PGE-1040

TROJAN NUCLEAR PLANT

CYCLE 6 STARTUP AND POWER ESCALATION PHYSICS TESTING REPORT

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PHYSICS TESTING REPORT

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1.0 ABSTRACT

Startup physics tests were performed at the beginning of the sixth fuel cycle at the Trojan Nuclear Power Plant in order to verify that the basic static and kinetic characteristics of the core were as expected and that values used in the safety analysis were conservative.

Due to fuel failures resulting from reactor vessel internals baffle-gap water-jetting (see LER 82-06), a total of 22 fuel assemblies in the Cycle 6 core were modified to contain either three or five stainless steel pins in place of fuel rods (see License Amendment 82, July 11, 1983). In addition, eight of those fuel assemblies also have 2 x 8 partial grids at the seven midspans on the baffle-jet side of the assembly to reduce the likelihood of jetting fuel failure.

The effect on power distribution of the fuel assembly modification was expected to be small. Startup physics tests confirmed the validity of this nuclear design prediction.

This startup report is being submitted in order to fulfill the requirements of Amendment 82 of Facility Operating License No. NPF-1. The subject matter of this report is limited to the performance of the reactor core.

2.0 INTRODUCTION

The Trojan Nuclear Power Plant, located in northwest Oregon on the Columbia River, is a high-power-density 4-loop Westinghouse pressurized water reactor rated at 3423 MWt gross using 17 x 17 array nuclear fuel.

The Trojan Nuclear Power Plant completed its fifth cycle of operation on January 22, 1983. The fifth cycle core contained 22 assemblies that were modified to include three or five stainless steel pins in response to a baffle-gap water-jet impingement problem (see Topical Report PGE-1035, "Cycle 5 Startup and Power Escalation Physics Testing Report", for additional details).

During a fuel inspection program at Trojan at the end of Cycle 5, all fuel assemblies from the core were visually examined with underwater television and binoculars by Portland General Electric Company during fuel transfer from the core to the spent fuel pool. Selected fuel assemblies were examined with underwater television in the spent fuel pool by Portland General Electric Company and Westinghouse Electric Corporation personnel. Special attention was given to the 22 fuel assemblies that had been modified to withstand baffle-jetting. The fuel assemblies, including all modified assemblies, appeared to be in good condition (see Attachment A). Since the fuel assemblies appeared to be in good condition and Cycle 5 radiochemistry did not indicate further baffle-jetting fuel failure, no fuel-sipping was conducted. The Cycle 6 core loading pattern returned to the baffle-jet locations the same 20 modified fuel assemblies for another cycle of irradiation. The two modified assemblies that were on the interior of the Cycle 5 core were returned to other interior locations.

The effect of the stainless steel rods and partial grids on the nuclear design of the core was expected to be small. Startup physics tests were performed to confirm the analytical predictions as described in the following sections.

3.0 DISCUSSION

The reload startup physics tests at the beginning of Cycle 6 resulted in excellent agreement between predicted and measured values as shown in Table 3-1. The results were the best to date for a reload core.

The quadrant power tilt at low power was measured to be less than 2 percent (1.5 percent in the high power quadrant). The magnitudes of Cycle 6 power distribution prediction errors were small and posed no safety concerns.

The other nuclear design parameters were well within acceptance criteria and were more accurately predicted for this reload startup than for past reload startups.

TABLE 3-1

PREDICTED AND MEASURED PHYSICS PARAMETERS

Parameter	Trojan Test Acceptance Criteria	Measured	Predicted
Critical Boron (ppm)			
All-rods-out	1486±50	1500	1486
D bank in	1357±21	1359	1343
D + C banks in	1237±18	1231	1221
All-rods-in loss one rod	871±114	879	858
Isothermal Temperature Coefficient (pcm/°F)			
All-rods-out	-2.5±3	-1.6	-2.5
D bank in	-6.0±3	-4.9	-6.0
Moderator temperature coefficient, ARO	≤+5.0 ≥-53.6	+0.7	-0.2
Boron Worth (pcm/ppm)			
Differential boron worth, over D	-8.8±0.9	-8.9	-8.8
Differential boron worth, over C	-9.0±0.9	-8.4	-9.0
Integral Rod Worth (pcm except as noted)			
Control D	1273±127	1263	1273
Control C	1111±111	1073	1111
Control B	1193+119 -238	1140	1193
Control A	799+300 -160	847	799
All-rods-in less one rod	5523+2000 -500	5560	5523
All-rods-in less one rod (ppm)	628+200 -50	621	628

TABLE 3-1

Parameter	Trojan Test Acceptance Criteria	Measured	Predicted
Doppler Coefficient (pcm/% Power)			
At 30%	-17.5 to -9.5	-14.9	-10.6
At 45%	-16.0 to -8.4	-10.1	-9.9
At 69%	-13.8 to -7.7	-9.4	-9.1
At 97%	-12.8 to -6.7	-7.2	-8.2
Low-Power Core Power Distribution, ARO			
F_Q	≤4.64*K(z)	2.63	2.89
$F_{\Delta H}$	≤2.001	1.57	1.54
F_{xy}	≤1.84	1.72	1.84
Quadrant tilt	≤1.02	1.015	1.025
Axial offset	≤46+5% -15%	30.1%	46%
$F_{\Delta H}$	≤15%	12.7%	
Full Power Core Power Distribution, ARO			
$F_{\Delta H}$	≤1.55	1.467	1.466
Quadrant tilt	≤1.02	1.006	~1.008
F_Q	≤2.32*K(z)	1.782	~1.769

4.0 LOW POWER PHYSICS TESTING

The purpose of the low power physics testing program is to assure Plant management that the reactor core is operating properly within design limits and safety assumptions, and to redetermine operating parameters related to the reactor system. The measurements of critical boron concentrations, rod worths, temperature coefficients, boron worths, and core power distribution provide sufficient nuclear design parameter confirmations to approve an overall nuclear design and extrapolate or infer all necessary reactor core operating information not explicitly measured.

The Trojan Cycle 6 core loading plan is shown in Figure 4-1, and the low power flux map results are presented in Figure 4-2. The Cycle 6 startup physics test results continued the improvement trend begun at the start of Cycle 4. The improved nuclear design methods were responsible for the improvement in predicted vs measured parameters. Most of the improvement was due to a more accurate assessment and handling of individual fuel assembly burnup values.

FIGURE 4-1

TROJAN CYCLE 6 CORE LOADING

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1					G03 L-01	E57 G-13	E60 P-10	A26 H-06 CYCLE 1	E54 B-10	E44 J-13	G36 E-01				
2			G02 N-02	G45 M-02	H04	G50	H14	G29 G-02	H16	G52	H27	G30 D-02	G25 C-02		
3		G27 P-03	G53	F06 L-06	E14 F-04	A07 F-12 CYCLE 1	E22 F-13	E24 M-04	E58 K-13	A31 K-12 CYCLE 1	E17 K-04	F54 E-06	G58	G01 B-03	
4		G33 P-04	F15 K-05	G44 H-15	E20 K-10	G34 F-01	E09 M-12	G08 J-02	E64 H-06	G17 K-01	E40 F-10	G28 A-08	F33 K-11	G15 B-04	
5	G10 R-05	H28	E31 M-10	E29 H-03	G46 C-13	E27 L-03	F53 E-02	F52 G-12	F25 L-02	E03 E-03	G04 N-13	E51 N-08	E32 D-10	H02	G41 A-05
6	E62 C-09	G59	A29 H-08 CYCLE 1	G07 A-10	E13 N-05	F24 M-07	F23 M-05	F12 J-06	F43 D-05	F41 G-04	E19 C-05	G18 A-10	A17 M-10 CYCLE 1	G49	E05 N-09
7	E53 F-02	H29	E07 C-10	E12 M-04	F01 P-11	F37 L-04	F20 K-09	F36 H-11	F22 F-09	F34 E-04	F40 B-11	E59 H-09	E63 N-10	H06	E45 K-02
8	A60 K-08 CYCLE 1	G48 P-07	E05 D-08	G09 P-09	F47 D-07	F50 G-06	F31 E-08	F13 G-08	D48 L-08	F44 J-10	F45 M-09	G31 B-07	E15 M-08	G43 B-09	A35 F-08 CYCLE 1
9	E25 F-14	H21	E33 C-06	E36 H-07	F28 P-05	F49 L-12	F42 K-07	F51 H-05	F09 F-07	F55 E-12	F27 B-05	E02 D-12	E11 N-06	H23	E56 K-14
10	E49 C-07	G60	A46 D-06 CYCLE 1	G39 A-06	E47 N-11	F39 J-12	F16 M-11	F29 G-10	F17 D-11	F10 D-09	E55 C-11	G32 A-06	A05 M-06 CYCLE 1	G51	E28 N-07
11	G37 A-11	H17	E34 K-12	E04 H-13	G19 C-03	E61 L-13	F14 E-14	F26 J-04	F08 L-14	E21 E-13	G16 N-03	E08 C-08	E42 D-06	H20	G23 A-11
12		G40 P-12	F32 F-05	G38 A-08	E39 K-06	G24 F-15	E23 H-10	G22 G-14	E01 D-04	G26 K-15	E50 F-06	G20 H-01	F35 F-11	G42 B-12	
13		G47 P-13	G56	F38 L-10	E26 F-12	A01 F-04 CYCLE 1	E48 F-03	E18 H-12	E30 K-03	A43 K-04 CYCLE 1	E38 M-06	F46 E-10	G57	G05 B-13	
14			G13 N-14	G06 M-14	H07	G54	H15	G14 J-14	H01	G55	H24	G21 D-14	G11 C-14		
15					G35 L-15	E37 G-03	E52 P-06	A11 H-10 CYCLE 1	E46 B-06	E35 J-03	G12 E-15				

(top-left corner)	INCORE THIMBLE NUMBER
XXX	ASSEMBLY IDENTITY
YYY	POSITION IN PREVIOUS CYCLES

FIGURE 4-2

FLUX MAP 131 (3 PERCENT POWER)

TROJAN FLUX MAP #131 07/15/83 3% HU(1) CY6 D=202 3% POWER -BAIR

CALCULATED POWER TILTS (NORMALIZED TO 1.000)

```
 . 0.9813.1.0247 .
   .     .     .
     .   .   .
0.9707 . . . 1.0059
 . . . . . . . . .
0.9862 . . . 1.0201
     .   .   .
   .     .     .
 . 1.0131.0.9980 .
```

```
             .
             .
0.9760 . 1.0153
             .
 . . . . . . . . .
             .
0.9996 . 1.0091
             .
             .
```

```
 .                    .
    .  1.0030    .
       .        .
          .   .
0.9785      .    1.0130
          .   .
       .        .
    .  1.0055    .
 .                    .
```

POSITIVE "Y" VS. NEGATIVE "Y" TILT
0.9956 1.0044

POSITIVE "X" VS. NEGATIVE "X" TILT
1.0122 0.9878

FIGURE 4-2

TROJAN FLUX MAP #131 07/15/83 3% BU(1) CY6 D=202 3% POWER -HAIR

THE FOLLOWING CALCULATIONS ARE BASED ON A DIVISION
OF THE CORE INTO "OCTANTS", THAT IS, QUADRANTS
DIVIDED INTO TWO AXIAL REGIONS OF EQUAL VOLUME.

RELATIVE POWER IN UPPER HALF OF CORE

(-,+)	(+,+)
1.2779	1.3270
1.2915	1.3077
(-,-)	(+,-)

RELATIVE POWER IN LOWER HALF OF CORE

(-,+)	(+,+)
0.6741	0.7037
0.7078	0.7105
(-,-)	(+,-)

PERCENT AXIAL OFFSET TOWARD TOP OF CORE

(-,+)	(+,+)
30.934	30.696
29.199	29.592
(-,-)	(+,-)

CORE AVERAGE AXIAL OFFSET

30.105

POWER TILT IN UPPER HALF OF CORE

(-,+)	(+,+)
0.9822	1.0199
0.9927	1.0051
(-,-)	(+,-)

POWER TILT IN LOWER HALF OF CORE

(-,+)	(+,+)
0.9643	1.0067
1.0126	1.0164
(-,-)	(+,-)

(-,+)	(+,+)
THESE	EDITS
ADDED	JAN.,1969
(-,-)	(+,-)

FIGURE 4-2

TROJAN FLUX MAP #131 07/15/83 3% BU(I) CY6 D#202 3% POWER -HAIR

TOP TWENTY NUCLEAR F-DELTA-H		TOP TWENTY NUCLEAR FQ	
391F 7NM	FDHN=1.5738	391F 7NM	FQN=2.4278
392F 7NE	FDHN=1.5441	370G 7MD	FQN=2.4017
370G 7MD	FDHN=1.5425	368G 6ED	FQN=2.3885
368G 6ED	FDHN=1.5262	341H 5EN	FQN=2.3825
321J 6MD	FDHN=1.5215	392F 7NE	FQN=2.3820
394F 8MD	FDHN=1.5198	342H 5EO	FQN=2.3698
369G 6MD	FDHN=1.5156	369G 6MD	FQN=2.3605
322J 7DF	FDHN=1.5138	394F 8MD	FQN=2.3445
341H 5EN	FDHN=1.5048	321J 6MD	FQN=2.3432
352H11MD	FDHN=1.5021	418E 8DM	FQN=2.3385
326J10MN	FDHN=1.4987	419E 8CM	FQN=2.3254
342H 5EO	FDHN=1.4969	322J 7DE	FQN=2.3250
325J 9EN	FDHN=1.4943	352H11MD	FQN=2.3114
353H11MC	FDHN=1.4932	325J 9EN	FQN=2.3016
418E 8DM	FDHN=1.4924	302K 9DE	FQN=2.3009
299K 7DM	FDHN=1.4848	366G 5EN	FQN=2.3005
419E 8CM	FDHN=1.4841	272L 5NM	FQN=2.3001
417E 7DE	FDHN=1.4819	326J10MN	FQN=2.2991
84F 7	FDHN=1.4802	390F 6DM	FQN=2.2987
375G10EN	FDHN=1.4783	339H 4LN	FQN=2.2980

NOTE= VALUES ARE BEST ESTIMATE AND DO NOT INCLUDE ENGINEERING OR NUCLEAR UNCERTAINTY.

FIGURE 4-2

LOCA FQ ENVELOPE LIMIT AXIALLY

AXIAL POINT	FQ(Z) LIMIT	MEAS. FQ(Z)	SOURCE NO.ID
1	1.9952	1.0331	368G 6ED
2	2.4035	1.3527	368G 6ED
3	2.8026	1.5969	368G 6ED
4	3.2062	1.7389	391F 7NM
5	3.6053	1.9743	368G 6ED
6	4.0043	2.0319	391F 7NM
7	4.1760	2.2011	368G 6ED
8	4.3802	2.3195	391F 7NM
9	4.3894	2.4499	391F 7NM
10	4.4034	2.5085	391F 7NM
11	4.4080	2.5938	391F 7NM
12	4.4266	2.5938	391F 7NM
13	4.4358	2.6257	391F 7NM
14	4.4498	2.6044	391F 7NM
15	4.4590	2.4556	278L 9NE
16	4.4730	2.5272	391F 7NM
17	4.4822	2.6177	391F 7NM
18	4.4962	2.5858	391F 7NM
19	4.5101	2.5858	391F 7NM
20	4.5194	2.5005	391F 7NM
21	4.5286	2.4739	391F 7NM
22	4.5426	2.4468	278L 9NE
23	4.5565	2.4114	278L 9NE
24	4.5658	2.1548	278L 9NE
25	4.5797	2.2928	391F 7NM
26	4.5890	2.2529	391F 7NM
27	4.6029	2.2396	391F 7NM
28	4.6168	2.1570	391F 7NM
29	4.6261	2.1117	391F 7NM
30	4.6354	2.0265	391F 7NM

FIGURE 4-2

LOCA FQ ENVELOPE LIMIT AXIALLY

AXIAL POINT	FQ(Z) LIMIT	MEAS. FQ(Z)	SOURCE NO.ID
31	4.6400	2.0132	278L 9NE
32	4.6400	1.9689	278L 9NE
33	4.6400	1.9026	278L 9NE
34	4.6400	1.7522	391F 7NM
35	4.6400	1.7576	391F 7NM
36	4.6400	1.6777	238N13MF
37	4.6400	1.6238	278L 9NE
38	4.6400	1.5760	487H11FD
39	4.6400	1.5574	278L 9NE
40	4.6400	1.4314	421E 9DM
41	4.6400	1.3760	278L 9NE
42	4.6400	1.2995	421E 9DM
43	4.6400	1.3155	391F 7NM
44	4.6400	1.2517	238N13MF
45	4.6400	1.2035	278L 9NE
46	4.6400	1.1264	391F 7NM
47	4.6400	1.1460	278L 9NE
48	4.6400	1.0434	421E 9DM
49	4.6400	1.0486	278L 9NE
50	4.6400	0.9062	421E 9DM
51	4.6400	0.9587	391F 7NM
52	4.6400	0.9159	373G 9DM
53	4.6400	0.8761	278L 9NE
54	4.6400	0.8451	278L 9NE
55	4.6400	0.8008	278L 9NE
56	4.6400	0.6887	421E 9DM
57	4.6400	0.6947	278L 9NE
58	4.6400	0.6283	278L 9NE
59	4.6400	0.5619	278L 9NE
60	4.6400	0.3672	278L 9NE

FIGURE 4-2

MEASURED AND PERCENT. DIFF. OF FDHN TROJAN FLUX MAP #131 07/15/83 3% BU(I) CY6 D=202 3% POWER -HAIR

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
					0.511	0.435	0.429	0.344	0.456	0.495	0.575				
1					1.5	-0.2	-0.3	-1.0	6.5	12.7	12.7				
			0.536	0.811	1.108	1.151	1.127	0.981	1.174	1.259	1.205	0.924	0.619		
2			-4.2	1.5	1.5	-0.1	-0.6	-1.2	3.7	8.4	8.4	12.7	7.9		
		0.541	1.038	0.949	0.831	0.765	0.834	0.815	0.841	0.791	0.879	1.061	1.195	0.620	
3		-4.2	-4.2	-4.2	1.5	1.5	-0.5	-1.2	0.2	4.2	4.2	4.2	7.9	7.9	
		0.774	0.964	1.222	0.965	1.222	0.977	1.251	1.004	1.257	1.009	1.257	1.043	0.845	
4		-4.2	-4.2	-1.6	1.1	1.1	-1.7	0.0	1.2	3.5	3.3	-0.3	2.2	2.6	
	0.503	1.086	0.813	0.931	1.325	1.123	1.353	1.381	1.348	1.128	1.334	0.955	0.840	1.120	0.531
5	-1.3	-2.1	-3.2	-1.5	3.3	3.6	1.4	0.7	0.9	3.1	2.4	-0.3	-0.7	-0.4	2.3
	0.446	1.167	0.753	1.291	1.102	1.341	1.432	1.396	1.454	1.376	1.131	1.215	0.770	1.183	0.461
6	1.4	-0.0	-1.6	-0.8	1.8	1.9	1.1	0.4	2.9	3.9	3.8	-0.5	-0.6	-0.3	2.3
	0.423	1.121	0.831	0.970	1.347	1.411	1.421	1.372	1.438	1.480	1.332	0.985	0.856	1.178	0.453
7	-2.8	-2.1	-1.6	-1.6	2.0	0.4	0.0	-1.7	2.6	5.4	-0.1	-2.2	-0.9	0.4	1.1
	0.328	0.961	0.824	1.216	1.331	1.351	1.360	1.375	1.339	1.385	1.369	1.243	0.858	1.040	0.364
8	-5.9	-4.2	-1.7	-1.7	-1.8	-2.5	-2.5	-3.3	0.0	0.3	-0.5	-2.4	-1.6	-0.2	-0.1
	0.407	1.094	0.824	0.980	1.314	1.391	1.401	1.369	1.349	1.342	1.353	1.025	0.884	1.198	0.455
9	-6.9	-4.2	-1.6	-1.2	-0.7	-1.4	-1.7	-2.8	-5.0	-5.0	-0.2	0.0	-0.0	0.0	-0.1
	0.448	1.183	0.755	1.223	1.083	1.335	1.411	1.371	1.374	1.280	1.133	1.288	0.847	1.261	0.477
10	1.5	1.5	-0.7	1.2	1.1	0.5	-1.8	-2.9	-4.1	-4.3	1.0	1.5	5.6	2.9	2.9
	0.521	1.133	0.852	0.971	1.321	1.114	1.340	1.379	1.341	1.090	1.317	0.983	0.879	1.240	0.569
11	1.5	1.5	1.5	1.3	0.8	0.3	-1.5	-2.0	-2.4	-2.7	-2.2	-2.1	-1.3	5.8	5.8
		0.841	1.047	1.309	1.010	1.264	1.008	1.268	1.010	1.234	0.960	1.250	1.041	0.891	
12		1.4	1.3	1.5	0.8	0.7	-1.3	-1.7	-1.7	-2.6	-5.9	-6.2	-3.6	3.4	
		0.603	1.167	1.074	0.870	0.786	0.867	0.856	0.864	0.784	0.856	1.022	1.132	0.608	
13		3.0	2.9	1.9	-0.3	-0.5	-0.6	-0.9	-1.2	-1.8	-4.0	-5.0	-2.9	1.2	
			0.609	0.865	1.164	1.211	1.162	1.024	1.170	1.200	1.151	0.848	0.601		
14			3.2	2.1	1.0	0.4	-1.6	-1.7	-2.0	-1.9	-1.9	-1.8	-0.4		
					0.541	0.458	0.436	0.355	0.442	0.454	0.529				
15					2.2	0.7	-2.4	-2.5	-2.9	-1.9	-1.9				

MEAS
DIFF

PERCENT. DIFF. OF EXPECT. AND MEAS. FDHN TROJAN FLUX MAP #131 07/15/83 3% BU(I) CY6 D=202 3% POWER -BAIR

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							-0.3			12.7					
2						-0.1		-1.2							
3								-1.2		4.2				7.9	
4		-4.2	-4.2					0.0							
5					3.3				0.9		2.4		-0.7		
6	1.4		-1.6			1.9		0.4						-0.3	
7				-1.6			0.0			5.4			-0.9		
8	-6.9		-1.7				-2.5					-2.4	-1.6	-0.2	
9									-5.0						-0.1
10					1.1		-1.8					1.5			
11	1.5				0.8			-2.0			-2.2				5.8
12						0.7			-1.7			-6.2			
13			2.9		-0.3			-0.9						1.2	
14			3.2				-1.6			-1.9		-1.8			
15					2.2			-2.5							

FIGURE 4-2

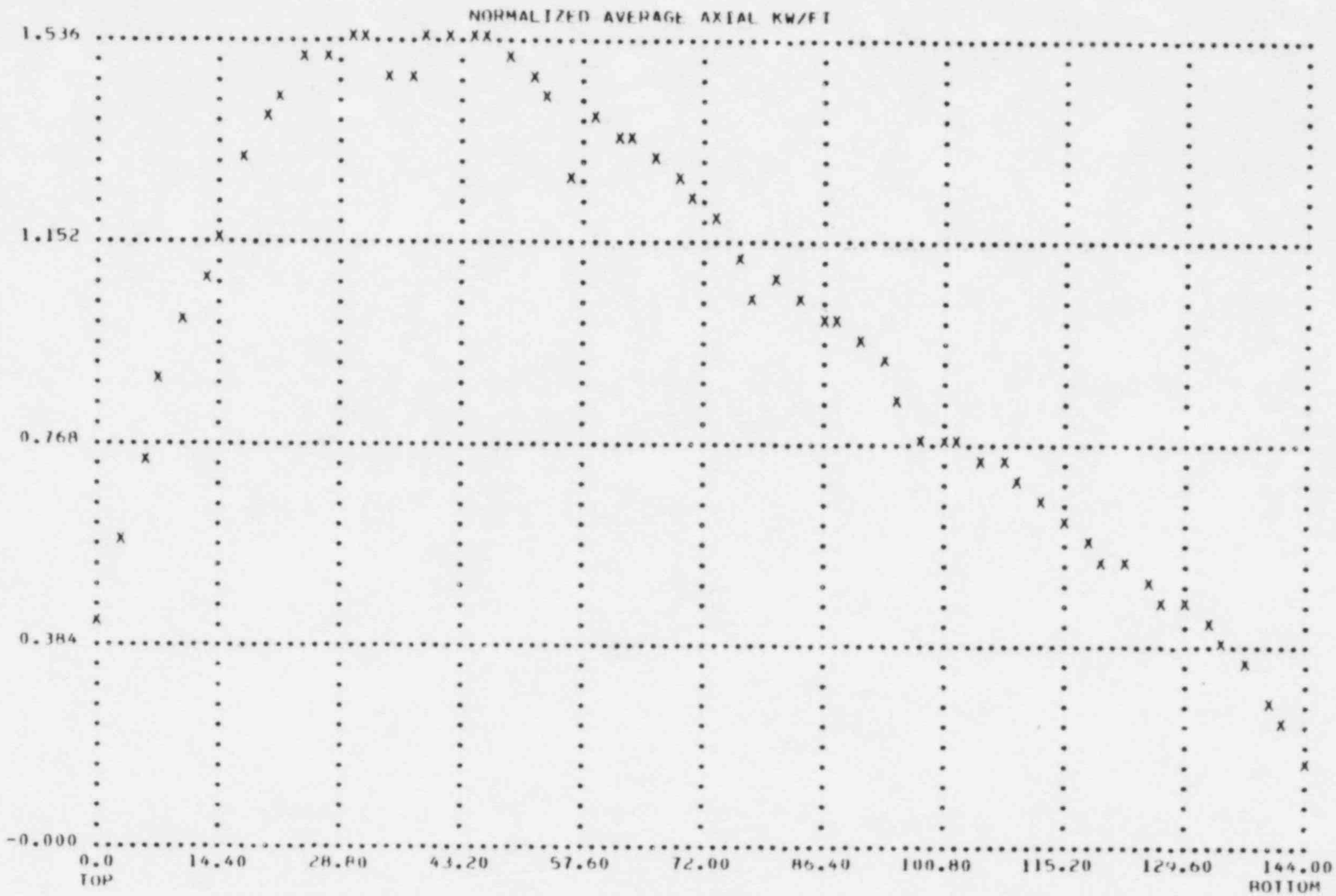
TROJAN FLUX MAP #131 07/15/83 3% HU(I) CY6 D#202 3% POWER -BAIR

POINT	SOURCE	NUCLEAR FXY	POINT	SOURCE	NUCLEAR FXY
1	368 G 6ED	2.1914	31	278 L 9NE	1.5592
2	368 G 6ED	2.1292	32	278 L 9NE	1.6464
3	368 G 6ED	1.9907	33	278 L 9NE	1.6701
4	391 F 7NM	1.8170	34	391 F 7NM	1.5190
5	368 G 6ED	1.8064	35	391 F 7NM	1.5640
6	391 F 7NM	1.7433	36	238 N13MF	1.5294
7	368 G 6ED	1.7896	37	278 L 9NE	1.5225
8	391 F 7NM	1.6659	38	487 R11FD	1.5397
9	391 F 7NM	1.6493	39	278 L 9NE	1.5824
10	391 F 7NM	1.6129	40	421 F 9DM	1.5625
11	391 F 7NM	1.6143	41	278 L 9NE	1.6224
12	391 F 7NM	1.5893	42	421 F 9DM	1.5644
13	391 F 7NM	1.5848	43	391 F 7NM	1.6139
14	391 F 7NM	1.5743	44	238 N13MF	1.5756
15	278 L 9NE	1.5662	45	278 L 9NE	1.5571
16	391 F 7NM	1.5946	46	391 F 7NM	1.5376
17	391 F 7NM	1.5782	47	278 L 9NE	1.6317
18	391 F 7NM	1.5629	48	421 F 9DM	1.5849
19	391 F 7NM	1.5566	49	278 L 9NE	1.6806
20	391 F 7NM	1.5148	50	421 F 9DM	1.6070
21	391 F 7NM	1.5222	51	391 F 7NM	1.6939
22	278 L 9NE	1.5303	52	373 G 9DM	1.6690
23	278 L 9NE	1.5749	53	278 L 9NE	1.7039
24	278 L 9NE	1.5607	54	278 L 9NE	1.7398
25	391 F 7NM	1.5381	55	278 L 9NE	1.7682
26	391 F 7NM	1.5500	56	421 F 9DM	1.7210
27	391 F 7NM	1.5581	57	278 L 9NE	1.9243
28	391 F 7NM	1.5339	58	278 L 9NE	2.0591
29	391 F 7NM	1.5332	59	278 L 9NE	2.3774
30	391 F 7NM	1.5129	60	278 L 9NE	2.1637

NOTE= VALUES ARE BEST ESTIMATE AND DO NOT INCLUDE ENGINEERING OR NUCLEAR UNCERTAINTY.

FIGURE 4-2

TROJAN FLUX MAP #131 07/15/83 3% RU(I) CY6 D#202 3% POWER -BAIR



5.0 POWER ESCALATION TESTING

The purpose of the power escalation physics testing program is primarily to monitor core power distribution at elevated power levels and to recalibrate instrumentation settings for important Plant parameters that may vary with core loading, power level, or other Plant changes.

In addition, the nuclear doppler/power coefficients are measured to further confirm the nuclear design.

The following measurements were performed during the power escalation testing:

(1) Incore thermocouple correction factors were obtained (see Table 5-1).

(2) Doppler coefficient was measured (see Figure 5-1).

(3) Delta temperature correlation was realigned (60°F equals 100 percent power, see Figure 5-2).

(4) Feedwater flow correlation was confirmed linear (see Figure 5-3).

(5) Incore-excore detector calibration relationship was established for incore and excore axial offsets (see Table 5-2 and Figures 5-4 through 5-15).

(6) Core power distributions were taken (see Figures 5-16 and 5-17 for Flux Maps 132 and 133). Quadrant tilting decreased with increasing power level and burnup. Hot channel factors limits were met.

TABLE 5-1

INCORE THERMOCOUPLE CORRECTION FACTORS

DATA SHEET 1a
T/C CALCULATIONS

True RTD
Correct Temperature: 556.24 °F

Hot Junction Box Temperatures: 158.6 / 160.5
(Computer U0058, U0059)

T/C No.	Measured Temp		(Meas-Truth) Difference (°F)		T/C No.	Measured Temp		Difference (°F)	
	Toggle	Computer	Toggle	Computer		Toggle	Computer	Toggle	Computer
(A8) 1	551.5	551.4	-4.74	-4.84	(A9) 34	556.0	554.0	-.24	-2.24
(B3) 2	553.5	553.5	-2.74	-2.74	(A11) 35	556.5	554.5	+.26	-1.74
(B10) 3	553.0	553.9	-3.24	-2.34	(B5) 36	556.0	554.6	-.24	-1.64
(C8) 4	553.5	553.5	-2.74	-2.74	(C3) 37	557.5	555.0	+1.26	-1.24
(C13) 5	553.0	553.0	-3.24	-3.24	(C12) 38	557.5	554.7	+1.26	-1.54
(D3) 6	553.5	553.8	-2.74	-2.44	(D7) 39	555.5	554.1	-.74	-2.14
(E4) 7	553.0	553.9	-3.24	-2.34	(D9) 40	556.5	554.1	+.26	-2.14
(E6) 8	551.5	551.5	-4.74	-4.74	(E2) 41	556.0	553.7	-.24	-2.54
(E8) 9	553.0	553.7	-3.24	-2.54	(E14) 42	553.5	551.6	-2.74	-4.64
(E10) 10	553.5	553.2	-2.74	-3.04	(F5) 43	556.5	554.8	+.26	-1.44
(F12) 11	553.5	553.2	-2.74	-3.04	(F9) 44	557.0	554.8	+.76	-1.44
(F15) 12	553.0	553.8	-3.24	-2.44	(F11) 45	557.0	0	+.76	—
(G2) 13	553.5	553.2	-2.74	-3.04	(G4) 46	556.0	554.1	-.24	-2.14
(G9) 14	553.0	553.4	-3.24	-2.84	(G8) 47	557.0	554.6	+.76	-1.64
(G11) 15	553.0	554.0	-3.24	-2.24	(H5) 48	556.5	554.6	+.26	-1.64
(H01) 16	550.5	550.6	-5.74	-5.64	(H9) 49	557.5	554.9	+1.26	-1.44
(H3) 17	551.5	551.5	-4.74	-4.74	(H11) 50	555.5	553.2	-.74	-3.04
(H8) 18	553.5	554.3	-2.74	-1.94	(H14) 51	556.5	555.0	+.26	-1.24
(H13) 19	552.0	552.5	-4.24	-3.74	(J7) 52	556.5	554.2	+.26	-2.04
(J10) 20	553.0	553.3	-3.24	-2.94	(K11) 53	556.0	553.9	-.24	-2.34
(K3) 21	554.5	549.4	-1.74	-6.84	(K13) 54	556.0	554.6	-.24	-1.64
(K5) 22	552.5	552.9	-3.74	-3.34	(L2) 55	—	0	—	—
(K15) 23	551.5	551.7	-4.74	-4.54	(L9) 56	556.0	554.6	-.24	-1.64
(L1) 24	552.5	553.3	-3.74	-2.94	(L14) 57	555.5	554.4	-.74	-1.84
(L8) 25	553.5	553.2	-2.74	-3.04	(M5) 58	557.0	554.6	+.76	-1.64
(L12) 26	553.0	553.1	-3.24	-3.14	(M12) 59	—	0	—	—
(M10) 27	555.5	555.9	-.74	-.34	(N2) 60	556.0	554.7	-.24	-1.54
(M13) 28	553.0	552.3	-3.24	-3.94	(N8) 61	557.5	555.2	+1.26	-1.04
(N3) 29	553.0	553.3	-3.24	-2.94	(N13) 62	556.0	554.4	-.24	-1.84
(N9) 30	553.5	553.6	-2.74	-2.64	(P7) 63	557.0	555.4	+.76	-.84
(P5) 31	554.0	553.4	-2.24	-2.84	(R5) 64	557.0	555.2	+.76	-1.04
(P11) 32	554.0	553.7	-2.24	-2.54	(R10) 65	556.5	554.2	+.26	-2.04
(R08) 33	553.5	553.7	-2.74	-2.54					

Completed By: [signature] Date 7/14/83 Time 0300

Engineering Supervisor: [signature] Date [illegible]

TABLE 5-2

INCORE/EXCORE DETECTOR CALIBRATION AND POINTS ANALYSIS SHEET

TROJAN NUCLEAR PLANT
F(DELTA Q) CALIBRATION AND POINTS ANALYSIS SHEET
GARY HAIR
TROJAN MAPS 133(REF),132,131A,B 132A,B,C QCFMS 35,45,50 HAIR 08/19/83

INPUT DATA

	TOP CHANNEL CURRENT				BOTTOM CHANNEL CURRENT				
AO	41	42	43	44	41	42	43	44	
10.6	89.0	101.0	93.0	100.0	85.0	92.0	87.0	97.0	MEASURED
10.6	268.5	299.9	279.0	300.5	256.5	273.1	261.0	291.5	NORMALIZED
11.4	129.0	144.0	133.0	143.0	116.0	127.0	120.0	134.0	MEASURED
11.4	276.4	304.5	283.9	305.6	248.6	268.5	256.1	286.4	NORMALIZED
-21.3	112.0	122.0	115.0	123.0	137.0	147.0	142.0	158.0	MEASURED
-21.3	236.1	259.9	241.6	259.1	288.9	313.1	298.4	332.9	NORMALIZED
-13.5	116.0	129.0	120.0	129.0	134.0	144.0	138.0	154.0	MEASURED
-13.5	243.6	270.8	251.2	269.9	281.4	302.2	288.8	322.1	NORMALIZED
-1.8	123.0	138.0	128.0	137.0	127.0	138.0	132.0	146.0	MEASURED
-1.8	258.3	286.5	265.8	286.6	266.7	286.5	274.2	305.4	NORMALIZED
-1.2	110.0	123.0	115.0	123.0	114.0	124.0	117.0	131.0	MEASURED
-1.2	257.8	285.3	267.7	286.7	267.2	287.7	272.3	305.3	NORMALIZED
-4.1	258.0	287.0	265.0	284.0	267.0	286.0	275.0	308.0	MEASURED
-4.1	258.0	287.0	265.0	284.0	267.0	286.0	275.0	308.0	NORMALIZED

FLUX DIFFERENCE METER VALUES

	TOP CHANNEL				BOTTOM CHANNEL				
AO	41	42	43	44	41	42	43	44	
10.0	271.6	301.5	280.7	302.1	253.4	271.5	259.3	289.9	NORMALIZED
-10.0	248.8	275.6	256.0	274.9	276.2	297.4	284.0	317.1	NORMALIZED
20.0	283.0	314.4	293.1	315.7	242.0	258.5	246.9	276.3	NORMALIZED
-20.0	237.4	262.6	243.7	261.3	287.6	310.4	296.3	330.7	NORMALIZED
30.0	294.4	327.4	305.4	329.3	230.6	245.6	234.5	262.7	NORMALIZED
-30.0	226.0	249.6	231.4	247.7	299.0	323.3	308.5	344.3	NORMALIZED

TROJAN NUCLEAR PLANT
F(DELTA Q) CALIBRATION AND POINTS ANALYSIS SHEET
GARY BAIR
TROJAN MAPS 133(REF),132,131A,B 132A,B,C QCFMS 35,45,50 BAIR 08/19/83

EXCORE DETECTOR	INCORE AXIAL OFFSET	I-TOP MICROAMP 100%	I-TOP MICROAMP 120%	I-BOT MICROAMP 100%	I-BOT MICROAMP 120%	V-TOP VOLTS	V-BOT VOLTS	DELTA V VOLTS	I TOTAL MICRO A	V/I TOP K OHMS	V/I BOT K OHMS
CH-41	0.0	260.2	312.3	264.8	317.7	8.333	8.333	0.0	525.0	0.03202	0.03147
CH-41	13.0	275.0	330.0	250.0	300.0	8.807	7.867	0.941	525.0	0.03202	0.03147
CH-41	3.0	263.6	316.4	261.4	313.6	8.442	8.225	0.217	525.0	0.03202	0.03147
CH-41	-3.0	256.8	308.2	268.2	321.8	8.224	8.441	-0.217	525.0	0.03202	0.03147
CH-41	-45.0	208.9	250.7	316.1	379.3	6.691	9.947	-3.256	525.0	0.03202	0.03147
CH-41	-50.0	203.2	243.9	321.8	386.1	6.508	10.126	-3.618	525.0	0.03202	0.03147
CH-41	59.4	327.9	393.5	197.1	236.5	10.501	6.203	4.298	525.0	0.03202	0.03147
CH-42	0.0	288.5	346.2	284.5	341.4	8.333	8.333	0.0	573.0	0.02888	0.02929
CH-42	13.0	305.4	366.4	267.6	321.2	8.819	7.840	0.980	573.0	0.02888	0.02929
CH-42	3.0	292.4	350.9	280.6	336.7	8.445	8.219	0.226	573.0	0.02888	0.02929
CH-42	-3.0	284.6	341.5	288.4	346.0	8.221	8.447	-0.226	573.0	0.02888	0.02929
CH-42	-45.0	230.2	276.3	342.8	411.3	6.649	10.040	-3.391	573.0	0.02888	0.02929
CH-42	-50.0	223.7	268.5	349.3	419.1	6.462	10.230	-3.768	573.0	0.02888	0.02929
CH-42	59.4	365.5	438.5	207.5	249.0	10.555	6.079	4.476	573.0	0.02888	0.02929
CH-43	0.0	268.4	322.1	271.6	325.9	8.333	8.333	0.0	540.0	0.03105	0.03068
CH-43	13.0	284.4	341.3	255.6	306.7	8.831	7.841	0.991	540.0	0.03105	0.03068
CH-43	3.0	272.1	326.5	267.9	321.5	8.448	8.219	0.229	540.0	0.03105	0.03068
CH-43	-3.0	264.7	317.6	275.3	330.4	8.218	8.447	-0.229	540.0	0.03105	0.03068
CH-43	-45.0	212.8	255.4	327.2	392.6	6.608	10.038	-3.430	540.0	0.03105	0.03068
CH-43	-50.0	206.7	248.0	333.3	400.0	6.416	10.227	-3.811	540.0	0.03105	0.03068
CH-43	59.4	341.7	410.1	198.3	237.9	10.610	6.083	4.527	540.0	0.03105	0.03068
CH-44	0.0	288.5	346.2	303.5	364.2	8.333	8.333	0.0	592.0	0.02888	0.02746
CH-44	13.0	306.2	367.4	285.8	343.0	8.844	7.848	0.996	592.0	0.02888	0.02746
CH-44	3.0	292.6	351.1	299.4	359.3	8.451	8.221	0.230	592.0	0.02888	0.02746
CH-44	-3.0	284.4	341.3	307.6	369.1	8.215	8.445	-0.230	592.0	0.02888	0.02746
CH-44	-45.0	227.3	272.8	364.7	437.6	6.565	10.913	-3.448	592.0	0.02888	0.02746
CH-44	-50.0	220.5	264.6	371.5	445.8	6.369	10.208	-3.831	592.0	0.02888	0.02746
CH-44	59.4	369.3	443.1	222.7	267.3	10.666	6.115	4.551	592.0	0.02888	0.02746

DELTA I SETPT PENALTY RATE FOR AO < -45% IS 2.20%/%
DELTA I SETPT PENALTY RATE FOR AO > 3% IS 2.66%/%

TABLE 5-2

TROJAN NUCLEAR PLANT
PET-2 APPENDIX A CALIBRATION SHEET 2

TROJAN MAPS 133(REF),132,131A,B 132A,B,C QCFMS 35,45,50 BAIR 08/19/83

	FN	G	H
N41	0.072363	2.303210	0.868353
N42	0.075358	2.211678	0.904291
N43	0.076212	2.186884	0.914543
N44	0.076619	2.175255	0.919432

FOUT	DELTA EIN41	DELTA EIN42	DELTA EIN43	DELTA EIN44
1.000	-4.342	-4.521	-4.573	-4.597
2.000	-2.171	-2.261	-2.286	-2.299
3.000	0.000	0.000	0.000	0.000
4.000	2.171	2.261	2.286	2.299
5.000	4.342	4.521	4.573	4.597

AO	N41			N42			N43			N44		
	EIN	FO	FGO	EIN	FO	FGO	EIN	EO	FGO	EIN	EO	FGO
0.0	0.0	3.000	1.000	0.0	3.000	1.000	0.0	3.000	1.000	0.0	3.000	1.000
13.0	0.941	3.433	1.709	0.980	3.433	1.709	0.991	3.433	1.709	0.996	3.433	1.709
3.0	0.217	3.100	1.000	0.226	3.100	1.000	0.229	3.100	1.000	0.230	3.100	1.000
-3.0	-0.217	2.900	1.000	-0.226	2.900	1.000	-0.229	2.900	1.000	-0.230	2.900	1.000
-45.0	-3.256	1.500	1.000	-3.391	1.500	1.000	-3.430	1.500	1.000	-3.448	1.500	1.000
-50.0	-3.618	1.333	1.293	-3.768	1.333	1.293	-3.811	1.333	1.293	-3.831	1.333	1.293
59.4	4.298	4.980	5.001	4.476	4.980	5.001	4.527	4.980	5.001	4.551	4.980	5.001
60.0	4.342	5.000	5.043	4.521	5.000	5.043	4.573	5.000	5.043	4.597	5.000	5.043
-60.0	-4.342	1.000	1.880	-4.521	1.000	1.880	-4.573	1.000	1.880	-4.597	1.000	1.880

INCORE/EXCORE SLOPE CALCULATION

BASIS: IN-AO	EX-AO(41-44)		FOR INFORMATION ONLY	
11.4	5.3	6.3	5.1	3.2
-21.3	-10.0	-9.3	-10.5	-12.5
	2.13	2.10	2.09	2.08

COMPUTER ADDRESSES	K0554	K0552	K0551	K0553
FOR USE IN P250	2.30	2.21	2.19	2.18

TABLE 5-2

TROJAN NUCLEAR PLANT
TROJAN MAPS 133(REF),132,131A,B 132A,B,C OCFMS 35,45,50 BAIR 08/19/83

......NIS INTERMEDIATE RANGE CHANNEL CALCULATIONS..........

N35 FULL POWER MICROAMPS = 287.

N35 22% TRIP CURRENT MICROAMPS = 63. (+- 6.)

N35 30% OVERCURRENT MICROAMPS = 86.

N35 16% RESET CURRENT MICROAMPS = 46. (+- 6.)

N35 22% TRIP VOLTAGE = 8.500 (+0.047 -0.052)

N35 30% OVERVOLTAGE = 8.669

N35 16% RESET VOLTAGE = 8.328 (+0.064 -0.072)

N36 FULL POWER MICROAMPS = 365.

N36 22% TRIP CURRENT MICROAMPS = 80. (+- 7.)

N36 30% OVERCURRENT MICROAMPS = 110.

N36 16% RESET CURRENT MICROAMPS = 58. (+- 7.)

N36 22% TRIP VOLTAGE = 8.631 (+0.047 -0.052)

N36 30% OVERVOLTAGE = 8.799

N36 16% RESET VOLTAGE = 8.458 (+0.064 -0.072)

FIGURE 5-1

DOPPLER COEFFICIENT

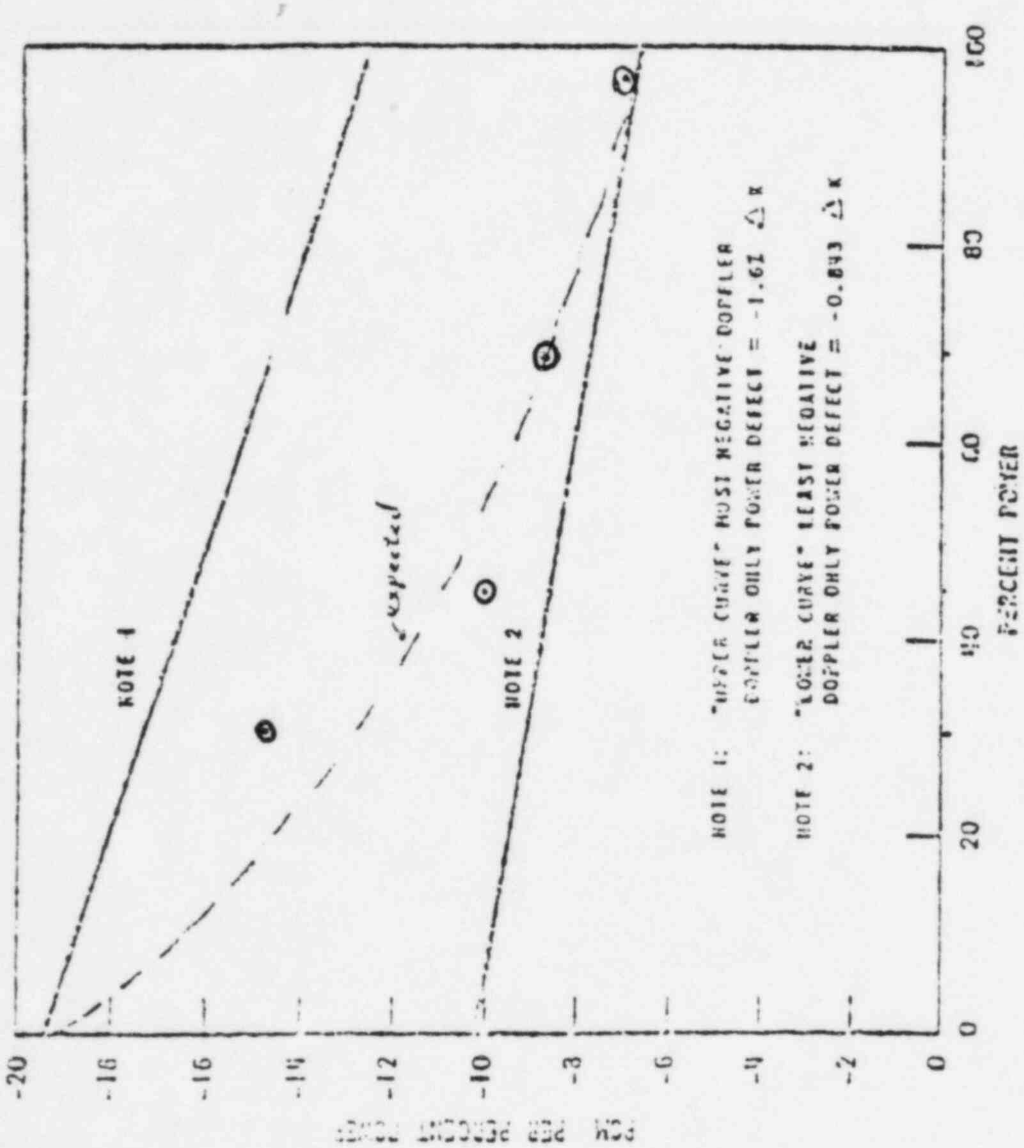


Figure 15.0-5 Doppler Power Coefficient Used In Accident Analysis

By *[signature]* Date *8-19-83*

Engineering Supervisor *[signature]* Date *8/19/83*

FIGURE 5-2

LOOP DELTA-T (T-HOT MINUS T-COLD) VS POWER

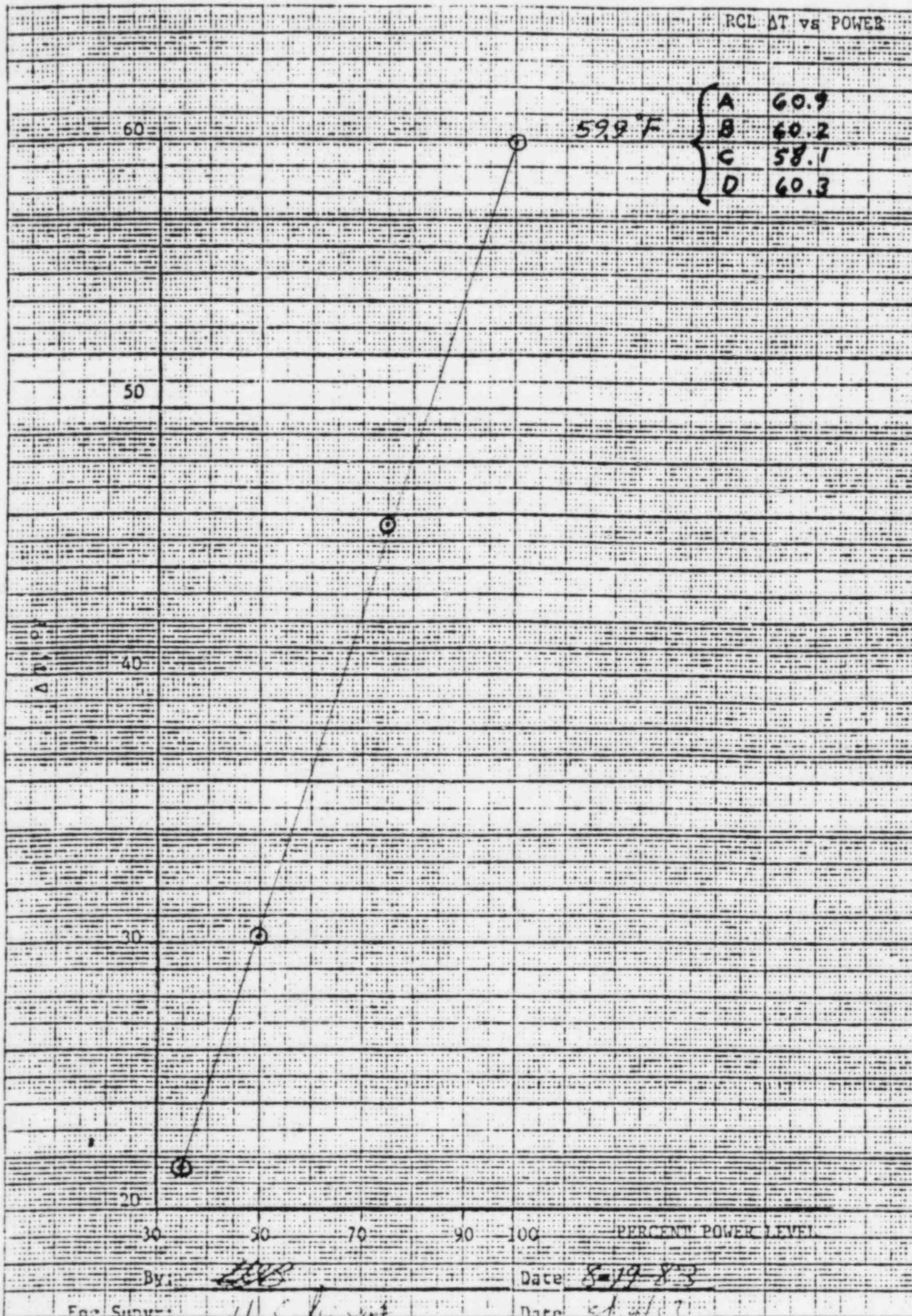
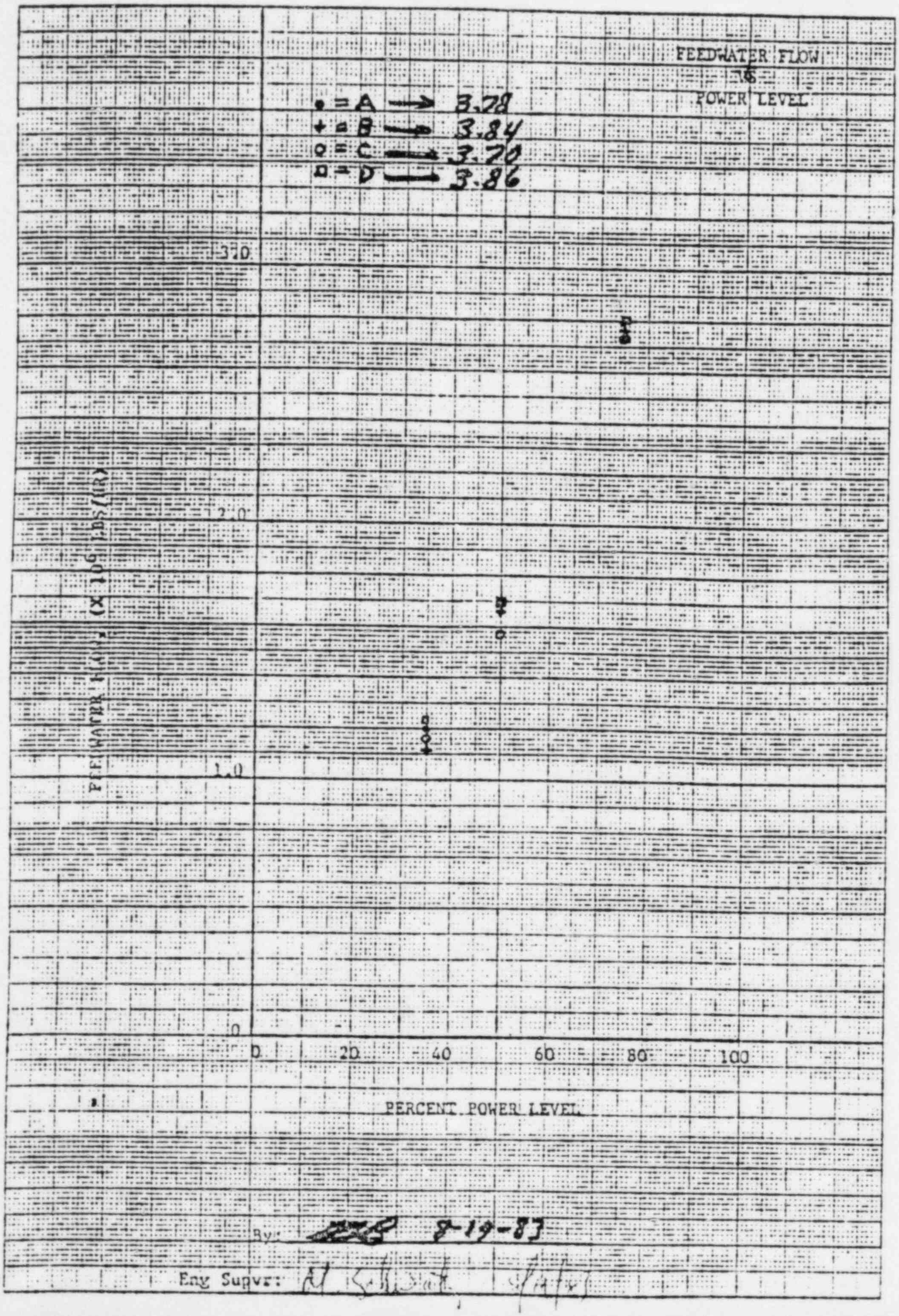


FIGURE 5-3

FEEDWATER FLOW VS POWER LEVEL



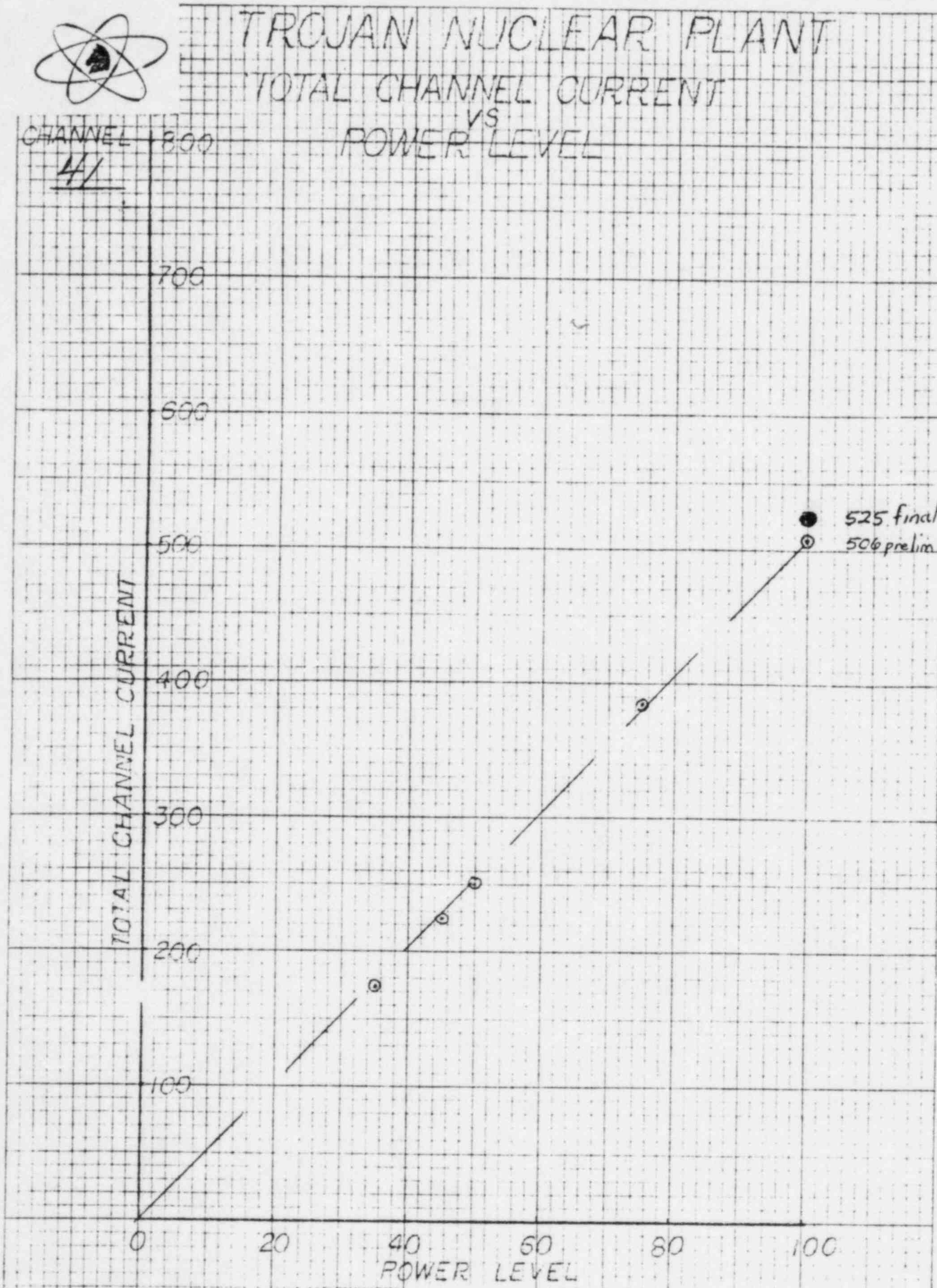


FIGURE 5-4

BY [signature]

DATE 7-25-83
8-19-83

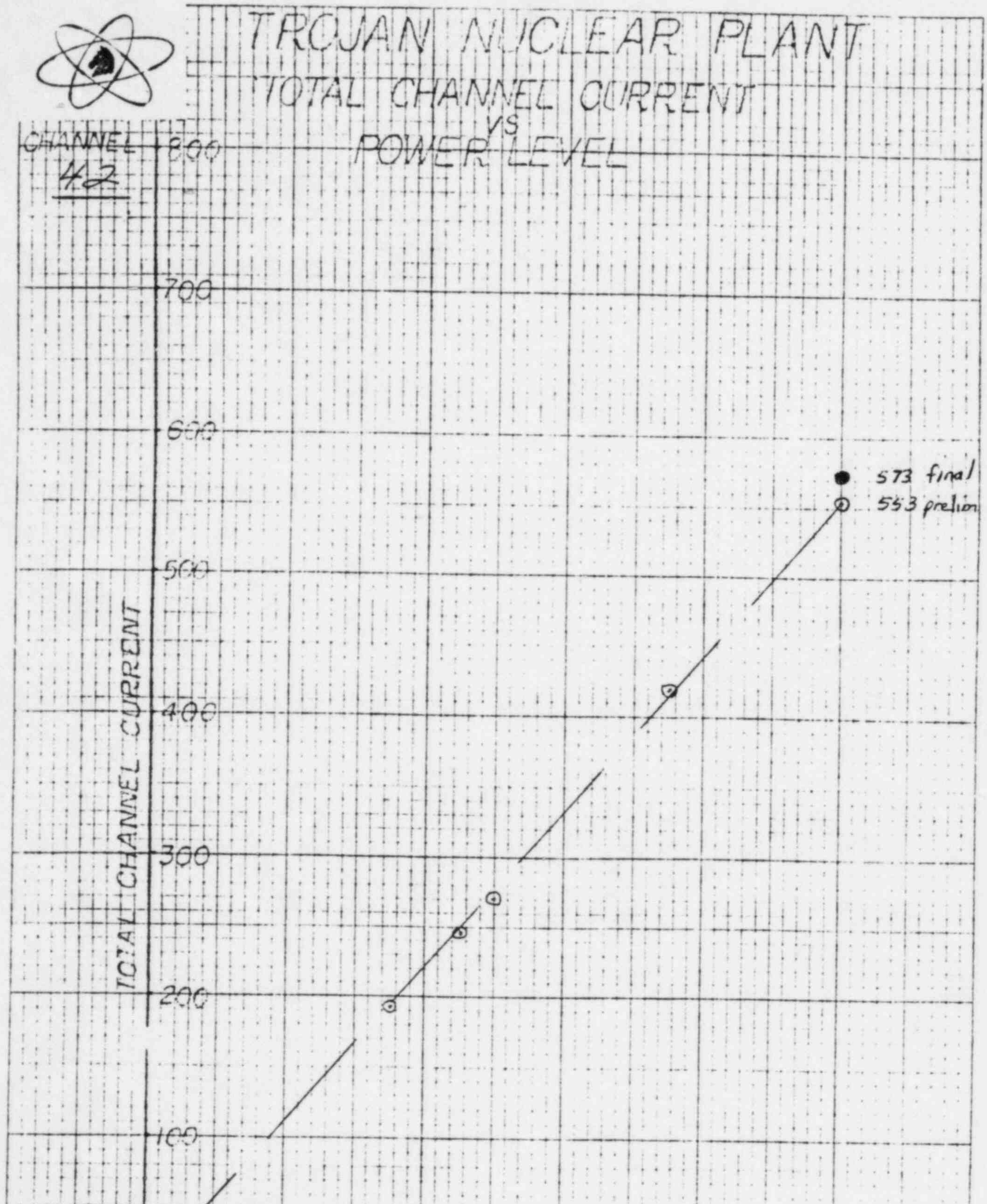


FIGURE 5-5

BY [signature] DATE 7-25-83
8-19-83

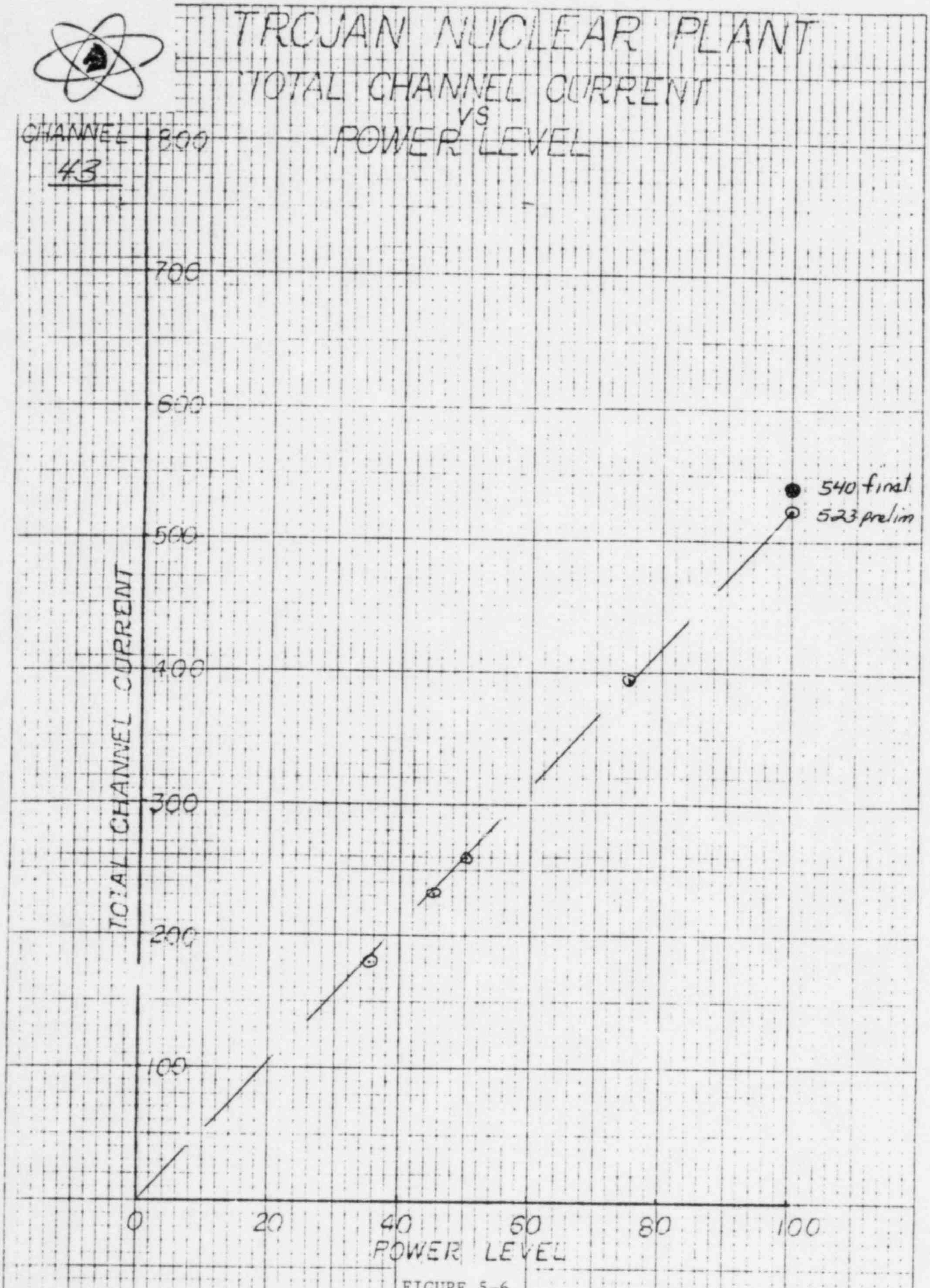


FIGURE 5-6

BY [signature] DATE 7-25-83 8-19-83

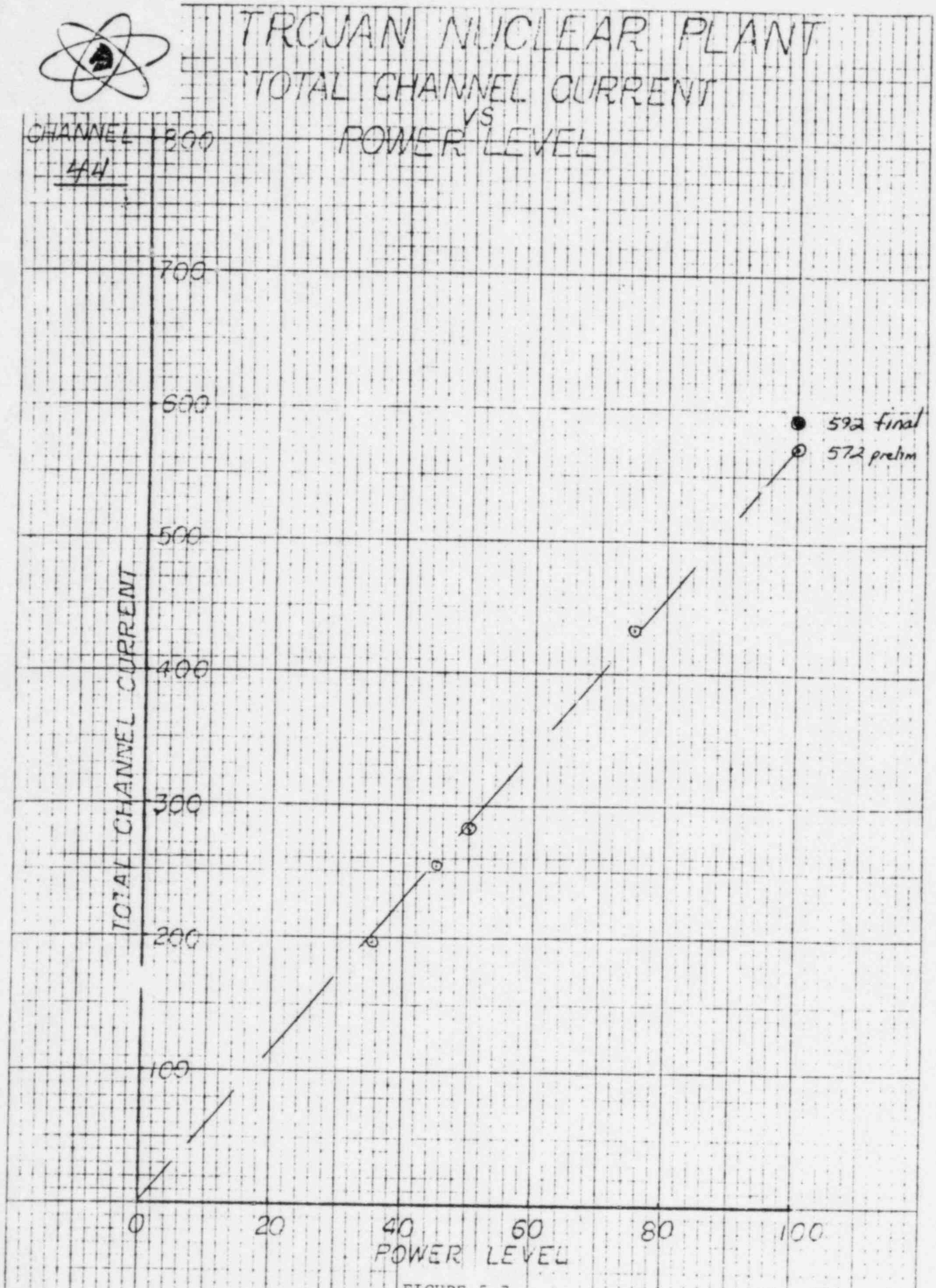


FIGURE 5-7

BY [signature]

DATE 7-25-83
8-19-83

TROJAN NUCLEAR PLANT
NORMALIZED EXCORE F.P. CURRENT VS INCORE AXIAL OFFSET

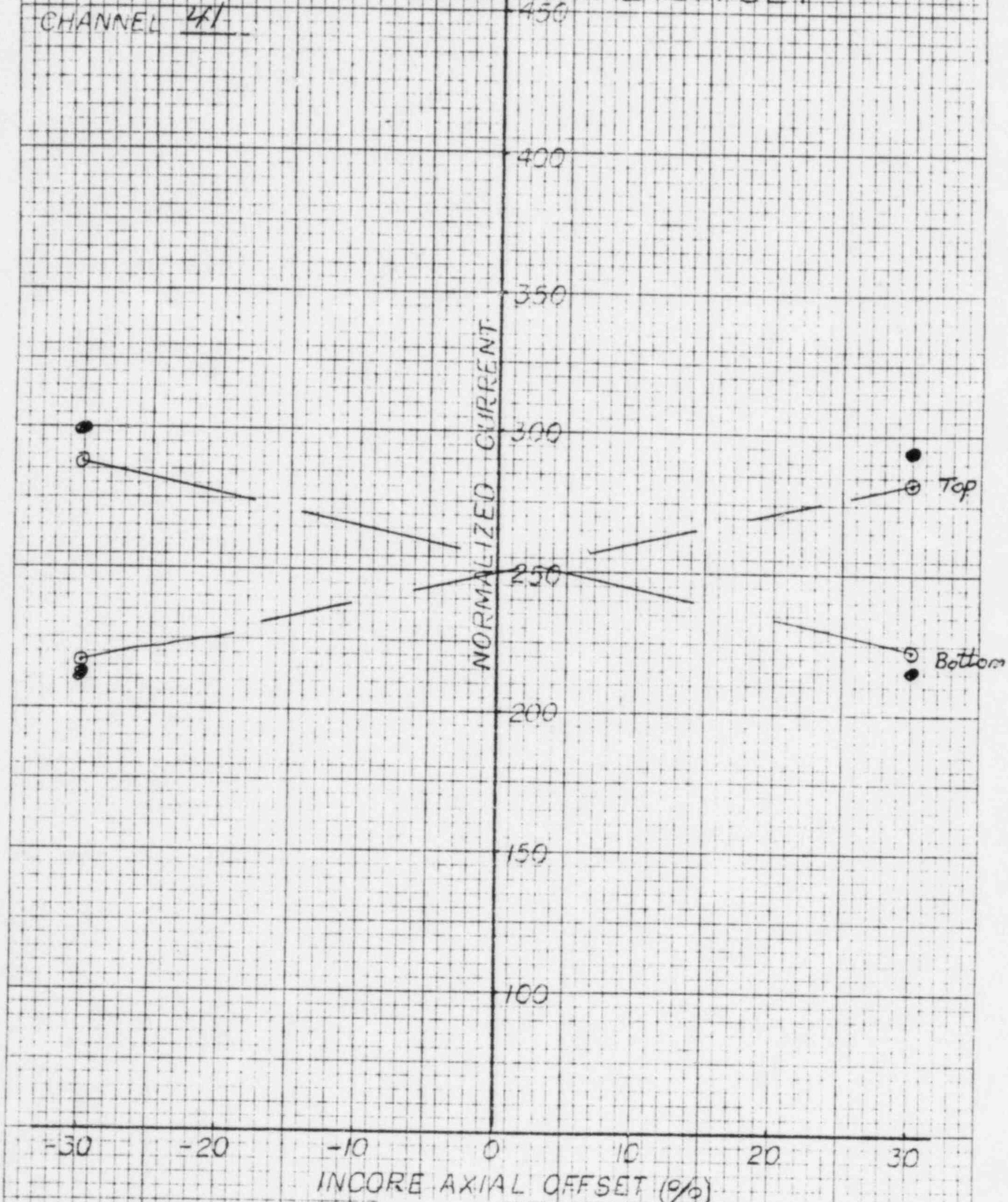


FIGURE 5-8

BY [signature] DATE 7-25-83
8-19-83

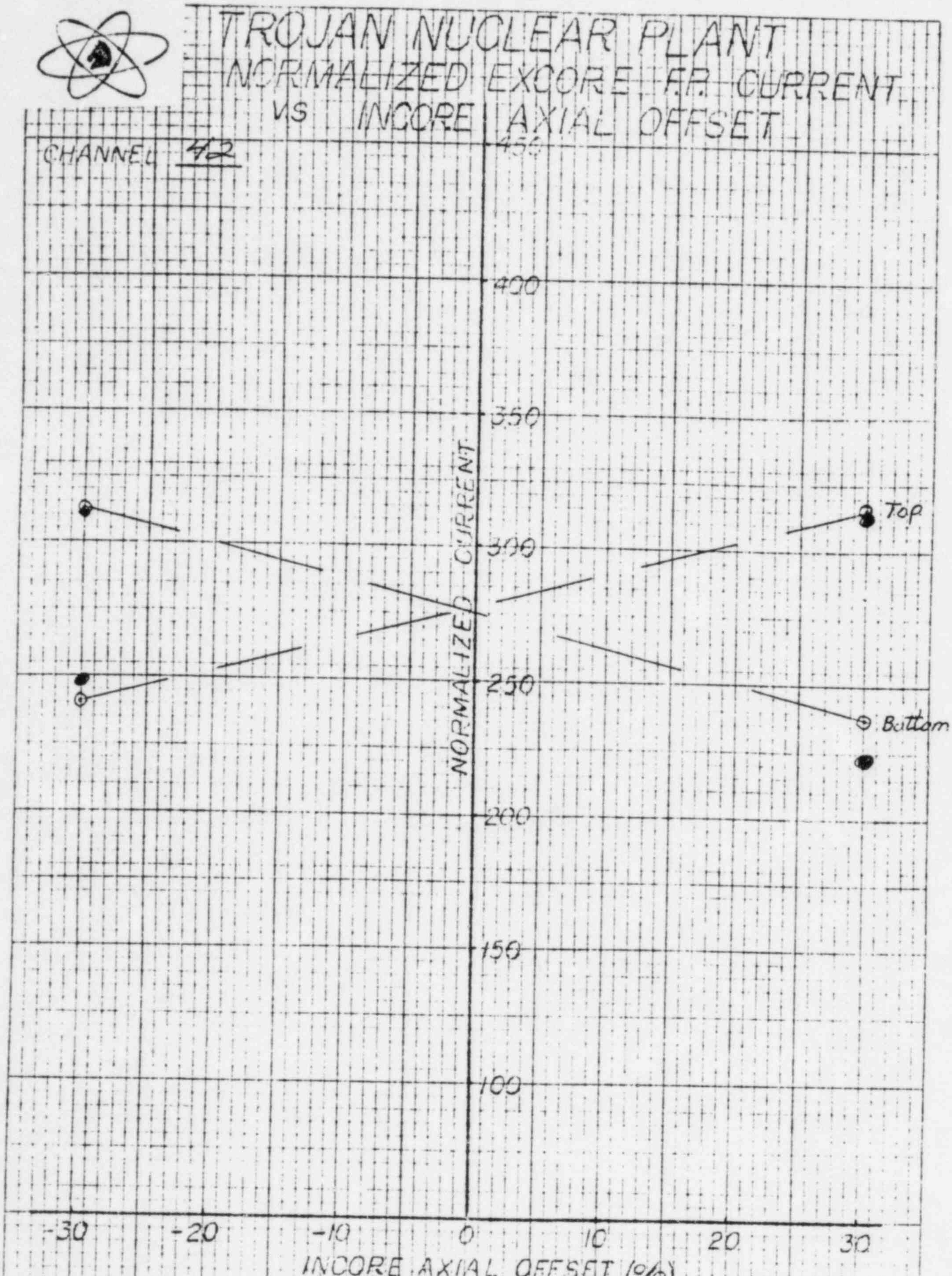


FIGURE 5-9

BY [signature] DATE 7-25-83 8-19-83

TROJAN NUCLEAR PLANT
NORMALIZED EXCORE P.R. CURRENT VS INCORE AXIAL OFFSET

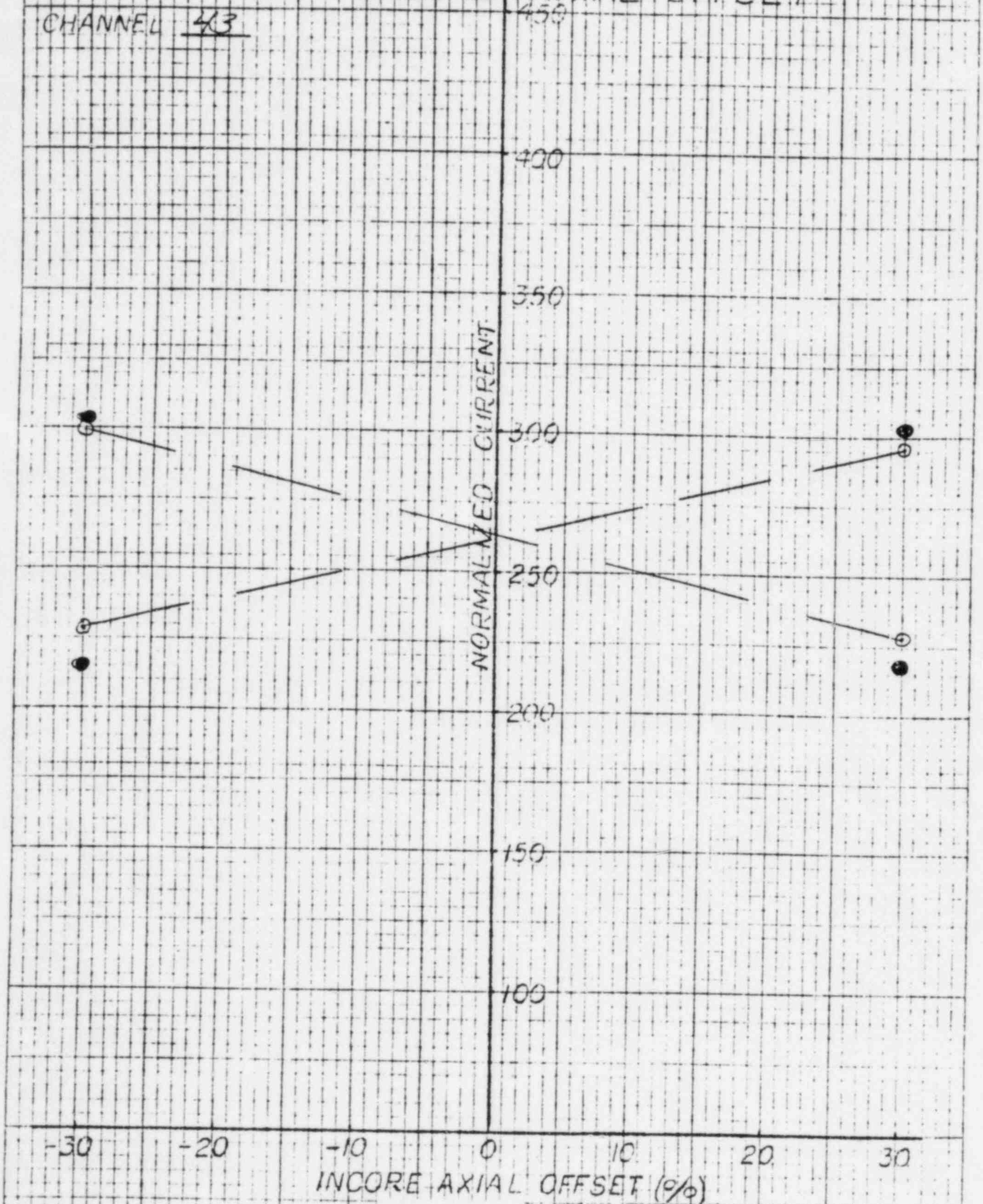


FIGURE 5-10

BY [illegible]

DATE 7-25-83
8-19-83

TROJAN NUCLEAR PLANT
NORMALIZED EXCORE P.R. CURRENT VS INCORE AXIAL OFFSET

CHANNEL 44

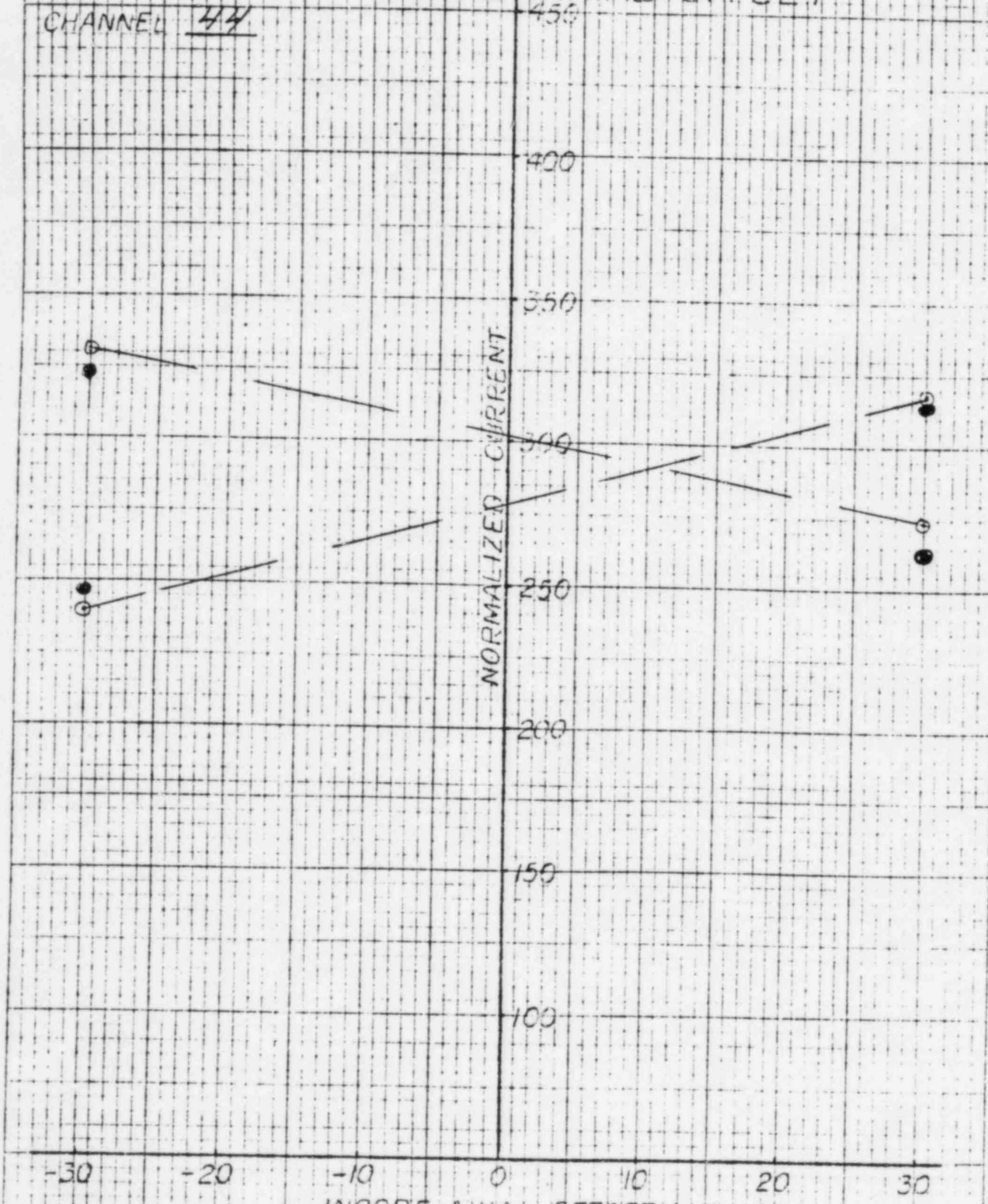


FIGURE 5-11

BY: [signature] DATE 7-25-83 8-19-83

TROJAN NUCLEAR PLANT

INCORE vs EXCORE OFFSETS

CHANNEL 41

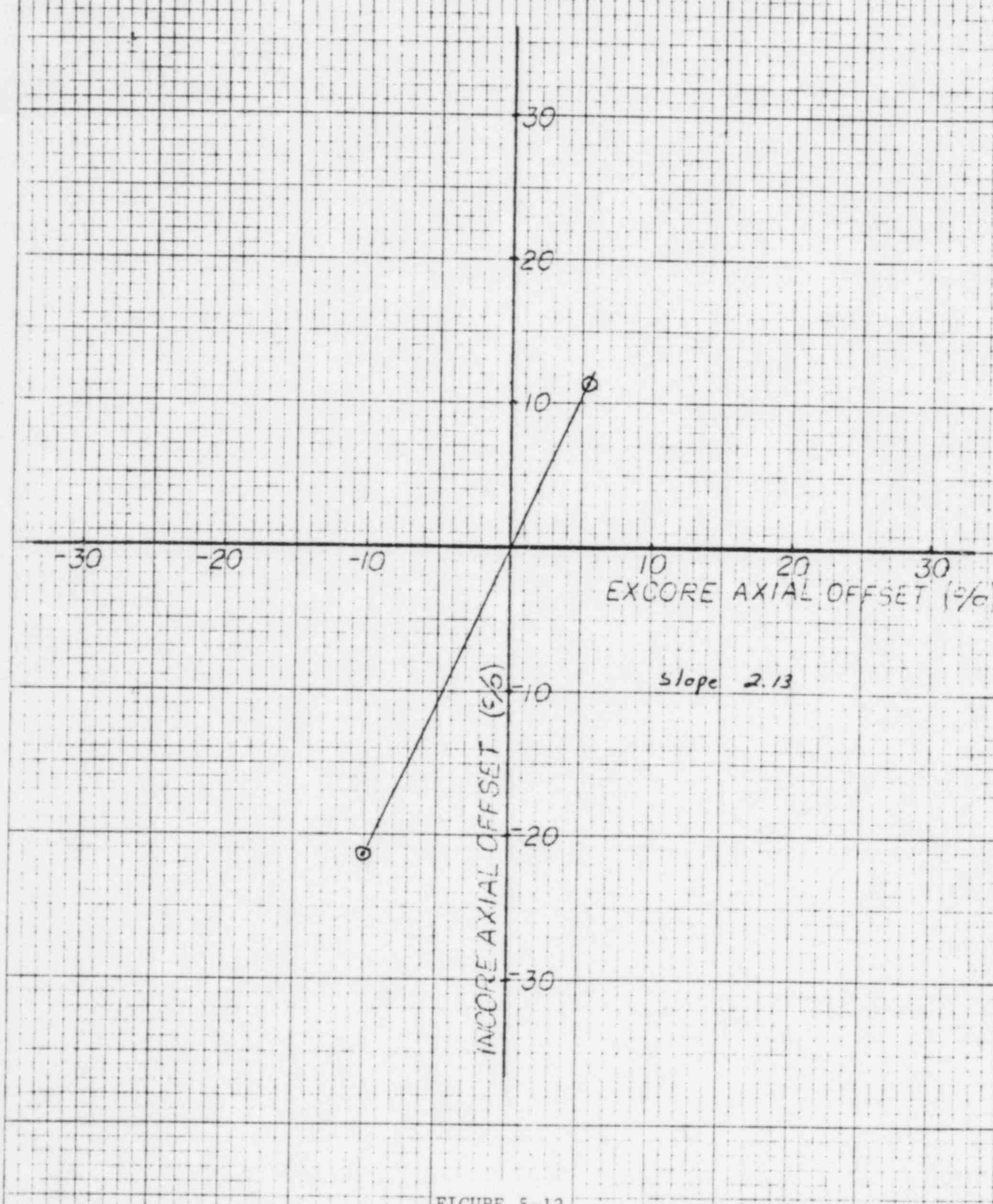


FIGURE 5-12

BY [illegible] DATE 7-25-83

TROJAN NUCLEAR PLANT

INCORE vs EXCORE OFFSETS

CHANNEL 42

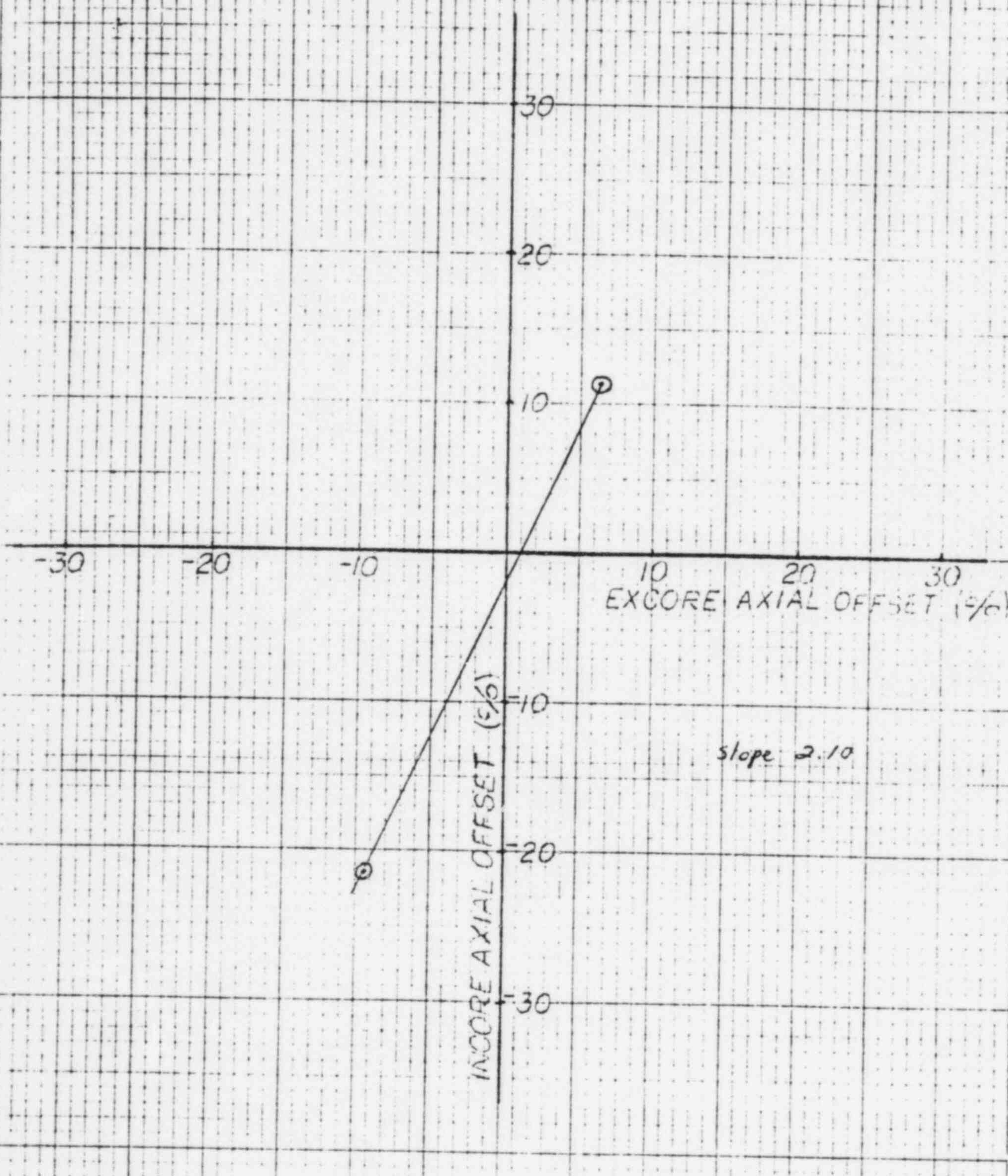


FIGURE 5-13

BY: DB DATE 7-25-83

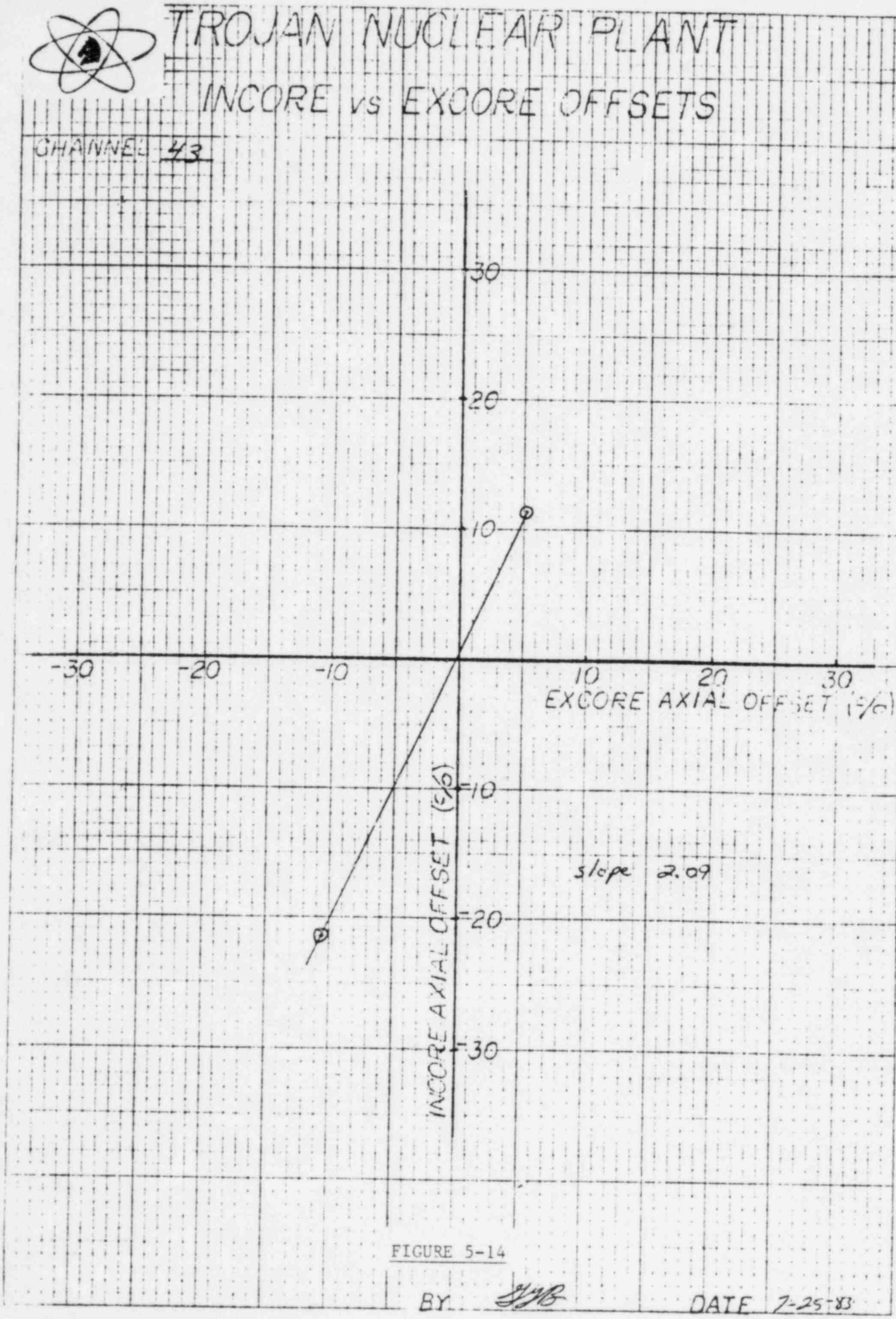

TROJAN NUCLEAR PLANT
INCORE vs EXCORE OFFSETS
CHANNEL 43
30
20
10
-10
-20
-30
-30
-20
-10
10
20
30
EXCORE AXIAL OFFSET (%)
INCORE AXIAL OFFSET (%)
slope 2.09
BY
DATE 7-25-83

FIGURE 5-14

TROJAN NUCLEAR PLANT

INCORE vs EXCORE OFFSETS

CHANNEL 44

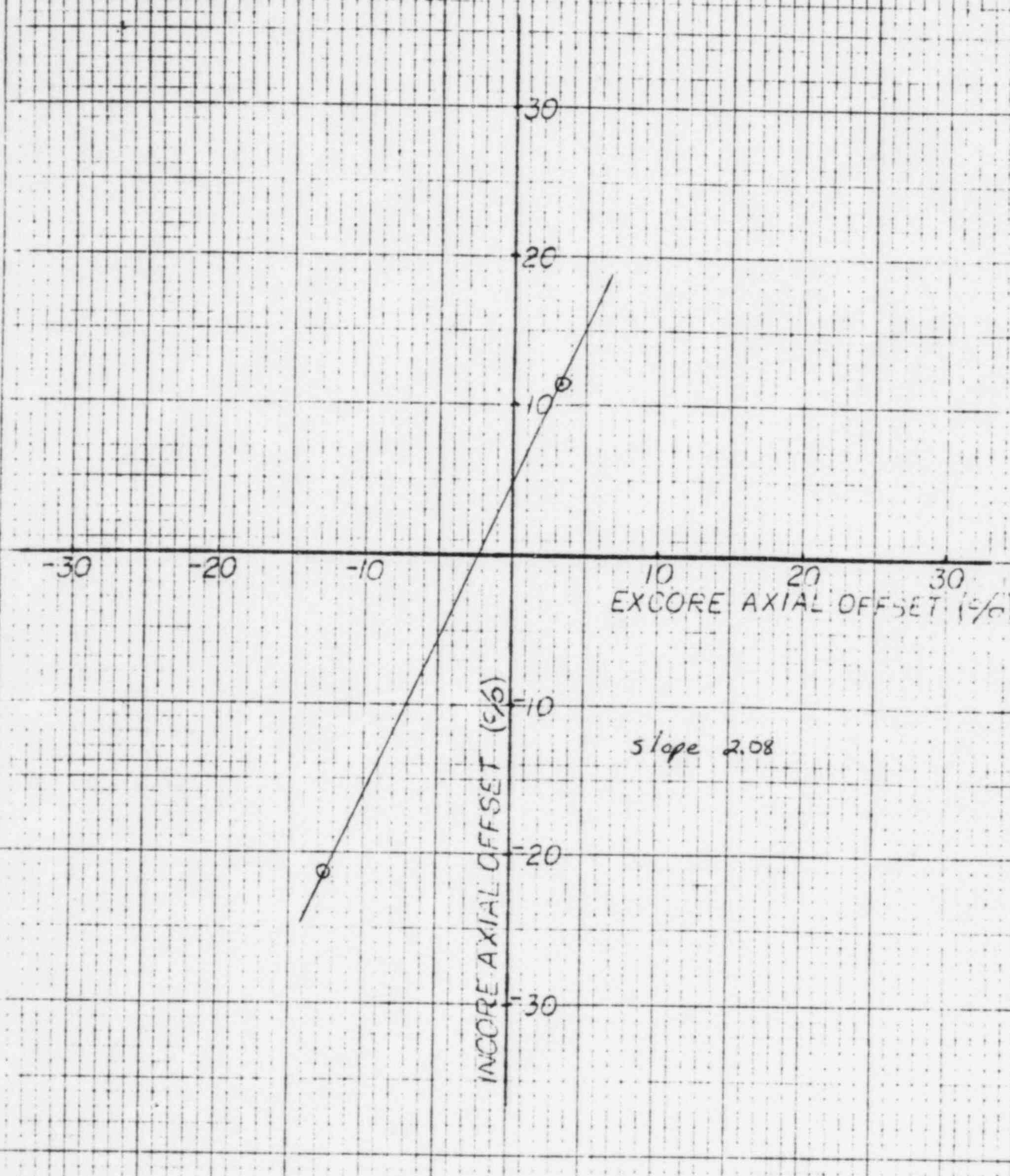


FIGURE 5-15

BY: [signature] DATE 7-25-83

FIGURE 5-16

FLUX MAP 132 (50 PERCENT POWER)

```
TROJAN FLUX MAP #132  07/21/83  50% HU(25    1 CY6 FCFM 50% D*179   -KENT
CALCULATED POWER TILTS (NORMALIZED TO 1.000)

 . 1.0031.0.9994 .                      .                  .                   .
   .     .     .                        .                    .  1.0012    .
     .   .   .             0.9889 . 1.0029                     .        .
0.9747 . . . 1.0064                     .                         .   .
 . . . . . . . . .              . . . . . . . . .         0.9849 .  1.0066
0.9952 . . . 1.0067                     .                         .   .
     .   .   .             1.0009 . 1.0073                     .        .
   .     .     .                        .                    .  1.0073    .
 . 1.0066.1.0080 .                      .                  .                   .


POSITIVE "Y" VS. NEGATIVE "Y" TILT
 0.9959            1.0041


POSITIVE "X" VS. NEGATIVE "X" TILT
 1.0051            0.9949
```

TROJAN FLUX MAP #132 07/21/83 50% RU(25) CY6 FCFM 50% DW179 -KENT

THE FOLLOWING CALCULATIONS ARE BASED ON A DIVISION OF THE CORE INTO "OCTANTS", THAT IS, QUADRANTS DIVIDED INTO TWO AXIAL REGIONS OF EQUAL VOLUME.

RELATIVE POWER IN UPPER HALF OF CORE

(-,+)	(+,+)
0.9629	0.9877
0.9885	0.9899
(-,-)	(+,-)

RELATIVE POWER IN LOWER HALF OF CORE

(-,+)	(+,+)
1.0148	1.0181
1.0133	1.0248
(-,-)	(+,-)

PERCENT AXIAL OFFSET TOWARD TOP OF CORE

(-,+)	(+,+)
-2.623	-1.515
-1.238	-1.730
(-,-)	(+,-)

CORE AVERAGE AXIAL OFFSET

-1.776

POWER TILT IN UPPER HALF OF CORE

(-,+)	(+,+)
0.9803	1.0056
1.0063	1.0078
(-,-)	(+,-)

POWER TILT IN LOWER HALF OF CORE

(-,+)	(+,+)
0.9971	1.0004
0.9956	1.0069
(-,-)	(+,-)

(-,+)	(+,+)
THESE	EDITS
ADDED	JAN.,1969
(-,-)	(+,-)

TROJAN FLUX MAP #132 07/21/83 50% BU(25) CY6 FCFM 50% D#179 -KENT

TOP TWENTY NUCLEAR F-DELTA-H		TOP TWENTY NUCLEAR FQ	
231J10MN	FDHN=1.4376	484N13MD	FQN=1.8049
230G 6ED	FDHN=1.4348	481N13LE	FQN=1.7851
204H11ED	FDHN=1.4284	205H 5EN	FQN=1.7720
205H 5EN	FDHN=1.4269	204H11ED	FQN=1.7718
226J 9EN	FDHN=1.4218	231J10MN	FQN=1.7707
225G 7MD	FDHN=1.4214	230G 6ED	FQN=1.7668
234J10EN	FDHN=1.4193	336E 8DE	FQN=1.7534
232J 6MD	FDHN=1.4153	476C13ED	FQN=1.7529
282F 7NM	FDHN=1.4130	474C13DE	FQN=1.7528
227J 7ED	FDHN=1.4130	378L 2NM	FQN=1.7521
233G 6MD	FDHN=1.4112	225G 7MD	FQN=1.7519
336E 8DE	FDHN=1.4105	381L 2NL	FQN=1.7517
228G10EN	FDHN=1.4104	477C 3DM	FQN=1.7488
283K 9DE	FDHN=1.4104	478N13NE	FQN=1.7482
280F 9NE	FDHN=1.4068	422D12FE	FQN=1.7458
355F 5DM	FDHN=1.4063	226J 9EN	FQN=1.7455
284K 7DM	FDHN=1.4013	282F 7NM	FQN=1.7446
285F 7NE	FDHN=1.4000	234J10EN	FQN=1.7439
286K 9DM	FDHN=1.3972	232J 6MD	FQN=1.7387
235J 6ED	FDHN=1.3970	425M12LE	FQN=1.7380

NOTE= VALUES ARE BEST ESTIMATE AND DO NOT INCLUDE ENGINEERING OR NUCLEAR UNCERTAINTY.

LOCA FQ ENVELOPE LIMIT AXIALLY

AXIAL POINT	FQ(Z) LIMIT	MEAS. FQ(Z)	SOURCE NO.ID
1	1.9952	0.5463	229G10MN
2	2.4035	0.7014	229G10MN
3	2.8026	0.8543	286K 9DM
4	3.2062	0.9833	286K 9DM
5	3.6053	1.0859	234J10EN
6	4.0043	1.1603	230G 6FD
7	4.1760	1.1466	286K 9DM
8	4.3802	1.3185	234J10FN
9	4.3894	1.3967	234J10EN
10	4.4034	1.4637	234J10FN
11	4.4080	1.5319	229G10MN
12	4.4266	1.6039	205H 5FN
13	4.4358	1.6764	205H 5FN
14	4.4498	1.6288	230G 6FD
15	4.4590	1.6107	230G 6FD
16	4.4730	1.6145	336F 8DE
17	4.4822	1.7522	205H 5EN
18	4.4962	1.8038	205H 5FN
19	4.5101	1.8395	205H 5EN
20	4.5194	1.8706	205H 5FN
21	4.5286	1.8814	205H 5FN
22	4.5426	1.8899	205H 5EN
23	4.5565	1.8680	230G 6ED
24	4.5658	1.7293	378L 2NM
25	4.5797	1.8622	484N13MD
26	4.5890	1.9050	205H 5EN
27	4.6029	1.9284	484N13MD
28	4.6168	1.9284	484N13MD
29	4.6261	1.9520	484N13MD
30	4.6354	1.9426	484N13MD

LOCA FQ ENVELOPE LIMIT AXIALLY

AXIAL POINT	FQ(Z) LIMIT	MEAS. FQ(Z)	SOURCE NO.ID
31	4.6400	1.9189	484N13MD
32	4.6400	1.8472	378L 2NM
33	4.6400	1.8150	484N13MD
34	4.6400	1.8859	484N13MD
35	4.6400	1.8859	484N13MD
36	4.6400	1.8859	484N13MD
37	4.6400	1.8859	484N13MD
38	4.6400	1.8622	484N13MD
39	4.6400	1.8386	484N13MD
40	4.6400	1.7913	484N13MD
41	4.6400	1.7040	378L 2NM
42	4.6400	1.7346	484N13MD
43	4.6400	1.7346	484N13MD
44	4.6400	1.7176	476C13ED
45	4.6400	1.7015	484N13MD
46	4.6400	1.6816	378L 2NM
47	4.6400	1.6479	378L 2NM
48	4.6400	1.6274	204H11ED
49	4.6400	1.5685	204H11ED
50	4.6400	1.4227	484N13MD
51	4.6400	1.4958	204H11ED
52	4.6400	1.4845	204H11ED
53	4.6400	1.4497	230G 6ED
54	4.6400	1.3986	204H11ED
55	4.6400	1.3355	204H11ED
56	4.6400	1.2579	204H11ED
57	4.6400	1.1500	226J 9EN
58	4.6400	1.0119	226J 9EN
59	4.6400	0.8337	226J 9EN
60	4.6400	0.6217	485N 3MN

FIGURE 5-16

MEASURED AND PERCENT. DIFF. OF FDHN   TROJAN FLUX MAP #132   07/21/83   50% BU(25   ) CY6 FCFM 50% DW179   -KENT

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1					0.589.	0.493.	0.483.	0.395.	0.481.	0.488.	0.565.				
					1.9.	0.7.	0.3.	-1.1.	-0.1.	-0.4.	-0.3.				
2			0.612.	0.859.	1.200.	1.224.	1.186.	1.043.	1.173.	1.195.	1.145.	0.869.	0.627.		
			-0.9.	-0.9.	4.0.	1.1.	-0.1.	-1.4.	-1.1.	-1.3.	-0.8.	0.3.	1.6.		
3		0.603.	1.094.	1.015.	0.927.	0.860.	0.898.	0.864.	0.884.	0.807.	0.880.	1.033.	1.134.	0.634.	
		-2.2.	-2.0.	-1.4.	4.2.	4.1.	1.1.	-0.0.	-0.6.	-2.4.	-1.1.	0.3.	1.6.	2.8.	
4		0.842.	1.006.	1.177.	0.987.	1.236.	0.998.	1.167.	0.995.	1.250.	0.995.	1.195.	1.034.	0.870.	
		-3.0.	-2.5.	-1.8.	-1.2.	-1.1.	-0.0.	0.2.	-0.3.	-0.0.	-0.4.	-0.3.	0.3.	0.3.	
5	0.545.	1.111.	0.857.	0.949.	1.289.	1.082.	1.302.	1.313.	1.307.	1.101.	1.311.	0.972.	0.899.	1.173.	0.599.
	-4.3.	-4.0.	-3.7.	-2.9.	-0.6.	-0.5.	1.5.	1.9.	1.9.	1.2.	1.1.	-0.6.	1.0.	1.4.	5.0.
6	0.472.	1.161.	0.791.	1.203.	1.069.	1.264.	1.333.	1.313.	1.346.	1.285.	1.097.	1.226.	0.827.	1.219.	0.519.
	-4.4.	-5.0.	-5.0.	-3.7.	-1.7.	-0.6.	0.4.	0.9.	1.4.	1.0.	0.8.	-1.9.	-0.5.	-0.2.	5.0.
7	0.466.	1.142.	0.860.	0.967.	1.269.	1.332.	1.318.	1.285.	1.325.	1.332.	1.294.	0.989.	0.908.	1.208.	0.509.
	-5.7.	-5.4.	-4.9.	-3.3.	-0.9.	0.4.	0.4.	0.6.	0.9.	0.4.	1.0.	-1.2.	0.3.	0.1.	3.1.
8	0.394.	1.038.	0.862.	1.140.	1.272.	1.304.	1.274.	1.227.	1.270.	1.298.	1.298.	1.163.	0.884.	1.063.	0.407.
	-3.9.	-3.9.	-3.1.	-2.7.	-1.1.	0.5.	-0.1.	-0.9.	-0.3.	0.0.	0.9.	-0.8.	-0.6.	-1.6.	-0.5.
9	0.477.	1.163.	0.883.	0.982.	1.277.	1.333.	1.326.	1.279.	1.302.	1.325.	1.294.	1.007.	0.911.	1.197.	0.490.
	-3.5.	-3.6.	-2.4.	-1.8.	-0.3.	0.4.	1.1.	0.1.	-0.7.	-0.1.	1.0.	0.6.	0.7.	-0.8.	-0.7.
10.	0.495.	1.224.	0.832.	1.221.	1.063.	1.266.	1.354.	1.313.	1.337.	1.268.	1.091.	1.254.	0.838.	1.214.	0.491.
	0.2.	0.2.	-0.0.	-2.3.	-2.3.	-0.5.	2.0.	1.0.	0.7.	-0.3.	0.3.	0.3.	0.7.	-0.6.	-0.6.
11.	0.573.	1.164.	0.896.	0.955.	1.280.	1.083.	1.299.	1.301.	1.291.	1.077.	1.305.	0.985.	0.902.	1.171.	0.576.
	0.5.	0.6.	0.7.	-2.4.	-1.3.	-0.4.	1.3.	0.9.	0.7.	-1.0.	0.6.	0.7.	1.4.	1.1.	1.0.
12		0.873.	1.061.	1.194.	0.996.	1.247.	1.002.	1.160.	0.996.	1.237.	1.006.	1.210.	1.058.	0.886.	
		0.6.	2.9.	-0.3.	-0.3.	-0.2.	0.4.	-0.4.	-0.2.	-1.0.	0.8.	0.9.	2.6.	2.2.	
13		0.634.	1.148.	1.043.	0.887.	0.840.	0.902.	0.871.	0.892.	0.838.	0.914.	1.052.	1.143.	0.636.	
		2.8.	2.8.	1.2.	-0.3.	1.7.	1.5.	0.8.	0.4.	1.4.	2.7.	2.1.	2.4.	3.1.	
14			0.634.	0.879.	1.162.	1.241.	1.193.	1.058.	1.182.	1.260.	1.188.	0.883.	0.632.		
			2.8.	1.4.	0.7.	2.4.	0.5.	0.1.	-0.4.	4.0.	2.9.	1.9.	2.5.		
15					0.576.	0.508.	0.485.	0.400.	0.480.	0.509.	0.583.				
					1.6.	3.6.	0.7.	0.2.	-0.3.	4.0.	2.9.				

MEAS
DIFF

FIGURE 5-16

PERCENT. DIFF. OF EXPECT. AND MEAS. FDHN TROJAN FLUX MAP #132 07/21/83 50% BU(25) CY6 FCFM 50% D#179 -KENT

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							0.3			-0.4					
2			-0.9			1.1		-1.4							
3								-0.0		-2.4		0.3		2.8	
4		-3.0	-2.5					0.2							
5					-0.6				1.9		1.1		1.0		
6	-4.4		-5.0			-0.6		0.9						-0.2	
7				-3.3			0.4			0.4			0.3		
8	-3.9		-3.1		-1.1		-0.1			0.0		-0.8	-0.6	-1.6	
9		-3.6							-0.7		1.0				-0.7
10					-2.3		2.0					0.3			
11	0.5							0.9			0.6				1.0
12						-0.2			-0.2			0.9			
13					-0.3			0.8						3.1	
14			2.8				0.5			4.0		1.9			
15					1.6			0.2							

TROJAN FLUX MAP #132 07/21/83 50% BU(25) CY6 FCFM 50% D#179 -KENT

POINT	SOURCE	NUCLEAR FXY
1	229 G10MN	1.6970
2	229 G10MN	1.6793
3	286 K 9DM	1.6403
4	286 K 9DM	1.6155
5	234 J10EN	1.5964
6	230 G 6ED	1.6065
7	286 K 9DM	1.5739
8	234 J10EN	1.5626
9	234 J10EN	1.5490
10	234 J10EN	1.5428
11	229 G10MN	1.5375
12	205 H 5EN	1.5362
13	205 H 5EN	1.5264
14	230 G 6ED	1.4424
15	230 G 6ED	1.4771
16	336 E 8DE	1.4240
17	205 H 5EN	1.4283
18	205 H 5EN	1.4327
19	205 H 5EN	1.4337
20	205 H 5EN	1.4340
21	205 H 5EN	1.4274
22	205 H 5EN	1.4274
23	230 G 6ED	1.4283
24	378 L 2NM	1.4357
25	484 N13MD	1.4191
26	205 H 5EN	1.4162
27	484 N13MD	1.4243
28	484 N13MD	1.4194
29	484 N13MD	1.4340
30	484 N13MD	1.4319
31	484 N13MD	1.4292
32	378 L 2NM	1.4456
33	484 N13MD	1.4830
34	484 N13MD	1.4335
35	484 N13MD	1.4269
36	484 N13MD	1.4305
37	484 N13MD	1.4360
38	484 N13MD	1.4270
39	484 N13MD	1.4258
40	484 N13MD	1.4182
41	378 L 2NM	1.4806
42	484 N13MD	1.4516
43	484 N13MD	1.4144
44	476 C13ED	1.4105
45	484 N13MD	1.4122
46	378 L 2NM	1.4117
47	378 L 2NM	1.4086
48	204 H11ED	1.4200
49	204 H11ED	1.4412
50	484 N13MD	1.4324
51	204 H11ED	1.4236
52	204 H11ED	1.4341
53	230 G 6ED	1.4484
54	204 H11ED	1.4571
55	204 H11ED	1.4723
56	204 H11ED	1.4973
57	226 J 9EN	1.5212
58	226 J 9EN	1.5525
59	226 J 9EN	1.6004
60	485 N 3MN	1.6416

NOTE= VALUES ARE BEST ESTIMATE AND DO NOT INCLUDE ENGINEERING OR NUCLEAR UNCERTAINTY.

FIGURE 5-16

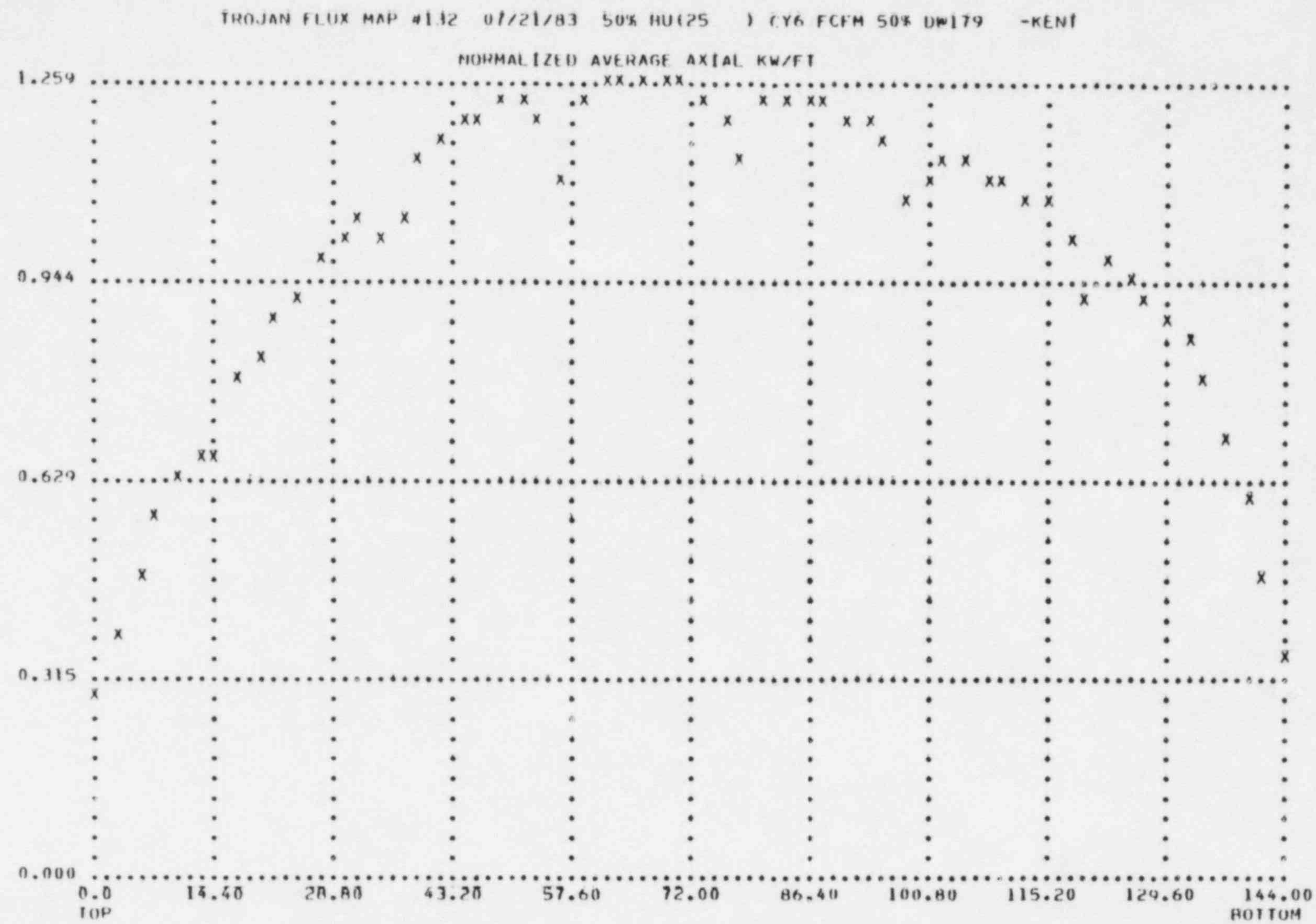

TROJAN FLUX MAP #132 07/21/83 50% HU(25) CY6 FCFM 50% DW179 -KENT
NORMALIZED AVERAGE AXIAL KW/FT
1.259
0.944
0.629
0.315
0.000
0.0
TOP
14.40
28.80
43.20
57.60
72.00
86.40
100.80
115.20
129.60
144.00
BOTTOM

FIGURE 5-17

FLUX MAP 133 (100 PERCENT POWER)

TROJAN FLUX MAP #133 08/19/83 100% HU(500) CY6 D#203 100% P -BAIR

CALCULATED POWER TILTS (NORMALIZED TO 1.000)

```
. 0.99[illegible].1.0104 .          .                       .                 .
  .       .      .                  .                         . 1.0024    .
     .    .    .          0.9908 . 1.0063                      .          .
0.9872 . . . 1.0023                 .                              .    .
. . . . . . . . .           . . . . . . . . . .           0.9921  .  1.0032
0.9971 . . . 1.0042                 .                              .    .
     .    .    .          1.0013 . 1.0015                      .          .
  .       .      .                  .                         . 1.0022    .
. 1.0055.0.9989 .                   .                       .                 .
```

POSITIVE "Y" VS. NEGATIVE "Y" TILT
0.9986 1.0014

POSITIVE "X" VS. NEGATIVE "X" TILT
1.0039 0.9961

TROJAN FLUX MAP #133 08/19/83 100% RU(500) CY6 D=203 100% P -RAIR

THE FOLLOWING CALCULATIONS ARE BASED ON A DIVISION
OF THE CORE INTO "OCTANTS", THAT IS, QUADRANTS
DIVIDED INTO TWO AXIAL REGIONS OF EQUAL VOLUME.

RELATIVE POWER IN UPPER HALF OF CORE

(-,+)	(+,+)
0.9484	0.9676
0.9631	0.9552
(-,-)	(+,-)

RELATIVE POWER IN LOWER HALF OF CORE

(-,+)	(+,+)
1.0332	1.0451
1.0396	1.0479
(-,-)	(+,-)

PERCENT AXIAL OFFSET TOWARD TOP OF CORE

(-,+)	(+,+)
-4.281	-3.848
-3.819	-4.631
(-,-)	(+,-)

CORE AVERAGE AXIAL OFFSET

-4.145

POWER TILT IN UPPER HALF OF CORE

(-,+)	(+,+)
0.9894	1.0095
1.0047	0.9965
(-,-)	(+,-)

POWER TILT IN LOWER HALF OF CORE

(-,+)	(+,+)
0.9921	1.0035
0.9982	1.0062
(-,-)	(+,-)

(-,+)	(+,+)
THESE	EDITS
ADDED	JAN.,1969
(-,-)	(+,-)

TROJAN FLUX MAP #133 08/19/83 100% HU(500) CY6 D#203 100% P -BAIR

TOP TWENTY NUCLEAR F-DELTA-H		TOP TWENTY NUCLEAR FQ	
204H11FD	FDHN=1.4102	484N13MD	FQN=1.6476
231J10MN	FDHN=1.4087	477C 3DM	FQN=1.6446
230G 6ED	FDHN=1.4072	425M12LE	FQN=1.6418
205H 5EN	FDHN=1.4014	424D 4FM	FQN=1.6392
355E 5DM	FDHN=1.3995	478N13NE	FQN=1.6307
225G 7MD	FDHN=1.3956	476C13FD	FQN=1.6306
336E 8DF	FDHN=1.3941	474C13DF	FQN=1.6303
228G10FN	FDHN=1.3941	481N13LE	FQN=1.6295
424D 4FM	FDHN=1.3911	480C 3FM	FQN=1.6265
425M12LF	FDHN=1.3910	483C 3EN	FQN=1.6248
282F 7NM	FDHN=1.3902	205H 5EN	FQN=1.6155
280F 9NF	FDHN=1.3879	510B11ED	FQN=1.6149
234J10FN	FDHN=1.3873	511B11FD	FQN=1.6147
232J 6MD	FDHN=1.3853	475C13FE	FQN=1.6131
226J 9EN	FDHN=1.3843	336E 8DE	FQN=1.6114
283K 9DF	FDHN=1.3832	204H11ED	FQN=1.6107
337L 8NF	FDHN=1.3812	231J10MN	FQN=1.6088
284K 7DM	FDHN=1.3810	422D12FE	FQN=1.6076
233G 6MD	FDHN=1.3809	230G 6ED	FQN=1.6044
206H12FD	FDHN=1.3801	355E 5DM	FQN=1.6031

NOTE= VALUES ARE BEST ESTIMATE AND DO NOT INCLUDE ENGINEERING OR NUCLEAR UNCERTAINTY.

FIGURE 5-17

LOCA FQ ENVELOPE LIMIT AXIALLY

AXIAL POINT	FQ(Z) LIMIT	MEAS. FQ(Z)	SOURCE NO. ID
1	0.9976	0.5649	306F 4MN
2	1.2018	0.7218	325F 2DM
3	1.4013	0.8657	325F 2DM
4	1.6031	0.9947	232J 6MD
5	1.8026	1.0997	232J 6MD
6	2.0022	1.1917	230G 6ED
7	2.0880	1.1782	325F 2DM
8	2.1901	1.3390	204H11FD
9	2.1947	1.4217	228G10FN
10	2.2017	1.4706	205H 5FN
11	2.2040	1.5186	205H 5FN
12	2.2133	1.5598	205H 5FN
13	2.2179	1.5858	205H 5EN
14	2.2249	1.5935	205H 5EN
15	2.2295	1.5354	230G 6ED
16	2.2365	1.5514	390D 8DF
17	2.2411	1.6468	205H 5FN
18	2.2481	1.6753	205H 5FN
19	2.2550	1.6900	205H 5FN
20	2.2597	1.7062	205H 5EN
21	2.2643	1.7038	205H 5FN
22	2.2713	1.7070	205H 5FN
23	2.2782	1.6852	230G 6FD
24	2.2829	1.5514	205H 5FN
25	2.2898	1.6814	425M12LE
26	2.2945	1.7229	425M12LE
27	2.3014	1.7342	425M12LE
28	2.3084	1.7464	425M12LE
29	2.3130	1.7500	425M12LE
30	2.3177	1.7525	425M12LE

FIGURE 5-17

LOCA FQ ENVELOPE LIMIT AXIALLY

AXIAL POINT	FQ(Z) LIMIT	MEAS. FQ(Z)	SOURCE NO.ID
31	2.3200	1.7430	425M12LF
32	2.3200	1.6911	2306 6FD
33	2.3200	1.6665	484N13MD
34	2.3200	1.7398	425M12LE
35	2.3200	1.7576	477C 3DM
36	2.3200	1.7707	477C 3DM
37	2.3200	1.7786	477C 3DM
38	2.3200	1.7774	477C 3DM
39	2.3200	1.7707	477C 3DM
40	2.3200	1.7519	477C 3DM
41	2.3200	1.6228	476C13ED
42	2.3200	1.7484	484N13MD
43	2.3200	1.7744	484N13MD
44	2.3200	1.7819	484N13MD
45	2.3200	1.7819	484N13MD
46	2.3200	1.7744	484N13MD
47	2.3200	1.7484	484N13MD
48	2.3200	1.7112	484N13MD
49	2.3200	1.6609	204H11FD
50	2.3200	1.5103	484N13MD
51	2.3200	1.6266	204H11FD
52	2.3200	1.6295	204H11FD
53	2.3200	1.6006	204H11ED
54	2.3200	1.5592	204H11FD
55	2.3200	1.5074	204H11FD
56	2.3200	1.4253	204H11FD
57	2.3200	1.3163	204H11FD
58	2.3200	1.1623	204H11FD
59	2.3200	0.9592	355E 5DM
60	2.3200	0.7116	226J 9FN

FIGURE 5-17

MEASURED AND PERCENT. DIFF. OF FDHW TROJAN FLUX MAP #133 08/19/83 100% BU(500) CY6 D#203 100% P -BAIR

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1					0.554	0.487	0.477	0.398	0.475	0.486	0.565				
					-0.1	2.0	1.7	2.4	1.3	1.8	1.8				
2			0.620	0.867	1.136	1.208	1.178	1.055	1.180	1.216	1.164	0.882	0.629		
			0.5	0.5	-0.1	1.7	1.2	1.6	1.4	2.4	2.4	2.2	2.1		
3		0.610	1.116	1.038	0.889	0.816	0.885	0.871	0.892	0.843	0.914	1.072	1.150	0.628	
		-0.9	-0.9	-0.9	-0.1	-0.1	-0.0	0.0	0.8	3.1	2.7	2.2	2.1	1.9	
4		0.842	1.024	1.255	0.995	1.224	1.006	1.243	1.018	1.269	1.034	1.296	1.063	0.871	
		-2.4	-2.4	-2.1	-1.8	-1.8	-0.4	0.1	0.9	1.8	2.1	1.1	1.4	1.0	
5	0.551	1.123	0.875	0.976	1.280	1.065	1.271	1.301	1.284	1.094	1.312	0.997	0.891	1.141	0.558
	-1.2	-1.5	-1.7	-1.7	-1.6	-1.5	-1.0	-0.1	-0.0	1.1	0.9	0.4	0.0	0.0	0.1
6	0.476	1.184	0.807	1.221	1.060	1.241	1.303	1.292	1.319	1.266	1.082	1.244	0.819	1.192	0.482
	-1.2	-1.1	-2.0	-2.0	-2.1	-1.6	-1.3	-0.4	-0.1	0.4	-0.0	-0.2	-0.5	-0.4	0.1
7	0.486	1.180	0.882	0.997	1.265	1.305	1.295	1.273	1.303	1.309	1.275	1.011	0.900	1.183	0.482
	0.9	-0.2	-2.0	-1.5	-1.3	-1.1	-1.4	-1.4	-0.8	-0.8	-0.6	-0.1	-0.0	0.0	0.3
8	0.402	1.059	0.876	1.230	1.28[illegible]	1.281	1.266	1.291	1.272	1.281	1.294	1.247	0.897	1.064	0.402
	0.9	-0.1	-2.2	-1.5	-1.2	-1.0	-1.8	-1.9	-1.3	-1.0	-0.4	-0.1	0.1	0.4	0.8
9	0.484	1.180	0.884	0.998	1.267	1.304	1.298	1.272	1.293	1.306	1.280	1.015	0.904	1.194	0.485
	0.7	-0.3	-1.7	-1.4	-1.2	1.1	-1.1	-1.5	-1.5	-1.0	-0.2	0.2	0.4	0.9	0.9
10	0.480	1.193	0.809	1.231	1.068	1.249	1.325	1.292	1.314	1.248	1.079	1.243	0.823	1.217	0.490
	-0.2	-0.3	-1.7	-1.3	-1.3	-1.0	0.4	-0.4	-0.5	-1.0	-0.3	-0.3	0.0	1.7	1.7
11	0.564	1.153	0.901	0.981	1.288	1.072	1.285	1.303	1.285	1.072	1.283	0.979	0.875	1.165	0.570
	1.1	1.1	1.1	-1.2	-1.0	-0.9	0.1	0.0	0.1	-1.0	-1.3	-1.4	-1.7	2.2	2.2
12		0.873	1.063	1.295	1.017	1.250	1.013	1.244	1.010	1.234	0.992	1.254	1.058	0.896	
		1.2	1.3	1.0	0.4	0.3	0.3	0.2	0.1	-1.0	-2.1	-2.2	0.8	3.8	
13		0.624	1.141	1.063	0.894	0.828	0.894	0.877	0.886	0.818	0.886	1.034	1.137	0.649	
		1.3	1.3	1.4	0.5	1.3	1.0	0.8	0.2	0.1	-0.5	-1.4	1.0	5.4	
14			0.625	0.874	1.152	1.210	1.195	1.066	1.187	1.204	1.149	0.868	0.635		
			1.3	1.3	1.3	2.0	2.7	2.6	2.0	1.4	1.0	0.6	2.9		
15					0.561	0.488	0.487	0.404	0.483	0.484	0.560				
					1.2	2.2	3.8	3.8	2.9	1.4	1.0				

MEAS
DIFF

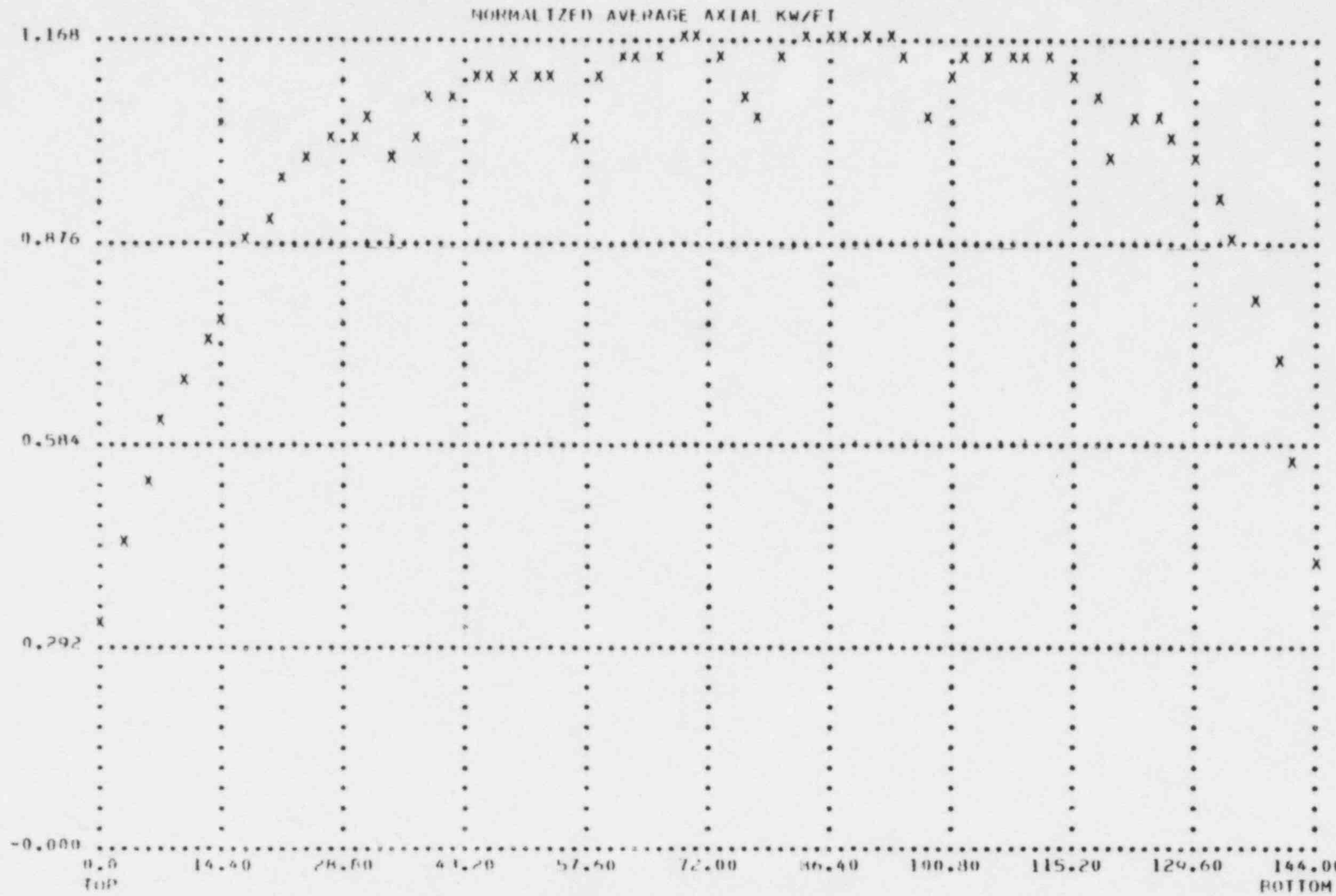
FIGURE 5-17

PERCENT. DIFF. OF EXPECT. AND MEAS. FDHN TROJAN FLUX MAP #133 08/19/83 100% BU(500) CY6 D#203 100% P -BAIR

	R	P	N	M	L	K	J	H	G	F	E	D	C	B	A
1							1.7			1.8					
2			0.5			1.7		1.6							
3								0.0		3.1		2.2		1.9	
4			-2.4					0.1							
5					-1.6				-0.0		0.9		0.0		
6	-1.2		-2.0			-1.6		-0.4						-0.4	
7				-1.5			-1.4			-0.8			-0.0		
8	0.9		-2.2		-1.2		-1.8			-1.0		-0.1	0.1	0.4	
9		-0.3							-1.5		-0.2				0.9
10					-1.3		0.4					-0.3			
11	1.1				-1.0			0.0			-1.3				2.2
12						0.3			0.1			-2.2			
13			1.3		0.5			0.8						5.4	
14							2.7			1.4		0.6			
15					1.2			3.8							

FIGURE 5-17

TROJAN FLUX MAP #133 08/19/83 100% BU(500) CY6 D#203 100% P -BAIR



6.0 CONCLUSIONS

The Cycle 6 startup test results were satisfactory and represent continued improvement over previous cycle startup test results. The more accurate treatment of individual fuel assembly burnups, along with other improvements to the nuclear design methods, have reduced the amount of nuclear design prediction error.

The startup tests also showed that the modified stainless steel pin fuel assemblies, with and without 2 x 8 partial grids, do not have a significant impact on core power distribution and that they can be accounted for in normal fuel management schemes.

ATTACHMENT A