



South Texas Project Electric Generating Station P.O. Box 289 Wadsworth, Texas 77483

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U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
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Rockville, MD 20852-2738

South Texas Project
Unit 2
Docket No. STN 50-499
Unit 2 Cycle 16 Core Operating Limits Report

Pursuant to Technical Specification 6.9.1.6.d, STP Nuclear Operating Company submits the attached Core Operating Limits Report for Unit 2 Cycle 16. The report covers the core design changes made during the 2RE15 refueling outage. Revision 0 is applicable to Modes 3, 4, and 5 and Revision 1 incorporates information to include Modes 1 and 2.

There are no commitments included in this letter.

If there are any questions on this report, please contact either Marilyn Kistler at (361) 972-8385 or me at (361) 972-7743.

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MK

Attachments: 1) Revision 0 Unit 2 Cycle 16 Core Operating Limits Report
2) Revision 1 Unit 2 Cycle 16 Core Operating Limits Report

STI: 33112964

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ATTACHMENT 1

South Texas Project

Revision 0 Unit 2 Cycle 16 Core Operating Limits Report



SOUTH TEXAS PROJECT

Unit 2 Cycle 16

CORE OPERATING LIMITS REPORT

Revision 0

MODES 3, 4 and 5

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report for STPEGS Unit 2 Cycle 16 has been prepared in accordance with the requirements of Technical Specification 6.9.1.6. The core operating limits have been developed using the NRC-approved methodologies specified in Technical Specification 6.9.1.6.

The Technical Specifications affected by this report are:

- 1) 2.1 SAFETY LIMITS
- 2) 2.2 LIMITING SAFETY SYSTEM SETTINGS
- 3) 3/4.1.1.1 SHUTDOWN MARGIN
- 4) 3/4.1.1.3 MODERATOR TEMPERATURE COEFFICIENT LIMITS
- 5) 3/4.1.3.5 SHUTDOWN ROD INSERTION LIMITS
- 6) 3/4.1.3.6 CONTROL ROD INSERTION LIMITS
- 7) 3/4.2.1 AFD LIMITS
- 8) 3/4.2.2 HEAT FLUX HOT CHANNEL FACTOR
- 9) 3/4.2.3 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR
- 10) 3/4.2.5 DNB PARAMETERS

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented below.

2.1 SAFETY LIMITS (Specification 2.1):

- 2.1.1 Will be added prior to Mode 2.

2.2 LIMITING SAFETY SYSTEM SETTINGS (Specification 2.2):

- 2.2.1 Will be added prior to Mode 2.

- 2.2.2 The Over-temperature ΔT and Over-power ΔT setpoint parameter values are listed below:

Over-temperature ΔT Setpoint Parameter Values

Will be added prior to Mode 2.

Over-power ΔT Setpoint Parameter Values

Will be added prior to Mode 2.

2.3 SHUTDOWN MARGIN (Specification 3.1.1.1):

The SHUTDOWN MARGIN shall be:

- 2.3.1 Will be added prior to Mode 2.
- 2.3.2 Greater than the limits in Figure 2 for MODES 3 and 4.
- 2.3.3 Greater than the limits in Figure 3 for MODE 5.

2.4 MODERATOR TEMPERATURE COEFFICIENT (Specification 3.1.1.3):

- 2.4.1 Will be added prior to Mode 2.
- 2.4.2 Will be added prior to Mode 2.
- 2.4.3 Will be added prior to Mode 2.
- 2.4.4 Will be added prior to Mode 2.

2.5 ROD INSERTION LIMITS (Specification 3.1.3.5 and 3.1.3.6):

- 2.5.1 Will be added prior to Mode 2.
- 2.5.2 Will be added prior to Mode 2.
- 2.5.3 Will be added prior to Mode 2.

2.6 AXIAL FLUX DIFFERENCE (Specification 3.2.1):

- 2.6.1 Will be added prior to Mode 2.
- 2.6.2 Will be added prior to Mode 2.

2.7 HEAT FLUX HOT CHANNEL FACTOR (Specification 3.2.2):

- 2.7.1 Will be added prior to Mode 2.
- 2.7.2 Will be added prior to Mode 2.
- 2.7.3 Will be added prior to Mode 2.
- 2.7.4 Will be added prior to Mode 2.

2.8 ENTHALPY RISE HOT CHANNEL FACTOR (Specification 3.2.3):

- 2.8.1 Will be added prior to Mode 2.
- 2.8.2 Will be added prior to Mode 2.
- 2.8.3 Will be added prior to Mode 2.

2.9 DNB PARAMETERS (Specification 3.2.5):

- 2.9.1 Will be added prior to Mode 2.

3.0 REFERENCES

- 3.1 Letter from J. M. Ralston (Westinghouse) to D. F. Hoppes (STPNOC), "South Texas Project Nuclear Operating Company South Texas Project Electric Generating Station Unit 2 Cycle 16 Final Reload Evaluation (RE), " ST-UB-NOC-11003208, November 1, 2011.
- 3.2 NUREG-1346, Technical Specifications, South Texas Project Unit Nos. 1 and 2.
- 3.3 Document RSE-U2, Rev. 0, "Unit 2 Cycle 16 Reload Safety Evaluation for Modes 3, 4, and 5." (CR Action 10-9938-85)

FIGURE 1

Reactor Core Safety Limits – Four Loops in Operation

Will be added prior to Mode 2.

Figure 2

Required Shutdown Margin for Modes 3 & 4

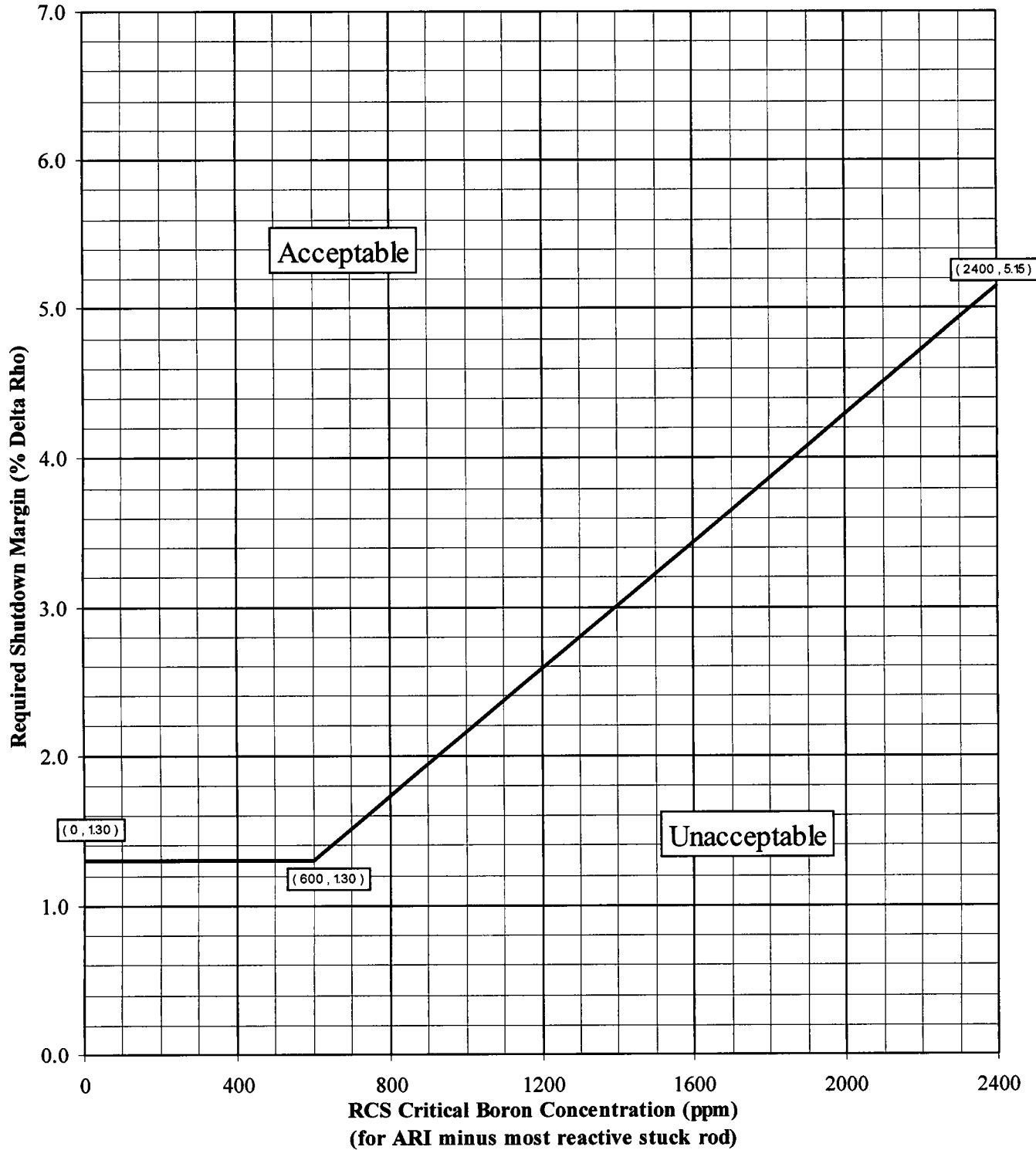


Figure 3

Required Shutdown Margin for Mode 5

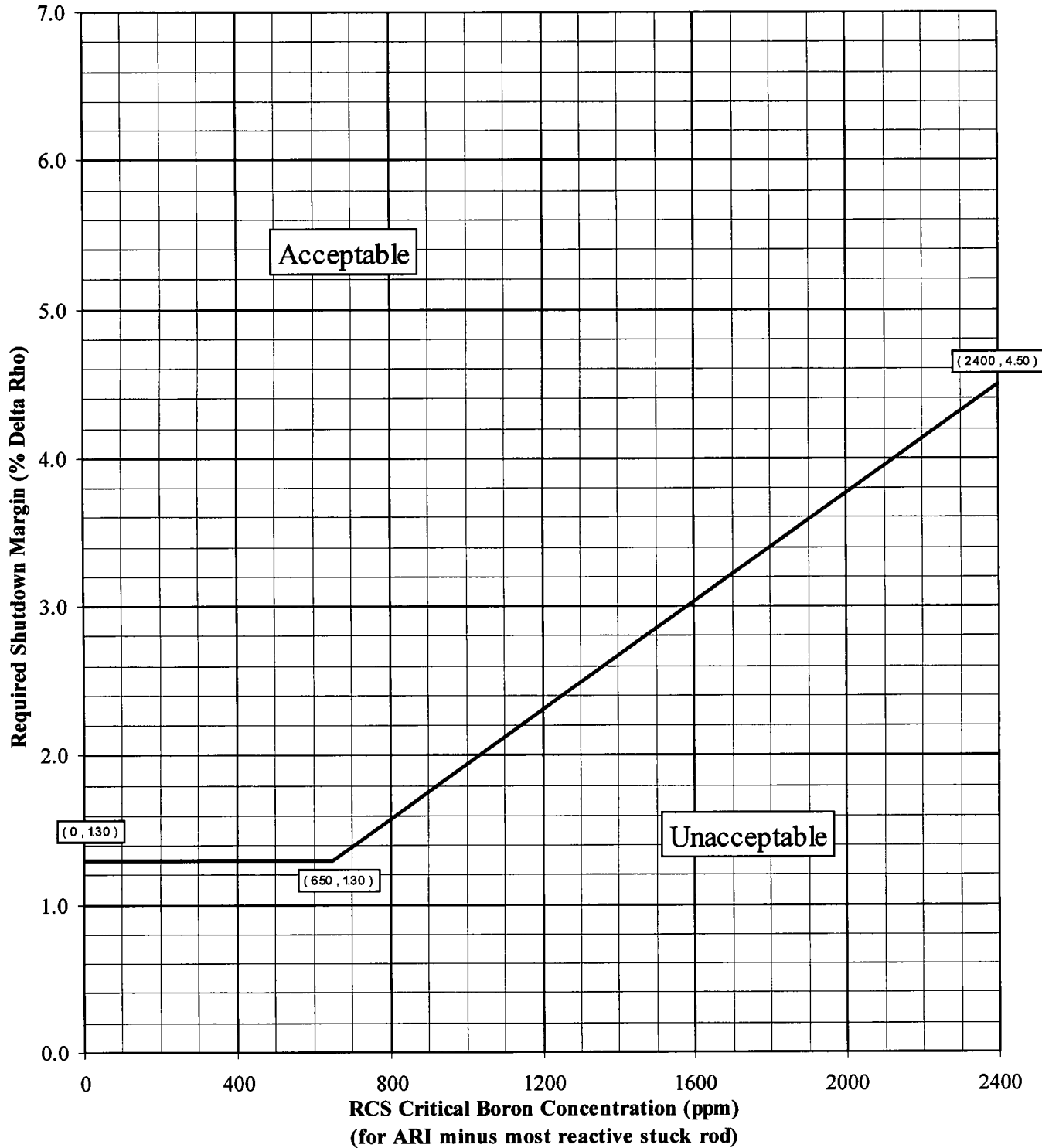


FIGURE 4

MTC versus Power Level

Will be added prior to Mode 2.

FIGURE 5

Control Rod Insertion Limits versus Power Level

Will be added prior to Mode 2.

FIGURE 6

AFD Limits versus Power Level

Will be added prior to Mode 2.

FIGURE 7

$K(Z)$ – Normalized $F_Q(Z)$ versus Core Height

Will be added prior to Mode 2.

TABLE 1

Unrodded F_{XY} for Each Core Height

Will be added prior to Mode 2.

ATTACHMENT 2

South Texas Project

Revision 1 Unit 2 Cycle 16 Core Operating Limits Report



SOUTH TEXAS PROJECT

Unit 2 Cycle 16

CORE OPERATING LIMITS REPORT

Revision 1

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report for STPEGS Unit 2 Cycle 16 has been prepared in accordance with the requirements of Technical Specification 6.9.1.6. The core operating limits have been developed using the NRC-approved methodologies specified in Technical Specification 6.9.1.6.

The Technical Specifications affected by this report are:

- 1) 2.1 SAFETY LIMITS
- 2) 2.2 LIMITING SAFETY SYSTEM SETTINGS
- 3) 3/4.1.1.1 SHUTDOWN MARGIN
- 4) 3/4.1.1.3 MODERATOR TEMPERATURE COEFFICIENT LIMITS
- 5) 3/4.1.3.5 SHUTDOWN ROD INSERTION LIMITS
- 6) 3/4.1.3.6 CONTROL ROD INSERTION LIMITS
- 7) 3/4.2.1 AFD LIMITS
- 8) 3/4.2.2 HEAT FLUX HOT CHANNEL FACTOR
- 9) 3/4.2.3 NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR
- 10) 3/4.2.5 DNB PARAMETERS

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented below.

2.1 SAFETY LIMITS (Specification 2.1):

- 2.1.1 The combination of THERMAL POWER, pressurizer pressure, and the highest operating loop coolant temperature (T_{avg}) shall not exceed the limits shown in Figure 1.

2.2 LIMITING SAFETY SYSTEM SETTINGS (Specification 2.2):

- 2.2.1 The Loop design flow for Reactor Coolant Flow-Low is 98,000 gpm.

2.2.2 The Over-temperature ΔT and Over-power ΔT setpoint parameter values are listed below:

Over-temperature ΔT Setpoint Parameter Values

- τ_1 measured reactor vessel ΔT lead/lag time constant, $\tau_1 = 8$ sec
- τ_2 measured reactor vessel ΔT lead/lag time constant, $\tau_2 = 3$ sec
- τ_3 measured reactor vessel ΔT lag time constant, $\tau_3 = 2$ sec
- τ_4 measured reactor vessel average temperature lead/lag time constant, $\tau_4 = 28$ sec
- τ_5 measured reactor vessel average temperature lead/lag time constant, $\tau_5 = 4$ sec
- τ_6 measured reactor vessel average temperature lag time constant, $\tau_6 = 2$ sec
- K_1 Overtemperature ΔT reactor trip setpoint, $K_1 = 1.14$
- K_2 Overtemperature ΔT reactor trip setpoint T_{avg} coefficient, $K_2 = 0.028/^\circ F$
- K_3 Overtemperature ΔT reactor trip setpoint pressure coefficient, $K_3 = 0.00143/\text{psig}$
- T' Nominal full power T_{avg} , $T' \leq 592.0$ $^\circ F$
- P' Nominal RCS pressure, $P' = 2235$ psig

$f_1(\Delta I)$ is a function of the indicated difference between top and bottom detectors of the power-range neutron ion chambers; with gains to be selected based on measured instrument response during plant startup tests such that:

- (1) For $q_t - q_b$ between -70% and $+8\%$, $f_1(\Delta I) = 0$, where q_t and q_b are percent RATED THERMAL POWER in the top and bottom halves of the core respectively, and $q_t + q_b$ is total THERMAL POWER in percent of RATED THERMAL POWER;
- (2) For each percent that the magnitude of $q_t - q_b$ exceeds -70% , the ΔT Trip Setpoint shall be automatically reduced by 0.0% of its value at RATED THERMAL POWER; and
- (3) For each percent that the magnitude of $q_t - q_b$ exceeds $+8\%$, the ΔT Trip Setpoint shall be automatically reduced by 2.65% of its value at RATED THERMAL POWER.

Over-power ΔT Setpoint Parameter Values

- τ_1 measured reactor vessel ΔT lead/lag time constant, $\tau_1 = 8$ sec
- τ_2 measured reactor vessel ΔT lead/lag time constant, $\tau_2 = 3$ sec
- τ_3 measured reactor vessel ΔT lag time constant, $\tau_3 = 2$ sec
- τ_6 measured reactor vessel average temperature lag time constant, $\tau_6 = 2$ sec
- τ_7 Time constant utilized in the rate-lag compensator for T_{avg} , $\tau_7 = 10$ sec
- K_4 Overpower ΔT reactor trip setpoint, $K_4 = 1.08$
- K_5 Overpower ΔT reactor trip setpoint T_{avg} rate/lag coefficient, $K_5 = 0.02/^\circ F$ for increasing average temperature, and $K_5 = 0$ for decreasing average temperature
- K_6 Overpower ΔT reactor trip setpoint T_{avg} heatup coefficient $K_6 = 0.002/^\circ F$ for $T > T''$, and $K_6 = 0$ for $T \leq T''$
- T'' Indicated full power T_{avg} , $T'' \leq 592.0$ $^\circ F$
- $f_2(\Delta I) = 0$ for all (ΔI)

2.3 SHUTDOWN MARGIN (Specification 3.1.1.1):

The SHUTDOWN MARGIN shall be:

- 2.3.1 Greater than 1.3% $\Delta\rho$ for MODES 1 and 2*
*See Special Test Exception 3.10.1
- 2.3.2 Greater than the limits in Figure 2 for MODES 3 and 4.
- 2.3.3 Greater than the limits in Figure 3 for MODE 5.

2.4 MODERATOR TEMPERATURE COEFFICIENT (Specification 3.1.1.3):

- 2.4.1 The BOL, ARO, MTC shall be less positive than the limits shown in Figure 4.
- 2.4.2 The EOL, ARO, HFP, MTC shall be less negative than -62.6 pcm/ $^{\circ}$ F.
- 2.4.3 The 300 ppm, ARO, HFP, MTC shall be less negative than -53.6 pcm/ $^{\circ}$ F (300 ppm Surveillance Limit).

Where: BOL stands for Beginning-of-Cycle Life,
EOL stands for End-of-Cycle Life,
ARO stands for All Rods Out,
HFP stands for Hot Full Power (100% RATED THERMAL POWER),
HFP vessel average temperature is 592 $^{\circ}$ F.

- 2.4.4 The Revised Predicted near-EOL 300 ppm MTC shall be calculated using the algorithm from T.S. 6.9.1.6.b.10:

Revised Predicted MTC = Predicted MTC + AFD Correction - 3 pcm/ $^{\circ}$ F

If the Revised Predicted MTC is less negative than the COLR Section 2.4.3 limit and all of the benchmark data contained in the surveillance procedure are met, then an MTC measurement in accordance with S.R. 4.1.1.3b is not required.

2.5 ROD INSERTION LIMITS (Specification 3.1.3.5 and 3.1.3.6):

- 2.5.1 All banks shall have the same Full Out Position (FOP) of either 258 or 259 steps withdrawn.
- 2.5.2 The Control Banks shall be limited in physical insertion as specified in Figure 5.
- 2.5.3 Individual Shutdown bank rods are fully withdrawn when the Bank Demand Indication is at the FOP and the Rod Group Height Limiting Condition for Operation is satisfied (T.S. 3.1.3.1).

2.6 AXIAL FLUX DIFFERENCE (Specification 3.2.1):

- 2.6.1 AFD limits as required by Technical Specification 3.2.1 are determined by Constant Axial Offset Control (CAOC) Operations with an AFD target band of +5, -10%.
- 2.6.2 The AFD shall be maintained within the ACCEPTABLE OPERATION portion of Figure 6, as required by Technical Specifications.

2.7 HEAT FLUX HOT CHANNEL FACTOR (Specification 3.2.2):

- 2.7.1 $F_Q^{RTP} = 2.55$.
- 2.7.2 $K(Z)$ is provided in Figure 7.
- 2.7.3 The F_{xy} limits for RATED THERMAL POWER (F_{xy}^{RTP}) within specific core planes shall be:
- 2.7.3.1 Less than or equal to 2.102 for all cycle burnups for all core planes containing Bank "D" control rods, and
- 2.7.3.2 Less than or equal to the appropriate core height-dependent value from Table 1 for all unrodded core planes.
- 2.7.3.3 $PF_{xy} = 0.2$.

These F_{xy} limits were used to confirm that the heat flux hot channel factor $F_Q(Z)$ will be limited by Technical Specification 3.2.2 assuming the most-limiting axial power distributions expected to result for the insertion and removal of Control Banks C and D during operation, including the accompanying variations in the axial xenon and power distributions, as described in WCAP-8385. Therefore, these F_{xy} limits provide assurance that the initial conditions assumed in the LOCA analysis are met, along with the ECCS acceptance criteria of 10 CFR 50.46.

2.7.4 Core Power Distribution Measurement Uncertainty for the Heat Flux Hot Channel Factor

- 2.7.4.1 If the Power Distribution Monitoring System (PDMS) is operable, as defined in the Technical Requirements Manual Section 3.3.3.12, the core power distribution measurement uncertainty (U_{FQ}) to be applied to the $F_Q(Z)$ and $F_{xy}(Z)$ using the PDMS shall be calculated by:

$$U_{FQ} = (1.0 + (U_Q/100)) * U_E$$

Where:

U_Q = Uncertainty for power peaking factor as defined in Equation 5-19 from the document referenced by Technical Specification 6.9.1.6.b.11

U_E = Engineering uncertainty factor of 1.03.

This uncertainty is calculated and applied automatically by the BEACON computer code.

2.7.4.2 If the moveable detector system is used, the core power distribution measurement uncertainty (U_{FQ}) to be applied to the $F_Q(Z)$ and $F_{xy}(Z)$ shall be calculated by:

$$U_{FQ} = U_{QU} * U_E$$

Where:

U_{QU} = Base F_Q measurement uncertainty of 1.05.

U_E = Engineering uncertainty factor of 1.03.

2.8 ENTHALPY RISE HOT CHANNEL FACTOR (Specification 3.2.3):

2.8.1 $F_{\Delta H}^{RTP} = 1.62^1$

2.8.2 $PF_{\Delta H} = 0.3$

2.8.3 Core Power Distribution Measurement Uncertainty for the Enthalpy Rise Hot Channel Factor

2.8.3.1 If the Power Distribution Monitoring System (PDMS) is operable, as defined in the Technical Requirements Manual Section 3.3.3.12, the core power distribution measurement uncertainty (U_{FAH}) to be applied to the $F_{\Delta H}^N$ using the PDMS shall be the greater of:

$$U_{FAH} = 1.04$$

OR

$$U_{FAH} = 1.0 + (U_{\Delta H}/100)$$

Where:

$U_{\Delta H}$ = Uncertainty for power peaking factor as defined in Equation 5-19 from the document referenced in Technical Specification 6.9.1.6.b.11.

This uncertainty is calculated and applied automatically by the BEACON computer code.

2.8.3.2 If the moveable detector system is used, the core power distribution measurement uncertainty (U_{FAH}) shall be:

$$U_{FAH} = 1.04$$

¹ Applies to all fuel in the Unit 2 Cycle 16 Core.

2.9 DNB PARAMETERS (Specification 3.2.5):

2.9.1 The following DNB-related parameters shall be maintained within the following limits: ¹

2.9.1.1 Reactor Coolant System $T_{avg} \leq 595$ °F ²,

2.9.1.2 Pressurizer Pressure > 2200 psig ³,

2.9.1.3 Minimum Measured Reactor Coolant System Flow $> 403,000$ gpm⁴.

3.0 REFERENCES

- 3.1** Letter from J. M. Ralston (Westinghouse) to D. F. Hoppes (STPNOC), "South Texas Project Nuclear Operating Company South Texas Project Electric Generating Station Unit 2 Cycle 16 Final Reload Evaluation (RE), " ST-UB-NOC-11003208, November 1, 2011.
- 3.2** NUREG-1346, Technical Specifications, South Texas Project Unit Nos. 1 and 2.
- 3.3** STPNOC Calculation ZC-7035, Rev. 2, "Loop Uncertainty Calculation for RCS Tavg Instrumentation," Section 10.1.
- 3.4** STPNOC Calculation ZC-7032, Rev. 4, "Loop Uncertainty Calculation for Narrow Range Pressurizer Pressure Monitoring Instrumentation," Section 2.3, Page 9.
- 3.5** 5Z529ZB01025 Rev. 4, Design Basis Document, Technical Specifications /LCO, Tech Spec Section 3.2.5.c.
- 3.6** Document RSE-U2, Rev. 1, "Unit 2 Cycle 16 Reload Safety Evaluation for Modes 1, 2, 3, 4, and 5." (CR Action 10-9938-9)

¹ A discussion of the processes to be used to take these readings is provided in the basis for Technical Specification 3.2.5.

² Includes a 1.9 °F measurement uncertainty per Reference 3.3.

³ Limit not applicable during either a Thermal Power ramp in excess of 5% of RTP per minute or a Thermal Power step in excess of 10% RTP. Includes a 9.6 PSI averaged measurement uncertainty as read on QDPS display per Reference 3.4.

⁴ Includes the most limiting flow measurement uncertainty of 2.8% from Reference 3.5.

Figure 1

Reactor Core Safety Limits - Four Loops in Operation

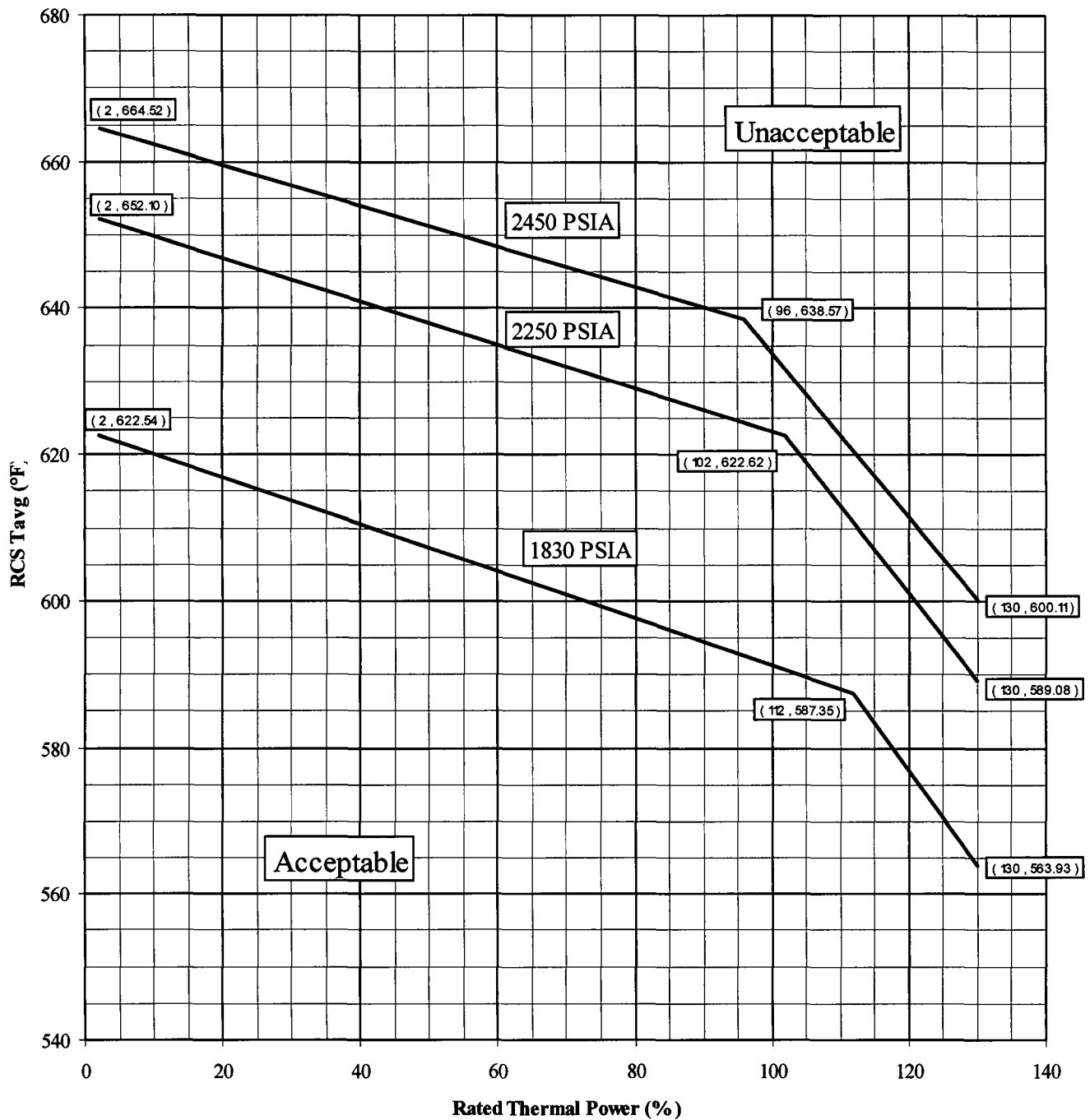


Figure 2

Required Shutdown Margin for Modes 3 & 4

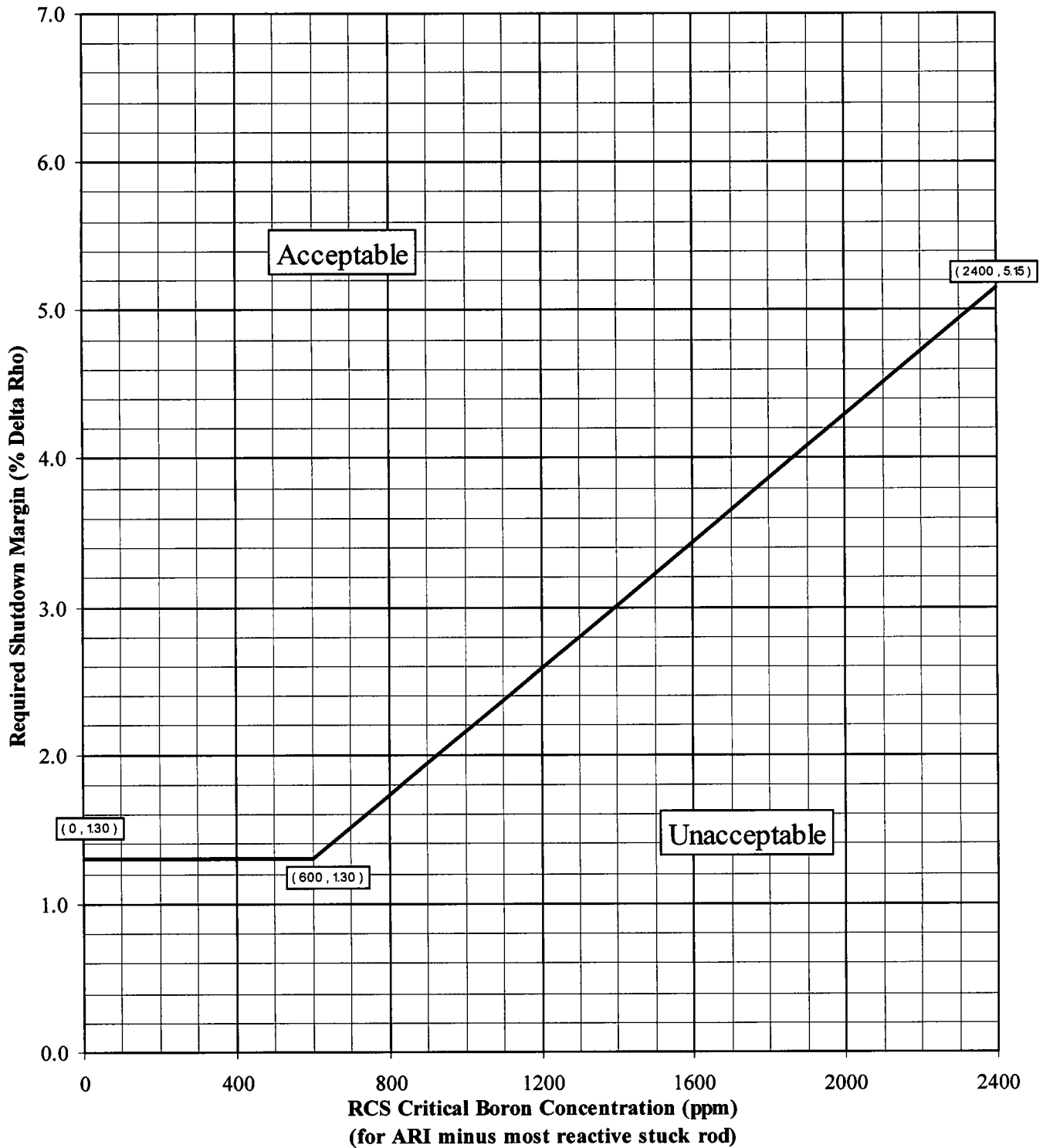


Figure 3

Required Shutdown Margin for Mode 5

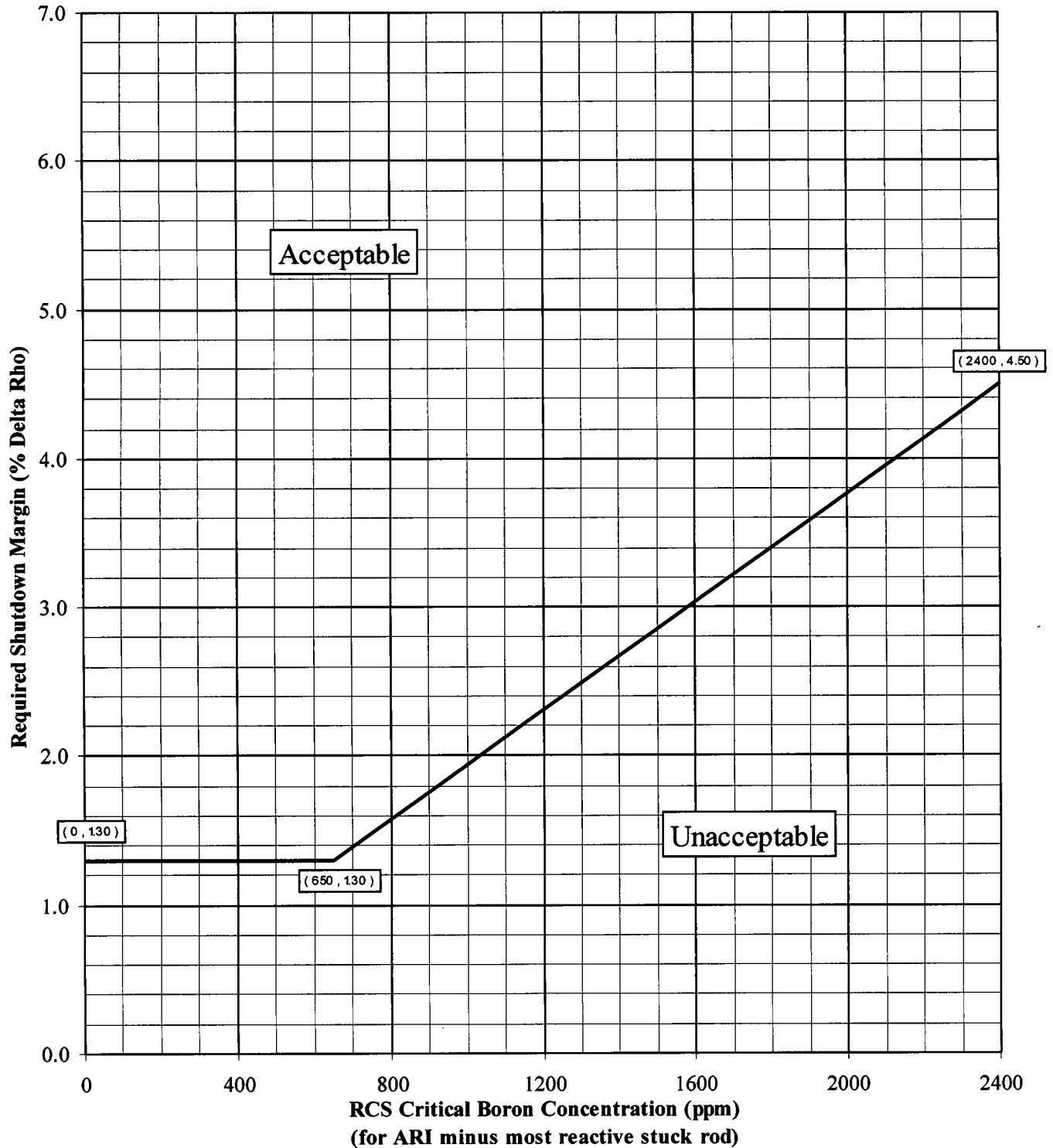


Figure 4

MTC versus Power Level

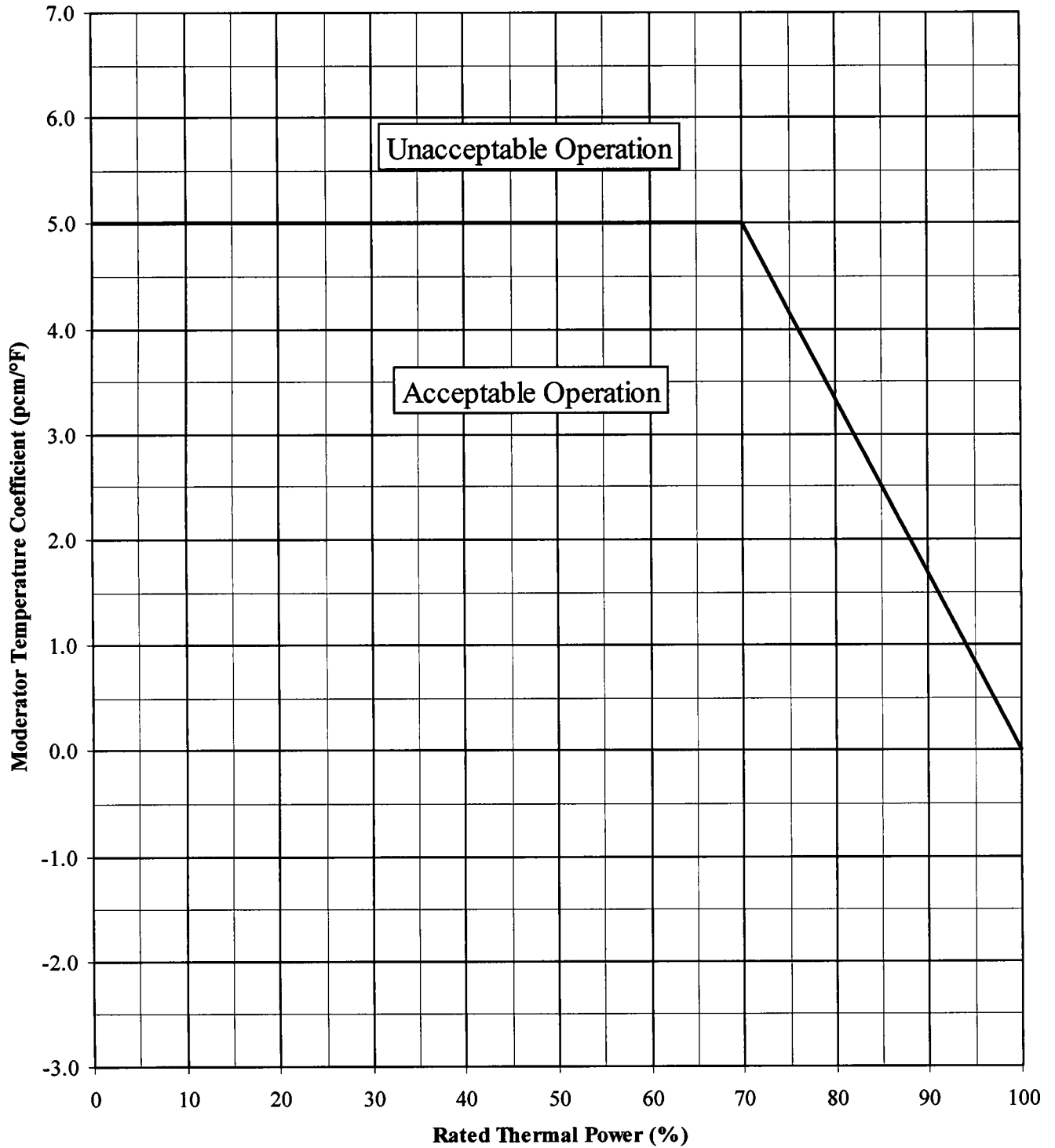


Figure 5

Control Rod Insertion Limits* versus Power Level

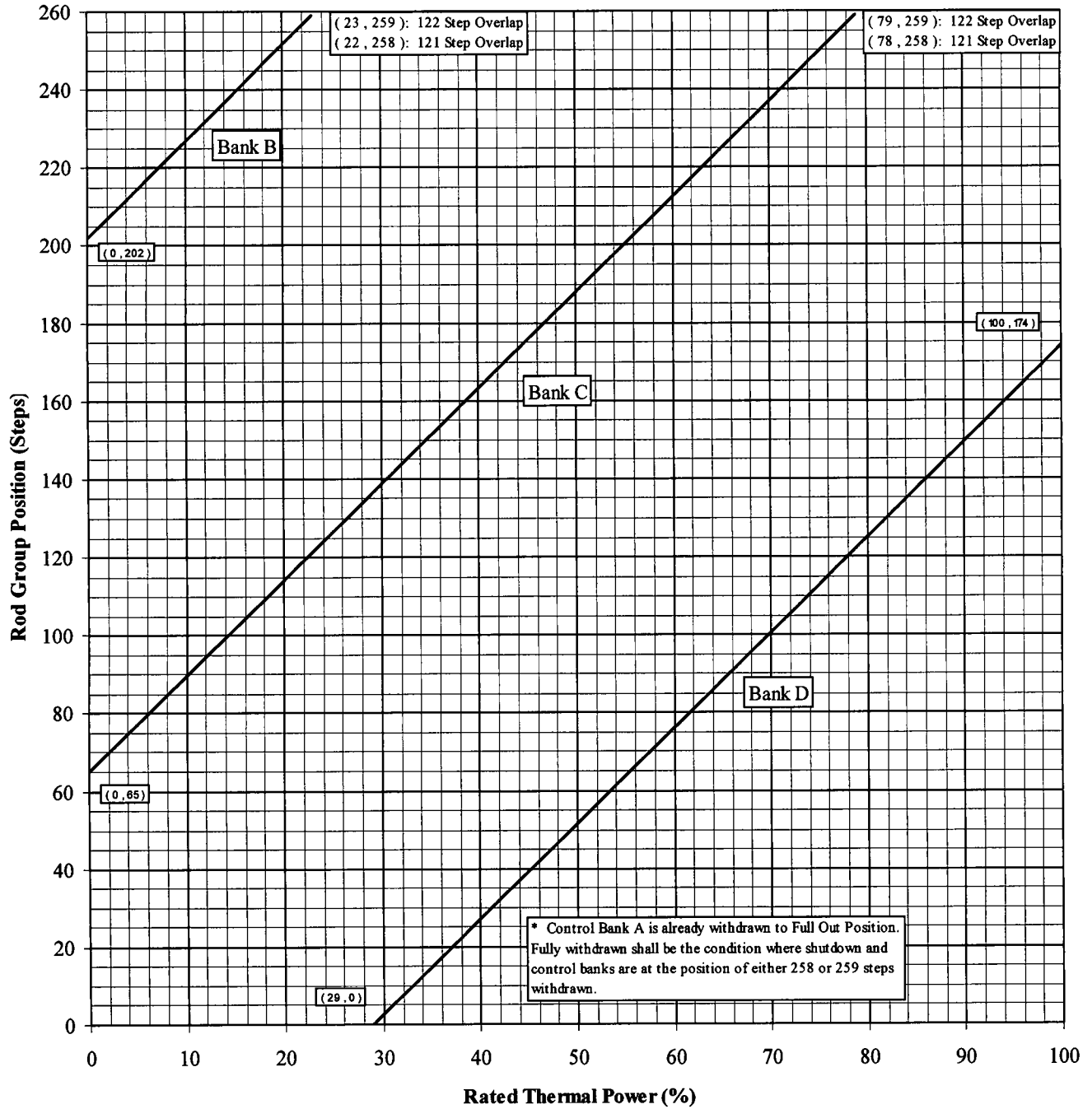


Figure 6

AFD Limits versus Power Level

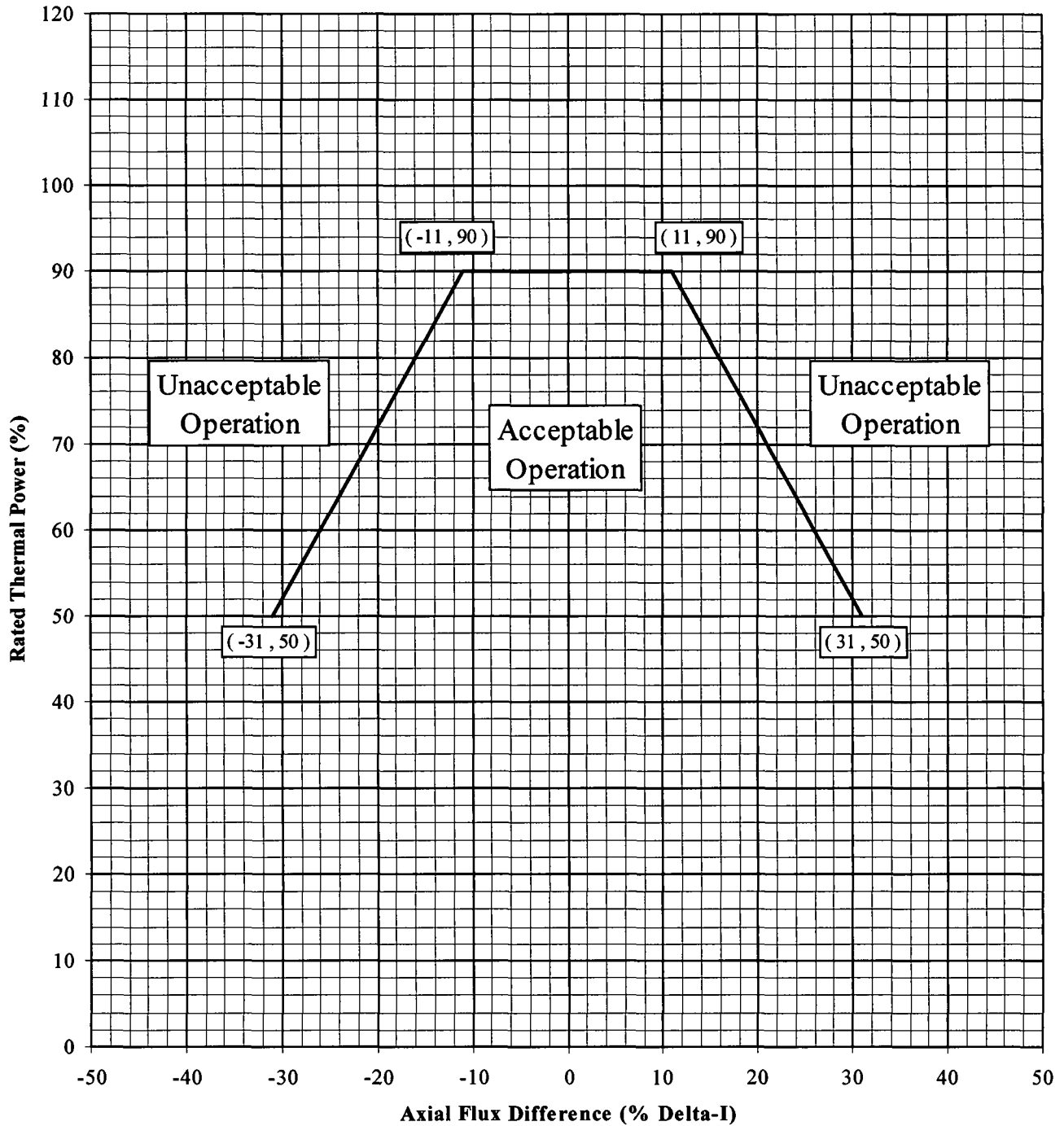
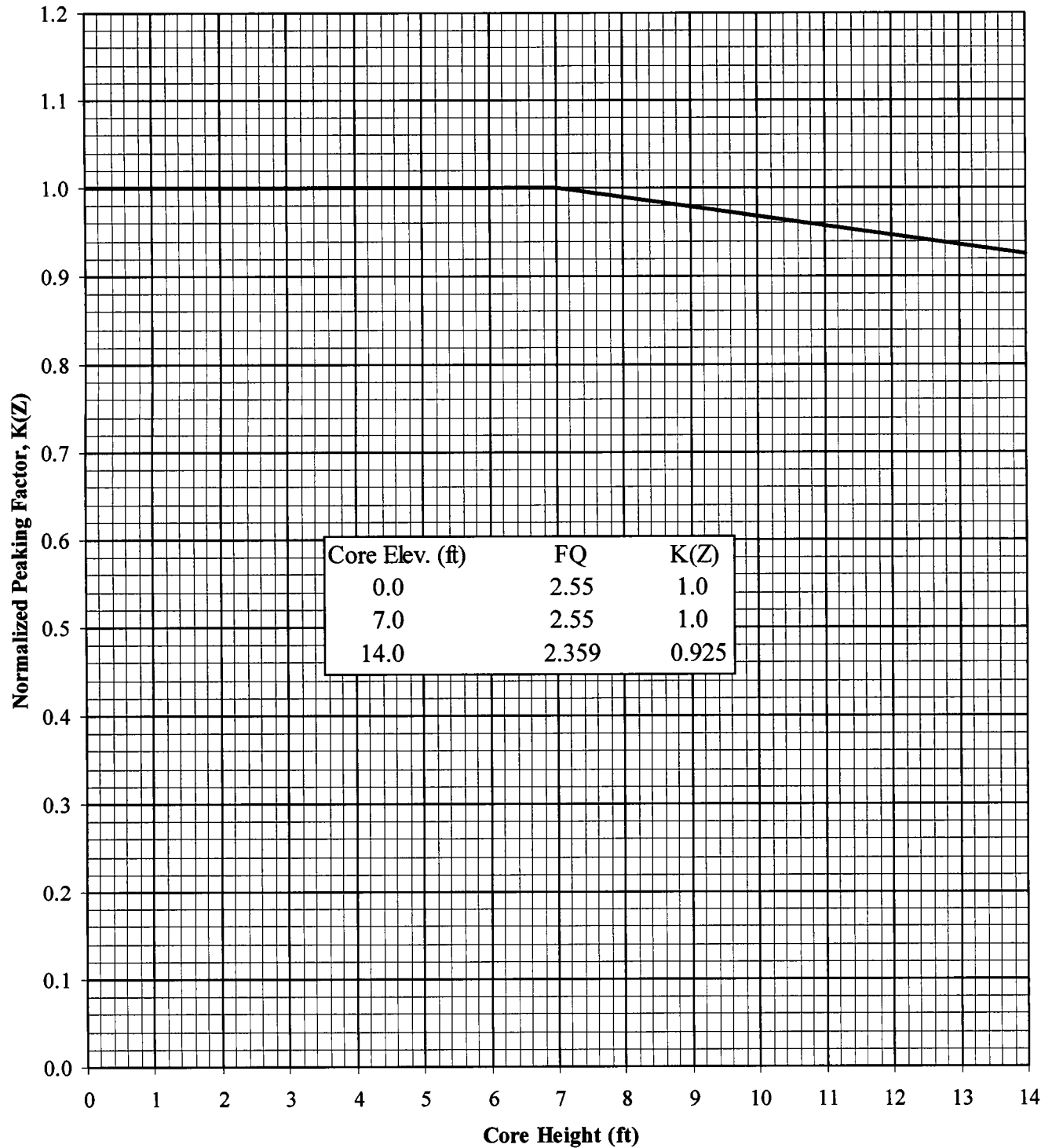


Figure 7

K(Z) - Normalized FQ(Z) versus Core Height



**Table 1 (Part 1 of 2)
Unrodded F_{xy} for Each Core Height
for Cycle Burnups Less Than 10000 MWD/MTU**

Core Height (Ft.)	Axial Point	Unrodded F _{xy}	Core Height (Ft.)	Axial Point	Unrodded F _{xy}
14.0	1	4.337	6.8	37	1.957
13.8	2	3.807	6.6	38	1.953
13.6	3	3.277	6.4	39	1.947
13.4	4	2.747	6.2	40	1.943
13.2	5	2.420	6.0	41	1.942
13.0	6	2.157	5.8	42	1.941
12.8	7	2.122	5.6	43	1.942
12.6	8	2.078	5.4	44	1.945
12.4	9	2.042	5.2	45	1.950
12.2	10	2.006	5.0	46	1.955
12.0	11	1.982	4.8	47	1.962
11.8	12	1.965	4.6	48	1.965
11.6	13	1.956	4.4	49	1.963
11.4	14	1.945	4.2	50	1.959
11.2	15	1.931	4.0	51	1.955
11.0	16	1.914	3.8	52	1.951
10.8	17	1.904	3.6	53	1.948
10.6	18	1.898	3.4	54	1.950
10.4	19	1.894	3.2	55	1.948
10.2	20	1.898	3.0	56	1.946
10.0	21	1.906	2.8	57	1.945
9.8	22	1.916	2.6	58	1.942
9.6	23	1.925	2.4	59	1.940
9.4	24	1.935	2.2	60	1.941
9.2	25	1.943	2.0	61	1.934
9.0	26	1.950	1.8	62	1.920
8.8	27	1.958	1.6	63	1.903
8.6	28	1.967	1.4	64	1.913
8.4	29	1.986	1.2	65	1.911
8.2	30	2.007	1.0	66	1.934
8.0	31	2.022	0.8	67	2.156
7.8	32	2.028	0.6	68	2.571
7.6	33	2.012	0.4	69	3.082
7.4	34	1.998	0.2	70	3.593
7.2	35	1.982	0.0	71	4.105
7.0	36	1.967			

**Table 1 (Part 2 of 2)
Unrodded Fxy for Each Core Height
for Cycle Burnups Greater Than or Equal to 10000 MWD/MTU**

Core Height (Ft.)	Axial Point	Unrodded Fxy	Core Height (Ft.)	Axial Point	Unrodded Fxy
14.00	1	4.109	6.80	37	2.116
13.80	2	3.688	6.60	38	2.116
13.60	3	3.268	6.40	39	2.118
13.40	4	2.847	6.20	40	2.118
13.20	5	2.559	6.00	41	2.118
13.00	6	2.308	5.80	42	2.115
12.80	7	2.213	5.60	43	2.109
12.60	8	2.134	5.40	44	2.100
12.40	9	2.071	5.20	45	2.087
12.20	10	2.030	5.00	46	2.074
12.00	11	2.020	4.80	47	2.063
11.80	12	2.013	4.60	48	2.052
11.60	13	2.010	4.40	49	2.039
11.40	14	2.011	4.20	50	2.025
11.20	15	2.014	4.00	51	2.009
11.00	16	2.020	3.80	52	1.997
10.80	17	2.022	3.60	53	1.986
10.60	18	2.023	3.40	54	1.977
10.40	19	2.025	3.20	55	1.960
10.20	20	2.042	3.00	56	1.938
10.00	21	2.065	2.80	57	1.909
9.80	22	2.092	2.60	58	1.877
9.60	23	2.106	2.40	59	1.847
9.40	24	2.110	2.20	60	1.818
9.20	25	2.109	2.00	61	1.806
9.00	26	2.103	1.80	62	1.799
8.80	27	2.099	1.60	63	1.798
8.60	28	2.096	1.40	64	1.809
8.40	29	2.095	1.20	65	1.851
8.20	30	2.095	1.00	66	1.927
8.00	31	2.096	0.80	67	2.085
7.80	32	2.100	0.60	68	2.333
7.60	33	2.106	0.40	69	2.626
7.40	34	2.111	0.20	70	2.919
7.20	35	2.114	0.00	71	3.212
7.00	36	2.115			