Harris Unit 1 Cycle 6
Core Operating Limits Report - Rev. 2
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Shearon Harris Unit 1 Cycle 6
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1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Shearon Harris Unit 1 Cycle 6 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:

3/4.1.1.3	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 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 -45 pcm/°F.

2. The MTC Surveillance limit is:

   The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -37.4 pcm/°F.

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

2.2 Shutdown Rod Insertion Limit (Specification 3/4.1.3.5)

Fully withdrawn for all shutdown rods shall be 231 steps.

2.3 Control Rod Insertion Limit (Specification 3/4.1.3.6)

The control rod banks shall be limited in physical insertion as specified in Figure 1. Fully withdrawn for all control rods shall be 231 steps.

2.4 Axial Flux Difference (Specification 3/4.2.1)

The AXIAL FLUX DIFFERENCE (AFD) target band is specified in Figure 2.

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

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

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

where: P = THERMAL POWER/RATED THERMAL POWER

a. F_Q^{RTP} = 2.45 for LOPAR and VANTAGE 5 fuel

b. F_Q^{RTP} = 2.52 for SPC fuel

c. K(Z) is specified in Figure 3.

d. V(Z) Curve for PDC-3 Operation is specified in Figure 4. The V(z) curve is sufficient to determine the PDC-3 V(z) versus core height for Cycle 6 burnups through the end of full power reactivity plus a coastdown for a maximum cycle energy of 461 EFPDs.

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

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

where: P = THERMAL POWER/RATED THERMAL POWER

a. $F_{\Delta H}^{RTP}$ = 1.62 for LOPAR fuel

b. $F_{\Delta H}^{RTP}$ = 1.65 for VANTAGE 5 fuel

c. $F_{\Delta H}^{RTP}$ = 1.73 for SPC fuel

d. $PF_{\Delta H}$ = 0.3 for LOPAR fuel

e. $PF_{\Delta H}$ = 0.35 for VANTAGE 5 and SPC fuel

2.7 Boron Concentration for Refueling Operations (Specification 3/4.9.1.a)

Through the end of Cycle 6, the boron concentration required to maintain K_{eff} less than or equal to .95 is less restrictive than the 2000 ppm boron requirement. Boron concentration must be maintained greater than or equal to 2000 ppm during refueling operations.

3.0 METHODOLOGY REFERENCES

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 3.1.1.3 - 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.

   (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.

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

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. XN-NF-84-93(A), and Supplement 1, "Steamline Break Methodology for PWRs," Exxon Nuclear Company, Richland, WA 99352.

   (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).

3.0 METHODOLOGY REFERENCES (continued)

6. EXEM PWR Large Break LOCA Evaluation Model as defined by:

   XN-NF-82-20(A), Revision 1 and Supplements 1, 2, 3, and 4, "Exxon Nuclear Company Evaluation Model EXEM/PWR ECCS Model Updates," Exxon Nuclear Company, Richland, WA 99352.

   XN-NF-82-07(A), Revision 1, "Exxon Nuclear Company ECCS Cladding Swelling and Rupture Model," Exxon Nuclear Company, Richland, WA 99352.

   XN-NF-81-58(A), Revision 2 and Supplements 1, 2, 3, and 4, "RODEX2 Fuel Rod Thermal Response Evaluation Model," Exxon Nuclear Company, Richland, WA 99352.

   XN-NF-85-16(A), Volume 1 and Supplements 1, 2, and 3, Volume 2, Revision 1 and Supplement 1, "PWR 17x17 Fuel Cooling Test Program," Exxon Nuclear Company, Richland, WA 99352.

   XN-NF-85-105(A), and Supplement 1, "Scaling of FCTF Based Reflood Heat Transfer Correlation for Other Bundle Designs," 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).

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.

   (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).

3.0 METHODOLOGY REFERENCES (continued)

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.

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

9. WCAP-9272-P-A, "WESTINGHOUSE RELOAD SAFETY EVALUATION METHODOLOGY", July 1985 (W Proprietary).

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

10. WCAP-10266-P-A, Rev. 2, "The 1981 Version of the WESTINGHOUSE ECCS EVALUATION MODEL USING THE BASH CODE", March 1987 (W Proprietary).

(Methodology for Specification 3.2.2 - Heat Flux Hot Channel Factor).

11. WCAP-11837-P-A, "EXTENSION OF METHODOLOGY FOR CALCULATING TRANSITION CORE DNBR PENALTIES", January 1990 (W Proprietary).

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

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

(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).

13. 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.

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

3.0 METHODOLOGY REFERENCES (Continued)

14. XN-NF-82-49(A), Revision 1, and XN-NF-82-49(P), Revision 1, Supplement 1, "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).

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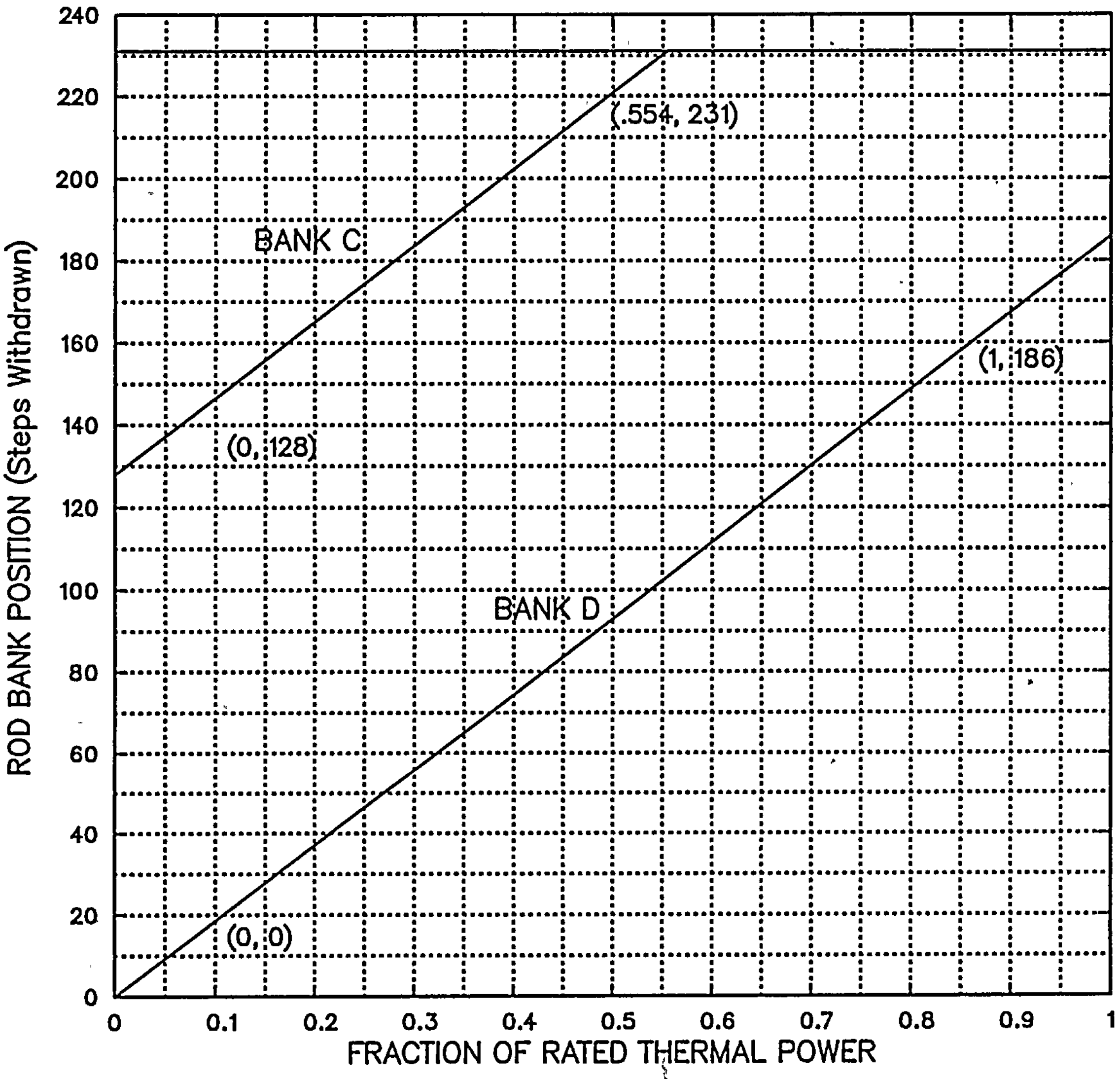
FIGURE 1
ROD GROUP INSERTION LIMITS VERSUS THERMAL POWER
(THREE–LOOP OPERATION)



(Fully withdrawn shall be 231 steps)

Note: Control Banks A and B Must be Withdrawn From The Core Prior to Power Operation

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FIGURE 2
AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF
RATED THERMAL POWER

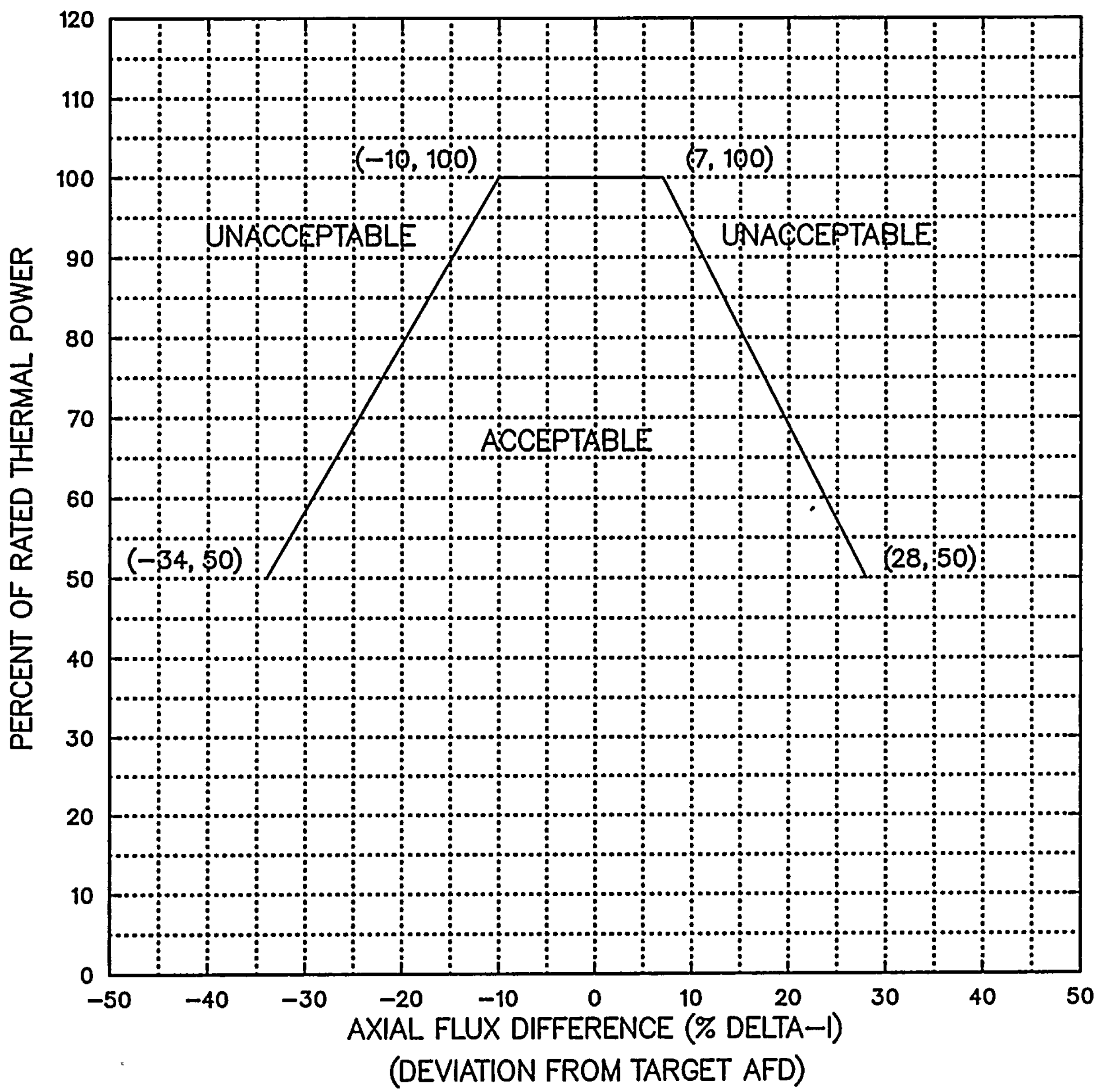

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FIGURE 3
K(Z) — LOCAL AXIAL PENALTY FUNCTION FOR FQ(Z)

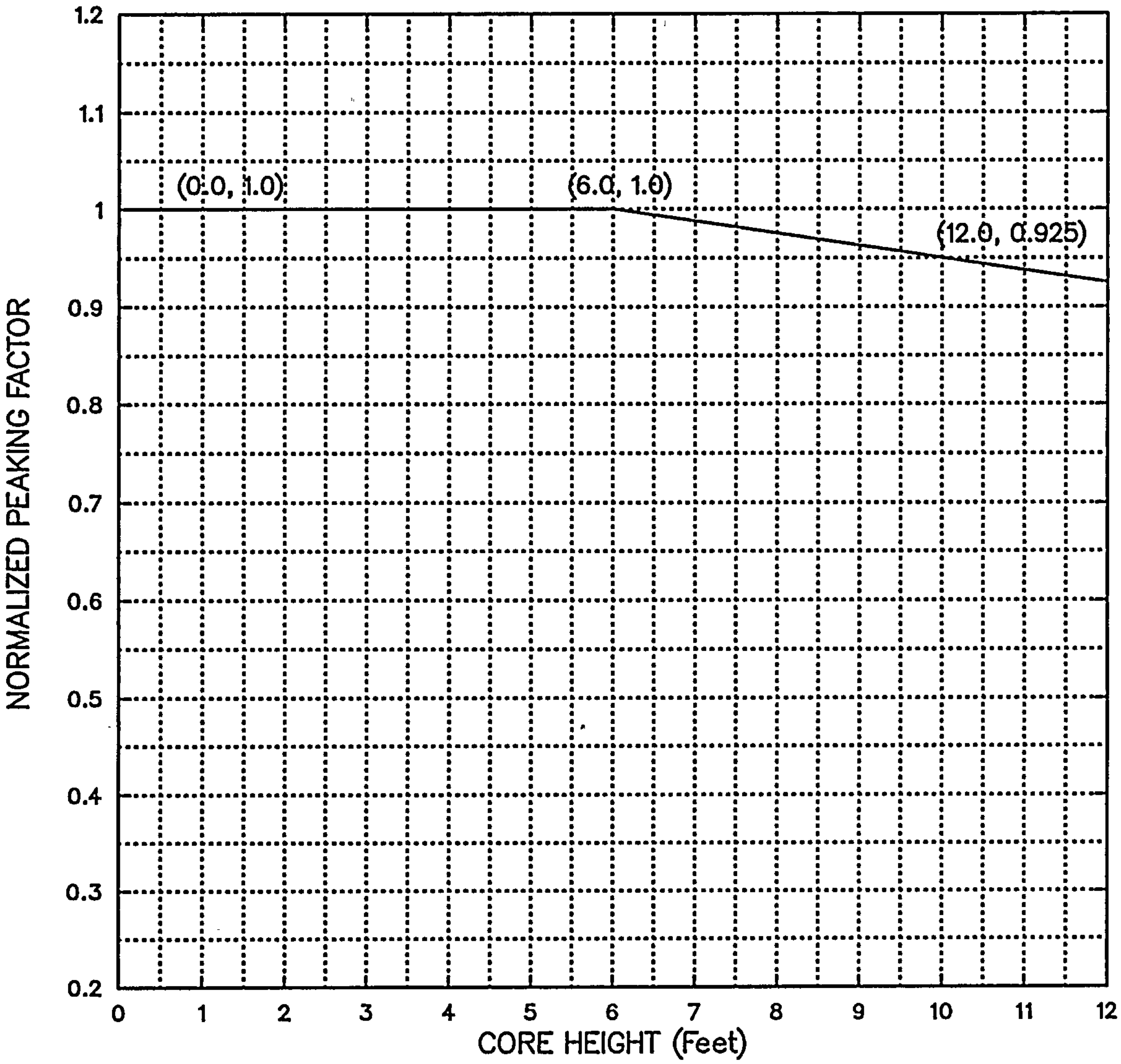

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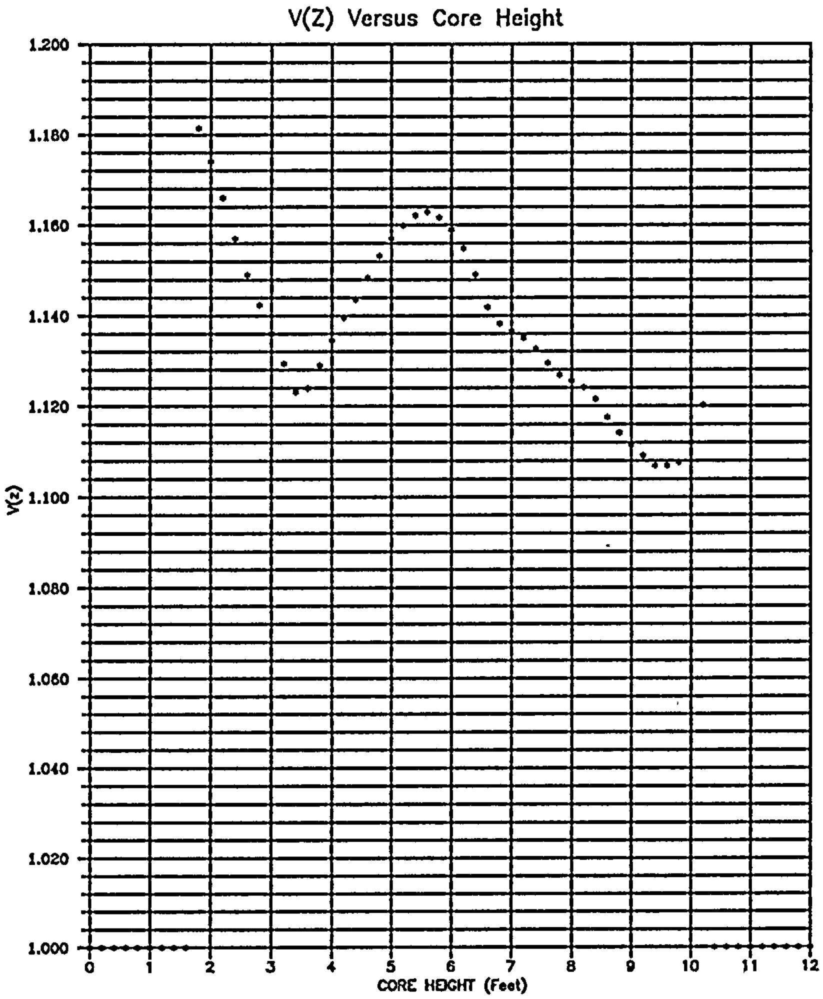
Figure 4



Ht.	V(Z)	Ht.	V(Z)
0.0	1.0000	6.2	1.1549
0.2	1.0000	6.4	1.1491
0.4	1.0000	6.6	1.1419
0.6	1.0000	6.8	1.1382
0.8	1.0000	7.0	1.1365
1.0	1.0000	7.2	1.1351
1.2	1.0000	7.4	1.1326
1.4	1.0000	7.6	1.1294
1.6	1.0000	7.8	1.1269
1.8	1.1814	8.0	1.1255
2.0	1.1740	8.2	1.1241
2.2	1.1660	8.4	1.1215
2.4	1.1570	8.6	1.1175
2.6	1.1490	8.8	1.1142
2.8	1.1424	9.0	1.1115
3.0	1.1360	9.2	1.1091
3.2	1.1293	9.4	1.1070
3.4	1.1231	9.6	1.1070
3.6	1.1239	9.8	1.1077
3.8	1.1289	10.0	1.1120
4.0	1.1345	10.2	1.1202
4.2	1.1395	10.4	1.0000
4.4	1.1436	10.6	1.0000
4.6	1.1484	10.8	1.0000
4.8	1.1532	11.0	1.0000
5.0	1.1570	11.2	1.0000
5.2	1.1599	11.4	1.0000
5.4	1.1621	11.6	1.0000
5.6	1.1629	11.8	1.0000
5.8	1.1616	12.0	1.0000
6.0	1.1590		

* Note that the top and bottom 15% are excluded per Technical Specification 4.2.2.2.