

Shearon Harris Unit 1 Cycle 5
Core Operating Limits Report - Rev. 0

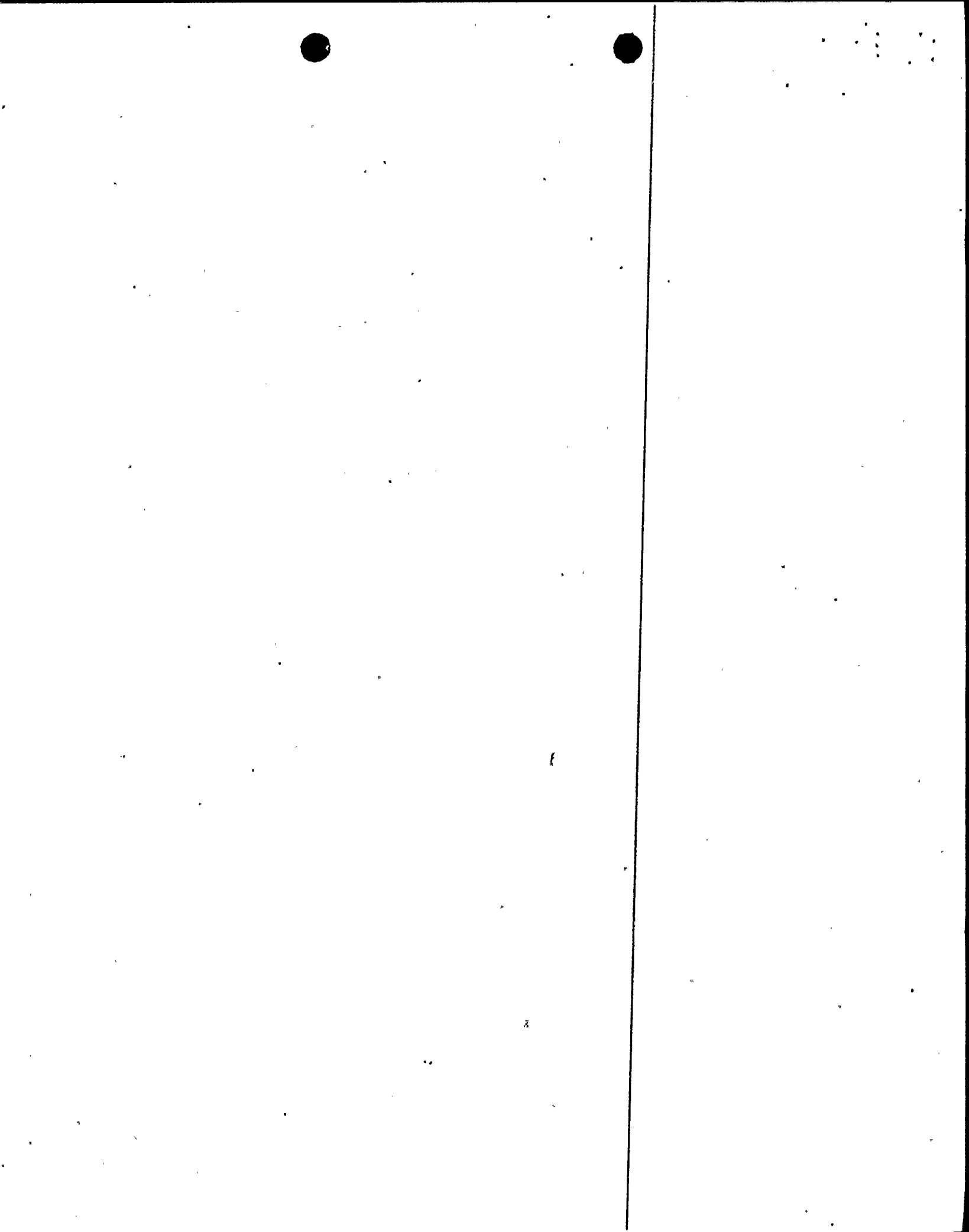
1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Shearon Harris Unit 1 Cycle 5 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 - $FQ^{(2)}$
3/4.2.3	Nuclear Enthalpy Rise Hot Channel Factor - $F_{\Delta H}$
3/4.9.1.a	Boron Concentration During Refueling Operations

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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 the 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 -49 pcm/°F.

2. The MTC Surveillance limit is:

The 300 ppm/ARO/RTP-MTC should be less negative than or equal to -41.5 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)

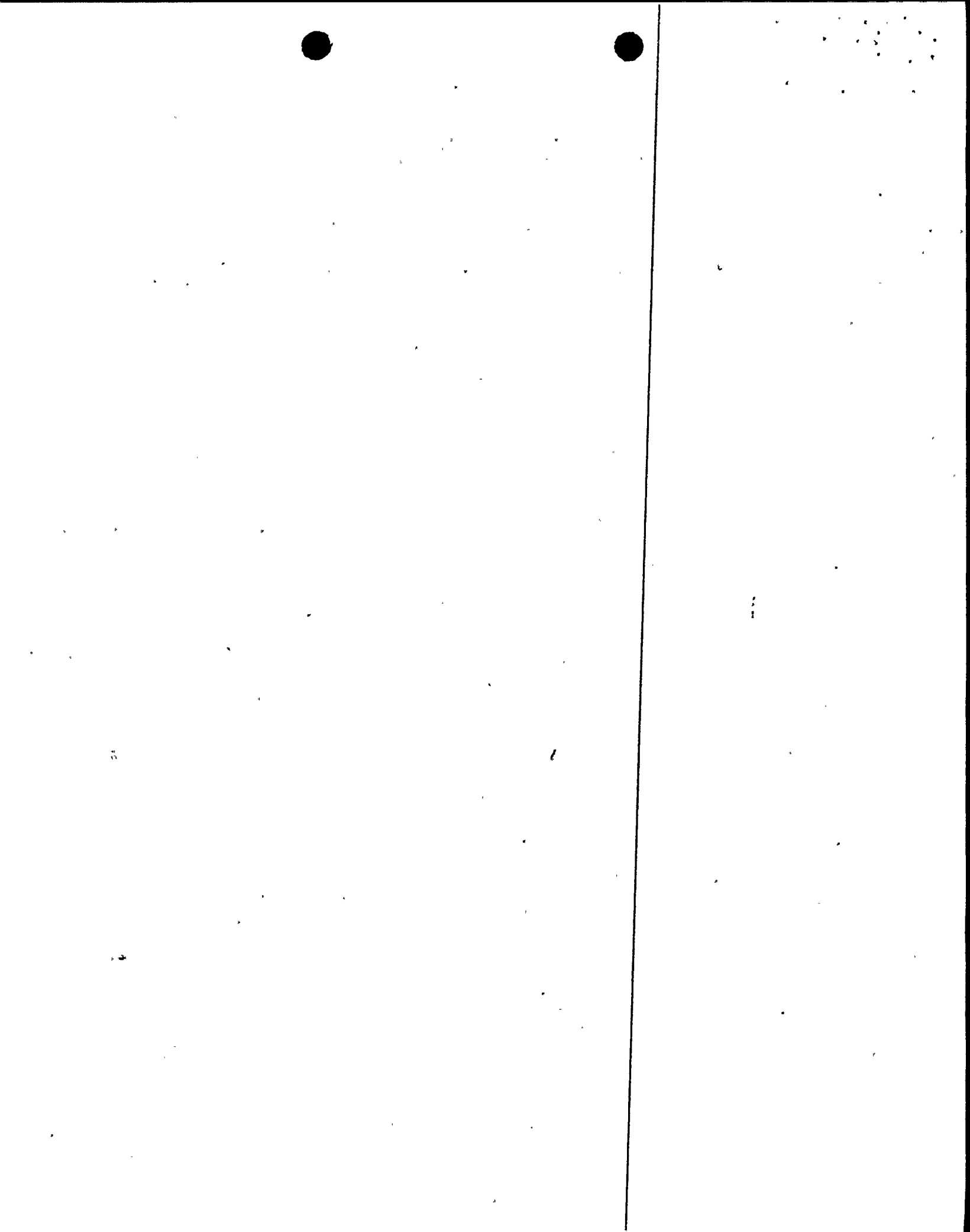
1. Fully withdrawn for all shutdown rods shall be 228 steps.

2.3 Control Rod Insertion Limits (Specification 3/4.1.3.6)

1. The control rod banks shall be limited in physical insertion as specified in Figure 1 of this attachment. Fully withdrawn for all control rods shall be 228 steps.

2.4 Axial Flux Difference (Specification 3/4.2.1)

1. The acceptable operational space for Relaxed Axial Offset Control (RAOC) operation is specified in Figure 2 of this attachment.
2. The AXIAL FLUX DIFFERENCE (AFD) target band for Base Load operation is ±5%.
3. The APLND for Base Load operation is 85% of RATED THERMAL POWER.



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2.5 Heat Flux Hot Channel Factor - $F_0(Z)$ (Specification 3/4.2.2)

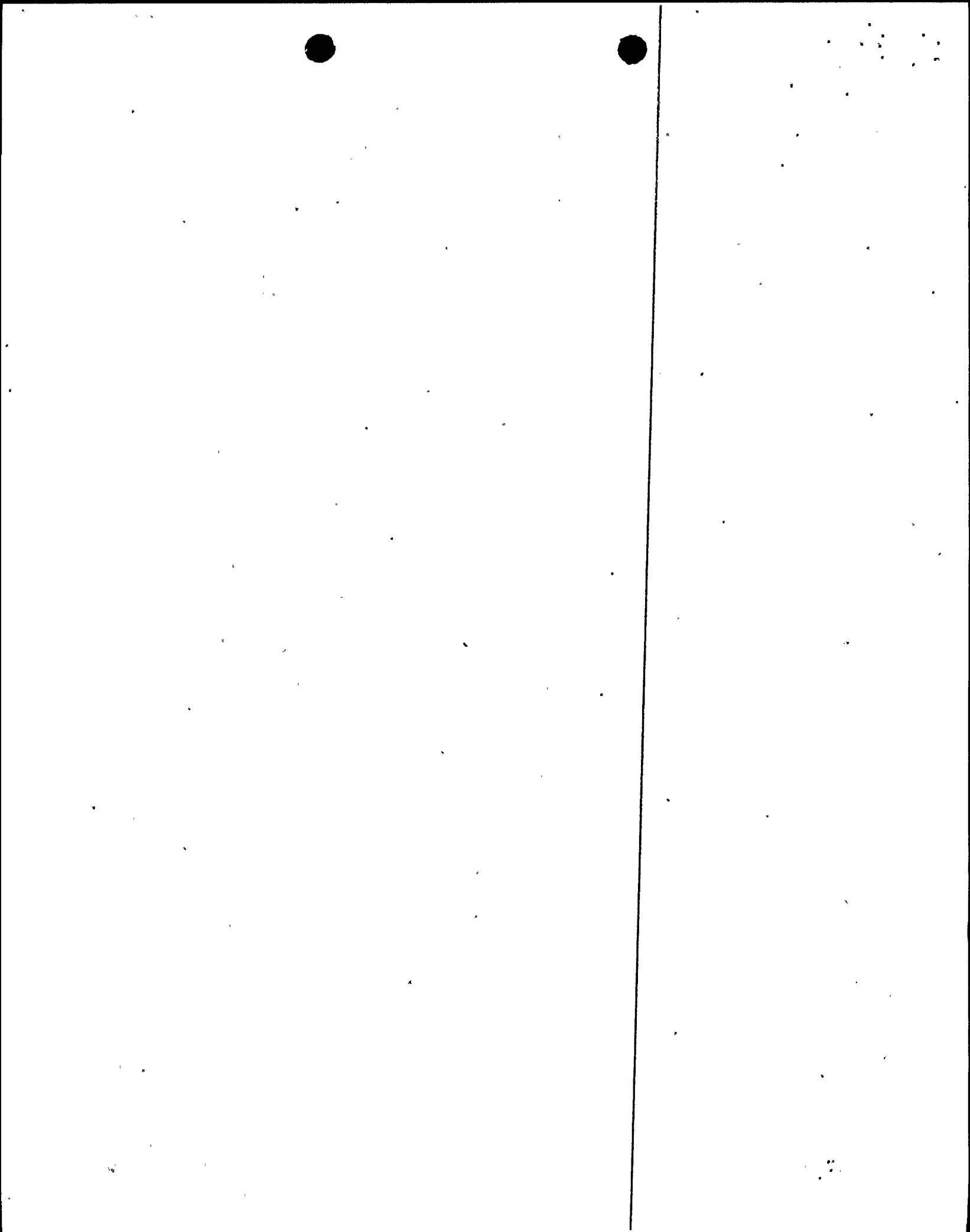
$$1. \quad F_0(Z) \leq \frac{F^{RTP} Q}{P} = K(Z) \text{ for } P > 0.5$$

$$F_0(Z) \leq \frac{F^{RTP} Q}{0.5} = K(Z) \text{ for } P \leq 0.5$$

$$\text{where: } P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

$$2. \quad F^{RTP} Q = 2.45$$

3. $K(Z)$ is specified in Figure 3 of this attachment.
4. $W(z)$ Curves for RAOC Operation are specified in Figures 4 through 6 of this attachment. These $W(z)$ curves are sufficient to determine the RAOC $W(z)$ versus core height for Cycle 5 burnups through the end of full power reactivity plus a power coastdown of up to 1245 MWD/MTU through the use of three point interpolation.
5. $W(z)$ Curves for Base Load Operation are specified in Figures 7 through 9 of this attachment. These $W(z)$ curves are sufficient to determine the Base Load $W(z)$ versus core height for Cycle 5 burnups through the end of full power reactivity plus a power coastdown of up to 1245 MWD/MTU through the use of three point interpolation.



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

$$1. \quad F_{\Delta H} \leq \frac{RTP}{F} \Delta H * (1 + PF_{\Delta H} * (1 - P))$$

$$\text{where: } P = \frac{\text{THERMAL POWER}}{\text{RATED THERMAL POWER}}$$

$$a. \quad \frac{RTP}{F} \Delta H = 1.62 \text{ for LOPAR fuel}$$

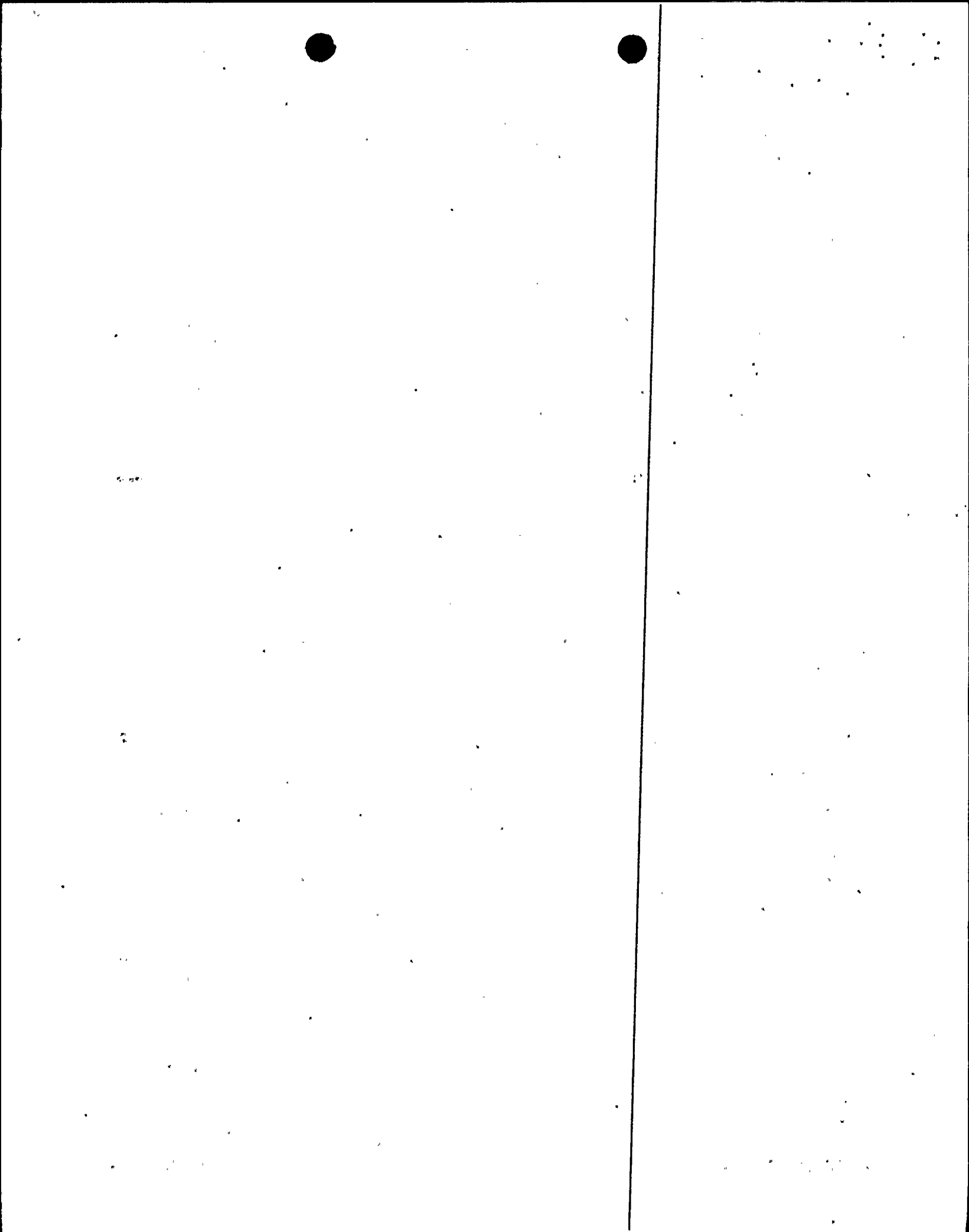
$$b. \quad \frac{RTP}{F} \Delta H = 1.65 \text{ for VANTAGE-5 fuel}$$

$$c. \quad PF_{\Delta H} = 0.3 \text{ for LOPAR fuel}$$

$$d. \quad PF_{\Delta H} = 0.35 \text{ for VANTAGE-5 fuel}$$

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

Through the end of Cycle 5, the boron concentration required to maintain K_{off} 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.



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3.0 METHODOLOGY REFERENCES

1. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985 (W Proprietary).

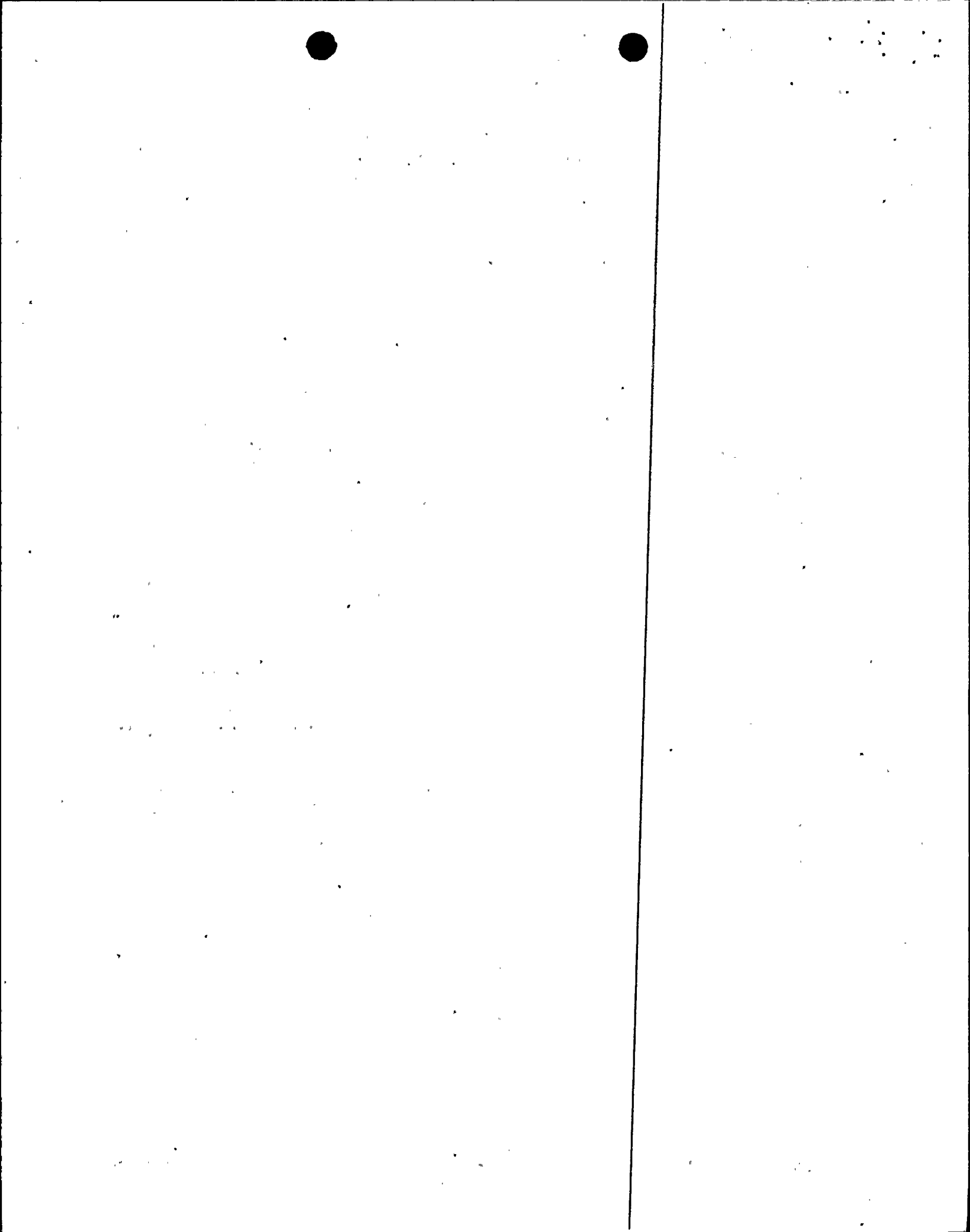
(Methodology for Specification 3.1.1.3 - Moderator Temperature Coefficient, 3.1.3.5 - Shutdown Rod Insertion Limit, 3.1.3.6 - Control Rod Insertion Limit, 3.2.1 - Axial Flux Difference, 3.2.2 - Heat Flux Hot Channel Factor, and 3.2.3 - Nuclear Enthalpy Rise Hot Channel Factor, and 3.9.1.a - Boron Concentration.)
2. WCAP-11914, "Safety Evaluation Supporting a More Negative EOL Moderator Temperature Coefficient Technical Specification for the Shearon Harris Nuclear Power Plant," August 1988 (W Proprietary). Approved by NRC Safety Evaluation dated May 22, 1989.

(Methodology for Specification 3.1.1.3 - Moderator Temperature Coefficient.)
3. WCAP-10216-P-A, "Relaxation of Constant Axial Offset Control F_Q Surveillance Technical Specification," June 1983 (W Proprietary).

(Methodology for Specifications 3.2.1 - Axial Flux Difference (Rexated Axial Offset Control) and 3.2.2 - Heat Flux Hot Channel Factor (F_Q Methodology for $W(Z)$ Surveillance requirements).)
4. WCAP-10266-P-A, Rev. 2, "The 1981 Version of the Westinghouse ECCS Evaluation Model Using the BASH Code," March 1987 (W Proprietary).

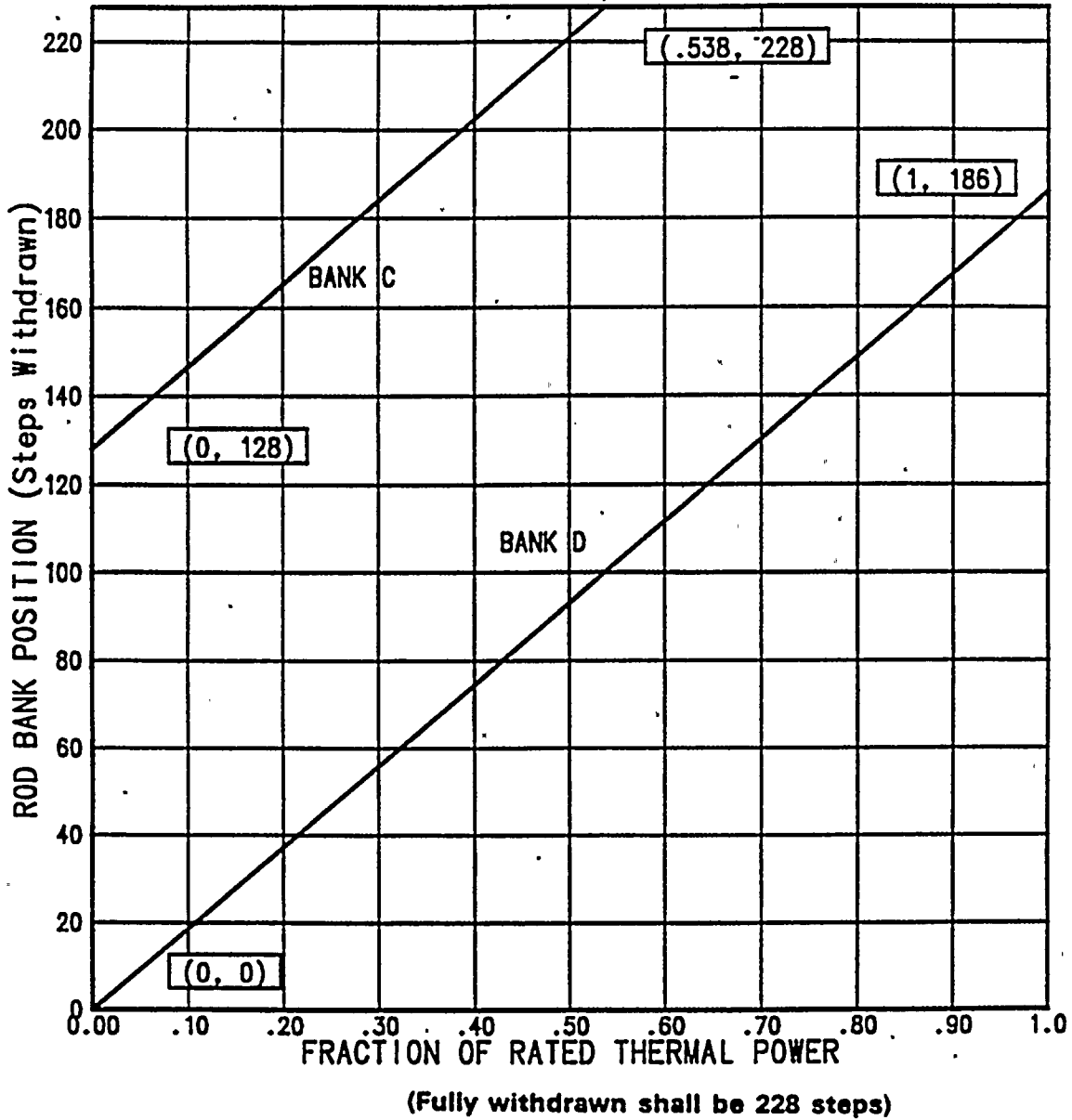
(Methodology for Specification 3.2.2 - Heat Flux Hot Channel Factor.)
5. WCAP-8385, "Power Distribution Control and Load Following Procedures - Topical Report," September 1974 (W Proprietary).

(Methodology for Specification 3.2.1 - Axial Flux Difference (Constant Axial Offset Control).)
6. WCAP-11832-P-A, "Extension of Methodology for Calculating Transition Core DNBR Penalties," January 1990 (W Proprietary).



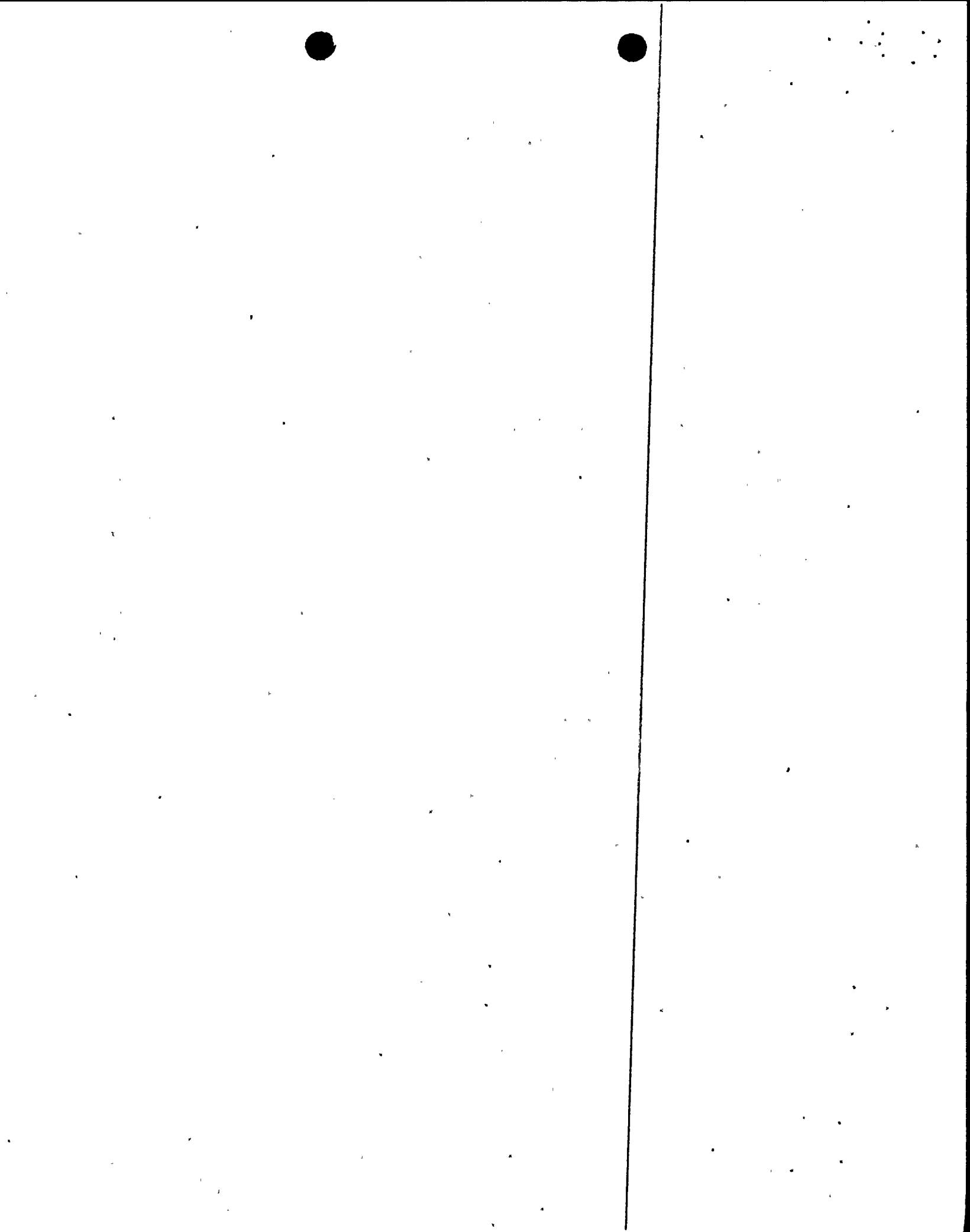
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FIGURE 1
 ROD GROUP INSERTION LIMITS VERSUS THERMAL POWER
 (THREE-LOOP OPERATION)



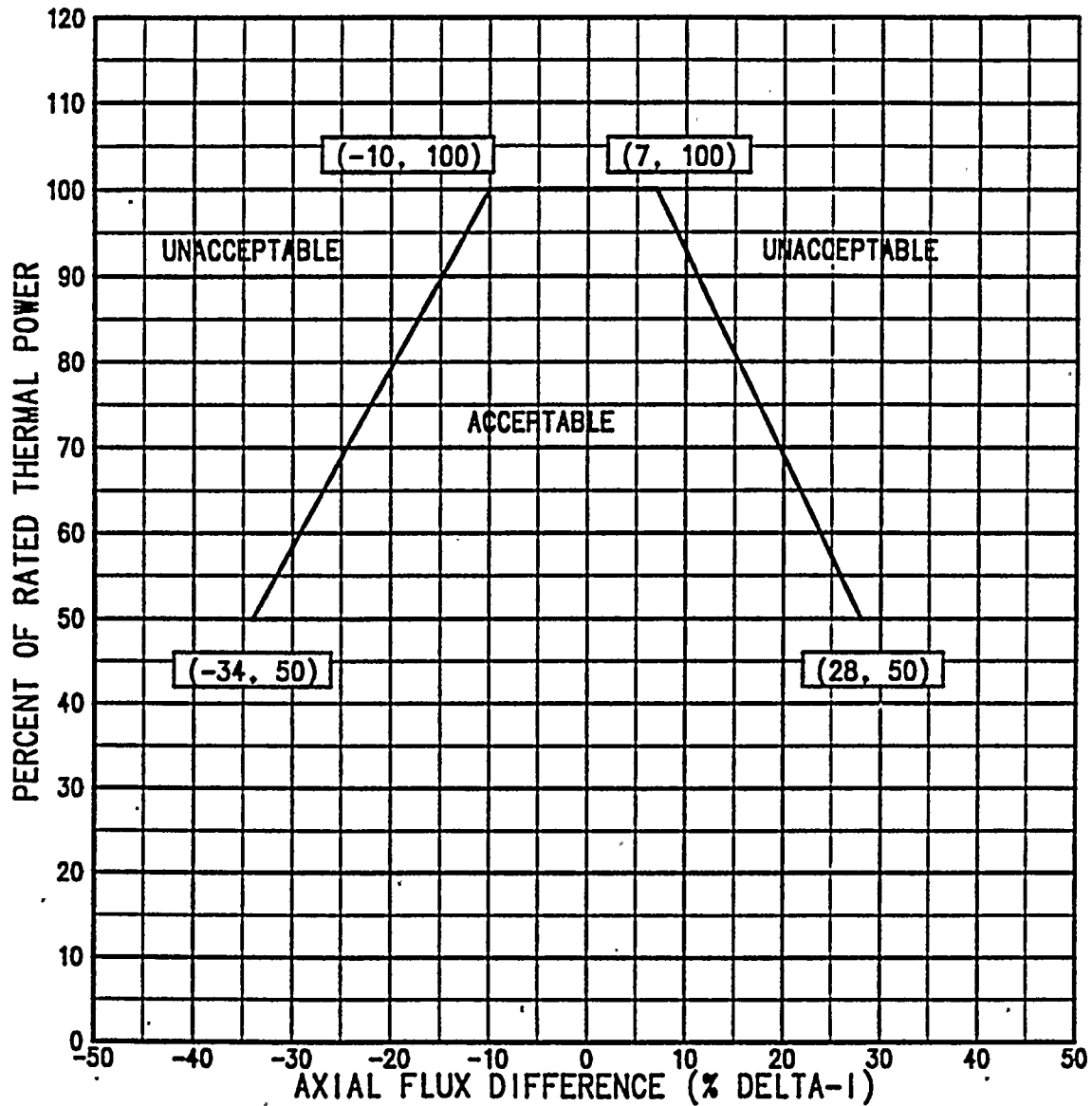
Note: Control Banks A and B Must be Withdrawn From The Core Prior To Power Operation

This figure is referred to by Technical Specifications
 3.1.3.1.d.2
 3.1.3.5
 3.1.3.6

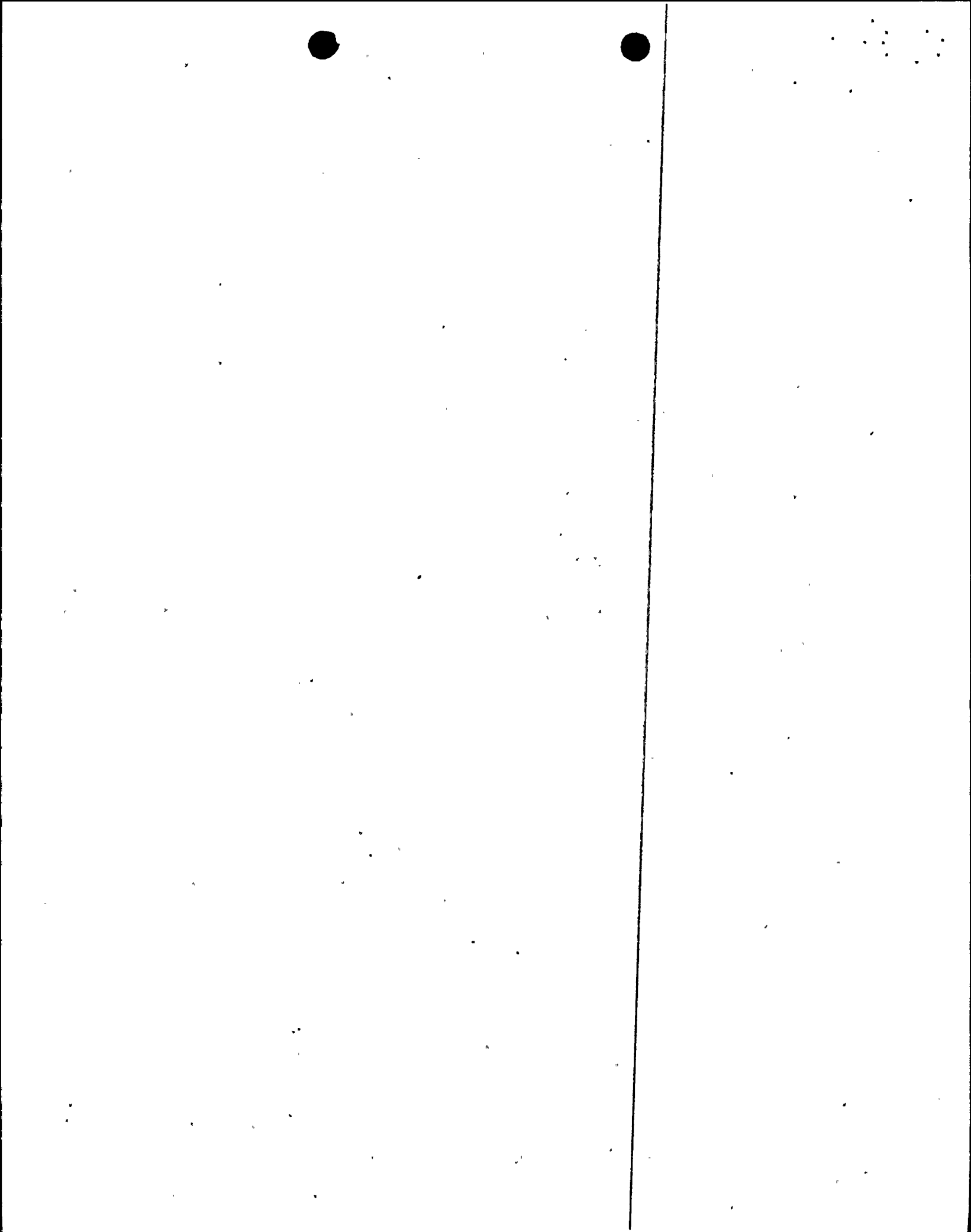


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FIGURE 2
AXIAL FLUX DIFFERENCE LIMITS AS A FUNCTION OF
RATED THERMAL POWER FOR RAOC

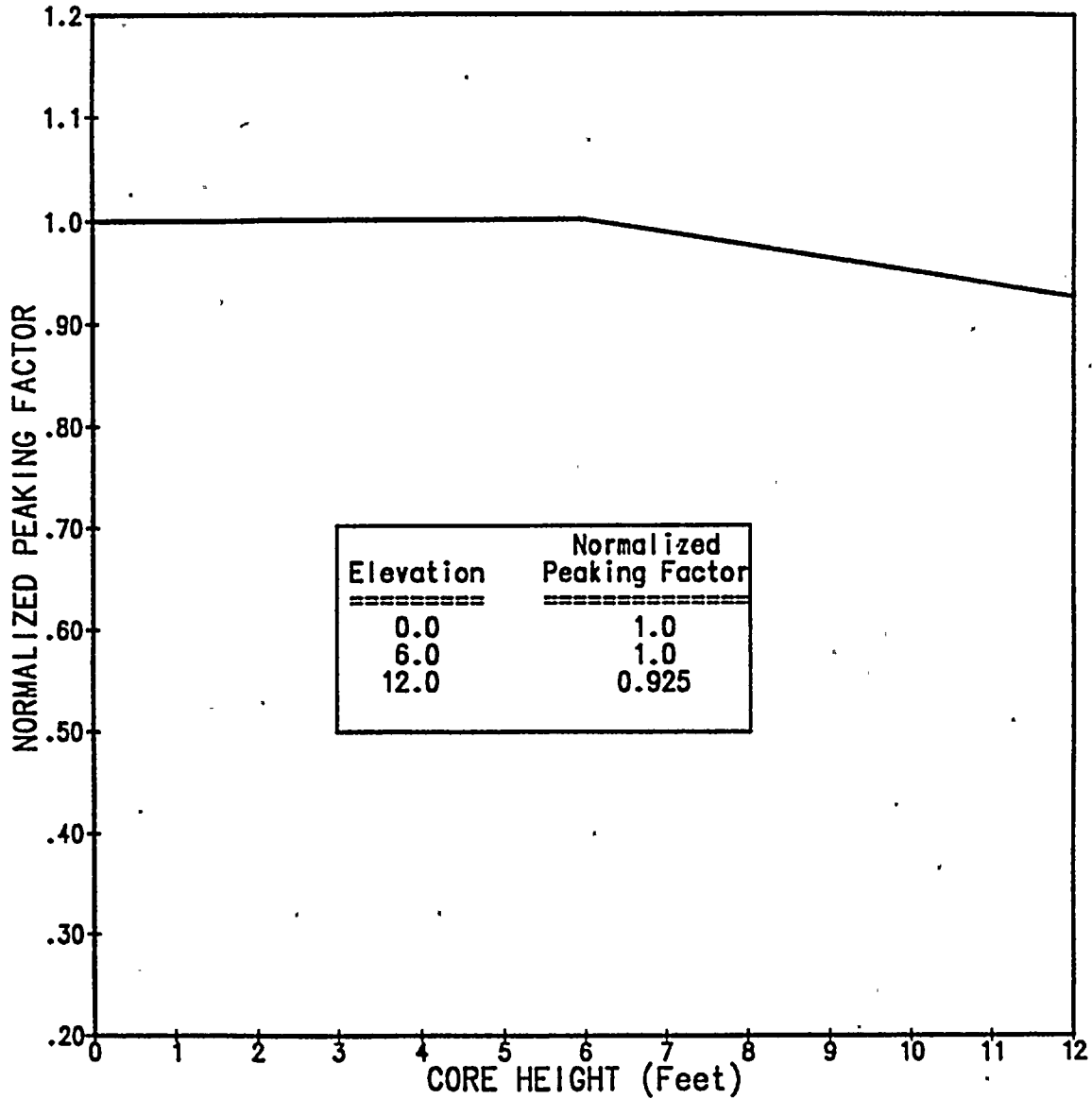


This figure is referred to by Technical Specifications 3.2.1, 4.2.2.2f, and B3/4.2.1

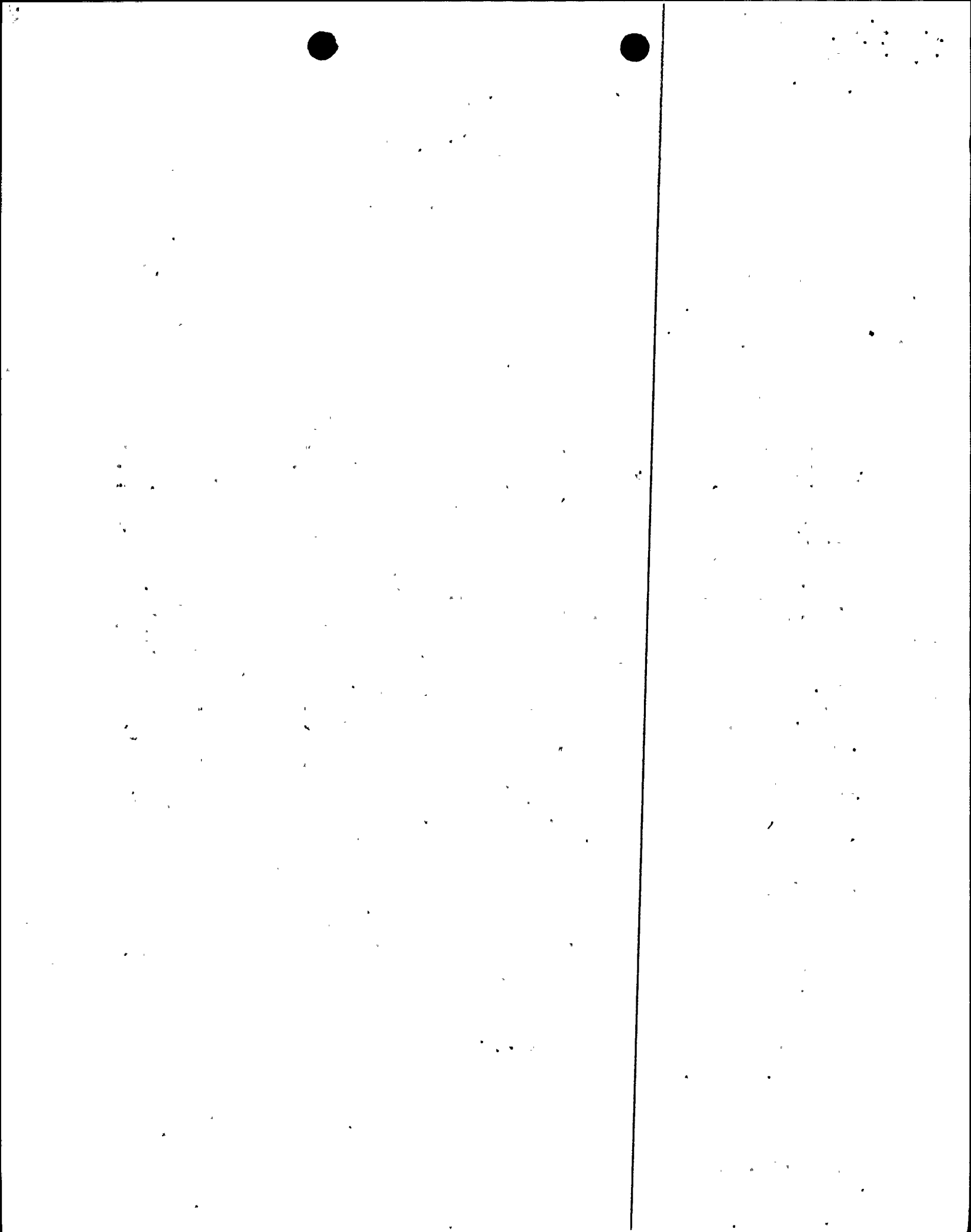


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FIGURE 3
 K(z) - LOCAL AXIAL PENALTY FUNCTION FOR $F_Q(z)$

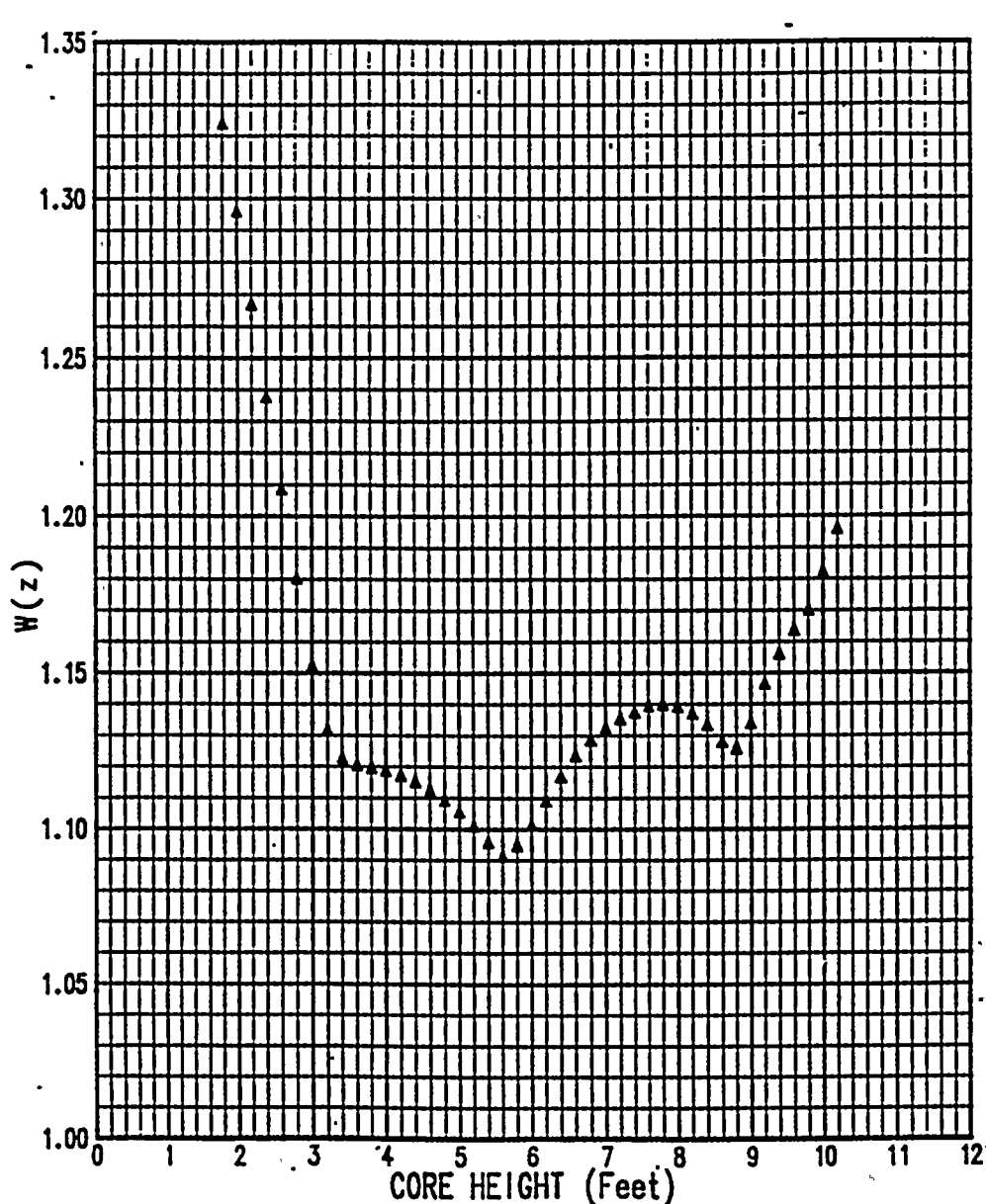


This figure is referred to by Technical Specification 3/4.2.2



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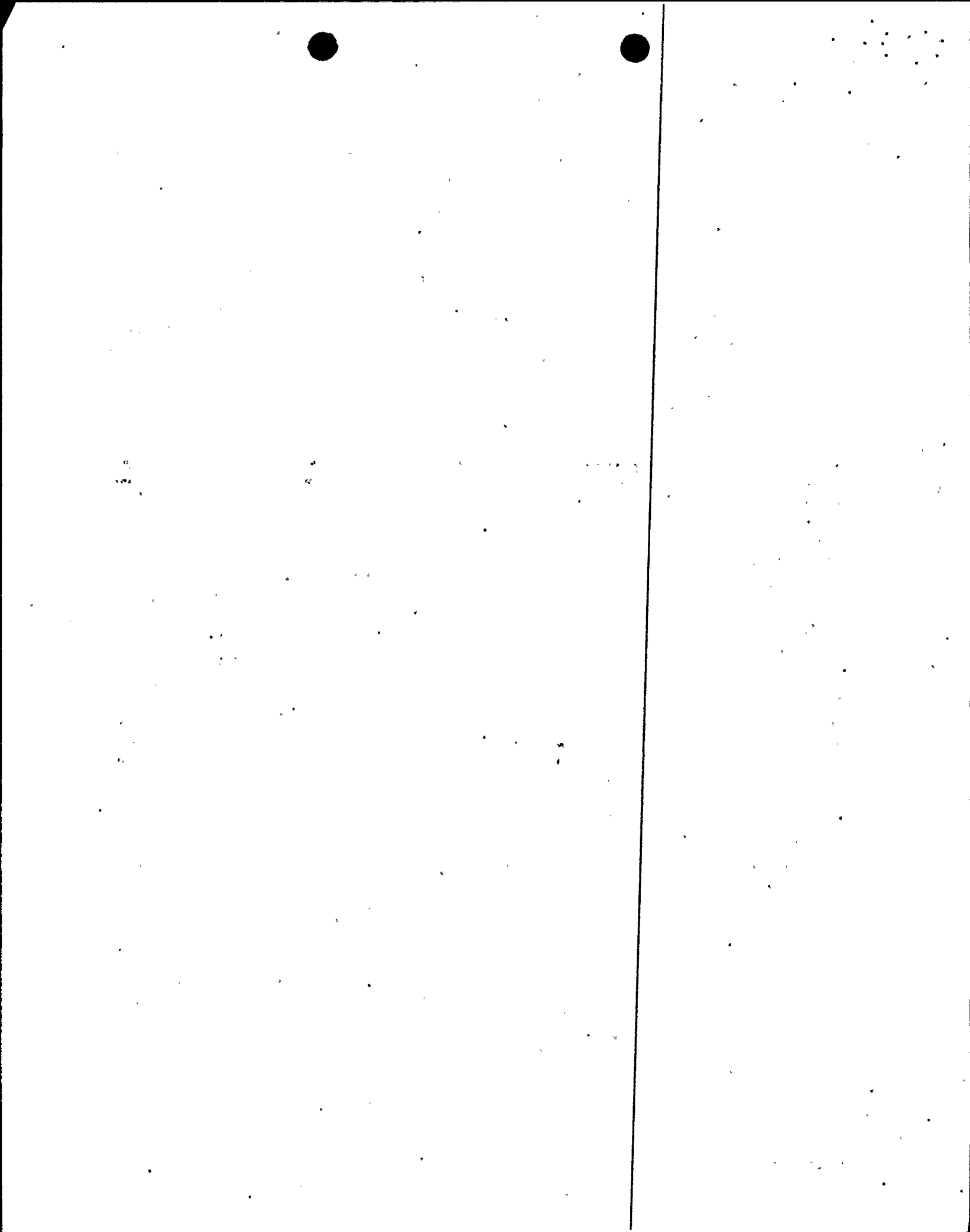
FIGURE 4
RAOC W(Z) AT 150 MWD/MTU (3.6 EFPD)



Height (Feet)	80L W(z)
* 0.00	1.0000
* 0.20	1.0000
* 0.40	1.0000
* 0.60	1.0000
* 0.80	1.0000
* 1.00	1.0000
* 1.20	1.0000
* 1.40	1.0000
* 1.60	1.0000
* 1.80	1.3241
2.00	1.2980
2.20	1.2670
2.40	1.2378
2.60	1.2087
2.80	1.1803
3.00	1.1525
3.20	1.1318
3.40	1.1227
3.60	1.1205
3.80	1.1197
4.00	1.1187
4.20	1.1172
4.40	1.1152
4.60	1.1128
4.80	1.1094
5.00	1.1058
5.20	1.1011
5.40	1.0958
5.60	1.0915
5.80	1.0848
6.00	1.1017
6.20	1.1092
6.40	1.1170
6.60	1.1235
6.80	1.1287
7.00	1.1326
7.20	1.1354
7.40	1.1376
7.60	1.1398
7.80	1.1401
8.00	1.1393
8.20	1.1371
8.40	1.1333
8.60	1.1281
8.80	1.1259
9.00	1.1340
9.20	1.1488
9.40	1.1582
9.60	1.1637
9.80	1.1702
10.00	1.1824
10.20	1.1960
* 10.40	1.0000
* 10.60	1.0000
* 10.80	1.0000
* 11.00	1.0000
* 11.20	1.0000
* 11.40	1.0000
* 11.60	1.0000
* 11.80	1.0000
* 12.00	1.0000

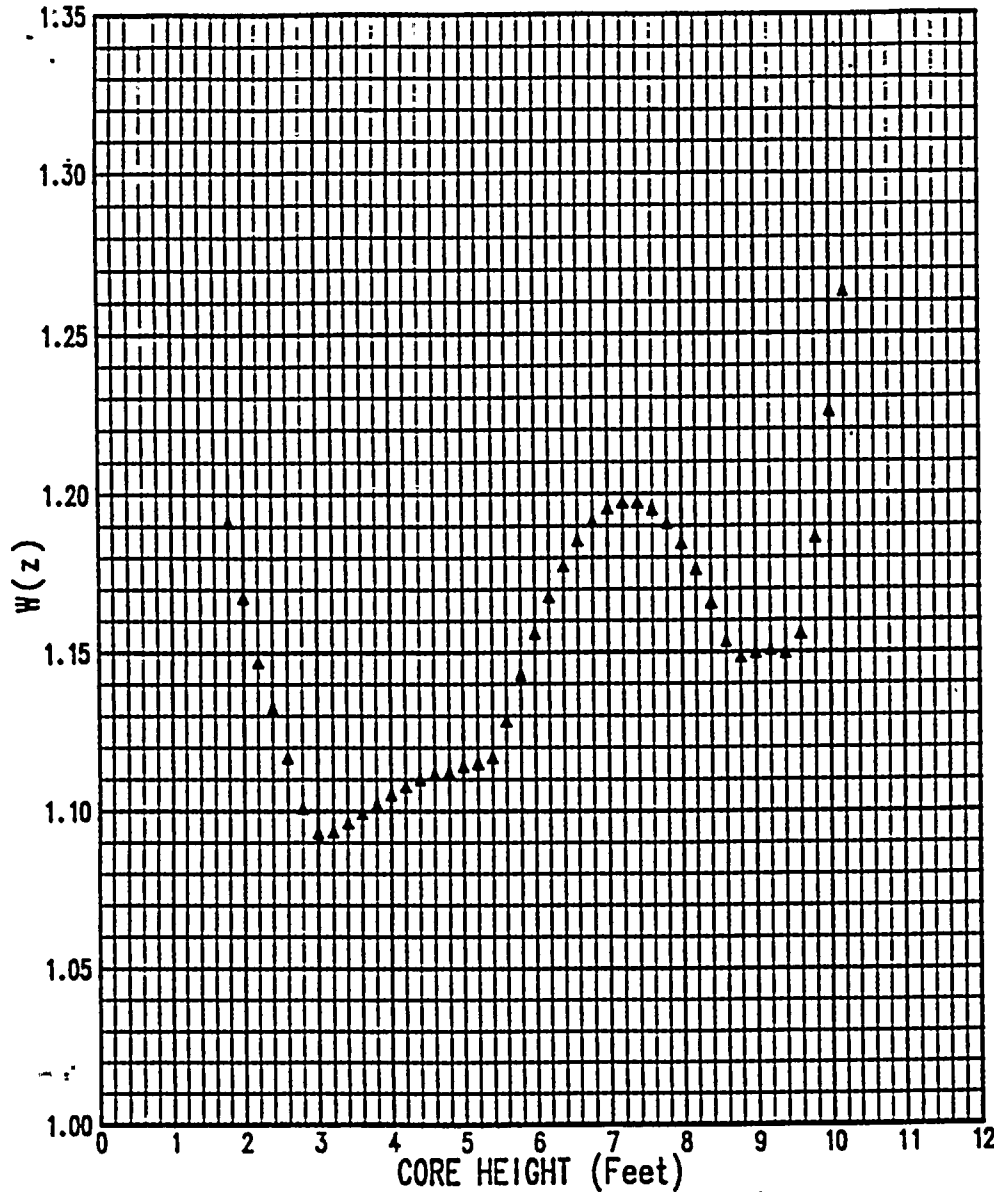
* Top and Bottom 15% excluded as per Technical Specification 4.2.2.2.

This figure is referred to by Technical Specifications 4.2.2.2c B3/4.2.2



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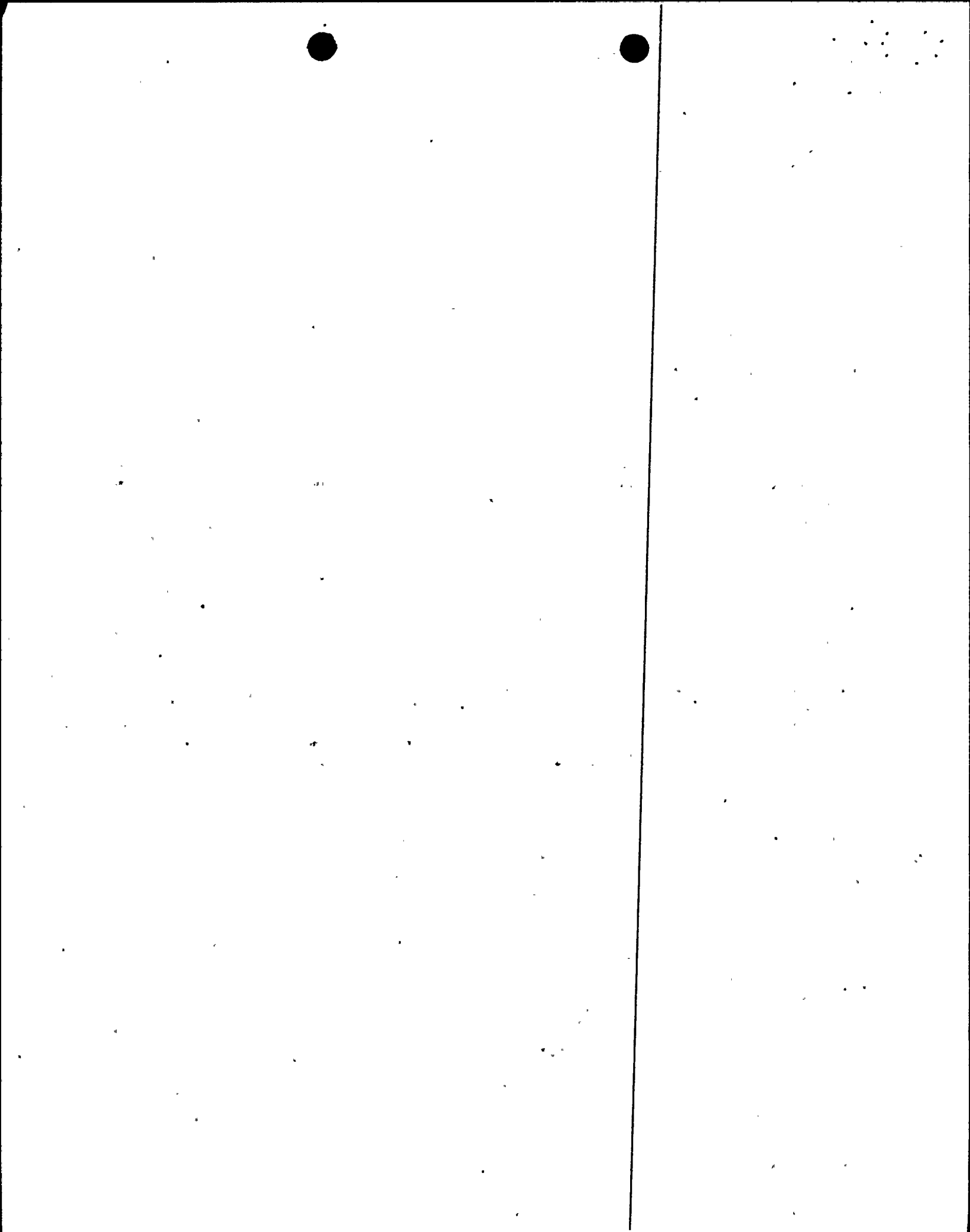
FIGURE 5
RAOC W(Z) AT 9000 MWD/MTU (216.9 EFPD)



Height (Feet)	MOL W(z)
* 0.00	1.0000
* 0.20	1.0000
* 0.40	1.0000
* 0.80	1.0000
* 1.00	1.0000
* 1.20	1.0000
* 1.40	1.0000
* 1.60	1.0000
* 1.80	1.1914
* 2.00	1.1674
* 2.20	1.1471
* 2.40	1.1324
* 2.60	1.1168
* 2.80	1.1009
* 3.00	1.0929
* 3.20	1.0933
* 3.40	1.0963
* 3.60	1.0993
* 3.80	1.1023
* 4.00	1.1052
* 4.20	1.1078
* 4.40	1.1100
* 4.60	1.1116
* 4.80	1.1122
* 5.00	1.1141
* 5.20	1.1150
* 5.40	1.1169
* 5.60	1.1189
* 5.80	1.1284
* 6.00	1.1428
* 6.20	1.1551
* 6.40	1.1676
* 6.60	1.1775
* 6.80	1.1854
* 7.00	1.1915
* 7.20	1.1955
* 7.40	1.1974
* 7.60	1.1973
* 7.80	1.1951
* 8.00	1.1908
* 8.20	1.1844
* 8.40	1.1782
* 8.60	1.1656
* 8.80	1.1532
* 9.00	1.1485
* 9.20	1.1498
* 9.40	1.1507
* 9.60	1.1496
* 9.80	1.1558
* 10.00	1.1661
* 10.20	1.2255
* 10.40	1.2529
* 10.60	1.0000
* 10.80	1.0000
* 11.00	1.0000
* 11.20	1.0000
* 11.40	1.0000
* 11.60	1.0000
* 11.80	1.0000
* 12.00	1.0000

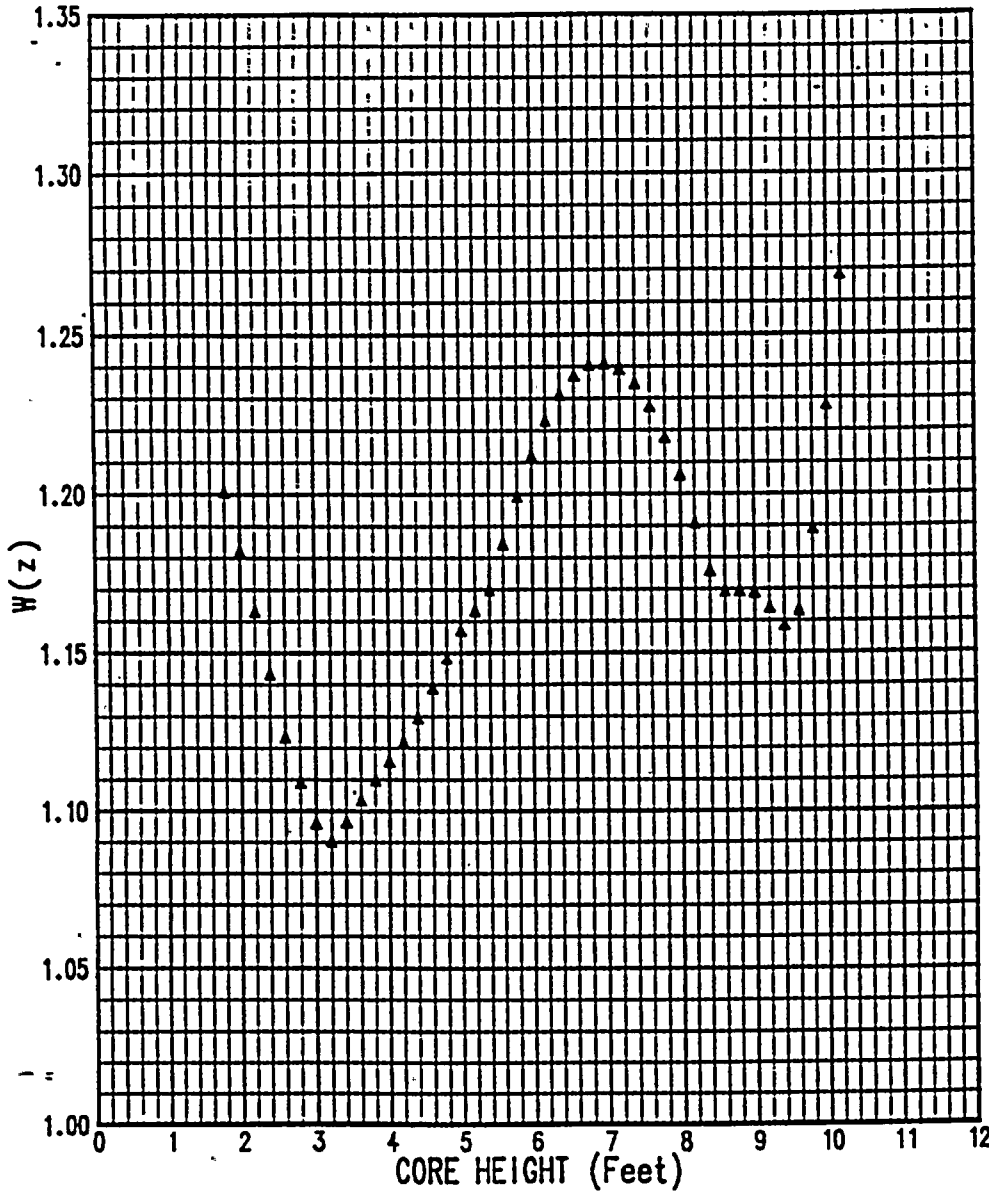
* Top and Bottom 15% excluded as per Technical Specification 4.2.2.2.

This figure is referred to by Technical Specifications 4.2.2.2c B3/4.2.2



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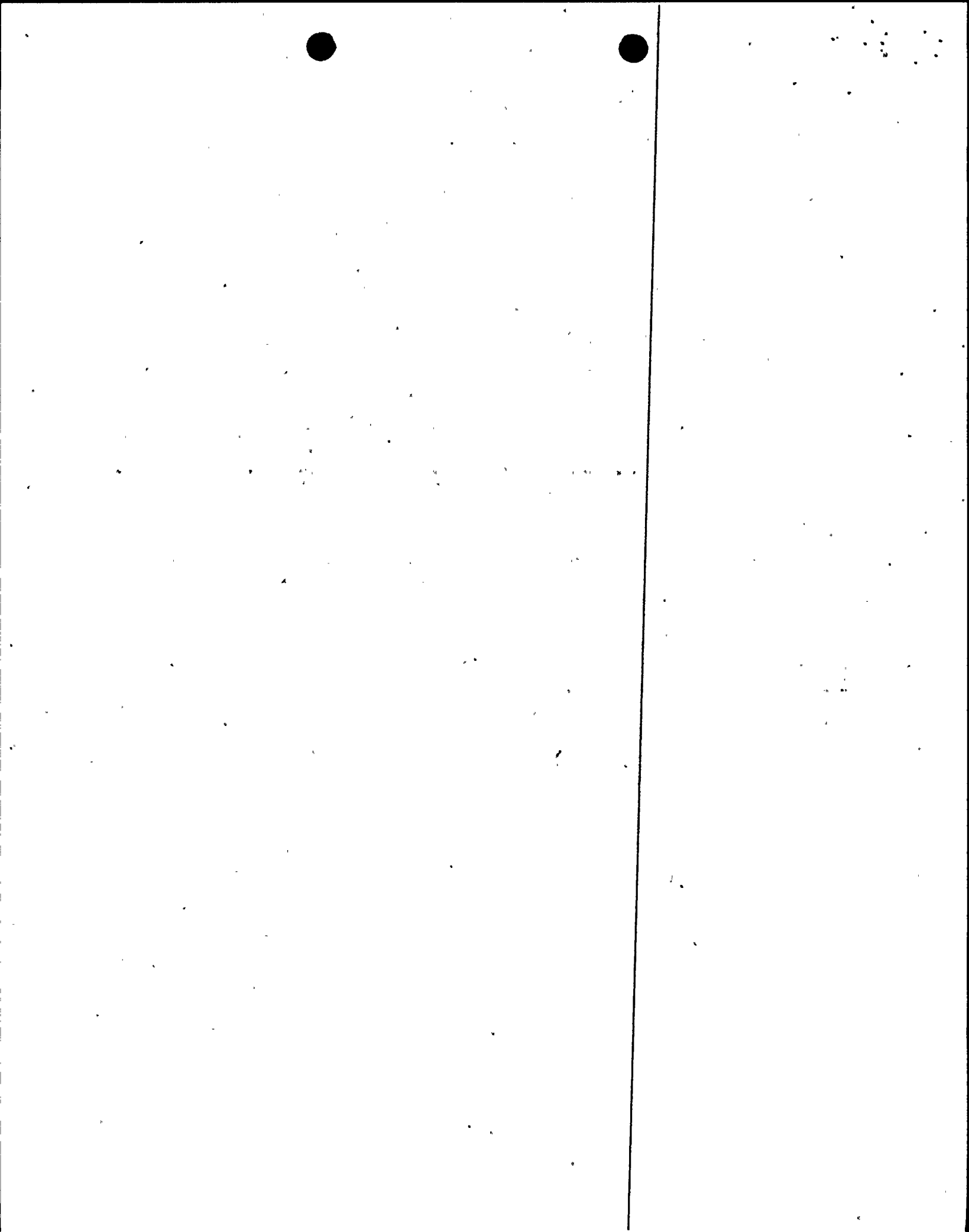
FIGURE 6
 RAOC W(Z) AT 15000 MWD/MTU (361.5 EFPD)



Height (Feet)	EOL W(z)
* 0.00	1.0000
* 0.20	1.0000
* 0.40	1.0000
* 0.60	1.0000
* 0.80	1.0000
* 1.00	1.0000
* 1.20	1.0000
* 1.40	1.0000
* 1.60	1.0000
* 1.80	1.0000
* 2.00	1.1822
* 2.20	1.1831
* 2.40	1.1433
* 2.60	1.1233
* 2.80	1.1092
* 3.00	1.0950
* 3.20	1.0904
* 3.40	1.0955
* 3.60	1.1033
* 3.80	1.1099
* 4.00	1.1158
* 4.20	1.1219
* 4.40	1.1297
* 4.60	1.1390
* 4.80	1.1485
* 5.00	1.1573
* 5.20	1.1633
* 5.40	1.1699
* 5.60	1.1843
* 5.80	1.1894
* 6.00	1.2124
* 6.20	1.2231
* 6.40	1.2314
* 6.60	1.2373
* 6.80	1.2406
* 7.00	1.2412
* 7.20	1.2393
* 7.40	1.2348
* 7.60	1.2275
* 7.80	1.2179
* 8.00	1.2061
* 8.20	1.1909
* 8.40	1.1758
* 8.60	1.1695
* 8.80	1.1695
* 9.00	1.1689
* 9.20	1.1642
* 9.40	1.1587
* 9.60	1.1630
* 9.80	1.1692
* 10.00	1.2280
* 10.20	1.2585
* 10.40	1.0000
* 10.60	1.0000
* 10.80	1.0000
* 11.00	1.0000
* 11.20	1.0000
* 11.40	1.0000
* 11.60	1.0000
* 11.80	1.0000
* 12.00	1.0000

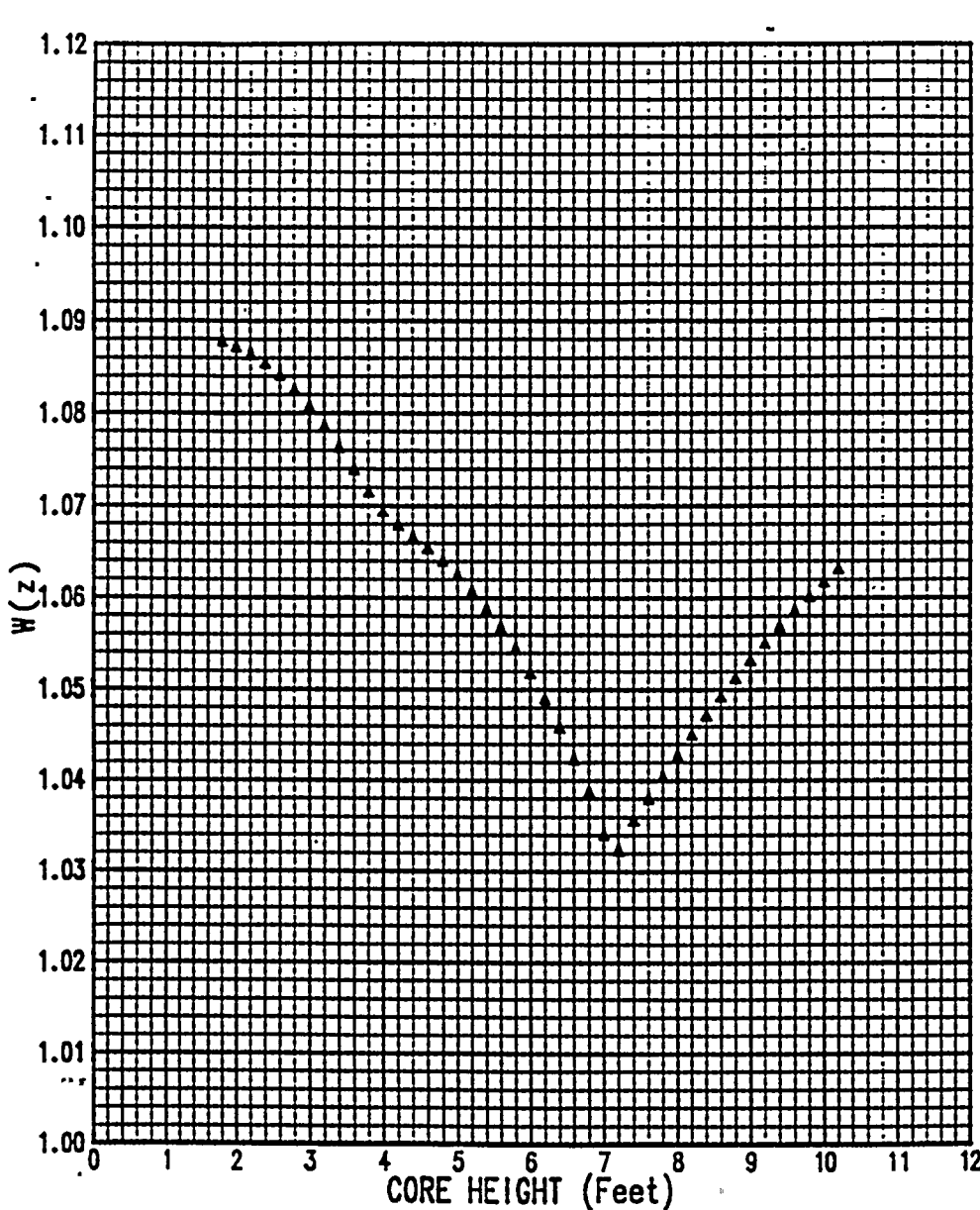
* Top and Bottom 15% excluded as per Technical Specification 4.2.2.2.

This figure is referred to by Technical Specifications 4.2.2.2c B3/4.2.2



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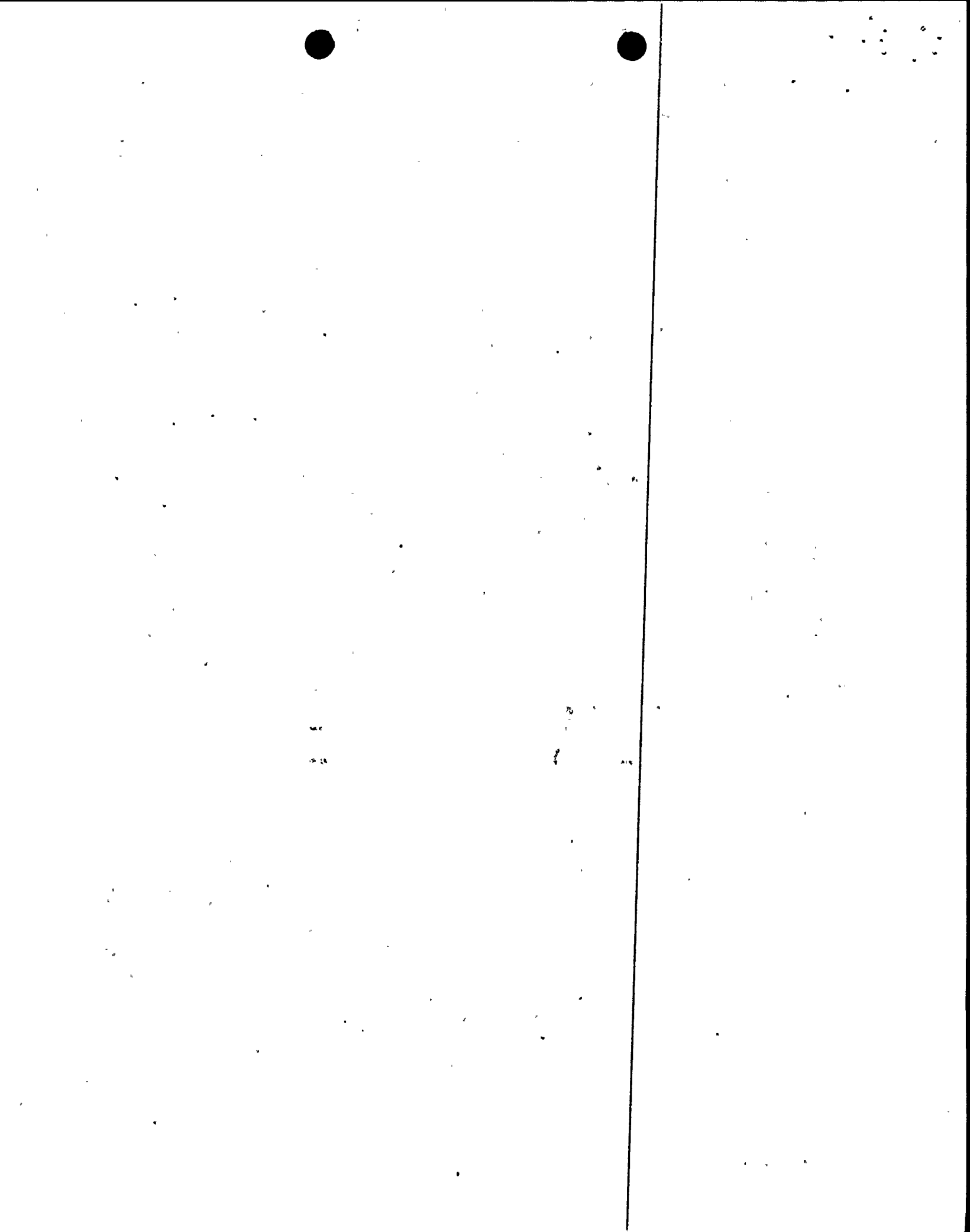
FIGURE 7
BASE LOAD W(Z) AT 150 MWD/MTU (3.6 EFPD)
FOR POWER LEVELS ABOVE 85% OF RATED THERMAL POWER



Height (Feet)	BOL W(z)
* 0.00	1.0000
* 0.20	1.0000
* 0.40	1.0000
* 0.60	1.0000
* 0.80	1.0000
* 1.00	1.0000
* 1.20	1.0000
* 1.40	1.0000
* 1.60	1.0000
1.80	1.0879
2.00	1.0873
2.20	1.0865
2.40	1.0855
2.60	1.0842
2.80	1.0828
3.00	1.0808
3.20	1.0787
3.40	1.0764
3.60	1.0740
3.80	1.0716
4.00	1.0695
4.20	1.0680
4.40	1.0667
4.60	1.0655
4.80	1.0641
5.00	1.0628
5.20	1.0608
5.40	1.0589
5.60	1.0568
5.80	1.0545
6.00	1.0519
6.20	1.0490
6.40	1.0459
6.60	1.0424
6.80	1.0388
7.00	1.0341
7.20	1.0324
7.40	1.0357
7.60	1.0381
7.80	1.0405
8.00	1.0428
8.20	1.0451
8.40	1.0472
8.60	1.0493
8.80	1.0513
9.00	1.0533
9.20	1.0551
9.40	1.0569
9.60	1.0585
9.80	1.0602
10.00	1.0618
10.20	1.0632
* 10.40	1.0000
* 10.60	1.0000
* 10.80	1.0000
* 11.00	1.0000
* 11.20	1.0000
* 11.40	1.0000
* 11.60	1.0000
* 11.80	1.0000
* 12.00	1.0000

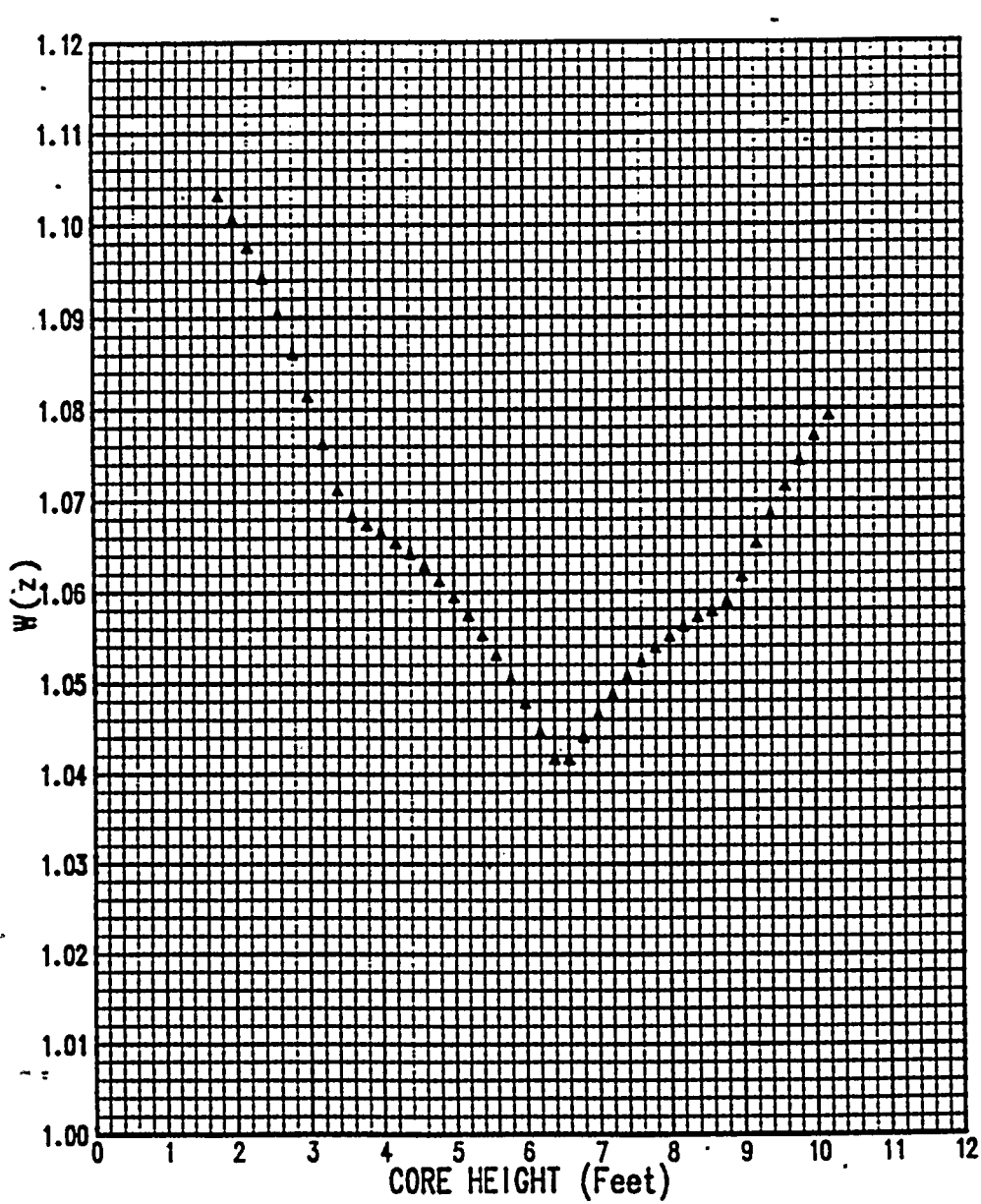
* Top and Bottom 15%
excluded as per
Technical
Specification
4.2.2.4.

This figure is referred to by
Technical Specifications
4.2.2.3a
4.2.2.4c
B3/4.2.2



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FIGURE 8
BASE LOAD W(Z) AT 9000 MWD/MTU (216.9 EFPD)
FOR POWER LEVELS ABOVE 85% OF RATED THERMAL POWER



Height (Feet)	MQL W(z)
* 0.00	1.0000
* 0.20	1.0000
* 0.40	1.0000
* 0.60	1.0000
* 0.80	1.0000
* 1.00	1.0000
* 1.20	1.0000
* 1.40	1.0000
* 1.60	1.0000
* 1.80	1.1032
* 2.00	1.1007
* 2.20	1.0977
* 2.40	1.0943
* 2.60	1.0904
* 2.80	1.0881
* 3.00	1.0815
* 3.20	1.0763
* 3.40	1.0712
* 3.60	1.0684
* 3.80	1.0675
* 4.00	1.0666
* 4.20	1.0655
* 4.40	1.0643
* 4.60	1.0629
* 4.80	1.0613
* 5.00	1.0595
* 5.20	1.0575
* 5.40	1.0553
* 5.60	1.0531
* 5.80	1.0505
* 6.00	1.0479
* 6.20	1.0445
* 6.40	1.0417
* 6.60	1.0417
* 6.80	1.0441
* 7.00	1.0466
* 7.20	1.0487
* 7.40	1.0507
* 7.60	1.0524
* 7.80	1.0539
* 8.00	1.0551
* 8.20	1.0562
* 8.40	1.0572
* 8.60	1.0579
* 8.80	1.0589
* 9.00	1.0617
* 9.20	1.0654
* 9.40	1.0685
* 9.60	1.0716
* 9.80	1.0744
* 10.00	1.0770
* 10.20	1.0793
* 10.40	1.0000
* 10.60	1.0000
* 10.80	1.0000
* 11.00	1.0000
* 11.20	1.0000
* 11.40	1.0000
* 11.60	1.0000
* 11.80	1.0000
* 12.00	1.0000

* Top and Bottom 15% excluded as per Technical Specification 4.2.2.4.

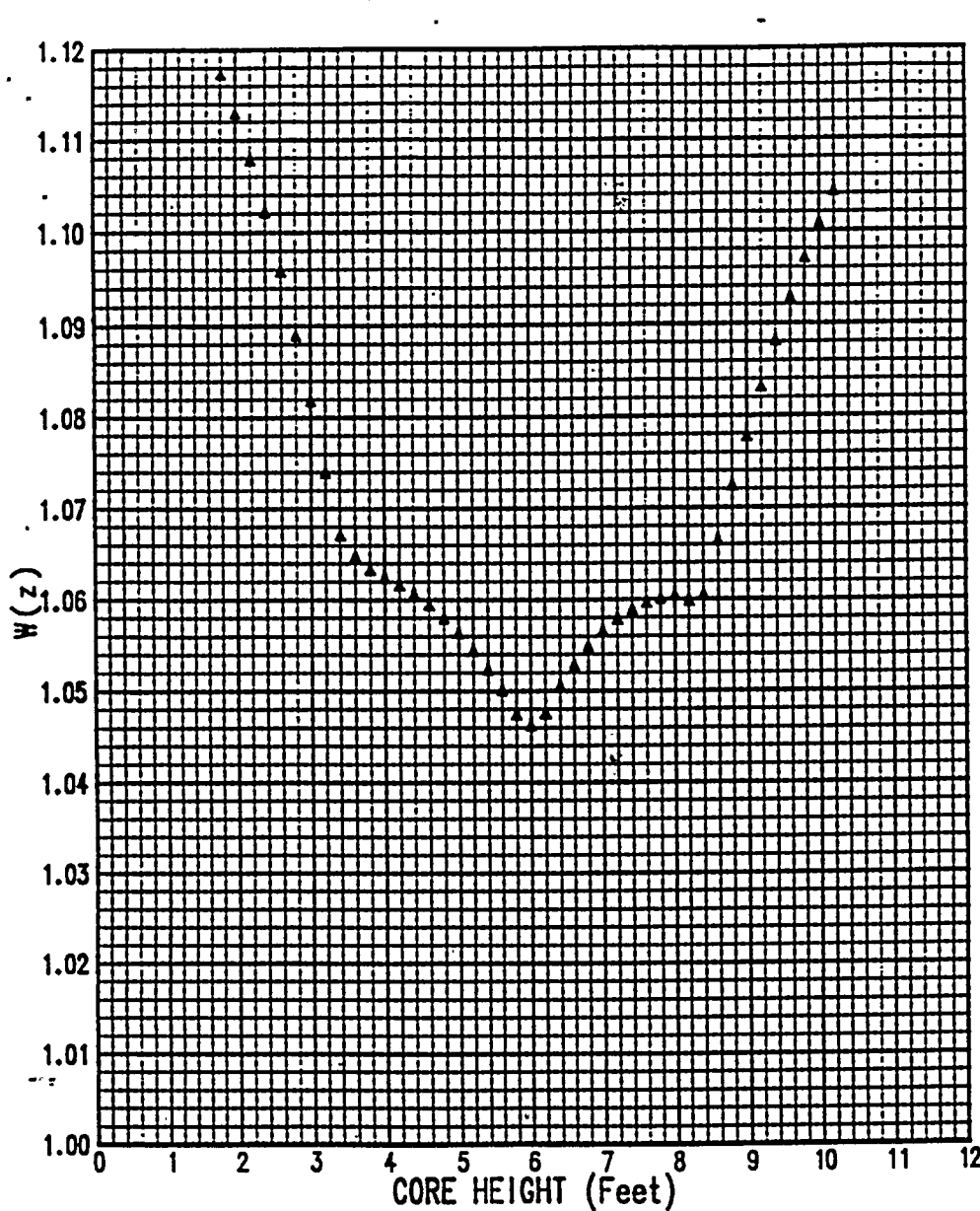
This figure is referred to by Technical Specifications 4.2.2.3a, 4.2.2.4c, B3/4.2.2



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FIGURE 9
BASE LOAD $W(z)$ AT 15000 MWD/MTU (361.5 EFPD)
FOR POWER LEVELS ABOVE 85% OF RATED THERMAL POWER



Height (Feet)	EOL $W(z)$
* 0.00	1.0000
* 0.20	1.0000
* 0.40	1.0000
* 0.80	1.0000
* 1.00	1.0000
* 1.20	1.0000
* 1.40	1.0000
* 1.80	1.0000
* 1.80	1.1174
* 2.00	1.1130
* 2.20	1.1079
* 2.40	1.1022
* 2.60	1.0959
* 2.80	1.0890
* 3.00	1.0819
* 3.20	1.0740
* 3.40	1.0671
* 3.60	1.0648
* 3.80	1.0634
* 4.00	1.0625
* 4.20	1.0617
* 4.40	1.0607
* 4.60	1.0595
* 4.80	1.0580
* 5.00	1.0564
* 5.20	1.0545
* 5.40	1.0524
* 5.60	1.0501
* 5.80	1.0475
* 6.00	1.0463
* 6.20	1.0475
* 6.40	1.0506
* 6.60	1.0529
* 6.80	1.0549
* 7.00	1.0568
* 7.20	1.0579
* 7.40	1.0589
* 7.60	1.0597
* 7.80	1.0601
* 8.00	1.0605
* 8.20	1.0599
* 8.40	1.0605
* 8.60	1.0605
* 8.80	1.0724
* 9.00	1.0778
* 9.20	1.0832
* 9.40	1.0882
* 9.60	1.0928
* 9.80	1.0971
* 10.00	1.1009
* 10.20	1.1043
* 10.40	1.0000
* 10.60	1.0000
* 10.80	1.0000
* 11.00	1.0000
* 11.20	1.0000
* 11.40	1.0000
* 11.60	1.0000
* 11.80	1.0000
* 12.00	1.0000

* Top and Bottom 15% excluded as per Technical Specification 4.2.2.4.

This figure is referred to by Technical Specifications 4.2.2.3a, 4.2.2.4c, B3/4.2.2

