KEWAUNEE NUCLEAR POWER PLANT

CYCLE 21
STARTUP REPORT
JULY 1995

WISCONSIN PUBLIC SERVICE CORPORATION
WISCONSIN POWER & LIGHT COMPANY
MADISON GAS & ELECTRIC COMPANY

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GREEN BAY, WISCONSIN

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Prepared By: Senior Nuclear Fuel Technician **Date:** 7-13-95

Reviewed By: Lead Plant Reactor Engineer **Date:** 7-18-95

Reviewed By: Nuclear Fuel Analysis Supervisor **Date:** 7-13-95

Reviewed By: Director Nuclear Fuel **Date:** 7-13-95

Reviewed By: Nuclear Licensing Director **Date:** 7-17-95

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1.0 INTRODUCTION, SUMMARY, AND CONCLUSION

1.1 Introduction

This report presents the results of the physics tests performed during startup of Kewaunee Cycle 21. The core design and reload safety evaluation were performed by Wisconsin Public Service Corporation (1) using methods previously described in WPS topical reports (2,3). The results of the physics tests were compared to WPS analytical results to confirm calculated safety margins. The tests performed and reported herein satisfy the requirements of the Reactor Test Program (4).

During Cycle 20-21 refueling, 48 of the 121 fuel assemblies in the core were replaced with Siemens Power Corporation design(s) fresh fuel assemblies. Twenty are enriched to 3.8 weight percent U235, twenty are enriched to 4.1 weight percent U235, and eight Lead Test Assemblies (LTA) are enriched to 4.1 weight percent U235. The Cycle 21 core consists of the following regions of fuel:

Region	ID	Vendor	Initial U235 W/O	Number of Previous Duty Cycles	Number of Assemblies
20	W	SPC	3.4	2	1
20	W	SPC	3.4	3	4
21	X	SPC	3.4	2	28
21	X	WES	3.1	2	4
22	Z	SPC	3.5	1	12
22	Z	SPC	3.7	1	24
23	A	SPC	3.8	0	20 (Feed)
23	A	SPC	4.1	0	20 (Feed)
23	A	SPC	4.1 (LTA)	0	8 (Feed)

The core loading pattern, assembly identification, RCCA bank identification, instrument thimble I.D., thermocouple I.D., and burnable poison rod configurations for Cycle 21 are presented in Figure 1.1.

On May 16, 1995, at 1950 hours, initial criticality was achieved on the Cycle 21 core. The schedule of physics tests and measurements is outlined in Table 1.1.

1.2 Summary

RCCA measurements are shown in Section 2. All RCCA drop time measurements were within Technical Specification limits. RCCA bank worths were measured using the rod swap reactivity comparison technique previously described (4,6). The reactivity comparison was made to the reference bank, Bank C, which was measured using the dilution technique. All results were within the established acceptance criteria (4), and thereby demonstrated adequate shutdown margin.

Section 3 presents the boron endpoint and boron worth measurements. The endpoint measurements for ARO and Bank C In core configurations were within the acceptance criteria (4). The available boron letdown data covering the first month of reactor operation is also shown. The agreement between measurements and predictions meets the review and acceptance criteria (4).

Section 4 shows the results of the isothermal temperature coefficient measurements. The differences between measurements and predictions were within the acceptance criteria (4).

Power distributions were measured via flux maps using the INCORE code for beginning of cycle (BOC) core conditions covering power escalation to full power equilibrium xenon. The results indicate compliance with Technical Specification limits (7) and are presented in Section 5. Section 6 discusses the various calibrations performed during the startup of Cycle 21.

1.3 Conclusion

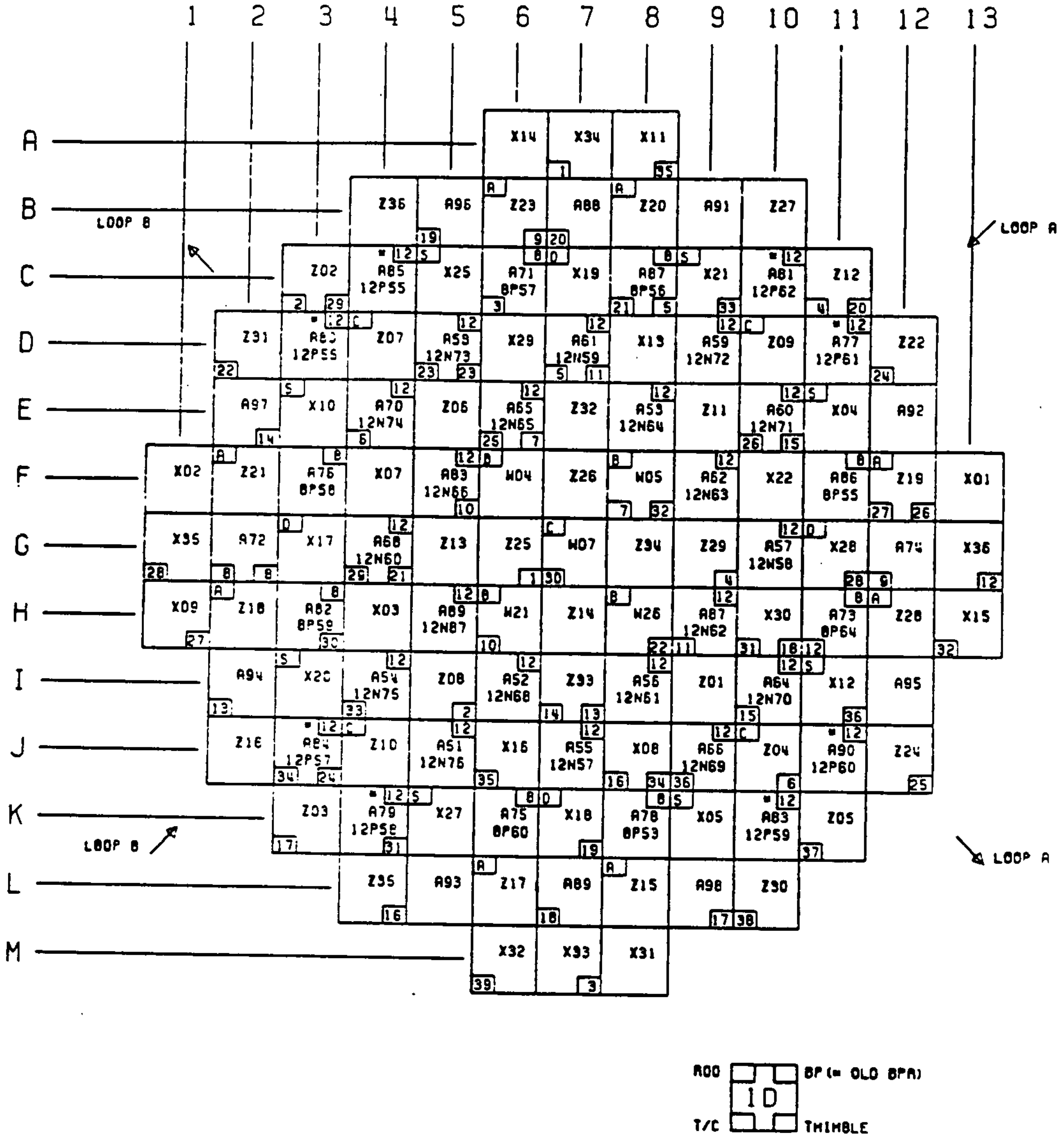
The startup testing of Kewaunee's Cycle 21 core verified that the reactor core has been properly loaded and the core characteristics satisfy the Technical Specifications (7) and are consistent with the parameters used in the design and safety analysis (I).

TABLE 1.1

BOC Physics Test

Test	Date Completed	Time Completed	Plant Conditions
Control Rod Operability Test	05/12/95	2000	Cold SD
Hot Rod Drops	05/13/95	2345	HSD
RPI Calibrations	05/14/95	0527	HSD
Initial Criticality	05/14/95	1614	HZP
Reactivity Computer Checkout	05/15/95	0030	HZP
ARO Endpoint	05/15/95	0312	HZP
Bank C Worth (Dilution)	05/15/95	0430	HZP
Bank C In-ORO Endpoint	05/15/95	0715	HZP
Bank C Worth (Boration)	05/15/95	1530	HZP
ITC Determination	05/15/95	1819	HZP
Power Accention Flux Map 2101	05/16/95	0926	25%
Power Accention Flux Map 2102	05/22/95	1427	36%
Power Accention Flux Map 2103	05/24/95	0900	73%
Power Accention Flux Map 2104	05/25/95	1431	87%
Power Accention Flux Map 2105	05/26/95	1548	94%
Power Accention Flux Map 2106	05/27/95	1103	94%
Power Accention Flux Map 2107	05/30/95	0949	94%
Power Accention Flux Map 2108	06/06/95	0926	94%
Power Accention Flux Map 2109	06/14/95	0934	96%

Figure 1.1
Core Loading Map



	1	2	3	4	5	6	7	8	9	10	11	12	13
A						X14	X34	X11					
B				Z36	A96	Z23	A88	Z20	A91	Z27			
C			Z02	A85 12P55	X25	A71 8P57	X19	A87 8P56	X21	A81 12P62	Z12		
D		Z31	A8[illegible] 12P55	Z07	A58 12N73	X29	A61 12N59	X13	A59 12N72	Z09	A77 12P61	Z22	
E		A97	X10	A70 12N74	Z06	A65 12N65	Z32	A53 12N64	Z11	A60 12N71	X04	A92	
F	X02	Z21	A76 8P58	X07	A83 12N66	W04	Z26	W05	A62 12N63	X22	A86 8P55	Z19	X01
G	X35	A72	X17	A68 12N60	Z13	Z25	W07	Z34	Z29	A57 12N58	X28	A74	X36
H	X09	Z18	A82 8P59	X03	A89 12N87	W21	Z14	W26	A87 12N62	X30	A73 8P64	Z28	X15
I		A94	X20	A54 12N75	Z08	A52 12N68	Z33	A56 12N61	Z01	A64 12N70	X12	A95	
J		Z16	A84 12P57	Z10	A51 12N76	X16	A55 12N57	X08	A66 12N69	Z04	A90 12P60	Z24	
K			Z03	A79 12P58	X27	A75 8P60	X18	A78 8P53	X05	A83 12P59	Z05		
L				Z35	A93	Z17	A89	Z15	A98	Z30			
M						X32	X33	X31					

CYCLE TWENTY-ONE

5-3-95
NUCLEAR FUEL TECHNICIAN

5-3-95
NUCLEAR FUEL ENGINEER

5-16-95
FUEL CYCLE SUPERVISOR

2.0 RCCA MEASUREMENTS

2.1 RCCA Drop Time Measurements

RCCA drop times to dashpot and rod bottom were measured at hot shutdown core conditions. The results of the hot shutdown measurements are presented in Table 2.1. The acceptance criterion (4) of 1.8 seconds to dashpot is adequately met for all fuel.

2.2 RCCA Bank Measurements

During Cycle 21 startup the reactivity of the reference bank (Bank C) was measured during dilution using the reactivity computer. The reactivity worth of the remaining banks was inferred using rod swap reactivity comparisons to the reference bank.

2.2.1 Rod Swap Results

The worth of the reference bank (Bank C) measured during dilution differed from the WPSC predicted Bank C worth by -17.5 pcm or -1.6 percent. A comparison of the measured to predicted reference bank integral and differential worth is presented in Figure 2.1.

Rod swap results for the remaining banks are presented in Table 2.2. The measured to predicted total rod worth difference is -5.2 percent which is within the acceptance criteria of 10.0 percent. All individual bank worths were within the 15.0 percent measured to predicted review criterion.

2.3 Shutdown Margin Evaluation

Prior to power escalation a shutdown margin evaluation was made to verify the existence of core shutdown capability. The minimum shutdown margins at beginning and end of cycle are presented in Table 2.3. A 10 percent uncertainty in the calculation of rod worth is allowed for in these shutdown margin analyses. Since the measured rod worths resulted in less than a 10 percent difference from predicted values, the analysis in Table 2.3 is conservative and no additional evaluations were required.

TABLE 2.1

Kewaunee Cycle 21

RCCA Drop Time Measurements

Hot Zero Power

Average Dashpot Delta T (Seconds)	1.267
Standard Deviation	0.033
Average Rod Bottom Delta T (Seconds)	1.789
Standard Deviation	0.025

TABLE 2.2

Kewaunee Cycle 21

RCCA Bank Worth Summary

Reference Bank Measured by Dilution/Reactivity Computer

Rod Swap Method RCCA Bank	Measured Worth (PCM)	WPS Predicted Worth (PCM)	Difference (PCM)	Percent Difference
D	683.7	788.0	-104.3	-13.2
C*	1053.5	1071.0	-17.5	-1.6
B	473.6	470.0	3.6	0.8
A	900.9	946.0	-45.1	-4.8
SA	700.4	744.0	-43.6	-5.9
SB	705.1	744.0	-38.9	-5.2
Total	4517.1	4763.0	-245.9	-5.2

* Reference bank

FIGURE 2.1

RCCA Bank C Integral and Differential Worth

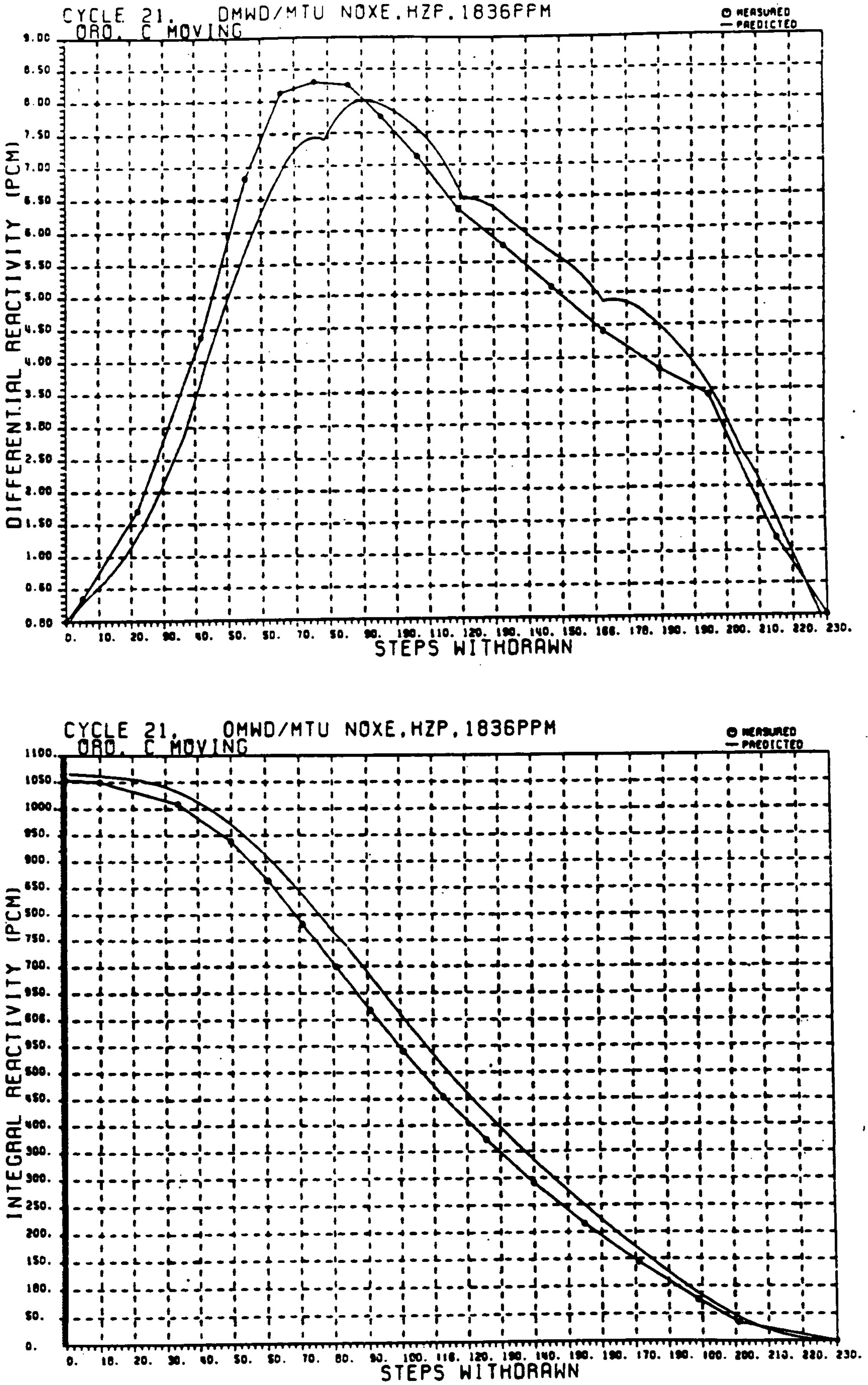


TABLE 2.3

Kewaunee Cycle 21

Minimum Shutdown Margin Analysis

RCCA Bank Worths (PCM)	BOC	EOC
N	6006	6028
N-1	5315	5349
Less 10 Percent	532	535
Sub Total	4783	4814
Total Requirements (Including Uncertainties)	2360	2800
Shutdown Margin	2423	2014
Required Shutdown Margin	1000	2000

3.0 BORON ENDPOINTS AND BORON WORTH MEASUREMENTS

3.1 Boron Endpoints

Dilution is stopped at the near ARO and at the Reference Bank nearly inserted core conditions. Boron concentration is allowed to stabilize. The critical boron concentration for these core configurations is then determined by boron endpoint measurement.

Table 3.1 lists the measured and WPSC predicted boron endpoints for the RCCA bank configurations shown. The results indicate a difference of -8 ppm and -8 ppm for the ARO and Bank C In conditions, respectively. The acceptance criterion on the all rods out boron endpoint is ±100 PPM, thus, the boron endpoint comparisons are considered acceptable.

3.2 Differential Boron Worth

The differential boron worth is calculated by dividing the worth of control Bank C by the difference in boron concentration of the corresponding bank out and bank in configuration. Table 3.2 presents a comparison between measured and predicted boron concentration change and differential boron worth. No acceptance criteria are applied to these comparisons.

3.3 Boron Letdown

The measured boron concentration data for the first month of power operation is corrected to nominal core conditions and presented versus cycle burnup in Figure 3.1. The predicted boron letdown curve is included for comparison.

TABLE 3.1

Kewaunee Cycle 21

RCCA Bank Endpoint Measurements

RCCA Bank Configuration	Measured Endpoint (PPM)	WPS Predicted Endpoint (PPM)	Difference (PPM)
All Rods Out	1898	1906	-8
Bank C In	1757	1765	-8

TABLE 3.2

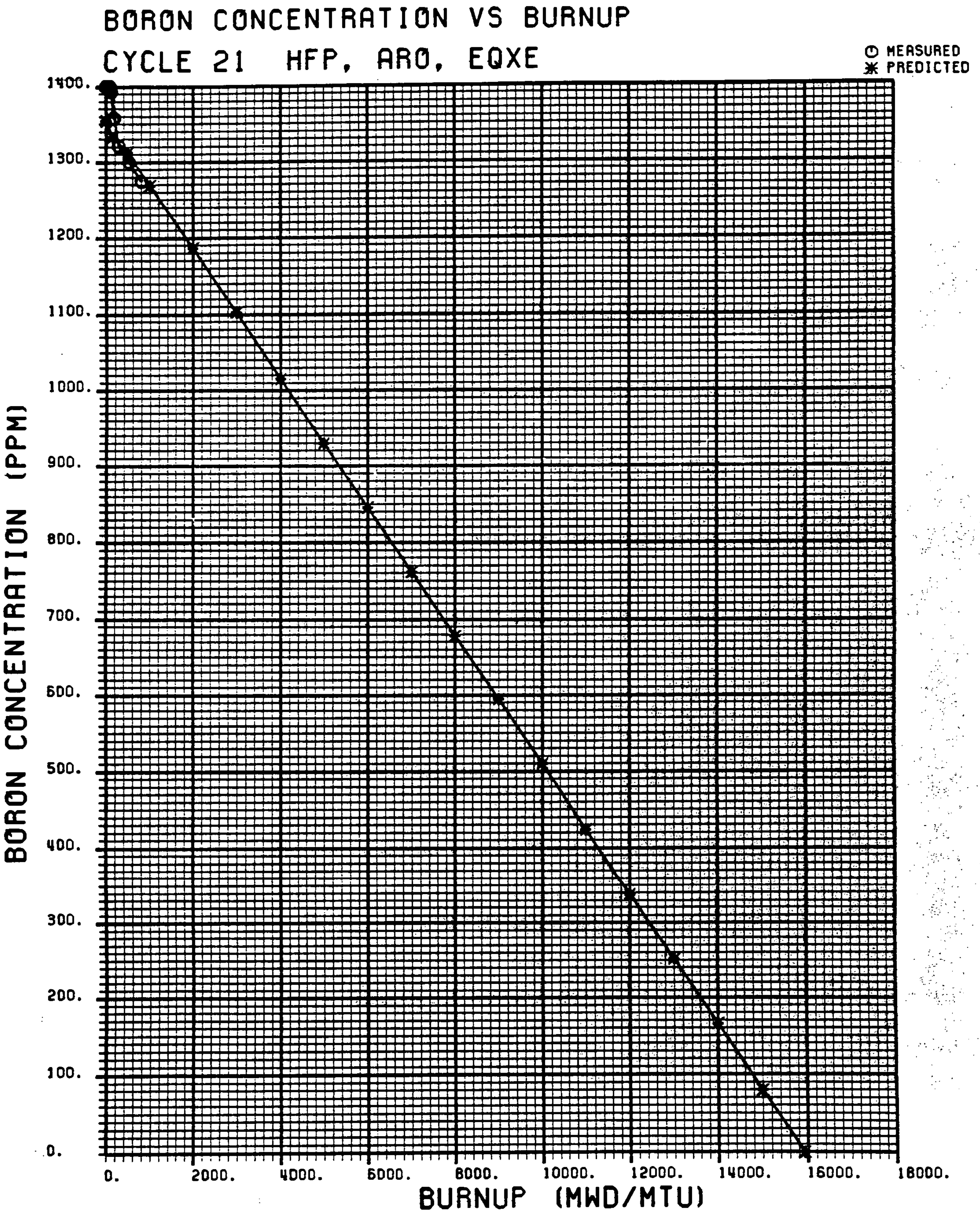
Kewaunee Cycle 21

Differential Boron Worth

RCCA Bank Configuration	CB Change Measured (PPM)	CB Change Predicted (PPM)	Percent Difference
ARO to C Bank In	141	141	0.0

RCCA Bank Configuration	Measured Boron Worth (PCM/PPM)	Predicted Boron Worth (PCM/PPM)	Difference (PCM/PPM)
ARO/C Bank In	-7.5	-7.6	+0.1

FIGURE 3.1


BORON CONCENTRATION VS BURNUP
CYCLE 21 HFP, ARO, EQXE
MEASURED
PREDICTED
BORON CONCENTRATION (PPM)
1400.
1300.
1200.
1100.
1000.
900.
800.
700.
600.
500.
400.
300.
200.
100.
0.
0.
2000.
4000.
6000.
8000.
10000.
12000.
14000.
16000.
18000.
BURNUP (MWD/MTU)

4.0 ISOTHERMAL TEMPERATURE COEFFICIENT

The measurement of the isothermal temperature coefficient was accomplished by monitoring reactivity while cooling down and heating up the reactor by manual control of the steam dump valves. The temperature and reactivity changes were plotted on an X-Y recorder and the temperature coefficient was obtained from the slope of this curve.

Core conditions at the time of the measurement were Bank D slightly inserted, all other RCCA banks full out, with a boron concentration of 1890 ppm. These conditions approximate the HZP, all rods out core condition which yields the most conservative (least negative) isothermal temperature coefficient measurement.

Table 4.1 presents the heatup and cooldown core conditions and compares the measured and predicted values for the isothermal temperature coefficient. The review criterion (4) of ±3 PCM/°F was met.

TABLE 4.1

Kewaunee Cycle 21

Isothermal Temperature Coefficient

Cooldown

Tave Start - 546.9°F

Tave End - 542.0°F

Bank D - 192 Steps

Boron Concentration - 1B90 PPM

Measured ITC (PCM/°F)	WPSC Predicted ITC (PCM/°F)	Difference (PCM/°F)
-1.9	-2.2	0.3

Heat Up

Tave Start - 541.8°F

Tave End - 547.0°F

Bank D - 192 Steps

Boron Concentration - 1890 PPM

Measured ITC (PCM/°F)	WPSC Predicted ITC (PCM/°F)	Difference (PCM/°F)
-1.4	-2.2	0.8

5.0 POWER DISTRIBUTION

5.1 Summary of Power Distribution Criteria

Power distribution predictions are verified through data recorded using the incore detector system and processed through the INCORE computer code. The computer code calculates FQEQ and FDHN which are limited by technical specifications. These parameters are defined as the acceptance criteria on a flux map (4).

The review criterion for measurement is that the percent differences of the normalized reaction rate integrals of symmetric thimbles do not exceed 10 percent at low power physics test conditions and 6 percent at equilibrium conditions (4).

The review criterion for the prediction is that the standard deviation of the percent differences between measured and predicted reaction rate integrals does not exceed 5 percent.

The review criteria for the INCORE calculated quadrant powers are that the quadrant tilt is less than 4 percent at low power physics test conditions and less than 2 percent at equilibrium conditions (4).

Power generation is limited to 96%-97% because of steam generator tube plugging.

5.2 Power Distribution Measurements

Table 5.1 identifies the reactor conditions for each flux map recorded at the beginning of Cycle 21.

Comparisons of measured to predicted power distributions for the flux maps are exhibited in Figures 5.1 through 5.9.

Table 5.2 identifies flux map peak FDHN and minimum margin FQEQ. This table addresses acceptance criteria by verifying that technical specification limits are not exceeded. Table 5.3 identifies FQW for the four Westinghouse assemblies and FQS for the eight Siemens Power Corporation lead test assemblies and verifies that applied limits are reviewed. The Cycle 21 flux maps met all acceptance criteria.

Table 5.4 addresses the established review criteria for the flux maps. All review criteria were met for all the Cycle 21 flux maps.

TABLE 5.1

Flux Map Chronology and Reactor Characteristics

Map	Date	Percent Power	Xenon	Boron PPM	D Rods Steps	Exposure MDW/MTU
2101	05/16/95	25	NON-EQ.	1825	190	0
2102	05/22/95	36	NON-EQ.	1542	168	60
2103	05/24/95	73	NON-EQ.	1428	197	95
2104	05/25/95	87	NON-EQ.	1393	208	130
2105	05/26/95	95	NON-EQ.	1358	218	162
2106	05/27/95	94	NON-EQ.	1358	230	191
2107	05/30/95	94	EQ.	1321	230	289
2108	06/06/95	94	EQ.	1300	230	528
2109	06/14/95	96	EQ.	1275	230	802

TABLE 5.2

Verification of Acceptance Criteria

Flux Map	Core Location	FDHN	Limit
2101	K-6 (HG)	1.60	1.78
2102	K-6 (HG)	1.60	1.75
2103	L-7 (JD)	1.56	1.63
2104	L-7 (JD)	1.57	1.59
2105	L-7 (JD)	1.54	1.57
2106	L-7 (JD)	1.56	1.57
2107	L-7 (JD)	1.55	1.57
2108	L-7 (JD)	1.54	1.57
2109	L-7 (ED)	1.54	1.56

Flux Map	Core Location	FQEQ	Limit
2101	K-6 (HG), 27	2.56	4.51
2102	K-6 (HG), 30	2.45	4.50
2103	L-7 (JD), 26	2.27	3.10
2104	K-6 (HG), 33	2.23	2.56
2105	K-6 (HG), 33	2.23	2.41
2106	K-6 (HG), 34	2.19	2.38
2107	K-6 (HG), 34	2.21	2.41
2108	K-6 (HG), 35	2.20	2.41
2109	K-6 (HG), 31	2.17	2.37

FDHN and FQEQ include appropriate uncertainties and penalties.

Limit on FQEQ is a function of core power and axial location.

Limit on FDHN is a function of core power and assembly burnup.

TABLE 5.3

Verification of Acceptance Criteria

Flux Map	W Assembly Core Location	FQW	Limit
2101	M-7	1.11	4.10
2102	M-7	1.10	4.10
2103	M-7	1.05	2.81
2104	M-7	1.05	2.33
2105	M-7	1.04	2.16
2106	M-7	1.04	2.18
2107	M-7	1.04	2.18
2108	M-7	1.03	2.17
2109	M-7	1.02	2.16

Flux Map	SPC Lead Test Assembly Core Location	FQS	Limit
2101	I-12	2.34	4.32
2102	E-2	2.23	4.32
2103	L-5	2.13	2.96
2104	L-5	2.12	2.45
2105	L-5	2.10	2.27
2106	L-5	2.09	2.30
2107	L-5	2.09	2.30
2108	L-5	2.07	2.28
2109	8-5	2.06	2.25

FQW and FQS include appropriate uncertainties and penalties.

Limit on FQW and FQS is a function of core power and axial location.

TABLE 5.4

Verification of Review Criteria

Flux Map	(a) Maximum Percent Difference	(b) Standard Deviation	(c) Maximum Quadrant Tilt
2101	1.9	2.4	1.1
2102	1.1	3.4	0.7
2103	0.7	1.9	0.5
2104	0.7	2.1	0.6
2105	2.3	2.0	0.7
2106	1.1	2.0	0.6
2107	2.3	2.0	0.7
2108	1.2	2.0	0.5
2109	1.0	2.1	0.6

(a) Maximum Percent Difference between symmetric thimbles for measured reaction rate integrals. Review criterion is 10 percent at low power. Review criterion is 6 percent at equilibrium power.

(b) Standard Deviation of the percent difference between measured and predicted reaction rate integrals. Review criterion is 5 percent.

(c) Percent Maximum Quadrant Tilt from normalized calculated quadrant powers. Review criteria are 4 percent at low power and 2 percent at equilibrium power.

Figure 5.1

Power Distribution For Flux Map 2101

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.283 0.292 -3.12	0.349 0.360 -3.13	0.283 0.292 -3.12					
B				0.553 0.570 -3.00	1.049 1.048 0.05	0.965 0.965 0.01	1.206 1.227 -1.55	0.955 0.965 -1.09	1.037 1.048 -1.06	0.570 0.570 -0.05			
C			0.607 0.625 -2.99	1.212 1.231 -1.50	1.071 1.070 0.05	1.332 1.326 0.47	0.963 0.959 0.45	1.329 1.328 0.23	1.069 1.070 -0.06	1.230 1.231 -0.06	0.625 0.625 0.00		
D		0.551 0.571 -3.47	1.190 1.233 -3.45	1.239 1.256 -1.43	1.280 1.279 0.05	0.980 0.975 0.46	1.201 1.195 0.49	0.978 0.975 0.27	1.292 1.279 1.02	1.269 1.256 1.07	1.252 1.233 1.57	0.571 0.571 0.00	
E		1.009 1.050 -3.93	1.029 1.071 -3.93	1.260 1.279 0.05	1.238 1.237 0.05	1.220 1.214 0.47	1.275 1.258 1.36	1.231 1.214 1.38	1.269 1.237 2.55	1.320 1.279 3.21	1.084 1.071 1.19	1.040 1.050 -0.92	
F	0.281 0.292 -3.93	0.928 0.968 -3.93	1.293 1.325 -2.47	0.966 0.976 -1.02	1.203 1.215 -0.98	0.845 0.853 -0.94	1.121 1.115 0.50	0.860 0.853 0.84	1.234 1.215 1.54	0.985 0.976 0.89	1.334 1.326 0.62	0.983 0.966 1.71	0.301 0.292 2.94
G	0.349 0.361 -3.38	1.212 1.228 -1.29	0.960 0.961 -0.11	1.197 1.199 -0.19	1.253 1.265 -0.98	1.111 1.121 -0.94	0.820 0.812 0.97	1.134 1.121 1.20	1.276 1.265 0.85	1.197 1.199 -0.20	0.958 0.961 -0.37	1.251 1.228 1.88	0.373 0.361 3.27
H	0.282 0.292 -3.39	0.954 0.966 -1.29	1.325 1.326 -0.04	0.970 0.976 -0.70	1.199 1.215 -1.30	0.844 0.853 -1.02	1.119 1.115 0.32	0.858 0.853 0.59	1.222 1.215 0.58	0.975 0.976 -0.18	1.325 1.326 -0.11	0.993 0.966 3.27	0.312 0.292 6.81
I		1.046 1.050 -0.37	1.083 1.071 1.13	1.280 1.279 0.08	1.214 1.237 -1.90	1.201 1.214 -1.06	1.268 1.258 0.83	1.225 1.214 0.92	1.250 1.237 1.07	1.280 1.279 0.05	1.074 1.071 0.27	1.055 1.050 0.49	
J		0.579 0.571 1.45	1.251 1.233 1.46	1.254 1.256 -0.18	1.255 1.279 -1.90	0.965 0.975 -1.07	1.192 1.195 -0.24	0.973 0.975 -0.25	1.254 1.279 -1.94	1.262 1.258 0.49	1.239 1.233 0.49	0.574 0.571 0.49	
K			0.626 0.625 0.08	1.231 1.231 0.02	1.056 1.070 -1.35	1.391 1.326 4.89	1.006 0.959 4.69	1.300 1.326 -1.94	1.049 1.070 -1.93	1.207 1.231 -1.93	0.628 0.625 0.50		
L				0.563 0.570 -1.35	1.034 1.048 -1.35	1.013 0.965 4.89	1.287 1.227 4.89	0.979 0.965 1.39	1.028 1.048 -1.94	0.559 0.570 -1.93			
M						0.306 0.292 4.90	0.378 0.360 4.88	0.296 0.292 1.54					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN

PREDICTED FDHN

PERCENT DIFFERENCE

FLUX MAP 2101

δ= 2.03

Figure 5.2

Power Distribution for Flux Map 2102

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.274 0.297 -7.69	0.338 0.367 -7.69	0.274 0.297 -7.69					
B				0.568 0.578 -1.27	1.030 1.045 -1.49	0.978 0.960 1.91	1.170 1.205 -2.88	0.931 0.960 -2.98	1.014 1.045 -2.99	0.565 0.576 -1.79			
C			0.624 0.632 -1.27	1.212 1.229 -1.38	1.055 1.071 -1.49	1.297 1.302 -0.39	0.937 0.924 1.31	1.300 1.302 -0.12	1.062 1.071 -0.80	1.207 1.229 -1.79	0.630 0.632 -0.40		
D		0.565 0.576 -1.87	1.208 1.231 -1.85	1.243 1.260 -1.39	1.275 1.278 -0.27	0.981 0.979 0.13	1.199 1.164 1.23	0.978 0.979 -0.14	1.263 1.278 0.41	1.257 1.260 -0.25	1.245 1.231 1.10	0.574 0.578 -0.40	
E		1.021 1.047 -2.45	1.046 1.072 -2.45	1.274 1.277 -0.26	1.248 1.245 0.22	1.227 1.222 0.38	1.281 1.268 1.01	1.234 1.222 0.94	1.269 1.245 1.94	1.311 1.277 2.67	1.060 1.072 -1.15	0.994 1.047 -5.11	
F	0.299 0.297 0.84	0.968 0.960 0.83	1.314 1.302 0.89	0.990 0.981 0.99	1.232 1.223 0.74	0.882 0.876 0.63	1.151 1.143 0.71	0.884 0.876 0.89	1.241 1.223 1.45	0.993 0.981 1.28	1.293 1.302 -0.69	0.968 0.960 0.62	0.301 0.297 1.52
G	0.359 0.367 -2.10	1.200 1.206 -0.52	0.948 0.927 2.28	1.202 1.187 1.23	1.283 1.275 0.58	1.153 1.149 0.31	0.851 0.842 1.09	1.165 1.149 1.37	1.287 1.275 0.96	1.191 1.187 0.29	0.913 0.927 -1.47	1.221 1.206 1.20	0.374 0.367 2.07
H	0.289 0.297 -2.63	0.952 0.960 -0.81	1.331 1.302 2.25	0.986 0.981 0.78	1.224 1.223 0.08	0.877 0.876 0.14	1.156 1.143 1.14	0.889 0.876 1.44	1.234 1.223 0.91	0.983 0.981 0.27	1.304 1.302 0.16	1.002 0.960 4.33	0.321 0.297 8.09
I		1.020 1.047 -2.58	1.075 1.072 0.25	1.277 1.277 -0.01	1.239 1.245 -0.49	1.226 1.222 0.34	1.290 1.268 1.73	1.244 1.222 1.78	1.259 1.245 1.08	1.274 1.277 -0.24	1.052 1.072 -1.87	1.011 1.047 -3.48	
J		0.569 0.576 -1.25	1.216 1.231 -1.25	1.249 1.260 -0.88	1.272 1.278 -0.49	0.983 0.979 0.34	1.198 1.184 1.16	0.991 0.979 1.15	1.246 1.276 -2.50	1.216 1.260 -3.47	1.188 1.231 -3.47	0.556 0.576 -3.45	
K			0.626 0.632 -1.04	1.216 1.229 -1.04	1.062 1.071 -0.84	1.392 1.302 6.90	0.988 0.924 6.89	1.269 1.302 -2.50	1.044 1.071 -2.51	1.198 1.229 -2.51	0.610 0.632 -3.46		
L				0.571 0.576 -0.63	1.036 1.045 -0.84	1.026 0.960 6.90	1.286 1.205 6.90	0.979 0.960 2.06	1.019 1.045 -2.51	0.561 0.576 -2.50			
M						0.317 0.297 6.91	0.392 0.367 6.90	0.303 0.297 2.33					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN

PREDICTED FDHN

PERCENT DIFFERENCE

FLUX MAP 2102

δ=2.65

Figure 5.3

Power Distribution for Flux Map 2103

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.298 0.310 -3.93	0.370 0.385 -3.92	0.298 0.310 -3.93					
B				0.560 0.577 -2.68	1.041 1.034 0.65	0.981 0.969 1.18	1.201 1.216 -1.36	0.958 0.969 -1.19	1.022 1.034 -1.18	0.573 0.577 -0.71			
C			0.612 0.830 -2.87	1.186 1.200 -1.15	1.074 1.067 0.65	1.310 1.304 0.48	0.988 0.981 0.74	1.307 1.304 0.26	1.068 1.067 0.11	1.191 1.200 -0.71	0.627 0.630 -0.59		
D		0.562 0.577 -2.70	1.168 1.201 -2.71	1.223 1.236 -1.06	1.262 1.258 0.33	0.993 0.989 0.30	1.202 1.196 0.47	0.992 0.989 0.24	1.268 1.258 0.83	1.240 1.236 0.30	1.210 1.201 0.77	0.574 0.577 -0.59	
E		1.010 1.036 -2.55	1.041 1.068 -2.55	1.262 1.258 0.29	1.233 1.231 0.18	1.215 1.213 0.21	1.265 1.262 0.27	1.216 1.213 0.44	1.248 1.231 1.41	1.286 1.258 2.20	1.076 1.068 0.74	1.028 1.036 -0.78	
F	0.311 0.310 0.26	0.972 0.970 0.25	1.305 1.304 0.08	0.969 0.991 -0.15	1.209 1.214 -0.40	0.885 0.889 -0.46	1.144 1.147 -0.24	0.889 0.869 0.05	1.223 1.214 0.71	0.992 0.991 0.11	1.304 1.304 -0.04	0.974 0.970 0.48	0.315 0.310 1.55
G	0.383 0.386 -0.54	1.220 1.218 0.20	0.996 0.984 1.30	1.202 1.199 0.25	1.262 1.269 -0.53	1.146 1.154 -0.72	0.859 0.858 0.19	1.159 1.154 0.44	1.270 1.269 0.09	1.188 1.199 -0.94	0.973 0.984 -1.04	1.225 1.218 0.57	0.392 0.386 1.74
H	0.308 0.310 -0.87	0.970 0.970 0.02	1.321 1.304 1.30	0.988 0.991 -0.29	1.200 1.214 -1.14	0.882 0.689 -0.83	1.150 1.147 0.25	0.893 0.889 0.52	1.214 1.214 -0.03	0.984 0.991 -0.69	1.295 1.304 -0.72	0.978 0.970 0.86	0.322 0.310 3.87
I		1.030 1.036 -0.55	1.081 1.068 1.21	1.260 1.258 0.16	1.208 1.231 -1.84	1.206 1.213 -0.60	1.267 1.262 0.36	1.217 1.213 0.35	1.229 1.231 -0.15	1.253 1.256 -0.37	1.065 1.068 -0.29	1.035 1.036 -0.05	
J		0.585 0.577 1.28	1.223 1.201 1.84	1.245 1.236 0.70	1.262 1.258 0.29	0.984 0.989 -0.61	1.194 1.196 -0.14	0.988 0.989 -0.20	1.247 1.258 -0.90	1.237 1.236 0.11	1.200 1.201 -0.05	0.577 0.577 -0.07	
K			0.634 0.630 0.62	1.208 1.200 0.54	1.070 1.067 0.28	1.337 1.304 2.51	0.972 0.981 -0.90	1.289 1.304 -1.13	1.055 1.067 -1.13	1.184 1.200 -1.37	0.629 0.630 -0.21		
L				0.577 0.577 0.09	1.036 1.034 0.16	1.009 0.969 4.05	1.267 1.218 4.06	0.962 0.989 1.28	1.020 1.034 -1.36	0.589 0.577 -1.37			
M						0.323 0.310 4.06	0.401 0.385 4.05	0.314 0.310 1.42					

LOOP B

LOOP A

LOOP B

LOOP A

← MEASURED FDHN
← PREDICTED FDHN
← PERCENT DIFFERENCE

FLUX MAP 2103

δ= 1.42

Figure 5.4

Power Distribution for Flux Map 2104

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.302 0.315 -4.29	0.375 0.392 -4.26	0.302 0.315 -4.29					
B				0.562 0.577 -2.77	1.029 1.029 0.01	0.985 0.971 1.35	1.201 1.219 -1.46	0.960 0.971 -1.21	1.017 1.029 -1.20	0.573 0.577 -0.74			
C			0.613 0.630 -2.78	1.173 1.190 -1.41	1.065 1.065 0.01	1.304 1.303 0.05	1.006 0.999 0.71	1.307 1.303 0.28	1.068 1.065 0.24	1.181 1.190 -0.76	0.625 0.630 -0.78		
D		0.562 0.578 -2.75	1.158 1.191 -2.77	1.212 1.226 -1.34	1.252 1.252 0.02	0.994 0.994 0.04	1.205 1.199 0.48	0.996 0.994 0.25	1.262 1.252 0.81	1.230 1.228 0.16	1.197 1.191 0.51	0.573 0.578 -0.78	
E		1.003 1.031 -2.75	1.037 1.066 -2.75	1.250 1.252 -0.17	1.226 1.227 -0.11	1.210 1.211 -0.06	1.262 1.261 0.10	1.213 1.211 0.15	1.240 1.227 1.07	1.276 1.252 1.88	1.075 1.066 0.61	1.028 1.031 -0.31	
F	0.318 0.315 0.73	0.979 0.972 0.71	1.307 1.303 0.26	0.990 0.995 -0.50	1.205 1.212 -0.57	0.890 0.895 -0.57	1.146 1.150 -0.37	0.897 0.895 0.21	1.221 1.212 0.75	1.000 0.995 0.48	1.306 1.303 0.25	0.963 0.972 1.10	0.322 0.315 2.16
G	0.390 0.392 -0.43	1.226 1.219 0.52	1.020 1.002 1.75	1.205 1.202 0.20	1.257 1.267 -0.78	1.147 1.157 -0.90	0.863 0.865 -0.21	1.161 1.157 0.32	1.266 1.267 -0.08	1.195 1.202 -0.61	0.994 1.002 -0.78	1.234 1.219 1.19	0.401 0.392 2.35
H	0.313 0.315 -0.82	0.975 0.972 0.30	1.326 1.303 1.75	0.993 0.995 -0.17	1.197 1.212 -1.23	0.888 0.895 -0.83	1.149 1.150 -0.06	0.899 0.895 0.44	1.210 1.212 -0.20	0.990 0.995 -0.48	1.295 1.303 -0.65	0.985 0.972 1.31	0.330 0.315 4.57
I		1.023 1.031 -0.79	1.080 1.066 1.31	1.256 1.252 0.29	1.207 1.227 -1.66	1.205 1.211 -0.54	1.280 1.261 -0.10	1.209 1.211 -0.14	1.218 1.227 -0.77	1.244 1.252 -0.62	1.061 1.066 -0.52	1.029 1.031 -0.17	
J		0.583 0.578 0.90	1.212 1.191 1.79	1.237 1.228 0.73	1.259 1.252 0.54	0.988 0.994 -0.55	1.193 1.199 -0.48	0.986 0.994 -0.57	1.233 1.252 -1.51	1.229 1.228 0.07	1.169 1.191 -0.18	0.577 0.578 -0.19	
K			0.638 0.630 1.21	1.205 1.190 1.25	1.080 1.065 1.35	1.340 1.303 2.84	0.984 0.999 -1.51	1.287 1.303 -1.20	1.052 1.065 -1.19	1.160 1.190 -0.88	0.626 0.630 -0.41		
L				0.585 0.577 1.23	1.042 1.029 1.27	1.013 0.971 4.30	1.272 1.219 4.31	0.987 0.971 1.64	1.020 1.029 -0.88	0.572 0.577 -0.87			
M						0.329 0.315 4.32	0.409 0.392 4.31	0.321 0.315 1.78					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN

PREDICTED FDHN

PERCENT DIFFERENCE

FLUX MAP 2104

δ= 1.55

Figure 5.5

Power Distribution for Flux Map 2105

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.301 0.318 -5.41	0.374 0.396 -5.43	0.301 0.318 -5.41					
B				0.556 0.578 -3.72	1.036 1.027 0.83	0.991 0.973 1.93	1.198 1.219 -1.74	0.959 0.973 -1.37	1.013 1.027 -1.34	0.575 0.578 -0.43			
C			0.607 0.630 -3.71	1.167 1.184 -1.49	1.073 1.064 0.63	1.308 1.302 0.47	1.021 1.010 1.03	1.309 1.302 0.54	1.070 1.064 0.57	1.179 1.184 -0.42	0.629 0.630 -0.22		
D		0.563 0.578 -2.70	1.153 1.185 -2.74	1.206 1.223 -1.38	1.259 1.249 0.82	1.001 0.996 0.47	1.213 1.201 0.95	1.001 0.996 0.49	1.257 1.249 0.62	1.218 1.223 -0.43	1.183 1.185 -0.22	0.577 0.578 -0.22	
E		1.011 1.028 -1.70	1.047 1.065 -1.71	1.257 1.248 0.66	1.233 1.225 0.66	1.216 1.210 0.48	1.262 1.260 0.12	1.212 1.210 0.12	1.233 1.225 0.64	1.255 1.248 0.57	1.071 1.085 0.57	1.034 1.028 0.57	
F	0.323 0.318 1.41	0.987 0.973 1.40	1.315 1.302 0.96	1.000 0.997 0.31	1.210 1.211 -0.06	0.897 0.898 -0.19	1.142 1.152 -0.89	0.904 0.898 0.63	1.219 1.211 0.64	0.993 0.997 -0.46	1.296 1.302 -0.49	0.984 0.973 1.14	0.326 0.318 2.55
G	0.396 0.396 -0.08	1.228 1.220 0.66	1.033 1.013 1.99	1.212 1.204 0.64	1.265 1.266 -0.09	1.155 1.158 -0.26	0.870 0.869 0.08	1.168 1.158 0.86	1.289 1.266 0.25	1.196 1.204 -0.66	1.006 1.013 -0.72	1.235 1.220 1.18	0.407 0.396 2.70
H	0.317 0.318 -0.44	0.977 0.973 0.42	1.328 1.302 1.96	0.998 0.997 0.09	1.203 1.211 -0.72	0.895 0.896 -0.33	1.158 1.152 0.49	0.907 0.898 0.99	1.214 1.211 0.23	0.990 0.997 -0.69	1.288 1.302 -1.12	0.980 0.973 0.72	0.332 0.316 4.50
I		1.012 1.028 -1.50	1.080 1.065 1.41	1.248 1.248 0.00	1.209 1.225 -1.32	1.210 1.210 -0.06	1.267 1.260 0.51	1.218 1.210 0.48	1.222 1.225 -0.29	1.237 1.248 -0.91	1.060 1.065 -0.48	1.026 1.028 -0.18	
J		0.593 0.578 2.63	1.216 1.185 2.62	1.232 1.223 0.70	1.257 1.249 0.60	0.996 0.998 -0.05	1.203 1.201 0.14	0.997 0.996 0.06	1.236 1.249 -0.90	1.214 1.223 -0.79	1.183 1.185 -0.19	0.577 0.578 -0.14	
K			0.834 0.630 0.67	1.193 1.184 0.73	1.071 1.064 0.57	1.336 1.302 2.63	1.001 1.010 -0.90	1.292 1.302 -0.78	1.056 1.064 -0.76	1.177 1.184 -0.63	0.633 0.630 0.41		
L				0.581 0.576 0.48	1.033 1.027 0.57	0.959 0.973 -1.38	1.211 1.219 -0.64	0.966 0.973 -0.63	1.021 1.027 -0.63	0.574 0.576 -0.64			
M						0.313 0.318 -1.35	0.393 0.396 -0.66	0.316 0.318 -0.63					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN

PREDICTED FDHN

PERCENT DIFFERENCE

FLUX MAP 2105

δ= 1.47

Figure 5.6

Power Distribution for Flux Map 2106

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.305 0.318 -4.21	0.379 0.396 -4.22	0.305 0.318 -4.21					
B				0.559 0.577 -3.14	1.026 1.026 0.02	0.981 0.973 0.85	1.201 1.221 -1.67	0.959 0.973 -1.42	1.012 1.026 -1.40	0.572 0.577 -0.78			
C			0.809 0.629 -3.13	1.163 1.182 -1.59	1.064 1.064 0.02	1.307 1.304 0.25	1.023 1.016 0.67	1.306 1.304 0.17	1.063 1.064 -0.07	1.173 1.182 -0.79	0.625 0.629 -0.70		
D		0.563 0.577 -2.46	1.155 1.184 -2.49	1.203 1.222 -1.51	1.247 1.248 -0.10	0.997 0.996 0.09	1.208 1.203 0.37	0.998 0.996 0.16	1.256 1.248 0.61	1.224 1.222 0.15	1.191 1.184 0.58	0.573 0.577 -0.69	
E		1.008 1.027 -1.81	1.046 1.065 -1.81	1.247 1.247 -0.04	1.223 1.224 -0.10	1.210 1.210 0.03	1.261 1.260 0.10	1.213 1.210 0.26	1.236 1.224 1.00	1.271 1.247 1.92	1.073 1.065 0.77	1.023 1.027 -0.42	
F	0.322 0.316 1.10	0.984 0.974 1.11	1.309 1.304 0.42	0.992 0.997 -0.51	1.203 1.210 -0.55	0.894 0.896 -0.45	1.146 1.151 -0.39	0.898 0.898 -0.01	1.217 1.210 0.60	0.999 0.997 0.16	1.304 1.304 0.01	0.963 0.974 0.91	0.325 0.318 2.17
G	0.395 0.396 -0.33	1.228 1.222 0.48	1.034 1.019 1.49	1.207 1.206 0.07	1.257 1.266 -0.69	1.151 1.158 -0.60	0.866 0.868 -0.26	1.159 1.158 0.06	1.265 1.266 -0.10	1.198 1.206 -0.68	1.011 1.019 -0.82	1.234 1.222 1.00	0.406 0.396 2.40
H	0.316 0.318 -0.69	0.976 0.974 0.27	1.323 1.304 1.50	0.994 0.997 -0.36	1.195 1.210 -1.21	0.893 0.898 -0.57	1.152 1.151 0.08	0.901 0.898 0.36	1.208 1.210 -0.16	0.992 0.997 -0.56	1.295 1.304 -0.71	0.984 0.974 1.07	0.334 0.318 4.74
I		1.019 1.027 -0.75	1.076 1.065 1.20	1.250 1.247 0.22	1.204 1.224 -1.65	1.206 1.210 -0.33	1.282 1.260 0.15	1.211 1.210 0.10	1.219 1.224 -0.42	1.242 1.247 -0.39	1.062 1.065 -0.29	1.026 1.027 -0.15	
J		0.563 0.577 0.97	1.205 1.184 1.78	1.231 1.222 0.73	1.254 1.248 0.50	0.993 0.996 -0.33	1.203 1.203 0.04	0.996 0.996 -0.04	1.237 1.248 -0.88	1.220 1.222 -0.20	1.162 1.184 -0.14	0.577 0.577 -0.14	
K			0.634 0.629 0.84	1.193 1.162 0.89	1.072 1.064 0.78	1.340 1.304 2.75	1.007 1.016 -0.89	1.294 1.304 -0.74	1.056 1.064 -0.73	1.175 1.182 -0.58	0.626 0.629 -0.10		
L				0.581 0.577 0.61	1.033 1.026 0.68	1.009 0.973 3.65	1.266 1.221 3.65	0.986 0.973 1.48	1.020 1.026 -0.58	0.574 0.577 -0.59			
M						0.330 0.318 3.65	0.411 0.396 3.66	0.323 0.316 1.57					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

FLUX MAP 2106

δ= 1.43

Figure 5.7

Power Distribution for Flux Map 2107

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.306 0.319 -4.20	0.381 0.397 -4.20	0.306 0.319 -4.20					
B				0.561 0.577 -2.89	1.023 1.024 -0.14	0.971 0.973 -0.11	1.193 1.219 -2.16	0.956 0.973 -1.69	1.007 1.024 -1.65	0.574 0.577 -0.54			
C			0.612 0.629 -2.69	1.163 1.160 -1.44	1.062 1.083 -0.13	1.308 1.302 0.29	1.019 1.016 0.31	1.302 1.302 -0.05	1.059 1.063 -0.42	1.174 1.180 -0.55	0.626 0.629 -0.40		
D		0.564 0.577 -2.18	1.155 1.181 -2.23	1.204 1.221 -1.38	1.242 1.248 -0.48	0.996 0.997 -0.10	1.203 1.203 -0.05	0.997 0.997 -0.02	1.255 1.248 0.58	1.228 1.221 0.53	1.194 1.181 1.08	0.575 0.577 -0.40	
E		1.007 1.025 -1.73	1.046 1.064 -1.73	1.241 1.247 -0.50	1.217 1.225 -0.63	1.207 1.211 -0.31	1.264 1.262 0.14	1.219 1.211 0.68	1.245 1.225 1.62	1.279 1.247 2.58	1.071 1.064 0.66	1.011 1.025 -1.35	
F	0.321 0.319 0.59	0.979 0.973 0.58	1.304 1.302 0.14	0.991 0.999 -0.79	1.202 1.212 -0.84	0.893 0.901 -0.88	1.151 1.155 -0.36	0.902 0.901 0.17	1.223 1.212 0.92	1.001 0.999 0.28	1.300 1.302 -0.14	0.980 0.973 0.74	0.326 0.319 2.07
G	0.393 0.398 -1.08	1.220 1.219 0.07	1.033 1.019 1.31	1.208 1.207 0.04	1.258 1.266 -0.82	1.151 1.161 -0.87	0.872 0.872 -0.01	1.163 1.161 0.18	1.269 1.268 0.03	1.198 1.207 -0.72	1.006 1.019 -1.08	1.230 1.219 0.88	0.407 0.398 2.34
H	0.315 0.319 -1.41	0.972 0.973 -0.10	1.320 1.302 1.35	0.999 0.999 0.02	1.201 1.212 -0.90	0.900 0.901 -0.18	1.159 1.155 0.33	0.905 0.901 0.47	1.210 1.212 -0.14	0.993 0.999 -0.51	1.295 1.302 -0.57	0.986 0.973 1.36	0.337 0.319 5.45
I		1.018 1.025 -0.69	1.080 1.064 1.46	1.254 1.247 0.59	1.212 1.225 -1.08	1.214 1.211 0.24	1.267 1.262 0.38	1.215 1.211 0.31	1.221 1.225 -0.31	1.246 1.247 -0.11	1.063 1.064 -0.12	1.025 1.025 -0.05	
J		0.583 0.577 1.09	1.202 1.181 1.79	1.232 1.221 0.92	1.257 1.248 0.74	1.000 0.997 0.23	1.207 1.203 0.32	1.000 0.997 0.22	1.237 1.248 -0.87	1.222 1.221 0.11	1.181 1.181 -0.05	0.577 0.577 -0.05	
K			0.634 0.629 0.80	1.190 1.160 0.81	1.070 1.063 0.62	1.337 1.302 2.64	1.007 1.016 -0.88	1.293 1.302 -0.72	1.056 1.063 -0.71	1.174 1.160 -0.56	0.626 0.629 -0.19		
L				0.579 0.577 0.45	1.030 1.024 0.53	1.003 0.973 3.09	1.257 1.219 3.10	0.984 0.973 1.21	1.018 1.024 -0.57	0.573 0.577 -0.55			
M						0.329 0.319 3.10	0.410 0.397 3.10	0.323 0.319 1.32					

LOOP B

LOOP A

LOOP B

LOOP A

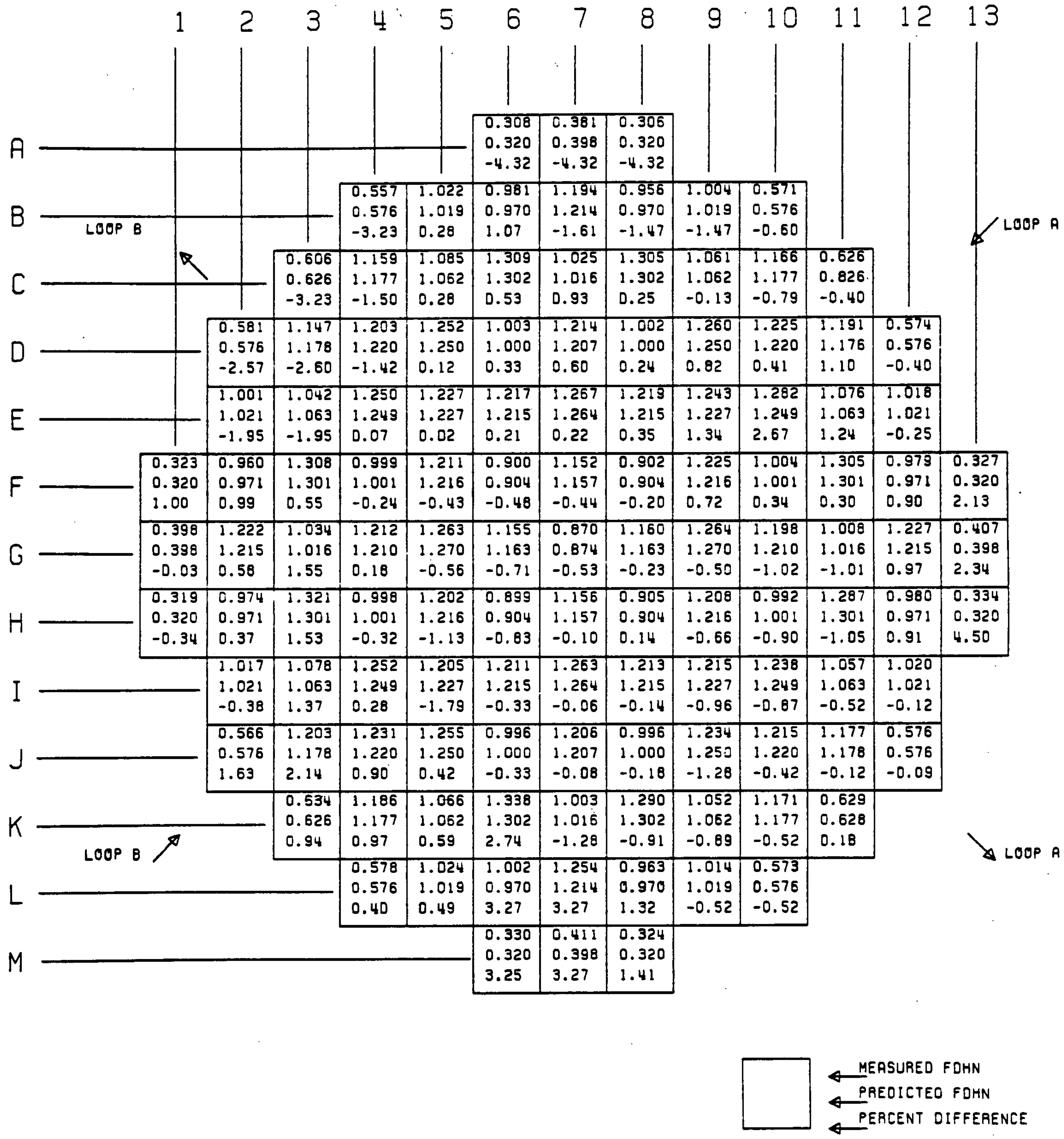
MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

FLUX MAP 2107

δ= 1.40

Figure 5.8

Power Distribution for Flux Map 2108



	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.308 0.320 -4.32	0.381 0.398 -4.32	0.306 0.320 -4.32					
B				0.557 0.576 -3.23	1.022 1.019 0.28	0.981 0.970 1.07	1.194 1.214 -1.61	0.956 0.970 -1.47	1.004 1.019 -1.47	0.571 0.576 -0.60			
C			0.606 0.626 -3.23	1.159 1.177 -1.50	1.085 1.062 0.28	1.309 1.302 0.53	1.025 1.016 0.93	1.305 1.302 0.25	1.061 1.062 -0.13	1.166 1.177 -0.79	0.626 0.826 -0.40		
D		0.581 0.576 -2.57	1.147 1.178 -2.60	1.203 1.220 -1.42	1.252 1.250 0.12	1.003 1.000 0.33	1.214 1.207 0.60	1.002 1.000 0.24	1.260 1.250 0.82	1.225 1.220 0.41	1.191 1.176 1.10	0.574 0.576 -0.40	
E		1.001 1.021 -1.95	1.042 1.063 -1.95	1.250 1.249 0.07	1.227 1.227 0.02	1.217 1.215 0.21	1.267 1.264 0.22	1.219 1.215 0.35	1.243 1.227 1.34	1.282 1.249 2.67	1.076 1.063 1.24	1.018 1.021 -0.25	
F	0.323 0.320 1.00	0.960 0.971 0.99	1.308 1.301 0.55	0.999 1.001 -0.24	1.211 1.216 -0.43	0.900 0.904 -0.48	1.152 1.157 -0.44	0.902 0.904 -0.20	1.225 1.216 0.72	1.004 1.001 0.34	1.305 1.301 0.30	0.979 0.971 0.90	0.327 0.320 2.13
G	0.398 0.398 -0.03	1.222 1.215 0.58	1.034 1.016 1.55	1.212 1.210 0.18	1.263 1.270 -0.56	1.155 1.163 -0.71	0.870 0.874 -0.53	1.160 1.163 -0.23	1.264 1.270 -0.50	1.198 1.210 -1.02	1.008 1.016 -1.01	1.227 1.215 0.97	0.407 0.398 2.34
H	0.319 0.320 -0.34	0.974 0.971 0.37	1.321 1.301 1.53	0.998 1.001 -0.32	1.202 1.216 -1.13	0.899 0.904 -0.83	1.156 1.157 -0.10	0.905 0.904 0.14	1.208 1.216 -0.66	0.992 1.001 -0.90	1.287 1.301 -1.05	0.980 0.971 0.91	0.334 0.320 4.50
I		1.017 1.021 -0.38	1.078 1.063 1.37	1.252 1.249 0.28	1.205 1.227 -1.79	1.211 1.215 -0.33	1.263 1.264 -0.06	1.213 1.215 -0.14	1.215 1.227 -0.96	1.238 1.249 -0.87	1.057 1.063 -0.52	1.020 1.021 -0.12	
J		0.566 0.576 1.63	1.203 1.178 2.14	1.231 1.220 0.90	1.255 1.250 0.42	0.996 1.000 -0.33	1.206 1.207 -0.08	0.996 1.000 -0.18	1.234 1.250 -1.28	1.215 1.220 -0.42	1.177 1.178 -0.12	0.576 0.576 -0.09	
K			0.534 0.626 0.94	1.186 1.177 0.97	1.066 1.062 0.59	1.338 1.302 2.74	1.003 1.016 -1.28	1.290 1.302 -0.91	1.052 1.062 -0.89	1.171 1.177 -0.52	0.629 0.628 0.18		
L				0.578 0.576 0.40	1.024 1.019 0.49	1.002 0.970 3.27	1.254 1.214 3.27	0.963 0.970 1.32	1.014 1.019 -0.52	0.573 0.576 -0.52			
M						0.330 0.320 3.25	0.411 0.398 3.27	0.324 0.320 1.41					

FLUX MAP 2108

δ = 1.45

Figure 5.9

Power Distribution for Flux Map 2109

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.305 0.321 -4.74	0.360 0.399 -4.74	0.305 0.321 -4.74					
B				0.554 0.575 -3.77	1.025 1.016 0.64	0.966 0.968 1.83	1.191 1.209 -1.46	0.954 0.968 -1.42	1.002 1.016 -1.43	0.569 0.575 -1.04			
C			0.604 0.628 -3.77	1.156 1.174 -1.52	1.070 1.061 0.64	1.314 1.301 1.02	1.031 1.016 1.52	1.309 1.301 0.60	1.062 1.061 0.13	1.162 1.174 -1.05	0.624 0.628 -0.73		
D		0.562 0.576 -2.48	1.145 1.175 -2.56	1.201 1.218 -1.40	1.261 1.252 0.72	1.011 1.002 0.87	1.225 1.210 1.21	1.008 1.002 0.59	1.263 1.252 0.85	1.219 1.218 0.07	1.183 1.175 0.69	0.572 0.576 -0.73	
E		1.004 1.017 -1.30	1.048 1.062 -1.29	1.262 1.252 0.75	1.238 1.229 0.69	1.229 1.219 0.81	1.270 1.264 0.46	1.224 1.219 0.36	1.240 1.229 0.90	1.279 1.252 2.17	1.085 1.062 0.24	0.999 1.017 -1.76	
F	0.326 0.321 1.68	0.985 0.969 1.67	1.316 1.301 1.18	1.008 1.003 0.45	1.221 1.220 0.07	0.907 0.907 -0.02	1.151 1.156 -0.40	0.903 0.907 -0.40	1.225 1.220 0.43	1.007 1.003 0.40	1.299 1.301 -0.14	0.973 0.969 0.46	0.325 0.321 1.25
G	0.399 0.399 0.13	1.220 1.210 0.79	1.039 1.018 2.07	1.222 1.213 0.74	1.269 1.271 -0.14	1.158 1.163 -0.41	0.870 0.875 -0.62	1.160 1.163 -0.29	1.262 1.271 -0.71	1.201 1.213 -1.02	1.003 1.016 -1.43	1.217 1.210 0.60	0.405 0.399 1.50
H	0.320 0.321 -0.25	0.974 0.969 0.57	1.328 1.301 2.04	1.005 1.003 0.14	1.210 1.220 -0.80	0.901 0.907 -0.60	1.154 1.156 -0.17	0.908 0.907 0.12	1.210 1.220 -0.81	0.993 1.003 -1.04	1.285 1.301 -1.21	0.977 0.969 0.87	0.334 0.321 4.21
I		1.012 1.017 -0.50	1.077 1.062 1.40	1.258 1.252 0.47	1.213 1.229 -1.29	1.216 1.219 -0.24	1.261 1.264 -0.25	1.215 1.219 -0.33	1.214 1.229 -1.25	1.234 1.252 -1.46	1.051 1.062 -1.06	1.011 1.017 -0.62	
J		0.584 0.576 1.41	1.196 1.175 1.76	1.228 1.216 0.80	1.257 1.252 0.42	1.000 1.002 -0.24	1.205 1.210 -0.45	0.997 1.002 -0.55	1.231 1.252 -1.68	1.207 1.216 -0.93	1.168 1.175 -0.61	0.572 0.576 -0.57	
K			0.632 0.628 0.62	1.181 1.174 0.62	1.063 1.061 0.21	1.330 1.301 2.21	0.999 1.016 -1.68	1.287 1.301 -1.06	1.050 1.061 -1.03	1.169 1.174 -0.42	0.626 0.626 -0.30		
L				0.576 0.575 0.05	1.017 1.016 0.11	0.999 0.968 3.23	1.248 1.209 3.23	0.981 0.968 1.38	1.012 1.016 -0.41	0.573 0.575 -0.40			
M						0.331 0.321 3.24	0.412 0.399 3.24	0.325 0.321 1.47					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

FLUX MAP 2109

δ= 1.51

6.0 REACTOR STARTUP CALIBRATIONS

6.1 Rod Position Calibration

The rod position indicators are calibrated each refueling in accordance with an approved surveillance procedure. The calibration includes the following:

a) The position signal output is checked at 20 and 200 steps for all rods.

b) The rod bottom lamps are checked to assure that they light at the proper rod height.

c) The control room rod position indicators are calibrated to read correctly at 20 and 200 steps.

d) The pulse-to-analog convertor alignment is checked.

e) The rod bottom bypass bi-stable trip setpoint is checked.

The calibration was performed satisfactorily during the Cycle 20 startup; no problems or abnormalities were encountered and site procedure acceptance criteria were met. At full power an adjustment was made to selected RPI channels to compensate for the temperature increase associated with power ascension.

6.2 Nuclear Instrumentation Calibration

The nuclear instrumentation (NI) calibration was performed in accordance with the Kewaunee Reactor Test Program during the Cycle 21 startup (4). A flux map was performed at approximately 75 percent power. The incore axial offset was determined from the data collected during the map. The NI's were then calibrated with a conservative incore axial offset-to-excore axial offset ratio of 1.7.

7.0 REFERENCES

(1) "Reload Safety Evaluation for Kewaunee Cycle 21," Wisconsin Public Service Corporation, May 1995.

(2) "Qualification of Reactor Physics Methods for Application to Kewaunee," Wisconsin Public Service Corporation, October 1978.

(3) "Reload Safety Evaluation Methods for Application to Kewaunee", WPSRSEM-NP-A, Revision 2, October 1988.

(4) "Reactor Test Program, Kewaunee Nuclear Power Plant," Wisconsin Public Service Corporation (Revision 5, April 17, 1995)

(5) "Generic Mechanical and Thermal Hydraulic Design for Exxon Nuclear 14 x 14 Reload Assemblies with Zircaloy Guide Tubes for Westinghouse 2-Loop Pressurized Water Reactors," Exxon Nuclear Corporation, November 1978.

(6) "Rod Exchange Technique for Rod Worth Measurement" and "Rod Worth Verification Tests Utilizing RCC Bank Interchange," Westinghouse Corporation, May 12, 1978.

(7) "Kewaunee Nuclear Power Plant Technical Specifications," Wisconsin Public Service Corporation, Docket 50-305.