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REYES,L.A.	Region 2 (Post 820201)

SUBJECT: Forwards rev 0 to NE-1148, "Surry Unit 2 Cycle 15 Startup Physics Test Rept," summarizing results of physics testing program performed after initial criticality of cycle 15 on 971030.

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C A T E G O R Y 1

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VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

January 22, 1998

Mr. Luis A. Reyes, Administrator
United States Nuclear Regulatory Commission
Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, Georgia 30303

Serial No. 98-048
NLOS/GDM
Docket No. 50-281
License No. DPR-37

Dear Mr. Reyes:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNIT 2
CYCLE 15 STARTUP PHYSICS TESTS REPORT

As required by Surry Technical Specification 6.6.A.1, enclosed is the Virginia Electric and Power Company Technical Report NE-1148, Revision 0, entitled "Surry Unit 2, Cycle 15 Startup Physics Tests Report." This report summarizes the results of the physics testing program performed after the initial criticality of Cycle 15 on October 30, 1997. The results of the physics tests were within the applicable Technical Specification limits.

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

Very truly yours,

J. H. McCarthy, Manager
Nuclear Operations and Licensing Support

Enclosure - Surry Unit 2, Cycle 15 Startup Physics Tests Report

Commitment Summary: No new commitments are intended as a result of this letter.

cc: U. S. Nuclear Regulatory Commission - 5 copies
Attention: Document Control Desk
Washington, D. C. 20555

Mr. R. A. Musser
NRC Senior Resident Inspector
Surry Power Station

Ie26

Surry Unit 2, Cycle 15 Startup Physics Test Report

Nuclear Analysis and Fuel
Nuclear Engineering & Services

December, 1997

VIRGINIA POWER

TECHNICAL REPORT NE-1148 - Rev. 0

SURRY UNIT 2, CYCLE 15
STARTUP PHYSICS TESTS REPORT

NUCLEAR ANALYSIS AND FUEL
NUCLEAR ENGINEERING AND SERVICES
VIRGINIA POWER
DECEMBER 1997

PREPARED BY: D T Bloom 12/16/97
D. T. Bloom Date

REVIEWED BY: Thomas S. Psuik 12/16/97
T. S. Psuik Date

REVIEWED BY: D C Lawrence 12/22/97
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APPROVED BY: D. Dziadosz 1/5/98
D. Dziadosz Date

QA Category: Nuclear Safety Related

Keywords: SPS2, S2C15, Startup

CLASSIFICATION/DISCLAIMER

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PREFACE

This report presents the analysis and evaluation of the physics tests which were performed to verify that the Surry 2, Cycle 15 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 test techniques and methods of data analysis were used. The test data, results, and evaluations, coupled with the detailed startup procedures, are on file at the Surry 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 Surry 2, Cycle 15 Startup Physics Test 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 these design conditions for 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 occuring during the tests.

SECTION 1

INTRODUCTION AND SUMMARY

On October 6, 1997, Surry Unit 2 shut down for its fourteenth refueling. During this shutdown, 57 of the 157 fuel assemblies in the core were replaced with 56 fresh assemblies and 1 once-burned assembly. The Cycle 15 core consists of seven sub-batches of fuel: two fresh batches (batches 17A and 17B); three once burned batches, two from cycle 14 (batches 16A and 16B), and one from Surry 1 Cycle 13 (batch S1/15A); and two twice burned batches (batches 15A and 15B). The core loading pattern and the design parameters for each sub-batch are shown in Figure 1.1. Beginning-of-cycle (BOC) fuel assembly burnups are given in Figure 1.2. The incore thimble locations available during startup physics testing are identified in Figure 1.3. Figure 1.4 identifies the location and number of burnable poison rods for Cycle 15, while Figure 1.5 identifies the control rod locations.

The Cycle 15 core achieved initial criticality at 1213 on October 30, 1997. Startup Physics tests, with the exception of hot rod drops, were peformed after criticality as outlined in Table 1.1. Hot rod drops were performed prior to criticality. A summary of the physics test results follows.

1. The measured drop time of each control rod was within the 2.4 second limit of Technical Specification 3.12.C.1.

2. The reference control rod bank was measured with the dilution method, and the result was within 3.0% of the design prediction. Individual control rod bank worths were measured using the rod swap technique[2,3] and all results were within 3.6% of the design predictions. The sum of the individual measured control rod bank worths was within 0.6% of the design prediction. All results were 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 3 ppm of the design predictions. The all-rods-out (ARO) result was within the 50 ppm design tolerance, and met the Technical Specification 4.10.A criterion that the overall core reactivity balance shall be within ±1% Δk/k of the design prediction. The reference bank in critical boron concentration was within its design tolerance.

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 configuration was within 1.29 pcm/°F of the design prediction. This result is within the design tolerance of ±3 pcm/°F. The measured ITC was -1.43 pcm/°F. When the Doppler temperature coefficient (-1.69 pcm/°F) and a 0.5 pcm/°F uncertainty are accounted for in the +6.0 pcm/°F MTC limit of the

Core Operating Limits Report (COLR) Section 2.1, the MTC requirement is satisfied as long as the ITC is less positive than 3.81 pcm/^{0}F.

6. Measured core power distributions were within established acceptance criteria and COLR limits. The average relative assembly power distribution measured/predicted percent difference was 1.8% or less for the three initial power ascension flux maps. 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 2.3 and 2.4, respectively. Note that since there are no LOPAR assemblies in this cycle, the FdH limits for all assemblies are the same.

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

SURRY 2 - CYCLE 15 STARTUP PHYSICS TESTS
CHRONOLOGY OF TESTS

Test	Date	Time	Power	Reference Procedure
Hot Rod Drop - Hot Full Flow...	10/29/97	1700	HSD	2-NPT-RX-014
Zero Power Testing Range.......	10/30/97	1302	HZP	2-NPT-RX-008
Reactivity Computer Checkout...	10/30/97	1340	HZP	2-NPT-RX-008
Boron Endpoint - ARO...........	10/30/97	1800	HZP	2-NPT-RX-008
Boron Worth Coefficient - ARO..	10/30/97	1800	HZP	2-NPT-RX-008
Temperature Coefficient - ARO..	10/30/97	1810	HZP	2-NPT-RX-008
Bank B Worth...................	10/30/97	1930	HZP	2-NPT-RX-008
Boron Endpoint - B in..........	10/30/97	2330	HZP	2-NPT-RX-008
Bank D Worth - Rod Swap........	10/31/97	0037	HZP	2-NPT-RX-008
Bank C Worth - Rod Swap........	10/31/97	0117	HZP	2-NPT-RX-008
Bank A Worth - Rod Swap........	10/31/97	0155	HZP	2-NPT-RX-008
Bank SB Worth - Rod Swap.......	10/31/97	0220	HZP	2-NPT-RX-008
Bank SA Worth - Rod Swap.......	10/31/97	0254	HZP	2-NPT-RX-008
Flux Map - 30% Power........... Peaking Factor Verification & Power Range Calibration	10/31/97	2327	29.6%	2-NPT-RX-002 2-NPT-RX-008
Flux Map - 69% Power........... Peaking Factor Verification & Power Range Calibration	11/02/97	1843	68.8%	2-NPT-RX-002 2-NPT-RX-008
Flux Map -100% Power........... Peaking Factor Verification & Power Range Calibration	11/07/97	1000	99.8%	2-NPT-RX-002 2-NPT-RX-008

Figure 1.1

SURRY UNIT 2 - CYCLE 15
CORE LOADING MAP

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							15A 2X3	15A 0X3	15A 0X9						
2					15B 3X3	15B 3X2	17B 33L	16B 4Y0	17B 40L	15B 3X9	15B 4X6				
3				15B 4X2	17A 29L	17B 55L	16A 2Y8	16B 3Y8	16A 2Y1	17B 45L	17A 14L	15B 5X0			
4			15B 4X5	15B 3X1	17B 44L	16A 1Y5	17A 06L	16A 2Y6	17A 10L	16A 0Y5	17B 49L	15B 2X9	15B 5X5		
5		15B 4X8	17A 05L	17B 52L	16A 0Y6	17A 17L	16B 4Y1	16B 4Y7	16B 5Y6	17A 22L	16A 1Y7	17B 36L	17A 26L	15B 4X4	
6		15B 4X3	17B 39L	16A 2Y2	17A 28L	16A 1Y3	17A 21L	16B 5Y3	17A 16L	16A 0Y2	17A 07L	16A 2Y9	17B 54L	15B 5X4	
7	15A 0X5	17B 47L	16A 0Y7	17A 25L	16B 4Y4	17A 12L	16A 0Y9	16B 3Y5	16A 1Y6	17A 04L	16B 4Y2	17A 32L	16A 1Y1	17B 37L	15A 1X8
8	15A 0X4	16B 5Y9	16B 5Y5	16A 2Y4	16B 4Y6	16B 6Y0	16B 5Y0	S1/15A 1K5	16B 4Y9	16B 4Y5	16B 5Y7	16A 2Y7	16B 3Y4	16B 3Y6	15A 2X8
9	15A 2X0	17B 34L	16A 3Y0	17A 18L	16B 5Y2	17A 02L	16A 0Y3	16B 5Y8	16A 1Y0	17A 23L	16B 5Y4	17A 08L	16A 2Y5	17B 43L	15A 2X2
10		15B 4X1	17B 46L	16A 0Y8	17A 20L	16A 3Y2	17A 09L	16B 5Y1	17A 11L	16A 2Y0	17A 15L	16A 0Y1	17B 50L	15B 3X7	
11		15B 3X0	17A 01L	17B 56L	16A 3Y1	17A 13L	16B 4Y3	16B 3Y3	16B 4Y8	17A 30L	16A 1Y9	17B 41L	17A 03L	15B 5X2	
12			15B 5X6	15B 3X8	17B 42L	16A 1Y4	17A 27L	16A 2Y3	17A 24L	16A 1Y8	17B 53L	15B 5X1	15B 3X6		
13				15B 4X0	17A 19L	17B 38L	16A 0Y4	16B 3Y7	16A 1Y2	17B 48L	17A 31L	15B 3X5			
14					15B 3X4	15B 4X7	17B 51L	16B 3Y9	17B 35L	15B 4X9	15B 5X3				
15							15A 2X7	15A 1X1	15A 2X6						

|--> BATCH
|--> ASSEMBLY ID

FUEL ASSEMBLY DESIGN PARAMETERS

	SUB-BATCH						
	S1/15A	15A	15B	16A	16B	17A	17B
INITIAL ENRICHMENT (W/O U-235)	3.82	3.81	4.01	3.80	4.01	3.90	4.06
BURNUP AT BOC 15 (MWD/MTU)	22426	37587	34851	20129	18758	0	0
ASSEMBLY TYPE	15x15	15X15	15X15	15X15	15X15	15X15	15X15
NUMBER OF ASSEMBLIES	1	12	28	32	28	32	24
FUEL RODS PER ASSEMBLY	204	204	204	204	204	204	204

Figure 1.2

SURRY UNIT 2 - CYCLE 15
BEGINNING OF CYCLE FUEL ASSEMBLY BURNUPS

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							2X3 37.58	0X3 37.74	0X9 37.74						
2					3X3 38.21	3X2 33.87	33L 0.00	4Y0 19.25	40L 0.00	3X9 33.89	4X6 37.29				
3				4X2 34.62	29L 0.00	55L 0.00	2Y8 20.97	3Y8 16.17	2Y1 21.38	45L 0.00	14L 0.00	5X0 34.66			
4			4X5 34.65	3X1 32.24	44L 0.00	1Y5 16.44	06L 0.00	2Y6 21.29	10L 0.00	0Y5 16.14	49L 0.00	2X9 32.50	5X5 34.04		
5		4X8 37.34	05L 0.00	52L 0.00	0Y6 21.44	17L 0.00	4Y1 19.49	4Y7 15.95	5Y6 19.99	22L 0.00	1Y7 21.91	36L 0.00	26L 0.00	4X4 37.23	
6		4X3 33.99	39L 0.00	2Y2 16.23	28L 0.00	1Y3 22.02	21L 0.00	5Y3 20.53	16L 0.00	0Y2 22.06	07L 0.00	2Y9 16.11	54L 0.00	5X4 33.81	
7	0X5 37.70	47L 0.00	0Y7 21.00	25L 0.00	4Y4 19.89	12L 0.00	0Y9 20.87	3Y5 19.06	1Y6 21.25	04L 0.00	4Y2 19.55	32L 0.00	1Y1 21.39	37L 0.00	1X8 38.01
8	0X4 37.32	5Y9 19.06	5Y5 16.13	2Y4 21.34	4Y6 16.20	6Y0 20.51	5Y0 19.23	1K5 22.56	4Y9 19.65	4Y5 20.59	5Y7 16.22	2Y7 21.17	3Y4 16.10	3Y6 18.96	2X8 37.75
9	2X0 37.87	34L 0.00	3Y0 21.65	18L 0.00	5Y2 20.18	02L 0.00	0Y3 21.21	5Y8 19.38	1Y0 21.25	23L 0.00	5Y4 20.40	08L 0.00	2Y5 21.51	43L 0.00	2X2 37.84
10		4X1 33.62	46L 0.00	0Y8 16.22	20L 0.00	3Y2 21.68	09L 0.00	5Y1 20.23	11L 0.00	2Y0 21.32	15L 0.00	0Y1 15.94	50L 0.00	3X7 33.95	
11		3X0 37.37	01L 0.00	56L 0.00	3Y1 21.88	13L 0.00	4Y3 20.05	3Y3 16.01	4Y8 20.05	30L 0.00	1Y9 21.70	41L 0.00	03L 0.00	5X2 36.77	
12			5X6 34.05	3X8 32.44	42L 0.00	1Y4 15.88	27L 0.00	2Y3 20.96	24L 0.00	1Y8 16.08	53L 0.00	5X1 32.24	3X6 34.38		
13				4X0 34.81	19L 0.00	38L 0.00	0Y4 21.34	3Y7 16.03	1Y2 21.43	48L 0.00	31L 0.00	3X5 34.77			
14					3X4 36.71	4X7 33.77	51L 0.00	3Y9 19.16	35L 0.00	4X9 33.73	5X3 37.06				
15							2X7 37.93	1X1 37.38	2X6 38.03						

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

Figure 1.3

SURRY UNIT 2 - CYCLE 15
INCORE THIMBLE LOCATIONS

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

IT - Incore Thimble
* - Unavailable Location

Figure 1.4

SURRY UNIT 2 - CYCLE 15
BURNABLE POISON LOCATIONS

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1															
2							4P BP571		4P BP579						
3					4P BP572	20P BP613		8P BP567		20P BP614	4P BP580				
4					20P BP619		20P BP595		20P BP596		20P BP620				
5			4P BP586	20P BP625		20P BP603		12P BP564		20P BP604		20P BP623	4P BP574		
6			20P BP617		20P BP609		20P BP591		20P BP592		20P BP607		20P BP615		
7		4P BP585		20P BP601		20P BP593		12P BP559		20P BP594		20P BP599		4P BP573	
8			8P BP569		12P BP565		12P BP560		12P BP561		12P BP566		8P BP570		
9		4P BP577		20P BP602		20P BP589		12P BP562		20P BP590		20P BP600		4P BP581	
10			20P BP618		20P BP610		20P BP587		20P BP588		20P BP608		20P BP616		
11			4P BP578	20P BP626		20P BP605		12P BP563		20P BP606		20P BP624	4P BP582		
12					20P BP621		20P BP597		20P BP598		20P BP622				
13					4P BP584	20P BP611		8P BP568		20P BP612	4P BP576				
14							4P BP583		4P BP575						
15															

4P - 4 BURNABLE POISON ROD CLUSTER
8P - 8 BURNABLE POISON ROD CLUSTER
12P - 12 BURNABLE POISON ROD CLUSTER
20P - 20 BURNABLE POISON ROD CLUSTER

XXP	- # OF BP RODS
BP###	- BP ASSEMBLY ID

Figure 1.5

SURRY UNIT 2 - CYCLE 15
CONTROL ROD LOCATIONS

180°

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

N-41 N-43

90°- - 270°

N-44 N-42

0°

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

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 (Tave of 547±5°F) 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 3.12.C.1.

The rod drop times were measured by withdrawing a bank to its fully withdrawn position and tripping all eight control rods within the bank by opening the reactor trip breakers. This allowed the rods to drop into the core as they would during a plant trip. The Individual Rod Position Indication (IRPI) primary coil voltage signals were recorded for each rod in the bank to determine each rod's drop time. This procedure was repeated for each bank.

As shown on the sample rod drop trace in Figure 2.1, the initiation of the rod drop is indicated by the increase in IRPI coil voltage when the reactor trip breakers are opened. 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 voltage. 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 3.12.C.1 specifies a maximum rod drop time from loss of stationary gripper coil voltage to dashpot entry of 2.4 seconds with the RCS at hot, full flow conditions. The test results satisfy this limit. In addition, rod bounce was observed at the end of each trace which demonstrated that no control rod stuck in the dashpot region.

Table 2.1

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
HOT ROD DROP TIME SUMMARY

ROD DROP TIME TO DASHPOT ENTRY

SLOWEST ROD	FASTEST ROD	AVERAGE TIME
B-06 1.35 sec.	F-04* 1.25 sec.	1.29 sec.

* Rods M-06, K-04, H-02, and P-08 also had drop times of 1.25 sec.

Figure 2.1

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
TYPICAL ROD DROP TRACE

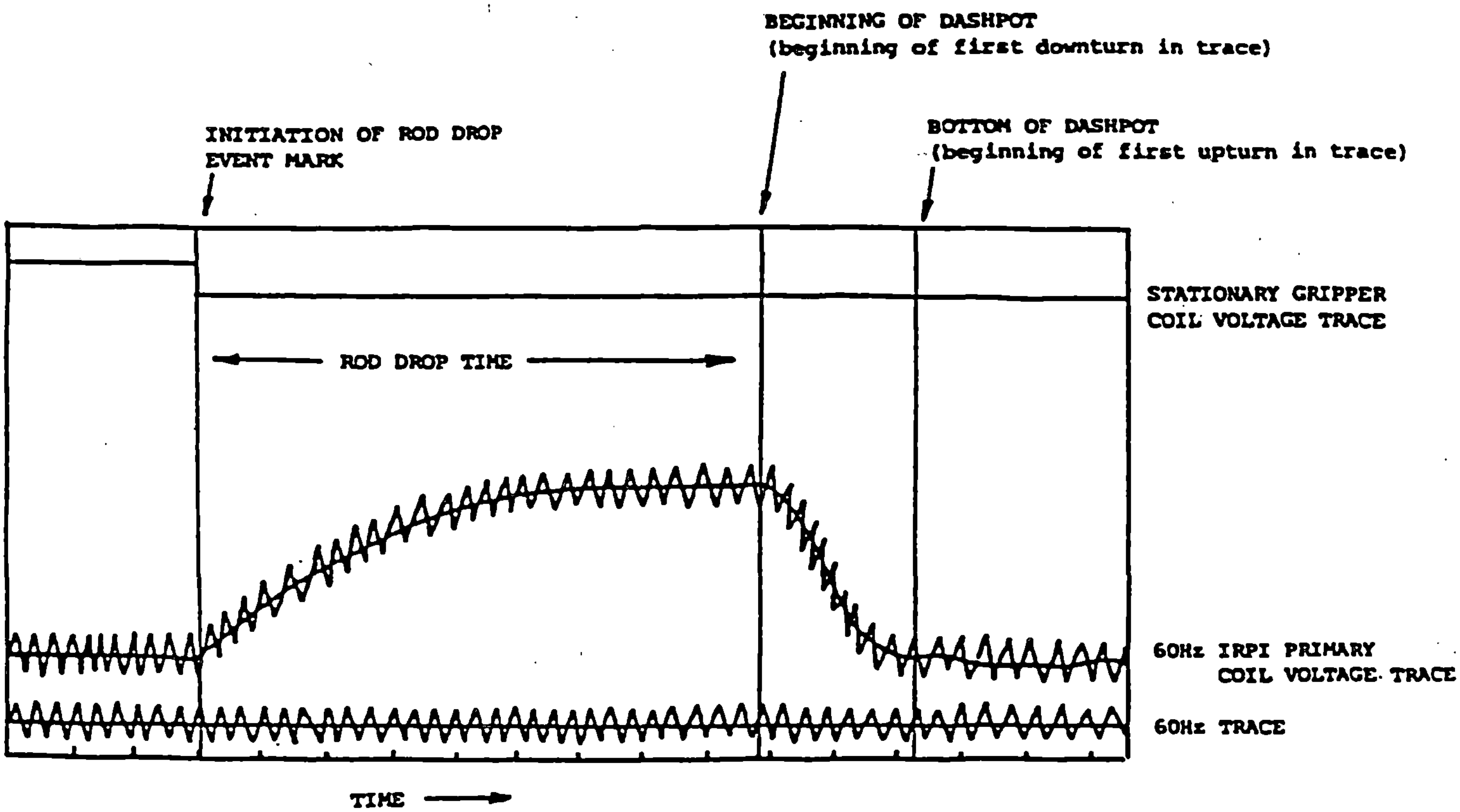


Figure 2.2

SURRY UNIT 2 - CYCLE 15 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
					1.27		1.25		1.26						2
						1.28		1.30							3
			1.28		1.25				1.25		1.32				4
				1.26						1.29					5
	1.27		1.25		1.28		1.30		1.34		1.28		1.35		6
		1.29				1.30		1.30				1.29			7
	1.25				1.30				1.29				1.30		8
		1.28				1.32		1.32				1.28			9
	1.28		1.28		1.30		1.31		1.32		1.26		1.29		10
				1.30						1.32					11
			1.28		1.27				1.30		1.30				12
						1.29		1.31							13
					1.31		1.27		1.29						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[2,3]. 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 15, 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 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 or near the initial statepoint reactivity. 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 fully inserted 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, all of 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 worth greater than 600 pcm, and ±100 pcm for test banks worth less than or equal to 600 pcm). The sum of the individual measured rod bank worths was within 0.6% of the design prediction. This is well within the design tolerance of ±10% for the sum of the individual control rod bank worths.

The integral and differential reactivity worths of the reference bank (Control Bank B) are shown in Figures 3.1 and 3.2, respectively. The design predictions and the measured data are plotted together in order to illustrate their agreement. In summary, the measured rod worth values were satisfactory.

Table 3.1

SURRY UNIT 2 - CYCLE 15 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	1537.0	1492.0	3.0
D	1005.0	1022.4	-1.7
C	881.0	914.0	-3.6
A	196.0	200.8	-2.4*
SB	1225.0	1243.5	-1.5
SA	803.0	809.1	-0.8
Total Worth	5647.0	5681.8	-0.6

* Difference is less than 100 pcm.

Figure 3.1

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
BANK B INTEGRAL ROD WORTH - HZP
ALL OTHER RODS WITHDRAWN

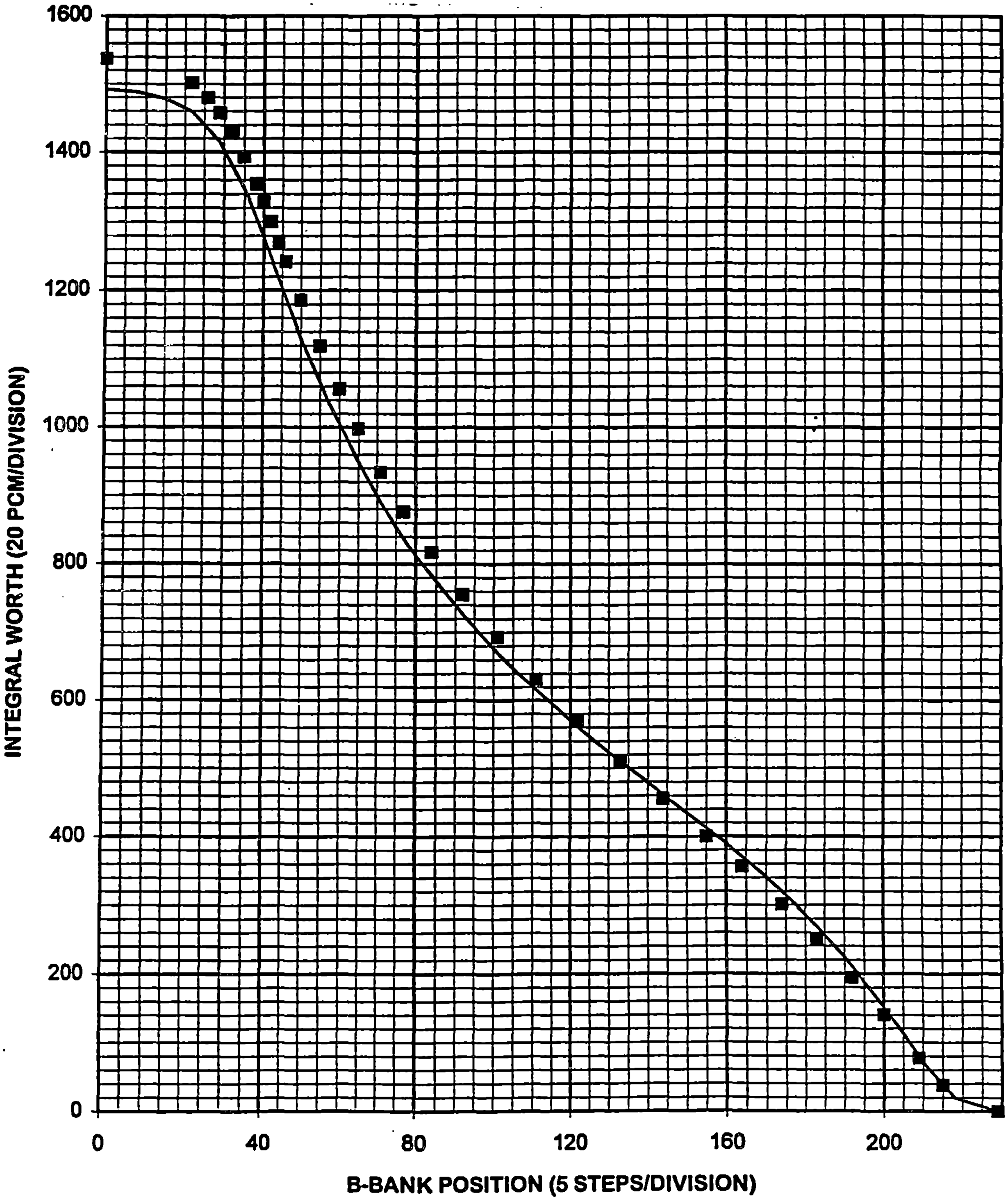
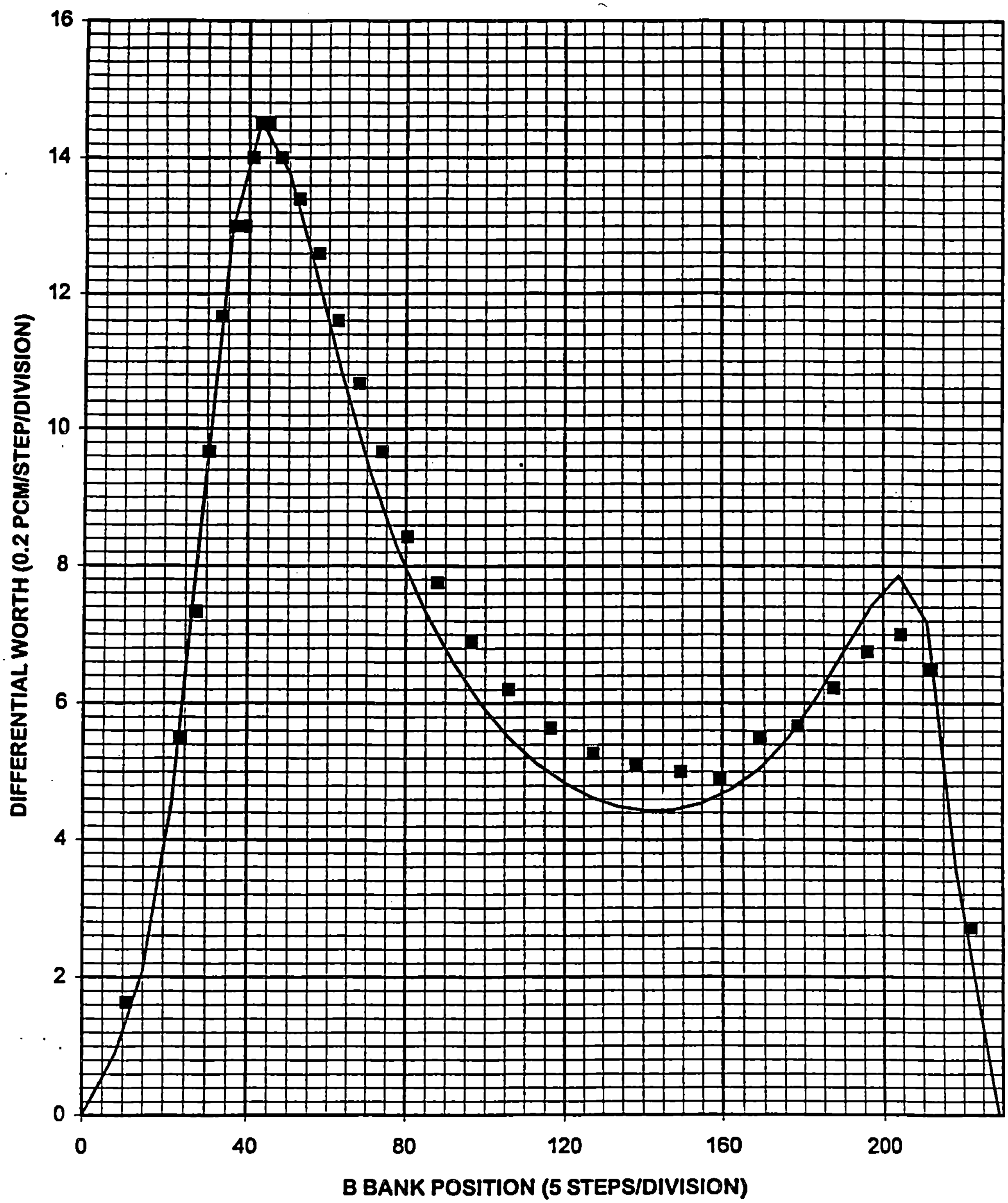


Figure 3.2

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
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 all-rods-out (ARO) endpoint comparison to the predicted value met the requirements of Technical Specification 4.10.A 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 -7.39 pcm/ppm. This is within 4.1% of the predicted value of -7.10 pcm/ppm and is well within the design tolerance of ±10%. In summary, the measured boron worth coefficient was satisfactory.

Table 4.1

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
BORON ENDPOINTS SUMMARY

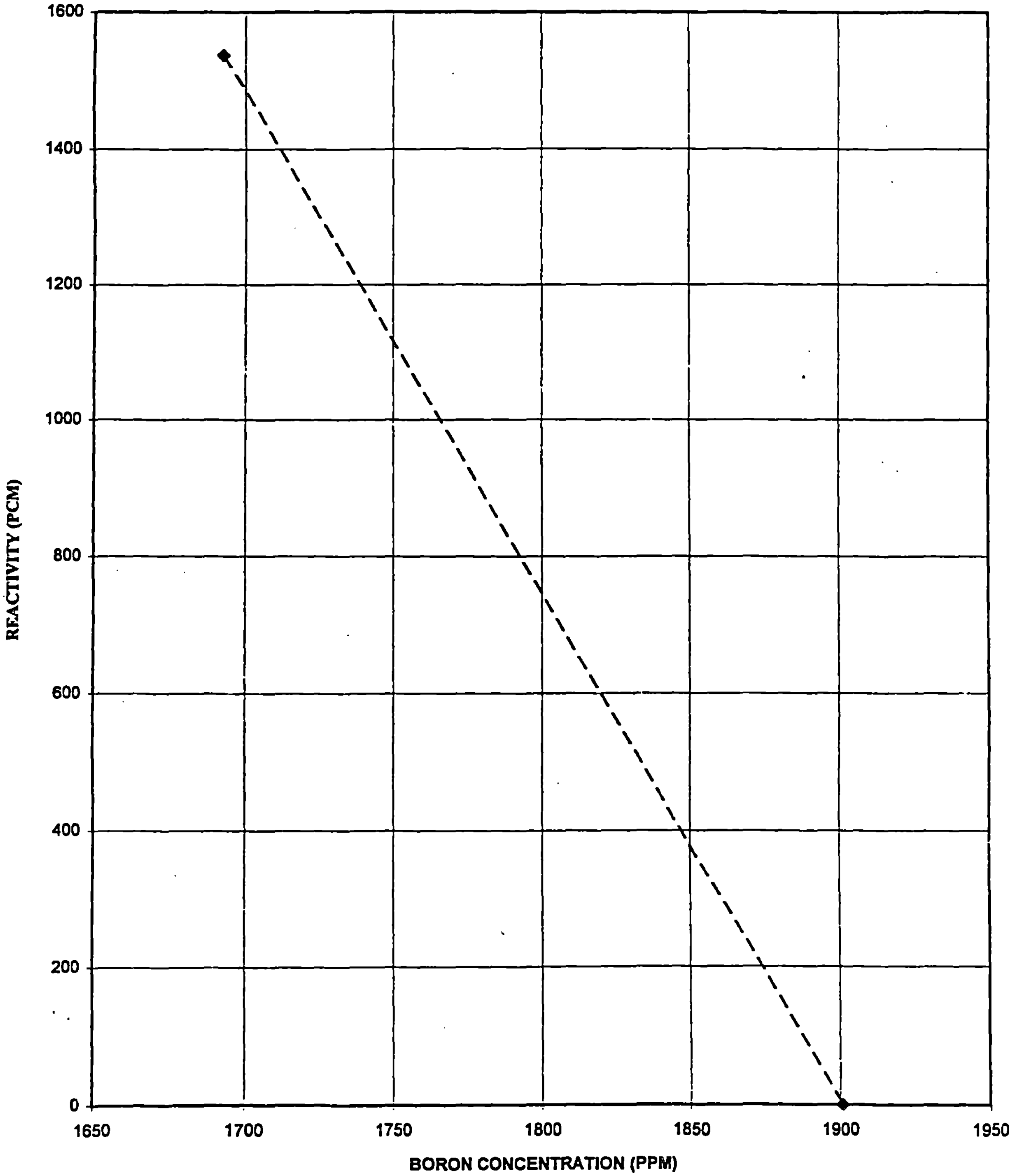
Control Rod Configuration	Measured Endpoint (ppm)	Predicted Endpoint (ppm)	Difference M-P (ppm)
ARO	1901	1898	3
B Bank In	1693	1691*	2

* 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

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
BORON WORTH COEFFICIENT

Measured DBW = -7.39 pcm/ppm



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 through varying the steam generator blowdown flow, 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 an RCS cooldown of 3.0°F and an RCS heatup of 2.6°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. Accounting for the Doppler temperature coefficient (-1.69 pcm/°F) and a 0.5 pcm/°F uncertainty, the moderator temperature coefficient was 0.76 pcm/°F, which meets the requirement of Core Operating Limits Report Section 2.1. In summary, the measured result was satisfactory.

Table 5.1

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
ISOTHERMAL TEMPERATURE COEFFICIENT SUMMARY

CORE CONDITIONS			ISOTHERMAL TEMPERATURE COEFFICIENT (PCM/ F)				
D-BANK POSITION	TEMPERATURE RANGE (F)	BORON CONCENTRATION (ppm)	C/D	H/U	AVE. MEAS.	PRED.	DIFFER. (M-P)
214/215	543.8 to 548.3	1896	-1.50	-1.35	-1.43	-2.72	1.29

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 depicted in Figure 1.3. 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 CECOR code[4]. CECOR couples the measured voltages with predetermined analytic signal-to-power conversions, pin-to-box factors, and average coupling coefficients 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 Technical Specification limits as specified in the COLR[6] is given in Table 6.2. Flux map 2 was taken at approximately 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 3 through 4 were taken near 69% 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 through 6.3. These figures show that the average relative assembly power distribution measured/predicted percent difference was 1.8% or less for the three maps. The measured F-Q(Z) and F-DH(N) peaking factor values for all flux maps were within the limits of the Core Operating Limits Report (COLR) Sections 2.3 and 2.4, respectively. Flux maps 2 and 3 were used to recalibrate the power range excore detectors. Power range detector calibration contants based on flux map 4 measurements verified the existing calibration from map 3 was satisfactory.

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 limits. It is therefore anticipated that the core will continue to operate as designed throughout Cycle 15.

TABLE 6.1

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
INCORE FLUX MAP SUMMARY

MAP DESCRIPTION [3]	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		POWER TILT [2]		AXIAL OFF SET (%)	NO. OF THIMBLES
						ASSY	AXIAL POINT	F-Q(Z)	ASSY	F-DH(N)	AXIAL POINT	F(Z)	MAX	LOC		
LESS THN 30% PWR	2	10-31-97	5	30	191	D11	19	2.041	D10	1.556	19	1.230	1.014	NE	6.75	42
BTWN 65% AND 75%	3	11-02-97	29	69	211	D10	19	1.836	D10	1.503	19	1.146	1.009	SE	4.06	42
GRT THAN 95% PWR	4	11-07-97	178	100	228	D10	34	1.773	D10	1.497	30	1.088	1.011	SE	-0.72	38

NOTES: HOT SPOT LOCATIONS ARE SPECIFIED BY GIVING ASSEMBLY LOCATIONS (E.G. H08 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 1.08.

2. POWER TILT - DEFINED AS THE AVERAGE QUADRANT POWER TILT FROM CECOR.

3. EACH MAP WAS USED TO PERFORM A PEAKING FACTOR VERIFICATION AND A POWER RANGE EXCORE DETECTOR CALIBRATION. THE FLUX MAP 4 CALIBRATION VERIFIED THE EXISTING CALIBRATION.

Table 6.2

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
COMPARISON OF MEASURED POWER DISTRIBUTION PARAMETERS
WITH THEIR CORE OPERATING LIMITS

	PEAK F-Q(Z) HOT CHANNEL FACTOR*			F-Q(Z) HOT CHANNEL FACTOR** (AT NODE OF MINIMUM MARGIN)				F-DH(N) HOT CHANNEL FACTOR#		
MAP NO.	MEAS	LIMIT	NODE	MEAS	LIMIT	NODE	MARGIN (%)	MEAS	LIMIT	MARGIN (%)
2	2.041	4.501	19	2.041	4.501	19	54.7	1.556	1.890	17.7
3	1.836	3.270	19	1.836	3.270	19	43.9	1.503	1.706	11.9
4	1.773	2.324	34	1.728	2.254	19	23.3	1.497	1.561	4.1

* 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 values for F-Q(Z) listed are 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 are the minimum percent difference between the measured values of F-Q(Z) and the Technical Specification's limit at that node for each map.

The measured F-Q(Z) hot channel factors include 8% total uncertainty.

Since all fuel assemblies in the core are SIF fuel (i.e. there are no lopar assemblies), the FdH(N) limit for all assemblies is the same.

Figure 6.1

SURRY UNIT 2 - CYCLE 15 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
						0.227	0.256	0.227						
						0.227	0.259	0.233						
						0.1	1.0	2.4						
				0.310	0.493	0.919	0.780	0.919	0.493	0.310				
				0.302	0.487	0.918	0.786	0.945	0.531	0.325				
				-2.5	-1.2	-0.1	0.8	2.8	7.7	4.9				
			0.375	1.079	1.206	1.110	1.075	1.110	1.206	1.079	0.375			
			0.382	1.047	1.185	1.107	1.079	1.134	1.242	1.119	0.407			
			1.8	-3.0	-1.7	-0.2	0.3	2.1	3.0	3.7	8.8			
		0.389	0.734	1.315	1.381	1.339	1.233	1.339	1.381	1.315	0.734	0.389		
		0.379	0.711	1.240	1.352	1.344	1.283	1.370	1.400	1.348	0.751	0.394		
		-2.7	-3.2	-5.7	-2.1	0.4	4.1	2.3	1.4	2.5	2.2	1.3		
	0.313	1.092	1.324	1.297	1.346	1.360	1.255	1.360	1.346	1.297	1.324	1.092	0.313	
	0.306	1.066	1.293	1.275	1.328	1.361	1.275	1.382	1.371	1.333	1.330	1.100	0.317	
	-2.3	-2.3	-2.3	-1.7	-1.4	0.1	1.6	1.6	1.9	2.7	0.4	0.8	1.2	
	0.496	1.213	1.387	1.348	1.226	1.284	1.293	1.284	1.226	1.348	1.387	1.213	0.496	
	0.485	1.185	1.353	1.303	1.203	1.281	1.303	1.293	1.246	1.362	1.387	1.221	0.508	
	-2.3	-2.3	-2.4	-3.3	-1.9	-0.3	0.8	0.7	1.6	1.1	0.0	0.7	2.4	
0.228	0.922	1.113	1.342	1.360	1.283	1.182	1.102	1.182	1.283	1.360	1.342	1.113	0.922	0.228
0.223	0.901	1.090	1.316	1.336	1.267	1.179	1.097	1.165	1.284	1.358	1.314	1.122	0.968	0.238
-2.3	-2.3	-2.1	-1.9	-1.7	-1.2	-0.3	-0.4	-1.5	0.1	-0.2	-2.1	0.8	4.9	4.3
0.257	0.782	1.077	1.235	1.255	1.291	1.100	1.047	1.100	1.291	1.255	1.235	1.077	0.782	0.257
0.250	0.762	1.055	1.216	1.249	1.278	1.089	1.039	1.092	1.293	1.259	1.237	1.085	0.790	0.262
-2.5	-2.5	-2.1	-1.5	-0.5	-1.0	-1.0	-0.8	-0.8	0.2	0.3	0.2	0.7	1.1	2.0
0.228	0.922	1.113	1.342	1.360	1.283	1.182	1.102	1.182	1.283	1.360	1.342	1.113	0.922	0.228
0.222	0.899	1.087	1.320	1.348	1.264	1.161	1.089	1.169	1.278	1.373	1.367	1.138	0.944	0.232
-2.6	-2.5	-2.4	-1.6	-0.9	-1.4	-1.8	-1.1	-1.1	-0.4	1.0	1.9	2.2	2.3	1.9
	0.496	1.213	1.387	1.348	1.226	1.284	1.293	1.284	1.226	1.348	1.387	1.213	0.496	
	0.481	1.171	1.359	1.326	1.196	1.237	1.282	1.278	1.222	1.373	1.442	1.258	0.519	
	-3.0	-3.4	-2.1	-1.6	-2.4	-3.6	-0.8	-0.4	-0.3	1.9	4.0	3.7	4.6	
	0.313	1.092	1.324	1.297	1.346	1.360	1.255	1.360	1.346	1.297	1.324	1.092	0.313	
	0.306	1.067	1.302	1.281	1.328	1.345	1.279	1.363	1.335	1.332	1.378	1.140	0.328	
	-2.5	-2.2	-1.7	-1.3	-1.4	-1.1	1.9	0.3	-0.8	2.7	4.1	4.5	4.5	
		0.389	0.734	1.315	1.381	1.339	1.233	1.339	1.381	1.315	0.734	0.389		
		0.389	0.726	1.303	1.367	1.322	1.236	1.344	1.386	1.344	0.779	0.421		
		-0.1	-1.1	-1.0	-1.0	-1.3	0.3	0.4	0.4	2.2	6.1	8.1		
			0.375	1.079	1.206	1.110	1.075	1.110	1.206	1.079	0.375			
			0.372	1.076	1.199	1.104	1.076	1.115	1.202	1.093	0.387			
			-0.6	-0.3	-0.6	-0.6	0.1	0.5	-0.3	1.3	3.2			
				0.310	0.493	0.919	0.780	0.919	0.493	0.310				
				0.321	0.494	0.916	0.781	0.938	0.497	0.313				
				3.8	0.1	-0.4	0.1	2.0	0.8	1.1				
						0.227	0.256	0.227						
						0.222	0.256	0.231						
						-2.3	0.0	1.6						

STANDARD DEVIATION =1.536

AVERAGE PCT DIFFERENCE = 1.8

SUMMARY

MAP NO: S2-15-02 DATE: 10/31/97 POWER: 29.6%

CONTROL ROD POSITIONS: F-Q(Z) = 2.041 QPTR:

D BANK AT 191 STEPS F-DH(N) = 1.556

NW 0.9856	NE 1.0142
SW 0.9865	SE 1.0138

F(Z) = 1.230

BURNUP = 5.0 MWD/MTU A.O. = 6.752%

Figure 6.2

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
69% POWER

PREDICTED
MEASURED
PCT DIFFERENCE

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
						0.251	0.288	0.251							
						0.252	0.292	0.256							1
						0.6	1.4	2.2							
				0.322	0.514	0.961	0.849	0.961	0.514	0.322					
				0.317	0.511	0.965	0.862	0.984	0.541	0.333					2
				-1.7	-0.6	0.4	1.4	2.4	5.3	3.2					
			0.385	1.072	1.194	1.121	1.097	1.121	1.194	1.072	0.358				
			0.390	1.049	1.181	1.122	1.109	1.141	1.222	1.097	0.403				3
			1.3	-2.1	-1.1	0.1	1.1	1.8	2.3	2.3	4.6				
		0.400	0.738	1.284	1.352	1.315	1.225	1.315	1.352	1.284	0.738	0.400			
		0.391	0.720	1.230	1.333	1.317	1.244	1.336	1.374	1.301	0.743	0.401			4
		-2.1	-2.4	-4.2	-1.5	0.1	1.6	1.6	1.6	1.3	0.7	0.2			
	0.326	1.083	1.291	1.273	1.323	1.338	1.237	1.338	1.323	1.273	1.291	1.083	0.326		
	0.320	1.063	1.270	1.263	1.314	1.344	1.255	1.356	1.338	1.279	1.281	1.083	0.337		5
	-1.9	-1.8	-1.7	-0.8	-0.6	0.4	1.5	1.3	1.1	0.5	-0.8	0.1	3.5		
	0.516	1.199	1.357	1.324	1.253	1.272	1.278	1.272	1.253	1.324	1.357	1.199	0.516		
	0.507	1.177	1.330	1.286	1.245	1.283	1.312	1.288	1.266	1.327	1.351	1.198	0.521		6
	-1.8	-1.9	-2.0	-2.8	-0.7	0.8	2.7	1.2	1.0	0.2	-0.5	-0.1	0.9		
0.251	0.963	1.123	1.317	1.338	1.271	1.181	1.101	1.181	1.271	1.338	1.317	1.123	0.963	0.251	
0.247	0.946	1.104	1.297	1.321	1.267	1.192	1.112	1.178	1.277	1.337	1.302	1.120	0.976	0.254	7
-1.7	-1.8	-1.7	-1.5	-1.2	-0.3	0.9	1.0	-0.3	0.5	-0.1	-1.2	-0.3	1.4	1.0	
0.288	0.850	1.099	1.226	1.237	1.276	1.099	1.054	1.099	1.276	1.237	1.226	1.099	0.850	0.288	
0.283	0.836	1.081	1.212	1.236	1.273	1.101	1.058	1.103	1.292	1.240	1.223	1.088	0.841	0.287	8
-1.7	-1.6	-1.6	-1.1	-0.1	-0.2	0.1	0.4	0.4	1.2	0.3	-0.2	-1.0	-1.0	-0.3	
0.251	0.963	1.123	1.317	1.338	1.271	1.181	1.101	1.181	1.271	1.338	1.317	1.123	0.963	0.251	
0.246	0.944	1.101	1.299	1.331	1.264	1.176	1.102	1.183	1.247	1.340	1.329	1.132	0.968	0.252	9
-2.0	-2.0	-2.0	-1.3	-0.5	-0.5	-0.5	0.1	0.2	-1.9	0.1	0.9	0.8	0.5	0.4	
	0.516	1.199	1.357	1.324	1.253	1.272	1.278	1.272	1.253	1.324	1.357	1.199	0.516		
	0.503	1.162	1.333	1.308	1.241	1.253	1.284	1.277	1.253	1.341	1.395	1.227	0.531		10
	-2.6	-3.1	-1.8	-1.2	-1.0	-1.5	0.4	0.4	-0.1	1.3	2.8	2.3	2.9		
	0.326	1.083	1.291	1.273	1.323	1.338	1.237	1.338	1.323	1.273	1.291	1.083	0.326		
	0.319	1.063	1.271	1.253	1.310	1.335	1.272	1.349	1.319	1.300	1.331	1.116	0.336		11
	-2.1	-1.8	-1.6	-1.6	-0.9	-0.3	2.8	0.8	-0.3	2.1	3.0	3.1	3.0		
		0.400	0.738	1.284	1.352	1.315	1.225	1.315	1.352	1.284	0.738	0.400			
		0.406	0.731	1.271	1.339	1.297	1.230	1.320	1.354	1.304	0.775	0.422			12
		1.5	-0.9	-1.0	-1.0	-1.4	0.4	0.3	0.1	1.6	5.0	5.7			
			0.385	1.072	1.194	1.121	1.097	1.121	1.194	1.072	0.385				
			0.383	1.068	1.186	1.113	1.097	1.121	1.179	1.077	0.394				13
			-0.6	-0.4	-0.6	-0.7	0.0	0.0	-1.3	0.4	2.3				
				0.322	0.514	0.961	0.849	0.961	0.514	0.322					
				0.334	0.513	0.956	0.851	0.972	0.513	0.323					14
				3.5	-0.1	-0.5	0.2	1.2	-0.1	0.3					
						0.251	0.288	0.251							
						0.243	0.287	0.253							15
						-3.0	-0.2	0.9							

PREDICTED
MEASURED
PCT DIFFERENCE

STANDARD DEVIATION =1.091

AVERAGE PCT DIFFERENCE = 1.3

SUMMARY

MAP NO: S2-15-03 DATE: 11/02/97 POWER: 68.82%

CONTROL ROD POSITIONS: F-Q(Z) = 1.836 QPTR:

D BANK AT 211 STEPS F-DH(N) = 1.503

F(Z) = 1.146

BURNUP = 29 MWD/MTU A.O. = 4.061%

QPTR		
NW 0.9916	NE 1.0088
SW 0.9908	SE 1.0088

Figure 6.3

SURRY UNIT 2 - CYCLE 15 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
100% POWER

PREDICTED / MEASURED / PCT DIFFERENCE

R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
						0.262	0.303	0.262							
						0.263	0.306	0.268							
						0.4	1.1	2.3							
				0.327	0.522	0.974	0.881	0.974	0.522	0.327					
				0.323	0.519	0.976	0.890	0.999	0.559	0.339					
				-1.3	-0.6	0.2	1.0	2.6	7.2	3.7					
			0.389	1.059	1.182	1.124	1.108	1.124	1.182	1.059	0.389				
			0.406	1.042	1.170	1.123	1.111	1.145	1.213	1.081	0.394				
			4.4	-1.7	-1.0	-0.1	0.3	1.8	2.6	2.0	1.2				
		0.403	0.737	1.264	1.334	1.304	1.224	1.304	1.334	1.264	0.737	0.403			
		0.394	0.721	1.211	1.314	1.307	1.250	1.328	1.360	1.279	0.738	0.402			
		-2.2	-2.2	-4.2	-1.5	0.2	2.1	1.9	2.0	1.2	0.1	-0.1			
	0.330	1.096	1.270	1.261	1.313	1.332	1.236	1.332	1.313	1.261	1.270	1.069	0.330		
	0.323	1.046	1.244	1.238	1.300	1.335	1.254	1.351	1.330	1.266	1.254	1.067	0.344		
	-2.2	-2.2	-2.1	-1.8	-1.0	0.3	1.4	1.4	1.3	0.4	-1.3	-0.2	4.2		
	0.524	1.187	1.338	1.314	1.275	1.275	1.281	1.275	1.275	1.314	1.338	1.187	0.524		
	0.513	1.161	1.307	1.268	1.261	1.282	1.306	1.290	1.292	1.317	1.329	1.182	0.525		
	-2.1	-2.2	-2.4	-3.5	-1.1	0.6	2.0	1.2	1.4	0.2	-0.7	-0.4	0.2		
0.262	0.976	1.126	1.306	1.331	1.274	1.192	1.114	1.192	1.274	1.331	1.306	1.126	0.976	0.262	
0.257	0.955	1.103	1.284	1.315	1.270	1.204	1.123	1.188	1.278	1.329	1.288	1.120	0.971	0.261	
-2.1	-2.1	-2.0	-1.6	-1.2	-0.3	1.0	0.8	-0.4	0.4	-0.2	-1.4	-0.6	-0.4	-0.4	
0.303	0.881	1.109	1.225	1.236	1.279	1.113	1.073	1.113	1.279	1.236	1.225	1.109	0.881	0.303	
0.296	0.863	1.089	1.213	1.246	1.279	1.115	1.076	1.115	1.285	1.238	1.226	1.111	0.876	0.302	
-2.1	-2.1	-1.8	-1.0	0.8	0.0	0.2	0.3	0.2	0.5	0.2	0.1	0.1	-0.6	-0.1	
0.262	0.976	1.126	1.306	1.331	1.274	1.192	1.114	1.192	1.274	1.331	1.306	1.126	0.976	0.262	
0.256	0.952	1.100	1.287	1.323	1.266	1.185	1.116	1.198	1.249	1.335	1.325	1.144	0.990	0.266	
-2.3	-2.4	-2.3	-1.4	-0.6	-0.6	-0.6	0.1	0.4	-1.9	0.3	1.5	1.6	1.4	1.7	
	0.524	1.187	1.338	1.314	1.275	1.275	1.281	1.275	1.275	1.314	1.338	1.187	0.524		
	0.508	1.142	1.312	1.298	1.259	1.250	1.285	1.279	1.271	1.332	1.389	1.226	0.547		1
	-3.1	-3.7	-2.0	-1.2	-1.2	-2.0	0.3	0.3	-0.2	1.3	3.8	3.3	4.5		
	0.330	1.069	1.270	1.261	1.313	1.332	1.236	1.332	1.313	1.261	1.270	1.069	0.330		
	0.322	1.048	1.251	1.245	1.300	1.324	1.273	1.341	1.303	1.278	1.313	1.111	0.344		1
	-2.4	-2.0	-1.6	-1.3	-1.0	-0.6	3.0	0.7	-0.7	1.3	3.3	3.9	4.1		
		0.403	0.737	1.264	1.334	1.304	1.224	1.304	1.334	1.264	0.737	0.403			
		0.411	0.732	1.254	1.319	1.278	1.228	1.309	1.335	1.281	0.773	0.433			1
		2.1	-0.7	-0.8	-1.1	-2.0	0.3	0.4	0.0	1.4	4.9	7.5			
			0.389	1.059	1.182	1.124	1.108	1.124	1.182	1.059	0.389				
			0.388	1.058	1.176	1.117	1.110	1.128	1.172	1.065	0.398				1
			-0.4	-0.1	-0.5	-0.7	0.1	0.3	-0.8	0.5	2.3				
				0.327	0.522	0.974	0.881	0.974	0.522	0.327					
				0.343	0.524	0.974	0.886	0.991	0.524	0.329					14
				4.8	0.4	0.0	0.6	1.7	0.4	0.5					
						0.262	0.303	0.262							
						0.262	0.305	0.266							15
						0.2	0.7	1.6							

STANDARD DEVIATION =1.314

AVERAGE PCT DIFFERENCE = 1.4

SUMMARY

MAP NO: S2-15-04 DATE: 11/07/97 POWER: 99.83%

CONTROL ROD POSITIONS: F-Q(Z) = 1.773 QPTR:

D BANK AT 228 STEPS F-DH(N) = 1.497

NW 0.9904	NE 1.0077
SW 0.9906	SE 1.0112

F(Z) = 1.088

BURNUP = 178 MWD/MTU A.O. = -0.722%

SECTION 7

REFERENCES

1. T. S. Psuik and C. B. LaRoe, "Surry Unit 2, Cycle 15 Design Report", Technical Report NE-1146, Revision 0, October, 1997.

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

3. 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.

4. T. W. Schleicher, "Reactor Power Distribution Analysis Using a Moveable In-Core Detector System and the TIP/CECOR Computer Code Package", VEP-NAF-2, November, 1991.

5. Surry Unit 1 and 2 Technical Specifications, Sections 3.1.E.1, 3.12.B.1, 3.12.C.1, 4.10.A, and 5.3.A.6.b.

6. "Core Operating Limits Report Surry 2 Cycle 15 Pattern UZ, Revision 0", September, 1997.

APPENDIX

STARTUP PHYSICS TEST RESULTS
AND EVALUATION SHEETS

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Zero Power Testing Range Determination Proc No / Section: 2-NPT-RX-008	Sequence Step No:
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: * CD: *	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: 104	RCS Temperature (°F): 547.4 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/30/97 1302	
	Reactivity Computer Initial Flux Background Reading	0 * amps *Backing current set to 1.33×10^{-9} amps
	Flux Reading At Point Of Nuclear Heating	3.0×10^{-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: Pamela D. Banning

Reviewed By: Thomas S. [illegible]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Reactivity Computer Checkout Proc No / Section: 2-NPT-RX-008	Sequence Step No:
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: * CD: *	RCS Temperature (^{O}F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: 109	RCS Temperature (^{O}F): 548.5 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/30/97 13:40	
	Measured Parameter (Description)	ρ_c= Measured Reactivity using ρ-computer ρ_t= Predicted Reactivity
	Measured Value	ρ_c= -44.0, 49.0 ρ_t= -45.4, 49.8 %D= -3.1, -1.2
	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 results from the benchmark test. Allowable Range = -44 pcm to +49 pcm	

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

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

<table>
<tr><td>I
Reference</td><td colspan="2">Test Description: Critical Boron Concentration - ARO
Proc No / Section: 2-NPT-RX-008</td><td>Sequence Step No:</td></tr>
<tr><td>II
Test
Conditions
(Design)</td><td colspan="2">Bank Positions (Steps)
SDA: 229 SDB: 229 CA: 229
CB: 229 CC: 229 CD: 229</td><td>RCS Temperature (^{o}F): 547
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating</td></tr>
<tr><td>III
Test
Conditions
(Actual)</td><td colspan="2">Bank Positions (Steps)
SDA: 229 SDB: 229 CA: 229
CB: 229 CC: 229 CD: 229</td><td>RCS Temperature (^{o}F): 547.0
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating</td></tr>
<tr><td rowspan="5">IV
Test
Results</td><td colspan="2">Date/Time Test Performed:
10/30/97 1800</td><td></td></tr>
<tr><td>Measured Parameter
(Description)</td><td colspan="2">$(C_B)^M{}_{ARO}$; Critical Boron Concentration - ARO</td></tr>
<tr><td>Measured Value
(Design Conditions)</td><td colspan="2">$(C_B)^M{}_{ARO}$= 1901 ppm</td></tr>
<tr><td>Design Value
(Design Conditions)</td><td colspan="2">$C_B = 1898 \pm 50$ ppm</td></tr>
<tr><td>Reference</td><td colspan="2">Technical Report NE-1146, Rev. 0</td></tr>
<tr><td rowspan="2">V
Acceptance
Criteria</td><td>FSAR/Tech Spec</td><td colspan="2">$|\alpha C_B \times C_B{}^D| \leq 1000$ pcm</td></tr>
<tr><td>Reference</td><td colspan="2">Technical Specification 4.10.A</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">αC_B = -7.09 pcm/ppm
$C_B{}^D = |(C_B)^M{}_{ARO} - C_B|$; C_B is design value</td></tr>
</table>

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

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Isothermal Temperature Coefficient - ARO Proc No / Section: 2-NPT-RX-008	Sequence Step No:
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: 229	RCS Temperature (^{o}F): 547 Power Leve' (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: 214/215	RCS Temperature (^{o}F): 546.8 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/30/97 1810	
	Measured Parameter (Description)	$(\alpha_T^{ISO})_{ARO}$: Isothermal Temperature Coefficient - ARO
	Measured Value	$(\alpha_T^{ISO})_{ARO}$= -1.43 pcm/^{o}F (C_B= 1896 ppm)
	Design Value (Actual Conditions)	$(\alpha_T^{ISO})_{ARO}$= -2.72 ±3.0 pcm/^{o}F (C_B= 1896 ppm)
	Design Value (Design Conditions)	$(\alpha_T^{ISO})_{ARO}$= -2.70 ±3.0 pcm/^{o}F (C_B= 1898 ppm)
	Reference	Technical Report NE-1146, Rev. 0
V Acceptance Criteria	FSAR/COLR	$\alpha^{ISO} \leq$ 3.81 * pcm/^{o}F α_T^{DOP} = -1.69 pcm/^{o}F
	Reference	COLR 2.1.1,Technical Report NE-1146, Rev. 0
VI Comments	Design Tolerance is met : Acceptance Criteria is met :	✓ YES ____ NO ✓ YES ____ NO
	*Uncertainty on αT_{MOD} = 0.5 pcm/^{o}F (Reference: memorandum from C.T. Snow to E.J. Lozito dated June 27, 1980.)	

Prepared By: [signature]

Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Control Bank B Worth Measurement, Rod Swap Ref. Bank Proc No / Section: 2-NPT-RX-008 Sequence Step No:	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: 229 CD: 229	RCS Temperature (^{o}F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: 229 CD: 229	RCS Temperature (^{o}F): 546.5 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/30/97 1930	
	Measured Parameter (Description)	I_B^{REF}; Integral Worth Of Control Bank B, All Other Rods Out
	Measured Value	I_B^{REF}= 1537 pcm
	Design Value (Design Conditions)	I_B^{REF}= 1492 ± 149 pcm
	Reference	Technical Report NE-1146, 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: [signature]   Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - B Bank In Proc No / Section: 2-NPT-RX-008 Sequence Step No:	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 0 CC: 229 CD: 229	RCS Temperature (^{O}F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 0 CC: 229 CD: 229	RCS Temperature (^{O}F): 546.1 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/30/97 2330	
	Measured Parameter (Description)	$(C_B)^M{}_B$; Critical Boron Concentration, B Bank In
	Measured Value (Design Conditions)	$(C_B)^M{}_B$= 1693 ppm
	Design Value (Design Conditions)	$C_B = 1688 + \Delta C_B{}^{Prev} \pm (10 + 149.2/\lvert\alpha C_B\rvert)$ ppm C_B = 1691 ± 31 ppm
	Reference	Technical Report NE-1146, 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 = -7.10 pcm/ppm $\Delta C_B{}^{Prev} = (C_B)^M{}_{ARO}$ - 1898 ppm	

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

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: HZP Boron Worth Coefficient Measurement Proc No / Section: 2-NPT-RX-008	Sequence Step No:
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: 229 CD: 229	RCS Temperature (^{O}F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: 229 CD: 229	RCS Temperature (^{O}F): 547.0 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/30/97 18:00	
	Measured Parameter (Description)	αC_B ; Boron Worth Coefficient
	Measured Value	αC_B = -7.39 pcm/ppm
	Design Value (Design Conditions)	αC_B = -7.10 ± 0.71 pcm/ppm
	Reference	Technical Report NE-1146, 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: [signature]

Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Control Bank D Worth Measurement, Rod Swap Proc No / Section: 2-NPT-RX-008 Sequence Step No:	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: 229 CD: moving	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: 229 CD: moving	RCS Temperature (°F): 546.3 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/31/97 00:37	
	Measured Parameter (Description)	I_D^{RS}; Integral Worth of Control Bank D, Rod Swap
	Measured Value	I_D^{RS}= 1005 pcm (Adjusted Measured Critical Reference Bank Position = 129 steps)
	Design Value (Actual Conditions)	I_D^{RS}= 1022.4 pcm (Adjusted Measured Critical Reference Bank Position = 129 steps)
	Design Value (Design Conditions)	I_D^{RS}= 1026 ± 154 pcm (Critical Reference Bank Position = 143 steps)
	Reference	Technical Report NE-1146, 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: DM Kohlivon Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Control Bank C Worth Measurement, Rod Swap Proc No / Section: 2-NPT-RX-008	Sequence Step No:
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: moving CD: 229	RCS Temperature (^{o}F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: moving CC: moving CD: 229	RCS Temperature (^{o}F): 546.5 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/31/97 01:17	
	Measured Parameter (Description)	I_C^{RS}; Integral Worth of Control Bank C, Rod Swap
	Measured Value	I_C^{RS}= 881 pcm (Adjusted Measured Critical Reference Bank Position = 107 steps)
	Design Value (Actual Conditions)	I_C^{RS}= 914.0 pcm (Adjusted Measured Critical Reference Bank Position = 107 steps)
	Design Value (Design Conditions)	I_C^{RS}= 912 ± 137 pcm (Critical Reference Bank Position = 118 steps)
	Reference	Technical Report NE-1146, 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 : Acceptance Criteria is met :	✓ YES ____ NO ✓ YES NO

Prepared By: [illegible] Reviewed By: [illegible]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

<table>
<tr><td>I
Reference</td><td colspan="2">Test Description: Control Bank A Worth Measurement, Rod Swap
Proc No / Section: 2-NPT-RX-008 Sequence Step No:</td></tr>
<tr><td>II
Test
Conditions
(Design)</td><td>Bank Positions (Steps)
SDA: 229 SDB: 229 CA: moving
CB: moving CC: 229 CD: 229</td><td>RCS Temperature (^{O}F): 547
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating</td></tr>
<tr><td>III
Test
Conditions
(Actual)</td><td>Bank Positions (Steps)
SDA: 229 SDB: 229 CA: moving
CB: moving CC: 229 CD: 229</td><td rowspan="2">RCS Temperature (^{O}F): 546.3
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating</td></tr>
<tr><td rowspan="6">IV
Test
Results</td><td>Date/Time Test Performed:
10/31/97 01:55</td></tr>
<tr><td>Measured Parameter
(Description)</td><td>I_A^{RS}; Integral Worth of Control Bank A,
Rod Swap</td></tr>
<tr><td>Measured Value</td><td>I_A^{RS}= 196 pcm (Adjusted Measured
Critical Reference Bank Position = 39 steps)</td></tr>
<tr><td>Design Value
(Actual Conditions)</td><td>I_A^{RS}= 200.8 pcm (Adjusted Measured
Critical Reference Bank Position = 39 steps)</td></tr>
<tr><td>Design Value
(Design Conditions)</td><td>I_A^{RS}= 201 ± 100 pcm
(Critical Reference Bank Position = 39 steps)</td></tr>
<tr><td>Reference</td><td>Technical Report NE-1146, Rev. 0, VEP-FRD-36A</td></tr>
<tr><td rowspan="2">V
Acceptance
Criteria</td><td>FSAR/Tech Spec</td><td>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>VEP-FRD-36A</td></tr>
<tr><td rowspan="2">VI
Comments</td><td colspan="2">Design Tolerance is met : ✓ YES ____ NO
Acceptance Criteria is met : ✓ YES NO</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Prepared By: SN Kohlhorn Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank B Worth Measurement, Rod Swap Proc No / Section: 2-NPT-RX-008 Sequence Step No:	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: moving CA: 229 CB: moving CC: 229 CD: 229	RCS Temperature (^{o}F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: moving CA: 229 CB: moving CC: 229 CD: 229	RCS Temperature (^{o}F): 546.4 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/31/97 02:20	
	Measured Parameter (Description)	I_{SB}^{RS}; Integral Worth of Shutdown Bank B, Rod Swap
	Measured Value	I_{SB}^{RS}= 1225 pcm (Adjusted Measured Critical Reference Bank Position = 172 steps)
	Design Value (Actual Conditions)	I_{SB}^{RS}= 1243.5 pcm (Adjusted Measured Critical Reference Bank Position = 172 steps)
	Design Value (Design Conditions)	I_{SB}^{RS}= 1242 ± 186 pcm (Critical Reference Bank Position = 186 steps)
	Reference	Technical Report NE-1146, 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] Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank A Worth Measurement, Rod Swap Proc No / Section: 2-NPT-RX-008			Sequence Step No:
II Test Conditions (Design)	Bank Positions (Steps) SDA: moving SDB: 229 CA: 229 CB: moving CC: 229 CD: 229			RCS Temperature (^{O}F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA: moving SDB: 229 CA: 229 CB: moving CC: 229 CD: 229			RCS Temperature (^{O}F): ~~564.4~~ 546.4 WHL 10/31/97 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/31/97 02:54			
	Measured Parameter (Description)	I_{SA}^{RS}: Integral Worth of Shutdown Bank A, Rod Swap		
	Measured Value	I_{SA}^{RS}= 803 pcm (Adjusted Measured Critical Reference Bank Position = 95 steps)		
	Design Value (Actual Conditions)	I_{SA}^{RS}= 809.1 pcm (Adjusted Measured Critical Reference Bank Position = 95 steps)		
	Design Value (Design Conditions)	I_{SA}^{RS}= 810 ± 122 pcm (Critical Reference Bank Position = 99 steps)		
	Reference	Technical Report NE-1146, 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: WH [signature]　　　　Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Total Rod Worth, Rod Swap Proc No / Section: 2-NPT-RX-008	Sequence Step No:
II Test Conditions (Design)	Bank Positions (Steps) SDA: moving SDB: moving CA: moving CB: moving CC: moving CD: moving	RCS Temperature (^oF): 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 (^oF): 546.5 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 10/30/97 19:30	
	Measured Parameter (Description)	I_{Total}: Integral Worth of All Banks, Rod Swap
	Measured Value	I_{Total}= 5647 pcm
	Design Value (Actual Conditions)	I_{Total}= 5681.8 pcm
	Design Value (Design Conditions)	I_{Total}= 5683 ± 568 pcm
	Reference	Technical Report NE-1146, 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] Reviewed By: [signature]

ATTACHMENT 7

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map - At Power Proc No / Section: 2-NPT-RX-008 ,002 Sequence Step No:				
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: * CD: *		RCS Temperature (^{o}F): $T_{REF} \pm 1$ Power Level (% F.P.): ≤ 30 Other (specify): Must have ≥ 38 thimbles**		
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: 191		RCS Temperature (^{o}F): T_{REF} Power Level (% F.P.): 29.55 Other (specify): 42 thimbles		
IV Test Results	Date/Time Test Performed: 10/31/97 @ 2327				
	Measured Parameter (Description)	Maximum Relative Assembly Power %DIFF (M-P)/P	Nuclear Enthalpy Rise Hot Channel Factor $F\Delta H(N)$	Total Heat Flux Hot Channel Factor $F_Q(Z)$	Maximum Positive Incore Quadrant Power Tilt
	Measured Value	-5.7 $P_i \geq 0.9$ 8.8 $P_i < 0.9$	1.556	2.041	1.0142
	Design Value (Design Conditions)	±10% for $P_i \geq 0.9$ ±15% for $P_i < 0.9$ (P_i = assy power)	N/A	N/A	≤ 1.02
	Reference	WCAP-7905, Rev. 1	None	None	WCAP-7905, Rev. 1
V Acceptance Criteria	FSAR/COLR	None	$F\Delta H(N) \leq 1.56(1+0.3(1-P))$	$F_Q(Z) \leq 4.64 * K(Z)$	None
	Reference	None	COLR 2.4	COLR 2.3	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: Pamela D. Barnum

Reviewed By: [signature]

ATTACHMENT 7

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map - At Power Proc No / Section: 2-NPT-RX-008 ,002 Sequence Step No:				
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: *			RCS Temperature (°F): $T_{REF} \pm 1$ Power Level (% F.P.): $65 \leq P \leq 75$ Other (specify): Must have ≥ 38 thimbles**	
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: 211			RCS Temperature (°F): TREF ± 1 Power Level (% F.P.): 68.82 Other (specify): 42 THIMBLES	
IV Test Results	Date/Time Test Performed: 11/2/97 1343				
	Measured Parameter (Description)	Maximum 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% $P_i \geq 0.9$ 5.7% $P_i < 0.9$	1.503	1.836	1.0088
	Design Value (Design Conditions)	±10% for $P_i \geq 0.9$ ±15% for $P_i < 0.9$ (P_i = assy power)	N/A	N/A	≤ 1.02
	Reference	WCAP-7905, Rev. 1	None	None	WCAP-7905, Rev. 1
V Acceptance Criteria	FSAR/COLR	None	$F\Delta H(N) \leq 1.56(1+0.3(1-P))$	$F_Q(Z) \leq 2.32/P \cdot K(Z)$	None
	Reference	None	COLR 2.4	COLR 2.3	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: [signature]

Reviewed By: [signature]

SURRY POWER STATION UNIT 2 CYCLE 15
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map - At Power Proc No / Section: 2-NPT-RX-008 ,002 Sequence Step No:	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: *	RCS Temperature (^{o}F): $T_{REF} \pm 1$ Power Level (% F.P.): $95 \leq P \leq 100$ Other (specify): Must have ≥ 38 thimbles**
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 229 SDB: 229 CA: 229 CB: 229 CC: 229 CD: 228	RCS Temperature (^{o}F): 573.0°F Power Level (% F.P.): 99.83% Other (specify): 38 thimbles
	Date/Time Test Performed: 11/7/97 1000	

	Measured Parameter (Description)	Maximum Relative Assembly Power %DIFF (M-P)/P	Nuclear Enthalpy Rise Hot Channel Factor $F\Delta H(N)$	Total Heat Flux Hot Channel Factor $F_Q(Z)$	Maximum Positive Incore Quadrant Power Tilt
IV Test Results	Measured Value	-4.2% for P≥0.9 +7.5% for P<0.9	1.497	1.773	1.0137 ~~1.13~~ 11/7/97
	Design Value (Design Conditions)	±10% for $P_i \geq 0.9$ ±15% for $P_i < 0.9$ (P_i = assy power)	N/A	N/A	≤ 1.02
	Reference	WCAP-7905, Rev. 1	None	None	WCAP-7905, Rev. 1
V Acceptance Criteria	FSAR/COLR	None	$F\Delta H(N) \leq 1.56(1+0.3(1-P))$	$F_Q(Z) \leq 2.32/P^{*}K(Z)$	None
	Reference	None	COLR 2.4	COLR 2.3	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: [signature] Reviewed By: [signature]