VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

July 16, 1992

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Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNIT 2
CYCLE 9 STARTUP PHYSICS TESTS REPORT

As required by North Anna Technical Specification 6.9.1, enclosed are five copies of the Virginia Electric and Power Company Technical Report NE-895, "North Anna Unit 2, Cycle 9 Startup Physics Test Report." This report summarizes the results of the physics testing program performed after initial criticality of Cycle 9 on April 22, 1992.

Very truly yours,

J.P. OHanlon

for W. L. Stewart
Senior Vice President - Nuclear

Enclosures

cc: U.S. Nuclear Regulatory Commission
Region II
101 Marietta Street, N.W.
Suite 2900
Atlanta, GA 30323

Mr. M. S. Lesser
NRC Senior Resident Inspector
North Anna Power Station

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North Anna
Unit 2 Cycle 9
Startup Physics
Report

Nuclear Analysis and Fuel
Nuclear Engineering
Services

June, 1992

TECHNICAL REPORT NE-895 - Rev. 0

NORTH ANNA UNIT 2, CYCLE 9

STARTUP PHYSICS TEST REPORT

NUCLEAR ANALYSIS AND FUEL
NUCLEAR ENGINEERING SERVICES
VIRGINIA POWER
JUNE 1992

PREPARED BY: E. A. Hoffman 6/23/92
E. A. Hoffman Date

REVIEWED BY: Pamela D Banning 6/23/92
P. D. Banning Date

REVIEWED BY: 6-24-92
A. P. Main Date

APPROVED BY: D. Dziadosz 6/24/92
D. Dziadosz Date

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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 2, Cycle 9 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 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 include a brief summary of each test, a comparison of the test results with design predictions, and an evaluation of the results.

The North Anna 2, Cycle 9 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 the startup physics testing. The entries for the design values were based on the calculations performed by Virginia Power's Nuclear Analysis and Fuel 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.

SECTION 1

INTRODUCTION AND SUMMARY

On February 26, 1992 Unit No. 2 of the North Anna Power Station was shutdown for its eighth refueling. During this shutdown, 75 of the 157 fuel assemblies in the core were replaced with 60 fresh fuel assemblies, 2 once burned fuel assemblies, 9 twice burned fuel assemblies, and 4 thrice burned fuel assemblies. The ninth cycle core consists of 11 sub-batches of fuel: four once-burned batches, two from Cycle 8 (batches 10A and 10B), one from cycle 7 (batch 9A), and one from North Anna 1 Cycle 4 (batch N1/6); four twice burned batches, two from Cycles 7 and 8 (batches N1/10A and 9B), one from Cycles 3 and 4 (batch 5A), and one from North Anna 1 Cycles 7 and 8 (batch N1/9B); one thrice burned batch from North Anna 1 Cycles 5, 6, and 7 (batch N1/7); and two fresh batches (batches 11A and 11B). 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 for Cycle 9, and Figure 1.5 identifies the location and number of control rods in the Cycle 9 core.

On April 22, 1992 at 0038, the ninth 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 measured drop time of each control rod was within the 2.7 second limit of Technical Specification 3.1.3.4.

2. Individual control rod bank worths for the control rod banks were measured using the rod swap technique[2] and were found to be within 8.5% of the design predictions. The sum of the individual control rod bank worths was measured to be within 1.1% of the design prediction. These results are within the design tolerance of ±15% or ±100 pcm 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. Measured critical boron concentrations for two control bank configurations were within 43 ppm of the design predictions. The ARO result was not within the design tolerance of 32 ppm, but met the Technical Specification 4.1.1.1.2 criterion that the overall core reactivity balance shall be within ±1% Δk/k of the design prediction. Further analysis was done to evaluate the impact of the boron misprediction on the safety analysis[6]. The safety analysis was not affected by the boron difference.

4. The boron worth coefficient was measured to be within 0.7% of the design prediction, which is within the design tolerance of ±10%.

5. The isothermal temperature coefficient for the all-rods-out configuration was measured to be within 0.67 pcm/°F of the design prediction. This result is within the design tolerance of ±3 pcm/°F. The measured temperature coefficient of -1.75 pcm/°F

meets the criterion of Technical Specification 3.1.1.4. Technical Specification 3.1.1.4 requires that the moderator temperature coefficient be less than +6.0 pcm/°F. When the Doppler temperature coefficient and a 0.5 pcm/°F uncertainty are accounted for, this requirement is met as long as the isothermal temperature coefficient is less than +3.75 pcm/°F.

6. Mode 1 (See Reference 4) core power distributions were within established design tolerances. Generally, the measured core power distribution was within 1.8% of the design predictions. The heat flux hot channel factors, F-Q(T), and enthalpy rise hot channel factors, F-DH(M), were within the limits of Technical Specifications 3.2.2 and 3.2.3, respectively.

In summary, the 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 2 - CYCLE 9 STARTUP PHYSICS TESTS
CHRONOLOGY OF TESTS

Test	Date	Time	Power	Reference Procedure
Hot Rod Drop - Hot Full Flow	4/21/92	1100	HSD	2-PT-17.2
Zero Power Testing Range	4/22/92	0102	HZP	2-PT-94.0
Reactivity Computer Checkout	4/22/92	0128	HZP	2-PT-94.0
Boron Worth Coefficient - ARO	4/22/92	0430	HZP	2-PT-94.0
Boron Endpoint - ARO	4/22/92	0431	HZP	2-PT-94.0
Temperature Coefficient - ARO	4/22/92	0442	HZP	2-PT-94.0
Bank B Worth	4/22/92	0542	HZP	2-PT-94.0
Boron Endpoint - B in	4/22/92	0542	HZP	2-PT-94.0
Bank D Worth - Rod Swap	4/22/92	1119	HZP	2-PT-94.0
Bank C Worth - Rod Swap	4/22/92	1156	HZP	2-PT-94.0
Bank A Worth - Rod Swap	4/22/92	1224	HZP	2-PT-94.0
Bank SB Worth - Rod Swap	4/22/92	1244	HZP	2-PT-94.0
Bank SA Worth - Rod Swap	4/22/92	1311	HZP	2-PT-94.0
Flux Map - P ≤ 30%	4/26/92	0427	30%	2-PT-21.1
Flux Map - 50% ≤ P ≤ 75%	4/27/92	2230	73%	2-PT-21.1
Flux Map - 95% ≤ P ≤ 100%	5/01/92	0820	99%	2-PT-21.1

Figure 1.1

NORTH ANNA UNIT 2 - CYCLE 9
CORE LOADING MAP

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
						9B X21	N1/7 G28	9B X38							1
				N1/10A K12	5A S54	11B 6L1	10B Y43	11B 4L1	5A S46	N1/10A K03					2
			9B X23	11A 2L7	11B 5L0	10B Y55	11B 5L4	10B Y46	11B 5L2	11A 3L8	9B X26				3
		9B X27	10B Y34	11B 5L7	10A Y16	11A 1L3	10B Y51	11A 3L4	10A Y14	11B 6L4	10B Y58	9B X25			4
	N1/10A K04	11A 3L5	11B 6L3	10B Y45	11A 1L5	10A Y09	11A 2L5	10A Y17	11A 2L2	10B Y53	11B 4L6	11A 3L1	N1/10A K07		5
	5A S04	11B 4L4	10A Y24	11A 1L9	10A Y25	10B Y48	10A Y21	10B Y64	10A Y10	11A 1L0	10A Y03	11B 5L8	5A S10		6
N1/9B [illegible]44	11B 6L8	10B Y33	11A 4L0	10A Y20	10B [illegible]	10A [illegible]	11A 1L8	10A Y11	10B Y61	10A Y27	11A 2L8	10B Y56	11B 4L3	9B X34	7
N1/7 G02	10B [illegible]	11B 6L0	10B Y35	11A 3L7	10A [illegible]	11A 1L2	9A X09	11A 3L2	10A Y05	11A 1L6	10B Y36	11B 4L8	N1/6 F06	N1/7 G27	8
9B X47	11B 4L9	10B Y30	11A 2L1	10A Y04	10B Y38	10A Y12	11A 2L4	10A Y08	10B Y41	10A Y01	11A 3L3	10B Y49	11B 6L2	9B X48	9
	5A S49	11B 6L6	10A Y06	11A 2L9	10A Y26	10B Y50	10A Y18	10B Y59	10A Y02	11A 2L3	10A Y22	11B 5L5	5A S52		10
	N1/10A K09	11A 2L6	11B 5L3	10B Y62	11A 3L6	10A Y19	11A 0L9	10A Y15	11A 3L9	10B Y31	11B 6L5	11A 1L1	N1/10A K10		11
		9B X31	10B Y52	11B 4L5	10A Y23	11A 1L7	10B Y57	11A 3L0	10A Y28	11B 4L7	10B Y37	9B X37			12
			9B X52	11A 1L4	11B 5L6	10B Y29	11B 4L2	10B Y54	11B 6L7	11A 2L6	9B X4[illegible]				13
				N1/10A K01	5A S37	11B 5L1	10B Y44	11B 5L9	5A S35	N1/10A K06					14
						9B X24	N1/7 G46	9B X39							15

--> BATCH
--> ASSEMBLY ID

FUEL ASSEMBLY DESIGN PARAMETERS

	SUB-BATCH										
	N1/6	N1/7	N1/9B	N1/10A	5A	9A	9B	10A	10B	11A	11B
INITIAL ENRICHMENT (W/O U-235)	3.59	3.60	3.99	3.80	3.59	3.80	4.01	3.99	4.21	4.02	4.21
BURNUP AT BOC 9 (MWD/MTU)	12233	29676	37675	35569	36153	23847	37101	23963	21752	0	0
ASSEMBLY TYPE	17x17	17x17	17x17	17x17	17x17	17x17	17x17	17x17	17x17	17x17	17X17
NUMBER OF ASSEMBLIES	1	4	1	8	8	1	15	28	31	32	28
FUEL RODS PER ASSEMBLY	264	264	264	264	264	264	264	264	264	264	264

Figure 1.2

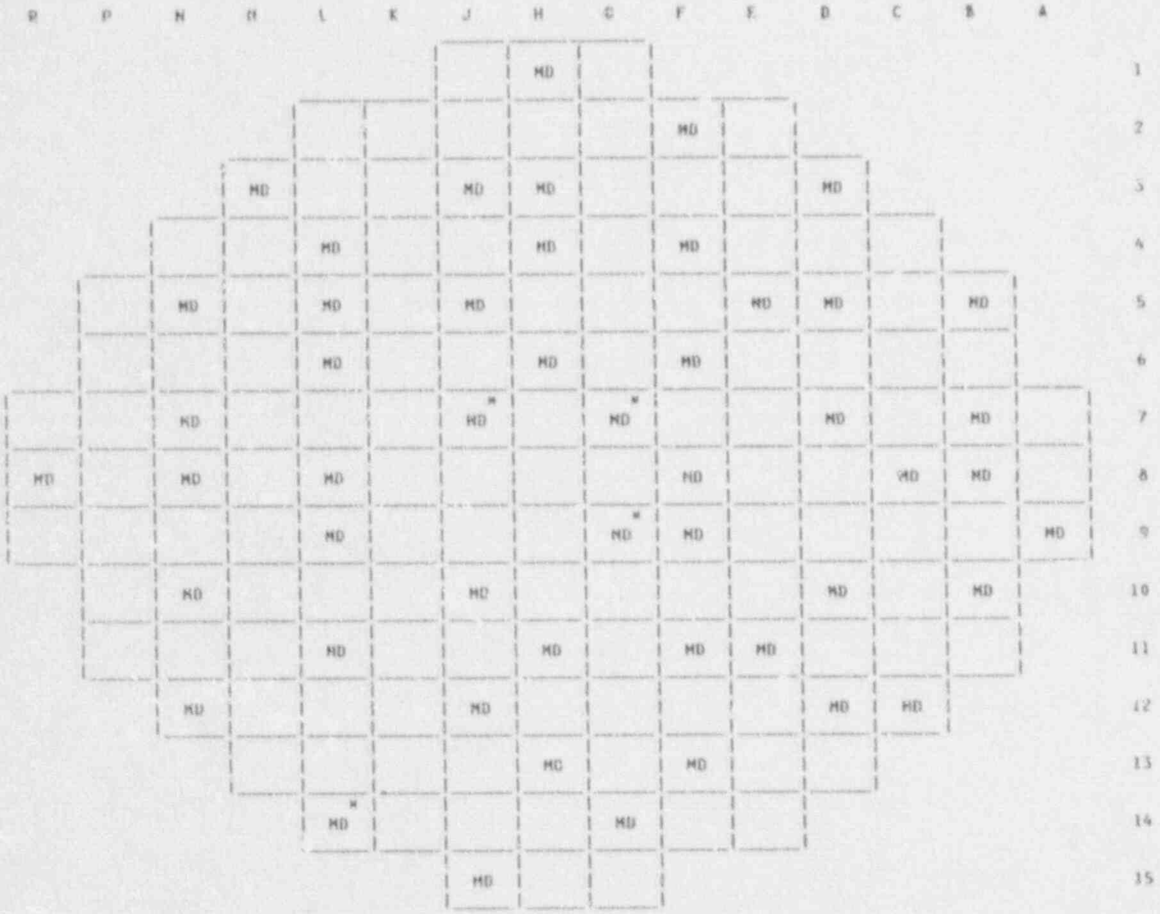
NORTH ANNA UNIT 2 - CYCLE 9
BEGINNING OF CYCLE FUEL ASSEMBLY BURNUPS

R	P	N	M	L	X	J	H	G	F	E	D	C	B	A	
						X21 38583	G28 29838	X38 38750							1
				K12 35174	S54 36119	6L1 0	Y43 20199	4L1 0	S46 36298	K03 35955					2
			X23 35530	2L7 0	5L0 0	Y55 19130	5L4 0	Y46 18856	5L2 0	3L8 0	X26 35097				3
		X27 35577	Y34 [illegible]9321	5L7 0	Y16 24168	1L3 0	Y51 23183	3L4 0	Y14 25102	6L4 0	Y58 19719	X25 36621			4
	K04 35753	3L5 0	6L3 0	Y45 23588	[illegible] 0	Y09 [illegible]	2L5 0	Y17 24849	2L2 0	Y53 23950	4L6 0	3L1 0	K07 35236		5
	S04 36386	4L4 0	Y24 25236	1L9 0	Y25 22178	Y48 24618	Y21 2[illegible]280	Y64 24608	Y10 21631	1L0 0	Y03 25122	5L8 0	S10 36023		6
J44 37675	6L8 0	Y33 19156	4L0 0	Y20 24391	Y63 24134	Y07 22363	1L8 0	Y11 22293	Y61 23585	Y27 24295	2L8 0	Y56 19249	4L3 0	X34 38502	7
G02 30184	Y60 19736	6L0 0	Y35 23896	3L7 0	Y13 24284	1L2 0	X09 23847	3L2 0	Y05 24637	1L6 0	Y36 23458	4L8 0	F06 12233	G27 292[illegible]	8
X47 38860	4L9 0	Y30 19160	2L1 0	Y04 24751	Y38 24229	Y12 21924	2L4 0	Y08 22979	Y41 24359	Y01 24534	3L3 0	Y49 18583	6L2 0	X48 39272	9
	S49 35926	6L6 0	Y06 24539	2L9 0	Y26 22988	Y50 23912	Y18 24129	Y59 24055	Y02 22218	2L3 0	Y22 24418	5L5 0	S52 36411		10
	K09 35619	2L6 0	5L3 0	Y62 23929	3L6 0	Y19 24282	6L9 0	Y15 24624	3L9 0	Y31 23715	6L5 0	1L1 0	K10 35196		11
		X31 35789	Y52 19760	4L5 0	Y23 24454	1L7 0	Y57 24168	3L0 0	Y28 24643	4L7 0	Y37 20142	X37 35609			12
			X52 35063	2L4 0	5L6 0	Y29 18896	4L2 0	Y54 19196	6L7 0	2L0 0	X46 34367				13
				K01 35991	S37 36099	5L1 0	Y44 19804	5L9 0	S35 35960	K06 35654					14
						X24 39692	G46 29483	X39 39391							15

--> BATCH
--> ASSEMBLY BURNUP

Figure 1.3

NORTH ANNA UNIT 2 - CYCLE 9
INCORE MOVABLE DETECTOR LOCATIONS



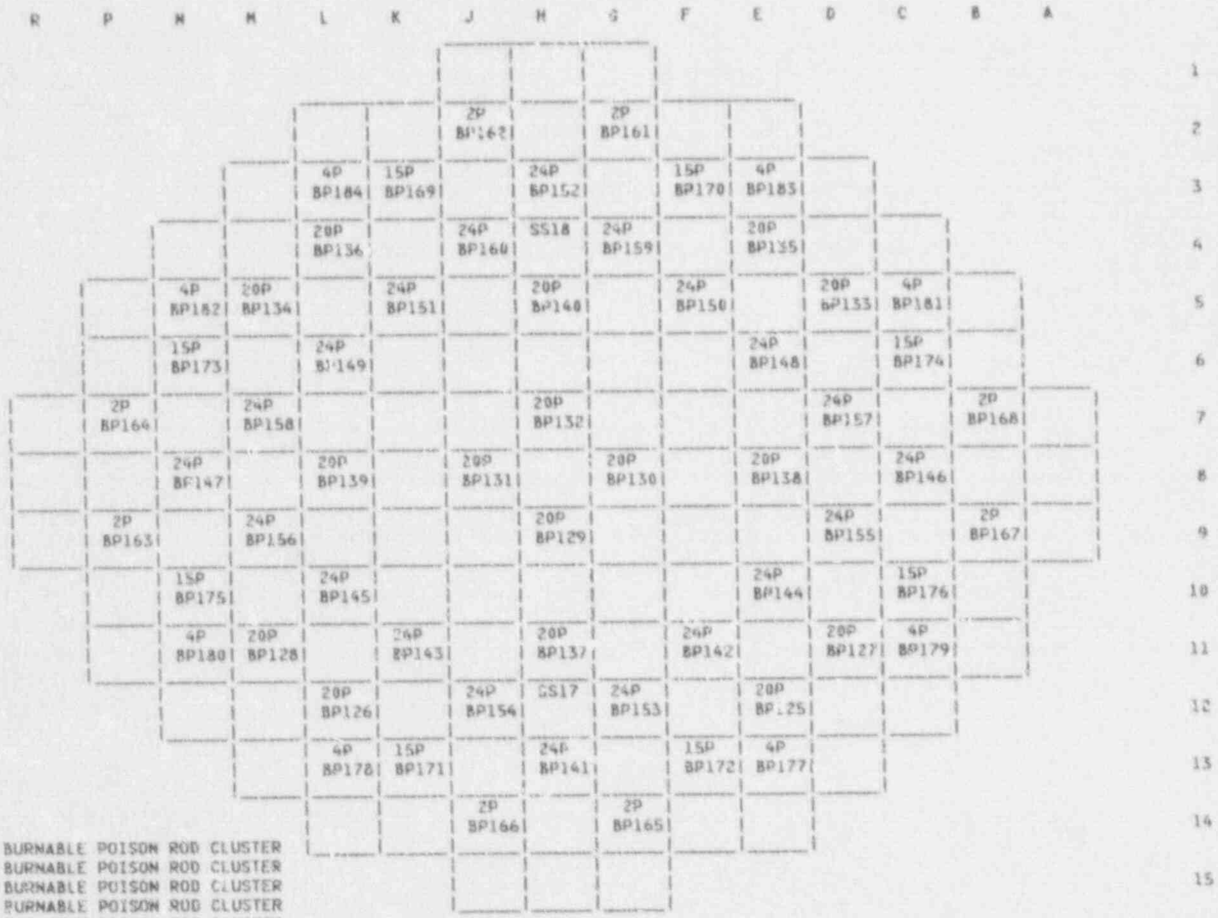
R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
							MD								1
									MD						2
			MD			MD	MD				MD				3
				MD			MD		MD						4
		MD		MD		MD				MD	MD		MD		5
				MD			MD		MD						6
		MD				MD*		MD*			MD		MD		7
MD		MD		MD					MD			MD	MD		8
				MD				MD*	MD					MD	9
		MD				MD					MD		MD		10
				MD			MD		MD	MD			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

MD · Movable Detector Location

* - Locations not available to flux mapping system for Cycle 9

Figure 1.4

NORTH ANNA UNIT 2 - CYCLE 9
BURNABLE POISON AND SOURCE ASSEMBLY LOCATIONS

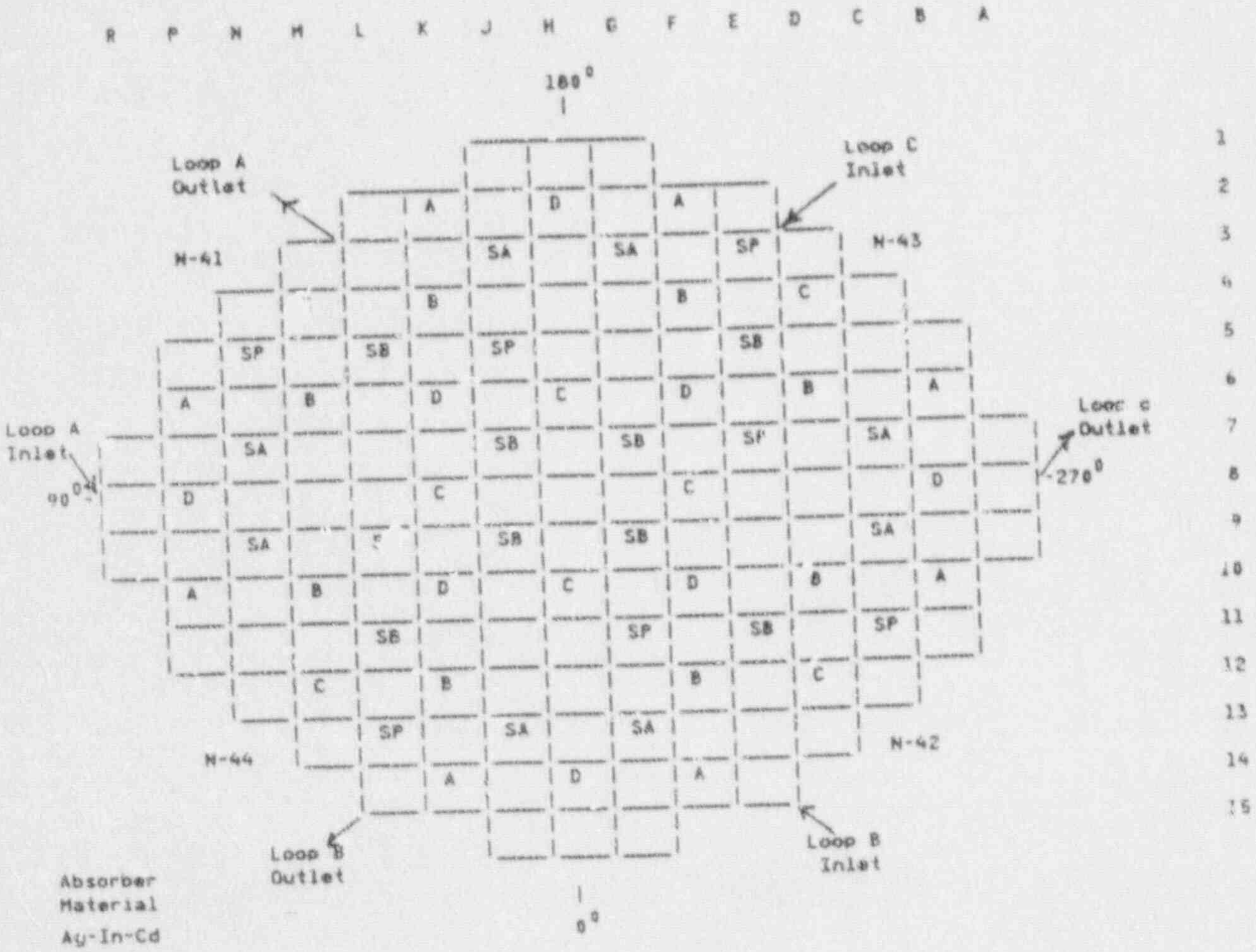


R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
															1
						2P BP162		2P BP161							2
				4P BP184	15P BP169		24P BP152		15P BP170	4P BP183					3
				20P BP136		24P BP160	SS18	24P BP159		20P BP135					4
		4P BP182	20P BP134		24P BP151		20P BP140		24P BP150		20P BP133	4P BP181			5
		15P BP173		24P BP149						24P BP148		15P BP174			6
	2P BP164		24P BP158				20P BP132				24P BP157		2P BP168		7
		24P BP147		20P BP139		20P BP131		20P BP130		20P BP138		24P BP146			8
	2P BP163		24P BP156				20P BP129				24P BP155		2P BP167		9
		15P BP175		24P BP145						24P BP144		15P BP176			10
		4P BP180	20P BP128		24P BP143		20P BP137		24P BP142		20P BP127	4P BP179			11
				20P BP126		24P BP154	SS17	24P BP153		20P BP125					12
				4P BP178	15P BP171		24P BP141		15P BP172	4P BP177					13
						2P BP166		2P BP165							14
															15

2P - 2 BURNABLE POISON ROD CLUSTER
4P - 4 BURNABLE POISON ROD CLUSTER
15P - 15 BURNABLE POISON ROD CLUSTER
20P - 20 BURNABLE POISON ROD CLUSTER
24P - 24 BURNABLE POISON ROD CLUSTER
SSxx - SECONDARY SOURCE

Figure 1.5

NORTH ANNA UNIT 2 - CYCLE 9
CONTROL ROD LOCATIONS



Absorber
Material
Ag-In-Cd

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

CALLED
NORTH

SECTION 2

CONTROL ROD DROP TIME MEASUREMENTS

The drop time of each control rod was measured at hot full-flow reactor coolant system (RCS) conditions in order to verify that the time from initiation of the rod drop to the entry of the rod into the dashpot was less than or equal to the maximum allowed by Technical Specification 3.1.3.4. The control rod drop times were measured in Mode 3* with the RCS Tavg above 500°F and all reactor coolant pumps operating.

The rod drop times were measured by withdrawing a rod bank 229 steps, and removing the movable gripper coil fuse and stationary gripper coil fuse for the particular rod of the bank to be dropped. This allowed the rod to drop into the core as it would during a plant trip. The stationary gripper coil voltage and the Individual Rod Position Indication (IRPI) primary coil voltage signals were recorded to determine the rod drop time. This procedure was repeated for each control rod.

As shown on the sample rod drop trace 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. As the rod drops, a voltage is induced in the IRPI primary coil. The magnitude of this voltage is a function of control rod velocity. As the rod enters the dashpot region of the guide tube, its velocity slows causing a voltage decrease in the IRPI coil. This voltage reaches a minimum when the rod reaches the bottom of the dashpot. Subsequent variations in the trace are caused by rod bouncing.

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 2.7 seconds with the RCS at hot, full flow conditions. These test results satisfied this limit.

Table 2.1

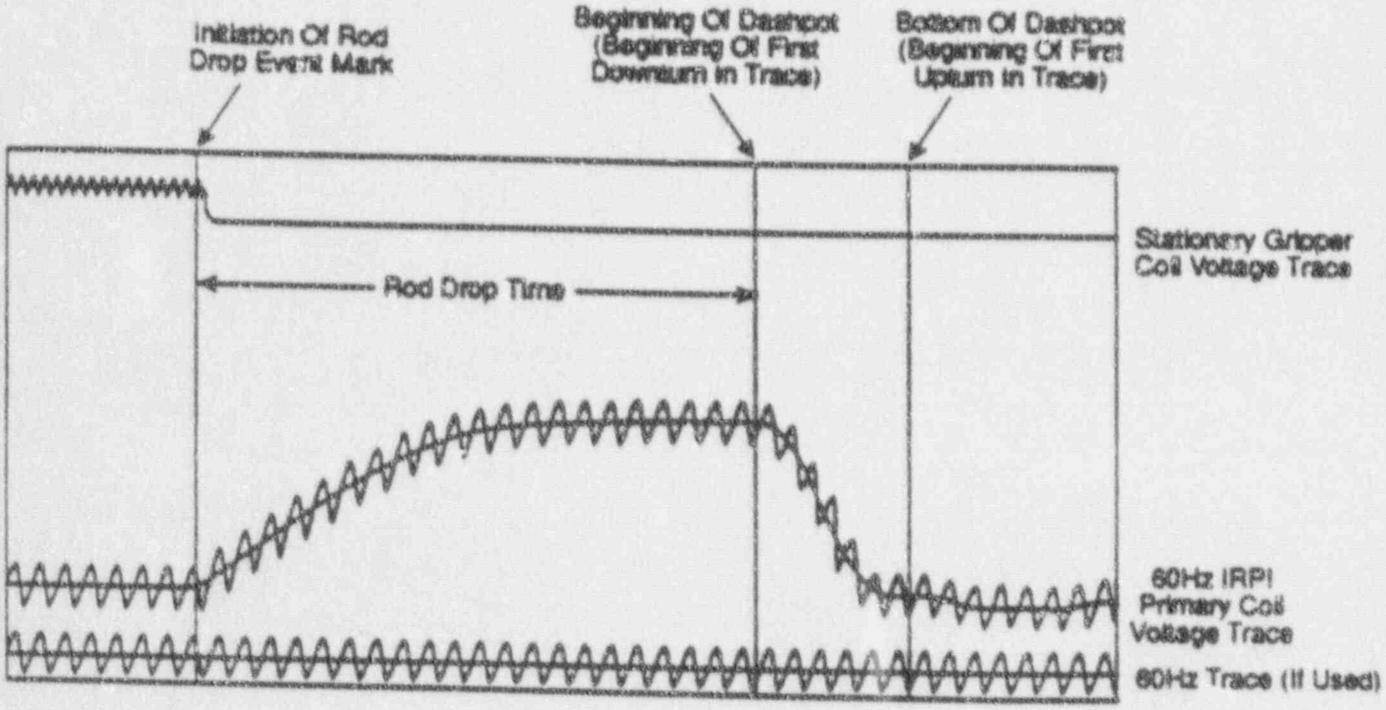
NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
HOT ROD DROP TIME SUMMARY

ROD DROP TIME TO DASHPOT ENTRY

SLOWEST ROD	FASTEST ROD	AVERAGE TIME
B-06 1.83 sec.	M-04 1.44 sec.	1.61 sec.

Figure 2.1

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
TYPICAL ROD DROP TRACE

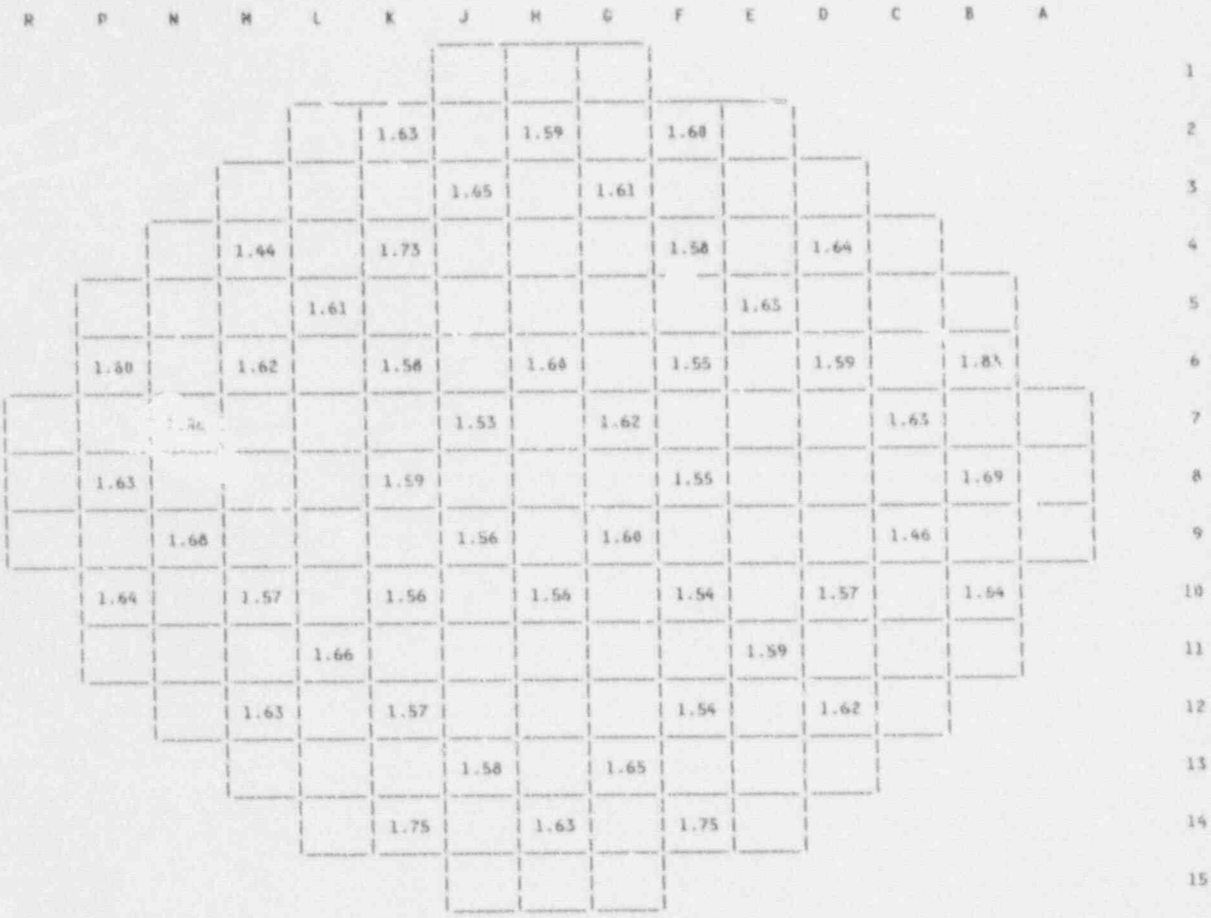


Graphics No. [illegible]

ROD DROP TIME MEASUREMENT

Figure 2.2

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
ROD DROP TIME - HOT FULL FLOW CONDITIONS



R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
															1
					1.63		1.59		1.60						2
						1.65		1.61							3
			1.44		1.73				1.58		1.64				4
				1.61						1.65					5
	1.60		1.62		1.58		1.64		1.55		1.59		1.83		6
		[illegible]				1.53		1.62				1.63			7
	1.63				1.59				1.55				1.69		8
		1.68				1.56		1.60				1.46			9
	1.64		1.57		1.56		1.56		1.54		1.57		1.64		10
				1.66						1.59					11
			1.63		1.57				1.54		1.62				12
						1.58		1.65							13
					1.75		1.63		1.75						14
															15

| X.XX | --> ROD DROP TIME TO DASHPOT ENTRY (SEC)

SECTION 3

CONTROL ROD BANK WORTH MEASUREMENTS

Control rod bank worths were measured for the control and shutdown banks using the rod swap technique[2,5]. The initial step of the rod swap method diluted the predicted most reactive control rod bank (hereafter referred to as the reference bank) into the core and measured its reactivity worth using conventional test techniques. The reactivity changes resulting from the reference bank movements were recorded continuously by the reactivity computer and were used to determine the differential and integral worth of the reference bank. For Cycle 9, Control Bank B was used as the reference bank.

After the completion of the reference bank reactivity worth measurement, the reactor coolant system temperature and boron concentration were stabilized with the reactor just critical and 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. From this point, a rod swap maneuver was performed by withdrawing the reference bank several steps and then one of the other control rod banks (i.e., a test bank) was inserted to balance the reactivity of the reference bank withdrawal. This sequence was repeated until the test bank was fully inserted and the reference bank was positioned such that the core was just critical. This measured critical position (MCP) of the reference bank with the test bank fully inserted was used to determine the integral reactivity worth of the test bank.

The 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 then was repeated in reverse such that the reference bank again was near full insertion with the test bank fully withdrawn from the core. This rod swap process was then repeated for each of the other control and shutdown banks.

A summary of the test results is given in Table 3.1. As shown in this table and the Startup Physics Tests Results and Evaluation Sheets given in the Appendix, the individual measured bank worths for the control and shutdown banks were within the design tolerance (±10% for the reference bank, and ±15% or 100 pcm, whichever is greater, for the test banks). The sum of the individual measured rod bank worths was within 1.1% 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, the measured rod worth values were satisfactory.

Table 3.1

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
CONTROL ROD BANK WORTH SUMMARY

BANK	MEASURED WORTH (PCM)	PREDICTED WORTH (PCM)	PERCENT DIFFERENCE (%) (M-P)/P X 100
B-Reference Bank	1227.5	1288.0	-4.70
D	980.1	939.9	4.28
C	829.8	765.6	8.39
A	213.1	227.1	-6.16 *
SB	1066.8	988.8	7.89
SA	1009.0	1061.5	-4.95
Total Worth	5326.3	5270.9	1.05

* Difference is less than 100 pcm.

Figure 3.1

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
BANK B INTEGRAL ROD WORTH - HZP
BANK B WITH ALL OTHER RODS OUT

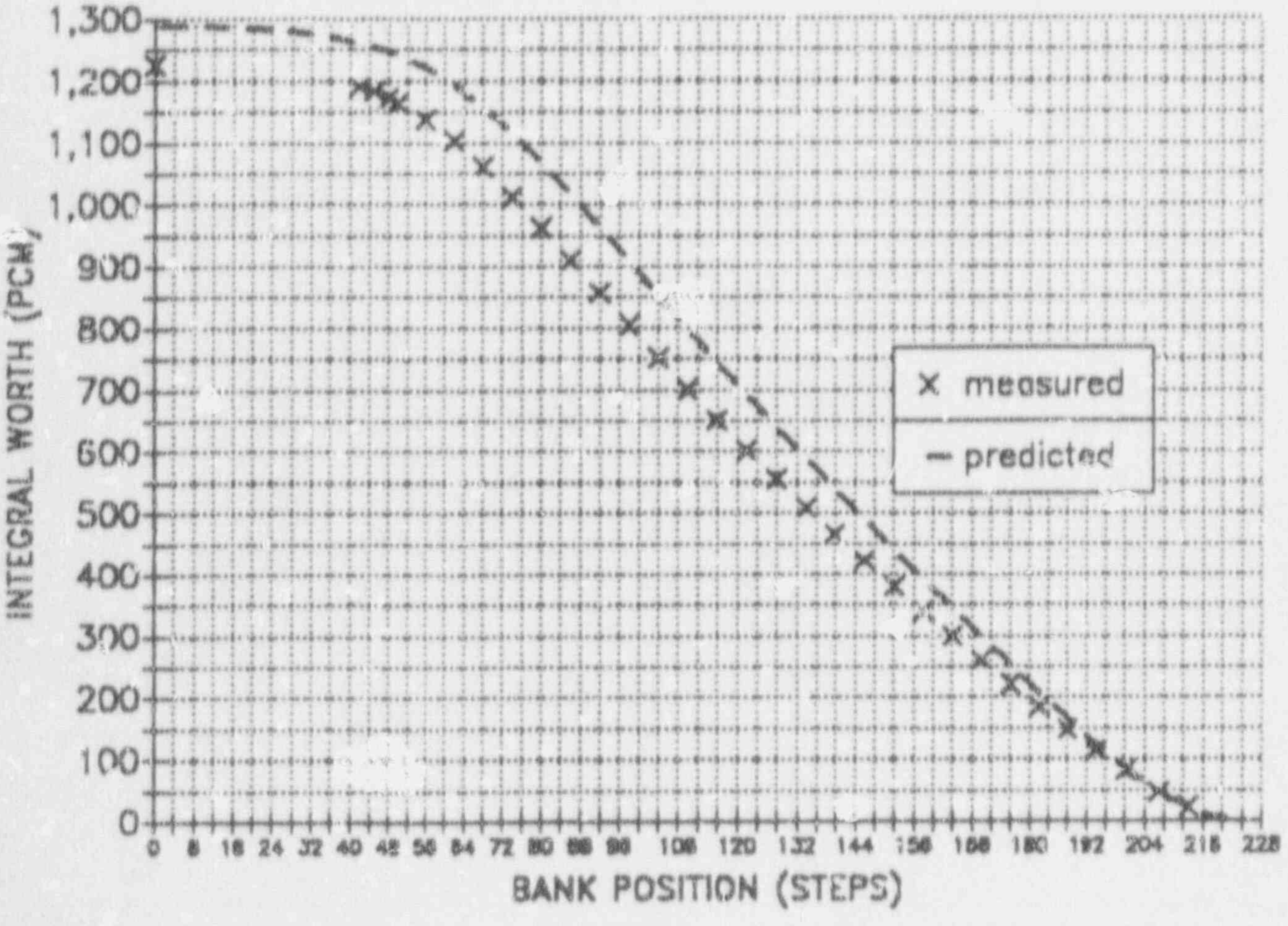
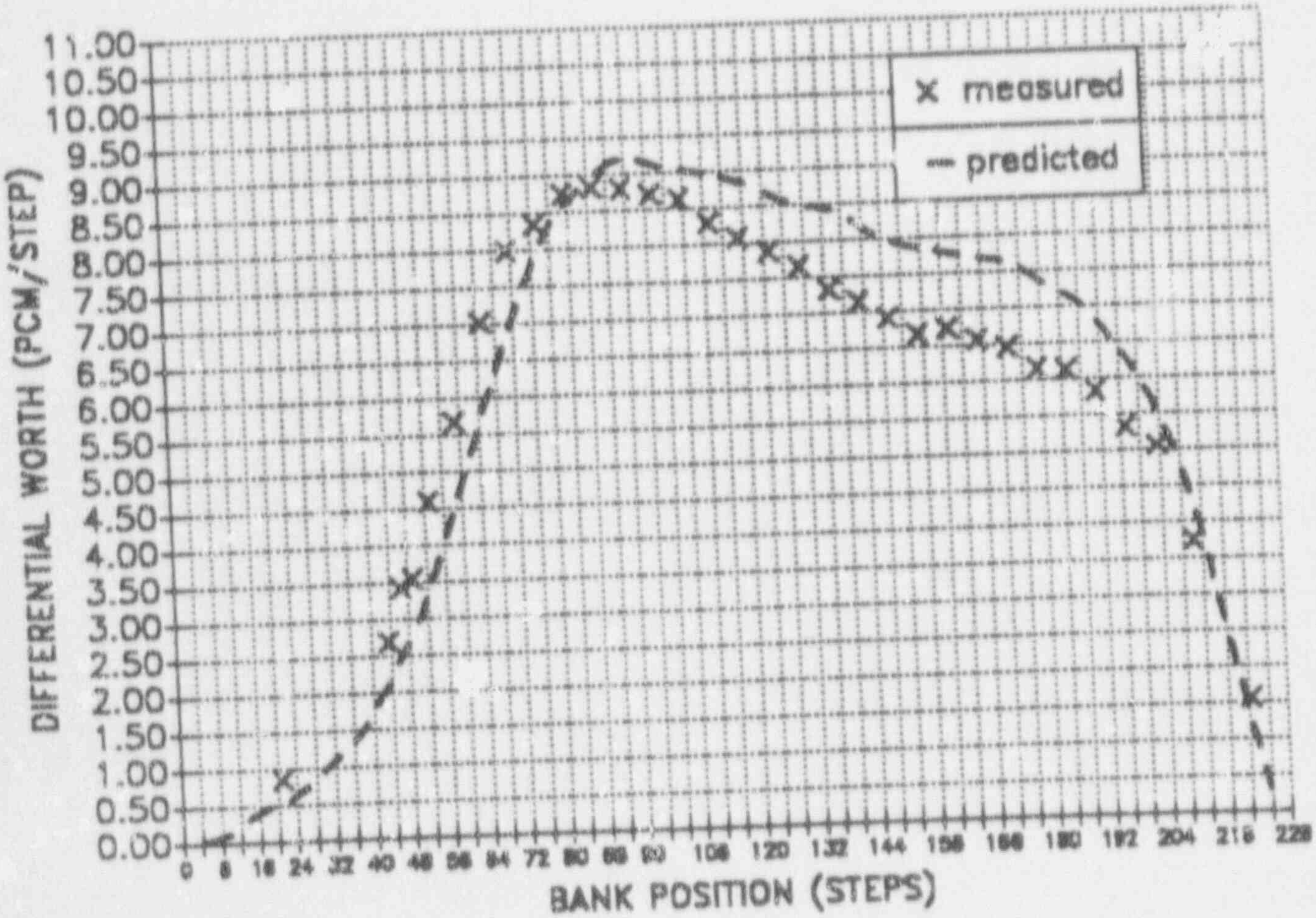


Figure 3.2

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
BANK B DIFFERENTIAL ROD WORTH - HZP
BANK B 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 (RCS) boron concentrations were measured at selected rod bank configurations to enable a direct comparison of measured boron endpoints with design predictions. For each critical boron concentration measurement, the RCS conditions were stabilized with the control banks at or very near a selected endpoint position. Adjustments to the measured critical boron concentration values were made to account for off-nominal control rod position and moderator temperature, if necessary.

The results of these measurements are given in Table 4.1. As shown in this table and in the Startup Physics Tests Results and Evaluation Sheets given in the Appendix, the measured ARO critical boron endpoint value was not within design tolerance, but did meet the requirements of Technical Specification 4.1.1.1.2 regarding core reactivity balance. The ARO endpoint exceeded its design tolerance of 32 ppm, but further analysis showed no impact on the safety analysis. In summary, the boron endpoint results were satisfactory.

Boron Worth Coefficient

The measured boron endpoint values provide stable statepoint data from which the boron worth coefficient or differential boron worth (DBW) was determined. 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 DBW over the range of boron endpoint concentrations was obtained.

A plot of the boron concentration versus inserted control rod worth is shown in Figure 4.1. As indicated in this figure and in the Appendix, the measured DBW was -6.86 pcm/ppm. This is within 0.7% of the predicted value of -6.81 pcm/ppm and is well within the design tolerance of ±10%. In summary, the measured boron worth coefficient was satisfactory.

Table 4.1

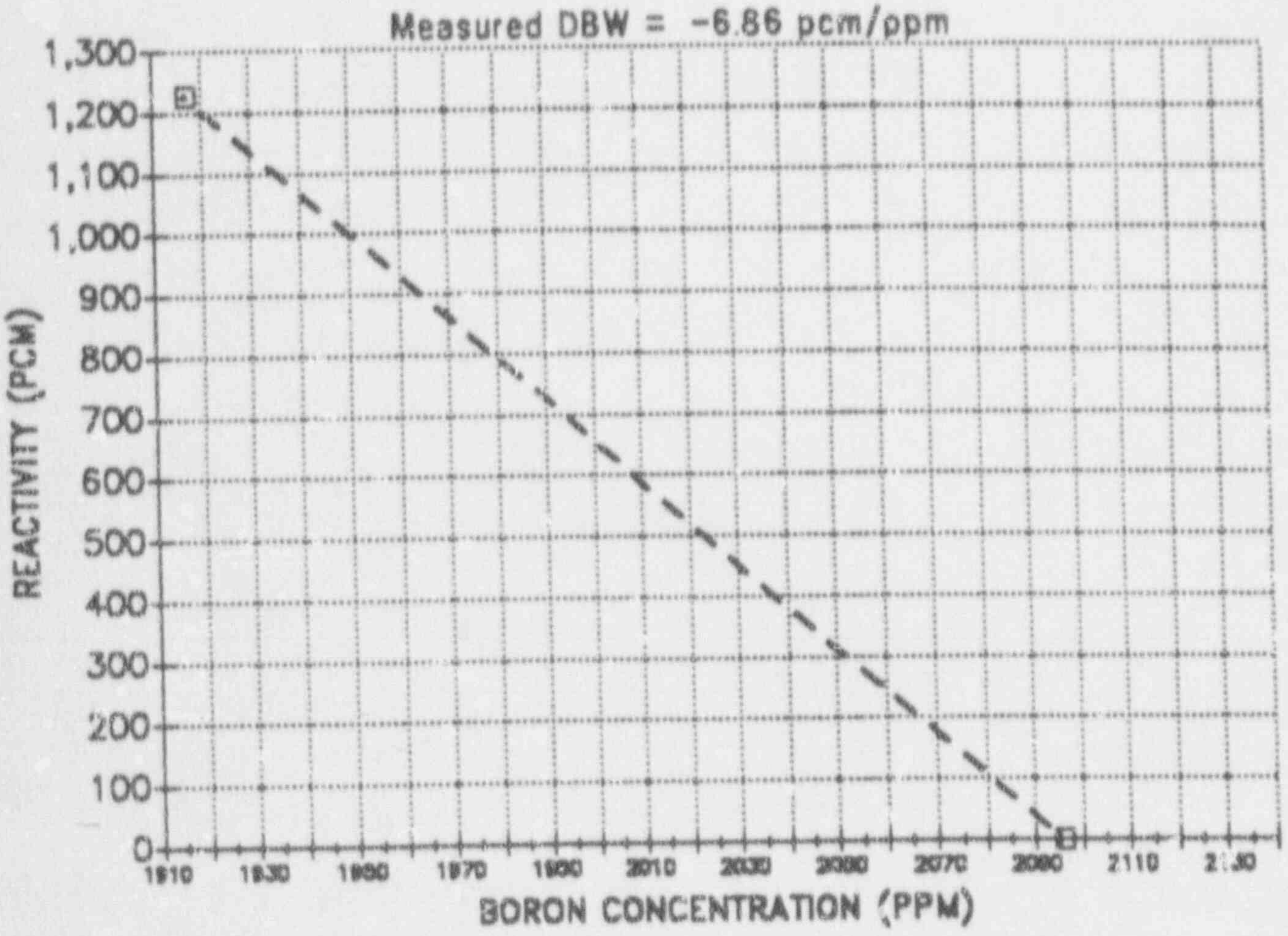
NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
BORON ENDPOINTS SUMMARY

Control Rod Configuration	Measured Endpoint (ppm)	Predicted Endpoint (ppm)	Difference M-P (ppm)
ARO	2096	2053	+43
B Bank In	1917	1907*	+10

* 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 2 - CYCLE 9 STARTUP PHYSICS TESTS
BORON WORTH COEFFICIENT



SECTION 5

TEMPERATURE COEFFICIENT MEASUREMENT

The isothermal temperature coefficient (ITC) at the all-rods-out condition is measured by controlling the reactor coolant system (RCS) temperature with the steam dump valves to the condenser, establishing a constant heatup or cooldown rate, and monitoring the resulting reactivity changes on the reactivity computer. This test sequence includes a cooldown followed by a heatup.

Reactivity was measured during the RCS cooldown of approximately 3.1°F and the RCS heatup of approximately 3.2°F. Reactivity and temperature data was taken from the reactivity computer and strip chart recorders. Using the statepoint method, the temperature coefficient was determined by dividing the change in reactivity by the change in RCS temperature. An X-Y plotter, which plotted reactivity versus temperature, confirmed the statepoint method in calculating the measured ITC.

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 Sheet given in the Appendix, the measured isothermal temperature coefficient value was within the design tolerance of ±3 pcm/°F. The moderator temperature coefficient was determined to be +0.02 pcm/°F which met the requirements of Technical Specification 3.1.1.4. In summary, the measured result was satisfactory.

Table 5.1

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
ISOTHERMAL TEMPERATURE COEFFICIENT SUMMARY

BANK POSITION	TEMPERATURE RANGE (°F)	BORON CONCENTRATION (ppm)	ISOTHERMAL TEMPERATURE COEFFICIENT (PCM/°F)				
			C/D	H/U	MEAS.	PRED.	DIFFER. (M-P)
D/213	544.2 to 547.4	2093	-1.77	-1.72	-1.75	-1.08	-0.67

SECTION 6

POWER DISTRIBUTION MEASUREMENTS

The core power distributions were measured using the movable incore detector flux mapping system. This system consists of five fission chamber detectors which traverse fuel assembly instrumentation thimbles in up to 50 core locations. Figure 1.3 shows the available locations monitored by the movable detectors for Cycle 9. For each traverse, the detector voltage output is continuously monitored on a strip chart recorder, and scanned for 61 discrete axial points by the PRODAC P-250 process computer. Full core, three-dimensional power distributions are determined from this data using the Westinghouse computer program, INCORE[3]. INCORE couples the measured voltages with predetermined analytic power-to-flux ratios in order to determine the power distribution for the whole core.

A list of the full-core flux maps taken during the startup test program and the measured values of the important power distribution parameters is given in Table 6.1. A comparison of these measured values with their Technical Specification limits is given in Table 6.2. Flux Map 1 was taken at 30% power to verify the radial power distribution (RPD) predictions at low power. Figure 6.1 shows the measured RPDs from this flux map. Flux maps 2 and 3 were taken at 73% and 99% power levels respectively with different control rod configurations. These radial power distributions for these maps are given in Figures 6.2 and 6.3. The radial power distributions for the maps given in Figures 6.1, 6.2 and 6.3 show that the measured relative assembly power values were generally within 1.8% of the predicted values. Further, the measured F-Q(Z) and

F-DH(N) peaking factor values for the at-power flux maps were within the limits of Technical Specifications 3.2.2 and 3.2.3, respectively.

In conclusion, the 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 9.

TABLE 6.1

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
INCORE FLUX MAP SUMMARY

MAP DESCRIPTION	MAP NO.	DATE	BURN UP MWD/MTU	PWR (%)	BANK D STEPS	F-Q(Z) HOT CHANNEL FACTOR[1]				F-DH(N) HOT CHNL.FACTOR			CORE F(Z) MAX		CORE TILT[2]		AXIAL OFF SET (%)	NO. OF THIMBLES
						ASSY	PIN	AXIAL POINT	F-Q(Z)	ASSY	PIN	F-DH(N)	AXIAL POINT	F(Z)	MAX	LOC		
LOW POWER	1	4-26-92	7	30	143	H 3	AA	31	2.122	L13	LP	1.501	31	1.348	1.011	NW	-5.52	46
QTPR VERIFICATION	2	4-27-92	36	73	184	L13	LN	27	1.982	L13	LN	1.447	27	1.288	1.006	NE	2.65	46
HOT FULL POWER	3	5-01-92	159	99	228	L13	LN	36	1.847	H 7	IH	1.411	31	1.210	1.009	NE	0.58	46

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 FULL 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. F-Q(Z) INCLUDES A TOTAL UNCERTAINTY OF 1.05 X 1.03.

2. CORE TILT - DEFINED AS THE AVERAGE QUADRANT POWER TILT FROM INCORE.

Table 6.2

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS COMPARISION OF MEASURED POWER DISTRIBUTION PARAMETERS WITH THEIR TECHNICAL SPECIFICATION LIMITS

MAP NO.	F-Q(Z) HOT CHANNEL FACTOR*			F-Q(Z) HOT CHANNEL FACTOR** (AT NODE OF MINIMUM MARGIN)				F-DH(N) HOT CHANNEL FACTOR		
	MEAS	LIMIT	MARGIN (%)	MEAS	LIMIT	NODE	MARGIN (%)	MEAS	LIMIT	MARGIN (%)
1	2.122	4.380	51.6	2.122	4.380	31	51.6	1.501	1.803	16.7
2	1.982	2.976	33.4	1.977	2.968	26	33.4	1.447	1.611	10.2
3	1.842	2.202	16.3	1.819	2.158	23	15.7	1.411	1.492	5.4

* The Technical Specification's limit for the heat flux hot channel factor, F-Q(Z), is a function of core height and power level. The value for F-Q(Z) listed above is the maximum value of F-Q(Z) in the core. The Technical Specification's limit listed above is evaluated at the plane of maximum F-Q(Z).

** The value for F-Q(Z) listed above is the value at the plane of minimum margin. The minimum margin values listed above are the minimum percent difference between the measured values of F-Q(Z) and the Technical Specification's limit for each map.

The measured F-Q(Z) hot channel factors include 8.15% total uncertainty.

Figure 6.1

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
30% POWER

PREDICTED
MEASURED
PCT DIFFERENCE

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
						0.23 0.24 2.6	0.27 0.28 2.3	0.23 0.24 0.3							1
				0.31 0.32 3.6	0.45 0.46 1.5	1.05 1.06 1.1	0.84 0.85 0.8	1.06 1.05 -0.2	0.45 0.44 -2.4	0.31 0.31 -1.2					2
			0.41 0.41 -0.3	1.17 1.16 -0.7	1.29 1.27 -1.6	1.28 1.29 1.0	1.30 1.31 0.9	1.28 1.27 -0.2	1.29 1.27 -1.3	1.17 1.16 -0.8	0.41 0.41 0.2				3
		0.40 0.40 0.4	0.93 0.93 -0.7	1.34 1.34 -0.3	1.25 1.26 0.6	1.36 1.38 2.0	1.32 1.34 1.9	1.35 1.36 0.5	1.24 1.25 0.4	1.34 1.33 -0.4	0.93 0.92 -0.6	0.40 0.40 -0.4			4
	0.31 0.30 -2.4	1.17 1.14 -2.5	1.34 1.32 -1.7	1.28 1.26 -1.3	1.26 1.26 0.2	1.18 1.23 4.4	1.29 1.34 4.5	1.17 1.21 3.0	1.25 1.27 1.5	1.26 1.27 0.4	1.34 1.32 -1.0	1.16 1.16 -0.7	0.31 0.31 1.3		5
	0.46 0.46 0.3	1.30 1.30 0.2	1.25 1.25 0.2	1.26 1.27 0.2	1.01 1.03 1.6	1.08 1.14 5.3	1.09 1.15 5.5	1.08 1.13 4.8	1.01 1.03 2.2	1.26 1.26 0.2	1.24 1.23 -1.1	1.29 1.27 -1.5	0.45 0.45 -0.8		6
0.24 0.24 2.4	1.06 1.07 1.0	1.28 1.29 0.4	1.36 1.35 -0.2	1.18 1.18 -0.6	1.09 1.08 -0.6	1.10 1.17 6.3	1.24 1.32 6.4	1.10 1.15 4.5	1.09 1.12 3.5	1.18 1.20 1.9	1.36 1.32 -2.3	1.27 1.25 -2.1	1.05 1.03 -2.3	0.23 0.23 -1.9	7
0.28 0.28 2.2	0.85 0.85 0.8	1.30 1.30 -0.0	1.32 1.33 0.9	1.29 1.32 1.6	1.10 1.12 1.7	1.25 1.24 -0.4	1.12 1.17 3.9	1.25 1.28 2.7	1.10 1.13 2.8	1.29 1.31 1.4	1.31 1.28 -2.4	1.30 1.27 -2.1	0.83 0.81 -1.6	0.28 0.28 -0.7	8
0.23 0.24 2.4	1.05 1.04 -0.8	1.28 1.25 -2.6	1.36 1.36 -0.4	1.18 1.21 1.9	1.09 1.11 1.9	1.10 1.13 2.3	1.24 1.27 2.4	1.10 1.13 2.6	1.09 1.11 2.4	1.18 1.19 1.5	1.35 1.32 -2.0	1.27 1.25 -2.1	1.06 1.05 -1.4	0.24 0.24 -0.6	9
	0.45 0.44 -2.8	1.29 1.25 -2.9	1.25 1.25 0.7	1.26 1.29 2.7	1.01 1.03 2.5	1.08 1.09 0.6	1.09 1.10 0.5	1.08 1.06 -1.6	1.01 0.99 -1.3	1.25 1.24 -0.8	1.24 1.24 -0.1	1.29 1.26 -2.3	0.45 0.45 -1.0		10
	0.31 0.31 2.3	1.17 1.17 0.2	1.34 1.35 1.6	1.26 1.28 1.4	1.25 1.26 0.8	1.17 1.17 0.3	1.28 1.28 -0.7	1.17 1.14 3.0	1.25 1.23 -2.2	1.26 1.25 -1.3	1.34 1.34 -0.1	1.16 1.15 -1.2	0.31 0.30 -1.6		11
		0.40 0.41 3.4	0.93 0.95 2.4	1.34 1.36 1.3	1.25 1.24 -0.2	1.36 1.32 -2.2	1.31 1.28 -2.3	1.35 1.30 -3.9	1.24 1.20 -3.3	1.34 1.31 -2.5	0.93 0.93 0.1	0.40 0.40 -0.1			12
			0.41 0.43 3.4	1.17 1.19 1.3	1.29 1.27 -1.6	1.28 1.24 -2.8	1.30 1.26 -3.3	1.27 1.21 -4.7	1.29 1.22 -5.1	1.17 1.13 -3.3	0.41 0.41 -0.2				13
				0.31 0.32 2.4	0.45 0.47 2.3	1.06 1.05 -0.8	0.84 0.82 -2.4	1.05 1.00 -4.7	0.45 0.43 -5.0	0.31 0.29 -5.8					14
						0.23 0.24 2.1	0.27 0.27 -1.2	0.23 0.22 -4.5							15

STANDARD
DEVIATION
=1.430

AVERAGE
PCT DIFFERENCE
= 1.8

SUMMARY

MAP NO: N2-9-01 DATE: 4/26/92 POWER: 30%

CONTROL ROD POSITIONS: F-Q(Z) = 2.122 CORE TILT:

D BANK AT 143 STEPS F-DH(N) = 1.501

NW 1.0107	NE 1.0035
SW 1.0028	SE 0.9831

F(Z) = 1.348

BURNUP = 7 MWD/MTU A.O. = -3.518%

Figure 6.2

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
73% POWER

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

 ...................                       ......................                ...............
 .   PREDICTED     .                       . 0.26 . 0.31 . 0.26 .                .  PREDICTED  .
 .   MEASURED      .                       . 0.26 . 0.31 . 0.25 .                .  MEASURED   .      1
 .PCT DIFFERENCE.  .                       .  0.0 . -0.3 . -2.2 .                .PCT DIFFERENCE.
 ...................         ..................................................  ...............
                             . 0.32 . 0.47 . 1.08 . 0.92 . 1.09 . 0.47 . 0.32 .
                             . 0.32 . 0.47 . 1.07 . 0.92 . 1.06 . 0.45 . 0.31 .                      2
                             .  0.2 .  0.5 . -0.4 . -0.7 . -2.2 . -4.6 . -2.6 .
                      ................................................................
                      . 0.41 . 1.14 . 1.25 . 1.26 . 1.29 . 1.26 . 1.25 . 1.14 . 0.41 .
                      . 0.41 . 1.12 . 1.24 . 1.26 . 1.29 . 1.25 . 1.23 . 1.12 . 0.41 .               3
                      . -1.5 . -1.7 . -1.4 . -0.0 . -0.1 . -0.9 . -1.5 . -1.2 . -0.4 .
               ..............................................................................
               . 0.40 . 0.91 . 1.29 . 1.21 . 1.32 . 1.29 . 1.31 . 1.21 . 1.29 . 0.91 . 0.40 .
               . 0.40 . 0.90 . 1.27 . 1.22 . 1.33 . 1.30 . 1.32 . 1.23 . 1.29 . 0.91 . 0.40 .        4
               . -1.8 . -1.6 . -1.1 .  0.2 .  0.9 .  0.9 .  0.4 .  1.5 .  0.1 .  -0. . -1.1 .
        ............................................................................................
        . 0.32 . 1.13 . 1.29 . 1.25 . 1.25 . 1.18 . 1.27 . 1.18 . 1.25 . 1.24 . 1.29 . 1.13 . 0.32 .
        . 0.31 . 1.09 . 1.26 . 1.23 . 1.25 . 1.22 . 1.31 . 1.22 . 1.28 . 1.25 . 1.28 . 1.12 . 0.32 . 5
        . -3.8 . -3.8 . -1.9 . -1.2 .  0.0 .  3.5 .  3.5 .  3.4 .  2.8 .  1.4 . -0.6 . -1.4 . -0.3 .
        ............................................................................................
        . 0.47 . 1.25 . 1.21 . 1.25 . 1.09 . 1.12 . 1.11 . 1.12 . 1.09 . 1.25 . 1.21 . 1.25 . 0.47 .
        . 0.46 . 1.23 . 1.20 . 1.25 . 1.10 . 1.17 . 1.16 . 1.17 . 1.13 . 1.27 . 1.21 . 1.24 . 0.46 . 6
        . -1.6 . -1.6 . -0.9 . -0.2 .  1.1 .  4.3 .  4.5 .  5.1 .  3.3 .  1.1 . -0.4 . -1.5 . -1.7 .
 ..........................................................................................................
 . 0.26 . 1.09 . 1.26 . 1.32 . 1.18 . 1.12 . 1.14 . 1.26 . 1.14 . 1.12 . 1.13 . 1.32 . 1.26 . 1.09 . 0.26 .
 . 0.26 . 1.09 . 1.25 . 1.31 . 1.18 . 1.12 . 1.20 . 1.32 . 1.19 . 1.17 . 1.22 . 1.31 . 1.24 . 1.07 . 0.26 . 7
 .  0.5 . -0.2 . -0.6 . -0.6 . -0.3 .  0.4 .  5.3 .  5.3 .  4.7 .  4.3 .  2.8 . -0.8 . -1.4 . -2.0 . -2.2 .
 ..........................................................................................................
 . 0.31 . 0.93 . 1.29 . 1.29 . 1.28 . 1.12 . 1.26 . 1.15 . 1.26 . 1.12 . 1.28 . 1.29 . 1.30 . 0.92 . 0.32 .
 . 0.31 . 0.92 . 1.28 . 1.30 . 1.30 . 1.14 . 1.26 . 1.19 . 1.31 . 1.16 . 1.31 . 1.28 . 1.28 . 0.90 . 0.32 . 8
 .  0.2 . -0.4 . -0.8 .  0.4 .  1.5 .  1.6 .  0.0 .  3.7 .  3.6 .  3.6 .  2.4 . -0.9 . -1.5 . -1.7 . -1.5 .
 ..........................................................................................................
 . 0.26 . 1.08 . 1.26 . 1.32 . 1.18 . 1.12 . 1.14 . 1.26 . 1.14 . 1.12 . 1.18 . 1.32 . 1.26 . 1.10 . 0.27 .
 . 0.26 . 1.06 . 1.22 . 1.31 . 1.20 . 1.15 . 1.17 . 1.29 . 1.18 . 1.16 . 1.21 . 1.31 . 1.25 . 1.09 . 0.26 . 9
 .  0.5 . -1.9 . -3.3 . -0.8 .  1.8 .  2.4 .  2.9 .  3.0 .  3.5 .  3.4 .  2.5 . -0.6 . -1.3 . -1.4 . -1.5 .
 ..........................................................................................................
        . 0.47 . 1.25 . 1.21 . 1.25 . 1.09 . 1.12 . 1.11 . 1.12 . 1.09 . 1.25 . 1.21 . 1.26 . 0.47 .
        . 0.45 . 1.19 . 1.21 . 1.29 . 1.12 . 1.13 . 1.12 . 1.12 . 1.10 . 1.26 . 1.22 . 1.24 . 0.46 .10
        . -4.6 . -4.7 .  0.1 .  2.2 .  2.7 .  1.3 .  1.1 .  0.2 .  0.4 .  0.6 .  0.6 . -1.3 . -1.4 .
        ............................................................................................
        . 0.32 . 1.13 . 1.29 . 1.24 . 1.25 . 1.18 . 1.27 . 1.18 . 1.25 . 1.24 . 1.29 . 1.13 . 0.32 .
        . 0.31 . 1.11 . 1.28 . 1.26 . 1.26 . 1.18 . 1.27 . 1.16 . 1.24 . 1.23 . 1.29 . 1.13 . 0.31 .11
        . -1.6 . -1.6 . -0.4 .  2.1 .  1.2 .  0.3 .  0.2 . -1.3 . -0.7 . -0.2 .  0.3 . -0.6 . -1.4 .
        ............................................................................................
               . 0.40 . 0.91 . 1.29 . 1.21 . 1.31 . 1.29 . 1.31 . 1.21 . 1.29 . 0.91 . 0.40 .
               . 0.41 . 0.93 . 1.31 . 1.22 . 1.29 . 1.27 . 1.28 . 1.19 . 1.27 . 0.91 . 0.40 .       12
               .  1.4 .  1.7 .  2.0 .  0.8 . -1.4 . -1.4 . -2.3 . -2.6 . -1.5 .  0.2 .  0.1 .
               ..............................................................................
                      . 0.41 . 1.14 . 1.25 . 1.26 . 1.29 . 1.26 . 1.25 . 1.14 . 0.41 .
                      . 0.42 . 1.16 . 1.23 . 1.24 . 1.26 . 1.21 . 1.20 . 1.11 . 0.41 .              13
                      .  1.4 .  2.0 . -1.5 . -1.8 . -2.4 . -3.5 . -4.2 . -2.5 .  0.0 .
                      ................................................................
                             . 0.32 . 0.47 . 1.09 . 0.92 . 1.08 . 0.47 . 0.32 .
                             . 0.32 . 0.47 . 1.08 . 0.90 . 1.04 . 0.45 . 0.30 .                     14
                             .  0.5 .  0.4 . -0.9 . -2.2 . -3.5 . -4.1 . -4.7 .
    ..................       ..................................................  ...............
    .   STANDARD     .                     . 0.26 . 0.31 . 0.26 .                .   AVERAGE   .
    .   DEVIATION    .                     . 0.26 . 0.30 . 0.25 .                .PCT DIFFERENCE.    15
    .    =1.341      .                     .  0.1 . -1.9 . -3.8 .                .   = 1.7     .
    ..................                     ......................                ...............
```

<u>SUMMARY</u>

```
MAP NO:  N2-9-02          DATE:  4/27/92           POWER:  73%

CONTROL ROD POSITIONS:    F-Q(Z)  = 1.982          CORE TILT:

 D BANK AT 184 STEPS      F-DH(N) = 1.447          NW  1.0005 | NE  1.0060
                                                   ___________|___________
                          F(Z)    = 1.268          SW  0.9997 | SE  0.9937

                          BURNUP  =    36 MWD/MTU  A.O. =  2.646%
```

Figure 6.3

NORTH ANNA UNIT 2 - CYCLE 9 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
99% POWER

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

     .................                    ......................             .................
     .  PREDICTED    .                    . 0.27 . 0.33 . 0.27 .             .  PREDICTED    .
     .  MEASURED     .                    . 0.27 . 0.33 . 0.27 .             .  MEASURED     .        1
     .PCT DIFFERENCE.                     . -0.2 . -0.2 . -1.3 .             .PCT DIFFERENCE.
     .................             ..................................... .................
                            . 0.32 . 0.47 . 1.10 . 0.98 . 1.10 . 0.47 . 0.32 .
                            . 0.32 . 0.47 . 1.08 . 0.97 . 1.08 . 0.46 . 0.32 .                       2
                            .  2.2 . -0.3 . -1.2 . -1.3 . -2.0 . -2.4 . -0.8 .
                     ...............................................................
                     . 0.41 . 1.11 . 1.23 . 1.25 . 1.28 . 1.25 . 1.23 . 1.11 . 0.41 .
                     . 0.41 . 1.10 . 1.20 . 1.24 . 1.27 . 1.24 . 1.22 . 1.12 . 0.42 .                3
                     . -0.8 . -1.1 . -2.3 . -0.9 . -1.1 . -0.9 . -0.5 .  0.6 .  2.5 .
              .............................................................................
              . 0.40 . 0.89 . 1.25 . 1.19 . 1.30 . 1.27 . 1.29 . 1.19 . 1.25 . 0.89 . 0.40 .
              . 0.40 . 0.88 . 1.24 . 1.19 . 1.30 . 1.27 . 1.29 . 1.21 . 1.27 . 0.90 . 0.40 .         4
              . -0.8 . -1.5 . -1.0 . -0.5 .  0.1 . -0.0 . -0.3 .  1.8 .  1.0 .  0.7 .  0.5 .
       ...........................................................................................
       . 0.32 . 1.11 . 1.25 . 1.23 . 1.25 . 1.18 . 1.26 . 1.18 . 1.25 . 1.22 . 1.26 . 1.11 . 0.32 .
       . 0.31 . 1.07 . 1.22 . 1.21 . 1.24 . 1.21 . 1.30 . 1.21 . 1.29 . 1.24 . 1.25 . 1.10 . 0.32 .  5
       . -3.7 . -3.7 . -2.4 . -1.9 . -0.7 .  2.8 .  2.8 .  2.9 .  2.8 .  1.5 . -0.3 . -0.5 .  1.4 .
       ...........................................................................................
       . 0.47 . 1.23 . 1.17 . 1.26 . 1.16 . 1.14 . 1.13 . 1.14 . 1.16 . 1.26 . 1.20 . 1.23 . 0.48 .
       . 0.46 . 1.20 . 1.17 . 1.25 . 1.16 . 1.19 . 1.17 . 1.20 . 1.20 . 1.27 . 1.19 . 1.22 . 0.47 .  6
       . -2.2 . -2.2 . -1.5 . -0.9 .  0.4 .  3.8 .  3.9 .  4.7 .  3.6 .  1.0 . -0.3 . -1.1 . -0.8 .
.........................................................................................................
. 0.28 . 1.11 . 1.25 . 1.30 . 1.18 . 1.15 . 1.16 . 1.27 . 1.16 . 1.15 . 1.19 . 1.30 . 1.26 . 1.11 . 0.28 .
. 0.28 . 1.09 . 1.23 . 1.28 . 1.17 . 1.14 . 1.21 . 1.33 . 1.21 . 1.20 . 1.22 . 1.29 . 1.24 . 1.09 . 0.27 .   7
. -0.1 . -1.2 . -1.7 . -1.4 . -1.1 . -1.1 .  4.8 .  4.8 .  4.6 .  4.4 .  2.7 . -1.3 . -1.7 . -2.1 . -2.0 .
.........................................................................................................
. 0.34 . 0.98 . 1.28 . 1.27 . 1.27 . 1.13 . 1.27 . 1.16 . 1.27 . 1.13 . 1.27 . 1.28 . 1.30 . 0.99 . 0.35 .
. 0.34 . 0.97 . 1.26 . 1.27 . 1.28 . 1.15 . 1.26 . 1.21 . 1.32 . 1.18 . 1.30 . 1.26 . 1.28 . 0.97 . 0.35 .   8
. -0.1 . -1.2 . -1.8 . -0.3 .  1.1 .  1.2 . -0.6 .  4.2 .  3.9 .  3.9 .  2.5 . -1.4 . -1.7 . -1.3 . -0.9 .
.........................................................................................................
. 0.27 . 1.10 . 1.25 . 1.30 . 1.18 . 1.15 . 1.15 . 1.27 . 1.16 . 1.15 . 1.18 . 1.30 . 1.26 . 1.12 . 0.28 .
. 0.27 . 1.07 . 1.20 . 1.28 . 1.20 . 1.17 . 1.19 . 1.30 . 1.20 . 1.20 . 1.22 . 1.29 . 1.25 . 1.12 . 0.28 .   9
. -0.1 . -2.6 . -3.8 . -1.2 .  1.4 .  1.8 .  2.9 .  2.9 .  3.9 .  3.9 .  2.9 . -0.7 . -0.8 . -0.7 . -0.1 .
.........................................................................................................
       . 0.47 . 1.23 . 1.19 . 1.25 . 1.16 . 1.14 . 1.13 . 1.14 . 1.16 . 1.26 . 1.19 . 1.23 . 0.48 .
       . 0.45 . 1.17 . 1.19 . 1.29 . 1.19 . 1.16 . 1.14 . 1.15 . 1.17 . 1.27 . 1.21 . 1.23 . 0.48 .  10
       . -4.9 . -4.9 . -0.0 .  2.6 .  2.7 .  1.2 .  0.9 .  0.4 .  1.2 .  1.1 .  1.0 . -0.1 . -0.0 .
       ...........................................................................................
       . 0.32 . 1.10 . 1.25 . 1.22 . 1.25 . 1.18 . 1.26 . 1.18 . 1.25 . 1.22 . 1.26 . 1.11 . 0.32 .
       . 0.31 . 1.09 . 1.25 . 1.25 . 1.26 . 1.18 . 1.26 . 1.17 . 1.25 . 1.23 . 1.27 . 1.12 . 0.32 .  11
       . -1.2 . -1.2 . -0.1 .  2.1 .  1.1 .  0.1 .  0.0 . -1.2 . -0.1 .  0.5 .  1.3 .  0.6 .  1.0 .
       ...........................................................................................
              . 0.40 . 0.89 . 1.25 . 1.19 . 1.29 . 1.27 . 1.30 . 1.19 . 1.25 . 0.89 . 0.40 .
              . 0.41 . 0.91 . 1.28 . 1.20 . 1.27 . 1.25 . 1.26 . 1.18 . 1.26 . 0.91 . 0.41 .         12
              .  2.5 .  2.3 .  2.1 .  0.2 . -1.8 . -1.8 . -2.4 . -1.5 . -1.0 .  1.4 .  1.7 .
              .............................................................................
                     . 0.41 . 1.11 . 1.23 . 1.25 . 1.28 . 1.25 . 1.23 . 1.11 . 0.41 .
                     . 0.42 . 1.13 . 1.21 . 1.22 . 1.25 . 1.20 . 1.18 . 1.09 . 0.42 .                13
                     .  2.5 .  2.1 . -1.6 . -2.3 . -2.7 . -3.6 . -4.0 . -2.1 .  1.5 .
                     ...............................................................
                            . 0.32 . 0.47 . 1.10 . 0.98 . 1.10 . 0.47 . 0.32 .
                            . 0.32 . 0.48 . 1.09 . 0.96 . 1.06 . 0.45 . 0.30 .                       14
                            .  0.7 .  0.7 . -1.0 . -2.0 . -3.6 . -3.9 . -4.3 .
     .................      .................................................     .................
     .  STANDARD     .                    . 0.27 . 0.33 . 0.27 .             .   AVERAGE      .
     .  DEVIATION    .                    . 0.28 . 0.33 . 0.26 .             .PCT DIFFERENCE.        15
     .  =1.280       .                    .  0.7 . -1.3 . -3.5 .             .    = 1.7       .
     .................                    ......................             .................
```

SUMMARY

```
MAP NO:  N2-9-03          DATE:  5/01/92          POWER: 99%

CONTROL ROD POSITIONS:    F-Q(Z)  = 1.842         CORE TILT:

 D BANK AT 228 STEPS      F-DH(N) = 1.411         NW  0.9943 | NE  1.0089
                                                  ___________|___________
                          F(Z)    = 1.210         SW  0.9978 | SE  0.9990

                          BURNUP  =   159 MWD/MTU   A.O. =  0.532%
```

SECTION 7

REFERENCES

1. A. H. Nicholson, "North Anna Unit 2, Cycle 9 Design Report," Technical Report NE-885, Revision 0, Virginia Power, April, 1992.

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

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

4. North Anna Unit 2 Technical Specifications, Sections 3.1.3.4, 3.2.2, 3.2.3, 3.1.1.4 and 4.1.1.1.2.

5. Letter from W.L Stewart (Virginia Power) to the U.S.N.R.C., "Surry Power Station Units 1 and 2, North Anna Power Station Units 1 and 2: Modification of Startup Physics Test Program - Inspector Followup Item 280, 281/88-29-01," Serial No. 89-541, December 8,1989.

6. Memorandum from C.B. LaRoe and R.T. Robins to Mr. R.G. McAndrew, "Evaluation of Measured N2C9 HZP ARO Critical Boron Concentration," April 22, 1992.

APPENDIX

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEETS

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Reactivity Computer Checkout Proc No /Section: 2-PT-94.0	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
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: ~~228~~ 198 4/22/92 CD: 70 Date/Time Test Performed: 0128 4/22/92	RCS Temperature (°F): 546.0 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Measured Parameter (Description)	ρ_c = Meas. Reactivity using ρ-computer ρ_t = Predicted Reactivity
	Measured Value	ρ_c = -46.0 +45.5 ρ_t = -47.2 +45.9 %D = -2.54 -0.87
	Design Value	%D = $((\rho_c - \rho_t)/\rho_t) \times 100\% \leq 4.0\%$
	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 : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	
	* At The Just Critical Position Allowable Range = +45.5, -46.0	

Prepared By:

4/22/92

Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: HZP Boron Worth Coefficent Measurement Proc No /Section: 2-PT-94.0 Sequence Step No: 7	
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): 547 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 4/22/92 0430	
	Measured Parameter (Description)	αC_B, Boron Worth Coefficient
	Measured Value	αC_B = -6.86 ~~-6.97~~ PDB
	Design Value (Design Conditions)	αC_B = -6.81 ± 0.68 pcm/ppm
	Reference	Technical Report NE-885, Rev. 0
V Acceptance Criteria	FSAR/Tech Spec	Not Applicable
	Reference	Not Applicable
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	

Prepared By: Pamela D [illegible] Reviewed By: William K [illegible]

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - ARO Proc No /Section: 2-PT-94.0 Sequenca 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): 546.6 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 0431 4/22/92	
IV	Meas Parameter (Description)	$(C_B)^{M}_{ARO}$; Critical Boron Conc - ARO
Test Results	Measured Value (Design Cond)	$(C_B)^{M}_{ARO}$: 2096
	Design Value (Design Cond)	$C_B = 2053 \pm 32$ ppm
	Reference	Technical Report NE-885, Rev. 0
V Acceptance Criteria	FSAR/Tech Spec	$\alpha C_B \times C_B^{D} \leq 1000$ pcm
	Reference	Technical Specification 4.1.1.1.2
	Design Tolerance is met : ___YES ✓ NO Acceptance Criteria is met : ✓ YES ___NO	
VI Comments	$\alpha C_B = -6.78$ pcm/ppm $C_B^{D} = \lvert (C_B)^{M}_{ARO} - C_B \rvert$; C_B is design value.	

Prepared by:

Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Isothermal Temperature Coefficient - ARO Proc No /Section: 2-PT-94.0 Sequence Step No: 5	
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: 213	RCS Temperature (°F): 547.4 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 4/22/92 0442	
IV	Meas Parameter (Description)	$(\alpha_T^{ISO})_{ARO}$ Isothermal Temp Coeff - ARO
Test Results	Measured Value	$(\alpha_T^{ISO})_{ARO}$ = -1.75 pcm/°F (C_B =2093ppm)
	Design Value (Actual Cond)	$(\alpha_T^{ISO})_{ARO}$ = -1.08 pcm/°F (C_B =2093ppm)
	Design Value (Design Cond)	$(\alpha_T^{ISO})_{ARO}$ = -1.45 ± 3.0 pcm/°F (C_B = 2053 ppm)
	Reference	Technical Report NE-885, Rev. 0
V Acceptance Criteria	FSAR/Tech Spec	$\alpha_T^{ISO} \leq 3.73^*$pcm/°F α_T^{Dop} = -1.77 pcm/°F
	Reference	TS 3.1.1.4, Technical Report NE-885, Rev. 0
VI	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	
Comments	* Uncertainty on αT_{MOD} = 0.5 pcm/°F (Reference: memorandum from C. T. Snow to E. J. Lozito dated June 27, 1980).	

Prepared By: Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank B Worth Meas.,Rod Swap Ref. Bank Proc No /Section: 2-PT-94.0 Sequence Step No: 6	
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): 547.2 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 4/22/92 0542	
IV Test Results	Measured Parameter (Description)	I_B^{REF} ; Integral Worth of Cntl Bank B, All Other Rods Out
	Measured Value	I_B^{REF} = 1227.5 pcm
	Design Value (Design Conditions)	I_B^{REF} = 1288 ± 129 pcm
	Reference	Technical Report NE-885, Rev. 0
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 : ✓ YES ___ NO Acceptance Criteria is met : ✓ YES ___ NO	

Prepared By: Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - B Bank In Proc No /Section: 2-PT-94.0 Sequence Step No: 7	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 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): 547 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 4/22/92 / 0542	
IV Test Results	Meas Parameter (Description)	$(C_B)_B^M$; Critical Boron Conc - B Bank In
	Measured Value (Design Cond)	$(C_B)_B^M =$ 1917
	Design Value (Design Cond)	$C_B = 1864 + \Delta C_B^{Prev} \pm (10 + 128.8/\lvert\alpha C_B\rvert)$ppm $C_B =$ ~~1904~~ 1907 ppm ± 29
	Reference	Technical Report NE-885, Rev. 0
V Acceptance Criteria	FSAR/Tech Spec	Not Applicable
	Reference	Not Applicable
	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	
VI Comments	$\alpha C_B = -6.81$ pcm/ppm $\Delta C_B^{Prev} = (C_B)_{ARO}^M - 2053$	

Prepared By: William R Kohlwer 4/22/92 Reviewed By: Pamela D. Bannon 4/22/92

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank D Worth Measurement-Rod Swap Proc No /Section: 2-PT-94.0 Sequence Step No: 8	
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): 547.2 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 4/22/92 1119	
	Meas Parameter (Description)	I_D^{RS} ; Int Worth of Cntl Bank D-Rod Swap
	Measured Value	I_D^{RS} = 980.1 (Adj. Meas. Crit. Ref Bank Position = ~~170~~ 172.1 steps)
	Design Value (Actual Cond)	I_D^{RS} = 939.9 ± 141 (Adj. Meas. Crit. Ref Bank Position = ~~170~~ 172.1 steps)
	Design Value (Design Cond)	I_D^{RS} = 941 ± 141 pcm (Critical Ref Bank Position = 164 steps)
	Reference	Technical Report NE-885, Rev. 0, VEP-FRD-36A
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 : ✓ YES ___ NO Acceptance Criteria is met : ✓ YES ___ NO	

Prepared By: Pamela D Bamstone Reviewed By: William R Kohleiser

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank C Worth Measurement-Rod Swap Proc No /Section: 2-PT-94.0 Sequence Step No: 9	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB:Moving CC:MovingCD: 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:MovingCD: 228	RCS Temperature (°F): 546.8 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 4/22/92 150	
IV Test Results	Meas Parameter (Description)	I_C^{RS} ; Int Worth of Cntl Bank C-Rod Swap
	Measured Value	I_C^{RS} = 829.8 (Adj. Meas. Crit. Ref Bank Position =149.6 steps)
	Design Value (Actual Cond)	I_C^{RS} = 765.6 ±115 (Adj. Meas. Crit. Ref Bank Position =149.6steps)
	Design Value (Design Cond)	I_C^{RS} = 765 ± 115 pcm (Critical Ref Bank Position = 142 steps)
	Reference	Technical Report NE-885, Rev. 0, VEP-FRD-36A
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 : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	

Prepared By: Pamela D. [illegible] Reviewed By: William R. [illegible]

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

<table>
<tr><td>I
Reference</td><td colspan="3">Test Description: Cntl Bank A Worth Measurement-Rod Swap
Proc No /Section: 2-PT-94.0 Sequence Step No: 10</td></tr>
<tr><td rowspan="2">II
Test
Conditions
(Design)</td><td colspan="2">Bank Positions (Steps)</td><td rowspan="2">RCS Temperature (°F): 547
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating</td></tr>
<tr><td colspan="2">SDA: 228 SDB: 228 CA:Moving
CB:Moving CC: 228 CD: 228</td></tr>
<tr><td rowspan="3">III
Test
Conditions
(Actual)</td><td colspan="2">Bank Positions (Steps)</td><td rowspan="3">RCS Temperature (°F): 547.
Power Level (% F.P.): 0
Other (Specify):
Below Nuclear Heating</td></tr>
<tr><td colspan="2">SDA: 228 SDB: 228 CA:Moving
CB:Moving CC: 228 CD: 228</td></tr>
<tr><td colspan="2">Date/Time Test Performed:
4/22/92 1224</td></tr>
<tr><td rowspan="5">IV
Test
Results</td><td>Meas Parameter
(Description)</td><td colspan="2">I_A^{RS} ; Int Worth of Cntl Bank A-Rod Swap</td></tr>
<tr><td>Measured Value</td><td colspan="2">I_A^{RS} = 213.1 (Adj. Meas. Crit. Ref Bank Position = 73.9 steps)</td></tr>
<tr><td>Design Value
(Actual Cond)</td><td colspan="2">I_A^{RS} = 227.1 ± 100 (Adj. Meas. Crit. Ref Bank Position = 73.9 steps)</td></tr>
<tr><td>Design Value
(Design Cond)</td><td colspan="2">I_A^{RS} = 236 ± 100 pcm (Critical Ref Bank Position = 82 steps)</td></tr>
<tr><td>Reference</td><td colspan="2">Technical Report NE-885, Rev. 0, VEP-FRD-36A</td></tr>
<tr><td rowspan="2">V
Acceptance
Criteria</td><td>FSAR/Tech Spec</td><td colspan="2">If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.</td></tr>
<tr><td>Reference</td><td colspan="2">VEP-FRD-36A</td></tr>
<tr><td rowspan="2">VI
Comments</td><td colspan="3">Design Tolerance is met : ✓ YES __NO
Acceptance Criteria is met : ✓ YES __NO</td></tr>
<tr><td colspan="3"></td></tr>
</table>

Prepared By: William R. Kellner Reviewed By: Pamela D. Bannister

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank B Worth Meas. - Rod Swap Proc No /Section: 2-PT-94.0 Sequence Step No: 11	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB:Moving 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:Moving CA: 228 CB:Moving CC: 228 CD: 228	RCS Temperature (°F): 547.4 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 4/22/92 1244	
IV Test Results	Meas Parameter (Description)	I_{SB}^{RS}; Int Worth of Shutdown Bank B-Rod Swap
	Measured Value	I_{SB}^{RS} = 1066.8 (Adj. Meas. Crit. Ref Bank Position = 186.0 steps)
	Design Value (Actual Cond)	I_{SB}^{RS} = 988.8 ± 148 (Adj. Meas. Crit. Ref Bank Position = 186.0 steps)
	Design Value (Design Cond)	I_{SB}^{RS} = 979 ± 147 pcm (Critical Ref Bank Position = 169 steps)
	Reference	Technical Report NE-885, Rev. 0, VEP-FRD-36A
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 : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	

Prepared By: Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank A Worth Meas. - Rod Swap Proc No /Section: 2-PT-94.0	Sequence Step No: 12
	Bank Positions (Steps) SDA:MovingSDB: 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:MovingSDB: 228 CA: 228 CB:Moving CC: 228 CD: 228	RCS Temperature (°F): 547.6 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 4/22/92 1311	
IV Test Results	Meas Parameter (Description)	I_{SA}^{RS}; Int Worth of Shutdown Bank A-Rod Swap
	Measured Value	I_{SA}^{RS} = 1009.0 (Adj. Meas. Crit. Ref Bank Position = 176.6 steps)
	Design Value (Actual Cond)	I_{SA}^{RS} = 1061.5 ± 159 (Adj. Meas. Crit. Ref Bank Position = 176.6 steps)
	Design Value (Design Cond)	I_{SA}^{RS} = 1063 ± 159 pcm (Critical Ref Bank Position = 180 steps)
	Reference	Technical Report NE-885, Rev. 0, VEP-FRD-36A
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 : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	

Prepared By: William R

Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Total Rod Worth - Rod Swap Proc No /Section: 2-PT-94.0	Sequence Step No: 12
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): 547.2 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 4/22/92 0542	
IV Test Results	Meas Parameter (Description)	I_{Total}; Int Worth of All Banks - Rod Swap
	Measured Value	I_{Total} = 5326.3 pcm
	Design Value (Actual Cond)	I_{Total} = 5270.9 ± 527 pcm
	Design Value (Design Cond)	I_{Total} = 5272 ± 527 pcm
	Reference	Technical Report NE-885, Rev. 0, VEP-FRD-36A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. Additional testing must be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	

Prepared By:

Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference

Test Description: M/D Flux Map-At Power
Proc No / Section: 2-PT-94.0,2-PT-21.1 Sequence Step No: 34

II Test Conditions (Design)

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

RCS Temperature (°F): T_{REF} ±
Power Level (% F.P.): ≤30
Other (specify):
Must have 16 thimbles**

III Test Conditions (Actual)

Bank Positions (Steps)
SDA: 228 SDB: 228 CA: 228
CB : 228 CC : 228 CD: 143

RCS Temperature(°F): TREF
Power Level (% F.P.): 30.0%
Other (Specify):
46 thimbles

Date/Time Test Performed:
[illegible]/26/92 4:27

IV Test Results	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(Z)	MAXIMUM POS. INCORE QUADRANT POWER TILT
	Measured Value	6.4 For $P_i \geq 0.9$ -5.8 For $P_i < 0.9$	1.351	2.172	1.011
	Design Value (Design Conds)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.0213
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.49(1+0.3(1-P))$	$F_Q(Z) \leq 4.38 \times K(Z)$	NONE
	Reference	NONE	TS 3.2.3	TS 3.2.2	NONE

VI Comments

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

* As Required
** Must have at least 16 thimbles for quarter core maps for multi-point calibrations.

Prepared By: Thomas S. [illegible]   Reviewed By: [illegible]

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map-At Power Proc No / Section: 2-PT-94.0,2-PT-21.1 Sequence Step No: 36	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB : 228 CC : * CD: *	RCS Temperature (°F): T_{REF} ±1 Power Level (% F.P.): 50%≤P≤75% Other (specify): Must have ≥ 38 thimbles**
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 228 SDB: 228 CA: 228 CB : 228 CC : 228 CD: 184	RCS Temperature(°F): Tref Power Level (% F.P.): 72.8 % Other (Specify): 46 Thimbles
	Date/Time Test Performed: 4/27/92 2230	

IV Test Results	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(Z)	MAXIMUM POS. INCORE QUADRANT POWER TILT
	Measured Value	5.3% for P ≥ 0.90 -4.7% for P < 0.90	1.4465	1.9773	1.006
	Design Value (Design Conds)	[illegible]	NA	NA	≤ 1.0207
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	[illegible]	[illegible]	NONE
	Reference	NONE	TS 3.2.3	TS 3.2.2	NONE

VI Comments

Design Tolerance is met : ✓ YES ___NO

Acceptance Criteria is met : ✓ YES ___NO

* As Required

** Must have at least 16 thimbles for quarter core maps for multi-point calibrations.

Prepared By: Brandon D Bowman

Reviewed By:

NORTH ANNA POWER STATION UNIT 2 CYCLE 9
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map-At Power Proc No / Section: 2-PT-94.0,2-PT-21.1 Sequence Step No: 37	
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.): 95%≤P≤100% 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	RCS Temperature(°F): T_{REF} Power Level (% F.P.): 99.45% Other (Specify): 46 THIMBLES
	Date/Time Test Performed: 5-1-92 0820	

IV Test Results	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(Z)	MAXIMUM POS. INCORE QUADRANT POWER TILT
	Measured Value	-4.9% FOR P ≥ 0.90 -4.9% FOR P < 0.90	1.4107	1.8188	1.0089
	Design Value (Design Conds)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.0211
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.49(1+.3(1-P))$	$F_Q(Z) \leq 2.19/P \times K(Z)$	NONE
	Reference	NONE	TS 3.2.3	TS 3.2.2	NONE

VI
Comments

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

* As Required
** Must have at least 16 thimbles for quarter core maps for multi-point calibrations.

Prepared By: Al P Mi   Reviewed By: D.S. McCandless