VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

August 21, 1995

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NL&P/JDH/CMC
Docket No. 50-338
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Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
NORTH ANNA POWER STATION UNIT 2
CYCLE 11 STARTUP PHYSICS TESTS REPORT

For your information, enclosed are five copies of the Virginia Electric and Power Company Technical Report NE-1039, Revision 0, entitled "North Anna Unit 2, Cycle 11 Startup Physics Tests Report."

Should you have any questions or require additional information, please contact us.

Very truly yours,

M. R. Kansler,
Vice President - Nuclear Services

Enclosure

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

Mr. R. D. McWhorter
NRC Senior Resident Inspector
North Anna Power Station

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North Anna Unit 2 Cycle 11 Startup Physics Tests Report

Nuclear Analysis and Fuel
Nuclear Engineering Services

August, 1995

VIRGINIA POWER

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TECHNICAL REPORT NE-1039 - REV. 0

NORTH ANNA UNIT 2, CYCLE 11

STARTUP PHYSICS TESTS REPORT

NUCLEAR ANALYSIS AND FUEL
NUCLEAR ENGINEERING SERVICES
VIRGINIA POWER
AUGUST 1995

PREPARED BY: T. L. Wheeler 7-26-95
T. L. Wheeler Date

REVIEWED BY: Pamela D. Banning 7/27/95
P. D. Banning Date

REVIEWED BY: A. P. Main 8-2-95
A. P. Main Date

APPROVED BY: D. Dziaobsz 8/3/95
D. Dziaobsz Date

QA Category: Nuclear Safety Related

Keywords: N2C11, Startup

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PREFACE

This report presents the analysis and evaluation of the physics tests which were performed to verify that the North Anna 2, Cycle 11 core could be operated safely, and makes 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 testing 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 11 startup physics tests results and evaluation sheets are 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 (at design conditions) 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 Electric and Power Company'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 March 25, 1995 Unit No. 2 of the North Anna Power Station shutdown for its tenth refueling. During this shutdown, 73 of the 157 fuel assemblies in the core were replaced with 64 fresh fuel assemblies, 1 once-burned fuel assembly, and 8 thrice-burned fuel assemblies. The eleventh cycle core consists of 8 sub-batches of fuel: three once-burned batches, two from Cycle 10 (batches 12A, and 12B) and one from North Anna 2 Cycle 7 (batch 9A); two twice-burned batches from Cycles 9 and 10 (batches 11A and 11B); one thrice-burned batch from Cycles 4, 5, and 6 (batch 6); and two fresh batches (batches 13A and 13B). Batches 11 and 12 have top and bottom grids of Inconel-718 while the inner six grids are made of Zircaloy-4. Batch 13 has top and bottom grids of Inconel-718, six inner grids made of ZIRLO (ZIRLO provides improved corrosion resistance and dimensional stability under irradiation relative to Zircaloy-4 components), and one Inconel-718 protective grid placed below the fuel and above the bottom nozzle for debris resistance. All other batches are composed of 8 Inconel-718 grids.

Cycle 11, similar to Cycle 10, incorporated the burnable poison rod design made of B_4C in Alumina, which is available in various enrichments of B_4C. There are no thimble plugging devices inserted in N2C11. Reference 1 provides a more detailed description of the Cycle 11 core.

The core loading pattern and the design parameters for each sub-batch are shown in Figure 1.1. Fuel assembly burnups are given in Figure 1.2.

These burnups are documented in reference 6. The available incore moveable detector locations used for the BOC flux map analyses are identified in Figure 1.3. Figure 1.4 identifies the location and number of burnable poison rods and source assemblies for Cycle 11, and Figure 1.5 identifies the location and number of control rods in the Cycle 11 core.

On May 31, 1995 at 0516, the Cycle 11 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 were measured using the rod swap technique[2,5] and the results were within 5.6% of the design predictions. The sum of the individual measured control rod bank worths was within 1.9% 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. Measured critical boron concentrations for two control bank configurations were within 8 ppm of the design predictions. These results were within the design tolerances and also 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.

4. The boron worth coefficient measurement was within 4.1% of the design prediction, which is within the design tolerance of ±10%.

5. The measured isothermal temperature coefficient (ITC) for the all-rods-out (ARO) configuration was within 0.34 pcm/°F of the design prediction. This result is within the design tolerance of ±3 pcm/°F. The measured ITC of -2.93 pcm/°F meets the Core Operating Limits Report (COLR) 2.1.1 criterion that the moderator temperature coefficient (MTC) be less than or equal to +6.0 pcm/°F. When the Doppler temperature coefficient and a 0.5 pcm/°F uncertainty are accounted for in the MTC limit, the MTC requirement is satisfied as long as the ITC is less than or equal to +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 1.7% of the design predictions. The heat flux hot channel factors, F-Q(Z), and enthalpy rise hot channel factors, F-DH(N), were within the limits of COLR Sections 2.5.1 and 2.6, respectively.

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

Table 1.1

NORTH ANNA 2 - CYCLE 11 STARTUP PHYSICS TESTS
CHRONOLOGY OF TESTS

Test	Date	Time	Power	Reference Procedure
Hot Rod Drop - Hot Full Flow	05/30/95	1400	HSD	2-PT-17.2
Zero Power Testing Range	05/31/95	0609	HZP	2-PT-94.0
Reactivity Computer Checkout	05/31/95	0658	HZP	2-PT-94.0
Temperature Coefficient - ARO	05/31/95	1046	HZP	2-PT-94.0
Boron Endpoint - ARO	05/31/95	1028	HZP	2-PT-94.0
Bank B Worth	05/31/95	1153	HZP	2-PT-94.0
Boron Endpoint - B in	05/31/95	1153	HZP	2-PT-94.0
Bank D Worth - Rod Swap	05/31/95	1537	HZP	2-PT-94.0
Bank C Worth - Rod Swap	05/31/95	1630	HZP	2-PT-94.0
Bank A Worth - Rod Swap	05/31/95	1701	HZP	2-PT-94.0
Bank SB Worth - Rod Swap	05/31/95	1725	HZP	2-PT-94.0
Bank SA Worth - Rod Swap	05/31/95	1805	HZP	2-PT-94.0
Flux Map - 29% Power	06/02/95	0056	29%	2-PT-94.0
Peaking Factor Verification				2-PT-21.1
& Power Range Calibration				2-PT-21.2
				2-PT-22.4
Flux Map - 74% Power	06/04/95	1125	74%	2-PT-94.0
Peaking Factor Verification				2-PT-21.1
& Power Range Calibration				2-PT-21.2
				2-PT-22.4
Flux Map - 100% Power	06/12/95	1016	100%	2-PT-94.0
Peaking Factor Verification				2-PT-21.1
& Power Range Calibration *				2-PT-21.2
				2-PT-22.4

* Power range calibration calculation was performed which verified that the existing calibration was satisfactory.

Figure 1.1

NORTH ANNA UNIT 2 - CYCLE 11
CORE LOADING MAP

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
						11B SL9	11A 2L0	11B SL1							1
				6 T50	12A 0M3	13B 5N4	12B 6M4	13B 2N9	12A 2M6	6 T39					2
			11B 6L7	13B 5N6	13B 4M7	12B 3M3	13B 3M5	12B 4M2	13B 4N8	13B 4N4	11B SL6				3
		11B SL5	12A 1M3	13B 6N1	12B 3M1	13A 2N8	12A 0M9	13A 1N8	12B 5M6	13B 6N2	12A 1M4	11B 6L6			4
	6 T13	13B 3M3	13B 6M3	12B 4M0	13A 0N2	12A 1M6	13A 0N6	12A 0M6	13A 1N0	12B 4M7	13B 3N2	13B 5N0	6 T29		5
	12A 2M8	13B 5N9	12B 3M4	13A 1N9	12A 1M1	13A 0N7	12B 3M7	13A 2N3	12A 1M8	13A 2N7	12B 3M9	13B 3M8	12A 2M7		6
11B 4L3	13B 3N9	12B 6M1	13A 1N2	12A 1M5	13A 2N2	12B 5M5	12B 2M9	12B 5M9	13A 0N4	12A 0M2	13A 1N1	12B 3M6	13B 5N7	11B 6L8	7
11A 3L8	12B 6M2	13B 4N3	12A 2M1	13A 0N1	12B 4M5	12B 3M5	9A X19	12B 4M1	12B 3M0	13A 2N1	12A 0M4	13B 5N3	12B 4M9	11A 1L4	8
11B 6L2	13B 3N4	12B 6M0	13A 2N0	12A 2M2	13A 1N3	12B 5M4	12B 3M8	12B 5M1	13A 1N4	12A 1M9	13A 2N4	12B 6M3	13B 4N2	11B 4L9	9
	12A 0M5	13B 5N2	12B 4M8	13A 0N5	12A 2M4	13A 1N7	12B 5M0	13A 2N6	12A 2M5	13A 1N5	12B 5M8	13B 4N7	12A 1M7		10
	6 T12	13B 5N8	13B 4N0	12B 5M3	13A 2N5	12A 0M8	13A 0N8	12A 1M0	13A 0N3	12B 3M2	13B 3N7	13B 6N0	6 T09		11
		11B 5L8	12A 0M1	13B 6N4	12B 4M6	13A 0N9	12A 1M2	13A 1N6	12B 5M7	13B 3N1	12A 2M3	11B 4L4			12
			11B 5L2	13B 4N1	13B 4N5	12B 4M4	13B 5M1	12B 5M2	13B 3N6	13B 4N6	11B 5L0				13
				6 T53	12A 2M0	13B 3N0	12B 4M3	13B 5N5	12A 0M7	6 T16					14
						11B 4L1	11A 2L7	11B 6L1							15

|--> BATCH
|--> ASSEMBLY ID

FUEL ASSEMBLY DESIGN PARAMETERS

	SUB-BATCH							
	6	9A	11A	11B	12A	12B	13A	13B
INITIAL ENRICHMENT (W/O U-235)	3.5959	3.8025	4.0155	4.2087	4.0067	4.2012	4.0052	4.2061
BURNUP AT BOC 11 (MWD/MTU)	38419	23870	37280	43248	25704	22461	0	0
ASSEMBLY TYPE	17x17	17x17	17x17	17x17	17x17	17x17	17x17	17x17
NUMBER OF ASSEMBLIES	8	1	4	16	28	36	28	36
FUEL RODS PER ASSEMBLY	264	264	264	264	264	264	264	264

Figure 1.2

NORTH ANNA UNIT 2 - CYCLE 11
BEGINNING OF CYCLE FUEL ASSEMBLY BURNUPS

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
						SL9 41578	2L0 37193	SL1 41659							1
				T50 38111	0M3 25228	5N4 0	6M4 20784	2M9 0	2M6 24896	T39 38383					2
			6L7 43950	5N6 0	4N9 0	3M3 23142	3N5 0	4M2 23764	4N8 0	4N4 0	5L6 43484				3
		5L5 45204	1M3 25525	6N1 0	3M1 25403	2N8 0	0M9 25212	1N8 0	5M6 24551	6N2 0	1M4 25841	6L6 43846			4
	T13 38620	3N3 0	6N3 0	4M0 20827	0N2 0	1M6 25459	0N6 0	0M6 24996	1N0 0	4M7 20686	3N2 0	5N0 0	T29 38166		5
	2M8 25552	5N9 0	3M4 25353	1N9 0	1M1 25709	0N7 0	3M7 24352	2N3 0	1M8 26166	2N7 0	3M9 25588	3N8 0	2M7 25574		6
4L3 42560	3N9 0	6M1 23324	1N2 0	1M5 26144	2N2 0	5M5 19963	2M9 18970	5M9 19411	0N4 0	0M2 26114	1N1 0	3M6 23030	5N7 0	6L8 42943	7
3L8 37448	6M2 21366	4N3 0	2M1 25646	0N1 0	4M5 24637	3M5 19516	X19 23870	4M1 19348	3M0 24853	2N1 0	0M4 25505	5N3 0	4M9 20856	1L4 37657	8
6L2 42605	3N4 0	6M0 22827	2N0 0	2M2 25142	1N3 0	5M4 19848	3M8 19536	5M1 19820	1N4 0	1M9 25090	2N4 0	6M3 23597	4N2 0	4L9 41993	9
	0M5 25303	5N2 0	4M8 24992	0N5 0	2M4 26298	1N7 0	5M0 24846	2N6 0	2M5 25822	1N5 0	5M8 24568	4N7 0	1M7 25762		10
	T12 38825	5N8 0	4N0 0	5M3 21049	2N5 0	0M8 25480	0N8 0	1M0 25830	0N3 0	3M2 21441	3N7 0	6N0 0	T09 38307		11
		5L8 44146	0M1 26606	6N4 0	4M6 24990	0N9 0	1M2 26332	1N6 0	5M7 25130	3N1 0	2M3 26172	4L4 44879			12
			5L2 45371	4N1 0	4N5 0	4M4 22752	5N1 0	5M2 22756	3N6 0	4N6 0	5L0 44583				13
				T53 38689	2M0 26198	3N0 0	4M3 20751	5N5 0	0M7 26119	T16 38248					14
						4L1 41688	2L7 36821	6L1 41464							15

|--> ASSEMBLY ID
|--> ASSEMBLY BURNUP (MWD/MTU)

Figure 1.3

NORTH ANNA UNIT 2 - CYCLE 11
AVAILABLE INCORE MOVEABLE DETECTOR LOCATIONS

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

MD - Moveable Detector

** - Locations Not Available For
Flux Mapping System For Cycle 11

Figure 1.4

NORTH ANNA UNIT 2 - CYCLE 11
ASSEMBLY INSERT LOCATIONS

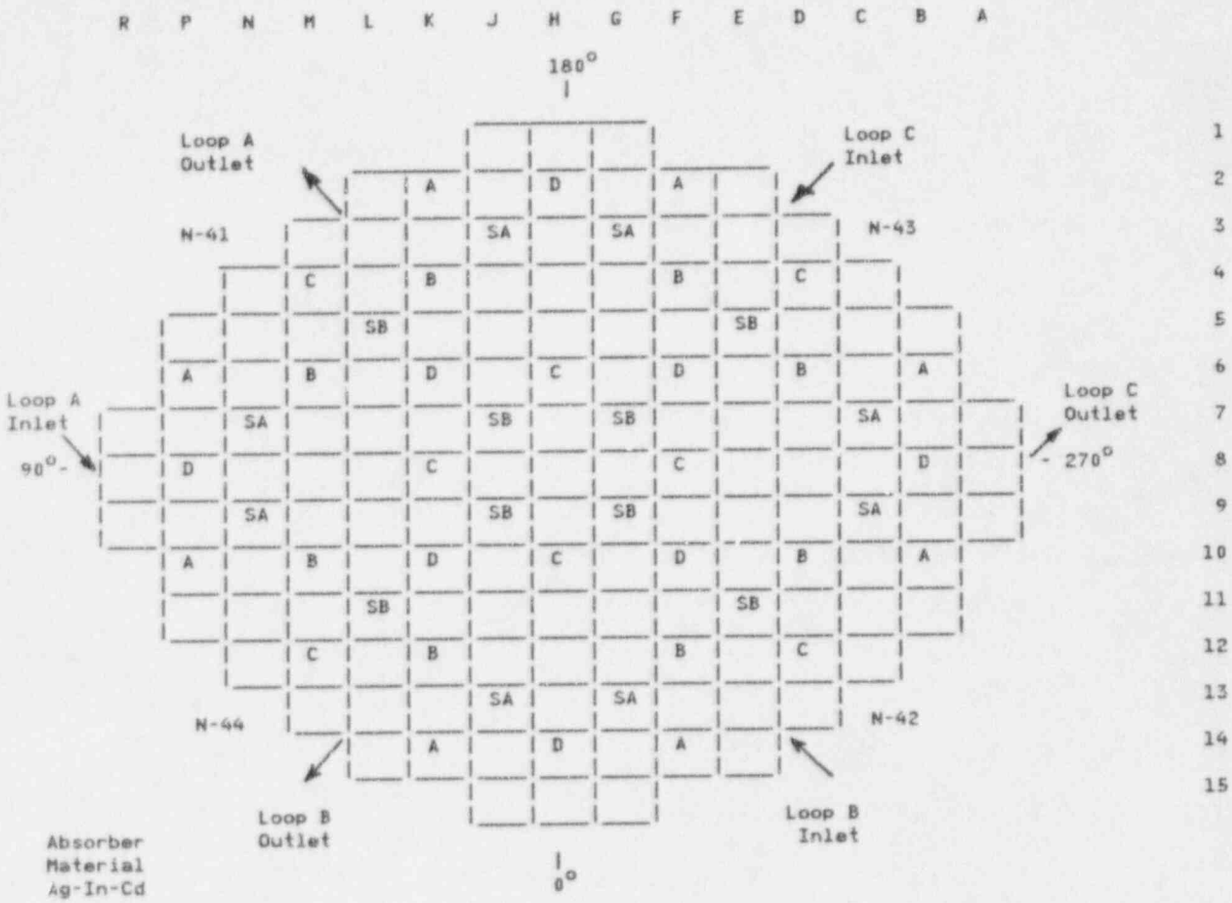
	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							VSDA	VSDA	VSDA						
2							3P BP402		3P BP401						
3				VSDA	6P BP433	19P BP417		24P BP392		19P BP418	6P BP440	VSDA			
4			VSDA		21P BP425		24P BP368	SS18	24P BP387		21P BP428		VSDA		
5			6P BP434	21P BP430		24P BP416		24P BP386		24P BP415		21P BP431	6P BP439		
6			19P BP424		24P BP414		24P BP400		24P BP399		24P BP413		19P BP421		
7	VSDA	3P BP406		24P BP385		24P BP398		4P BP376		24P BP397		24P BP384		3P BP408	VSDA
8	VSDA		24P BP391		24P BP383		4P BP375		4P BP374		24P BP382		24P BP390		VSDA
9	VSDA	3P BP405		24P BP381		24P BP396		4P BP373		24P BP395		24P BP380		3P BP407	VSDA
10			19P BP423		24P BP412		24P BP394		24P BP393		24P BP411		19P BP422		
11			6P BP436	21P BP429		24P BP410		24P BP379		24P BP409		21P BP432	6P BP438		
12			VSDA		21P BP426		24P BP378	SS17	24P BP377		21P BP427		VSDA		
13				VSDA	6P BP435	19P BP420		24P BP389		19P BP419	6P BP437	VSDA			
14							3P BP404		3P BP403						
15							VSDA	VSDA	VSDA						

3P - 3 BURNABLE POISON ROD CLUSTER
4P - 4 BURNABLE POISON ROD CLUSTER
6P - 6 BURNABLE POISON ROD CLUSTER
19P - 19 BURNABLE POISON ROD CLUSTER
21P - 21 BURNABLE POISON ROD CLUSTER
24P - 24 BURNABLE POISON ROD CLUSTER
SSxx - SECONDARY SOURCE
VSDA - VIBRATION SUPPRESSION DAMPING ASSEMBLY

xxP or SSxx	- # OF BP RODS or SECONDARY SOURCE ID
BP### or VSDA	- BP ASSEMBLY ID or VSDA

Figure 1.5

NORTH ANNA UNIT 2 - CYCLE 11
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

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 then removing the moveable 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 11 STARTUP PHYSICS TESTS
HOT ROD DROP TIME SUMMARY

ROD DROP TIME TO DASHPOT ENTRY

SLOWEST ROD	FASTEST ROD	AVERAGE TIME
B-06 1.95 sec.	C-09 1.54 sec.	1.70 sec.

Figure 2.1

NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
TYPICAL ROD DROP TRACE

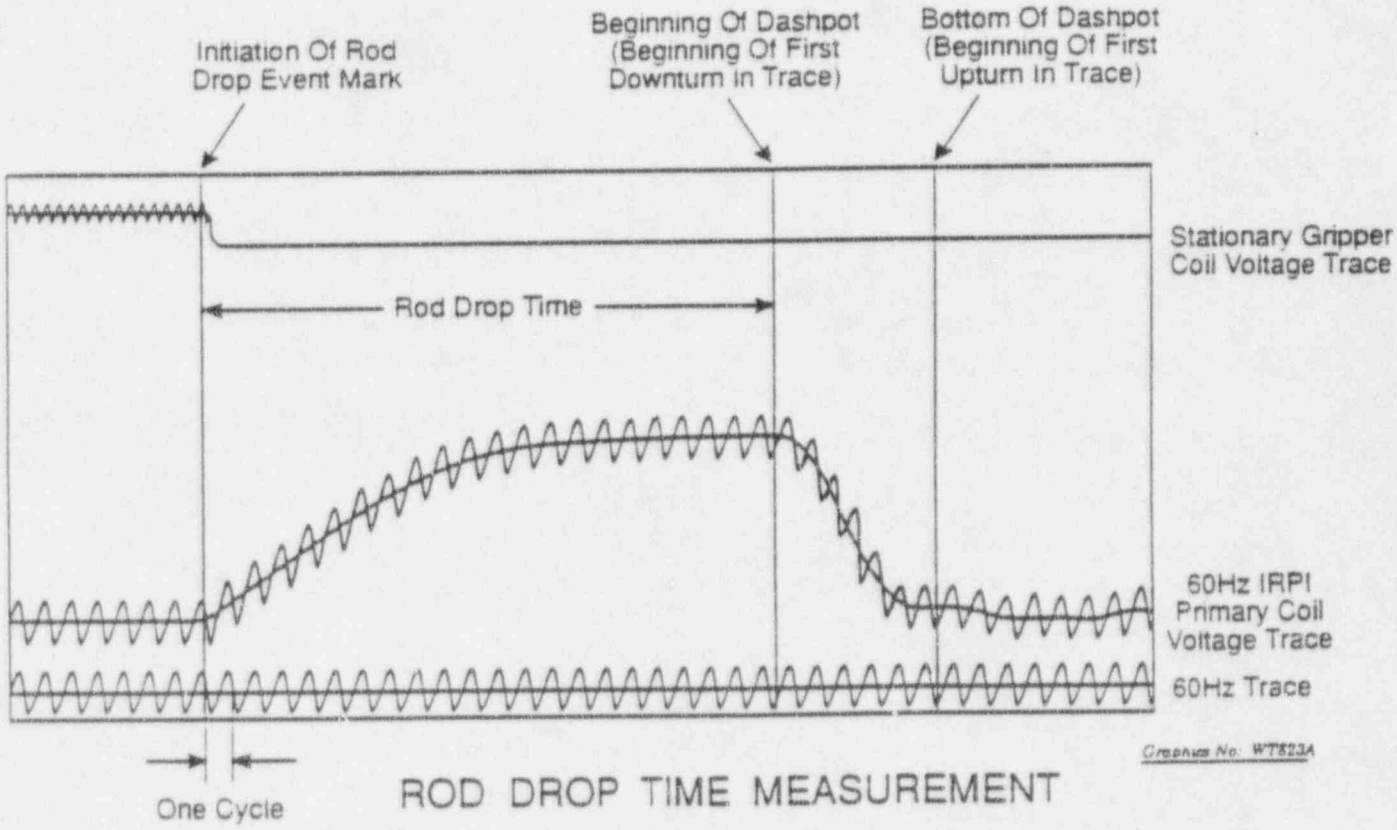


Figure 2.2

NORTH ANNA UNIT 2 - CYCLE 11 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															
2						1.75		1.69		1.71					
3							1.71		1.69						
4				1.55		1.79				1.66		1.75			
5					1.67						1.68				
6		1.67		1.69		1.67		1.67		1.66		1.66		1.95	
7			1.65				1.61		1.63				1.73		
8		1.73				1.68				1.63				1.85	
9			1.72				1.60		1.65				1.54		
10		1.72		1.65		1.64		1.67		1.65		1.69		1.79	
11					1.68						1.64				
12				1.70		1.65				1.64		1.77			
13							1.70		1.71						
14						1.91		1.75		1.84					
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 11, 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 with all other banks fully withdrawn 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 inserting one of the other control rod banks (i.e., a test bank) 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 or near the initial statepoint condition. 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 Test 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, ±15% for test banks of worth greater than 600 pcm, and ±100 pcm for test banks of worth less than or equal to 600 pcm.) The sum of the individual measured rod bank worths was within 1.9% 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 11 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	1287.5	1292.0	-0.3
D	1032.5	1012.0	2.0
C	838.5	794.4	5.6
A	356.5	346.0	3.0 *
SB	1118.5	1083.0	3.3
SA	1000.5	1002.0	-0.1
Total Worth	5634.0	5529.4	1.9

* Difference is less than 100 pcm.

Figure 3.1

NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
CONTROL BANK B INTEGRAL ROD WORTH - HZP
ALL OTHER RODS WITHDRAWN

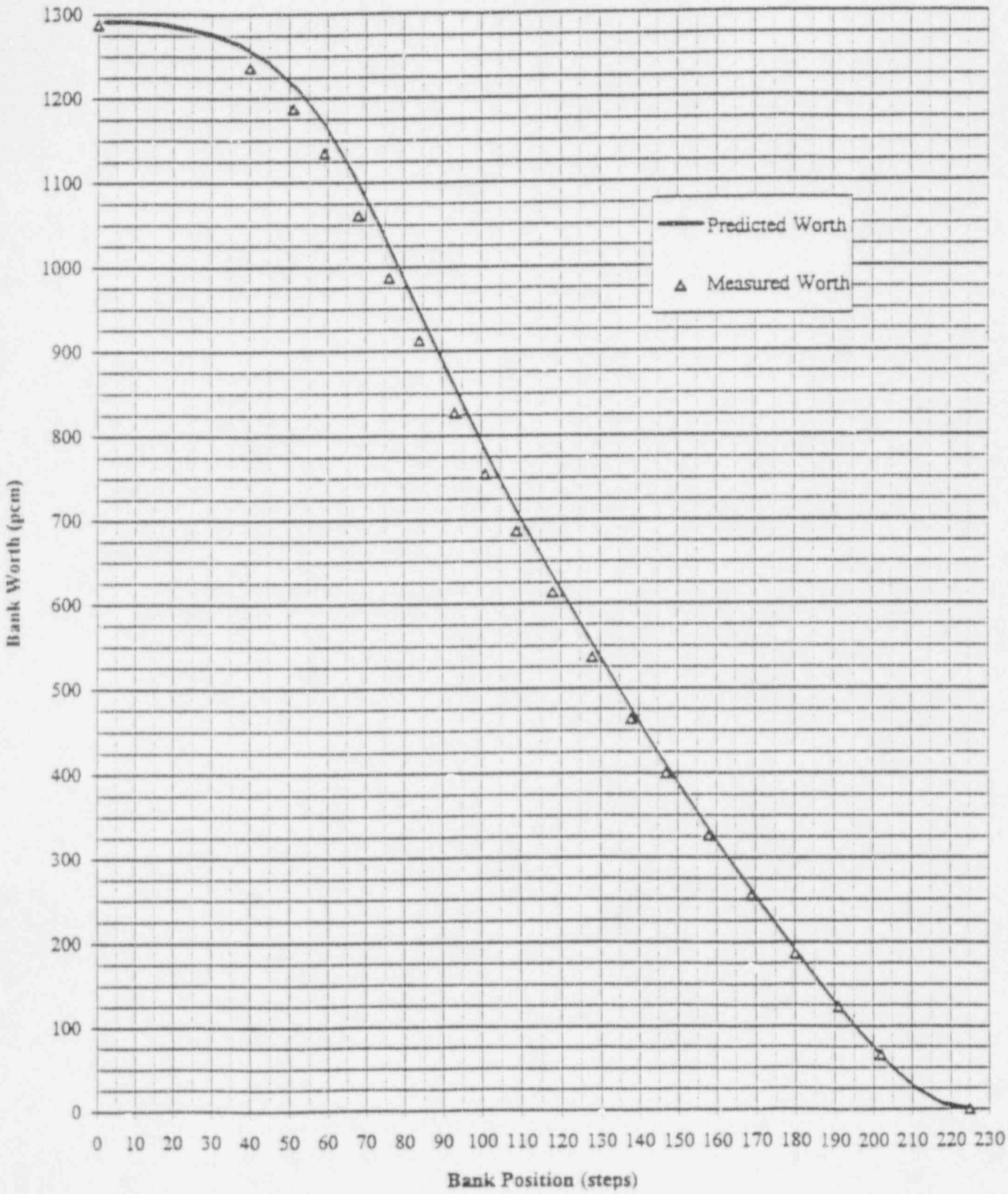
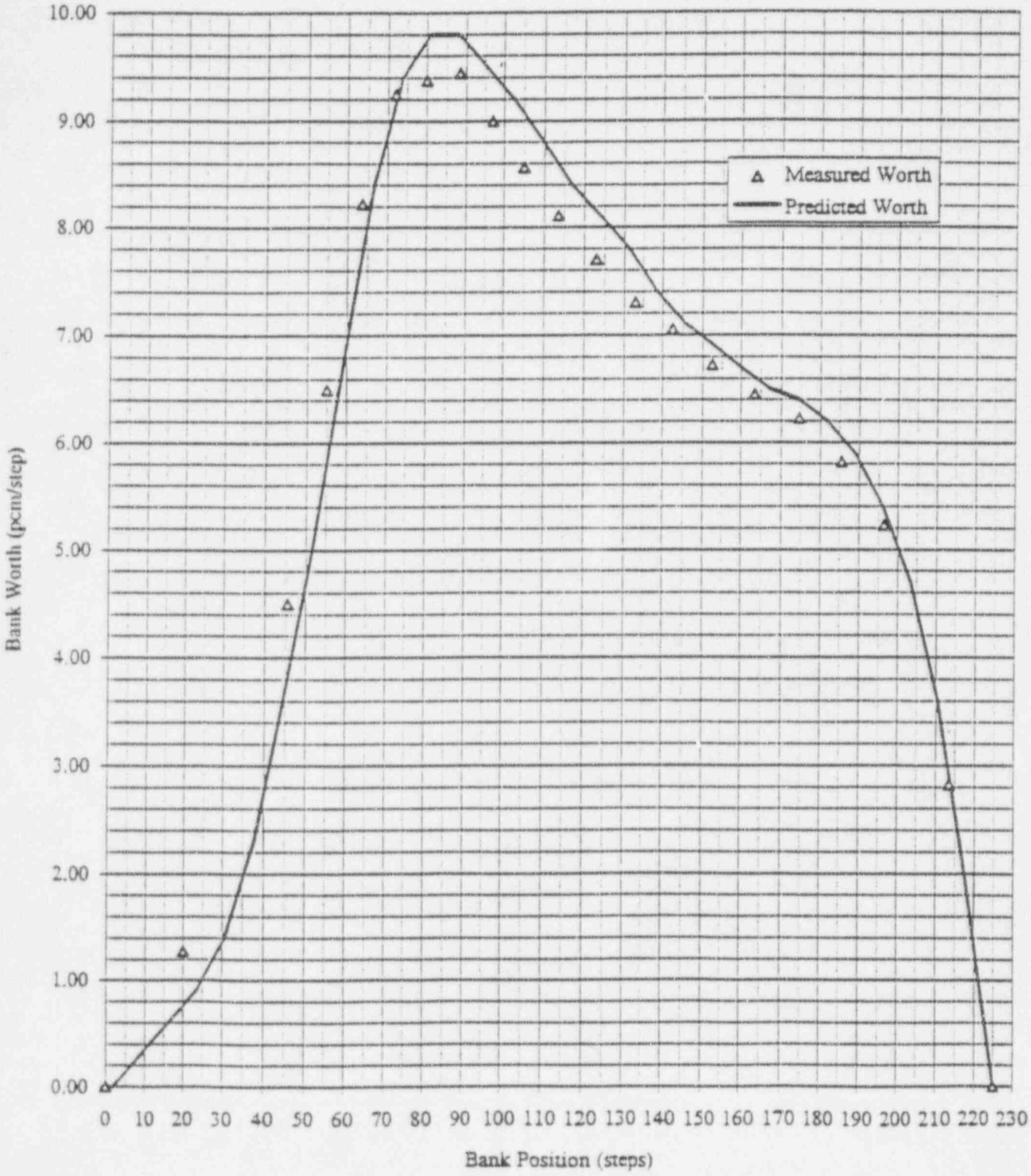


Figure 3.2

NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
CONTROL BANK B DIFFERENTIAL ROD WORTH - HZP
ALL OTHER RODS WITHDRAWN



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 Test Results and Evaluation Sheets given in the Appendix, the measured critical boron endpoint values were within their respective design tolerances. The ARO endpoint comparison to the predicted value met the requirements of Technical Specification 4.1.1.1.2 regarding core reactivity balance. 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 -7.00 pcm/ppm. This is within 4.1% of the predicted value of -6.73 pcm/ppm and is well within the design tolerance of ±10%. In summary, the measured boron worth coefficient was satisfactory.

Table 4.1

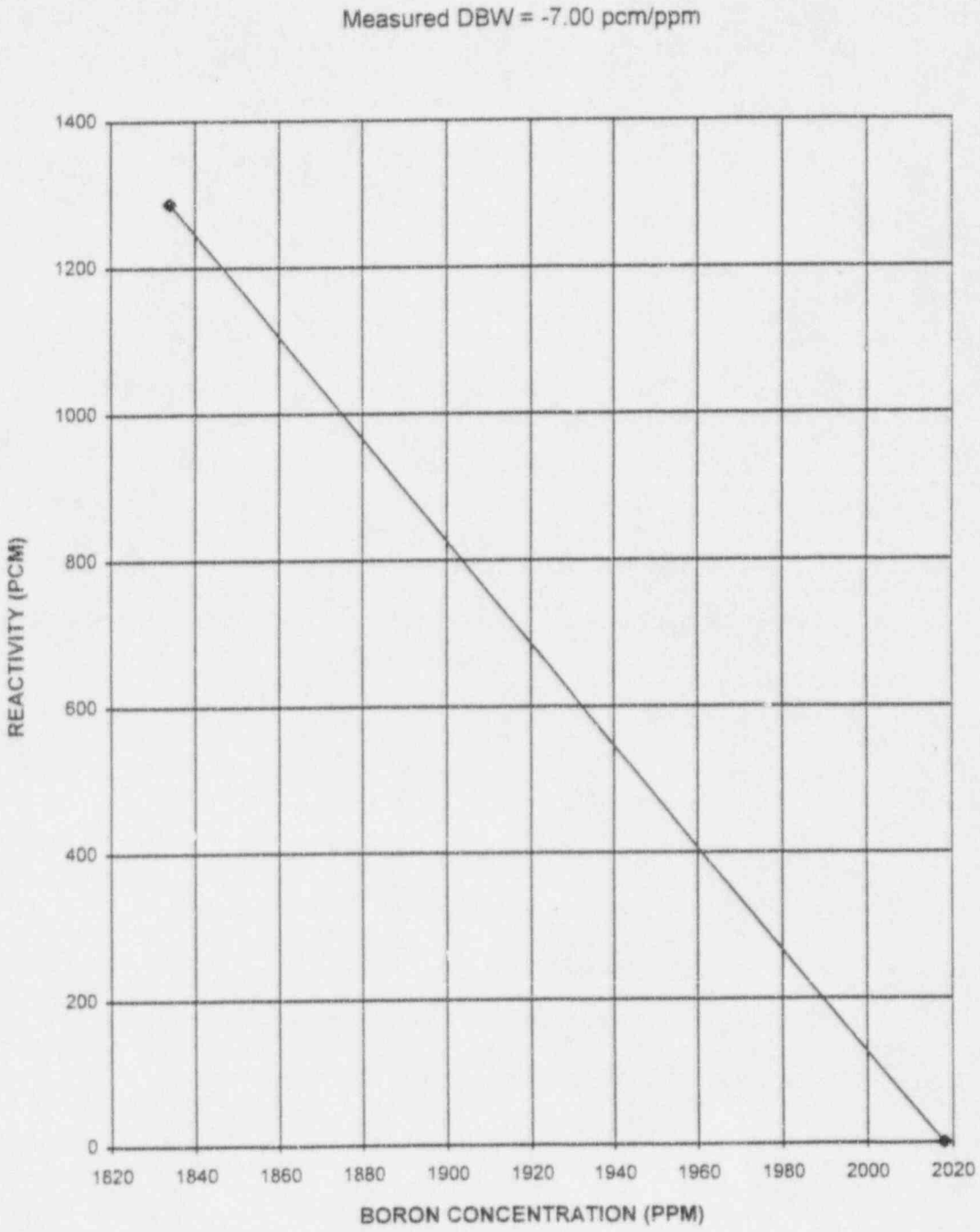
NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
BORON ENDPOINTS SUMMARY

Control Rod Configuration	Measured Endpoint (ppm)	Predicted Endpoint (ppm)	Difference M-P (ppm)
ARO	2018	2011	7
B Bank In	1834	1826*	8

* The predicted endpoint for the B Bank In configuration was 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 Sheet in the Appendix.

Figure 4.1

NORTH ANNA UNIT 2 - CYCLE 11 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.

Reactivity was measured during the RCS cooldown of 3.2°F and RCS heatup of 3.2°F. Reactivity and temperature data were 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 -1.18 pcm/°F which met the requirements of COLR Section 2.1.1. In summary, the measured result was satisfactory.

Table 5.1

NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
ISOTHERMAL TEMPERATURE COEFFICIENT SUMMARY

BANK POSITION (STEPS)	TEMPERATURE RANGE (°F)	BORON CONCENTRATION (ppm)	ISOTHERMAL TEMPERATURE COEFFICIENT (PCM/°F)				
			C/D	H/U	AVE. MEAS.	PRED.	DIFFER. (M-P)
D/207	543.8 to 547.0	2018	-3.13	-2.73	-2.93	-3.27	0.34

SECTION 6

POWER DISTRIBUTION MEASUREMENTS

The core power distributions were measured using the moveable 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 moveable detectors for the ramp to full power flux maps for Cycle 11. 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 a Virginia Power modified version of the Combustion Engineering computer program, CECOR[3]. CECOR 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 are given in Table 6.1. A comparison of these measured values with their COLR limits is given in Table 6.2. Flux map 1 was taken at 29% 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 74% and 100% power, respectively, with different control rod configurations. These flux maps were taken to check at-power design predictions and to measure core power distributions at various operating conditions. The 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 1.7% 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 COLR Sections 2.5.1 and 2.6, respectively. Flux maps 1, 2, and 3 were used to perform power range detector calibrations (flux map 3 verified that the existing calibration was satisfactory, thus no adjustments to the power range detector calibration were required).

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 COLR. It is therefore anticipated that the core will continue to operate safely throughout Cycle 11. Reference 7 documents the flux maps.

TABLE 6.1

NORTH ANNA UNIT 2 - CYCLE 11 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) ASSY	AXIAL POINT	F-Q(Z)	F-DH(N) HOT CHNL.FACTOR ASSY	F-DH(N)	CORE F(Z) MAX AXIAL POINT	F(Z)	(2) CORE TILT MAX	LOC	AXIAL OFF SET (%)	NO. OF THIMBLES
LOW POWER	1	06-02-95	8	29	130	B07	35	2.233	N05	1.499	35	1.370	1.013	SE	-7.25	42
P.F.V. (3)	2	06-04-95	46	74	192	B07	35	1.975	B07	1.430	35	1.253	1.013	SE	-3.54	46
HOT FULL POWER	3	06-12-95	325	100	225	B07	35	1.882	B07	1.417	35	1.204	1.011	SE	-1.59	46

NOTES: HOT SPOT LOCATIONS ARE SPECIFIED BY GIVING ASSEMBLY LOCATIONS (E.G. H-8 IS THE CENTER-OF-CORE ASSEMBLY) AND CORE HEIGHT (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 CECOR.

(3) P.F.V. - PEAKING FACTOR VERIFICATION.

(4) MAPS 1, 2, AND 3 WERE USED FOR POWER RANGE DETECTOR CALIBRATIONS. THE CALIBRATION FOR FLUX MAP 3 VERIFIED THE ACCEPTABILITY OF THE EXISTING CALIBRATION.

Table 6.2

NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
COMPARISION OF MEASURED POWER DISTRIBUTION PARAMETERS
WITH THEIR CORE OPERATING LIMITS

MAP NO.	PEAK 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	NODE	MEAS.	LIMIT	NODE	MARGIN (%)	MEAS.	LIMIT	MARGIN (%)
1	2.233	4.380	35	2.233	4.380	35	49.0	1.499	1.806	16.9
2	1.975	2.941	35	1.972	2.934	30	32.7	1.430	1.604	10.8
3	1.882	2.190	35	1.882	2.190	35	14.0	1.417	1.490	4.8

* The Core Operating 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 COLR 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 COLR 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 11 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
29% POWER

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
	PREDICTED / MEASURED / PCT DIFFERENCE					0.263 / 0.259 / -1.6	0.274 / 0.270 / -1.4	0.262 / 0.259 / -1.1			PREDICTED / MEASURED / PCT DIFFERENCE				
				0.300 / 0.292 / -2.7	0.659 / 0.645 / -2.0	1.088 / 1.070 / -1.6	0.837 / 0.825 / -1.4	1.095 / 1.084 / -1.0	0.660 / 0.662 / 0.3	0.300 / 0.300 / -0.1					
			0.356 / 0.337 / -5.4	1.170 / 1.135 / -3.0	1.330 / 1.301 / -2.2	1.238 / 1.221 / -1.4	1.287 / 1.253 / -2.7	1.243 / 1.225 / -1.4	1.332 / 1.326 / -0.5	1.171 / 1.168 / -0.2	0.356 / 0.351 / -1.4				3
		0.356 / 0.362 / 1.6	0.856 / 0.845 / -1.4	1.354 / 1.312 / -3.0	1.287 / 1.258 / -2.3	1.217 / 1.189 / -2.3	1.181 / 1.138 / -3.7	1.219 / 1.202 / -1.3	1.288 / 1.287 / -0.1	1.353 / 1.358 / 0.3	0.855 / 0.858 / 0.3	0.356 / 0.359 / 1.0			
	0.299 / 0.308 / 2.9	1.170 / 1.216 / 3.9	1.355 / 1.364 / 0.7	1.318 / 1.315 / -0.3	1.209 / 1.193 / -1.3	1.143 / 1.120 / -2.0	1.155 / 1.143 / -1.0	1.143 / 1.141 / -0.2	1.208 / 1.215 / 0.5	1.317 / 1.335 / 1.3	1.352 / 1.361 / 0.6	1.167 / 1.185 / 1.5	0.298 / 0.306 / 2.5		5
	0.659 / 0.668 / 1.4	1.329 / 1.349 / 1.5	1.286 / 1.289 / 0.2	1.209 / 1.191 / -1.5	0.987 / 0.980 / -0.7	1.153 / 1.152 / -0.1	1.161 / 1.184 / 2.0	1.150 / 1.163 / 1.1	0.987 / 0.999 / 1.3	1.207 / 1.224 / 1.4	1.283 / 1.300 / 1.4	1.323 / 1.354 / 2.4	0.654 / 0.683 / 4.4		6
0.249 / 0.250 / 0.6	1.090 / 1.099 / 0.9	1.237 / 1.246 / 0.8	1.214 / 1.215 / 0.1	1.139 / 1.132 / -0.6	1.149 / 1.145 / -0.4	1.225 / 1.227 / 0.1	1.212 / 1.223 / 1.0	1.226 / 1.241 / 1.2	1.152 / 1.171 / 1.6	1.138 / 1.156 / 1.5	1.212 / 1.225 / 1.1	1.229 / 1.268 / 3.2	1.074 / 1.155 / 7.5	0.245 / 0.263 / 7.0	7
0.269 / 0.268 / -0.6	0.827 / 0.834 / 0.8	1.278 / 1.291 / 1.0	1.177 / 1.175 / -0.1	1.150 / 1.143 / -0.7	1.159 / 1.153 / -0.6	1.211 / 1.210 / -0.1	1.139 / 1.145 / 0.5	1.212 / 1.227 / 1.2	1.159 / 1.188 / 2.5	1.151 / 1.174 / 2.0	1.177 / 1.200 / 2.0	1.278 / 1.310 / 2.6	0.827 / 0.874 / 5.7	0.269 / 0.283 / 5.1	8
0.245 / 0.245 / -0.3	1.074 / 1.072 / -0.2	1.229 / 1.224 / -0.4	1.212 / 1.200 / -0.9	1.138 / 1.116 / -2.0	1.152 / 1.141 / -1.0	1.226 / 1.220 / -0.5	1.212 / 1.212 / 0.0	1.226 / 1.233 / 0.6	1.150 / 1.162 / 1.0	1.139 / 1.160 / 1.9	1.214 / 1.243 / 2.4	1.237 / 1.273 / 3.0	1.090 / 1.133 / 4.0	0.249 / 0.252 / 1.4	9
	0.654 / 0.648 / -0.9	1.322 / 1.305 / -1.3	1.283 / 1.266 / -1.3	1.207 / 1.191 / -1.4	0.987 / 0.975 / -1.2	1.150 / 1.141 / -0.8	1.161 / 1.153 / -0.7	1.154 / 1.155 / 0.1	0.987 / 0.998 / 1.1	1.209 / 1.235 / 2.2	1.286 / 1.319 / 2.6	1.329 / 1.369 / 3.0	0.659 / 0.690 / 4.8		10
	0.298 / 0.294 / -1.3	1.167 / 1.151 / -1.4	1.352 / 1.334 / -1.4	1.317 / 1.303 / -1.1	1.208 / 1.185 / -1.9	1.143 / 1.117 / -2.3	1.155 / 1.132 / -1.9	1.143 / 1.137 / -0.6	1.209 / 1.214 / 0.5	1.318 / 1.355 / 2.8	1.355 / 1.389 / 2.5	1.170 / 1.201 / 2.7	0.299 / 0.310 / 3.4		11
		0.356 / 0.350 / -1.6	0.855 / 0.840 / -1.8	1.353 / 1.326 / -2.1	1.288 / 1.252 / -2.8	1.219 / 1.165 / -4.4	1.182 / 1.151 / -2.6	1.217 / 1.206 / -0.9	1.288 / 1.289 / 0.1	1.354 / 1.370 / 1.2	0.856 / 0.871 / 1.7	0.356 / 0.362 / 1.6			12
			0.356 / 0.348 / -2.2	1.171 / 1.142 / -2.5	1.332 / 1.293 / -2.9	1.243 / 1.201 / -3.4	1.287 / 1.249 / -3.0	1.238 / 1.231 / -0.6	1.330 / 1.324 / -0.4	1.170 / 1.176 / 0.5	0.356 / 0.360 / 1.0				13
				0.300 / 0.292 / -2.7	0.660 / 0.640 / -3.0	1.095 / 1.060 / -3.2	0.837 / 0.824 / -1.6	1.088 / 1.112 / 2.2	0.659 / 0.664 / 0.7	0.300 / 0.301 / 0.5					14
	STANDARD / DEVIATION / =1.419					0.262 / 0.240 / -8.4	0.274 / 0.267 / -2.3	0.263 / 0.266 / 1.3			AVERAGE / PCT DIFFERENCE / = 1.7				15

SUMMARY

MAP NO: N2-11-01 DATE: 06/02/95 POWER: 29.30%

CONTROL ROD POSITIONS: F-Q(Z) = 2.233 CORE TILT:

D BANK AT 130 STEPS F-DH(N) = 1.499 NW 0.994 | NE 1.009

F(Z) = 1.370 SW 0.983 | SE 1.013

BURNUP = 7.5 MWD/MTU A.O. = -7.25%

Figure 6.2

NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
74% POWER

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
	PREDICTED					0.291	0.315	0.290			PREDICTED				
	MEASURED					0.284	0.302	0.283			MEASURED				1
	PCT DIFFERENCE					-2.4	-4.2	-2.4			PCT DIFFERENCE				
				0.302	0.665	1.128	0.973	1.137	0.666	0.302					
				0.294	0.651	1.107	0.950	1.115	0.659	0.299					2
				-2.6	-2.0	-1.9	-2.3	-2.0	-1.1	-1.1					
			0.352	1.119	1.279	1.230	1.298	1.234	1.281	1.120	0.352				
			0.331	1.085	1.253	1.215	1.259	1.210	1.264	1.108	0.344				3
			-5.9	-3.8	-2.0	-1.2	-3.0	-2.0	-1.3	-1.0	-2.1				
		0.352	0.827	1.285	1.243	1.190	1.167	1.191	1.244	1.285	0.826	0.351			
		0.354	0.812	1.245	1.219	1.171	1.135	1.174	1.231	1.280	0.821	0.349			4
		0.7	-1.8	-3.1	-1.9	-1.6	-2.7	-1.4	-1.1	-0.4	-0.7	-0.5			
	0.301	1.119	1.286	1.282	1.210	1.147	1.145	1.146	1.210	1.281	1.284	1.116	0.300		
	0.307	1.147	1.286	1.269	1.199	1.141	1.144	1.147	1.215	1.295	1.276	1.113	0.291		5
	1.9	2.6	0.0	-1.0	-0.9	-0.5	-0.1	0.1	0.4	1.1	-0.6	-0.3	-3.2		
	0.664	1.278	1.242	1.210	1.122	1.184	1.171	1.181	1.122	1.209	1.240	1.273	0.660		
	0.670	1.291	1.243	1.198	1.121	1.193	1.202	1.200	1.141	1.223	1.245	1.283	0.673		6
	0.8	1.0	0.0	-1.0	-0.2	0.8	2.6	1.6	1.7	1.1	0.4	0.8	1.9		
0.275	1.131	1.228	1.187	1.143	1.180	1.247	1.224	1.248	1.183	1.143	1.184	1.221	1.115	0.271	
0.275	1.135	1.236	1.189	1.142	1.183	1.259	1.245	1.271	1.208	1.159	1.188	1.242	1.167	0.283	7
0.0	0.4	0.6	0.1	-0.1	0.3	0.9	1.7	1.9	2.1	1.4	0.3	1.7	4.6	4.5	
0.310	0.963	1.290	1.163	1.142	1.170	1.224	1.154	1.225	1.171	1.143	1.163	1.290	0.963	0.310	
0.306	0.963	1.292	1.163	1.146	1.175	1.234	1.170	1.250	1.213	1.167	1.180	1.308	1.009	0.322	8
-1.4	0.0	0.2	0.0	0.4	0.4	0.8	1.4	2.1	3.6	2.1	1.4	1.4	4.8	3.8	
0.271	1.115	1.221	1.184	1.143	1.183	1.247	1.225	1.248	1.181	1.143	1.187	1.228	1.131	0.275	
0.269	1.107	1.211	1.178	1.139	1.185	1.256	1.236	1.265	1.203	1.166	1.211	1.256	1.166	0.273	9
-0.9	-0.7	-0.8	-0.6	-0.3	0.2	0.7	1.0	1.4	1.9	2.0	2.0	2.2	3.1	-0.8	
	0.660	1.273	1.239	1.209	1.122	1.181	1.171	1.184	1.122	1.210	1.242	1.278	0.664		
	0.650	1.247	1.226	1.203	1.121	1.188	1.176	1.193	1.139	1.236	1.270	1.310	0.689		10
	-1.5	-2.0	-1.1	-0.5	-0.1	0.6	0.4	0.8	1.4	2.2	2.2	2.5	3.7		
	0.300	1.116	1.284	1.281	1.210	1.146	1.146	1.147	1.210	1.282	1.286	1.119	0.302		
	0.295	1.097	1.269	1.273	1.200	1.136	1.137	1.145	1.214	1.319	1.321	1.146	0.310		11
	-1.6	-1.7	-1.2	-0.6	-0.8	-0.9	-0.7	-0.1	0.3	2.9	2.7	2.5	2.9		
		0.351	0.826	1.285	1.244	1.191	1.168	1.190	1.244	1.285	0.827	0.352			
		0.343	0.814	1.268	1.222	1.160	1.145	1.180	1.242	1.305	0.858	0.355			12
		-2.2	-1.4	-1.4	-1.7	-2.6	-1.9	-0.9	-0.1	1.5	3.7	1.0			
			0.352	1.120	1.281	1.234	1.298	1.230	1.279	1.119	0.352				
			0.346	1.099	1.253	1.200	1.255	1.215	1.260	1.120	0.357				13
			-1.6	-1.8	-2.2	-2.8	-3.4	-1.2	-1.5	0.2	1.7				
				0.302	0.666	1.137	0.973	1.128	0.665	0.302					
				0.296	0.649	1.103	0.957	1.143	0.663	0.302					14
				-2.1	-2.5	-3.0	-1.7	1.3	-0.2	0.0					
	STANDARD					0.290	0.315	0.291			AVERAGE				
	DEVIATION					0.265	0.307	0.292			PCT DIFFERENCE				15
	=1.255					-8.9	-2.7	0.4			= 1.6				

SUMMARY

MAP NO: N2-11-02 DATE: 06/04/95 POWER: 74.46%

CONTROL ROD POSITIONS: F-Q(Z) = 1.975 CORE TILT:

D BANK AT 192 STEPS F-DH(N) = 1.430 NW 0.995 | NE 1.004

F(Z) = 1.253 SW 0.989 | SE 1.013

BURNUP = 45.8 MWD/MTU A.O. = -3.54%

Figure 6.3

NORTH ANNA UNIT 2 - CYCLE 11 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
100% POWER

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
	PREDICTED MEASURED PCT DIFFERENCE					0.300 0.295 -1.9	0.329 0.323 -1.9	0.299 0.295 -1.6			PREDICTED MEASURED PCT DIFFERENCE			
				0.304 0.297 -2.6	0.666 0.652 -2.0	1.131 1.110 -1.9	1.008 0.984 -2.4	1.138 1.121 -1.6	0.667 0.669 0.3	0.305 0.304 -0.1				
			0.352 0.339 -3.6	1.099 1.067 -2.9	1.260 1.234 -2.0	1.220 1.203 -1.4	1.296 1.247 -3.8	1.224 1.202 -1.8	1.261 1.252 -0.7	1.100 1.096 -0.4	0.352 0.351 -0.2			
		0.352 0.352 -0.1	0.820 0.804 -1.9	1.263 1.217 -3.7	1.229 1.205 -1.9	1.183 1.168 -1.3	1.163 1.134 -2.5	1.184 1.172 -1.1	1.230 1.224 -0.5	1.264 1.262 -0.2	0.820 0.813 -0.8	0.352 0.349 -0.7		
	0.304 0.307 0.9	1.099 1.113 1.3	1.265 1.263 -0.2	1.270 1.267 -0.2	1.215 1.210 -0.4	1.151 1.158 0.7	1.148 1.153 0.4	1.151 1.155 0.4	1.215 1.221 0.5	1.269 1.278 0.7	1.263 1.242 -1.7	1.097 1.091 -0.6	0.303 0.302 -0.2	
	0.666 0.668 0.3	1.259 1.264 0.4	1.228 1.223 -0.4	1.215 1.195 -1.6	1.168 1.166 -0.1	1.198 1.213 1.2	1.178 1.215 3.1	1.196 1.217 1.7	1.168 1.184 1.4	1.215 1.224 0.8	1.225 1.224 0.0	1.255 1.261 0.5	0.661 0.674 2.0	
0.283 0.284 0.3	1.133 1.133 0.1	1.219 1.223 0.3	1.181 1.179 -0.1	1.148 1.146 -0.2	1.195 1.200 0.4	1.255 1.269 1.1	1.232 1.255 1.9	1.256 1.280 1.9	1.198 1.221 1.9	1.148 1.161 1.2	1.179 1.182 0.3	1.212 1.227 1.2	1.118 1.165 4.2	0.280 0.291 3.9
0.323 0.327 1.1	0.998 0.994 -0.5	1.288 1.277 -0.9	1.159 1.156 -0.2	1.145 1.153 0.7	1.177 1.184 0.6	1.231 1.242 1.0	1.166 1.183 1.4	1.232 1.256 1.9	1.178 1.216 3.3	1.145 1.165 1.7	1.159 1.169 0.8	1.288 1.288 0.0	0.998 1.032 3.3	0.323 0.333 3.1
0.280 0.278 -0.6	1.118 1.106 -1.1	1.212 1.197 -1.3	1.179 1.172 -0.5	1.147 1.153 0.5	1.198 1.204 0.4	1.255 1.264 0.7	1.232 1.244 1.0	1.256 1.272 1.2	1.195 1.211 1.3	1.148 1.165 1.5	1.181 1.196 1.3	1.219 1.239 1.6	1.133 1.165 2.9	0.283 0.287 1.3
	0.661 0.649 -1.9	1.255 1.222 -2.6	1.225 1.211 -1.1	1.215 1.211 -0.3	1.168 1.167 -0.1	1.196 1.199 0.2	1.178 1.184 0.5	1.199 1.207 0.7	1.168 1.178 0.9	1.215 1.234 1.5	1.228 1.244 1.3	1.259 1.289 2.3	0.666 0.701 5.3	
	0.303 0.298 -1.7	1.097 1.080 -1.5	1.243 1.251 -1.0	1.269 1.262 -0.5	1.215 1.206 -0.7	1.151 1.143 -0.7	1.148 1.150 0.2	1.151 1.151 0.0	1.215 1.215 0.0	1.270 1.300 2.3	1.265 1.300 2.7	1.099 1.127 2.5	0.304 0.315 3.6	
		0.352 0.353 0.5	0.820 0.813 -0.9	1.264 1.251 -1.1	1.230 1.212 -1.5	1.184 1.157 -2.3	1.163 1.146 -1.5	1.183 1.175 -0.8	1.229 1.225 -0.3	1.264 1.285 1.6	0.820 0.865 5.5	0.352 0.358 1.7		
			0.352 0.348 -1.2	1.100 1.085 -1.4	1.261 1.239 -1.8	1.224 1.195 -2.3	1.296 1.259 -2.9	1.220 1.205 -1.2	1.260 1.233 -2.1	1.099 1.100 0.0	0.352 0.360 2.4			
				0.305 0.300 -1.7	0.667 0.654 -2.0	1.138 1.111 -2.4	1.008 0.993 -1.5	1.131 1.144 1.1	0.666 0.662 -0.5	0.304 0.304 -0.2				
	STANDARD DEVIATION =1.128					0.299 0.281 -6.2	0.329 0.322 -2.0	0.300 0.301 0.4			AVERAGE PCT DIFFERENCE = 1.4			

SUMMARY

MAP NO: N2-11-03	DATE: 06/12/95	POWER: 100%
CONTROL ROD POSITIONS:	F-Q(Z) = 1.882	CORE TILT:
D BANK AT 225 STEPS	F-DH(N) = 1.417	NW 0.995 | NE 1.004
	F(Z) = 1.204	SW 0.991 | SE 1.011
	BURNUP =324.5 MWD/MTU	A.O. = -1.59%

SECTION 7

REFERENCES

1. P. D. Banning, "North Anna Unit 2, Cycle 11 Design Report", Technical Report NE-1021, Revision 0, Virginia Power, May, 1995.

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

3. T. W. Schleicher, "The Virginia Power CECOR Code Package", Technical Report NE-831, Revision 2, Virginia Power, March, 1994.

4. North Anna Unit 2 Technical Specifications, Sections 1.19, 3.1.3.4, 3.2.2, 3.2.3, 3.1.1.4, 4.1.1.1.2, and 4.2.2.2 and Core Operating Limits Report (COLR) for North Anna 2, Cycle 11 Pattern UM, Revision 0 (May, 1995) Sections 2.1.1, 2.5.1, and 2.6.

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. R. F. Villaflor, "North Anna 2, Cycle 11 TOTE Calculations", PM-605 Revision 0, May, 1995.

7. T. S. Psuik, et al, "North Anna 2, Cycle 11 Flux Map Analysis", PM-608, Revision 0, and Addenda A and B, June, 1995.

APPENDIX

STARTUP PHYSICS TEST RESULTS
AND EVALUATION SHEETS

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Zero Power Testing Range Determination Proc No / Section: 2-PT-94.0 Sequence Step No:_____	
II Test Conditions (Design)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: 225 CC: * CD: *	
III Test Conditions (Actual)	Bank Positions (Steps)	RCS Temperature (°F): 546.8 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 109	
IV Test Results	Date/Time Test Performed: 5/31/95 06:09	
	Reactivity Computer Initial Flux Background Reading	1×10^{-9} amps
	Flux Reading At Point of Nuclear Heating	6×10^{-7} amps
	Zero Power Testing Range	1×10^{-8} to 10×10^{-8} amps
	Reference	Not Applicable
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 ** Design Tolerance and Acceptance Criteria are met if ZPTR is below the Point of Nuclear Heating and above background.	

Prepared By: [signature] Reviewed By: [signature]

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Reactivity Computer Checkout Proc No / Section: 2-PT-94.0 Sequence Step No:____	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: * CD: *	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 103	RCS Temperature (°F): 545.7 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 5/31/95 06:58	
	Measured Parameter (Description)	ρ_c = Measured Reactivity using ρ-computer ρ_t = Predicted Reactivity
	Measured Value	ρ_c = +44.5 ρ_t = +44.9 %D = -0.9
	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 The allowable range will be set based on the above results, as well as the results from the benchmark test. Benchmark Test Results: -58.6, +99.3 Allowable Range = ± 50 pcm	

Prepared By: [signature] Reviewed By: [signature]

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - ARO Proc No / Section: 2-PT-94.0 Sequence Step No:____	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 225	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 225	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 5/31/95 10:28	
	Measured Parameter (Description)	$(C_B)^M_{ARO}$; Critical Boron Concentration - ARO
	Measured Value (Design Conditions)	$(C_B)^M_{ARO}$ = 2018
	Design Value (Design Conditions)	$C_B = 2011 \pm 50$ ppm
	Reference	Technical Report NE-1021, 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
VI Comments	Design Tolerance is met : ✓ YES ____ NO Acceptance Criteria is met : ✓ YES ____ NO	
	αC_B = -6.68 pcm/ppm $C_B^D = \lvert(C_B)^M_{ARO} - C_B\rvert$; C_B is design value	

Prepared By: Pamela D. Bonning Reviewed By: Paul F. Vitteller

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
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:_____	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 225	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 207	RCS Temperature (°F): 543.8 - 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 5/31/95 10:46	
	Measured Parameter (Description)	$(\alpha_T^{ISO})_{ARO}$; Isothermal Temperature Coeff - ARO
	Measured Value	$(\alpha_T^{ISO})_{ARO}$ = -2.93 pcm/°F (C_B = 2018 ppm)
	Design Value (Actual Conditions)	$(\alpha_T^{ISO})_{ARO}$ = -3.27 pcm/°F (C_B = 2018 ppm)
	Design Value (Design Conditions)	$(\alpha_T^{ISO})_{ARO}$ = -3.33 ± 3.0 pcm/°F (C_B = 2011 ppm)
	Reference	Technical Report NE-1021, Rev. 0
V Acceptance Criteria	FSAR/COLR	$\alpha_T^{ISO} \leq 3.75$* pcm/°F α_T^{DOP} = -1.75 pcm/°F
	Reference	COLR 2.1.1, Technical Report NE-1021, Rev. 0
VI Comments	Design Tolerance is met : ✓ YES ____ NO Acceptance Criteria is met : ✓ YES ____ NO	
	* Uncertainty on αT_{MOD} = 0.5 pcm/°F (Reference: memorandum from C. T. Snow to E. J. Lozito dated June 27, 1980).	

Prepared By: Pamela D. Barnaby Reviewed By: Paul F. Vilhofer

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Control Bank B Worth Measurement, Rod Swap Ref. Bank Proc No / Section: 2-PT-94.0 Sequence Step No:_____	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: moving CC: 225 CD: 225	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: moving CC: 225 CD: 225	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 11:53 5/31/95	
	Measured Parameter (Description)	I_B^{REF} ; Integral Worth of Control Bank B, All Other Rods Out
	Measured Value	I_B^{REF} = 1287.5
	Design Value (Design Conditions)	I_B^{REF} = 1292 ± 129 pcm
	Reference	Technical Report NE-1021, 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: Pamela D Banning Reviewed By: Ronald F Villiffe

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
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:_____
II Test Conditions (Design)	Bank Positions (Steps)		RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: 0 CC: 225 CD: 225		
III Test Conditions (Actual)	Bank Positions (Steps)		RCS Temperature (°F): 546.7 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: 0 CC: 225 CD: 225		
IV Test Results	Date/Time Test Performed: 5/31/95 , 11:53		
	Measured Parameter (Description)	$(C_B)^M{}_B$; Critical Boron Concentration, Bank B In	
	Measured Value (Design Conditions)	$(C_B)^M{}_B$ = 1834	
	Design Value (Design Conditions)	$C_B = 1819 + \Delta C_B^{Prev} \pm (10 + 129.2/\lvert\alpha C_B\rvert)$ ppm C_B = 1826 ppm	
	Reference	Technical Report NE-1021, 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		
	αC_B = -6.73 pcm/ppm $\Delta C_B^{Prev} = (C_B)^M{}_{ARO}$ - 2011 ppm		

Prepared By: Paul F. Vitzthum

Reviewed By: Ronald D. Bynum

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: HZP Boron Worth Coefficient Measurement Proc No / Section: 2-PT-94.0 Sequence Step No:____	
II Test Conditions (Design)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: moving CC: 225 CD: 225	
III Test Conditions (Actual)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: moving CC: 225 CD: 225	
IV Test Results	Date/Time Test Performed: 5/31/95 11:53	
	Measured Parameter (Description)	αC_B ; Boron Worth Coefficient
	Measured Value	αC_B = -7.00 pcm/ppm
	Design Value (Design Conditions)	αC_B = -6.73 ± 0.67 pcm/ppm
	Reference	Technical Report NE-1021, 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. Barning Reviewed By: [illegible]

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Control Bank D Worth Measurement, Rod Swap Proc No / Section: 2-PT-94.0 Sequence Step No:_____	
II Test Conditions (Design)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: moving CC: 225 CD: moving	
III Test Conditions (Actual)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: moving CC: 225 CD: moving	
IV Test Results	Date/Time Test Performed: 5/31/95 1537	
	Measured Parameter (Description)	I_D^{RS} ; Integral Worth of Control Bank D, Rod Swap
	Measured Value	I_D^{RS} = 1032.5 (Adjusted Measured Critical Reference Bank Position = 169 steps)
	Design Value (Actual Conditions)	I_D^{RS} = 1012 (Adjusted Measured Critical Reference Bank Position = 169 steps)
	Design Value (Design Conditions)	I_D^{RS} = 1011 ± 152 pcm (Critical Reference Bank Position = 166 steps)
	Reference	Technical Report NE-1021, 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: [signature] 5/31/95 Reviewed By: [signature] 5/31/95

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Control Bank C Worth Measurement. Rod Swap Proc No / Section: 2-PT-94.0 Sequence Step No:_____	
II Test Conditions (Design)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: moving CC: moving CD: 225	
III Test Conditions (Actual)	Bank Positions (Steps)	RCS Temperature (°F): 547.4 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: 225 CB: moving CC: moving CD: 225	
IV Test Results	Date/Time Test Performed: 5/31/95 16:30	
	Measured Parameter (Description)	I_C^{RS} ; Integral Worth of Control Bank C, Rod Swap
	Measured Value	I_C^{RS} = 838.5 (Adjusted Measured Critical Reference Bank Position = 140 steps)
	Design Value (Actual Conditions)	I_C^{RS} = 794.4 (Adjusted Measured Critical Reference Bank Position = 140 steps)
	Design Value (Design Conditions)	I_C^{RS} = 793 ± 119 pcm (Critical Reference Bank Position = 135 steps)
	Reference	Technical Report NE-1021, R[illegible] 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: [signature] 5/31/95 Reviewed By: [signature] 5/31/95

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Control Bank A Worth Measurement, Rod Swap Proc No / Section: 2-PT-94.0		Sequence Step No:_____
II Test Conditions (Design)	Bank Positions (Steps)		RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: moving CB: moving CC: 225 CD: 225		
III Test Conditions (Actual)	Bank Positions (Steps)		RCS Temperature (°F): 546.9 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: 225 CA: moving CB: moving CC: 225 CD: 225		
IV Test Results	Date/Time Test Performed: 5/31/95 17:01		
	Measured Parameter (Description)	I_A^{RS} ; Integral Worth of Control Bank A, Rod Swap	
	Measured Value	I_A^{RS} = 356.5 (Adjusted Measured Critical Reference Bank Position = 82 steps)	
	Design Value (Actual Conditions)	I_A^{RS} = 346 (Adjusted Measured Critical Reference Bank Position = 82 steps)	
	Design Value (Design Conditions)	I_A^{RS} = 345 ± 100 pcm (Critical Reference Bank Position = 84 steps)	
	Reference	Technical Report NE-1021, 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: [signature] 5/31/95 Reviewed By: [signature] 5/31/95

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank B Worth Measurement, Rod Swap Proc No / Section: 2-PT-94.0 Sequence Step No:_____	
II Test Conditions (Design)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: moving CA: 225 CB: moving CC: 225 CD: 225	
III Test Conditions (Actual)	Bank Positions (Steps)	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: 225 SDB: moving CA: 225 CB: moving CC: 225 CD: 225	
IV Test Results	Date/Time Test Performed: 5/31/95 17:25	
	Measured Parameter (Description)	I_{SB}^{RS} ; Integral Worth of Shutdown Bank B, Rod Swap
	Measured Value	I_{SB}^{RS} = 1118.5 (Adjusted Measured Critical Reference Bank Position = 183 steps)
	Design Value (Actual Conditions)	I_{SB}^{RS} = 1083 (Adjusted Measured Critical Reference Bank Position = 183 steps)
	Design Value (Design Conditions)	I_{SB}^{RS} = 1082 ± 162 pcm (Critical Reference Bank Position = 177 steps)
	Reference	Technical Report NE-1021, 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: [signature] 5/31/95 Reviewed By: [signature] 5/31/95

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank A Worth Measurement, Rod Swap Proc No / Section: 2-PT-94.0		Sequence Step No:_____
II Test Conditions (Design)	Bank Positions (Steps)		RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: moving SDB: 225 CA: 225 CB: moving CC: 225 CD: 225		
III Test Conditions (Actual)	Bank Positions (Steps)		RCS Temperature (°F): 546.6 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: moving SDB: 225 CA: 225 CB: moving CC: 225 CD: 225		
IV Test Results	Date/Time Test Performed: 5/31/95 1805		
	Measured Parameter (Description)	I_{SA}^{RS} ; Integral Worth of Shutdown Bank A. Rod Swap	
	Measured Value	I_{SA}^{RS} = 1000.5 (Adjusted Measured Critical Reference Bank Position = 164 steps)	
	Design Value (Actual Conditions)	I_{SA}^{RS} = 1002 (Adjusted Measured Critical Reference Bank Position = 164 steps)	
	Design Value (Design Conditions)	I_{SA}^{RS} = 1004 ± 151 pcm (Critical Reference Bank Position = 165 steps)	
	Reference	Technical Report NE-1021, 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: [signature] 5/31/95 Reviewed By: [signature] 5/31/95

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
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:_____
II Test Conditions (Design)	Bank Positions (Steps)		RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: moving SDB: moving CA:moving CB: moving CC: moving CD:moving		
III Test Conditions (Actual)	Bank Positions (Steps)		RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	SDA: moving SDB: moving CA:moving CB: moving CC: moving CD:moving		
IV Test Results	Date/Time Test Performed: 5/31/95 11:53		
	Measured Parameter (Description)	I_{Total}; Integral Worth of All Banks, Rod Swap	
	Measured Value	I_{Total} = 5634	
	Design Value (Actual Conditions)	I_{Total} = 5529.4	
	Design Value (Design Conditions)	I_{Total} = 5527 ± 553 pcm	
	Reference	Technical Report NE-1021, 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: [signature] 5/31/95 Reviewed By: [signature] 5/31/95

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
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, 2-PT-21.2 Sequence Step No:_____				
II Test Conditions (Design)	Bank Positions (Steps)			RCS Temperature (°F): $T_{Ref} \pm 1$ Power Level (% F.P.): ≤30 Other (specify): Must have ≥ 38 thimbles**	
	SDA: 225 SDB: 225 CA: 225 CB: 225 CC: * CD: *				
III Test Conditions (Actual)	Bank Positions (Steps)			RCS Temperature (°F): Tref Power Level (% F.P.): 29.3 Other (specify): 42 Thimbles	
	SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 130				
IV Test Results	Date/Time Test Performed: 6/2/95 00:56				
	Measured Parameter (Description)	Max. Relative Assembly Power % DIFF (M-P)/P	Nuclear Enthalpy Rise Hot Channel Factor FΔH(N)	Total Heat Flux Hot Channel Factor $F_Q(Z)$	Maximum Positive Incore Quadrant Power Tilt
	Measured Value	-8.4 for P_i<0.9 +7.5 for P_i ≥0.9	1.499	2.233	1.0132
	Design Value (Design Conds)	± 10% for P_i ≥0.9 ± 15% for P_i<0.9 (P_i = assy pwr)	N/A	N/A	≤ 1.0205
	Reference	WCAP- 7905 Rev. 1	None	None	WCAP-7905 Rev. 1
V Acceptance Criteria	FSAR/COLR	None	FΔH(N)≤1.49(1+0.3(1-P))	$F_Q(Z)$≤4.38*K(Z)	None
	Reference	None	COLR 2.6	COLR 2.5.1	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. Pirl Reviewed By: Robert G. Hall

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
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, 2-PT-21.2 Sequence Step No:_____				
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: *		RCS Temperature (°F): $T_{Ref} \pm 1$ Power Level (% F.P.): $65 \le P \le 75$ Other (specify): Must have ≥ 38 thimbles**		
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 192		RCS Temperature (°F): Tref ±1 Power Level (% F.P.): 74.46% Other (specify): 46 Thimbles		
IV Test Results	Date/Time Test Performed: 6/4/95 1125				
	Measured Parameter (Description)	Max. Relative Assembly Power % DIFF (M-P)/P	Nuclear Enthalpy Rise Hot Channel Factor FΔH(N)	Total Heat Flux Hot Channel Factor $F_Q(Z)$	Maximum Positive Incore Quadrant Power Tilt
	Measured Value	4.89% RPD≥0.9 -8.9% RPD<0.9	1.430	1.975	1.0127
	Design Value (Design Conds)	± 10% for $P_i \ge 0.9$ ± 15% for $P_i < 0.9$ (P_i = assy pwr)	N/A	N/A	≤ 1.0204
	Reference	WCAP-7905 Rev. 1	None	None	WCAP-7905 Rev. 1
V Acceptance Criteria	FSAR/COLR	None	$F\Delta H(N) \le 1.49(1+0.3(1-P))$	$F_Q(Z) \le 2.19/P * K(Z)$	None
	Reference	None	COLR 2.6	COLR 2.5.1	None
VI Comments	Design Tolerance is met : X YES ____ NO Acceptance Criteria is met : X YES ____ NO				
	* As required ** Must have at least 16 thimbles for quarter core maps for multi-point calibrations				

Prepared By: Pamela D Banning Reviewed By: [signature]

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
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, 2-PT-21.2 Sequence Step No:_____				
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 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: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 225		RCS Temperature (°F): 580.8 (T_{ref}) Power Level (% F.P.): 99.99 % Other (specify):		
IV Test Results	Date/Time Test Performed: 6-12-95 / 1016 STARTED ⊕ MAP.				
	Measured Parameter (Description)	Max. Relative Assembly Power % DIFF (M-P)/P	Nuclear Enthalpy Rise Hot Channel Factor FΔH(N)	Total Heat Flux Hot Channel Factor $F_Q(Z)$	Maximum Positive Incore Quadrant Power Tilt
	Measured Value	4.2, P > 0.9 -6.2, P ≤ 0.9	1.417	1.882	1.0111
	Design Value (Design Conds)	± 10% for P_i ≥0.9 ± 15% for P_i<0.9 (P_i = assy pwr)	N/A	N/A	≤ 1.0204
	Reference	WCAP- 7905 Rev. 1	None	None	WCAP-7905 Rev. 1
V Acceptance Criteria	FSAR/COLR	None	FΔH(N)≤1.49(1+0.3(1-P))	$F_Q(Z)$≤2.19/P * K(Z)	None
	Reference	None	COLR 2.6	COLR 2.5.1	None
VI Comments	Design Tolerance is met : X YES ___ NO Acceptance Criteria is met : X YES ___ NO				
	* As required ** Must have at least 16 thimbles for quarter core maps for multi-point calibrations				

Prepared By: R J McCandrew Reviewed By: E. R. Kohlhoser

NORTH ANNA POWER STATION UNIT 2 CYCLE 11
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: RCS Flow Measurement Proc No / Section: 2-PT-27		Sequence Step No:_____
II Test Conditions (Design)	Bank Positions (Steps)		RCS Temperature (°F): $T_{Ref} \pm 1$ Power Level (% F.P.): $95 \le P \le 100$ Other (specify): 580.8°F, 100% Power
	SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: *		
III Test Conditions (Actual)	Bank Positions (Steps)		RCS Temperature (°F): Power Level (% F.P.): Other (specify): 580.8°F 100% Power
	SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 CD: 225		
IV Test Results	Date/Time Test Performed: 7/6/95 At 0820-0920		
	Measured Parameter (Description)	F_{Total}; Total RCS Flow Rate	
	Measured Value	F_{Total} = 308,071 GPM	
	Design Value (Actual Conditions)	Not Applicable	
	Design Value (Design Conditions)	Not Applicable	
	Reference	Not Applicable	
V Acceptance Criteria	FSAR/Tech Spec	$F_{Total} \ge 275300$ gpm	
	Reference	Technical Specification 3.2.5	
VI Comments	Design Tolerance is met : ✓ YES ___ NO Acceptance Criteria is met : ✓ YES ___ NO		
	* As required		

Prepared By: R.S. McCandrew Reviewed By: [illegible]