INDIAN POINT UNIT 2
CYCLE 13 STARTUP TEST REPORT

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
INDIAN POINT UNIT NO. 2

August, 1995

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ABSTRACT

This report summarizes the results of the core loading and startup physics test program. Results of these activities verify the Cycle 13 nuclear design calculations and demonstrate adequate conservatism in core performance with respect to the Indian Point Unit 2 FSAR, Technical Specifications and the Cycle 13 Reload Safety Evaluation. Cycle 13 achieved initial criticality on May 21, 1995.

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1.0 INTRODUCTION

This report summarizes the results of the Indian Point Unit No. 2 Cycle 13 startup physics test program. The Cycle 13 startup physics tests program consisted of a series of tests performed at various stages, including prior to initial criticality, at hot zero power (HZP), and during power ascension. Table 1.0-1 provides a chronological listing of these tests as well as core refueling operations.

The objectives of these tests were: (a) to demonstrate that during reactor operation the measured core physics parameters would be within the assumptions of the FSAR accident analyses (Reference 1) and within the limitations of the plant Technical Specifications (Reference 2), and the Cycle 13 reload safety evaluation (Reference 3); (b) to verify the nuclear design calculations (Reference 4); and (c) to provide the bases for calibration of the reactor core instrumentation. Section 2 of this report gives a brief description of the reactor core and the Cycle 13 loading. Reactor instrumentation calibration tests are discussed in Section 3. In Section 4 the results of the HZP physics tests are presented. Section 5 presents the Reactor Coolant System Flow determination results. Section 6 covers the incore power distribution measurements taken at different power levels from 30% to 100% power. The conclusions of this report are given in Section 7. Section 8 lists the references cited in this report.

Table 1.0-1

Indian Point Unit No. 2 Cycle 13
Refueling and Startup Events in Chronological Order

DATE	TIME	ACTIVITY
02-04-95	0001	Plant shutdown for refueling (End of Cycle 12)
02-15-95	1008	Core unload started
02-20-95	0514	Core unload completed
02-23-95	1458	RCCA inspection started
03-02-95	1024	RCCA inspection completed
03-08-95	1515	SFP insert changeout started
03-10-95	1201	SFP insert changeout completed
03-20-95	2157	Fuel sipping started
03-25-95	1430	Ultrasonic testing fuel inspection started
03-25-95	1730	Ultrasonic testing fuel inspection completed
03-28-95	0940	Fuel Reconstitution started
03-30-95	1110	Fuel sipping completed
03-31-95	0853	Fuel Reconstitution completed
04-05-95	0955	Final insert changeout for core redesign completed
04-07-95	1829	Core reload started
04-10-95	0750	Core reload completed
04-10-95	1400	Core mapping completed
05-19-95	0200	RTD calibration test completed
05-19-95	0430	RCS flow trip setpoint determination completed
05-20-95	2114	HZP physics testing initiated & reactor trip breaker function verified
05-21-95	1245	NIS base count and control rod withdrawal completed
	1528	NIS base count and boron dilution to criticality completed
	1528	Initial criticality achieved
	1639	Boron mix completed

Table 1.0-1 (cont'd)

DATE	TIME	ACTIVITY
	1655	Test range determination completed
	1835	Reactivity computer checkout and ARO Boron Endpoint completed
	2115	ARO isothermal temperature coefficient completed
	2315	D-Bank worth measurement completed
05-22-95	0041	C-Bank worth measurement completed
	0218	B-Bank worth measurement completed
	0530	A-Bank worth measurement completed
	0611	Boron adjustment completed
	0620	All control banks in boron end point completed
	0704	All control banks in isothermal temperature coefficient completed
	0805	Rod bank overlap unit reset
	1028	Rods borated to normal startup configuration
	1110	Reactivity computer disconnected and HZP physics testing completed
06-06-95	0550	Unit initially synchonized to bus
06-09-95		30% flux map performed
06-11-95		Reactor coolant temperature measurements
06-18-95		65% flux map performed
06-20-95		Incore-Excore data collection completed
07-02-95		Reactor coolant flow measurement
07-02-95		Plant achieved 100% power
07-13-95		100% flux map performed

2.0 REACTOR CORE DESCRIPTION

Starting with Cycle 6, Indian Point Unit No. 2 has utilized a low leakage loading pattern core design. This design involves placing previously burned fuel at selected locations on the core periphery to decrease neutron flux close to the core periphery. This causes reduced leakage of neutrons from the core, resulting in lower irradiation of the reactor vessel.

During the Cycle 12/13 outage, the Indian Point Unit 2 core was refueled with a Westinghouse VANTAGE+ (V+) fuel assembly region (Region 15). The V+ fuel assembly utilizes ZIRLO cladding instead of Zircaloy. The V+ fuel also includes three Intermediate Flow Mixer grids (IFMs), low pressure drop grids, and enriched axial blanket pellets. In addition, Region 15 fuel assemblies incorporate a keyless/cuspless top nozzle assembly, modified Debris Filter Bottom Nozzle (DFBN), repositioned fuel rods, and enriched Integral Fuel Burnable Absorbers (IFBAs) with 1.5 x B-10 loading. The safety input of these changes has been addressed in Reference 3.

2.1 Loading Pattern and Assembly Burnup

The Cycle 13 core consists of 9 Region 12, 17 Region 13, 87 Region 14, and 80 Region 15 assemblies. The initial enrichment of fresh fuel and assembly burnups of reloaded assemblies at the beginning of Cycle 13 (0 MWD/MTU) are shown in Figure 2.1-1.

2.2 Location of Secondary Sources and Burnable Poisons

Cycle 13 core contains 4 assemblies with secondary neutron source rods. The secondary sources are used to provide a minimum count rate to monitor reactor status during reactor refueling, periods of shutdown and startup operations. These sources were placed in core locations H-3, N-8, H-13 and C-8. An additional secondary source (SS-13) with an improved design is currently stored at the site and acts as a spare.

Fresh WABAs (Wet Annular Burnable Absorbers) and IFBAs (Integrated Fuel Burnable Absorbers) were loaded into the Cycle 13 core for power shaping and reactor coolant boron concentration reduction to ensure a non-positive moderator temperature coefficient. There are 12 fuel assemblies containing 4 WABA rods per assembly, 24 assemblies containing 8 WABA rods per assembly, and 16 assemblies containing 12 WABA rods per assembly , comprising a total of 432 fresh WABA rods. There are 12 fuel assemblies containing 48 IFBA rods per assembly, 16 assemblies containing 100 IFBA rods per assembly, 12 assemblies containing 116 IFBA rods per assembly, and 40 assemblies containing 148 IFBA rods per assembly comprising a total of 9488 IFBA rods. The core locations of the secondary sources, IFBAs , and WABAs are shown in Figure 2.2-1.

2.3 Control Rod Locations

There are 4 banks of control rods and 4 banks of shutdown rods totaling 53 full-length rod cluster control assemblies at core locations as shown in Figure 2.3-1. During the Cycle 12/13 refueling outage 25 RCCAs were replaced in Control Banks B, C, D and Shutdown Bank SD.

2.4 Incore Instrumentation

The incore instrumentation design consists of 65 fuel assembly outlet thermocouples and six movable detectors which can be inserted in 50 instrumentation guide tube thimble locations as shown in Figure 2.4-1.

2.5 Verification of Core Loading

After the reactor core was loaded, core mapping was performed using an underwater television camera, monitors and video taping equipment. This core mapping operation verified that the core was correctly loaded. Core mapping was jointly performed by licensee's Reactor Engineering organization and Westinghouse. Licensee's Fuel Engineering group later performed an independent review of the video tape and found the core loading to be as prescribed.

The core mapping operation as well as the independent review included a comparison of the identification numbers on the fuel assemblies and their inserts, insert configuration and fuel assembly insertion orientation against the design

configuration as shown in Figure 2.5-1. A specific review of the loaded core included verification of proper fuel assembly alignment to preclude improper alignment of upper internals with fuel that might occur due to misaligned fuel.

FIGURE 2.1-1
CYCLE 13 ENRICHMENT AND ASSEMBLY BURNUPS AT 0 MWD/MTU

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
				13A 29556	14C 26877	14B 25587	12B 14208	14B 25647	14C 26955	12A 34703					R
		13B 33641	13B 22675	15A 0	15A 0	15A 0	14B 14587	15A 0	15A 0	15A 0	14C 26117	13A 29216			P
	13B 41865	15A 0	15B 0	14A 16086	15A 0	14C 24933	15A 0	14C 24881	15A 0	14A 15952	15B 0	15A 0	13B 32994		N
	14C 26125	15B 0	14A 24695	15A 0	14C 23810	14C 27116	14A 24987	14C 27189	14C 23747	15A 0	14A 24719	15B 0	12A 17050		M
13B 33689	15A 0	14A 16043	15A 0	14C 21714	15A 0	14C 25792	15B 0	14C 25859	15A 0	14C 21732	15A 0	14A 15972	15A 0	13B 33420	L
14C 26733	15A 0	15A 0	14C 23870	15A 0	14D 24535	15A 0	14D 25116	15A 0	14D 24503	15A 0	14C 23662	15A 0	15A 0	14C 26984	K
14B 25588	15A 0	14C 25005	14C 27051	14C 25785	15A 0	14D 24591	15A 0	14D 24646	15A 0	14C 25822	14C 27227	14C 24949	15A 0	13B 32783	J
12B 15444	14B 14530	15A 0	14A 24974	15B 0	14D 25045	15A 0	13A 29222	15A 0	14D 25132	15B 0	14A 24912	15A 0	14B 14509	12B 15582	H
14B 25597	15A 0	14C 25005	14C 27205	14C 25953	15A 0	14D 24686	15A 0	14D 24620	15A 0	14C 25874	14C 27226	14C 24916	15A 0	14B 25533	G
14C 26849	15A 0	15A 0	14C 23699	15A 0	14D 24559	15A 0	14D 25082	15A 0	14D 24532	15A 0	14C 23830	15A 0	15A 0	14C 26841	F
13A 29635	15A 0	14A 16018	15A 0	14C 21796	15A 0	14C 25943	15B 0	14C 25866	15A 0	14C 21745	15A 0	14A 15965	15A 0	13A 29459	E
	12A 17126	15B 0	14A 24776	15A 0	14C 23708	14C 27283	14A 24915	14C 27225	14C 23677	15A 0	14A 24799	15B 0	14C 26016		D
	12A 27296	15A 0	15B 0	14A 15979	15A 0	14C 25002	15A 0	14C 24949	15A 0	14A 16034	15B 0	15A 0	13B 33111		C
		13A 29596	14C 26071	15A 0	15A 0	15A 0	14B 14525	15A 0	15A 0	15A 0	12A 17308	13B 33454			B
				13A 29419	14C 26820	14B 25529	12B 15721	14B 25610	14C 26915	13A 29587				REG BU	A

REGION	12A	12B	13A	13B	14A	14B	14C	14D	15A	15B
ENRICHMENT (w/o)	3.608	4.208	3.757	4.056	3.757	4.202	4.593	3.610	4.399	4.794
NUMBER OF ASSEMBLIES	5	4	8	9	16	11	48	12	68	12

Note: Burnups in MWD/MTU
Enrichments are as-built

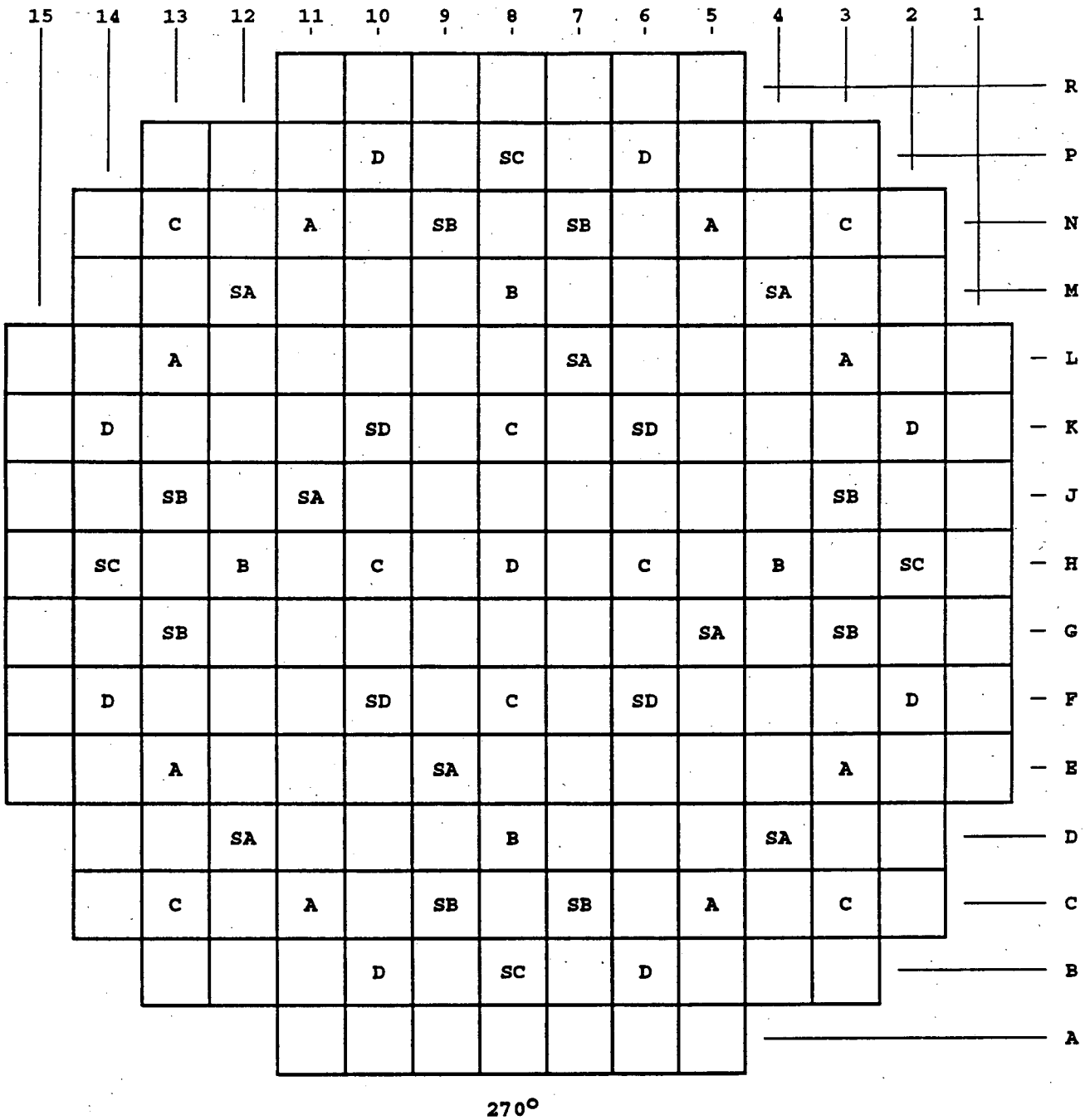
FIGURE 2.2-1
CYCLE 13 BURNABLE POISONS AND SECONDARY SOURCES

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
																R
					48/0	100/0	100/12		100/12	100/0	48/0					P
			48/0	116/4		148/12		148/0 4		148/12		116/4	48/0			N
			116/4		148/8						148/8		116/4			M
		48/0		148/8		148/8		116/4		148/8		148/8		48/0		L
		100/0	148/12		148/8		148/8		148/8		148/8		148/12	100/0		K
		100/12				148/8		148/0		148/8				100/12		J
			148/0 4		116/4		148/0		148/0		116/4		148/0 4			H
		100/12				148/8		148/0		148/8				100/12		G
		100/0	148/12		148/8		148/8		148/8		148/8		148/12	100/0		F
		48/0		148/8		148/8		116/4		148/8		148/8		48/0		E
			116/4		148/8						148/8		116/4			D
			48/0	116/4		148/12		148/0 4		148/12		116/4	48/0			C
					48/0	100/0	100/12		100/12	100/0	48/0					B
															I/W SS	A

TYPE	Total
Number of IFBA rods I	9488
Number od WABA rods W	432
Number of Secondary Sources rodlets SS	16

FIGURE 2.3-1

Control and Shutdown Rod Locations



BANK IDENTIFIER	NUMBER OF LOCATIONS	BANK IDENTIFIER	NUMBER OF LOCATIONS
A	8	SA	8
B *	4	SB	8
C *	8	SC	4
D *	9	SD *	4

* Indicates banks which have new RCCAs.

FIGURE 2.4-1

Movable Detector, Thermocouple and Flow Mixing Device Locations

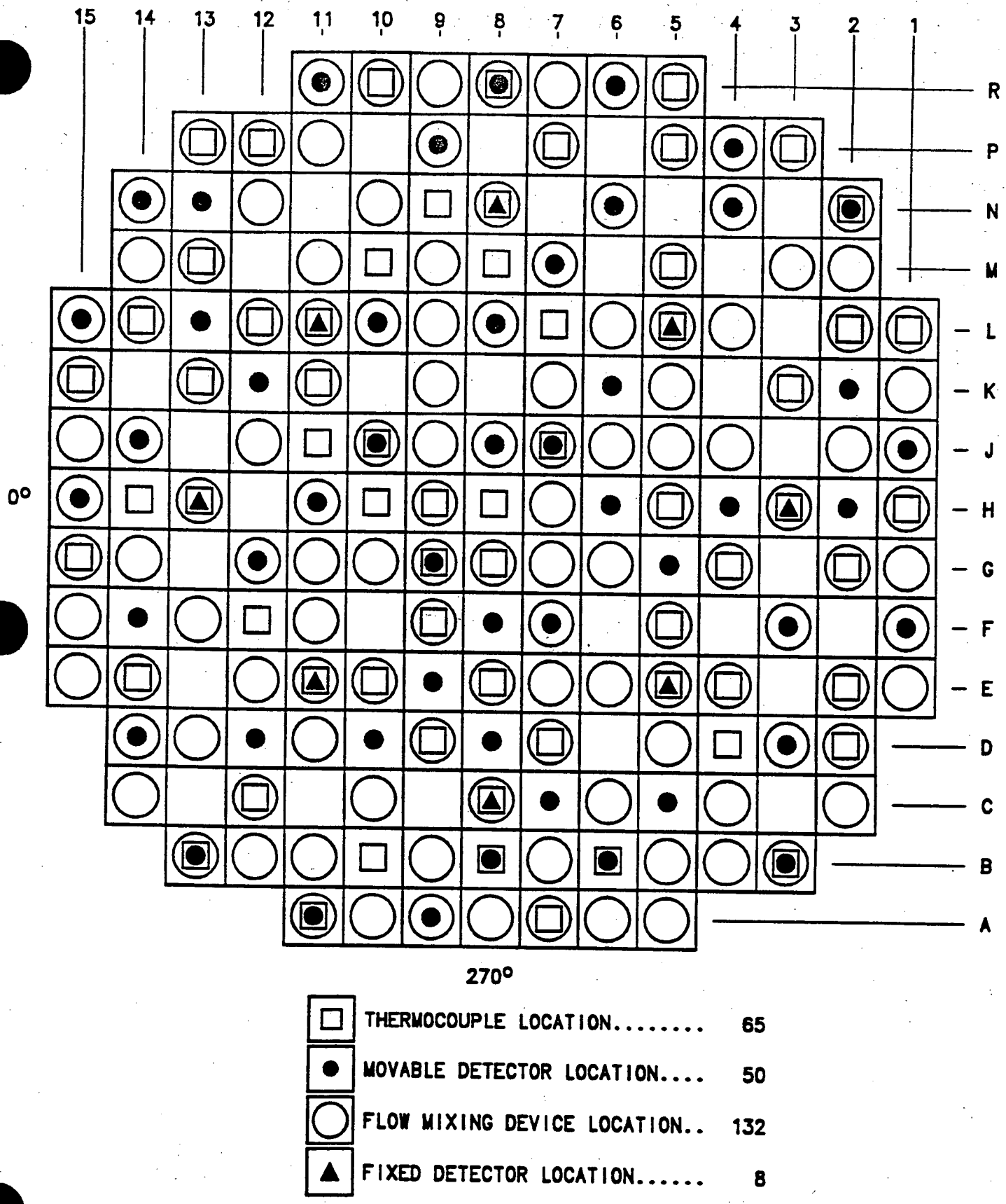


FIGURE 2.5-1
CYCLE 13 LOADING PATTERN

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
				13A N-21	14C P-13	14B P-06	12B M-67	14B P-09	14C P-27	12A M-17					R
		13B N-38	13B N-39	15A Q-02	15A Q-15	15A Q-18	14B P-02	15A Q-20	15A Q-26	15A Q-04	14C P-45	13A N-22			P
	13B N-48	15A Q-05	15B Q-70	14A N-14	15A Q-31	14C P-60	15A Q-43	14C P-43	15A Q-46	14A N-08	15B Q-72	15A Q-10	13B N-54		N
	14C P-40	15B Q-73	14A N-10	15A Q-56	14C P-38	14C P-42	14A N-02	14C P-37	14C P-24	15A Q-57	14A N-12	15B Q-78	12A M-06		M
13B N-40	15A Q-11	14A N-01	15A Q-30	14C P-48	15A Q-65	14C P-41	15B Q-79	14C P-39	15A Q-36	14C P-20	15A Q-51	14A N-13	15A Q-01	13B N-62	L
14C P-51	15A Q-27	15A Q-52	14C P-53	15A Q-48	14D P-64	15A Q-49	14D P-67	15A Q-42	14D P-71	15A Q-45	14C P-28	15A Q-29	15A Q-14	14C P-44	K
14B P-08	15A Q-28	14C P-29	14C P-31	14C P-14	15A Q-55	14D P-70	15A Q-41	14D P-65	15A Q-38	14C P-57	14C P-22	14C P-32	15A Q-16	13B N-37	J
12B M-45	14B P-01	15A Q-62	14A N-04	15B Q-69	14D P-72	15A Q-60	13A N-24	15A Q-54	14D P-61	15B Q-80	14A N-11	15A Q-68	14B P-12	12B M-64	H
14B P-11	15A Q-23	14C P-56	14C P-35	14C P-33	15A Q-53	14D P-69	15A Q-50	14D P-68	15A Q-59	14C P-23	14C P-16	14C P-36	15A Q-24	14B P-10	G
14C P-19	15A Q-21	15A Q-37	14C P-58	15A Q-64	14D P-63	15A Q-35	14D P-62	15A Q-44	14D P-66	15A Q-58	14C P-49	15A Q-47	15A Q-22	14C P-30	F
13A N-17	15A Q-12	14A N-03	15A Q-61	14C P-34	15A Q-63	14C P-17	15B Q-71	14C P-26	15A Q-67	14C P-47	15A Q-32	14A N-06	15A Q-03	13A N-19	E
	12A M-12	15B Q-76	14A N-16	15A Q-66	14C P-15	14C P-25	14A N-09	14C P-18	14C P-46	15A Q-33	14A N-15	15B Q-77	14C P-50		D
	12A M-04	15A Q-08	15B Q-74	14A N-07	15A Q-39	14C P-21	15A Q-34	14C P-55	15A Q-40	14A N-05	15B Q-75	15A Q-09	13B N-53		C
		13A N-18	14C P-54	15A Q-06	15A Q-17	15A Q-19	14B P-07	15A Q-13	15A Q-25	15A Q-07	12A M-11	13B N-77			B
				13A N-23	14C P-52	14B P-05	12B M-61	14B P-04	14C P-59	13A N-20				REG ID	A

3.0 INSTRUMENT CALIBRATION

3.1 Reactor Coolant Loop Flow Setpoint Determination

The Technical Specifications (Reference 2) require that the low reactor coolant loop flow trip setpoint be set at or above 92% of nominal indicated loop flow. On May 19, 1995, prior to achieving initial criticality, the elbow tap transducer output and reactor coolant cold leg temperature data were collected when all four reactor coolant pumps were operating. Elbow tap transducer output for zero flow had been previously obtained. From this data, the values shown in Table 3.1-1 corresponding to 93% of nominal indicated loop flow were determined. These values are corrected to normal cold leg temperature at full power. The 93% values are used to set the trip bistables.

3.2 Incore T/C and Wide/Narrow Range RTD Calibration

During the Reactor Coolant System heatup, electrical resistance of RCS hot and cold leg Resistance Temperature Detectors (RTDs) including spares, corrected for their lead wire resistance, core exit thermocouple outputs and wide range hot and cold leg RTD outputs, were monitored at approximately 40°F intervals from 390°F to 525°F. RTD resistances were converted into temperature using a conversion equation and factory supplied parameters for each RTD, and were compared to a best estimate temperature derived from a linear regression method based on all measured RTD data. Operable RTDs were then selected for use in the protection and process circuits. Table 3.2-1 shows the correction factors of each RTD over 390°F to 525°F temperature range. The RTDs normalized resistance values are presented in Table 3.2-2.

The adjustment factors for the Wide Range RTDs were calculated using measured time and instrumentation voltage output, and are presented in Table 3.2-3. The Ohmic values for the Wide Range RTDs are calculated and listed in Table 3.2-4.

Incore thermocouples (T/Cs) which are distributed throughout the core provide a continuous on-line monitoring of the exit temperature of the fuel assemblies. The thermocouple temperatures, obtained during RCS heatup, were compared to the best estimate temperature derived from the RTD calibration. Based on this comparison, correction factors for each thermocouple at the highest test temperature are then calculated for use in the thermocouple temperature adjustment, e.g., in the INCORE code. The T/C correction factors are presented in Table 3.2-3.

3.3 Overpower and Overtemperature Delta-T Setpoints

Reactor coolant loop Delta-T and T-Average final measurements were performed at approximately 89% of full power. Individual Loop Delta-T and T-Average measurements were obtained from the instrument racks and were converted into Degrees °F. The full power T-Average (T") values, used within the overpower and overtemperature Delta-T trip setpoints, were then obtained via extrapolation from 89% power. Table 3.3-1 lists the full power Delta-T and T-Average values for overpower and overtemperature setpoints on each loop. It should be noted that RCS loop to loop differences in measured full power Delta-T are expected and result from temperature stratification and RTD configuration differences.

3.4 Excore-Incore Calibration

An excore detector calibration using movable incore detectors was performed at approximately 65% of full power. A range of axial off-sets was obtained via an axial xenon oscillation induced by rod insertion and subsequent withdrawal following xenon buildup in the upper portion of the core (see Figure 3.4-1). The test was performed so as not to exceed the administrative limits of flux difference on more than one excore channel (See Figure 3.4-2). A full core map was taken at the equilibrium condition prior to the onset of the oscillation.

During rod insertion and the subsequent oscillations, quarter core (partial) maps were taken at various axial offsets. The full power total excore detector currents were extrapolated from data obtained during operation at 65% power.

A least square fit was performed with the heat balance data to obtain a value for each detector at 100% power (Table 3.4-1). For each map, the top and bottom detector currents for each detector were normalized to the extrapolated full power current.

Plots of detector current versus the axial offset calculated by the 3-D INCORE code (Reference 5) are given in Figures 3.4-3 through 3.4-6 for each excore detector. A linear least square fit of the 3-D INCORE average axial offset versus the top and bottom detector currents was performed. The results of the least square fit for top and bottom detector current versus axial offset were used to calibrate the Delta Flux instrumentation and associated input to the overtemperature Delta-T setpoints.

3.5 Addressable Constants for the Delta Flux Alarm

The addressable constants (K0551 through K0554) for the PROTEUS computer delta-flux program are calculated for the true axial offset (incore) by using the top and bottom detector currents.

The equation used in the calculation is as follows:

$$K = \frac{I_{OT} \times I_{OB}}{50\ S\ (I_{OT} + I_{OB})}$$

where:

I_{OT} and I_{OB} are the top and bottom full power detector currents at zero axial offset, respectively.

S is the slope of the curve (straight line between current and axial offset).

Table 3.5-1 shows the calculated constants.

Table 3.1-1

Reactor Coolant Loop Flow Bistable Setpoints

RCS Loop	Flow Transducer Number	Measured at Zero Flow (ma)	Nominal Low Flow Bistable Setting 93% of Flow (ma)
21	FT-414	9.85	33.51
	FT-415	9.85	31.06
	FT-416	9.90	32.97
22	FT-424	9.87	33.24
	FT-425	9.95	31.77
	FT-426	9.96	31.77
23	FT-434	9.89	33.75
	FT-435	9.97	32.66
	FT-436	9.82	33.20
24	FT-444	9.88	32.92
	FT-445	10.03	32.24
	FT-446	9.98	32.55

TABLE 3.2-1

Narrow Range RTD Adjustment Factors

RTD No.	Measured Temperature Adjustment Factors											
Temperature (F)	410A	411A	412A	410B	411B	412B	420A	421A	422A	420B	421B	422B
390	0.792	-0.058	0.204	-0.257	-0.860	0.062		0.091	0.516	-0.106	-0.225	-0.128
430	0.807	-0.022	0.248	-0.294	-0.874	0.119		0.009	0.463	-0.119	-0.318	-0.144
465	0.750	-0.005	0.274	-0.310	-0.888	0.155		0.018	0.459	-0.069	-0.355	-0.116
500	0.758	0.015	0.293	-0.311	-0.882	0.203		-0.049	0.399	0.015	-0.361	-0.053
525	0.839	0.018	0.251	-0.357	-0.938	0.194		-0.180	0.300	-0.114	-0.543	-0.177

RTD No.	Measured Temperature Adjustment Factors											
Temperature (F)	430A	431A	432A	430B	431B	432B	440A	441A	442A	440B	441B	442B
390	0.050	0.657	0.032		-0.862	-0.035	-0.257	0.251	-0.173	0.253	-0.138	0.190
430	0.137	0.602	0.059		-0.819	-0.004	-0.278	0.245	-0.225	0.249	-0.142	0.302
465	0.130	0.496	-0.001		-0.885	-0.059	-0.265	0.285	-0.280	0.355	-0.088	0.399
500	0.164	0.391	-0.036		-0.919	-0.070	-0.302	0.332	-0.362	0.360	-0.041	0.456
525	0.276	0.425	0.045		-0.733	0.106	-0.274	0.385	-0.369	0.409	0.005	0.432

TABLE 3.2-2

Narrow Range RTD Normalized Resistance Values

RTD	SERIAL NO.	ALPHA	DELTA	Ro	Rp	Slope	Y-Intercept	510	525	540	555	570	600
						Fit of Adjustment Factors versus Temperature		Normalized Resistance Values F/C					
								265.56	273.89	282.22	290.56	298.89	315.56
410A	N3004	0.00392898	1.46013	200.147	1.997	8.93081E-05	0.747803395	405.5971	411.7300	417.8470	423.9480	430.0331	442.1555
411A	N31581	0.00393427	1.453956	200.004	0	0.000566651	-0.27231792	403.9250	410.0598	416.1788	422.2818	428.3690	440.4959
412A	9398	0.00393307	1.4288	200.174	1.5467	0.000440769	0.050449099	405.7337	411.8801	418.0110	424.1262	430.2259	442.3783
410B	N31651	0.00393188	1.415854	200.082	0	-0.000629128	-0.015223763	404.2351	410.3865	416.5225	422.6429	428.7479	440.9114
411B	4819	0.00393207	1.44844	200.1524	1.7198	-0.000461023	-0.675575597	406.2296	412.3724	418.4994	424.6106	430.7059	442.8490
412B	4836	0.00393249	1.44043	200.0274	1.926	0.001041318	-0.334478827	405.7790	411.9129	418.0312	424.1337	430.2205	442.3471
420A	4810	0.00392973	1.45994	200.1254	1.9707	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
421A	9396	0.00393617	1.45451	200.092	1.6673	-0.001717847	0.771634721	405.9163	412.0705	418.2088	424.3310	430.4374	442.6021
422A	4828	0.00393337	1.43461	199.9694	1.9703	-0.001424276	1.085319754	405.7053	411.8558	417.9906	424.1097	430.2130	442.3726
420B	4814	0.00393157	1.45596	200.0024	2.108	0.000400883	-0.263819264	405.9140	412.0449	418.1600	424.2591	430.3424	442.4612
421B	6275	0.00393435	1.44655	199.9316	2.0421	-0.001945317	0.538513357	406.0433	412.1931	418.3270	424.4450	430.5472	442.7039
422B	4842	0.00393034	1.46439	200.1124	1.9908	2.54704E-05	-0.135220963	405.9517	412.0839	418.2000	424.3002	430.3844	442.5048
430A	6291	0.0039322	1.46519	199.9605	2.2061	0.001372985	-0.482864692	405.8150	411.9373	418.0437	424.1341	430.2085	442.3095
431A	6293	0.00393438	1.45398	200.0635	1.8025	-0.002019056	1.4469482	405.6891	411.8422	417.9793	424.1005	430.2057	442.3683
432A	4838	0.00393229	1.43645	200.1314	1.694	-0.000232137	0.127068275	405.8374	411.9830	418.1129	424.2270	430.3255	442.4753
430B	6285	0.00393506	1.47097	200.1115	1.7418	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
431B	4802	0.0039315	1.45426	199.9044	2.3144	0.000383734	-1.020833862	406.2381	412.3657	418.4775	424.5734	430.6534	442.7658
432B	4848	0.00393173	1.45212	200.1504	1.7617	0.000556945	-0.269633119	405.8579	411.9938	418.1139	424.2181	430.3065	442.4357
440A	4807	0.00393124	1.46167	200.1263	1.8835	-0.00018453	-0.189780547	405.9947	412.1306	418.2506	424.3545	430.4425	442.5705
441A	4804	0.00393327	1.44217	199.7754	2.43	0.001016253	-0.169946977	405.7464	411.8737	417.9852	424.0810	430.1612	442.2743
442A	4808	0.00393241	1.42933	200.0734	1.7769	-0.001562559	0.439836264	405.9841	412.1379	418.2760	424.3985	430.5053	442.6720
440B	N31830	0.00393294	1.446959	200.1762	1.6356	0.001233434	-0.244809159	405.7128	411.8492	417.9697	424.0745	430.1635	442.2942
441B	5665	0.00393505	1.46152	199.9426	2.0595	0.001117606	-0.59700327	405.8926	412.0212	418.1338	424.2305	430.3112	442.4249
442B	9395	0.00393548	1.447232	200.099	1.6571	0.001930518	-0.536065104	405.6828	411.8165	417.9343	424.0365	430.1228	442.2482

TABLE 3.2-3

Wide Range RTD Adjustment Factors

TEST TEMPERATURE = 525

TEMP (B.E.) = a*TIME + 0.34708 b= 524.522
A.F. = TEMP(B.E.) - TEMP

SOURCE	W/R RTD	(F) TIME	(H) VOLTAGE (mv)	TEMP	TEMP (B.E.)	A.F.
R/I CONVERTER	413 **	1.45	401.100	526.925	525.025	-1.900
	433 **	1.75	401.600	527.800	525.129	-2.671
	443 **	2	401.000	526.750	525.216	-1.534
	423 **	2.85	399.600	524.300	525.511	1.211
	411A/1 **	3.16667	402.000	528.500	525.621	-2.879
	422A/1 **	3.56667	402.100	528.675	525.760	-2.915
	431A/1 **	4	401.700	527.975	525.910	-2.065
	440A/1 **	4.3	402.300	529.025	526.014	-3.011

** TEMP = ((mv-100)/400)*700

TABLE 3.2-4

Wide Range RTD Calculated Ohmic Values

	Equation of Fitted Values of Ohm vs. Temp (B		Temperature (F)				
			30	175	350	525	700
W/R RTD	Slope	Y-Intercept	Ohmic Values				
413	0.412424	194.6278	207.00	266.80	338.98	411.15	483.32
433	0.410023	194.83268	207.13	266.59	338.34	410.09	481.85
443	0.412275	193.76438	206.13	265.91	338.06	410.21	482.36
423	0.410554	194.90939	207.23	266.76	338.60	410.45	482.30
411A/1	0.40778	195.64417	207.88	267.01	338.37	409.73	481.09
422A/1	0.411863	193.52067	205.88	265.60	337.67	409.75	481.82
431A/1	0.412772	193.25884	205.64	265.49	337.73	409.96	482.20
440A/1	0.413577	193.22862	205.64	265.60	337.98	410.36	482.73

TABLE 3.2-5

Incore Thermocouple Correction Factors

TEST TEMPERATURE 525
TEMP (B.E.) = a*TIME + b 0.34707747 524.522007
C.F. = TEMP (B.E.) - TEMP

	(D)	(F)		
T/C NO.	TIME	TEMP	TEMP (B.E.)	C.F.
1	2.13333333	0	525.26	525.26
2	2.13333333	528.22	525.26	-2.96
3	2.13333333	494.86	525.26	30.40
4	2.13333333	526.01	525.26	-0.75
5	2.13333333	531.96	525.26	-6.70
6	2.13333333	532.79	525.26	-7.53
7	2.13333333	532.09	525.26	-6.83
8	2.13333333	532.09	525.26	-6.83
9	2.13333333	526.98	525.26	-1.72
10	2.13333333	527.25	525.26	-1.99
11	2.13333333	528.77	525.26	-3.51
12	2.13333333	529.74	525.26	-4.48
13	2.13333333	528.36	525.26	-3.10
14	2.13333333	532.24	525.26	-6.98
15	2.13333333	531.55	525.26	-6.29
16	2.13333333	0	525.26	525.26
17	2.13333333	527.39	525.26	-2.13
18	2.13333333	530.3	525.26	-5.04
19	2.13333333	0	525.26	525.26
20	2.13333333	528.08	525.26	-2.82
21	2.13333333	528.5	525.26	-3.24
22	2.13333333	529.47	525.26	-4.21
23	2.13333333	531.27	525.26	-6.01
24	2.13333333	0	525.26	525.26
25	2.13333333	532.1	525.26	-6.84
26	2.13333333	533.07	525.26	-7.81
27	2.13333333	530.02	525.26	-4.76
28	2.13333333	530.58	525.26	-5.32
29	2.13333333	533.06	525.26	-7.80
30	2.13333333	533.06	525.26	-7.80
31	2.13333333	526.97	525.26	-1.71
32	2.13333333	529.46	525.26	-4.20
33	2.13333333	0	525.26	525.26
34	2.13333333	531.96	525.26	-6.70
35	2.13333333	532.37	525.26	-7.11
36	2.13333333	526.42	525.26	-1.16

TABLE 3.2-5(cont'd)

Incore Thermocouple Correction Factors

TEST TEMPERATURE 525
TEMP (B.E.) = a*TIME + b 0.34707747 524.522007
C.F. = TEMP (B.E.) - TEMP

T/C NO.	(D) TIME	(F) TEMP	TEMP (B.E.)	C.F.
37	2.13333333	0	525.26	525.26
38	2.13333333	527.53	525.26	-2.27
39	2.13333333	526.42	525.26	-1.16
40	2.13333333	0	525.26	525.26
41	2.13333333	527.81	525.26	-2.55
42	2.13333333	527.94	525.26	-2.68
43	2.13333333	529.47	525.26	-4.21
44	2.13333333	528.64	525.26	-3.38
45	2.13333333	531.82	525.26	-6.56
46	2.13333333	526.14	525.26	-0.88
47	2.13333333	527.67	525.26	-2.41
48	2.13333333	527.8	525.26	-2.54
49	2.13333333	531.13	525.26	-5.87
50	2.13333333	530.3	525.26	-5.04
51	2.13333333	530.16	525.26	-4.90
52	2.13333333	532.37	525.26	-7.11
53	2.13333333	529.47	525.26	-4.21
54	2.13333333	527.94	525.26	-2.68
55	2.13333333	528.08	525.26	-2.82
56	2.13333333	532.93	525.26	-7.67
57	2.13333333	531.96	525.26	-6.70
58	2.13333333	0	525.26	525.26
59	2.13333333	527.66	525.26	-2.40
60	2.13333333	527.66	525.26	-2.40
61	2.13333333	528.63	525.26	-3.37
62	2.13333333	0	525.26	525.26
63	2.13333333	527.67	525.26	-2.41
64	2.13333333	533.2	525.26	-7.94
65	2.13333333	529.33	525.26	-4.07

Table 3.3-1

Calculated Full Power Delta-T and T-average

RCS Loop	Calculated Full Power Delta-T(F)*	Calculated Full Power T-average(F)**
21	59.0	558.9
22	61.8	559.7
23	60.1	560.2
24	56.3	557.2

* Delta-To in Overpower and Overtemperature Delta-T Trip Equations
** T" in Overpower Delta-T trip setpoint equation

TAB[illegible].4-1

Relationship Between Excore Detector Current and Reactor Power

DATE	TIME	DETECTOR	TOP	BOTTOM	TOTAL	POWER	POWER/3071.4	NORM. TOTAL
(Page 1 of 1)								
6/11/95	00:37	N41	126.6	121.2	247.8	2728.9	0.88849	278.9
		N42	92.0	123.0	215	2728.9	0.88849	242.0
		N43	108.1	124.7	232.8	2728.9	0.88849	262.0
		N44	110.1	124.4	234.5	2728.9	0.88849	263.9
6/11/95	05:47	N41	127.7	121.4	249.1	2729.6	0.88872	280.3
		N42	92.9	123.0	215.9	2729.6	0.88872	242.9
		N43	108.7	124.9	233.6	2729.6	0.88872	262.9
		N44	111.0	124.6	235.6	2729.6	0.88872	265.1
6/11/95	09:43	N41	128.3	121.0	249.3	2741.1	0.89246	279.3
		N42	93.2	122.6	215.8	2741.1	0.89246	241.8
		N43	109.4	124.3	233.7	2741.1	0.89246	261.9
		N44	111.7	124.3	236	2741.1	0.89246	264.4
6/12/95	02:22	N41	127.6	121.7	249.3	2751.0	0.89568	278.3
		N42	92.9	123.5	216.4	2751.0	0.89568	241.6
		N43	108.7	125.2	233.9	2751.0	0.89568	261.1
		N44	111.3	125.3	236.6	2751.0	0.89568	264.2

AVG	N41	279.2
TOTAL	N42	242.1
CURRENT	N43	262.0
	N44	264.4

TABLE 3.5-1

Addressable Constants for Delta Flux Alarm

DATA:

CHANNEL	I ot	I ob	S
N-41	145.4310	133.7690	0.8699
N-42	106.2881	135.8119	0.7478
N-43	124.3339	137.6661	0.8180
N-44	126.8278	137.5722	0.8107

I t = I ot + S (AO)
I b = I ob - S (AO)
I = current (microamps)
AO = axial offset (%)

RESULTS:

K0551 (N-43) =	1.597320
K0552 (N-42) =	1.594675
K0553 (N-44) =	1.627997
K0554 (N-41) =	1.601982

FIG[illegible].4-1

Cycle 13 First Calibration -65% Power Incore-Excore Calibration, CH 43 Delta Flux Vs. Time

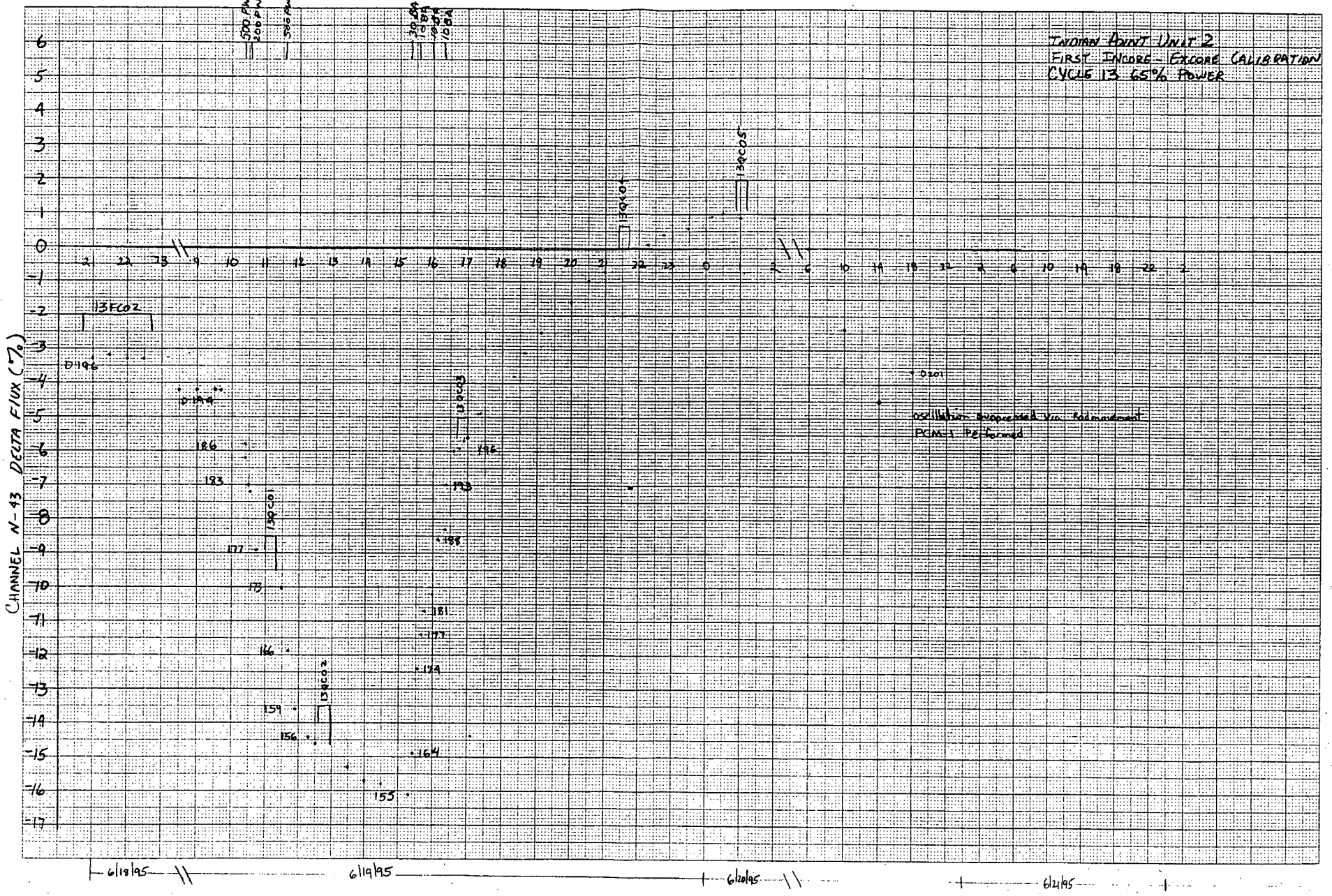


FIGURE 3.4-2 Indian Point Unit No. 2
Administrative Limits on Axial Flux Difference
As a Function of Reactor Power

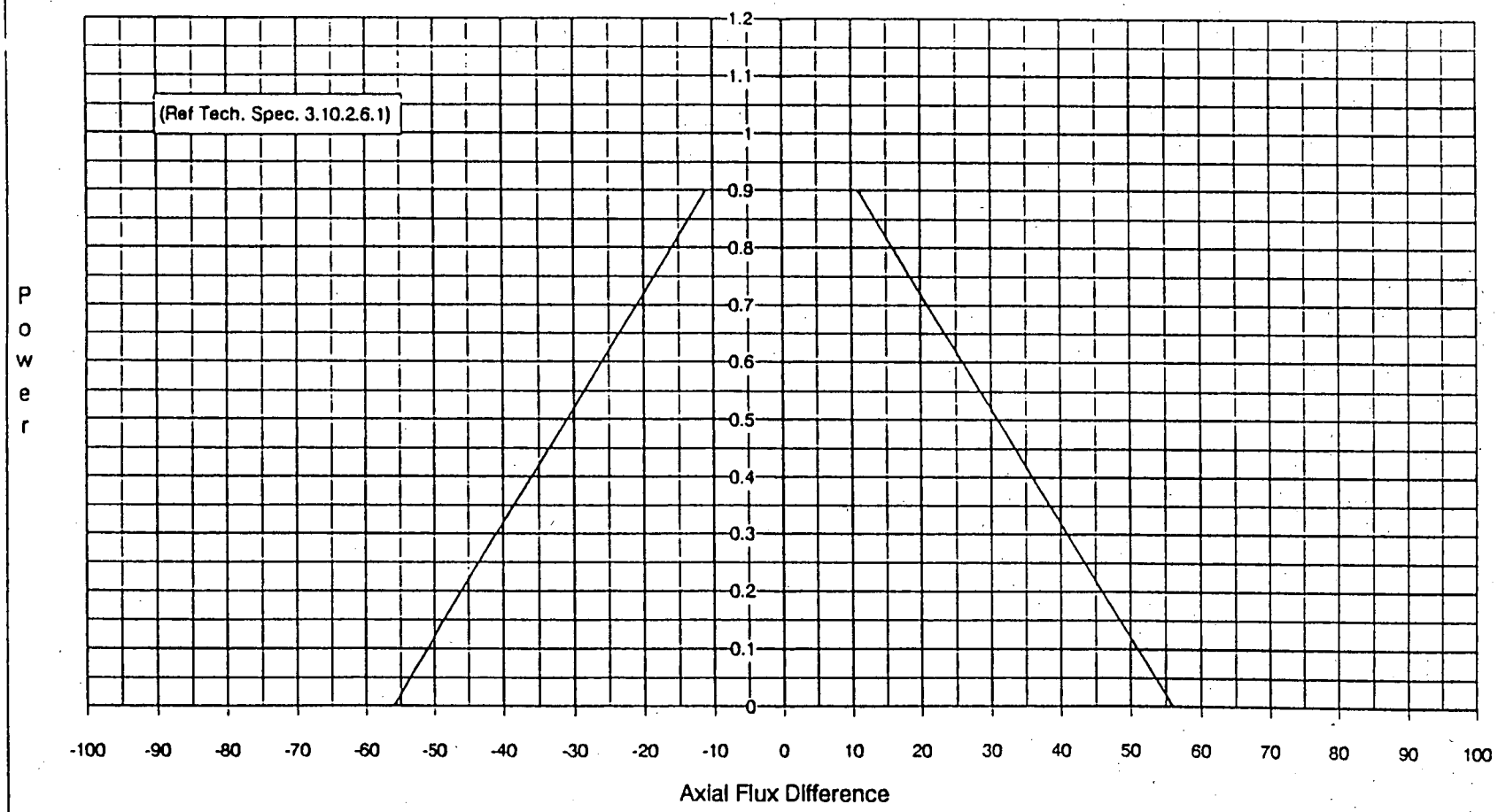


FIGURE 4-3

Channel 41 Detector Current vs. Axial Offset

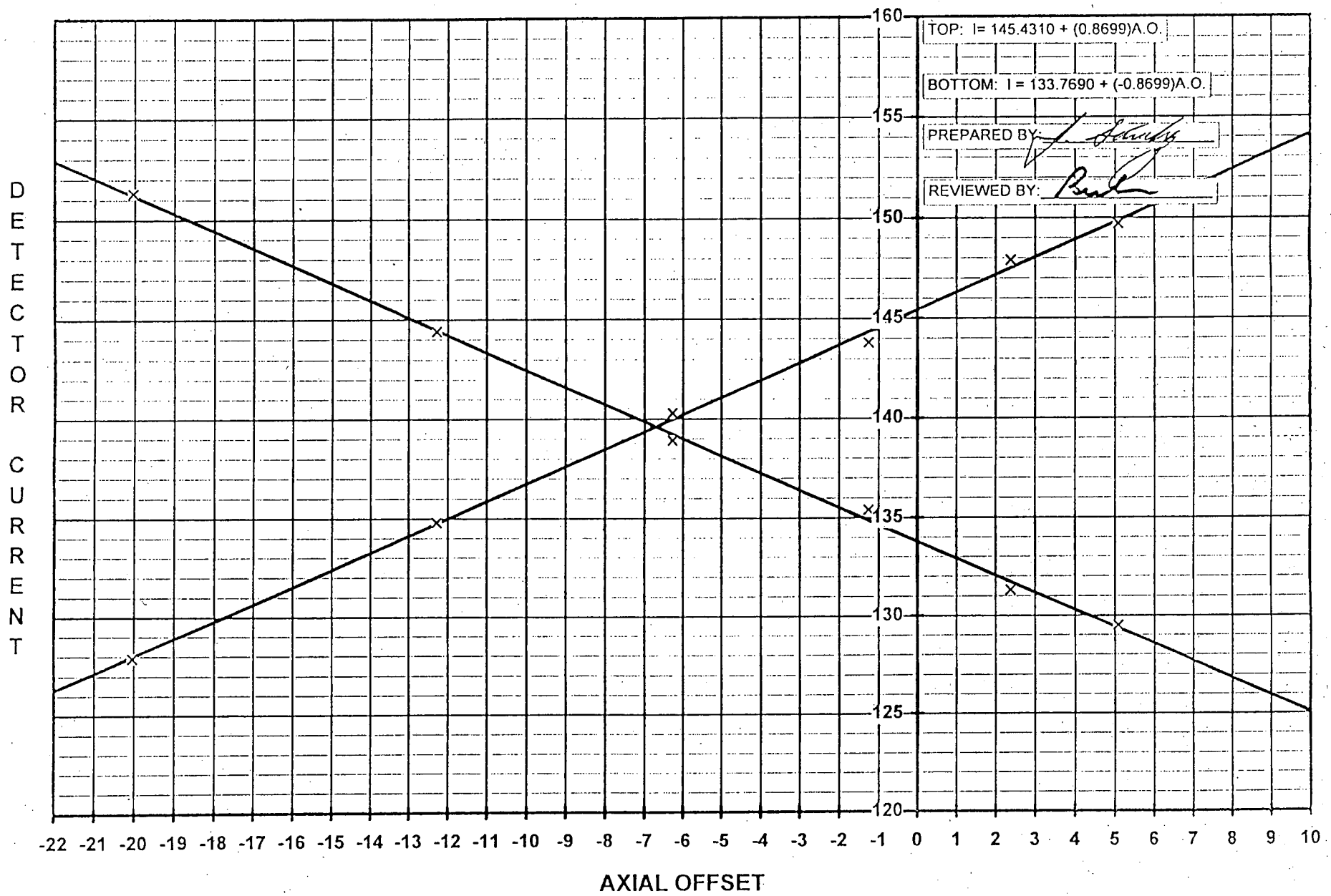


FIGURE 3.4

Channel 42 Detector Current vs. Axial Offset

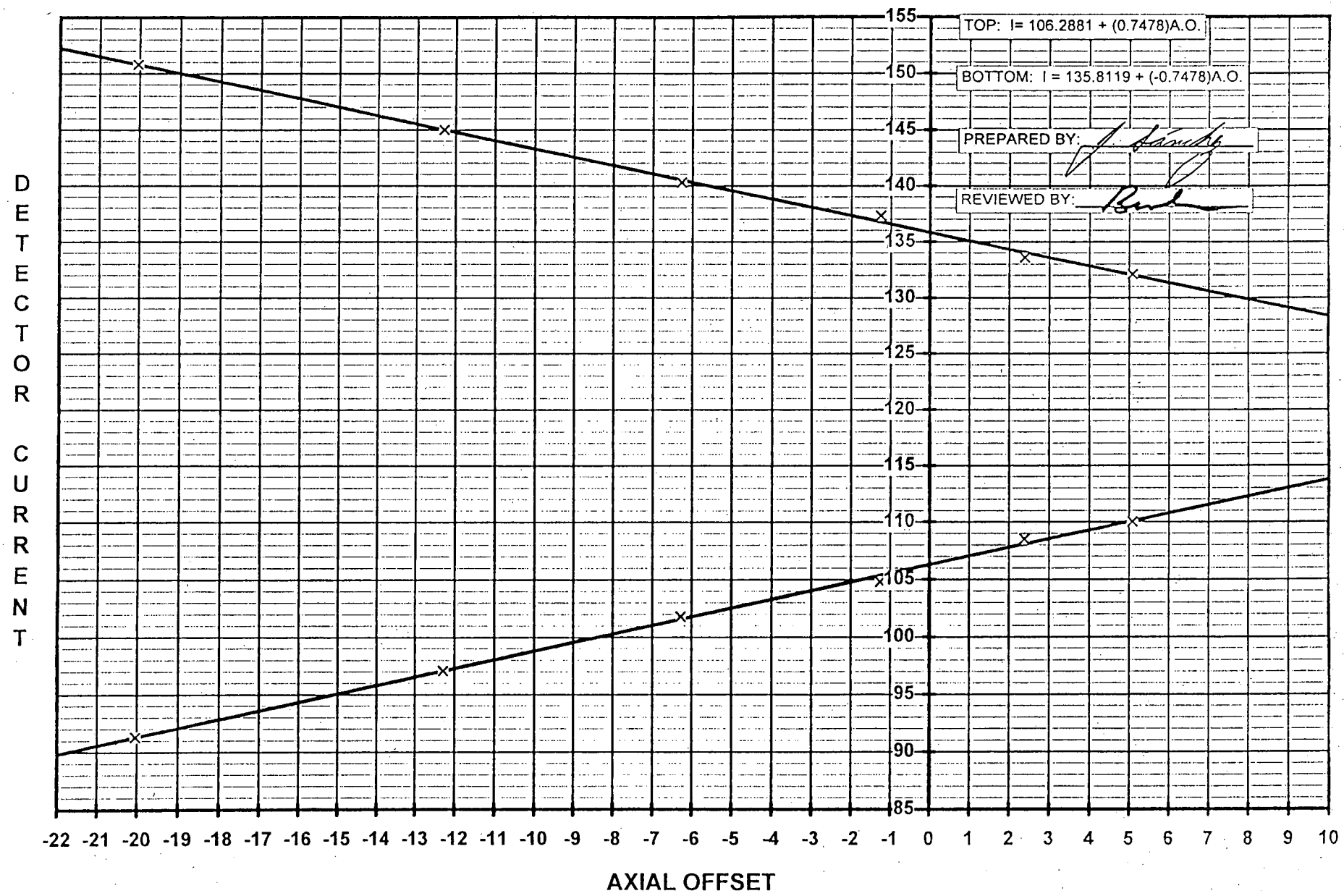


FIGURE 4-5

CHANNEL 43 DETECTOR CURRENT vs. AXIAL OFFSET

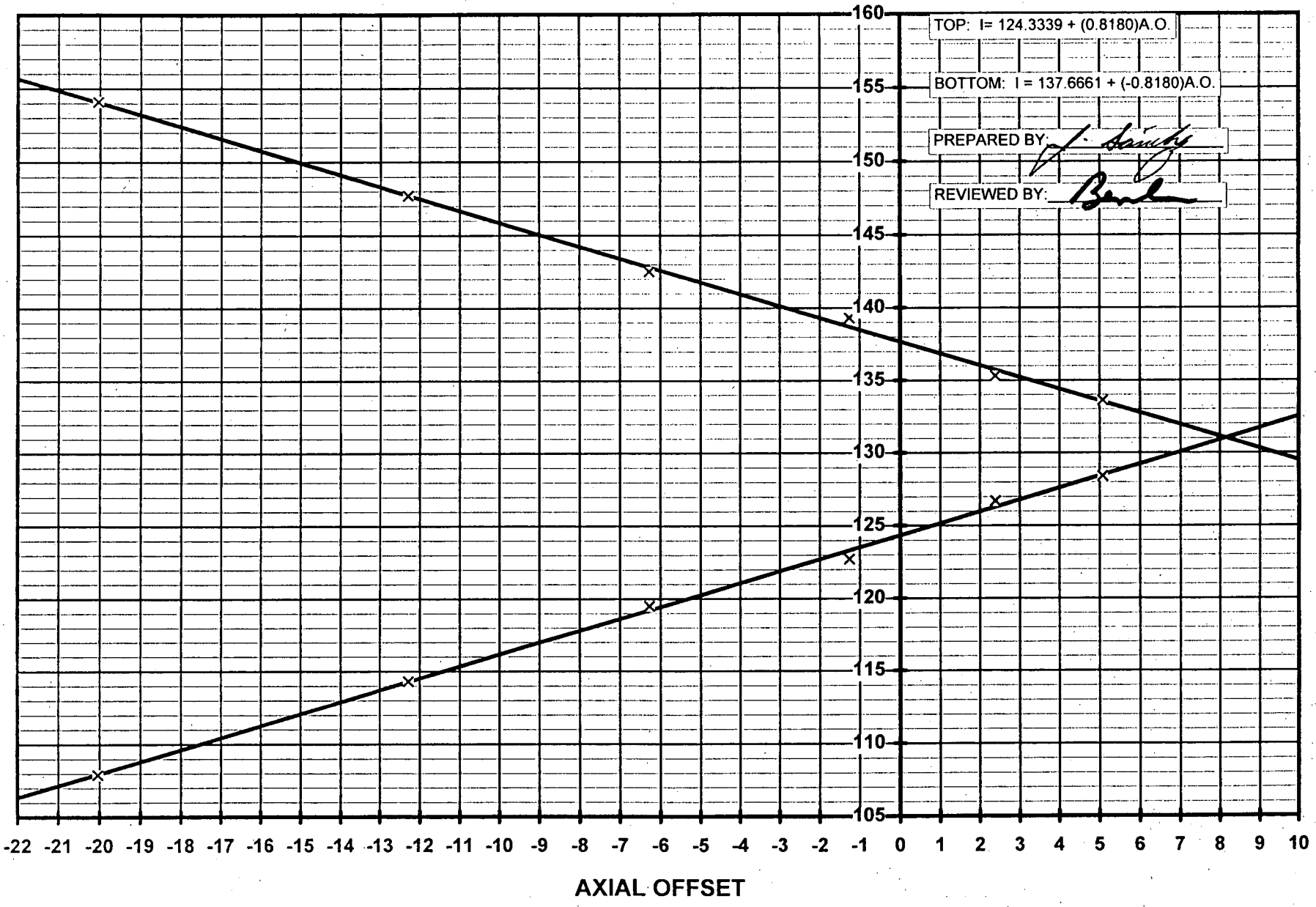
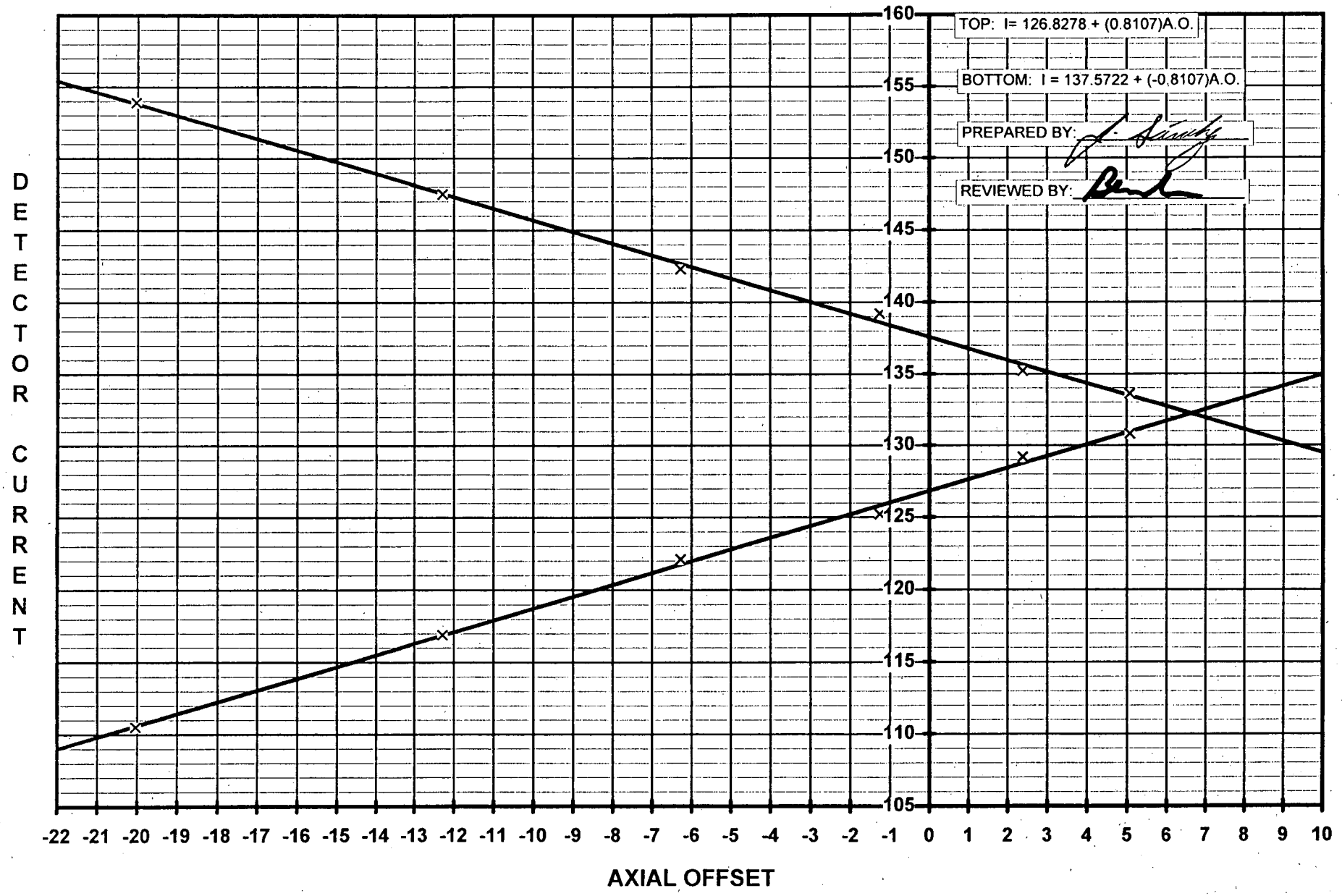


FIGURE 3.4-6

CHANNEL 44 DETECTOR CURRENT vs. AXIAL OFFSET



4.0 HOT ZERO POWER (HZP) TESTS

4.1 Reactivity Measurement

The absolute measurement of core reactivity changes was provided by the on-line solution of the point-reactor kinetics equations, using a Westinghouse Advanced Digital Reactivity Computer (ADRC). An input signal of neutron flux to the reactivity computer from the excore channel N-42 was used to solve the neutron kinetics equation, and to provide reactivity as output signal. The computer results were verified by comparing the design reactor period with those measured directly by the reactivity computer. Data for two computer checks and design values are shown in Table 4.1-1. The delayed neutron data is given in Table 4.1-2.

4.2 Initial Criticality

Indian Point Unit No. 2 Cycle 13 initial criticality was attained at 15:28 on May 21, 1995. Criticality was achieved by the sequential withdrawal of RCC shutdown and control banks, and then by subsequent boron dilution of the reactor coolant (initial boron concentration prior to dilution was 1671 ppm).

During the approach to criticality, ICRR (Inverse Count Rate Ratio) plots versus control rod position and integrated primary water addition (Figure 4.2.-1 and 4.2.-2) were maintained. At the time of initial criticality, neutron flux level as indicated by the reactivity computer (Recorder) was 4×10^{-10} Amperes (Sum of upper and lower detector signals).

4.3 Determination of Flux Range for Zero Power Tests

The neutron flux range for HZP tests was established by the following method: The upper flux limit was determined by observing the effect of nuclear heating, which decreases reactivity due to a rise in fuel rod temperature as flux increases. The upper flux limit for testing was set approximately 0.3 times the flux level at which nuclear heating was observed. The nuclear heating flux level indicated by the reactivity computer was 3.3×10^{-7} Amps. A lower flux limit for testing was not applicable as the ADRC compensates for the gamma leakage current.

4.4 Endpoint Boron Concentrations and Boron Worth

Endpoint boron concentrations for All Rods Out (ARO) conditions and All Control Banks In were measured. The measured boron endpoints for these conditions were directly compared against their design values. The measured and expected values are given in Table 4.4-1. The measured endpoints met both the review and acceptance criteria for this test.

The measured endpoints for the all control banks inserted condition, in conjunction with the measured ARO endpoint and total control bank worth, was used to calculate the differential boron worth. The measured boron worth was compared against its design value. Both the measured and expected values are given in Table 4.4-1. The measured boron worth met the review criterion for this test.

4.5 Isothermal Temperature Coefficient

The isothermal temperature coefficient measurements were carried out for two RCCA configurations, ARO and All Control Banks In. Results of the measurements are presented in Table 4.5-1. Both measured values of the isothermal temperature coefficient met the associated test review and acceptance criteria.

Using the design value of Doppler coefficient at HZP equal to -1.61 pcm/°F, the ARO moderator temperature coefficient calculated from the measured isothermal temperature coefficient is equal to -3.32 pcm/°F. The measured value of moderator temperature coefficient at ARO condition satisfied the Indian Point Unit 2 Technical Specification (Reference 2) requirement for operation with a non-positive moderator temperature coefficient. It also was used to assure conservatism within operating limitation graph RV-8, Minimum Temperature for Criticality vs RCS Boron Concentration, in order to assure operation with a non-positive moderator temperature coefficient.

4.6 RCCA Bank Differential and Integral Worth Measurements

The objective of this test was to measure the integral and differential worth of all four control banks.

With the reactor at HZP condition, differential control bank worth was determined by making a series of small stepwise rod insertions to maintain nominal system criticality during a continuous controlled Reactor Coolant System boron dilution. The flux level response to the step change in rod position was translated to an equivalent reactivity increment via the reactivity computer, and was observable on the strip chart recording of the computer output. The reactivity worth of each step insertion within the entire length of a bank was summed to determine the integral control bank worth. Control banks D, C, B and A, were inserted in the core sequentially accompanied by boron dilution and the bank worths were measured. This was compared with their respective design worths. It was found that all the measured bank worths met their associated test review/acceptance criteria. Tables 4.6-1 to 4.6-4 list the differential and integral worths of the Control Banks D, C, B and A, respectively. Figures 4.6-1 to 4.6-4 are the plots of differential rod worths of Control Banks D, C, B and A. Table 4.6-5 presents the measured bank worths, the design bank worths, the deviations of measured values from the design value for each bank, and the acceptance criteria.

Table 4.1-1

DOUBLING TIME & REACTIVITY COMPARISON

Measured Period (sec)	Reactivity Pred. (pcm)	Reactivity Meas. (pcm)	Difference (m-p/p) %
298.7	21.9	22	0.46
263.7	24.4	24.5	0.41

Average % Difference 0.44 absolute value

Table 4.1-2

HZP DELAYED NEUTRON DATA, BOL CYCLE 13

Group	βi	λi (sec-1)
1	0.000205	0.0128
2	0.001283	0.0316
3	0.001163	0.1207
4	0.002507	0.3219
5	0.000921	1.4037
6	0.000224	3.8819

l^* = 13.055 μ sec (Prompt Neutron Life Time)

l = 0.970 (Delayed Neutron Importance Factor)

B_{eff} = 0.006114

Table 4.4-1

Endpoint Boron Concentration and Boron Worth

Boron Endpoint

	(1) Measured ppm	(2) Design ppm	(1) - (2) Deviation ppm
HZP, All Rods Out	1449	1440	+9
HZP, All Contron Banks In	982	978	+4

Differential Boron Worth

	(1) Measured (pcm/ppm)	(2) Design (pcm/ppm)	Deviation (1)-(2)/(2)
HZP, All Rods Out To All Control Rods In	-6.98	-7.18	-2.8%

Notes: A - The acceptance criterion for the ARO boron endpoint is ± 100 ppm.

B - The review criterion for both the ARO and all control banks in boron endpoint is ± 50 ppm.

C - The review criterion for differential boron worth is ± 15%.

Table 4.5-1

RESULTS OF ISOTHERMAL TEMPERATURE COEFFICIENT MEASUREMENTS

Rod Configuration	(1) Measured Value pcm/°F	(2) Design Value (corrected for measurement conditions) pcm/°F	(1)-(2) Deviation pcm/°F
HZP, All Rods Out	-4.93	-5.32	+0.39
HZP, All Control Banks In	-12.62	-11.95	-0.67

Notes: A - Acceptance criterion for ARO ITC is assurance of non-positive MTC

B - Review criterion for ITC is $\pm$ 2.0 pcm/°F.

Table 4.6-1

Cycle 13 Control Rod Worth Measurement

BANK: D DATE: 05/21/95

INITIAL STEP	FINAL STEP	AVERAGE STEP	DELTA STEP	PCM	DIFF WORTH	INTEGRAL WORTH
223.0	212.0	216.5	13.0	17.0	1.31	17
212.0	197.5	204.8	14.5	49.0	3.38	66
197.5	185.0	191.3	12.5	46.0	3.68	112
185.0	174.0	179.5	11.0	37.0	3.36	149
174.0	163.0	168.5	11.0	34.5	3.14	184
163.0	150.0	156.5	13.0	41.0	3.15	225
150.0	138.0	144.0	12.0	40.5	3.38	265
138.0	126.0	132.0	12.0	41.5	3.46	307
126.0	115.0	120.5	11.0	39.5	3.59	346
115.0	105.0	110.0	10.0	40.0	4.00	386
105.0	95.0	100.0	10.0	43.5	4.35	430
95.0	85.0	90.0	10.0	48.5	4.85	478
85.0	76.0	80.5	9.0	45.0	5.00	523
76.0	65.0	70.5	11.0	56.0	5.09	579
65.0	57.0	61.0	8.0	39.0	4.88	618
57.0	48.0	52.5	9.0	38.5	4.28	657
48.0	39.0	43.5	9.0	33.0	3.67	690
39.0	21.0	30.0	18.0	41.0	2.28	731
21.0	0.0	10.5	21.0	15.5	0.74	746

INTEGRAL WORTH = 746.0 pcm

Table 4.6-2

Cycle 13 Control Rod Worth Measurement

BANK: C DATE: 05/22/95

INITIAL STEP	FINAL STEP	AVERAGE STEP	DELTA STEP	PCM	DIFF WORTH	INTEGRAL WORTH
223.0	201.0	212.0	22.0	46.0	2.09	46
201.0	190.0	195.5	11.0	41.0	3.73	87
190.0	181.0	185.5	9.0	33.5	3.72	121
181.0	169.0	175.0	12.0	43.5	3.63	164
169.0	157.0	163.0	12.0	38.0	3.17	202
157.0	146.0	151.5	11.0	34.0	3.09	236
146.0	135.0	140.5	11.0	34.0	3.09	270
135.0	126.0	130.5	9.0	29.0	3.22	299
126.0	116.0	121.0	10.0	34.0	3.40	333
116.0	106.0	111.0	10.0	35.5	3.55	369
106.0	96.0	101.0	10.0	37.0	3.70	406
96.0	86.0	91.0	10.0	40.0	4.00	446
86.0	76.0	81.0	10.0	40.5	4.05	486
76.0	66.0	71.0	10.0	39.0	3.90	525
66.0	56.0	61.0	10.0	37.5	3.75	563
56.0	43.0	49.5	13.0	38.5	2.96	601
43.0	21.0	32.0	22.0	37.0	1.68	638
21.0	0.0	10.5	21.0	12.5	0.60	651

INTEGRAL WORTH = 650.5 pcm

Table 4.6-3

Cycle 13 Control Rod Worth Measurement

BANK: B DATE: 05/22/95

INITIAL STEP	FINAL STEP	AVERAGE STEP	DELTA STEP	PCM	DIFF WORTH	INTEGRAL WORTH
223.0	207.0	215.0	16.0	47.0	2.94	47.0
207.0	196.0	201.5	11.0	50.5	4.59	98
196.0	184.0	190.0	12.0	51.0	4.25	149
184.0	172.0	178.0	12.0	47.0	3.92	196
172.0	160.0	166.0	12.0	42.5	3.54	238
160.0	145.0	152.5	15.0	47.5	3.17	286
145.0	132.0	138.5	13.0	42.0	3.23	328
132.0	119.0	125.5	13.0	44.0	3.38	372
119.0	105.0	112.0	14.0	51.5	3.68	423
105.0	93.0	99.0	12.0	47.0	3.92	470
93.0	81.0	87.0	12.0	50.5	4.21	521
81.0	71.0	76.0	10.0	43.0	4.30	564
71.0	60.0	65.5	11.0	48.5	4.41	612
60.0	48.0	54.0	12.0	49.0	4.08	661
48.0	35.0	41.5	13.0	42.5	3.27	704
35.0	0.0	17.5	35.0	44.0	1.26	748

INTEGRAL WORTH = 747.5 pcm

Table 4.6-4

Cycle 13 Control Rod Worth Measurement

BANK: A DATE: 05/22/95

INITIAL STEP	FINAL STEP	AVERAGE STEP	DELTA STEP	PCM	DIFF WORTH	INTEGRAL WORTH
223.0	209.0	216.0	14.0	48.0	3.43	48
209.0	200.0	204.5	9.0	48.5	5.39	97
200.0	193.0	196.5	7.0	36.0	5.14	133
193.0	185.0	189.0	8.0	36.5	4.56	169
185.0	177.0	181.0	8.0	30.5	3.81	200
177.0	168.0	172.5	9.0	30.0	3.33	230
168.0	158.0	163.0	10.0	32.0	3.20	262
158.0	147.0	152.5	11.0	36.0	3.27	298
147.0	136.0	141.5	11.0	37.0	3.36	335
136.0	126.0	131.0	10.0	36.0	3.60	371
126.0	115.0	120.5	11.0	45.0	4.09	416
115.0	106.0	110.5	9.0	38.0	4.22	454
106.0	97.0	101.5	9.0	42.0	4.67	496
97.0	89.0	93.0	8.0	46.0	5.75	542
89.0	82.0	85.5	7.0	46.0	6.57	588
82.0	77.0	79.5	5.0	35.0	7.00	623
77.0	72.0	74.5	5.0	39.5	7.90	662
72.0	67.0	69.5	5.0	43.0	8.60	705
67.0	62.0	64.5	5.0	45.5	9.10	751
62.0	58.0	60.0	4.0	39.0	9.75	790
58.0	54.0	56.0	4.0	41.0	10.25	831
54.0	50.0	52.0	4.0	42.5	10.63	873
50.0	46.0	48.0	4.0	42.0	10.50	915
46.0	41.0	43.5	5.0	52.0	10.40	967
41.0	36.0	38.5	5.0	46.0	9.20	1013
36.0	31.0	33.5	5.0	31.5	6.30	1045
31.0	26.0	28.5	5.0	24.0	4.80	1069
26.0	24.0	25.0	2.0	6.5	3.25	1075
24.0	18.0	21.0	6.0	17.0	2.83	1092
18.0	10.0	14.0	8.0	15.5	1.94	1108
10.0	0.0	5.0	10.0	7.0	0.70	1115

INTEGRAL WORTH = 1114.5 pcm

Table 4.6-5

Summary of Cycle 13 Bank Worths at BOL, HZP

Control Bank	(1) Measured Bank Worth (pcm)	(2) Design Bank Worth (pcm)	(3) Measured Deviation
D	746.0	773	-3.5%
C (D in)	650.5	639	1.8%
B (D, C in)	747.5	740	1.0%
A (D,C,B in)	1114.5	1165	-4.3%
TOTAL	3258.5	3317	-1.8%

Note: (3)=[(1) - (2)] / (2)

A - Review criterion for individual bank worth is +/- 15% or +/- 100 pcm

B - Review criterion for maximum total bank worth is design +10%

C - Acceptance criterion for minimum total bank worth is design -10%

FIGURE 4.2-1

Inverse Count Rate vs. Bank Position

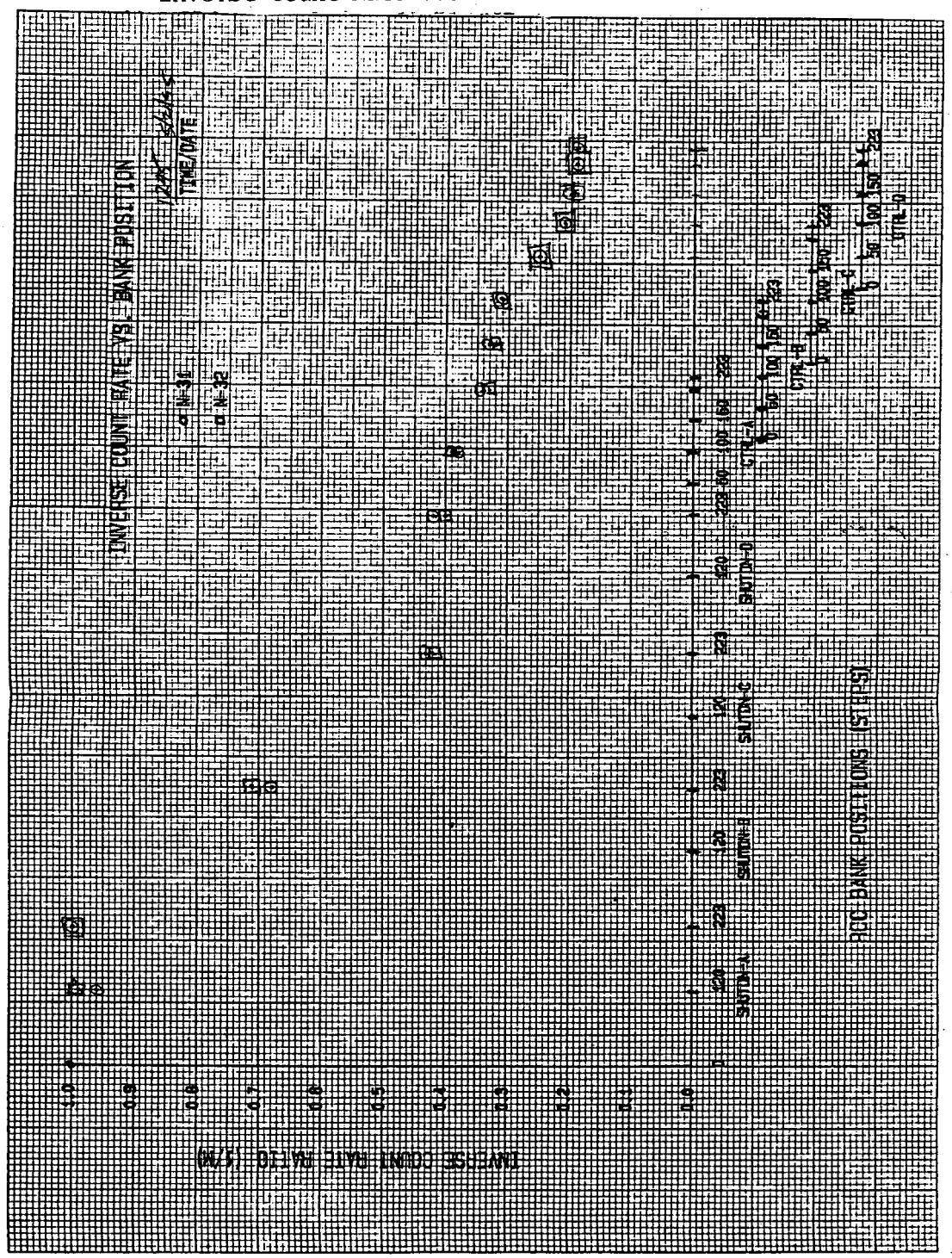


FIGURE 4.2-2

Inverse Count Rate vs. Dilution Water Added

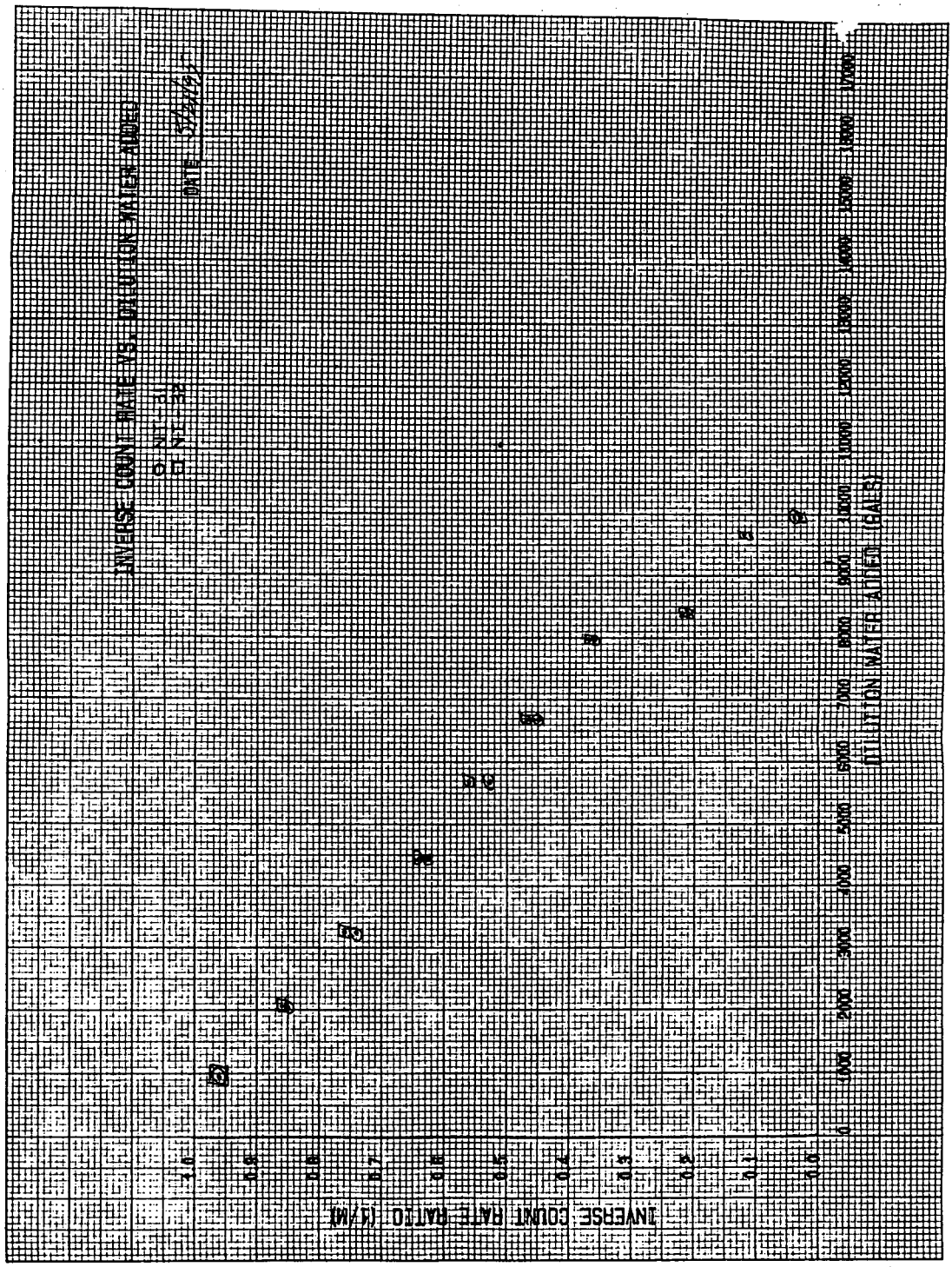


Figure 4.6-1
Measured Differential Rod Worth

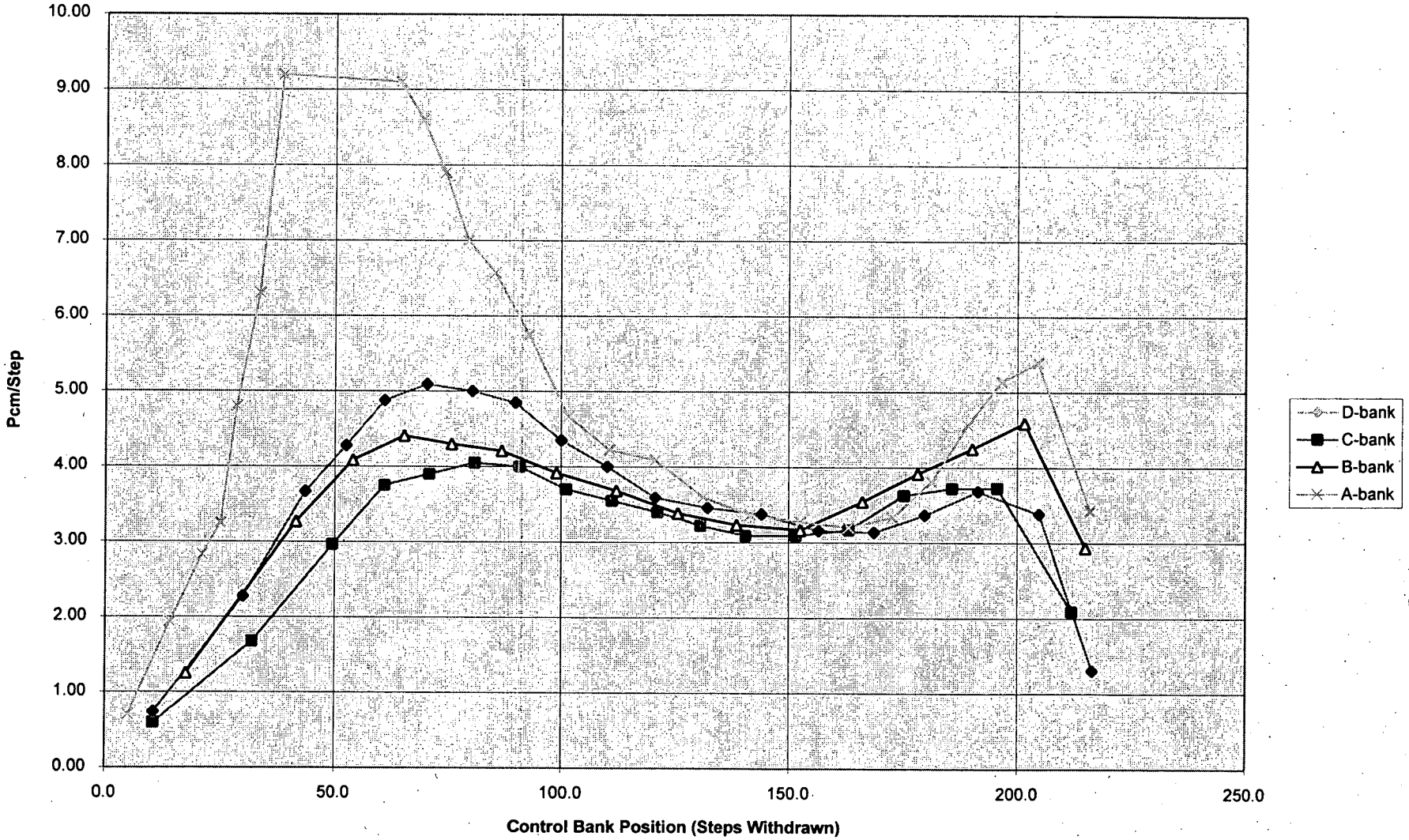


Figure 4.6-2
Measured Integral Rod Worth

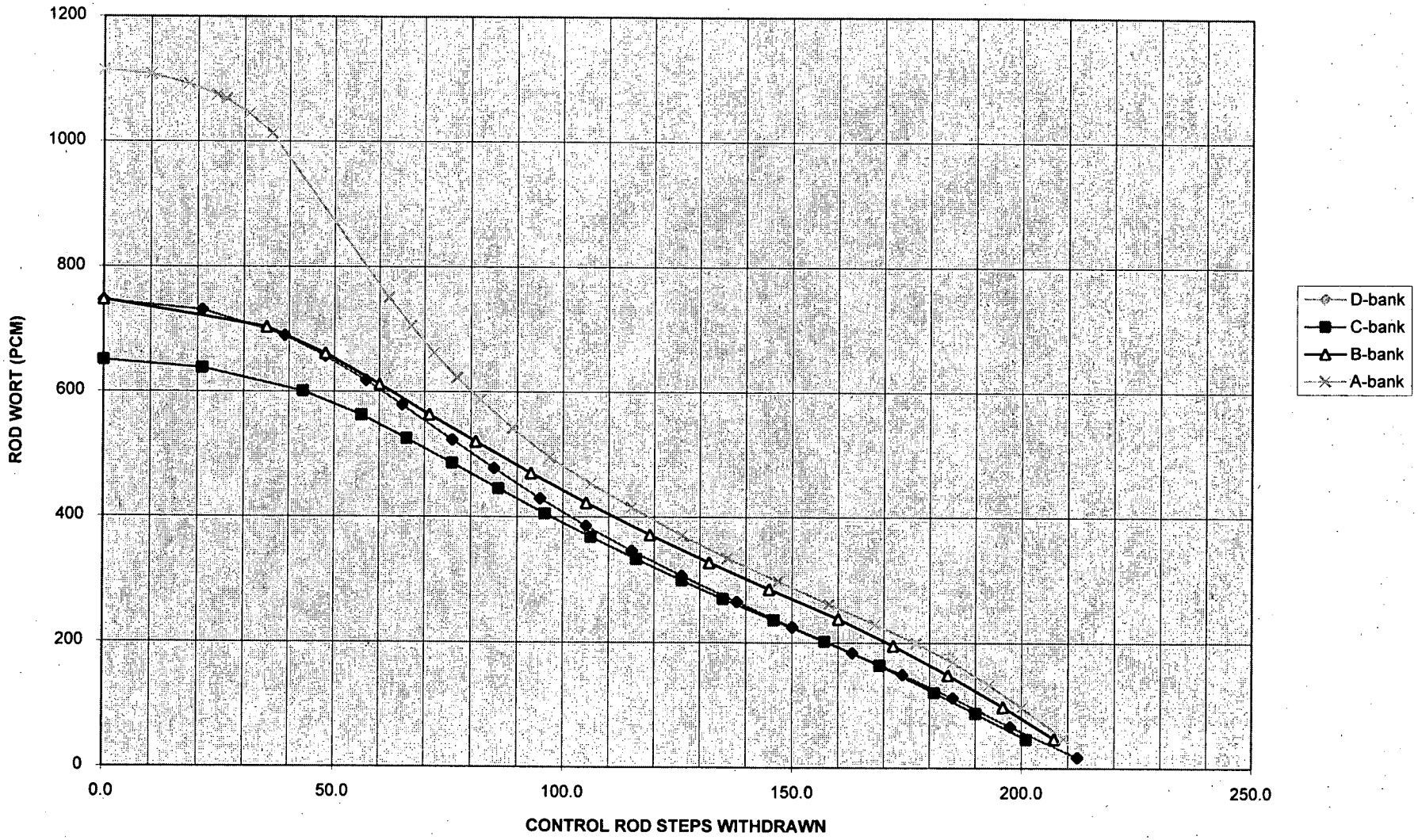


Figure 4.6-3
COMPARISON OF CONTROL BANK D DIFFERENTIAL ROD WORTH

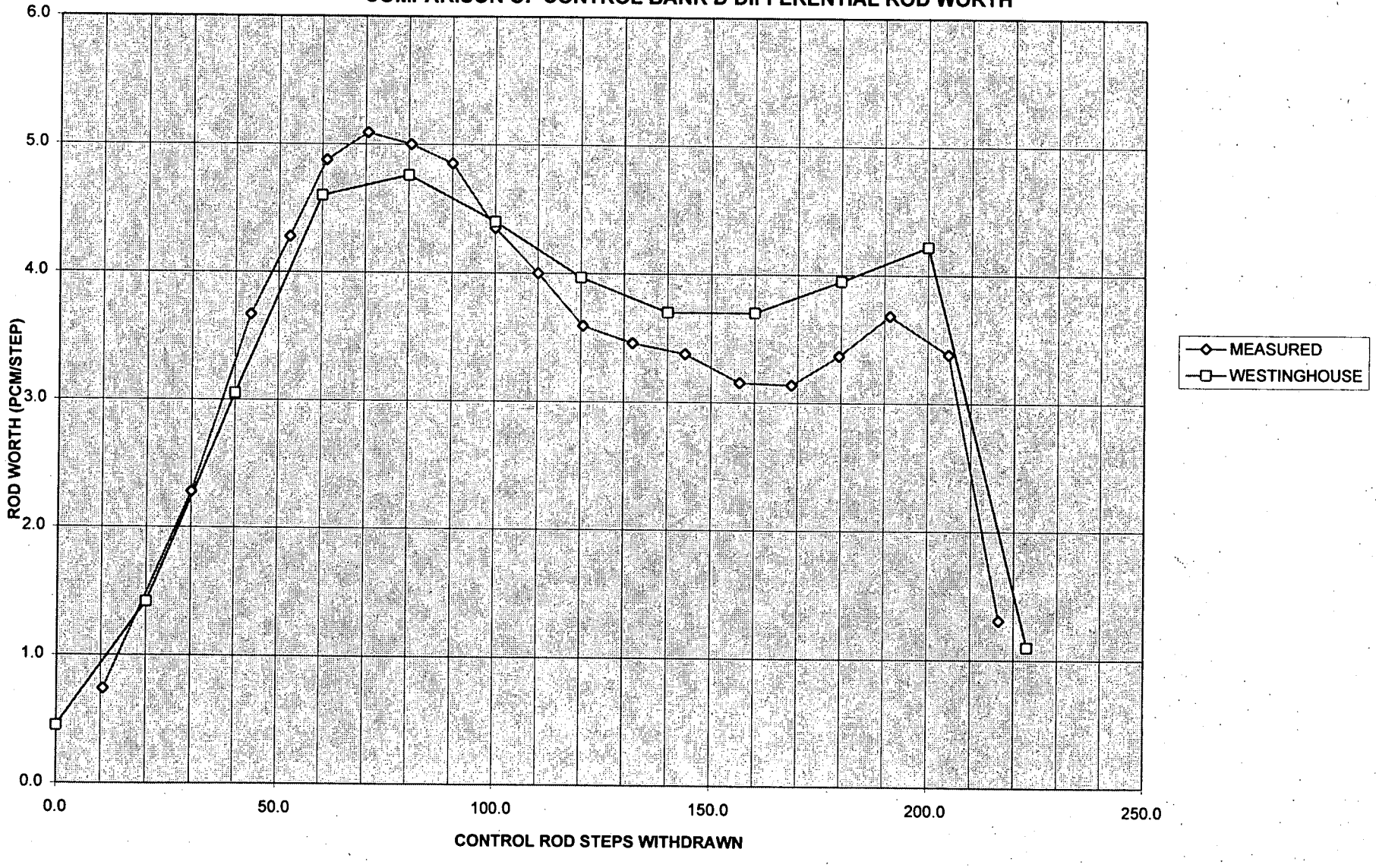


Figure 4.6-4

COMPARISON OF CONTROL BANK C DIFFERENTIAL ROD WORTH

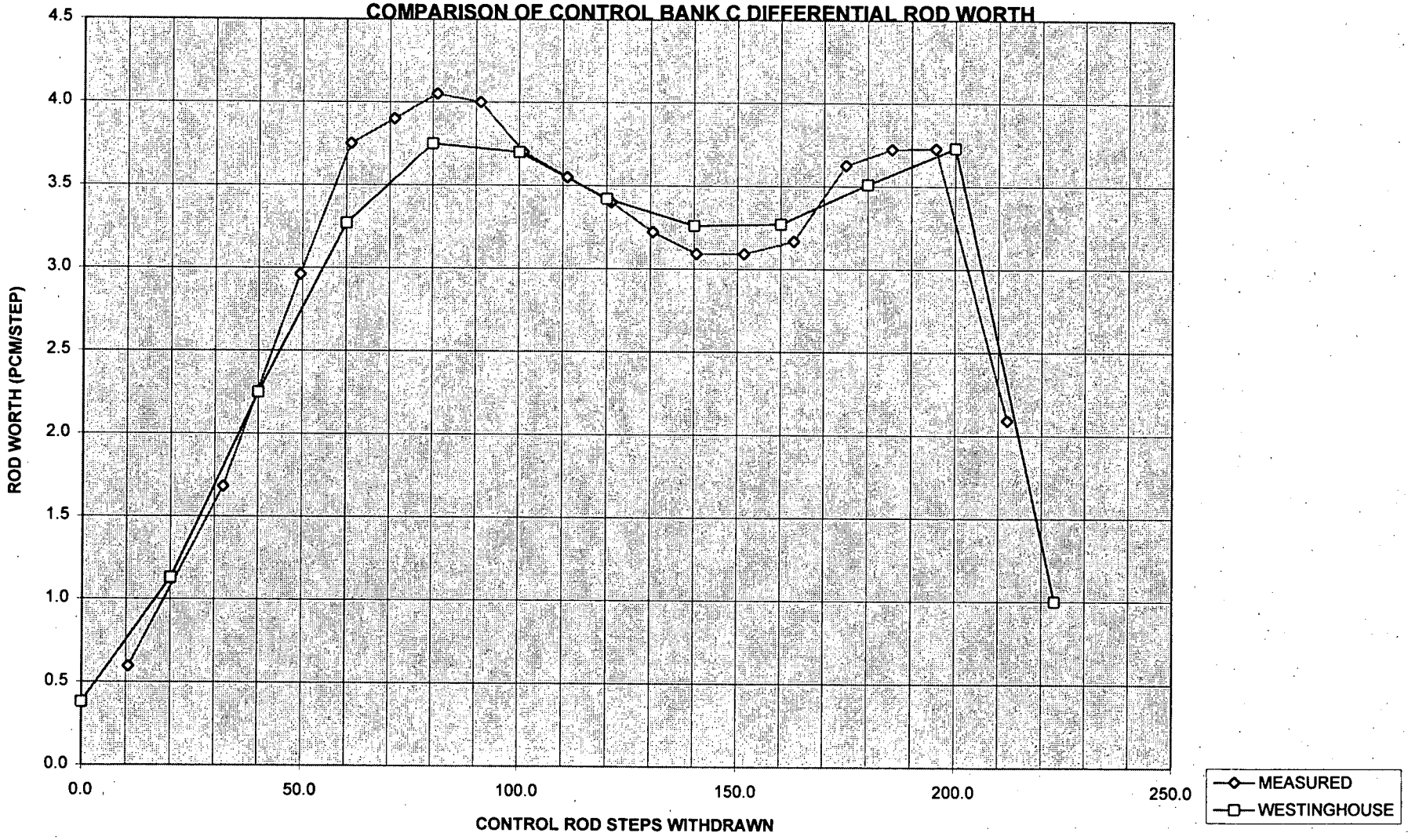


Figure 4.6-5

COMPARISON OF CONTROL BANK B DIFFERENTIAL ROD WORTH

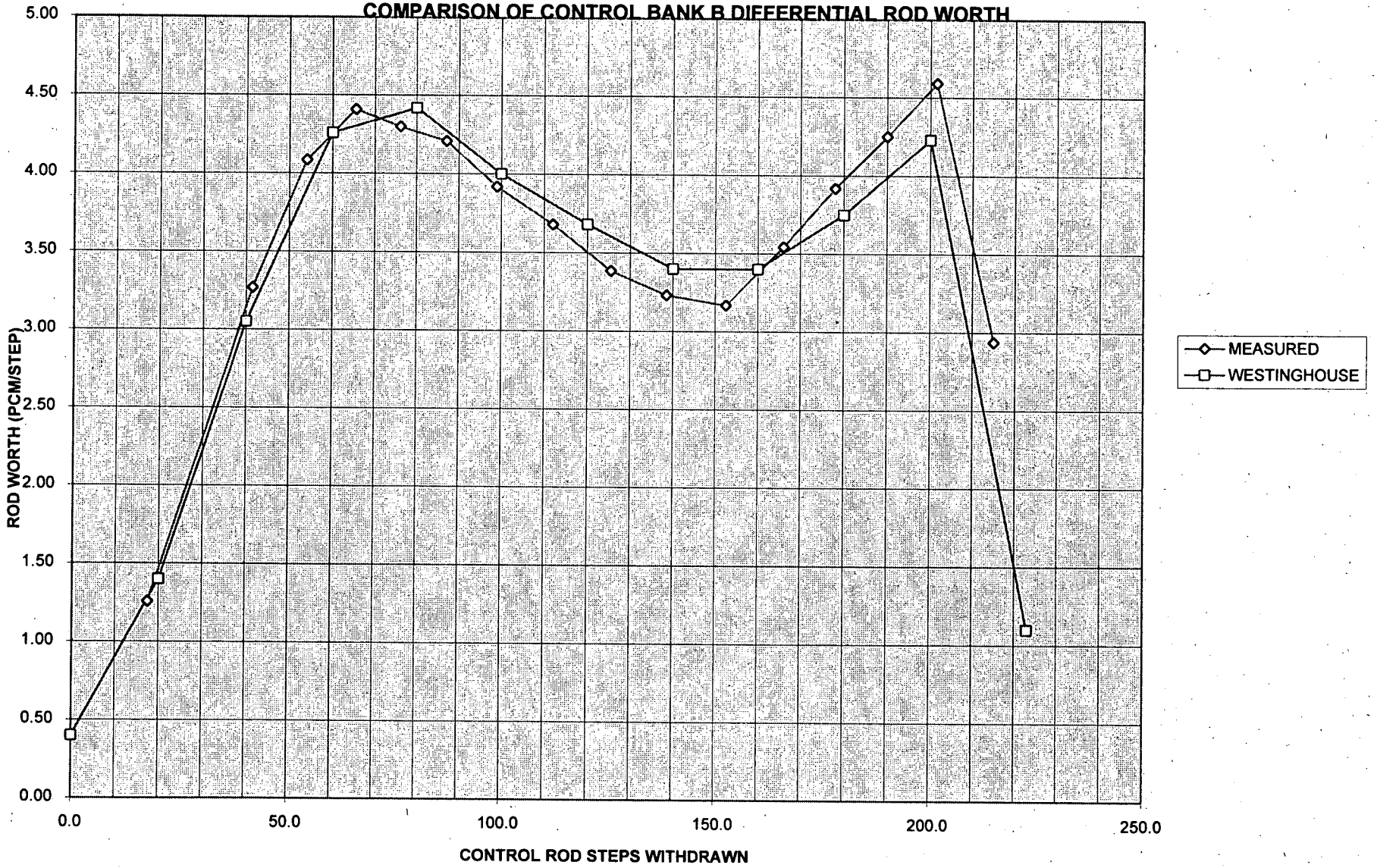
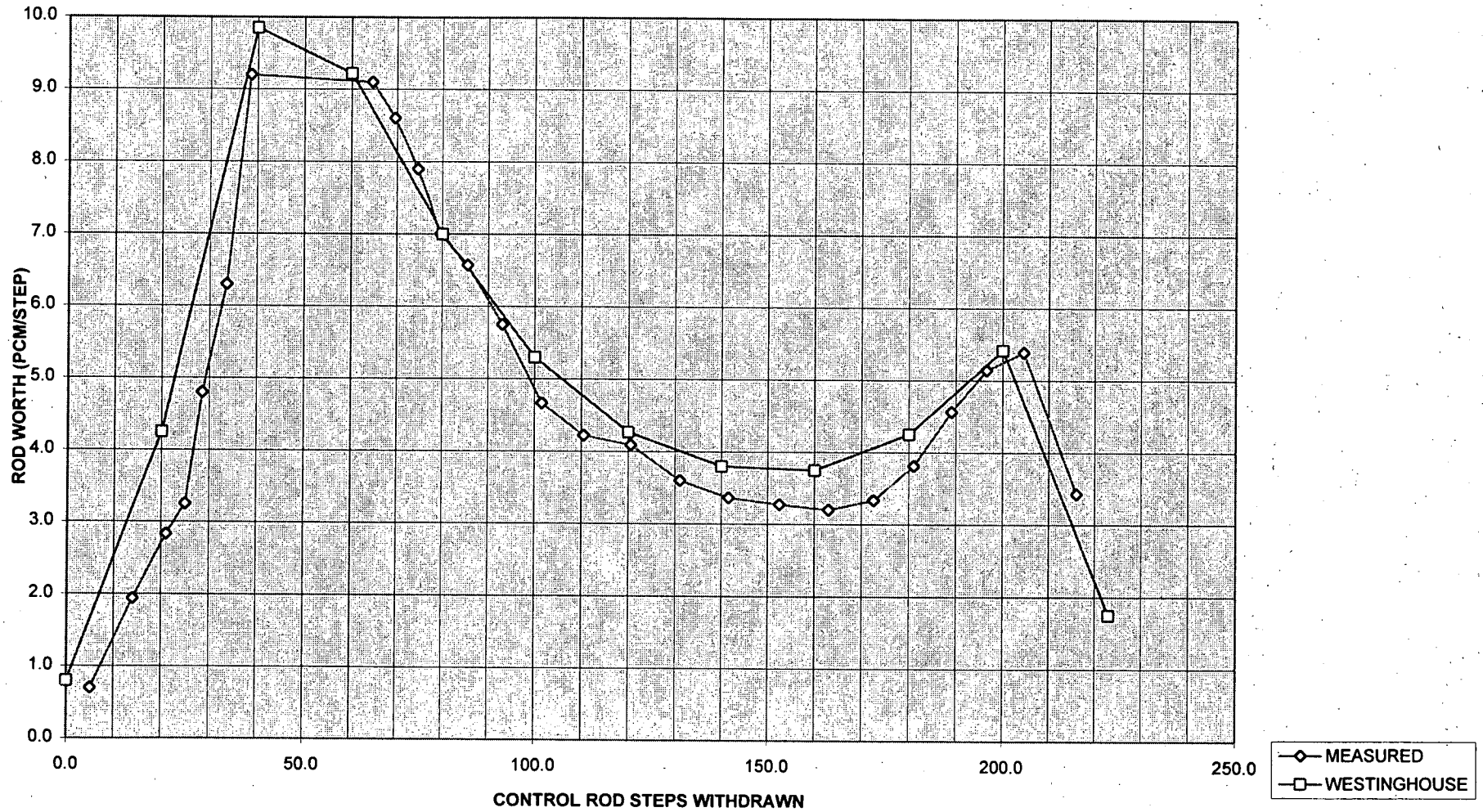


Figure 4.6-6
COMPARISON OF CONTROL BANK A DIFFERENTIAL ROD WORTH



5.0 REACTOR COOLANT SYSTEM FLOW DETERMINATION

The Reactor Coolant System flow measurement was performed at approximately 97% of full power. The Technical Specifications (Reference 2) require that the total RCS flow exceed 331,840 gpm prior to exceeding 98% of licensed power. Using the known reactor thermal power (Q) (Reference 6), enthalpies $h(T_h)$ and $h(T_c)$ at hot and cold leg temperatures, mass flow rate (W) is given by:

$$W = \frac{Q}{h(T_h) - h(T_c)}$$

The volumetric flow rate, then, is the mass flow rate multiplied by the specific volume at cold-leg temperature.

The calculated flow rate using this method was 351,160 gpm after correcting for temperature uncertainties. This measured flow rate met the minimum required by the Technical Specifications.

6.0 POWER DISTRIBUTION TESTS

The purpose of incore flux map testing was first, to verify that the Cycle 13 fuel loading pattern was correct; second, to verify core power distribution (quadrant power tilts, hot channel factors, and relative assembly powers, etc.) meets the required acceptance criteria; and third, to verify Westinghouse design predictions. Three full core flux maps were taken during power escalation at approximately 30%, 65% and 100% of full power. Table 6.0-1 is a summary of the calculated INCORE parameters for these three maps. The values listed for $F\Delta_H$ and F_Q include corrections for measurement and design uncertainties. The listed quadrant tilts are the maximum calculated values for each map.

Table 6.0-1

Summary of INCORE Paramaters

During Cycle 13 Startup

MAP	POWER (%)	$F\Delta_H$(1)	$F\Delta_H$ Acceptance Criteria	F_Q(2)	F_Q Acceptance Criteria	Quadrant Tilt	Tilt Review Criteria	Quadrant with Max. Tilt
13FC01	30	1.60	2.06	2.09	4.78	1.037	1.04	42
13FC02	65	1.56	1.88	1.97	3.69	1.025	1.02	42
13FC03	100	1.56	1.70	2.05	2.40	1.023	1.02	42

(1) With measurement uncertainty factor of 1.04

(2) With measurement and engineering uncertainty factors of 1.03 x 1.05

The flux traces were processed via the PROTEUS computer and transmitted to the in-house IBM computer, where they were analyzed using the INCORE-3-D code which extrapolates measured power from the assembly thimbles to all remaining assemblies in the core.

6.1 30% Power Flux Map

The 30% power flux map (13FC01) was performed on June 9, 1995 at approximately 23.4 MWD/MTU burnup with control Bank-D at 192 steps withdrawn. A summary output of the 30% power (13FC01) map is shown in Figures 6.1-1 to 6.1-4. The measured hot channel peaking factors met the acceptance criteria and were within Technical Specification limits. The maximum quadrant power tilt was 1.0368 and was located in the lower half of the core in Quadrant 42. Based upon a review of peaking factors it was concluded that power could be safely escalated to a maximum of 90%. A second map was scheduled to be taken at elevated power levels. No measured assembly power exceeded the power distribution review criteria of design assembly power $\pm$ 10% for relative assembly power greater than 0.9.

6.2 65% Power Flux Map

Following the reactor attaining 65% power, the 65% power flux map (13FC02) was performed on June 18, 1995 at approximately 154.7 MWD/MTU burnup with control Bank-D at 196 steps withdrawn. This map was a base map for the BOL Cycle 13 INCORE/EXCORE calibration. The measured assembly power and hot channel factors met their associated acceptance criteria and were within Technical Specification limits. The measured tilt was above the review criterion of 2% and was found to be acceptable after being reviewed and analyzed by Westinghouse. The evaluation indicated that even with the measured tilt, the power peaking factors were well below the Technical Specification limits and would not exceed the Technical Specification limits prior to the next flux map. A summary output of 13FC02 is shown in Figures 6.2-1 and 6.2-4.

6.3 100% Power Flux Map

The 100% power flux map (13FC03) was performed on July 13, 1995 at approximately 801.5 MWD/MTU with control Bank-D at 215 steps withdrawn. The measured assembly power hot channel factors met their associated acceptance criteria and were within Technical Specification limits. The measured tilt was above the review criterion of 2% and was found to be acceptable after being reviewed and analyzed by Westinghouse. The evaluation indicated that even with the measured tilt, the power peaking factors were well below the Technical Specification limits and would not exceed the Technical Specification limits prior to the next flux map. A summary output of 13FC03 is shown in Figures 6.3-1 to 6.3-4.

7.0 CONCLUSIONS

Based upon analysis of the startup physics test results, it is concluded that the measured core parameters verify the Cycle 13 nuclear design calculations and the proper loading of the core. All test values met acceptance criteria limits and requirements contained within the Indian Point 2 FSAR and Technical Specifications. These results include:

Doubling Time and Reactivity (Table 4.1-1)

Endpoint Boron Concentrations , Boron Worths and Differential Boron Worths (Table 4.4- 1)

Isothermal Temperature Coefficients (Table 4.5-1)

Control Bank Worths at BOL, HZP (Table 4.6-5)

Core Peaking factors from the INCORE code (Table 6.0-1)

The above tests results demonstrate adequate conservatism in Cycle 13 core performance with respect to the Indian Point 2 FSAR, Technical Specifications and the Cycle 13 reload safety evaluations.

8.0 REFERENCES

(1) Indian Point Nuclear Generating Unit No. 2 Updated Final Safety Analysis Report.

(2) Technical Specification and Bases, Appendix A to Facility Operating License DPR-26 for Consolidated Edison Company of New York, Inc., Indian Point Nuclear Generating Plant Unit No. 2, Docket No. 50-247.

(3) Indian Point Unit 2 Cycle 13 Reload Safety Evaluation, April 1995.

(4) WCAP 14302, Nuclear Parameters and Operations Package for Indian Point Unit 2, Cycle 13, April 1995.

(5) INCORE-3D Code Program's Manual, Version 7.4.0, August 1992.

(6) Indian Point Station Unit 2, SOP 15.1, Reactor Thermal Power Calculation.

FIGURE 6.1-1
30% Power Flux Map Summary Output

1 IP2 CY13,13FC01,30% POWER MAP,06-09-95,D-BANK=192, BU=23.4 MWD PER MTU
INCORE 3D 7.4.2 COPYRIGHT (C) WESTINGHOUSE ELECTRIC CORP. ALL RIGHTS RESERVED

MEASURED ASSEMBLY POWER AND PERCENT DIFF. TO EXPECTED POWER

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
					.369.	.564.	.594.	.723.	.576.	.524.	.310.				
R					-.8.	.4.	.9.	-.1.	-1.9.	-4.0.	-4.2.				
			.371.	.700.	1.161.	1.113.	1.103.	1.225.	1.055.	1.059.	1.120.	.707.	.362.		
P			.5.	1.1.	-1.0.	.3.	1.9.	1.0.	-2.4.	-3.8.	-3.8.	-4.5.	-4.5.		
		.309.	1.040.	1.235.	1.230.	1.172.	1.297.	1.278.	1.243.	1.118.	1.207.	1.189.	1.020.	.375.	
N		-2.2.	2.6.	2.7.	-.6.	1.9.	2.0.	.1.	-2.3.	-3.0.	-3.5.	-3.6.	-4.7.	-5.7.	
		.722.	1.215.	1.133.	1.175.	1.284.	1.278.	1.163.	1.266.	1.252.	1.141.	1.082.	1.185.	.688.	
M		.4.	1.2.	3.2.	.7.	.7.	-.7.	-1.9.	-1.7.	-2.3.	-3.2.	-3.3.	-4.7.	-5.8.	
	.375.	1.183.	1.281.	1.193.	1.254.	1.108.	1.168.	1.245.	1.148.	1.076.	1.208.	1.140.	1.195.	1.134.	.366.
L	-2.1.	.4.	3.2.	2.2.	1.1.	.7.	-.7.	-2.2.	-2.3.	-2.6.	-3.4.	-3.4.	-5.0.	-4.9.	-5.1.
	.556.	1.112.	1.168.	1.291.	1.113.	.914.	.910.	.834.	.893.	.875.	1.067.	1.216.	1.093.	1.040.	.504.
K	-1.0.	.2.	1.6.	1.4.	1.2.	1.2.	-.4.	-1.9.	-2.3.	-3.4.	-3.4.	-5.0.	-4.9.	-5.0.	-6.4.
	.597.	1.081.	1.279.	1.308.	1.195.	.929.	.751.	.798.	.740.	.895.	1.148.	1.253.	1.214.	.992.	.468.
J	2.3.	.3.	.9.	1.6.	1.6.	1.6.	-.1.	-1.9.	-1.7.	-2.1.	-2.2.	-2.2.	-3.5.	-5.3.	-7.6.
	.735.	1.233.	1.305.	1.223.	1.297.	.867.	.817.	.632.	.802.	.842.	1.254.	1.155.	1.229.	1.142.	.642.
H	4.2.	2.3.	2.4.	3.1.	1.9.	1.9.	.7.	-.3.	-1.5.	-1.0.	-1.3.	-2.2.	-2.7.	-3.3.	-5.4.
	.604.	1.112.	1.312.	1.345.	1.212.	.933.	.768.	.828.	.758.	.910.	1.168.	1.260.	1.231.	1.037.	.559.
G	2.9.	2.7.	3.1.	4.4.	3.1.	2.0.	2.2.	1.8.	.6.	-.5.	-.6.	-1.9.	-2.8.	-3.2.	-3.1.
	.575.	1.136.	1.195.	1.343.	1.155.	.940.	.946.	.876.	.919.	.904.	1.099.	1.258.	1.123.	1.079.	.545.
F	1.5.	1.5.	3.0.	4.4.	4.3.	3.7.	3.3.	2.7.	.3.	-.3.	-.6.	-1.8.	-3.0.	-3.4.	-3.3.
	.388.	1.233.	1.299.	1.211.	1.297.	1.161.	1.240.	1.313.	1.196.	1.111.	1.261.	1.154.	1.233.	1.165.	.369.
	3.1.	3.1.	2.9.	2.2.	3.3.	4.8.	5.2.	2.8.	1.4.	.3.	.6.	-2.5.	-2.5.	-2.9.	-3.2.
		.745.	1.290.	1.151.	1.227.	1.347.	1.355.	1.255.	1.320.	1.306.	1.191.	1.114.	1.214.	.737.	
D		4.7.	3.4.	2.2.	3.2.	4.4.	4.8.	5.3.	2.1.	1.3.	.5.	-.7.	-2.1.	-2.0.	
		.407.	1.102.	1.262.	1.315.	1.218.	1.335.	1.324.	1.306.	1.175.	1.272.	1.223.	1.037.	.373.	
C		2.3.	2.1.	1.0.	3.3.	4.3.	4.3.	3.2.	2.1.	1.0.	.6.	-1.8.	-3.1.	-2.9.	
			.380.	.763.	1.217.	1.129.	1.112.	1.266.	1.112.	1.121.	1.204.	.714.	.380.		
B			-.3.	.3.	.6.	.0.	2.0.	4.3.	2.2.	-.2.	.3.	-1.7.	-3.8.		
+															
					.388.	.573.	.590.	.725.	.603.	.568.	.379.				
+															. MEAS .
A					.7.	.2.	-.3.	2.0.	2.2.	.0.	.0.				
+															. DIFF .
+															

NOTE -- EXPECTED VALUES ARE CALCULATED FROM A SYNTHESIS OF MEASURED AXIAL POWER SHARINGS WITH PREDICTED REGIONWISE RADIAL PEAKING FACTORS

NOTE -- VALUES DO NOT INCLUDE F-DELTA-H UNCERTAINTY

STANDARD DEVIATION = 2.796 ROOT-MEAN-SQUARE ERROR = 2.795

THE MAXIMUM PERCENT DIFFERENCE IN MEASURED VS. EXPECTED ASSEMBLY POWER IS -7.607 IN LOCATION J 1

FIGURE 6.1-2
30% Power Flux Map Summary Output

1 IP2 CY13,13FC01,30% POWER MAP,06-09-95,D-BANK=192, BU=23.4 MWD PER MTU
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THE FOLLOWING CALCULATIONS ARE BASED ON A DIVISION

OF THE CORE INTO OCTANTS QUARDANTS

DIVIDED INTO TWO AXIAL REGIONS OF EQUAL VOLUME.

RELATIVE POWER IN UPPER HALF OF CORE		RELATIVE POWER IN LOWER HALF OF CORE		PERCENT AXIAL OFFSET TOWARD TOP OF CORE	
(-,+)	(+,+)	(-,+)	(+,+)	(-,+)	(+,+)
1.0458	1.0011	.9586	.9251	4.350	3.943
1.0767	1.0345	.9959	.9622	3.902	3.621
(-,-)	(+,-)	(-,-)	(+,-)	(-,-)	(+,-)

1 IP2 CY13,13FC01,30% POWER MAP,06-09-95,D-BANK=192, BU=23.4 MWD PER MTU
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POWER TILT IN UPPER HALF OF CORE		POWER TILT IN LOWER HALF OF CORE		CORE AVERAGE AXIAL OFFSET
(-,+)	(+,+)	(-,+)	(+,+)	
1.0061	.9630	.9981	.9632	3.954
1.0358	.9952	1.0368	1.0018	
(-,-)	(+,-)	(-,-)	(+,-)	

0

CALCULATED POWER TILTS (NORMALIZED TO 1.000) BASED ON ASSEMBLY POWER FROM ALL ASSEMBLIES

P R E D I C T E D

.9936	.9974	.9929	.9957	.9955	
.9922	.9939	.9982	.9978		
1.0041	1.0017	1.0071	1.0043		
1.0100	1.0070			1.0085	

FIGURE 6.1-3
30% Power Flux Map Summary Output

1 IP2 CY13,13FC01,30% POWER MAP,06-09-95,D-BANK=192, BU=23.4 MWD PER MTU
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TOP TWENTY NUCLEAR F-DELTA-H

LIMIT = 2.057

SOURCE NO	SOURCE ID	FDHN NUCLEAR	FDH INCLUDING UNCERTAINTIES
329	E14NC	1.5429	1.6046
371	B11MB	1.5220	1.5829
359	C11LJ	1.5218	1.5827
335	E 8JO	1.5155	1.5761
377	B 5CB	1.5058	1.5661
330	E13FD	1.4915	1.5511
239	L14NM	1.4866	1.5461
287	H11AF	1.4797	1.5389
361	C 9FD	1.4795	1.5386
344	D13JA	1.4776	1.5367
347	D10FD	1.4774	1.5365
316	F12LJ	1.4736	1.5325
240	L13FL	1.4699	1.5287
358	C12OF	1.4690	1.5277
332	E11EL	1.4670	1.5257
348	D 9FL	1.4622	1.5207
203	P11MN	1.4590	1.5174
341	E 2BC	1.4567	1.5150
365	C 5DJ	1.4565	1.5148
300	G13LJ	1.4537	1.5118

FDH MARGIN = 21.99 %

NOTE: FDH = FDHN * FHE * FHU WHERE
FHE = ENGINEERING UNCERTAINTY (FHE = 1.01)
FHU = NUCLEAR MEASUREMENT UNCERTAINTY (FHU = 1.04)

FIGURE 6.1-4
30% Power Flux Map Summary Output

1 IP2 CY13,13FC01,30% POWER MAP,06-09-95,D-BANK=192, BU=23.4 MWD PER MTU
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LIMITING FQ COMPUTED COMPARED TO STEADY-STATE FQ LIMIT AT EACH AXIAL POINT

AXIAL POINT	FQ NUC (FQN)	FQ COMP (FQC)	STEADY STATE FQ(Z) LIMIT	% MARGIN TO STEADY-STATE FQ LIMIT	SOURCE NO.	ID	AXIAL POINT	FQ NUC (FQN)	FQ COMP (FQC)	STEADY STATE FQ(Z) LIMIT	% MARGIN TO STEADY-STATE FQ LIMIT	SOURCE NO.	ID
1	1.0556	1.1416	4.4400	74.2885	420	M12XX	32	1.8338	1.9833	4.8000	58.6819	564	B11XX
2	1.1140	1.2048	4.4520	72.9391	422	M10XX	33	1.8443	1.9946	4.8000	58.4453	522	E14XX
3	1.1734	1.2690	4.4640	71.5729	449	K12XX	34	1.8441	1.9944	4.8000	58.4504	522	E14XX
4	1.3141	1.4212	4.4760	68.2487	540	D10XX	35	1.8406	1.9906	4.8000	58.5289	522	E14XX
5	1.4238	1.5398	4.4880	65.6899	540	D10XX	36	1.8351	1.9846	4.8000	58.6540	522	E14XX
6	1.5175	1.6412	4.5000	63.5288	540	D10XX	37	1.8197	1.9680	4.8000	58.9997	522	E14XX
7	1.4888	1.6101	4.5120	64.3152	543	D 7XX	38	1.6872	1.8247	4.8000	61.9845	522	E14XX
8	1.6599	1.7951	4.5240	60.3198	442	L 4XX	39	1.8001	1.9469	4.8000	59.4406	564	B11XX
9	1.7339	1.8752	4.5360	58.6595	528	E 8XX	40	1.8133	1.9611	4.8000	59.1430	522	E14XX
10	1.7480	1.8904	4.5480	58.4341	528	E 8XX	41	1.8110	1.9587	4.8000	59.1948	522	E14XX
11	1.7449	1.8871	4.5600	58.6170	528	E 8XX	42	1.7936	1.9398	4.8000	59.5871	522	E14XX
12	1.7595	1.9029	4.5720	58.3789	528	E 8XX	43	1.7786	1.9236	4.8000	59.9260	522	E14XX
13	1.7694	1.9136	4.5840	58.2549	528	E 8XX	44	1.7693	1.9135	4.8000	60.1347	522	E14XX
14	1.7761	1.9208	4.5960	58.2071	528	E 8XX	45	1.7272	1.8680	4.8000	61.0832	522	E14XX
15	1.7685	1.9127	4.6080	58.4923	522	E14XX	46	1.6048	1.7356	4.8000	63.8414	564	B11XX
16	1.6555	1.7905	4.6200	61.2451	522	E14XX	47	1.7092	1.8485	4.8000	61.4896	564	B11XX
17	1.8003	1.9470	4.6320	57.9653	522	E14XX	48	1.6928	1.8308	4.8000	61.8589	522	E14XX
18	1.8405	1.9905	4.6440	57.1373	522	E14XX	49	1.6745	1.8110	4.8000	62.2712	522	E14XX
19	1.8524	2.0034	4.6560	56.9713	522	E14XX	50	1.6329	1.7659	4.8000	63.2094	522	E14XX
20	1.8525	2.0035	4.6680	57.0812	371	B11MB	51	1.5974	1.7276	4.8000	64.0089	522	E14XX
21	1.8785	2.0316	4.6800	56.5897	522	E14XX	52	1.5711	1.6991	4.8000	64.6012	570	B 5XX
22	1.8959	2.0505	4.6920	56.2988	522	E14XX	53	1.4162	1.5316	4.8000	68.0911	522	E14XX
23	1.8821	2.0355	4.7040	56.7283	522	E14XX	54	1.3878	1.5009	4.8000	68.7308	564	B11XX
24	1.7836	1.9290	4.7160	59.0974	522	E14XX	55	1.3441	1.4536	4.8000	69.7160	329	E14NC
25	1.8802	2.0335	4.7280	56.9906	522	E14XX	56	1.2340	1.3346	4.8000	72.1956	329	E14NC
26	1.9230	2.0798	4.7400	56.1232	522	E14XX	57	1.1523	1.2462	4.8000	74.0371	556	C 7XX
27	1.9243	2.0811	4.7520	56.2062	522	E14XX	58	1.0117	1.0942	4.8000	77.2046	509	F12XX
[illegible]	1.8944	2.0488	4.7640	56.9944	522	E14XX	59	.9870	1.0674	4.8000	77.7617	423	M 9XX
[illegible]	1.9291	2.0864	4.7760	56.3155	522	E14XX	60	.7161	.7744	4.8000	83.8657	410	N 9XX
30	1.9075	2.0629	4.7880	56.9148	522	E14XX	61	.8877	.9600	4.8000	80.0001	540	D10XX
31	1.7318	1.8729	4.8000	60.9810	522	E14XX							

NOTE: FQC = FQN * FQE * FQU WHERE
FQN = FXY(Z) * CORE AVG F(Z)
FQE = ENGINEERING UNCERTAINTY (FQE = 1.03)
FQU = NUCLEAR MEASUREMENT UNCERTAINTY (FQU = 1.05).

NOTE: STEADY-STATE FQ LIMIT = FQRTP * K(Z)/P, P GREATER THAN 0.5
FQRTP * K(Z)/0.5, P LESS THEN OR EQUAL TO 0.5
K(Z) = NORMALIZED FQ LIMIT AS A FUNCTION OF CORE HEIGHT
P = RELATIVE CORE POWER (P = .300)

NOTE: PERCENT MARGIN TO STEADY-STATE FQ LIMIT = (1.0 - (FQC/STEADY-STATE FQ LIMIT)) * 100.0

NOTE: STEADY STATE FQ LIMIT APPLICABLE TO FQC AT ALL AXIAL POINTS

NOTE: DETERMINATION OF LIMITING FQ IS BASED ON PERCENT TO FQ LIMIT.

*** NO VALUES EXCEEDED THE STEADY-STATE FQ LIMIT ***

FIGURE 6.2-1
65% Power Flux Map Summary Output

1 IP2 CY13,13FC02,65% POWER, 06-18-95, D-BANK=196, BU= 154.7 MWD PER MTU
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MEASURED ASSEMBLY POWER AND PERCENT DIFF. TO EXPECTED POWER

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
R					.374. -1.8.	.568. -.9.	.608. 1.4.	.752. 2.5.	.590. -1.3.	.528. -5.2.	.316. -4.8.				
P			.368. -2.1.	.691. -.9.	1.137. -1.8.	1.095. -1.0.	1.078. .2.	1.220. 1.4.	1.065. -.8.	1.067. -2.7.	1.112. -3.2.	.706. -4.4.	.363. -5.5.		
N		.309. -4.1.	1.003. .0.	1.184. .0.	1.201. -1.6.	1.141. .2.	1.263. .3.	1.261. -.6.	1.254. -.5.	1.144. .4.	1.209. -1.9.	1.156. -4.4.	.994. -5.7.	.375. -6.8.	
M		.717. -.3.	1.173. -.7.	1.101. 1.0.	1.160. .3.	1.267. .4.	1.288. .5.	1.185. -.4.	1.264. -1.4.	1.262. -.4.	1.171. .5.	1.061. -4.3.	1.136. -6.9.	.683. -6.8.	
L	.393. .9.	1.176. 1.3.	1.248. 2.0.	1.173. 1.5.	1.241. .7.	1.108. .3.	1.189. .5.	1.286. .5.	1.170. -1.1.	1.084. -2.1.	1.206. -2.7.	1.116. -4.4.	1.182. -4.6.	1.122. -4.5.	.374. -4.6.
K	.579. 1.2.	1.121. 1.4.	1.155. 1.5.	1.274. 1.0.	1.111. .7.	.933. .5.	.941. -.1.	.877. -.9.	.929. -1.4.	.904. -2.8.	1.077. -2.7.	1.209. -4.5.	1.086. -4.5.	1.041. -4.7.	.522. -4.8.
J	.606. 1.8.	1.089. 1.6.	1.273. 1.4.	1.312. 2.4.	1.205. 1.9.	.949. .8.	.789. -.7.	.843. -2.2.	.786. -1.3.	.925. -1.9.	1.156. -2.2.	1.249. -2.1.	1.229. -1.3.	1.018. -2.3.	.491. -5.0.
H	.729. 1.9.	1.218. 1.8.	1.293. 2.1.	1.228. 3.3.	1.327. 3.8.	.912. 3.0.	.869. 1.2.	.689. .5.	.848. -1.7.	.871. -1.5.	1.257. -1.5.	1.160. -2.1.	1.258. .2.	1.204. 2.6.	.681. -1.2.
G	.603. .9.	1.084. .8.	1.275. 1.3.	1.316. 2.6.	1.221. 3.3.	.982. 4.2.	.830. 4.5.	.878. 2.0.	.795. -.1.	.935. -.8.	1.173. -.7.	1.263. -1.2.	1.253. .0.	1.056. -.8.	.583. -.9.
F	.576. -.2.	1.113. -.1.	1.161. 1.2.	1.305. 2.6.	1.138. 2.6.	.968. 4.2.	.973. 3.1.	.897. 1.3.	.943. -.1.	.927. -.4.	1.098. -.8.	1.258. -.6.	1.137. -.6.	1.080. -2.7.	.547. -4.5.
E	.389. 1.0.	1.191. 1.0.	1.253. .8.	1.175. .3.	1.263. 1.7.	1.146. 3.3.	1.228. 3.8.	1.312. 2.4.	1.210. 2.0.	1.109. -.1.	1.289. 3.8.	1.145. -2.0.	1.216. -2.0.	1.144. -2.9.	.370. -4.4.
D		.730. 2.2.	1.238. 1.2.	1.117. .3.	1.192. 1.6.	1.313. 3.1.	1.334. 3.9.	1.253. 4.9.	1.320. 2.7.	1.301. 2.2.	1.215. 3.8.	1.110. .1.	1.171. -3.6.	.722. -3.5.	
C		.409. 1.6.	1.073. 1.1.	1.230. .6.	1.269. 1.7.	1.185. 2.9.	1.311. 3.8.	1.309. 2.9.	1.270. .5.	1.160. .9.	1.290. 3.8.	1.228. .7.	1.041. -1.0.	.384. -.9.	
B			.390. 1.0.	.757. .1.	1.174. -1.1.	1.103. -1.6.	1.090. 1.0.	1.244. 3.5.	1.088. .8.	1.097. -1.8.	1.194. 1.0.	.748. 2.7.	.406. 1.7.		
A					.388. -1.0.	.573. -1.3.	.592. -1.4.	.727. 1.0.	.606. .9.	.568. -1.7.	.380. -1.7.				MEAS DIFF

NOTE -- EXPECTED VALUES ARE CALCULATED FROM A SYNTHESIS OF MEASURED AXIAL POWER SHARINGS WITH PREDICTED REGIONWISE RADIAL PEAKING FACTORS

NOTE -- VALUES DO NOT INCLUDE F-DELTA-H UNCERTAINTY

STANDARD DEVIATION = 2.469 ROOT-MEAN-SQUARE ERROR = 2.471

THE MAXIMUM PERCENT DIFFERENCE IN MEASURED VS. EXPECTED ASSEMBLY POWER IS -6.900 IN LOCATION M 3

FIGURE 6.2-2
65% Power Flux Map Summary Output

1 IP2 CY13,13FC02,65% POWER, 06-18-95, D-BANK=196, BU= 154.7 MWD PER MTU
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THE FOLLOWING CALCULATIONS ARE BASED ON A DIVISION

OF THE CORE INTO OCTANTS QUARDANTS

DIVIDED INTO TWO AXIAL REGIONS OF EQUAL VOLUME.

RELATIVE POWER IN UPPER HALF OF CORE		RELATIVE POWER IN LOWER HALF OF CORE		PERCENT AXIAL OFFSET TOWARD TOP OF CORE	
(-,+)	(+,+)	(-,+)	(+,+)	(-,+)	(+,+)
.9794	.9502	1.0212	.9919	-2.085	-2.146
1.0013	.9797	1.0476	1.0287	-2.263	-2.443
(-,-)	(+,-)	(-,-)	(+,-)	(-,-)	(+,-)

1 IP2 CY13,13FC02,65% POWER, 06-18-95, D-BANK=196, BU= 154.7 MWD PER MTU
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POWER TILT IN UPPER HALF OF CORE		POWER TILT IN LOWER HALF OF CORE		CORE AVERAGE AXIAL OFFSET
(-,+)	(+,+)	(-,+)	(+,+)	
1.0018	.9720	.9988	.9702	-2.234
1.0242	1.0020	1.0247	1.0062	
(-,-)	(+,-)	(-,-)	(+,-)	

0

CALCULATED POWER TILTS (NORMALIZED TO 1.000) BASED ON ASSEMBLY POWER FROM ALL ASSEMBLIES

P R E D I C T E D

.9955	.9979			.9967	
.9933	.9946	.9944	.9962		
1.0042	1.0007			.9988	.9977
		1.0061	1.0033		
1.0079	1.0059			1.0069	

FIGURE 6.2-3
65% Power Flux Map Summary Output

1 IP2 CY13,13FC02,65% POWER, 06-18-95, D-BANK=196, BU= 154.7 MWD PER MTU
NCORE 3D 7.4.2 COPYRIGHT (C) WESTINGHOUSE ELECTRIC CORP. ALL RIGHTS RESERVED PAGE- 308

TOP TWENTY NUCLEAR F-DELTA-H

LIMIT = 1.878

SOURCE NO	ID	FDHN NUCLEAR	FDH INCLUDING UNCERTAINTIES
287	H11AJ	1.5034	1.5636
335	E 8FO	1.4994	1.5594
377	B 5CB	1.4793	1.5385
329	E14NC	1.4755	1.5345
365	C 5DJ	1.4738	1.5328
359	C11LJ	1.4688	1.5276
239	L14NM	1.4643	1.5228
245	L 8FA	1.4564	1.5147
371	B11MB	1.4546	1.5128
361	C 9FD	1.4526	1.5108
338	E 5KL	1.4508	1.5088
351	D 6JD	1.4492	1.5072
366	C 4AF	1.4485	1.5064
347	D10FD	1.4389	1.4965
348	D 9JL	1.4371	1.4945
330	E13FD	1.4335	1.4908
316	F12LJ	1.4315	1.4887
240	L13FL	1.4286	1.4858
293	H 5OJ	1.4227	1.4796
332	E11EL	1.4223	1.4792

FDH MARGIN = 16.76 %

NOTE: FDH = FDHN * FHE * FHU WHERE
FHE = ENGINEERING UNCERTAINTY (FHE = 1.01)
FHU = NUCLEAR MEASUREMENT UNCERTAINTY (FHU = 1.04)

FIGURE 6.2-4
65% Power Flux Map Summary Output

CY13,13FC02,65% POWER, 06-18-95, D-BANK=196, BU= 154.7 MWD PER MTU
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LIMITING FQ COMPUTED COMPARED TO STEADY-STATE FQ LIMIT AT EACH AXIAL POINT

AXIAL POINT	FQ NUC (FQN)	FQ COMP (FQC)	STEADY STATE FQ(Z) LIMIT	% MARGIN TO STEADY-STATE FQ LIMIT	SOURCE NO.	ID
1	.8898	.9623	3.4153	71.8255	509	F12XX
2	.9207	.9958	3.4246	70.9226	529	E 7XX
3	1.0909	1.1798	3.4338	65.6430	540	D10XX
4	1.2009	1.2987	3.4430	62.2796	540	D10XX
5	1.3357	1.4445	3.4523	58.1578	335	E 8FO
6	1.3717	1.4835	3.4615	57.1440	528	E 8XX
7	1.3762	1.4884	3.4707	57.1159	287	H11AJ
8	1.5300	1.6547	3.4800	52.4521	335	E 8FO
9	1.5592	1.6863	3.4892	51.6706	480	H11XX
10	1.5757	1.7042	3.4984	51.2882	335	E 8FO
11	1.5959	1.7259	3.5076	50.7958	335	E 8FO
12	1.6113	1.7426	3.5169	50.4497	528	E 8XX
13	1.6209	1.7530	3.5261	50.2844	528	E 8XX
14	1.6344	1.7676	3.5353	50.0013	528	E 8XX
15	1.6472	1.7814	3.5446	49.7432	480	H11XX
16	1.5384	1.6638	3.5538	53.1831	528	E 8XX
17	1.6585	1.7937	3.5630	49.6582	528	E 8XX
18	1.6625	1.7980	3.5723	49.6677	528	E 8XX
19	1.6692	1.8052	3.5815	49.5957	528	E 8XX
20	1.6730	1.8094	3.5907	49.6110	528	E 8XX
21	1.6865	1.8239	3.6000	49.3349	528	E 8XX
22	1.6894	1.8271	3.6092	49.3778	528	E 8XX
23	1.6793	1.8162	3.6184	49.8074	522	E14XX
24	1.5841	1.7132	3.6276	52.7756	522	E14XX
[illegible]	1.7057	1.8447	3.6369	49.2776	528	E 8XX
[illegible]	1.7179	1.8579	3.6461	49.0441	522	E14XX
27	1.7268	1.8676	3.6553	48.9093	522	E14XX
28	1.7222	1.8625	3.6646	49.1750	570	B 5XX
29	1.7392	1.8810	3.6738	48.8005	522	E14XX
30	1.7375	1.8791	3.6830	48.9811	522	E14XX
31	1.6386	1.7722	3.6923	52.0030	522	E14XX
32	1.7697	1.9139	3.6923	48.1658	564	B11XX
33	1.8172	1.9653	3.6923	46.7733	564	B11XX
34	1.8119	1.9596	3.6923	46.9280	564	B11XX
35	1.8066	1.9539	3.6923	47.0827	564	B11XX
36	1.8119	1.9596	3.6923	46.9280	564	B11XX
37	1.7986	1.9452	3.6923	47.3177	329	E14NC
38	1.6826	1.8197	3.6923	50.7166	329	E14NC
39	1.8013	1.9482	3.6923	47.2375	564	B11XX
40	1.8130	1.9607	3.6923	46.8969	329	E14NC
41	1.8041	1.9512	3.6923	47.1558	329	E14NC
42	1.8057	1.9529	3.6923	47.1100	329	E14NC
43	1.8039	1.9509	3.6923	47.1640	329	E14NC
44	1.8056	1.9528	3.6923	47.1127	329	E14NC
45	1.7763	1.9211	3.6923	47.9706	329	E14NC
46	1.6482	1.7825	3.6923	51.7246	564	B11XX
47	1.7538	1.8967	3.6923	48.6300	564	B11XX
48	1.7735	1.9180	3.6923	48.0532	377	B 5CB
49	1.7524	1.8953	3.6923	48.6698	377	B 5CB
50	1.7272	1.8680	3.6923	49.4087	377	B 5CB
51	1.7154	1.8552	3.6923	49.7541	377	B 5CB
52	1.6812	1.8183	3.6923	50.7553	377	B 5CB
53	1.5108	1.6339	3.6923	55.7480	377	B 5CB
54	1.5125	1.6357	3.6923	55.6989	570	B 5XX
55	1.5378	1.6631	3.6923	54.9573	558	C 5XX
56	1.4195	1.5352	3.6923	58.4221	558	C 5XX
57	1.3052	1.4116	3.6923	61.7695	558	C 5XX
58	1.1229	1.2144	3.6923	67.1103	556	C 7XX
59	1.1985	1.2962	3.6923	64.8955	422	M10XX
60	.8011	.8664	3.6923	76.5339	544	D 6XX
61	1.0424	1.1274	3.6923	69.4674	540	D10XX

NOTE: FQC = FQN * FQE * FQU WHERE
FQN = FXY(Z) * CORE AVG F(Z)
FQE = ENGINEERING UNCERTAINTY (FQE = 1.03)
FQU = NUCLEAR MEASUREMENT UNCERTAINTY (FQU = 1.05)

NOTE: STEADY-STATE FQ LIMIT = FQRTP * K(Z)/P, P GREATER THAN 0.5
FQRTP * K(Z)/0.5, P LESS THEN OR EQUAL TO 0.5
K(Z) = NORMALIZED FQ LIMIT AS A FUNCTION OF CORE HEIGHT
P = RELATIVE CORE POWER (P = .650)

NOTE: PERCENT MARGIN TO STEADY-STATE FQ LIMIT = (1.0 - (FQC/STEADY-STATE FQ LIMIT)) * 100.0

NOTE: STEADY STATE FQ LIMIT APPLICABLE TO FQC AT ALL AXIAL POINTS

NOTE: DETERMINATION OF LIMITING FQ IS BASED ON PERCENT TO FQ LIMIT.

*** NO VALUES EXCEEDED THE STEADY-STATE FQ LIMIT ***

FIGURE 6.3-1
100% Power Flux Map Summary Output

CY13,13FC03,100%POWER, 07-13-95, D-BANK=215, BU= 801.5 MWD PER MTU
ORE 3D 7.4.2 COPYRIGHT (C) WESTINGHOUSE ELECTRIC CORP. ALL RIGHTS RESERVED

MEASURED ASSEMBLY POWER AND PERCENT DIFF. TO EXPECTED POWER

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
					.383.	.585.	.607.	.735.	.592.	.549.	.328.				
R					.6.	1.0.	1.3.	1.0.	-1.0.	-3.2.	-3.1.				
			.369.	.697.	1.168.	1.163.	1.109.	1.203.	1.078.	1.117.	1.122.	.709.	.367.		
P			-.3.	.4.	.5.	.9.	1.4.	1.3.	-1.3.	-2.4.	-2.9.	-3.0.	-3.2.		
		.315.	1.000.	1.196.	1.218.	1.183.	1.257.	1.271.	1.218.	1.151.	1.191.	1.177.	1.016.	.386.	
N		-.8.	.2.	.2.	.7.	1.5.	1.6.	-.2.	-1.6.	-1.5.	-2.6.	-3.5.	-3.3.	-3.1.	
		.708.	1.190.	1.092.	1.190.	1.253.	1.236.	1.129.	1.213.	1.226.	1.161.	1.066.	1.192.	.711.	
M		-.3.	.3.	.8.	1.0.	1.0.	.0.	-1.4.	-1.8.	-1.6.	-2.4.	-3.4.	-3.4.	-3.1.	
	.381.	1.158.	1.228.	1.184.	1.229.	1.127.	1.153.	1.252.	1.142.	1.108.	1.231.	1.151.	1.190.	1.140.	.379.
L	-1.9.	-.4.	1.4.	.5.	.4.	1.0.	.1.	-1.0.	-1.0.	-1.0.	-.2.	-3.4.	-3.2.	-3.5.	-3.4.
	.571.	1.146.	1.167.	1.234.	1.125.	.936.	.961.	.882.	.959.	.922.	1.117.	1.208.	1.126.	1.097.	.536.
K	-1.1.	-.4.	.3.	-.3.	1.0.	1.6.	.7.	.5.	.3.	-.2.	-.2.	-3.0.	-3.3.	-3.6.	-3.5.
	.596.	1.084.	1.230.	1.244.	1.167.	.975.	.812.	.893.	.817.	.964.	1.150.	1.215.	1.198.	1.026.	.498.
J	.4.	-.3.	-.2.	.7.	1.3.	2.2.	1.4.	.5.	1.9.	.9.	-.2.	-1.3.	-2.1.	-3.0.	-3.4.
	.715.	1.185.	1.275.	1.160.	1.287.	.905.	.911.	.737.	.900.	.885.	1.259.	1.126.	1.239.	1.137.	.667.
H	1.1.	.4.	.3.	1.4.	1.7.	3.0.	2.7.	2.6.	1.1.	.9.	-.3.	-1.3.	-1.7.	-1.8.	-2.6.
	.597.	1.090.	1.237.	1.249.	1.168.	.989.	.842.	.922.	.820.	.963.	1.147.	1.219.	1.212.	1.058.	.575.
G	-.1.	-.3.	-.1.	1.0.	1.4.	3.5.	5.2.	3.8.	2.3.	.8.	-.4.	-1.1.	-1.6.	-2.1.	-2.2.
	.577.	1.149.	1.175.	1.263.	1.132.	.962.	.995.	.914.	.976.	.932.	1.115.	1.232.	1.151.	1.129.	.565.
	-1.3.	-1.2.	-.2.	1.0.	.9.	4.2.	4.1.	4.0.	2.0.	.9.	-.4.	-1.0.	-1.7.	-2.4.	-2.6.
	.387.	1.190.	1.239.	1.202.	1.252.	1.152.	1.191.	1.304.	1.187.	1.145.	1.261.	1.165.	1.203.	1.151.	.377.
E	.3.	.2.	.3.	.4.	1.2.	2.6.	3.2.	2.8.	2.7.	2.0.	2.0.	-2.3.	-2.3.	-2.6.	-2.6.
		.730.	1.250.	1.113.	1.213.	1.278.	1.270.	1.175.	1.253.	1.265.	1.219.	1.099.	1.188.	.718.	
D		1.8.	1.0.	.4.	1.2.	2.0.	2.5.	2.2.	1.0.	.9.	1.9.	-.5.	-3.0.	-2.9.	
		.405.	1.070.	1.244.	1.253.	1.205.	1.272.	1.299.	1.242.	1.184.	1.260.	1.219.	1.017.	.370.	
C		1.7.	1.2.	.9.	1.3.	2.1.	2.4.	1.6.	-.2.	.3.	2.0.	-1.2.	-2.9.	-2.8.	
			.386.	.759.	1.208.	1.172.	1.108.	1.222.	1.105.	1.157.	1.197.	.727.	.384.		
B			1.5.	1.6.	1.5.	.3.	.9.	2.8.	.5.	-.9.	.5.	-.4.	-2.7.		
+															. . . .
					.398.	.590.	.596.	.723.	.607.	.581.	.385.				
+															. MEAS .
A					1.6.	.4.	-.8.	1.0.	1.0.	-.9.	-.8.				
+															. DIFF .
+															. . . .

NOTE -- EXPECTED VALUES ARE CALCULATED FROM A SYNTHESIS OF MEASURED AXIAL POWER SHARINGS WITH PREDICTED REGIONWISE RADIAL PEAKING FACTORS

NOTE -- VALUES DO NOT INCLUDE F-DELTA-H UNCERTAINTY

STANDARD DEVIATION = 1.899 ROOT-MEAN-SQUARE ERROR = 1.895

THE MAXIMUM PERCENT DIFFERENCE IN MEASURED VS. EXPECTED ASSEMBLY POWER IS 5.240 IN LOCATION G 9

FIGURE 6.3-2
100% Power Flux Map Summary Output

1 IP2 CY13,13FC03,100%POWER, 07-13-95, D-BANK=215, BU= 801.5 MWD PER MTU
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THE FOLLOWING CALCULATIONS ARE BASED ON A DIVISION

OF THE CORE INTO OCTANTS QUARDANTS

DIVIDED INTO TWO AXIAL REGIONS OF EQUAL VOLUME.

RELATIVE POWER IN UPPER HALF OF CORE		RELATIVE POWER IN LOWER HALF OF CORE		PERCENT AXIAL OFFSET TOWARD TOP OF CORE	
(-,+)	(+,+)	(-,+)	(+,+)	(-,+)	(+,+)
.9479	.9319	1.0505	1.0253	-5.136	-4.775
.9651	.9491	1.0759	1.0543	-5.426	-5.248
(-,-)	(+,-)	(-,-)	(+,-)	(-,-)	(+,-)

1 IP2 CY13,13FC03,100%POWER, 07-13-95, D-BANK=215, BU= 801.5 MWD PER MTU
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POWER TILT IN UPPER HALF OF CORE		POWER TILT IN LOWER HALF OF CORE		CORE AVERAGE AXIAL OFFSET
(-,+)	(+,+)	(-,+)	(+,+)	
.9994	.9824	.9991	.9751	-5.146
1.0175	1.0007	1.0232	1.0027	
(-,-)	(+,-)	(-,-)	(+,-)	

0

CALCULATED POWER TILTS (NORMALIZED TO 1.000) BASED ON ASSEMBLY POWER FROM ALL ASSEMBLIES

P R E D I C T E D

.9947	.9982	.9931	.9965	.9964	
.9915	.9948	.9983	.9976		
1.0050	1.0003	1.0065	1.0039	1.0078	
1.0080	1.0075				

FIGURE 6.3-3
100% Power Flux Map Summary Output

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1 IP2 CY13,13FC03,100%POWER, 07-13-95, D-BANK=215, BU= 801.5 MWD PER MTU
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TOP TWENTY NUCLEAR F-DELTA-H

LIMIT = 1.700

SOURCE NO	ID	FDHN NUCLEAR	FDH INCLUDING UNCERTAINTIES
371	B11MB	1.4974	1.5573
377	B 5CB	1.4802	1.5394
329	E14NC	1.4719	1.5308
335	E 8JO	1.4562	1.5144
203	P11MN	1.4524	1.5105
359	C11LJ	1.4431	1.5009
239	L14NM	1.4423	1.5000
365	C 5DJ	1.4384	1.4960
287	H11AJ	1.4321	1.4893
341	E 2BC	1.4268	1.4839
366	C 4AF	1.4243	1.4813
338	E 5KL	1.4195	1.4762
344	D13JA	1.4137	1.4703
330	E13FD	1.4130	1.4695
332	E11EL	1.4099	1.4662
358	C12OF	1.4067	1.4630
251	L 2BM	1.4067	1.4630
240	L13FL	1.4055	1.4618
209	P 5CN	1.4048	1.4610
351	D 6JD	1.4032	1.4593

FDH MARGIN = 8.39 %

NOTE: FDH = FDHN * FHE * FHU WHERE
FHE = ENGINEERING UNCERTAINTY (FHE = 1.01)
FHU = NUCLEAR MEASUREMENT UNCERTAINTY (FHU = 1.04)

FIGURE 6.3-4
100% Power Flux Map Summary Output

1 IP2 CY13,13FC03,100%POWER, 07-13-95, D-BANK=215, BU= 801.5 MWD PER MTU
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LIMITING FQ COMPUTED COMPARED TO STEADY-STATE FQ LIMIT AT EACH AXIAL POINT

AXIAL POINT	FQ NUC (FQN)	FQ COMP (FQC)	STEADY STATE FQ(Z) LIMIT	% MARGIN TO STEADY-STATE FQ LIMIT	SOURCE NO.	ID	AXIAL POINT	FQ NUC (FQN)	FQ COMP (FQC)	STEADY STATE FQ(Z) LIMIT	% MARGIN TO STEADY-STATE FQ LIMIT	SOURCE NO.	ID
1	.7796	.8431	2.2200	62.0227	422	M10XX	32	1.7435	1.8856	2.4000	21.4325	377	B 5CB
2	.9332	1.0093	2.2260	54.6584	71	K 4	33	1.8169	1.9649	2.4000	18.1276	564	B11XX
3	1.1015	1.1913	2.2320	46.6280	544	D 6XX	34	1.8237	1.9723	2.4000	17.8204	564	B11XX
4	1.1283	1.2203	2.2380	45.4747	544	D 6XX	35	1.8271	1.9760	2.4000	17.6668	564	B11XX
5	1.1802	1.2763	2.2440	43.1217	457	K 4XX	36	1.8475	1.9981	2.4000	16.7452	564	B11XX
6	1.2533	1.3555	2.2500	39.7565	528	E 8XX	37	1.8373	1.9871	2.4000	17.2060	564	B11XX
7	1.2494	1.3512	2.2560	40.1051	528	E 8XX	38	1.6879	1.8255	2.4000	23.9372	329	E14NC
8	1.3957	1.5094	2.2620	33.2693	544	D 6XX	39	1.8165	1.9646	2.4000	18.1421	377	B 5CB
9	1.4300	1.5466	2.2680	31.8087	528	E 8XX	40	1.8612	2.0129	2.4000	16.1308	564	B11XX
10	1.4553	1.5739	2.2740	30.7879	528	E 8XX	41	1.8680	2.0202	2.4000	15.8235	564	B11XX
11	1.4747	1.5949	2.2800	30.0474	528	E 8XX	42	1.8748	2.0276	2.4000	15.5163	564	B11XX
12	1.4901	1.6115	2.2860	29.5059	528	E 8XX	43	1.8816	2.0350	2.4000	15.2091	564	B11XX
13	1.5034	1.6260	2.2920	29.0597	528	E 8XX	44	1.8953	2.0497	2.4000	14.5947	564	B11XX
14	1.5202	1.6441	2.2980	28.4532	371	B11MB	45	1.8544	2.0055	2.4000	16.4380	564	B11XX
15	1.5202	1.6441	2.3040	28.6395	371	B11MB	46	1.7719	1.9163	2.4000	20.1554	377	B 5CB
16	1.4347	1.5516	2.3100	32.8308	570	B 5XX	47	1.8367	1.9863	2.4000	17.2356	377	B 5CB
17	1.5242	1.6484	2.3160	28.8240	570	B 5XX	48	1.8612	2.0129	2.4000	16.1308	564	B11XX
18	1.5689	1.6967	2.3220	26.9281	371	B11MB	49	1.8305	1.9797	2.4000	17.5132	564	B11XX
19	1.5721	1.7002	2.3280	26.9658	371	B11MB	50	1.8066	1.9539	2.4000	18.5885	564	B11XX
20	1.5948	1.7248	2.3340	26.1022	371	B11MB	51	1.7874	1.9331	2.4000	19.4542	377	B 5CB
21	1.6110	1.7423	2.3400	25.5426	371	B11MB	52	1.7351	1.8765	2.4000	21.8142	564	B11XX
22	1.6207	1.7528	2.3460	25.2847	371	B11MB	53	1.5863	1.7156	2.4000	28.5165	444	L 2XX
23	1.6207	1.7528	2.3520	25.4753	371	B11MB	54	1.6189	1.7508	2.4000	27.0482	570	B 5XX
24	1.5031	1.6256	2.3580	31.0591	522	E14XX	55	1.6392	1.7728	2.4000	26.1350	564	B11XX
25	1.6288	1.7616	2.3640	25.4842	570	B 5XX	56	1.4803	1.6010	2.4000	33.2937	564	B11XX
26	1.6531	1.7879	2.3700	24.5622	371	B11MB	57	1.3323	1.4409	2.4000	39.9644	564	B11XX
27	1.6661	1.8019	2.3760	24.1625	371	B11MB	58	1.1852	1.2818	2.4000	46.5903	396	P11XX
28	1.6758	1.8124	2.3820	23.9120	371	B11MB	59	1.2231	1.3228	2.4000	44.8822	422	M10XX
29	1.6856	1.8229	2.3880	23.6628	371	B11MB	60	.9129	.9873	2.4000	58.8637	410	N 9XX
30	1.6791	1.8159	2.3940	24.1470	371	B11MB	61	.9040	.9777	2.4000	59.2618	509	F12XX
31	1.5973	1.7275	2.4000	28.0226	522	E14XX							

NOTE: FQC = FQN * FQE * FQU WHERE
FQN = FXY(Z) * CORE AVG F(Z)
FQE = ENGINEERING UNCERTAINTY (FQE = 1.03)
FQU = NUCLEAR MEASUREMENT UNCERTAINTY (FQU = 1.05)

NOTE: STEADY-STATE FQ LIMIT = FQRTP * K(Z)/P, P GREATER THAN 0.5
FQRTP * K(Z)/0.5, P LESS THEN OR EQUAL TO 0.5
K(Z) = NORMALIZED FQ LIMIT AS A FUNCTION OF CORE HEIGHT
P = RELATIVE CORE POWER (P = 1.000)

NOTE: PERCENT MARGIN TO STEADY-STATE FQ LIMIT = (1.0 - (FQC/STEADY-STATE FQ LIMIT)) * 100.0

NOTE: STEADY STATE FQ LIMIT APPLICABLE TO FQC AT ALL AXIAL POINTS

NOTE: DETERMINATION OF LIMITING FQ IS BASED ON PERCENT TO FQ LIMIT.

*** NO VALUES EXCEEDED THE STEADY-STATE FQ LIMIT ***