VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

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Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNIT 2
CYCLE 10 STARTUP PHYSICS TESTS REPORT

As required by Surry Technical Specification 6.6.A.1, enclosed are five (5) copies of the Virginia Electric and Power Company Technical Report NE-757 "Surry Unit 2, Cycle 10 Startup Physics Tests Report." This report summarizes the results of the physics testing program performed after initial criticality of Cycle 10 on September 16, 1989. The results of the physics tests were within required design tolerances and applicable Technical Specification limits.

Very truly yours,

W. L. Stewart
Senior Vice President - Nuclear

Attachments

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Surry Unit 2 Cycle 10 Startup Physics Tests Report

Nuclear Analysis and Fuel
Nuclear Engineering Services

VIRGINIA POWER

TECHNICAL REPORT NE-757 - Rev. 0

SURRY UNIT 2, CYCLE 10

STARTUP PHYSICS TESTS REPORT

NUCLEAR ANALYSIS AND FUEL
NUCLEAR ENGINEERING SERVICES
VIRGINIA POWER
DECEMBER 1989

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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 10 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, together 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 10 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 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 occuring during the tests.

SECTION 1

INTRODUCTION AND SUMMARY

On September 10, 1988 Unit No. 2 of the Surry Power Station shutdown for its ninth refueling. During this shutdown, 77 of the 157 fuel assemblies in the core were replaced with 52 fresh fuel assemblies, 17 once burned fuel assemblies, and 8 twice burned fuel assemblies. The tenth cycle core consists of 10 sub-batches of fuel: five once-burned batches, two from Cycle 9 (batches 11A and 11B), two from Surry Unit 1 Cycle 6 (batches S1/8A and S1/8B), and one from Surry Unit 1 Cycle 8 (batch S1/10); two twice burned batches, one from Cycles 8 and 9 (batch 10), and one from Cycles 7 and 8 (batch 9A); and three fresh batches (batches 12A, 12B, and 12C). Fourteen of the batch S1/8A and S1/8B assemblies are reconstituted, containing a total of 26 solid zircaloy rods. The three fresh batches are of the Surry Improved Fuel (SIF) product design. The core loading pattern and the design parameters for each batch are shown in Figure 1.1. Fuel assembly burnups are given in Figure 1.2. The incore movable detector locations are identified in Figure 1.3. Figure 1.4 identifies the location and number of burnable poison rods and source assemblies for Cycle 10, and Figure 1.5 identifies the location and number of control rods in the Cycle 10 core.

On September 16, 1989 at 19:59, the tenth cycle core achieved initial criticality. Following criticality, startup physics tests were performed as outlined in Table 1.1. A summary of the results of these tests follows:

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

2. Individual control rod bank worths were measured using the rod swap technique[2,6] and the results were within 8.2% of the design predictions. The sum of the individual measured control rod bank worths was within 0.7% 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 36 ppm of the design predictions. These results were within the design tolerances and also met the accident analysis acceptance criterion.

4. The boron worth coefficient measurement was within 3.5% 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 0.78 pcm/°F of the design prediction. This result is within the design tolerance of ±3 pcm/°F, and also meets the accident analysis acceptance criterion.

6. Core power distributions for at-power conditions were within established design tolerances. Generally, the measured core

power distribution was within 4.5% of the predicted power distribution. The heat flux hot channel factors, F-Q(T), and enthalpy rise hot channel factors, F-dH(M), were within the limits of their respective Technical Specifications.

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 10 STARTUP PHYSICS TESTS
CHRONOLOGY OF TESTS

Test	Date	Time	Power	Reference Procedure
Hot Rod Drop Timing Test	9/14/89	1842	HSD	2-PT-7.2
Zero Power Testing Range	9/16/89	2232	HZP	2-PT-28.11
Reactivity Computer Checkout	9/17/89	0251	HZP	2-PT-28.11
Boron Endpoint - ARO	9/17/89	0557	HZP	2-PT-28.11
Temperature Coefficient - ARO	9/17/89	0715	HZP	2-PT-28.11
Bank B Worth	9/17/89	1124	HZP	2-PT-28.11
Boron Endpoint - B in	9/17/89	1330	HZP	2-PT-28.11
Bank D Worth - Rod Swap	9/17/89	1420	HZP	2-PT-28.11
Bank C Worth - Rod Swap	9/17/89	1459	HZP	2-PT-28.11
Bank A Worth - Rod Swap	9/17/89	1547	HZP	2-PT-28.11
Bank SB Worth - Rod Swap	9/17/89	1725	HZP	2-PT-28.11
Bank SA Worth - Rod Swap	9/17/89	1808	HZP	2-PT-28.11
Flux Map - 30% Power	9/20/89	0739	30%	2-PT-28.2
Flux Map - 70% Power	10/02/89	0727	64%	2-PT-28.2
Flux Map - I/E Calibration	10/02/89	0957	64%	2-PT-28.2
Flux Map - I/E Calibration	10/02/89	1350	64%	2-PT-28.2
Flux Map - I/E Calibration	10/03/89	0947	61%	2-PT-28.2
Flux Map - HFP	10/09/89	1638	100%	2-PT-28.2

Figure 1.1

SURRY UNIT 2 - CYCLE 10
CORE LOADING MAP

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							10 5S9	S1/8B 0C1	10 3S5						
2					10 1S2	S1/8A 1B8	12B 2U9	11B 3T7	12B 4U1	S1/8A 0B2	10 1S4				
3				10 2S2	12A 1U9	12B 4U4	11A 1T4	12A 2U3	11A 1T6	12B 3U2	12A 1U1	10 5S7			
4			10 0S9	10 5S1	12B 3U5	11B 5T1	12A 0U5	11A 1T0	12A 2U1	11B 5T0	12B 4U6	10 1S9	10 4S2		
5		10 5S3	12A 1U8	12B 5U2	11B 4T1	11A 0T6	9A 4R1	11B 3T0	9A 3R5	11A 0T7	11B 4T4	12B 3U3	12A 0U9	10 5S8	
6		S1/8A 1B5	12B 4U3	11B 4T7	11A 0T3	11A 2T0	12A 1U7	11A 2T8	12A 2U4	11A 1T8	11A 0T2	11B 4T6	12B 4U7	S1/8A 0B6	
7	10 0S4	12B 4U9	11A 2T4	12A 2U5	9A 0R7	12A 0U1	S1/8B 2C9	11B 3T3	S1/8B 1C1	12A 2U7	9A 1R1	12A 1U2	11A 2T1	12B 3U0	10 4S9
8	S1/8B 2C7	11B 3T8	12A 1U6	11A 1T1	11B 3T2	11A 2T5	11B 3T6	S1/10 2E0	11B 3T1	11A 2T6	11B 3T5	11A 1T2	12A 1U5	11B 4T0	S1/8B 2C6
9	10 1S0	12B 4U2	11A 2T2	12A 2U8	9A 2R0	12A 0U7	S1/8B 4C6	11B 2T9	S1/8B 3C6	12A 2U6	9A 5R8	12A 0U4	11A 2T3	12B 4U5	10 5S5
10		S1/8A 2B0	12B 3U6	11B 4T8	11A 0T4	11A 1T9	12A 0U2	11A 2T7	12A 0U3	11A 1T7	11A 0T1	11B 4T5	12B 4U8	S1/8A 1B1	
11		10 2S1	12A 0U8	12B 3U8	11B 4T2	11A 0T5	9A 3R6	11B 3T4	9A 5R1	11A 0T8	11B 4T3	12B 3U4	12C 5U3	10 4S0	
12			10 4S7	10 2S8	12B 4U0	11B 5T2	12A 2U2	11A 0T9	12A 1U3	11B 4T9	12B 3U1	10 4S6	10 1S3		
13				10 3S4	12A 1U0	12B 5U0	11A 1T5	12A 0U6	11A 1T3	12B 3U9	12A 1U4	10 1S5			
14					10 4S5	S1/8A 0B3	12B 5U1	11B 3T9	12B 3U7	S1/8A 0B1	10 2S9				
15							10 6S0	S1/8B 3C5	10 5S6						

|-- > BATCH
|-- > ASSEMBLY ID

FUEL ASSEMBLY DESIGN PARAMETERS

	SUB-BATCH									
	S1/8A	S1/8B	S1/10	9A	10	11A	11B	12A	12B	12C
INITIAL ENRICHMENT (W/O U-235)	3.217	3.399	3.601	3.593	3.597	3.588	3.794	3.791	3.999	3.800
BURNUP AT BOC 10 (MWD/MTU)	20682	17588	17727	31346	31543	19005	18790	0	0	0
ASSEMBLY TYPE	15x15	15x15	15x15	15x15	15x15	15x15	15x15	15x15	15x15	15x15
NUMBER OF ASSEMBLIES	8	8	1	8	28	28	24	27	24	1
FUEL RODS PER ASSEMBLY	204	204	204	204	204	204	204	204	204	204

Figure 1.2

SURRY UNIT 2 - CYCLE 10
BEGINNING OF CYCLE FUEL ASSEMBLY BURNUPS

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							5S9 34725	0C1 14828	3S5 34672						
2					1S2 27711	1B8 19909	2U9 0	3T7 20021	4U1 0	0B2 20806	1S4 28299				
3				2S2 32139	1U9 0	4U4 0	1T4 20255	2U3 0	1T6 20152	3U2 0	1U1 0	5S7 32171			
4			0S9 31621	5S1 30932	3U5 0	5T1 19595	0U5 0	1T0 19511	2U1 0	5T0 19318	4U6 0	1S9 30894	4S2 31942		
5		5S3 28215	1U8 0	5U2 0	4T1 20173	0T6 16583	4R1 31612	3T0 16912	3R5 30890	0T7 17368	4T4 20194	3U3 0	0U9 0	5S8 27670	
6		1B5 19971	4U3 0	4T7 19512	0T3 17002	2T0 19748	1U7 0	2T8 20223	2U4 0	1T8 19688	0T2 16935	4T6 19815	4U7 0	0B6 20855	
7	0S4 34656	4U9 0	2T4 20110	2U5 0	0R7 31638	0U1 0	2C9 20536	3T3 16758	1C1 20813	2U7 0	1R1 31299	1U2 0	2T1 20289	3U0 0	4S9 34912
8	2C7 14566	3T8 20079	1U6 0	1T1 19362	3T2 16750	2T5 19147	3T6 16483	2E0 17727	3T1 16559	2T6 19799	3T5 17059	1T2 19397	1U5 0	4T0 20408	2C6 14268
9	1S0 34742	4U2 0	2T2 19862	2U8 0	2R0 31359	0U7 0	4C6 20747	2T9 16548	3C6 20887	2U6 0	5R8 31108	0U4 0	2T3 20300	4U5 0	5S5 34984
10		2B0 20998	3U6 0	4T8 19756	0T4 16732	1T9 19584	0U2 0	2T7 19699	0U3 0	1T7 19477	0T1 16849	4T5 19125	4U8 0	1B1 20976	
11		2S1 28148	0U8 0	3U8 0	4T2 19585	0T5 17100	3R6 31547	3T4 17699	5R1 31319	0T8 17011	4T3 19882	3U4 0	5U3 0	4S0 27937	
12			4S7 32210	2S8 31548	4U0 0	5T2 19151	2U2 0	0T9 19354	1U3 0	4T9 19708	3U1 0	4S6 31109	1S3 31965		
13				3S4 31433	1U0 0	5U0 0	1T5 20133	0U6 0	1T3 20458	3U9 0	1U4 0	1S5 32394			
14					4S5 28496	0B3 20924	5U1 0	3T9 19872	3U7 0	0B1 21016	2S9 28247				
15							6S0 34747	3C5 14053	5S6 34733						

Legend (upper line of each box) --> ASSEMBLY ID
Legend (lower line of each box) --> ASSEMBLY BURNUP

Figure 1.3

SURRY UNIT 2 - CYCLE 10
INCORE MOVABLE 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 - Movable Detector

Figure 1.4

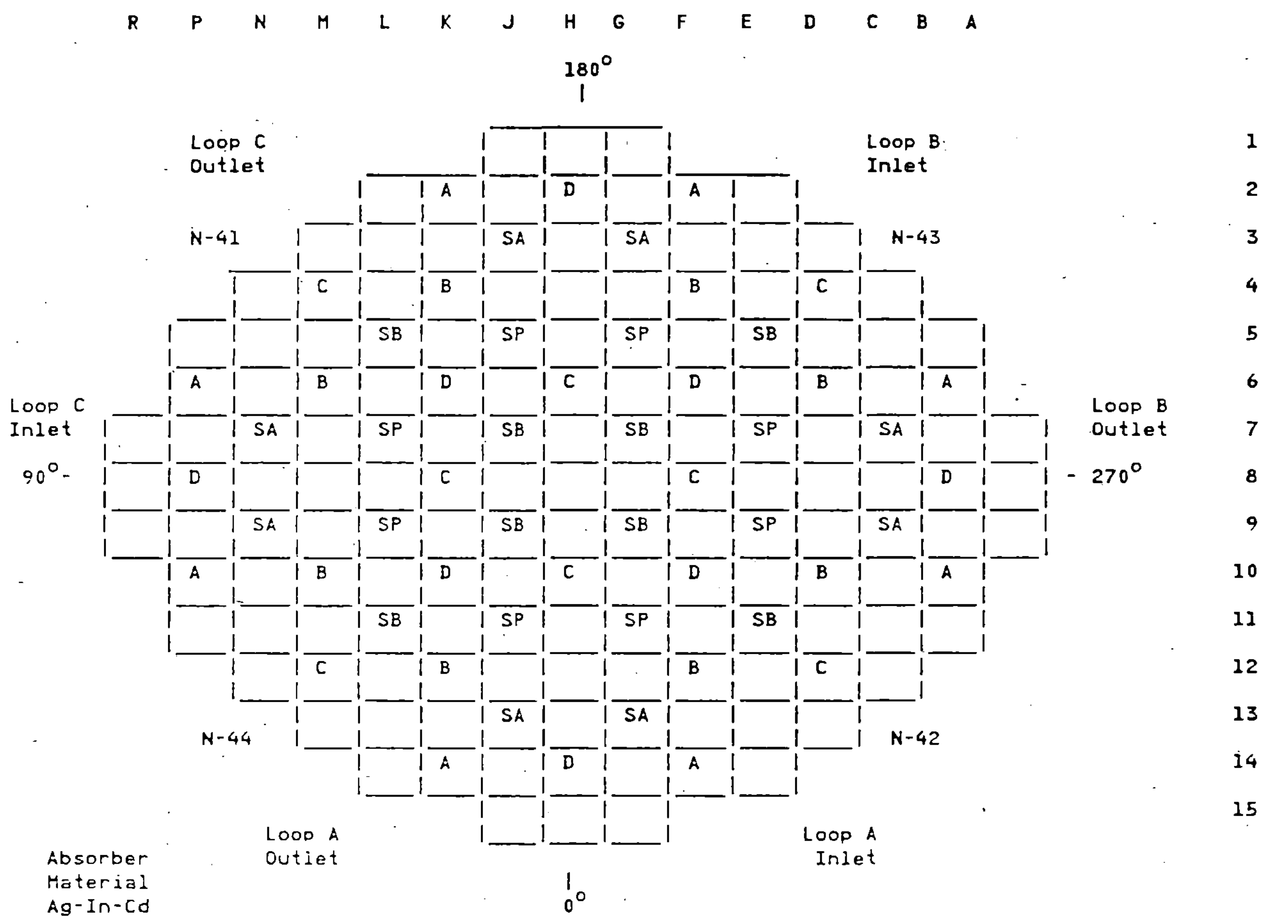
SURRY UNIT 2 - CYCLE 10
BURNABLE POISON AND SOURCE ASSEMBLY LOCATIONS

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1															
2							20P*		20P*						
3					20P*	16P		16P		16P	20P*				
4					16P		16P	4P	16P		16P				
5			20P*	16P								16P	20P*		
6			16P				17P		17P		SS4		16P		
7		20P*		16P		17P		4P*		17P		16P		20P*	
8			16P	4P			4P*	4P	4P*			4P	16P		
7		20P*		16P		17P		4P*		17P		16P		20P*	SS5
6			16P		SS3		17P		17P				16P		
5			20P*	16P								16P	20P*		
4					16P		16P	4P	16P		16P				
3					20P*	16P		16P		16P	20P*				
14							20P*		20P*						
15															

4P - 4 BURNABLE POISON ROD CLUSTER
16P - 16 BURNABLE POISON ROD CLUSTER
17P - 17 BURNABLE POISON ROD CLUSTER
4P* - 4 DEPLETED BURNABLE POISON ROD CLUSTER
20P* - 20 DEPLETED BURNABLE POISON ROD CLUSTER
SSx - SECONDARY SOURCE

Figure 1.5

SURRY UNIT 2 - CYCLE 10
CONTROL ROD LOCATIONS



Absorber
Material
Ag-In-Cd

Function	Number of Clusters
Control Bank D	8
Control Bank C	8
Control Bank B	8
Control Bank A	8
Shutdown Bank SB	8
Shutdown Bank SA	8
SP (Spare Rod Locations)	8

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 3.12.C.1. The hot control rod drop time measurements were run with the RCS at hot full flow conditions (547°F, 2235 psig) and are described below.

The rod drop times were measured by withdrawing a rod bank to its fully withdrawn position, and then removing the movable gripper coil fuse and stationary gripper coil fuse for the particular rod of the bank to be dropped. This allowed the rod to drop into the core as it would during a plant trip. The data recorded during this test are the stationary gripper coil voltage, the LVDT (Linear Variable Differential Transformer) primary coil voltage, and a 60 Hz timing trace which are recorded via a visicorder. The rod drop time to the dashpot entry and to the bottom of the dashpot are determined from this data. Figure 2.1 provides an example of the data that is recorded during a rod drop time measurement.

As shown in Figure 2.1, the initiation of the rod drop is indicated by the decay of the stationary gripper coil voltage when the stationary coil fuse is removed. A voltage is then induced in the LVDT primary coil as the rod drops. The magnitude of this voltage is a function of the rod velocity. When the rod enters the dashpot section of its guide tube, the velocity slows causing a voltage decrease in the LVDT coil. The LVDT

voltage then reaches a minimum as the rod reaches the bottom of the dashpot. Subsequent variations in the trace are caused by the rod bouncing. This procedure was repeated for each control rod.

The measured drop times for each control rod are recorded on Figure 2.2. The slowest, fastest, and average drop times are summarized in Table 2.1. Technical Specification 3.12.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. These test results satisfied this limit.

Table 2.1

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
HOT ROD DROP TIME SUMMARY

ROD DROP TIME TO DASHPOT ENTRY

SLOWEST ROD	FASTEST ROD	AVERAGE TIME
K-06 1.22 sec.	M-12 1.11 sec.	1.17 sec.

ROD DROP TIME TO BOTTOM OF DASHPOT

SLOWEST ROD	FASTEST ROD	AVERAGE TIME
M-06 1.91 sec.	P-06 1.64 sec.	1.77 sec.

FIGURE 2.1

TYPICAL ROD DROP TRACE

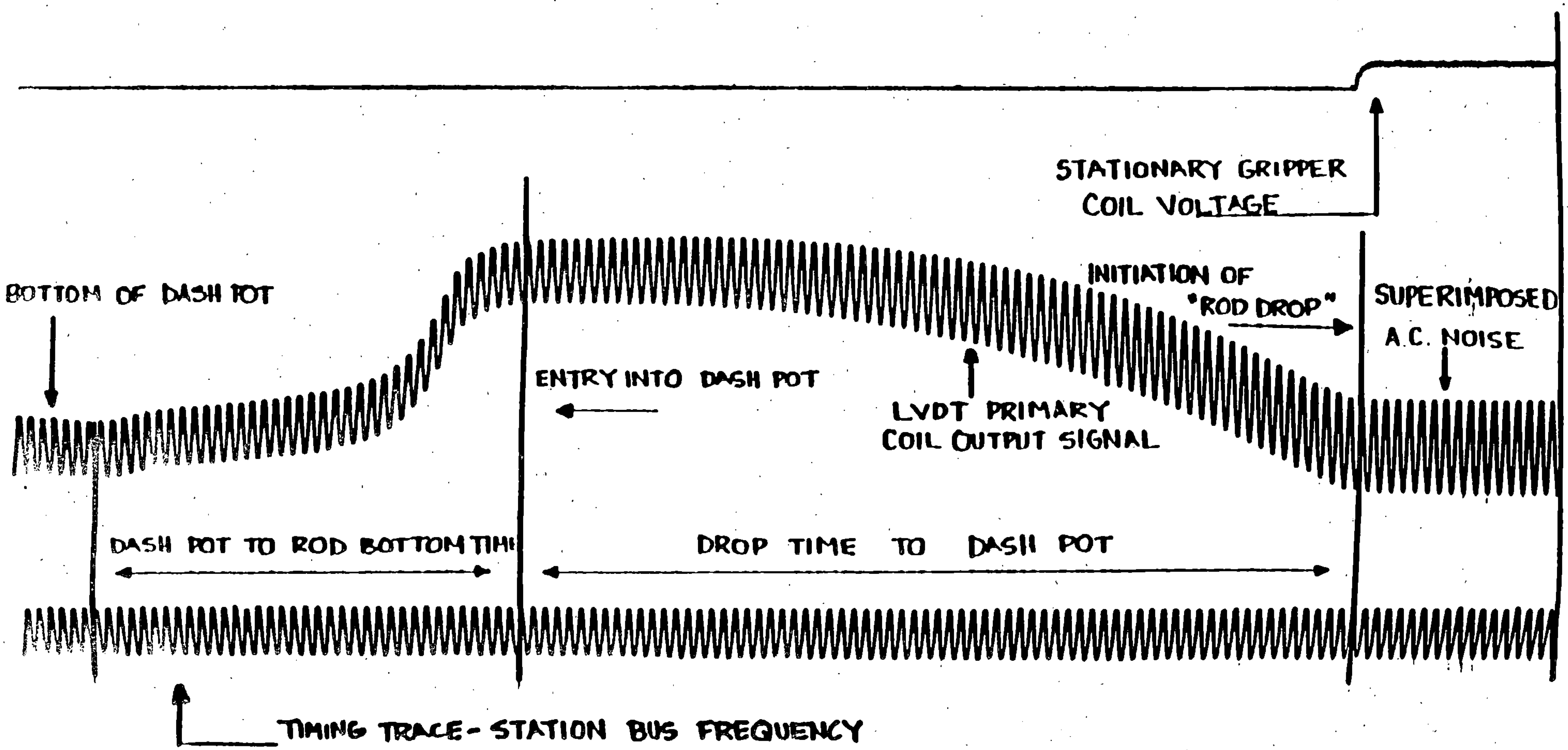


Figure 2.2

SURRY UNIT 2 - CYCLE 10 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						1.16 1.71		1.18 1.80		1.19 1.69					
3							1.13 1.76		1.16 1.79						
4				1.18 1.74		1.14 1.77				1.18 1.78		1.18 1.75			
5					1.13 1.79						1.18 1.81				
6		1.13 1.64		1.20 1.91		1.22 1.80		1.13 1.76		1.20 1.83		1.18 1.76		1.18 1.75	
7			1.15 1.73				1.13 1.68		1.18 1.72				1.14 1.77		
8		1.20 1.76				1.17 1.87				1.20 1.86				1.20 1.83	
9			1.17 1.84				1.17 1.70		1.15 1.68				1.13 1.75		
10		1.14 1.74		1.18 1.81		1.19 1.80		1.17 1.81		1.18 1.85		1.13 1.76		1.15 1.69	
11					1.13 1.77						1.18 1.79				
12				1.11 1.69		1.16 1.79				1.17 1.70		1.18 1.73			
13							1.17 1.80		1.17 1.79						
14						1.20 1.77		1.17 1.83		1.20 1.78					
15															

| X.XX |--> ROD DROP TIME TO DASHPOT ENTRY (SEC)
| Y.YY |--> ROD DROP TIME TO BOTTOM OF DASHPOT (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[2,6]. The initial step of the rod swap procedure was to dilute the predicted most reactive control rod bank (hereafter referred to as the reference bank) into the core and measure its reactivity worth using conventional test techniques. The reactivity changes resulting from the reference bank movements were recorded continuously by the reactivity computer[3] and were used to determine the differential and integral worth of the reference bank. For Cycle 10, Control Bank B was used as the reference bank.

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

moderator temperature, and the differential worth of the reference bank were recorded with the reference bank at the MCP. The rod swap maneuver was then repeated in reverse order such that the reference bank was once again 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 by this table and the Startup Physics Tests Results and Evaluation Sheets given in the Appendix, the individual measured bank worths for the control and shutdown banks were within the design tolerance (±10% for the reference bank, ±15% for each test bank worth greater than 600 pcm, and ±100 pcm for each test bank worth of less than 600 pcm). The sum of the individual measured rod bank worths was within 0.7% 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 10 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	1347.9	1364.0	-1.2
D	1154.6	1118.0	3.3
C	781.4	739.8	5.6
A	331.1	360.6	-8.2 *
SB	1054.2	989.7	6.5
SA	1018.7	1078.3	-5.5
Total Worth	5687.9	5650.4	0.7

* Difference is less than 100 pcm.

Figure 3.1

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
BANK B INTEGRAL ROD WORTH - HZP
ALL OTHER RODS WITHDRAWN

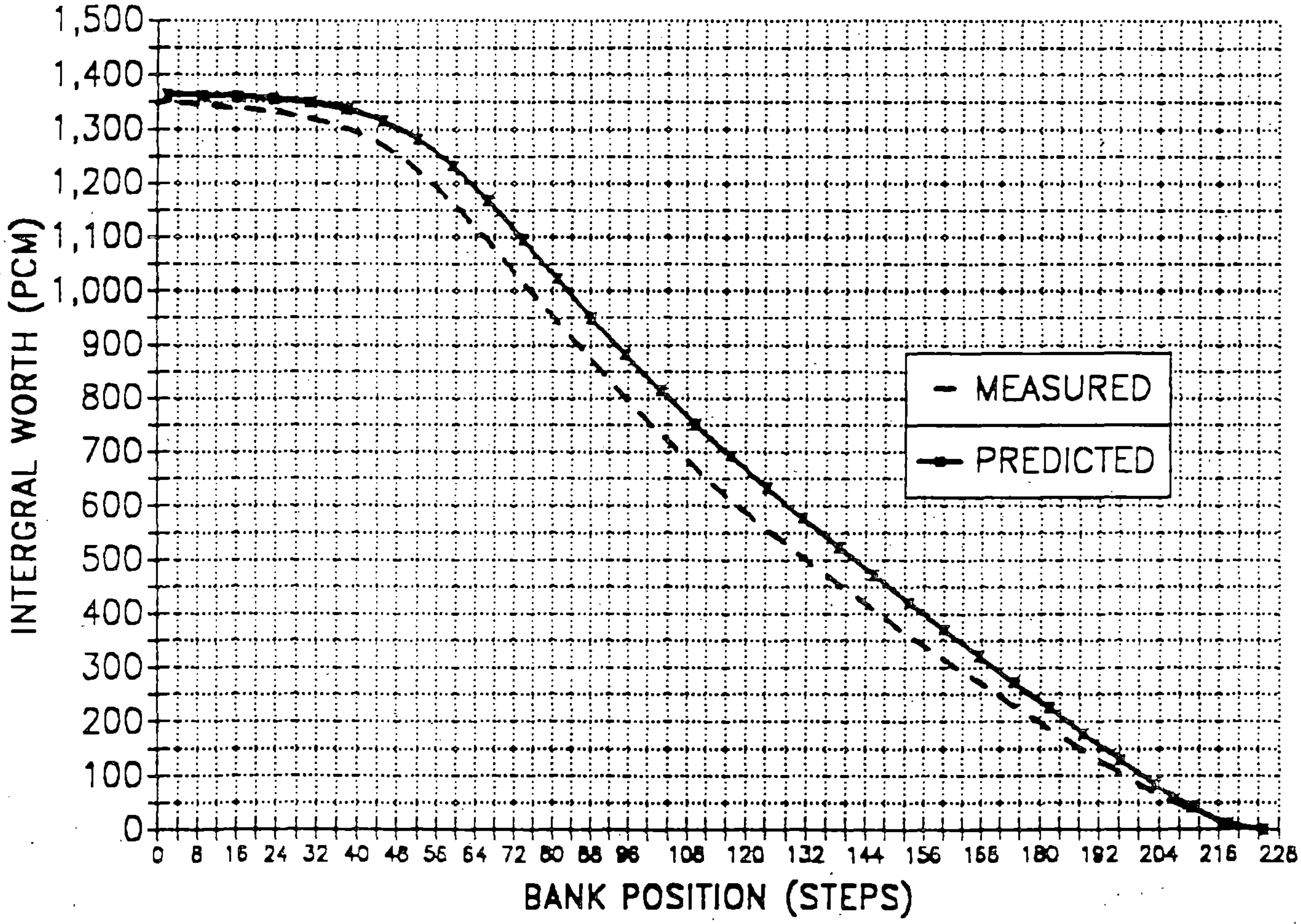
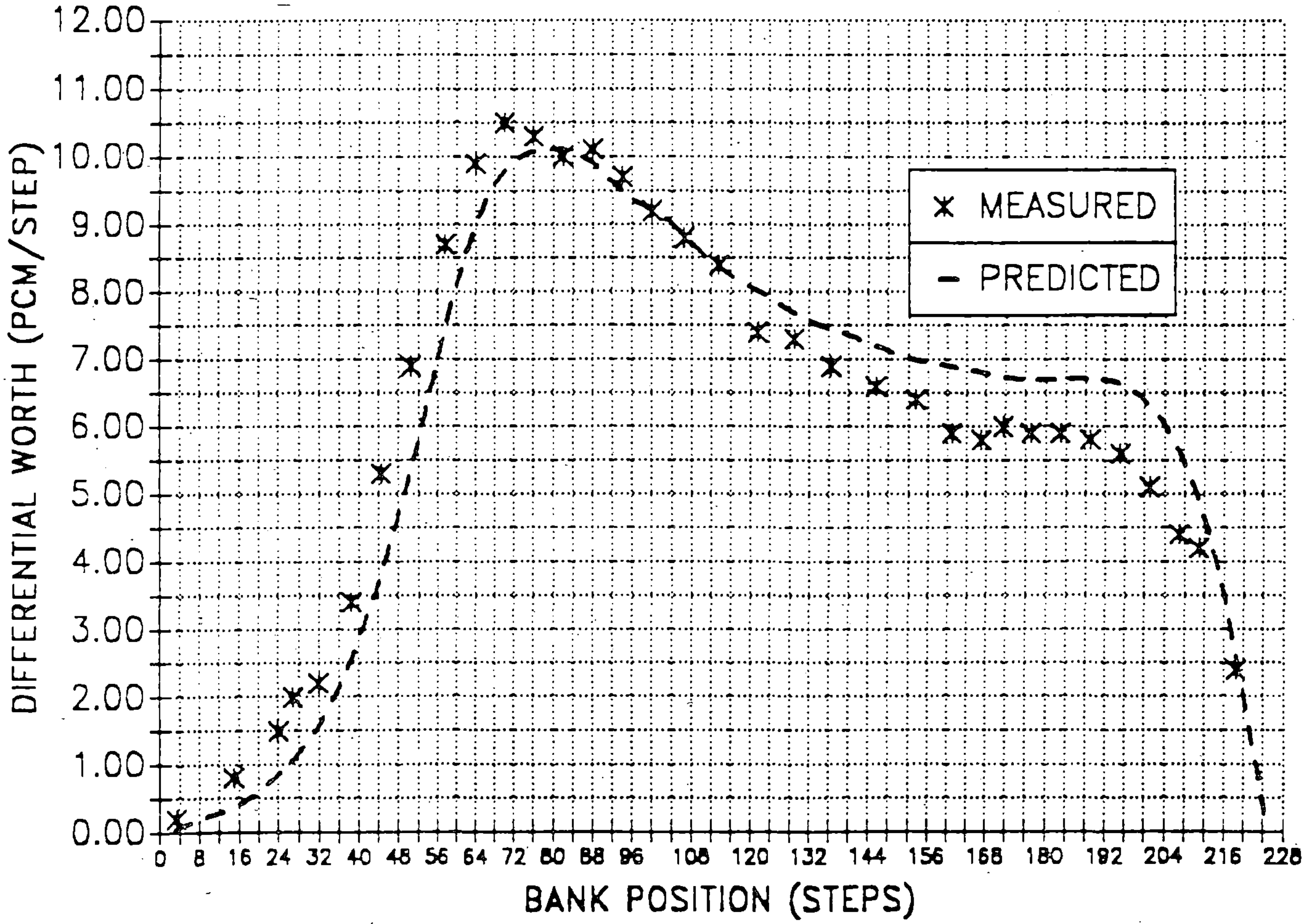


Figure 3.2

SURRY UNIT 2 - CYCLE 10 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 Tests Results and Evaluation Sheets given in the Appendix, the measured critical boron endpoint values were within their respective design tolerances and met the accident analysis acceptance criterion. 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 DBW measured was -8.07 pcm/ppm. This is within 3.3% of the predicted value of -7.80 pcm/ppm and is well within the design tolerance of ±10%. The measurement result also met the accident analysis acceptance criterion. In summary, the measured boron worth coefficient was satisfactory.

Table 4.1

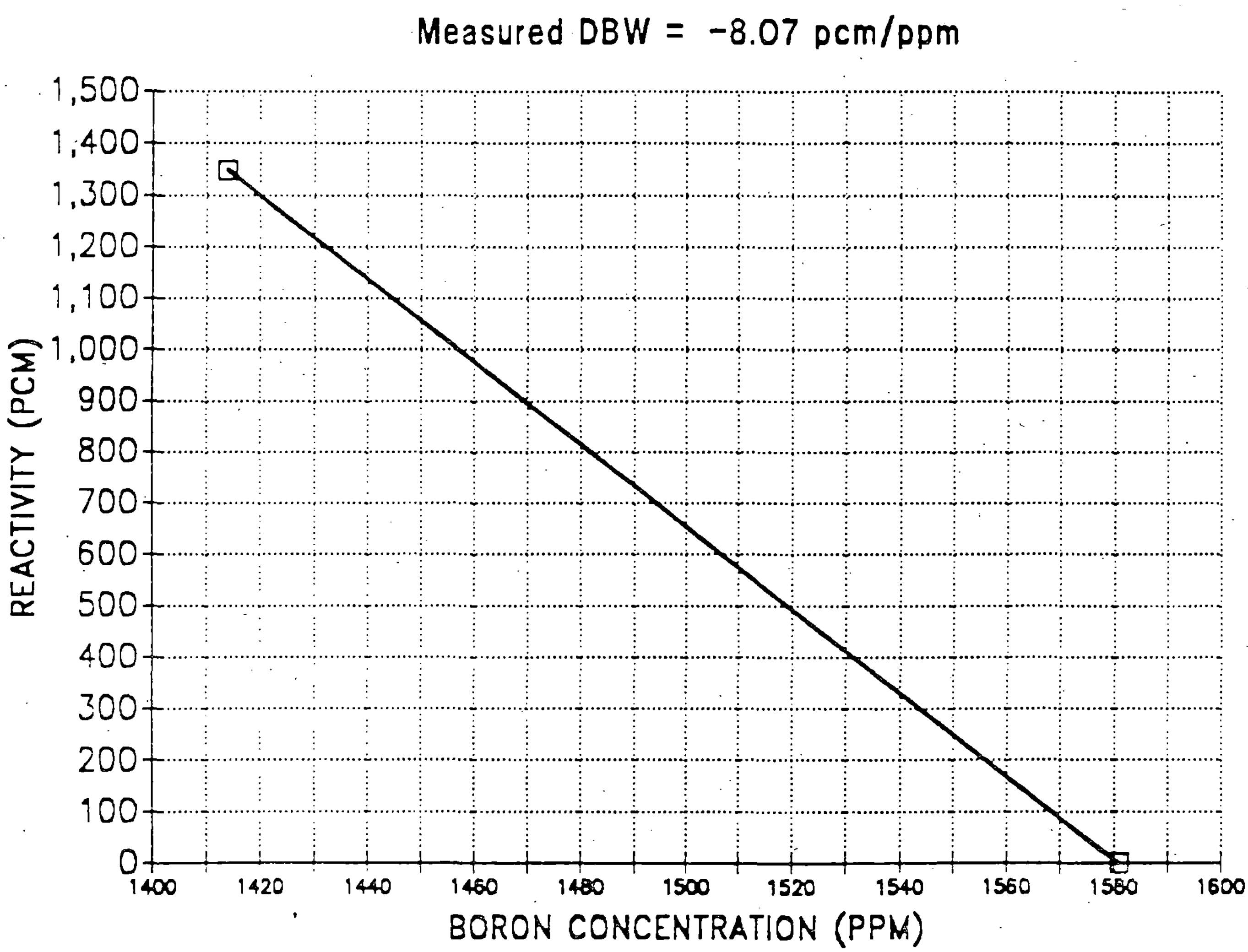
SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
BORON ENDPOINTS SUMMARY

Control Rod Configuration	Measured Endpoint (ppm)	Predicted Endpoint (ppm)	Difference M-P (ppm)
ARO	1581	1617	-36
B Bank In	1414	1405*	+9

* 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 Sheets in the Appendix.

Figure 4.1

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
BORON WORTH COEFFICIENT



SECTION 5

TEMPERATURE COEFFICIENT MEASUREMENTS

The isothermal temperature coefficient (ITC) measurement was accomplished by controlling the reactor coolant system (RCS) temperature with the steam dump valves to the condenser and/or the steam generator blowdown, establishing a constant and uniform heatup/cooldown rate, and then monitoring the resulting reactivity changes on the reactivity computer. This measurement was performed at a very low power level in order to minimize the effects of non-uniform nuclear heating, thus the moderator and fuel were at approximately the same temperature during the measurement. To eliminate the boron reactivity effect of outflow from the pressurizer, the pressurizer level was held constant or slightly increasing during the measurement.

Reactivity was measured during both the RCS cooldown and heatup while the RCS temperature varied by approximately 5°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 applicability of using the statepoint method to calculate 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 Sheets given in the Appendix, the measured isothermal temperature coefficient value was within the design tolerance of ±3 pcm/°F and met the accident analysis acceptance criterion. In summary, the measured temperature coefficient was satisfactory.

Table 5.1

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
ISOTHERMAL TEMPERATURE COEFFICIENT SUMMARY

			ISOTHERMAL TEMPERATURE COEFFICIENT (PCM/°F)				
BANK POSITION (steps)	TEMPERATURE RANGE (°F)	BORON CONCENTRATION (ppm)	COOL DOWN	HEAT UP	AVE. MEAS.	PRED.	DIFF. (M-P)
D 215/216	542.5 to 547.5	1580	-3.50	-3.44	-3.47	-4.25	+0.78

SECTION 6

POWER DISTRIBUTION MEASUREMENTS

The core power distributions were measured using the movable incore detector flux mapping system. This system consists of five fission chamber detectors which traverse fuel assembly instrumentation thimbles in up to 50 core locations (see 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 Westinghouse computer program, INCORE[4]. INCORE couples the measured voltages with predetermined analytic power-to-flux ratios in order to determine the power distribution for the whole core.

A list of the full-core flux maps taken during the startup test program and the measured values of the important power distribution parameters is given in Table 6.1. The measured power distribution parameter values are compared with their Technical Specifications limits in Table 6.2. Flux Map 1 was taken at 30% power to verify the radial power distribution (RPD) predictions at low power. Figure 6.1 shows the measured RPDs from this flux map. Flux maps 2 and 6 were taken at 64% and 100% power levels 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. These figures show that the measured relative assembly power values were generally within 4.5% of the predicted values. Further, the measured

F-Q(T) and F-DH(N) peaking factor values for the at-power flux maps were within the respective Technical Specification limits.

In conclusion, the power distribution measurement results were considered to be acceptable with respect to the design tolerances, the accident analysis acceptance criteria, and the Technical Specification limits. It is therefore anticipated that the core will continue to operate safely throughout Cycle 10.

TABLE 6.1

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
INCORE FLUX MAP SUMMARY

MAP DESCRIPTION	MAP NO.	DATE	BURN UP MWD/MTU	PWR (%)	BANK D STEPS	F-Q(T) HOT CHANNEL FACTOR [1]				F-dH(N) HOT CHNL.FACTOR			CORE F(Z) MAX		QPTR [2]		AXIAL OFF SET (%)	NO. OF THIMBLES
						ASSY	PIN	AXIAL POINT	F-Q(T)	ASSY	PIN	F-dH(N)	AXIAL POINT	F(Z)	MAX	LOC		
LOW POWER	1	9-20-89	2	30	166	H13	DC	34	2.203	E12	GH	1.524	31	1.374	1.015	SE	-0.88	42
QPTR VERIFICATION	2	10-02-89	115	64	180	H13	DC	24	2.006	J12	DM	1.467	32	1.278	1.010	SE	-1.96	42
HOT FULL POWER	6	10-09-89	315	100	207	F 9	AM	33	1.840	F 9	AM	1.474	33	1.214	1.010	SE	-1.21	41

NOTES: HOT SPOT LOCATIONS ARE SPECIFIED BY GIVING ASSEMBLY LOCATIONS (E.G. H-8 IS THE CENTER-OF-CORE ASSEMBLY), FOLLOWED BY THE PIN LOCATION (DENOTED BY THE "Y" COORDINATE WITH THE SEVENTEEN ROWS OF FUEL RODS LETTERED A THROUGH R AND THE "X" COORDINATE DESIGNATED IN A SIMILAR MANNER).
IN THE "Z" DIRECTION THE CORE IS DIVIDED INTO 61 AXIAL POINTS STARTING FROM THE TOP OF THE CORE.

1. F-Q(T) INCLUDES A TOTAL UNCERTAINTY OF 8%.

2. FdH(N) INCLUDES A TOTAL UNCERTAINTY OF 4%.

3. QPTR - QUADRANT POWER TILT RATIO.

4. MAPS 3 AND 4 WERE QUARTER-CORE FLUX MAPS TAKEN FOR INCORE/EXCORE CALIBRATION. (I/E CALIBRATION) MAP 5 WAS A QUARTER-CORE FLUX MAP TAKEN OUTSIDE OF THE PHYSICS TEST PROGRAM TO MEASURE AXIAL OFFSET.

Table 6.2

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
COMPARISION OF MEASURED POWER DISTRIBUTION PARAMETERS
WITH THEIR TECHNICAL SPECIFICATION LIMITS

MAP NO.	F-Q(T) HOT CHANNEL FACTOR*			F-dH(N) HOT CHANNEL FACTOR		
	MEAS	LIMIT	MARGIN (%)	MEAS	LIMIT	MARGIN (%)
1	2.203	4.640	52.0	1.524	1.876	18.8
2	2.006	3.566	43.8	1.467	1.717	14.6
6	1.840	2.320	20.6	1.474	1.550	4.9

* The Technical Specification's limit for the heat flux hot channel factor, F-Q(T), is a function of core height. The value for F-Q(T) listed above is the maximum value of F-Q(T) in the core. The Technical Specification's limit listed above is evaluated at the plane of maximum F-Q(T). The minimum margin values listed above are the minimum percent difference between the measured values of F-Q(T) and the Technical Specification's limit for each map. The measured F-Q(T) hot channel factors include 8% total uncertainty.

Figure 6.1

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
30% POWER

Row		R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1	PREDICTED							0.30	0.43	0.30						
	MEASURED							0.29	0.42	0.29						
	PCT DIFFERENCE							-4.2	-4.2	-1.7						
2	PREDICTED					0.38	0.62	1.13	0.98	1.13	0.61	0.38				
	MEASURED					0.37	0.59	1.09	0.94	1.10	0.60	0.38				
	PCT DIFFERENCE					-2.0	-4.2	-4.2	-4.2	-2.7	-1.9	-0.6				
3	PREDICTED				0.38	1.14	1.28	1.22	1.29	1.22	1.27	1.13	0.38			
	MEASURED				0.38	1.10	1.22	1.18	1.24	1.18	1.25	1.13	0.39			
	PCT DIFFERENCE				-2.4	-3.4	-4.7	-3.5	-3.9	-2.8	-2.0	-0.4	1.6			
4	PREDICTED			0.38	0.69	1.29	1.33	1.31	1.18	1.30	1.32	1.28	0.69	0.38		
	MEASURED			0.38	0.67	1.24	1.29	1.28	1.15	1.27	1.30	1.27	0.68	0.38		
	PCT DIFFERENCE			-2.1	-3.2	-4.2	-2.8	-2.0	-2.5	-2.7	-1.9	-1.0	-0.4	0.8		
5	PREDICTED		0.38	1.14	1.29	1.27	1.23	0.99	1.22	0.99	1.22	1.26	1.28	1.13	0.38	
	MEASURED		0.38	1.11	1.25	1.23	1.20	0.99	1.22	0.98	1.21	1.25	1.26	1.13	0.39	
	PCT DIFFERENCE		-2.0	-2.7	-3.5	-3.1	-2.4	0.0	0.1	-0.2	-0.7	-1.0	-1.8	0.5	2.9	
6	PREDICTED		0.62	1.28	1.33	1.23	1.12	1.18	1.19	1.17	1.11	1.22	1.32	1.27	0.61	
	MEASURED		0.60	1.24	1.29	1.19	1.11	1.21	1.22	1.19	1.11	1.21	1.30	1.27	0.62	
	PCT DIFFERENCE		-2.7	-3.4	-3.2	-3.4	-1.3	2.0	2.6	2.1	0.4	-0.5	-1.2	0.3	1.8	
7	PREDICTED	0.30	1.14	1.22	1.31	0.99	1.18	1.12	1.20	1.08	1.16	0.98	1.29	1.21	1.12	0.29
	MEASURED	0.29	1.11	1.19	1.28	0.97	1.18	1.16	1.23	1.11	1.19	0.99	1.29	1.21	1.13	0.30
	PCT DIFFERENCE	-2.8	-2.7	-2.7	-2.6	-2.6	0.0	3.6	3.2	2.9	2.7	1.3	-0.6	0.4	0.8	1.3
8	PREDICTED	0.43	0.96	1.29	1.16	1.22	1.19	1.20	1.09	1.18	1.17	1.20	1.17	1.28	0.97	0.43
	MEASURED	0.42	0.95	1.26	1.17	1.20	1.20	1.24	1.14	1.23	1.22	1.24	1.16	1.28	0.99	0.44
	PCT DIFFERENCE	-2.8	-2.8	-2.7	-0.9	-1.0	1.1	3.7	3.9	4.0	4.3	2.8	-0.4	0.2	1.8	2.4
9	PREDICTED	0.30	1.13	1.22	1.30	0.99	1.17	1.08	1.19	1.08	1.16	0.98	1.30	1.21	1.13	0.29
	MEASURED	0.29	1.10	1.19	1.30	1.01	1.18	1.10	1.23	1.13	1.20	1.01	1.29	1.22	1.15	0.31
	PCT DIFFERENCE	-2.1	-2.5	-2.6	-0.4	2.3	1.2	1.9	3.8	4.6	3.5	2.7	-0.2	0.8	2.3	3.6
10	PREDICTED		0.61	1.27	1.32	1.22	1.11	1.16	1.17	1.16	1.10	1.22	1.32	1.27	0.61	
	MEASURED		0.59	1.24	1.31	1.23	1.12	1.19	1.21	1.20	1.13	1.24	1.31	1.28	0.62	
	PCT DIFFERENCE		-2.5	-2.5	-0.6	0.8	1.1	1.9	2.9	3.5	2.9	1.6	-0.1	0.7	2.0	
11	PREDICTED		0.38	1.13	1.29	1.26	1.22	0.98	1.20	0.98	1.21	1.26	1.28	1.13	0.38	
	MEASURED		0.38	1.13	1.27	1.24	1.22	1.00	1.24	1.00	1.24	1.28	1.30	1.14	0.38	
	PCT DIFFERENCE		-0.6	-0.6	-1.0	-1.5	-0.1	2.3	2.6	2.7	2.6	1.6	1.4	1.4	1.7	
12	PREDICTED			0.38	0.69	1.28	1.32	1.30	1.16	1.29	1.31	1.28	0.68	0.38		
	MEASURED			0.39	0.69	1.26	1.30	1.33	1.20	1.31	1.33	1.30	0.70	0.39		
	PCT DIFFERENCE			1.4	0.2	-1.6	-1.6	2.7	2.7	1.5	1.1	1.6	2.3	1.9		
13	PREDICTED				0.38	1.13	1.27	1.21	1.28	1.21	1.26	1.12	0.38			
	MEASURED				0.39	1.14	1.28	1.26	1.31	1.20	1.25	1.13	0.39			
	PCT DIFFERENCE				1.2	1.1	1.2	3.8	2.6	-0.8	-0.9	0.4	2.2			
14	PREDICTED					0.38	0.60	1.12	0.97	1.12	0.60	0.38				
	MEASURED					0.38	0.62	1.16	1.00	1.11	0.60	0.37				
	PCT DIFFERENCE					1.1	2.2	3.7	3.6	-0.7	-0.9	-1.0				
15	PREDICTED							0.29	0.43	0.29						
	MEASURED							0.30	0.45	0.30						
	PCT DIFFERENCE							3.7	3.6	3.7						

STANDARD DEVIATION =1.196

AVERAGE PCT DIFFERENCE = 2.1

SUMMARY

MAP NO: S2-10-01 DATE: 9/20/89 POWER: 30%

CONTROL ROD POSITIONS: F-Q(T) = 2.203 QPTR:

D BANK AT 166 STEPS F-dH(N) = 1.524 NW 0.9825 | NE 0.9972

F(Z) = 1.374 SW 1.0052 | SE 1.0151

BURNUP = 2 MWD/MTU A.O. = -0.863%

Figure 6.2

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
64% POWER

Legend (each cell): PREDICTED / MEASURED / PCT DIFFERENCE

Row		R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1	Predicted							0.31	0.46	0.31						
	Measured							0.31	0.45	0.30						
	Pct Difference							-2.3	-2.4	-2.5						
2	Predicted					0.39	0.62	1.12	0.99	1.12	0.61	0.39				
	Measured					0.38	0.61	1.09	0.97	1.09	0.60	0.38				
	Pct Difference					-2.7	-2.3	-2.3	-2.4	-2.5	-2.7	-1.2				
3	Predicted				0.39	1.10	1.23	1.19	1.26	1.19	1.23	1.10	0.39			
	Measured				0.38	1.07	1.19	1.17	1.23	1.18	1.22	1.10	0.39			
	Pct Difference				-2.8	-3.3	-3.9	-1.5	-2.0	-1.3	-1.1	-0.2	1.1			
4	Predicted			0.39	0.69	1.25	1.29	1.28	1.16	1.28	1.29	1.25	0.69	0.39		
	Measured			0.38	0.67	1.21	1.27	1.28	1.16	1.27	1.29	1.24	0.68	0.39		
	Pct Difference			-2.7	-2.6	-3.3	-1.4	-0.1	-0.4	-0.5	0.3	-0.6	-1.0	-0.1		
5	Predicted		0.39	1.10	1.25	1.25	1.23	1.01	1.23	1.01	1.23	1.25	1.24	1.10	0.39	
	Measured		0.38	1.10	1.22	1.24	1.22	1.03	1.25	1.02	1.23	1.23	1.21	1.09	0.39	
	Pct Difference		-2.7	-0.6	-2.0	-1.3	-0.9	1.6	1.7	1.3	0.1	-1.2	-2.7	-0.7	1.5	
6	Predicted		0.62	1.23	1.29	1.24	1.16	1.21	1.22	1.20	1.15	1.23	1.29	1.23	0.62	
	Measured		0.62	1.21	1.27	1.21	1.16	1.25	1.26	1.22	1.15	1.22	1.27	1.22	0.62	
	Pct Difference		-0.5	-2.4	-1.7	-2.2	-0.0	2.9	3.4	1.9	0.2	-0.7	-1.6	-0.7	0.3	
7	Predicted	0.31	1.12	1.19	1.28	1.01	1.21	1.17	1.25	1.13	1.20	1.01	1.27	1.19	1.11	0.31
	Measured	0.31	1.11	1.19	1.27	1.00	1.22	1.21	1.28	1.15	1.21	1.01	1.27	1.19	1.11	0.31
	Pct Difference	-0.6	-0.6	-0.5	-1.1	-1.5	0.7	3.7	2.9	1.3	1.4	0.8	-0.4	0.3	-0.4	0.4
8	Predicted	0.46	0.99	1.26	1.16	1.23	1.22	1.25	1.15	1.24	1.21	1.23	1.16	1.26	0.99	0.46
	Measured	0.46	0.98	1.25	1.17	1.24	1.24	1.29	1.19	1.28	1.24	1.25	1.16	1.27	1.00	0.46
	Pct Difference	-0.7	-0.8	-0.6	0.6	0.2	2.0	3.7	3.4	3.0	2.6	1.8	0.1	0.8	1.5	0.8
9	Predicted	0.31	1.12	1.19	1.28	1.01	1.20	1.13	1.24	1.13	1.20	1.01	1.28	1.19	1.12	0.31
	Measured	0.30	1.09	1.16	1.28	1.04	1.22	1.15	1.29	1.19	1.23	1.03	1.28	1.20	1.13	0.31
	Pct Difference	-3.5	-2.1	-2.2	0.3	3.3	2.2	2.3	4.3	4.9	3.1	1.9	0.1	0.9	1.2	0.8
10	Predicted		0.61	1.23	1.29	1.23	1.15	1.19	1.21	1.19	1.15	1.23	1.29	1.23	0.61	
	Measured		0.59	1.18	1.28	1.25	1.17	1.22	1.25	1.23	1.18	1.24	1.29	1.23	0.62	
	Pct Difference		-3.9	-3.9	-0.7	1.8	1.9	2.2	3.0	3.6	2.6	1.1	-0.3	0.1	0.5	
11	Predicted		0.39	1.10	1.25	1.25	1.23	1.01	1.23	1.00	1.23	1.25	1.25	1.10	0.39	
	Measured		0.38	1.08	1.23	1.24	1.24	1.03	1.25	1.03	1.26	1.25	1.25	1.10	0.39	
	Pct Difference		-1.9	-1.9	-1.3	-0.4	0.7	2.1	2.0	2.7	2.8	0.2	0.3	0.5	0.5	
12	Predicted			0.39	0.69	1.24	1.29	1.27	1.16	1.27	1.29	1.24	0.69	0.39		
	Measured			0.39	0.69	1.24	1.28	1.30	1.18	1.29	1.29	1.25	0.70	0.39		
	Pct Difference			0.1	-0.2	-0.5	-0.5	2.0	2.0	1.2	0.5	0.6	1.1	0.7		
13	Predicted				0.39	1.10	1.23	1.19	1.25	1.19	1.23	1.10	0.39			
	Measured				0.38	1.06	1.19	1.23	1.28	1.17	1.20	1.09	0.39			
	Pct Difference				-1.6	-3.3	-3.3	3.7	1.9	-1.7	-1.8	-0.6	1.0			
14	Predicted					0.39	0.61	1.11	0.99	1.11	0.61	0.39				
	Measured					0.37	0.61	1.15	1.02	1.09	0.60	0.38				
	Pct Difference					-3.3	-0.5	3.6	3.3	-1.6	-1.7	-1.8				
15	Predicted							0.31	0.46	0.31						
	Measured							0.32	0.48	0.32						
	Pct Difference							3.5	3.4	3.5						

STANDARD DEVIATION =1.152

AVERAGE PCT DIFFERENCE = 1.7

SUMMARY

MAP NO: S2-10-02	DATE: 10/02/89	POWER: 64%
CONTROL ROD POSITIONS:	F-Q(T) = 2.006	QPTR:
D BANK AT 180 STEPS	F-dH(N) = 1.467	NW 0.9917 | NE 0.9969
	F(Z) = 1.278	SW 1.0018 | SE 1.0096
	BURNUP = 115 MWD/MTU	A.O. = -1.961%

Figure 6.3

SURRY UNIT 2 - CYCLE 10 STARTUP PHYSICS TESTS
ASSEMBLYWISE POWER DISTRIBUTION
100% POWER

Key: PREDICTED / MEASURED / PCT DIFFERENCE

Row	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							0.32 0.32 -2.5	0.48 0.47 -2.5	0.32 0.32 -1.9						
2					0.39 0.39 -0.8	0.62 0.61 -2.5	1.12 1.09 -2.5	1.03 1.00 -2.5	1.12 1.10 -2.1	0.61 0.60 -2.0	0.39 0.39 -0.3				
3				0.39 0.39 -1.2	1.07 1.05 -2.7	1.21 1.15 -4.5	1.18 1.16 -2.0	1.25 1.22 -2.3	1.18 1.16 -1.8	1.20 1.18 -1.6	1.07 1.07 0.1	0.39 0.40 2.3			
4			0.39 0.39 -0.9	0.69 0.67 -2.5	1.22 1.17 -3.8	1.27 1.24 -2.0	1.26 1.26 -0.5	1.16 1.14 -1.1	1.26 1.24 -1.5	1.27 1.25 -1.2	1.22 1.21 -0.7	0.69 0.68 -0.3	0.39 0.39 0.2		
5		0.39 0.39 -0.8	1.07 1.06 -1.8	1.22 1.19 -2.3	1.24 1.21 -2.0	1.24 1.23 -1.1	1.02 1.03 1.4	1.24 1.25 1.0	1.02 1.02 0.3	1.24 1.23 -0.4	1.24 1.23 -0.8	1.22 1.19 -2.4	1.07 1.06 -0.8	0.39 0.39 1.2	
6		0.62 0.61 -2.3	1.21 1.20 -0.8	1.27 1.26 -1.2	1.24 1.23 -1.0	1.21 1.22 0.5	1.23 1.26 2.8	1.23 1.26 2.8	1.22 1.24 2.2	1.20 1.21 0.6	1.24 1.23 -0.7	1.27 1.25 -1.6	1.20 1.19 -0.8	0.62 0.62 0.2	
7	0.32 0.32 -2.4	1.12 1.10 -2.3	1.18 1.16 -2.3	1.27 1.25 -1.1	1.02 1.02 -0.5	1.22 1.24 1.6	1.18 1.23 4.2	1.26 1.30 3.5	1.15 1.19 3.1	1.21 1.24 2.4	1.02 1.02 0.7	1.26 1.25 -1.0	1.18 1.18 -0.4	1.12 1.11 -0.6	0.32 0.32 -0.1
8	0.48 0.47 -2.4	1.03 1.01 -2.4	1.25 1.23 -2.3	1.16 1.14 -1.2	1.24 1.24 -0.1	1.23 1.25 1.6	1.26 1.31 4.4	1.16 1.21 4.1	1.25 1.30 3.5	1.22 1.26 3.3	1.23 1.26 1.9	1.15 1.14 -1.0	1.25 1.25 0.0	1.03 1.04 0.7	0.48 0.48 0.7
9	0.32 0.32 -2.5	1.12 1.09 -2.4	1.18 1.15 -2.5	1.26 1.24 -1.7	1.02 1.02 -0.1	1.22 1.22 0.7	1.15 1.17 1.7	1.25 1.30 3.3	1.15 1.20 4.0	1.21 1.25 2.8	1.02 1.04 1.7	1.26 1.25 -1.2	1.18 1.19 0.4	1.12 1.14 1.3	0.32 0.33 1.5
10		0.61 0.60 -2.7	1.20 1.17 -2.7	1.27 1.24 -2.2	1.24 1.22 -1.3	1.20 1.21 0.5	1.21 1.24 1.7	1.22 1.25 2.6	1.21 1.25 3.0	1.20 1.23 2.5	1.24 1.25 1.0	1.27 1.26 -1.0	1.20 1.20 -0.2	0.62 0.62 1.0	
11		0.39 0.38 -1.3	1.07 1.06 -1.4	1.22 1.20 -1.4	1.24 1.22 -1.4	1.24 1.23 -0.2	1.02 1.03 1.2	1.23 1.26 2.0	1.02 1.04 2.3	1.24 1.26 2.2	1.24 1.25 1.2	1.22 1.22 0.6	1.07 1.08 0.6	0.39 0.39 1.0	
12			0.39 0.39 0.0	0.69 0.68 -0.6	1.22 1.20 -1.4	1.27 1.26 -0.8	1.26 1.26 -0.1	1.15 1.16 1.0	1.26 1.27 1.0	1.27 1.27 0.5	1.22 1.23 0.9	0.69 0.70 1.4	0.39 0.39 1.1		
13				0.39 0.39 -0.1	1.07 1.07 -0.2	1.20 1.20 -0.3	1.18 1.17 -0.4	1.25 1.25 -0.4	1.18 1.16 -1.7	1.20 1.18 -1.8	1.07 1.07 -0.5	0.39 0.39 1.3			
14					0.39 0.39 -0.2	0.62 0.62 1.3	1.12 1.16 3.4	1.03 1.06 3.2	1.12 1.10 -1.7	0.61 0.60 -1.8	0.39 0.38 -1.8				
15							0.32 0.33 3.4	0.48 0.50 3.3	0.32 0.33 3.4						

STANDARD DEVIATION =1.050

AVERAGE PCT DIFFERENCE = 1.6

SUMMARY

MAP NO: S2-10-06 DATE: 10/09/89 POWER: 100%

CONTROL ROD POSITIONS: F-Q(T) = 1.840 QPTR:

D BANK AT 207 STEPS F-dH(N) = 1.474

NW 0.9925	NE 0.9989
SW 0.9990	SE 1.0096

F(Z) = 1.214

BURNUP = 315 MWD/MTU A.O. = -1.212%

SECTION 7

REFERENCES

1. D. A. Trace, "Surry Unit 2, Cycle 10 Design Report," Technical Report NE-657, Revision 1, Virginia Electric and Power Company, August, 1989.

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

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

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

5. Surry Power Station Technical Specifications, Sections 3.12.C.1, 3.12.B.1, and 3.1.E.1.

6. Letter from W. L. Stewart (VP) to USNRC, "Modification of Startup Physics Test Program - Inspector Followup Item 280,281/88-29-01", dated December 8, 1989.

APPENDIX

STARTUP PHYSICS TESTS RESULTS
AND EVALUATION SHEETS

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Reactivity Computer Checkout Proc No /Section: 2-PT-28.11 Sequence Step No: 3	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 225 CC: 225 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: 140	RCS Temperature (°F): 546.3 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 9/17/89 0230	
	Measured Parameter (Description)	ρ_c = Meas. Reactivty using ρ-computer ρ_t = Inferred React from react period
	Measured Value	ρ_c = 45 -43 ρ_t = +44.5 -44.5 %D = 1.1% -3.37%
	Design Value (Actual Conditions)	$\%D = \{(\rho_c-\rho_t)/\rho_t\} \times 100\% \leq 4.0\%$
	Design Value (Design Conditions)	$\%D = \{(\rho_c-\rho_t)/\rho_t\} \times 100\% \leq 4.0\%$
	Reference	WCAP 7905, Rev. 1, Table 3.6
V Acceptance Criteria	FSAR/Tech Spec	Not Applicable
	Reference	Not Applicable
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	
	* At The Just Critical Position Allowable Range = ± +45 -43	

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature]
NAF Engineer

FINAL

SEP [illegible]

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - ARO Proc No /Section: 2-PT-28.11 Sequence Step No: 4	
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): 545.9 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9/17/89 0542	
IV Test Results	Meas Parameter (Description)	$(C_B)^{M}_{ARO}$; Critical Boron Conc - ARO
	Measured Value	$(C_B)^{M}_{ARO}$ = 1581 ppm
	Design Value (Actual Cond.)	C_B = 1617 ± 50 ppm
	Design Value (Design Cond)	C_B = 1617 ± 50 ppm
	Reference	NE Technical Report No. 657, Rev. 1
V Acceptance Criteria	FSAR/Tech Spec	$\alpha C_B \times C_B \leq 15{,}115$ pcm
	Reference	UFSAR Section 14.2.5
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	
	αC_B = -7.80 pcm/ppm for preliminary analysis αC_B = -8.07 pcm/ppm for final analysis	

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature]
NAF Engineer

SEP 0 ? 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Isothermal Temperature Coefficient - ARO Proc No /Section: 2-PT-28.11 Sequence Step No: 5	
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: 215/216	RCS Temperature (°F): 545 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9-17-89 0603	

IV Test Results	Meas Parameter (Description)	$(\alpha_T^{ISO})_{ARO}$ Isothermal Temp Coeff - ARO
	Measured Value	$(\alpha_T^{ISO})_{ARO}$ = -3.47 pcm/°F (C_B = 1580 ppm)
	Design Value (Actual Cond)	$(\alpha_T^{ISO})_{ARO}$ = -4.25 pcm/°F (C_B = 1580 ppm)
	Design Value (Design Cond)	$(\alpha_T^{ISO})_{ARO}$ = -3.88 ± 3.0 pcm/°F (C_B = 1617 ppm)
	Reference	NE Technical Report No. 657, Rev. 1
V Acceptance Criteria	FSAR/Tech Spec	$\alpha_T^{ISO} \leq 0.79^{*}$ pcm/°F α_T^{Dop} = -1.71 pcm/°F
	Reference	TS 3.1.E, NE Technical Report No. 657, Rev. 1
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).	

Completed By: [signature]
Test Engineer

Evaluated By: C A Ford

Recommended for Approval By: S. M. Bourne
NAF Engineer

SEP 0 5 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank B Worth Meas.,Rod Swap Ref. Bank Proc No /Section: 2-PT-28.11 Sequence Step No: 6	
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): 546.0 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9/17/89 07:19	
IV Test Results	Measured Parameter (Description)	I_B^{REF} ; Integral Worth of Cntl Bank B, All Other Rods Out
	Measured Value	I_B^{REF} = 1347.9 pcm
	Design Value (Actual Conditions)	I_B^{REF} = 1364 ± 136 pcm
	Design Value (Design Conditions)	I_B^{REF} = 1364 ± 136 pcm
	Reference	NE Technical Report No. 657, 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	

Completed By: [signature] Test Engineer

Evaluated By: [signature]

Recommended for Approval By : [signature] NAF Engineer

FINAL

SEP [illegible] 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Critical Boron Concentration - B Bank In Proc No /Section: 2-PT-28.11 Sequence Step No: 7	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB: 0 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: 0 CC: 225 CD: 225	RCS Temperature (°F): 546.4 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 9/17/89 12:00	
	Meas Parameter (Description)	$(C_B)^M_D$; Critical Boron Conc - B Bank In
	Measured Value	$(C_B)^M_D$ = 1414 ppm
	Design Value (Actual Cond)	C_B = 1405 ± 27 ppm
	Design Value (Design Cond)	$C_B = 1441 + \Delta C_B^{Prev} \pm (10 + 136.4/\lvert\alpha C_B\rvert)$ ppm
	Reference	NE Technical Report No. 657, Rev. 1
V Acceptance Criteria	FSAR/Tech Spec	$\alpha C_B \times C_B \leq 15{,}115$ pcm
	Reference	UFSAR Section 14.2.5
VI Comments	Design Tolerance is met : ✓ YES ___ NO Acceptance Criteria is met : ✓ YES ___ NO	
	αC_B = -7.80 pcm/ppm for preliminary analysis $\Delta C_B^{Prev} = (C_B)^M_{ARO} - 1617$ αC_B = -8.07 pcm/ppm for final analysis	

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature]
NAF Engineer

FINAL

SEP 0 5 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: HZP Boron Worth Coefficent Measurement Proc No /Section: 2-PT-28.11 Sequence Step No: 4	
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): 545.8 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9/17/89 05:42	
IV Test Results	Measured Parameter (Description)	αC_B, Boron Worth Coefficient
	Measured Value	αC_B = -8.07 pcm/ppm
	Design Value (Actual Conditions)	αC_B = -7.80 ± 0.78 pcm/ppm
	Design Value (Design Conditions)	αC_B = -7.80 ± 0.78 pcm/ppm
	Reference	NE Technical Report No. 657, Rev. 0
V Acceptance Criteria	FSAR/Tech Spec	$\alpha C_B \times C_B \leq$ 15,115 pcm
	Reference	UFSAR Section 14.2.5
VI Comments	Design Tolerance is met : ✓ YES __NO Acceptance Criteria is met : ✓ YES __NO	

Completed By: [signature] Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature] NAF Engineer

SEP 0 5 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank D Worth Measurement-Rod Swap Proc No /Section: 2-PT-28.11 Sequence Step No: 9	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB:Moving CC: 225 CD:Moving	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:Moving	RCS Temperature (°F): 545.9 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 9/17/89 13:30	
	Meas Parameter (Description)	I_D^{RS} ; Int Worth of Cntl Bank D-Rod Swap
	Measured Value	I_D^{RS} = 1155 (Adj. Meas. Crit. Ref Bank Position = 181 steps)
	Design Value (Actual Cond)	I_D^{RS} = 1118 ± 168 (Adj. Meas. Crit. Ref Bank Position = 181 steps)
	Design Value (Design Cond)	I_D^{RS} = ~~1102~~ 1119 ± ~~165~~ 168 pcm (Critical Ref Bank Position = 179 steps) 9/17/89
	Reference	NE Technical Report No. 657, Rev. 0, VEP-FRD-36A, NFO-TI-2.2A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature]
NAF Engineer

SEP 0 5 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank C Worth Measurement-Rod Swap Proc No /Section: 2-PT-28.11 Sequence Step No: 10	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB:Moving CC:Moving 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:Moving CD: 225	RCS Temperature (°F): 546.7 ✓ Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9/17/89 14:25 ✓	

IV Test Results		
	Meas Parameter (Description).	I_C^{RS} ; Int Worth of Cntl Bank C-Rod Swap
	Measured Value	I_C^{RS} = 781.4 (Adj. Meas. Crit. Ref Bank Position = 123 steps) ✓
	Design Value (Actual Cond)	I_C^{RS} = 740 ± 111 (Adj. Meas. Crit. Ref Bank Position = 123 steps) ✓
	Design Value (Design Cond)	I_C^{RS} = ~~732~~ 737 ± ~~110~~ 111 pcm (Critical Ref Bank Position = 125 steps) ✓ 8-17-89
	Reference	NE Technical Report No. 657, Rev. 0, VEP-FRD-36A, NFO-TI-2.2A

V Acceptance Criteria		
	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A

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

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By : [signature]
NAF Engineer

SEP 0 5 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Cntl Bank A Worth Measurement-Rod Swap Proc No /Section: 2-PT-28.11 Sequence Step No: 11		
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA:Moving 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:Moving CB:Moving CC: 225 CD: 225		RCS Temperature (°F): 546.2 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
IV Test Results	Date/Time Test Performed: 9/17/89 15:17		
	Meas Parameter (Description)	I_A^{RS} ; Int Worth of Cntl Bank A - Rod Swap	
	Measured Value	I_A^{RS} = 331 (Adj. Meas. Crit. Ref Bank Position = 74 steps) ✓	
	Design Value (Actual Cond)	I_A^{RS} = 361±100 (Adj. Meas. Crit. Ref Bank Position = 74 steps) ✓	
	Design Value (Design Cond)	I_A^{RS} = ~~362~~ 371 ± 100 pcm (Critical Ref Bank Position = 84 steps) ✓ 891758	
	Reference	NE Technical Report No. 657, Rev. 0, VEP-FRD-36A, NFO-TI-2.2A	
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.	
	Reference	VEP-FRD-36A	
VI Comments	Design Tolerance is met : ✓ YES __NO Acceptance Criteria is met : ✓ YES __NO		

Completed By: [signature] Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature] NAF Engineer

SEP 0 6 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank B Worth Meas. - Rod Swap Proc No /Section: 2-PT-28.11 Sequence Step No: 12	
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB:Moving 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:Moving CA: 225 CB:Moving CC: 225 CD: 225	RCS Temperature (°F): 546.7 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9/17/89 16:27	

IV Test Results	Meas Parameter (Description)	I_{SB}^{RS}; Int. Worth of Shutdown Bank B-Rod Swap
	Measured Value	I_{SB}^{RS} = 1054 (Adj. Meas. Crit. Ref Bank Position = 164 steps)
	Design Value (Actual Cond)	I_{SB}^{RS} = 990 ± 149 (Adj. Meas. Crit. Ref Bank Position = 164 steps)
	Design Value (Design Cond)	I_{SB}^{RS} = ~~1020~~ 992 ± ~~150~~ 149 pcm (Critical Ref Bank Position = 160 steps) 9-17-89
	Reference	NE Technical Report No. 657, Rev. 0, VEP-FRD-36A, NFO-TI-2.2A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : ✓ YES ___ NO Acceptance Criteria is met : ✓ YES ___ NO	

Completed By: [signature] Test Engineer

Evaluated By: [signature]

Recommended for Approval By [signature] NAF Engineer

SEP 0 - 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Shutdown Bank A Worth Meas. - Rod Swap Proc No /Section: 2-PT-28.11 Sequence Step No: 13		
II Test Conditions (Design)	Bank Positions (Steps) SDA:Moving 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:Moving SDB: 225 CA: 225 CB:Moving CC: 225 CD: 225		RCS Temperature (°F): 545.7 ✓ Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9/17/89 17:26		
IV Test Results	Meas Parameter (Description)	I_{SA}^{RS}; Int Worth of Shutdown Bank A-Rod Swap	
	Measured Value	I_{SA}^{RS} = 1019 pcm (Adj. Meas. Crit. Ref Bank Position = 158 steps) ✓	
	Design Value (Actual Cond)	I_{SA}^{RS} = 1078 ± 162 (Adj. Meas. Crit. Ref Bank Position = 158 steps) ✓	
	Design Value (Design Cond)	I_{SA}^{RS} = ~~1047~~ 1073 ± ~~157~~ 161 pcm (Critical Ref Bank Position = 172 steps) ✓ @9-11-89	
	Reference	NE Technical Report No. 657, Rev. 0, VEP-FRD-36A, NFO-TI-2.2A	
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.	
	Reference	VEP-FRD-36A	
VI Comments	Design Tolerance is met : ✓ YES ___ NO Acceptance Criteria is met : ✓ YES ___ NO		

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature]
NAF Engineer

SEP 0 : 983

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: Total Rod Worth - Rod Swap Proc No /Section: 2-PT-28.11 Sequence Step No: 14	
II Test Conditions (Design)	Bank Positions (Steps) SDA:Moving SDB:Moving CA:Moving CB:Moving CC:Moving CD:Moving	RCS Temperature (°F): 547 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (Steps) SDA:Moving SDB:Moving CA:Moving CB:Moving CC:Moving CD:Moving	RCS Temperature (°F): 545.7 Power Level (% F.P.): 0 Other (Specify): Below Nuclear Heating
	Date/Time Test Performed: 9/17/89 7:19	

IV Test Results	Meas Parameter (Description)	I_{Total}; Int Worth of All Banks - Rod Swap
	Measured Value	I_{Total} = 5688
	Design Value (Actual Cond)	I_{Total} = 5650 ± 565
	Design Value (Design Cond)	I_{Total} = ~~5627~~ ± ~~563~~ pcm @9-17-89 5656 566
	Reference	NE Technical Report No. 657, Rev. 0, VEP-FRD-36A, NFO-TI-2.2A
V Acceptance Criteria	FSAR/Tech Spec	If Design Tolerance is exceeded, SNSOC shall evaluate impact of test result on safety analysis. SNSOC may specify that additional testing be performed.
	Reference	VEP-FRD-36A
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO	

Completed By: [signature] Test Engineer

Evaluated By: [signature]

Recommended for Approval By [signature] NAF Engineer

SEP 0 1 1989

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map - Low power Proc No / Section: 2-PT-28.2, 2-OP-57 Sequence Step No: 41				
II Test Conditions (Design)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB : 225 CC : * CD: *		RCS Temperature (°F): T_{REF} ±1 Power Level (% F.P.): <30 Other (specify) Must have ≥ 38 thimbles		
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB : 225 CC : 225 CD: 166		RCS Temperature(°F): TREF Power Level (% F.P.): 30% Other (Specify): 42 THIMBLES MAP S2-10-01		
	Date/Time Test Performed: 9/20/89 0441				
IV	Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
Test Results	Measured Value	-4.7% For P_i ≥ 0.9 -4.2% For P_i < 0.9	1.524	2.203	1.015
	Design Value (Design Conds)	± 10% for P_i ≥ 0.9 ± 15% for P_i < 0.9 (P_i = Assy. Pwr.)	NA	NA	≤ 1.020
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \le 1.55(1+0.3(1-P))$	$F^T_Q(Z) \le 4.64 \times K(Z)$	NA
	Reference	NONE	TS 3.12	TS 3.12	TS 3.12
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO				
	* As Required				

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature]
NAF Engineer

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Descri6tion: M/D Flux Map-At Power Proc No / Section: 2-PT-28.2, 2-OP-57 Sequence Step No: 44	
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.): ~ 70 Other (specify): Must have ≥ 38 thimbles
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB : 225 CC : 225 CD: 180	RCS Temperature(°F): T_{REF} Power Level (% F.P.): 64% Other (Specify): 42 THIMBLES
	Date/Time Test Performed: 10/2/89 0521	MAP S2-10-02

		MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
IV	Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
Test Results	Measured Value	4.9% For $P_i \geq 0.9$ -3.9% For $P_i < 0.9$	1.467	2.006	1.0096
	Design Value (Design Conds)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.55(1+0.3(1-P))$	$F^T_Q(Z) \leq 2.32/P \times K(Z)$	NA
	Reference	NONE	TS 3.12	TS 3.12	TS 3.12

VI

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

Comments: * As Required

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By: [signature]
NAF Engineer

SEP [illegible]

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map-At Power,NI Calibration Proc No / Section: 2-PT-28.2, 2-OP-57 Sequence Step No:45		
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.): ~ 70 Other (specify): *	
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB : 225 CC : 225 CD: 170	RCS Temperature(°F): TREF Power Level (% F.P.): 64% Other (Specify): QUARTER CORE MAP 21 THIMBLES MAP S2-10-C3	
	Date/Time Test Performed: 10/2/89 0920		

	Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
IV Test Results	Measured Value	NA	NA	NA	NA
	Design Value (Design Conds)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.55(1+0.3(1-P))$	$F^T_Q(Z) \leq 2.32/P \times K(Z)$	NA
	Reference	NONE	TS 3.12	TS 3.12	TS 3.12

VI Comments

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

* Must have at least 38 thimbles for a full-core flux map, or at least 16 thimbles for a quarter-core flux map.
** As Required

Completed By: [signature] Test Engineer

Evaluated By: S. M. [signature]

Recommended for Approval By: [signature] NAF Engineer

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map-At Power, NI Calibration Proc No / Section: 2-PT-28.2, 2-OP-57 Sequence Step No: 46	
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.): ~ 70 Other (specify): *
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB : 225 CC : 225 CD: 190	RCS Temperature (°F): TREF Power Level (% F.P.): 64% Other (Specify): QUARTER CORE MAP 21 THIMBLES MAP S2-10-04
	Date/Time Test Performed: 10/2/89 1319	

		MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
IV	Meas Parameter (Description)				
Test Results	Measured Value	NA	NA	NA	NA
	Design Value (Design Conds)	± 10% for $P_i \geq 0.9$ ± 15% for $P_i < 0.9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \leq 1.55(1+0.3(1-P))$	$F^T_Q(Z) \leq 2.32/P \times K(Z)$	NA
	Reference	NONE	TS 3.12	TS 3.12	TS 3.12

	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO
VI Comments	* Must have at least 38 thimbles for a full-core flux map, or at least 16 thimbles for a quarter-core flux map. ** As Required

Completed By: [signature]
Test Engineer

Evaluated By: S. M. Brumann [signature]

Recommended for Approval By: [signature]
NAF/Engineer

SEP [illegible]

SURRY POWER STATION UNIT 2 CYCLE 10
STARTUP PHYSICS TEST RESULTS AND EVALUATION SHEET

I Reference	Test Description: M/D Flux Map - HFP, ARO, Eq. Xe Proc No / Section: 2-PT-28.2, 2-OP-57 Sequence Step No: 47				
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 ± 5 Other (specify): Eq. Xe. Must have ≥ 38 thimbles			
III Test Conditions (Actual)	Bank Positions (Steps) SDA: 225 SDB: 225 CA: 225 CB : 225 CC : 225 CD: 207	RCS Temperature(°F): TREF Power Level (% F.P.): 100% Other (Specify): 41 THIMBLES			
	Date/Time Test Performed: 10/9/89 14:27	MAP S2-10-06			
IV	Meas Parameter (Description)	MAX. REL ASSY PWR % DIFF (M-P)/P	NUC ENTHAL RISE HOT CHAN FACT F-dH(N)	TOTAL HEAT FLUX HOT CHAN FACT F-Q(T)	QUADRANT POWER TILT RATIO QPTR
Test Results	Measured Value	-4.5% FOR P_i ≥ 0.9 3.4% FOR P_i < 0.9	1.474	1.840	1.010
	Design Value (Design Conds)	[illegible]	NA	NA	≤ 1.02
	Reference	WCAP-7905 REV.1	NONE	NONE	WCAP-7905 REV.1
V Acceptance Criteria	FSAR/Tech Spec	NONE	$F^N_{\Delta H} \le 1.55(1+0.3(1-P))$	$F_Q^T(Z) \le (2.32/P) \times K(Z)$	NA
	Reference	NONE	TS 3.12	TS 3.12	TS 3.12
VI Comments	Design Tolerance is met : ✓ YES ___NO Acceptance Criteria is met : ✓ YES ___NO				
	* As Required				

Completed By: [signature]
Test Engineer

Evaluated By: [signature]

Recommended for Approval By : [signature]
NAF Engineer