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September 9, 1997

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Ladies/Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Cycle 22 Startup Report

In accordance with our practice of reporting the results of physics tests, enclosed is a copy of the Kewaunee Nuclear Power Plant Cycle 22 Startup Report.

Sincerely,

M. L. Marchi
Manager - Nuclear Business Group

MJT/jmf

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KEWAUNEE NUCLEAR POWER PLANT

CYCLE 22
STARTUP REPORT
AUGUST 1997

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

DOCKET 50-305

KEWAUNEE NUCLEAR POWER PLANT

STARTUP REPORT

CYCLE 22

AUGUST 1997

WISCONSIN PUBLIC SERVICE CORPORATION

GREEN BAY, WISCONSIN

KEWAUNEE NUCLEAR POWER PLANT

STARTUP REPORT

CYCLE 22

AUGUST 1997

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1.0 INTRODUCTION, SUMMARY, AND CONCLUSION

1.I Introduction

This report presents the results of the physics tests performed during startup of Kewaunee Cycle 22. 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 21-22 refueling, 44 of the 121 fuel assemblies in the core were replaced with Siemens Power Corporation design(s) fresh fuel assemblies. Twenty-four are enriched to 4.1 weight percent U235, twelve are enriched to 4.5 weight percent U235, and eight Lead Test Assemblies (LTA) are enriched to 4.5 weight percent U235 with four gadolinia rods at 4 weight percent. The Cycle 22 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
22	Z	SPC	3.5	2	4
22	Z	SPC	3.7	2	24
23	A	SPC	3.8	1	20
23	A	SPC	4.1	1	20
23	A	SPC	4.1 (LTA)	1	8
24	B	SPC	4.1	0	24 (Feed)
24	B	SPC	4.5	0	12 (Feed)
24	B	SPC	4.5 (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 22 are presented in Figure 1.1.

On June 10, I997, at 1420 hours, initial criticality was achieved on the Cycle 22 core. The schedule of physics tests and measurements is outlined in Table 1.I.

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). The reactivity comparison was made to the reference bank, Control Bank A, 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 Control Bank A inserted 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 satisfies the 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 (5) and are presented in Section 5. Section 6 discusses the various calibrations performed during the startup of Cycle 22.

1.3 Conclusion

The startup testing of Kewaunee's Cycle 22 core verified that the reactor core has been properly loaded and the core characteristics satisfy the Technical Specifications (5) and are consistent with the parameters used in the design and safety analysis (1).

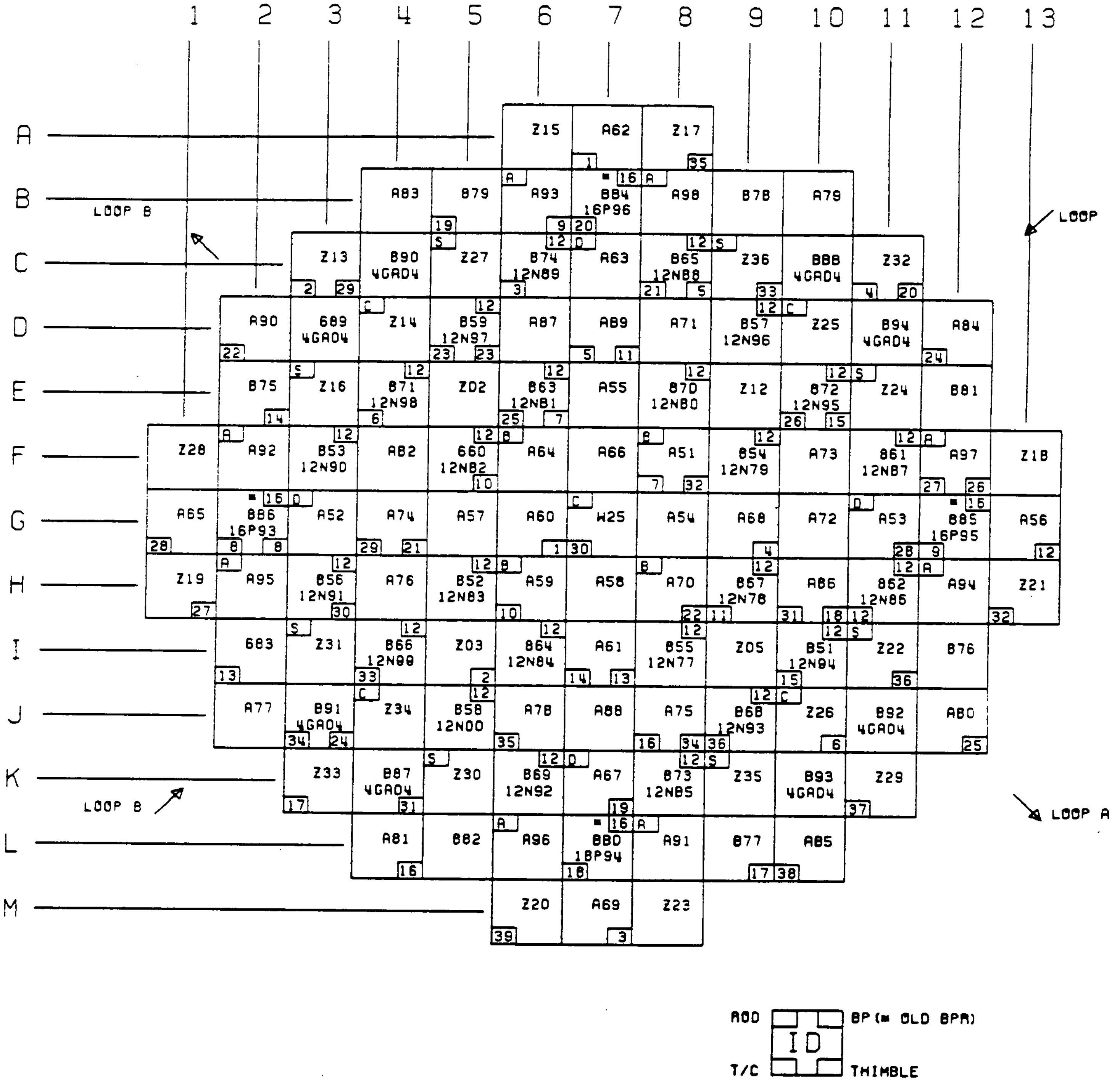
TABLE 1.1

BOC Physics Test

Test	Date Completed	Time Completed	Plant Conditions
Control Rod Operability Test	06/06/97	1115	Cold SD
Hot Rod Drops	06/09/97	0856	HSD
RPI Calibrations	06/10/97	023B	HSD
Initial Criticality	06/10/97	1420	HZP
Reactivity Computer Checkout	06/10/97	2025	HZP
ARO Endpoint	06/10/97	2240	HZP
Bank A Worth (Dilution)	06/11/97	0450	HZP
Bank A Worth (Boration)	06/11/97	1700	HZP
ARO Endpoint	06/11/97	1815	HZP
ITC Determination	06/11/97	1940	HZP
Power Ascension Flux Map 2201	06/12/97	1102	26%
Power Ascension Flux Map 2202	06/13/97	1435	37%
Power Ascension Flux Map 2203	06/20/97	1238	69%
Power Ascension Flux Map 2204	06/24/97	1432	90%
Power Ascension Flux Map 2205	07/02/97	1559	94%

FIGURE 1.1

Core Loading Map



	1	2	3	4	5	6	7	8	9	10	11	12	13
A						Z15	A62 1	Z17 35					
B				A83	B79 19	A A93 9	■ 16 B84 16P96 20	A A98	B78	A79			
C			Z13 2 29	B90 4GAD4	S Z27	12 B74 12N89 3	D A63	12 B65 12N88 21 5	S Z36 33	B88 4GAD4	Z32 4 20		
D		A90 22	B89 4GAD4	C Z14	12 B59 12N97 23 23	A87	A89 5 11	A71	12 B57 12N96	C Z25	B94 4GAD4	A84 24	
E		B75 14	S Z16	12 B71 12N98 6	Z02	12 B63 12N81 25 7	A55	12 B70 12N80	Z12	12 B72 12N95 26 15	S Z24	B81	
F	Z28	A A92	12 B53 12N90	A82	12 B60 12N82 10	B A64	A66	B A51 7 32	12 B54 12N79	A73	12 B61 12N87	A A97 27 26	Z18
G	A65 28	■ 16 B86 16P93 8 8	D A52	A74 29 21	A57	A60 1	C W25 30	A54	A68 4	A72	D A53 28	■ 16 B85 16P95 9	A56 12
H	Z19 27	A A95	12 B56 12N91 30	A76	12 B52 12N83	B A59 10	A58	B A70 22	12 B67 12N78 11	A86 31 18	12 B62 12N86 12	A A94	Z21 32
I		B83 13	S Z31	12 B66 12N88 33	Z03 2	12 B64 12N84	A61 14 13	12 B55 12N77	Z05	12 B51 12N94 15	S Z22 36	B76	
J		A77	B91 4GAD4 34 24	C Z34	12 B58 12N00	A78 35	A88	A75 16 34	12 B68 12N93 36	C Z26 6	B92 4GAD4	A80 25	
K			Z33 17	B87 4GAD4 31	S Z30	12 B69 12N92	D A67 19	12 B73 12N85	S Z35	B93 4GAD4	Z29 37		
L				A81 16	B82	A A96	■ 16 B80 18P94 18	A A91	B77 17	A85 38			
M						Z20 39	A69 3	Z23					

CYCLE TWENTY-TWO

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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 22 startup the reactivity of the reference bank, Control Bank A, 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, Control Bank A, measured during dilution differed from the WPSC predicted Control Bank A worth by 46.9 pcm or 4.4 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 3.3 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 22

RCCA Drop Time Measurements

Hot Zero Power

Average Dashpot Delta T (Seconds)	1.239
Standard Deviation	0.036
Average Rod Bottom Delta T (Seconds)	1.772
Standard Deviation	0.034

TABLE 2.2

Kewaunee Cycle 22

RCCA Bank Worth Summary

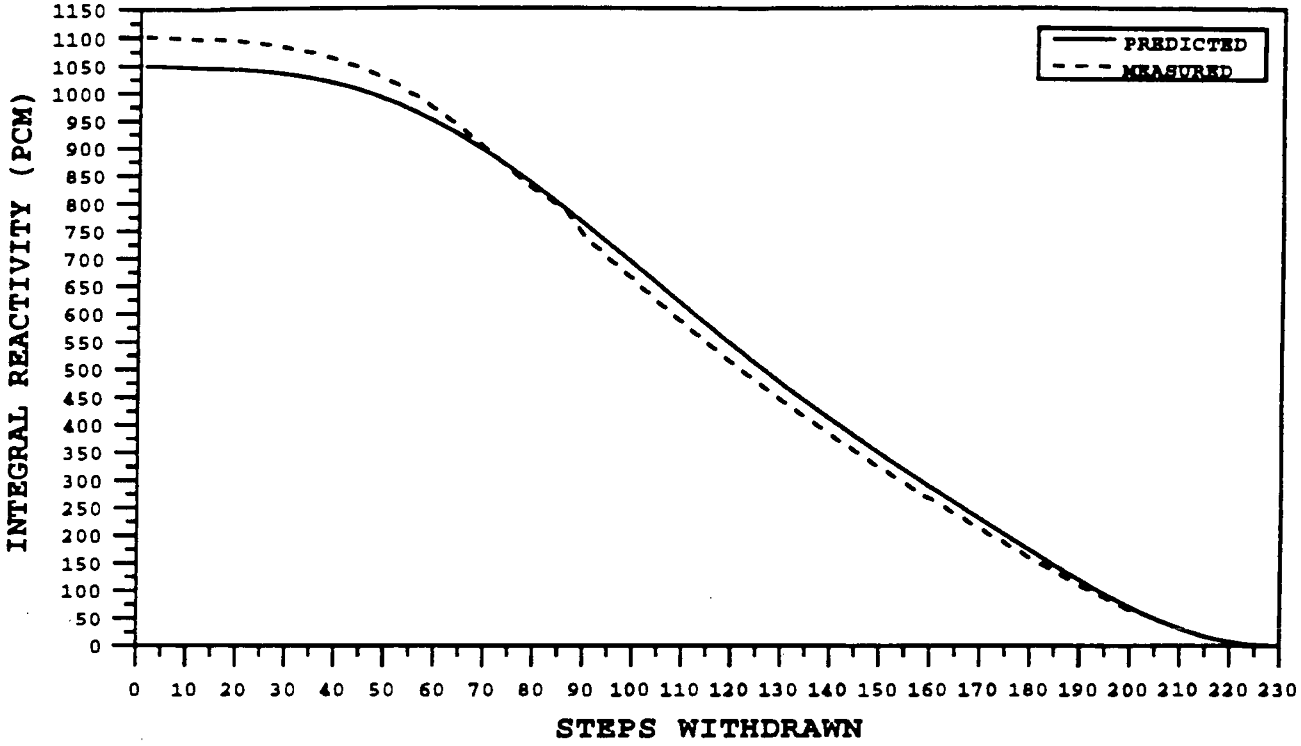
Reference Bank Measured by Dilution/Reactivity Computer

Rod Swap Method RCCA Bank	Measured Worth (PCM)	WPS Predicted Worth (PCM)	Difference (PCM)	Percent Difference
D	979.7	946.0	33.7	3.6
C	680.1	687.0	-6.9	-1.0
B	570.9	572.0	-1.1	-0.2
A*	1101.9	1055.0	46.9	4.4
SA	673.7	635.0	38.7	6.1
SB	672.2	635.0	37.2	5.9
Total	4678.5	4530.0	148.5	3.3

* Reference bank

RCC[illegible]Bank A Integral and Differentia[illegible]orth

CYCLE 22,0MWD/MTU,NOXE,HZP,1893PPM,
ORO, A MOVING



CYCLE 22,0MWD/MTU,NOXE,HZP,1893PPM,
ORO, A MOVING

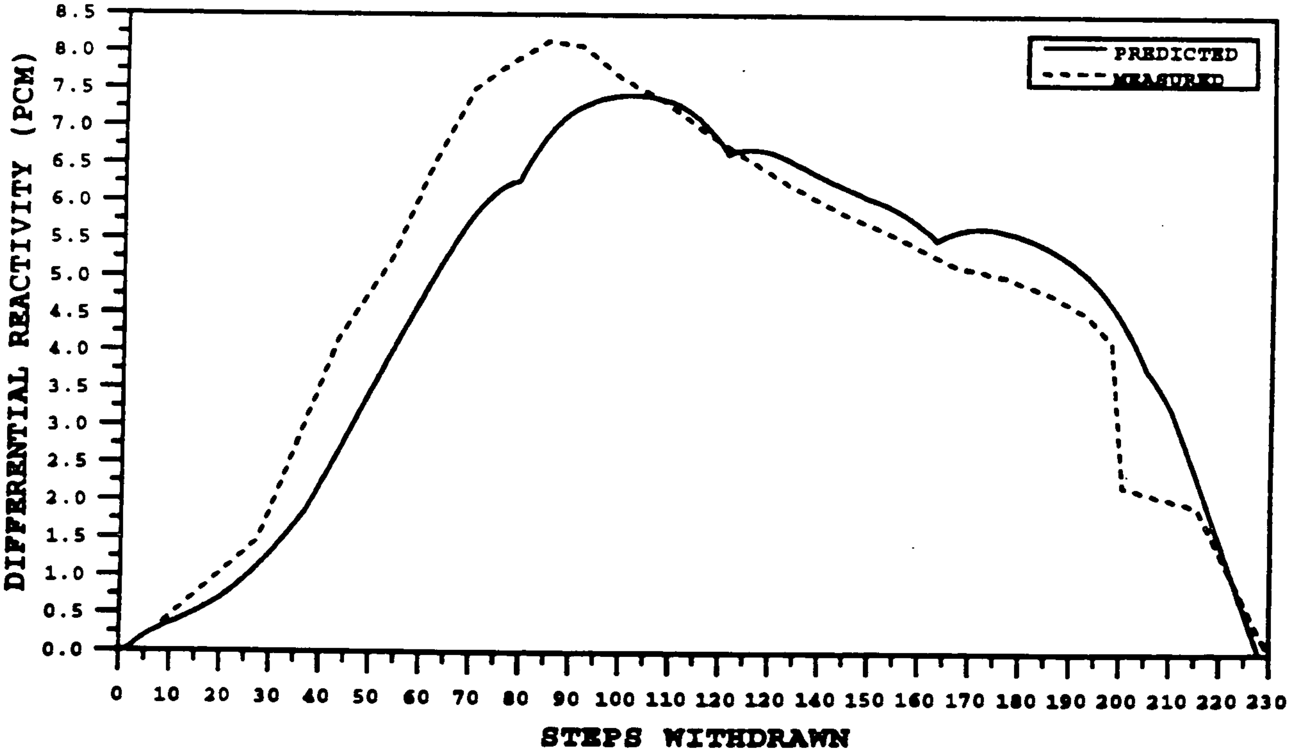


TABLE 2.3

Kewaunee Cycle 22

Minimum Shutdown Margin Analysis

RCCA Bank Worths (PCM)	BOC	EOC
N	5786	6193
N-1	5157	5460
Less 10 Percent	516	546
Sub Total	4641	4914
Total Requirements (Including Uncertainties)	2406	2779
Shutdown Margin	2235	2135
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 -52 ppm and -50 ppm for the ARO and Control Bank A 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 A 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 22

RCCA Bank Endpoint Measurements

RCCA Bank Configuration	Measured Endpoint (PPM)	WPS Predicted Endpoint (PPM)	Difference (PPM)
All Rods Out	1912	1964	-52
Bank A In	1772	1822	-50

TABLE 3.2

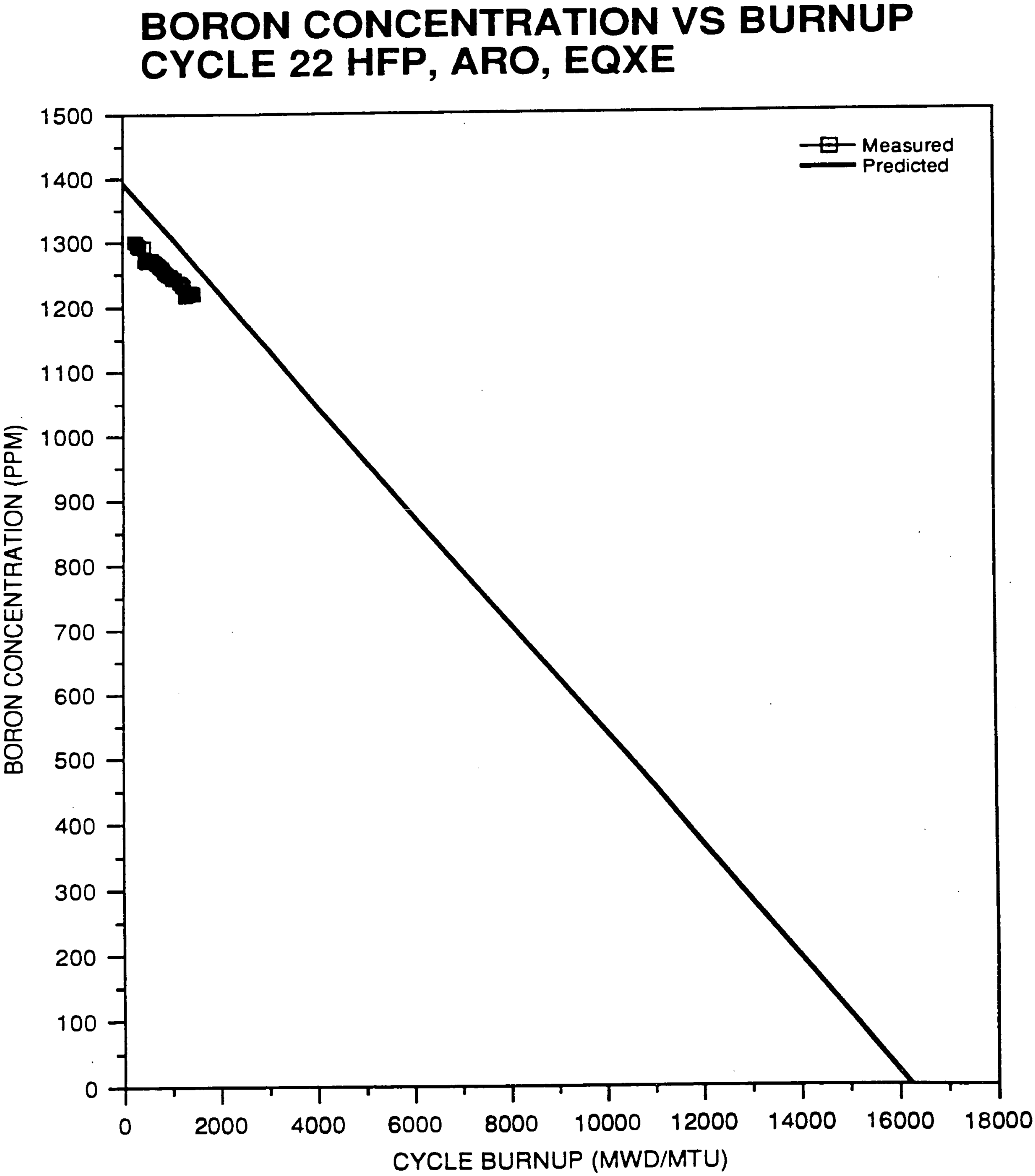
Kewaunee Cycle 22

Differential Boron Worth

RCCA Bank Configuration	CB Change Measured (PPM)	CB Change Predicted (PPM)	Percent Difference
ARO to A Bank In	140	142	-1.4

RCCA Bank Configuration	Measured Boron Worth (PCM/PPM)	Predicted Boron Worth (PCM/PPM)	Difference (PCM/PPM)
ARO/A Bank In	-7.9	-7.2	-0.7

FIGURE 3.1



BORON CONCENTRATION VS BURNUP
CYCLE 22 HFP, ARO, EQXE
Measured
Predicted
BORON CONCENTRATION (PPM)
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
CYCLE BURNUP (MWD/MTU)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000

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 near 1900 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 22

Isothermal Temperature Coefficient

Cooldown

Tave Start - 546.4°F

Tave End - 541.7°F

Bank D - 203 Steps

Boron Concentration - 1899 PPM

Measured ITC (PCM/°F)	WPSC Predicted ITC (PCM/°F)	Difference (PCM/°F)
-2.29	-2.26	-0.03

Heat Up

Tave Start - 542.4°F

Tave End - 544.3°F

Bank D - 203 Steps

Boron Concentration - 1902 PPM

Measured ITC (PCM/°F)	WPSC Predicted ITC (PCM/°F)	Difference (PCM/°F)
-2.16	-2.167	0.007

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 because of steam generator tube plugging, but is projected to reach approximately 97.5% of full power after the feedwater heater bypass is opened.

5.2 Power Distribution Measurements

Table 5.1 identifies the reactor conditions for each flux map recorded at the beginning of Cycle 22.

Comparisons of measured to predicted power distributions for the flux maps are exhibited in Figures 5.1 through 5.5.

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 FQS-1 for the eight Siemens Power Corporation lead test assemblies and FQS-2 for the eight Siemens Power Corporation gadolinia lead test assemblies and verifies that applied limits are reviewed. The Cycle 22 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 22 flux maps.

TABLE 5.1

Flux Map Chronology and Reactor Characteristics

Map	Date	Percent Power	Xenon	Boron PPM	D Rods Steps	Exposure MDW/MTU
2201	06/12/97	26	NON-EQ.	1824	199	0
2202	06/13/97	37	NON-EQ.	1650	193	0
2203	06/20/97	69	NON-EQ.	I442	200	I35
2204	06/24/97	90	NON-EQ.	1344	213	254
2205	07/02/97	94	EQ.	1293	224	514

TABLE 5.2

Verification of Acceptance Criteria

Flux Map	Core Location	FDHN	Limit
2201	H-3 (LB)	1.59	1.78
2202	H-3 (LB)	1.53	1.75
2203	H-3 (LB)	1.52	1.65
2204	H-3 (LB)	1.52	1.58
2205	H-3 (LB)	1.52	1.57

Flux Map	Core Location	FQEQ	Limit
2201	H-3 (LB), 20	2.60	4.43
2202	H-3 (LB), 25	2.25	4.49
2203	H-3 (LB), 30	2.16	3.27
2204	H-11 (CB), 33	2.10	2.51
2205	H-11 (CB), 32	2.08	2.38

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.

TABLE 5.3

Verification of Acceptance Criteria

Flux Map	SPC Lead Test Assembly Core Location	FQS-1	Limit
2201	B-6	2.49	4.21
2202	H-2	2.19	4.25
2203	H-2	2.07	3.09
2204	H-2	2.02	2.37
2205	H-2	1.99	2.26

Flux Map	SPC Lead Test Assembly Core Location	FQS-2	Limit
2201	J-11	2.29	4.20
2202	J-11	2.10	4.23
2203	J-11	2.01	3.08
2204	J-11	2.00	2.40
2205	J-11	1.97	2.29

FQS-1 and FQS-2 include appropriate uncertainties and penalties.

Limit on FQS-1 and FQS-2 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
2201	3.0	2.7	1.0
2202	2.2	1.7	0.8
2203	1.5	1.6	0.5
2204	2.0	1.5	0.4
2205	3.2	1.6	0.4

(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 2201

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.338 0.334 1.14	0.478 0.472 1.12	0.338 0.334 1.14					
B				0.484 0.506 -4.71	1.055 1.044 1.03	1.123 1.091 2.97	1.284 1.258 2.05	1.115 1.091 2.18	1.067 1.044 2.18	0.506 0.508 -0.22			
C			0.371 0.389 -4.70	1.116 1.138 -1.90	1.040 1.029 1.04	1.319 1.305 1.03	1.210 1.175 2.97	1.341 1.305 2.72	1.057 1.029 2.69	1.136 1.136 -0.22	0.378 0.389 -2.85		
D		0.490 0.507 -3.35	1.099 1.138 -3.41	0.858 0.873 -1.75	1.253 1.239 1.15	1.250 1.236 1.16	1.270 1.244 2.12	1.270 1.236 2.71	1.268 1.239 2.33	0.877 0.873 0.41	1.130 1.138 -0.69	0.493 0.507 -2.86	
E		1.023 1.044 -2.05	1.008 1.029 -2.05	1.256 1.240 1.25	1.058 1.045 1.26	1.292 1.276 1.26	1.156 1.141 1.27	1.296 1.276 1.58	1.062 1.045 1.59	1.260 1.240 1.58	1.025 1.029 -0.43	1.018 1.044 -2.53	
F	0.336 0.334 0.568	1.097 1.091 0.57	1.342 1.305 2.85	1.291 1.236 4.43	1.304 1.276 2.16	1.069 1.064 0.47	0.996 0.996 -0.02	1.067 1.064 0.25	1.288 1.276 0.90	1.245 1.236 0.76	1.302 1.305 -0.21	1.084 1.091 -0.69	0.331 0.334 -1.08
G	0.478 0.472 1.10	1.279 1.259 1.58	1.225 1.175 4.27	1.293 1.244 3.91	1.169 1.140 2.50	0.996 0.996 -0.04	0.760 0.770 -1.27	0.991 0.996 -0.49	1.136 1.140 -0.37	1.246 1.244 0.15	1.167 1.175 -0.71	1.252 1.259 -0.57	0.468 0.472 -0.95
H	0.337 0.334 0.93	1.107 1.091 1.46	1.359 1.305 4.15	1.268 1.236 4.21	1.314 1.276 2.99	1.056 1.064 0.16	0.984 0.996 -1.20	1.056 1.064 -0.72	1.271 1.276 -0.40	1.242 1.236 0.50	1.313 1.305 0.63	1.100 1.091 0.82	0.336 0.334 0.39
I		1.035 1.044 -0.89	1.020 1.029 -0.86	1.246 1.240 0.46	1.076 1.045 2.93	1.268 1.276 0.92	1.126 1.141 -1.31	1.259 1.276 -1.33	1.034 1.045 -1.04	1.249 1.240 0.73	1.028 1.029 -0.06	1.043 1.044 -0.14	
J		0.467 0.507 -3.94	1.091 1.138 -4.10	0.857 0.873 -1.84	1.232 1.239 -0.60	1.247 1.236 0.92	1.227 1.244 -1.37	1.219 1.236 -1.39	1.218 1.239 -1.68	0.888 0.873 1.68	1.136 1.138 -0.14	0.506 0.507 -0.30	
K			0.373 0.389 -4.14	1.091 1.138 -4.14	0.986 1.029 -4.23	1.249 1.305 -4.30	1.156 1.175 -1.68	1.271 1.305 -2.62	1.002 1.029 -2.67	1.097 1.136 -3.62	0.382 0.389 -1.95		
L				0.486 0.508 -4.22	1.000 1.044 -4.22	1.064 1.091 -2.49	1.227 1.258 -2.50	1.057 1.091 -3.08	1.006 1.044 -3.62	0.489 0.508 -3.63			
M						0.326 0.334 -2.48	0.460 0.472 -2.50	0.324 0.334 -3.05					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

STANDARD DEVIATION = 2.21

FIGURE 5.2

Power Distribution for Flux Map 2202

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.345 0.336 2.59	0.485 0.473 2.58	0.345 0.336 2.59					
B				0.497 0.511 -2.86	1.042 1.041 0.08	1.092 1.082 0.96	1.264 1.242 1.77	1.106 1.082 2.21	1.064 1.041 2.24	0.518 0.511 1.33			
C			0.383 0.393 -2.67	1.122 1.137 -1.32	1.031 1.030 0.08	1.296 1.294 0.12	1.167 1.150 0.58	1.312 1.294 1.41	1.052 1.030 2.11	1.152 1.137 1.34	0.392 0.393 -0.43		
D		0.499 0.511 -2.23	1.111 1.137 -2.26	0.888 0.879 -1.25	1.240 1.239 0.09	1.236 1.235 0.11	1.248 1.243 0.39	1.252 1.235 1.36	1.265 1.239 2.07	0.893 0.879 1.59	1.146 1.137 0.79	0.509 0.511 -0.43	
E		1.023 1.042 -1.83	1.012 1.031 -1.83	1.242 1.239 0.24	1.055 1.053 0.19	1.282 1.280 0.18	1.151 1.149 0.13	1.282 1.260 0.16	1.075 1.053 2.09	1.265 1.239 2.08	1.038 1.031 0.72	1.035 1.042 -0.70	
F	0.338 0.336 0.714	1.090 1.082 0.72	1.300 1.294 0.46	1.238 1.236 0.18	1.276 1.280 -0.33	1.071 1.076 -0.47	1.003 1.012 -0.90	1.058 1.076 -1.72	1.282 1.280 0.13	1.239 1.236 0.25	1.301 1.294 0.53	1.083 1.082 0.10	0.336 0.336 0.09
G	0.485 0.473 2.47	1.268 1.242 2.13	1.178 1.161 1.47	1.249 1.243 0.49	1.143 1.149 -0.51	1.003 1.012 -0.85	0.776 0.788 -1.46	0.998 1.012 -1.35	1.140 1.149 -0.77	1.240 1.243 -0.27	1.162 1.161 0.08	1.244 1.242 0.15	0.474 0.473 0.15
H	0.344 0.336 2.41	1.104 1.082 2.05	1.313 1.294 1.46	1.250 1.236 1.09	1.281 1.260 0.11	1.070 1.076 -0.54	0.996 1.012 -1.55	1.060 1.076 -1.47	1.271 1.260 -0.70	1.242 1.238 0.48	1.309 1.294 1.18	1.096 1.082 1.27	0.339 0.338 0.86
I		1.046 1.042 0.36	1.028 1.031 -0.30	1.246 1.239 0.55	1.076 1.053 2.15	1.282 1.280 0.17	1.134 1.149 -1.31	1.264 1.260 -1.28	1.048 1.053 -0.49	1.259 1.239 1.62	1.047 1.031 1.58	1.083 1.042 1.98	
J		0.502 0.511 -1.80	1.111 1.137 -2.33	0.871 0.879 -0.92	1.235 1.239 -0.35	1.237 1.235 0.17	1.225 1.243 -1.42	1.218 1.235 -1.39	1.226 1.239 -1.07	0.902 0.879 2.65	1.160 1.137 1.98	0.521 0.511 1.92	
K			0.384 0.393 -2.26	1.111 1.137 -2.30	1.004 1.030 -2.50	1.258 1.294 -2.96	1.146 1.180 -1.06	1.280 1.294 -1.10	1.019 1.030 -1.10	1.124 1.137 -1.13	0.398 0.393 1.32		
L				0.498 0.511 -2.47	1.015 1.041 -2.48	1.068 1.082 -1.26	1.226 1.242 -1.26	1.069 1.082 -1.19	1.029 1.041 -1.13	0.505 0.511 -1.14			
M						0.332 0.336 -1.25	0.467 0.473 -1.27	0.332 0.336 -1.19					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

STANDARD DEVIATION = 1.43

FIGURE 5.3

Power Distribution for Flux Map 2203

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.347 0.345 0.55	0.485 0.483 0.54	0.347 0.345 0.55					
B				0.499 0.515 -3.11	1.031 1.027 0.39	1.090 1.072 1.64	1.234 1.221 1.09	1.089 1.072 1.55	1.043 1.027 1.58	0.520 0.515 0.83			
C			0.367 0.399 -3.11	1.105 1.120 -1.39	1.034 1.030 0.39	1.279 1.279 -0.02	1.179 1.172 0.61	1.296 1.279 1.29	1.052 1.030 2.11	1.129 1.120 0.82	0.396 0.399 -0.85		
D		0.506 0.515 -1.86	1.099 1.120 -1.93	0.873 0.894 -1.29	1.233 1.229 0.32	1.236 1.235 0.06	1.257 1.251 0.43	1.250 1.235 1.23	1.253 1.229 1.91	0.894 0.894 1.09	1.124 1.120 0.32	0.511 0.515 -0.83	
E		1.020 1.027 -0.70	1.023 1.030 -0.70	1.235 1.230 0.37	1.066 1.062 0.32	1.281 1.279 0.14	1.164 1.165 -0.09	1.274 1.279 -0.41	1.079 1.062 1.55	1.249 1.230 1.55	1.037 1.030 0.62	1.024 1.027 -0.34	
F	0.351 0.345 1.767	1.091 1.072 1.77	1.295 1.280 1.14	1.237 1.235 0.12	1.274 1.279 -0.44	1.092 1.098 -0.60	1.031 1.042 -1.07	1.085 1.098 -1.22	1.281 1.279 0.13	1.235 1.235 0.01	1.283 1.280 0.25	1.089 1.072 -0.33	0.344 0.345 -0.29
G	0.493 0.483 2.09	1.245 1.221 1.94	1.194 1.173 1.78	1.257 1.251 0.46	1.157 1.165 -0.71	1.030 1.042 -1.13	0.809 0.825 -1.94	1.028 1.042 -1.38	1.158 1.165 -0.79	1.248 1.251 -0.39	1.172 1.173 -0.12	1.217 1.221 -0.33	0.461 0.483 -0.29
H	0.352 0.345 1.91	1.091 1.072 1.80	1.303 1.260 1.75	1.248 1.235 1.08	1.278 1.279 -0.07	1.091 1.068 -0.64	1.023 1.042 -1.81	1.062 1.098 -1.45	1.269 1.279 -0.77	1.240 1.235 0.38	1.291 1.280 0.87	1.079 1.072 0.65	0.344 0.345 -0.23
I		1.029 1.027 0.14	1.032 1.030 0.22	1.241 1.230 0.89	1.085 1.062 2.15	1.283 1.279 0.27	1.149 1.165 -1.40	1.261 1.279 -1.38	1.055 1.062 -0.72	1.249 1.230 1.50	1.041 1.030 1.10	1.040 1.027 1.29	
J		0.511 0.515 -0.78	1.107 1.120 -1.21	0.883 0.984 -0.15	1.232 1.229 0.26	1.236 1.235 0.27	1.235 1.251 -1.33	1.219 1.235 -1.30	1.216 1.229 -1.06	0.907 0.894 2.59	1.135 1.120 1.29	0.521 0.515 1.18	
K			0.393 0.399 -1.55	1.102 1.120 -1.60	1.010 1.030 -1.98	1.257 1.279 -1.71	1.160 1.172 -1.06	1.270 1.279 -0.70	1.023 1.030 -0.68	1.117 1.120 -0.32	0.399 0.399 0.03		
L				0.505 0.515 -1.98	1.007 1.027 -1.96	1.058 1.072 -1.34	1.205 1.221 -1.34	1.063 1.072 -0.82	1.024 1.027 -0.33	0.514 0.515 -0.31			
M						0.341 0.345 -1.33	0.476 0.483 -1.35	0.342 0.345 -0.64					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

STANDARD DEVIATION = 1.20

FIGURE 5.4

Power Distribution for Flux Map 2204

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.344 0.351 -1.98	0.487 0.490 -0.69	0.353 0.351 0.54					
B				0.503 0.517 -2.67	0.999 1.019 -2.01	1.047 1.068 -2.01	1.211 1.214 -0.26	1.082 1.098 1.27	1.033 1.019 1.31	0.525 0.517 1.47			
C			0.392 0.402 -2.66	1.090 1.109 -1.18	1.021 1.029 -0.79	1.269 1.275 -0.50	1.187 1.191 -0.31	1.290 1.275 1.18	1.047 1.029 1.73	1.125 1.109 1.45	0.404 0.402 0.40		
D		0.510 0.517 -1.30	1.095 1.110 -1.38	0.876 0.888 -1.11	1.222 1.223 -0.08	1.234 1.234 0.00	1.258 1.258 0.14	1.248 1.234 1.18	1.245 1.223 1.78	0.900 0.888 1.84	1.123 1.110 1.15	0.519 0.517 0.39	
E		1.019 1.019 -0.03	1.029 1.029 -0.03	1.221 1.223 -0.16	1.062 1.065 -0.30	1.274 1.278 -0.20	1.183 1.170 -0.63	1.267 1.278 -0.70	1.068 1.065 0.28	1.247 1.223 1.96	1.038 1.029 0.68	1.017 1.019 -0.25	
F	0.358 0.351 1.936	1.089 1.068 1.92	1.292 1.275 1.34	1.231 1.234 -0.24	1.266 1.276 -0.81	1.092 1.105 -1.17	1.039 1.054 -1.45	1.086 1.105 -1.69	1.269 1.278 -0.53	1.237 1.234 0.21	1.284 1.275 0.71	1.068 1.068 -0.04	0.350 0.351 -0.26
G	0.499 0.490 1.78	1.237 1.214 1.90	1.214 1.191 1.95	1.262 1.256 0.43	1.160 1.170 -0.91	1.038 1.054 -1.53	0.829 0.842 -1.60	1.039 1.054 -1.48	1.157 1.170 -1.09	1.251 1.256 -0.39	1.193 1.191 0.17	1.214 1.214 -0.02	0.489 0.490 -0.24
H	0.357 0.351 1.59	1.087 1.068 1.78	1.300 1.275 1.94	1.250 1.234 1.25	1.275 1.278 -0.08	1.099 1.105 -0.55	1.030 1.054 -1.42	1.091 1.105 -1.31	1.265 1.278 -0.69	1.239 1.234 0.38	1.290 1.275 1.14	1.078 1.068 0.96	0.350 0.351 -0.26
I		1.024 1.019 0.47	1.038 1.029 0.87	1.237 1.223 1.17	1.034 1.065 1.73	1.280 1.278 0.32	1.181 1.170 -0.79	1.266 1.276 -0.78	1.061 1.065 -0.35	1.241 1.223 1.47	1.043 1.029 1.35	1.037 1.019 1.79	
J		0.517 0.517 -0.06	1.103 1.110 -0.68	0.888 0.886 0.08	1.226 1.223 0.20	1.230 1.234 -0.30	1.244 1.256 -0.96	1.223 1.234 -0.91	1.220 1.223 -0.24	0.910 0.886 2.71	1.130 1.110 1.78	0.526 0.517 1.72	
K			0.398 0.402 -1.07	1.097 1.109 -1.13	1.013 1.029 -1.60	1.256 1.275 -1.53	1.180 1.191 -0.64	1.270 1.275 -0.42	1.031 1.029 0.17	1.115 1.109 0.54	0.406 0.402 0.90		
L				0.509 0.517 -1.60	1.003 1.019 -1.61	1.052 1.068 -1.54	1.195 1.214 -1.55	1.059 1.068 -0.82	1.025 1.019 0.54	0.520 0.517 0.58			
M						0.346 0.351 -1.54	0.482 0.490 -1.55	0.349 0.351 -0.51					

MEASURED FDHN PREDICTED FDHN PERCENT DIFFERENCE

STANDARD DEVIATION = 1.19

FIGURE 5.5

Power Distribution for Flux Map 2205

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.342 0.354 -3.42	0.468 0.494 -1.62	0.354 0.354 0.08					
B				0.504 0.517 -2.48	0.979 1.013 -3.42	1.031 1.067 -3.41	1.204 1.213 -0.74	1.079 1.067 1.10	1.025 1.013 1.13	0.526 0.517 1.74			
C			0.393 0.403 -2.48	1.099 1.103 -0.42	1.020 1.028 -0.77	1.265 1.278 -0.91	1.192 1.204 -0.99	1.287 1.278 0.82	1.045 1.028 1.68	1.122 1.103 1.72	0.406 0.403 1.42		
D		0.510 0.517 -1.26	1.089 1.103 -1.32	0.883 0.888 -0.32	1.228 1.221 0.57	1.234 1.234 -0.01	1.255 1.256 -0.21	1.243 1.234 0.75	1.241 1.221 1.83	0.901 0.886 1.68	1.120 1.103 1.50	0.524 0.517 1.43	
E		1.012 1.013 -0.11	1.027 1.028 -0.11	1.231 1.222 0.73	1.068 1.065 0.22	1.274 1.275 -0.10	1.157 1.172 -1.29	1.255 1.275 -1.57	1.054 1.068 -0.23	1.242 1.222 1.60	1.041 1.028 1.21	1.021 1.013 0.81	
F	0.360 0.354 1.750	1.086 1.067 1.73	1.295 1.277 1.39	1.237 1.234 0.22	1.268 1.275 -0.75	1.093 1.107 -1.26	1.037 1.057 -1.68	1.084 1.107 -2.08	1.264 1.275 -0.87	1.239 1.234 0.37	1.283 1.277 1.26	1.072 1.067 0.50	0.354 0.354 0.03
G	0.504 0.494 2.07	1.236 1.213 1.87	1.226 1.204 1.81	1.265 1.256 0.55	1.162 1.171 -0.75	1.040 1.067 -1.59	0.834 0.847 -1.54	1.044 1.067 -1.27	1.160 1.171 -0.94	1.257 1.256 -0.10	1.214 1.204 0.85	1.219 1.213 0.48	0.494 0.494 -0.02
H	0.361 0.354 1.95	1.086 1.087 1.76	1.300 1.277 1.78	1.247 1.234 1.01	1.272 1.275 -0.25	1.095 1.107 -1.07	1.043 1.057 -1.30	1.090 1.107 -0.99	1.269 1.275 -0.47	1.239 1.234 0.43	1.293 1.277 1.22	1.077 1.067 0.89	0.352 0.354 -0.73
I		1.021 1.013 0.80	1.038 1.028 0.92	1.234 1.222 1.00	1.078 1.068 1.13	1.272 1.275 -0.23	1.164 1.172 -0.72	1.267 1.275 -0.68	1.068 1.098 -0.08	1.236 1.222 1.14	1.044 1.028 1.51	1.034 1.013 2.09	
J		0.520 0.517 0.68	1.103 1.103 -0.03	0.888 0.886 0.29	1.223 1.221 0.17	1.226 1.234 -0.70	1.242 1.258 -1.30	1.219 1.234 -1.26	1.213 1.221 -0.70	0.904 0.886 2.03	1.126 1.103 2.09	0.528 0.517 2.11	
K			0.401 0.403 -0.47	1.097 1.103 -0.52	1.017 1.028 -1.05	1.255 1.278 -1.64	1.190 1.294 -1.20	1.268 1.278 -0.54	1.027 1.028 -0.11	1.108 1.103 0.44	0.411 0.403 2.16		
L				0.511 0.517 -1.06	1.002 1.013 -1.06	1.051 1.067 -1.55	1.194 1.213 -1.58	1.059 1.067 -0.98	1.018 1.013 0.44	0.519 0.517 0.45			
M						0.349 0.354 -1.44	0.487 0.404 -1.44	0.352 0.354 -0.51					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

STANDARD DEVIATION = 1.30

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 22 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 22 startup (4). A flux map was performed at approximately 70 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 22," Wisconsin Public Service Corporation, August 1996.

(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 6, May 19, 1997)

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