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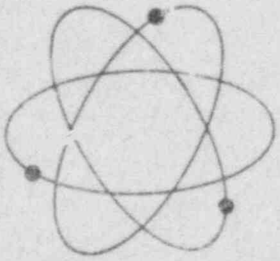
NORTH ANNA UNIT 1, CYCLE 2
STARTUP PHYSICS TEST REPORT



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FUEL RESOURCES DEPARTMENT

VIRGINIA ELECTRIC AND POWER COMPANY

VEP-FRD-35

NORTH ANNA UNIT 1, CYCLE 2
STARTUP PHYSICS TEST REPORT

BY

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PREFACE

The purpose of this report is to present the analysis and evaluation of the physics tests which were performed to verify that the North Anna 1, Cycle 2 core could be operated safely, and to make an initial evaluation of the expected performance of the core. It is not the intent of this report to discuss the particular methods of testing or to present the detailed data taken. Standard test techniques and methods of data analysis were used. The test data, results and evaluations, together with the detailed startup procedures, are on file at the North Anna Power Station. Therefore, only a cursory discussion of these items is included in this report. The analyses presented includes a brief summary of each test, a comparison of the test results with design predictions, and an evaluation of the results.

The North Anna 1, Cycle 2 Startup Physics Tests Results and Evaluation Sheets have been included as an appendix to provide additional information on the startup test results. Each data sheet provides the following information: 1) test identification, 2) test conditions (design), 3) test conditions (actual), 4) test results, 5) acceptance criteria, and 6) comments concerning the test. These sheets provide a compact summary of the startup test results in a consistent format. The design test conditions and design values of the measured parameters were completed prior to startup physics testing. The entries for the design values were based on calculations performed by Vepco's Nuclear Fuel Engineering Group.[1] During the tests, the data sheets were used as guidelines both to verify that the proper test conditions were met and to facilitate the preliminary comparison between measured and predicted test results, thus enabling a quick identification of possible problems occurring during the tests. The appendix to this report contains the final completed and approved version of the Startup Physics Tests Results and Evaluation Sheets.

INTRODUCTION AND SUMMARY

On September 25, 1979, Unit No. 1 of the North Anna Power Station was shutdown for its first refueling. During this shutdown, 52 of the 157 fuel assemblies in the core were replaced with fresh fuel assemblies. The second cycle core consists of four regions of fuel: three once-burned regions from Cycle 1 (Regions 1A, 2 and 3), and one fresh region (Region 4). The core loading pattern and the design parameters for each region are shown in Figure 1.1. The core location of each fuel assembly is identified in Figure 1.2 together with the incore instrumentation locations. Figure 1.3 identifies the location and number of burnable poison rods in the Cycle 2 core. Figure 1.4 identifies the location and number of control rods in the Cycle 2 core.

On January 15, 1980, at 1624, the second cycle core achieved initial criticality. Following criticality, startup physics tests were performed as outlined in Table 1.1. A summary of the results of these tests follows:

1. The drop time of each control rod was confirmed to be within the 2.2 second limit of the Technical Specifications.[2]
2. The reactor coolant system flow rate was confirmed to be greater than the minimum limit specified in the Technical Specifications.
3. Individual control rod bank worths for control banks A through D and shutdown bank B were measured to be within 7.9% of the design predictions. The total control rod bank worth in the overlap mode was measured to be within 4.2% of the design prediction. In addition, the total worth of all

control and shutdown banks less the most reactive rod (RCCA H-14) was measured to be within 1.7% of the design prediction. These results are within the design tolerance of ±15% for individual bank worths and the design tolerance of ±10% for the total control bank worth and the total worth of N-1 rods.

4. Critical boron concentrations for six basic control and shutdown bank configurations and for the all-rods-in less the most reactive rod condition were measured to be within 34 ppm of the design predictions. These results are within the design tolerances and also met the accident analysis acceptance criterion.

5. The boron worth coefficient was measured to be within 3.8% of the design prediction, which is within the design tolerance of ±10% and met the accident analysis acceptance criterion.

6. Isothermal temperature coefficients over the range of normal operating control rod bank insertions were measured to be within 2.6 pcm/^{o}F of the design predictions. These results are within the design tolerance of ±3 pcm/^{o}F and also met the accident analysis acceptance criterion.

7. Core power distributions for various HZP and at-power conditions were generally within 7% of the predicted power distributions. The quadrant power tilt ratio at ARO, HZP was 1.09, decreasing to 1.01 at HFP. This directly affected the values of the hot channel factors. The control rod insertion limits were raised on an administrative basis, with NRC concurrence, in order to preclude potential violations of the $F^{N}_{\Delta H}$ Technical Specifications limit.

In summary, all startup physics test results were acceptable. Detailed results together with specific design tolerances and acceptance criteria for each measurement are presented in the appropriate sections of this report.

Table 1.1

NORTH ANNA UNIT 1 - BOL CYCLE 2 PHYSICS TESTS

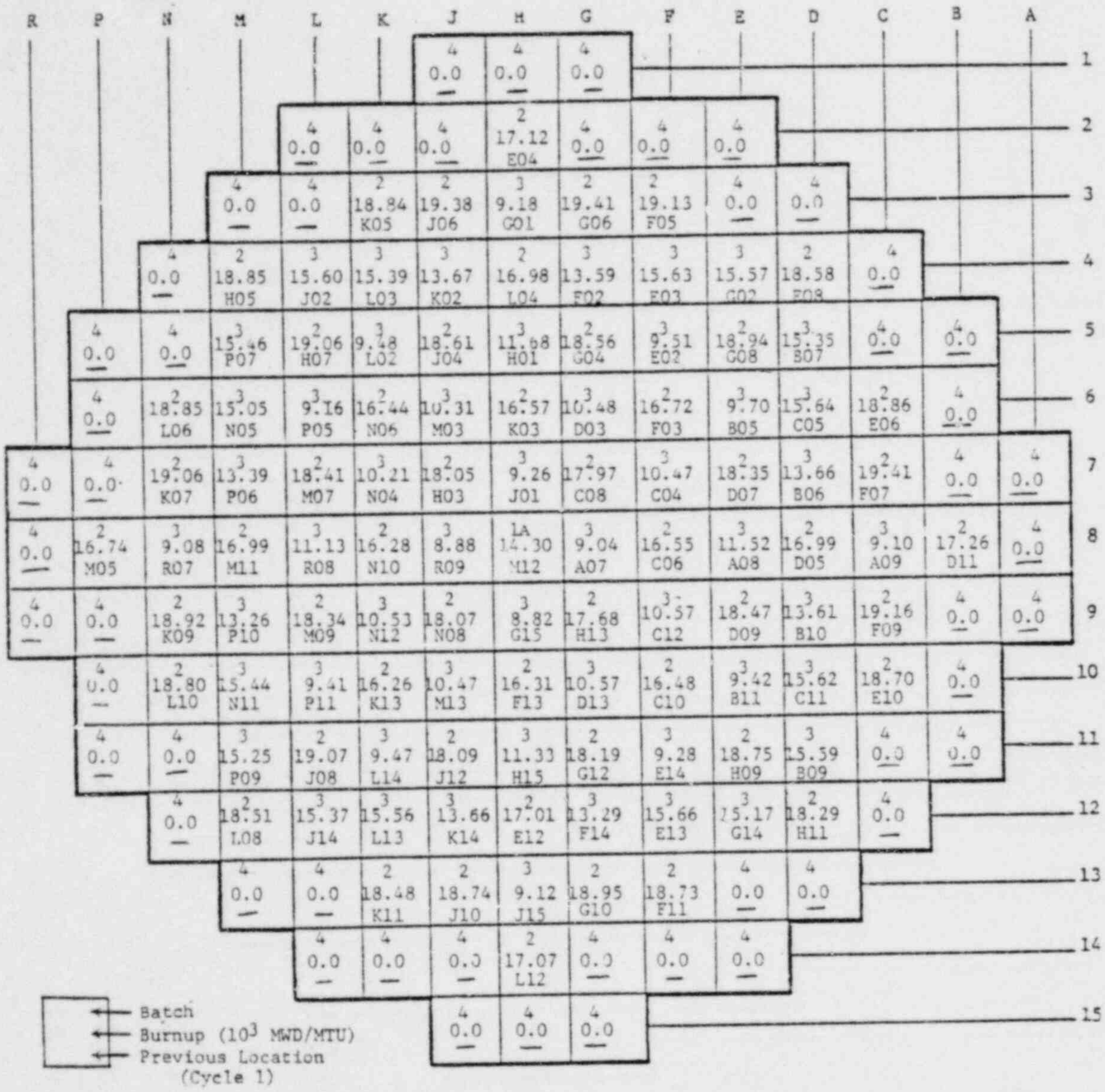
CHRONOLOGY OF TESTS

Test	Date	Time	Power	Reference Procedure
Hot Rod Drops-Hot Full Flow	1-12-80	1455	HSD	1-PT-17.2
Reactivity Computer Checkout	1-16-80	0735	HZP	1-PT-94(B)
Boron Endpoint - ARO	1-16-80	1205	HZP	1-PT-94(C)
Temperature Coefficient - ARO	1-16-80	1434	HZP	1-PT-94(D)
Flux Map - ARO	1-16-80	1733	HZP	1-PT-21.1
Bank D Worth	1-17-80	0924	HZP	1-PT-94(E)
Boron Endpoint - D In	1-17-80	1455	HZP	1-PT-94(C)
Temperature Coefficient - D In	1-17-80	1655	HZP	1-PT-94(D)
Flux Map - D In	1-17-80	2027	HZP	1-PT-21.1
Bank C Worth	1-18-80	1756	HZP	1-PT-94(E)
Boron Endpoint - C In	1-18-80	1929	HZP	1-PT-94(C)
Bank B Worth	1-19-80	0400	HZP	1-PT-94(E)
Boron Endpoint - B In	1-19-80	0454	HZP	1-PT-94(C)
Bank A Worth	1-19-80	1829	HZP	1-PT-94(E)
Boron Endpoint - A In	1-19-80	1901	HZP	1-PT-94(C)
N-1 Worth	1-20-80	0215	HZP	1-PT-94(H)
Boron Endpoint - N-1	1-20-80	0211	HZP	1-PT-94(H)
Boron Endpoint - SB In	1-20-80	0403	HZP	1-PT-94(H)
Bank SB Worth	1-20-80	0603	HZP	1-PT-94(H)
Banks A→D Worth in Overlap	1-20-80	1345	HZP	1-PT-94(F)
Flux Map - ARO	1-20-80	2014	∿3%	1-PT-21.1
Flux Map - D at 0 Steps C at 118 Steps	1-21-80	0120	∿3%	1-PT-21.1
Flux Map-D at 100 Steps	1-21-80	1344	∿3%	1-PT-21.1
Flux Map - I/E Calibration	1-24-80	1749	∿30%	1-PT-22.2
Flux Map - I/E Calibration	1-25-80	1006	∿30%	1-PT-22.2
Flux Map - APDMS, I/E Calibration	1-25-80	1511	∿30%	1-PT-22.2
Flux Map - APDMS, I/E Calibration	1-26-80	1644	∿30%	1-PT-22.2
Flux Map - APDMS, I/E Calibration	1-29-80	0429	∿47%	1-PT-22.2
RCS Flow Measurement	1-29-80	0545	∿48%	1-PT-27
Flux Map - APDMS, I/E Calibration	1-31-80	1209	∿45%	1-PT-22.2
Flux Map - APDMS, I/E Calibration	2-03-80	1353	∿66%	1-PT-22.2
Flux Map - APDMS, I/E Calibration	2-04-80	0144	∿83%	1-PT-22.2
RCS Flow Measurement	2-05-80	1555	∿99%	1-PT-27
Flux Map - I/E Calibration	2-07-80	1136	∿99%	1-PT-22.2
Flux Map - I/E Calibration	2-07-80	1905	∿99%	1-PT-22.2
Flux Map - HFP, Eq. Xenon	2-14-80	1616	100%	1-PT-21.1

Figure 1.1

NORTH ANNA UNIT 1 - CYCLE 2

CORE LOADING MAP



	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							4 0.0 —	4 0.0 —	4 0.0 —						
2					4 0.0 —	4 0.0 —	4 0.0 —	2 17.12 E04	4 0.0 —	4 0.0 —	4 0.0 —				
3				4 0.0 —	4 0.0 —	2 18.84 K05	2 19.38 J06	3 9.18 G01	2 19.41 G06	2 19.13 F05	4 0.0 —	4 0.0 —			
4			4 0.0 —	2 18.85 H05	3 15.60 J02	3 15.39 L03	3 13.67 K02	2 16.98 L04	3 13.59 F02	3 15.63 E03	3 15.57 G02	2 18.58 F08	4 0.0 —		
5		4 0.0 —	4 0.0 —	3 15.46 P07	2 19.06 H07	3 9.48 L02	2 18.61 J04	3 11.68 H01	2 18.56 G04	3 9.51 E02	2 18.94 G08	3 15.35 B07	4 0.0 —	4 0.0 —	
6		4 0.0 —	2 18.85 L06	3 15.05 N05	3 9.16 P05	2 16.44 N06	3 10.31 M03	2 16.57 K03	3 10.48 D03	2 16.72 F03	3 9.70 B05	3 15.64 C05	2 18.86 E06	4 0.0 —	
7	4 0.0 —	4 0.0 —	2 19.06 K07	3 13.39 P06	2 18.41 M07	3 10.21 N04	2 18.05 H03	3 9.26 J01	2 17.97 C08	3 10.47 C04	2 18.35 D07	3 13.66 B06	2 19.41 F07	4 0.0 —	4 0.0 —
8	4 0.0 —	2 16.74 M05	3 9.08 R07	2 16.99 M11	3 11.13 R08	2 16.28 N10	3 8.88 R09	1A 14.30 M12	3 9.04 A07	2 16.55 C06	3 11.52 A08	2 16.99 D05	3 9.10 A09	2 17.26 D11	4 0.0 —
9	4 0.0 —	4 0.0 —	2 18.92 K09	3 13.26 P10	2 18.34 M09	3 10.53 N12	2 18.07 N08	3 8.82 G15	2 17.68 H13	3 10.57 C12	2 18.47 D09	3 13.61 B10	2 19.16 F09	4 0.0 —	4 0.0 —
10		4 0.0 —	2 18.80 L10	3 15.44 N11	3 9.41 P11	2 16.26 K13	3 10.47 M13	2 16.31 F13	3 10.57 D13	2 16.48 C10	3 9.42 B11	3 15.62 C11	2 18.70 E10	4 0.0 —	
11		4 0.0 —	4 0.0 —	3 15.25 P09	2 19.07 J08	3 9.47 L14	2 18.09 J12	3 11.33 H15	2 18.19 G12	3 9.28 E14	2 18.75 H09	3 15.59 B09	4 0.0 —	4 0.0 —	
12			4 0.0 —	2 18.51 L08	3 15.37 J14	3 15.56 L13	3 13.66 K14	2 17.01 E12	3 13.29 F14	3 15.66 E13	3 15.17 G14	2 18.29 H11	4 0.0 —		
13				4 0.0 —	4 0.0 —	2 18.48 K11	2 18.74 J10	3 9.12 J15	2 18.95 G10	2 18.73 F11	4 0.0 —	4 0.0 —			
14					4 0.0 —	4 0.0 —	4 0.0 —	2 17.07 L12	4 0.0 —	4 0.0 —	4 0.0 —				
15							4 0.0 —	4 0.0 —	4 0.0 —						

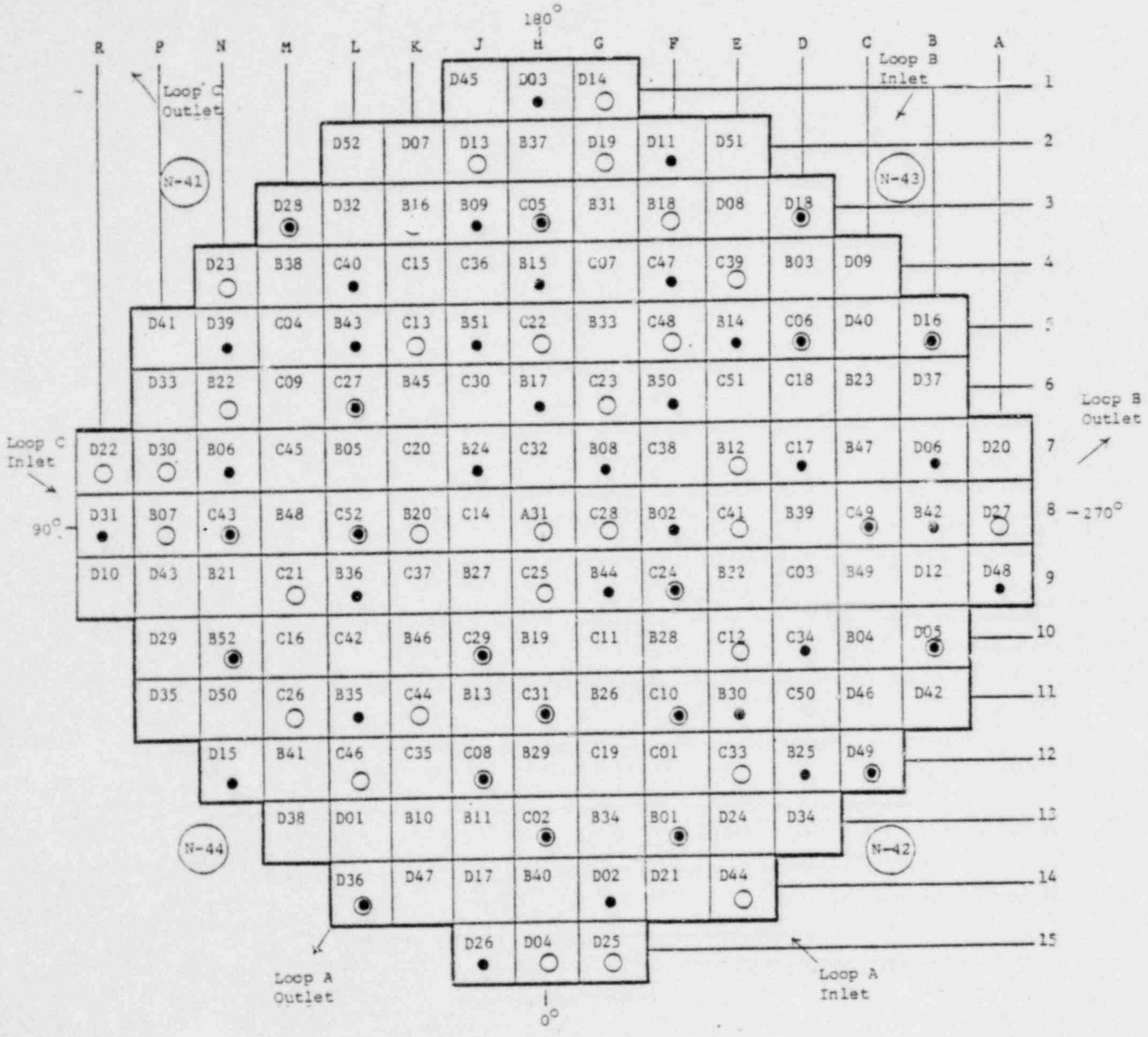
FUEL ASSEMBLY DESIGN PARAMETERS

	Batch			
	1A	2	3	4
Initial Enrichment (w/o U235)	2.11	2.60	3.10	3.21
Burnup At BOC-2 (MWD/MTU)	14,300	18,077	12,166	0
Assembly Type	17X17	17X17	17X17	17X17
No. of Assemblies	1	52	52	52
Fuel Rods per Assembly	264	264	264	264

Figure 1.2

NORTH ANNA UNIT 1 - CYCLE 2

ASSEMBLY ID's AND INCORE INSTRUMENTATION LOCATIONS



	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							D45	D03 ●	D14 ○						
2					D52	D07	D13 ○	B37	D19 ○	D11 ●	D51				
3				D28 ◉	D32	B16 ○	B09 ●	C05 ◉	B31	B18 ○	D08	D18 ◉			
4			D23 ○	B38	C40 ●	C15	C36	B15 ●	C07	C47 ●	C39 ○	B03	D09		
5		D41	D39 ●	C04	B43 ●	C13 ○	B51 ●	C22 ○	B33	C48 ○	B14 ●	C06 ◉	D40	D16 ◉	
6		D33	B22 ○	C09	C27 ◉	B45	C30	B17 ●	C23 ○	B50 ●	C51	C18	B23	D37	
7	D22 ○	D30 ○	B06 ●	C45	B05	C20	B24 ●	C32	B08 ●	C38	B12 ○	C17 ●	B47	D06 ●	D20
8	D31 ●	B07 ○	C43 ◉	B48	C52 ◉	B20 ○	C14	A31 ○	C28 ○	B02 ●	C41 ○	B39	C49 ◉	B42 ●	D27 ○
9	D10	D43	B21	C21 ○	B36 ●	C37	B27	C25 ○	B44 ●	C24 ◉	B32	C03	B49	D12	D48 ●
10		D29	B52 ◉	C16	C42	B46	C29 ◉	B19	C11	B28	C12 ○	C34 ●	B04	D05 ◉	
11		D35	D50	C26 ○	B35 ●	C44 ○	B13	C31 ◉	B26	C10 ◉	B30 ●	C50	D46	D42	
12			D15 ●	B41	C46 ○	C35	C08 ◉	B29	C19	C01	C33 ○	B25 ●	D49 ◉		
13				D38	D01	B10	B11	C02 ◉	B34	B01 ◉	D24	D34			
14					D36 ◉	D47	D17	B40	D02 ●	D21	D44 ○				
15							D26 ●	D04 ○	D25 ○						

← Fuel Assembly I.D. Number
← Indicates Location and Type of Incore Instrumentation

● M/D

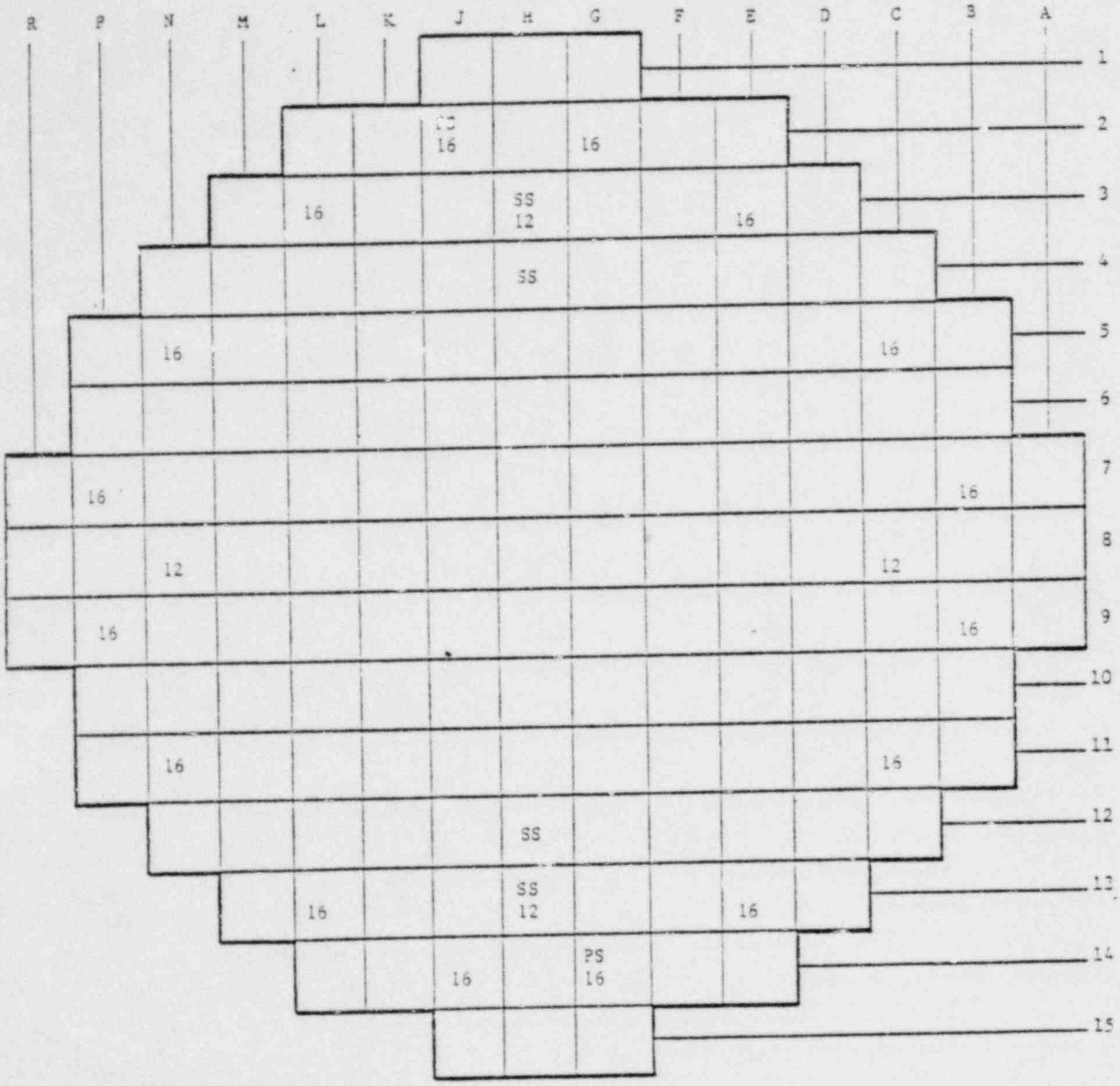
○ T/C

◉ Both M/D and T/C

Figure 1.3

NORTH ANNA UNIT 1 - CYCLE 2

BURNABLE POISON AND SOURCE ASSEMBLY LOCATIONS



R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
															1
						PS 16		16							2
				16			SS 12			16					3
							SS								4
		16										16			5
															6
	16												16		7
		12										12			8
	16												16		9
															10
		16										16			11
							SS								12
				16			SS 12			16					13
						16		PS 16							14
															15

PS - Primary Source

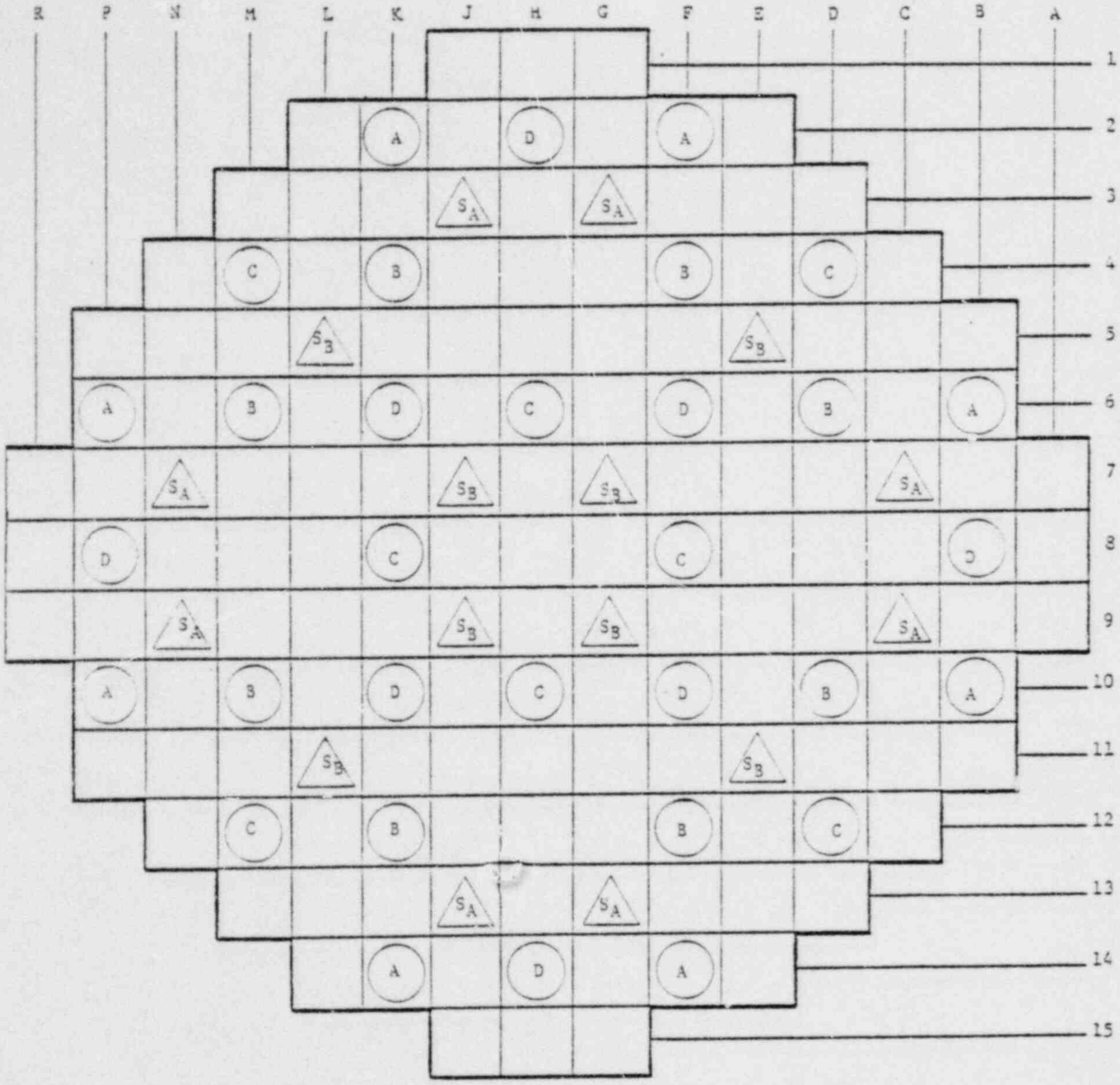
SS - Secondary Source

304 Depleted Burnable Poison Rods

Figure 1.4

NORTH ANNA UNIT 1 - CYCLE 2

CONTROL ROD LOCATIONS



Function	Number of Clusters
Control Bank D	8
Control Bank C	8
Control Bank B	8
Control Bank A	8
Shutdown Bank S_B	8
Shutdown Bank S_A	8

CONTROL ROD DROP TIME MEASUREMENTS

The drop time of each control rod was measured at cold and at hot RCS conditions in order to confirm satisfactory operation and to verify that the rod drop times were less than the maximum allowed by the Technical Specifications. The hot control rod drop time measurements were run with the RCS at hot, full flow conditions ($\sim 547^{\circ}$F, $\sim$2235 psig) and are described below.

The rod drop time measurements were performed by first withdrawing a rod bank to its fully withdrawn position, and then removing the movable gripper coil fuse and stationary gripper coil fuse for the test rod. This allows the rod to drop into the core as it would in a normal plant trip. The data recorded during this test are, the stationary gripper coil voltage, the IRPI (Integrated Rod Position Indicator) detector primary coil voltage and a 60Hz timing trace which are recorded via a visicorder. The rod drop time to the dashpot entry and to the bottom of the dashpot are determined from this data. Figure 2.1 provides an example of the data that is recorded during a rod drop time measurement.

As shown in Figure 2.1, the initiation of the rod drop is indicated by the decay of the stationary gripper coil voltage when the stationary gripper coil fuse is removed. A voltage is then induced in the IRPI detector primary coil as the rod drops. The magnitude of this voltage is a function of the rod velocity. When the rod enters the dashpot section of its guide tube, the velocity slows causing a voltage decrease in the IRPI coil. The IRPI voltage then reaches a minimum as the rod reaches the bottom of the dashpot. Subsequent variations in the trace are caused by the rod bouncing. This procedure was repeated for each control rod.

The measured drop times for each control rod are recorded on Figure 2.2. The slowest, fastest and average drop times are summarized in Table 2.1. Technical Specification 3.1.3.4 specifies a maximum rod drop time from loss of stationary gripper coil voltage to dashpot entry of 2.2 seconds with the RCS at hot, full flow conditions. All test results met this limit.

Table 2.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS

HOT ROD DROP TIME SUMMARY

ROD DROP TIME TO DASHPOT ENTRY

Slowest Rod	Fastest Rod	Average Time
B-6, 1.78 sec.	C-9, 1.48 sec.	1.63 sec.

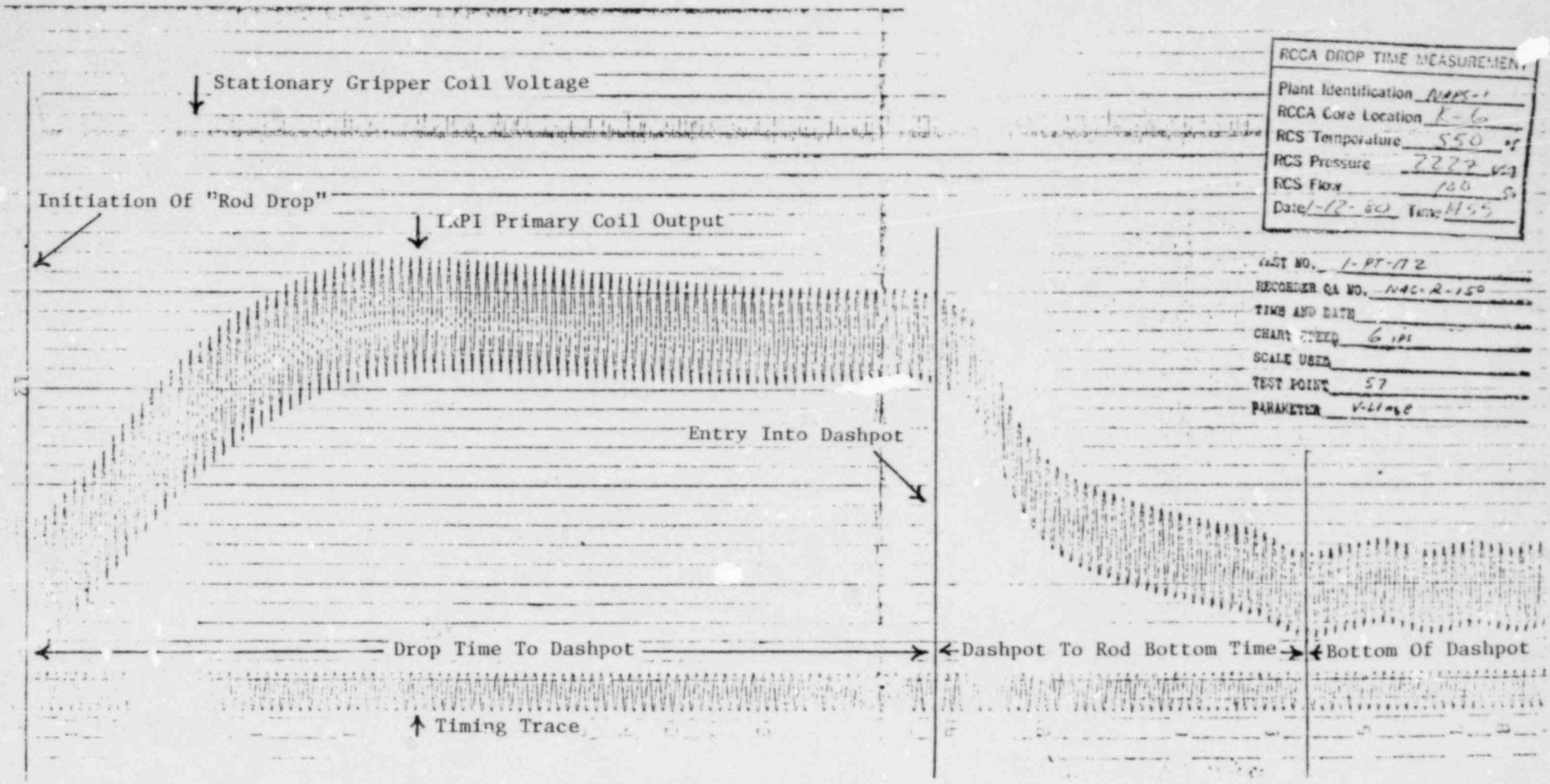
ROD DROP TIME TO BOTTOM OF DASHPOT

Slowest Rod	Fastest Rod	Average Time
B-6, 2.52 sec.	C-9, 2.05 sec.	2.29 sec.

Figure 2.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

TYPICAL ROD DROP TRACE



RCCA DROP TIME MEASUREMENT

Plant Identification NAPS-1
RCCA Core Location K-6
RCS Temperature 550 °F
RCS Pressure 2227 psig
RCS Flow 100 %
Date 1-12-80 Time 1155

TEST NO. 1-PT-17.2
RECORDER QA NO. NAC-R-150
TIME AND DATE
CHART SPEED 6 ips
SCALE USED
TEST POINT 57
PARAMETER Voltage

Figure 2.2

NORTH ANNA UNIT 1 CYCLE 2 BOL PHYSICS TEST

ROD DROP TIME - HOT FULL FLOW CONDITIONS

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
															1
					1.55 2.24		1.48 2.11		1.57 2.24						2
						1.58 2.27		1.55 2.18							3
			1.60 2.30		1.58 2.30				1.58 2.30		1.60 2.33				4
				1.63 2.33						1.55 2.22					5
	1.53 2.18		1.62 2.34		1.58 2.25		1.58 2.25		1.62 2.31		1.63 2.33		1.78 2.52		6
		1.57 2.25				1.52 2.19		1.55 2.25				1.58 2.30			7
	1.63 2.35				1.58 2.28				1.58 2.27				1.70 2.42		8
		1.57 2.26				1.50 2.20		1.55 2.24				1.48 2.05			9
	1.60 2.30		1.60 2.29		1.57 2.22		1.58 2.28		1.60 2.29		1.57 2.26		1.62 2.34		10
				1.68 2.40						1.55 2.27					11
			1.53 2.23		1.65 2.37				1.53 2.20		1.58 2.27				12
						1.55 2.22		1.53 2.23							13
					1.70 2.42		1.53 2.26		1.60 2.30						14
															15

Rod Drop Time to Dashpot Entry (sec.)
Rod Drop Time to Bottom of Dashpot (sec.)

Section 3

REACTOR COOLANT SYSTEM FLOW MEASUREMENT

The reactor coolant flow rate is measured in order to verify that the minimum flow rate requirement is satisfied. The RCS flow rate is determined using the calorimetric measurement technique. Precision calorimetric data (i.e., feedwater temperature, feedwater flow, and steam pressure) are obtained in order to accurately determine the secondary-side heat rate. The primary-side enthalpy rise is determined from the RCS pressure and the temperature increase associated with each RCS loop. The flow for each RCS loop is determined by establishing a primary-side to secondary-side heat balance. Steam generator blowdown heat loss, system heat losses, and the power produced by the reactor coolant pumps are taken into account in the heat balance. Reactor coolant flow measurements were performed during power ascension at 50% power and 100% power. These data were analyzed using the RXFLOW[3] computer code. A summary of the results for these tests is given in Table 3.1. As shown by this table, the test results were consistent and demonstrated that the RCS flow limit was met.

Table 3.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS

REACTOR COOLANT SYSTEM FLOW MEASUREMENT SUMMARY

Percent Power	Loop A Flow (gpm)	Loop B Flow (gpm)	Loop C Flow (gpm)	Total Flow (gpm)	Minimum Flow Limit * (gpm)
50%	97,882	98,412	106,244	302,538	278,400
100%	101,999	103,228	105,341	310,568	278,400

* North Anna Power Station Technical Specifications

CONTROL ROD BANK WORTH MEASUREMENTS

Differential and integral control bank worths were obtained by monitoring reactivity changes associated with boron/RCCA exchanges. Following the establishment of a constant RCS boron dilution/boration rate, the controlling RCCA bank was periodically inserted/withdrawn in order to provide reactivity compensation for the changing RCS boron concentration. The reactivity changes resulting from the control bank movements were recorded continuously by the reactivity computer.[4] The differential reactivity worth is defined as the ratio of the change in reactivity to the corresponding change in bank position about an average bank position, and the integral worth was obtained by summing the individual reactivity changes between measurement endpoints.

A summary of the results for these tests is given in Table 4.1. As shown by this table and the Startup Physics Test Results and Evaluation Sheets given in the Appendix, the individual measured bank worths for control banks D, C, B, and A and shutdown bank B were within the design tolerance of ±15%. The total bank worth (non-overlap mode) for control banks A through D was measured to be within 2.0% of the design prediction. This is well within the design tolerance of ±10% for total control bank worth. In addition, a second measurement of total worth of the control banks (in overlap mode) was performed. This measured value was within 4.2% of the design prediction. The total worth of N-1 rods was measured to be within 1.7% of the design prediction. This is well within the design tolerance of ±10% for the worth of N-1 rods.

The integral and differential reactivity worths for control rod banks D through A (non-overlap mode) and shutdown bank B are shown in Figures 4.1 through Figure 4.10, respectively. The design predictions and the measured data (non-overlap mode) are plotted together in order to illustrate their agreement. The rod worth measurements are quite exact in defining the shape of the individual differential rod worth curves, as illustrated by the distinct depressions occurring at the assembly grid locations. The integral and differential worths for control banks A through D operating in the overlap mode are shown in Figures 4.11 and 4.12, respectively.

The worth of N-1 rods was used in the shutdown margin calculation shown in Table 4.2. As indicated in this table, the calculated shutdown margin verifies that the shutdown margin requirements are met and that an excess shutdown reactivity of 464 pcm is also available.

In summary, all measured rod worth values were satisfactory.

Table 4.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS

CONTROL ROD BANK WORTH SUMMARY

BANK	MEASURED WORTH (PCM)	PREDICTED WORTH (PCM)	PERCENT DIFFERENCE $(\frac{M-P}{P}) \times 100$
D	1069	1095	-2.4
C-Bank D In	908	873	+4.0
B-Banks C+D In	1321	1434	-7.9
A-Banks B+C+D In	1651	1649	+0.1
SB-Banks A+B+C+D In	933	907	+2.9
ΣA → D	4949	5051	-2.0
A → D In Overlap Mode	4838	5051	-4.2
Total Worth N-1 Rods	5942	6044	-1.7

Table 4.2

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
SHUTDOWN MARGIN CALCULATION

A.	Control Rod Worth	Measured Data(pcm)
	Total Rod Worth Less RCCA B-8 (N-1 Rod Worth)	5942
	Measurement Uncertainty (4%)	238
	N-1 Rod Worth Less Uncertainty	5704(a)
B.	Reactivity Worth Requirements	Most Limiting Design Data*(pcm)
	Reactivity Defects (Combined Doppler, Tavg, Void and Redistribution Effects)	2970
	Rod Insertion Allowance	500
	Total Reactivity Worth Requirement	3470(b)
C.	Shutdown Margin	
	Calculated Shutdown Margin (a)-(b)	2234
	Required Shutdown Margin	1770
	Excess Shutdown Reactivity	464

*These reactivity worth requirements are the most limiting of the BOL and EOL design values.[5]

FIGURE 4.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

BANK D INTEGRAL ROD WORTH - HZP

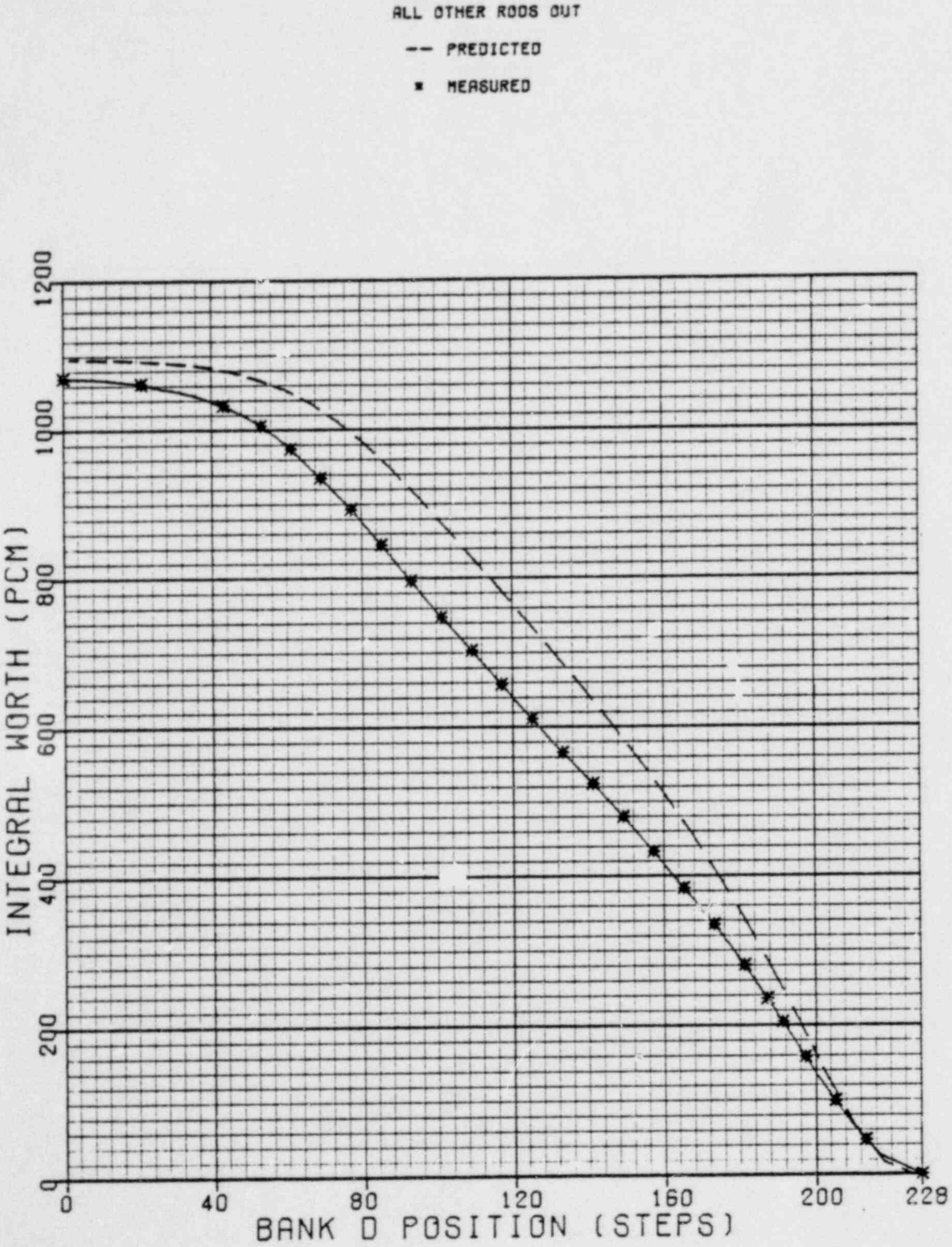


FIGURE 4.2
NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
BANK D DIFFERENTIAL ROD WORTH - HZP

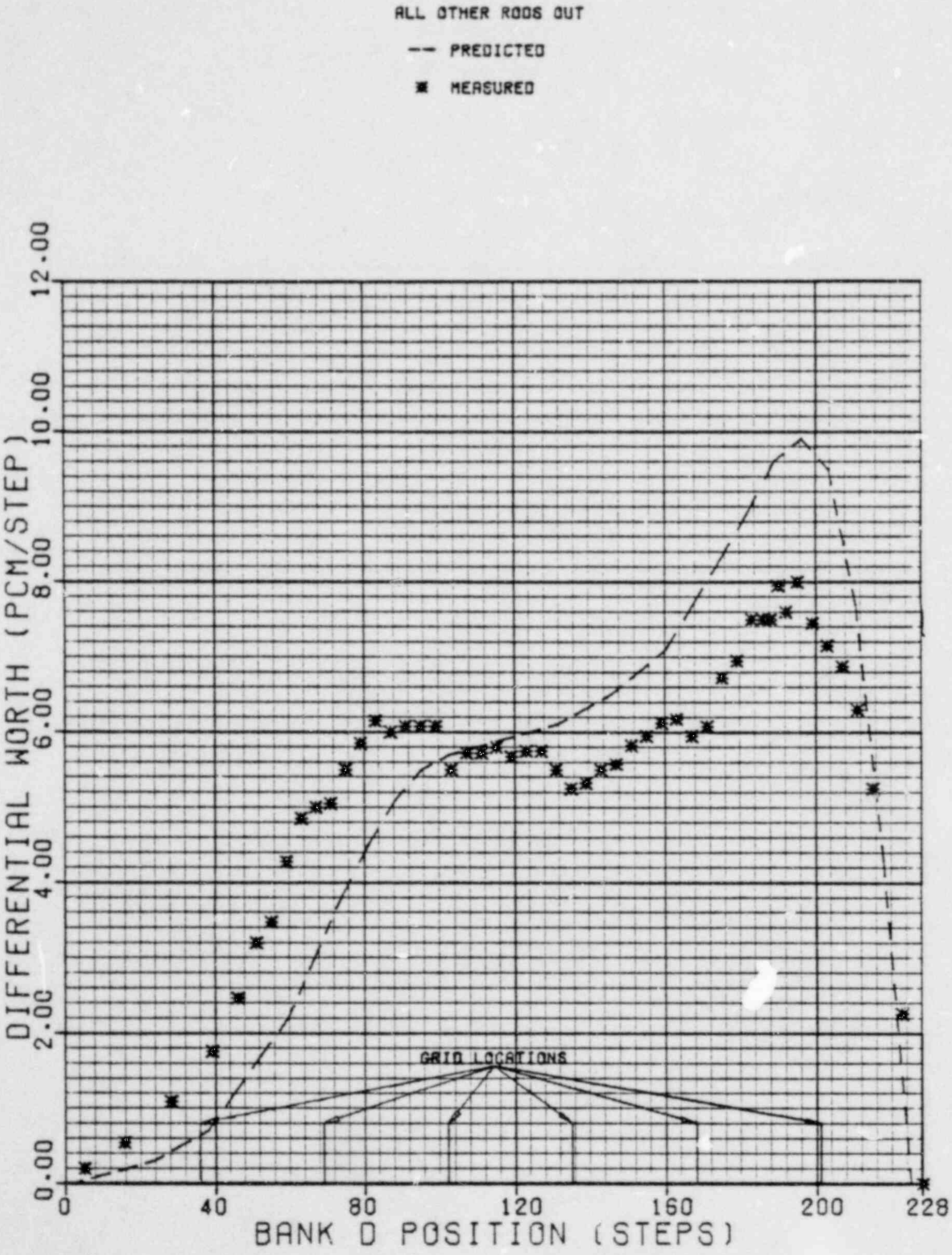


FIGURE 4.3

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
BANK C INTEGRAL ROD WORTH - HZP

D BANK IN. ALL OTHER RODS OUT

-- PREDICTED

* MEASURED

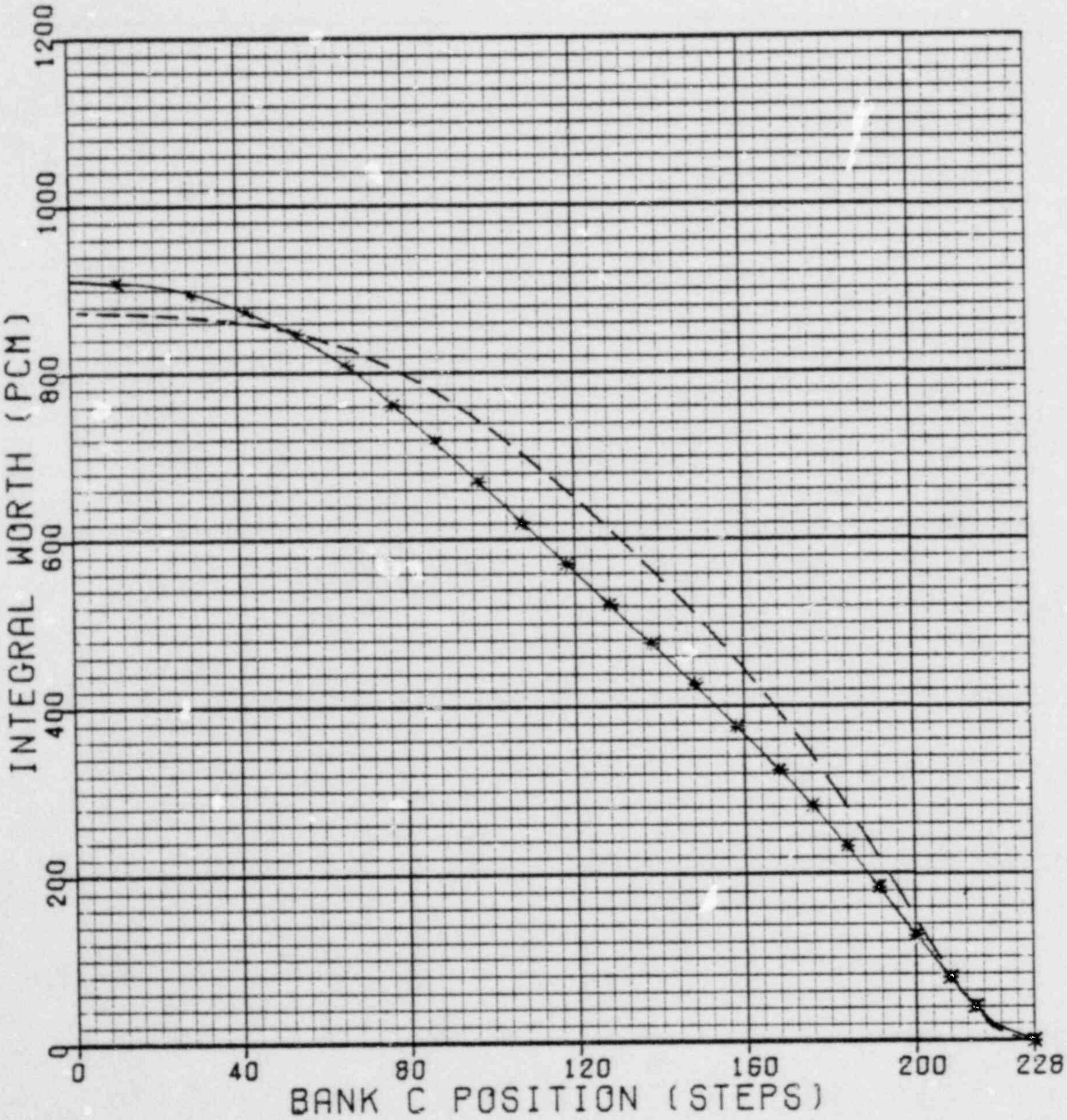


FIGURE 4.4

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
BANK C DIFFERENTIAL ROD WORTH - HZP

D BANK IN. ALL OTHER RODS OUT

-- PREDICTED

✱ MEASURED

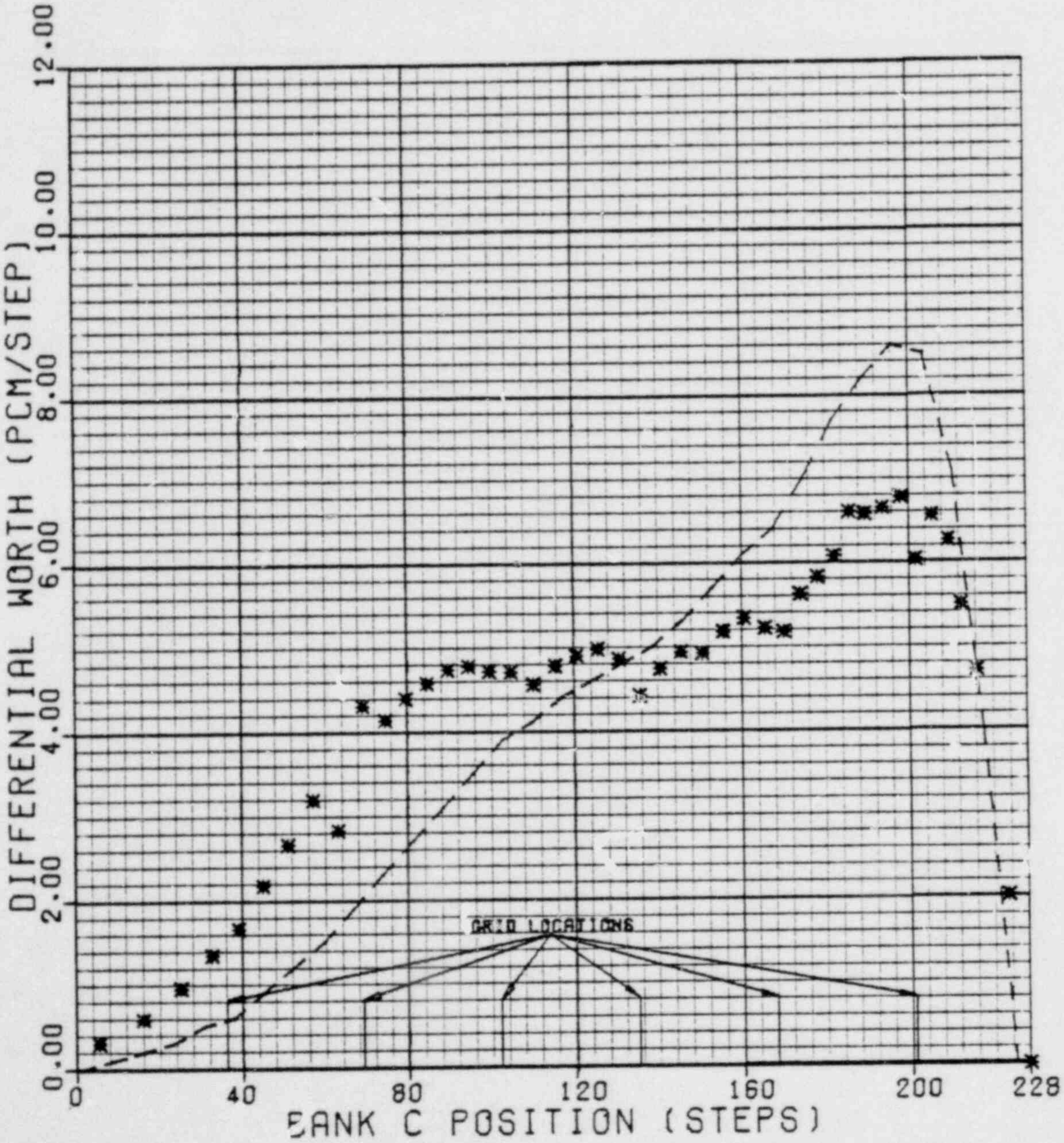


FIGURE 4.5

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
BANK B INTEGRAL ROD WORTH - HZP

C+D BANKS IN, ALL OTHER RODS OUT

-- PREDICTED

* MEASURED

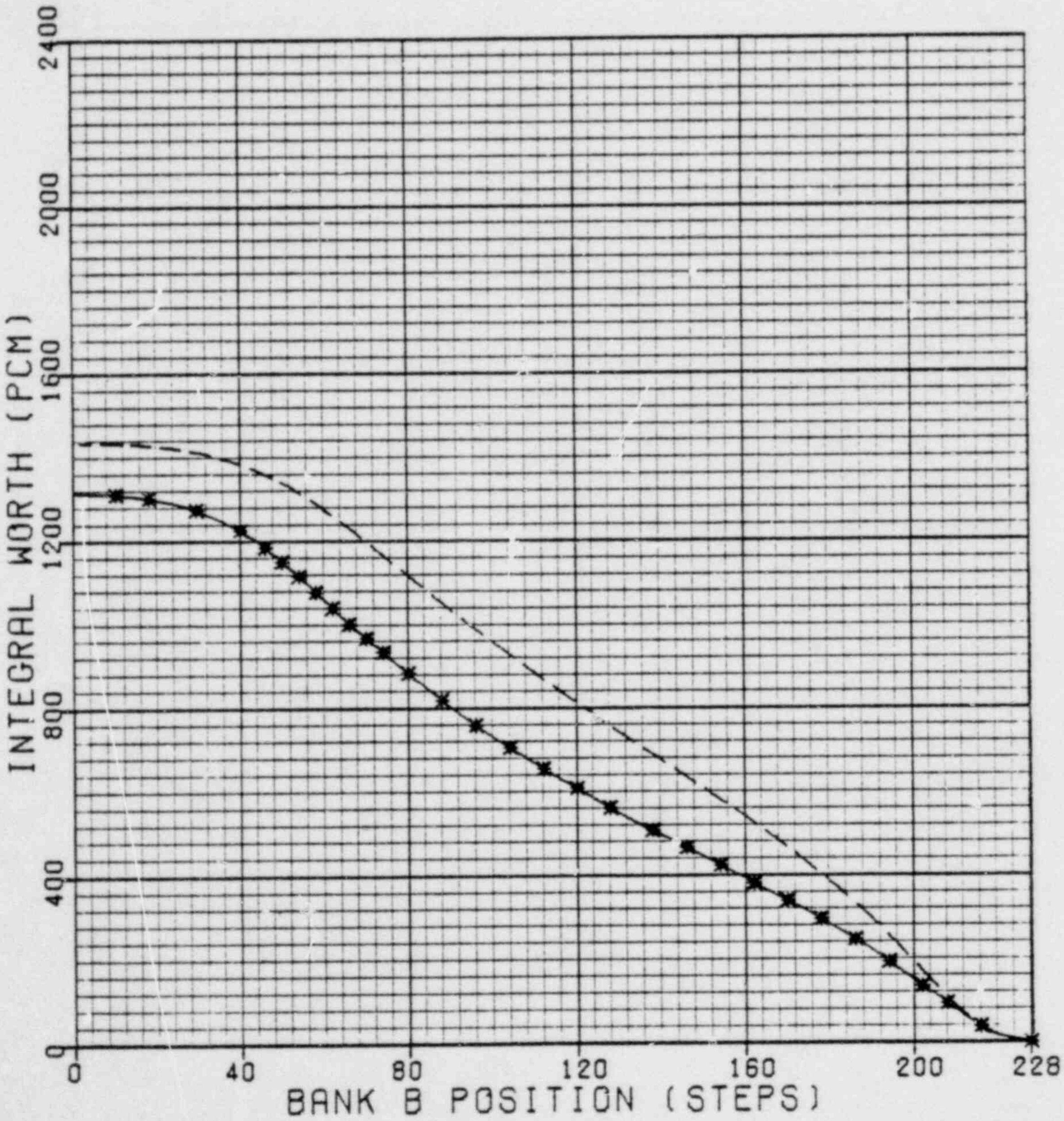


FIGURE 4.6

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
BANK B DIFFERENTIAL ROD WORTH - HZP

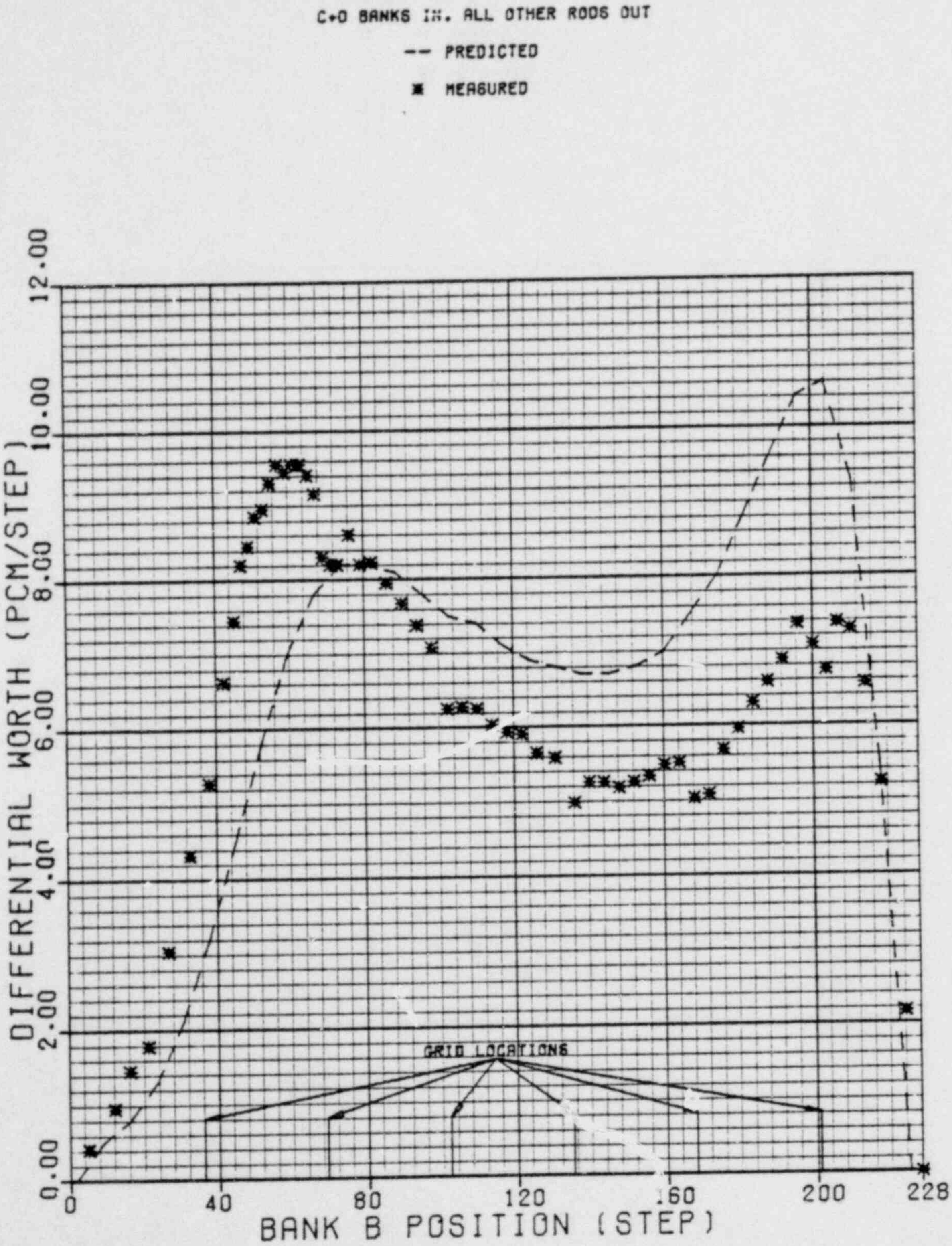


FIGURE 4.7

NORTH ANNA UNIT 1 - CYCLE 2 BOL

BANK A INTEGRAL ROD WORTH

B+C+D BANKS IN. ALL OTHER RODS OUT

-- PREDICTED

■ MEASURED

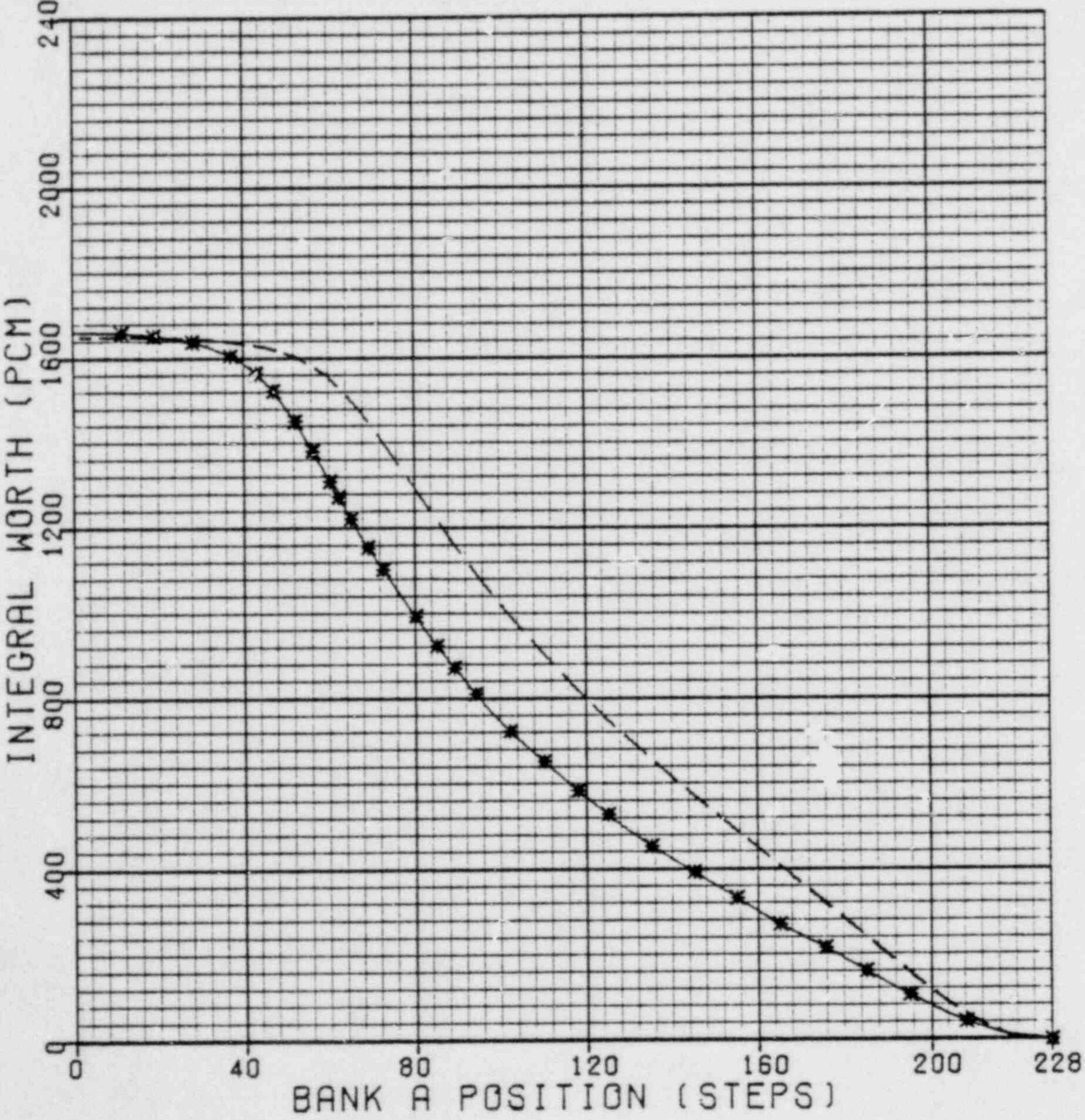


FIGURE 4.8

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

BANK A DIFFERENTIAL ROD WORTH - HZP

B+C+D BANKS IN. ALL OTHER RODS OUT

-- PREDICTED

✱ MEASURED

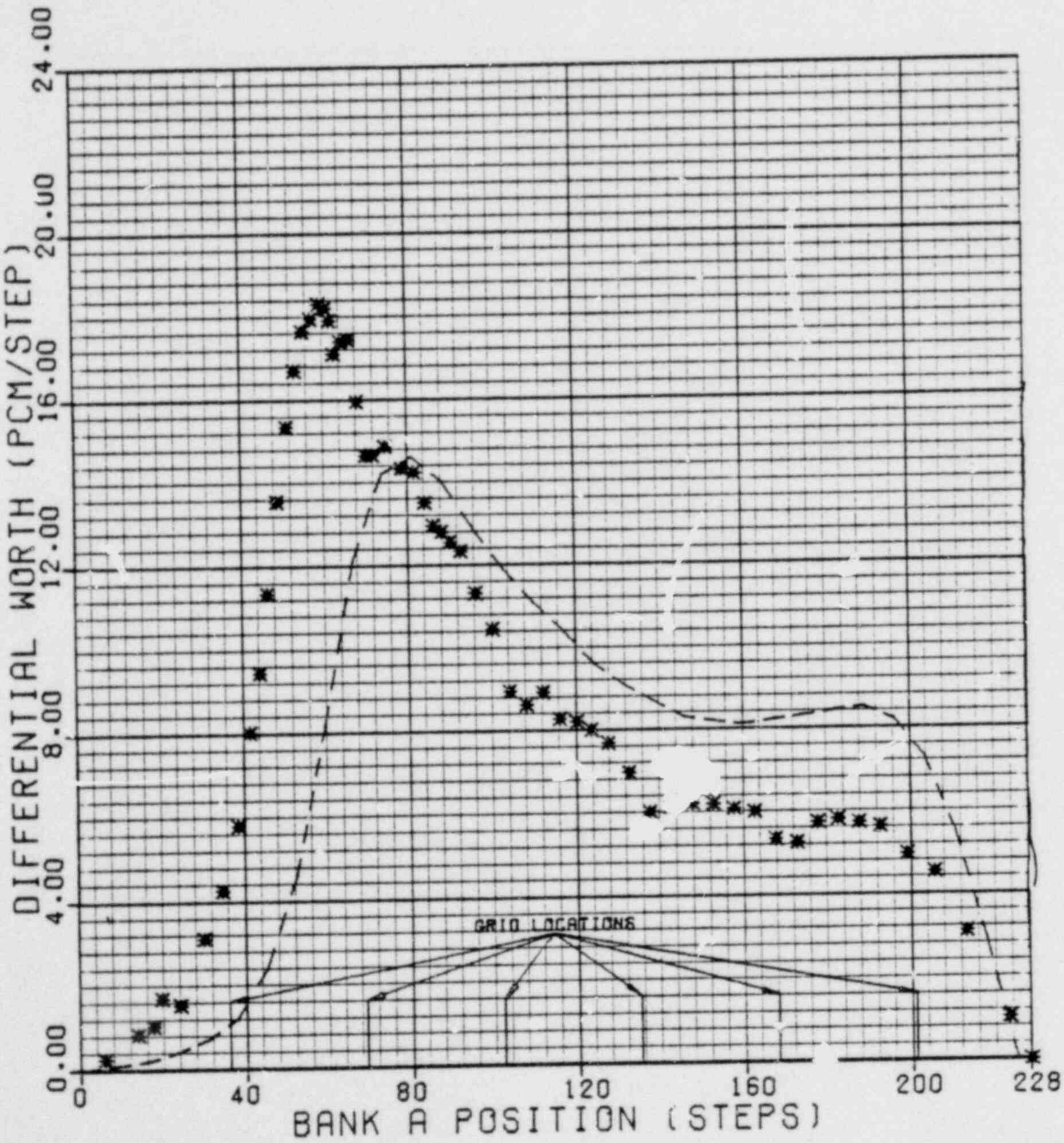


FIGURE 4.9

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

SHUTDOWN BANK B INTEGRAL ROD WORTH - HZP

A+B+C+D BANKS IN. ALL OTHER RODS OUT

-- PREDICTED

■ MEASURED

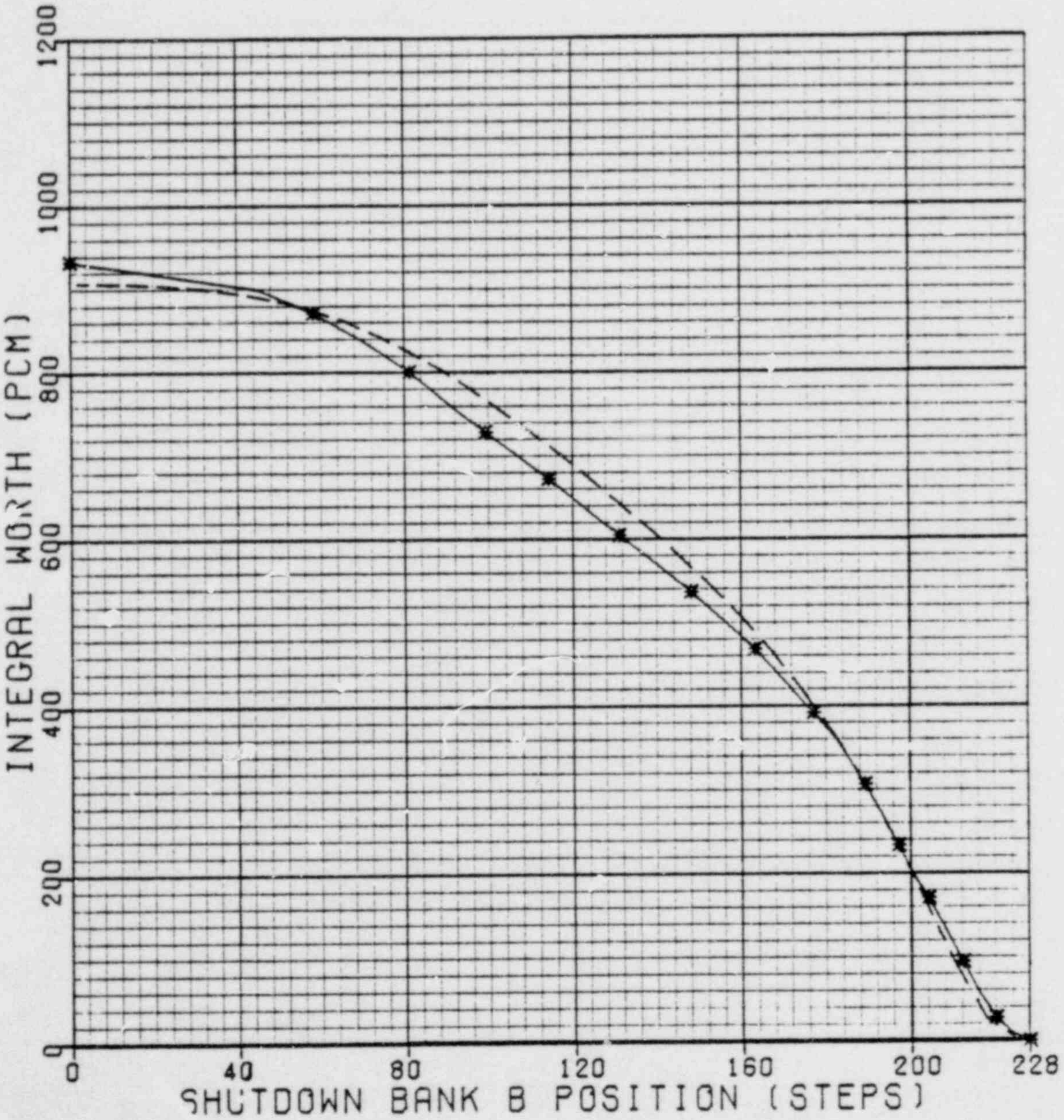


FIGURE 4.10

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
SHUTDOWN BANK B DIFFERENTIAL ROD WORTH - HZP

A+B+C+D BANKS IN. ALL OTHER RODS OUT

-- PREDICTED

✱ MEASURED

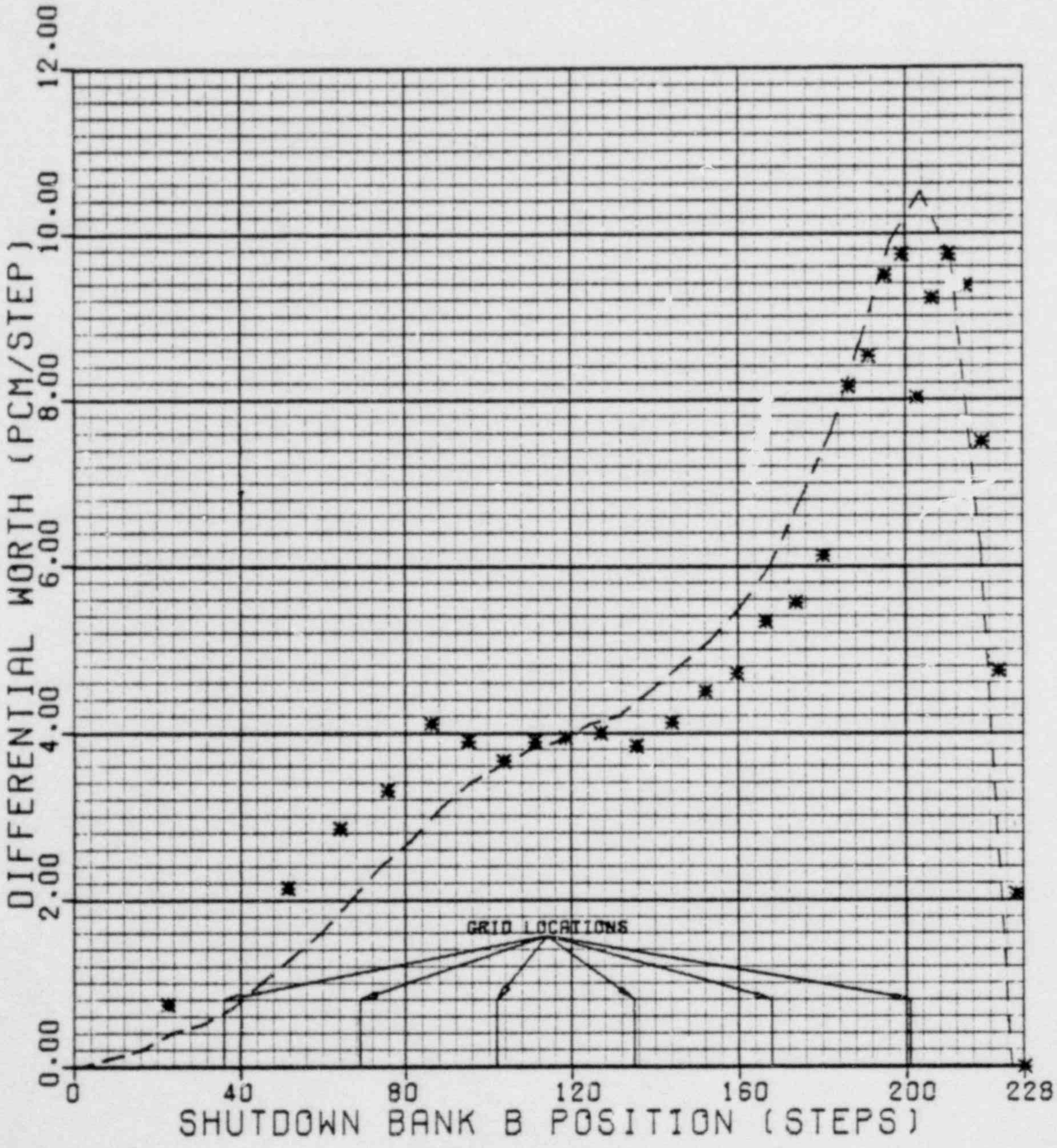


FIGURE 4.11

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
INTEGRAL WORTH OF CONTROL BANKS A
THROUGH D IN OVERLAP MODE

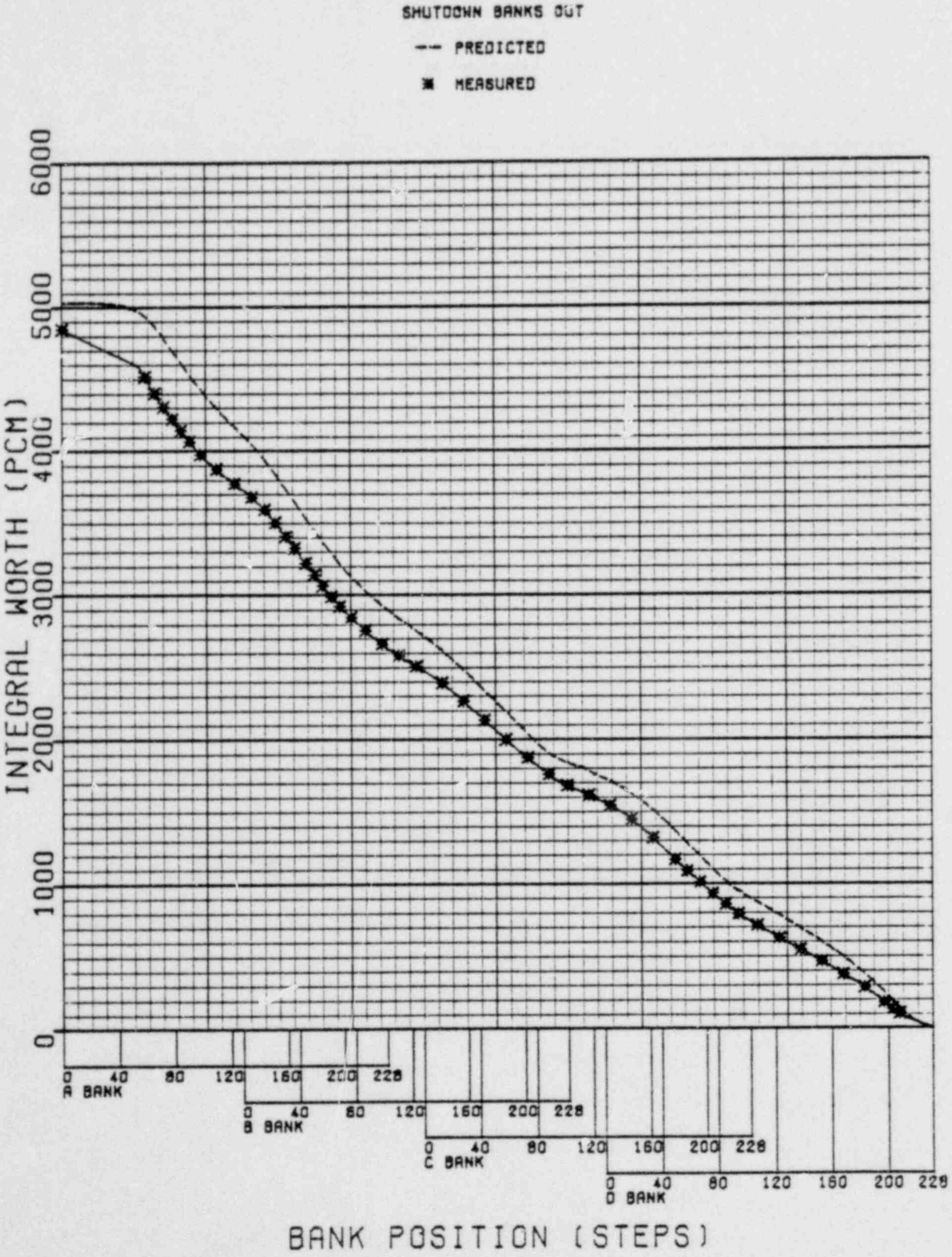
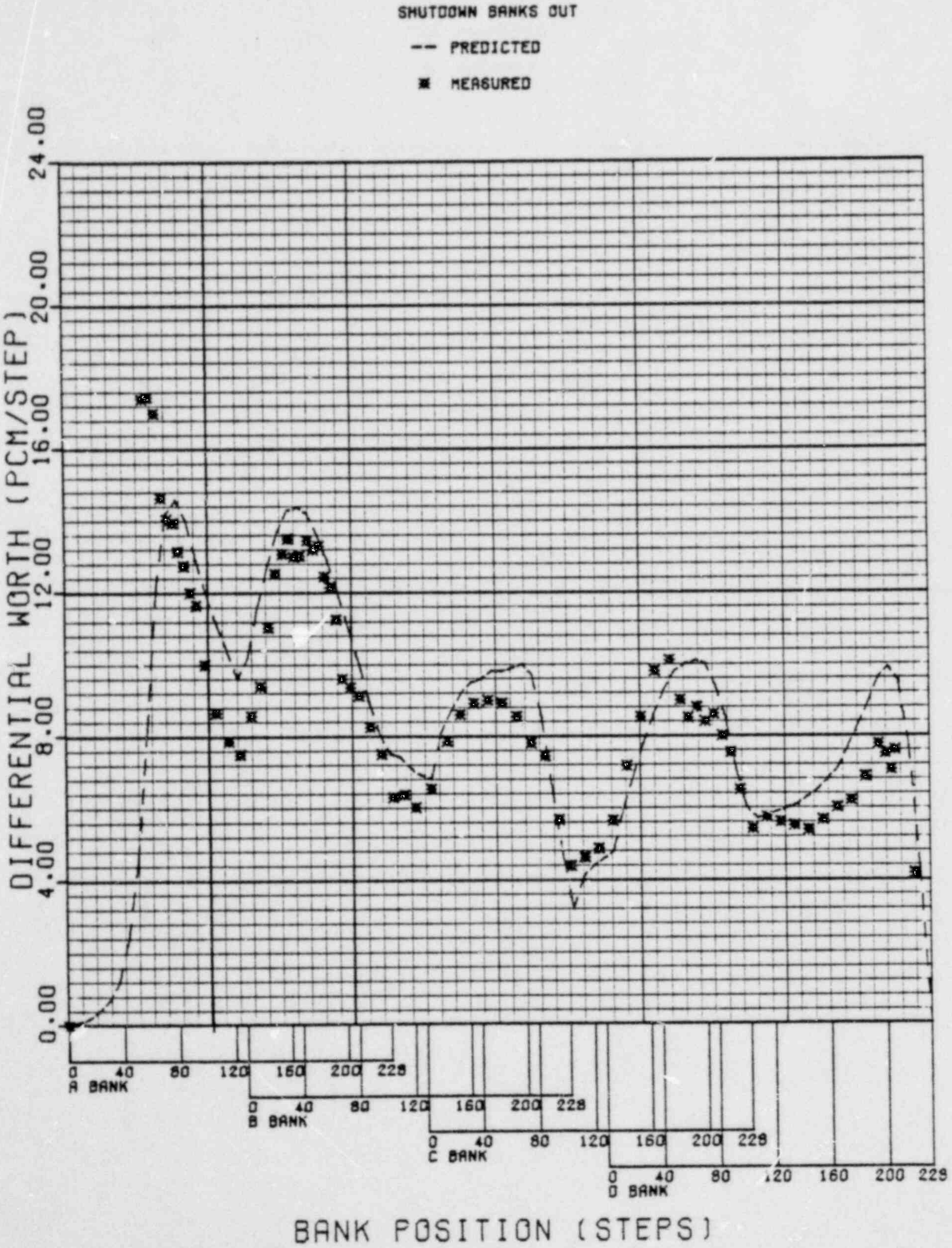


FIGURE 4.12

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST
DIFFERENTIAL WORTH OF CONTROL BANKS A
THROUGH D IN OVERLAP MODE



Section 5

BORON ENDPOINT AND WORTH MEASUREMENTS

Boron Endpoint

With the reactor critical at hot zero power, reactor coolant system boron concentrations were measured at selected rod bank configurations to enable a direct comparison of measured boron endpoints with design predictions. For each measurement, the RCS conditions were stabilized with the control bank at or very near a selected endpoint position. The critical boron concentration was then measured. If necessary, an adjustment to the measured critical boron concentration value was made to account for off-nominal core conditions, i.e., for rod position and moderator temperature.

The results of these measurements are given in Table 5.1. As shown in this table and in the Startup Physics Test Results and Evaluation Sheets given in the Appendix, all measured critical boron endpoint values were within their respective design tolerances. All measured values met the accident analysis acceptance criterion.

In summary, all results were satisfactory.

Boron Worth Coefficient

The measured boron endpoint values provide stable statepoint data from which the boron worth coefficient was determined. A plot of the boron concentration as a function of integrated reactivity can be constructed by relating each boron endpoint concentration to the integrated rod worth present in the core at the time of the endpoint measurement.

The value of the boron worth coefficient, over the range of boron endpoint concentrations, is obtained directly from this plot.

The boron worth plot is shown in Figure 5.1. As indicated in this figure and in the Appendix, the boron worth coefficient of reactivity was measured to be -8.88 pcm/ppm. The measured boron worth coefficient is within 3.8% of the predicted value of -9.23 pcm/ppm and is well within the design tolerance of ±10%. The measurement result also met the accident analysis acceptance criterion.

In summary, this result was satisfactory.

Table 5.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS

BORON ENDPOINTS SUMMARY

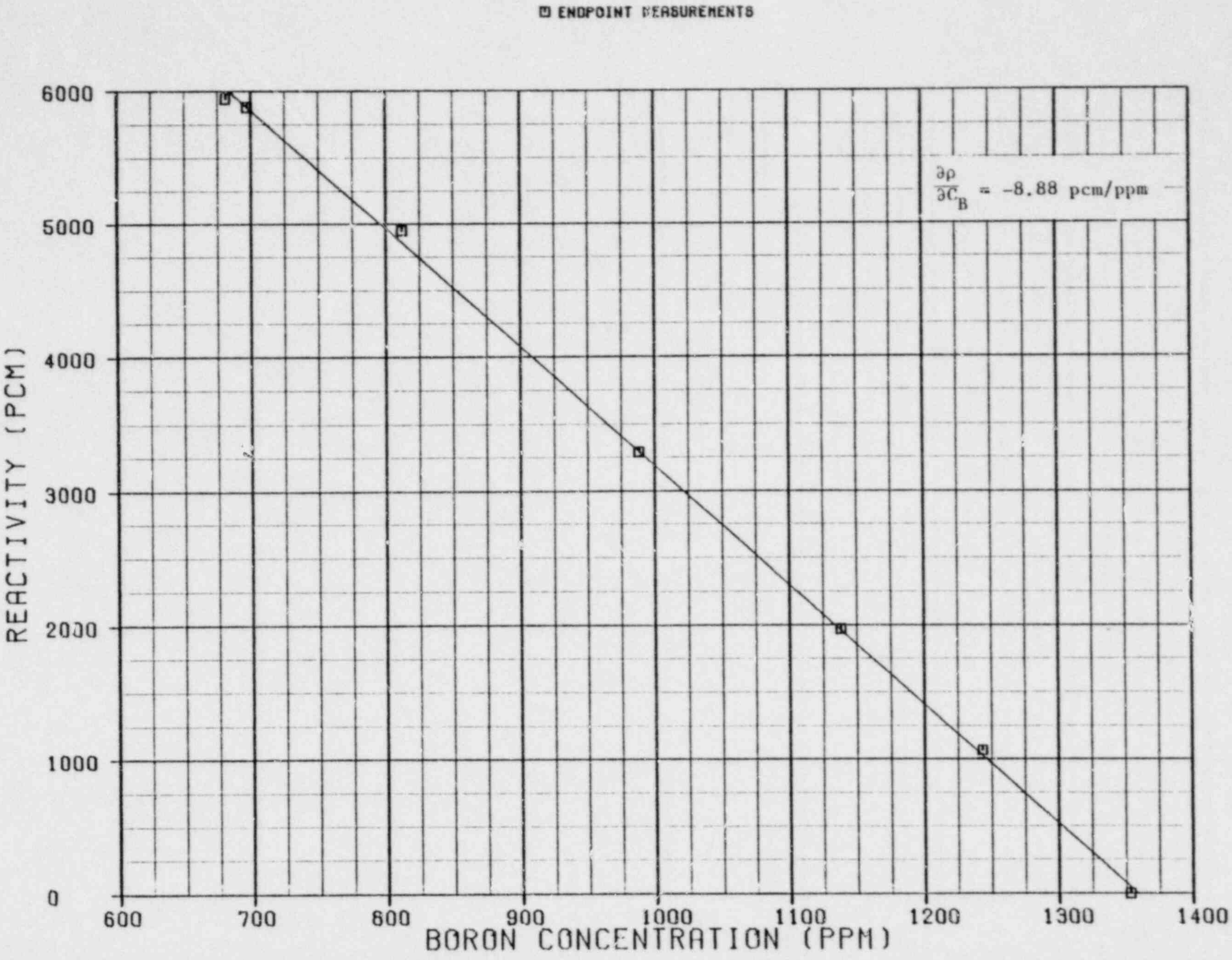
Control Rod Configuration	Measured Endpoint (ppm)	Predicted Endpoint (ppm)*	Difference M-P (ppm)
ARO	1353	1319	+34
D Bank In	1243	1233	+10
D+C Banks In	1138	1147	-9
D+C+B Banks In	988	984	+ 4
D+C+B+A Banks In	812	811	+ 1
D+C+B+A+SB Banks In	697	715	-18
All Rods In Except RCCA H-14	681	691	-10

*Predicted endpoints have been adjusted for the difference between the measured and predicted values of the previous endpoint as shown in the boron endpoint Startup Physics Test Results and Evaluation Sheets in the Appendix.

FIGURE 5.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

BORON WORTH COEFFICIENT



Section 6

TEMPERATURE COEFFICIENT MEASUREMENTS

The isothermal temperature coefficient measurements were accomplished by controlling the RCS heat gains/losses with the steam dump valves to the condenser, establishing a constant and uniform heatup/cooldown rate, and then monitoring the resulting reactivity changes on the reactivity computer. These measurements were performed at very low power levels in order to minimize the effects of non-uniform nuclear heating, thus, the moderator and fuel were approximately at the same temperature (between 543-549 ^{o}F) during these measurements. To eliminate the boron reactivity effect of outflow from the pressurizer, the pressurizer level was maintained constant or slightly increasing during these measurements.

Isothermal temperature coefficient measurements were performed at various control rod configurations. For each rod configuration, reactivity measurements were taken during both RCS heatup and cooldown ramps during which the RCS temperature varied approximately 6^{o}F. Reactivity was determined using the reactivity computer and was plotted against the RCS temperature on an x-y recorder. The temperature coefficient was then determined from the slope of the plotted lines. The x-y recorder plots of reactivity change vs. RCS temperature for each measurement are shown in Figures 6.1 and 6.2.

The predicted and measured isothermal temperature coefficient values are compared in Table 6.1. As can be seen from this summary and from the Startup Physics Test Results and Evaluation Sheets given in the

Appendix, all measured isothermal temperature coefficient values were within the design tolerance of ±3 pcm/°F and met the accident analysis acceptance criterion.

In summary, all measured results were satisfactory.

Table 6.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS

ISOTHERMAL TEMPERATURE COEFFICIENT SUMMARY

BANK POSITION (STEPS)		TEMPERATURE RANGE (°F)	BORON CONCENTRATION (PPM)	ISOTHERMAL TEMPERATURE COEFFICIENT (PCM/°F)				
C	D			HEATUP	COOLDOWN	AVERAGE	PREDICTED	DIFFERENCE (M-P)
228	216/ 215	543-549	1351	-2.57	-2.15	-2.36	-3.49	+1.13
228	15	543-549	1234	-3.47	-3.92	-3.70	-6.34	+2.64

Figure 6.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ISOTHERMAL TEMPERATURE COEFFICIENT

HZP, ARO

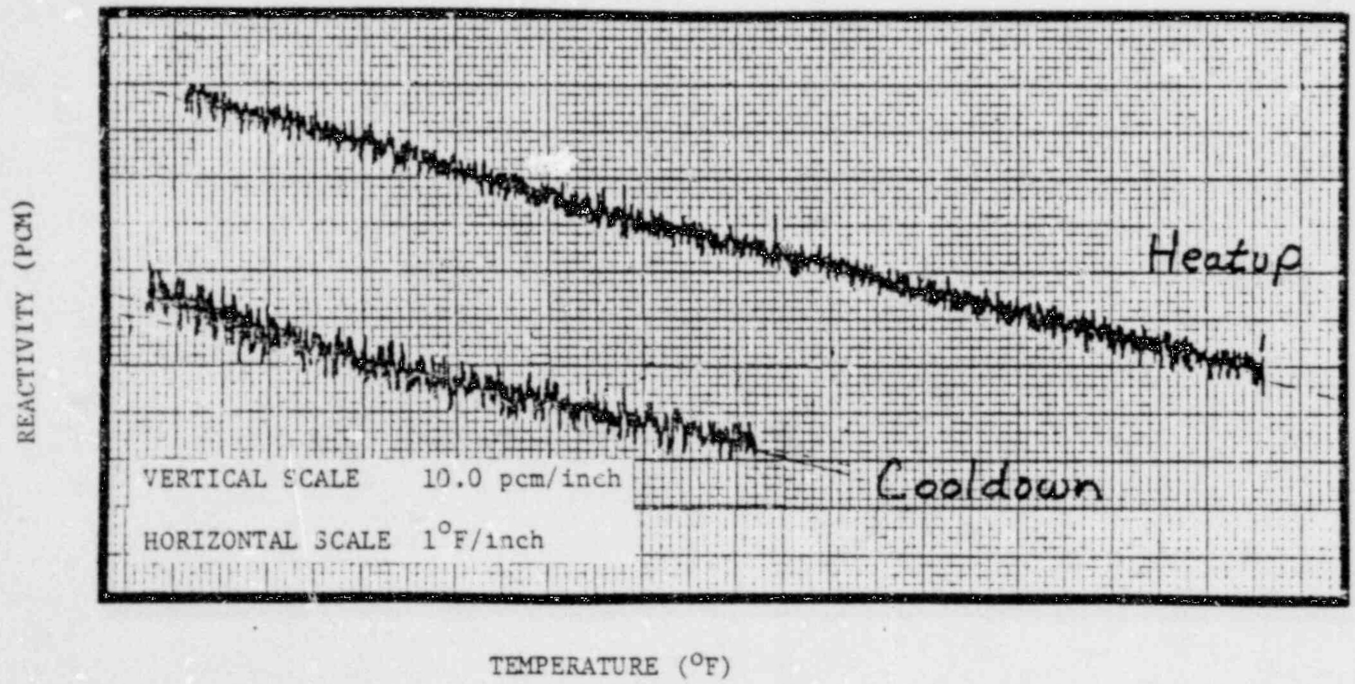
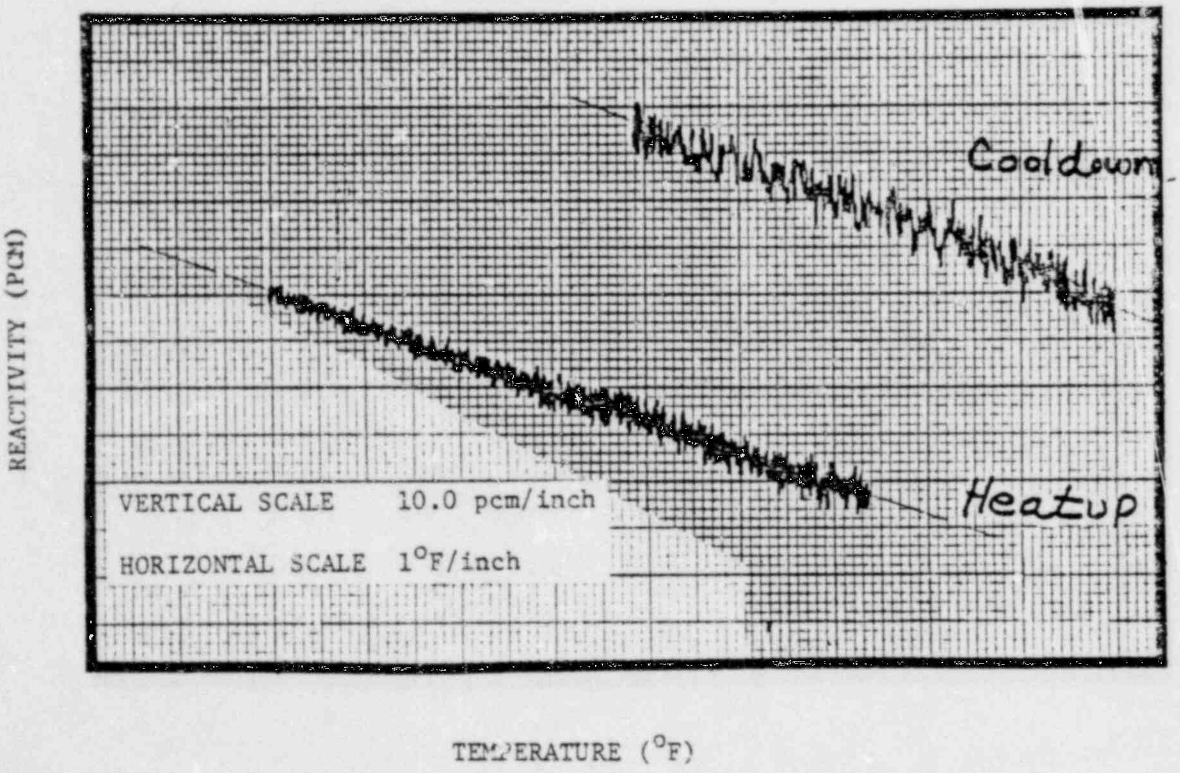


Figure 6.2

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ISOTHERMAL TEMPERATURE COEFFICIENT

HZP, D-BANK IN



POWER DISTRIBUTION MEASUREMENTS

The core power distributions were measured using the incore movable detector flux mapping system. This system consists of five fission detectors which traverse fuel assembly instrumentation thimbles in 50 core locations (see Figure 1.2). For each traverse, the detector output is continuously monitored on a strip chart recorder. The output is also scanned for 61 discrete axial points by the PRODAC P-250 process computer. Full core, three-dimensional power distributions are then determined by analyzing this data using the Westinghouse computer program, INCORE.[6] INCORE couples the measured flux map data with predetermined analytic power-to-flux ratios in order to determine the power distribution for the whole core.

A list of all the flux maps taken during the test program together with a list of the measured values of the important power distribution parameters is given in Table 7.1. The measured power distribution parameter values are compared with their Technical Specifications limits in Table 7.2. Flux maps 1 and 2 were taken at zero power. These flux maps serve as base case design checks. Figures 7.1 and 7.2 show the resulting radial power distributions associated with these flux maps. These maps identified the presence of a large quadrant power tilt (∿9% and ∿6% for the ARO and D bank in maps, respectively) and also indicated that the nuclear enthalpy rise hot channel factor, $F_{\Delta H}^{N}$, could potentially exceed its design basis value, with the control rods at their insertion limits. Flux map 3 was taken at ∿3% power (ARO) in order to re-confirm the results of the previous maps. Flux map 4 was taken at ∿3% power with the control rods at the HZP insertion limit. The results of this map verified that $F_{\Delta_H}^{N}$ exceeded its design basis value at that core configuration. In order to preclude violating the $F^N_{\Delta H}$ design basis during normal plant operation, the control rod insertion limits were revised (see Figure 7.3) based on additional design calculations and the flux map results. Flux map 6 was taken at ∿3% power with the control rods at the revised HZP insertion limit. The results of this map verified that $F^N_{\Delta H}$ was below its design basis value at that core configuration. Figures 7.4 through 7.6 show the radial power distributions associated with flux maps 3, 4, and 6. A safety evaluation was performed to assess the impact of the core tilt and the revised control rod insertion limits on the conclusions stated in the FSAR regarding core safety.[7] This evaluation concluded that the presence of the observed and predicted core tilt did not invalidate the conclusions presented in the FSAR. On this basis, the revised control rod insertion limits were administratively implemented, with NRC concurrence, and the power ascension phase of the testing program was begun.

Flux maps 7 through 18 were taken over a wide range of power levels and control rod configurations. These flux maps were taken to check the at-power design predictions, to measure core power distributions, and to verify that the hot channel factor limits would be met during normal operation in accordance with the revised control rod insertion limits. These maps also provide incore/excore calibration data for the nuclear instrumentation system as well a base data for axial power distribution surveillance. The radial power distributions for these maps are given in Figures 7.7 through 7.17. These figures show that the measured relative assembly power values are generally within 5% of the predicted values. Figure 7.18 shows a plot of quadrant power tilt versus power level.

In conclusion, with the establishment of the revised control rod insertion limits, all power distribution measurement results were considered to be acceptable with respect to the accident analysis acceptance criteria and the Technical Specification limits. It is therefore anticipated that the core will continue to operate safely throughout Cycle 2.

Table 7.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS

INCORE FLUX MAP SUMMARY

MAP DESCRIPTION	MAP NO.	PWR (%)	BANK POSITION (STEPS)		F_Q^T HOT CHANNEL FACTOR*				$F_{\Delta H}^N$ HOT CHANNEL FACTOR**			CORE $\bar{F}_Z$ MAX		F_{xy}+	QPTR^x	AXIAL OFFSET (%)	NO. OF THIMBLES
			C	D	ASSY.	PIN	AXIAL POINT	F_Q^T	ASSY.	PIN	$F_{\Delta H}^N$	AXIAL POINT	F_Z				
Flux Map - ARO	1	~ 0	228	218	P06	MD	12	3.09	P07	LG	1.64	12	1.90	1.81	1.090	+47.96	48
Flux Map - D In	2	~ 0	228	12	N11	LK	13	3.64	N11	LK	1.92	11	1.88	2.14	1.063	+47.30	48
Flux Map - ARO	3	~ 3	228	228	P10	MN	12	3.00	P09	LK	1.61	11	1.87	1.87	1.084	+46.72	48
Flux Map	4	~ 3	118	0	L13	KL	39	2.95	L13	LK	1.93	38	1.35	2.15	1.034	-13.60	49
Flux Map	6^{xx}	~ 3	228	99	K14	NM	46	2.58	L13	KL	1.74	45	1.42	2.03	1.051	-19.24	49
Flux Map - I/E Calibration	7	~30	228	165	K14	NM	29	2.08	L13	LM	1.54	28	1.25	1.67	1.024	+ 0.48	47
Flux Map - I/E Calibration	8	~30	228	138	B10	EN	45	2.20	L13	LM	1.57	45	1.30	1.66	1.024	-14.90	48
Flux Map - APDMS, I/E Calibration	9	~30	228	217	J14	KL	12	2.86	P09	LK	1.47	11	1.93	1.69	1.045	+48.20	48
Flux Map - APDMS, I/E Calibration	10	~30	228	218	K14	NM	29	1.87	K14	NM	1.48	13	1.20	1.65	1.029	+ 6.24	48
Flux Map - APDMS, I/E Calibration	11	~47	228	218	L13	LM	20	1.90	L13	LM	1.46	13	1.27	1.62	1.020	+11.06	46
Flux Map - APDMS, I/E Calibration	12	~45	228	192	L13	LM	21	1.94	L13	LM	1.49	20	1.24	1.63	1.025	+ 6.08	48
Flux Map - APDMS, I/E Calibration	13	~66	228	217	L13	LM	21/20	1.84	N11	ML	1.43	13	1.24	1.59	1.018	+ 8.90	48
Flux Map - APDMS, I/E Calibration	14	~80	228	228	K14	NM	29	1.75	L13	LM	1.41	13	1.17	1.57	1.018	+ 4.57	48
Flux Map - I/E Calibration	15	~99	228	228	B10	EN	45	1.76	P09	LK	1.39	20	1.11	1.54	1.010	+ 0.13	48
Flux Map - I/E Calibration	16	~99	228	208	B10	EN	46	1.90	L13	LM	1.40	46	1.20	1.53	1.014	- 7.27	46
Flux Map - HFP, Eq. Xenon	18^{++}	~100	228	213	B10	EN	45	1.78	L13	LM	1.40	20	1.12	1.53	1.010	- 0.55	47

Notes: Hot spot locations are specified by giving assembly locations (e.g. H-8 is the center-of-core assembly location), followed by the pin location (denoted by the "Y" coordinate with the seventeen rows of fuel rods lettered A through Q and the "X" coordinate designated in a similar manner). In the "Z" direction the core is divided into 61 axial points starting from the top of the core.

*F_Q^T includes a total uncertainty of 1.05 X 1.03.

**$F_{\Delta H}^N$ including a measurement uncertainty of 1.04.

+F_{xy} is evaluated at the midplane of the core and includes a total uncertainty of 1.05 x 1.03.

^{x}QPTR - Quadrant Power Tilt Ratio. This value is the maximum QPTR of the upper and lower halves of the core.

^{xx}Map 5 was aborted.

$^{++}$Map 17 was a quarter core M/D flux map.

Table 7.2

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS
COMPARISON OF MEASURED POWER DISTRIBUTION PARAMETERS
WITH THEIR TECHNICAL SPECIFICATIONS LIMIT

	$F^N_{\Delta H}$ Hot Channel Factor[a]			F^T_Q Hot channel Factor[b]			$F_{xy}{}^{MAX}$[c]			
Map	Measured	Limit	Margin (%)	Measured	Limit	Minimum Margin (%)	Measured	Axial Point	Limit	Margin (%)
7	1.54	1.77	12.9	2.08	4.20	50.2	1.71	12	1.95	12.3
8	1.57	1.77	11.3	2.20	4.20	47.6	1.79	21	1.95	8.2
9	1.47	1.76	16.5	2.86	4.20	28.4	1.75	46	1.87	6.4
10	1.48	1.76	15.9	1.87	4.20	54.6	1.69	45	1.87	9.6
11	1.46	1.71	14.6	1.90	4.20	53.4	1.67	45	1.83	8.7
12	1.49	1.72	13.4	1.94	4.20	52.6	1.66	37	1.83	9.2
13	1.43	1.66	13.9	1.84	3.08	40.2	1.63	38	1.76	7.4
14	1.41	1.60	11.9	1.75	2.52	28.6	1.60	36	1.71	6.4
15	1.39	1.55	10.3	1.76	2.12	16.8	1.59	45	1.65	3.6
16	1.40	1.55	9.7	1.90	2.12	10.8	1.59	45	1.66	4.2
18	1.40	1.55	9.7	1.78	2.10	15.6	1.59	45	1.65	3.6

[a] The measured value for the enthalpy rise hot channel factor, $F^N_{\Delta H}$, includes 4% measurement uncertainty.

[b] The Technical Specifications limit for the heat flux hot channel factor, F^T_Q, is a function of core height. The value for F^T_Q listed above is the maximum value of F^T_Q in the core. The Technical Specifications limit listed above is evaluated at the plane of maximum F^T_Q. The minimum margin values listed above are the minimum percent difference between the measured values of $F^T_Q(Z)$ and the Technical Specifications limit for each map. All measured F^T_Q hot channel factors include 5% measurement uncertainty and 3% engineering uncertainty.

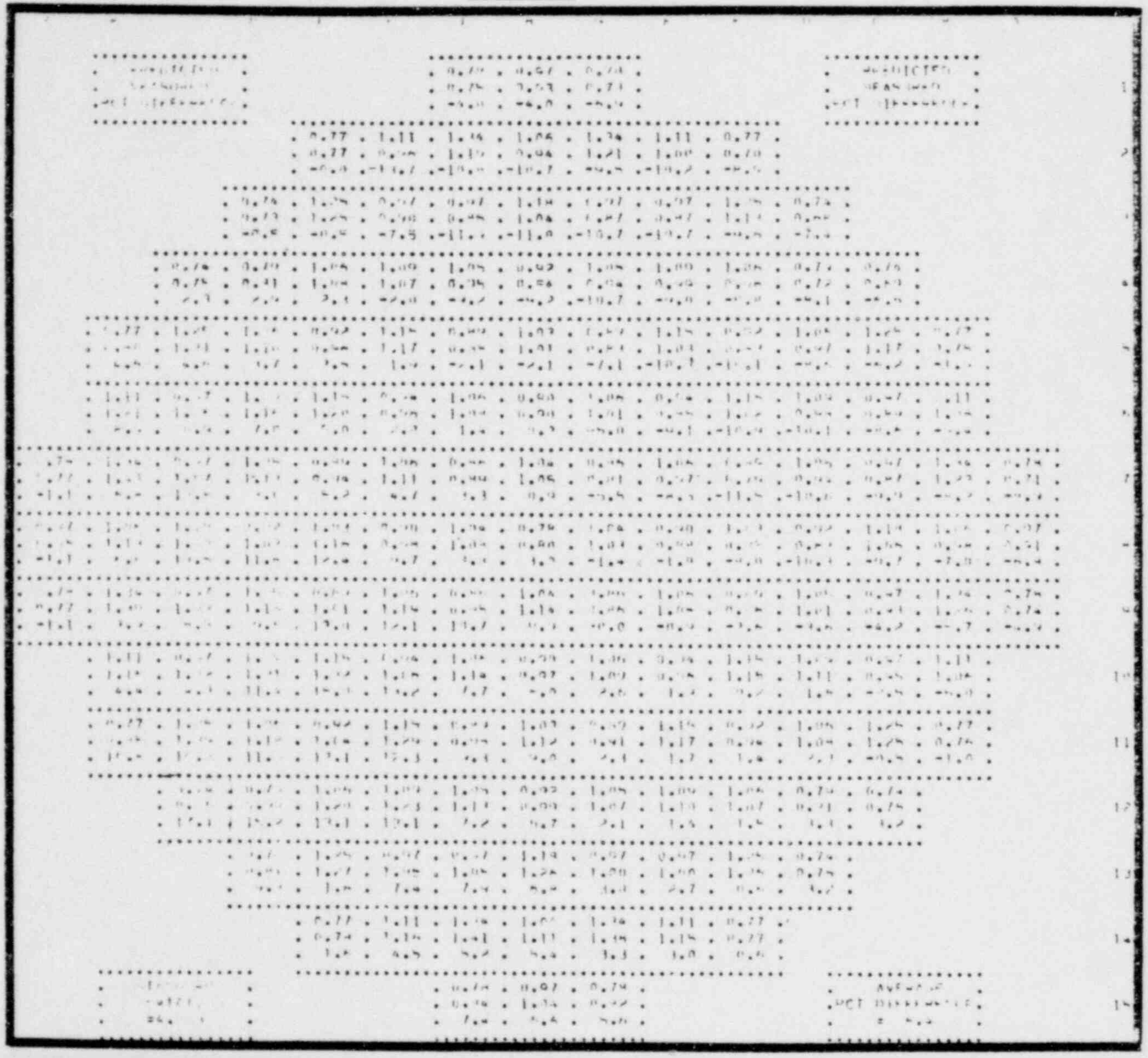
[c] All measured $F_{xy}{}^{MAX}$ values include 5% measurement uncertainty and 3% engineering uncertainty.

Figure 7.1

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HZP, ARO



MAP NO: N1-2-1

DATE: 1/16/80

POWER ≈ 0%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.637

QPTR:

D BANK AT 218 STEPS

F^T_Q = 3.090

NW - 0.996

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.896

NE - 0.908

A.O. = +47.960

SW - 1.090

BURNUP = 0 MWD/MTU

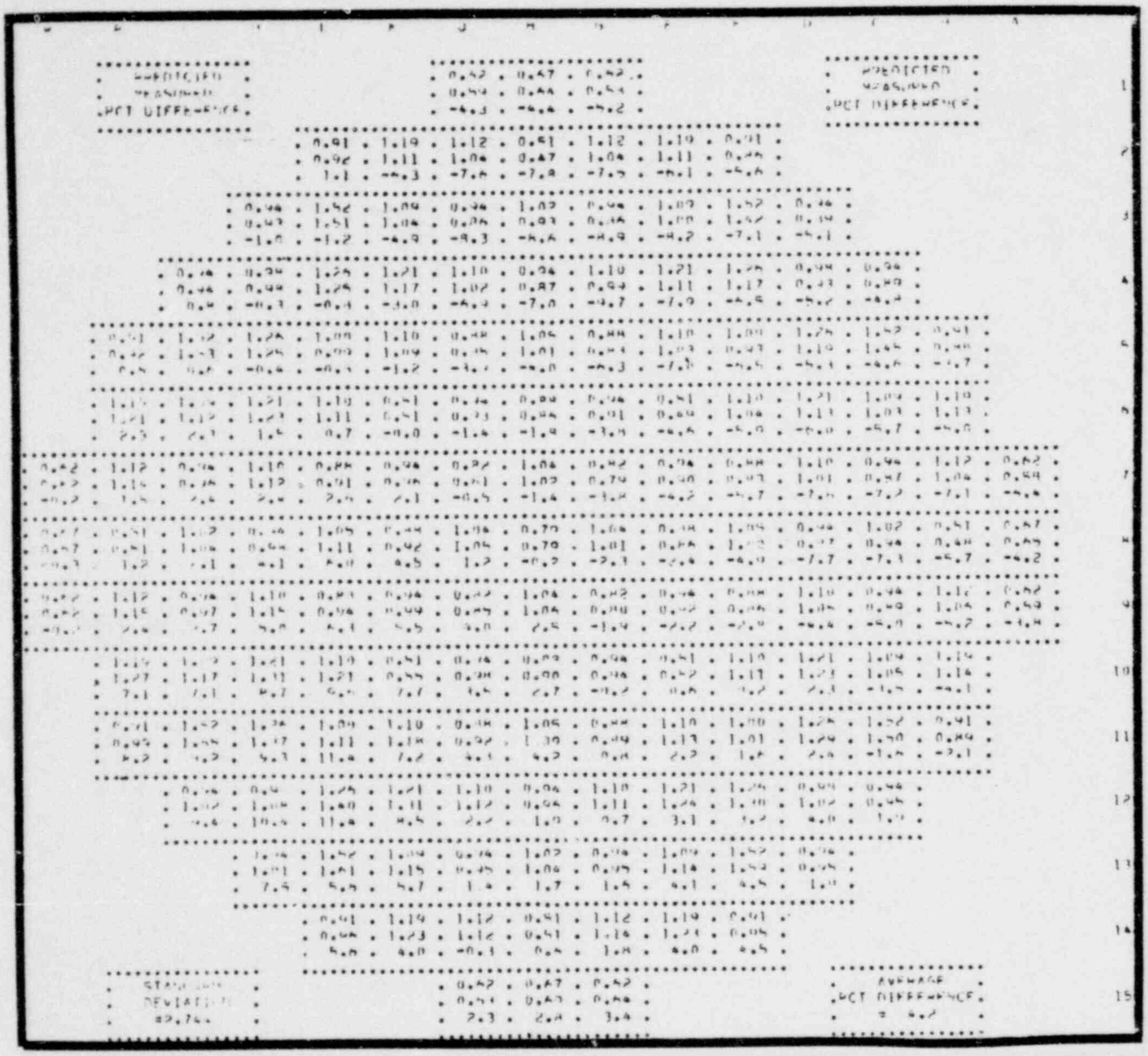
SE - 1.006

Figure 7.2

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HZP, D-BANK IN



MAP NO: N1-2-2

DATE: 1/17/80

POWER ≈ 0%

CONTROL ROD POSITIONS:

$F^N_{\Delta H} = 1.917$

QPTR:

D BANK AT 12 STEPS

$F^T_Q = 3.636$

NW - 0.983

C BANK AT 228 STEPS

$\overline{F}_z = 1.875$

NE - 0.943

A.O. = +47.308

SW - 1.063

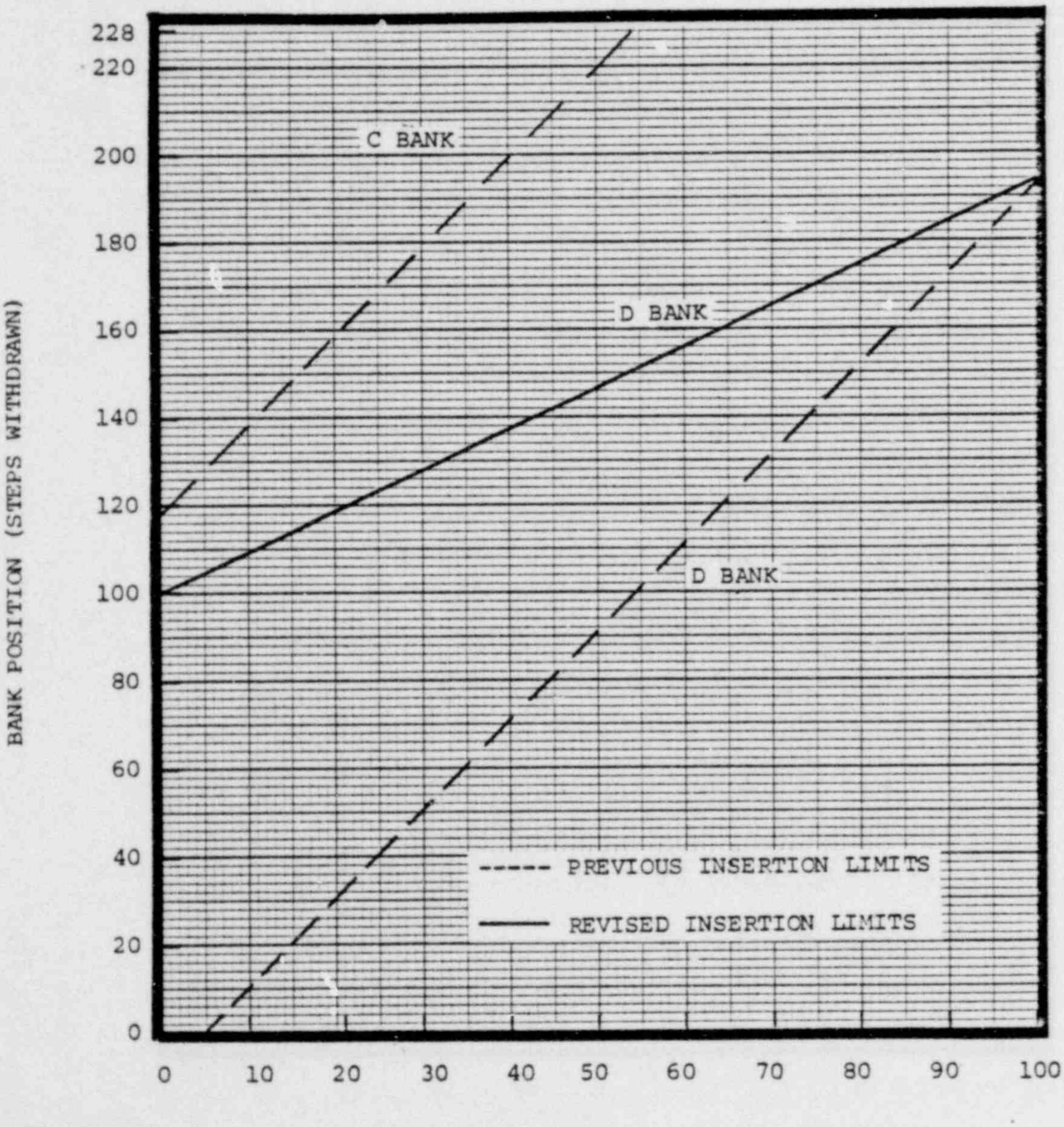
BURNUP ≈ 0 MWD/MTU

SE - 1.011

Figure 7.3

NORTH ANNA UNIT 1 - CYCLE 2

CONTROL ROD INSERTION LIMITS



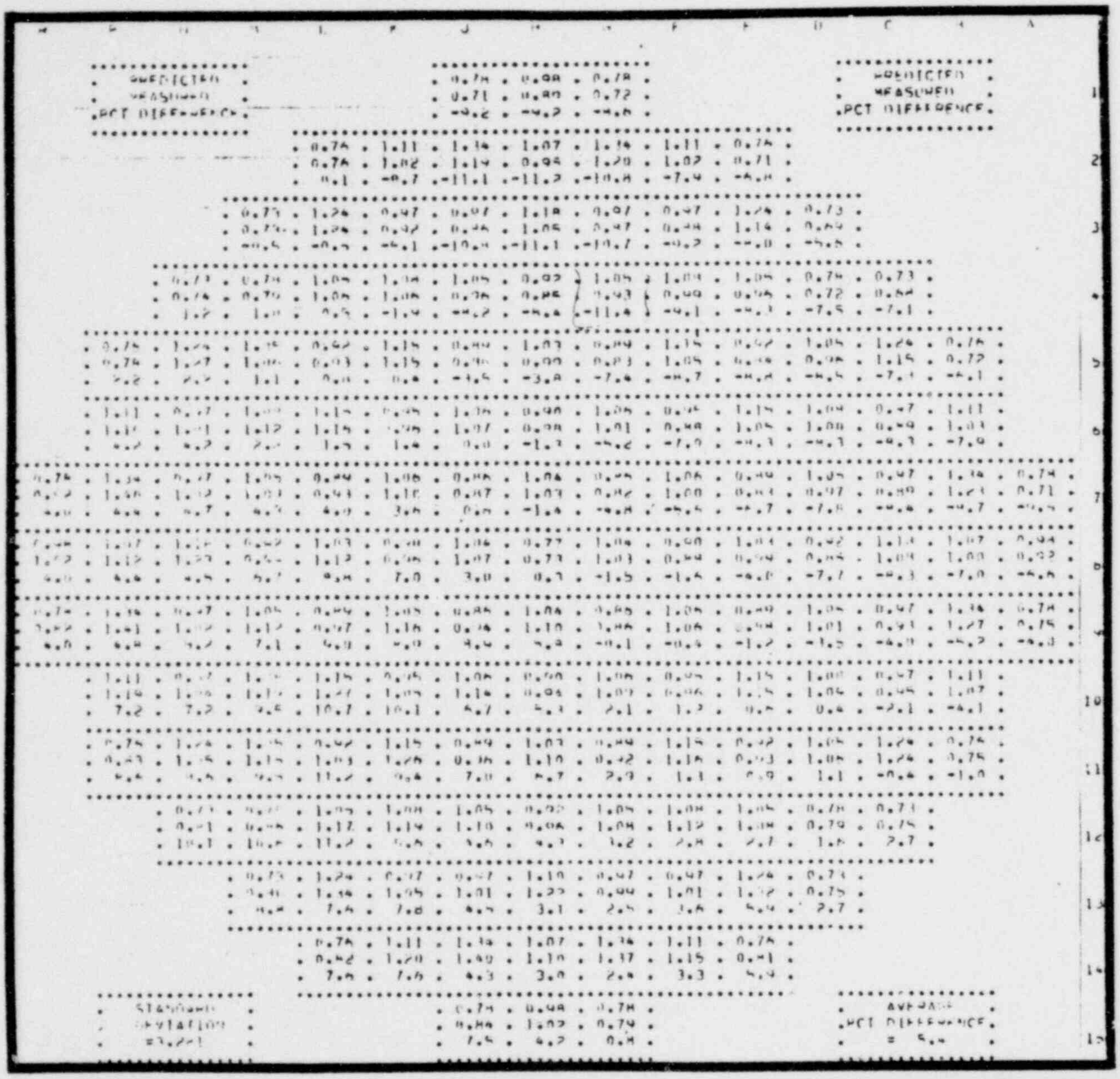
POWER LEVEL (% FULL POWER)

Figure 7.4

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HZP, ARC



MAP NO: N1-2-3

DATE: 1/20/80

POWER ≈ 3%

CONTROL ROD POSITIONS:

D BANK AT 228 STEPS

C BANK AT 228 STEPS

$F^N_{\Delta H} = 1.611$

$F^T_Q = 3.000$

$\overline{F}_z = 1.866$

A.O. = +46.721

BURNUP ≈ 0 MWD/MTU

QPTR:

NW - 0.988

NE - 0.916

SW - 1.084

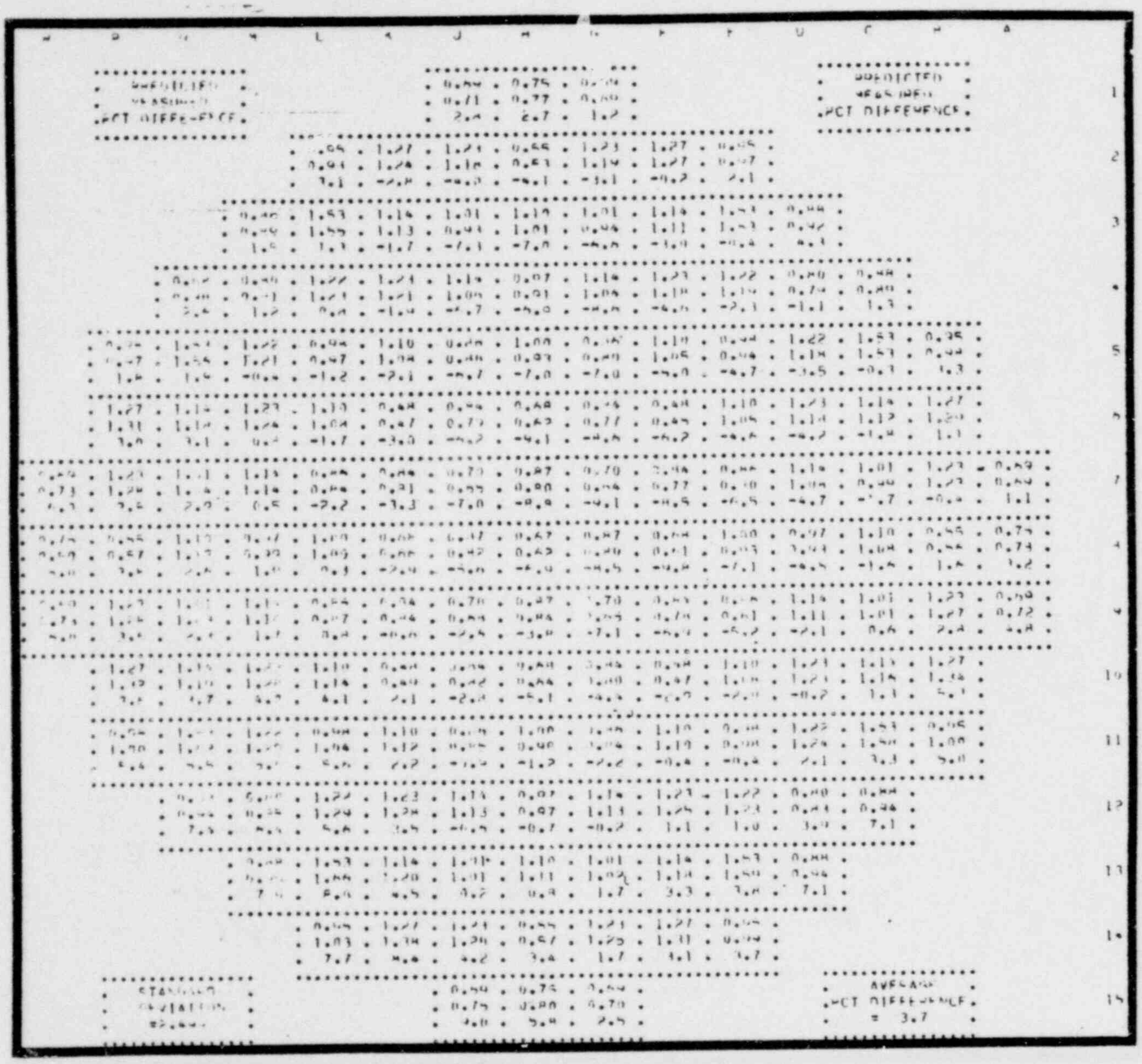
SE - 1.012

Figure 7.5

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HZP, D-BANK AT 0 STEPS AND C-BANK AT 118 STEPS



MAP NO: N1-2-4

DATE: 1/20/80

POWER ≈ 3%

CONTROL ROD POSITIONS:

$F_{\Delta H}^{N} = 1.930$

QPTR:

D BANK AT 0 STEPS

$F_Q^T = 2.946$

NW - 0.990

C BANK AT 118 STEPS

$\overline{F}_z = 1.353$

NE - 0.968

A.O. =-13.600

SW - 1.034

BURNUP ≈ 0 MWD/MTU

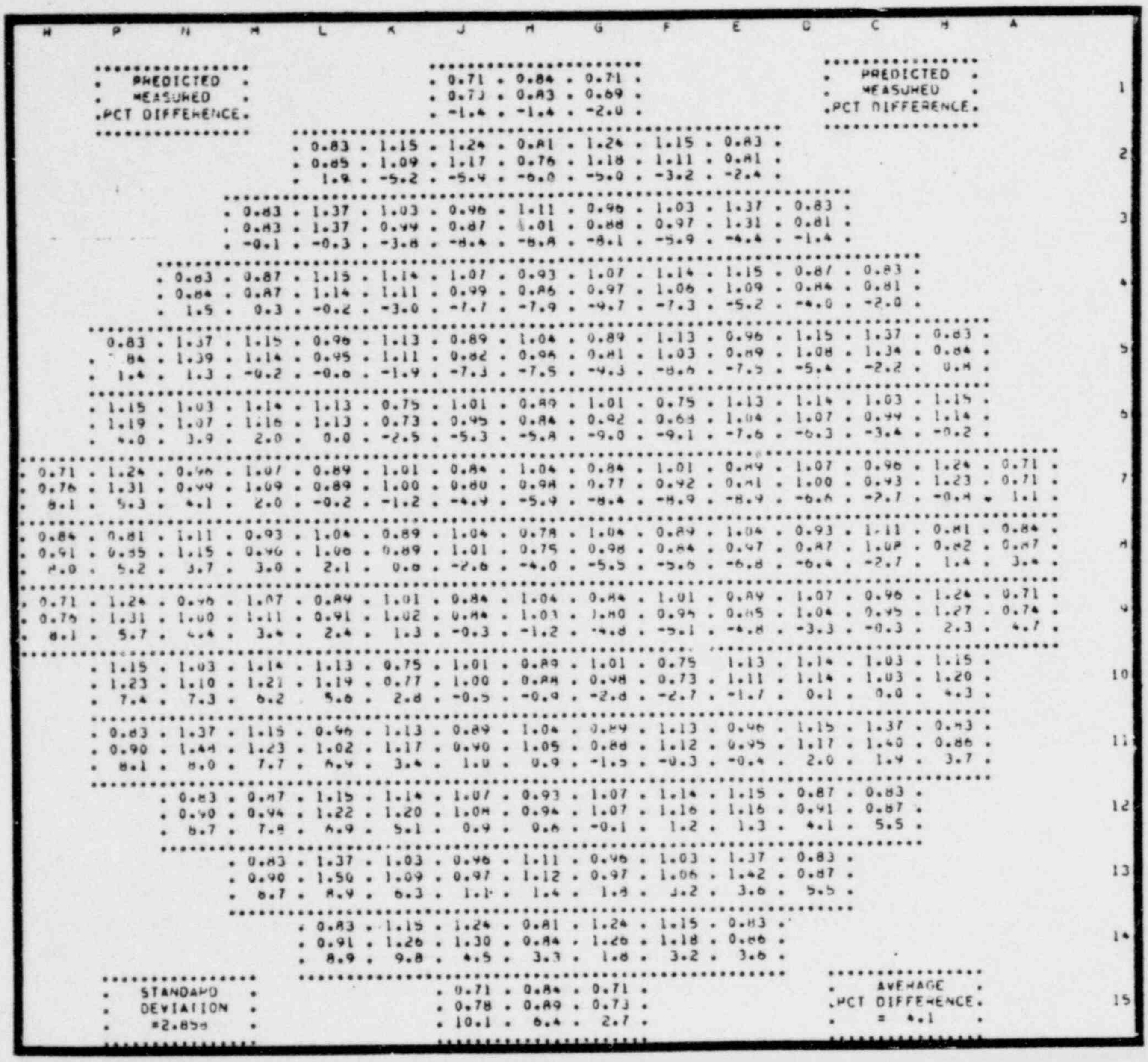
SE - 1.008

Figure 7.6

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HZP, D-BANK AT 100 STEPS



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

       .................                  ......................                    .................
       .   PREDICTED   .                  . 0.71 . 0.84 . 0.71 .                    .   PREDICTED   .
       .   MEASURED    .                  . 0.70 . 0.83 . 0.69 .                    .   MEASURED    .     1
       .PCT DIFFERENCE.                   . -1.4 . -1.4 . -2.0 .                    .PCT DIFFERENCE.
       .................    ...................................................     .................
                            . 0.83 . 1.15 . 1.24 . 0.81 . 1.24 . 1.15 . 0.83 .
                            . 0.85 . 1.09 . 1.17 . 0.76 . 1.18 . 1.11 . 0.81 .                            2
                            .  1.9 . -5.2 . -5.4 . -6.0 . -5.0 . -3.2 . -2.4 .
                     .................................................................
                     . 0.83 . 1.37 . 1.03 . 0.96 . 1.11 . 0.96 . 1.03 . 1.37 . 0.83 .
                     . 0.83 . 1.37 . 0.99 . 0.87 . 1.01 . 0.88 . 0.97 . 1.31 . 0.81 .                     3
                     . -0.1 . -0.3 . -3.8 . -8.4 . -8.8 . -8.1 . -5.9 . -4.4 . -1.4 .
              ...............................................................................
              . 0.83 . 0.87 . 1.15 . 1.14 . 1.07 . 0.93 . 1.07 . 1.14 . 1.15 . 0.87 . 0.83 .
              . 0.84 . 0.87 . 1.14 . 1.11 . 0.99 . 0.86 . 0.97 . 1.06 . 1.09 . 0.84 . 0.81 .              4
              .  1.5 .  0.3 . -0.2 . -3.0 . -7.7 . -7.9 . -9.7 . -7.3 . -5.2 . -4.0 . -2.0 .
       .............................................................................................
         0.83 . 1.37 . 1.15 . 0.96 . 1.13 . 0.89 . 1.04 . 0.89 . 1.13 . 0.96 . 1.15 . 1.37 . 0.83 .
       . 0.84 . 1.39 . 1.14 . 0.95 . 1.11 . 0.82 . 0.96 . 0.81 . 1.03 . 0.89 . 1.08 . 1.34 . 0.84 .       5
       .  1.4 .  1.3 . -0.2 . -0.6 . -1.9 . -7.3 . -7.5 . -9.3 . -8.6 . -7.5 . -5.4 . -2.2 .  0.8 .
       .............................................................................................
       . 1.15 . 1.03 . 1.14 . 1.13 . 0.75 . 1.01 . 0.89 . 1.01 . 0.75 . 1.13 . 1.14 . 1.03 . 1.15 .
       . 1.19 . 1.07 . 1.16 . 1.13 . 0.73 . 0.95 . 0.84 . 0.92 . 0.68 . 1.04 . 1.07 . 0.99 . 1.14 .       6
       .  4.0 .  3.9 .  2.0 .  0.0 . -2.5 . -5.3 . -5.8 . -9.0 . -9.1 . -7.6 . -6.3 . -3.4 . -0.2 .
..........................................................................................................
. 0.71 . 1.24 . 0.96 . 1.07 . 0.89 . 1.01 . 0.84 . 1.04 . 0.84 . 1.01 . 0.89 . 1.07 . 0.96 . 1.24 . 0.71 .
. 0.76 . 1.31 . 0.99 . 1.09 . 0.89 . 1.00 . 0.80 . 0.98 . 0.77 . 0.92 . 0.81 . 1.00 . 0.93 . 1.23 . 0.71 .   7
.  8.1 .  5.3 .  4.1 .  2.0 . -0.2 . -1.2 . -4.9 . -5.9 . -8.4 . -8.9 . -8.9 . -6.6 . -2.7 . -0.8 .  1.1 .
..........................................................................................................
. 0.84 . 0.81 . 1.11 . 0.93 . 1.04 . 0.89 . 1.04 . 0.78 . 1.04 . 0.89 . 1.04 . 0.93 . 1.11 . 0.81 . 0.84 .
. 0.91 . 0.85 . 1.15 . 0.96 . 1.06 . 0.89 . 1.01 . 0.75 . 0.98 . 0.84 . 0.97 . 0.87 . 1.08 . 0.82 . 0.87 .   8
.  8.0 .  5.2 .  3.7 .  3.0 .  2.1 .  0.0 . -2.6 . -4.0 . -5.5 . -5.6 . -6.8 . -6.4 . -2.7 .  1.4 .  3.4 .
..........................................................................................................
. 0.71 . 1.24 . 0.96 . 1.07 . 0.89 . 1.01 . 0.84 . 1.04 . 0.84 . 1.01 . 0.89 . 1.07 . 0.96 . 1.24 . 0.71 .
. 0.76 . 1.31 . 1.00 . 1.11 . 0.91 . 1.02 . 0.84 . 1.03 . 0.80 . 0.95 . 0.85 . 1.04 . 0.95 . 1.27 . 0.74 .   9
.  8.1 .  5.7 .  4.4 .  3.4 .  2.4 .  1.3 . -0.3 . -1.2 . -4.8 . -5.1 . -4.8 . -3.3 . -0.3 .  2.3 .  4.7 .
..........................................................................................................
       . 1.15 . 1.03 . 1.14 . 1.13 . 0.75 . 1.01 . 0.89 . 1.01 . 0.75   1.13 . 1.14 . 1.03 . 1.15 .
       . 1.23 . 1.10 . 1.21 . 1.19 . 0.77 . 1.00 . 0.88 . 0.98 . 0.73 . 1.11 . 1.14 . 1.03 . 1.20 .       10
       .  7.4 .  7.3 .  6.2    5.6 .  2.8 . -0.5 . -0.9 . -2.8 . -2.7 . -1.7 .  0.1 .  0.0 .  4.3 .
       .............................................................................................
       . 0.83 . 1.37 . 1.15 . 0.96 . 1.13 . 0.89 . 1.04 . 0.89 . 1.13 . 0.96 . 1.15 . 1.37 . 0.83 .
       . 0.90 . 1.44 . 1.23 . 1.02 . 1.17 . 0.90 . 1.05 . 0.88 . 1.12 . 0.95 . 1.17 . 1.40 . 0.86 .       11
       .  8.1 .  8.0 .  7.7 .  6.9 .  3.4 .  1.0 .  0.9 . -1.5 . -0.3 . -0.4 .  2.0 .  1.9 .  3.7 .
       .............................................................................................
              . 0.83 . 0.87 . 1.15 . 1.14 . 1.07 . 0.93 . 1.07 . 1.14 . 1.15 . 0.87 . 0.83 .
              . 0.90 . 0.94 . 1.22 . 1.20 . 1.08 . 0.94 . 1.07 . 1.16 . 1.16 . 0.91 . 0.87 .              12
              .  8.7 .  7.8 .  6.9 .  5.1 .  0.9 .  0.6 . -0.1 .  1.2 .  1.3 .  4.1 .  5.5 .
              ...............................................................................
                     . 0.83 . 1.37 . 1.03 . 0.96 . 1.11 . 0.96 . 1.03 . 1.37 . 0.83 .
                     . 0.90 . 1.50 . 1.09 . 0.97 . 1.12 . 0.97 . 1.06 . 1.42 . 0.87 .                     13
                     .  8.7 .  8.9 .  6.3 .  1.1 .  1.4 .  1.4 .  3.2 .  3.6 .  5.5 .
                     .................................................................
                            . 0.83 . 1.15 . 1.24 . 0.81 . 1.24 . 1.15 . 0.83 .
                            . 0.91 . 1.26 . 1.30 . 0.84 . 1.26 . 1.18 . 0.86 .                            14
                            .  8.9 .  9.8 .  4.5 .  3.3 .  1.8 .  3.2 .  3.6 .
       .................    ...................................................     .................
       .   STANDARD    .                  . 0.71 . 0.84 . 0.71 .                    .    AVERAGE    .
       .   DEVIATION   .                  . 0.78 . 0.89 . 0.73 .                    .PCT DIFFERENCE.      15
       .    =2.856     .                  . 10.1 .  6.4 .  2.7 .                    .    = 4.1      .
       .................                  ......................                    .................
```

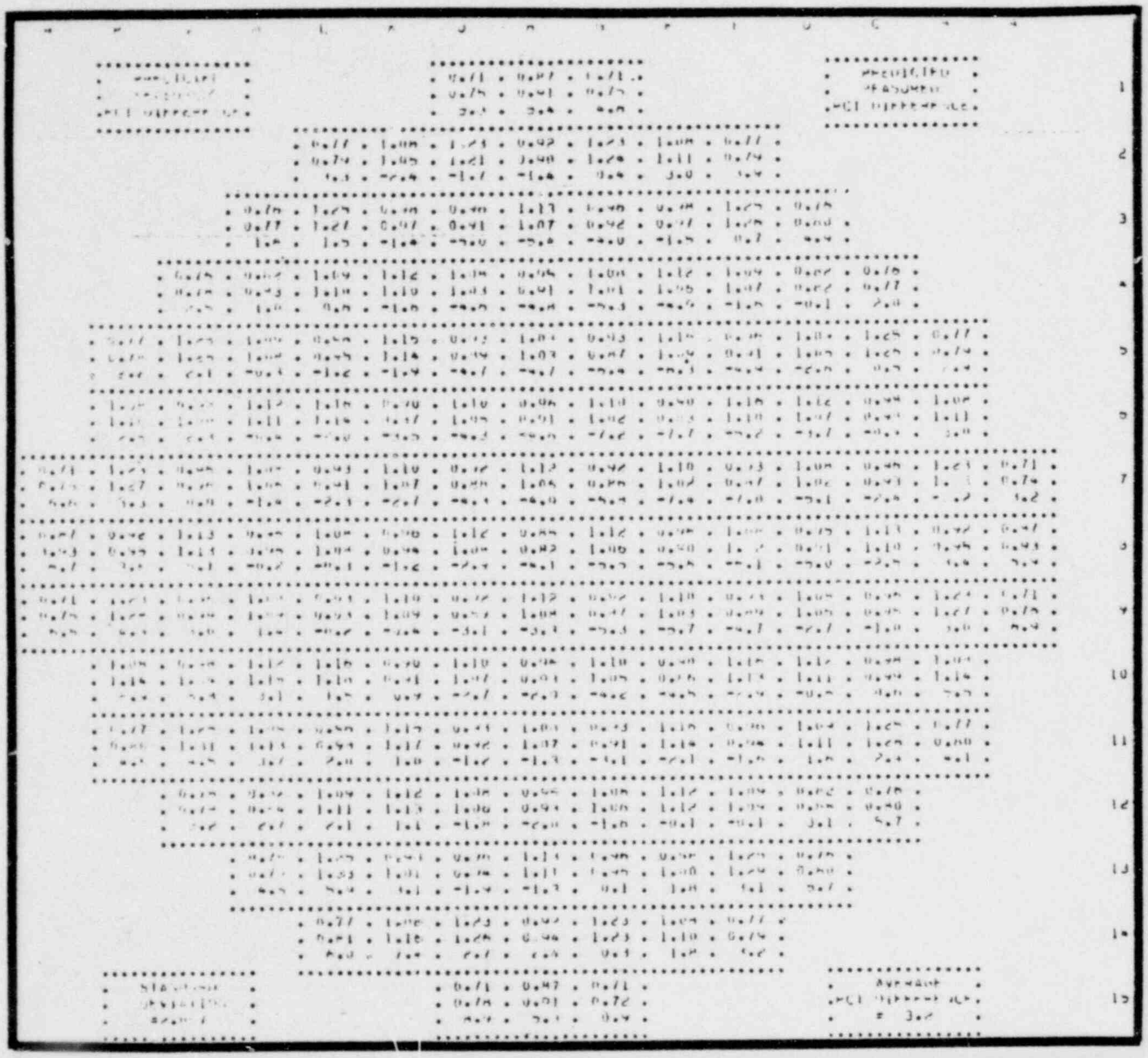
MAP NO: N1-2-6	DATE: 1/21/8	POWER = 3%
CONTROL ROD POSITIONS:	$F^N_{\Delta H}$ = 1.740	QPTR:
D BANK AT 99 STEPS	F^T_Q = 2.580	NW - 0.997
C BANK AT 228 STEPS	$\overline{F}_z$ = 1.424	NE - 0.950
	A.O. =-19.243	SW - 1.051
	BURNUP = 0 MWD/MTU	SE - 1.002

Figure 7.7

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - FLUX MAP



MAP NO: N1-2-7

DATE: 1/24/80

POWER = 30%

CONTROL ROD POSITIONS:

D BANK AT 165 STEPS

C BANK AT 228 STEPS

$F^N_{\Delta H}$ = 1.542

F^T_Q = 2.078

$\overline{F}_z$ = 1.246

A.O. = +0.482

3URNUP = 28 MWD/MTU

QPTR:

NW - 0.996

NE - 0.981

SW - 1.024

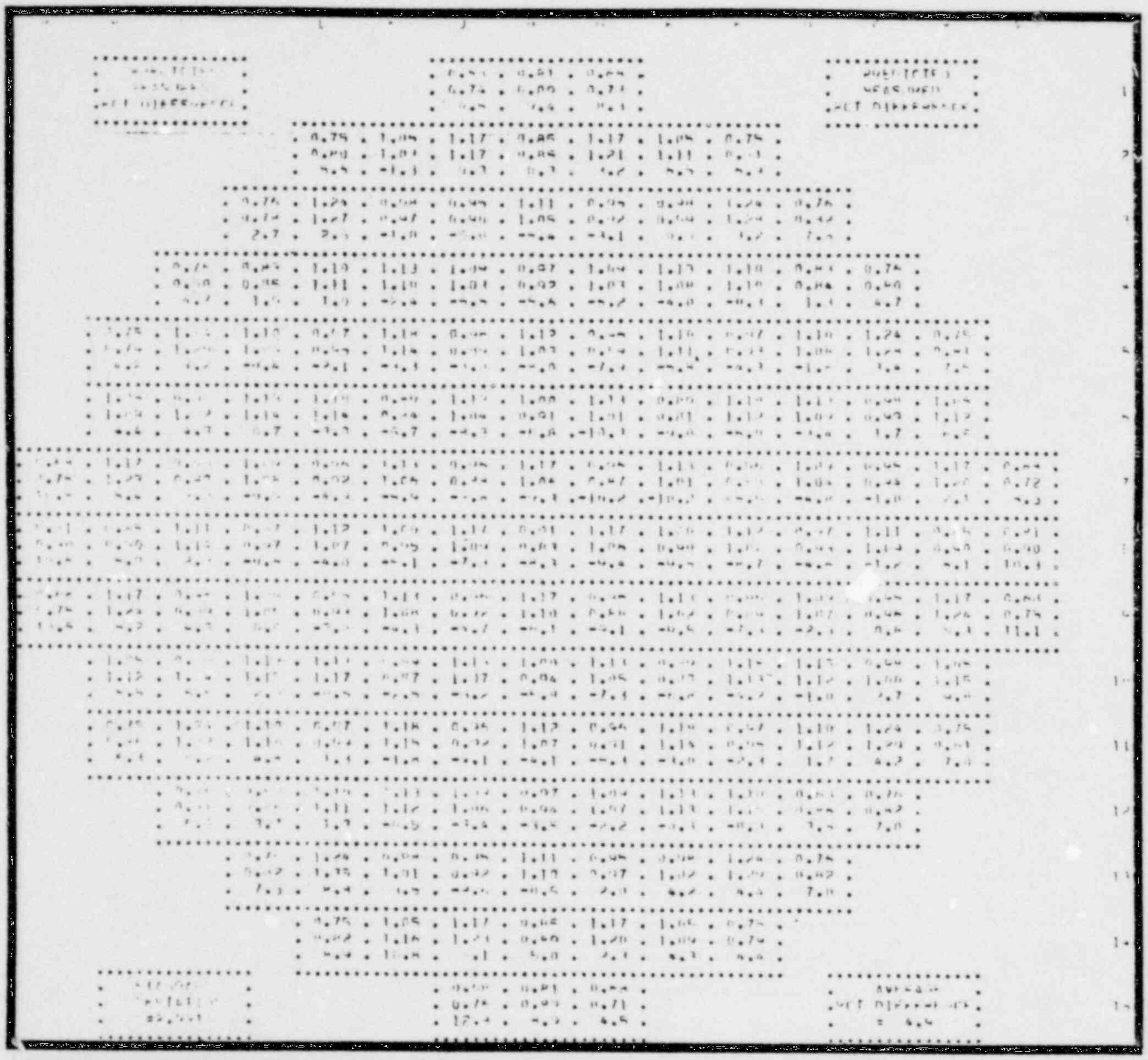
SE - 0.999

Figure 7.8

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - FLUX MAP



MAP NO: N1-2-8

CONTROL ROD POSITIONS:

D BANK AT 138 STEPS

C BANK AT 228 STEPS

DATE: 1/25/80

$F^N_{\Delta H} = 1.566$

$F^T_Q = 2.200$

$\overline{F}_z = 1.300$

A.O. = -14.856

BURNUP = 40 MWD/MTU

POWER = 30%

QPTR:

NW - 0.994

NE - 0.980

SW - 1.024

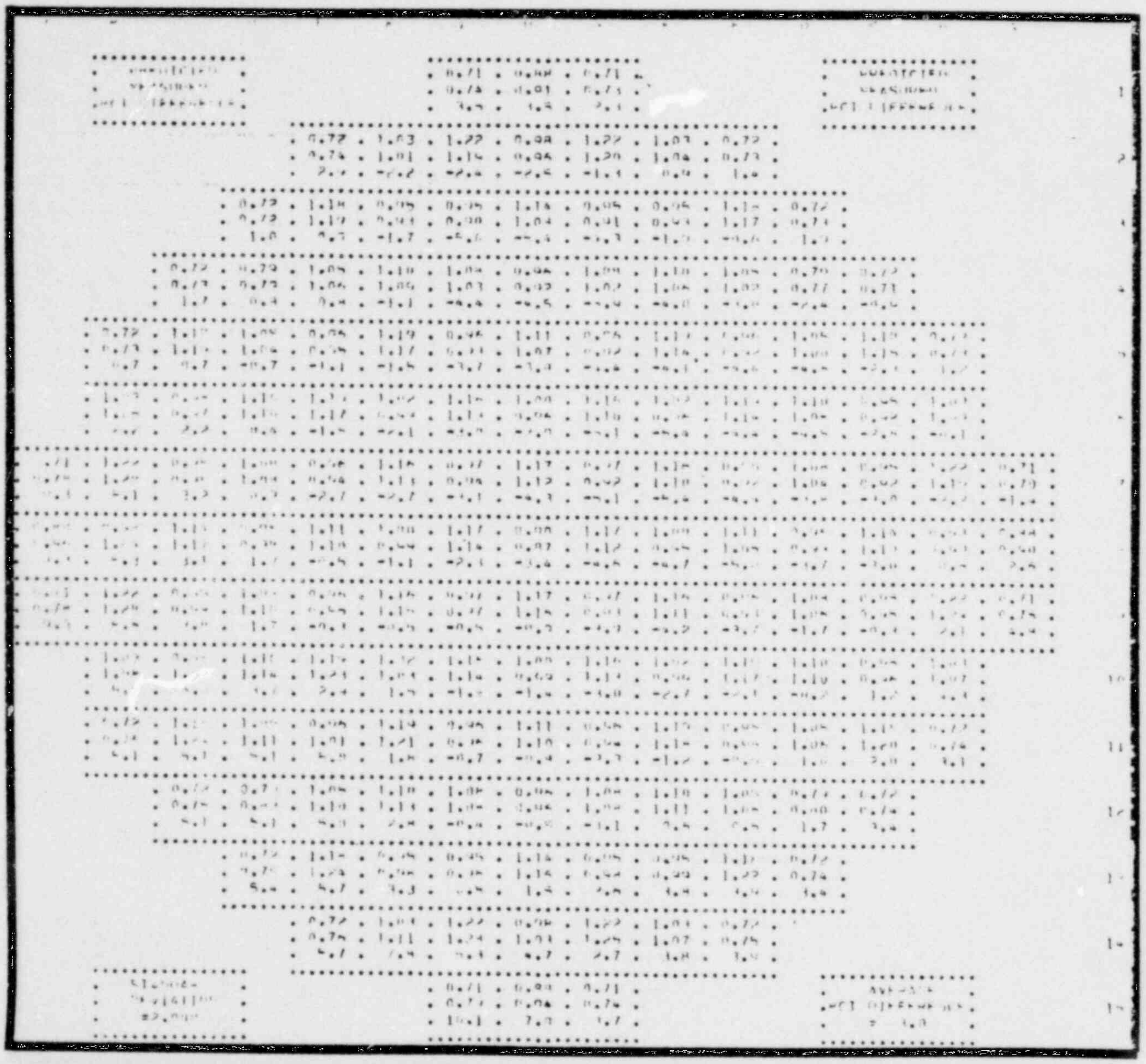
SE - 1.002

Figure 7.9

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: N1-2-9

DATE: 1/25/80

POWER = 30%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.467

QPTR:

D BANK AT 217 STEPS

F^T_Q = 2.863

NW - 0.991

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.925

NE - 0.962

A.O. = +48.182

SW - 1.045

BURNUP ≈ 50 MWD/MTU

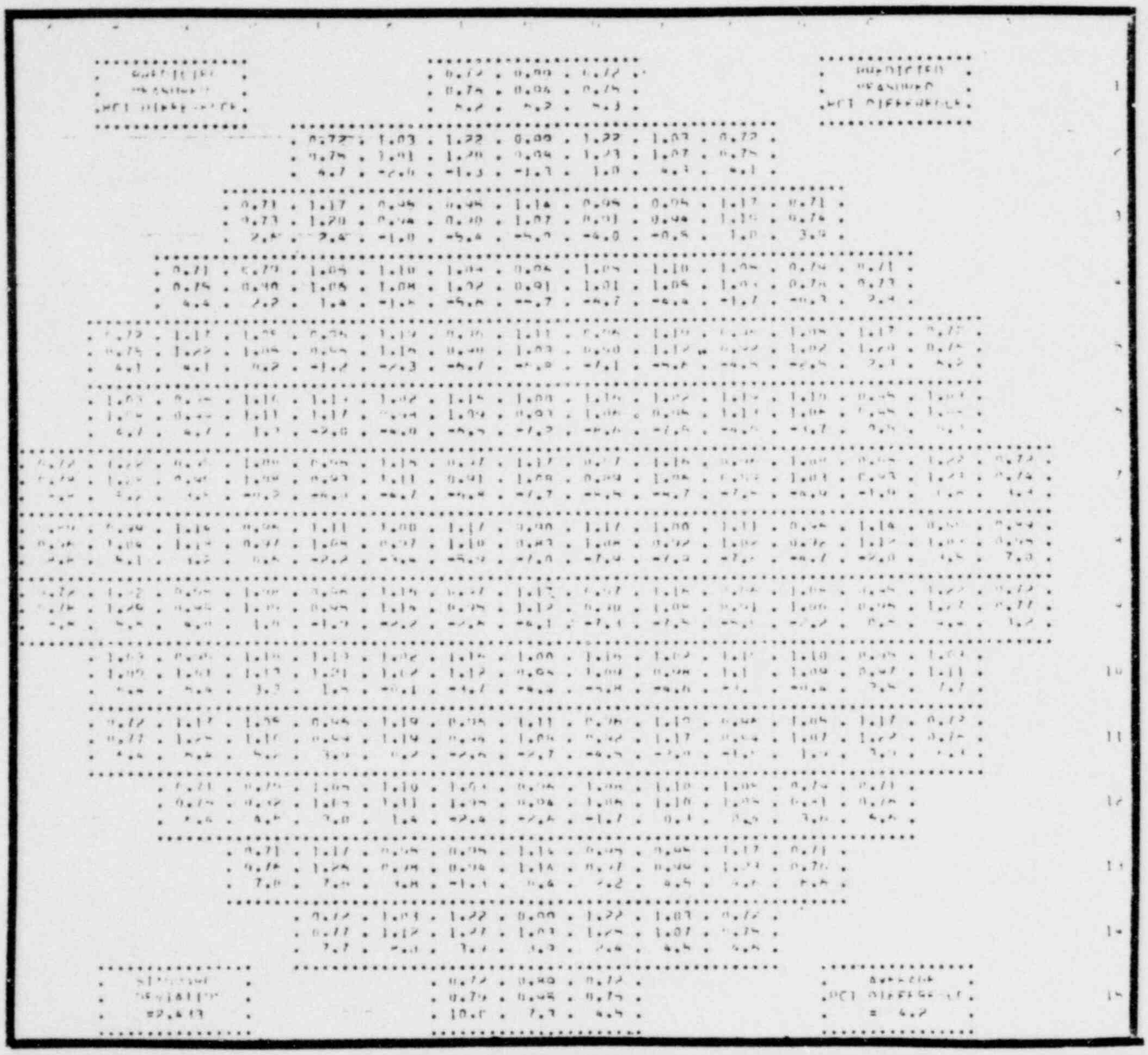
SE - 1.002

Figure 7.10

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: N1-2-10	DATE: 1/26/80	POWER ≈ 30%
CONTROL ROD POSITIONS:	$F^N_{\Delta H}$ = 1.476	QPTR:
D BANK AT 218 STEPS	F^T_Q = 1.868	NW - 0.989
C BANK AT 228 STEPS	$\overline{F}_z$ = 1.198	NE - 0.975
	A.O. = +6.243	SW - 1.029
	BURNUP ≈ 50 MWD/MTU	SE - 1.007

Figure 7.11

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP

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

       ................                 ..........................                     ................
       .   PREDICTED  .                 . 0.71 . 0.89 . 0.71 .                         .   PREDICTED  .
       .   MEASURED   .                 . 0.74 . 0.92 . 0.74 .                         .   MEASURED   .     1
       .PCT DIFFERENCE.                 .  4.2 .  4.2 .  3.9 .                         .PCT DIFFERENCE.
       ................   ..................................................           ................
                          . 0.72 . 1.03 . 1.22 . 0.99 . 1.22 . 1.03 . 0.72 .
                          . 0.75 . 1.02 . 1.20 . 0.98 . 1.22 . 1.06 . 0.75 .                                2
                          .  4.9 . -1.2 . -1.4 . -1.5 .  0.3 .  3.4 .  3.9 .
                   ................................................................
                   . 0.72 . 1.17 . 0.95 . 0.95 . 1.14 . 0.95 . 0.95 . 1.17 . 0.72 .
                   . 0.73 . 1.20 . 0.94 . 0.91 . 1.09 . 0.92 . 0.95 . 1.19 . 0.75 .                         3
                   .  2.5 .  2.2 . -0.8 . -4.4 . -4.4 . -3.4 . -0.4 .  1.3 .  4.5 .
            ..............................................................................
            . 0.72 . 0.79 . 1.05 . 1.10 . 1.08 . 0.96 . 1.08 . 1.10 . 1.05 . 0.79 . 0.72 .
            . 0.74 . 0.81 . 1.07 . 1.09 . 1.03 . 0.92 . 1.02 . 1.07 . 1.04 . 0.79 . 0.73 .                  4
            .  4.0 .  2.1 .  1.6 . -1.1 . -4.3 . -4.4 . -5.5 . -3.0 . -0.9 .  0.3 .  2.6 .
     ............................................................................................
     . 0.72 . 1.17 . 1.05 . 0.96 . 1.19 . 0.96 . 1.11 . 0.96 . 1.19 . 0.96 . 1.05 . 1.17 . 0.72 .
     . 0.74 . 1.21 . 1.05 . 0.95 . 1.17 . 0.92 . 1.05 . 0.91 . 1.14 . 0.93 . 1.03 . 1.19 . 0.76 .           5
     .  3.2 .  3.2 .  0.2 . -0.7 . -1.5 . -4.6 . -4.9 . -5.4 . -4.1 . -3.4 . -1.8 .  1.7 .  5.3 .
     ............................................................................................
     . 1.03 . 0.95 . 1.10 . 1.14 . 1.02 . 1.16 . 1.00 . 1.16 . 1.02 . 1.14 . 1.10 . 0.95 . 1.03 .
     . 1.06 . 0.98 . 1.11 . 1.13 . 1.00 . 1.11 . 0.96 . 1.09 . 0.97 . 1.15 . 1.07 . 0.95 . 1.06 .           6
     .  3.5 .  3.5 .  1.2 . -1.2 . -2.4 . -4.2 . -4.4 . -5.2 . -5.3 . -3.8 . -3.0 . -0.1 .  3.4 .
..........................................................................................................
. 0.71 . 1.22 . 0.95 . 1.04 . 0.96 . 1.16 . 0.97 . 1.17 . 0.97 . 1.16 . 0.96 . 1.04 . 0.95 . 1.22 . 0.71 .
. 0.76 . 1.26 . 0.97 . 1.07 . 0.94 . 1.13 . 0.93 . 1.11 . 0.91 . 1.09 . 0.91 . 1.03 . 0.93 . 1.21 . 0.73 .  7
.  6.2 .  3.3 .  1.9 . -0.4 . -2.7 . -2.4 . -4.1 . -5.0 . -6.1 . -6.3 . -5.9 . -4.5 . -2.5 . -0.8 .  1.6 .
..........................................................................................................
. 0.89 . 0.99 . 1.14 . 0.95 . 1.11 . 1.00 . 1.17 . 0.90 . 1.17 . 1.00 . 1.11 . 0.95 . 1.14 . 0.99 . 0.89 .
. 0.94 . 1.02 . 1.15 . 0.97 . 1.10 . 0.98 . 1.13 . 0.85 . 1.10 . 0.94 . 1.04 . 0.92 . 1.11 . 1.01 . 0.93 .  8
.  5.2 .  3.3 .  1.8 .  0.8 . -1.1 . -1.7 . -3.2 . -5.2 . -5.5 . -5.6 . -6.0 . -4.5 . -2.6 .  1.9 .  4.4 .
..........................................................................................................
. 0.71 . 1.22 . 0.95 . 1.04 . 0.96 . 1.16 . 0.97 . 1.17 . 0.97 . 1.16 . 0.96 . 1.04 . 0.95 . 1.22 . 0.71 .
. 0.76 . 1.26 . 0.97 . 1.04 . 0.96 . 1.15 . 0.94 . 1.13 . 0.92 . 1.10 . 0.92 . 1.05 . 0.95 . 1.25 . 0.76 .  9
.  6.2 .  3.1 .  2.4 .  0.7 . -0.8 . -1.0 . -3.2 . -3.2 . -5.2 . -5.4 . -4.7 . -2.5 . -0.8 .  2.8 .  5.2 .
..........................................................................................................
     . 1.03 . 0.95 . 1.10 . 1.14 . 1.02 . 1.16 . 1.00 . 1.16 . 1.02 . 1.14 . 1.10 . 0.95 . 1.03 .
     . 1.08 . 1.00 . 1.13 . 1.22 . 1.04 . 1.12 . 0.98 . 1.11 . 0.99 . 1.10 . 1.10 . 0.96 . 1.09 .          10
     .  5.0 .  5.0 .  3.1 .  2.1 .  1.9 . -3.7 . -2.5 . -4.3 . -3.4 . -2.6 . -0.3 .  1.2 .  5.6 .
     ............................................................................................
     . 0.72 . 1.17 . 1.05 . 0.96 . 1.19 . 0.96 . 1.11 . 0.96 . 1.19 . 0.96 . 1.05 . 1.17 . 0.72 .
     . 0.76 . 1.24 . 1.10 . 0.99 . 1.21 . 0.95 . 1.08 . 0.93 . 1.17 . 0.95 . 1.07 . 1.21 . 0.75 .          11
     .  5.5 .  5.5 .  4.7 .  3.6 .  1.6 . -2.0 . -2.2 . -3.7 . -1.6 . -1.2 .  1.7 .  2.8 .  4.6 .
     ............................................................................................
            . 0.72 . 0.79 . 1.05 . 1.10 . 1.08 . 0.96 . 1.08 . 1.10 . 1.05 . 0.79 . 0.72 .
            . 0.76 . 0.82 . 1.09 . 1.12 . 1.05 . 0.94 . 1.06 . 1.10 . 1.05 . 0.81 . 0.76 .                 12
            .  6.0 .  4.0 .  3.8 .  1.5 . -2.1 . -2.5 . -1.6 .  0.2 .  0.2 .  3.4 .  5.6 .
            ..............................................................................
                   . 0.72 . 1.17 . 0.95 . 0.95 . 1.14 . 0.95 . 0.95 . 1.17 . 0.72 .
                   . 0.76 . 1.25 . 0.98 . 0.93 . 1.13 . 0.96 . 0.98 . 1.21 . 0.76 .                        13
                   .  5.2 .  6.4 .  3.0 . -1.9 . -0.6 .  0.9 .  3.1 .  2.4 .  5.6 .
                   ................................................................
                          . 0.72 . 1.03 . 1.22 . 0.99 . 1.22 . 1.03 . 0.72 .
                          . 0.77 . 1.10 . 1.18 . 0.99 . 1.23 . 1.06 . 0.74 .                               14
                          .  6.4 .  6.5 . -3.4 . -0.2 .  1.1 .  3.1 .  3.4 .
       ................   ..................................................           ................
       .   STANDARD   .                 . 0.71 . 0.89 . 0.71 .                         .    AVERAGE   .
       .   DEVIATION  .                 . 0.76 . 0.91 . 0.74 .                         .PCT DIFFERENCE.     15
       .    =1.744    .                 .  5.8 .  2.9 .  2.8 .                         .    =  3.2    .
       ................                 ..........................                     ................
```

MAP NO: N1-2-11

DATE: 1/29/80

POWER = 47%

CONTROL ROD POSITIONS:

D BANK AT 218 STEPS

C BANK AT 228 STEPS

$F^N_{\Delta H}$ = 1.456

F^T_Q = 1.903

$\overline{F}_z$ = 1.274

A.O. = +11.059

BURNUP = 85 MWD/MTU

QPTR:

NW - 0.997

NE - 0.980

SW - 1.020

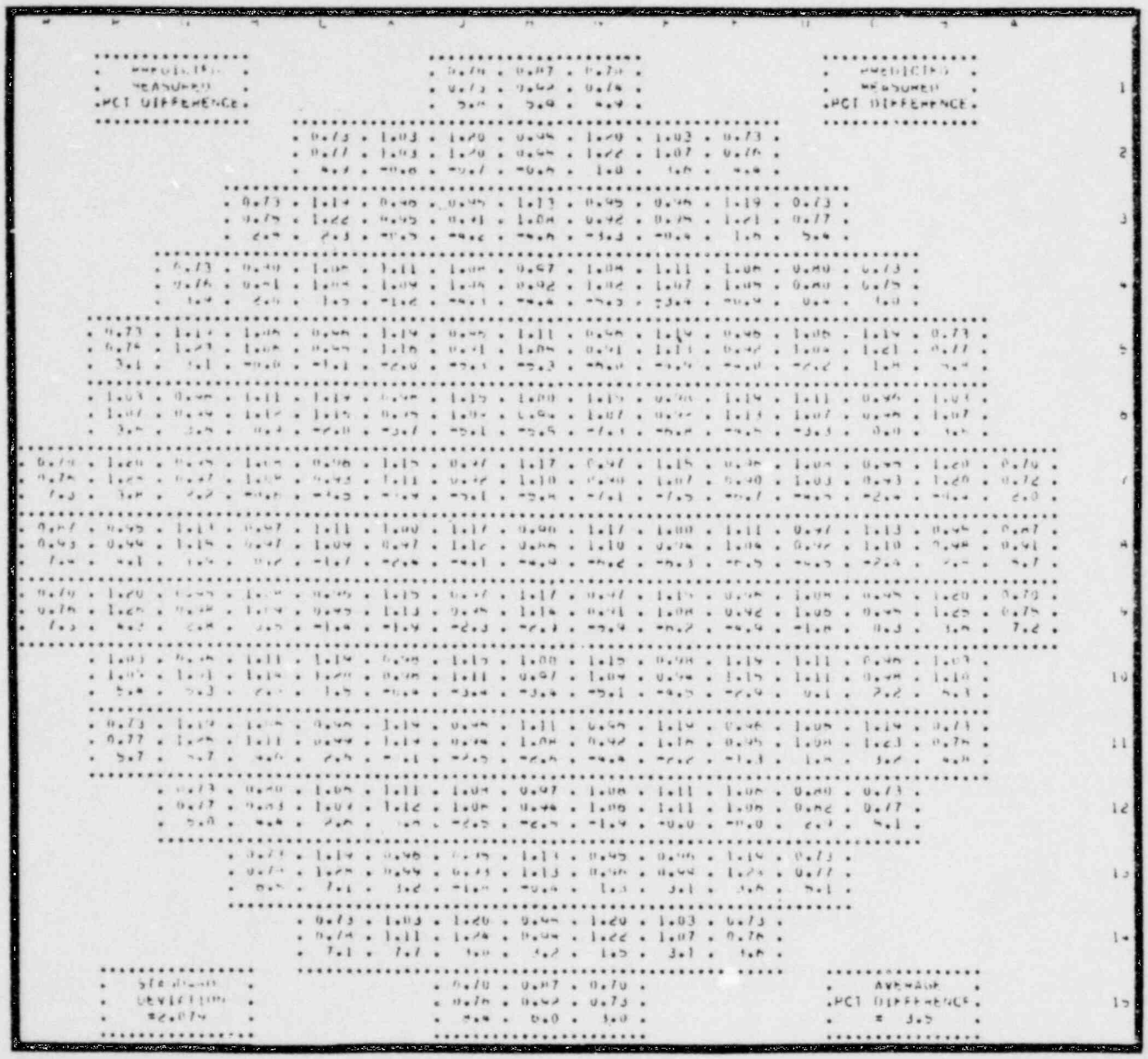
SE - 1.003

Figure 7.12

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



PREDICTED
MEASURED
PCT DIFFERENCE

STANDARD
DEVIATION
=2.074

AVERAGE
PCT DIFFERENCE
= 3.5

MAP NO: N1-2-12

DATE: 1/31/80

POWER = 45%

CONTROL ROD POSITIONS:

$F^{N}_{\Delta H}$ = 1.487

QPTR:

D BANK AT 192 STEPS

F^{T}_{Q} = 1.943

NW - 0.995

C BANK AT 228 STEPS

$\overline{F}_{z}$ = 1.243

NE - 0.975

A.O. = +6.076

SW - 1.025

BURNUP = 110 MWD/MTU

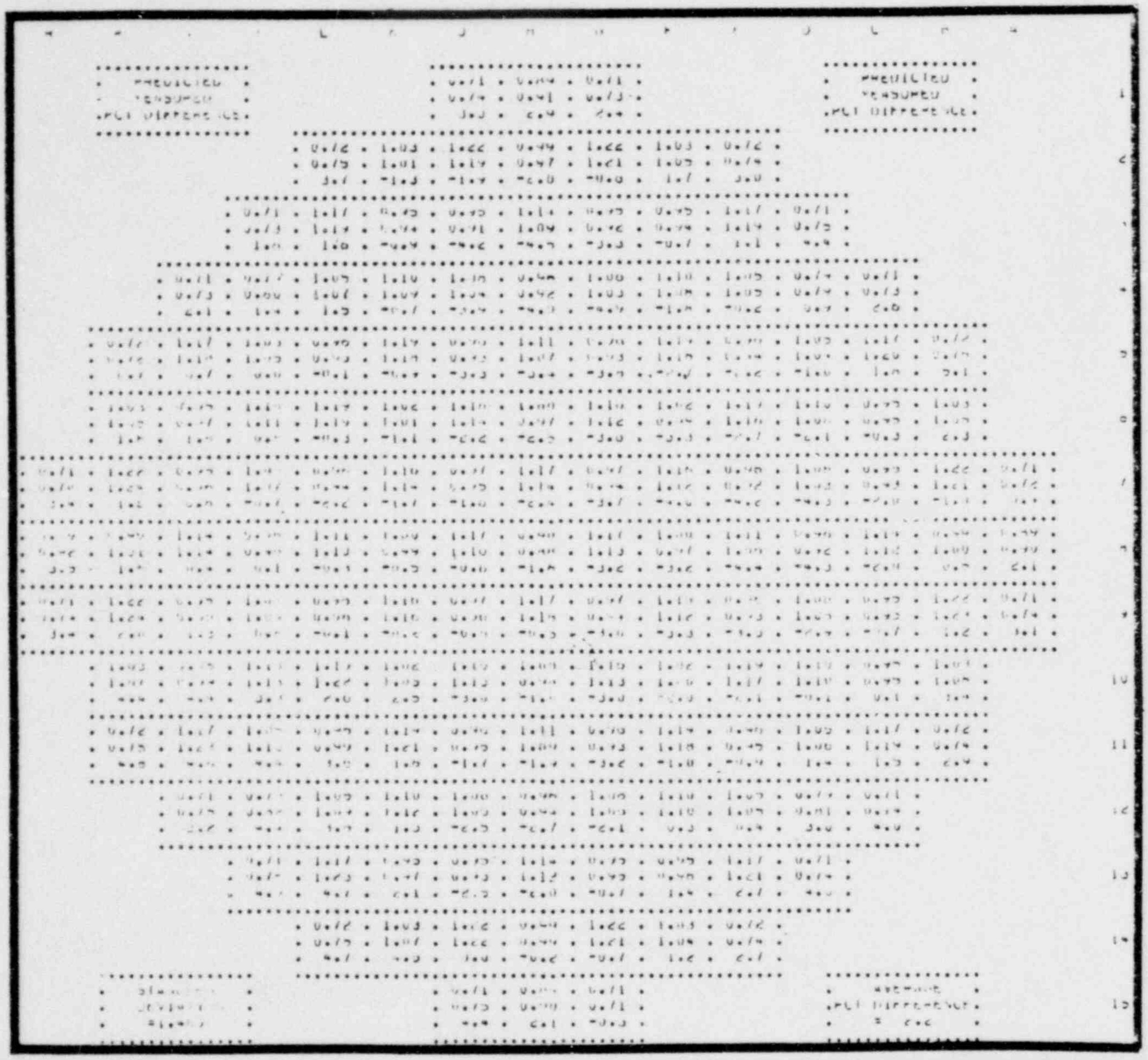
SE - 1.005

Figure 7.13

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



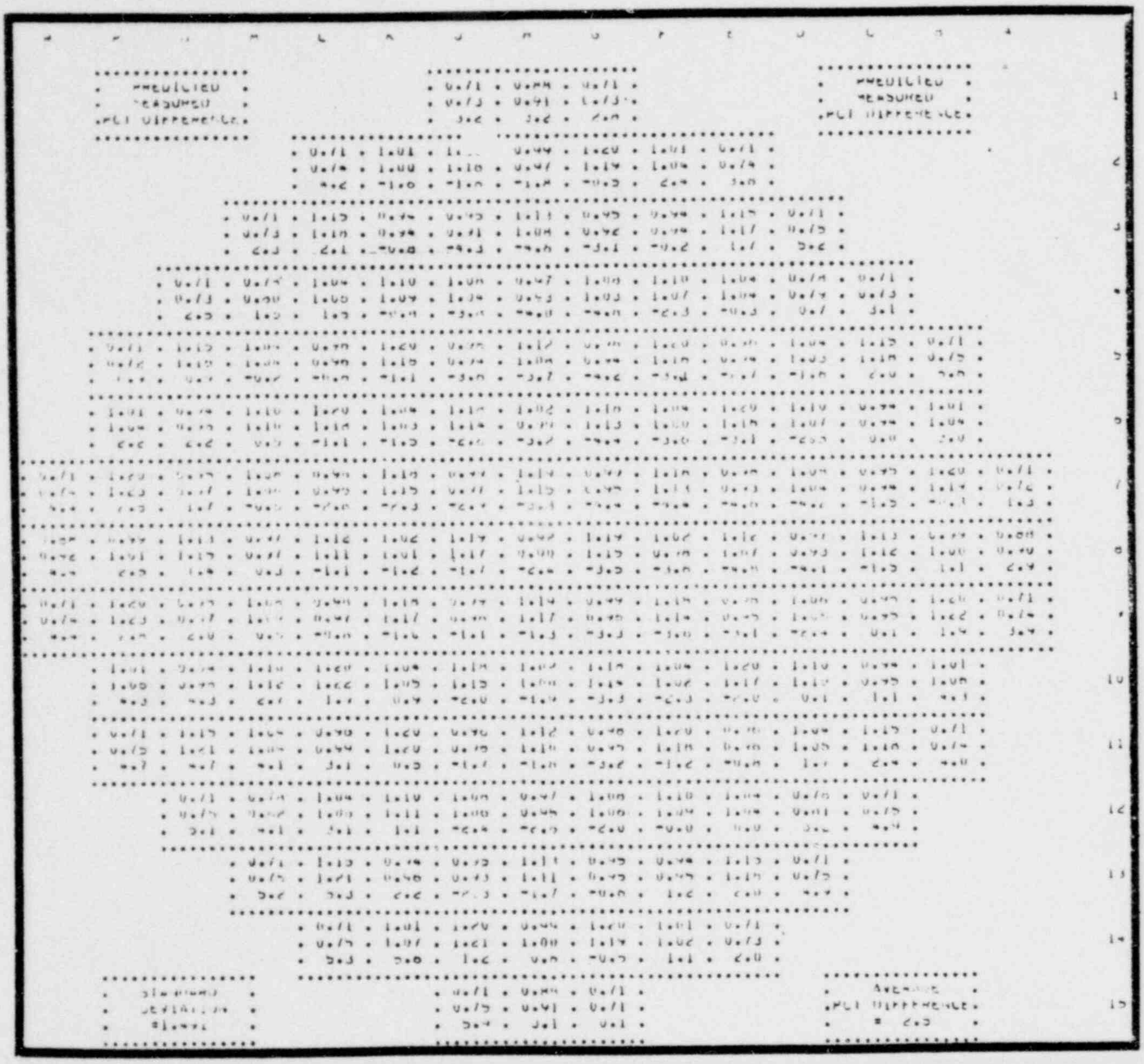
MAP NO: N1-2-13	DATE: 2/3/80	POWER = 66%
CONTROL ROD POSITIONS:	$F^N_{\Delta H}$ = 1.433	QPTR:
D BANK AT 217 STEPS	F^T_Q = 1.844	NW - 0.996
C BANK AT 228 STEPS	$\overline{F}_z$ = 1.239	NE - 0.986
	A.O. = +8.899	SW - 1.018
	BURNUP = 144 MWD/MTU	SE - 1.000

Figure 7.14

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: N1-2-14

CONTROL ROD POSITIONS:

D BANK AT 228 STEPS

C BANK AT 228 STEPS

DATE: 2/4/80

$F_{\Delta H}^{N}$ = 1.412

F_{Q}^{T} = 1.749

$\overline{F}_z$ = 1.174

A.O. = +4.567

BURNUP ≈ 150 MWD/MTU

POWER ≈ 83%

QPTR:

NW - 0.994

NE - 0.987

SW - 1.018

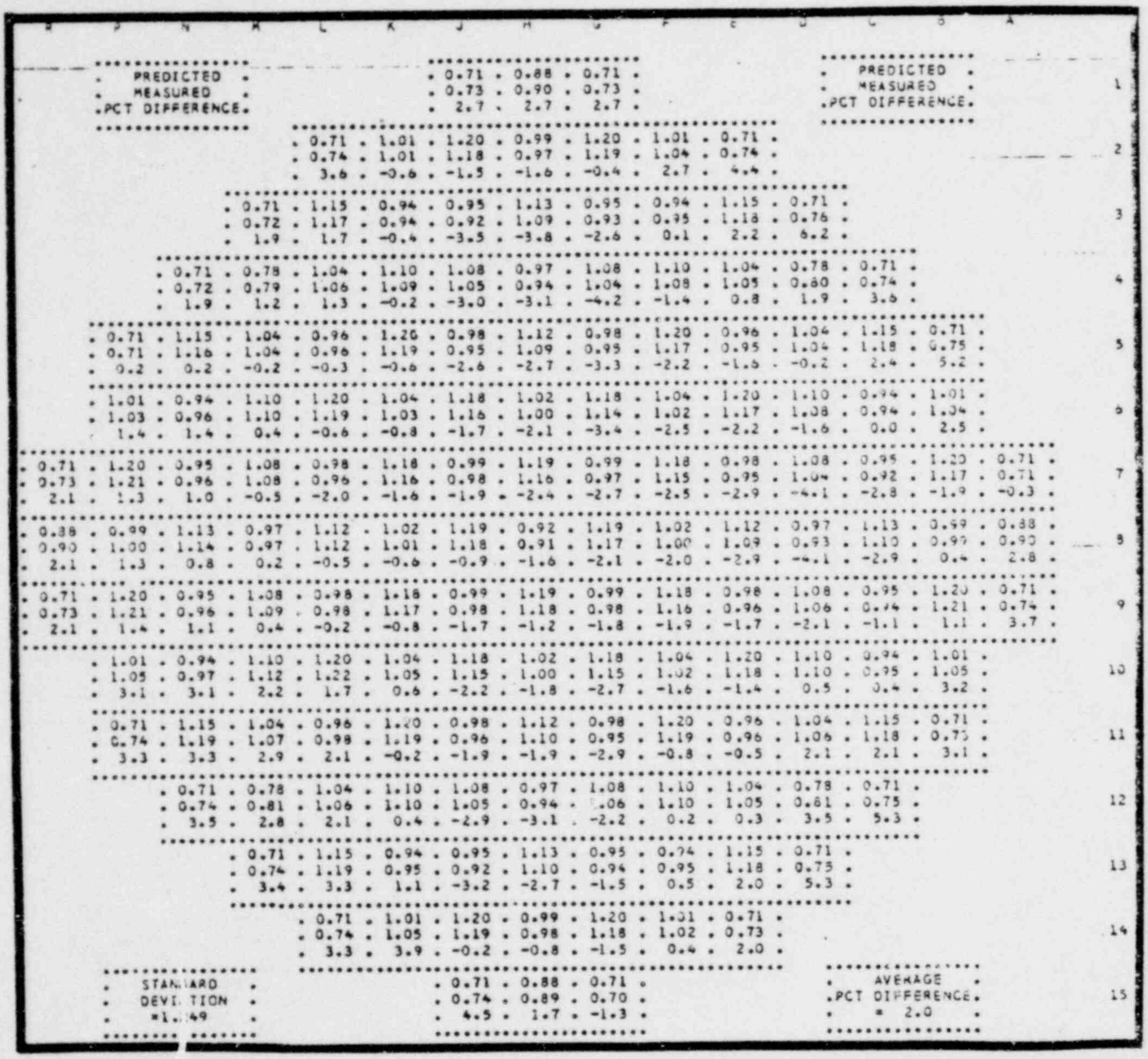
SE - 1.001

Figure 7.15

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - FLUX MAP



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

       ****************                   **********************                ****************
       .   PREDICTED  .                   . 0.71 . 0.88 . 0.71 .                .   PREDICTED  .
       .   MEASURED   .                   . 0.73 . 0.90 . 0.73 .                .   MEASURED   .              1
       .PCT DIFFERENCE.                   .  2.7 .  2.7 .  2.7 .                .PCT DIFFERENCE.
       ****************     **************************************************  ****************
                            . 0.71 . 1.01 . 1.20 . 0.99 . 1.20 . 1.01 . 0.71 .
                            . 0.74 . 1.01 . 1.18 . 0.97 . 1.19 . 1.04 . 0.74 .                                2
                            .  3.6 . -0.6 . -1.5 . -1.6 . -0.4 .  2.7 .  4.4 .
                     ****************************************************************
                     . 0.71 . 1.15 . 0.94 . 0.95 . 1.13 . 0.95 . 0.94 . 1.15 . 0.71 .
                     . 0.72 . 1.17 . 0.94 . 0.92 . 1.09 . 0.93 . 0.95 . 1.18 . 0.76 .                         3
                     .  1.9 .  1.7 . -0.4 . -3.5 . -3.8 . -2.6 .  0.1 .  2.2 .  6.2 .
              ******************************************************************************
              . 0.71 . 0.78 . 1.04 . 1.10 . 1.08 . 0.97 . 1.08 . 1.10 . 1.04 . 0.78 . 0.71 .
              . 0.72 . 0.79 . 1.06 . 1.09 . 1.05 . 0.94 . 1.04 . 1.08 . 1.05 . 0.80 . 0.74 .                  4
              .  1.9 .  1.2 .  1.3 . -0.2 . -3.0 . -3.1 . -4.2 . -1.4 .  0.8 .  1.9 .  3.6 .
       ********************************************************************************************
       . 0.71 . 1.15 . 1.04 . 0.96 . 1.20 . 0.98 . 1.12 . 0.98 . 1.20 . 0.96 . 1.04 . 1.15 . 0.71 .
       . 0.71 . 1.16 . 1.04 . 0.96 . 1.19 . 0.95 . 1.09 . 0.95 . 1.17 . 0.95 . 1.04 . 1.18 . 0.75 .           5
       .  0.2 .  0.2 . -0.2 . -0.3 . -0.6 . -2.6 . -2.7 . -3.3 . -2.2 . -1.6 . -0.2 .  2.4 .  5.2 .
       ********************************************************************************************
       . 1.01 . 0.94 . 1.10 . 1.20 . 1.04 . 1.18 . 1.02 . 1.18 . 1.04 . 1.20 . 1.10 . 0.94 . 1.01 .
       . 1.03 . 0.96 . 1.10 . 1.19 . 1.03 . 1.16 . 1.00 . 1.14 . 1.02 . 1.17 . 1.08 . 0.94 . 1.04 .           6
       .  1.4 .  1.4 .  0.4 . -0.6 . -0.8 . -1.7 . -2.1 . -3.4 . -2.5 . -2.2 . -1.6 .  0.0 .  2.5 .
**********************************************************************************************************
. 0.71 . 1.20 . 0.95 . 1.08 . 0.98 . 1.18 . 0.99 . 1.19 . 0.99 . 1.18 . 0.98 . 1.08 . 0.95 . 1.20 . 0.71 .
. 0.73 . 1.21 . 0.96 . 1.08 . 0.96 . 1.16 . 0.98 . 1.16 . 0.97 . 1.15 . 0.95 . 1.04 . 0.92 . 1.17 . 0.71 .    7
.  2.1 .  1.3 .  1.0 . -0.5 . -2.0 . -1.6 . -1.9 . -2.4 . -2.7 . -2.5 . -2.9 . -4.1 . -2.8 . -1.9 . -0.3 .
**********************************************************************************************************
. 0.88 . 0.99 . 1.13 . 0.97 . 1.12 . 1.02 . 1.19 . 0.92 . 1.19 . 1.02 . 1.12 . 0.97 . 1.13 . 0.99 . 0.88 .
. 0.90 . 1.00 . 1.14 . 0.97 . 1.12 . 1.01 . 1.18 . 0.91 . 1.17 . 1.00 . 1.09 . 0.93 . 1.10 . 0.99 . 0.90 .    8
.  2.1 .  1.3 .  0.8 .  0.2 . -0.5 . -0.6 . -0.9 . -1.6 . -2.1 . -2.0 . -2.9 . -4.1 . -2.9 .  0.4 .  2.8 .
**********************************************************************************************************
. 0.71 . 1.20 . 0.95 . 1.08 . 0.98 . 1.18 . 0.99 . 1.19 . 0.99 . 1.18 . 0.98 . 1.08 . 0.95 . 1.20 . 0.71 .
. 0.73 . 1.21 . 0.96 . 1.09 . 0.98 . 1.17 . 0.98 . 1.18 . 0.98 . 1.16 . 0.96 . 1.06 . 0.94 . 1.21 . 0.74 .    9
.  2.1 .  1.4 .  1.1 .  0.4 . -0.2 . -0.8 . -1.7 . -1.2 . -1.8 . -1.9 . -1.7 . -2.1 . -1.1 .  1.1 .  3.7 .
**********************************************************************************************************
       . 1.01 . 0.94 . 1.10 . 1.20 . 1.04 . 1.18 . 1.02 . 1.18 . 1.04 . 1.20 . 1.10 . 0.94 . 1.01 .
       . 1.05 . 0.97 . 1.12 . 1.22 . 1.05 . 1.15 . 1.00 . 1.15 . 1.02 . 1.18 . 1.10 . 0.95 . 1.05 .           10
       .  3.1 .  3.1 .  2.2 .  1.7 .  0.6 . -2.2 . -1.8 . -2.7 . -1.6 . -1.4 .  0.5 .  0.4 .  3.2 .
       ********************************************************************************************
       . 0.71 . 1.15 . 1.04 . 0.96 . 1.20 . 0.98 . 1.12 . 0.98 . 1.20 . 0.96 . 1.04 . 1.15 . 0.71 .
       . 0.74 . 1.19 . 1.07 . 0.98 . 1.19 . 0.96 . 1.10 . 0.95 . 1.19 . 0.96 . 1.06 . 1.18 . 0.73 .           11
       .  3.3 .  3.3 .  2.9 .  2.1 . -0.2 . -1.9 . -1.9 . -2.9 . -0.8 . -0.5 .  2.1 .  2.1 .  3.1 .
       ********************************************************************************************
              . 0.71 . 0.78 . 1.04 . 1.10 . 1.08 . 0.97 . 1.08 . 1.10 . 1.04 . 0.78 . 0.71 .
              . 0.74 . 0.81 . 1.06 . 1.10 . 1.05 . 0.94 . 1.06 . 1.10 . 1.05 . 0.81 . 0.75 .                  12
              .  3.5 .  2.8 .  2.1 .  0.4 . -2.9 . -3.1 . -2.2 .  0.2 .  0.3 .  3.5 .  5.3 .
              ******************************************************************************
                     . 0.71 . 1.15 . 0.94 . 0.95 . 1.13 . 0.95 . 0.94 . 1.15 . 0.71 .
                     . 0.74 . 1.19 . 0.95 . 0.92 . 1.10 . 0.94 . 0.95 . 1.18 . 0.75 .                         13
                     .  3.4 .  3.3 .  1.1 . -3.2 . -2.7 . -1.5 .  0.5 .  2.0 .  5.3 .
                     ****************************************************************
                            . 0.71 . 1.01 . 1.20 . 0.99 . 1.20 . 1.01 . 0.71 .
                            . 0.74 . 1.05 . 1.19 . 0.98 . 1.18 . 1.02 . 0.73 .                                14
                            .  3.3 .  3.9 . -0.2 . -0.8 . -1.5 .  0.4 .  2.0 .
       ****************     **************************************************  ****************
       .   STANDARD   .                   . 0.71 . 0.88 . 0.71 .                .    AVERAGE   .
       .   DEVIATION  .                   . 0.74 . 0.89 . 0.70 .                .PCT DIFFERENCE.              15
       .  =1.[illegible]49  .                   .  4.5 .  1.7 . -1.3 .                .     = 2.0    .
       ****************                   **********************                ****************
```

MAP NO: N1-[illegible]-15

CONTROL ROD POSITIONS:

D BANK AT 228 STEPS

C BANK AT 228 STEPS

DATE: 2/7/80

$F^N_{\Delta H} = 1.387$

$F^T_Q = 1.762$

$\overline{F}_z = 1.113$

A.O. = +0.127

BURNUP ≈ 300 MWD/MTU

POWER ≈ 99%

QPTR:

NW - 1.001

NE - 0.994

SW - 1.010

SE - 0.995

Figure 7.16

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - FLUX MAP

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

       ................                   ......................                    ................
       .  PREDICTED   .                   . 0.71 . 0.87 . 0.71 .                    .  PREDICTED   .
       .  MEASURED    .                   . 0.73 . 0.90 . 0.73 .                    .  MEASURED    .        1
       .PCT DIFFERENCE.                   .  3.8 .  3.8 .  3.6 .                    .PCT DIFFERENCE.
       ................     ..................................................      ................
                            . 0.72 . 1.02 . 1.19 . 0.97 . 1.19 . 1.02 . 0.72 .
                            . 0.75 . 1.02 . 1.18 . 0.96 . 1.19 . 1.05 . 0.75 .                              2
                            .  4.2 .  0.3 . -0.8 . -0.9 .  0.2 .  3.0 .  4.5 .
                     ................................................................
                     . 0.72 . 1.16 . 0.95 . 0.95 . 1.13 . 0.95 . 0.95 . 1.16 . 0.72 .
                     . 0.73 . 1.18 . 0.95 . 0.92 . 1.09 . 0.93 . 0.95 . 1.19 . 0.76 .                       3
                     .  2.1 .  1.9 . -0.0 . -3.2 . -3.5 . -2.0 .  0.0 .  2.2 .  6.3 .
              ..............................................................................
              . 0.72 . 0.79 . 1.05 . 1.10 . 1.08 . 0.97 . 1.08 . 1.10 . 1.05 . 0.79 . 0.72 .
              . 0.74 . 0.80 . 1.06 . 1.10 . 1.05 . 0.94 . 1.04 . 1.08 . 1.06 . 0.81 . 0.74 .                4
              .  2.5 .  1.2 .  1.2 . -0.4 . -2.9 . -3.0 . -4.4 . -1.5 .  0.7 .  2.0 .  3.7 .
       ............................................................................................
       . 0.72 . 1.16 . 1.05 . 0.97 . 1.19 . 0.98 . 1.12 . 0.93 . 1.19 . 0.97 . 1.05 . 1.16 . 0.72 .
       . 0.72 . 1.17 . 1.04 . 0.96 . 1.18 . 0.95 . 1.09 . 0.94 . 1.17 . 0.95 . 1.05 . 1.19 . 0.76 .         5
       .  1.0 .  1.0 . -0.5 . -0.9 . -1.2 . -3.0 . -3.1 . -3.6 . -2.2 . -1.6 . -0.2 .  2.4 .  5.4 .
       ............................................................................................
       . 1.02 . 0.95 . 1.10 . 1.19 . 1.02 . 1.17 . 1.02 . 1.17 . 1.02 . 1.19 . 1.10 . 0.95 . 1.02 .
       . 1.04 . 0.97 . 1.10 . 1.18 . 1.00 . 1.14 . 0.99 . 1.13 . 0.99 . 1.17 . 1.08 . 0.95 . 1.05 .         6
       .  1.9 .  1.9 .  0.2 . -1.5 . -1.8 . -2.5 . -2.8 . -3.9 . -3.0 . -2.1 . -1.6 .  0.2 .  3.0 .
..........................................................................................................
. 0.71 . 1.19 . 0.95 . 1.08 . 0.98 . 1.17 . 0.99 . 1.19 . 0.99 . 1.17 . 0.98 . 1.08 . 0.95 . 1.19 . 0.71 .
. 0.73 . 1.21 . 0.96 . 1.08 . 0.95 . 1.15 . 0.97 . 1.16 . 0.96 . 1.13 . 0.94 . 1.04 . 0.93 . 1.17 . 0.71 .  7
.  3.6 .  2.0 .  1.3 . -0.1 . -2.8 . -2.2 . -2.6 . -3.0 . -3.8 . -3.9 . -4.0 . -4.1 . -2.5 . -1.4 .  0.0 .
..........................................................................................................
. 0.87 . 0.97 . 1.13 . 0.97 . 1.12 . 1.02 . 1.19 . 0.93 . 1.19 . 1.02 . 1.12 . 0.97 . 1.13 . 0.97 . 0.87 .
. 0.90 . 0.99 . 1.14 . 0.98 . 1.13 . 1.01 . 1.17 . 0.90 . 1.15 . 0.98 . 1.07 . 0.93 . 1.10 . 0.98 . 0.90 .  8
.  3.6 .  2.0 .  1.0 .  0.8 .  0.3 . -0.6 . -1.5 . -2.3 . -3.4 . -3.4 . -4.5 . -4.1 . -2.6 .  1.2 .  3.8 .
..........................................................................................................
. 0.71 . 1.19 . 0.95 . 1.08 . 0.98 . 1.17 . 0.99 . 1.19 . 0.99 . 1.17 . 0.98 . 1.08 . 0.95 . 1.19 . 0.71 .
. 0.73 . 1.22 . 0.96 . 1.09 . 0.98 . 1.17 . 0.99 . 1.18 . 0.96 . 1.13 . 0.95 . 1.06 . 0.94 . 1.21 . 0.74 .  9
.  3.6 .  2.1 .  1.4 .  1.0 .  0.3 . -0.3 . -0.8 . -1.3 . -3.1 . -3.4 . -3.1 . -2.5 . -1.1 .  1.7 .  4.6 .
..........................................................................................................
       . 1.02 . 0.95 . 1.10 . 1.19 . 1.02 . 1.17 . 1.02 . 1.17 . 1.02 . 1.19 . 1.10 . 0.95 . 1.02 .
       . 1.05 . 0.98 . 1.12 . 1.21 . 1.02 . 1.15 . 1.00 . 1.14 . 1.00 . 1.17 . 1.10 . 0.95 . 1.06 .         10
       .  3.2 .  3.2 .  1.9 .  1.1 .  0.2 . -1.9 . -1.9 . -3.3 . -2.6 . -2.1 . -0.3 .  0.3 .  3.9 .
       ............................................................................................
       . 0.72 . 1.16 . 1.05 . 0.97 . 1.19 . 0.98 . 1.12 . 0.98 . 1.19 . 0.97 . 1.05 . 1.16 . 0.72 .
       . 0.74 . 1.20 . 1.08 . 0.99 . 1.19 . 0.96 . 1.10 . 0.95 . 1.18 . 0.95 . 1.07 . 1.19 . 0.74 .         11
       .  3.3 .  3.3 .  2.9 .  2.0 . -0.1 . -1.8 . -1.9 . -3.2 . -1.4 . -1.1 .  1.6 .  2.1 .  3.6 .
       ............................................................................................
              . 0.72 . 0.79 . 1.05 . 1.10 . 1.08 . 0.97 . 1.08 . 1.10 . 1.05 . 0.79 . 0.72 .
              . 0.74 . 0.81 . 1.07 . 1.10 . 1.05 . 0.94 . 1.06 . 1.10 . 1.05 . 0.82 . 0.76 .                12
              .  3.5 .  2.8 .  2.1 .  0.2 . -3.0 . -3.2 . -2.4 . -0.2 . -0.2 .  3.3 .  5.4 .
              ..............................................................................
                     . 0.72 . 1.16 . 0.95 . 0.95 . 1.13 . 0.95 . 0.95 . 1.16 . 0.72 .
                     . 0.74 . 1.21 . 0.96 . 0.92 . 1.10 . 0.94 . 0.95 . 1.18 . 0.76 .                       13
                     .  3.6 .  3.9 .  1.3 . -3.2 . -2.5 . -1.2 .  0.7 .  1.7 .  5.4 .
                     ................................................................
                            . 0.72 . 1.02 . 1.19 . 0.97 . 1.19 . 1.02 . 0.72 .
                            . 0.75 . 1.06 . 1.20 . 0.97 . 1.18 . 1.02 . 0.73 .                              14
                            .  3.9 .  4.7 .  0.5 .  0.2 . -1.1 .  0.6 .  1.7 .
       ................     ..................................................      ................
       .  STANDARD    .                   . 0.71 . 0.87 . 0.71 .                    .   AVERAGE    .
       .  DEVIATION   .                   . 0.74 . 0.89 . 0.70 .                    .PCT DIFFERENCE.        15
       .   =1.398     .                   .  5.6 .  2.8 . -0.3 .                    .    = 2.2     .
       ................                   ......................                    ................
```

MAP NO: N1-2-16

DATE: 2/7/80

POWER = 99%

CONTROL ROD POSITIONS:

$F^N_{\Delta H} = 1.403$

QPTR:

D BANK AT 208 STEPS

$F^T_Q = 1.902$

NW - 0.997

C BANK AT 228 STEPS

$\overline{F}_z = 1.201$

NE - 0.992

A. O. = -7.267

SW - 1.014

BURNUP = 349 MWD/MTU

SE - 0.997

Figure 7.17

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HFP, EQ. XENON

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

  *****************                       *************************                   *****************
  .   PREDICTED   .                       . 0.71 . 0.87 . 0.71 .                      .   PREDICTED   .
  .   MEASURED    .                       . 0.74 . 0.91 . 0.74 .                      .   MEASURED    .     1
  .PCT DIFFERENCE.                        .  4.8 .  4.9 .  4.3 .                      .PCT DIFFERENCE.
  *****************               *********************************************       *****************
                                  . 0.71 . 1.01 . 1.19 . 0.98 . 1.19 . 1.01 . 0.71 .
                                  . 0.74 . 1.00 . 1.18 . 0.97 . 1.20 . 1.05 . 0.75 .                         2
                                  .  4.3 . -0.7 . -0.6 . -0.6 .  1.0 .  3.7 .  5.5 .
                          *****************************************************************
                          . 0.71 . 1.15 . 0.95 . 0.95 . 1.13 . 0.95 . 0.95 . 1.15 . 0.71 .
                          . 0.73 . 1.17 . 0.94 . 0.92 . 1.09 . 0.93 . 0.95 . 1.19 . 0.77 .                   3
                          .  2.0 .  1.7 . -0.8 . -3.2 . -3.5 . -2.0 .  0.7 .  3.0 .  7.4 .
                  *************************************************************************************
                  . 0.71 . 0.79 . 1.05 . 1.10 . 1.09 . 0.98 . 1.09 . 1.10 . 1.05 . 0.79 . 0.71 .
                  . 0.73 . 0.80 . 1.06 . 1.09 . 1.05 . 0.95 . 1.04 . 1.09 . 1.06 . 0.81 . 0.75 .             4
                  .  2.5 .  1.4 .  1.4 . -0.6 . -3.0 . -3.1 . -3.8 . -1.0 .  1.4 .  2.7 .  4.6 .
          *****************************************************************************************************
          . 0.71 . 1.15 . 1.05 . 0.97 . 1.19 . 0.98 . 1.12 . 0.98 . 1.19 . 0.97 . 1.05 . 1.15 . 0.71 .
          . 0.72 . 1.16 . 1.05 . 0.96 . 1.18 . 0.95 . 1.09 . 0.95 . 1.17 . 0.95 . 1.05 . 1.19 . 0.76 .     5
          .  0.4 .  0.9 . -0.2 . -0.6 . -1.0 . -2.9 . -3.0 . -3.6 . -2.2 . -1.5 .  0.3 .  3.5 .  7.0 .
          *****************************************************************************************************
          . 1.01 . 0.95 . 1.10 . 1.19 . 1.03 . 1.17 . 1.02 . 1.17 . 1.03 . 1.19 . 1.10 . 0.95 . 1.01 .
          . 1.03 . 0.96 . 1.11 . 1.18 . 1.02 . 1.15 . 0.99 . 1.13 . 1.00 . 1.17 . 1.08 . 0.95 . 1.05 .     6
          .  1.8 .  1.5 .  0.6 . -0.7 . -1.4 . -2.5 . -2.8 . -4.2 . -3.2 . -2.3 . -1.4 .  0.8 .  3.9 .
  *********************************************************************************************************************
  . 0.71 . 1.19 . 0.95 . 1.09 . 0.98 . 1.17 . 1.00 . 1.19 . 1.00 . 1.17 . 0.98 . 1.09 . 0.95 . 1.19 . 0.71 .
  . 0.72 . 1.21 . 0.96 . 1.08 . 0.96 . 1.15 . 0.97 . 1.15 . 0.95 . 1.12 . 0.93 . 1.04 . 0.93 . 1.18 . 0.71 .     7
  .  2.5 .  1.5 .  1.0 . -0.8 . -2.7 . -2.4 . -2.6 . -3.0 . -4.1 . -4.4 . -4.8 . -4.3 . -2.6 . -1.2 .  0.8 .
  *********************************************************************************************************************
  . 0.87 . 0.98 . 1.13 . 0.98 . 1.12 . 1.02 . 1.19 . 0.93 . 1.19 . 1.02 . 1.12 . 0.98 . 1.13 . 0.98 . 0.87 .
  . 0.89 . 0.99 . 1.14 . 0.98 . 1.11 . 1.01 . 1.17 . 0.91 . 1.15 . 0.99 . 1.07 . 0.94 . 1.10 . 0.99 . 0.91 .     8
  .  2.5 .  1.4 .  0.7 . -0.2 . -1.3 . -1.4 . -1.7 . -2.2 . -3.3 . -3.4 . -4.8 . -4.2 . -2.6 .  1.8 .  4.7 .
  *********************************************************************************************************************
  . 0.71 . 1.19 . 0.95 . 1.09 . 0.98 . 1.17 . 1.00 . 1.19 . 1.00 . 1.17 . 0.98 . 1.09 . 0.95 . 1.19 . 0.71 .
  . 0.72 . 1.21 . 0.96 . 1.09 . 0.97 . 1.16 . 0.98 . 1.17 . 0.97 . 1.14 . 0.95 . 1.06 . 0.95 . 1.22 . 0.74 .     9
  .  2.5 .  1.6 .  1.1 . -0.0 . -1.0 . -1.4 . -1.9 . -1.5 . -3.0 . -3.3 . -3.1 . -2.4 . -0.9 .  2.4 .  5.6 .
  *********************************************************************************************************************
          . 1.01 . 0.95 . 1.10 . 1.19 . 1.03 . 1.17 . 1.02 . 1.17 . 1.03 . 1.19 . 1.10 . 0.95 . 1.01 .
          . 1.04 . 0.98 . 1.12 . 1.21 . 1.03 . 1.15 . 1.00 . 1.14 . 1.00 . 1.17 . 1.10 . 0.95 . 1.06 .     10
          .  3.1 .  3.1 .  1.9 .  1.2 . -0.1 . -2.4 . -2.0 . -3.4 . -2.5 . -2.2 .  0.1 .  0.6 .  4.8 .
          *****************************************************************************************************
          . 0.71 . 1.15 . 1.05 . 0.97 . 1.19 . 0.98 . 1.12 . 0.98 . 1.19 . 0.97 . 1.05 . 1.15 . 0.71 .
          . 0.74 . 1.20 . 1.08 . 0.98 . 1.19 . 0.96 . 1.10 . 0.95 . 1.17 . 0.96 . 1.07 . 1.18 . 0.74 .     11
          .  3.9 .  3.9 .  3.2 .  1.8 . -0.4 . -2.1 . -2.1 . -3.6 . -1.6 . -1.1 .  2.0 .  2.4 .  3.9 .
          *****************************************************************************************************
                  . 0.71 . 0.79 . 1.05 . 1.10 . 1.09 . 0.98 . 1.09 . 1.10 . 1.05 . 0.79 . 0.71 .
                  . 0.75 . 0.82 . 1.07 . 1.10 . 1.05 . 0.94 . 1.06 . 1.09 . 1.04 . 0.82 . 0.76 .             12
                  .  4.6 .  3.3 .  1.8 .  0.2 . -3.2 . -3.3 . -2.8 . -0.5 . -0.4 .  3.6 .  5.7 .
                  *************************************************************************************
                          . 0.71 . 1.15 . 0.95 . 0.95 . 1.13 . 0.95 . 0.95 . 1.15 . 0.71 .
                          . 0.75 . 1.20 . 0.96 . 0.92 . 1.10 . 0.94 . 0.95 . 1.17 . 0.76 .                   13
                          .  4.2 .  3.9 .  1.3 . -3.5 . -2.5 . -1.4 .  0.8 .  1.5 .  5.7 .
                          *****************************************************************
                                  . 0.71 . 1.01 . 1.19 . 0.98 . 1.19 . 1.01 . 0.71 .
                                  . 0.74 . 1.06 . 1.19 . 0.98 . 1.18 . 1.02 . 0.72 .                         14
                                  .  3.9 .  4.8 .  0.2 .  0.1 . -1.2 .  0.7 .  1.5 .
  *****************               *********************************************       *****************
  .   STANDARD    .                       . 0.71 . 0.87 . 0.71 .                      .    AVERAGE    .
  .   DEVIATION   .                       . 0.75 . 0.90 . 0.71 .                      .PCT DIFFERENCE.      15
  .    =1.541     .                       .  5.7 .  3.0 .  0.1 .                      .    = 2.4      .
  *****************                       *************************                   *****************
```

MAP NO: N1-2-18

DATE: 2/14/80

POWER = 100%

CONTROL ROD POSITIONS:

D BANK AT 213 STEPS

C BANK AT 228 STEPS

$F^N_{\Delta H} = 1.395$

$F^T_Q = 1.776$

$\overline{F}_z = 1.124$

A. O. = -0.553

BURNUP = 570 MWD/MTU

QPTR:

NW - 0.995

NE - 0.994

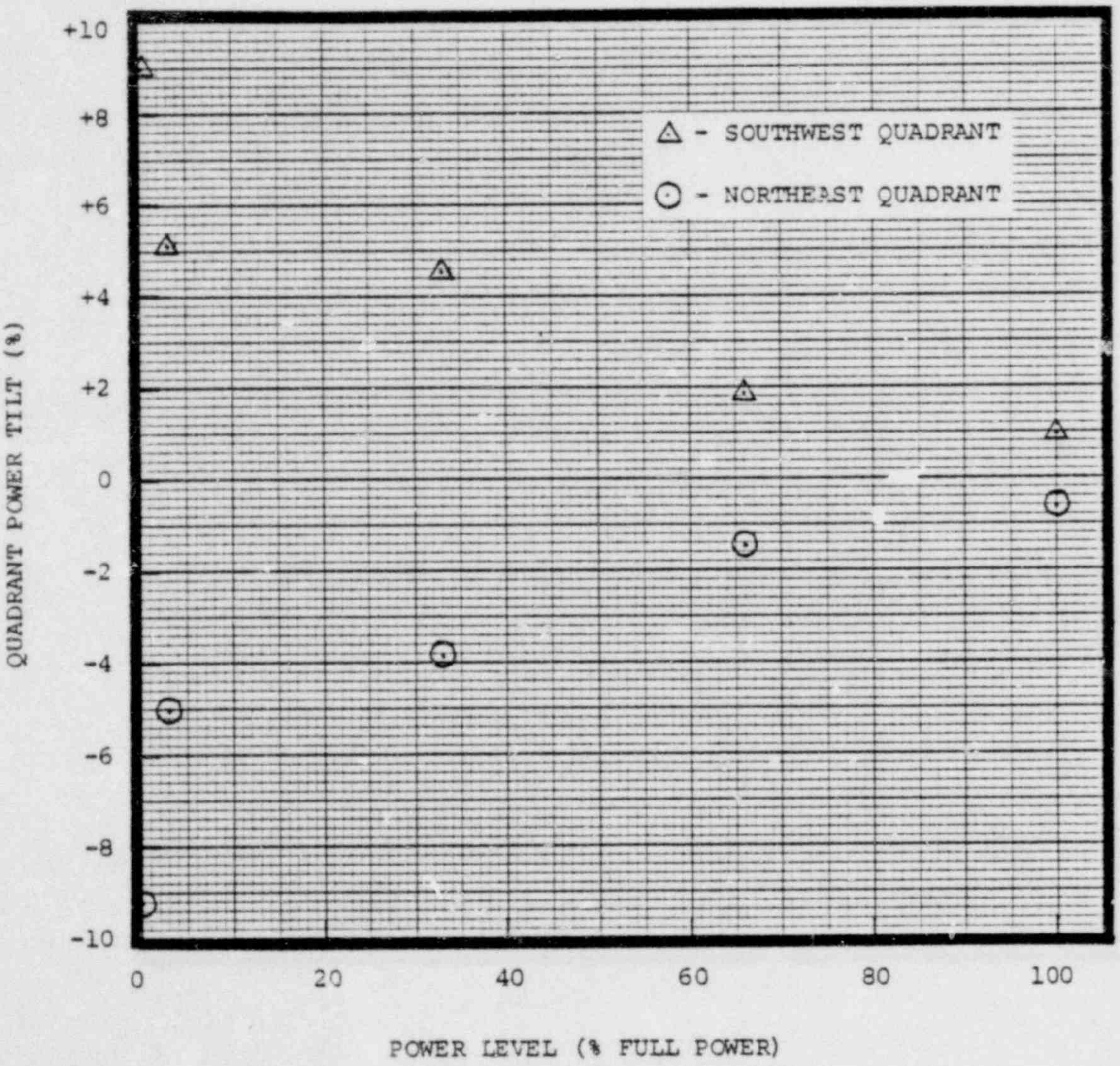
SW - 1.010

SE - 1.001

Figure 7.18

NORTH ANNA UNIT 1 - CYCLE 2 BOL PHYSICS TESTS

PERCENT QUADRANT POWER TILT vs. POWER LEVEL



REFERENCES

1. M. C. Cheok, S. A. Ahmed, and R. T. Robins, "North Anna Unit 1, Cycle 2, Design Report," NFE Technical Report No. 127, November, 1979.
2. North Anna Unit 1 Technical Specifications.
3. T. J. Kunsitis, "RXFLOW, A Computer Program to Calculate Reactor Flow and Thermal Output," NFO-CCR-8, Vepco, December, 1979.
4. "Technical Manual for Westinghouse Solid State Reactivity Computer," Westinghouse Electric Corporation.
5. Letter from Mr. C. M. Stallings (Vepco) to Mr. H. R. Denton (NRC) dated November 2, 1979.
6. W. Leggett, and L. Eisenhart, "The INCORE Code," WCAP-7149, December, 1967.
7. Letter from Mr. C. M. Stallings (Vepco) to Mr. H. R. Denton (NRC) dated March 11, 1980.

APPENDIX

STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEETS

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: Reactivity Computer Checkout Procedure Number/Section: 1-PT-94/APP.B Sequence Step Number: 4	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: * RCCA: NA	RCS Temperature (°F): 547 $^{+0}_{-5}$ Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating *At the just critical position
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 140/141 RCCA: N/A	RCS Temperature (°F): 545.7 Power Level (%F.P.): 0 Other (specify): BELOW NUCLEAR HEATING
IV Test Results	Date/Time Test Performed: 1-16-80 0457-0735	
	Measured Parameter (description)	$\Delta\rho c$ = Measured reactivity using the reactivity computer $\Delta\rho r$ = Inferred reactivity from reactor period.
	Measured Value	0.038 (MAXIMUM)
	Design Value (Actual Conditions)	$\left\lvert \frac{\Delta\rho_c - \Delta\rho_r}{\Delta\rho_r} \right\rvert \leq 0.04$
	Design Value (Design Conditions)	$\left\lvert \frac{\Delta\rho c - \Delta\rho r}{\Delta\rho r} \right\rvert \leq 0.04$
	Reference	WCAP-7905, Rev. 1, Table 3.6
V Acceptance Criteria	FSAR/Tech Spec	NA
	Reference	NA
VI Comments	MAXIMUM ALLOWABLE REACTIVITY RANGE = ± 60 PCM	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By

Recommended For Approval By T K Ross
NFC Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CONTROL BANK D WORTH MEASUREMENT Procedure Number/Section: 1-PT-94/APP.E	Sequence Step Number: 8
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: Moving RCCA: NA	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: Moving RCCA: NA	RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-17-80 0610-0924	
	Measured Parameter (description)	I_D; Integral Worth of Control Bank D
	Measured Value	1069 pcm
	Design Value (Actual Conditions)	1095 ± 164 pcm
	Design Value (Design Conditions)	1095 ± 164 pcm
	Reference	Vepco NFE Technical Report No. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
	Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (Serial No. 272).
VI Comments	Design Tolerance met. Acceptance Criteria met.	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By J. H. Leberstein

Recommended For Approval By TK Ross
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CONTROL BANK C WORTH MEASUREMENT - BANK D IN Procedure Number/Section: 1-PT-94/ APP.E. Sequence Step Number: 25	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: Moving CD: 0 RCCA: NA	RCS Temperature (°F): 547 $^{+0}_{-5}$ Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: Moving CD: 0 RCCA: NA	RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-18-80 1510 - 1756	
	Measured Parameter (description)	I_c; Integral worth of Control Bank C
	Measured Value	908 pcm
	Design Value (Actual Conditions)	873 ± 131 pcm
	Design Value (Design Conditions)	873 ± 131 pcm
	Reference	Vepco NFE Technical Report NO. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
	Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (Serial NO. 272).
VI Comments	Design Tolerance met Acceptance Criteria met	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By T. L. Rotella

Recommended For Approval By TK Ross
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CONTROL BANK B WORTH MEASUREMENT - BANKS C,D IN. Procedure Number/Section: 1-PT-94/APP.E Sequence Step Number: 27	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: Moving CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 547 $^{+0}_{-5}$ Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: Moving CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1/18-19/80 2015-0400	
	Measured Parameter (description)	I_B; Integral Worth of Control Bank B
	Measured Value	1321 pcm.
	Design Value (Actual Conditions)	1434 ± 215 pcm
	Design Value (Design Conditions)	1434 ± 215 pcm
	Reference	Vepco NFE Technical Report No. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
	Reference	Letter from C. M. Stallings (Vepco) to E.G. Case (NRC) dated May 11, 1978 (Serial No. 272).
VI Comments	Design Tolerance met Acceptance Criteria met	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By T. S. Rotella

Recommended For Approval By TK Ross
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CONTROL BANK A WORTH MEASUREMENT-BANKS B,C,D IN. Procedure Number/Section: 1-PT-94/APP.E Sequence Step Number: 32		
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: Moving CB: 0 CC: 0 CD: 0 RCCA: NA		RCS Temperature (°F): 547 $^{+0}_{-5}$ Power level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: MOVING CB: 0 CC: 0 CD: 0 RCCA: NA		RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): BELOW NUCLEAR HEATING.
IV Test Results	Date/Time Test Performed: 1-19-80 1325 — 1829.		
	Measured Parameter (description)	I_A; Integral Worth of Control Bank A	
	Measured Value	1651 pcm.	
	Design Value (Actual Conditions)	1649 ± 247 pcm.	
	Design Value (Design Conditions)	1649 ± 247 pcm	
	Reference	Vepco NFE Technical Report No. 127, November, 1979.	
V Acceptance Criteria	FSAR/Tech Spec	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.	
	Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (Serial No. 272).	
VI Comments	DESIGN TOLERANCE MET. ACCEPTANCE CRITERIA MET.		

Completed By J. P. Smith
Startup Test Engineer

Evaluated By

Recommended For Approval By T K Ross
NFO Engineer

FINAL RESULTS

1-Pt-94
ATTACHMENT 6.11
12-26-79
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North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: SHUTDOWN BANK B WORTH MEASUREMENT, CONTROL BANKS IN Procedure Number/Section: 1-PT-94/APP. H Sequence Step Number: 39	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: Moving CA: 0 CB: 0 CC: 0 CD: 0 RCCA: N/A	RCS Temperature (°F): 547 $^{+0}_{-5}$ Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: MOVING CA: 0 CB: 0 CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): BELOW NUCLEAR HEATING
IV Test Results	Date/Time Test Performed: 1-20-80 0433 — 0603	
	Measured Parameter (description)	I_{SDB} ; Integral Worth of Shutdown Bank B
	Measured Value	933 pcm.
	Design Value (Actual Conditions)	907 ± 136 pcm.
	Design Value (Design Conditions)	907 ± 136 pcm
	Reference	Memorandum from M. L. Smith to E. J. Lozito, dated December 7, 1979
V Acceptance Criteria	FSAR/Tech Spec	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
	Reference	Letter from C. M. Stallings (Vepco) to B. C. Rusche (NRC), dated May 14, 1976 (Serial No. 017/043073).
VI Comments	DESIGN TOLERANCE MET ACCEPTANCE CRITERIA MET.	

Completed By J.P. Smith
Startup Test Engineer

Evaluated By

Recommended For Approval By TK Ross
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: Rod Worth Measurement - D,C,B,A In Overlap Procedure Number/Section: 1-PT-94/APP.F Sequence Step Number: 4.0	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: Moving CB: Moving CC: Moving CD: Moving RCCA: NA	RCS Temperature (°F): 547 +0 -5 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: Moving CB: Moving CC: Moving CD: Moving RCCA: NA	RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-20-80 0604-1345	
	Measured Parameter (description)	I_{DCBA}; Integral Worth of Control Bank D,C,B,A In Overlap
	Measured Value	4838 pcm
	Design Value (Actual Conditions)	5051 ± 505 pcm
	Design Value (Design Conditions)	5051 ± 505 pcm (From A at 0 steps to D at 228 steps)
	Reference	Vepco NFE Technical Report No. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
	Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1973 (Serial No. 270).
VI Comments	Design Tolerance met. Acceptance Criteria met.	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By J. H. Leberstien

Recommended For Approval By TK Ross
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: TOTAL WORTH OF N-1 RODS Procedure Number/Section: 1-PT-94/APP. H Sequence Step Number: 35	
II Test Conditions (Design)	Bank Positions (steps) SDA: 0 SDB: 0 CA: 0 CB: 0 CC: 0 CD: 0 RCCA: ~~B-8~~ H-14 at 228 TKR 2/14/80	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 0 SDB: 0 CA: 0 CB: 0 CC: 0 CD: 0 RCCA: H-14 at 228	RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-17-80 - 1/20/80	
	Measured Parameter (description)	I_{N-1}, Total Integral Worth of All Control and Shutdown Banks Less RCCA ~~B-8~~ H-14 TKR 2/14/80
	Measured Value	5942 pcm
	Design Value (Actual Conditions)	6044 ± 604 pcm
	Design Value (Design Conditions)	6044 ± 604 pcm
	Reference	Vepco NFE Technical Report No. 127, November, 1979
V Acceptance Criteria	FSAR/Tech Spec	$I_{N-1}/1.04$ (measurement uncertainty) ≥ 5420 pcm
	Reference	WCAP 9594, Table 6.3 and memorandum from C. T. Snow to E. J. Lozito dated December 17, 1979
VI Comments	Design Tolerance met. Acceptance Criteria met.	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By J. H. Leberstien

Recommended For Approval By TK Ross
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CRITICAL BORON CONCENTRATION - ARO Procedure Number/Section: 1-PT-94/APP.C Sequence Step Number: 5	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 228^{+0}_{-15} RCCA: NA	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 228 RCCA: NA	RCS Temperature (°F): 545.6 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed:	1-16-80 1205
	Measured Parameter (description)	$(C_B)^M_{ARO}$; Critical Boron Concentration - ARO
	Measured Value	C_B = 1353 ppm
	Design Value (Actual Conditions)	C_B = 1319 ± 50 ppm
	Design Value (Design Conditions)	C_B = 1319 ± 50 ppm
	Reference	Vepco NFE Technical Report No. 127, November 1979
V Acceptance Criteria	FSAR/Tech Spec	$(\frac{\delta\rho}{\delta C_B}) \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	Design Tolerance met. Acceptance Criteria met. Use $\frac{\delta\rho}{\delta C_B}$ = -9.23 pcm/ppm for preliminary analysis. $\frac{\partial\rho}{\partial C_B}$ = -8.88 pcm/ppm for final analysis.	

Completed By J.P. Smith
Startup Test Engineer

Evaluated By TKRoss

Recommended For Approval By T. J. Kunsitis
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CRITICAL BORON CONCENTRATION - BANK D IN. Procedure Number/Section: 1-PT-94/APP.C Sequence Step Number: 9		
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228^{+0}_{-15} CD: 0^{+15}_{-0} RCCA: NA		RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 0 RCCA: NA		RCS Temperature (°F): 545.7 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed:	1-17-80 1455	
	Measured Parameter (description)	$(C_B)^M_D$; Critical Boron Concentration - Bank D In	
	Measured Value	C_B = 1243 ppm	
	Design Value (Actual Conditions)	C_B = 1233 ± 22 ppm	
	Design Value (Design Conditions)	$C_B = 1199 + [(C_B)^M_{ARO} - 1319] \pm [10 + 109.5/\vert(\partial\rho/\partial C_B)\vert]$	
	Reference	Vepco NFE Technical Report No. 127, November, 1979.	
V Acceptance Criteria	FSAR/Tech Spec	$(\frac{\delta\rho}{\delta C_B}) \times C_B \leq 24{,}000$ pcm	
	Reference	FSAR Section 15.2.4	
VI Comments	Design Tolerance met. Acceptance Criteria met. Use $\frac{\delta\rho}{\delta C_B}$ = -9.23 pcm/ppm for preliminary analysis $\frac{\partial\rho}{\partial C_B}$ = -8.88 pcm/ppm for final analysis		

Completed By J P Smith
Startup Test Engineer

Evaluated By TK Ross

Recommended For Approval By T. J. Kuester
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CRITICAL BORON CONCENTRATION - BANKS C,D IN. Procedure Number/Section: 1-PT-94/APP.C Sequence Step Number: 26	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 $^{+0}$ SDB: 228 $^{+15}$ CA: 228 CB:228 $_{-15}$ CC: 0 $_{-0}$ CD: 0 RCCA: NA	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 546.1 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed:	1-18-80 1929
	Measured Parameter (description)	$(C_B)^M_{C,D}$; Critical Boron Concentration-Banks C, D In
	Measured Value	C_B = 1138 ppm
	Design Value (Actual Conditions)	C_B = 1147 ± 20 ppm
	Design Value (Design Conditions)	$C_B = 1103 + [(C_B)^M_D - 1199] \pm [10 + 87.3/|(\partial\rho/\partial C_B)|]$
	Reference	Vepco NFE Technical Report No. 127, November, 1979
V Acceptance Criteria	FSAR/Tech Spec	$(\frac{\delta\rho}{\delta C_B}) \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	Design Tolerance met. Acceptance Criteria met. Use $\frac{\delta\rho}{\delta C_B}$ = -9.23 pcm/ppm for preliminary analysis. $\frac{\partial\rho}{\partial C_B}$ = -8.88 pcm/ppm for final analysis.	

Completed By O. P. Smith
Startup Test Engineer

Evaluated By TK Ross

Recommended For Approval By T. J. Kunsitis
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: CRITICAL BORON CONCENTRATION - BANKS B,C,D IN. Procedure Number/Section: 1-PT-94/APP.C Sequence Step Number: 25	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228^{+0}_{-15} CB: 0^{+15}_{-0} CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 0 CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 546.6 Power Level (%F.P.): 0 Other (specify): BELOW NUCLEAR HEATING
IV Test Results	Date/Time Test Performed: 1-19-80 0454	
	Measured Parameter (description)	$(C_B)^M_{B,C,D}$; Critical Boron Concentration-Banks B,C,D In
	Measured Value	C_B = 988
	Design Value (Actual Conditions)	C_B = 984 ± 26 PPM
	Design Value (Design Conditions)	$C_B = 949 + [(C_B)^M_{C,D} - 1103] \pm [10 + 143.4/\lvert(\partial\rho/\partial C_B)\rvert]$
	Reference	Vepco NFE Technical Report No. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	$(\frac{\partial\rho}{\partial C_B}) \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	DESIGN TOLERANCE MET. ACCEPTANCE CRITERIA MET. Use $\frac{\partial\rho}{\partial C_B}$ = -9.23 pcm/ppm for preliminary analysis. $\frac{\partial\rho}{\partial C_B}$ = -8.88 pcm/PPM FOR FINAL ANALYSIS.	

Completed By O. P. Smith
Startup Test Engineer

Evaluated By T K Ross

Recommended For Approval By T. J. Kunsitis
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

Reference	Test Description: CRITICAL BORON CONCENTRATION - BANKS A,B,C,D IN. Procedure Number/Section: 1-PT-94/APP.C Sequence Step Number: 33	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228^{+0}_{-15} CA: 0^{+15}_{-0} CB: 0 CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 0 CB: 0 CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 546.0 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-19-80 1901	
	Measured Parameter (description)	$(C_B)^M_{A,B,C,D}$; Critical Boron Concentration-Banks A,B,C,D In
	Measured Value	C_B = 812 ppm
	Design Value (Actual Conditions)	C_B = 811 ± 29 ppm
	Design Value (Design Conditions)	$C_B = 772 + [(C_B)^M_{B,C,D} - 949] \pm [10 + 164.9/\|(\partial\rho/\partial C_B)\|]$
	Reference	Vepco NFE Technical Report No. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	$(\frac{\partial\rho}{\partial C_B}) \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	Design Tolerance met. Acceptance Criteria met. Use $\frac{\partial\rho}{\partial C_B}$ = -9.23 pcm/ppm for preliminary analysis. $\frac{\partial\rho}{\partial C_B}$ = -8.88 pcm/ppm for final analysis.	

Completed By O.P. Smith
Startup Test Engineer

Evaluated By J K Ross

Recommended For Approval By T. J. Kuniter
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Initial Startup Physics Tests Results and Evaluation

I Reference	Test Description: CRITICAL BORON CONCENTRATION-BANKS A,B,C,D & SDB IN Procedure Number/Section: 1-PT-94/APP. H Sequence Step Number: 38	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 0 CA: 0 CB: 0 CC: 0 CD: 0 RCCA: N/A	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 0 CA: 0 CB: 0 CC: 0 CD: 0 RCCA: NA	RCS Temperature (°F): 546.2 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-20-80 0403	
	Measured Parameter (description)	$(C_B)^M_{A,B,C,D,SDB}$; Critical Boron Concentration-A,B,C,D,Shutdown Bank B In
	Measured Value	697 ppm
	Design Value (Actual Conditions)	715 ± 20 ppm
	Design Value (Design Conditions)	$C_B=675 + \left[(C_B)^M_{A,B,C,D}-772\right] \pm \left[10+90.7/\left\|(\partial\rho/\partial C_B)\right\|\right]$
	Reference	Memorandum from M. L. Smith to E. J. Lozito, dated December 7, 1979
V Acceptance Criteria	FSAR/Tech Spec	$(\partial\rho/\partial C_B) \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	Use $\partial\rho/\partial C_B$ = -9.23 pcm/ppm for preliminary analysis. $\frac{\partial\rho}{\partial C_B}$ = −8.88 pcm/ppm for final analysis. Design Tolerance met. Acceptance Criteria met.	

Completed By ______________
Startup Test Engineer

Evaluated By TK Ross

Recommended For Approval By ______________
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Initial Startup Physics Tests Results and Evaluation

I Reference	Test Description: CRITICAL BORON CONCENTRATION-ALL RODS IN LESS THE MOST REACTIVE ROD Procedure Number/Section: 1-PT-94/APP. H Sequence Step Number: 36	
II Test Conditions (Design)	Bank Positions (steps) SDA: 0 SDB: 0 CA: 0 CB: 0 CC: 0 CD: 0 RCCA: ~~B-8~~ H-14 at 228 7KR 2/14/80	RCS Temperature (°F): 547^{+0}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 0 SDB: 0 CA: 0 CB: 0 CC: 0 CD: 0 RCCA: H-14 at 228	RCS Temperature (°F): 546.5 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-20-80 0211	
	Measured Parameter (description)	$(C_B)^M_{ARI-MRR}$; Critical Boron Concentration- All Rods In Except RCCA ~~B-8~~ H-14 7KR 2/14/80
	Measured Value	681 ppm
	Design Value (Actual Conditions)	691 ± 50 ppm
	Design Value (Design Conditions)	$C_B = 657 + \left[(C_B)^M_{ARO} - 1319\right] \pm 50$ ppm
	Reference	Vepco NFE Technical Report No. 127, November, 1979
V Acceptance Criteria	FSAR/Tech Spec	$(\partial\rho/\partial C_B) \times C_B \le 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	Use $\partial\rho/\partial C_B$ = -9.23 pcm/ppm for preliminary analysis. $\frac{\partial\rho}{\partial C_B}$ = -8.88 pcm/ppm for final analysis. Design Tolerance met. Acceptance Criteria met.	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By TK Ross

Recommended For Approval By T. J. Kenyon
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Initial Startup Physics Tests Results and Evaluation

I Reference	Test Description: Boron Worth Measurement Procedure Number/Section: 1-PT-94/APP.E. Sequence Step Number:	
II Test Condition (Design)	Bank Positions (steps) 7KR 2/14/80 SDA: ~~228~~ Moving SDB: ~~228~~ Moving CA: ~~228~~ Moving CB: Moving CC: Moving CD: Moving RCCA: NA	RCS Temperature (°F): 547 $^{+0}_{-5}$ Power Level (%F.P.): HZP Other (specify):
III Test Conditions (Actual)	Bank Positions (steps) SDA: Moving SDB: Moving CA: Moving CB: Moving CC: Moving CD: Moving RCCA: NA	RCS Temperature (°F): 546 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
	Date/Time Test Performed: 1/16-20/80	
IV Test Results	Measured Parameter (description)	$\left(\frac{\partial\rho}{\partial C_B}\right)$, Differential Boron Worth
	Measured Value	$\left(\frac{\partial\rho}{\partial C_B}\right) = -8.88$ pcm/ppm
	Design Value (Actual Conditions)	$\left(\frac{\partial\rho}{\partial C_B}\right) = -9.23 \pm 0.92$ pcm/ppm
	Design Value (Design Conditions)	$\left(\frac{\partial\rho}{\partial C_B}\right) = -9.23 \pm 0.92$ pcm/ppm
	Reference	Vepco NFE Technical Report No. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	$\left(\frac{\partial\rho}{\partial C_B}\right) \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	Design Tolerance met. Acceptance Criteria met.	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By TK Ross

Recommended For Approval By T. J. Kunitin
NFO Engineer

FINAL RESULTS

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North Anna Power Station Unit 1 Cycle 2 Startup

Initial Startup Physics Tests Results and Evaluation

<table>
<tr><td>I
Reference</td><td colspan="2">Test Description: Boron Worth Measurement
Procedure Number/Section: 1-PT-94/APP.F. Sequence Step Number:</td></tr>
<tr><td>II
Test Conditions
(Design)</td><td>Bank Positions (steps)
7KR 2/14/80 SDA: Moving ~~228~~ SDB: Moving ~~228~~ CA: Moving ~~228~~
CB: Moving CC: Moving CD: Moving
RCCA: NA</td><td>RCS Temperature (°F): 547 $^{+0}_{-5}$
Power Level (%F.P.): HZP
Other (specify):
Below Nuclear Heating</td></tr>
<tr><td rowspan="2">III
Test Conditions
(Actual)</td><td>Bank Positions (steps)
SDA: Moving SDB: Moving CA: Moving
CB: Moving CC: Moving CD: Moving
RCCA: NA</td><td rowspan="2">RCS Temperature (°F): 546
Power Level (%F.P.): 0
Other (specify):
Below Nuclear Heating</td></tr>
<tr><td>Date/Time Test Performed: 1/16-20/80</td></tr>
<tr><td rowspan="5">IV
Test Results</td><td>Measured Parameter (description)</td><td>$\left(\frac{\partial\rho}{\partial C_B}\right)$, Differential Boron Worth</td></tr>
<tr><td>Measured Value</td><td>$\left(\frac{\partial\rho}{\partial C_B}\right) = -8.88$ pcm/ppm</td></tr>
<tr><td>Design Value (Actual Conditions)</td><td>$\left(\frac{\partial\rho}{\partial C_B}\right) = -9.23 \pm 0.92$ pcm/ppm</td></tr>
<tr><td>Design Value (Design Conditions)</td><td>$\left(\frac{\partial\rho}{\partial C_B}\right) = -9.23 \pm 0.92$ pcm/ppm</td></tr>
<tr><td>Reference</td><td>Vepco NFE Technical Report No. 127, November, 1979.</td></tr>
<tr><td rowspan="2">V
Acceptance Criteria</td><td>FSAR/Tech Spec</td><td>$\left(\frac{\partial\rho}{\partial C_B}\right) \times C_B \leq 24{,}000$ pcm</td></tr>
<tr><td>Reference</td><td>FSAR Section 15.2.4</td></tr>
<tr><td>VI
Comments</td><td colspan="2">Design Tolerance met.
Acceptance Criteria met.</td></tr>
</table>

Completed By J.P. Smith
Startup Test Engineer

Evaluated By 7K Ross

Recommended For Approval By T.J. Kunsitis
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: Isothermal Temperature Coefficient - ARO Procedure Number/Section: 1-PT-94/APP.D Sequence Step Number: 6	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 228^{+0}_{-15} RCCA: NA	RCS Temperature (°F): 547^{+3}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 216/215 RCCA: NA	RCS Temperature (°F): 543-549 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-16-80 1330-1434	
	Measured Parameter (description)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO}_{ARO}$; Isothermal Temperature Coefficient-ARO
	Measured Value	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO}_{ARO} = -2.36$ pcm/°F
	Design Value (Actual Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO}_{ARO} = -3.49 \pm 3.0$ pcm/°F ($C_B = 1351$ ppm)
	Design Value (Design Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO}_{ARO} = -3.87 \pm 3.0$ pcm/°F (D/228, 1320 ppm, 547.0°F)
	Reference	Vepco NFE Technical Report No. 127, November,1979
V Acceptance Criteria	FSAR/Tech Spec	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO} < -1.98$ pcm/°F [DOPPLER$\left(\frac{\partial\rho}{\partial T}\right) = -1.98$pcm/°F]
	Reference	FSAR Table 4.3-2, VEP-FRD-NFE-127
VI Comments	Design Tolerance met. Acceptance Criteria met.	

Completed By J. P. Smith
Startup Test Engineer

Evaluated By TK Ross

Recommended For Approval By
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: Isothermal Temperature Coefficient - Bank D In Procedure Number/Section: 1-PT-94/APP.D Sequence Step Number: 9	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228^{+0}_{-15} CD: 0^{+15}_{-0} RCCA: NA	RCS Temperature (°F): 547^{+3}_{-5} Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 15 RCCA: NA	RCS Temperature (°F): 543-549 Power Level (%F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 1-17-80 1545 - 1655	
	Measured Parameter (description)	$(\frac{\partial\rho}{\partial T})^{ISO}_{D}$; Isothermal Temperature Coefficient-Bank D In
	Measured Value	$(\frac{\partial\rho}{\partial T})^{ISO}_{D}$ = -3.70 pcm/°F
	Design Value (Actual Conditions)	$(\frac{\partial\rho}{\partial T})^{ISO}_{D}$ = -6.34 ± 3.0 pcm/°F (C_B = 1234 ppm)
	Design Value (Design Conditions)	$(\frac{\partial\rho}{\partial T})^{ISO}_{D}$ = -6.87 ± 3.0 pcm/°F (D/0, C/228, 1199 ppm, 547.0°F)
	Reference	Vepco NFE Technical Report No. 127, November, 1979.
V Acceptance Criteria	FSAR/Tech Spec	$(\frac{\partial\rho}{\partial T})^{ISO}$<-1.98 pcm/°F [DOPPLER $(\frac{\partial\rho}{\partial T})$=-1.98 pcm/°F]
	Reference	FSAR Table 4.3-2, VEP-FRD-NFE-127
VI Comments	Design Tolerance met. Acceptance Criteria met.	

Completed By J. C. Smith
Startup Test Engineer

Evaluated By TK Ross

Recommended For Approval By T. J. Kuziuten
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: M/D FLUX MAP- ARO
Procedure Number/Section: 1-PT-21.1 Sequence Step Number: 7

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 213±15
RCCA: NA

RCS Temperature (°F): 547 ±5
Power Level (%F.P.): ~4
Other (specify):
Must have ≥ 33 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 218
RCCA: NA

RCS Temperature (°F): 546
Power Level (%F.P.): 0
Other (specify):
48 Thimbles

Date/Time Test Performed: 1-16-80 1555-1733

IV Test Results	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
	Measured Value	+17.1%*	1.637	3.090	1.090*
	Design Value (Actual Conditions)	±15%, P_i<0.9	≤ 1.860	≤ 4.200	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_1 \geq 0.9$ ± 15% for $P_1 < 0.9$ (P_1 = Assy pwr)	$F^N_{\Delta H} \leq 1.55 \times [1+.2(1-P)]$	$F^T_Q \leq 2.10 \times K(z)/P;\ P>0.5$ $F^T_Q \leq 4.20 \times K(z)\ ;\ P\leq 0.5$	≤ 1.02
	Reference	WCAP-7905 REV.1	TS 3.2.3	TS 3.2.2	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	NA	NA	NA
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4
VI Comments	The minimum F_Q margin = 23% at a core height of 9.8 feet.				

Completed By J. C. Smith

Evaluated By Jay K. Celestino

Recommended For Approval By TK Ross
NFO Engineer

*The test results are acceptable.
References: 1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, Serial No. 116.

FINAL RESULTS

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North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: M/D FLUX MAP- ARO
Procedure Number/Section: 1-PT-21.1
Sequence Step Number: 7

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: $213^{+}_{-}15$
RCCA: NA

RCS Temperature (°F): 547 ±5
Power Level (%F.P.): ~4
Other (specify):
Must have ≥ 33 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 228
RCCA: NA

RCS Temperature (°F): 548
Power Level (%F.P.): ~3
Other (specify):
48 Thimbles

Date/Time Test Performed: 1-20-80 1848-2014

IV Test Results

MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F^{N}_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^{T}_{Q}, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	-11.4%*	1.611	3.000	1.084*
Design Value (Actual Conditions)	±10%, $P_i \geq 0.9$	≤ 1.851	≤ 4.200	≤ 1.020
Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	$F^{N}_{\Delta H} \leq 1.55 \times [1+.2(1-P)]$	$F^{T}_{Q} \leq 2.10 \times K(z)/P;\ P>0.5$ $F^{T}_{Q} \leq 4.20 \times K(z)\ ;\ P \leq 0.5$	≤ 1.02
Reference	WCAP-7905 REV.1	TS 3.2.3	TS 3.2.2	WCAP-7905 REV.1

V Acceptance Criteria

FSAR/Tech Spec	NA	NA	NA	NA
Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

The minimum F_Q margin =25% at a core height of 9.8 feet.

Completed By J. C. Smith

Evaluated By Jay H. Leberstein

Recommended For Approval By T. J. Kunsitis
NFO Engineer

*The test results are acceptable.

References: 1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, Serial No. 116.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: H/D FLUX MAP- Bank D In Procedure Number/Section: 1-PT-21.1 Sequence Step Number: 11

	Bank Positions (steps)	
II Test Conditions (Design)	SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 213±15 CD: 0^{+15}_{-0} JHL 3/10/80 RCCA: NA	RCS Temperature (°F): 547 ±5 Power Level (%F.P.): ~4 Other (specify): Must have ≥ 38 thimbles
III Test Conditions (Actual)	SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 12 RCCA: NA	RCS Temperature (°F): 545 Power Level (%F.P.): 0 Other (specify): 48 Thimbles
	Date/Time Test Performed: 1-17-80 1817 - 2027	

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^N$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	+11.4%*	1.917*	3.636	1.063*
	Design Value (Actual Conditions)	±10%, $P_i \geq 0.9$	≤ 1.860	≤ 4.200	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	$F_{\Delta H}^N \leq 1.55 \times [1+.2(1-P)]$	$F_Q^T \leq 2.10 \times K(z)/P$: P>0.5 $F_Q^T \leq 4.20 \times K(z)$: P≤0.5	≤ 1.02
	Reference	WCAP-7905 REV.1	TS 3.2.3	TS 3.2.2	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	NA	NA	NA
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4
VI Comments	Minimum F_Q margin = 9% at a core height of 9.8 feet.				

Completed By

Evaluated By

Recommended For Approval By TK Ross
NFO Engineer

* Test results indicate that the $F_{\Delta H}^N$ limit may be violated with rods at the HZP insertion limits.

References: 1. North Anna LER 80-017/017-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, Serial No. 116.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

JHL 3/10/80

I Reference

Test Description: M/D FLUX MAP- ~~Bank D In~~ Zero Power Rod Insertion Limit
Procedure Number/Section: 1-PT-21.1
Sequence Step Number: 11

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: ~~213±15~~ 118±10 JHL 3/10/80 CD: 0
RCCA: NA

RCS Temperature (°F): 547 ±5
Power Level (%F.P.): ~4
Other (specify):
Must have ≥ 38 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 118 CD: 0
RCCA: NA

RCS Temperature (°F): 548
Power Level (%F.P.): ~3
Other (specify):
49 Thimbles

Date/Time Test Performed: 1/20-21/80 2330-0120

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	-9.8%	1.930*	2.946	1.034*
	Design Value (Actual Conditions)	±1.5%, $P_i \leq 0.9$	≤ 1.851	≤ 4.200	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	$F^N_{\Delta H} \leq 1.55 \times [1 + .2(1-P)]$	$F^T_Q \leq 2.10 \times K(z)/P : P > 0.5$ $F^T_Q \leq 4.20 \times K(z) : P \leq 0.5$	≤ 1.02
	Reference	WCAP-7905 REV.1	TS 3 2.3	TS 3.2.2	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	NA	NA	NA
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4
VI Comments	Minimum F_Q margin = 30% at a core height of 4.4 feet				

Completed By J. P. Smith

Evaluated By Jay H. Eberstein

Recommended For Approval By J. R. In
NFO Engineer

*Test results confirm that the $F^N_{\Delta H}$ limit is violated with the rods at the HZP insertion limits.

References: 1. North Anna LER 80-017/01T-0.
2. Letter from C. M. Stallings (Vepco) to H. R. Denton (NRC) dated March 11, 1980, Serial No. 116.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

1 Reference	Test Description: M/D FLUX MAP- Bank D In Procedure Number/Section: 1-PT-21.1 Sequence Step Number: 11	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: ~~213±15~~ 228 CD: ~~-0-~~ 100 $^{+0}_{-10}$ RCCA: NA JHL 3/10/80	RCS Temperature (°F): 547 ± 5 Power Level (%F.P.): ~4 Other (specify): Must have ≥ 38 thimbles
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 99 RCCA: NA	RCS Temperature (°F): 548 Power Level (%F.P.): ~3 Other (specify): 49 Thimbles
	Date/Time Test Performed: 1-21-80 1158-1344	

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	10.1%	1.740	2.580	1.051 *
	Design Value (Actual Conditions)	±15%, P_i<0.9	≤ 1.851	≤ 4.200	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	$F^N_{\Delta H} \leq 1.55 \times [1+.2(1-p)]$	$F^T_Q \leq 2.10 \times K(z)/P;\ P>0.5$ $F^T_Q \leq 4.20 \times K(z);\ P\leq 0.5$	≤ 1.02
	Reference	WCAP-7905 REV.1	TS 3.2.3	TS 3.2.2	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	NA	NA	NA
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4
VI Comments	Minimum F_Q Margin = 39% at a core height of 3.0 feet.				

Completed By J. P. Smith

Evaluated By Jay H. Leberstien

Recommended For Approval By TK Ross
NFO Engineer

*The test results are acceptable.
The test results confirm that the $F^N_{\Delta H}$ limit is not exceeded with the rods at the new administrative insertion limit.
References: 1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, Serial No. 116.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: H/D FLUX MAP- AT POWER, NI CALIB., $\overline{R}$ DATA MAP
Procedure Number/Section: 1-PT-22.2 Sequence Step Number: 42

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: AR
RCCA: NA

RCS Temperature (°F): Tref ±1
Power Level (%F.P.): ~25
Other (specify):
Must have ≥ 38 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 217
RCCA: NA

RCS Temperature (°F): 556
Power Level (%F.P.): ~30
Other (specify):
48 thimbles

Date/Time Test Performed: 1-25-80
1350 - 1511

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^{N}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	10.1 %	1.467	2.863	1.045 *
	Design Value (Actual Conditions)	±15%, $P_i < 0.9$	NA	NA	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F_{\Delta H}^{N} \leq 1.55 \times [1 + .2(1-P)]$	$F_Q^T \leq 2.10 \times K(z)/P;\ P > 0.5$ $F_Q^T \leq 4.20 \times K(z);\ P \leq 0.5$	NA
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Minimum F_Q margin = 28 % at a core height of 9.8 feet.
F_{XY} Unrodded = 1.752 which exceeds the F_{XY}^{RTP} limit of 1.650 but is less than the F_{XY}^{c} limit of 1.871.*

Completed By ________

Evaluated By ________

* The test results are acceptable.

Recommended For Approval By C. T. Snow
NFO Engineer

References:
1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, Serial No. 116.
3. North Anna Technical Specification 3.2.2.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: M/D FLUX MAP- AT POWER, NI CALIB. ~~, Ē DATA MAP~~ TKR 3-10-80
Procedure Number/Section: 1-PT-22.2 Sequence Step Number:

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: AR
RCCA: NA

RCS Temperature (°F): Tref ±1
Power Level (%F.P.): ~25
Other (specify):
Must have ≥ 38 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 165
RCCA: NA

RCS Temperature (°F): 556
Power Level (%F.P.): ~30
Other (specify):
47 thimbles

Date/Time Test Performed: 1-24-80 1625 - 1749

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^N$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	8.9%	1.542	2.078	1.024*
	Design Value (Actual Conditions)	±15%, $P_i<0.9$	NA	NA	≤1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i<0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F_{\Delta H}^N \leq 1.55 x [1+.2(1-P)]$	$F_Q^T \leq 2.10 \times K(z)/P;\ P>0.5$ $F_Q^T \leq 4.20 \times K(z);\ P\leq 0.5$	NA
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Minimum F_Q margin = 50% at a core height of 6.6 feet.
F_{XY} Unrodded = 1.625 which exceeds the F_{XY}^{RTP} limit of 1.570 but is less than the F_{XY}^{L} limit of 1.790.*

Completed By J.P. Smith Evaluated By TK Ross

Recommended For Approval By J. R. [illegible]
NFO Engineer

*The test results are acceptable.
References:
1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, Serial No. 116.
3. North Anna Technical Specification 3.2.2.

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FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: M/D FLUX MAP- AT POWER, NI CALIB. ~~[illegible]~~ JRJ 3/10/80 Procedure Number/Section: 1-PT-22.2 Sequence Step Number:	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: AR RCCA: NA	RCS Temperature (°F): Tref ±1 Power Level (%F.P.): ~25 Other (specify): Must have ≥ 38 thimbles
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 138 RCCA: NA	RCS Temperature (°F): 556 Power Level (%F.P.): ~30 Other (specify): 48 thimbles
IV	Date/Time Test Performed: 1-25-80 0838 – 1006	

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	12.8%	1.566	2.200	1.024*
	Design Value (Actual Conditions)	±15%, P_i<0.9	NA	NA	≤1.020
	Design Value (Design Conditions)	± 10% for P_i≥0.9 ± 15% for P_i<0.9 (P_i= Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F^N_{\Delta H} \leq 1.55 \times [1+.2(1-P)]$	$F^T_Q \leq 2.10 \times K(z)/P;\ P>0.5$ $F^T_Q \leq 4.20 \times K(z);\ P\leq 0.5$	NA
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Minimum FQ margin = 48% at a core height of 3.2 feet.

F_{XY} rodded = 1.796 which exceeds the F_{XY}^{RTP} limit of 1.710 but is less than the F_{XY}^{L} limit of 1.949.*

F_{XY} unrodded = 1.692 which exceeds the F_{XY}^{RTP} limit of 1.650 but is less than the F_{XY}^{L} limit of 1.881.*

Completed By J. P. Smith

Evaluated By J. R. Jr

Recommended For Approval By T K Ross
NFO Engineer

* Test results are acceptable.

Test results confirm that the $F^N_{\Delta H}$ limit is not exceeded with the rods at the new administrative insertion limits.

References:
1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC), dated March 11, 1980, Serial No. 116.
3. North Anna Technical Specification 3.2.2.

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FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: M/D FLUX MAP- AT POWER, NI CALIB., $\overline{R}$ DATA MAP
Procedure Number/Section: 1-PT-22.2   Sequence Step Number: 43

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: AR
RCCA: NA

RCS Temperature (°F): Tref ± 1
Power Level (%F.P.): ~40
Other (specify):
Must have $\geq$ 38 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 218
RCCA: NA

RCS Temperature (°F): 556
Power Level (%F.P.): ~30
Other (specify):
48 thimbles

Date/Time Test Performed: 1-26-80 1521 - 1644

IV Test Results

MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^N$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	10.0%	1.476	1.868	1.029 *
Design Value (Actual Conditions)	$\pm 15\%$, $P_i < 0.9$	NA	NA	≤ 1.020
Design Value (Design Conditions)	$\pm$ 10% for $P_i \geq 0.9$ $\pm$ 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1

V Acceptance Criteria

FSAR/Tech Spec	NA	$F_{\Delta H}^N \leq 1.55 x [1+.2(1-P)]$	$F_Q^T \leq 2.10 \times K(z)/P;\ P>0.5$ $F_Q^T \leq 4.20 \times K(z);\ P\leq 0.5$	NA
Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Minimum F_Q margin = 55% at a core height of 8.2 feet.
F_{XY} Unrodded = 1.692 which exceeds the F_{XY}^{RTP} limit of 1.650 but is less than the F_{XY}^{L} limit of 1.874. *

Completed By J. P. Smith   Evaluated By J. R. Jr

Recommended For Approval By C. J. [illegible]
NFO Engineer

* The test results are acceptable.

References: 1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, serial No. 116.
3. North Anna Technical Specification 3.2.2.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: M/D FLUX MAP-AT POWER, NI CALIB, $\overline{R}$ DATA MAP
Procedure Number/Section: 1-PT-22.2 Sequence Step Number: 44

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: AR
RCCA: NA

RCS Temperature (°F): Tref ± 1
Power Level (%F.P.): ~50
Other (specify):
Must have $\geq$ 38 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 218
RCCA: NA

RCS Temperature (°F): 563
Power Level (%F.P.): ~47
Other (specify):
46 thimbles

Date/Time Test Performed: 1-29-80 0304 – 0429

IV Test Results

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	6.8 %	1.456	1.903	1.0203 *
	Design Value (Actual Conditions)	±15%, P$_i$<0.9	NA	NA	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F^N_{\Delta H} \leq 1.55 \times [1+.2(1-p)]$	$F^T_Q \leq 2.10 \times K(z)/p$: $p > 0.5$ $F^T_Q \leq 4.20 \times K(z)$: $p \leq 0.5$	NA ~~≤1.02~~ JRJ 3/10/80
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Minimum Fq margin = 53% at a core height of 8.2 feet.
F_{XY} Unrodded = 1.672 which exceeds the F_{XY}^{RTP} limit of 1.650 but is less than the F_{XY}^{L} limit of 1.825.*

Completed By J. P. Smith Evaluated By J. R. Jr

Recommended For Approval By C. J. Snow
NFO Engineer

* The test Results are acceptable.

References:
1. North Anna LER 80-017/01T-0.
2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, serial No. 116.
3. North Anna Technical Specification 3.2.2.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: M/D FLUX MAP-AT POWER, NI CALIB, $\bar{R}$ DATA Procedure Number/Section: 1-PT-22.2 Sequence Step Number: 46				
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: AR RCCA: NA		RCS Temperature (°F): Tref ± 1 Power Level (%F.P.): ~ 60 Other (specify): Must have ≥ 38 thimbles		
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 192 RCCA: NA		RCS Temperature (°F): 562 Power Level (%F.P.): ~ 45 Other (specify): 48 thimbles		
IV Test Results	Date/Time Test Performed: 1-31-80 1055 – 1209				
	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^{N}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
	Measured Value	8.4 %	1.487	1.943	1.025 *
	Design Value (Actual Conditions)	±15%, $P_i < 0.9$	NA	NA	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F_{\Delta H}^{N} \leq 1.55 x [1+.2(1-p)]$	$F_Q^T \leq 2.10 \times K(z)/p;\ p>0.5$ $F_Q^T \leq 4.20 \times K(z)\ ;\ p \leq 0.5$	NA ~~≤ 1.02~~ JRJ 3/10/80
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4
VI Comments	Minimum FQ margin = 53% at a core height of 8.0 feet. FXY unrodded = 1.663 which exceeds the F_{XY}^{RTP} limit of 1.650 but is less than the F_{XY}^{L} limit of 1.831. *				

Completed By J. P. Smith

Evaluated By J. R. Jr

Recommended For Approval By T K Ross
NYO Engineer

* Test results are acceptable.

References: 1. North Anna LER 80-017/01T-0

2. Letter from C.M. Stallings (Vepco) to H.R. Denton (NRC) dated March 11, 1980, serial No. 116.

3. North Anna Technical Specification 3.2.2.

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: M/D FLUX MAP-AT POWER, NI CALIB, $\bar{R}$ DATA MAP
Procedure Number/Section: 1-PT-22.2
Sequence Step Number: 47

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: AR
RCCA: NA

RCS Temperature (°F): Tref ± 1
Power Level (%F.P.): ~70
Other (specify): Must have ≥ 38 Thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 217
RCCA: NA

RCS Temperature (°F): 569
Power Level (%F.P.): ~66
Other (specify): 48 thimbles.

Date/Time Test Performed: 2-3-80 1218 – 1353

IV Test Results

MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^{N}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	5.2%	1.433	1.844	1.008
Design Value (Actual Conditions)	±15%, $P_i<0.9$	NA	NA	≤1.020
Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1

V Acceptance Criteria

FSAR/Tech Spec	NA	$F_{\Delta H}^{N} \leq 1.55 \times [1+.2(1-p)]$	$F_Q^T \leq 2.10 \times k(z)/p;\ p>0.5$ $F_Q^T \leq 4.20 \times k(z);\ p \leq 0.5$	≤ 1.02
Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Minimum Fα margin = 40% at a core height of 8.2 feet.
Design Tolerance met.
Acceptance Criteria met.

Completed By J. P. Smith

Evaluated By J. R. Jr

Recommended For Approval By C. T. Snow
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference

Test Description: M/D FLUX MAP-AT POWER, NI CALIB, $\bar{R}$ DATA MAP
Procedure Number/Section: 1-PT-22.2 Sequence Step Number: 48

II Test Conditions (Design)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: AR
RCCA: NA

RCS Temperature (°F): Tref ±1
Power Level (%F.P.): ~80
Other (specify):
Must have ≥ 38 thimbles

III Test Conditions (Actual)

Bank Positions (steps)
SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 228
RCCA: NA

RCS Temperature (°F): 575
Power Level (%F.P.): ~83%
Other (specify):
48 Thimbles

IV Test Results

Date/Time Test Performed: 2-4-80 0011-0144

MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^{N}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	5.9%	1.412	1.749	1.018
Design Value (Actual Conditions)	±15%, P<0.9	NA	NA	≤1.020
Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1

V Acceptance Criteria

FSAR/Tech Spec	NA	$F_{\Delta H}^{N} \leq 1.55 x [1+.2(1-p)]$	$F_Q^T \leq 2.10 \times k(z)/p ; p>0.5$ $F_Q^T \leq 4.20 \times k(z) ; p \leq 0.5$	≤1.02
Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Minimum Fq margin = 29% at a core height of 10.2 feet.
Design Tolerance met.
Acceptance Criteria met.

Completed By J. C. Smith

Evaluated By Jay H. Leberstein

Recommended For Approval By TK Ross
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: M/D FLUX MAP-AT POWER,NI CALIB,~~F DATA MAP~~ DMK 3/10/80 Procedure Number/Section: 1-PT-22.2 Sequence Step Number: 49	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: AR RCCA: NA	RCS Temperature (°F): Tref ±1 Power Level (%F.P.): ~90 Other (specify): Must have ≥ 38 thimbles
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 228 RCCA: NA	RCS Temperature (°F): 580 Power Level (%F.P.): ~99 Other (specify): 48 Thimbles
	Date/Time Test Performed: 2-7-80 1005-1136	

	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^N$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV	Measured Value	6.2 %	1.387	1.762	1.010
Test Results	Design Value (Actual Conditions)	±15%, $P_i<0.9$	NA	NA	≤1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F_{\Delta H}^N$: $1.55 \times [1+.2(1-p)]$	$F_Q^T \leq 2.10 \times K(z)/P$; $P>0.5$ $F_Q^T \leq 4.20 \times K(z)$; $P \leq 0.5$	≤1.02
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments: Minimum F_Q margin = 17% at a core height of 3.2 feet.
Design Tolerance met.
Acceptance Criteria met.

Completed By J. P. Smith

Evaluated By D. M. Kapuschinsky

Recommended For Approval By J. R. [illegible]
NFO Engineer

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FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: H/D FLUX MAP-AT POWER,NI CALIB,~~$\bar{R}$ DATA MAP~~ JRJ 3-10-80 Procedure Number/Section: 1-PT-22.2 Sequence Step Number:				
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: AR RCCA: NA		RCS Temperature (°F): Tref ±1 Power Level (%F.P.): ~ 90 Other (specify): Must have ≥ 38 thimbles		
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 208 RCCA: NA		RCS Temperature (°F): 580 Power Level (%F.P.): ~99 Other (specify): 46 thimbles		
IV Test Results	Date/Time Test Performed: 2-7-80 1737 – 1905				
	MEASURED PARAMETER (description)	MAX. REL. ASSY. PWR. % Diff. $\frac{(M-P)}{P}$	$F_{\Delta H}^N$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F_Q^T, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
	Measured Value	6.3%	1.403	1.902	1.014
	Design Value (Actual Conditions)	±15%, $P_i < 0.9$	NA	NA	≤ 1.020
	Design Value (Design Conditions)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F_{\Delta H}^N \leq 1.55 \times [1+.2(1-p)]$	$F_Q^T \leq 2.10 \times K(z)/P;\ P>0.5$ $F_Q^T \leq 4.20 \times K(z);\ P \leq 0.5$	≤1.02
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4
VI Comments	Minimum Fq margin = 11% at a core height of 3.0 feet. Design Tolerance met. Acceptance Criteria met.				

Completed By J. P. Smith

Evaluated By J. R. Jr

Recommended For Approval By C. S. Evans
NFO Engineer

FINAL RESULTS

North Anna Power Station Unit 1 Cycle 2 Startup

Startup Physics Tests Results and Evaluation Sheet

I Reference	Test Description: M/D FLUX MAP- HFP, ARO, Eq Xe Procedure Number/Section: 1-PT-21.1 Sequence Step Number: 50	
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: AR RCCA: NA	RCS Temperature (°F): Tref ± 1 Power Level (%F.P.): 95 ± 5 Other (specify): Must have $\geq$ 38 thimbles
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 213 RCCA: NA	RCS Temperature (°F): 581 Power Level (%F.P.): 100 Other (specify): 47 thimbles
	Date/Time Test Performed: 2-14-80 1447 – 1616	

	MEASURED PARAMETER (description)	MAX. REL. ASST. PWR. % Diff. $\frac{(M-P)}{P}$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
IV Test Results	Measured Value	7.4%	1.395	1.776	1.010
	Design Value (Actual Conditions)	±15%, Pi<0.9	NA	NA	≤1.020
	Design Value (Design Conditions)	$\pm$ 10% for $P_i \geq 0.9$ $\pm$ 15% for $P_i < 0.9$ (P_i = Assy pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NA	NA	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NA	$F^N_{\Delta H} \leq 1.55 \times [1+.2(1-p)]$	$F^T_Q \leq 2.10 \times K(z)/P;\ P>0.5$ $F^T_Q \leq 4.20 \times K(z);\ P \leq 0.5$	≤ 1.02
	Reference	NA	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments: Minimum Fq margin = 16% at a core height of 3.2 feet.
Design Tolerance met.
Acceptance criteria met.

Completed By J. P. Smith

Evaluated By J. R. Jr

Recommended For Approval By C. T. Snow
NFO Engineer