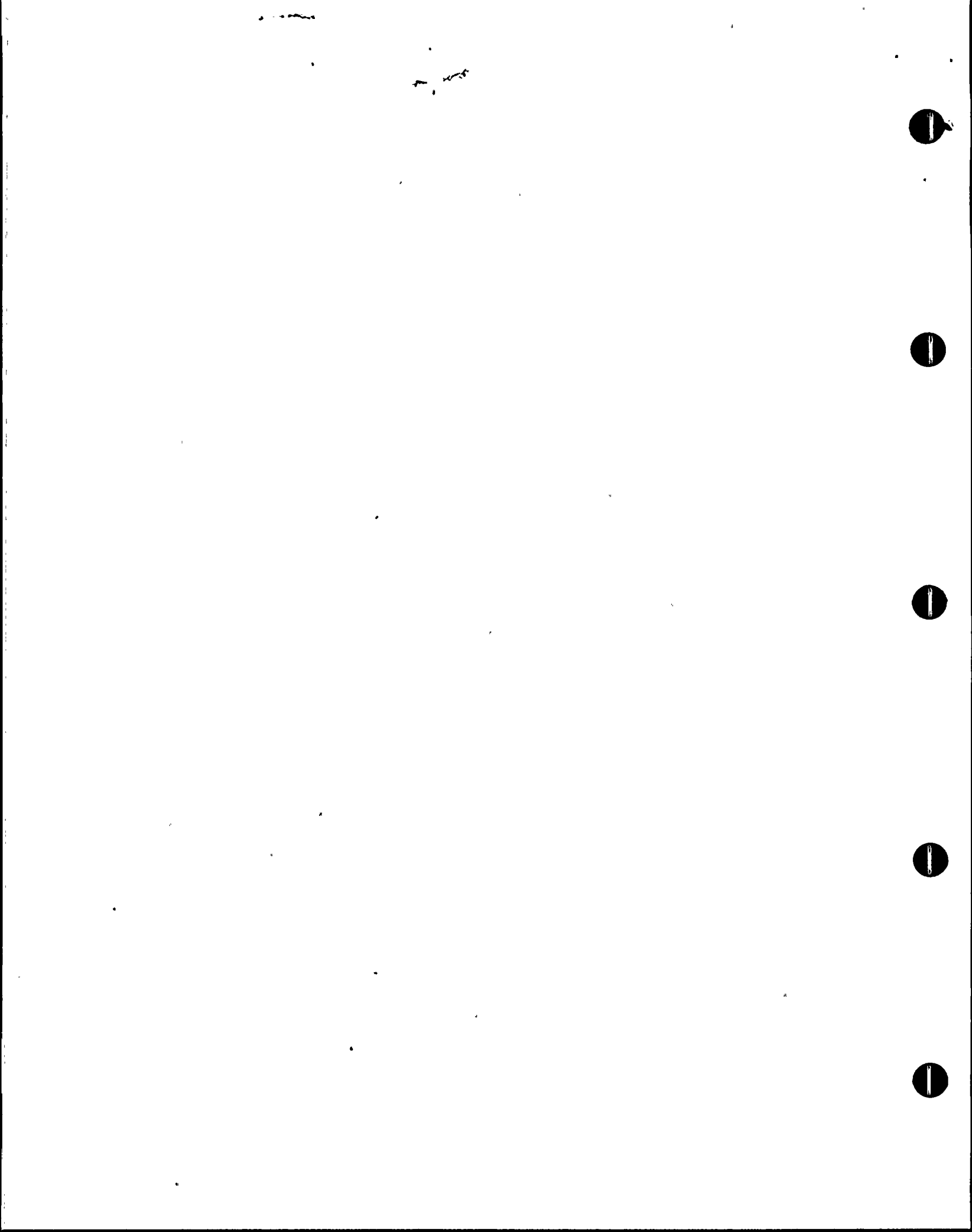


FLORIDA POWER & LIGHT COMPANY

TURKEY POINT PLANT

UNIT 4 CYCLE III

STARTUP REPORT



Acknowledgement

I would like to acknowledge all the members of the Turkey Point Nuclear Operations Group for their support during the Unit 4 Cycle III Startup Tests.

I would also like to thank the members of the Power Resources - Nuclear staff for their core data book and technical support given during the Startup Physics Tests.

Finally, I would like to acknowledge Jonell Collier for typing this report.



Introduction

This report contains an official summary of the Startup Physics Tests, Unit 4 Cycle III. The tests were conducted in accordance with Operating Procedure 0204.5, Startup Sequence After Refueling.

The testing program commenced on June 6, 1976, with initial criticality and was completed June 11, 1976.

Completed by Vito A. Kaminskas
Vito A. Kaminskas

Approved by Robert E. Dawson
Robert E. Dawson
Reactor Supervisor



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1.0 Unit 4 Cycle III

1.1 Loading Pattern

1.2 Rod Pattern

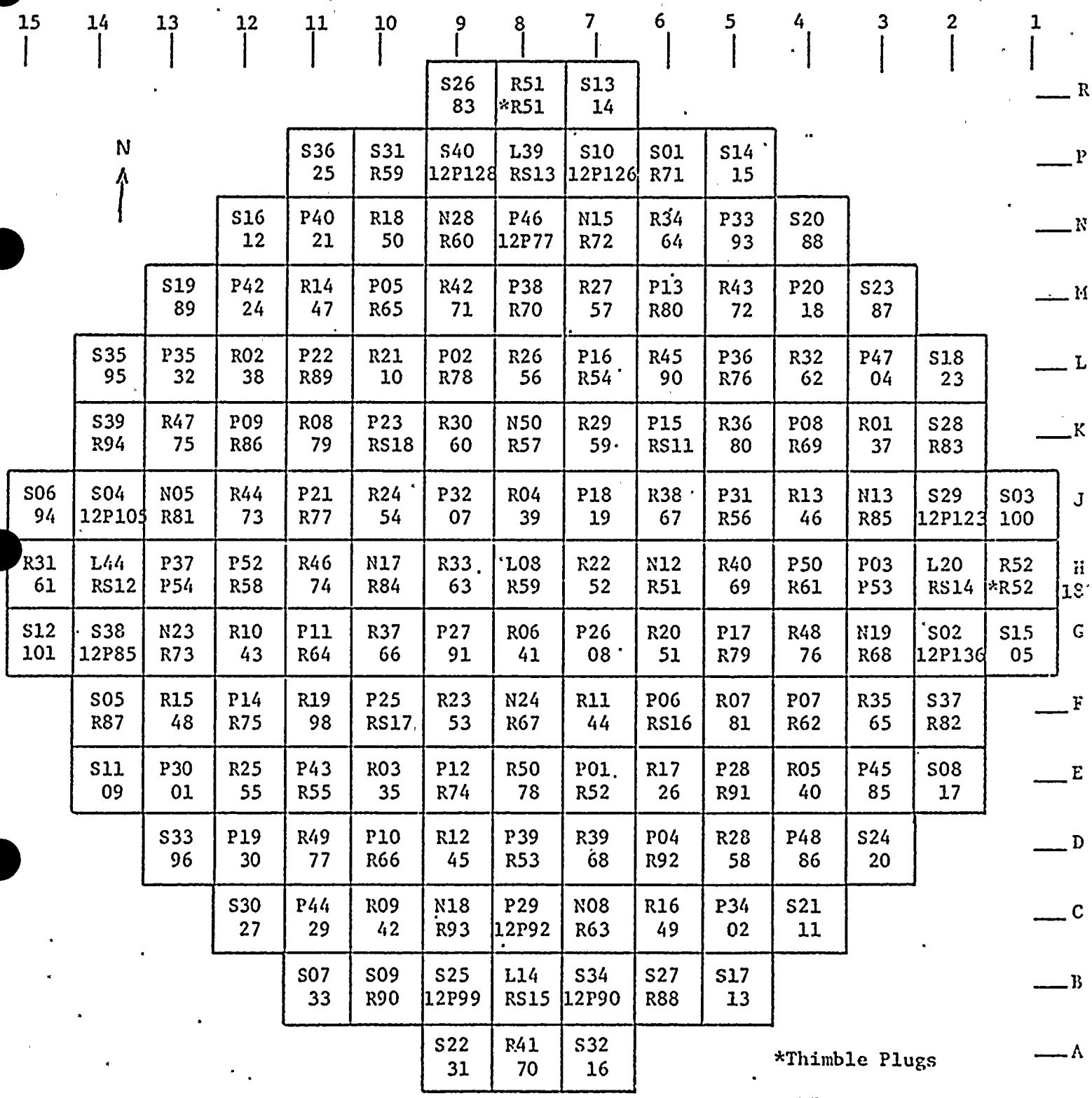
1.3 Rod Drop Times



Date: 5-14-76

Florida Power & Light Company REACTOR FUEL LOCATION TURKEY POINT PLANT UNIT NO. 4

90°



270°

*Thimble Plugs

LEGEND

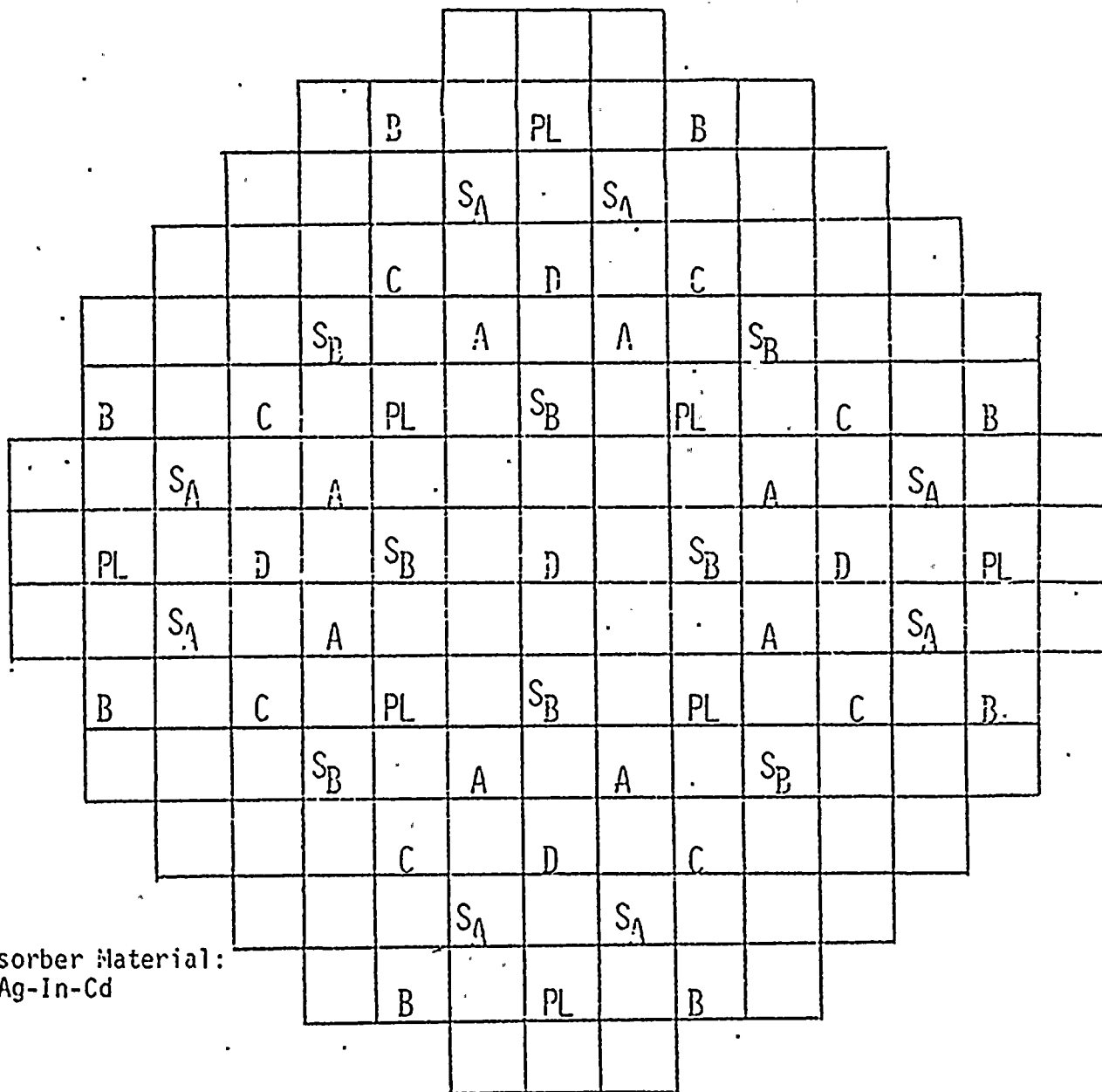
Assembly No.	
Insert No.	

Core III



Control, Shutdown and Part Length Rod Locations

R P N M L K J H G F E D C B A



1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

Absorber Material:
Ag-In-Cd

Control Rod Designation

Function	Number of Clusters
Control Bank D	5
Control Bank C	8
Control Bank B	8
Control Bank A	8
Shutdown Bank S_B	8
Shutdown Bank S_A	8
Part Length PL	8



ROD DROPS

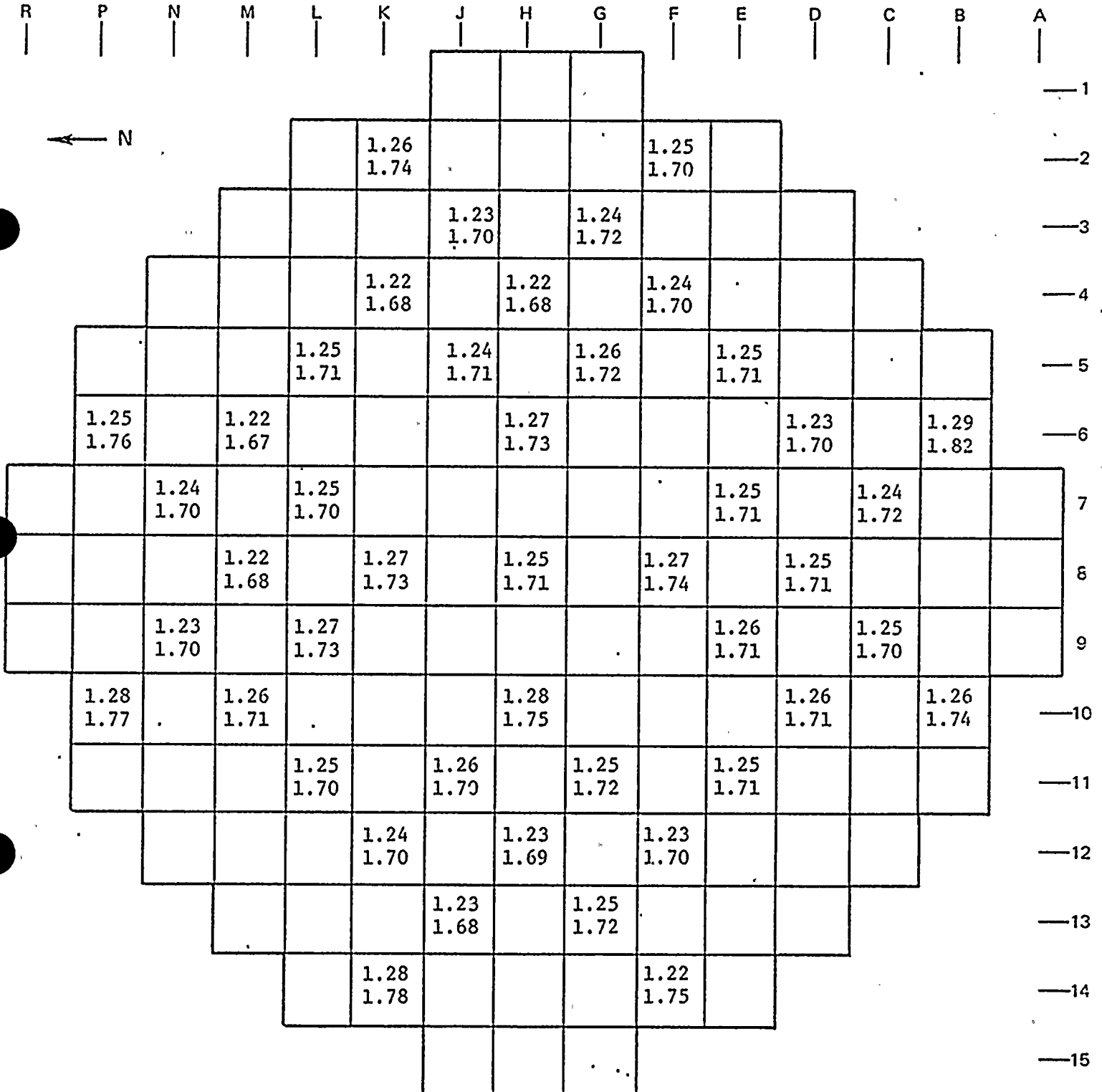
The following is a table of rod drops times as measured prior to Unit 4 Startup Physics Tests. The two times given are time to dashpot, a Technical Specification of 1.8 seconds or less, and time to the bottom of the core, which does not have a Technical Specification requirement.

All rods were dropped and met the Technical Specification requirement.

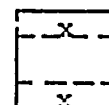


Date 6/5/76

Florida Power & Light Company
 REACTOR FUEL LOCATION
 TURKEY POINT PLANT UNIT NO. 4



LEGEND



Time to dash pot (sec)
 Time to bottom of core (sec)



2.0 Initial Criticality

The approach to criticality began June 6, 1976 at 1459 hours in accordance with Operating Procedure 0204.3, Initial Criticality After Refueling. Criticality was achieved June 6, 1976 at 2200 hours by withdrawing control rods to 119 step on Bank D and diluting 25,300 gallons of water.

Upon attaining criticality the flux level was increased to 1×10^{-8} amps on the immediate range to obtain critical data.

Tavg = 547°F

Control Bank = 119 steps

Flux = 1×10^{-8} amps

Boron = 1080 ppm

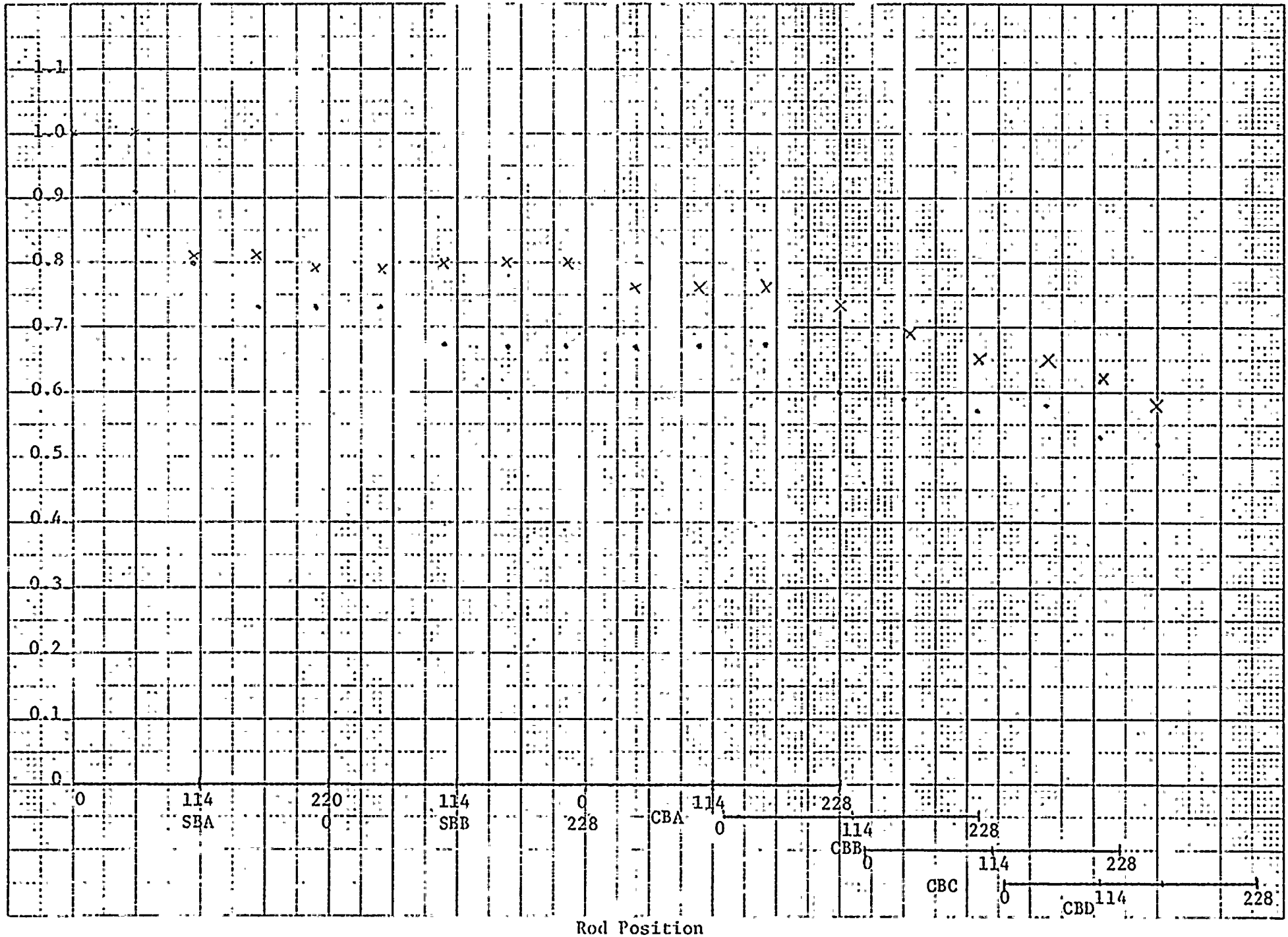
The following two graphs are a plot of the ICRR during the approach to criticality.



X - N31
 • - N32

ICRR Vs. Rod Position

Unit
 Cycle III





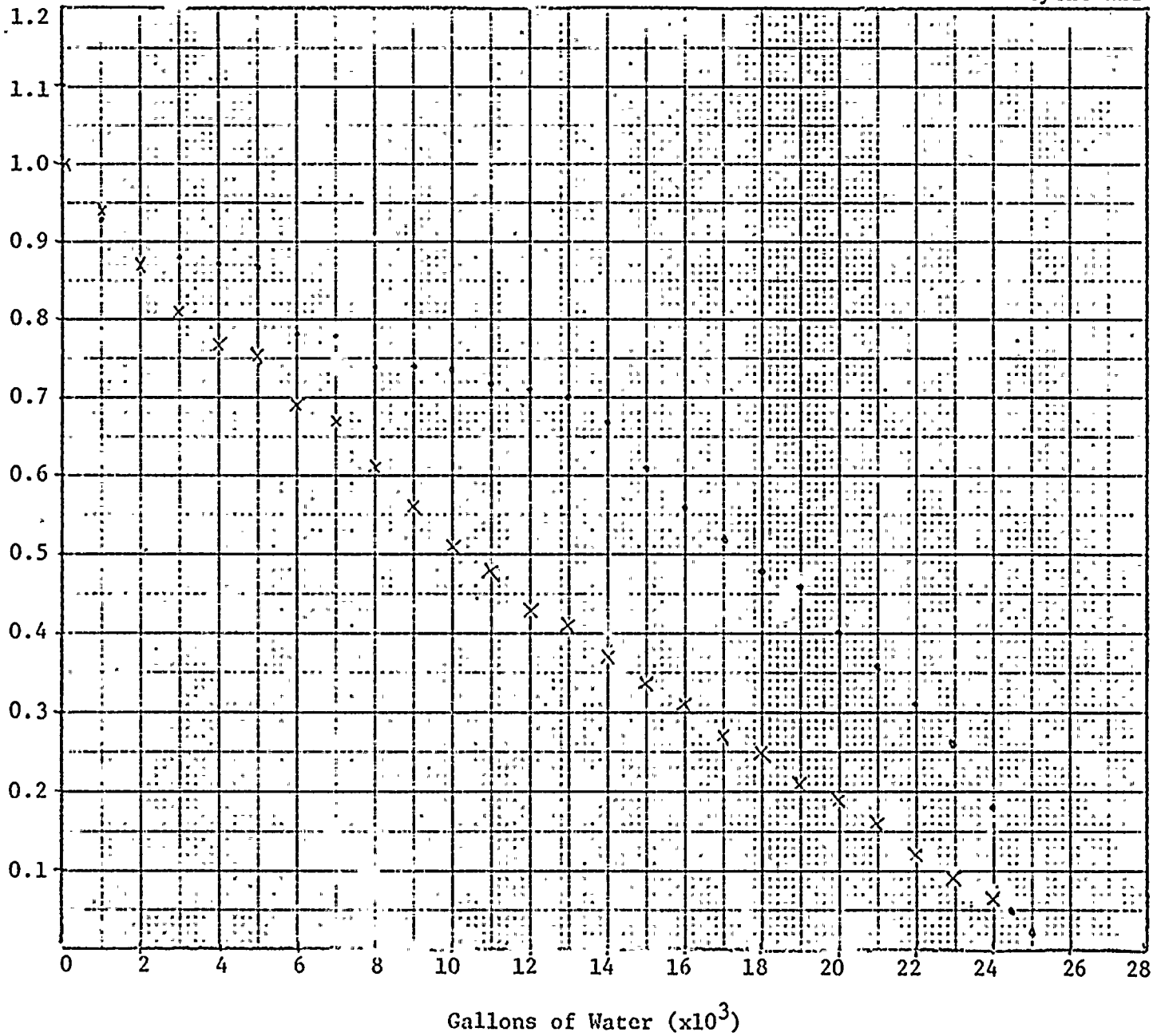
X - N31
• - N36

ICRR Vs. Dilution

Unit 4
Cycle III

ICRR

8





3.0 Summary of Tests

3.1 Nuclear Heating

3.2 Reactivity Vs. Period Check

3.3 Boron Endpoints

3.4 Rod Worths (PCM)

3.5 Rod Worths (PPM)

3.6 Temperature Coefficient



3.1 Nuclear Heating

Nuclear Heating was determined in accordance with Operating Procedure 0204.3, Initial Criticality After Refueling.

Nuclear heating first occurred at:

Kiethly Pico Ammeter = 7.5×10^{-7} amps

N-35 = 7.1×10^{-7} amps

N-36 = 7.3×10^{-7} amps

All physics tests were conducted at a flux level at or below 9.5×10^{-8} amps to assure nuclear heating did not occur.



3.2 Reactivity Vs. Period

Reactivity Computer Checkout was done in accordance with Operating Procedure 0204.3, Initial Criticality After Refueling. The results are as follows:

Period (sec)	Reactivity (pcm)	Reactivity (design)*	Diff (%)
140.8	41	40.5	-1.2
162	36.4	36.5	+0.3
199.4	30.5	30	-1.7
233.8	26	26.5	+1.9
248.2	24.5	24.8	+1.2
259	24	24	0
285.1	22.5	22	-2.3

*PRN delayed neutron data used.



3.3 Boron Endpoints

	Measured	PRN	Design Westinghouse
ARO	1095	1057	1043
D in	1032	993	977
D,C in	894	862	834
D,C,B in	832	768	756
D,C,B,A in	*--	604	589
D,C,B,A,SBB in	524	504	---
N-1 (F14)	539	552	492

*Not measured



3.4 Rod Worths (pcm)

Rods	Measured	Design	
		PRN	Westinghouse
D	673	669	699
C	1409	1356	1523
B	823	979	852
A	1733	1686	1826
SBB } SBA }	2490	2474	2710
TOTAL	7128	7164	7610
Diff(%)		+0.5%	+6.0%

3.5 Rod Worth (ppm)

Rods	*Measured	Design	
		PRN	Westinghouse
D	63	64	66
C	138	131	143
B	62	94	78
A } SBB }	308	264	---
ARI Less Most Reactive Rod	556	505	551

*Measurement uncertainty on PPM Boron is an average of ± 18 ppm



Temperature Coefficient

Temperature coefficient was measured in accordance with Operating Procedure 1604.6, Nuclear Design Check Tests.

The measured numbers are:

Isothermal Temperature Coefficient

Rods	Measured	Design (PRN)	Westinghouse
ARO	-1.2 pcm/°F	Not Calc	-2.3 pcm/°F
DIN**	-8.1 pcm/°F	Not Calc	-5.0 pcm/°F

*Moderator Temperature Coefficient

Rods	Measured	Design (PRN)	Westinghouse
ARO	+0.6 pcm/°F	-4.5 pcm/°F	-0.5 pcm/°F
DIN**	-6.3 pcm/°F	Not Calc	-3.2 pcm/°F

*Moderator Temperature Coefficient can be defined as Isothermal Temperature Coefficient minus Doppler Coefficient. Doppler Coefficient = -1.8 pcm/°F.

**Bank C = 214 steps



From the data taken the ARO case shows a positive moderator temperature coefficient of $+0.6 \text{ pcm}/^\circ\text{F}$. Technical Specification 3.1.2.6 states "the reactor shall not be made critical unless the moderator temperature coefficient is zero or negative . . . except for low power physics tests".

The point at which the moderator temperature coefficient is zero is defined as a boron concentration equal to or less than 1085 ppm or control bank D equal to or less than 194 steps.

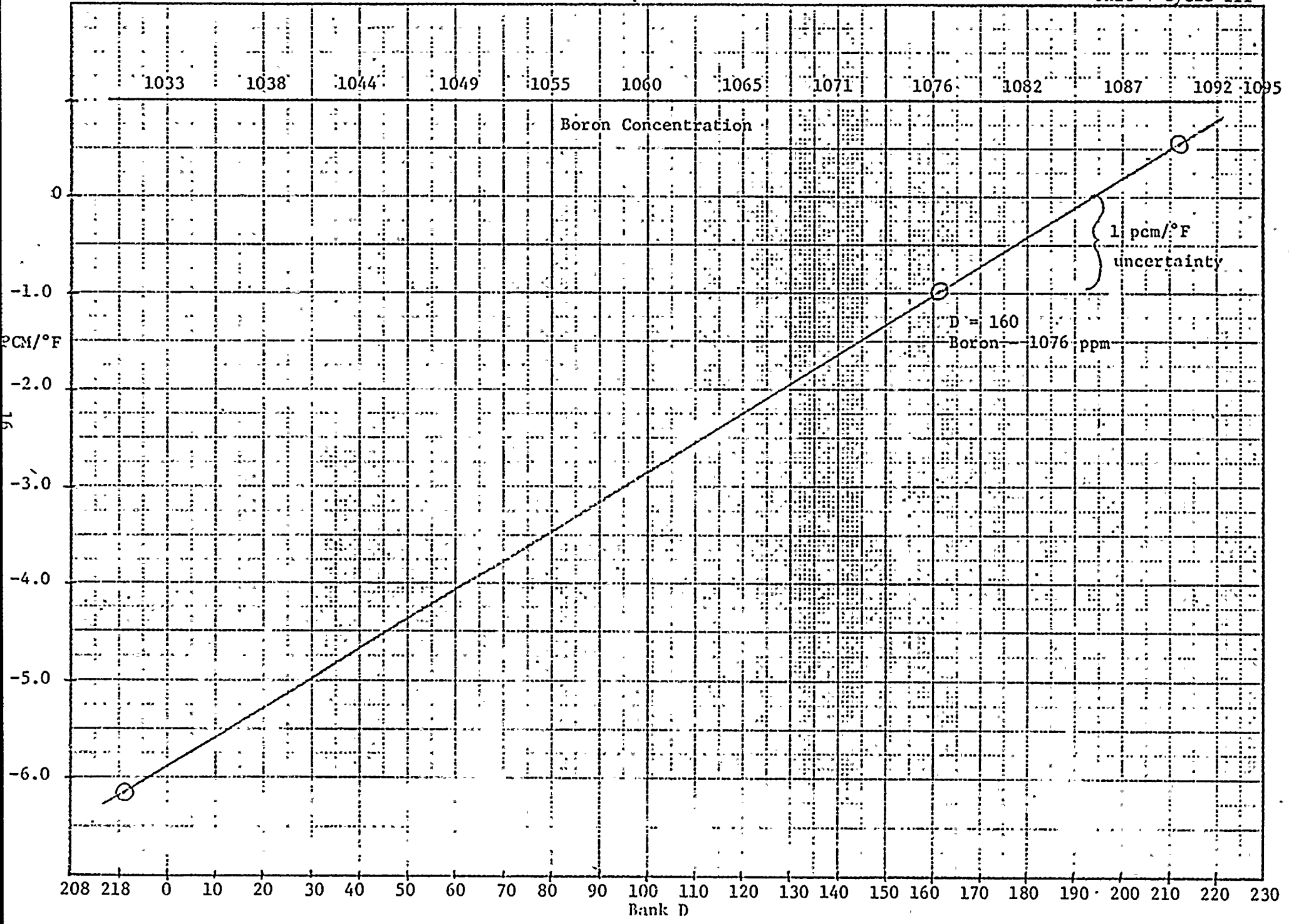
By assuming an error of $-1 \text{ pcm}/^\circ\text{F}$ the limit for a zero or negative moderator temperature coefficient is defined as a boron concentration equal to or less than 1076 ppm or control bank D equal to or less than 160 steps.

These limits assure a zero or negative moderator temperature coefficient for BOL operations.



Moderator Temperature Coefficient

Unit 4 Cycle III



1033 1038 1044 1049 1055 1060 1065 1071 1076 1082 1087 1092 1095

Boron Concentration

1 pcm/°F
uncertainty

D = 160
Boron = 1076 ppm

pcm/°F

Bank D



4.0 Shutdown Margin

Shutdown margin was calculated prior to power escalation to verify adequate shutdown capability. For this calculation design, numbers were used because of the excellent agreement with measured number. The following is a summary of the results:

4.1

	BOL (pcm)	EOL (pcm)
Rod Worth Stuck Rod Doppler Defect Moderator Defect	4324	3765
10% Rod Uncertainty	538	510
Rod Insertion	500	500
Flux Redistribution	500	850
Shutdown Margin	2786	1905
Required by Technical Specifications	1000	1770



5.0 Power Distribution Map

5.1 HZP Flux Map

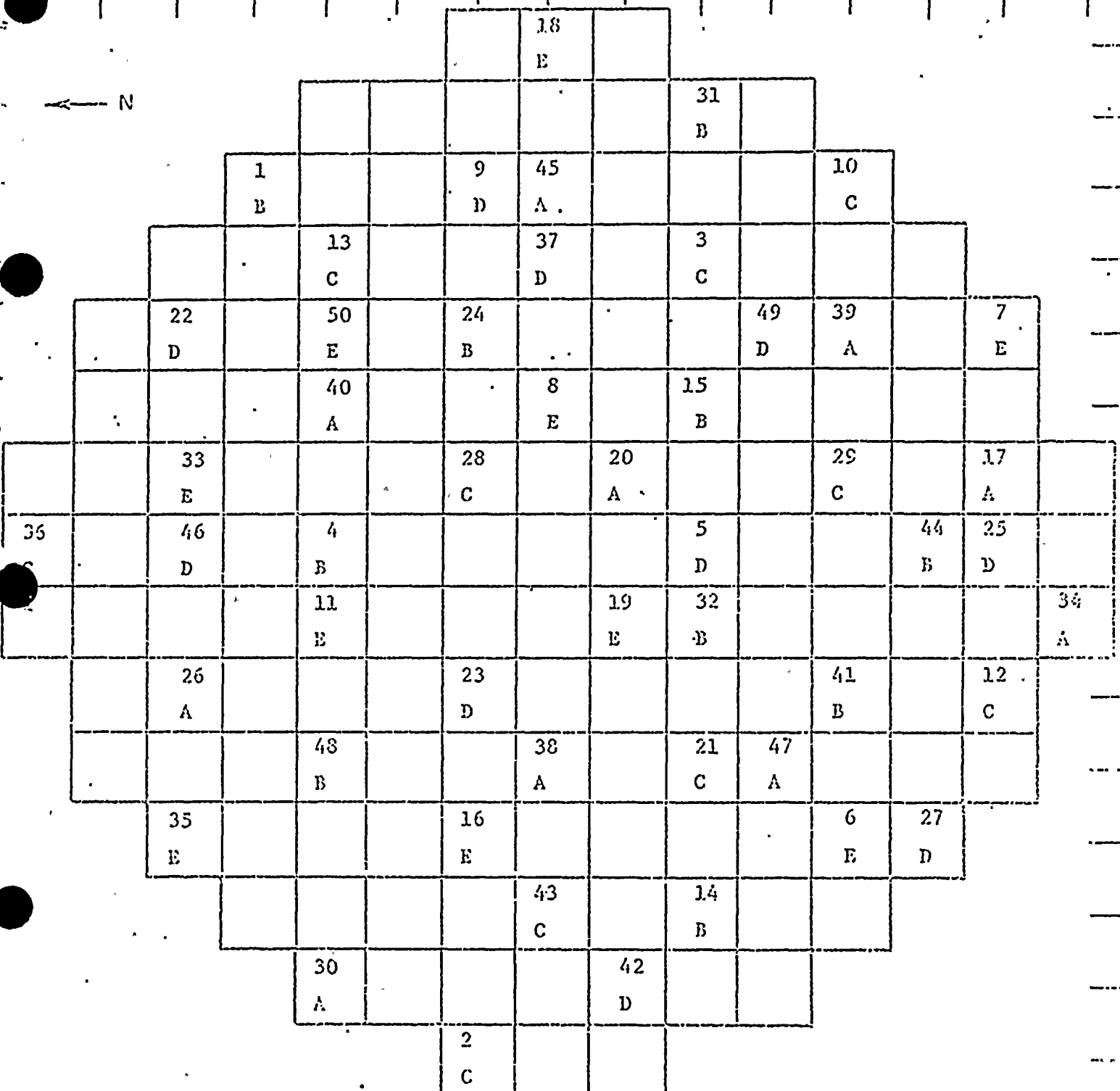
5.2 60% Flux Map



FLUX MAP THIMBLE LOCATIONS

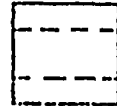
P | N | M | L | K | J | H | G | F | E | D | C | B | A

← N



LEGEND

Thimble
Detector





FLORIDA POWER & LIGHT COMPANY
 TURKEY POINT PLANT UNIT 4
 OPERATING SUMMARY

0.614 0.572 0.611
 0.640 0.596 0.640
 -4.0 -4.0 -4.6

0.723 1.095 1.103 0.693 1.091 1.043 0.682
 0.723 1.145 1.143 0.716 1.143 1.105 0.723
 -0.01 -0.91 -3.41 -3.41 -4.51 -5.61 -5.71

0.751 0.971 1.169 0.872 0.644 0.809 1.091 0.921 0.734
 0.751 0.958 1.132 0.877 0.863 0.877 1.132 0.956 0.751
 0.01 1.61 3.21 -2.91 -2.81 -3.21 -3.71 -3.71 -2.21

0.740 0.993 1.273 1.152 1.231 1.054 1.165 1.068 1.216 0.970 0.716
 0.740 0.976 1.235 1.197 1.169 1.047 1.189 1.171 1.235 0.976 0.740
 -0.21 1.81 3.11 4.31 3.51 0.61 -2.01 -1.71 -1.51 -0.61 -3.31

0.717 0.954 1.266 1.231 1.269 1.129 1.191 1.097 1.225 1.176 1.227 0.914 0.667
 0.715 0.944 1.225 1.199 1.234 1.055 1.092 1.056 1.234 1.199 1.225 0.944 0.715
 0.21 2.11 3.31 2.81 8.81 9.11 3.91 -0.71 -1.91 0.21 -3.21 -6.71

1.097 1.124 1.136 1.287 1.164 1.277 1.090 1.248 1.126 1.233 1.109 1.087 1.012
 1.095 1.122 1.101 1.226 1.108 1.191 0.901 1.101 1.158 1.220 1.101 1.172 1.095
 0.21 0.21 3.11 4.71 5.11 6.21 11.11 5.71 1.71 0.41 0.71 -3.11 -7.51

0.594 1.115 0.693 1.216 1.172 1.254 1.047 1.065 1.017 1.213 1.074 1.210 0.871 1.040 0.581
 0.694 1.133 0.890 1.182 1.511 1.179 0.977 0.993 0.977 1.179 1.051 1.182 0.890 1.133 0.634
 -6.31 -1.51 0.31 2.81 0.71 6.01 6.51 7.21 4.11 2.91 2.21 2.31 -2.21 -6.21 -6.41

20

0.594 0.694 0.661 1.076 1.174 1.051 1.053 0.824 1.044 0.949 1.135 1.057 0.855 0.883 0.541
 0.591 0.712 0.662 1.043 1.891 0.901 1.000 0.787 1.000 0.903 1.069 1.043 0.662 0.712 0.591
 -6.31 -2.51 -0.21 3.31 8.31 6.31 4.71 4.41 5.11 4.31 0.91 -0.81 -4.61 -2.41

0.544 1.043 0.850 1.199 1.751 1.238 1.039 1.033 1.017 1.257 1.007 1.170 0.872 1.069 0.599
 0.694 1.133 0.890 1.182 1.511 1.179 0.977 0.993 0.977 1.179 1.051 1.182 0.890 1.133 0.634
 -6.31 -4.31 -2.81 1.41 2.31 5.21 5.51 4.01 4.11 6.01 3.61 -1.61 -2.01 -3.91 -5.51

1.055 1.061 1.069 1.223 1.103 1.270 0.957 1.238 1.139 1.225 1.086 1.063 1.034
 1.095 1.122 1.101 1.226 1.109 1.181 0.900 1.181 1.168 1.228 1.101 1.122 1.095
 -5.51 -5.41 -2.91 -0.41 -0.41 7.61 6.41 4.61 2.81 -0.31 -1.41 -3.41 -5.51

0.683 0.902 1.179 1.164 1.231 1.110 1.174 1.108 1.258 1.157 1.189 0.911 0.675
 0.715 0.944 1.225 1.197 1.234 1.054 1.092 1.056 1.234 1.199 1.225 0.944 0.715
 -4.51 -4.51 -3.71 -3.01 -1.11 5.11 7.51 4.91 2.01 -3.61 -3.01 -3.51 -5.61

0.714 0.943 1.197 1.118 1.221 1.111 1.223 1.111 1.263 0.940 0.714
 0.740 0.976 1.235 1.107 1.139 1.047 1.185 1.171 1.235 0.976 0.740
 -3.51 -3.31 -3.01 0.71 2.71 5.11 2.81 -0.61 -2.41 -3.61 -3.61

0.701 0.863 1.072 1.092 0.690 0.603 1.113 0.934 0.724
 0.751 0.955 1.122 0.897 0.866 0.697 1.132 0.956 0.751
 -6.71 -9.71 -5.51 2.61 2.01 -1.51 -1.71 -2.41 -3.61

1.653 0.998 1.102 0.721 1.124 1.086 0.711
 0.723 1.105 1.143 0.715 1.143 1.105 0.723
 -9.81 -9.71 -3.51 0.51 -1.71 -1.71 -1.81

0.578 0.586 0.629 MEASURED F RECTA H
 0.640 0.596 0.640 EXPECTED F DELTA H
 -9.71 -1.71 -1.71 DIFFERENCE

ROD POSITION

Bank	Location In Steps	Classification
SBA	228	Map No: FM4I111
SBB	228	Power (%) 0
CEA	228	Axial Offset +27.76
CBB	228	
CBC	228	Max F _N _{ΔH} 1.414
CBD	208	
P/L	228	Max F _N _Q 2.121



FLORIDA POWER & LIGHT COMPANY
 TURKEY POINT PLANT UNIT 4
 OPERATING SUMMARY

10.610:0.594:0.659:
 10.634:0.606:0.634:
 -3.7: -1.9: 4.0:

10.700:1.037:1.061:0.690:1.093:1.083:0.731:
 10.703:1.041:1.093:0.729:1.093:1.041:0.703:
 -0.3: -0.3: -2.9: -5.4: -0.0: 4.0: 4.0:

10.753:0.941:1.093:0.893:0.828:0.857:1.141:0.968:0.753:
 10.741:0.731:1.077:0.900:0.866:0.900:1.097:0.931:0.741:
 1.6: 1.1: -0.3: -0.8: -7.6: -4.8: 4.0: 4.0: 1.6:

10.739:0.970:1.227:1.100:1.154:1.006:1.106:1.098:1.203:0.959:0.737:
 0.733:0.955:1.198:1.693:1.195:1.081:1.195:1.093:1.198:0.955:0.733:
 0.6: 1.6: 2.5: 0.6: -3.4: -7.0: -7.4: 0.5: 0.5: 0.5: 0.6:

0.704:0.930:1.205:1.203:1.234:1.075:1.115:1.065:1.227:1.18:1.197:0.928:0.703:
 0.698:0.923:1.191:1.170:1.227:1.081:1.132:1.081:1.227:1.176:1.191:0.923:0.698:
 0.8: 0.6: 1.1: 2.3: 0.6: -0.5: -1.3: -1.5: -1.5: 0.0: 0.5: 6.6: 0.7:

1.038:1.094:1.093:1.214:1.122:1.222:0.968:1.219:1.122:1.225:1.096:1.089:1.029:
 1.037:1.092:1.091:1.224:1.127:1.221:0.961:1.221:1.127:1.224:1.091:1.092:1.037:
 0.1: 0.1: 0.2: -0.8: -0.4: 0.1: 2.9: -0.1: -0.5: 0.1: 0.5: -0.3: -0.7:

0.622:1.075:0.892:1.194:1.081:1.208:1.021:1.073:1.015:1.205:1.074:1.148:0.875:0.666:0.622:
 0.632:1.089:0.897:1.192:1.074:1.220:1.045:1.081:1.045:1.220:1.078:1.192:0.897:0.632:
 -1.6: -1.3: -0.6: -0.7: 0.3: -1.0: -2.2: -0.7: -2.8: -1.2: -0.3: -3.7: -2.4: -2.1: -1.6:

0.593:0.711:0.858:1.009:1.145:0.959:1.061:0.870:1.081:0.963:1.143:1.040:0.852:0.721:0.595:
 0.604:0.727:0.863:1.000:1.130:0.964:1.087:0.894:1.087:0.964:1.130:1.080:0.863:0.727:0.604:
 -1.9: -2.1: -2.8: -1.9: 1.3: -0.5: -2.3: -2.7: -0.5: -0.1: 1.1: -3.7: -3.6: -0.8: -1.4:

0.613:1.056:0.671:1.172:1.051:1.221:1.067:1.124:1.070:1.203:1.103:1.148:0.673:1.07:1.062:
 0.632:1.089:0.897:1.192:1.074:1.220:1.045:1.081:1.045:1.220:1.078:1.192:0.897:1.089:0.632:
 -2.9: -2.9: -2.9: -1.6: -2.4: 0.1: 4.0: 4.0: 2.4: 3.6: 2.4: -3.7: -2.6: 1.7: -1.8:

1.038:1.087:1.078:1.209:1.142:1.269:0.981:1.245:1.153:1.235:1.085:1.077:1.018:
 1.037:1.092:1.091:1.224:1.127:1.221:0.961:1.221:1.127:1.224:1.091:1.092:1.037:
 0.2: -0.4: -1.2: -1.2: 1.4: 3.9: 2.1: 2.0: 2.3: 0.9: -0.5: -1.4: -1.8:

0.721:0.953:1.206:1.175:1.247:1.193:1.135:1.083:1.220:1.176:1.189:0.924:0.692:
 0.698:0.923:1.191:1.170:1.227:1.081:1.132:1.081:1.227:1.176:1.191:0.923:0.698:
 3.2: 3.2: 1.2: 0.2: 1.6: 2.1: 0.3: 0.2: -0.5: -0.5: -0.2: 0.1: -0.8:

0.757:0.976:1.203:1.109:1.219:1.094:1.211:1.110:1.202:0.956:0.734:
 0.733:0.955:1.198:1.093:1.195:1.081:1.195:1.093:1.198:0.955:0.733:
 3.2: 2.2: 0.2: 1.4: 2.0: 1.1: 1.4: 1.5: 0.4: 0.1: 0.1:

0.756:0.939:1.113:0.919:0.907:0.923:1.125:0.947:0.742:
 0.741:0.931:1.097:0.966:0.900:1.097:0.931:0.741:
 2.6: 0.0: 1.5: 2.1: 2.3: 2.4: 2.6: 1.8: 6.1:

0.700:1.049:1.113:0.748:1.122:1.066:0.721:
 0.703:1.041:1.093:0.729:1.093:1.041:0.703:
 0.0: 0.8: 1.8: 2.6: 2.6: 2.6: 2.6:

0.645:0.622:0.650: MEASURED F DELTA H
 0.634:0.606:0.634: EXPECTED F DELTA H
 1.7: 2.6: 2.6: DIFFERENCE

INCORE
 TILTS

Table

0.9945	0.9938
1.0066	1.0051

ROD POSITION

Bank	Location In Steps	Classification
SBA	228	Map No: FM4III2
SBB	228	Power (%) 59.3
CBA	228	Axial Offset -2.48
CBB	228	
CBC	228	Max F _N ^N 1.399
CBD	169	
P/L	228	Max F _Q ^N 1.829

21

