Progress Energy

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U. S. Nuclear Regulatory Commission
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SHEARON HARRIS NUCLEAR POWER PLANT, UNIT NO. 1
DOCKET NO. 50-400/LICENSE NO. NPF-63
CYCLE 12 CORE OPERATING LIMITS REPORT

Ladies and Gentlemen:

In accordance with Technical Specifications (TS) 6.9.1.6.4, Progress Energy Carolinas, Inc. hereby submits the Harris Nuclear Plant (HNP) Cycle 12 Core Operating Limits Report (COLR). This COLR revision incorporates: (1) changes necessary as a result of Cycle 12 core changes, and (2) changes required to update the COLR methodology references as a result of License Amendment 114.

Attachment 1 provides a summary of the COLR changes. Attachment 2 contains a copy of the Cycle 12 COLR.

Please refer any questions regarding this submittal to myself at (919) 362-3137.

Sincerely,

John R. Caves
Supervisor Licensing / Regulatory Programs
Harris Nuclear Plant

RTG/rtg

Attachments:
1. Summary of Cycle 12 COLR Changes
2. Copy of the Cycle 12 COLR

c: NRC Senior Resident Inspector
Mr. C. P. Patel, NRC Project Manager
Mr. L. A. Reyes, NRC Regional Administrator

A001

Progress Energy Carolinas, Inc.
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SUMMARY OF CYCLE 12 COLR REVISIONS

Section	Description of Change	Reason for Change (see Notes)
Title	Revised title throughout Attachment 9 from Cycle 11 to Cycle 12	1
1.0	Revised from Cycle 11 to Cycle 12	1
2.2	Item 2: Change -42.7 pcm/°F to -42.6 pcm/°F	1
2.3	Changed fully withdrawn rod position from 231 to 225	1
2.4	Changed fully withdrawn rod position from 231 to 225	1
2.6	Placed items in outline format and added the words "The $F_Q(Z)$ Limit as referenced in TS 3.2.2 is:" to item 1 • re-outlined items a., b. and c., • moved previous item c. to under new Item 2., • deleted words "for SPC fuel" from item b., • changed new Item 2 value from 20520 MWD/MTU to 20936 MWD/MTU	1
2.7	Deleted words "for SPC fuel" from items b. and c.	1
2.8	Changed boron concentration from 2202 to 2261	1
3.0.2	Changed "April" to "May" at end of first paragraph	2
3.0.3	Added ", September 1983" to end of first paragraph	2
3.0.9	Added ", February 1994" to end of first paragraph	2
3.0.10	Added ", March 1994" to end of first paragraph	2
3.0.11	Revised first paragraph to add dates for the 2 documents listed	2

3.0.13 (New)	Added methodology EMF-2328 (A)	2
3.0.14 (New)	Created new Mechanical Methodologies section with methodologies from page 73 section 3.0.6. Moved items between pages 73 and 74 to accommodate changes. Added ", and Letter, R. A. Copeland (SPC) to R. C. Jones (USNRC), RAC: 050: 91, dated May 13, 1992" to fifth paragraph	2
Figure 1	Changed Figure 1 to reflect the new Cycle 12 information	1
Figure 2	Changed Figure 2 to reflect the new rod park position of 225 steps for Cycle 12	1
Figure 4	Changed Figure 4 to reflect the new Cycle 12 information	1
Figure 5	Changed Figure 5 to reflect the V(Z) curve for Cycle 12 operation up to 16000 MWD/MTU	1
Figure 6	Changed Figure 6 to reflect the V(Z) curve for Cycle 12 operation for burnups from 16000 MWD/MTU through 20936 MWD/MTU	1

Notes:

1. Revised for Cycle 12 operation.
2. Revised per License Amendment 114 concerning COLR methodology references.

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Attachment 9 to HNP Procedure PLP-106,
"Technical Specification Equipment List Program and
Core Operating Limits Report," Rev. 32

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1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Shearon Harris Unit 1 Cycle 12 has been prepared in accordance with the requirements of Technical Specification 6.9.1.6.

The Technical Specifications affected by this report are listed below:

3/4.1.1.2	SHUTDOWN MARGIN - Modes 3, 4, and 5
3/4.1.1.3	Moderator Temperature Coefficient
3/4.1.3.5	Shutdown Rod Insertion Limit
3/4.1.3.6	Control Rod Insertion Limits
3/4.2.1	Axial Flux Difference
3/4.2.2	Heat Flux Hot Channel Factor - $F_Q(Z)$
3/4.2.3	Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}$
3/4.9.1.a	Boron Concentration During Refueling Operations

2.0 OPERATING LIMITS

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using NRC-approved methodologies specified in Technical Specification 6.9.1.6 and given in Section 3.0.

2.1 SHUTDOWN MARGIN - Modes 3, 4, and 5 (Specification 3/4.1.1.2)

The SHUTDOWN MARGIN versus RCS boron concentration - Modes 3, 4, and 5 is specified in Figure 1.

2.2 Moderator Temperature Coefficient (Specification 3/4.1.1.3)

1. The Moderator Temperature Coefficient (MTC) limits are:

   The Positive MTC Limit (ARO/HZP) shall be less positive than +5.0 pcm/°F for power levels up to 70% RTP with a linear ramp to 0 pcm/°F at 100% RTP.

   The Negative MTC Limit (ARO/RTP) shall be less negative than -50 pcm/°F.

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2.2 Moderator Temperature Coefficient (Specification 3/4.1.1.3) (continued)

2. The MTC Surveillance limit is:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -42.6 pcm/°F.

where: ARO stands for All Rods Out
HZP stands for Hot Zero THERMAL POWER
RTP stands for RATED THERMAL POWER

2.3 Shutdown Rod Insertion Limit (Specification 3/4.1.3.5)

Fully withdrawn for all shutdown rods shall be 225 steps.

2.4 Control Rod Insertion Limit (Specification 3/4.1.3.6)

The control rod banks shall be limited in physical insertion as specified in Figure 2. Fully withdrawn for all control rods shall be 225 steps.

2.5 Axial Flux Difference (Specification 3/4.2.1)

The AXIAL FLUX DIFFERENCE (AFD) target band is specified in Figure 3.

2.6 Heat Flux Hot Channel Factor - $F_Q(Z)$ (Specification 3/4.2.2)

1. The $F_Q(Z)$ Limit as referenced in TS 3.2.2 is:

$F_Q(Z) \leq F_Q^{RTP} * K(Z)/P$ for $P > 0.5$

$F_Q(Z) \leq F_Q^{RTP} * K(Z)/0.5$ for $P \leq 0.5$

where:

a. P = THERMAL POWER/RATED THERMAL POWER

b. $F_Q^{RTP} = 2.41$

c. K(Z) = the normalized $F_Q(Z)$ as a function of core height, as specified in Figure 4.

2. V(Z) Curves versus core height for PDC-3 Operation, as used in T.S. 4.2.2, are specified in Figures 5 and 6. The first V(Z) curve (Figure 5) is valid for Cycle 12 burnups from 0 up to but not including 16000 MWD/MTU. The second V(Z) curve (Figure 6) is valid for Cycle 12 burnups greater than or equal to 16000 MWD/MTU to a maximum cycle energy of 20936 MWD/MTU.

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2.7 <u>Nuclear Enthalpy Rise Hot Channel Factor</u> - $F_{\Delta H}$ (Specification 3/4.2.3)

$F_{\Delta H} \leq F_{\Delta H}^{RTP} * (1 + PF_{\Delta H} * (1 - P))$

where:

a. P = THERMAL POWER/RATED THERMAL POWER

b. $F_{\Delta H}^{RTP}$ = $F_{\Delta H}$ Limit at RATED THERMAL POWER = 1.66

c. $PF_{\Delta H}$ = Power Factor Multiplier for $F_{\Delta H}$ = 0.35

$F_{\Delta H}$ = Enthalpy rise hot channel factor obtained by using the movable incore detectors to obtain a power distribution map, with the measured value of the nuclear enthalpy rise hot channel factor ($F_{\Delta H}^{N}$) increased by an allowance of 4% to account for measurement uncertainty.

2.8 <u>Boron Concentration for Refueling Operations</u> (Specification 3/4.9.1.a)

Through the end of Cycle 12, the boron concentration required to maintain K_{eff} less than or equal to .95 is equal to 2261 ppm. Boron concentration must be maintained greater than or equal to 2261 ppm during refueling operations.

3.0 <u>METHODOLOGY REFERENCES</u>

1. XN-75-27(A), and Supplements 1, 2, 3, 4, and 5, "Exxon Nuclear Neutronics Design Methods for Pressurized Water Reactors," Exxon Nuclear Company, Richland, WA 99352.

   (Methodology for Specification 3.1.1.2 - SHUTDOWN MARGIN - Modes 3, 4, and 5, 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown Bank Insertion Limits, 3.1.3.6 - Control Bank Insertion Limits, 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor, and 3.9.1 - Boron Concentration).

2. ANF-89-151(A), and Correspondence, "ANF-RELAP Methodology for Pressurized Water Reactors: Analysis of Non-LOCA Chapter 15 Events," Advanced Nuclear Fuels Corporation, Richland, WA 99352, May 1992.

   (Methodology for Specification 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown Bank Insertion Limits, 3.1.3.6 - Control Bank Insertion Limits, 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

3. XN-NF-82-21(A), Revision 1, "Application of Exxon Nuclear Company PWR Thermal Margin Methodology to Mixed Core Configurations," Exxon Nuclear Company, Richland, WA 99352, September 1983.

   (Methodology for Specification 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

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3.0 METHODOLOGY REFERENCES (continued)

4. XN-75-32(A), Supplements 1, 2, 3, and 4, "Computational Procedure for Evaluating Fuel Rod Bowing," Exxon Nuclear Company, Richland, WA 99352.

   (Methodology for Specification 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

5. EMF-84-093(A), Revision 1, "Steamline Break Methodology for PWRs," Siemens Power Corporation, February 1999.

   (Methodology for Specification 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown Bank Insertion Limits, 3.1.3.6 - Control Bank Insertion Limits, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

6. EMF-2087(A), Revision 0, "SEM/PWR-98: ECCS Evaluation Model for PWR LBLOCA Applications," Siemens Power Corporation, June 1999.

   (Methodology for Specification 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

7. XN-NF-78-44(A), "A Generic Analysis of the Control Rod Ejection Transient for Pressurized Water Reactors," Exxon Nuclear Company, Richland, WA 99352, October 1983.

   (Methodology for Specification 3.1.3.5 - Shutdown Bank Insertion Limits, 3.1.3.6 - Control Bank Insertion Limits, and 3.2.2 - Heat Flux Hot Channel Factor).

8. ANF-88-054(A), "PDC-3: Advanced Nuclear Fuels Corporation Power Distribution Control for Pressurized Water Reactors and Application of PDC-3 to H. B. Robinson Unit 2," Advanced Nuclear Fuels Corporation, Richland, WA 99352, October 1990.

   (Methodology for Specification 3.2.1 - Axial Flux Difference, and 3.2.2 - Heat Flux Hot Channel Factor).

9. EMF-92-081(A), and Supplement 1, "Statistical Setpoint/Transient Methodology for Westinghouse Type Reactors," Siemens Power Corporation, Richland, WA 99352, February 1994.

   (Methodology for Specification 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown Bank Insertion Limits, 3.1.3.6 - Control Bank Insertion Limits, 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

10. EMF-92-153(A), and Supplement 1, "HTP: Departure from Nucleate Boiling Correlation for High Thermal Performance Fuel," Siemens Nuclear Power Corporation, Richland, WA 99352, March 1994.

   (Methodology for Specification 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

11. XN-NF-82-49(A), Revision 1, April 1989 and XN-NF-82-49(P), Revision 1, Supplement 1, December 1994, "Exxon Nuclear Company Evaluation Model EXEM PWR Small Break Model," Exxon Nuclear Company, Richland, WA 99352.

   (Methodology for Specification 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

3.0 METHODOLOGY REFERENCES (continued)

12. EMF-96-029(A), Volumes 1 and 2, "Reactor Analysis Systems for PWRs, Volume 1 - Methodology Description, Volume 2 - Benchmarking Results," Siemens Power Corporation, January 1997.

(Methodology for Specification 3.1.1.2 - SHUTDOWN MARGIN - Modes 3, 4, and 5, 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown Bank Insertion Limits, 3.1.3.6 - Control Bank Insertion Limits, 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor, and 3.9.1 - Boron Concentration).

13. EMF-2328 (A), Revision 0, "PWR Small Break LOCA Evaluation Model, S-RELAP5 Based," Siemens Power Corporation, March 2001

(Methodology for Specification 3.2.1 - Axial Flux Difference, and 3.2.2 - Heat Flux Hot Channel Factor), and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

14. Mechanical Design Methodologies

XN-NF-81-58(A), Revision 2 and Supplements 1 and 2, "RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model," Exxon Nuclear Company, March 1984.

ANF-81-58(A), Revision 2 and Supplements 3 and 4, "RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model," Advanced Nuclear Fuels Corporation, June 1990.

XN-NF-82-06(A), Revision 1 and Supplements 2, 4, and 5, "Qualification of Exxon Nuclear Fuel for Extended Burnup (PWR)," Exxon Nuclear Company, October 1986.

ANF-88-133(A), and Supplement 1, "Qualification of Advanced Nuclear Fuels' PWR Design Methodology for Rod Burnups of 62 GWd/MTU," Advanced Nuclear Fuels Corporation, December 1991.

XN-NF-85-92(A), "Exxon Nuclear Uranium Dioxide/Gadolinia Irradiation Examination and Thermal Conductivity Results," Exxon Nuclear Company, November 1986, and letter, R. A. Copeland (SPC) to R. C. Jones (USNRC), RAC: 050: 91, dated May 13, 1992.

EMF-92-116(A), Revision 0, "Generic Mechanical Design Criteria for PWR Fuel Designs," Siemens Power Corporation, February 1999.

(Methodologies for Specification 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor).

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4.0 OTHER REQUIREMENTS

4.1 Movable Incore Detection System

1. Operability: The Movable Incore Detection System shall be OPERABLE with:

R a. At least 38 detector thimbles at the beginning of cycle (where the beginning of cycle is defined in this instance as a flux map determination that the core is loaded consistent with design),

b. A minimum of 38 detector thimbles for the remainder of the operating cycle,

c. A minimum of two detector thimbles per core quadrant, and

d. Sufficient movable detectors, drive, and readout equipment to map these thimbles.

2. Applicability: When the Movable Incore Detection System is used for:

a. Recalibration of the Excore Neutron Flux Detection System, or

b. Monitoring the QUADRANT POWER TILT RATIO, or

c. Measurement of $F_{\Delta H}$ and $F_Q(Z)$

3. Surveillance Requirements: The Movable Incore Detection System shall be demonstrated OPERABLE, within 24 hours prior to use, by irradiating each detector used and determining the acceptability of its voltage curve when required for:

a. Recalibration of the Excore Neutron Flux Detection System, or

b. Monitoring the QUADRANT POWER TILT RATIO, or

c. Measurement of $F_{\Delta H}$ and $F_Q(Z)$

4. Bases

The OPERABILITY of the movable incore detectors with the specified minimum complement of equipment ensures that the measurements obtained from use of this system accurately represent the spatial neutron flux distribution of the core. The OPERABILITY of this system is demonstrated by irradiating each detector used and determining the acceptability of its voltage curve.

For the purpose of measuring $F_Q(Z)$ or $F_{\Delta H}$, a full incore flux map is used.

Quarter-core flux maps, as defined in WCAP-8648, June 1976, may be used in recalibration of the Excore Neutron Flux Detection System, and full incore flux maps or symmetric incore thimbles may be used for monitoring QUADRANT POWER TILT RATIO when one Power Range channel is inoperable.

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4.0 OTHER REQUIREMENTS (continued)

R 5. Evaluation Requirements

In order to change the requirements concerning the number and location of operable detectors, the NRC staff deems that a rigorous evaluation and justification is required. The following is a list of elements that must be part of a 50.59 determination and available for audit if the licensee wishes to change the requirements:

a. How an inadvertent loading of a fuel assembly into an improper location will be detected,

b. How the validity of the tilt estimates will be ensured,

c. How adequate core coverage will be maintained,

d. How the measurement uncertainties will be assured and why the added uncertainties are adequate to guarantee that measured nuclear heat flux hot channel factor, nuclear enthalpy rise hot channel factor, radial peaking factor and quadrant power tilt factor meet Technical Specification limits, and

e. How the Movable Incore Detection System will be restored to full (or nearly full) service before the beginning of each cycle.

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Figure 1

Shutdown Margin Versus RCS Boron Concentration
Modes 3, 4, and 5/Drained

* Applicable to Mode 4, with or without RCPs in operation

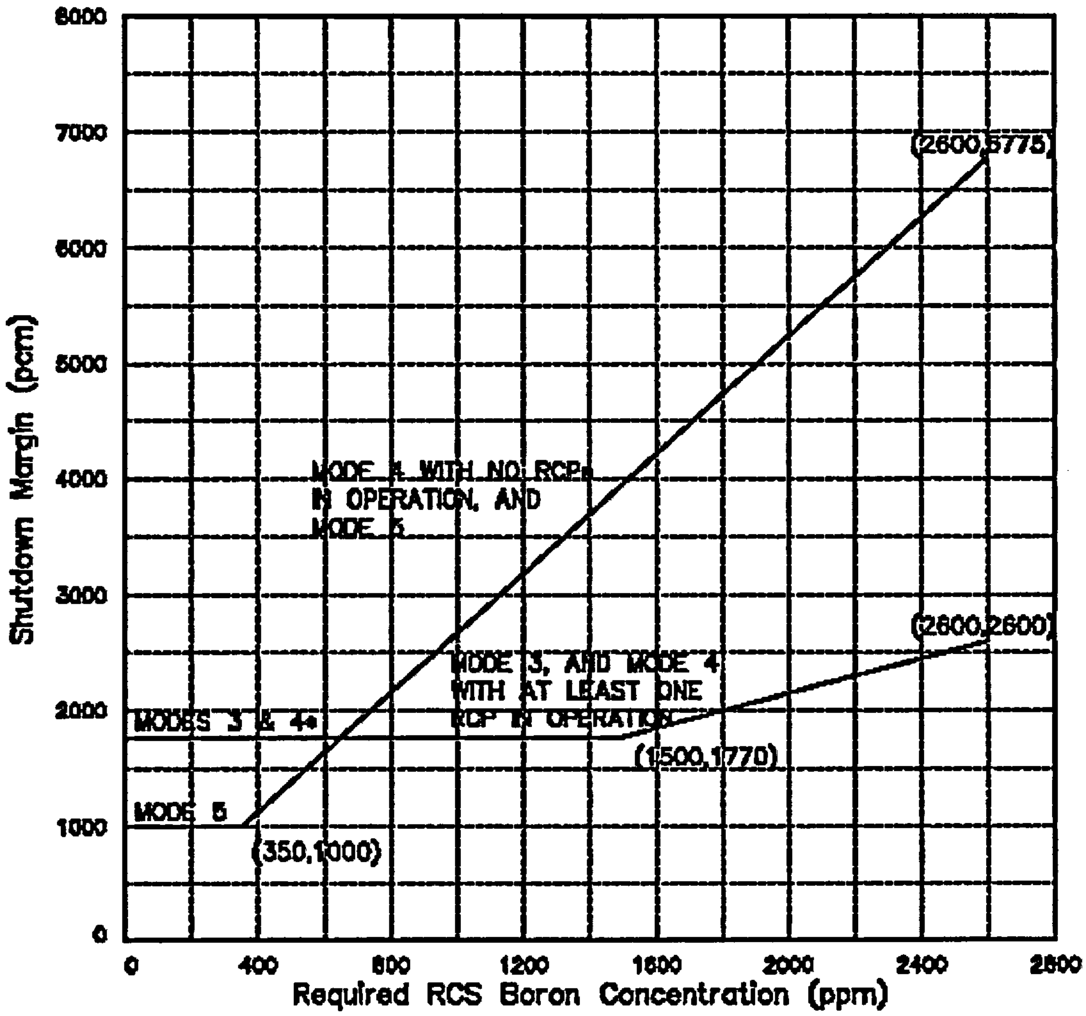

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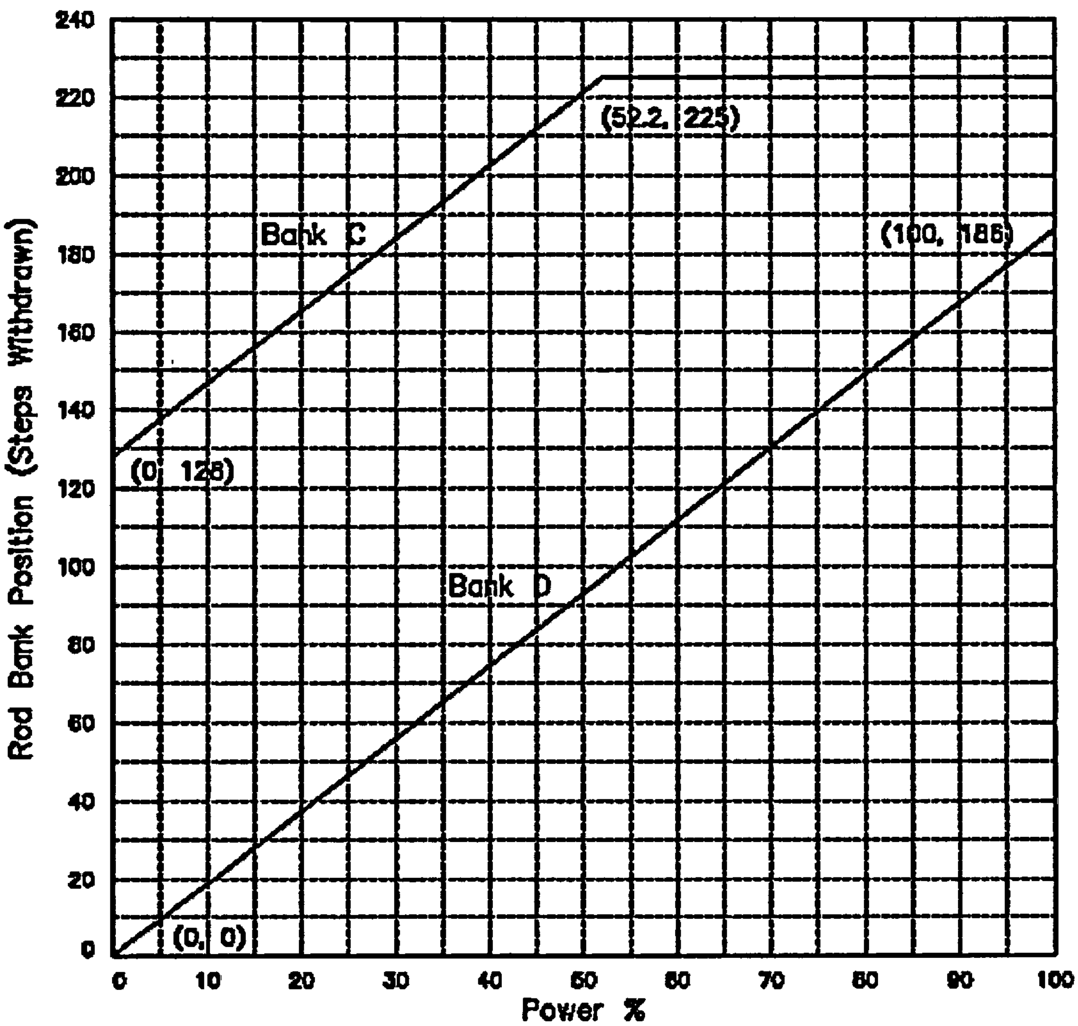
Figure 2

Rod Group Insertion Limits Versus Thermal Power
(Three-Loop Operation)



(Fully withdrawn shal be 225 steps)

Note: Control Banks A and B must be withdrawn from the core prior to power operation

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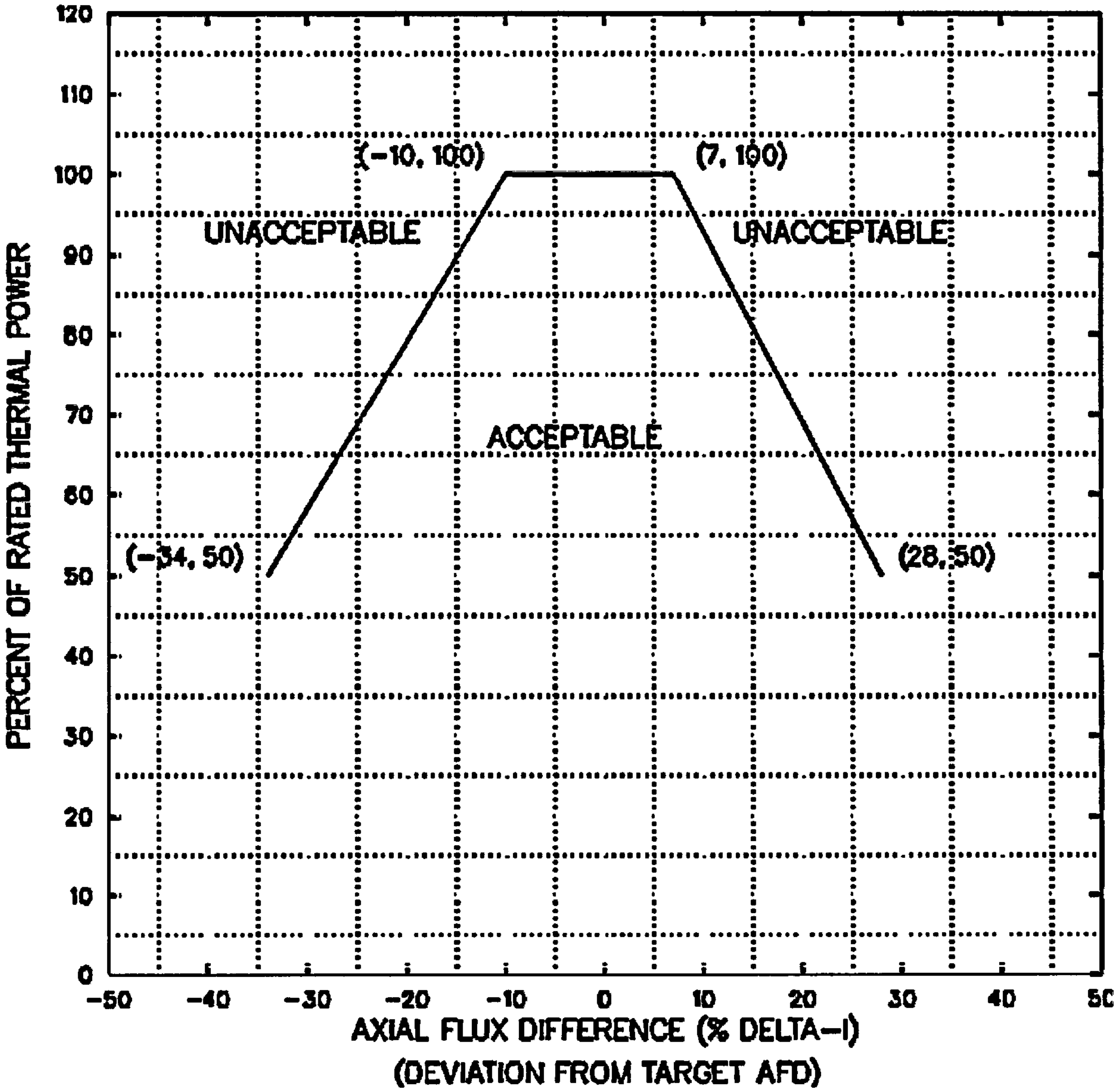
Figure 3

Axial Flux Difference Limits as a Function of Rated Thermal Power



Note: At power levels less than HFP, the deviation is applied to the target AFD appropriate to that power level. The target AFD varies linearly between the HFP target and zero at zero power.

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Figure 4

K(Z) - Local Axial Penalty Function for FQ(Z)

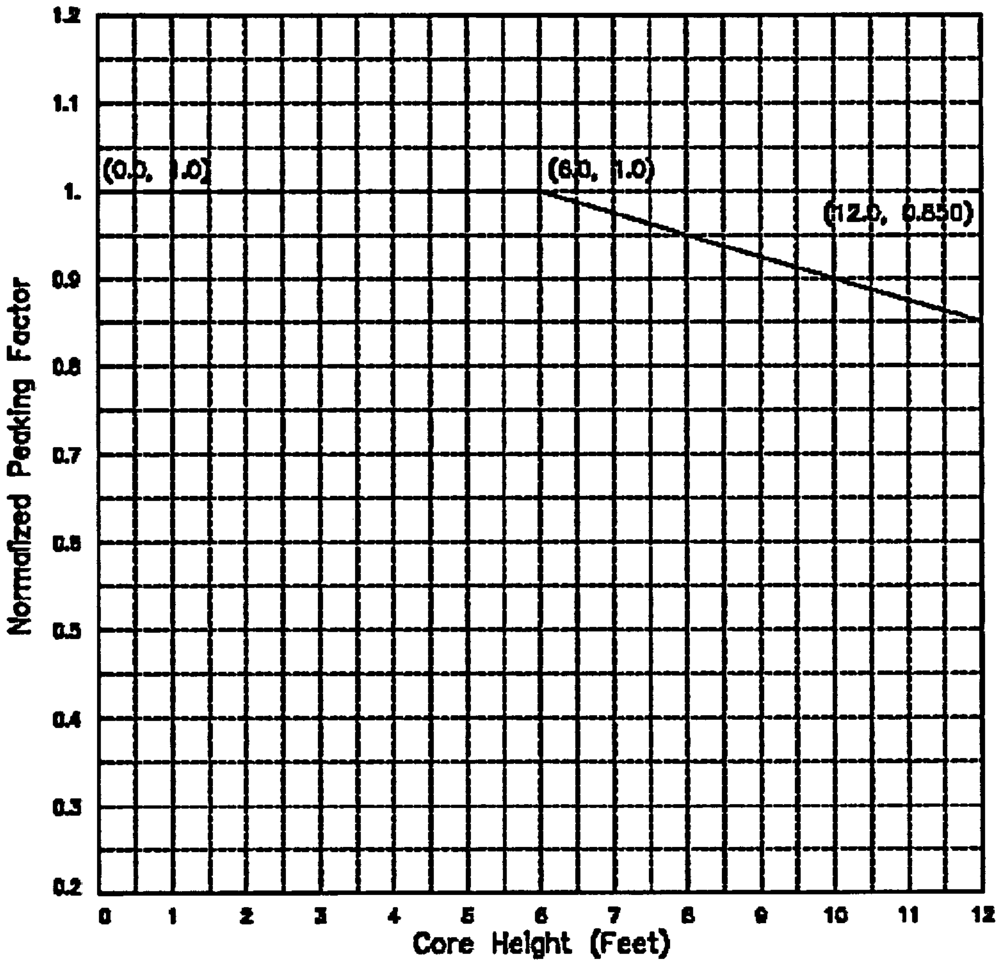

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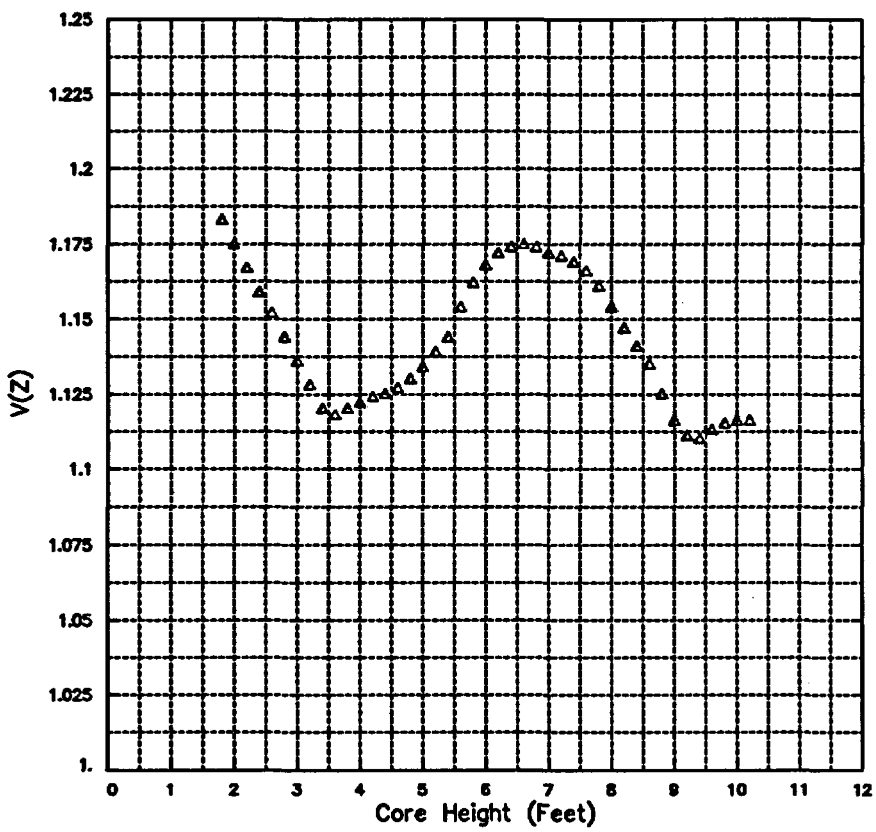
Figure 5
V(Z) Versus Core Height



Height (Feet)	V(Z)
*0.000	1.000
*0.200	1.000
*0.400	1.000
*0.600	1.000
*0.800	1.000
*1.000	1.000
*1.200	1.000
*1.400	1.000
*1.600	1.000
1.800	1.183
2.000	1.175
2.200	1.167
2.400	1.159
2.600	1.152
2.800	1.144
3.000	1.136
3.200	1.128
3.400	1.120
3.600	1.118
3.800	1.120
4.000	1.122
4.200	1.124
4.400	1.125
4.600	1.127
4.800	1.130
5.000	1.134
5.200	1.139
5.400	1.144
5.600	1.154
5.800	1.162
6.000	1.168
6.200	1.172
6.400	1.174
6.600	1.175
6.800	1.174
7.000	1.172
7.200	1.171
7.400	1.169
7.600	1.166
7.800	1.161
8.000	1.154
8.200	1.147
8.400	1.141
8.600	1.135
8.800	1.125
9.000	1.116
9.200	1.111
9.400	1.110
9.600	1.113
9.800	1.115
10.000	1.116
10.200	1.116
*10.400	1.000
*10.600	1.000
*10.800	1.000
*11.000	1.000
*11.200	1.000
*11.400	1.000
*11.600	1.000
*11.800	1.000
*12.000	1.000

- Top and bottom 15% excluded as per Technical Specification 4.2.2.2.
- (Figure 5) is valid for Cycle 12 burnups from 0 up to but not including 16000 MWD/MTU.

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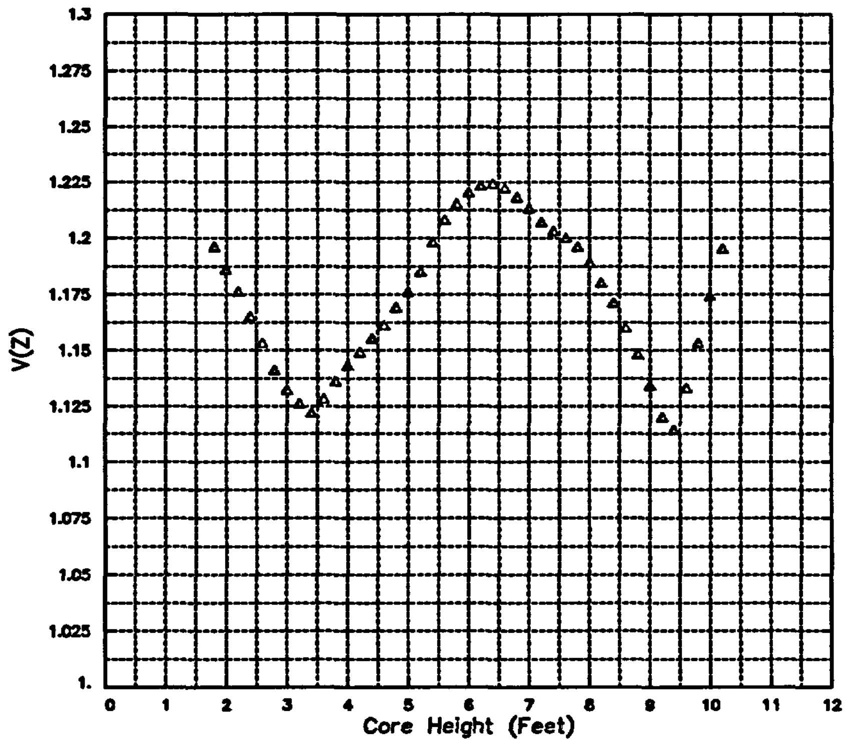
Figure 6
V(Z) Versus Core Height



Height (Feet)	V(Z)
*0.000	1.000
*0.200	1.000
*0.400	1.000
*0.600	1.000
*0.800	1.000
*1.000	1.000
*1.200	1.000
*1.400	1.000
*1.600	1.000
1.800	1.196
2.000	1.186
2.200	1.176
2.400	1.165
2.600	1.153
2.800	1.141
3.000	1.132
3.200	1.126
3.400	1.122
3.600	1.128
3.800	1.136
4.000	1.143
4.200	1.149
4.400	1.155
4.600	1.161
4.800	1.169
5.000	1.176
5.200	1.185
5.400	1.198
5.600	1.208
5.800	1.215
6.000	1.220
6.200	1.223
6.400	1.224
6.600	1.222
6.800	1.218
7.000	1.213
7.200	1.207
7.400	1.203
7.600	1.200
7.800	1.196
8.000	1.189
8.200	1.180
8.400	1.171
8.600	1.160
8.800	1.148
9.000	1.134
9.200	1.120
9.400	1.114
9.600	1.133
9.800	1.153
10.000	1.174
10.200	1.195
*10.400	1.000
*10.600	1.000
*10.800	1.000
*11.000	1.000
*11.200	1.000
*11.400	1.000
*11.600	1.000
*11.800	1.000
*12.000	1.000

- Top and bottom 15% excluded as per Technical Specification 4.2.2.2.
- (Figure 6) is valid for Cycle 12 burnups greater than or equal to 16000 MWD/MTU to a maximum cycle energy of 20936 MWD/MTU.