VEP-FRD-30

SURRY UNIT 1, CYCLE 5
STARTUP PHYSICS TEST REPORT

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September, 1978

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PREFACE

The purpose of this report is to present the analysis and evaluation of the physics tests which were performed to verify that the Surry 1, Cycle 5 reload core could be operated safely and to make an initial evaluation of the expected 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 includes a brief summary of each test, a comparison of the test results with design predictions, and an evaluation of the results.

The Surry 1, Cycle 5 Startup Physics Test Results and Evaluation Sheets have been included as an appendix to provide additional information on the startup test results. Each data sheet provides the following information: 1) test identification, 2) test conditions (design), 3) test conditions (actual), 4) test results, 5) acceptance criteria, and 6) comments concerning the test. These sheets provide a compact summary of the startup test results in a consistent format. The design test conditions and design values of the measured parameters were completed prior to startup physics testing. Except where noted, the entries for the design values were based on calculations performed by Vepco's Nuclear Fuel Engineering Group.[1] During the tests, the data sheets were used as guidelines both to verify that the proper test conditions were met and to serve as a preliminary comparison between measured and predicted values of measured parameters, thus enabling a quick identification of possible problems occurring during the tests. The appendix to this report contains the final completed and approved version of the Startup Physics Test Results and Evaluation Sheets.

INTRODUCTION AND SUMMARY

On April 22, 1978, Unit No. 1 of the Surry Power Station was shut down for its fourth refueling. During this shutdown, 73 of the 157 fuel assemblies in the core were replaced with eight once-burned assemblies from Cycle 3 of Unit 1, one once-burned assembly from Cycle 2 of Unit 2, and 64 fresh fuel assemblies. The fifth cycle core consists of seven regions of fuel: five once-burned regions from Cycles 3 and 4 of Unit 1 and Cycle 2 of Unit 2 (Regions 5, 6A, 6B, 6C, and S2/4A, respectively, and two fresh regions (Regions 7A and 7B). The actual core loading pattern and the design parameters for each region are shown in Figure 1.1. Each fuel assembly and its location in the core is identified in Figure 1.2 together with the incore instrumentation locations. Figure 1.3 identifies the location and number of burnable poison rods in the Cycle 5 core. Figure 1.4 identifies the location and number of control rods in the Cycle 5 core.

On July 6, 1978 at 1025, the fifth 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 test follows:

1. Individual control rod bank worths for control banks A through D were measured to be within 5.0% of the design predictions and the total control rod bank worth was measured to be within 1.2% of the design prediction. These results are within the design tolerance of ±15% for individual bank worths and ±10% for the total of the control bank worths.
2. Isothermal temperature coefficients over the range of normal operating control rod bank insertions were measured to be within 2 pcm/°F of the design predictions. These results are within the design tolerance of ±3 pcm/°F and also met the accident analysis acceptance criterion.
3. Critical boron concentrations for five basic control bank configurations were measured to be within 19 ppm of the design

predictions. These results are within the design tolerances and met the accident analysis acceptance criterion.

4. The boron worth coefficient was measured to be within 2.7% of the design prediction, which is within the design tolerance of ±10% and met the accident analysis acceptance criterion.

5. Core power distributions for various HZP and at-power conditions were generally within 3% of the predicted power distributions. For all maps, the hot channel factors were measured to be within the limits of the Technical Specifications. All measurement parameters met their respective design value tolerances and accident analysis acceptance criteria.

6. The power coefficient at 95% power was measured to be within 0.1 pcm/%pwr of the design prediction. This result is within the design value tolerance of ±3.2 pcm/%power.

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

Table 1.1

SURRY UNIT 1 - BOL CYCLE 5 PHYSICS TESTS

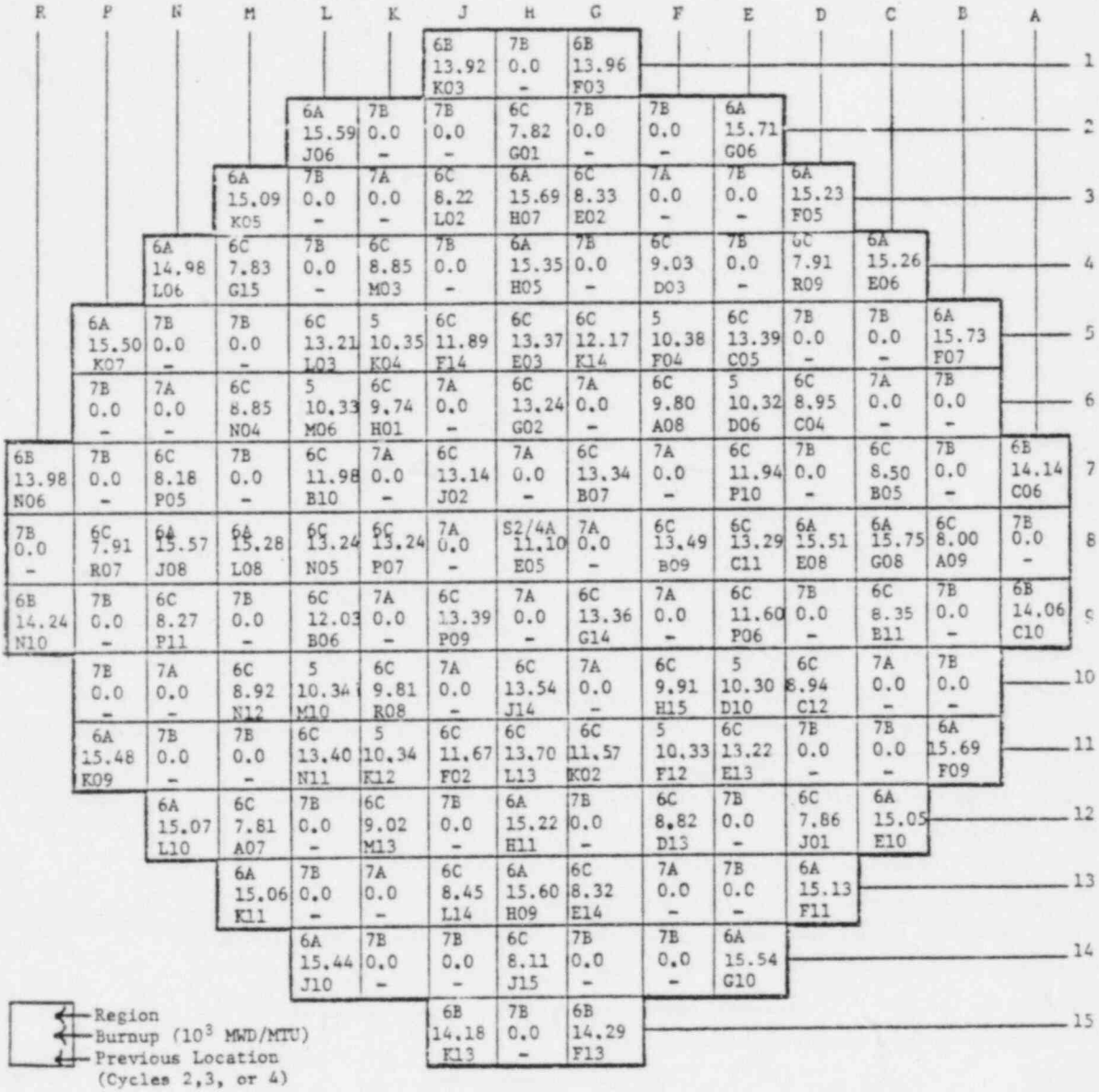
CHRONOLOGY OF TESTS

Test	Date	Time	Power	Reference Procedure
Reactivity Computer Checkout	7-6-78	1504	HZP	PT-28.11(B)
Boron Endpoint-ARO	7-6-78	2012	HZP	PT-28.11(C)
Temperature Coefficient - ARO	7-6-78	2100	HZP	PT-28.11(D)
HZP M/D Flux Map - ARO	7-7-78	0113	HZP	PT-28.2
Bank D Worth	7-7-78	0500	HZP	PT-28.11(E)
Boron Endpoint-D In	7-7-78	1015	HZP	PT-28.11(C)
Temperature Coefficient-D In	7-7-78	1030	HZP	PT-28.11(D)
HZP M/D Flux Map-D In	7-7-78	1804	4%	PT-28.2
Bank C Worth	7-7-78	2108	HZP	PT-28.11(E)
Boron Endpoint-C In	7-8-78	0037	HZP	PT-28.11(C)
Temperature Coefficient-C In	7-8-78	0210	HZP	PT-28.11(D)
Bank B Worth	7-8-78	1100	HZP	PT-28.11(E)
Boron Endpoint-B In	7-8-78	1515	HZP	PT-28.11(C)
Bank A Worth	7-8-78	1530	HZP	PT-28.11(E)
Boron Endpoint-A In	7-8-78	1900	HZP	PT-28.11(C)
Banks A→D Worth in Overlap	7-8-78	1915	HZP	PT-28.11(E)
I/E Calibration-APDM Flux Map	7-9-78	1648	50%	PT-28.8
I/E Calibration-APDM Flux Map	7-9-78	1920	50%	PT-28.8
I/E Calibration-APDM Flux Map	7-10-78	0129	57%	PT-28.8
I/E Calibration-APDM Flux Map	7-10-78	0940	67%	PT-28.8
I/E Calibration-APDM Flux Map	7-10-78	1846	88%	PT-28.8
I/E Calibration-APDM Flux Map	7-11-78	0530	98%	PT-28.8
HFP M/D Flux Map-Eq. Xenon	7-13-78	0911	100%	PT-28.2
Power Coefficient	8-10-78	2352	100%-90%	PT-28.12

SURRY UNIT 1 - CYCLE 5

Figure 1.1

CORE LOADING MAP



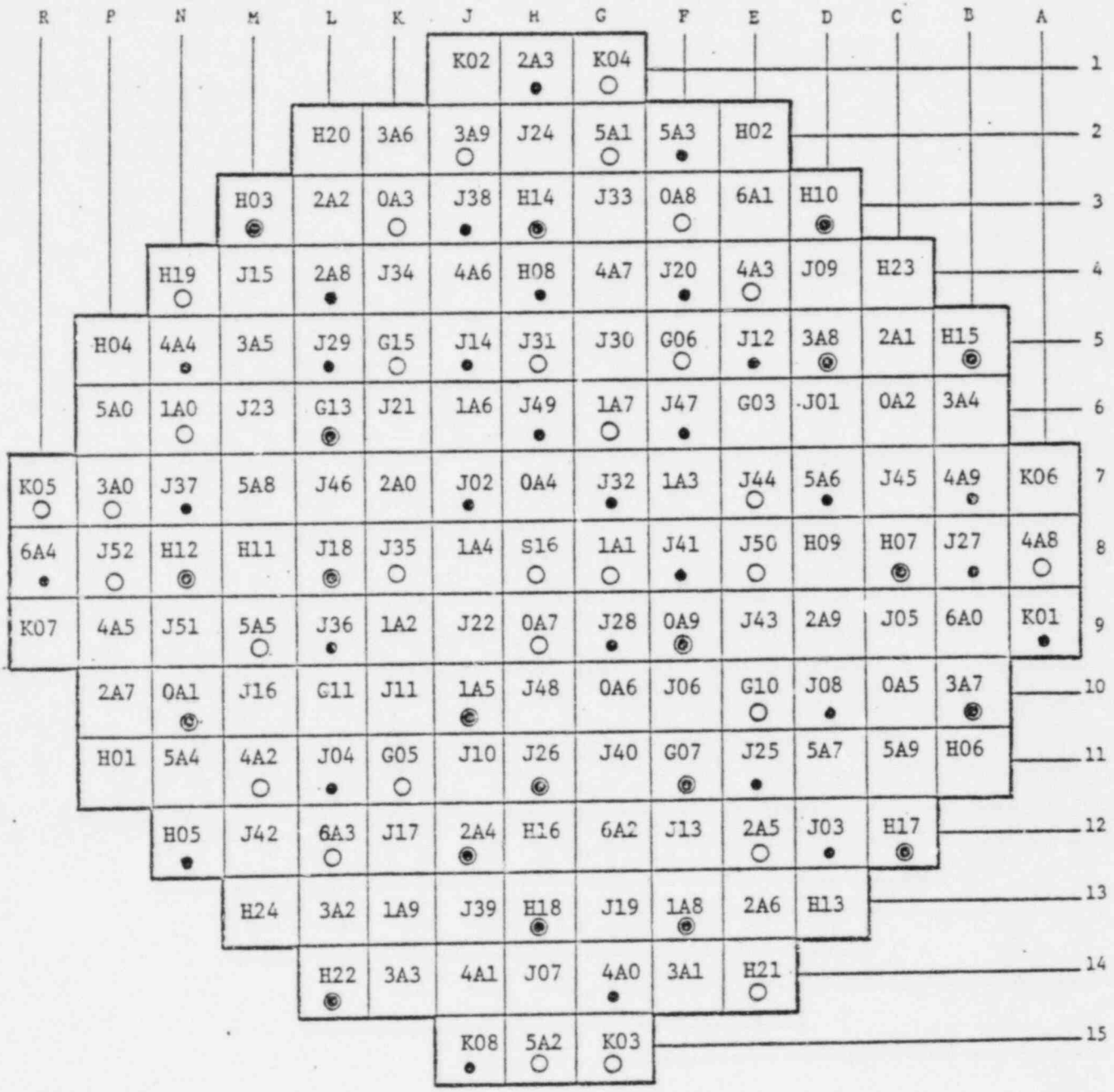
FUEL ASSEMBLY DESIGN PARAMETERS

	Batch						
	5	6A	6B	6C	7A	7B	S2/4A
Initial Enrichment (w/o U235)	2.11	2.62	2.60	2.90	2.90	3.39	2.61
Burnup At BOC-5(MWD/MTU)	10,337	15,397	14,097	10,557	0	0	11,098
Assembly Type	15x15	15x15	15x15	15x15	15x15	15x15	15x15
No. of Assemblies	8	24	8	52	20	44	1
Fuel Rods per Assembly	204	204	204	204	204	204	204

Figure 1.2

SURRY UNIT 1 - CYCLE 5

ASSEMBLY ID'S AND INCORE INSTRUMENTATION LOCATIONS



← Fuel Assembly I. D. Number
← Indicates Location & Type of Incore Instrumentation

● M/D

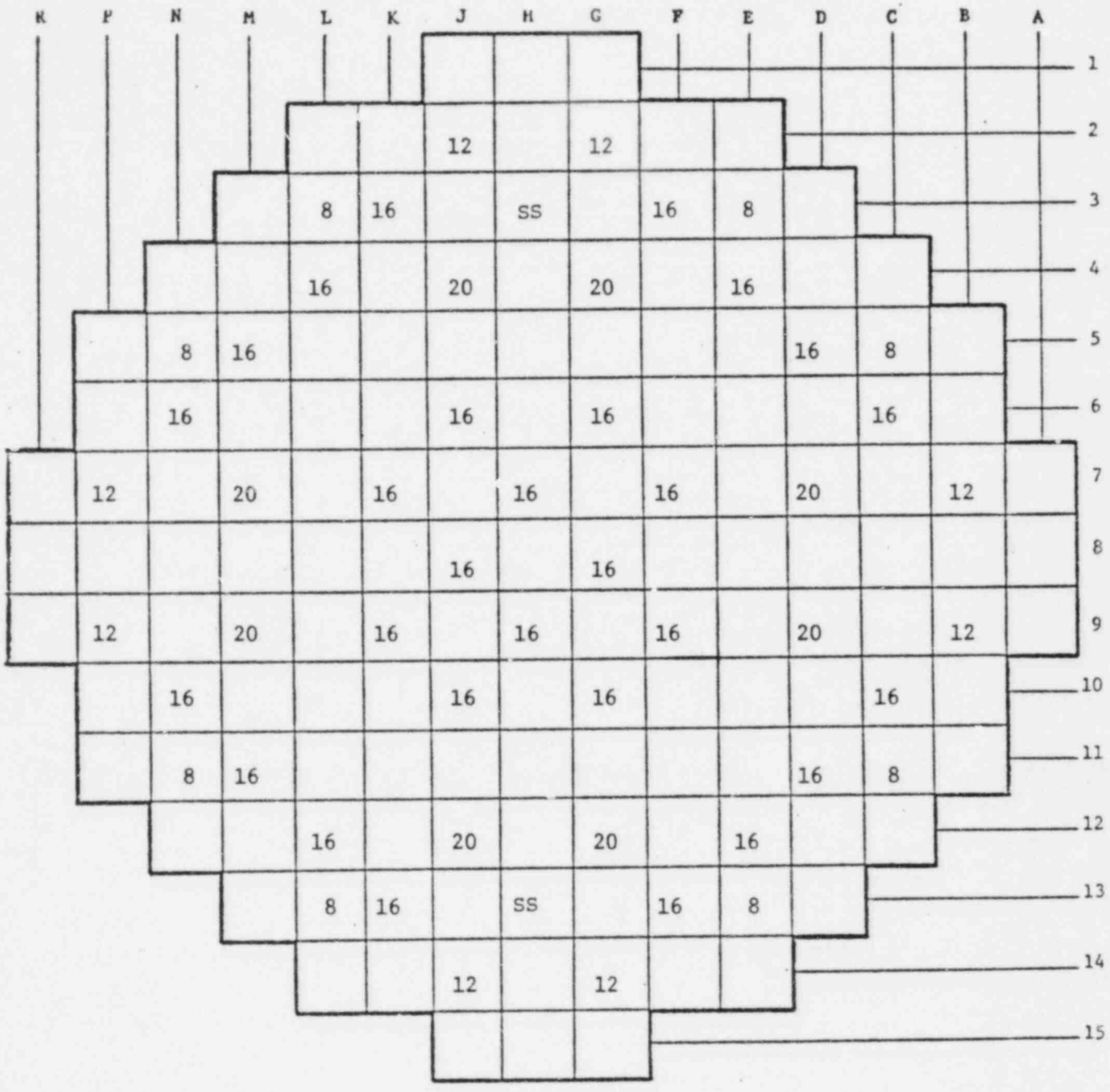
○ T/C

◉ Both M/D & T/C

Figure 1.3

SURRY UNIT 1 - CYCLE 5

BURNABLE POISON AND SOURCE ASSEMBLY LOCATIONS



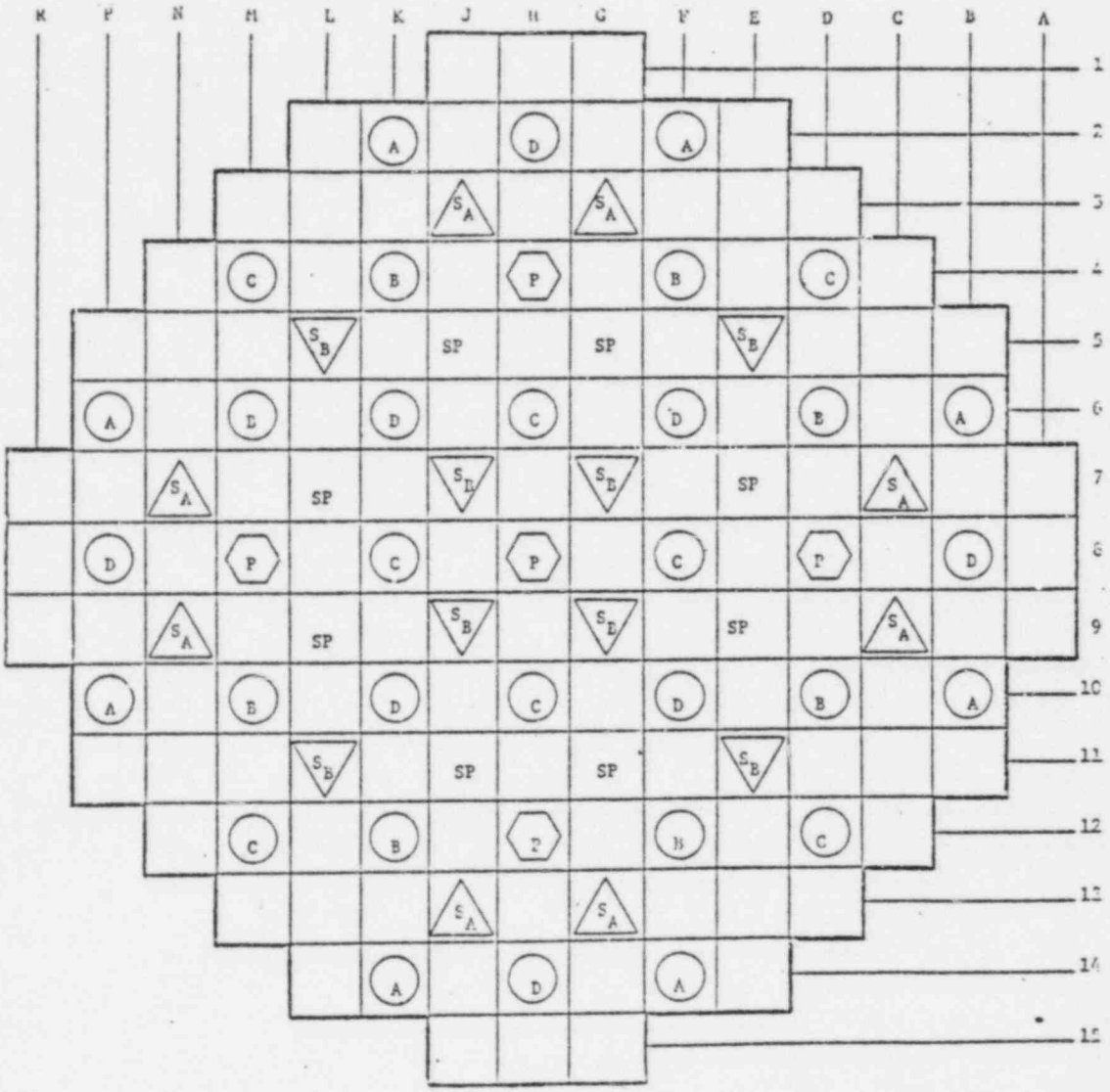
SS - Secondary Source

768 Fresh Burnable Poison Rods

Figure 1.4

SURRY UNIT 1 - CYCLE 5

CONTROL ROD LOCATIONS



Function	Number of Clusters
Control Bank D	8
Control Bank C	8
Control Bank B	8
Control Bank A	8
Shutdown Bank S_B	8
Shutdown Bank S_A	8
Part Length P	5
SP (Spare Rod Locations)	8

CONTROL ROD BANK WORTH MEASUREMENTS

Differential and integral control bank worths were obtained by monitoring reactivity changes associated with boron/RCCA exchanges. Following the establishment of a constant RCS boron dilution/boration rate, the controlling RCCA bank was periodically inserted/withdrawn in order to provide reactivity compensation for the changing RCS boron concentration. The reactivity changes resulting from the control bank movements were recorded continuously by the reactivity computer.[2] The differential reactivity worth is defined as the ratio of the change in reactivity to the corresponding change in bank position about an average bank position, and the integral worth was obtained by summing the individual reactivity changes between measurement endpoints.

A summary of the results for these tests is given in Table 2.1. As shown by this table and the Startup Physics Test Results and Evaluation Sheets given in the Appendix, the individual measured bank worths for control banks D, C, B, and A were within the design tolerance of ±15%. The total bank worth (non-overlap mode) for control banks A through D was measured to be within 1.2% of the design prediction. This is well within the design tolerance of ±10% for total control bank worth. In addition, a second independent measurement of total bank worth (in overlap mode) was performed. This measured value was within 1.0% of the design prediction.

The integral and differential reactivity worths for rod banks D through A (non-overlap mode) are shown in Figures 2.1 through Figure 2.8, respectively. The design predictions and the measured data (non-overlap mode) are plotted together in order to illustrate their agreement. The rod worth measurements are quite exact in defining the shape of the individual differential rod worth curves, as illustrated by the distinct depressions occurring at

the assembly grid locations. The integral and differential worth for control banks A through D operating in the overlap mode are shown in Figures 2.9 and 2.10, respectively.

In summary, all measured rod worth values were satisfactory.

Table 2.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TESTS

CONTROL BANK WORTH SUMMARY

Bank	Measured Worth (pcm)	Predicted Worth (pcm)	Percent Difference $(\frac{M-P}{P}) \times 100$
D	1207	1188	+1.6
C	1082	1056	+2.5
B	1999	2040	-2.0
A	1304	1242	+5.0
ΣA → D	5592	5526	+1.2
A → D In Overlap Mode	5577	5526	+0.92

Figure 2.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK D INTEGRAL ROD WORTH-HZP

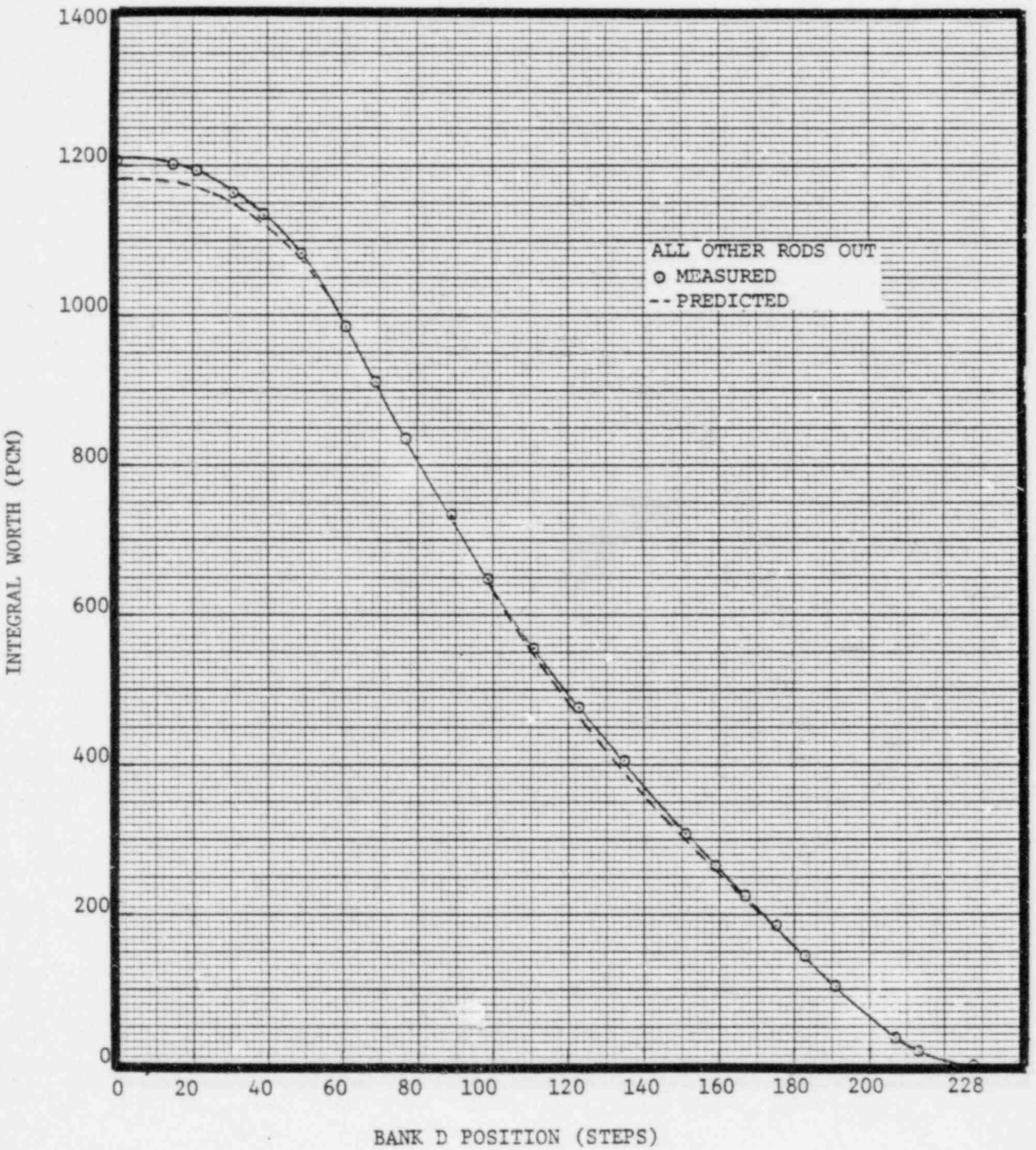


Figure 2.2

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK D DIFFERENTIAL ROD WORTH-HZP

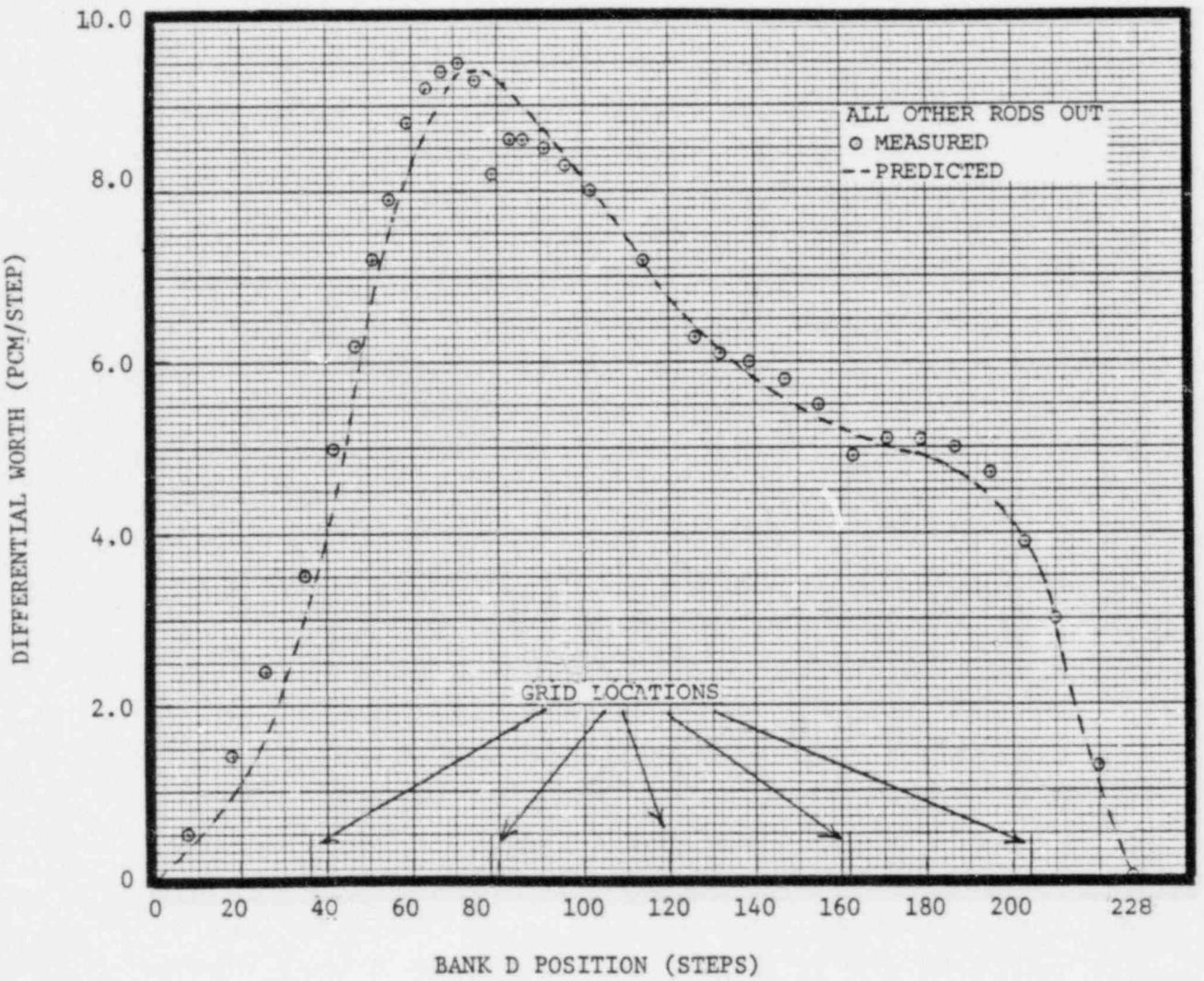


Figure 2.3

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK C INTEGRAL ROD WORTH - HZP

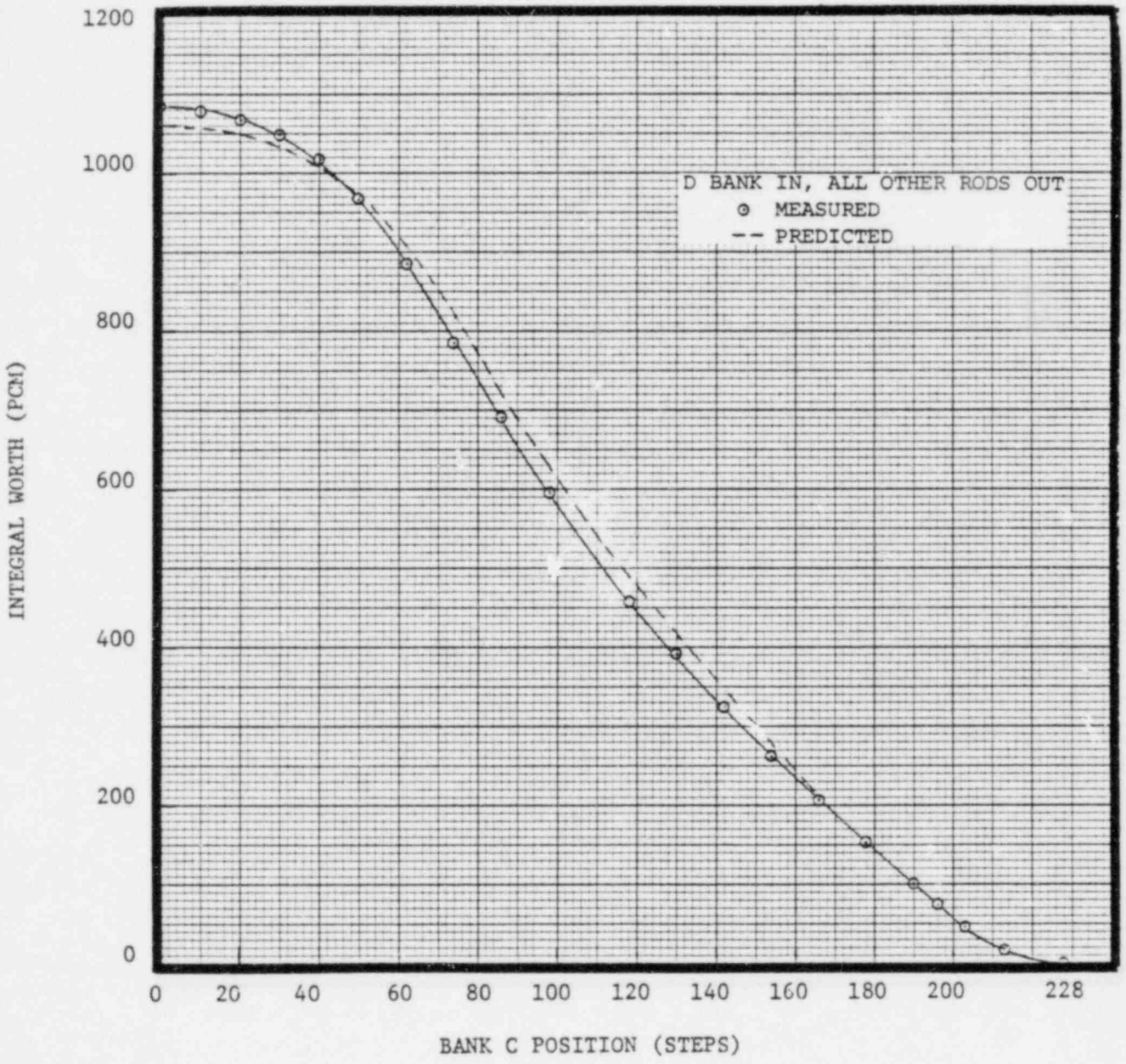


Figure 2.4

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK C DIFFERENTIAL ROD WORTH-HZP

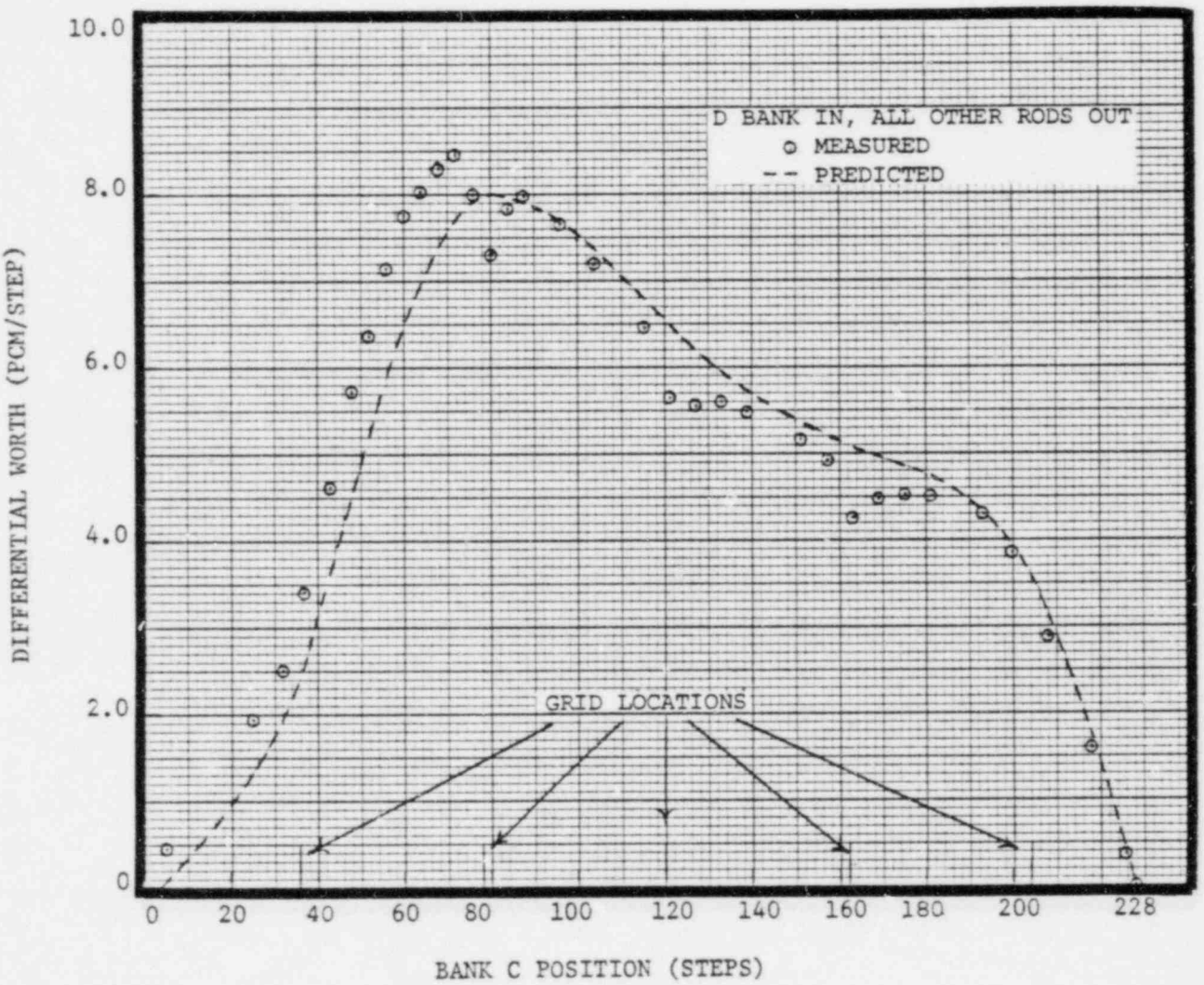


Figure 2.5

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK B INTEGRAL ROD WORTH-HZP

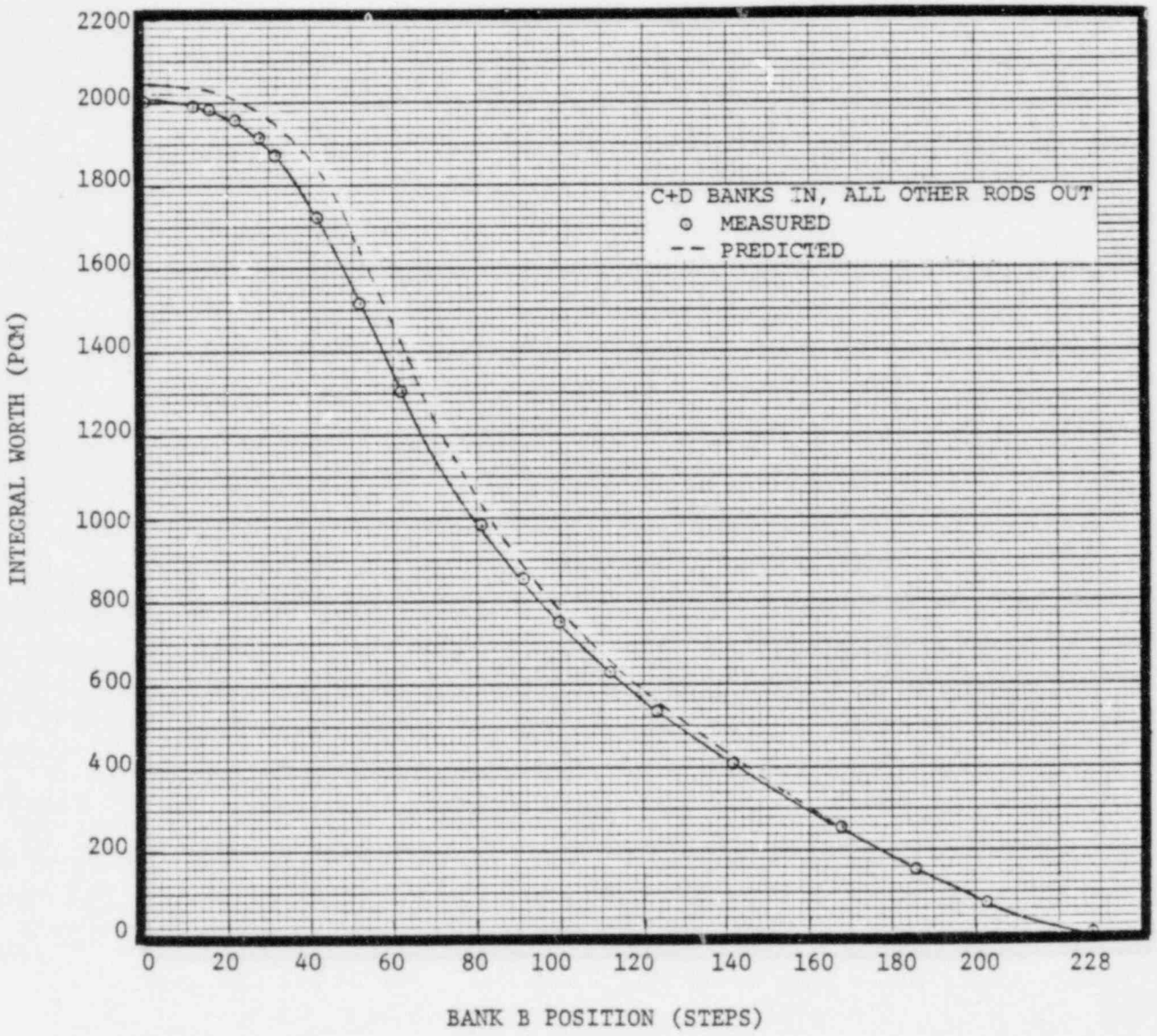


Figure 2.6

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK B DIFFERENTIAL ROD WORTH-HZP

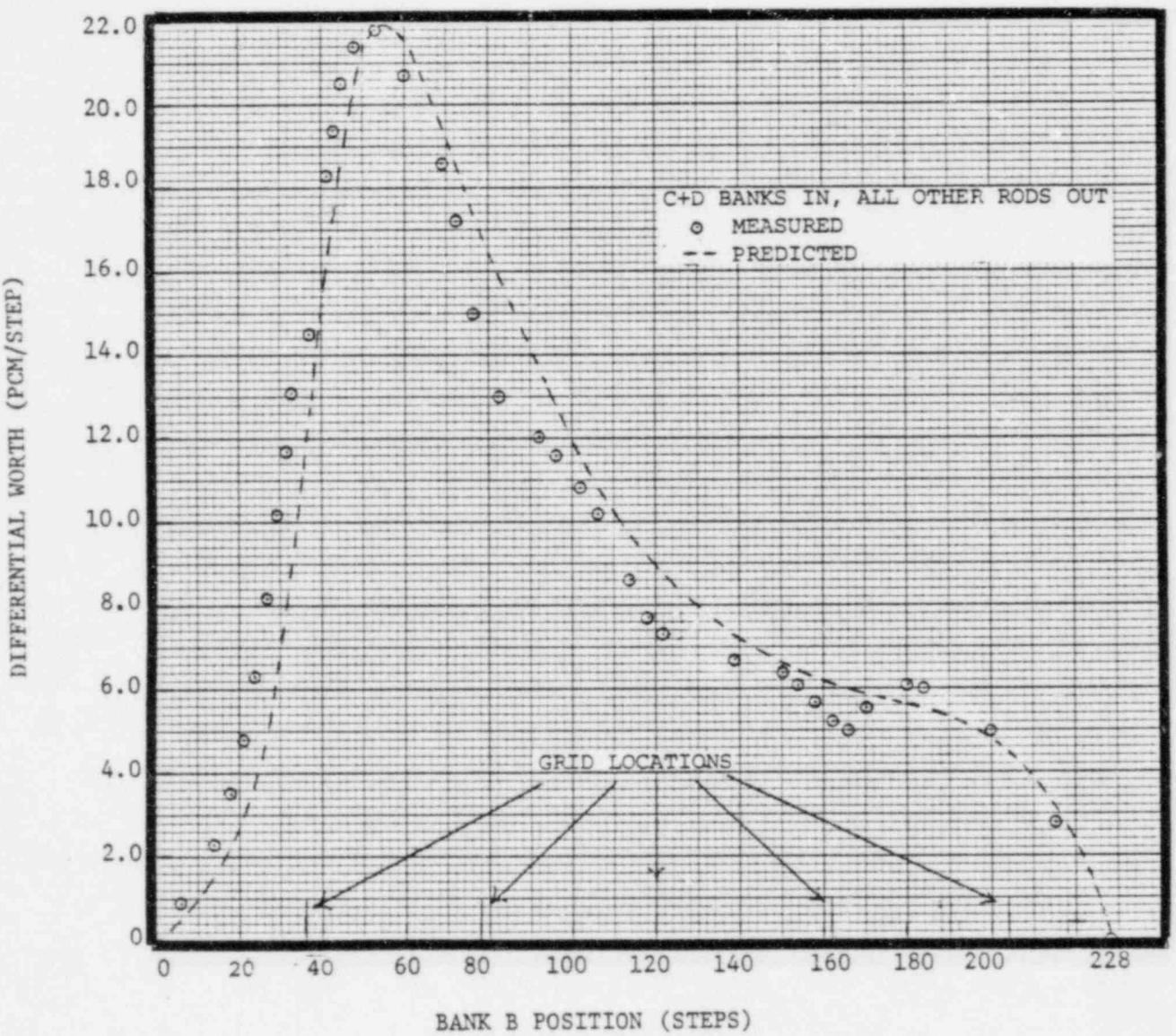


Figure 2.7

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK A INTEGRAL ROD WORTH-HZP

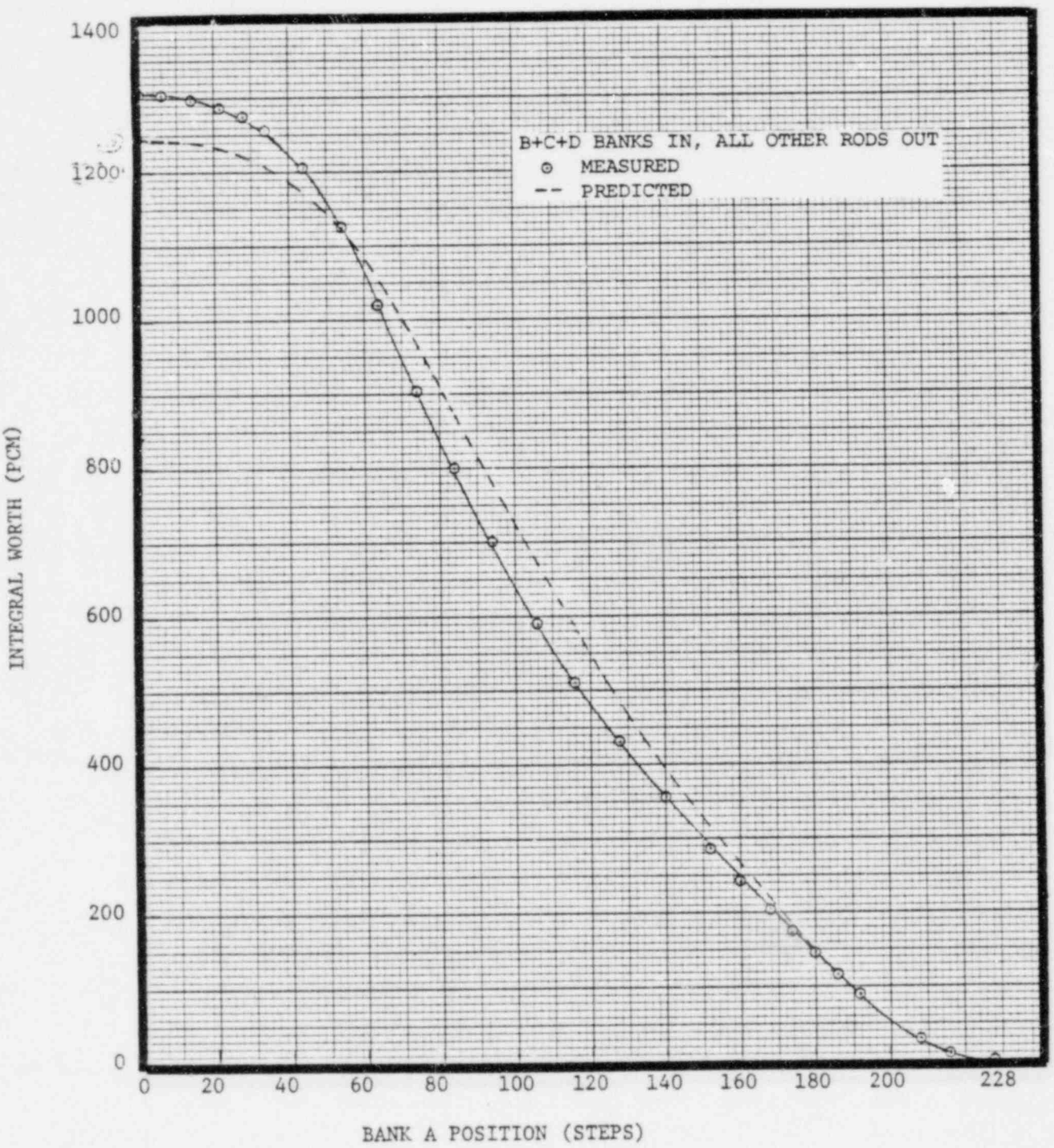


Figure 2.8

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BANK A DIFFERENTIAL ROD WORTH-HZP

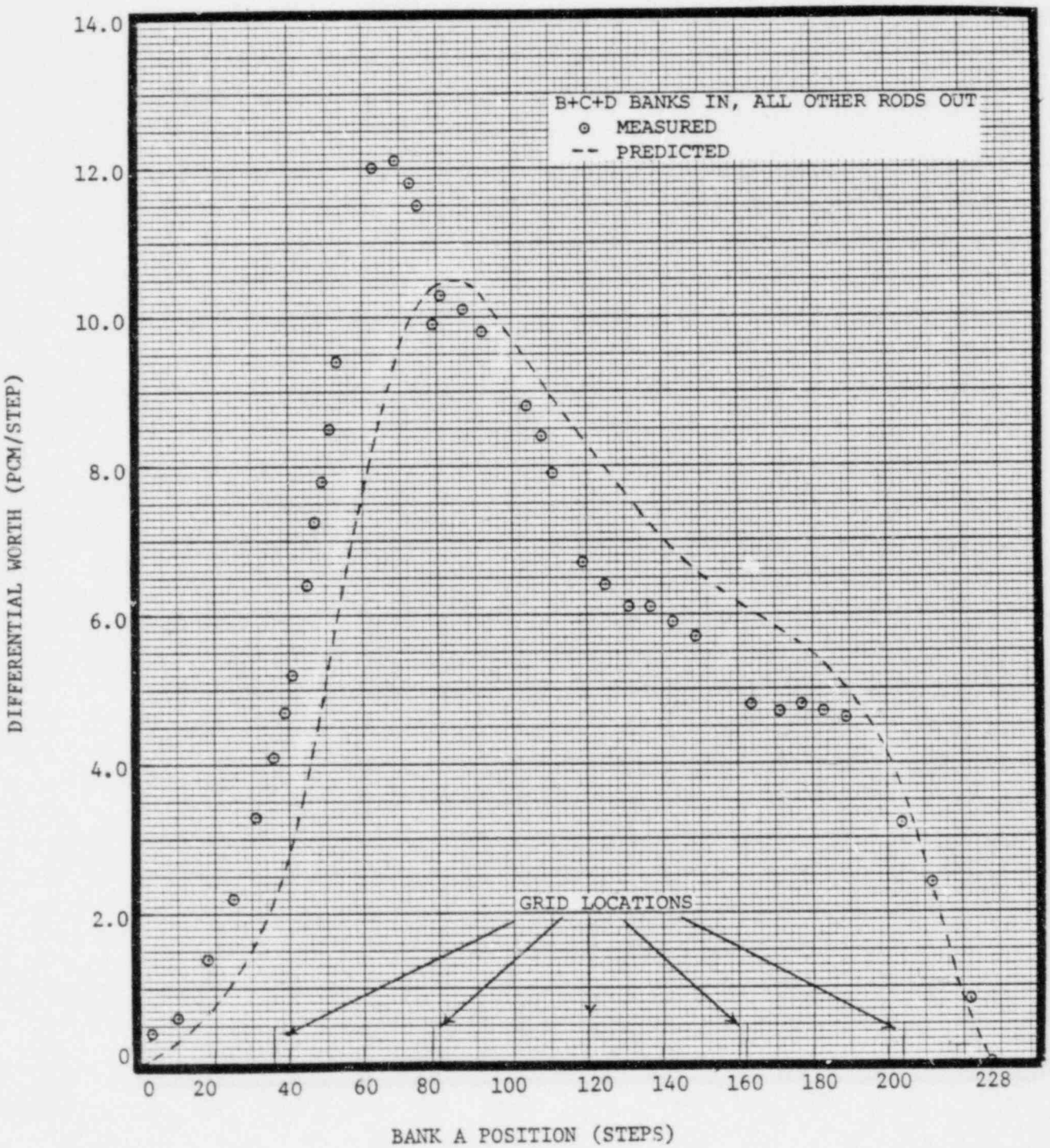


Figure 2.9

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

INTEGRAL WORTH OF CONTROL BANKS A

THROUGH D IN OVERLAP MODE

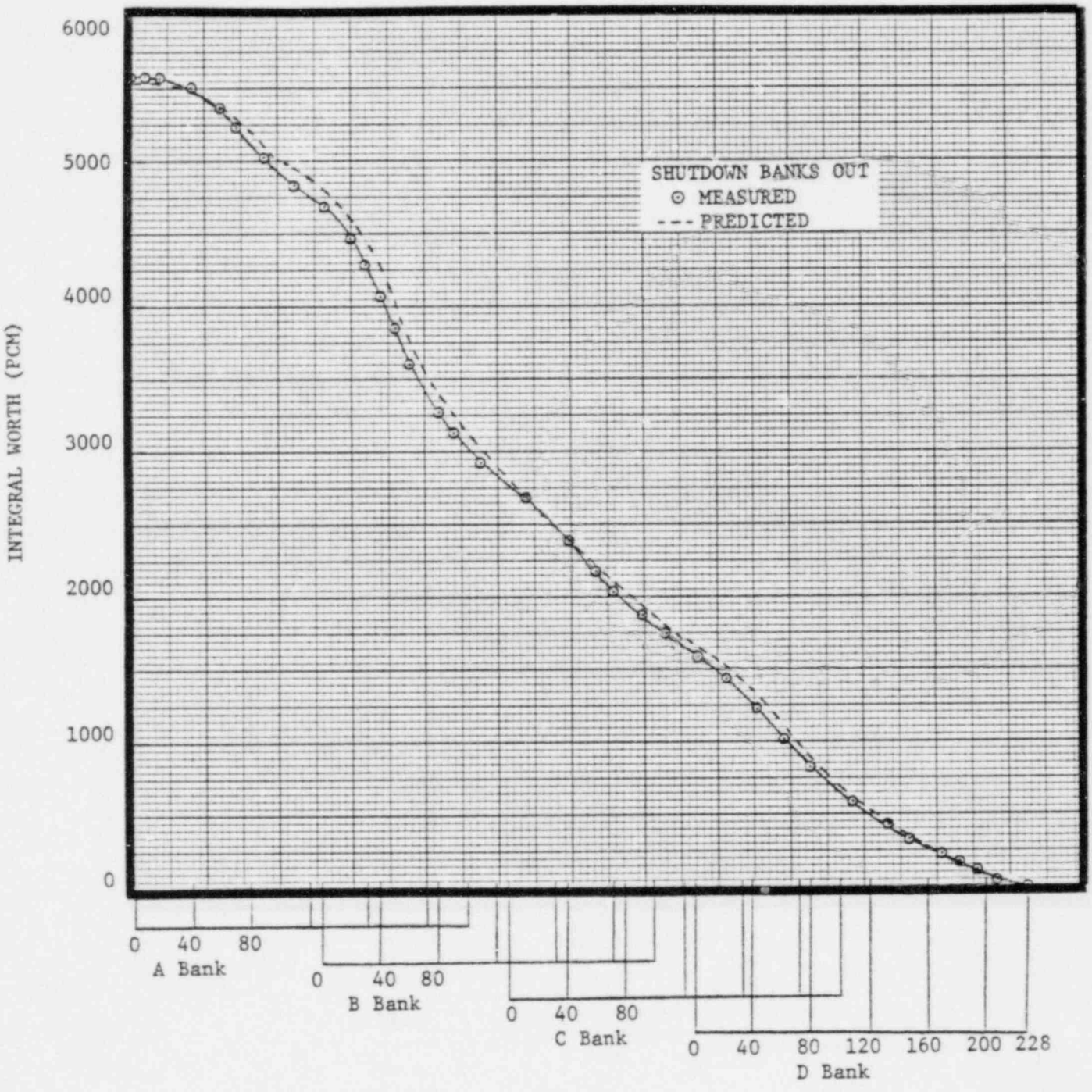
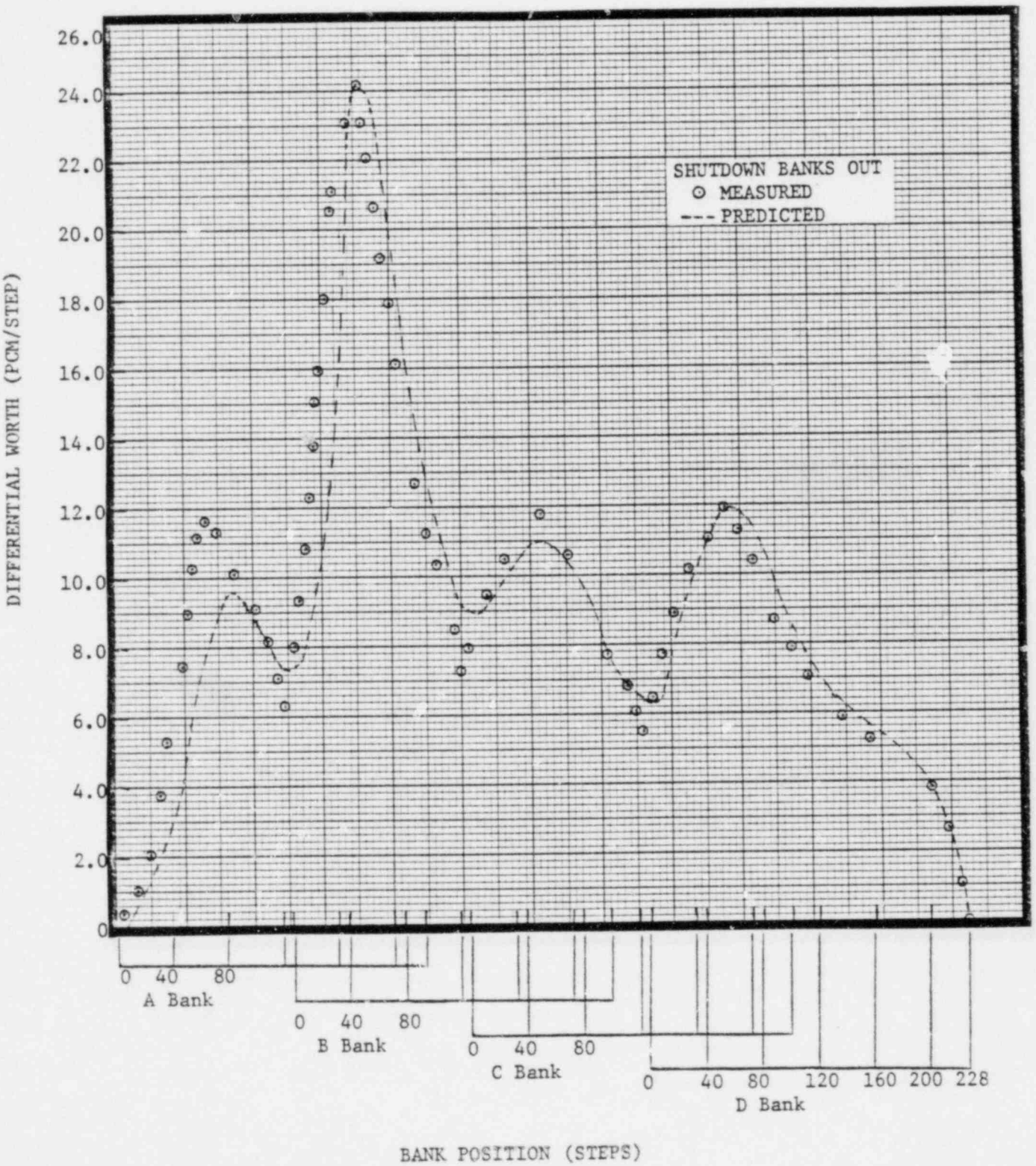


Figure 2.10

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

DIFFERENTIAL WORTH OF CONTROL BANKS

A THROUGH D IN OVERLAP MODE



TEMPERATURE COEFFICIENT MEASUREMENTS

The isothermal temperature coefficient measurements were accomplished by controlling the RCS heat gains/losses with the steam dump valves to the condenser, establishing a constant and uniform heatup/cooldown rate, and then monitoring the resulting reactivity changes on the reactivity computer. These measurements were performed at very low power levels in order to minimize the effects of non-uniform nuclear heating, thus, the moderator and fuel were approximately at the same temperature (between 540-550°F) during these measurements. To eliminate the boron reactivity effect of outflow from the pressurizer, the pressurizer level was maintained constant or slightly increasing during these measurements.

Isothermal temperature coefficient measurements were performed at various control rod configurations. For each rod configuration, reactivity measurements were taken during both RCS heatup and cooldown ramps during which the RCS temperature varied approximately 3°F. Reactivity was determined using the reactivity computer and was plotted against the RCS temperature on an x-y recorder. The temperature coefficient was then determined from the slope of the plotted lines. The x-y recorder plots of reactivity change vs. RCS temperature for each measurement are shown in Figures 3.1 through 3.3.

The predicted and measured isothermal temperature coefficient values are compared in Table 3.1. As can be seen from this summary and from the Start-up Physics Test Results and Evaluation Sheets given in the Appendix, all measured isothermal temperature coefficient values were within the design tolerance of ±3 pcm/°F and met the accident analysis acceptance criterion.

In summary, all measured results were satisfactory.

Table 3.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TESTS

ISOTHERMAL TEMPERATURE COEFFICIENT SUMMARY

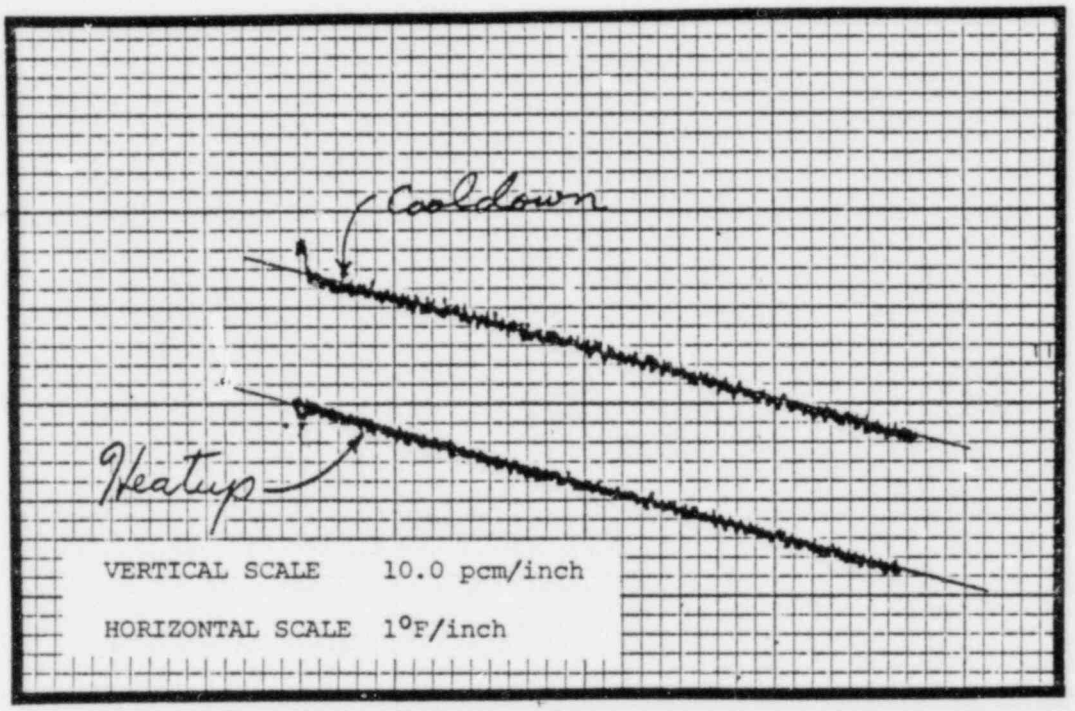
Bank Position (steps)			Temperature Range (°F)	Boron Concentration (ppm)	Isothermal Temperature Coefficient (pcm/°F)				
B	C	D			Heatup	Cooldown	Average	Predicted	Difference (M-P)
228	228	223	544-547	1311	-2.7	-2.7	-2.7	-3.7	+1.0
228	222	0	544-546	1173	-5.8	-6.0	-5.9	-6.9	+1.0
213	0	0	544-547	1052	-9.0	-9.0	-9.0	-10.4	+1.4

Figure 3.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ISOTHERMAL TEMPERATURE COEFFICIENT

HZP, ARO



REACTIVITY (PCM)

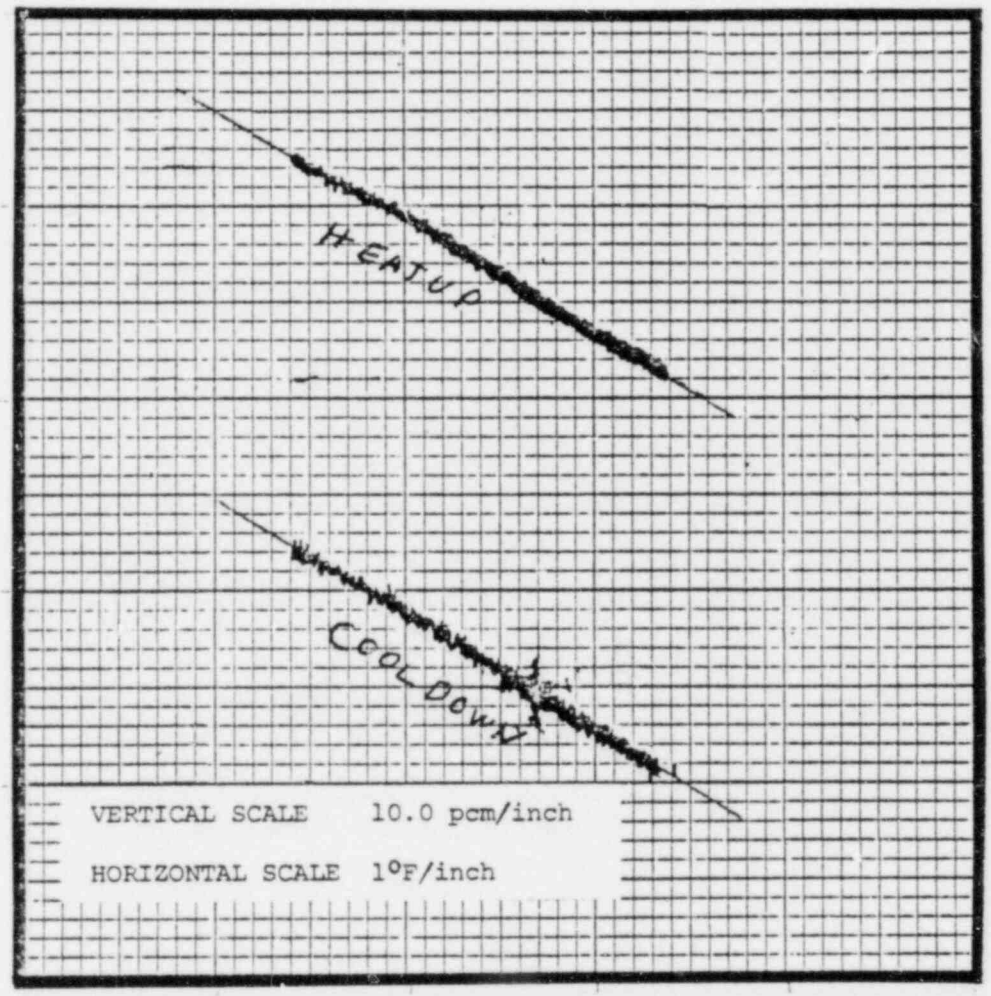
TEMPERATURE (°F)

Figure 3.2

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ISOTHERMAL TEMPERATURE COEFFICIENT

HZP, D-BANK IN



REACTIVITY (PCM)

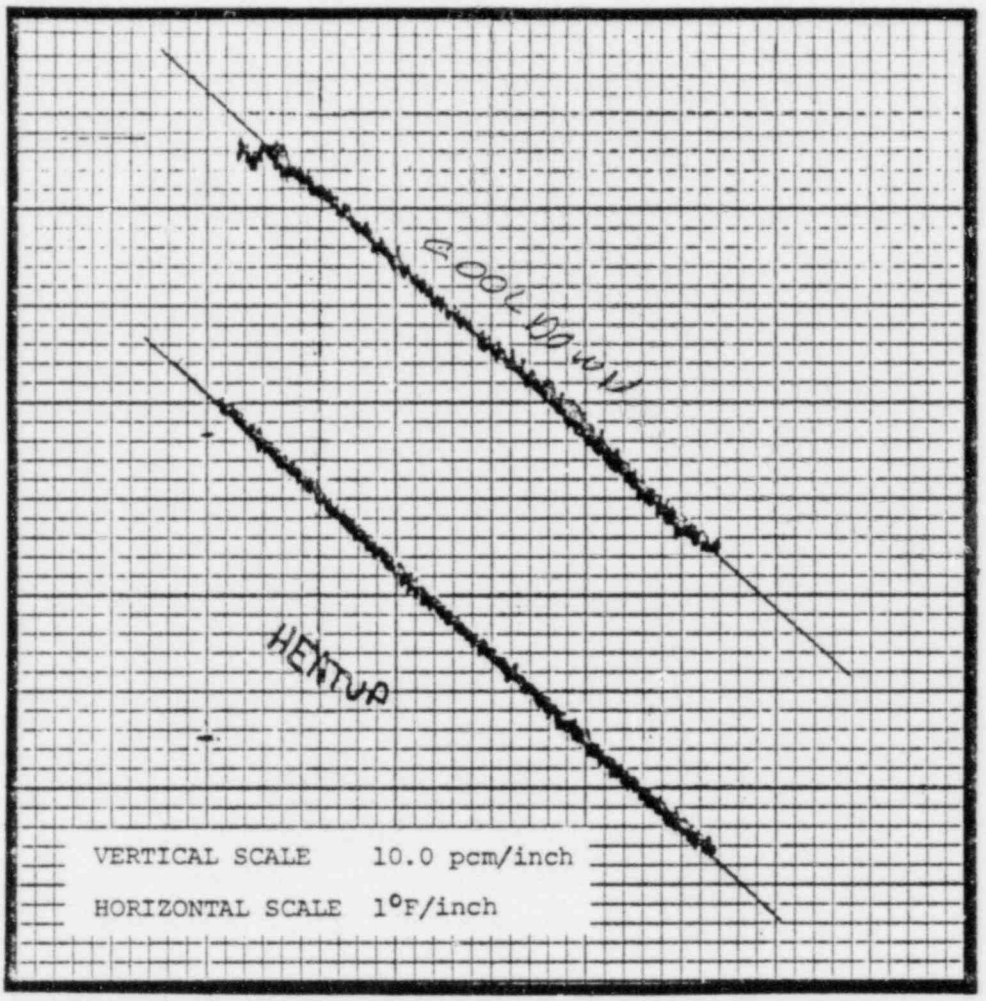
TEMPERATURE (°F)

Figure 3.3

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ISOTHERMAL TEMPERATURE COEFFICIENT

HZP, C+D BANKS IN



REACTIVITY (PCM)

TEMPERATURE (°F)

Section 4

BORON ENDPOINT AND WORTH MEASUREMENTS

Boron Endpoints

With the reactor critical at hot zero power, reactor coolant system boron concentrations were measured at selected rod bank configurations to enable a direct comparison of measured boron endpoints with design predictions. For each measurement, the RCS conditions were stabilized with the control bank at or very near a selected endpoint position. The critical boron concentration was then measured. If necessary, an adjustment to the measured critical boron concentration value was made to account for off-nominal core conditions, i.e., for rod position and moderator temperature.

The results of these measurements are given in Table 4.1. As shown in this table and in the Startup Physics Test Results and Evaluation Sheets given in the Appendix, all measured critical boron endpoint values were within 19 ppm of their design prediction which is within the design tolerances. All measured values met the accident analysis acceptance criterion.

In summary, all results were satisfactory.

Boron Worth Coefficient

Concurrent with the control bank reactivity worth measurements, samples of RCS water were obtained for boron analysis. Frequent sampling (taken at approximately 15 minute intervals) is necessary during the dilution and boron phases of the rod worth measurement program in order to provide adequate statistics for the determination of the boron worth coefficient.

Relevant data logged during this measurement were the control bank position (and hence integrated reactivity) as a function of time and the RCS boron concentration as a function of time. This second item contains a small correction factor (5 minutes) to account for the transit time of the RCS sample from the RCS coolant loop to the sample sink tap. With these data, a plot of boron concentration as a function of integrated reactivity can be constructed, since the core is kept nominally critical. The value of the boron worth

coefficient over this range of boron concentration is obtained directly from this plot.

The boron worth plot is shown in Figure 4.1. As indicated in this figure and in the Appendix, the boron worth coefficient of reactivity was measured to be -8.94 pcm/ppm. The measured boron worth coefficient is within 2.8% of the predicted value of -9.19 pcm/ppm. The measurement result falls well within the design tolerance of ±10%. Also, the measurement result met the accident analysis acceptance criterion.

In summary, this result was satisfactory.

Table 4.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TESTS

BORON ENDPOINTS SUMMARY

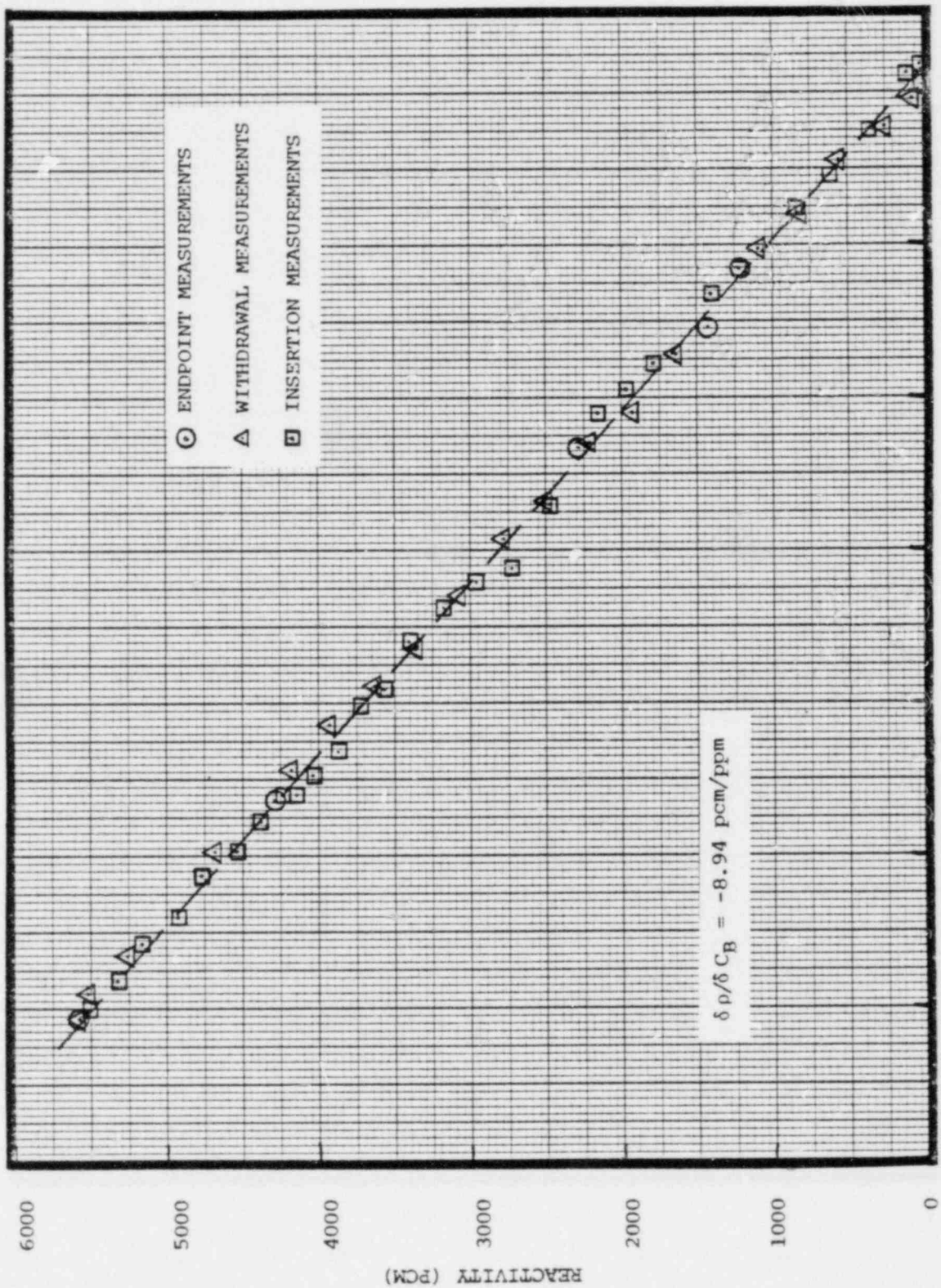
Control Rod Configuration	Measured Endpoint (ppm)	Predicted Endpoint (ppm)*	Difference M-P (ppm)
ARO	1304	1321	-17
D Bank In	1184	1165	+19
D+C Banks In	1067	1075	+8
D+C+B Banks In	836	846	-10
D+C+B+A Banks In	693	700	-7

*Predicted endpoints have been adjusted for the difference between the measured and predicted values of the previous endpoint as shown in the boron endpoint Startup Physics Test Results and Evaluation Sheets in the Appendix.

Figure 4.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

BORON WORTH COEFFICIENT



POWER DISTRIBUTION MEASUREMENTS

The core power distributions were measured using the incore movable detector flux mapping system. This system consists of five fission detectors which traverse fuel assembly instrumentation thimbles in 50 core locations (see Figure 1.2). For each traverse, the detector output is continuously monitored on a strip chart recorder. The output is also scanned for 61 discrete axial points by the PRODAC P-250 process computer. Full core, three-dimensional power distributions are then determined by analyzing this data using the Westinghouse computer program, INCORE.[3] INCORE couples the measured flux map data with predetermined analytic power-to-flux ratios in order to determine the power distribution for the whole core.

A list of all the flux maps taken during the test program together with a list of the measured values of the important power distribution parameters is given in Table 5.1. Flux maps 1 and 3 were taken at approximately zero power. These flux maps serve as base case design checks and verify that the core was loaded properly. Figures 5.1 and 5.2 show the resulting radial power distributions associated with these flux maps. As seen by Figures 5.1 and 5.2, the measured relative assembly power values are generally within 4% of the predicted values. Flux maps 4 through 10 were taken over a wide range of power levels and control rod configurations. These flux maps were taken to check the at-power design predictions and to measure core power distributions at various operating conditions. These maps also provide incore/excore calibration data for the nuclear instrumentation system as well as base data for axial power distribution surveillance. The radial power distributions for these maps are given in Figures 5.3 through 5.9. As seen by Figures 5.3 through 5.9, the measured relative assembly power values are generally within 3% of the predicted values.

The measured power distribution parameters are compared with their Technical Specifications limits in Table 5-2. The power distribution parameters for all flux maps met their design and accident analysis acceptance criteria and Technical Specifications limits (see Appendix).

In conclusion, all power distribution measurement results were considered acceptable with respect to the design tolerance, accident analysis acceptance criteria and Technical Specifications limits. It is therefore anticipated that the core will continue to operate safely throughout Cycle 5.

Table 5.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TESTS

SUMMARY OF INCORE FLUX MAPS

MAP DESCRIPTION	MAP NO.	PWR (%)	BANK POSITION (STEPS)		F_Q^T Hot CHANNEL FACTOR*				$F_{\Delta H}^N$ HOT CHANNEL FACTOR**			CORE $\overline{F}_Z$ MAX		F_{xy}^+	QPTR[X]	AXIAL OFFSET (%)	NO OF THIMBLES
			C	D	ASSY.	PIN	AXIAL POINT	F_Q^T	ASSY.	PIN	$F_{\Delta H}^N$	AXIAL POINT	F_Z				
Zero Power M/D Map - ARO	1	~ 0	228	218	K14	LM	20	2.40	K14	LM	1.55	20	1.50	1.52	1.014	+27.36	40
Zero Power M/D Map - D In	3[XX]	~ 4	219	0	E04	GH	21	2.57	M05	HG	1.68	21	1.46	1.64	1.013	+22.68	43
I/E Calibration APDM Flux Map	4	~ 50	228	200	P10	ML	23	1.99	P10	ML	1.44	23	1.32	1.44	1.002	+6.30	43
I/E Calibration APDM Flux Map	5	~ 50	228	185	P10	ML	33	2.04	P10	ML	1.43	33	1.32	1.41	1.004	-2.01	43
I/E Calibration APDM Flux Map	6	~ 57	228	162	K14	LM	36	2.16	K14	KL	1.47	36	1.39	1.42	1.007	-16.95	43
I/E Calibration APDM Flux Map	7	~ 67	228	196	P10	LK	23	1.90	P10	LK	1.43	23	1.27	1.41	1.004	+3.45	40
I/E Calibration APDM Flux Map	8	~ 88	228	218	P10	LK	32	1.80	P10	LK	1.41	23	1.21	1.39	1.007	+4.04	41
I/E Calibration APDM Flux Map	9	~ 98	228	224	K14	KL	34	1.84	K14	KL	1.42	35	1.22	1.39	1.007	-2.90	40
Full Power Map Eq. Xenon	10	~100	228	221	K14	KL	34	1.84	K14	KL	1.42	34	1.22	1.38	1.007	-1.48	42

NOTES: Hot spot locations are specified by giving assembly locations (e.g. H-8 is the center-of-core assembly location), followed by the pin location (denoted by the "Y" coordinate with the fifteen 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.

*F_Q^T includes a total uncertainty of 1.08.[4]

**$F_{\Delta H}^N$ including a measurement uncertainty of 1.04.

+F_{xy} is evaluated at the midplane of the core.

[X]QPTR - Quadrant Power Tilt Ratio.

[XX]Map 2 was aborted.

Table 5.2

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TESTS

COMPARISON OF MEASURED POWER DISTRIBUTION PARAMETERS WITH THEIR TECHNICAL SPECIFICATIONS LIMIT

	$F^N_{\Delta H}$ Hot Channel Factor[a]			$F^N_{\Delta H}\|^{LOCA}_{ASSY}$ Hot Channel Factor[a]			$F^N_{\Delta H}\|^{LOCA}_{ROD}$ Hot Channel Factor[a]			F^T_Q Hot Channel Factor[b]			Quadrant Power Tilt Ratio	
Map	Measured	Limit	Margin (%)	Measured	Limit	Margin (%)	Measured	Limit	Margin (%)	Measured	Limit	Minimum Margin (%)	Measured	Nominal[c] Limit
1	1.55	1.75	11.4	1.33	>50.00	>97.3	1.56	>50.00	>96.9	2.40	3.77	36.3	1.014	1.020
3[d]	1.68	1.74	3.4	1.51	34.50	95.6	1.69	36.25	95.3	2.57	3.78	32.0	1.013	1.020
4	1.44	1.61	10.6	1.31	2.76	52.5	1.46	2.90	49.7	1.99	3.80	47.6	1.002	1.020
5	1.43	1.61	11.2	1.31	2.76	52.5	1.44	2.90	50.3	2.04	3.88	47.4	1.004	1.020
6	1.47	1.58	7.0	1.31	2.42	45.9	1.47	2.54	42.1	2.16	3.40	36.5	1.007	1.020
7	1.43	1.56	8.3	1.30	2.06	36.9	1.44	2.16	33.3	1.90	2.84	33.1	1.004	1.020
8	1.41	1.49	5.4	1.29	1.57	17.8	1.43	1.65	13.3	1.80	2.21	18.6	1.007	1.020
9	1.42	1.47	3.4	1.30	1.41	7.8	1.43	1.48	3.4	1.84	1.98	7.1	1.007	1.020
10	1.42	1.46	2.7	1.29	1.39	7.2	1.43	1.46	2.1	1.84	1.95	5.6	1.007	1.020

[a]The measured values for the enthalpy rise hot channel factors, $F^N_{\Delta H}$, $F^N_{\Delta H}|^{LOCA}_{ASSY}$, and $F^N_{\Delta H}|^{LOCA}_{ROD}$, include 4% measurement uncertainty. The limit on $F^N_{\Delta H}$ includes the maximum penalty associated with the interim thimble cell rod bow penalty which is 6%.

[b]The Technical Specifications limit for the heat flux hot channel factor, Factor, F^T_Q, is a function of core height. The value for F^T_Q listed above is the maximum value of F^T_Q in the core. The Technical Specifications limit listed above is evaluated at the plane of maximum F^T_Q. The minimum margin values listed above are the minimum percent difference between the measured values of $F^T_{Q_4}(Z)$ and the Technical Specifications limit for each map. All measured F^T_Q hot channel factors include 8% total uncertainty.

[c]This is the full-power operating limit for normal operation. The limit does not apply during physics testing.

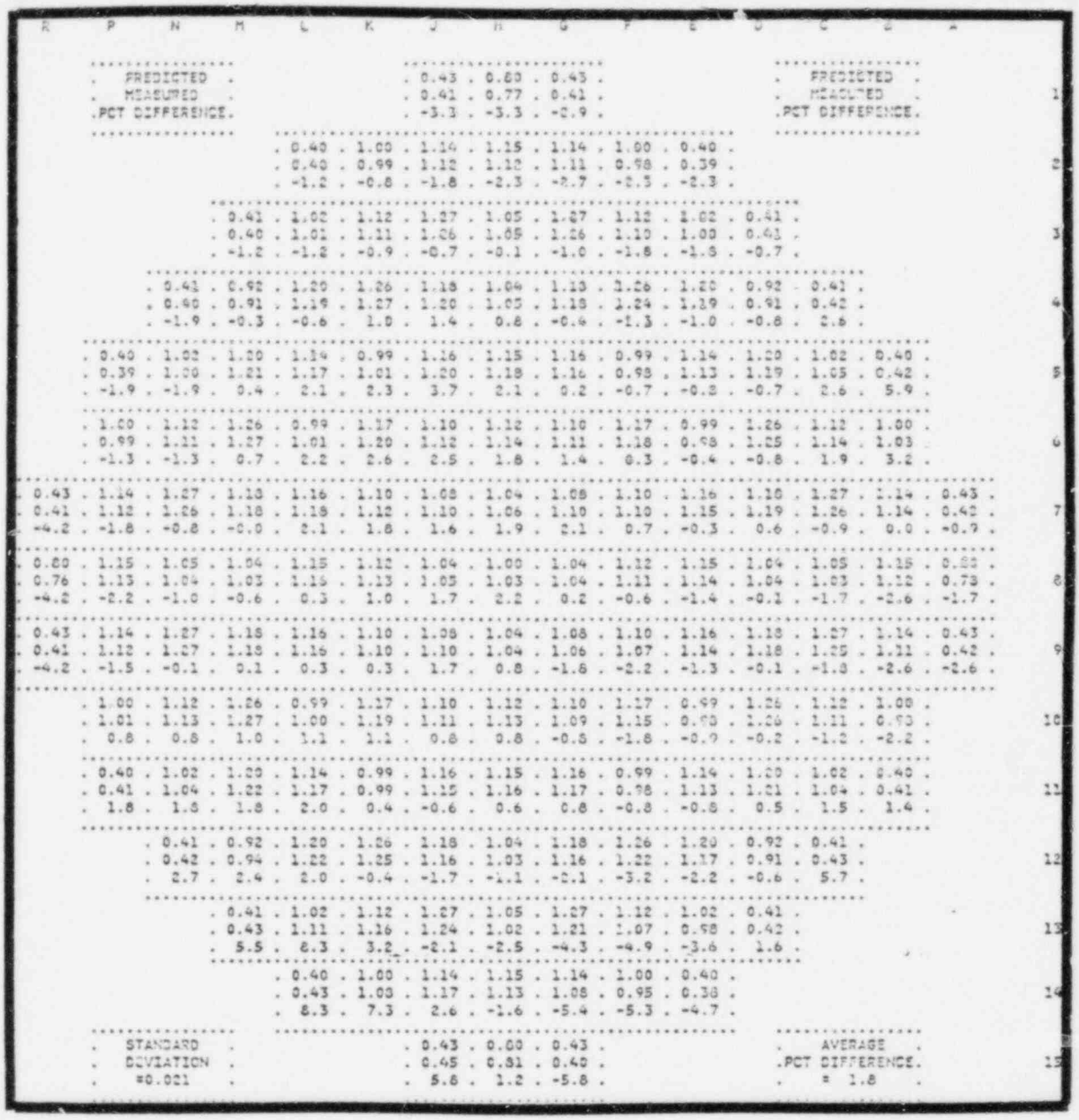
[d]Map 2 was aborted.

Figure 5.1

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HZP, ARO



MAP NO: S1-5-1

DATE: 7/7/78

POWER = 0%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.545

QPTR:

D BANK AT 218 STEPS

F^T_Q = 2.400

NW - 1.001

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.497

NE - 1.002

A.O = 27.357

SW - 1.014

BURNUP = 0 MWD/MTU

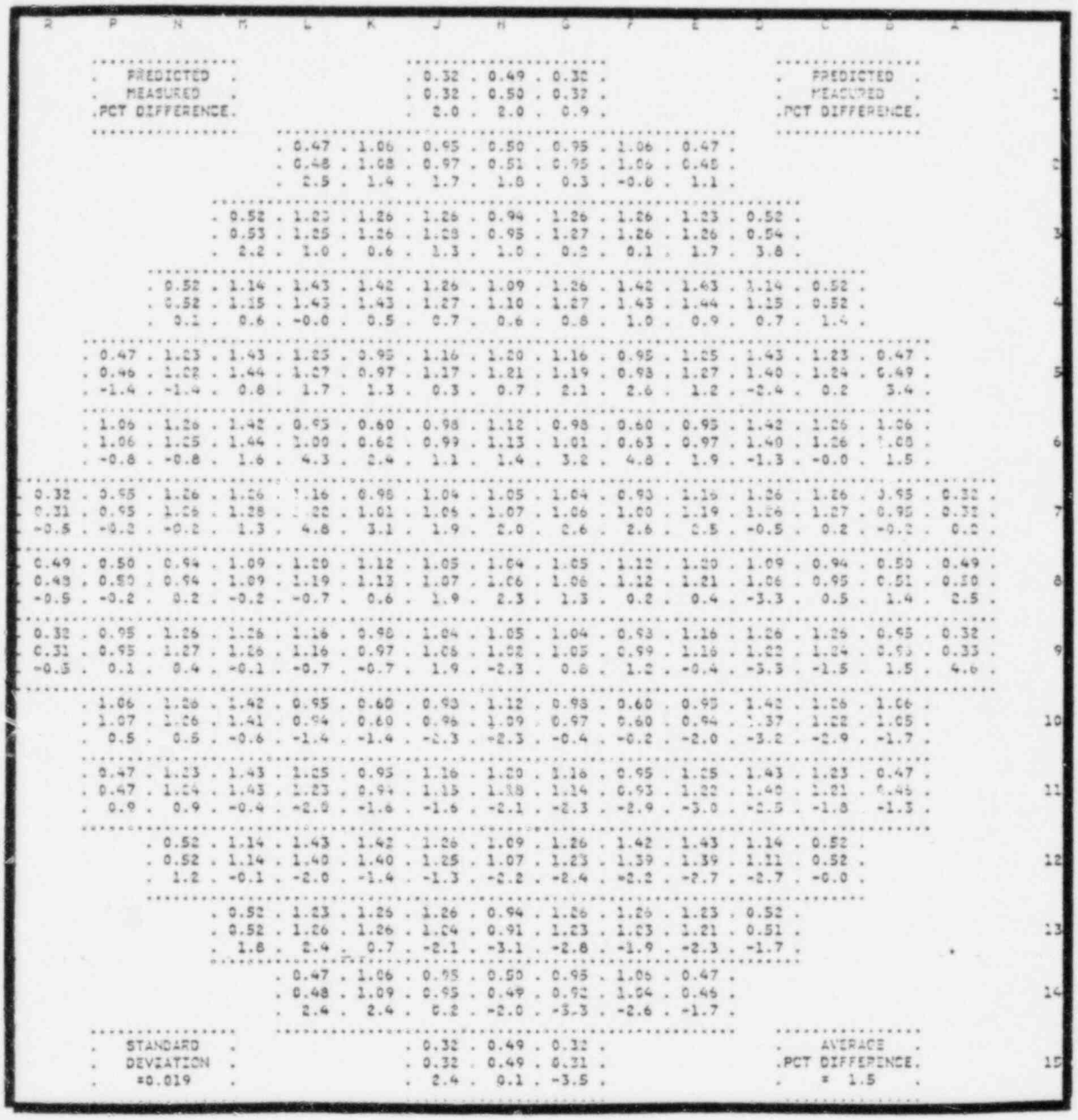
SE - 0.983

Figure 5.2

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HZP, D-BANK IN



R	P	N	M	L	K	J	H	G	F	E	D	C	B	A	
						0.32	0.49	0.32				PREDICTED			
						0.32	0.50	0.32				MEASURED			1
						2.0	2.0	0.9				PCT DIFFERENCE			
				0.47	1.06	0.95	0.50	0.95	1.06	0.47					
				0.48	1.08	0.97	0.51	0.95	1.06	0.48					2
				2.5	1.4	1.7	1.8	0.3	-0.6	1.1					
			0.52	1.20	1.26	1.26	0.94	1.26	1.26	1.20	0.52				
			0.53	1.25	1.26	1.28	0.95	1.27	1.26	1.26	0.54				3
			2.2	1.0	0.6	1.3	1.0	0.2	0.1	1.7	3.8				
		0.52	1.14	1.43	1.42	1.26	1.09	1.26	1.42	1.43	1.14	0.52			
		0.52	1.15	1.43	1.43	1.27	1.10	1.27	1.43	1.44	1.15	0.52			4
		0.1	0.6	-0.0	0.5	0.7	0.6	0.8	1.0	0.9	0.7	1.4			
	0.47	1.23	1.43	1.25	0.95	1.16	1.20	1.16	0.95	1.25	1.43	1.23	0.47		
	0.46	1.22	1.44	1.27	0.97	1.17	1.21	1.19	0.98	1.27	1.40	1.24	0.49		5
	-1.4	-1.4	0.8	1.7	1.3	0.3	0.7	2.1	2.6	1.2	-2.4	0.2	3.4		
	1.06	1.26	1.42	0.95	0.60	0.98	1.12	0.98	0.60	0.95	1.42	1.26	1.06		
	1.06	1.25	1.44	1.00	0.62	0.99	1.13	1.01	0.63	0.97	1.40	1.26	1.08		6
	-0.8	-0.8	1.6	4.3	2.4	1.1	1.4	3.2	4.8	1.9	-1.3	-0.0	1.5		
0.32	0.95	1.26	1.26	1.16	0.98	1.04	1.05	1.04	0.98	1.19	1.26	1.26	0.95	0.32	
0.31	0.95	1.26	1.28	1.22	1.01	1.06	1.07	1.06	1.00	1.19	1.26	1.27	0.98	0.32	7
-0.5	-0.2	-0.2	1.3	4.8	3.1	1.9	2.0	0.6	2.6	0.5	-0.5	0.2	-0.2	0.2	
0.49	0.50	0.94	1.09	1.20	1.12	1.05	1.04	1.05	1.12	1.20	1.09	0.94	0.50	0.49	
0.48	0.50	0.94	1.09	1.19	1.13	1.07	1.06	1.06	1.12	1.21	1.06	0.95	0.51	0.50	8
-0.5	-0.2	0.2	-0.2	-0.7	0.6	1.9	2.3	1.3	0.2	0.4	-3.3	0.5	1.4	2.5	
0.32	0.95	1.26	1.26	1.16	0.98	1.04	1.05	1.04	0.98	1.16	1.26	1.26	0.95	0.32	
0.31	0.95	1.27	1.26	1.16	0.97	1.06	1.08	1.05	0.99	1.16	1.22	1.24	0.96	0.33	9
-0.5	0.1	0.4	-0.1	-0.7	-0.7	1.9	-2.3	0.8	1.2	-0.4	-3.5	-1.5	1.5	4.6	
	1.06	1.26	1.42	0.95	0.60	0.98	1.12	0.98	0.60	0.95	1.42	1.26	1.06		
	1.07	1.26	1.41	0.94	0.60	0.96	1.09	0.97	0.60	0.94	1.37	1.22	1.05		10
	0.5	0.5	-0.6	-1.4	-1.4	-2.3	-2.3	-0.4	-0.2	-2.0	-3.2	-2.9	-1.7		
	0.47	1.23	1.43	1.25	0.95	1.16	1.20	1.16	0.95	1.25	1.43	1.23	0.47		
	0.47	1.24	1.43	1.23	0.94	1.15	1.18	1.14	0.93	1.22	1.40	1.21	0.46		11
	0.9	0.9	-0.4	-2.0	-1.6	-1.6	-2.1	-2.3	-2.9	-3.0	-2.5	-1.8	-1.3		
		0.52	1.14	1.43	1.42	1.26	1.09	1.26	1.42	1.43	1.14	0.52			
		0.52	1.14	1.40	1.40	1.25	1.07	1.23	1.39	1.39	1.11	0.52			12
		1.2	-0.1	-2.0	-1.4	-1.3	-2.2	-2.4	-2.2	-2.7	-2.7	-0.0			
			0.52	1.23	1.26	1.26	0.94	1.26	1.26	1.23	0.52				
			0.52	1.26	1.26	1.24	0.91	1.23	1.23	1.21	0.51				13
			1.8	2.4	0.7	-2.1	-3.1	-2.8	-1.9	-2.3	-1.7				
				0.47	1.06	0.95	0.50	0.95	1.06	0.47					
				0.48	1.09	0.95	0.49	0.92	1.04	0.46					14
				2.4	2.4	0.2	-2.0	-3.3	-2.6	-1.7					
						0.32	0.49	0.32				AVERAGE			
						0.32	0.49	0.31				PCT DIFFERENCE			15
						2.4	0.1	-3.5				± 1.5			
						STANDARD DEVIATION ±0.019									

MAP NO: S1-5-3

CONTROL ROD POSITIONS:

D BANK AT 0 STEPS

C BANK AT 219 STEPS

DATE: 7/7/78

$F^N_{\Delta H}$ = 1.684

F^T_Q = 2.570

$\overline{F}_z$ = 1.463

A.O. = 22.681

BURNUP = 0 MWD/MTU

POWER = 4%

QPTR:

NW - 1.013

NE - 1.008

SW - 1.000

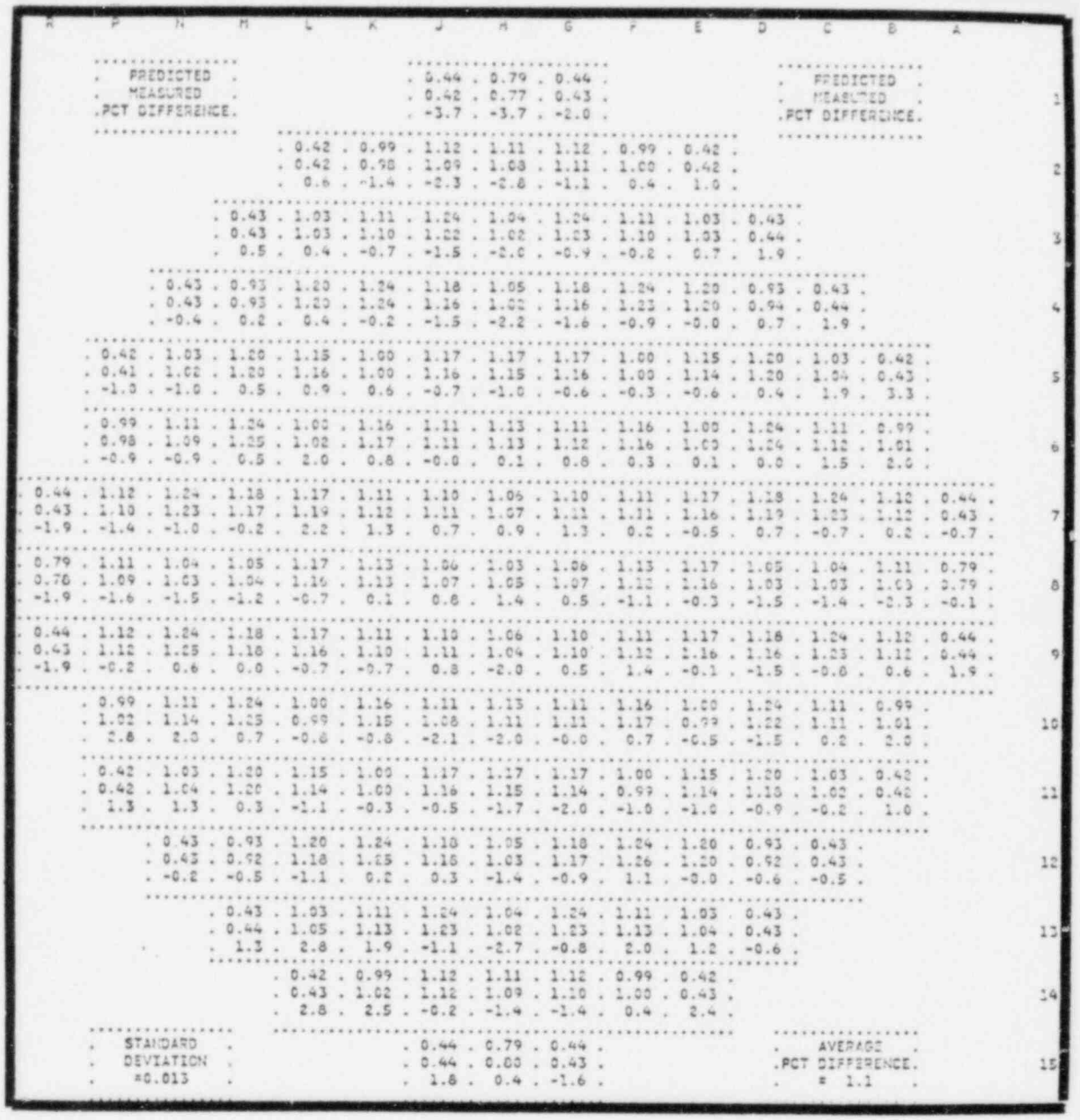
SE - 0.979

Figure 5.3

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: S1-5-4

DATE: 7/9/78

POWER = 50%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.442

QPTR:

D BANK AT 200 STEPS

F^T_Q = 1.994

NW - 0.998

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.315

NE - 1.001

A.O. = 6.301

SW - 1.002

BURNUP = 0 MWD/MTU

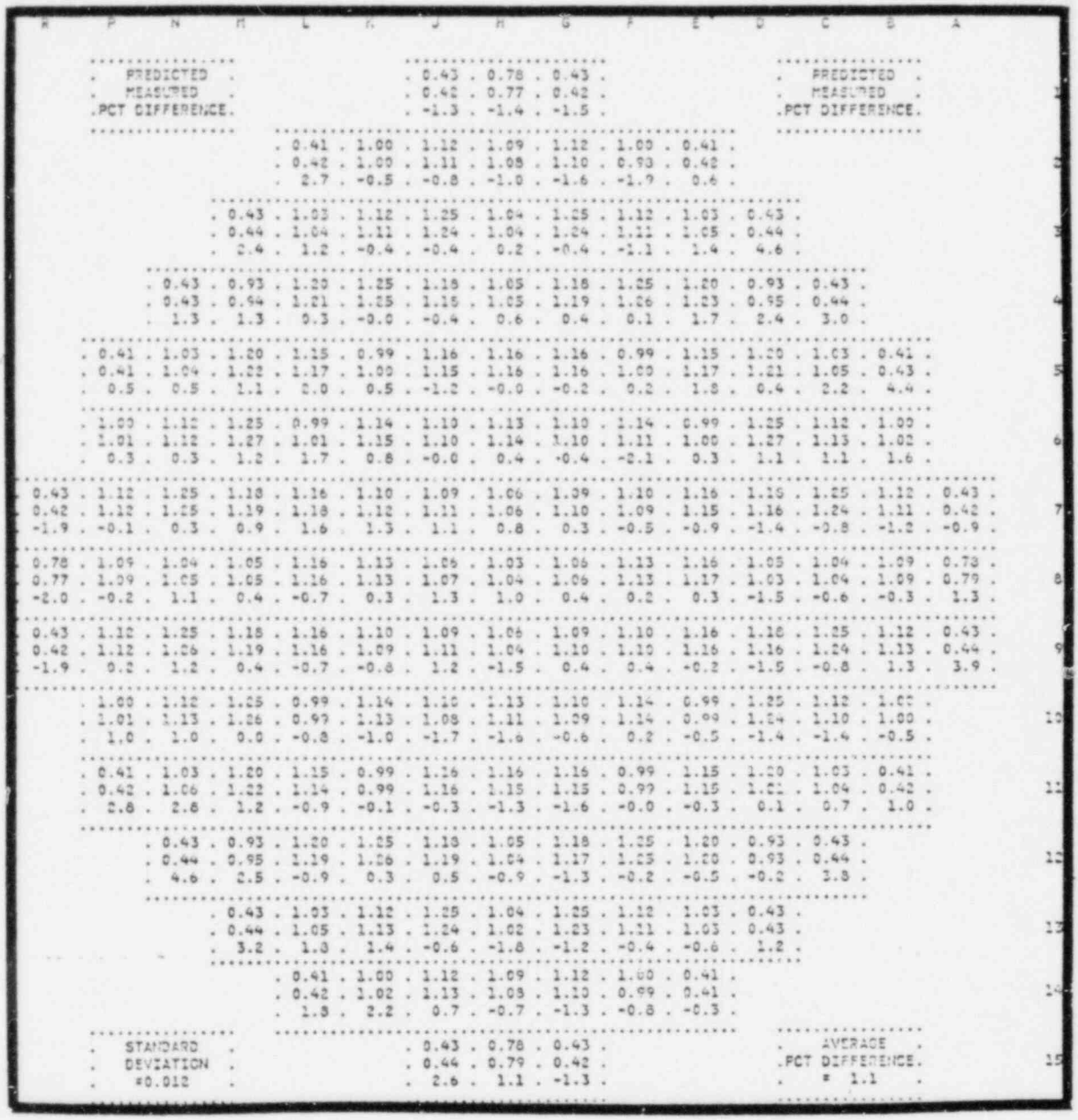
SE - 0.999

Figure 5.4

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: S1-5-5

DATE: 7/9/78

POWER = 50%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.434

QPTR:

D BANK AT 185 STEPS

F^T_Q = 2.037

NW - 1.002

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.321

NE - 1.001

A.O. = -2.006

SW - 1.004

BURNUP = 0 MWD/MTU

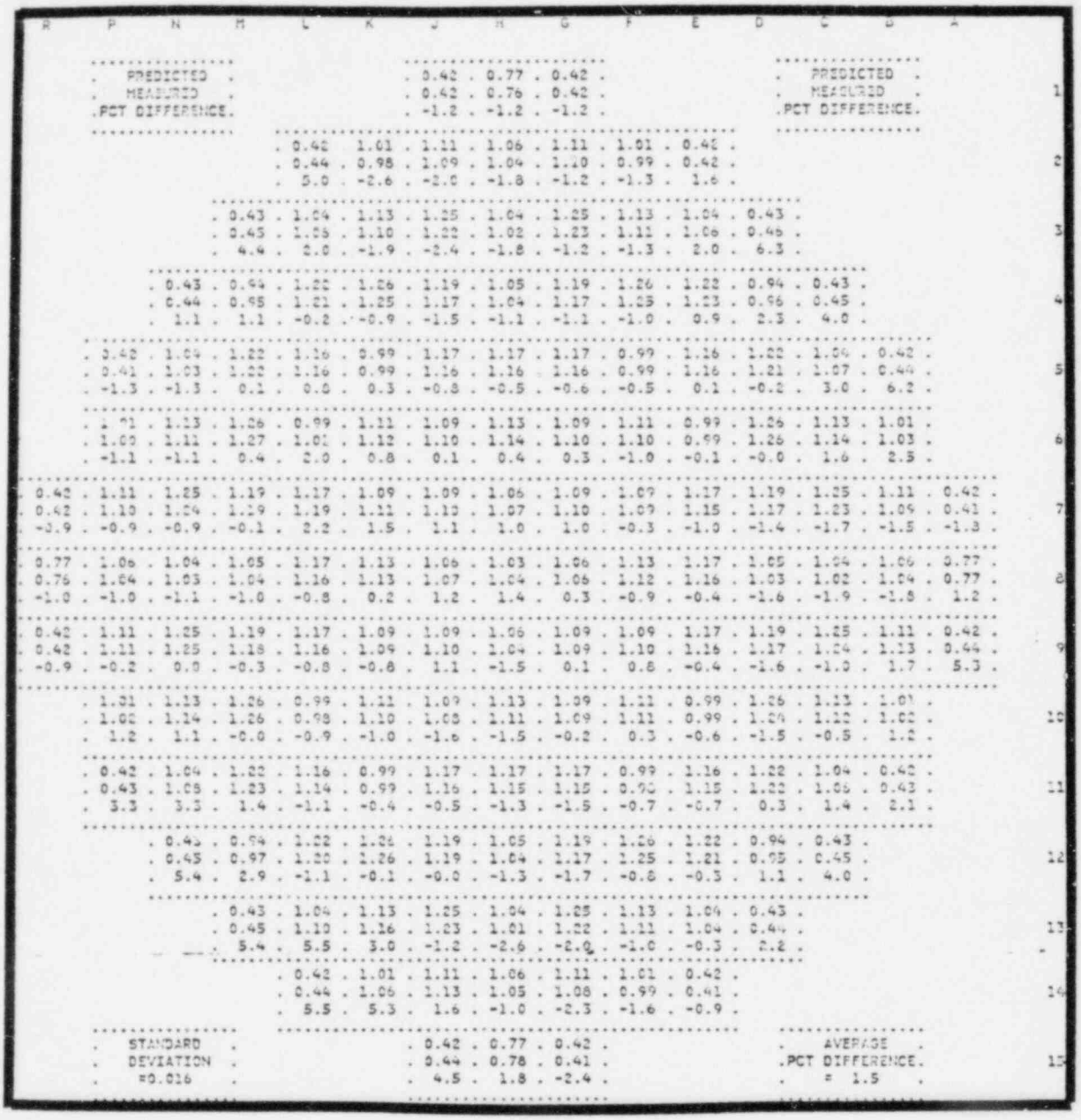
SE - 0.993

Figure 5.5

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: S1-5-6

DATE: 7/10/78

POWER = 57%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.465

QPTR:

D BANK AT 162 STEPS

F^T_Q = 2.163

NW - 0.992

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.385

NE - 1.007

A.O. = -16.953

SW - 1.004

BURNUP = 0 MWD/MTU

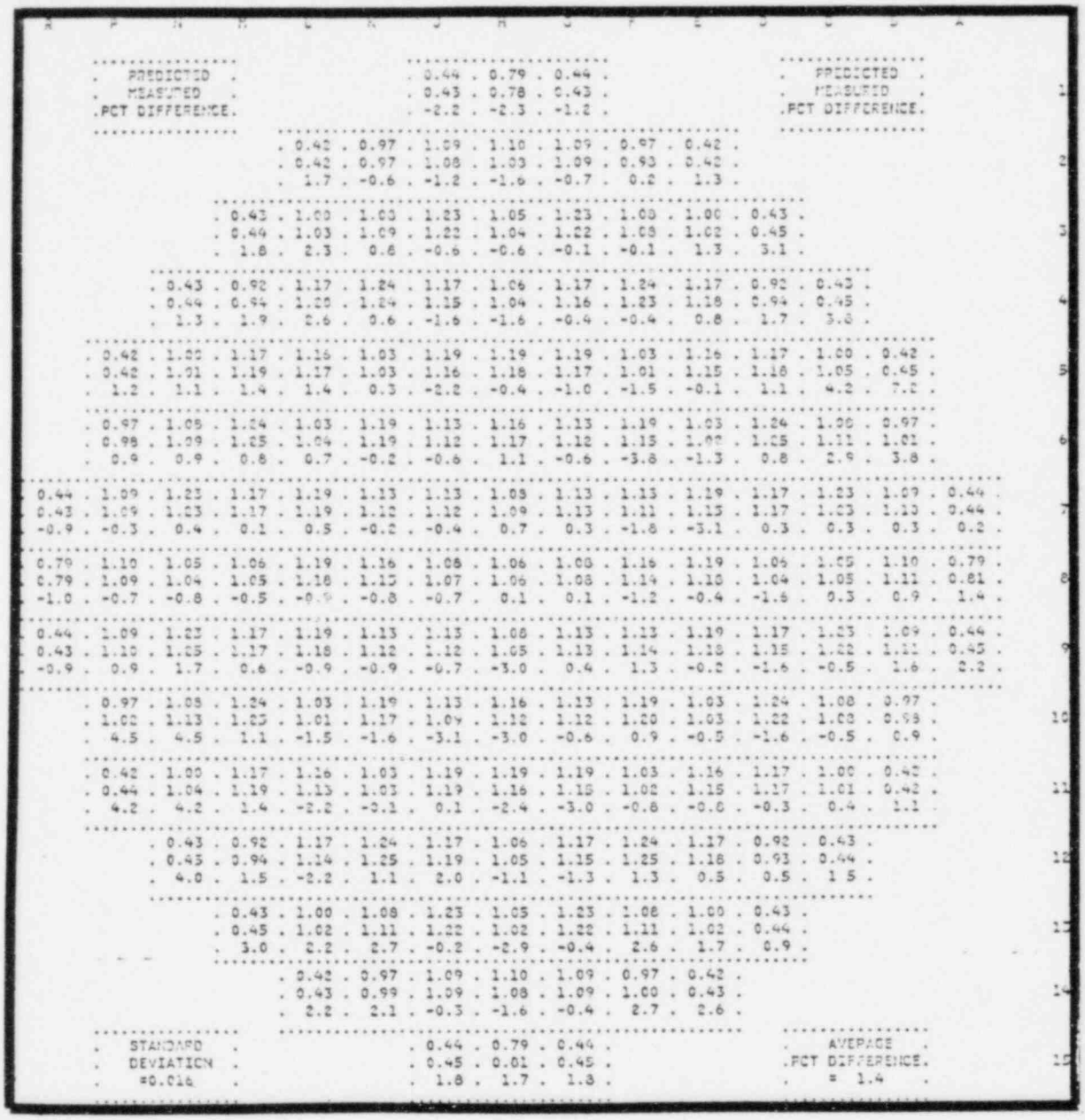
SE - 0.997

Figure 5.6

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: S1-5-7

DATE: 7/10/78

POWER = 67%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.430

QPTR:

D BANK AT 196 STEPS

F^T_Q = 1.901

NW - 0.999

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.270

NE - 1.003

A.O. = 3.451

SW - 1.004

BURNUP = 0 MWD/MTU

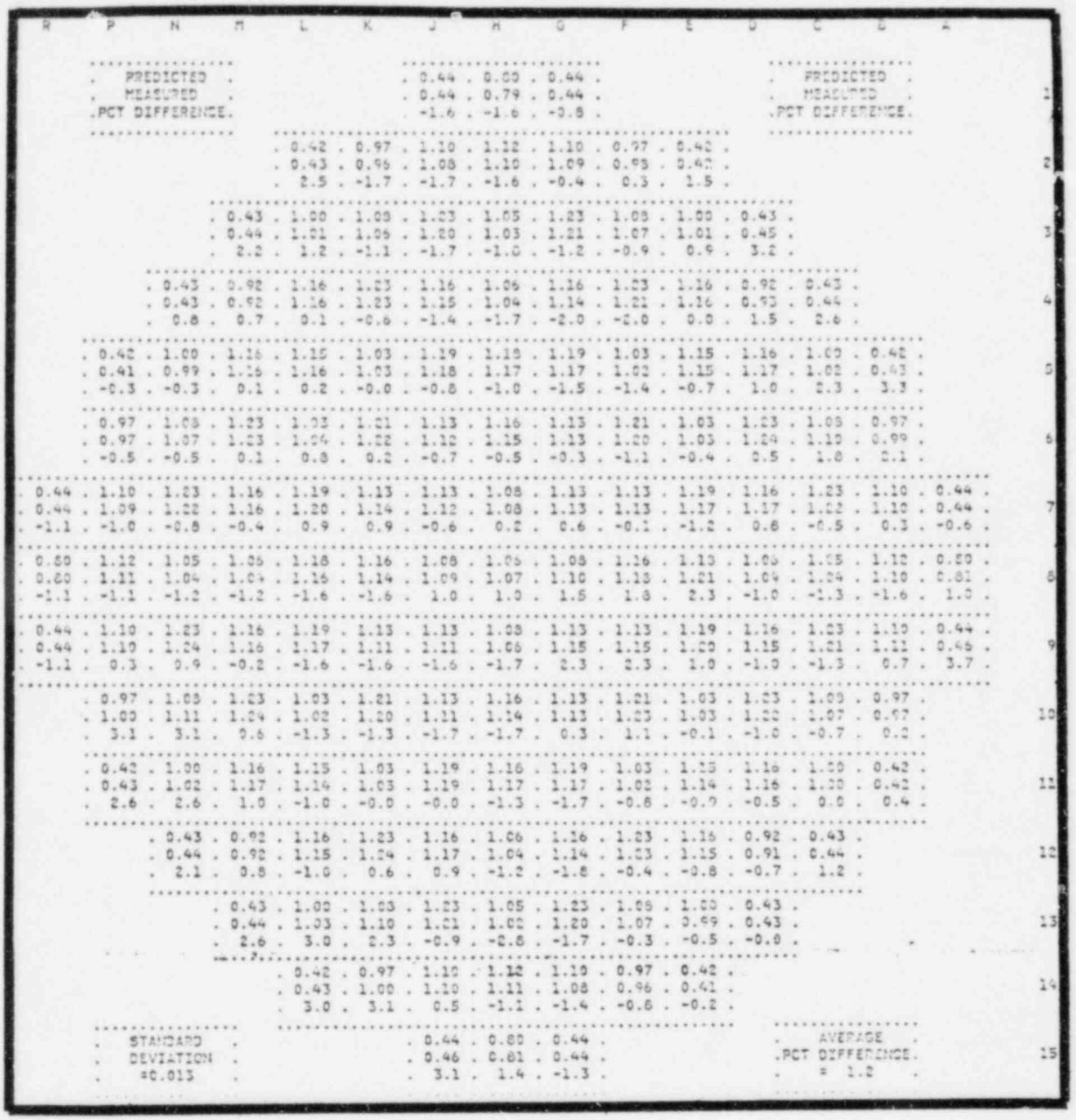
SE - 0.994

Figure 5.7

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: S1-5-8

DATE: 7/10/78

POWER = 88%

CONTROL ROD POSITIONS:

$F^N_{\Delta H} = 1.408$

QPTR:

D BANK AT 218 STEPS

$F^T_Q = 1.798$

NW - 0.996

C BANK AT 228 STEPS

$\overline{F}_z = 1.213$

NE - 1.000

A.O. = 4.043

SW - 1.007

BURNUP = 0 MWD/MTU

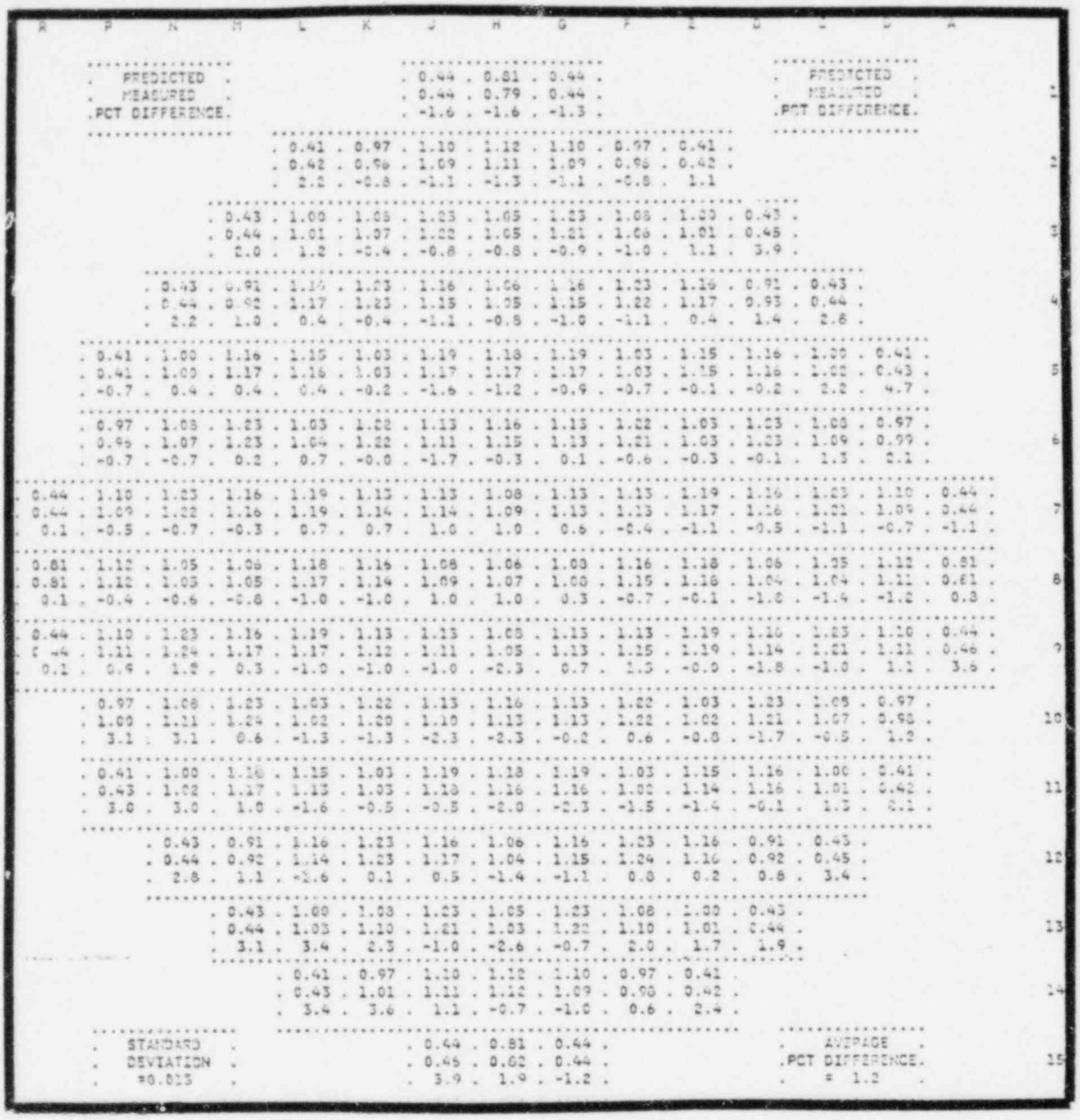
SE - 0.997

Figure 5.8

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

I/E CALIBRATION - APDM FLUX MAP



MAP NO: S1-5-9

DATE: 7/11/78

POWER = 98%

CONTROL ROD POSITIONS:

$F^N_{\Delta H}$ = 1.415

QPTR:

D BANK AT 224 STEPS

F^T_Q = 1.841

NW - 0.998

C BANK AT 228 STEPS

$\overline{F}_z$ = 1.220

NE - 0.998

$P_{THRESHOLD}$ = 98%

A.O. = -2.899

SW - 1.007

BURNUP = 0 MWD/MTU

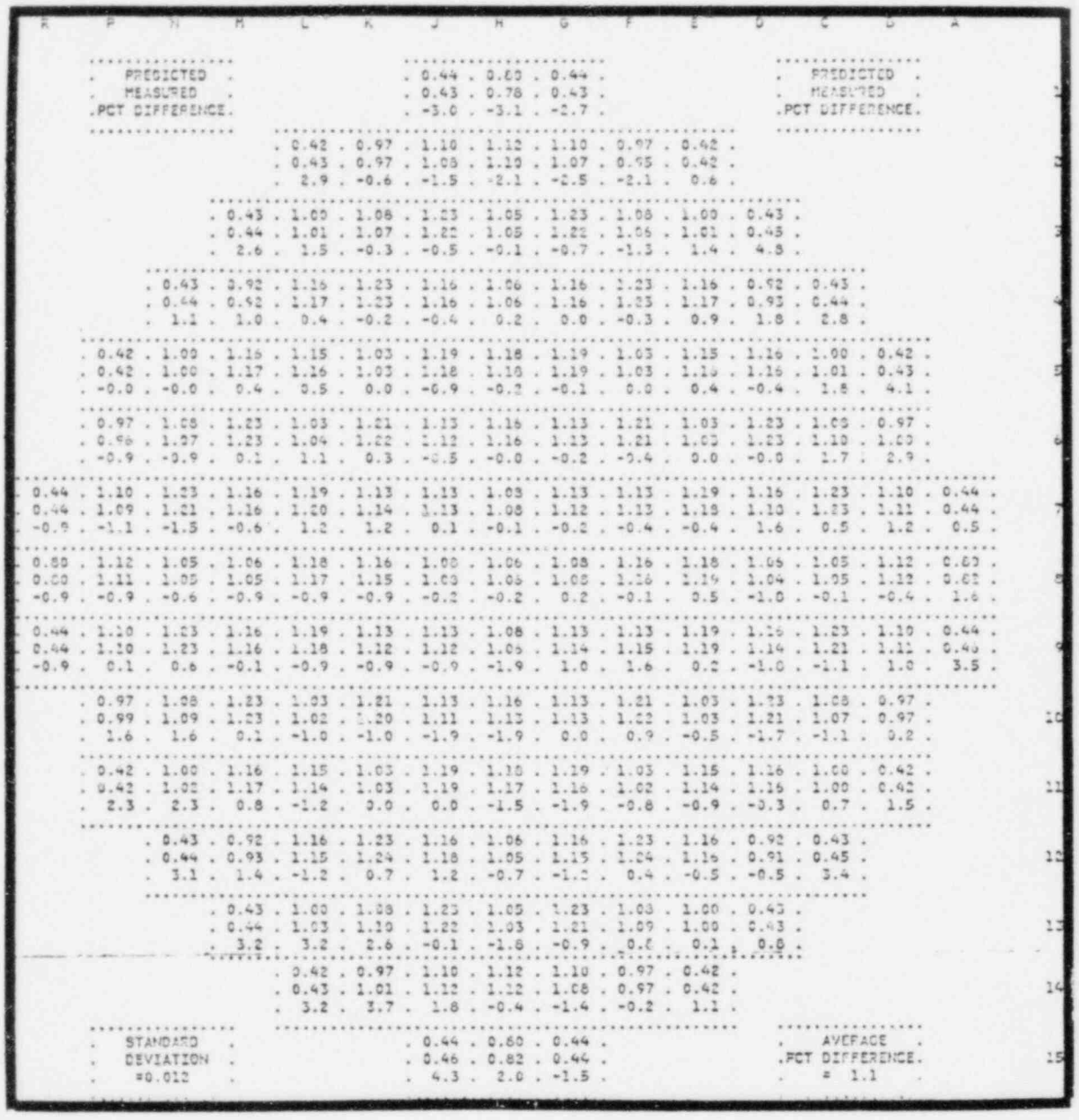
SE - 0.997

Figure 5.9

SURRY UNIT 1 - CYCLE 5 BOL PHYSICS TEST

ASSEMBLYWISE POWER DISTRIBUTION

HFP, EQ. XENON



MAP NO: S1-5-10

CONTROL ROD POSITIONS:

D BANK AT 221 STEPS

C BANK AT 228 STEPS

DATE: 7/13/78

$F^N_{\Delta H}$ = 1.416

F^T_Q = 1.838

$\overline{F}_z$ = 1.218

A.O. = -1.477

BURNUP = 150 MWD/MTU

POWER = 100%

QPTR:

NW - 1.000

NE - 1.001

SW - 1.007

SE - 0.992

POWER COEFFICIENT MEASUREMENT

The power coefficient measurement was performed by reducing/increasing reactor thermal power using the turbine control system to establish a constant rampdown/rampup rate of one percent power per minute. Positive/negative reactivity changes were compensated for via control bank D insertion/withdrawal in order to keep the RCS temperature within 0.5°F of the programmed reference RCS temperature (T_{ref} vs. %power). The worth of control bank D for each individual D bank movement was determined from the reactivity computer output traces, taking into consideration the dampening effect on the indicated value of reactivity due to doppler feedback.

The power coefficient measurement was performed over approximately a 10% power change starting at 100% power. The measurement was repeated during the ramp back up. An estimate of the change in reactivity due to the changing concentration of xenon was made based on design calculations[1] and a small correction term was applied to the measured reactivity values. The power coefficient was determined by dividing the xenon corrected reactivity change by the percent reactor thermal power change as determined from calculations based on calorimetric, NIS, and reactor coolant system data.

The predicted and measured values of the coefficient are compared in Table 6-1. As can be seen from this table and the Startup Physics Test Results and Evaluation Sheets in the Appendix, the measured value of the power coefficient was within 0.1 pcm/%pwr of the design value which is well within the design tolerance of ±3.2 pcm/%pwr.

In summary, this result was satisfactory.

Table 6-1

SURRY UNIT 1-CYCLE 5 BOL PHYSICS TEST

POWER COEFFICIENT SUMMARY

Power Level (%)	Bank D Position (steps)	Measured Rod Worth (pcm)	Xenon Correction (pcm)	Δ pcm	Δ % pwr	Power Coefficient (pcm/% pwr)		
						Measured	Predicted*	Difference (M-P)
100.0-90.1	220-187	+86	+5.8	+91.8	-9.9	-9.3	-10.6	+1.3
90.6-98.9	187-225	-101	+4.2	-96.8	+8.3	-11.7	-10.6	-1.1
				Ave. $\partial\rho/\partial\rho$ = -10.5			-10.6	+0.1

* Based on design values contained in WCAP-9322.[5]

REFERENCES

1. J. G. Miller, S. A. Ahmed, R. Y. Robins, and H. H. Barker, "Surry Unit No. 1, Cycle 5, Predictions for Startup and Core Follow", VEP-FRD-NFE-74, May, 1978.

2. "Westinghouse Reactivity Measurements System for the Surry Unit 1 Nuclear Power Station Utilizing a PC-12 Reactivity Computer", NSD Plant Data Files, Shop Order VPA-810.

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

4. Surry Power Station Technical Specifications, Section 3.12.

5. J. W. Miller and P. G. Isaac, "The Nuclear Design and Core Management of the Surry Unit 1 Nuclear Power Station Cycle 5", WCAP-9322, June, 1978.

APPENDIX

STARTUP PHYSICS TEST RESULTS
AND FVALUATION SHEETS

SURRY POWER STATION UNIT 1 CYCLE 1 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Reactivity Computer Checkout

Procedure Number / Section: PT28.11/App. B Sequence Step Number: 5

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB : 228 CC : 228 CD: *
P/L :228 RCCA: NA

RCS Temperature (°F): 547±2
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating
*At the just critical position

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 217-222 CD: 89-94
P/L: 226 RCCA: N/A

RCS Temperature (°F): 544-548
Power Level (% F.P.): 0
Other (specify):
BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/6/78 1434-1504

IV Test Results

Measured Parameter (description)	ρ_c = Measured Reactivity using ρ-computer ρ_t = Inferred Reactivity from reactor period		
Measured Value	ρ_c = 14.0 ρ_t = 14.5 $\Delta\%$ = -3.44	24.4 24.6 -0.8	46.0 47.5 -3.15
Design Value (Actual Conditions)	$\left\lvert \frac{\rho_c - \rho_t}{\rho_t} \right\rvert \leq .04$		
Design Value (Design Conditions)	$\left\lvert \frac{\rho_c - \rho_t}{\rho_t} \right\rvert \leq .04$		
Reference	NA		

V Acceptance Criteria

Accident Analysis Value	NA
Reference	NA

VI Comments

Design Tolerance is met : ☑ YES ☐ NO
Acceptance Criteria is met: ☐ YES ☐ NO N/A

Maximum Allowable Reactivity Range = ±46pcm.

Performed By: L. J. Curtman, Surry Test Engineer

Evaluated By: D. W. Lienau, NFO Startup Engineer

Approved: [illegible], Surry Engineering Supervising Nuclear Engineer

Recommended for Approval by: C. J. Bram for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Boron Endpoint Measurement - ARO

Procedure Number / Section: PT28.11/APP.C Sequence Step Number: 6

II Test Conditions (Desi' .)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB : 228 CC : 228 CD: 228 +0 -15
P/L: 228 RCCA: N/A

RCS Temperature (°F): 547 ±2.
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 214
P/L: 226 RCCA: N/A

RCS Temperature (°F): 547.3
Power Level (% F.P.): 0
Other (specify):
BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/6/77 1900-2012

IV Test Results

Measured Parameter (description)	$(C_B)_{ARO}$, Critical Boron Concentration - ARO
Measured Value	C_B = 1304 ppm
Design Value (Actual Conditions)	C_B = 1321 ± 50 ppm
Design Value (Design Conditions)	C_B = 1321 ± 50 ppm (D/228, 547.0°F)
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	$\left(\frac{\delta\rho}{\delta C_B}\right) \times C_B \leq 15{,}115$ pcm
Reference	FSAR Section 14.2.5

VI Comments

Design Tolerance is met : ☒ YES ☐ NO
Acceptance Criteria is met: ☒ YES ☐ NO

$\frac{\delta\rho}{\delta C_B} = -8.94$ pcm/ppm (MEASURED)

Performed By L. J. Curfman
Surry Test Engineer

Evaluated By [signature]
NFO Startup Engineer

Approved: [signature]
SUPV ENG SVCS. SURRY POWER STATION.

Recommended for Approval by D. W. Linnell for
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Isothermal Temperature Coefficient - ARO

Procedure Number / Section: PT28.11/APP D Sequence Step Number: 7

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB : 228 CC : 228 CD: 228^{+0}_{-15}
P/L: 228 RCCA: NA

RCS Temperature (°F): 544 ± 1
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating
Observe Precautions in PT28.11

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 225 CC: 228 CD: 222/223
P/L: 226 RCCA: N/A

RCS Temperature (°F): 543.8 - 546.5
Power Level (% F.P.): 0
Other (specify):
BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/6/78 2000 - 2236

IV Test Results

Measured Parameter (description)	$\left(\frac{\delta\rho}{\rho T}\right)^{ISO}_{ARO}$, Isothermal Temperature Coefficient - ARO
Measured Value	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO} = -2.7$ pcm/°F
Design Value (Actual Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO} = -3.7 \pm 3$ pcm/°F (C_B = 1311 ppm)
Design Value (Design Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO} = -3.6 \pm 3.0$ pcm/°F (D/228, 1321 ppm, 547.0°F)
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	$\left(\frac{\delta\rho}{\delta T}\right)^{ISO} \leq -0.96 \frac{pcm}{°F}$ [ISO$(\delta\rho/\delta T)$=MOD $(\delta\rho/\delta T)$ + DOPPLER $(\delta\rho/\delta T)$ DOPPLER $(\delta\rho/\delta T) = -2.04 \frac{pcm}{°F}$]
Reference	TS 3.1, VEP-FRD-NFE 74

VI Comments

Design Tolerance is met : ☒ YES ☐ NO
Acceptance Criteria is met: ☒ YES ☐ NO

Performed By L. J. Gutman
Surry Test Engineer

Evaluated By T. F. Hunsicker
NFO Startup Engineer

Approved: J. A. Hoffman
SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by D. W. Lindsey for
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - HZP, ARO — S1-5-1

Procedure Number / Section: PT28.2, OP-57 — Sequence Step Number: 9

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 228	CC: 228	CD: 228 +0 -5
P/L: 228	RCCA: N/A	

RCS Temperature (°F): 547 +0 -4

Power Level (% F.P.): 0

Other (specify):

Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 228	CC: 228	CD: 218
P/L: 226	RCCA: N/A	

RCS Temperature (°F): ~547

Power Level (% F.P.): 0

Other (specify):

40 THIMBLES

Date/Time Test Performed: 7/7/78 0113 - 0229

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. $\frac{\text{M}-\text{P}}{\text{P}}$ DIFF.	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	%DIFF = 9.3 P_{L13} = 1.11	1.545 K-14 LM	2.400 K-14 LM	1.0143
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_1 \geq .9$ ±15% for $P_1 < .9$ (P_1 = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H} = 1.55(1+.2(1-P))xT(BU)$	$F^T_Q(Z) = 2.88 \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{ROD}$ AND $F^N_{\Delta H}|^{LOCA}_{ASSY}$ WERE WITHIN THEIR TECHNICAL SPECIFICATIONS LIMITS. THE DATA FOR THIS MAP WAS TAKEN USING A NEW FLUX MAPPING TECHNIQUE DESIGNED SPECIFICALLY FOR USE AT VERY LOW POWER LEVELS. ALTHOUGH THE RESULTS OF THIS MAP ARE ACCEPTABLE, THE OVERALL QUALITY OF THIS MAP IS BELOW THE QUALITY NORMALLY EXPERIENCED USING CONVENTIONAL MAPPING TECHNIQUES

Performed By L. J. Curfman
Surry Test Engineer

Evaluated By C. J. Smith
NFO Startup Engineer

Approved: J. A. Hayes
SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by D. W. Lienau for
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Rod Worth Measurement - D Bank

Procedure Number / Section: PT28.11/App. E Sequence Step Number: 10

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB : 228	CC : 228	CD: Moving
P/L : 228	RCCA: NA	

RCS Temperature (°F): 547±2
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 228	CC: 228	CD: MOVING
P/L: 226	RCCA:	

RCS Temperature (°F): ~547
Power Level (% F.P.): 0
Other (specify):
BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/7/78 0500-0625

IV Test Results

Measured Parameter (description)	I_D; Integral Worth of Control Bank - D Bank
Measured Value	1207 pcm
Design Value (Actual Conditions)	1188 ± 178 pcm
Design Value (Design Conditions)	1188 ± 178 pcm
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (Serial No. 272)

VI Comments

Design Tolerance is met : ☒ YES ☐ NO

Acceptance Criteria is met: ☒ YES ☐ NO

Performed By L. J. Gerlman
Surry Test Engineer

Evaluated By T. J. Kenyon
NFO Startup Engineer

Approved: J. A. Stolzer
SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by D. W. Lynch for
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference	Test Description: Boron Endpoint Measurement - D Bank In Procedure Number / Section: PT28.11/APP.C	Sequence Step Number: 11
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 $^{+0}_{-15}$ CD: 0^{+15}_{-0} P/L: 228 RCCA: N/A	RCS Temperature (°F): 547^{+0}_{-2} Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 222 CD: 0 P/L: 226 RCCA: N/A	RCS Temperature (°F): 547.0 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	Date/Time Test Performed: 7/7/78 0845-1015	
IV Test Results	Measured Parameter (description)	$(C_B)_D$, Critical Boron Concentration - D Bank In
	Measured Value	C_B= 1184 ppm
	Design Value (Actual Conditions)	C_B= 1165 ± 25 ppm
	Design Value (Design Conditions)	$C_B = 1182 + [(C_B)^M_{ARO} - 1321] \pm [0.010 \times (C_D)^M_D + 118.8/(\partial\rho/\partial C_B)]$
	Reference	VEP-FRD-NFE 74
V Acceptance Criteria	Accident Analysis Value	$\left(\frac{\delta\rho}{\delta C_B}\right) \times C_B \leq 15{,}115$ pcm
	Reference	FSAR Section 14.2.5
VI Comments	Design Tolerance is met : ☒ YES ☐ NO Acceptance Criteria is met: ☒ YES ☐ NO	
	$\frac{\delta\rho}{\delta C_B} = -8.94$ pcm/ppm (MEASURED)	

Performed By: L. J. Curtman, Surry Test Engineer

Evaluated By: D W Lippard, NFO Startup Engineer

Approved: [illegible], SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by: C. J. Evans, for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference	Test Description: Isothermal Temperature Coefficient - D Bank In Procedure Number / Section: PT28.11/APP D	Sequence Step Number: 12
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 +0 CA: 228 CB : 228 CC : 228 -15 CD: 0 +15 -0 P/L: 228 RCCA:NA	RCS Temperature (°F): 544 ±1 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating Observe Precautions in PT28.11
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 222 CD: 0 P/L: 226 RCCA: N/A	RCS Temperature (°F): 544.2-546.2 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	Date/Time Test Performed: 7/7/78 1030-1110	
IV Test Results	Measured Parameter (description)	$\left(\frac{\delta\rho}{\rho T}\right)^{ISO}_{D}$, Isothermal Temperature Coefficient - D Bank In
	Measured Value	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO} = -5.9$ pcm/°F
	Design Value (Actual Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO} = -6.9 \pm 3$ pcm/°F (C_B = 1173 ppm)
	Design Value (Design Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO} = -6.8 \pm 3.0$ pcm/°F (D/0, C/228, 1182 ppm, 547.0°F)
	Reference	VEP-FRD-NFE 74
V Acceptance Criteria	Accident Analysis Value	$\left(\frac{\delta\rho}{\delta T}\right)^{ISO} \leq -0.96 \frac{pcm}{°F}$ [ISO($\delta\rho/\delta T$)=MOD ($\delta\rho/\delta T$) + DOPPLER ($\delta\rho/\delta T$) DOPPLER ($\delta\rho/\delta T$) = $-2.04 \frac{pcm}{°F}$]
	Reference	TS 3.1, VEP-FRD-NFE 74
VI Comments	Design Tolerance is met : ☒ YES ☐ NO Acceptance Criteria is met: ☒ YES ☐ NO	

Performed By: L. J. Gurkan
Surry Test Engineer

Evaluated By: D W Lipscomb
NFO Startup Engineer

Approved: J A Hayes
SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by: C J Burton
for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - HZP, D-Bank In S1-5-3

Procedure Number / Section: PT28.2, OF-57 Sequence Step Number: 13

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228^{+0}_{-15} CD: 0^{+15}_{0}
P/L: 228 RCCA: N/A

RCS Temperature (°F): 547^{+0}_{-4}
Power Level (% F.P.): 0
Other (specify):
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 229 SDB: 228 CA: 228
CB: 229 CC: 219 CD: 0
P/L: 226 RCCA: N/A

RCS Temperature (°F): 547
Power Level (% F.P.): ≈4
Other (specify):
43 THIMBLES

IV Test Results

Date/Time Test Performed: 7/7/78 1904 - 1914

Measured Parameter (description)	MAX. REL. ASSY PWR. % DIFF. $\left(\frac{M-P}{P}\right)$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	%DIFF = 4.8 P_{L7} = 1.22	1.684 M-5 (H-)	2.570 E-4 (S-H)	1.0129
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_i \geq .9$ ±15% for $P_i < .9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H} = 1.55(1+.2(1-P))$ xT(BU)	$F^T_Q(Z) = 2.88 \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{ROD}$ AND $F^N_{\Delta H}|^{LOCA}_{ASSY}$ WERE WITHIN THEIR TECHNICAL SPECIFICATIONS LIMITS

Performed By L. J. Curlman
Surry Test Engineer

Evaluated By TK Ladd
NFO Startup Engineer

Approved: [signature]
SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by [signature]
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference	Test Description: Rod Worth Measurement - C Bank Procedure Number / Section: PT28.11/App. E		Sequence Step Number: 14
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB : 228 CC : Moving CD: 0 P/L : 228 RCCA: NA		RCS Temperature (°F): 547±2 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 224 CC: MOVING CD: 0 P/L: 226 RCCA: N/A		RCS Temperature (°F): ~547 Power Level (% F.P.): 0 Other (specify): BELOW NUCLEAR HEATING
	Date/Time Test Performed: 7/7/78 2109-2240		
IV Test Results	Measured Parameter (description)	I_C; Integral Worth of Control Bank - C Bank	
	Measured Value	1092 pcm	
	Design Value (Actual Conditions)	1056 ± 158 pcm	
	Design Value (Design Conditions)	1056±158 pcm	
	Reference	VEP-FRD-NFE 74	
V Acceptance Criteria	Accident Analysis Value	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.	
	Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (serial No. 272)	
VI Comments	Design Tolerance is met : ☒ YES ☐ NO Acceptance Criteria is met: ☒ YES ☐ NO		

Performed By L. J. Curtman
Surry Test Engineer

Evaluated By T. A. Wentz
NFO-Startup Engineer

Approved: J. H. Holloway
SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by D. W. Lingard for
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Boron Endpoint Measurement - D, C Banks In

Procedure Number / Section: PT28.11/APP.C Sequence Step Number: 15

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 228^{+0}_{-15}	CC: 0^{+15}_{-0}	CD: 0
P/L: 228^{-15}	RCCA: N/A	

RCS Temperature (°F): $547^{\pm 0}_{\pm 4}$
Power Level (% F.P.): 0
Other (specify): Below Nuclear Heating

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 216	CC: 0	CD: 0
P/L: 226	RCCA: N/A	

RCS Temperature (°F): 546.5
Power Level (% F.P.): 0
Other (specify): BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/7/78 - 7/8/78 2317 - 0037

IV Test Results

Measured Parameter (description)	$(C_B)_{DC}$, Critical Boron Concentration - D,C Banks In
Measured Value	C_B= 1067 ppm
Design Value (Actual Conditions)	C_B= 1075 ± 22 ppm
Design Value (Design Conditions)	$C_B = 1073 + [(C_B)^M_D - 1182] \pm [0.010 \times (C_B)^M_{DC} + 105.6 / (\partial\rho/\partial C_B)]$
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	$\left(\frac{\delta\rho}{\delta C_B}\right) \times C_B \leq 15{,}115$ pcm
Reference	FSAR Section 14.2.5

VI Comments

Design Tolerance is met : ☒ YES ☐ NO
Acceptance Criteria is met: ☒ YES ☐ NO

$\frac{\delta\rho}{\delta C_B} = -8.94$ pcm/ppm (MEASURED)

Performed By L. J. Curfman, Surry Test Engineer

Evaluated By T. J. Houston, NFO Startup Engineer

Approved: [signature], SURV ENG SUPV. SURRY POWER STATION.

Recommended for Approval by DW Lippard for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Isothermal Temperature Coefficient - D,C Banks In

Procedure Number / Section: PT28.11/APP D Sequence Step Number: 16

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228

CB: 228 $^{+0}_{-15}$ CC: 0 $^{+15}_{-0}$ CD: 0

P/L: 228 RCCA: NA

RCS Temperature (°F): 544 ±1

Power Level (% F.P.): 0

Other (specify):

Below Nuclear Heating

Observe Precautions in PT28.11

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228

CB: 213 CC: 0 CD: 0

P/L: 226 RCCA: N/A

RCS Temperature (°F): 544.3 - 547.0

Power Level (% F.P.): 0

Other (specify):

BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/8/78 0210-0300

IV Test Results

Measured Parameter (description)	$\left(\frac{\delta\rho}{\rho T}\right)^{ISO}_{DC}$, Isothermal Temperature Coefficient - D,C Banks In
Measured Value	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO}$ = -9.0 pcm/°F
Design Value (Actual Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO}$ = -10.4 ± 3 pcm/°F (C_B = 1052 ppm)
Design Value (Design Conditions)	$\left(\frac{\partial\rho}{\partial T}\right)^{ISO}$ = -10.1 ± 3.0 pcm/°F (D,C/0, B/228, 1073 ppm, 547.0°F)
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	$\left(\frac{\delta\rho}{\delta T}\right)^{ISO} \leq -0.96 \frac{pcm}{°F}$ [ISO $(\delta\rho/\delta T)$ = MOD $(\delta\rho/\delta T)$ + DOPPLER $(\delta\rho/\delta T)$ DOPPLER $(\delta\rho/\delta T) = -2.04 \frac{pcm}{°F}$]
Reference	TS 3.1, VEP-FRD-NFE 74

VI Comments

Design Tolerance is met : ☒ YES ☐ NO

Acceptance Criteria is met: ☒ YES ☐ NO

Performed By: L. J. Curlman, Surry Test Engineer

Evaluated By: [signature], NFO/Startup Engineer

Approved: [signature], Surry Eng Svcs. Surry Power Station.

Recommended for Approval by: D. W. Lipinski for, NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference	Test Description: Rod Worth Measurement - B Bank Procedure Number / Section: PT28.11/App. E	Sequence Step Number: 17
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB : Moving CC : 0 CD: 0 P/L : 228 RCCA: NA	RCS Temperature (°F): 547±2 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: Moving CC: 0 CD: 0 P/L: 226 RCCA: N/A	RCS Temperature (°F): 546.2 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
	Date/Time Test Performed: 7/8/78 1100 - 1450	

IV Test Results		
	Measured Parameter (description)	I_B: Integral Worth of Control Bank - B Bank
	Measured Value	1999 pcm
	Design Value (Actual Conditions)	2040 ± 306 pcm
	Design Value (Design Conditions)	2040 ± 306 pcm
	Reference	VEP-FRD-NFE 74
V Acceptance Criteria	Accident Analysis Value	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
	Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (Serial No. 272)
VI Comments	Design Tolerance is met : ☒ YES ☐ NO Acceptance Criteria is met: ☒ YES ☐ NO	

Performed By L. J. Curfman
Surry Test Engineer

Evaluated By D. W. Lienau
NFO Startup Engineer

Approved: J. A. Stall
SURV ENG SVCS SURRY POWER STATION.

Recommended for Approval by C. J. Lienau
for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: boron Endpoint Measurement - D,C,B Banks In

Procedure Number / Section: PT28.11/APP.C Sequence Step Number: 18

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228 +0 -15

CB: 0 +15 -0 CC: 0 CD: 0

P/L: 228 RCCA: N/A

RCS Temperature (°F): 547±2

Power Level (% F.P.): 0

Other (specify): Below Nuclear Heating

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228

CB: 0 CC: 0 CD: 0

P/L: 226 RCCA: N/A

RCS Temperature (°F): 546.0

Power Level (% F.P.): 0

Other (specify): BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/8/78 1445-1515

IV Test Results

Measured Parameter (description)	$(C_B)_{DCB}$, Critical Boron Concentration - D,C,B Banks In
Measured Value	C_B= 836 ppm
Design Value (Actual Conditions)	C_B= 846 ± 31 ppm
Design Value (Design Conditions)	$C_B = 852 + [(C_B)^M_{DC} - 1073] \pm [0.010 \times (C_B/^M_{DCB} + 204/(\partial\rho/\partial C_B)]$
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	$\left(\frac{\delta\rho}{\delta C_B}\right) \times C_B \leq 15{,}115$ pcm
Reference	FSAR Section 14.2.5

VI Comments

Design Tolerance is met : ☒ YES ☐ NO

Acceptance Criteria is met: ☒ YES ☐ NO

$\frac{\delta\rho}{\delta C_B} = -8.94$ pcm/ppm (MEASURED)

Performed By L. J. Curfman, Surry Test Engineer

Evaluated By D. W. Lingard, NFO Startup Engineer

Approved: [illegible], SURRY ENG SUPV. SURRY POWER STATION.

Recommended for Approval by C. J. Lance for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Rod Worth Measurement - A Bank

Procedure Number / Section: PT28.11/App. E Sequence Step Number: 19

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: Moving
CB : 0	CC : 0	CD: 0
P/L : 228	RCCA: NA	

RCS Temperature (°F): 547±2
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: Moving
CB: 0	CC: 0	CD: 0
P/L: 226	RCCA: N/A	

RCS Temperature (°F): ~547
Power Level (% F.P.): 0
Other (specify):
BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/8/78 1530-1715

IV Test Results

Measured Parameter (description)	I_A; Integral Worth of Control Bank - A Bank
Measured Value	1304 pcm
Design Value (Actual Conditions)	1242 ± 186 pcm
Design Value (Design Conditions)	1242 ± 186 pcm
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.
Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (Serial No. 272)

VI Comments

Design Tolerance is met : ☒ YES ☐ NO
Acceptance Criteria is met: ☒ YES ☐ NO

Performed By: L. J. Curfman, Surry Test Engineer

Evaluated By: DW Lizard, NFO Startup Engineer

Approved: J. A. Price, SUPT ENG SVCS. SURRY POWER STATION.

Recommended for Approval by: C. J. Lowe, for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: Boron Endpoint Measurement - D,C,B,A Banks In

Procedure Number / Section: PT28.11/APP.C Sequence Step Number: 20

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228 $^{+0}_{-15}$	CA: 0 $^{+15}_{-0}$
CB: 0	CC: 0	CD: 0
P/L: 228	RCCA: N/A	

RCS Temperature (°F): 547 ± 2
Power Level (% F.P.): 0
Other (specify): Below Nuclear Heating

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 0
CB: 0	CC: 0	CD: 0
P/L: 226	RCCA: N/A	

RCS Temperature (°F): 546.0
Power Level (% F.P.): 0
Other (specify): BELOW NUCLEAR HEATING

Date/Time Test Performed: 7/8/74 1730 - 1900

IV Test Results

Measured Parameter (description)	$(C_B)_{DCBA}$, Critical Boron Concentration - D,C,B,A Banks In
Measured Value	C_B = 693 ppm
Design Value (Actual Conditions)	C_B = 700 ± 21 ppm
Design Value (Design Conditions)	$C_B = 716 + [(C_B)^M_{DCB} - 852] \pm [0.010 \times (C_B)^M_{DCBA} + 124.2/(\partial\rho/\partial C_B)]$
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	$\left(\frac{\partial\rho}{\partial C_B}\right) \times C_B \leq 15{,}115$ pcm
Reference	FSAR Section 14.2.5

VI Comments

Design Tolerance is met : ☒ YES ☐ NO
Acceptance Criteria is met: ☒ YES ☐ NO

$\frac{\delta\rho}{\delta C_B} = -8.94 \frac{pcm}{ppm}$ (MEASURED)

Performed By L. J. Curlman
Surry Test Engineer

Evaluated By D W Lindsey
NFO Startup Engineer

Approved: J A Stall
SURV ENG SVCS. SURRY POWER STATION

Recommended for Approval by C J Lowe
for NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference	Test Description: Rod Worth Measurement - D, C, B, A In Overlap Procedure Number / Section: PT28.11/App. E		Sequence Step Number: 21
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: Moving CB : Moving CC : Moving CD: Moving P/L : 228 RCCA: NA		RCS Temperature (°F): 547±2 Power Level (% F.P.): 0 Other (specify): Below Nuclear Heating
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: MOVING CB: MOVING CC: MOVING CD: MOVING P/L: 226 RCCA: N/A		RCS Temperature (°F): ~546 Power Level (% F.P.): 0 Other (specify): BELOW NUCLEAR HEATING
	Date/Time Test Performed: 7/8/78 - 7/9/78 1915 - 0005		
IV Test Results	Measured Parameter (description)	I_{DCBA} ; Integral Worth of Control Bank - D,C,B,A In Overlap	
	Measured Value	5577 pcm	
	Design Value (Actual Conditions)	5526 ± 553 pcm	
	Design Value (Design Conditions)	5526 ± 553 pcm (From A at 0 steps to D at 228 steps)	
	Reference	VEP-FRD-NFE 74	
V Acceptance Criteria	Accident Analysis Value	If Design Acceptance Criterion is exceeded, then assure adequate shutdown margin and/or evaluate other accidents, as necessary.	
	Reference	Letter from C. M. Stallings (Vepco) to E. G. Case (NRC) dated May 11, 1978 (Serial No. 272	
VI Comments	Design Tolerance is met : ☒ YES ☐ NO Acceptance Criteria is met: ☒ YES ☐ NO		

Performed By: L. J. Curfman
Surry Test Engineer

Evaluated By: [signature]
NFO Startup Engineer

Recommended for Approval by: D. W. Lippard for/ NFO Supervisor

Approved: [signature]
SUPT ENG SVCS. SURRY POWER STATION.

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: HZP Boron Worth Coefficient

Procedure Number / Section: NA

Sequence Step Number: NA

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: Moving
CB: Moving CC: Moving CD: Moving
P/L: 228 RCCA: NA

RCS Temperature (°F): 547 $^{+0}_{-4}$
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: Moving
CB: Moving CC: Moving CD: Moving
P/L: 228 RCCA: N/A

RCS Temperature (°F): ~547
Power Level (% F.P.): 0
Other (specify):
Below Nuclear Heating

Date/Time Test Performed: 7/6/78 - 7/8/78

IV Test Results

Measured Parameter (description)	$(\frac{\delta\rho}{\delta C_B})$, Boron Worth Coefficient
Measured Value	$(\frac{\delta\rho}{\delta C_B}) = -8.94$ pcm/ppm
Design Value (Actual Conditions)	$(\frac{\delta\rho}{\delta C_B}) = -9.19 \pm 0.92$ pcm/ppm
Design Value (Design Conditions)	$(\frac{\delta\rho}{\delta C_B}) = -9.19 \pm 0.92$ $\frac{\text{pcm}}{\text{ppm}}$
Reference	VEP-FRD-NFE 74

V Acceptance Criteria

Accident Analysis Value	$\left(\frac{\delta\rho}{\delta C_B}\right) \times C_B \leq 15{,}115$ pcm
Reference	FSAR Section 14.2.5

VI Comments

Design Tolerance is met : ☒ YES ☐ NO
Acceptance Criteria is met: ☒ YES ☐ NO

Performed By L. J. Curlman
Surry Test Engineer

Evaluated By T. A. Peacock
NFO/Startup Engineer

Approved: J. A. Hosmer
SUPT ENG SVCS SURRY POWER STATION.

Recommended for Approval by D. W. Lewis for
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - At Power, NI Calib., $\bar{R}$ Data Map 51-5-4

Procedure Number / Section: PT28.2, OP-57 Sequence Step Number: 24

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: Above
P/L: 228 RCCA: N/A Insertion Limits

RCS Temperature (°F): Oper. Temp.
Power Level (% F.P.): ~40
Other (specify):
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 200
P/L: 226 RCCA: NA

RCS Temperature (°F): OPER. TEMP.
Power Level (% F.P.): 50
Other (specify):
43 THIMBLES

Date/Time Test Performed: 7/9/78 1648-1803

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. $\frac{M-P}{P}$ DIFF.	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	%DIFF = -3.7 P_{H1} = 0.77	1.442 P-10 (ML)	1.944 P-10 ML	1.0022
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_i \geq .9$ ±15% for $P_i < .9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H} = 1.55(1+.2(1-P))xT(EOL)$	$F^T_Q(Z) = \frac{1.94}{P} \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{ROD}$ AND $F^N_{\Delta H}|^{LOCA}_{ASSY}$ WERE WITHIN THEIR TECHNICAL SPECIFICATIONS LIMITS

Performed By L. J. Cushman
Surry Test Engineer

Evaluated By T K Potts
NFO Startup Engineer

Approved: J A Hayes
SUPV. ENG SVCS. SURRY POWER STATION.

Recommended for Approval by for D W Lipscomb
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - At Power, NI Calib., $\bar{R}$ Data Map S1-5-5

Procedure Number / Section: PT28.2, OP-57 Sequence Step Number: 25

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB : 228	CC : 228	CD: Above
P/L: 228	RCCA: N/A	Insertion Limits

RCS Temperature (°F): Oper. Temp.
Power Level (% F.P.): ~ 50
Other (specify):
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 228	CC: 228	CD: 185
P/L: 226	RCCA: N/A	

RCS Temperature (°F): OPER. TEMP.
Power Level (% F.P.): 50
Other (specify):
43 THIMBLES

Date/Time Test Performed: 7/9/78 1920-2028

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. % DIFF. $\left(\frac{M-P}{P}\right)$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	$\%_{DIFF} = 3.2$ $P_{A9} = 0.45$	1.434 P10 (ML)	2.037 P10 (ML)	1.0043
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_i \geq .9$ ±15% for $P_i < .9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H} = 1.55(1+.2(1-P))RT(BU)$	$F^T_Q(Z) = \frac{1.94}{P} \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{ROD}$ AND $F^N_{\Delta H}|^{LOCA}_{ASSY}$ WERE WITHIN THEIR TECHNICAL SPECIFICATIONS LIMITS.

Performed By L. J. Guerman
Surry Test Engineer

Evaluated By C. J. Snow
NFO Startup Engineer

Approved: J. A. Stall
SURRY ENG SVCS. SURRY POWER STATION.

Recommended for Approval by for/ D. W. Lewis
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - At Power, NI Calib., $\bar{R}$ Data Map S1-5-6

Procedure Number / Section: PT28.2, OP-57 Sequence Step Number: 26

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB : 228 CC : 228 CD: Above
P/L: 228 RCCA: N/A Insertion Limits

RCS Temperature (°F): Oper. Temp.
Power Level (% F.P.): ~60
Other (specify):
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 161/162
P/L: 226 RCCA: N/A

RCS Temperature (°F): Oper. Temp
Power Level (% F.P.): 57
Other (specify):
43 Thimbles

Date/Time Test Performed: 7/10/78 0129-0251

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. % DIFF. $\left(\frac{M-P}{P}\right)$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	%diff = 4.9 P_{BS} = 0.44	1.465 K-14 (RL)	2.163 K-14 (LM)	1.0065
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_i \geq .9$ ±15% for $P_i < .9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H}$=1.55(1+.2(1-P))xT(BU)	$F^T_Q(Z) = \frac{1.94}{P} \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{ROD}$ and $F^N_{\Delta H}|^{LOCA}_{ASSY}$ were within their Technical Specifications limits.

Performed By L. J. Curtman
Surry Test Engineer

Evaluated By T K Rao
NFO Startup Engineer

Approved: J A Stall
SURV ENG SUPS. SURRY POWER STATION.

Recommended for Approval by
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - At Power, NI Calib., $\bar{R}$ Data Map 51-5-7

Procedure Number / Section: PT28.2, OP-57 Sequence Step Number: 27

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB : 228 CC : 228 CD: Above
P/L: 228 RCCA: N/A Insertion Limits

RCS Temperature (°F): Oper. Temp.
Power Level (% F.P.): ~70
Other (specify):
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 196
P/L: 226 RCCA: N/A

RCS Temperature (°F): OPER TEMP.
Power Level (% F.P.): 67%
Other (specify):
40 THIMBLES

Date/Time Test Performed: 7/10/78 0940-1220

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. % DIFF. $\left(\frac{M-P}{P}\right)$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR
Measured Value	%DIFF = 7.2 P_{E5} = 0.45	1.430 P-10 (LK)	1.901 P-10 (LK)	1.0043
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_i \geq .9$ ±15% for $P_i < .9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H} = 1.55(1+.2(1-P))$ xT(BU)	$F^T_Q(Z) = \frac{2.94}{P} \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{ROD}$ AND $F^N_{\Delta H}|^{LOCA}_{ASSY}$ WERE WITHIN TIER TECHNICAL SPECIFICATIONS LIMITS.

Performed By L. J. Gurlman
Surry Test Engineer

Evaluated By C. J. Sawyer
NFO Startup Engineer

Approved: J. H. Holloway
SURV ENG SUPS. SURRY POWER STATION.

Recommended for Approval by
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - At Power, NI Calib., $\bar{R}$ Data Map 51-5-8

Procedure Number / Section: PT28.2, OP-57 Sequence Step Number: 29

II Test Conditions (Design)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: Above
P/L: 228 RCCA: N/A Insertion Limits

RCS Temperature (°F): Oper. Temp.
Power Level (% F.P.): ~80
Other (specify):
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)

SDA: 228 SDB: 228 CA: 228
CB: 228 CC: 228 CD: 218
P/L: 226 RCCA: N/A

RCS Temperature (°F): OPER. TEMP.
Power Level (% F.P.): 98
Other (specify):
41 THIMBLES

Date/Time Test Performed: 7/10/78 1846 - 2108

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. % DIFF. $\left(\frac{M-P}{P}\right)$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	% DIFF = 3.6 P_{A9} = 0.46	1.408 D-10 (LK)	1.798 D-10 (LK)	1.0073
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_i \geq .9$ ±15% for $P_i < .9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H} = 1.55(1+.2(1-P))$ RTP(BU)	$F^T_Q(Z) = \frac{1.94}{P} \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{RCD}$ AND $F^N_{\Delta H}|^{LOCA}_{ASSY}$ WERE WITHIN THEIR TECHNICAL SPECIFICATIONS LIMITS.

Preliminary $P_{THRESHOLD}$ = 98%

Performed By L. J. Curtman
Surry Test Engineer

Evaluated By T K Rudd
NFO Startup Engineer

Approved: J Hayes
SURV ENG SUPV. SURRY POWER STATION.

Recommended for Approval by
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

51-5-4

I Reference

Test Description: M/D Flux Map - At Power, NI Calib, $\bar{R}$ Data, $P_{Thres.}$ Deter. Map

Procedure Number / Section: PT28.2, OP-57 Sequence Step Number: 30

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB : 228	CC : 228	CD: Above
P/L: 228	RCCA: N/A	Insertion Limits

RCS Temperature (°F): Oper. Temp.
Power Level (% F.P.): ~90
Other (specify):
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 228	CC: 228	CD: 224
P/L: 226	RCCA: N/A	

RCS Temperature (°F): OPER. TEMP.
Power Level (% F.P.): 98
Other (specify):
40 THIMBLES

Date/Time Test Performed: 7/11/78 0530-0747

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. % DIFF. $\left(\frac{M-P}{P}\right)$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR
Measured Value	% DIFF = 4.7 P_{B5} = 0.43	1.415 K-14 (KL)	1.841 K-14 (KL)	1.0068
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_1 \geq .9$ ±15% for $P_1 < .9$ (P_1 = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	NONE

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H}$=1.55(1+.2(1-P))xT(BU)	$F^T_Q(Z) = \frac{1.94}{P} \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|^{LOCA}_{ROD}$ AND $F^N_{\Delta H}|^{LOCA}_{ASSY}$ WERE WITHIN THEIR TECHNICAL SPECIFICATIONS LIMITS

$P_{THRESHOLD}$ = 98%

Performed By L. J. Gutman
Surry Test Engineer

Approved: H. F. Johnson
Surry Power Sta

Evaluated By T. M. Huntington
NFO Startup Engineer

Recommended for Approval by
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 5 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference

Test Description: M/D Flux Map - HFP, ARO, Eq. Xe. Map — 51-5-10

Procedure Number / Section: PT28.2, OP-57 — Sequence Step Number: 34

II Test Conditions (Design)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB : 228	CC : 228	CD: Above Insertion Limits
P/L: 228	RCCA: N/A	

RCS Temperature (°F): 566±2°F
Power Level (% F.P.): 100
Other (specify): Equil. Xenon
Must have ≥ 40 thimbles

III Test Conditions (Actual)

Bank Positions (steps)		
SDA: 228	SDB: 228	CA: 228
CB: 228	CC: 228	CD: 221
P/L: 226	RCCA: N/A	

RCS Temperature (°F): OPER. TEMP.
Power Level (% F.P.): 99.5
Other (specify): EQ. XENON
42 THIMBLES

Date/Time Test Performed: 7/13/78 0911-1121

IV Test Results

Measured Parameter (description)	MAX. REL. ASSY PWR. % DIFF. $\left(\frac{M-P}{P}\right)$	$F^N_{\Delta H}$, NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR	F^T_Q, TOTAL HEAT FLUX HOT CHANNEL FACTOR	QUADRANT POWER TILT RATIO (QPTR)
Measured Value	% DIFF = 4.8 $P_{D3} = 0.45$	1.416 K-14 KL	1.838 K-14 KL	1.0065
Design Value (Actual Conditions)	NA	NA	NA	≤ 1.02
Design Value (Design Conditions)	±10% for $P_i \geq .9$ ±15% for $P_i < .9$ (P_i = Assy. Pwr.)	NA	NA	≤ 1.02
Reference	WCAP-7905 Rev. 1	NONE	NONE	

V Acceptance Criteria

Accident Analysis Value	None	$F^N_{\Delta H} = 1.55(1+.2(1-P))xT(BU)$	$F^T_Q(Z) = \frac{1.94}{P} \times K(Z)$	≤ 1.02
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

$F^N_{\Delta H}|_{ROD}$ AND $F^N_{\Delta H}|_{ASSY}$ WERE WITHIN THEIR TECHNICAL SPECIFICATIONS LIMITS.

Performed By L. J. Curtman
Surry Test Engineer

Approved K. Fisher
Surry Power Sta.

Evaluated By
NFO Startup Engineer

Recommended for Approval by
NFO Supervisor

SURRY POWER STATION UNIT 1 CYCLE 4 STARTUP

STARTUP PHYSICS TESTS RESULTS AND EVALUATION SHEET

FINAL RESULTS

I Reference	Test Description: Power Coefficient Measurement Procedure Number / Section: PT 28.12		Sequence Step Number: 32
II Test Conditions (Design)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: Moving* P/L: 228 RCCA: NA		RCS Temperature (°F): Oper. Temp. Power Level (% F.P.): ~95% Other (specify): Equil. Xenon * Above Insertion Limits
III Test Conditions (Actual)	Bank Positions (steps) SDA: 228 SDB: 228 CA: 228 CB: 228 CC: 228 CD: 187-225 P/L: 228 RCCA: NA		RCS Temperature (°F): Oper. Temp. Power Level (% F.P.): 100.0-90.1 Other (specify): Burnup=1075 MWD/MTU
	Date/Time Test Performed: 8/10/78 2312-2352		
IV Test Results	Measured Parameter (description)	$(\delta\rho/\delta P)$, Differential Power Coefficient	
	Measured Value	$-10.5 \pm 3.2 \frac{pcm}{\%P}$	
	Design Value (Actual Conditions)	$-10.6 \frac{pcm}{\%P}$ (C_B = 805 ppm, P=95%)	
	Design Value (Design Conditions)	$-10.5 \frac{pcm}{\%P} \pm (.3 \times (\delta\rho/\delta P)^M)$ (C_B=825 ppm, P= 95%)	
	Reference	Letter from R. T. Meyer (Westinghouse) to W. R. Hostetler dated March 30, 1978 (PP-VP-573) and WCAP-9372.	
V Acceptance Criteria	Accident Analysis Value	NA	
	Reference	NA	
VI Comments	Design Tolerance is met : ☒ YES ☐ NO Acceptance Criteria is met: ☒ YES ☐ NO		

Performed by: [signature] Surry Test Engineer

Evaluated By: T K Ross [signature] NFO Startup Engineer

Recommended for Approval: [signature]

Recommended for Approval by: [signature] Supervisor

ACKNOWLEDGEMENTS

The authors would like to acknowledge the cooperation of the Surry Power Station personnel in performing the tests documented in this report. Special thanks is due Messrs. L. A. Johnson, L. J. Curfman, J. I. Kelly, P. L. Davis, III, and R. H. Blount.

The authors would like also to express gratitude to Mr. D. W. Lippard, Dr. E. J. Lozito, and Mr. L. M. Girvin for their aid and guidance in preparing this report. We would like to thank Ms. C. E. Bullock for her patience and accurate typing of the entire report.