.3068	1.3070	1.3042	1.3302	1.3319
10	1.80	1.2636	1.2744	1.2780	1.2740	1.2854	1.3065	1.3056	1.2992	1.3210	1.3184
11	2.00	1.2327	1.2420	1.2453	1.2406	1.2504	1.2674	1.2660	1.2583	1.2771	1.2729
12	2.20	1.1956	1.2032	1.2060	1.2006	1.2088	1.2218	1.2199	1.2116	1.2279	1.2232
13	2.40	1.2178	1.2233	1.2253	1.2177	1.2235	1.2313	1.2283	1.2174	1.2305	1.2232
14	2.60	1.2549	1.2577	1.2590	1.2490	1.2525	1.2548	1.2508	1.2382	1.2473	1.2371
15	2.80	1.2619	1.2641	1.2644	1.2532	1.2541	1.2524	1.2477	1.2343	1.2409	1.2300
16	3.00	1.2476	1.2505	1.2497	1.2381	1.2363	1.2319	1.2271	1.2133	1.2146	1.2054
17	3.20	1.2396	1.2408	1.2392	1.2266	1.2236	1.2160	1.2116	1.1990	1.1908	1.1846
18	3.40	1.2388	1.2376	1.2353	1.2219	1.2191	1.2061	1.2021	1.1914	1.1852	1.1813
19	3.60	1.2432	1.2399	1.2386	1.2253	1.2216	1.2062	1.2018	1.1922	1.1860	1.1826
20	3.80	1.2518	1.2465	1.2465	1.2334	1.2280	1.2099	1.2052	1.1962	1.1901	1.1875
21	4.00	1.2442	1.2370	1.2376	1.2248	1.2179	1.1983	1.1938	1.1863	1.1808	1.1814
22	4.20	1.2048	1.1967	1.1982	1.1868	1.1795	1.1600	1.1561	1.1511	1.1471	1.1518
23	4.40	1.1672	1.1603	1.1605	1.1505	1.1429	1.1236	1.1203	1.1176	1.1156	1.1234
24	4.60	1.1914	1.1846	1.1831	1.1727	1.1632	1.1431	1.1397	1.1353	1.1334	1.1419
25	4.80	1.2305	1.2235	1.2202	1.2090	1.1972	1.1760	1.1718	1.1652	1.1630	1.1716
26	5.00	1.2412	1.2345	1.2299	1.2190	1.2055	1.1847	1.1821	1.1728	1.1707	1.1801
27	5.20	1.2307	1.2245	1.2192	1.2089	1.1946	1.1749	1.1747	1.1630	1.1601	1.1711
28	5.40	1.2233	1.2167	1.2114	1.2007	1.1865	1.1669	1.1669	1.1546	1.1498	1.1612
29	5.60	1.2231	1.2165	1.2115	1.2006	1.1864	1.1669	1.1667	1.1540	1.1497	1.1573
30	5.80	1.2322	1.2254	1.2200	1.2094	1.1937	1.1752	1.1736	1.1620	1.1603	1.1629
31	6.00	1.2461	1.2386	1.2319	1.2225	1.2078	1.1894	1.1870	1.1755	1.1758	1.1768
32	6.20	1.2408	1.2330	1.2272	1.2175	1.2077	1.1885	1.1874	1.1738	1.1758	1.1794
33	6.40	1.2051	1.1976	1.1953	1.1842	1.1787	1.1604	1.1603	1.1474	1.1511	1.1592
34	6.61	1.1769	1.1698	1.1684	1.1581	1.1549	1.1378	1.1380	1.1308	1.1310	1.1427
35	6.81	1.2071	1.1991	1.1982	1.1870	1.1847	1.1708	1.1693	1.1624	1.1601	1.1709
36	7.01	1.2523	1.2429	1.2421	1.2324	1.2292	1.2180	1.2159	1.2066	1.2016	1.2105
37	7.21	1.2683	1.2600	1.2611	1.2533	1.2498	1.2395	1.2376	1.2268	1.2205	1.2275
38	7.41	1.2631	1.2573	1.2606	1.2535	1.2506	1.2405	1.2391	1.2275	1.2215	1.2261
39	7.61	1.2607	1.2555	1.2593	1.2523	1.2501	1.2407	1.2394	1.2273	1.2215	1.2237
40	7.81	1.2655	1.2600	1.2644	1.2575	1.2558	1.2469	1.2460	1.2328	1.2270	1.2261
41	8.01	1.2773	1.2712	1.2763	1.2693	1.2682	1.2596	1.2589	1.2444	1.2384	1.2328
42	8.21	1.2890	1.2833	1.2881	1.2816	1.2805	1.2725	1.2722	1.2564	1.2501	1.2397
43	8.41	1.2793	1.2751	1.2788	1.2740	1.2726	1.2657	1.2658	1.2495	1.2443	1.2300
44	8.61	1.2362	1.2340	1.2367	1.2346	1.2331	1.2288	1.2298	1.2149	1.2113	1.1971
45	8.81	1.1975	1.1975	1.1989	1.1997	1.1977	1.1971	1.1995	1.1904	1.1826	1.1734
46	9.01	1.2255	1.2288	1.2302	1.2320	1.2297	1.2289	1.2300	1.2210	1.2102	1.1973
47	9.21	1.2685	1.2704	1.2720	1.2740	1.2719	1.2731	1.2728	1.2647	1.2496	1.2332
48	9.41	1.2823	1.2828	1.2846	1.2871	1.2858	1.2882	1.2866	1.2813	1.2668	1.2468
49	9.61	1.2703	1.2719	1.2732	1.2777	1.2764	1.2800	1.2780	1.2766	1.2640	1.2475
50	9.81	1.2552	1.2574	1.2584	1.2650	1.2640	1.2721	1.2687	1.2725	1.2605	1.2532
51	10.01	1.2482	1.2481	1.2528	1.2571	1.2603	1.2724	1.2642	1.2756	1.2698	1.2620
52	10.21	1.2441	1.2407	1.2499	1.2503	1.2596	1.2748	1.2628	1.2832	1.2828	1.2739
53	10.41	1.2328	1.2287	1.2396	1.2369	1.2514	1.2700	1.2546	1.2851	1.2894	1.2798
54	10.61	1.1908	1.1883	1.1990	1.1959	1.2130	1.2350	1.2193	1.2577	1.2686	1.2622
55	10.81	1.1049	1.1037	1.1145	1.1130	1.1308	1.1554	1.1433	1.1865	1.2050	1.2085
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 18,500 MWD/MTU and 21,500 MWD/MTU is adequate for addressing burnups beyond 21,500 MWD/MTU.**

Table 3: R_J Margin Decrease Factors associated with Figure 5 (ROS1) and Table 2

Cycle Burnup (MWD/MTU)	R_J Penalty Multiplier	Cycle Burnup (MWD/MTU)	R_J Penalty Multiplier	Cycle Burnup (MWD/MTU)	R_J Penalty Multiplier
150	1.027	7176	1.015	14203	1.000
321	1.024	7348	1.014	14374	1.000
493	1.021	7519	1.014	14546	1.000
664	1.019	7691	1.013	14717	1.000
836	1.016	7862	1.012	14888	1.000
1007	1.012	8033	1.011	15060	1.000
1178	1.010	8205	1.011	15231	1.000
1350	1.008	8376	1.011	15403	1.000
1521	1.008	8547	1.011	15574	1.000
1692	1.006	8719	1.011	15745	1.000
1864	1.005	8890	1.012	15917	1.000
2035	1.004	9062	1.012	16088	1.000
2207	1.003	9233	1.012	16259	1.006
2378	1.003	9404	1.012	16431	1.007
2549	1.002	9576	1.011	16602	1.007
2721	1.001	9747	1.009	16774	1.008
2892	1.000	9918	1.008	16945	1.008
3063	1.000	10090	1.007	17116	1.007
3235	1.000	10261	1.004	17288	1.007
3406	1.000	10433	1.004	17459	1.006
3578	1.000	10604	1.004	17630	1.001
3749	1.000	10775	1.006	17802	1.001
3920	1.000	10947	1.008	17973	1.000
4092	1.000	11118	1.012	18145	1.000
4263	1.000	11289	1.013	18316	1.000
4434	1.000	11461	1.014	18487	1.000
4606	1.000	11632	1.015	18659	1.000
4777	1.000	11804	1.016	18830	1.000
4949	1.000	11975	1.020	19001	1.000
5120	1.000	12146	1.019	19173	1.000
5291	1.000	12318	1.018	19344	1.000
5463	1.000	12489	1.016	19516	1.000
5634	1.000	12660	1.015	19687	1.000
5805	1.001	12832	1.013	19858	1.000
5977	1.004	13003	1.011	20030	1.000
6148	1.007	13175	1.009	20201	1.000
6320	1.010	13346	1.003		
6491	1.013	13517	1.002		
6662	1.015	13689	1.001		
6834	1.016	13860	1.000		
7005	1.016	14031	1.000		

Values may be interpolated to the surveillance cycle burnup. The R_j factor value for the last burnup step shall be used for all burnups greater than the last burnup step.

Table 4 – T(z) Factors associated with Figures 6, 7, and 8 (ROS2) (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]									
	[ft]	150	1500	2000	2500	3000	3500	4000	5000	6500	8000
[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	1.1126	1.0758	1.0682	1.0669	1.0590	1.0621	1.0600	1.0650	1.0710	1.0810
7	1.20	1.1534	1.1218	1.1159	1.1159	1.1092	1.1134	1.1121	1.1186	1.1261	1.1370
8	1.40	1.1799	1.1533	1.1490	1.1501	1.1441	1.1492	1.1482	1.1552	1.1629	1.1730
9	1.60	1.2055	1.1834	1.1804	1.1824	1.1772	1.1827	1.1819	1.1892	1.1965	1.2051
10	1.80	1.2111	1.1935	1.1919	1.1945	1.1901	1.1960	1.1954	1.2026	1.2095	1.2168
11	2.00	1.1763	1.1634	1.1631	1.1664	1.1629	1.1690	1.1687	1.1760	1.1827	1.1888
12	2.20	1.1372	1.1287	1.1297	1.1334	1.1309	1.1370	1.1369	1.1439	1.1501	1.1549
13	2.40	1.1621	1.1565	1.1583	1.1623	1.1600	1.1660	1.1657	1.1720	1.1767	1.1792
14	2.60	1.2039	1.1999	1.2027	1.2069	1.2051	1.2107	1.2096	1.2154	1.2183	1.2181
15	2.80	1.2142	1.2145	1.2173	1.2207	1.2205	1.2238	1.2239	1.2276	1.2295	1.2282
16	3.00	1.2020	1.2071	1.2099	1.2126	1.2131	1.2152	1.2163	1.2184	1.2197	1.2177
17	3.20	1.1959	1.2031	1.2068	1.2108	1.2097	1.2145	1.2135	1.2169	1.2168	1.2129
18	3.40	1.1974	1.2081	1.2120	1.2163	1.2155	1.2200	1.2189	1.2214	1.2198	1.2177
19	3.60	1.2059	1.2214	1.2253	1.2297	1.2293	1.2332	1.2320	1.2333	1.2300	1.2282
20	3.80	1.2191	1.2363	1.2402	1.2448	1.2444	1.2480	1.2466	1.2469	1.2419	1.2413
21	4.00	1.2133	1.2313	1.2352	1.2399	1.2398	1.2430	1.2416	1.2410	1.2348	1.2362
22	4.20	1.1731	1.1917	1.1956	1.2004	1.2008	1.2037	1.2025	1.2016	1.1953	1.1993
23	4.40	1.1348	1.1539	1.1577	1.1627	1.1635	1.1662	1.1650	1.1652	1.1601	1.1640
24	4.60	1.1654	1.1826	1.1881	1.1917	1.1931	1.1950	1.1954	1.1967	1.1904	1.1910
25	4.80	1.2156	1.2322	1.2363	1.2402	1.2428	1.2442	1.2433	1.2441	1.2360	1.2331
26	5.00	1.2369	1.2551	1.2579	1.2623	1.2643	1.2650	1.2628	1.2631	1.2530	1.2464
27	5.20	1.2334	1.2532	1.2563	1.2605	1.2610	1.2604	1.2587	1.2585	1.2471	1.2374
28	5.40	1.2301	1.2499	1.2529	1.2571	1.2581	1.2560	1.2544	1.2528	1.2414	1.2309
29	5.60	1.2350	1.2550	1.2579	1.2619	1.2632	1.2607	1.2592	1.2566	1.2435	1.2332
30	5.80	1.2485	1.2684	1.2712	1.2742	1.2757	1.2730	1.2716	1.2683	1.2542	1.2430
31	6.00	1.2667	1.2864	1.2890	1.2906	1.2916	1.2882	1.2869	1.2837	1.2693	1.2561
32	6.20	1.2641	1.2836	1.2861	1.2870	1.2866	1.2837	1.2826	1.2787	1.2649	1.2500
33	6.40	1.2257	1.2447	1.2472	1.2483	1.2475	1.2469	1.2464	1.2395	1.2274	1.2122
34	6.61	1.1933	1.2118	1.2142	1.2153	1.2175	1.2169	1.2169	1.2038	1.1935	1.1783
35	6.81	1.2277	1.2461	1.2484	1.2494	1.2523	1.2511	1.2513	1.2358	1.2274	1.2099
36	7.01	1.2796	1.2979	1.3000	1.3005	1.3035	1.3019	1.3021	1.2832	1.2749	1.2547
37	7.21	1.2982	1.3159	1.3178	1.3182	1.3214	1.3196	1.3201	1.2996	1.2917	1.2701
38	7.41	1.2898	1.3068	1.3085	1.3089	1.3123	1.3105	1.3114	1.2907	1.2844	1.2624
39	7.61	1.2799	1.2960	1.2977	1.2980	1.3017	1.2998	1.3012	1.2812	1.2763	1.2537
40	7.81	1.2782	1.2932	1.2947	1.2949	1.2988	1.2969	1.2986	1.2793	1.2756	1.2527
41	8.01	1.2824	1.2961	1.2974	1.2974	1.3015	1.2994	1.3015	1.2830	1.2805	1.2608
42	8.21	1.2869	1.2991	1.3002	1.3000	1.3042	1.3020	1.3044	1.2868	1.2854	1.2714
43	8.41	1.2675	1.2782	1.2791	1.2789	1.2833	1.2811	1.2839	1.2688	1.2693	1.2601
44	8.61	1.2116	1.2207	1.2216	1.2216	1.2261	1.2243	1.2276	1.2189	1.2222	1.2161
45	8.81	1.1608	1.1682	1.1691	1.1691	1.1738	1.1722	1.1759	1.1753	1.1806	1.1766
46	9.01	1.1848	1.1915	1.1920	1.1916	1.1967	1.1947	1.1988	1.2000	1.2061	1.2047
47	9.21	1.2245	1.2301	1.2303	1.2292	1.2349	1.2325	1.2370	1.2393	1.2471	1.2437
48	9.41	1.2302	1.2338	1.2340	1.2329	1.2391	1.2365	1.2415	1.2452	1.2555	1.2534
49	9.61	1.2110	1.2104	1.2100	1.2080	1.2149	1.2125	1.2184	1.2251	1.2386	1.2391
50	9.81	1.1926	1.1875	1.1857	1.1819	1.1889	1.1864	1.1926	1.2015	1.2193	1.2211
51	10.01	1.1800	1.1745	1.1722	1.1678	1.1737	1.1688	1.1736	1.1785	1.2004	1.2087
52	10.21	1.1751	1.1650	1.1619	1.1565	1.1626	1.1565	1.1613	1.1636	1.1857	1.1980
53	10.41	1.1623	1.1491	1.1461	1.1410	1.1447	1.1400	1.1431	1.1450	1.1651	1.1808
54	10.61	1.1204	1.1051	1.1027	1.0985	1.0992	1.0962	1.0971	1.1000	1.1175	1.1372
55	10.81	1.0412	1.0221	1.0201	1.0154	1.0154	1.0126	1.0139	1.0186	1.0326	1.0548
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 18,500 MWD/MTU and 21,500 MWD/MTU is adequate for addressing burnups beyond 21,500 MWD/MTU.**

Table 4 (cont.) – T(z) Factors associated with Figures 6, 7 and 8 (ROS2) (Top 10% and Bottom 8% excluded)*

	Height	BU [MWd/MTU]									
	[ft]	9000	10000	10500	11500	12500	14000	14500	16500	18500	21500
[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	1.0876	1.0980	1.0939	1.1221	1.1385	1.1553	1.1592	1.1962	1.2061	1.2309
7	1.20	1.1440	1.1549	1.1508	1.1794	1.1957	1.2101	1.2129	1.2463	1.2516	1.2701
8	1.40	1.1793	1.1897	1.1851	1.2124	1.2271	1.2368	1.2381	1.2661	1.2663	1.2780
9	1.60	1.2104	1.2199	1.2147	1.2399	1.2525	1.2572	1.2569	1.2795	1.2752	1.2811
10	1.80	1.2211	1.2297	1.2242	1.2469	1.2577	1.2581	1.2568	1.2751	1.2678	1.2697
11	2.00	1.1926	1.2003	1.1949	1.2150	1.2244	1.2220	1.2200	1.2355	1.2272	1.2279
12	2.20	1.1579	1.1648	1.1595	1.1766	1.1845	1.1794	1.1771	1.1901	1.1815	1.1819
13	2.40	1.1808	1.1863	1.1804	1.1944	1.1999	1.1901	1.1867	1.1963	1.1858	1.1840
14	2.60	1.2181	1.2222	1.2155	1.2259	1.2292	1.2142	1.2099	1.2162	1.2036	1.1999
15	2.80	1.2272	1.2302	1.2235	1.2314	1.2321	1.2144	1.2094	1.2132	1.2002	1.1951
16	3.00	1.2159	1.2183	1.2117	1.2181	1.2161	1.1972	1.1920	1.1944	1.1822	1.1766
17	3.20	1.2101	1.2110	1.2047	1.2081	1.2046	1.1838	1.1786	1.1805	1.1695	1.1644
18	3.40	1.2141	1.2109	1.2073	1.2048	1.1991	1.1778	1.1742	1.1728	1.1657	1.1578
19	3.60	1.2237	1.2161	1.2158	1.2095	1.2006	1.1813	1.1767	1.1723	1.1678	1.1577
20	3.80	1.2357	1.2235	1.2270	1.2185	1.2036	1.1879	1.1829	1.1744	1.1735	1.1606
21	4.00	1.2301	1.2146	1.2211	1.2104	1.1926	1.1791	1.1749	1.1668	1.1656	1.1557
22	4.20	1.1934	1.1787	1.1851	1.1736	1.1579	1.1444	1.1425	1.1354	1.1338	1.1284
23	4.40	1.1582	1.1468	1.1507	1.1405	1.1266	1.1135	1.1124	1.1053	1.1034	1.1023
24	4.60	1.1843	1.1746	1.1758	1.1654	1.1511	1.1360	1.1350	1.1257	1.1216	1.1222
25	4.80	1.2250	1.2169	1.2155	1.2042	1.1892	1.1715	1.1705	1.1583	1.1531	1.1531
26	5.00	1.2389	1.2322	1.2279	1.2171	1.2023	1.1832	1.1823	1.1685	1.1636	1.1637
27	5.20	1.2311	1.2248	1.2190	1.2082	1.1946	1.1752	1.1746	1.1600	1.1560	1.1580
28	5.40	1.2233	1.2166	1.2114	1.1994	1.1865	1.1669	1.1669	1.1516	1.1484	1.1525
29	5.60	1.2231	1.2165	1.2115	1.2003	1.1864	1.1667	1.1667	1.1516	1.1495	1.1524
30	5.80	1.2321	1.2254	1.2192	1.2089	1.1930	1.1752	1.1733	1.1613	1.1596	1.1605
31	6.00	1.2454	1.2386	1.2312	1.2207	1.2061	1.1894	1.1862	1.1756	1.1738	1.1724
32	6.20	1.2397	1.2330	1.2273	1.2149	1.2052	1.1885	1.1860	1.1740	1.1727	1.1711
33	6.40	1.2035	1.1976	1.1953	1.1807	1.1752	1.1604	1.1584	1.1471	1.1470	1.1485
34	6.61	1.1748	1.1698	1.1684	1.1537	1.1505	1.1371	1.1356	1.1246	1.1260	1.1295
35	6.81	1.2045	1.1991	1.1982	1.1815	1.1793	1.1650	1.1634	1.1502	1.1540	1.1549
36	7.01	1.2490	1.2431	1.2426	1.2277	1.2218	1.2058	1.2039	1.1897	1.1944	1.1916
37	7.21	1.2650	1.2592	1.2592	1.2487	1.2384	1.2219	1.2200	1.2068	1.2114	1.2070
38	7.41	1.2582	1.2528	1.2537	1.2475	1.2343	1.2193	1.2178	1.2054	1.2097	1.2052
39	7.61	1.2504	1.2461	1.2476	1.2453	1.2301	1.2176	1.2164	1.2034	1.2074	1.2024
40	7.81	1.2503	1.2473	1.2480	1.2495	1.2340	1.2218	1.2209	1.2073	1.2104	1.2045
41	8.01	1.2591	1.2568	1.2535	1.2603	1.2434	1.2324	1.2318	1.2162	1.2183	1.2111
42	8.21	1.2706	1.2682	1.2616	1.2711	1.2535	1.2433	1.2429	1.2261	1.2271	1.2183
43	8.41	1.2604	1.2585	1.2510	1.2612	1.2437	1.2352	1.2352	1.2179	1.2178	1.2092
44	8.61	1.2180	1.2170	1.2080	1.2198	1.2034	1.1976	1.1985	1.1826	1.1830	1.1752
45	8.81	1.1800	1.1798	1.1694	1.1825	1.1672	1.1644	1.1669	1.1562	1.1599	1.1456
46	9.01	1.2069	1.2055	1.1964	1.2064	1.1939	1.1936	1.1965	1.1843	1.1875	1.1656
47	9.21	1.2435	1.2396	1.2397	1.2425	1.2369	1.2367	1.2396	1.2252	1.2276	1.2014
48	9.41	1.2499	1.2475	1.2537	1.2508	1.2521	1.2532	1.2567	1.2425	1.2425	1.2152
49	9.61	1.2361	1.2375	1.2422	1.2374	1.2429	1.2471	1.2516	1.2403	1.2385	1.2131
50	9.81	1.2234	1.2268	1.2277	1.2227	1.2308	1.2380	1.2436	1.2357	1.2339	1.2137
51	10.01	1.2140	1.2187	1.2181	1.2127	1.2232	1.2336	1.2403	1.2361	1.2325	1.2257
52	10.21	1.2065	1.2123	1.2099	1.2016	1.2164	1.2312	1.2394	1.2427	1.2401	1.2412
53	10.41	1.1909	1.1978	1.1956	1.1863	1.2047	1.2244	1.2342	1.2448	1.2452	1.2517
54	10.61	1.1478	1.1557	1.1543	1.1463	1.1666	1.1905	1.2016	1.2182	1.2230	1.2379
55	10.81	1.0658	1.0745	1.0722	1.0660	1.0869	1.1134	1.1255	1.1494	1.1611	1.1850
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 18,500 MWD/MTU and 21,500 MWD/MTU is adequate for addressing burnups beyond 21,500 MWD/MTU.**

Table 5: R_J Margin Decrease Factors associated with Figures 6, 7, and 8 (ROS2) and Table 4

Cycle Burnup (MWD/MTU)	R_J Penalty Multiplier	Cycle Burnup (MWD/MTU)	R_J Penalty Multiplier	Cycle Burnup (MWD/MTU)	R_J Penalty Multiplier
150	1.027	7176	1.000	14203	1.006
321	1.024	7348	1.004	14374	1.008
493	1.021	7519	1.004	14546	1.008
664	1.019	7691	1.004	14717	1.009
836	1.016	7862	1.003	14888	1.009
1007	1.012	8033	1.003	15060	1.009
1178	1.010	8205	1.007	15231	1.008
1350	1.008	8376	1.008	15403	1.008
1521	1.008	8547	1.007	15574	1.001
1692	1.006	8719	1.006	15745	1.000
1864	1.005	8890	1.006	15917	1.000
2035	1.004	9062	1.006	16088	1.000
2207	1.003	9233	1.006	16259	1.000
2378	1.003	9404	1.005	16431	1.000
2549	1.002	9576	1.001	16602	1.000
2721	1.002	9747	1.005	16774	1.000
2892	1.000	9918	1.009	16945	1.000
3063	1.000	10090	1.012	17116	1.000
3235	1.000	10261	1.017	17288	1.000
3406	1.000	10433	1.020	17459	1.000
3578	1.000	10604	1.022	17630	1.000
3749	1.000	10775	1.023	17802	1.000
3920	1.000	10947	1.023	17973	1.000
4092	1.000	11118	1.018	18145	1.000
4263	1.000	11289	1.015	18316	1.000
4434	1.000	11461	1.013	18487	1.000
4606	1.000	11632	1.010	18659	1.000
4777	1.000	11804	1.008	18830	1.000
4949	1.000	11975	1.006	19001	1.000
5120	1.000	12146	1.005	19173	1.000
5291	1.000	12318	1.004	19344	1.000
5463	1.001	12489	1.003	19516	1.000
5634	1.003	12660	1.002	19687	1.000
5805	1.000	12832	1.001	19858	1.000
5977	1.000	13003	1.000	20030	1.000
6148	1.000	13175	1.000	20201	1.000
6320	1.000	13346	1.000		
6491	1.000	13517	1.000		
6662	1.000	13689	1.000		
6834	1.000	13860	1.000		
7005	1.000	14031	1.000		

Values may be interpolated to the surveillance cycle burnup. The R_j factor value for the last burnup step shall be used for all burnups greater than the last burnup step.

Table 6: Required THERMAL POWER Limits and AFD Reductions

RAOC Operating Space	Required $F_Q^W(z)$ Margin Improvement (%)	Required THERMAL POWER Limit (%RTP)	Reference AFD Figure
ROS1 (Figure 5)	> 0	< 50	N/A
ROS2 (Figure 6)	≤ 2.5	≤ 95	Use Figure 7
	> 2.5 and ≤ 6.4	≤ 90	Use Figure 8
	> 6.4	< 50	N/A

Figure 1

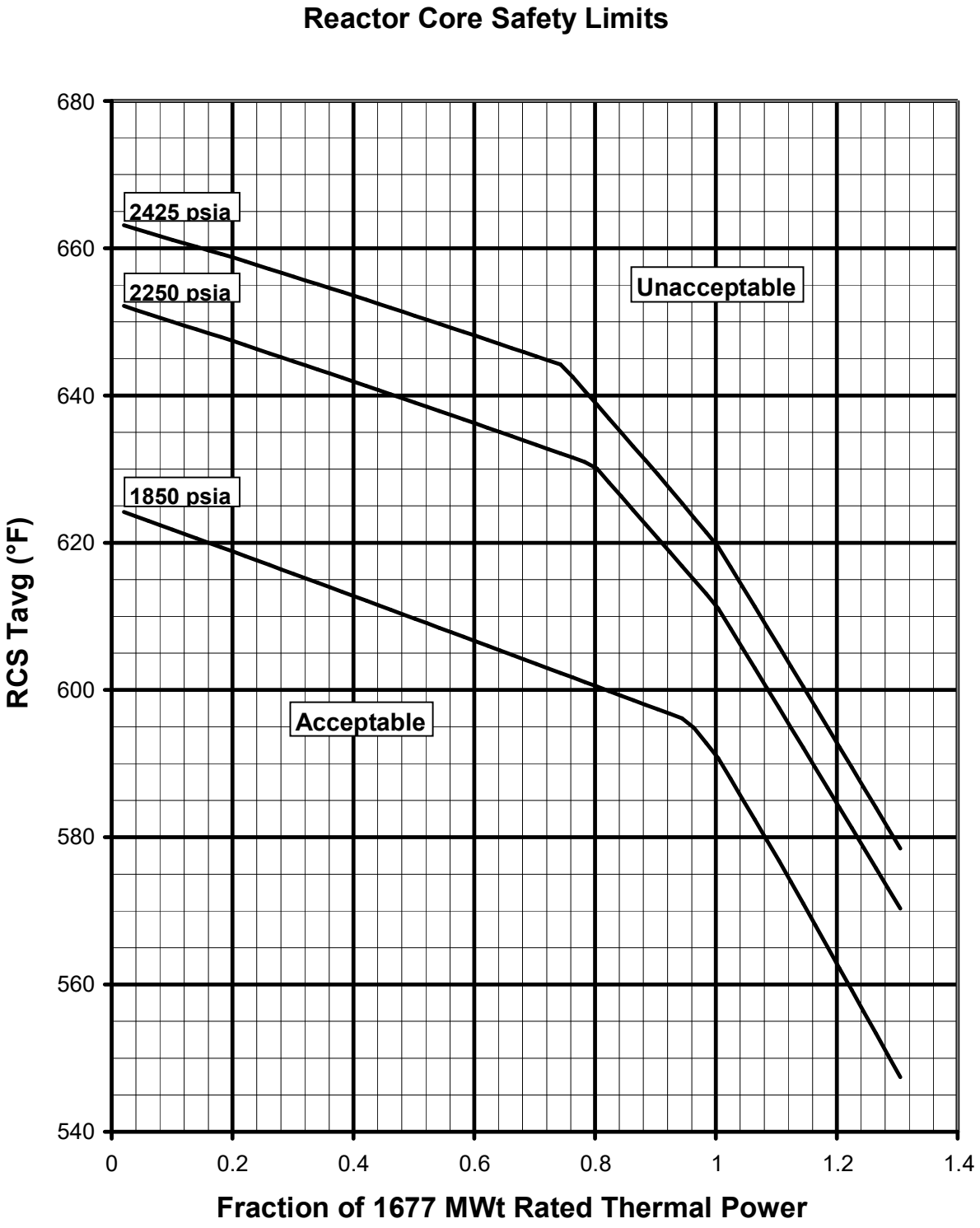
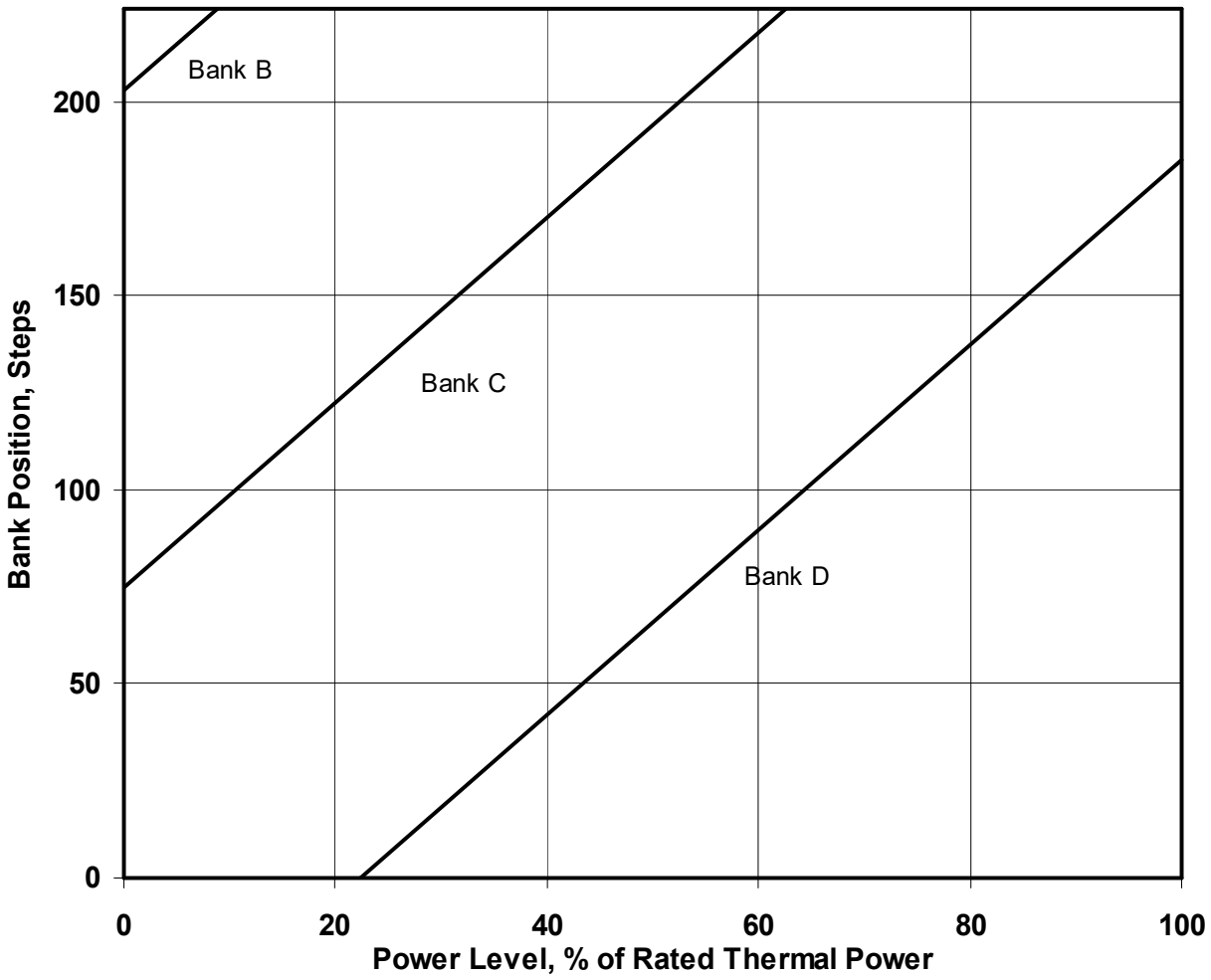

Reactor Core Safety Limits
680
660
640
620
600
580
560
540
RCS Tavg (°F)
2425 psia
2250 psia
1850 psia
Unacceptable
Acceptable
0
0.2
0.4
0.6
0.8
1
1.2
1.4
Fraction of 1677 MWt Rated Thermal Power

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

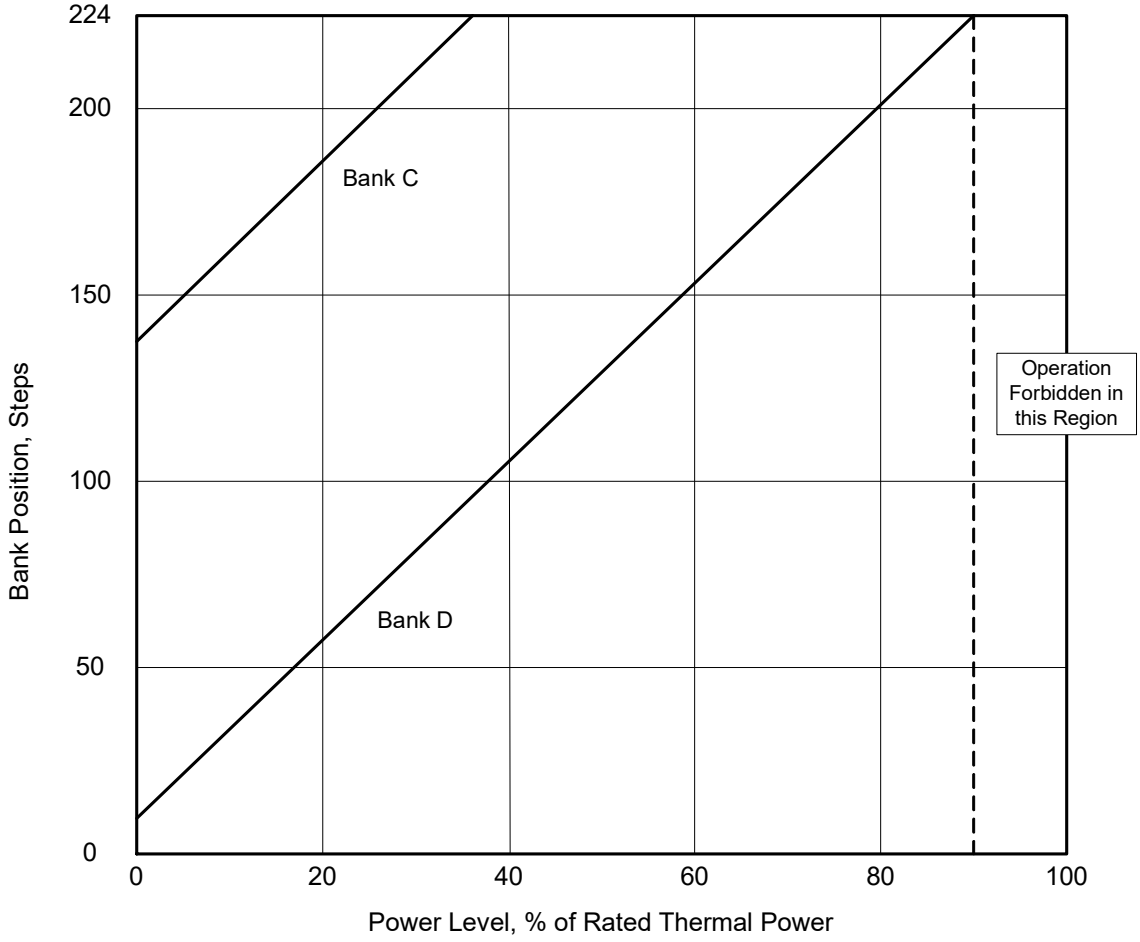


Bank Positions Given By:

- 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.

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

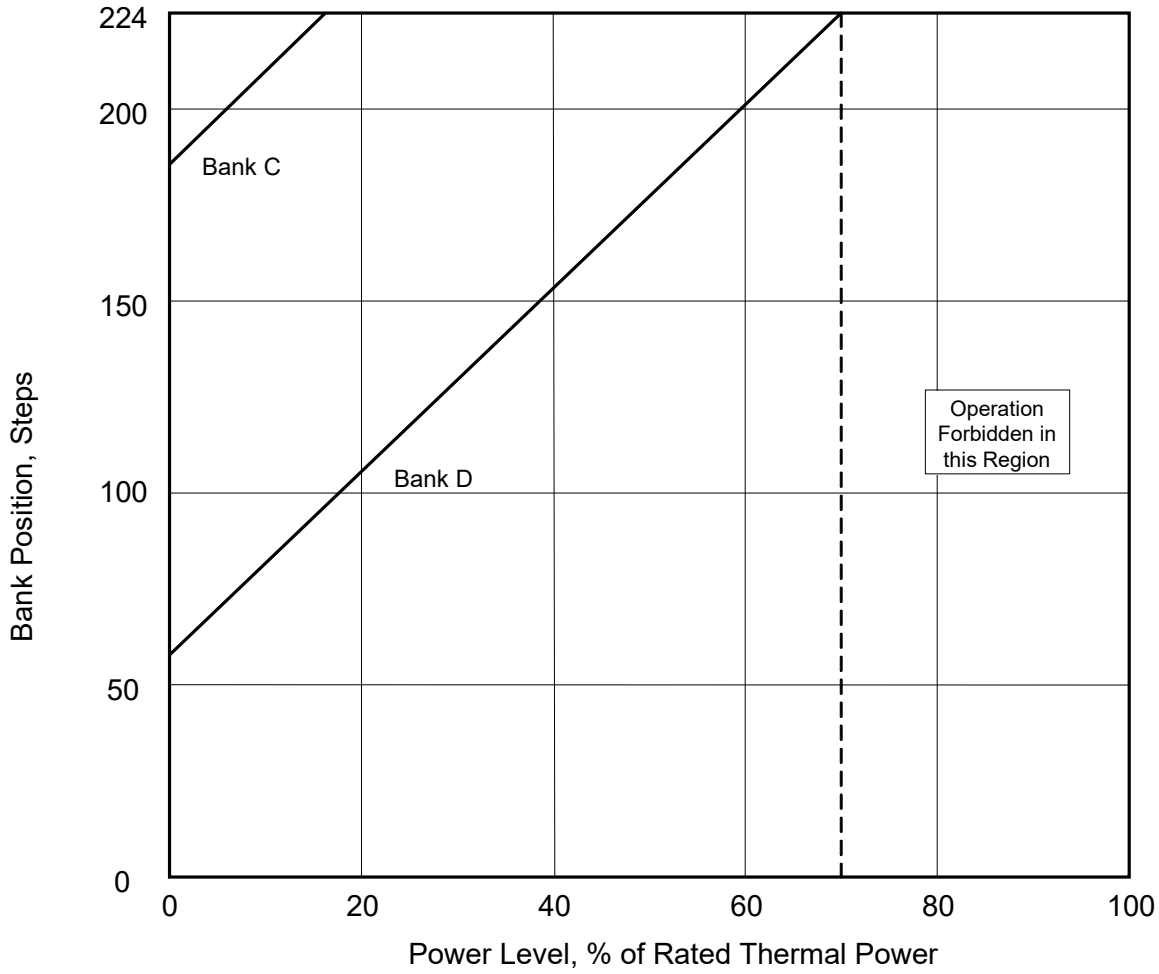


Bank Positions Given By:

- 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.

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.

Figure 5
Flux Difference Operating Envelope associated with ROS1 (Tables 2 and 3)

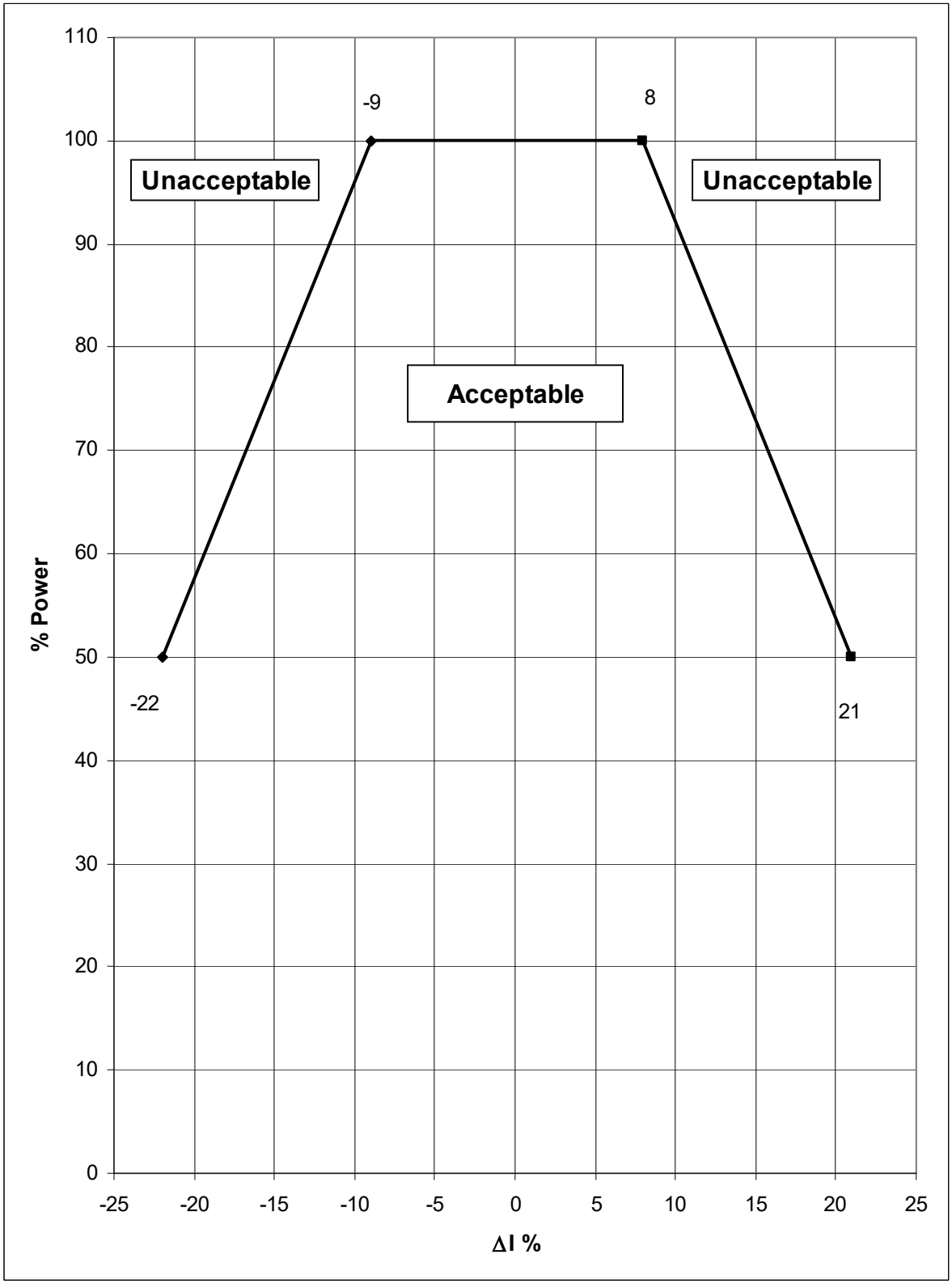


Figure 6
Flux Difference Operating Envelope associated with ROS2 (Tables 4 and 5)

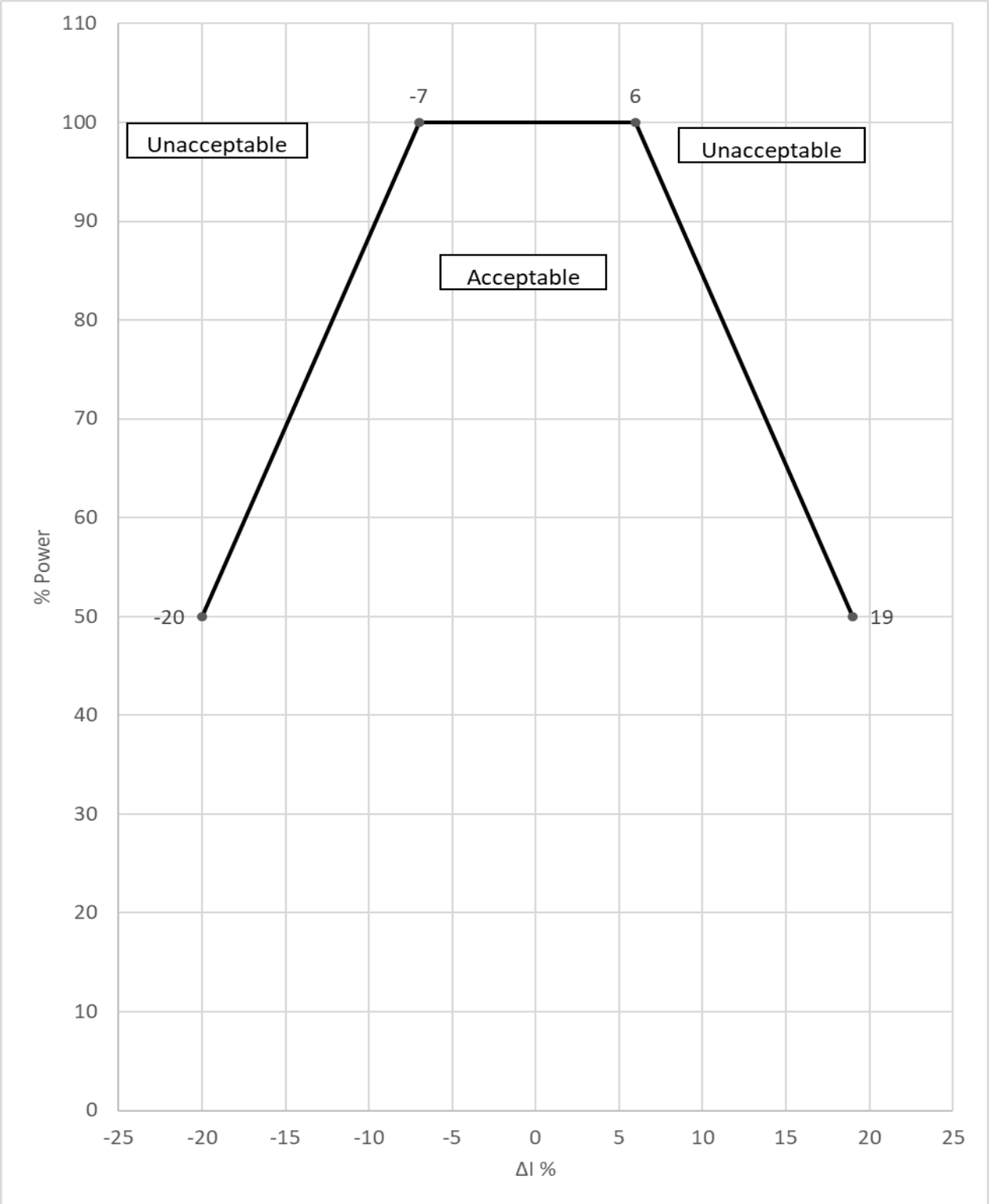


Figure 7
Flux Difference Operating Envelope associated with ROS2 95% THERMAL POWER Required Action (Tables 4, 5, and 6)

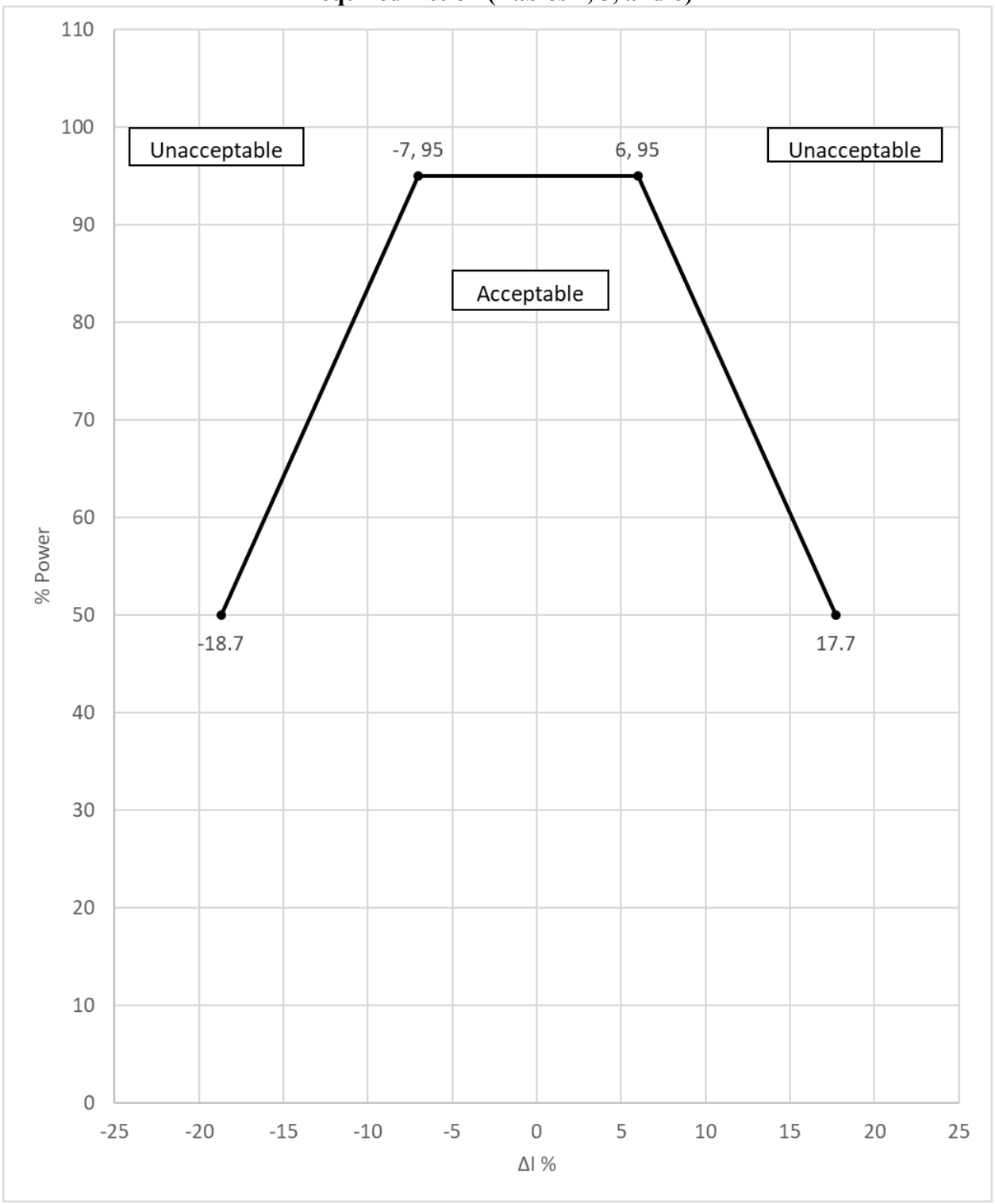


Figure 8
Flux Difference Operating Envelope associated with ROS2 90% THERMAL POWER Required Action (Tables 4, 5, and 6)