VEP-NOS-2

NORTH ANNA UNIT 1, CYCLE 4

STARTUP PHYSICS TEST REPORT

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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 4 core could be operated safely, and to make an initial evaluation of the 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 techiques 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 comparision of the test results with design predictions, and an evaluation of the results.

The North Anna 1, Cycle 4 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 the 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 occuring during the tests. The Appendix to this report contains the final completed and approved version of the Startup Physics Tests Results and Evaluation Sheets.

Section 1

INTRODUCTION AND SUMMARY

On May 17, 1982, Unit No. 1 of the North Anna Power Station was shut down for its third refueling. During this shutdown, 69 of the 157 fuel assemblies in the core were replaced with fresh fuel assemblies. The core loading pattern and the design parameters for each batch are shown in Figure 1.1. Fuel assembly burnups are given in Figure 1.2. The incore instrumentation locations are identified in Figure 1.3. Figure 1.4 identifies the location and number of burnable poison rods and source assemblies in the Cycle 4 core. Figure 1.5 identifies the location and number of control rods in the Cycle 4 core.

On November 18, 1982, at 4:49 p.m., the fourth 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 North Anna Technical Specifications[2].

2. Individual control rod bank worths for all control rod banks were measured using the rod swap technique[3] and were found to be within 10.3% of the design predictions. The sum of the individual control rod bank worths was measured to be within 6.6% of the design prediction. These results are within the design tolerance of ±15% for individual bank

worths (±10% for the rod swap reference bank worth) and the design tolerance of ±10% for the sum of the individual control rod bank worths.

3. Critical boron concentrations for two control bank configurations were measured to be within 6 ppm of the design predictions. These results were within the design tolerances and also met the accident analysis acceptance criterion.

4. The boron worth coefficient was measured to be within 2.2% of the design predication, which is within the design tolerance of ±10% and met the accident analysis criterion.

5. Isothermal temperature coefficients for the all-rods-out configuration was measured to be within 1.7 pcm/°F of design prediction. This result is within the design tolerance of ±3 pcm/°F and also meets the accident analysis acceptance criterion.

6. Core power distributions for various HZP and at power conditions were generally within 6% of the predicted power distributions. For all maps, the hot channel factors were measured to be within the limits of the Technical Specifications. Generally, all measurement parameters met their respective design value tolerances. All measurement parameters met their respective accident analysis acceptance criteria.

In summary, all startup physics test results are 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 1 - BOL CYCLE 4 PHYSICS TESTS

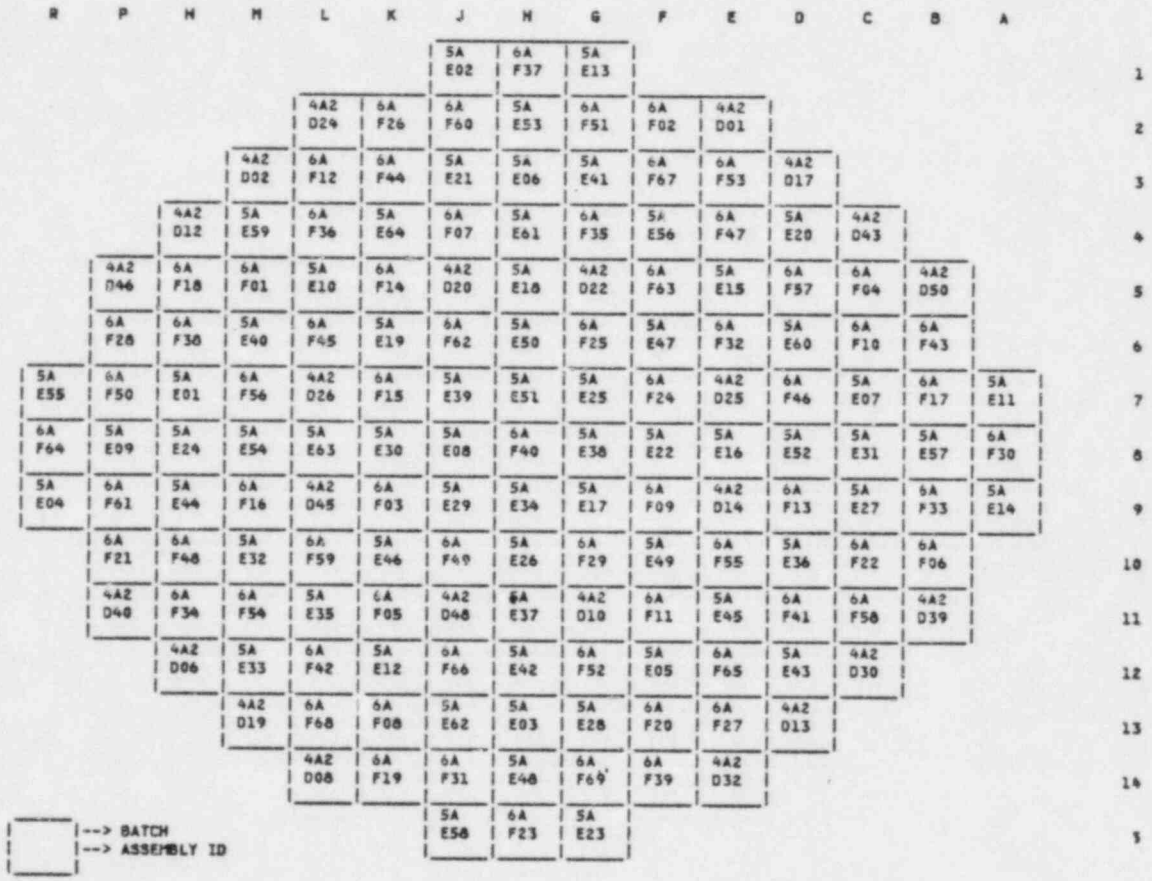
CHRONOLOGY OF TESTS

Test	Date	Time	Power	Reference Procedure
Hot Rod Drops-Hot Full Flow	11/17/82	2200	HSD	1-PT-17.2
Flux Map-ARO	11/19/82	0537	4%	1-PT-21.1
Reactivity Computer Checkout	11/19/82	0824	HZP	1-PT-94.2
Boron Endpoint-ARO	11/19/82	1129	HZP	1-PT-94.3
Temperature Coefficient-ARO	11/19/82	1327	HZP	1-PT-94.4
Bank B Worth	11/19/82	1516	HZP	1-PT-94.5
Boron Endpoint-B In	11/19/82	2035	HZP	1-PT-94.3
Bank C Worth - Rod Swap	11/19/82	2332	HZP	1-PT-94.7
Bank A Worth - Rod Swap	11/20/82	0024	HZP	1-PT-94.7
Bank SB Worth - Rod Swap	11/20/82	0106	HZP	1-PT-94.7
Bank SA Worth - Rod Swap	11/20/82	0149	HZP	1-PT-94.7
Bank D Worth - Rod Swap	11/20/82	0312	HZP	1-PT-94.7
Flux Map - I/E Calibration	3/14/83	1223	29%	1-PT-22.2
Flux Map - I/E Calibration	3/14/83	1609	29%	1-PT-22.2
Flux Map - I/E Calibration	3/14/83	1810	29%	1-PT-22.2
Flux Map - I/E Calibration	3/17/83	0913	52%	1-PT-22.2
Flux Map - HFP, Eq. Xenon	3/24/83	1241	100%	1-PT-21.1

Figure 1.1

NORTH ANNA UNIT 1 - CYCLE 4

CORE LOADING MAP



FUEL ASSEMBLY DESIGN PARAMETERS

	4A2	5A	6A
Initial Enrichment (w/o U235)	3.21	3.40	3.59
Burnup at BOC-4 (MWD/MTU)	26,211	14,868	0
Assembly Type	17x17	17x17	17x17
Number of Assemblies	24	64	69
Fuel Rods per Assembly	264	264	264

Figure 1.2

NORTH ANNA UNIT 1 - CYCLE 4

BEGINNING OF CYCLE FUEL ASSEMBLY BURNUPS

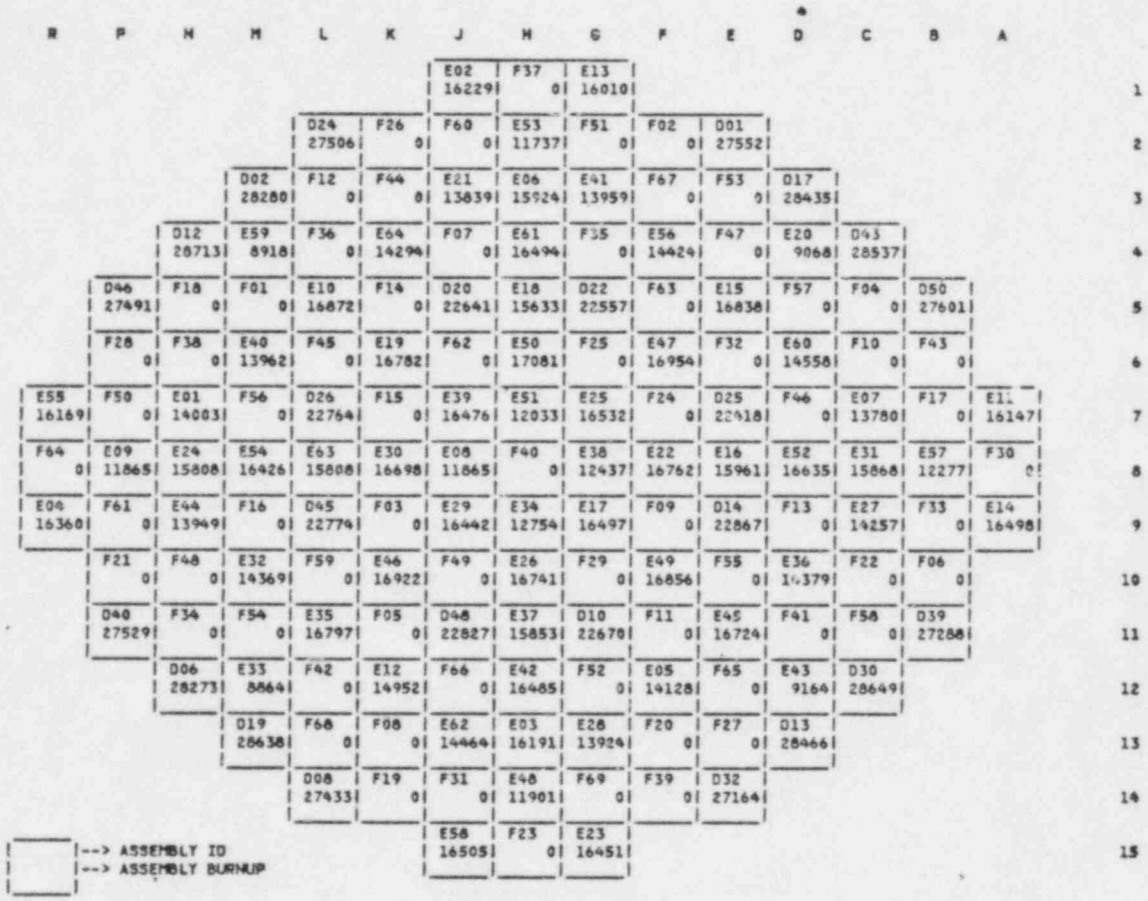


Figure 1.3

NORTH ANNA UNIT 1 - CYCLE 4

INCORE INSTRUMENTATION LOCATIONS

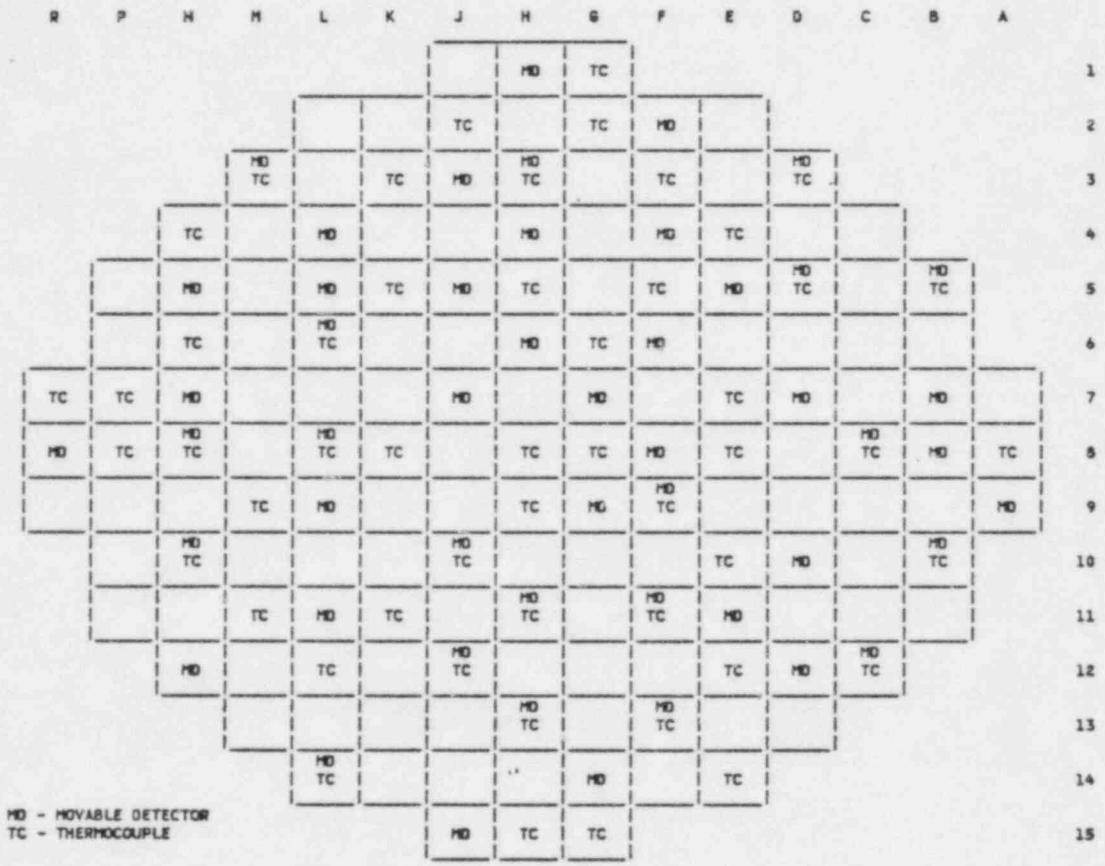


Figure 1.4

NORTH ANNA UNIT 1 - CYCLE 4

BURNABLE POISON AND SOURCE ASSEMBLY LOCATIONS

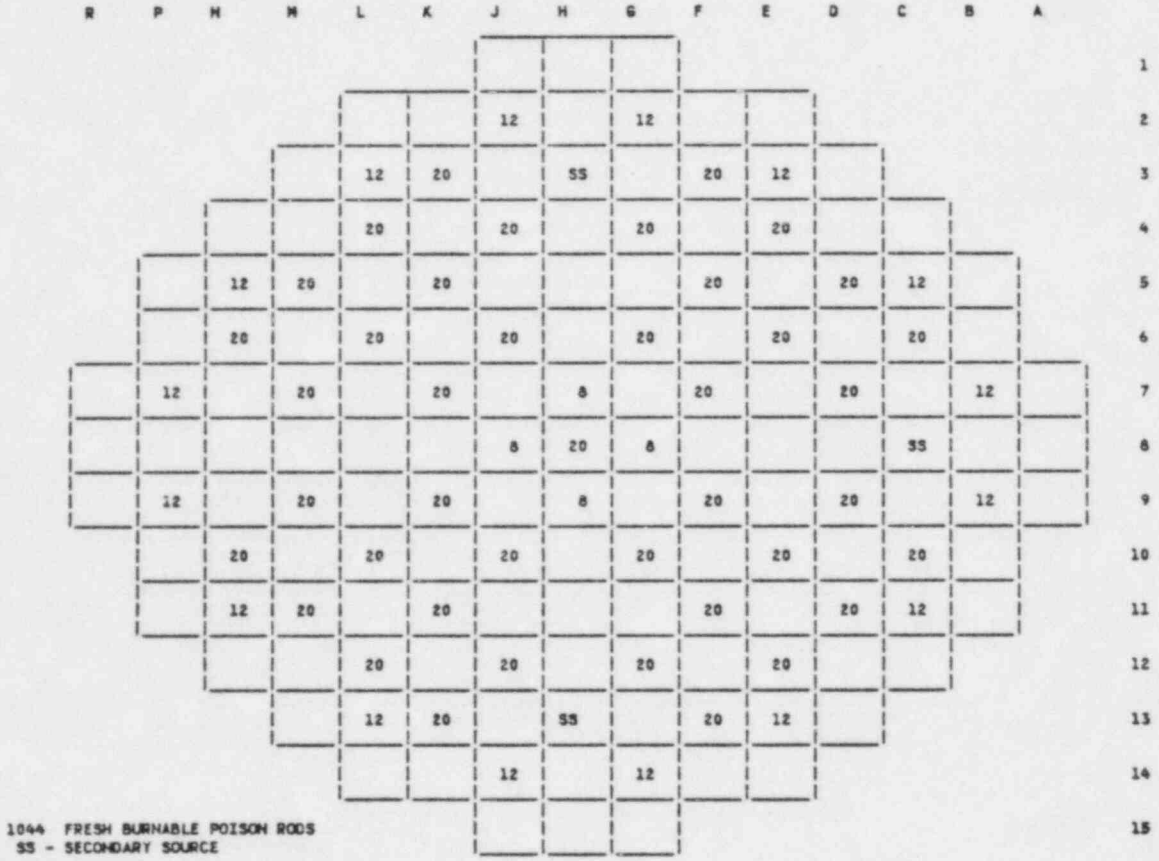
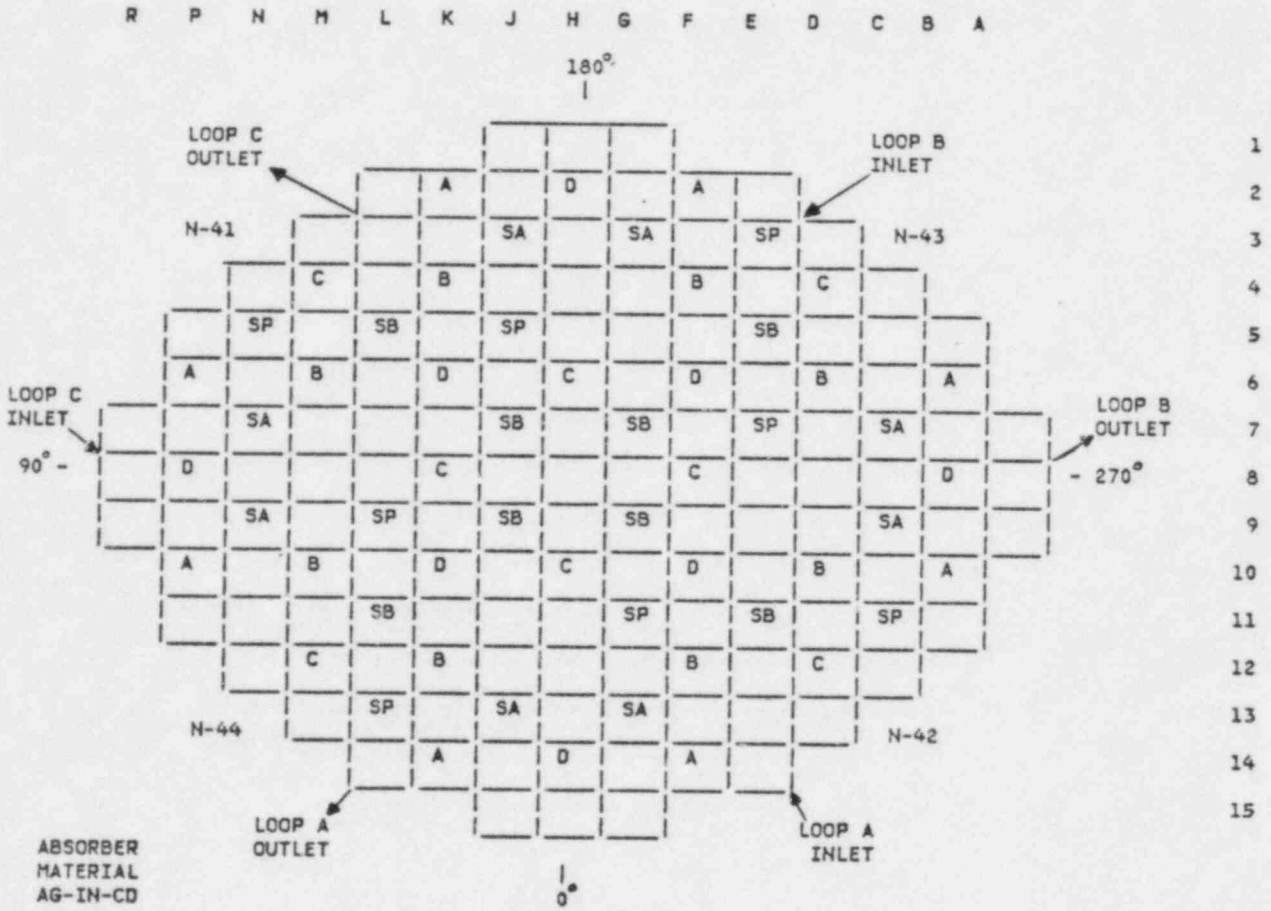


Figure 1.5

NORTH ANNA UNIT 1 - CYCLE 4

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 SB	8
SHUTDOWN BANK SA	8
SP (SPARE ROD LOCATIONS)	8

Section 2

CONTROL ROD DROP TIME MEASUREMENTS

The drop time of each control rod was measured 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 (547 °F, 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 LVDT (Linear Variable Differential Transformer) primary coil voltage and a 60Hz timing trace which are recorded using 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 coil fuse is removed. A voltage is then induced in the LVDT 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 LVDT coil. The LVDT 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 4 BOL PHYSICS TEST

HOT ROD DROP TIME SUMMARY

ROD DROP TIME TO DASHPOT ENTRY

SLOWEST ROD	FASTEST ROD	AVERAGE TIME
B-06, 1.82 sec.	H-02, 1.55 sec.	1.67 sec.

ROD DROP TIME TO BOTTOM OF DASHPOT

SLOWEST ROD	FASTEST ROD	AVERAGE TIME
B-06, 2.48 sec.	H-02, 2.09 sec.	2.25 sec.

Figure 2.1

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TEST

TYPICAL ROD DROP TRACE

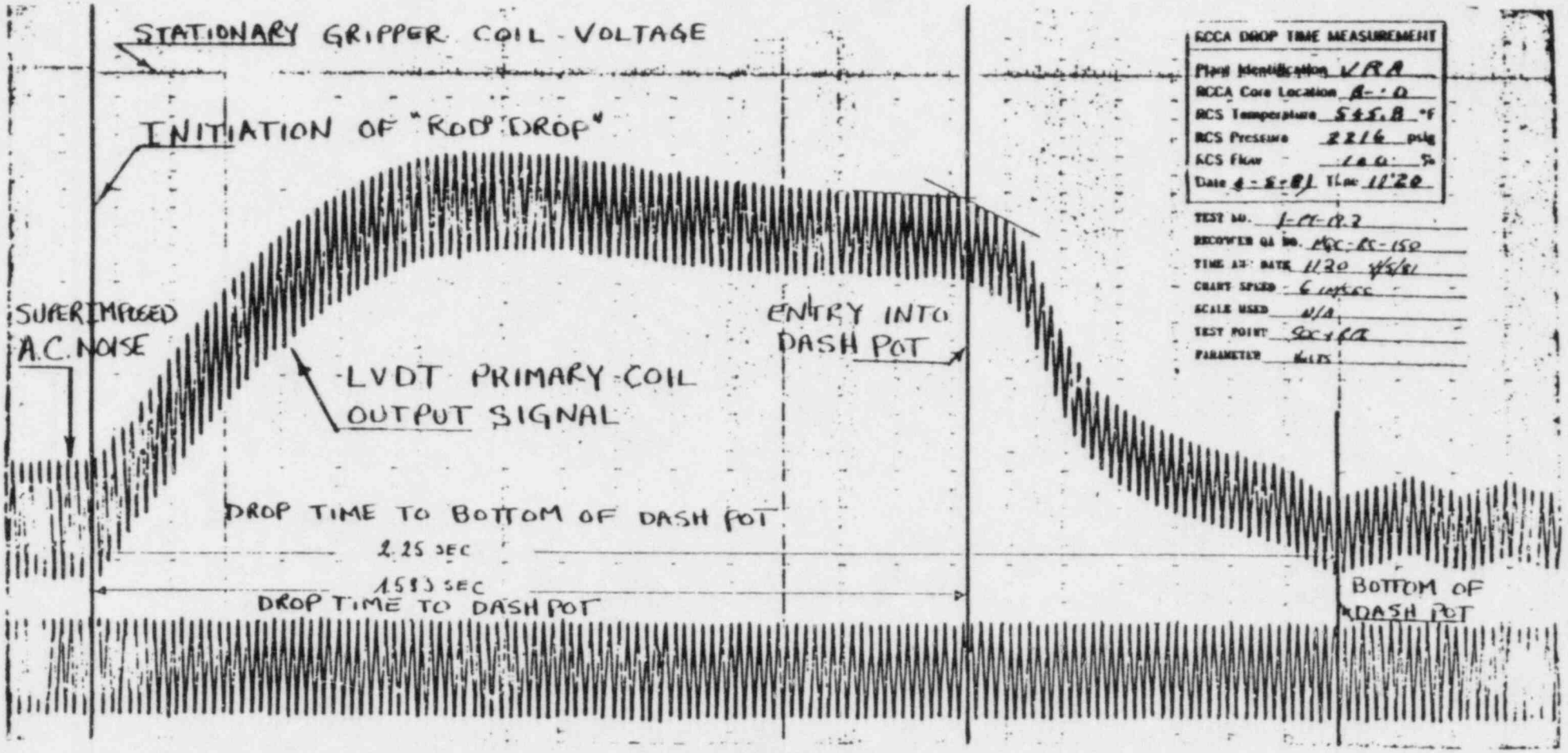
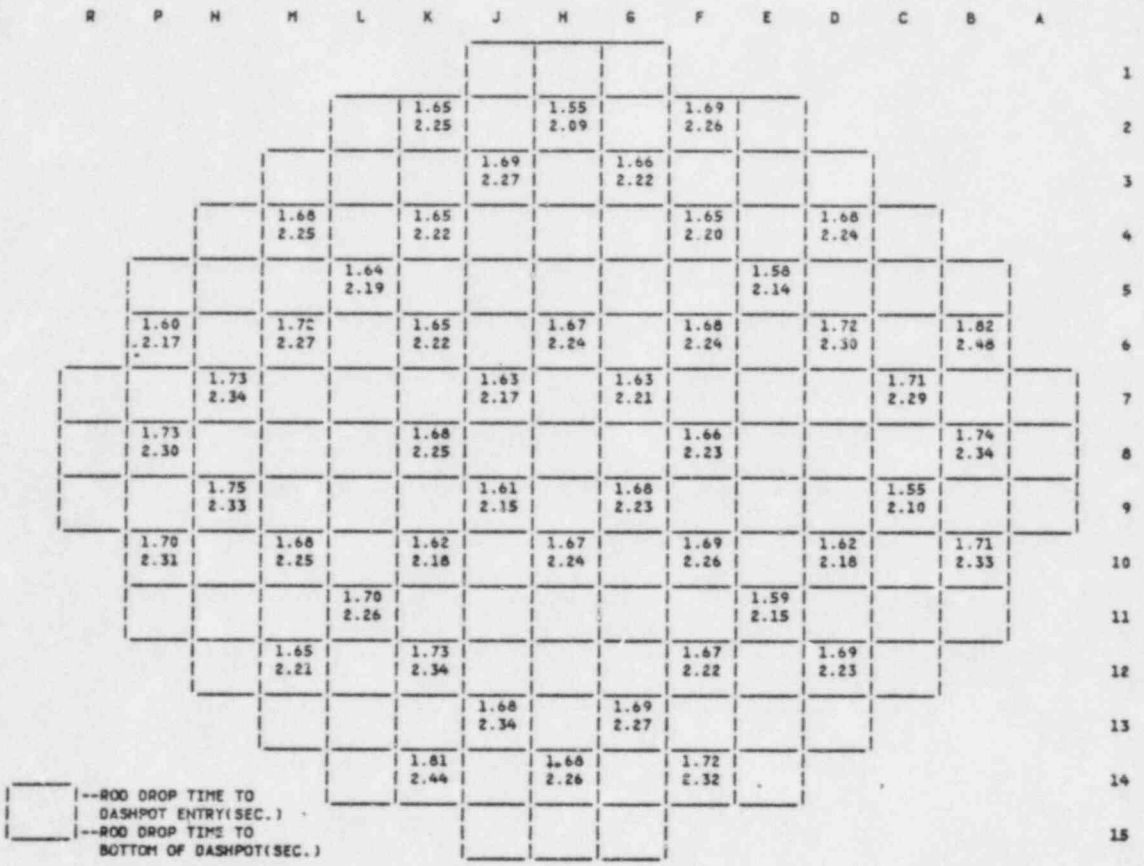


Figure 2.2

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TEST

ROD DROP TIME - HOT FULL FLOW CONDITIONS



Section 3

CONTROL ROD BANK WORTH MEASUREMENTS

Control rod bank worth measurements were obtained for all control and shutdown banks using the rod swap technique. The first step in the rod swap procedure was to dilute the most reactive control rod bank (hereafter referred to as the reference bank) into the core and measure its reactivity worth using conventional test techniques. The reactivity changes resulting from the reference bank movements were recorded continuously by the reactivity computer[4] and were used to determine the differential and integral worth of the reference bank (Control Bank B).

At the completion of the reference bank reactivity worth measurement, the reactor coolant system temperature and boron concentration were stabilized such that the reactor was critical with the reference bank near full insertion. Initial statepoint data for the rod swap maneuver were obtained by moving the reference bank to its fully inserted position and recording the core reactivity and moderator temperature. At this point, a rod swap maneuver was performed by withdrawing the reference bank while one of the other control rod banks (i.e., a test bank) was inserted. The core was kept nominally critical throughout this rod swap and the maneuver was continued until the test bank was fully inserted and the reference bank was at the position at which the core was just critical. This measured critical position (MCP) of the reference bank with the test bank fully inserted is the major parameter of interest and was used to determine the integral reactivity worth of the test bank. Statepoint data (core reactivity, moderator

temperature, and the differential worth of the reference bank) were recorded with the reference bank at the MCP. The rod swap maneuver was then performed in reverse order such that the reference bank once again was near full insertion and the test bank was once again fully withdrawn from the core. The rod swap process was then repeated for all of the other control rod banks (control and shutdown).

The procedure given above was modified during the measurement of the control bank D worth. Although control bank B was predicted to have the largest worth of all the banks, the measured worth of control bank D exceeded the worth of control bank B. The measured critical position for control bank D was B bank fully withdrawn and D bank partially inserted to 58 steps. Therefore, the worth of the last 58 steps of D bank was measured using the boron dilution method. The measured worth of control bank D is the sum of the worths determined by rod swap and the dilution of the last 58 steps.

A summary of the results for these tests is given in Table 3.1. As shown by this table and the Startup Physics Tests Results and Evaluation Sheets given in the Appendix, the individual measured bank worths for all of the control and shutdown banks were within the design tolerance (±10% for the reference bank and ±15% for the test banks). The sum of the individual rod bank worths was measured to be within 6.6% of the design prediction. This is well within the design tolerance of ±10% for the sum of the individual control rod bank worths.

The integral and differential reactivity worths of the reference bank (Control Bank B) are shown in Figures 3.1 and 3.2, respectively.

The design predictions and the measured data are plotted together in order to illustrate their agreement. In summary, all measured rod worth values are satisfactory.

Table 3.1

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TEST

CONTROL ROD BANK WORTH SUMMARY

BANK	MEASURED WORTH (PCM)	PREDICTED WORTH (PCM)	PERCENT DIFFERENCE (M-P)/P X 100
B-Reference Bank	1188	1187	0.1%
D	1294	1181	9.6%
C	843	764	10.3%
A	562	524	7.3% (38 pcm)
SB	1023	965	6.0%
SA	1094	1011	8.2%
Total Worth	6004	5632	6.6%

FIGURE 3.1

NORTH ANNA 1 - CYCLE 4 BOL PHYSICS TEST
BANK B INTEGRAL ROD WORTH - HZP
B BANK WITH ALL OTHER RODS OUT

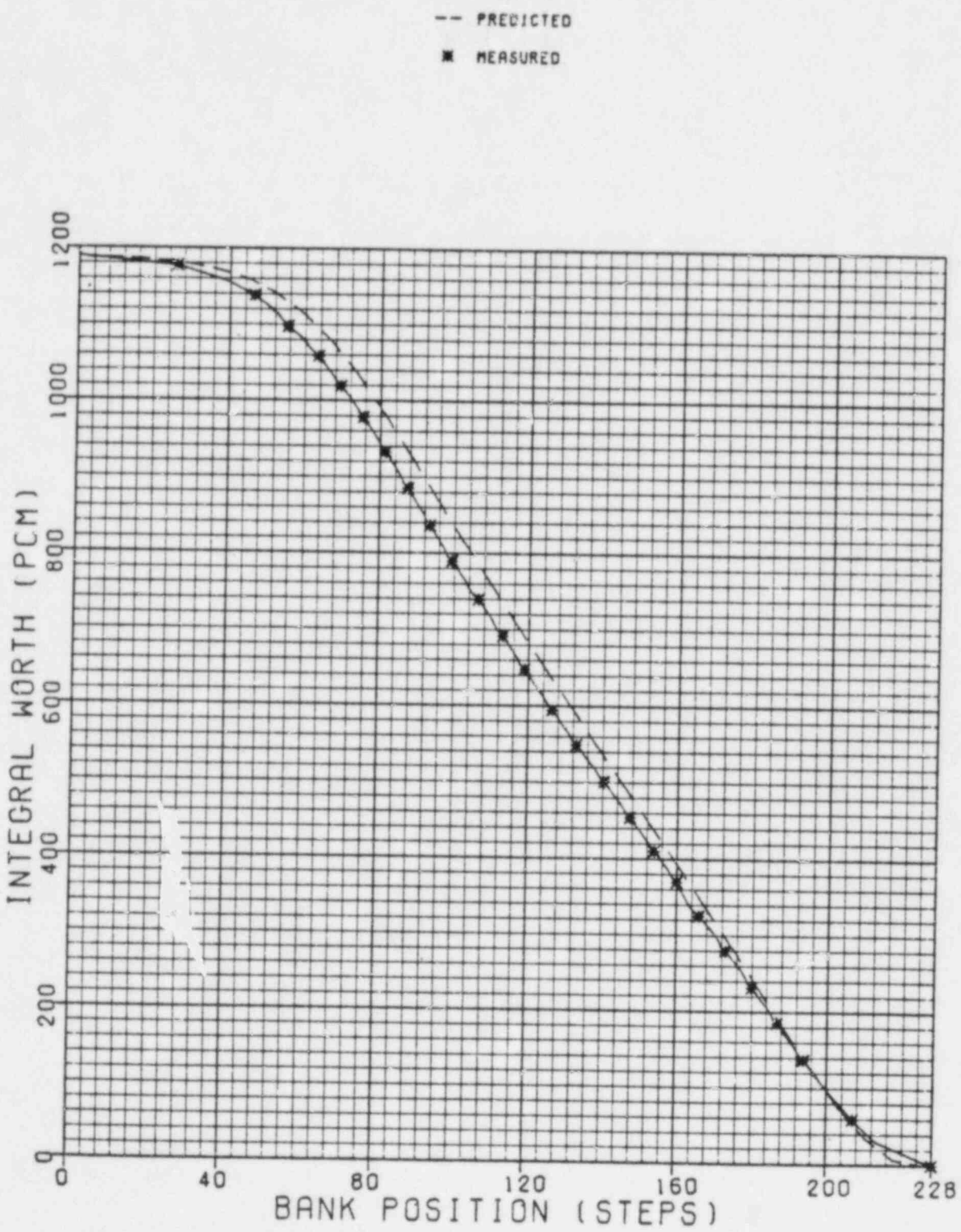
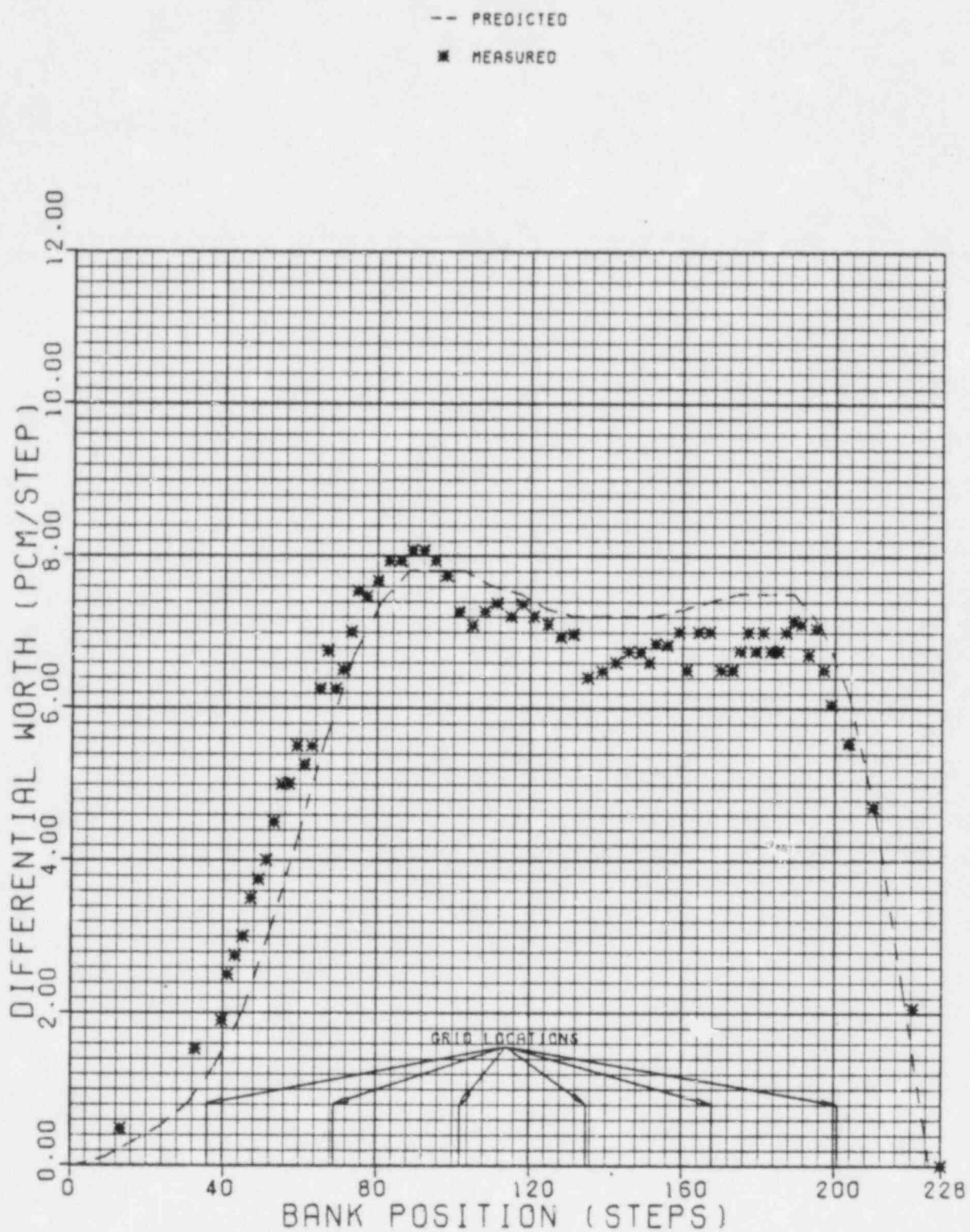


FIGURE 3.2

NORTH ANNA 1 - CYCLE 4 BOL PHYSICS TEST
BANK B DIFFERENTIAL ROD WORTH - HZP
B BANK WITH ALL OTHER RODS OUT



Section 4

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 banks 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 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 4.1. 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 are 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 endpoint concentration to the integrated

rod worth present in the core at the time of the endpoint measurement. The value of the boron coefficient, over the range of boron endpoint concentrations, is obtained directly from this plot.

The boron worth plot is shown in Figure 4.1. As indicated in this figure and in the Appendix, the boron worth coefficient of reactivity was measured to be -8.25 pcm/ppm. The measured boron worth coefficient is within 2.2% of the predicted value of -8.07 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 is satisfactory.

Table 4.1

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TEST

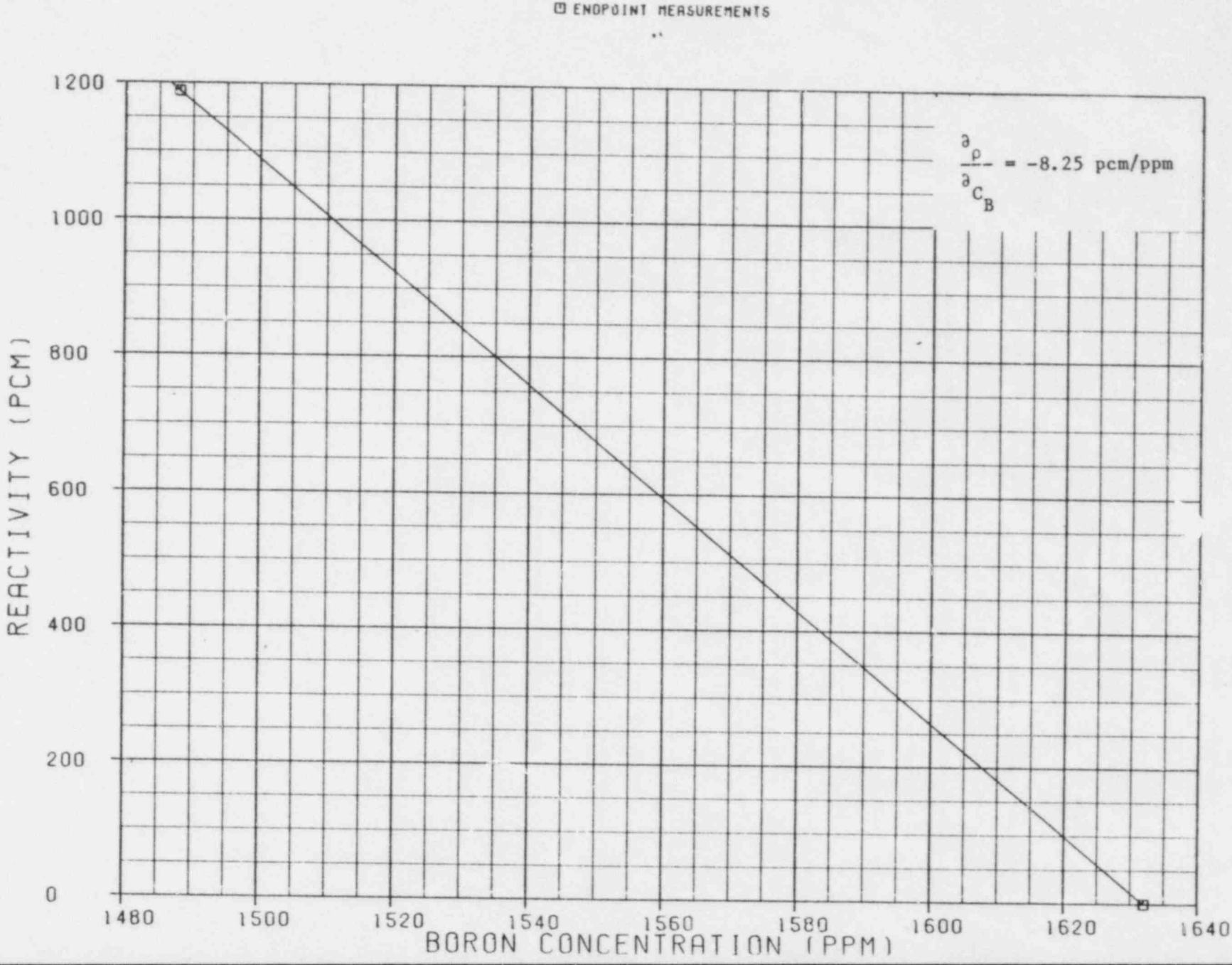
BORON ENDPOINTS SUMMARY

Control Rod Configuration	Measured Endpoint (ppm)	Predicted Endpoint (ppm)	Difference M-P (ppm)
ARO	1631	1628	3
B Bank In	1488	1482	6

*The predicted endpoint for the B Bank in configuration has been adjusted for the difference between the measured and predicted values of the endpoint taken at the ARO configuration as shown in the boron endpoint Startup Physics Test Results and Evaluation Sheets in the Appendix.

FIGURE 4.1

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TEST
BORON WORTH COEFFICIENT



Section 5

TEMPERATURE COEFFICIENT MEASUREMENT

The isothermal temperature coefficient measurement was 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. The measurement was performed at a very low power level 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 °F) during the measurement. To eliminate the boron reactivity effect of outflow from the pressurizer, the pressurizer level was maintained constant or slightly increasing during the measurement.

Reactivity measurements were taken at the all-rods-out configuration for both RCS heatup and cooldown ramps during which the RCS temperature varied approximately 6°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 changes versus RCS temperature for the measurement is shown in Figure 5.1.

The predicted and measured isothermal temperature coefficient values are compared in Table 5.1. As can be seen from this summary and from the Startup Physics Test Results and Evaluation Sheets given in the Appendix, the measured ARO isothermal temperature coefficient value was

within the design tolerance of ±3 pcm/°F and met the accident analysis acceptance criterion. In summary, the measured result is satisfactory.

Table 5.1

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TESTS

ISOTHERMAL TEMPERATURE COEFFICIENT SUMMARY

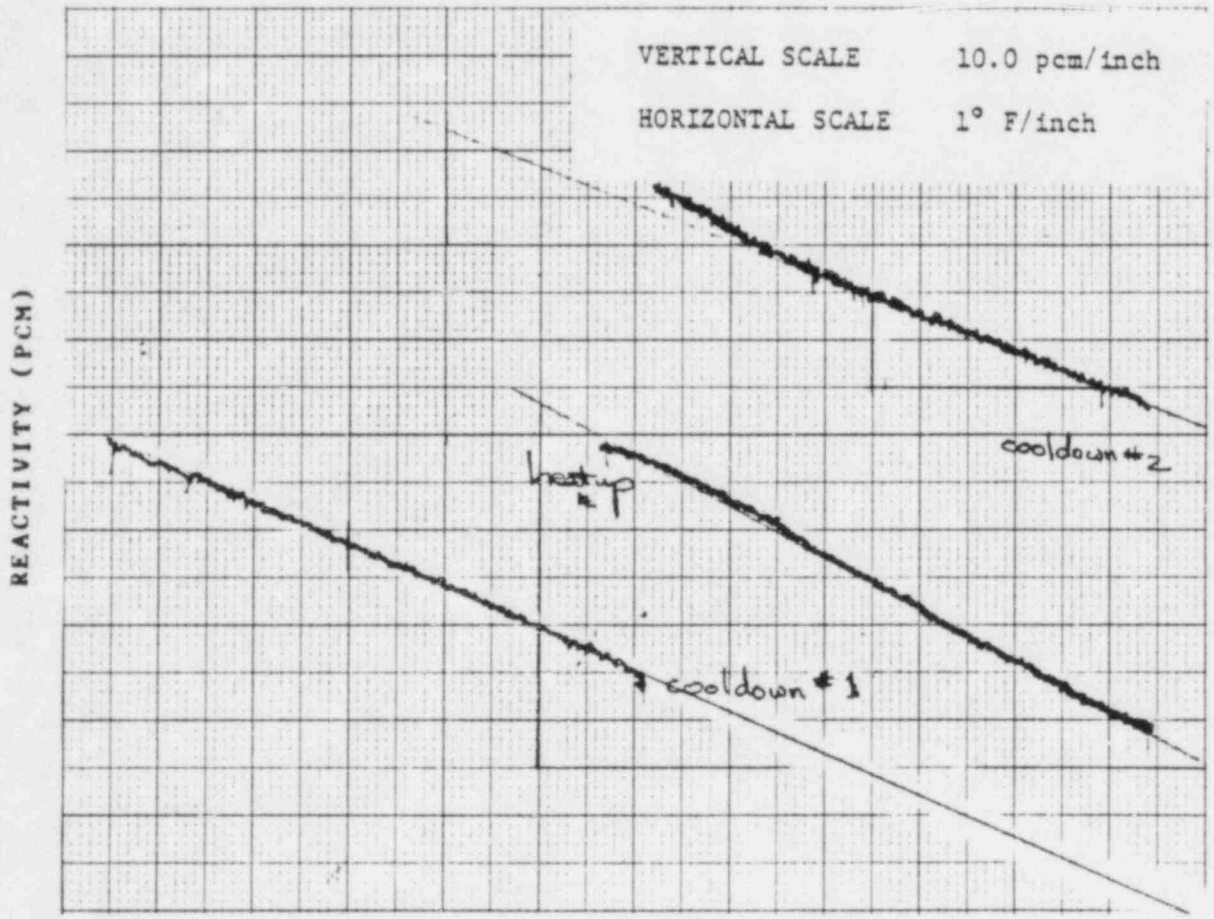
BANK POSITION	TEMPERATURE RANGE (°F)	BORON CONCENTRATION (PPM)	ISOTHERMAL TEMPERATURE COEFFICIENT (PCM/°F)				
			HEATUP	COOL DOWN	AVER.	PRED.	DIFFER. (M-P)
ALL RODS OUT	543.75 to 549.2	1634	-5.40	-4.43	-4.92	-3.30	-1.62

Figure 5.1

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TESTS

ISOTHERMAL TEMPERATURE COEFFICIENT

HZP, ARO



Section 6

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 1.3). 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[5]. 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 6.1. The measured power distribution parameter values are compared with their Technical Specifications limits in Table 6.2. Flux Map 1 was taken at zero power. This flux map serves as the base case design check. Figure 6.1 shows the resulting radial power distribution associated with this flux map. Flux Maps 2 through 7 were taken over a wide range of power levels and control rod configurations. Flux maps 3 and 4 were quarter-core maps used only to provide incore/excore calibration data for the nuclear instrumentation system. Flux maps 2, 5, 6, and 7 were taken to check the at-power design predictions and to measure core power distributions at various

operating conditions. These maps also provide incore/excore calibration data for the nuclear instrumentation system. The radial power distributions for maps 2, 5, 6, and 7 are given in Figures 6.2 through 6.5. These figures show that the measured relative assembly power values are generally within 6% of the predicted values.

In conclusion, all power distribution measurement results were considered to be acceptable with respect to the design tolerances, the accident analysis acceptance criteria, and the Technical Specification limits. It is therefore anticipated that the core will continue to operate safely throughout Cycle 4.

TABLE 6.1

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TESTS

INCORE FLUX MAP SUMMARY

MAP DESCRIPTION [1]	MAP NO.	DATE	BURN UP MWD/MTU	PWR (%)	BANK D STEPS	F-Q(T) HOT CHANNEL FACTOR [2]				F-DH(N) HOT CHNL.FACTOR [3]			CORE F(Z) MAX		F(XY) [4] MAX	QPTR [5]		AXIAL OFF SET (%)	NO. OF THIMBLES
						ASSY	PIN	AXIAL POINT	F-Q(T)	ASSY	PIN	F-DH(N)	AXIAL POINT	F(Z)		MAX	LOC		
ARO	1	11-19-82	0	0	228	J10	AQ	13	2.687	K09	QA	1.475	13	1.722	1.596	1.012	NE	40.29	48
POWER DIST. VER.	2	3-14-83	13	29	180	B06	CE	22	1.946	J04	IJ	1.428	22	1.310	1.660	1.006	SW	4.40	48
POWER DIST. VER.	5	3-17-83	41	52	188	K09	QA	21	1.882	J04	IJ	1.425	21	1.277	1.512	1.005	SW	3.42	49
POWER DIST. VER.	6	3-18-83	61	96	228	B06	DE	29	1.708	K09	JI	1.388	29	1.170	1.515	1.006	NE	0.64	48
HFP, EQ. XENON	7	3-24-83	305	100	221	B06	DE	29	1.765	K09	JI	1.393	29	1.176	1.513	1.009	NE	-1.16	45

NOTES: HOT SPOT LOCATIONS ARE SPECIFIED BY GIVING ASSEMBLY LOCATIONS (E.G. H-8 IS THE CENTER-OF-CORE ASSEMBLY), FOLLOWED BY THE PIN LOCATION (DENOTED BY THE "Y" COORDINATE WITH THE SEVENTEEN ROWS OF FUEL RODS LETTERED A THROUGH R 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.

1. MAPS 3 AND 4 WERE QUARTER-CORE MAPS USED FOR CALIBRATION OF THE EXCORE DETECTORS.

2. F-Q(T) INCLUDES A TOTAL UNCERTAINTY OF 1.05 X 1.03.

3. F-DH(N) INCLUDES A MEASUREMENT UNCERTAINTY OF 1.04.

4. F(XY) INCLUDES A TOTAL UNCERTAINTY OF 1.05 X 1.03.

5. QPTR - QUADRANT POWER TILT RATIO.

Table 6.2

NORTH ANNA UNIT 1 - CYCLE 4 BOL PHYSICS TESTS

COMPARISION OF MEASURED POWER DISTRIBUTION PARAMETERS

WITH THEIR TECHNICAL SPECIFICATION LIMITS

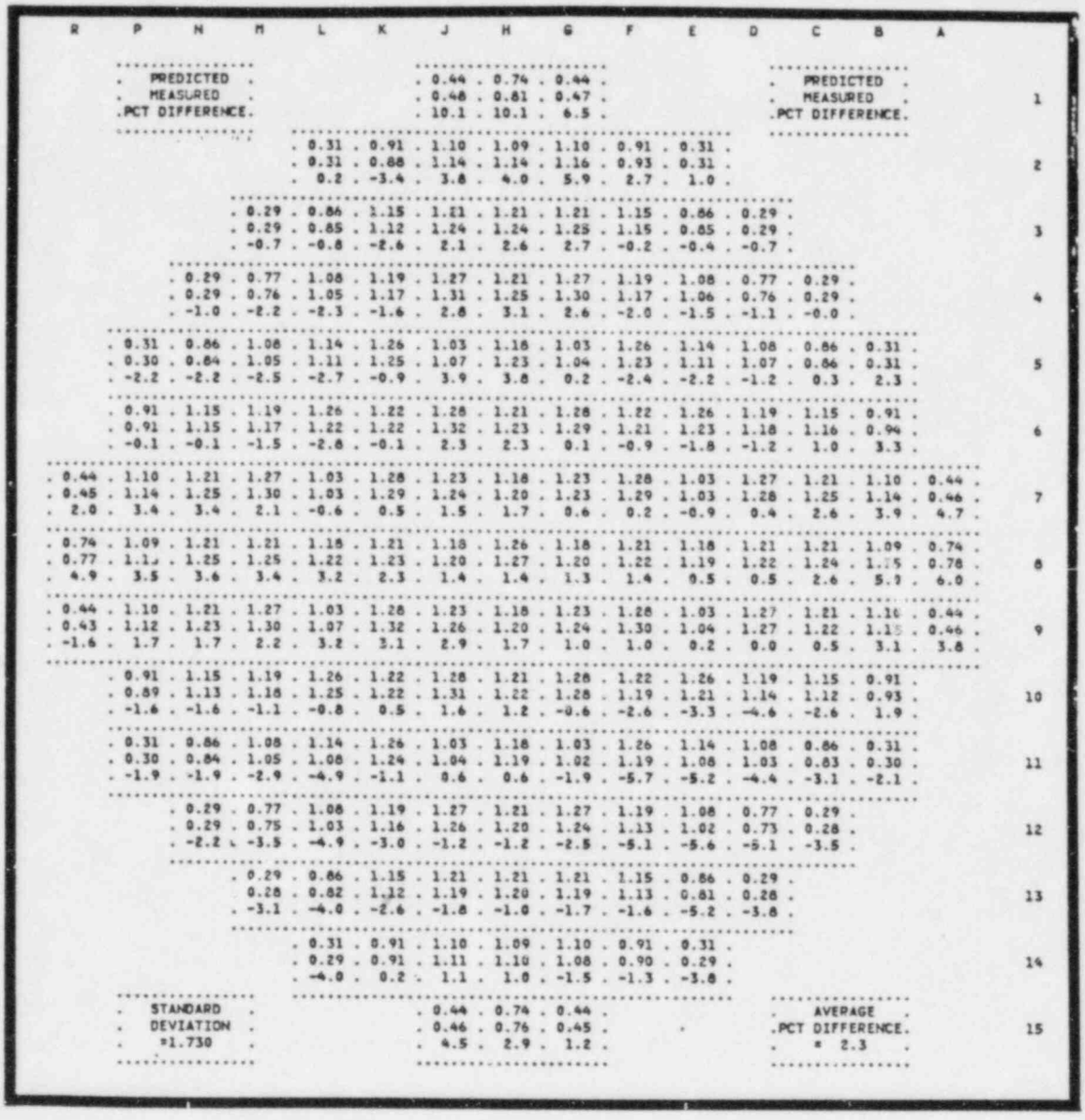
MAP NO.	F-Q(T) HOT CHANNEL FACTOR[1]			F-DH(N) HOT CHANNEL FACTOR[2]			F(XY) MAX[3]			
	MEAS	LIMIT	MARGIN (%)	MEAS	LIMIT	MARGIN (%)	MEAS	AXIAL POINT	LIMIT	MARGIN (%)
2	1.95	4.30	54.8	1.43	1.77	19.2	1.66	10	1.95	14.9
5	1.88	4.12	54.4	1.43	1.69	15.4	1.51	13	1.80	16.1
6	1.71	2.29	24.7	1.39	1.56	10.9	1.52	10	1.66	8.4
7	1.77	2.18	18.8	1.39	1.55	10.3	1.51	10	1.65	8.5

1 The technical specification limit for the heat flux hot channel factor, F-Q(T) is a function of core height. The value for F-Q(T) listed above is the maximum of F-Q(T) in the core. The technical specification limit listed above is evaluated at the plane of maximum F-Q(T). The minimum margin values listed above are the minimum percent difference between the measured values of F-Q(T) and the technical specifications limit for each map. All measured F-Q(T) hot channel factors include 5% measurement uncertainty and 3% engineering uncertainty.

2 The measured values for the enthalpy rise hot channel factor, F-DH(N) includes 4% measurement uncertainty.

3 All measured F(XY) MAX values include 5% measurement uncertainty and 3% engineering uncertainty.

FIGURE 6.1
NORTH ANNA 1, CYCLE 4
ASSEMBLYWISE POWER DISTRIBUTION
HZP, ARO



SUMMARY

MAP NO: N1-4- 1 DATE: 11/19/82 POWER: 0%

CONTROL ROD POSITIONS: F-Q(T) = 2.687 QPTR:

D BANK AT 228 STEPS F-DH(N) = 1.475

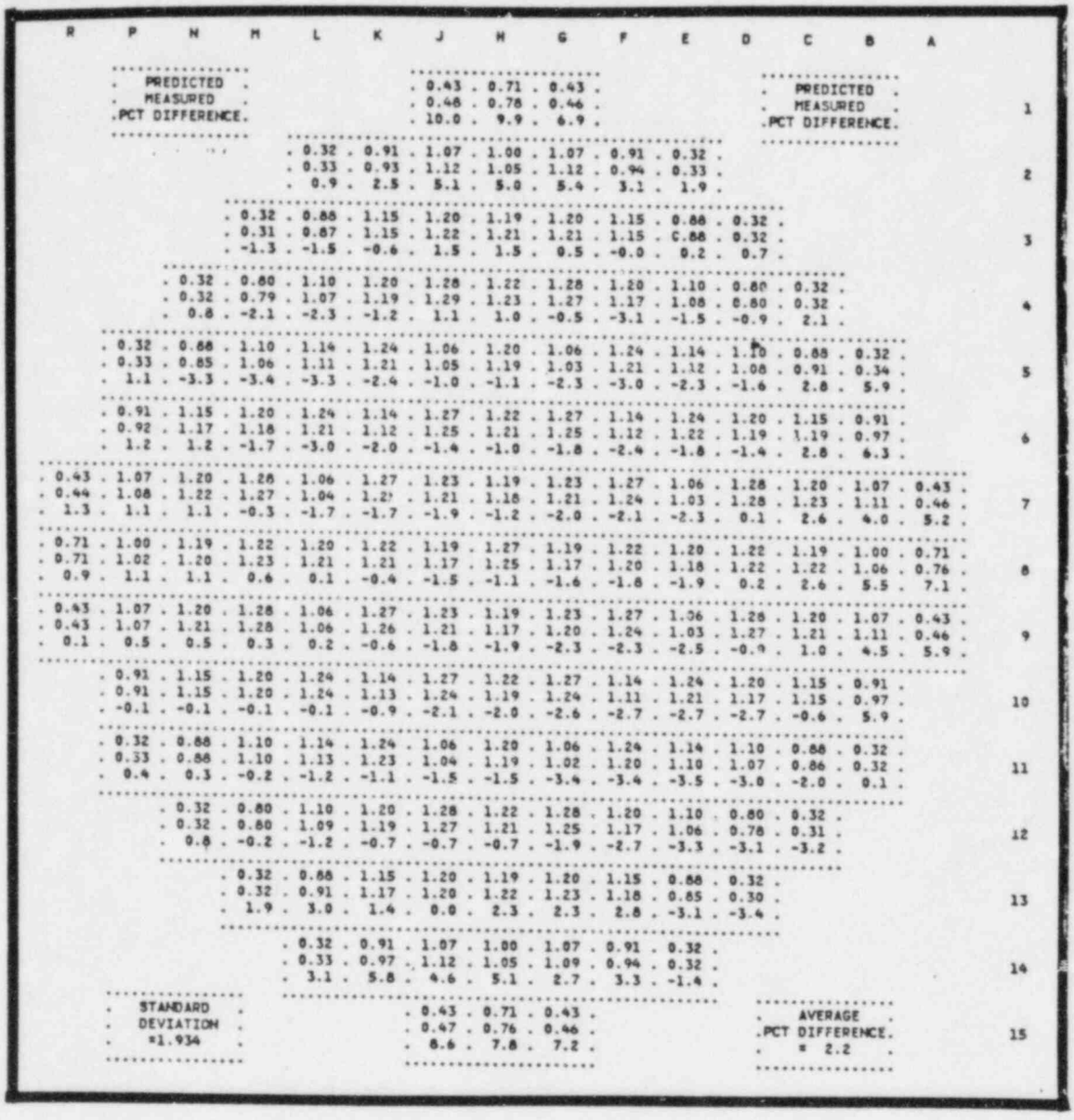
NW 1.005	NE 1.012
SW 0.993	SE 0.990

F(Z) = 1.722

F(XY) = 1.596

BURNUP = 0 MWD/MTU A.O = 40.29(%)

FIGURE 6.2
NORTH ANNA 1, CYCLE 4
ASSEMBLYWISE POWER DISTRIBUTION
29% POWER



SUMMARY

MAP NO: N1-4- 2 DATE: 3/14/83 POWER: 29%

CONTROL ROD POSITIONS: F-Q(T) = 1.946 QPTR:

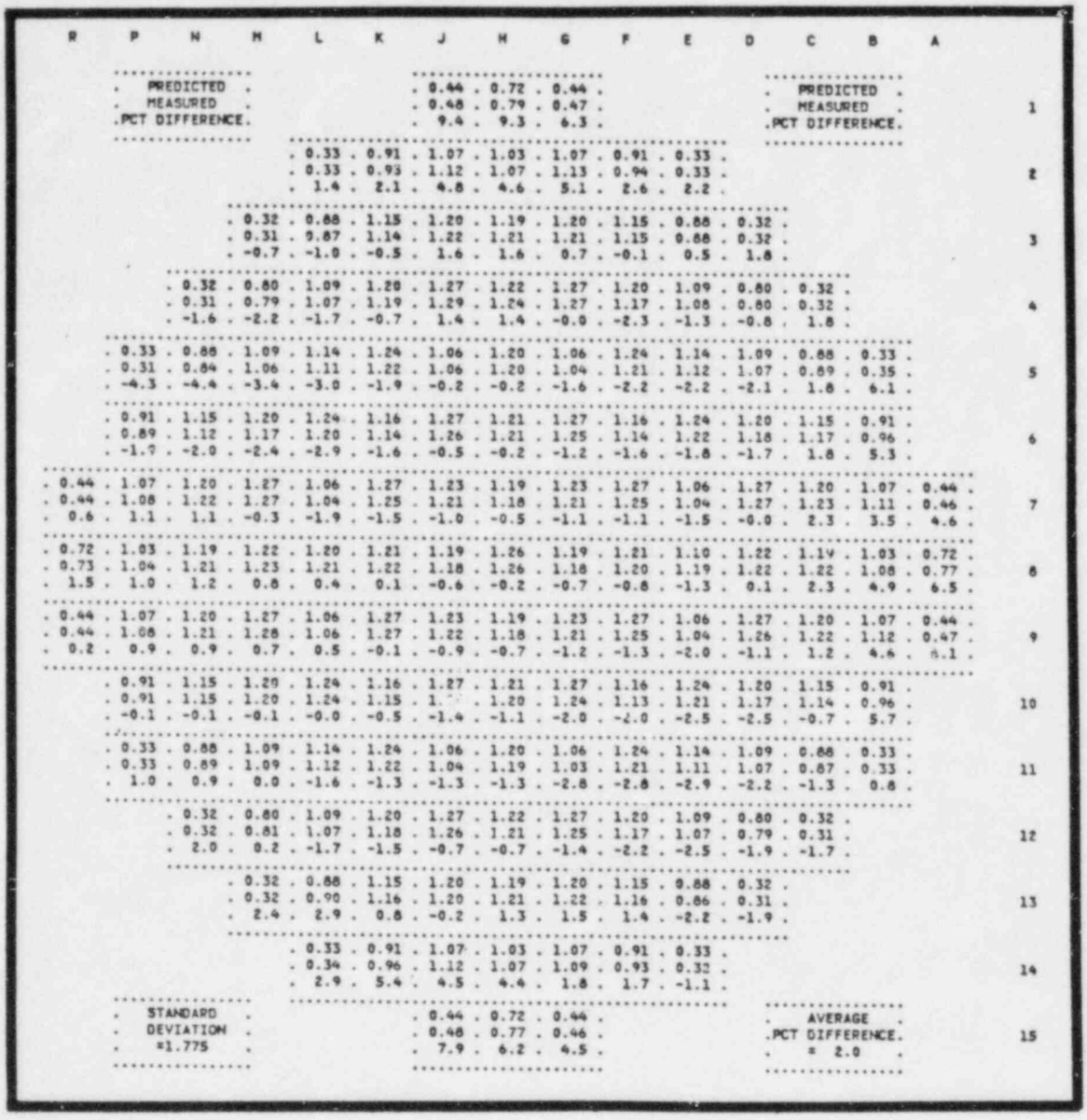
D BANK AT 180 STEPS F-DH(N) = 1.428 NW 1.000 | NE 1.002

F(Z) = 1.310 SW 1.006 | SE 0.992

F(XY) = 1.660

BURNUP = 13 MWD/MTU A.O = 4.40(%)

FIGURE 6.3
NORTH ANNA 1, CYCLE 4
ASSEMBLYWISE POWER DISTRIBUTION
52% POWER



SUMMARY

MAP NO: N1-4- 5 DATE: 3/17/83 POWER: 52%

CONTROL ROD POSITIONS: F-Q(T) = 1.882 QPTR:

D BANK AT 188 STEPS F-DH(N) = 1.425

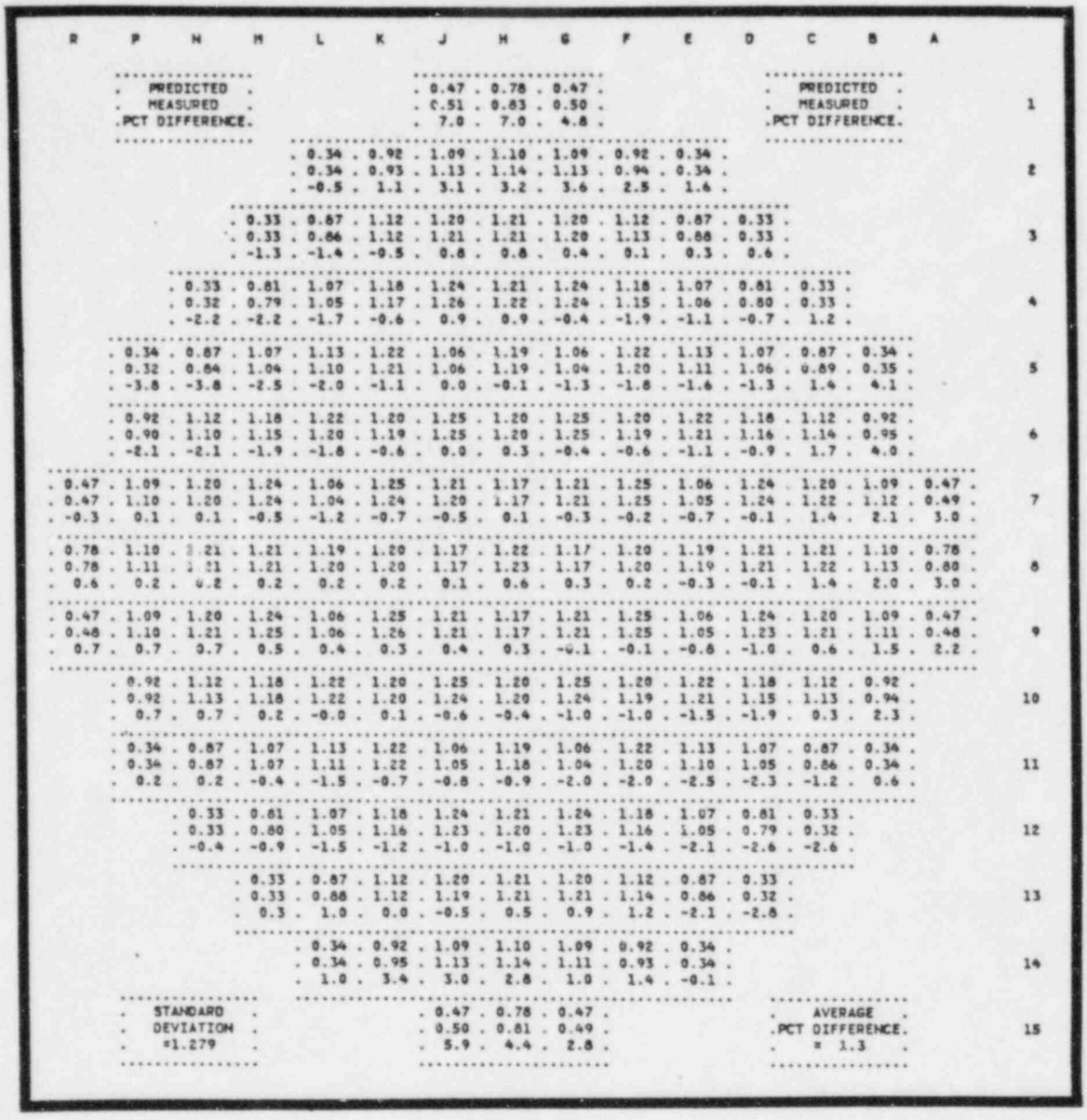
NW 1.001	NE 1.004
SW 1.005	SE 0.990

F(Z) = 1.277

F(XY) = 1.512

BURNUP = 41 MWD/MTU A.O = 3.42(%)

FIGURE 6.4
NORTH ANNA 1, CYCLE 4
ASSEMBLYWISE POWER DISTRIBUTION
96% POWER



SUMMARY

MAP NO: N1-4- 6 DATE: 3/18/83 POWER: 96%

CONTROL ROD POSITIONS: F-Q(T) = 1.708 QPTR:

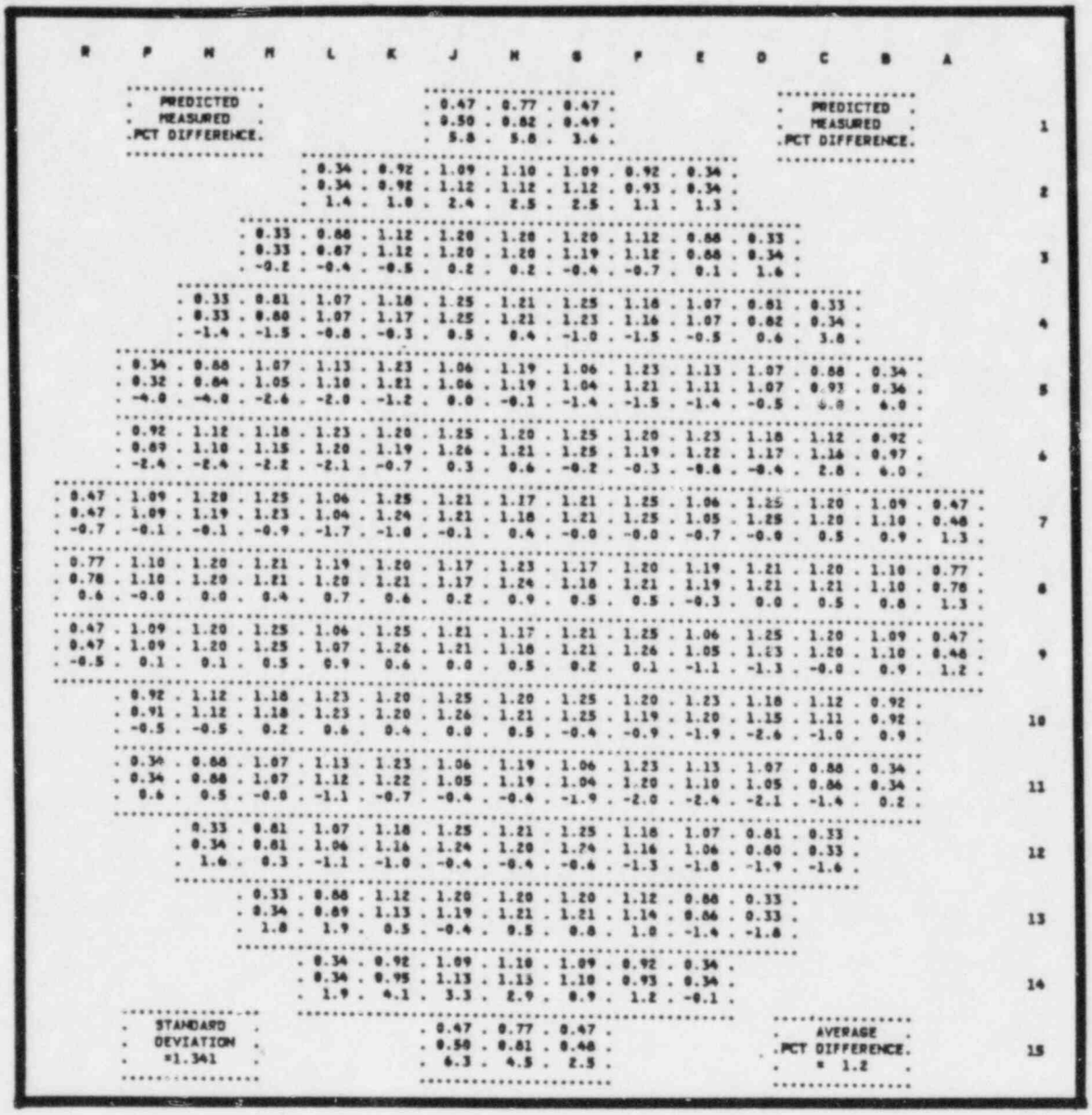
D BANK AT 228 STEPS F-DH(N) = 1.388 NW 0.996 | NE 1.006

F(Z) = 1.170 SW 1.006 | SE 0.992

F(XY) = 1.515

BURNUP = 61 MWD/MTU A.O = 0.64(%)

FIGURE 6.5
NORTH ANNA 1, CYCLE 4
ASSEMBLYWISE POWER DISTRIBUTION
HFP, EQUILIBRIUM XENON



SUMMARY

MAP NO: N1-4- 7 DATE: 3/24/83 POWER: 100%

CONTROL ROD POSITIONS: F-Q(T) = 1.765 QPTR:

D BANK AT 221 STEPS F-DH(N) = 1.393 NW 0.995 | NE 1.009

F(Z) = 1.176 SW 1.004 | SE 0.992

F(XY) = 1.513

BURNUP = 305 MWD/MTU A.O = -1.2 (%)

Section 8

REFERENCES

1. A. P. Main, T. W. Schleicher, "North Anna Unit 1, Cycle 4, Design Report," NFE Technical Report No. 231, Vepco, June, 1982.

2. North Anna Unit 1 Technical Specifications, Sections 3.1.3.4, 3/4.2.

3. T. K. Ross, W. C. Beck, "Control Rod Reactivity Worth Determination By The Rod Swap Technique," VEP-FRD-36A, December, 1980.

4. "Technical Manual for Westinghouse Solid State Reactivity Computer," Westinghouse Electric Corporation.

5. W. Leggett and L. Eisenhart, "The INCORE Code," WCAP-7149, December, 1967.

APPENDIX

STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEETS

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Reactivity Computer Checkout Proc No /Section: 1-PT-~~94/APP.B~~ 94.2	Sequence Step No: 3
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: *	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other-(specify): Below Nuclear Heating *At the just crit. positio
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 205 Data/Time Test Performed: 11-19-82 0824	RCS Temperature (°F): 545.6 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Measured Parameter (Description)	ρ_c = Meas. Reactivty using ρ-comput ρ_e = Inferred React from react pert
	Measured Value	ρ_c = -27.3 17.8 32.0 ρ_e = -28.4 18.3 32.5 %D = -3.9 -2.7 -1.5
	Design Value (Actual Conditions)	$\%D = \lvert(\rho_c - \rho_e)/\rho_e\rvert \times 100\% \leq 4.0\%$
	Design Value (Design Conditions)	$\%D = \lvert(\rho_c - \rho_e)/\rho_e\rvert \times 100\% \leq 4.0\%$
	Reference	WCAP 7905, Rev. 1, Table 3.6
V Acceptance Criteria	FSAR/Tech Spec	Not Applicable
	Reference	Not Applicable
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO Allowable Range = -27.3 to 32.0	

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - ARO Proc No /Section: 1-PT-~~94/APP.B~~ 94.3	Sequence Step No: 4
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 228	RCS Temperature (°F): 547 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	RCS Temperature (°F): 543.1 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Data/Time Test Performed: 11/19/82 1129	
IV Test Results	Meas Parameter (Description)	$(C_B)^M_{ARO}$; Critical Boron Conc - ARO
	Measured Value	$(C_B)^M_{ARO}$ = 1631 ppm
	Design Value (Actual Cond)	C_B = 1628 ± 50 ppm
	Design Value (Design Cond)	C_B = 1628 ± 50 ppm
	Reference	VEP-FRD-NFE-231, June, 1982
V Acceptance Criteria	FSAR/Tech Spec	$\alpha_{C_B} \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	
VI Comments	α_{C_B} = -8.07 pcm/ppm for preliminary analysis α_{C_B} = -8.25 pcm/ppm for final analysis	

Completed By: Test Engineer

Evaluated By: C. A. Ford

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Isothermal Temperature Coefficient - ARO Proc No /Section: 1-PT-~~94/App.B~~ 94.4	Sequence Step No: 5
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 220 CA: 228 CB: 220 CC: 228 CD: 228	RCS Temperature (°F): 547 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: 224	RCS Temperature (°F): 546.3 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11-19-82 1327	
IV Test Results	Meas Parameter (Description)	$(\alpha_T^{ITC})_{ARO}$ Iso Temp Coeff - ARO
	Measured Value	$(\alpha_T^{ITC})_{ARO} = -4.92$ pcm/°F ($C_B = 1634$ ppm
	Design Value (Actual Cond)	$(\alpha_T^{ITC})_{ARO} = -3.30 \pm 3.0$ pcm/°F ($C_B = 1634$ ppm
	Design Value (Design Cond)	$(\alpha_T^{ITC})_{ARO} = -3.33 \pm 3.0$ pcm/°F ($C_B = 1628$ ppm)
	Reference	VEP-FRD-NFE-231, June, 1982
V Acceptance Criteria	FSAR/Tech Spec	$\alpha_T^{ITC} \leq -2.11$ pcm/°F $\alpha_T^{DOP} = -2.11$ pcm/°F
	Reference	TS 3.1.1.4, VEP-FRD-NFE 231
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: [signature]
Test Engineer

Evaluated By: Paul J. Rocky Jr

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference

Test Description : M/D Flux Map - HZP, ARO
Proc No / Section: 1-PT-21.1 Sequence Step No: 6

II Test Conditions (Design)

Bank Positions (Steps)
SDA: 228 SDB: 228 CA: 228
CB : 228 CC : 228 CD: 228

RCS Temperature (°F): T_{REF} ±1
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

RCS Temperature(°F): 547.2
Power Level (% F.P.): 4%
Other (Specify):
48 monitored thimbles

Date/Time Test Performed: 11/19/82 0537

IV Test Results

Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(X)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
Measured Value	5.9% for P_{62}=1.16 10.1% for P_{H1}=0.81	1.475	2.688	1.012
Design Value (Design Conds)	5%DT for $P_T \geq .9$ 9%DT for $P_T < .9$ (P_T = Meas. Pwr)	$F^N_{\Delta H} \leq 1.55[1-0.3(1-P)]$	$F^N_Q(Z) \leq 2.32 \times K(Z)$	≤ 1.02
Reference	WCAP-7908 REV. 1	NONE	NONE	WCAP-7908 REV. 1

V Acceptance Criteria

	FSAR/Tech Spec	NONE	NA	NA	NA
	Reference	NONE	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Design Tolerance is met : X YES ___NO
Acceptance Criteria is met : X YES ___NO

Completed by: [signature]
Test Engineer

Evaluated by: [signature]

Recommended for Approval By: [signature]
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank B Worth Meas., Rod Swap Ref. Bank Proc No /Section: 1-PT-~~94/APP.E~~ 94.5	Sequence Step No: 7
II Test Conditions (Design)	Bank Positions (Steps) SDA: 220 SDB: 228 CA: 228 CB: Moving CC: 228 CD: 228	RCS Temperature (°F): 547 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: 228 CD: 228	RCS Temperature (°F): 545.6 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/19/82 1516	
IV Test Results	Measured Parameter (Description)	I_B^{REF} ; Integral Worth of Cntl Bank B, All Other Rods Out
	Measured Value	I_B^{REF} = 1188 pcm
	Design Value (Actual Conditions)	I_B^{REF} = 1187 ± 119 pcm
	Design Value (Design Conditions)	$\bar{I}_B^{REF}$ = 1187 ± 119 pcm
	Reference	VEP-FRD-NFE-231, June, 1982
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNS shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: _____
Test Engineer

Evaluated By: Susan F. Barnwell

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - 3 Bank In Proc No /Section: 1-PT-~~24/APP.G~~ 94.3	Sequence Step No: 8
II Test Conditions (Design)	Bank Positions (Steps) SDA: 223 SDB: 223 CA: 223 CB: 0 CC: 228 CD: 228	RCS Temperature (°F): 547 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: 228 CD: 228	RCS Temperature (°F): 546.1 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/19/82 2035	
IV Test Results	Meas Parameter (Description)	$(C_B)^M_3$; Critical Boron Conc - 3 Bank In
	Measured Value	$(C_B)^M_3 = 1488$ ppm
	Design Value (Actual Cond)	$C_3 = 1482 \pm 25$ ppm
	Design Value (Design Cond)	$C_B = 1473 + \Delta C_B^{PREV} \pm (10 + 110.7/\lvert \alpha_{C_B} \rvert)$ ppm
	Reference	WEP-FRD-NFE-231, June, 1982
V Acceptance Criteria	FSAR/Tech Spec	$\alpha_{C_B} \times C_B \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	
VI Comments	$\alpha_{C_B} = -8.07$ pcm/ppm for preliminary analysis $\Delta C_B^{PREV} = (C_B)^M_{ARO} - 1623$ $\alpha_{C_B} = -8.25$ pcm/ppm for final analysis	

Completed By: _____ Test Engineer

Evaluated By: C. A. Ford

Recommended for Approval By: C. J. Snow NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: HZP Boron Worth Coefficient Measurement Proc No /Section: 1-PT-~~94.4 App. B~~ 94.5	Sequence Step No: 8
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB: Moving CC: 228 CD: 228	RCS Temperature (°F): 547 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: 228 CD: 228	RCS Temperature (°F): 544.6 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/19/82 2035	
IV Test Results	Measured Parameter (Description)	α_{c_g}, Differential Boron Worth
	Measured Value	$\alpha_{c_g} = -8.25$ pcm/ppm
	Design Value (Actual Conditions)	$\alpha_{c_g} = -8.07 \pm 0.81$ pcm/ppm
	Design Value (Design Conditions)	$\alpha_{c_g} = -8.07 \pm 0.81$ pcm / ppm
	Reference	VEP-FRD-NFE-231, June, 1982
V Acceptance Criteria	FSAR/Tech Spec	$\alpha_{C_g} \times C_g \leq 24{,}000$ pcm
	Reference	FSAR Section 15.2.4
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: _____ Test Engineer

Evaluated By: C. A. Ford

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank D Worth Measurement-Rod Swap Proc No./Section: 1-PT-~~94.6~~ 94.7	Sequence Step No: 10
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB: Moving CC: 228 CD: Moving	RCS Temperature (°F): 547 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: 228 CD: Moving	RCS Temperature (°F): 546.6 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/28/82 0312	
IV Test Results	Meas Parameter (Description)	I_D^{RS} ; Int Worth of Cntl Bank D-Rod Swap
	Measured Value	I_D^{RS} = 1294 pcm (Adj. Meas. Crit. Ref Bank Position = NA steps)
	Design Value (Actual Cond)	I_D^{RS} = 1181 ± 177 pcm (Adj. Meas. Crit. Ref Bank Position = NA steps)
	Design Value (Design Cond)	I_D^{RS} = 1181 ± 177 pcm (Critical Ref Bank Position = 219 steps)
	Reference	VEP-FRD-MFE-231, VEP-FRD-36A, MFO-TI-2.2A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SMSOC shall evaluate impact of test result on safety analysis. SMSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: [signature] Test Engineer

Evaluated By: P.C. Hartzfell

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank C Worth Measurement-Rod Swap Proc No /Section: 1-PT-~~94/APP.G~~ 94.7	Sequence Step No: 11
II Test Conditions (Design)	Bank Positions (Steps) SDA: 220 SDB: 228 CA: 220 CB: Moving CC: Moving CD: 228	RCS Temperature (°F): 547 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: Moving CD: 228	RCS Temperature (°F): 545.1 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/19/82 2332	
IV Test Results	Meas Parameter (Description)	I_c^{RS} ;Int Worth of Cntl Bank C-Rod Swap
	Measured Value	I_c^{RS} = 843 pcm (Adj. Meas. Crit. Rod Bank Position = 163 steps)
	Design Value (Actual Cond)	I_c^{RS} = 764 ± 115 pcm (Adj. Meas. Crit. Rod Bank Position = 163 steps)
	Design Value (Design Cond)	I_c^{RS} = 765 ± 115 pcm (Critical Rod Bank Position = 180 steps)
	Reference	VEP-FRD-NFE-231, VEP-FRD-36A, NFO-EE-2.2A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : X YES ___ NO Acceptance Criteria is met : X YES ___ NO	

Completed By: _____ Test Engineer

Evaluated By: R.C. Hartsfield

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank A Worth Measurement-Rod Swap Proc No /Section: 1-PT-~~94/APP.G~~ 94.7	Sequence Step No: 12
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: Moving CB: Moving CC: 228 CD: 228	RCS Temperature (°F): 547 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: 228 CD: 228	RCS Temperature (°F): 545.0 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/20/82 0024	
IV Test Results	Meas Parameter (Description)	I_A^{RS} ; Int Worth of Cntl Bank A
	Measured Value	I_A^{RS} = 562 pcm (Adj. Meas. Crit. Ref Bank Position = 122 steps)
	Design Value (Actual Cond)	I_A^{RS} = 524 ± 100 pcm (Adj. Meas. Crit. Ref Bank Position = 122 steps)
	Design Value (Design Cond)	I_A^{RS} = 527 ± 100 pcm (Critical Ref Bank Position = 123 steps)
	Reference	VEP-FRD-NFE-231, VEP-FRD-36A, NFO-TE-2.CA
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: [signature] Test Engineer

Evaluated By: T.C. Hartsfield

Recommended for Approval By: C.J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank B Worth Meas. - Rod Swap Proc No /Section: 1-PT-~~94/APP.G~~ 94.7	Sequence Step No: 13
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: Moving CA: 220 CB: Moving CC: 228 CD: 228	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 228 SDB: moving CA: 228 CB: moving CC: 228 CD: 228	RCS Temperature (°F): 545.7 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/20/82 0106	
IV Test Results	Meas Parameter (Description)	I_{SB}^{RS} ; Int Worth of Shutdown Bank B-Rod Swap
	Measured Value	I_{SB}^{RS} = 1023 pcm (Adj. Meas. Crit. Ref Bank Position = 190 steps)
	Design Value (Actual Cond)	I_{SB}^{RS} = 965 ± 145 pcm (Adj. Meas. Crit. Ref Bank Position = 190 steps)
	Design Value (Design Cond)	I_{SB}^{RS} = 938 ± 144 pcm (Critical Ref Bank Position = 182 steps)
	Reference	VEP-FRD-NFE-231, VEP-FRD-36A, NFO-II-2.2A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: [signature] Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature] NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank A Worth Meas. - Rod Swap Proc No /Section: 1-PT-~~94.0/27.0~~ 94.7	Sequence Step No: 14
II Test Conditions (Design)	Bank Positions (Steps) SDA: Moving SDB: 220 CA: 220 CB: Moving CC: 220 CD: 220	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: Moving SDB: 228 CA: 228 CB: Moving CC: 228 CD: 228	RCS Temperature (°F): 546.1 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/20/82 0149	
IV Test Results	Meas Parameter (Description)	I^{RS}_{SA} ; Int Worth of Shutdown Bank A-Rod Swap
	Measured Value	I^{RS}_{SA} = 1094 pcm (Adj. Meas. Crit. Rod Bank Position = 201 steps)
	Design Value (Actual Cond)	I^{RS}_{SA} = 1011 ± 152 pcm (Adj. Meas. Crit. Rod Bank Position = 201 steps)
	Design Value (Design Cond)	I^{RS}_{SA} = 1004 ± 151 pcm (Critical Rod Bank Position = 188 steps)
	Reference	VEP-FRD-MTE-03A, VEP-FRD-36A, NFO-II-2.0A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: [signature] Test Engineer

Evaluated By: T.C. Hartsfield

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Total Rod Worth - Rod Swap Proc No /Section: 1-~~PT-94.0/ATT.G~~ PT-94.7	Sequence Step No: 14
II Test Conditions (Design)	Bank Positions (Steps) SDA:Moving SDB:Moving CA:Moving CB:Moving CC:Moving CD:Moving	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA:Moving SDB:Moving CA:Moving CB:Moving CC:Moving CD:Moving	RCS Temperature (°F): 546.0 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 11/20/82 0312	
IV Test Results	Meas Parameter (Description)	I_{TOTAL}; Int Worth of All Banks - Rod Swap
	Measured Value	I_{TOTAL} = 6004 pcm
	Design Value (Actual Cond)	I_{TOTAL} = 5632 ± 563 pcm
	Design Value (Design Cond)	I_{TOTAL} = 5622 ± 562 pcm
	Reference	VEP-FRD-NFE-231, VEP-FRD-36A, NFO-II-2.2A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : X YES ___NO Acceptance Criteria is met : X YES ___NO	

Completed By: [signature] Test Engineer

Evaluated By: [signature]

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference

Test Description: M/D Flux Map-At Power, NI Calibration
Proc No / Section: 1-PT-22.2 Sequence Step No: 44

II Test Conditions (Design)

Bank Positions (Steps): SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: #
RCS Temperature (°F): T_{REF} ±1
Power Level (% F.P.): ~50
Other (specify)
Must have ≥ 38 thimbles

III Test Conditions (Actual)

Bank Positions (Steps): SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 188
RCS Temperature (°F): T_{REF}
Power Level (% F.P.): 52.0
Other (Specify): 49 thimbles

Date/Time Test Performed: 3/17/83 0913

IV	Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	MUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
Test Results	Measured Value	15.7% for P_{B-10}=0.96 9.4% for P_{J-1}=0.48	1.425	1.882	1.005
	Design Value (Design Conds)	FLOX for $P_1 \geq .9$ TLSI for $P_1 < .9$ (P_1 = Assy. Pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV. 1	NONE	NONE	WCAP-7905 REV. 1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_\Delta \leq 1.55(1+0.2(1-P))$ x(1-RRP(3D))	$F^T_Q(Z) \leq \frac{2.20}{P} \times K(Z)^*$	NA
	Reference	NONE	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Design Tolerance is met : ✓ YES ___ NO
Acceptance Criteria is met : ✓ YES ___ NO

Above the insertion limits.
* The full-power F_Q limit was increased from 2.14 to 2.20 by Technical Specification Change No. 44, January 27, 1983.

Completed By: Test Engineer

Evaluated By: C. A. Ford

Recommended for Approval By: C. J. Snow
NFO Engineer

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference

Test Description: M/D Flux Map-At Power, NI Calibration
Proc No / Section: 1-PT-22.2 Sequence Step No: 45

II Test Conditions (Design)

Bank Positions (Steps): SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: #
RCS Temperature (°F): T_{REF} ±1
Power Level (% F.P.): ~60[1]
Other (specify): *

III Test Conditions (Actual)

Bank Positions (Steps): SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 194
RCS Temperature (°F): T_{REF}
Power Level (% F.P.): 29.2[1]
Other (Specify): 21 thimbles
Quarter-core flux m=
Date/Time Test Performed: 3/14/83 1609

IV Test Results

Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT $F^N_{\Delta H}(N)$	TOTAL HEAT FLUX HOT CHAN FACT $F_Q(T)$	QUADRANT POWER TILT RATIO QPTR
Measured Value	5.8% for $P_{M-2}=1.10$ 9.4% for $P_{M-15}=0.79$	NA[2]	NA[2]	NA[2]
Design Value (Design Conds)	±10% for $P_1 \geq .9$ ±15% for $P_1 < .9$ (P_1 = Assy. Pwr)	NA	NA	≤ 1.02
Reference	WCAP-7905 REV. 1	NONE	NONE	WCAP-7905 REV. 1

V Acceptance Criteria

FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.55(1+0.2(1-P))$ x(1-RRP(3D))	$F_Q(Z) \leq$ ~~2.32/P x K(Z)~~ $\frac{4.40 \times K(Z)}{P}$ for $P \geq 0.5$[3] / $\frac{2.20}{P} \times K(Z)$ for $P \geq 0.5$	NA
Reference	NONE	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Design Tolerance is met: ✓YES ___NO
Acceptance Criteria is met: ✓YES ___NO

* Must have at least 38 thimbles for a full-core flux map or, at least 16 thimbles for a quarter-core flux map.
# Above the insertion limits.

Completed By: [signature] Test Engineer
Evaluated By: C. A. Ford
Recommended for Approval By: C. J. Snow NFO Engineer

1 This difference is acceptable since NI calibration can be performed satisfactorily over a wide range of power levels.

2 These parameters are not verified using a partial-core flux map obtained for NI calibration.

3 The full-power F_Q limit was increased from 2.14 to 2.20 by Technical Specifications Change No. 44, January 27, 1983.

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference

Test Description: M/D Flux Map-At Power, NI Calibration
Proc No / Section: 1-PT-22.2 Sequence Step No: 46

II Test Conditions (Design)

Bank Positions (Steps): SDA: 223 SDB: 223 CA: 223 CB: 228 CC: 228 CD: #
RCS Temperature (°F): T_{REF} = 1
Power Level (% F.P.): ~70[1]
Other (specify) *

III Test Conditions (Actual)

Bank Positions (Steps): SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 157
RCS Temperature (°F): T_{REF}
Power Level (% F.P.): 29.2[1]
Other (Specify): 21 thimbles, Quarter-core flux map

Date/Time Test Performed: 3/14/83 1810

IV

	Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(X)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(Z)	QUADRANT POWER TILT RATIO QPTR
Test Results	Measured Value	4.7% for P_{M-2} = 1.03 8.7% for P_{M-15} = 0.96	NA[2]	NA[2]	NA[2]
	Design Value (Design Conds)	≤10% for $P_M \geq .9$ ≤15% for $P_M < .9$ (P_M = Meas. Pwr)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV. 1	NONE	NONE	WCAP-7905 REV. 1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.55(1-0.2(1-P))$ x(1-0.32(30))	$F^N_Q(Z) \leq$ ~~2.14/P x K(Z)~~ 4.40 x K(Z) for P ≤ 0.5[3] $\frac{2.20}{P} \times K(Z)$ for P ≥ 0.5	NA
	Reference	NONE	TS 3.2.3	TS 3.2.2	TS 3.2.4

VI Comments

Design Tolerance is met: ✓ YES ___ NO
Acceptance Criteria is met: ✓ YES ___ NO

* Must have at least 33 thimbles for a full-core flux map, or at least 16 thimbles for a quarter-core flux map.
# Above the insertion limits.

Completed By: [signature] Test Engineer

Evaluated By: C.A. Ford

Recommended for Approval By: C.J. Snow NFD Engineer

1 This difference is acceptable since NI calibration can be performed satisfactorily over a wide range of power levels.

2 These parameters are not verified using a partial-core flux map obtained for NI calibration.

3 The full-power F_Q limit was increased from 2.14 to 2.20 by Technical Specifications Change No. 44, January 27, 1983.

NORTH ANNA POWER STATION UNIT 1 CYCLE 4
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference

Test Description : M/D Flux Map - HFP, ARO, Eq. Xe
Proc No / Section: 1-PT-~~21.1 22.2 3.4.4 3.4.3~~ 21.1 Sequence Step No: 47

II Test Conditions (Design)

Bank Positions (Steps): SDA: 223 SDB: 223 CA: 223 CB: 223 CC: 228 CD: *

RCS Temperature (°F): T_{REF} ±1
Power Level (% F.P.): 95±5
Other (specify)
Must have ≥ 38 thimbles

III Test Conditions (Actual)

Bank Positions (Steps): SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 221

RCS Temperature (°F): T_{REF}
Power Level (% F.P.): 100.0
Other (Specify): 45 thimbles

Date/Time Test Performed: 3/24/83 1241

IV	Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
Test Results	Measured Value	6.0% for $P_{B-6} = 0.97$ 6.3% for $P_{J-15} = 0.50$	1.393	1.765	1.009
	Design Value (Design Conds)	$\leq$ [illegible] for $P_i \geq .9$ $\leq$ [illegible] for $P_i < .9$ (P_i = Meas. Pwr)	NA	NA	$\leq$ 1.02
	Reference	WCAP-7905 REV. 1	NONE	NONE	WCAP-7905 REV. 1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.55(1+0.3(1-P))$ $\times(1-RRP(3D))$	$F_Q(Z) \leq \frac{2.20}{P} \times K(Z)$* ~~$\leq$ [illegible]~~	NA
	Reference	NONE	TS 3.2.3	TS 3.2.2	TS 3.2.4

Design Tolerance is met : ✓ YES ___ NO
Acceptance Criteria is met : ✓ YES ___ NO

VI Comments

* Above the insertion limits.

* The full-power F_Q limit was increased from 2.14 to 2.20 by Technical Specification Change No. 44, January 27, 1983.

Completed By: [signature] Test Engineer

Evaluated By: C. A. Ford

Recommended for Approval By: C. J. Snow
NFO Engineer