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Committed to Nuclear Excellence

Kewaunee / Point Beach Nuclear
Operated by Nuclear Management Company, LLC

NRC-02-019 TS 6.9.a.1

February 28, 2002

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

Ladies/Gentlemen:

Docket 50-305
Operating License DPR-43
Kewaunee Nuclear Power Plant
Cycle 25 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 25 Startup Report.

Sincerely,

Thomas Coutu

Thomas Coutu
Manager-Kewaunee Plant

Enclosure

cc - US NRC - Region III - w/o attach.
NRC Senior Resident Inspector - w/o attach.

IE26

KEWAUNEE NUCLEAR POWER PLANT

STARTUP REPORT

CYCLE 25

FEBRUARY 2002

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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 25. The core design and reload safety evaluation (1) were performed by Nuclear Management Company (NMC) using methods previously described in approved topical reports (2, 3). The results of the physics tests were compared to NMC analytical results to confirm calculated safety margins. The tests performed and reported herein satisfy the requirements of the Reactor Test Program (4).

The reactor core consists of 121 fuel assemblies of 14 x 14 design. The core loading pattern, assembly identification, and burnable absorber configurations for Cycle 25 are presented in Figure 1.1.

Thirty-six (36) new Framatome ANP (FRA-ANP, formerly known as Siemens Power Corporation) heavy assemblies containing UO_2 rods enriched to 4.5 w/o U235 and four (4) new Westinghouse 422V+ assemblies containing UO_2 rods enriched to 3.3 w/o U235 will reside with 81 partially depleted FRA-ANP heavy assemblies. The FRA-ANP heavy assemblies contain approximately 405 KgU (per assembly). The four Westinghouse assemblies are Lead Use Assemblies (LUAs) containing approximately 402 KgU (per assembly). Table 1.1 displays the core breakdown by region, enrichment, number of previous duty cycles, fuel rod design, and grid design.

On December 1, 2001, at 2012 hours, initial criticality was achieved on the Cycle 25 core. The schedule of physics tests and measurements is outlined in Table 1.2.

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 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 Control Bank C inserted core configurations were within the acceptance criteria (4). The available boron letdown data covering early 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 pertinent Technical Specification limits (5) and are presented in Section 5. Section 6 discusses the various calibrations performed during the startup of Cycle 25.

1.3 Conclusion

The startup testing of Kewaunee's Cycle 25 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

Fuel Characteristics

Region	Region Identifier	Initial U02 Rod W/O U235 (Gad Load)	Number of Previous Duty Cycles	Cycle 25 Assemblies	Fuel Rod Design	Grid Design(1)
25	C	4.1 (8 rods - 8%)	2	8	Heavy	HTP
25	C	4.1 (12 rods - 8%)	2	9	Heavy	HTP
25	C	4.5 (4 rods - 4%)	2	8	Heavy	HTP
25	C	4.5 (8 rods - 4%)	2	8	Heavy	HTP
25	C	4.5 (8 rods - 8%)	2	8	Heavy	HTP
26	D	4.1 (8 rods - 8%)	1	20	Heavy	HTP
26	D	4.5 (4 rods - 4%)	1	8	Heavy	HTP
26	D	4.5 (8 rods - 4%)	1	4	Heavy	HTP
26	D	4.5 (8 rods - 8%)	1	8	Heavy	HTP
27	E	4.5 (8 rods - 4%)	0	16	Heavy	HTP
27	E	4.5 (8 rods - 8%)	0	20	Heavy	HTP
27	E	3.3	0	4	422 V+	ZIRLO

(1) HTP denotes the FRA-ANP High Thermal Performance mid-grid design. ZIRLO denotes the Westinghouse mid-grid design. The FRA-ANP top and bottom grids are bi-metallic (Zircaloy and Inconel). The Westinghouse top and bottom grids are Inconel.

TABLE 1.2

BOC Physics Test

Test	Date Completed	Time Completed	Plant Conditions
Control Rod Operability Test	11/26/01	0140	Cold SD
Hot Rod Drops	11/30/01	0205	HSD
RPI Calibrations	11/30/01	2152	HSD
Initial Criticality	12/01/01	2012	HZP
Reactivity Computer Checkout	12/01/01	2048	HZP
ARO Endpoint	12/01/01	2048	HZP
ITC Determination	12/01/01	2155	HZP
Bank C Worth (Dilution)	12/01/01	2337	HZP
Low Power Physics Test Completion	12/02/01	0323	HZP
Power Ascension Flux Map 2501	12/05/01	1749	30%
Power Ascension Flux Map 2502	12/09/01	0218	73%
Power Ascension Flux Map 2503	12/11/01	0955	90%
Power Ascension Flux Map 2504	12/16/01	2132	99%
Power Ascension Flux Map 2505	12/17/01	1518	99%
Power Ascension Flux Map 2506	12/26/01	1608	100%

FIGURE 1.1

Core Loading Map

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						C55 4.1 8GAD8	D66 4.1 8GAD8	C58 4.1 8GAD8					
B				D58 4.1 8GAD8	D76 4.5 4GAD4	E51 4.5 8GAD4	E88 3.3	E64 4.5 8GAD4	D75 4.5 4GAD4	D59 4.1 8GAD8			
C			C64 4.1 12GAD8	E55 4.5 8GAD4	E83 4.5 8GAD8	C92 4.5 8GAD8	D80 4.5 8GAD4	C93 4.5 8GAD8	E69 4.5 8GAD8	E60 4.5 8GAD4	C65 4.1 12GAD8		
D		D63 4.1 8GAD8	E62 4.5 8GAD4	D87 4.5 8GAD8	D69 4.1 8GAD8	C71 4.5 4GAD4	E81 4.5 8GAD8	C78 4.5 4GAD4	D55 4.1 8GAD8	D83 4.5 8GAD8	E52 4.5 8GAD4	D65 4.1 8GAD8	
E		D78 4.5 4GAD4	E68 4.5 8GAD8	D62 4.1 8GAD8	C81 4.5 8GAD4	E84 4.5 8GAD8	C60 4.1 12GAD8	E78 4.5 8GAD8	C86 4.5 8GAD4	D61 4.1 8GAD8	E79 4.5 8GAD8	D72 4.5 4GAD4	
F	C51 4.1 8GAD8	E59 4.5 8GAD4	C88 4.5 8GAD8	C76 4.5 4GAD4	E74 4.5 8GAD8	C96 4.5 8GAD4	D84 4.5 8GAD8	C80 4.5 8GAD4	E70 4.5 8GAD8	C74 4.5 4GAD4	C87 4.5 8GAD8	E63 4.5 8GAD4	C54 4.1 8GAD8
G	D54 4.1 8GAD8	E87 3.3	D79 4.5 8GAD4	E71 4.5 8GAD8	C61 4.1 12GAD8	D89 4.5 8GAD8	C69 4.1 12GAD8	D85 4.5 8GAD8	C62 4.1 12GAD8	E86 4.5 8GAD8	D82 4.5 8GAD4	E90 3.3	D70 4.1 8GAD8
H	C57 4.1 8GAD8	E54 4.5 8GAD4	C89 4.5 8GAD8	C77 4.5 4GAD4	E80 4.5 8GAD8	C95 4.5 8GAD4	D90 4.5 8GAD8	C85 4.5 8GAD4	E82 4.5 8GAD8	C75 4.5 4GAD4	C90 4.5 8GAD8	E66 4.5 8GAD4	C56 4.1 8GAD8
I		D71 4.5 4GAD4	E73 4.5 8GAD8	D68 4.1 8GAD8	C84 4.5 8GAD4	E72 4.5 8GAD8	C59 4.1 12GAD8	E77 4.5 8GAD8	C79 4.5 8GAD4	D52 4.1 8GAD8	E75 4.5 8GAD8	D73 4.5 4GAD4	
J		D60 4.1 8GAD8	E57 4.5 8GAD4	D88 4.5 8GAD8	D56 4.1 8GAD8	C73 4.5 4GAD4	E67 4.5 8GAD8	C72 4.5 4GAD4	D53 4.1 8GAD8	D86 4.5 8GAD8	E53 4.5 8GAD4	D64 4.1 8GAD8	
K			C70 4.1 12GAD8	E65 4.5 8GAD4	E85 4.5 8GAD8	C91 4.5 8GAD8	D81 4.5 8GAD4	C94 4.5 8GAD8	E76 4.5 8GAD8	E56 4.5 8GAD4	C68 4.1 12GAD8		
L				D57 4.1 8GAD8	D74 4.5 4GAD4	E58 4.5 8GAD4	E89 3.3	E61 4.5 8GAD4	D77 4.5 4GAD4	D67 4.1 8GAD8			
M						C53 4.1 8GAD8	D51 4.1 8GAD8	C52 4.1 8GAD8					

CYCLE TWENTY-FIVE

Legend: ASSEMBLY ID / INITIAL ENRICHMENT / GADOLINIA LOADING

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 25 startup the reactivity of the reference bank, Control 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, Control Bank C, measured during dilution differed from the NMC predicted Control Bank C worth by 81.12 pcm or 9.2 percent. This difference meets the review criterion of 10% for reference bank worth. A comparison of the measured to predicted reference bank integral and differential worth is presented in Figures 2.1 and 2.2

Rod swap results for the remaining banks are presented in Table 2.2. The measured- to-predicted total rod worth difference is +8.4 percent, which is within the acceptance criterion of –5.0 percent to +10.0 percent. All individual remaining 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 at end of cycle are presented in Table 2.3. A –5 percent to +10 percent uncertainty in the calculation of total rod worth is accounted for in the shutdown margin analyses. Since the measured total rod worth result fell within a –5 percent to +10 percent range compared to the predicted value, the analysis in Table 2.3 is conservative and no additional evaluations were required.

TABLE 2.1

Kewaunee Cycle 25

RCCA Drop Time Measurements

Hot Zero Power

Average Dashpot Delta T (Seconds)	1.256
Standard Deviation	0.030
Average Rod Bottom Delta T (Seconds)	1.740
Standard Deviation	0.043

TABLE 2.2

Kewaunee Cycle 25

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	882.09	866.0	16.09	1.9
C*	960.12	879.0	81.12	9.2
B	540.27	511.0	29.27	5.7
A	926.37	826.0	100.37	12.2
SA	711.29	639.0	72.29	11.3
SB	705.18	639.0	66.18	10.4
Total	4725.32	4360.0	365.32	8.4

* Reference bank

TABLE 2.3

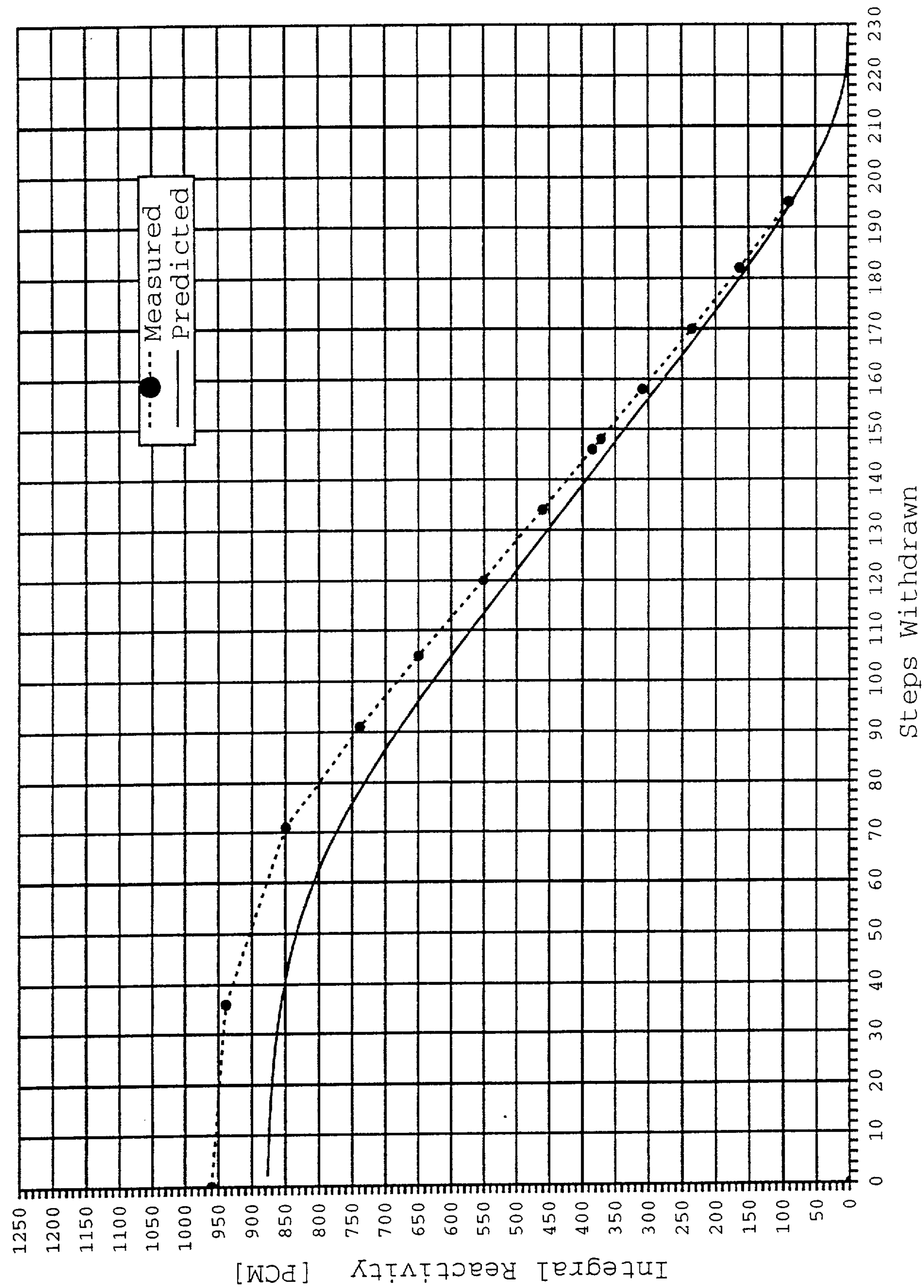
Kewaunee Cycle 25

Minimum Shutdown Margin Analysis

RCCA Bank Worths (PCM)	BOC	EOC
N	5685	5997
N-1	5081	5265
Less 5 Percent	254	263
Sub Total	4827	5002
Total Requirements (Including Uncertainties)	2439	2938
Shutdown Margin	2388	2064
Required Shutdown Margin	1000	2000

FIGURE 2.1

RCCA Control Bank C Integral Worth
Cycle 25, 0 MWD/MTU, HZP, NoXe, 1943 PPM, ORO - C MOVING



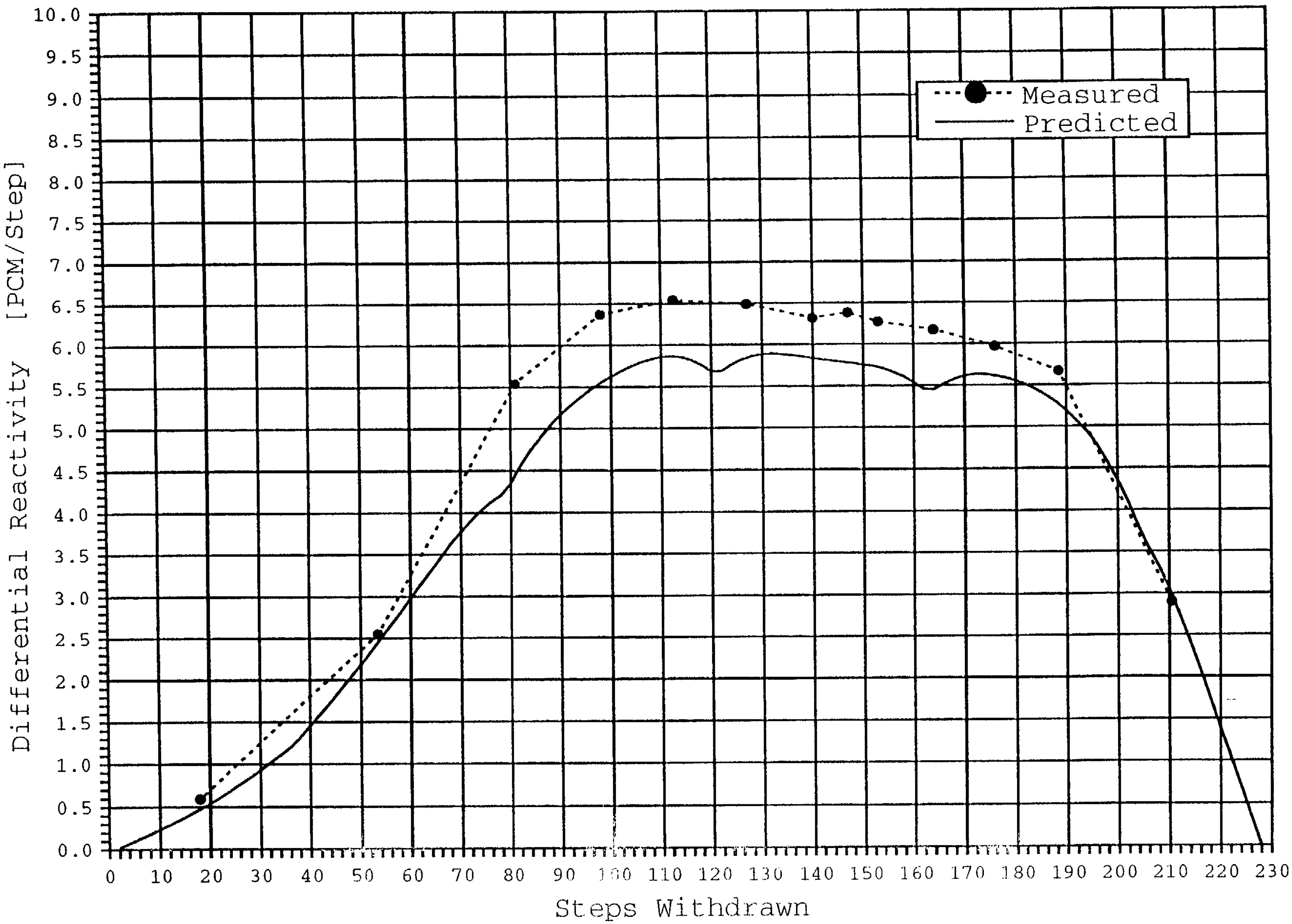


FIGURE 2.2

RCCA Control Bank C Differential Worth

Cycle 25, 0 MWD/MTU, HZP, NoXe, 1943 PPM, ORO - C MOVING

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 NMC predicted boron endpoints for the RCCA bank configurations shown. The results indicate a difference of -60 ppm and -64 ppm for the ARO and Control 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 25

RCCA Bank Endpoint Measurements

RCCA Bank Configuration	Measured Endpoint (PPM)	WPS Predicted Endpoint (PPM)	Difference (PPM)
All Rods Out	1949	2009	-60
Bank C In	1812	1876	-64

TABLE 3.2

Kewaunee Cycle 25

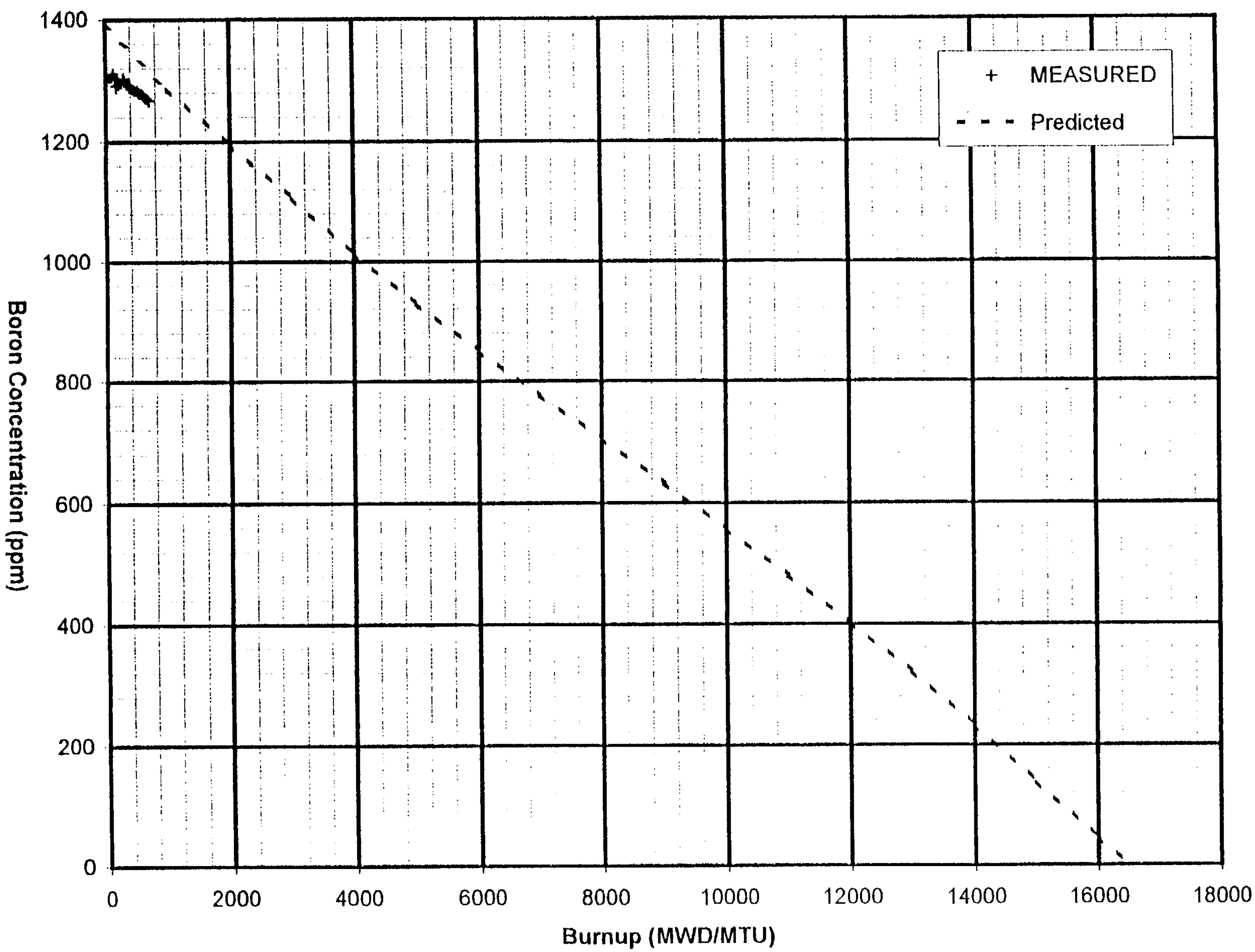
Differential Boron Worth

RCCA Bank Configuration	CB Change Measured (PPM)	CB Change Predicted (PPM)	Percent Difference
ARO to C Bank In	137	133	2.9

RCCA Bank Configuration	Measured Boron Worth (PCM/PPM)	Predicted Boron Worth (PCM/PPM)	Difference (PCM/PPM)
ARO/C Bank In	-7.0	-6.6	-0.4

FIGURE 3.1

BORON CONCENTRATION VS BURNUP - CYCLE 25 HFP, ARO, EQXE



Reactor Engineering
12/31/2001

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 change, reactivity change, and the temperature coefficient were obtained from the reactivity computer temperature coefficient analysis results.

Core conditions at the time of the measurement were Bank D slightly inserted, all other RCCA banks full out, with a boron concentration of 1935 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 25

Isothermal Temperature Coefficient

Cooldown

Tave Start	-	550.20°F
Tave End	-	546.75°F
Bank D	-	199 Steps
Boron Concentration	-	1935 PPM

Measured ITC (PCM/°F)	WPSC Predicted ITC (PCM/°F)	Difference (PCM/°F)
-4.519	-5.495	0.976

Heat Up

Tave Start	-	547.31°F
Tave End	-	550.18°F
Bank D	-	199 Steps
Boron Concentration	-	1935 PPM

Measured ITC (PCM/°F)	WPSC Predicted ITC (PCM/°F)	Difference (PCM/°F)
-3.783	-5.495	1.712

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).

5.2 Power Distribution Measurements

Table 5.1 identifies the reactor conditions for each flux map recorded at the beginning of Cycle 25.

Comparisons of measured to predicted power distributions for the flux maps are exhibited in Figures 5.1 through 5.6.

Table 5.2 identifies flux map peak FDHN and minimum margin FQEQ for FRA-ANP heavy fuel. Table 5.3 identifies flux map peak FDHN and minimum margin FQEQ for Westinghouse 422V+ fuel. These tables address acceptance criteria by verifying that technical specification limits are not exceeded. The Cycle 25 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 25 flux maps.

TABLE 5.1

Flux Map Chronology and Reactor Characteristics

Map	Date	Percent Power	Xenon	Boron PPM	D Rods Steps	Exposure MDW/MTU
2501	12/05/01	30	EQ.	1660	150	8
2502	12/09/01	73	EQ.	1427	187	61
2503	12/11/01	90	EQ.	1409	204	124
2504	12/16/01	99	EQ.	1311	207	307
2505	12/17/01	99	EQ.	1306	209	340
2506	12/26/01	100	EQ.	1277	226	631

TABLE 5.2

Verification of Acceptance Criteria for FRA-ANP Heavy Fuel

Flux Map	Core Location	FDHN	Limit
2501	G-4 (CK)	1.67	1.94
2502	G-4 (CK)	1.67	1.79
2503	G-4 (CK)	1.67	1.73
2504	G-4 (CK)	1.65	1.70
2505	G-4 (CK)	1.65	1.70
2506	G-4 (CK)	1.65	1.70

Flux Map	Core Location	FQEQ	Limit
2501	G-4 (CK), 31	2.63	4.70
2502	G-4 (CK), 25	2.42	3.16
2503	G-4 (CK), 23	2.32	2.55
2504	G-4 (CK), 27	2.28	2.34
2505	G-4 (CK), 20	2.25	2.32
2506	G-4 (CK), 22	2.21	2.30

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 for Westinghouse 422V+ Fuel

Flux Map	Core Location	FDHN	Limit
2501	G-2 (KE)	1.45	1.77
2502	G-2 (KE)	1.50	1.63
2503	G-2 (KE)	1.51	1.58
2504	G-2 (KE)	1.50	1.55
2505	G-2 (KE)	1.51	1.55
2506	G-2 (KE)	1.51	1.55

Flux Map	Core Location	FQEQ	Limit
2501	L-7 (ED), 30	2.35	4.33
2502	G-2 (KE), 25	2.18	2.92
2503	G-2 (KE), 26	2.12	2.37
2504	G-2 (KE), 26	2.07	2.15
2505	G-2 (KE), 22	2.06	2.14
2506	G-2 (KE), 22	2.03	2.12

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 5.4

Verification of Review Criteria

Flux Map	(a) Maximum Percent Difference	(b) Standard Deviation	(c) Percent Maximum Quadrant Tilt
2501	0.9	3.2	0.8
2502	1.9	3.4	0.8
2503	0.6	3.5	0.4
2504	0.8	3.6	0.7
2505	1.4	3.7	1.0
2506	0.9	3.3	0.8

(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 2501

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.366 0.363 0.853	0.499 0.498 0.121	0.361 0.363 -0.551					
B				0.461 0.491 -6.053	0.824 0.817 0.856	1.095 1.086 0.847	1.128 1.124 0.356	1.090 1.086 0.359	0.820 0.817 0.379	0.487 0.491 -0.795			
C			0.411 0.437 -6.059	1.094 1.131 -3.289	1.329 1.326 0.211	1.063 1.053 0.969	1.151 1.136 1.356	1.067 1.053 1.330	1.337 1.326 0.830	1.122 1.131 -0.805	0.427 0.437 -2.492		
D		0.465 0.491 -5.138	1.072 1.131 -5.181	1.253 1.294 -3.145	1.220 1.217 0.263	1.067 1.056 1.042	1.387 1.367 1.478	1.071 1.056 1.373	1.220 1.217 0.255	1.283 1.294 -0.835	1.112 1.131 -1.724	0.478 0.491 -2.508	
E		0.782 0.817 -4.260	1.270 1.326 -4.261	1.223 1.217 0.468	1.048 1.041 0.663	1.387 1.372 1.108	1.088 1.081 0.666	1.377 1.372 0.372	1.028 1.041 -1.239	1.206 1.217 -0.904	1.338 1.326 0.875	0.839 0.817 2.730	
F	0.376 0.363 3.750	1.126 1.085 3.751	1.088 1.052 3.460	1.080 1.057 2.129	1.385 1.372 0.940	1.023 1.020 0.245	1.195 1.204 -0.739	1.013 1.020 -0.676	1.363 1.372 -0.692	1.058 1.057 0.076	1.062 1.052 0.903	1.106 1.085 1.945	0.372 0.363 2.454
G	0.528 0.498 6.070	1.173 1.123 4.470	1.190 1.135 4.837	1.387 1.367 1.492	1.090 1.081 0.870	1.201 1.204 -0.274	0.890 0.906 -1.755	1.191 1.204 -1.080	1.071 1.081 -0.962	1.368 1.367 0.102	1.145 1.135 0.872	1.144 1.123 1.897	0.510 0.498 2.432
H	0.383 0.363 5.569	1.129 1.085 4.018	1.100 1.052 4.553	1.072 1.057 1.438	1.381 1.372 0.649	1.011 1.020 -0.873	1.189 1.204 -1.246	1.013 1.020 -0.667	1.361 1.372 -0.838	1.058 1.057 0.076	1.052 1.052 0.019	1.096 1.085 1.041	0.371 0.363 2.178
I		0.819 0.817 0.196	1.326 1.326 -0.038	1.217 1.217 -0.041	1.040 1.041 -0.106	1.371 1.372 -0.109	1.071 1.081 -0.925	1.359 1.372 -0.977	1.028 1.041 -1.239	1.213 1.217 -0.353	1.301 1.326 -1.878	0.796 0.817 -2.558	
J		0.498 0.491 1.570	1.149 1.131 1.574	1.314 1.294 1.569	1.236 1.217 1.569	1.060 1.056 0.417	1.367 1.367 0.015	1.056 1.056 -0.028	1.208 1.217 -0.781	1.296 1.294 0.170	1.102 1.131 -2.564	0.477 0.491 -2.793	
K			0.425 0.437 -2.835	1.101 1.131 -2.679	1.288 1.326 -2.836	1.063 1.053 0.931	1.138 1.136 0.150	1.044 1.053 -0.855	1.302 1.326 -1.817	1.099 1.131 -2.794	0.414 0.437 -5.281		
L				0.475 0.491 -3.220	0.792 0.817 -3.059	1.107 1.086 1.888	1.145 1.124 1.895	1.089 1.086 0.267	0.795 0.817 -2.790	0.477 0.491 -2.792			
M						0.374 0.363 2.835	0.512 0.498 2.852	0.364 0.363 0.083					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

Standard Deviation = 2.27

FIGURE 5.2

Power Distribution for Flux Map 2502

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.391 0.386 1.061	0.531 0.532 -0.338	0.380 0.386 -1.656					
B				0.461 0.495 -7.045	0.830 0.822 1.059	1.114 1.102 1.062	1.165 1.166 -0.060	1.104 1.102 0.136	0.823 0.822 0.183	0.491 0.495 -0.969			
C			0.408 0.439 -7.044	1.057 1.098 -3.770	1.296 1.292 0.333	1.094 1.081 1.230	1.253 1.235 1.474	1.099 1.081 1.619	1.306 1.292 1.107	1.087 1.098 -0.974	0.423 0.439 -3.693		
D		0.465 0.495 -6.200	1.029 1.097 -6.244	1.207 1.252 -3.602	1.203 1.194 0.712	1.078 1.062 1.535	1.392 1.367 1.836	1.080 1.062 1.695	1.202 1.194 0.678	1.244 1.252 -0.679	1.076 1.097 -1.951	0.477 0.495 -3.695	
E		0.777 0.821 -5.407	1.221 1.291 -5.407	1.206 1.194 1.005	1.045 1.031 1.329	1.357 1.334 1.754	1.088 1.075 1.172	1.343 1.334 0.652	1.023 1.031 -0.815	1.192 1.194 -0.134	1.310 1.291 1.441	0.847 0.821 3.081	
F	0.396 0.386 2.695	1.132 1.102 2.695	1.113 1.080 3.037	1.094 1.062 3.051	1.357 1.334 1.739	1.023 1.012 1.038	1.183 1.186 -0.287	1.004 1.012 -0.761	1.327 1.334 -0.510	1.055 1.062 -0.669	1.083 1.080 0.315	1.110 1.102 0.717	0.393 0.386 1.866
G	0.558 0.532 4.851	1.209 1.166 3.696	1.295 1.235 4.834	1.397 1.367 2.165	1.094 1.076 1.626	1.191 1.186 0.422	0.896 0.908 -1.343	1.175 1.186 -0.894	1.068 1.076 -0.753	1.356 1.367 -0.805	1.236 1.235 0.049	1.173 1.166 0.566	0.541 0.532 1.767
H	0.403 0.386 4.353	1.138 1.102 3.258	1.129 1.080 4.556	1.082 1.062 1.911	1.351 1.334 1.259	1.003 1.012 -0.870	1.174 1.186 -1.003	1.006 1.012 -0.603	1.327 1.334 -0.555	1.060 1.062 -0.188	1.077 1.080 -0.278	1.103 1.102 0.109	0.388 0.386 0.648
I		0.817 0.821 -0.463	1.292 1.291 0.085	1.195 1.194 0.092	1.026 1.031 -0.514	1.327 1.334 -0.517	1.066 1.075 -0.856	1.322 1.334 -0.877	1.022 1.031 -0.873	1.201 1.194 0.603	1.273 1.291 -1.371	0.804 0.821 -2.094	
J		0.508 0.495 2.645	1.126 1.097 2.653	1.285 1.252 2.652	1.226 1.194 2.647	1.059 1.062 -0.330	1.360 1.367 -0.490	1.057 1.062 -0.508	1.184 1.194 -0.804	1.273 1.252 1.701	1.074 1.097 -2.097	0.483 0.495 -2.423	
K			0.430 0.439 -2.006	1.078 1.098 -1.849	1.266 1.292 -2.020	1.079 1.081 -0.148	1.229 1.235 -0.453	1.069 1.081 -1.082	1.271 1.292 -1.594	1.072 1.098 -2.332	0.413 0.439 -5.858		
L				0.483 0.495 -2.422	0.803 0.822 -2.252	1.103 1.102 0.109	1.167 1.166 0.103	1.094 1.102 -0.735	0.802 0.822 -2.337	0.484 0.495 -2.342			
M						0.388 0.386 0.362	0.534 0.532 0.357	0.383 0.386 -0.958					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

Standard Deviation = 2.31

FIGURE 5.3

Power Distribution for Flux Map 2503

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.401	0.541	0.385					
						0.393	0.542	0.393					
						1.830	-0.203	-2.110					
B				0.463	0.838	1.124	1.173	1.105	0.824	0.493			
				0.497	0.822	1.104	1.173	1.104	0.822	0.497			
				-6.821	1.836	1.830	0.034	0.109	0.182	-0.825			
C			0.409	1.049	1.292	1.110	1.293	1.111	1.297	1.078	0.423		
			0.439	1.087	1.280	1.091	1.270	1.091	1.280	1.087	0.439		
			-6.827	-3.459	0.906	1.760	1.835	1.879	1.320	-0.810	-3.823		
D		0.468	1.023	1.199	1.200	1.085	1.395	1.086	1.199	1.234	1.066	0.478	
		0.497	1.086	1.240	1.188	1.065	1.367	1.065	1.188	1.240	1.086	0.497	
		-5.776	-5.820	-3.283	1.052	1.897	2.056	1.972	0.926	-0.460	-1.851	-3.824	
E		0.783	1.218	1.202	1.045	1.349	1.090	1.334	1.022	1.190	1.300	0.848	
		0.822	1.279	1.188	1.029	1.323	1.075	1.323	1.029	1.188	1.279	0.822	
		-4.780	-4.778	1.162	1.526	1.996	1.405	0.847	-0.641	0.202	1.619	3.090	
F	0.406	1.139	1.128	1.098	1.349	1.024	1.181	1.005	1.319	1.067	1.102	1.119	0.401
	0.393	1.103	1.090	1.065	1.323	1.011	1.181	1.011	1.323	1.065	1.090	1.103	0.393
	3.259	3.282	3.487	3.089	1.973	1.316	0.008	-0.633	-0.302	0.178	1.073	1.496	2.138
G	0.567	1.216	1.335	1.397	1.095	1.191	0.901	1.173	1.069	1.368	1.281	1.189	0.553
	0.541	1.173	1.270	1.367	1.075	1.182	0.911	1.182	1.075	1.367	1.270	1.173	0.541
	4.636	3.632	5.103	2.224	1.870	0.736	-1.076	-0.753	-0.558	0.044	0.866	1.390	2.050
H	0.409	1.138	1.143	1.087	1.345	1.008	1.174	1.008	1.319	1.073	1.100	1.118	0.398
	0.393	1.103	1.090	1.065	1.323	1.011	1.181	1.011	1.323	1.065	1.090	1.103	0.393
	4.073	3.155	4.826	2.047	1.671	-0.267	-0.559	-0.277	-0.295	0.770	0.945	1.405	1.197
I		0.815	1.281	1.190	1.029	1.323	1.071	1.318	1.024	1.205	1.272	0.813	
		0.822	1.279	1.188	1.029	1.323	1.075	1.323	1.029	1.188	1.279	0.822	
		-0.876	0.195	0.194	0.029	0.030	-0.381	-0.408	-0.476	1.473	-0.571	-1.107	
J		0.498	1.088	1.153	1.189	1.066	1.367	1.065	1.187	1.279	1.074	0.490	
		0.497	1.086	1.240	1.188	1.065	1.367	1.065	1.188	1.240	1.086	0.497	
		0.181	0.193	-7.001	0.084	0.056	0.000	0.000	-0.109	3.121	-1.105	-1.469	
K			0.409	1.011	1.190	1.092	1.270	1.080	1.259	1.054	0.416		
			0.439	1.087	1.280	1.091	1.270	1.091	1.280	1.087	0.439		
			-7.010	-7.002	-7.001	0.083	-0.008	-0.999	-1.633	-3.064	-5.303		
L				0.462	0.765	1.108	1.177	1.095	0.797	0.482			
				0.497	0.822	1.104	1.173	1.104	0.822	0.497			
				-7.002	-7.004	0.335	0.333	-0.842	-3.064	-3.078			
M						0.396	0.545	0.389					
						0.393	0.542	0.393					
						0.585	0.572	-1.220					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

Standard Deviation = 2.73

FIGURE 5.4

Power Distribution for Flux Map 2504

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.405 0.398 1.809	0.544 0.547 -0.566	0.387 0.398 -2.814					
B				0.467 0.500 -6.617	0.839 0.824 1.821	1.122 1.102 1.824	1.166 1.172 -0.495	1.098 1.102 -0.399	0.821 0.824 -0.304	0.496 0.500 -0.940			
C			0.413 0.442 -6.624	1.042 1.082 -3.733	1.279 1.272 0.495	1.108 1.092 1.410	1.289 1.271 1.432	1.108 1.092 1.493	1.284 1.272 0.943	1.072 1.082 -0.933	0.424 0.442 -4.160		
D		0.471 0.500 -5.899	1.018 1.082 -5.914	1.193 1.237 -3.597	1.199 1.187 0.994	1.086 1.066 1.820	1.387 1.360 1.934	1.083 1.066 1.595	1.191 1.187 0.345	1.226 1.237 -0.873	1.055 1.082 -2.477	0.479 0.500 -4.159	
E		0.781 0.823 -5.186	1.206 1.272 -5.196	1.198 1.187 0.901	1.048 1.031 1.629	1.345 1.318 2.041	1.093 1.077 1.476	1.325 1.318 0.546	1.018 1.031 -1.280	1.178 1.187 -0.741	1.285 1.272 0.975	0.846 0.823 2.769	
F	0.409 0.397 2.969	1.134 1.101 2.988	1.127 1.091 3.254	1.100 1.066 3.180	1.346 1.318 2.101	1.030 1.015 1.507	1.186 1.186 0.000	1.003 1.015 -1.172	1.305 1.318 -0.994	1.061 1.066 -0.469	1.098 1.091 0.605	1.114 1.101 1.126	0.404 0.397 1.661
G	0.570 0.547 4.132	1.207 1.171 3.091	1.332 1.271 4.791	1.388 1.360 2.073	1.096 1.077 1.764	1.193 1.186 0.582	0.906 0.920 -1.533	1.171 1.186 -1.307	1.063 1.077 -1.309	1.350 1.360 -0.735	1.275 1.271 0.267	1.183 1.171 1.016	0.556 0.547 1.590
H	0.411 0.397 3.523	1.130 1.101 2.597	1.140 1.091 4.491	1.084 1.066 1.679	1.336 1.318 1.365	1.004 1.015 -1.123	1.171 1.186 -1.324	1.004 1.015 -1.113	1.302 1.318 -1.199	1.070 1.066 0.347	1.099 1.091 0.697	1.117 1.101 1.399	0.400 0.397 0.579
I		0.810 0.823 -1.627	1.267 1.272 -0.448	1.182 1.187 -0.455	1.019 1.031 -1.203	1.302 1.318 -1.206	1.064 1.077 -1.179	1.303 1.318 -1.191	1.018 1.031 -1.290	1.201 1.187 1.179	1.261 1.272 -0.849	0.816 0.823 -0.947	
J		0.517 0.500 3.319	1.118 1.082 3.327	1.278 1.237 3.322	1.227 1.187 3.319	1.056 1.066 -0.929	1.349 1.360 -0.845	1.057 1.066 -0.835	1.179 1.187 -0.674	1.285 1.237 3.872	1.072 1.082 -0.952	0.493 0.500 -1.360	
K			0.434 0.442 -1.809	1.065 1.082 -1.626	1.249 1.272 -1.816	1.085 1.092 -0.659	1.263 1.271 -0.669	1.077 1.092 -1.346	1.250 1.272 -1.761	1.052 1.082 -2.772	0.417 0.442 -5.743		
L				0.489 0.500 -2.279	0.807 0.824 -2.076	1.101 1.102 -0.127	1.171 1.172 -0.128	1.091 1.102 -1.043	0.801 0.824 -2.780	0.486 0.500 -2.779			
M						0.400 0.398 0.402	0.550 0.547 0.402	0.393 0.398 -1.156					

Legend (each cell):
MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

Standard Deviation = 2.36

FIGURE 5.5

Power Distribution for Flux Map 2505

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.406 0.398 1.935	0.544 0.547 -0.621	0.386 0.398 -3.015					
B				0.463 0.500 -7.420	0.840 0.824 1.943	1.123 1.102 1.933	1.169 1.172 -0.282	1.099 1.102 -0.318	0.822 0.824 -0.243	0.496 0.500 -0.760			
C			0.409 0.442 -7.419	1.041 1.082 -3.808	1.284 1.272 0.920	1.113 1.093 1.802	1.298 1.274 1.852	1.113 1.093 1.784	1.286 1.272 1.132	1.074 1.082 -0.767	0.427 0.442 -3.529		
D		0.468 0.500 -6.381	1.012 1.082 -6.433	1.192 1.237 -3.622	1.200 1.187 1.104	1.087 1.066 1.979	1.390 1.361 2.116	1.086 1.066 1.876	1.200 1.187 1.095	1.228 1.237 -0.760	1.044 1.082 -3.521	0.482 0.500 -3.521	
E		0.779 0.823 -5.394	1.203 1.272 -5.393	1.204 1.187 1.398	1.049 1.031 1.756	1.346 1.317 2.202	1.091 1.077 1.328	1.325 1.317 0.615	1.009 1.031 -2.095	1.229 1.187 3.505	1.317 1.272 3.506	0.852 0.823 3.499	
F	0.409 0.397 2.894	1.133 1.101 2.916	1.128 1.092 3.315	1.104 1.067 3.477	1.345 1.317 2.141	1.030 1.015 1.438	1.183 1.186 -0.236	1.002 1.015 -1.291	1.301 1.317 -1.215	1.061 1.067 -0.572	1.107 1.092 1.355	1.113 1.101 1.108	0.405 0.397 1.837
G	0.572 0.547 4.644	1.211 1.172 3.294	1.334 1.273 4.800	1.391 1.361 2.168	1.099 1.077 1.996	1.195 1.186 0.767	0.907 0.920 -1.435	1.171 1.186 -1.239	1.064 1.077 -1.244	1.349 1.361 -0.860	1.277 1.273 0.346	1.183 1.172 0.964	0.556 0.547 1.700
H	0.414 0.397 4.076	1.132 1.101 2.807	1.141 1.092 4.478	1.085 1.067 1.649	1.338 1.317 1.579	1.002 1.015 -1.320	1.170 1.186 -1.315	1.004 1.015 -1.123	1.304 1.317 -1.025	1.068 1.067 0.094	1.096 1.092 0.339	1.111 1.101 0.872	0.398 0.397 0.176
I		0.812 0.823 -1.348	1.262 1.272 -0.825	1.177 1.187 -0.826	1.014 1.031 -1.697	1.295 1.317 -1.701	1.061 1.077 -1.476	1.298 1.317 -1.458	1.017 1.031 -1.377	1.198 1.187 0.910	1.260 1.272 -0.983	0.814 0.823 -1.154	
J		0.515 0.500 3.001	1.114 1.082 2.994	1.274 1.237 2.999	1.223 1.187 2.999	1.056 1.066 -0.910	1.346 1.361 -1.073	1.054 1.066 -1.098	1.170 1.187 -1.398	1.277 1.237 3.234	1.070 1.082 -1.155	0.492 0.500 -1.520	
K			0.434 0.442 -1.787	1.064 1.082 -1.627	1.249 1.272 -1.800	1.092 1.093 -0.128	1.265 1.274 -0.706	1.072 1.093 -1.940	1.235 1.272 -2.940	1.035 1.082 -4.390	0.418 0.442 -5.519		
L				0.489 0.500 -2.220	0.807 0.824 -2.040	1.104 1.102 0.191	1.174 1.172 0.196	1.087 1.102 -1.397	0.787 0.824 -4.384	0.478 0.500 -4.380			
M						0.400 0.398 0.503	0.550 0.547 0.512	0.391 0.398 -1.884					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

Standard Deviation = 2.58

FIGURE 5.6

Power Distribution for Flux Map 2506

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.407 0.401 1.547	0.548 0.551 -0.490	0.391 0.401 -2.421					
B				0.470 0.501 -6.074	0.836 0.824 1.529	1.121 1.104 1.531	1.170 1.176 -0.485	1.101 1.104 -0.308	0.822 0.824 -0.231	0.497 0.501 -0.619			
C			0.416 0.443 -6.079	1.044 1.079 -3.262	1.277 1.269 0.583	1.113 1.097 1.404	1.310 1.293 1.276	1.113 1.097 1.413	1.280 1.269 0.890	1.072 1.079 -0.630	0.427 0.443 -3.480		
D		0.473 0.500 -5.536	1.019 1.079 -5.569	1.195 1.233 -3.114	1.192 1.183 0.778	1.083 1.066 1.576	1.382 1.361 1.550	1.082 1.066 1.510	1.189 1.183 0.524	1.228 1.233 -0.446	1.059 1.079 -1.835	0.483 0.500 -3.477	
E		0.782 0.824 -5.039	1.204 1.268 -5.031	1.193 1.183 0.854	1.041 1.028 1.255	1.334 1.311 1.708	1.086 1.074 1.127	1.318 1.311 0.526	1.019 1.028 -0.914	1.182 1.183 -0.101	1.285 1.268 1.333	0.847 0.824 2.829	
F	0.411 0.400 2.824	1.134 1.103 2.828	1.130 1.097 3.035	1.095 1.066 2.739	1.333 1.312 1.585	1.021 1.012 0.919	1.179 1.183 -0.363	0.999 1.012 -1.334	1.300 1.312 -0.899	1.059 1.066 -0.657	1.103 1.097 0.556	1.113 1.103 0.925	0.407 0.400 1.750
G	0.574 0.550 4.324	1.214 1.175 3.327	1.354 1.293 4.679	1.387 1.361 1.932	1.089 1.074 1.387	1.186 1.183 0.211	0.904 0.918 -1.525	1.167 1.183 -1.361	1.060 1.074 -1.350	1.346 1.361 -1.109	1.294 1.293 0.031	1.185 1.175 0.800	0.560 0.550 1.672
H	0.415 0.400 3.774	1.135 1.103 2.865	1.146 1.097 4.412	1.085 1.066 1.735	1.326 1.312 1.082	1.001 1.012 -1.087	1.169 1.183 -1.226	1.001 1.012 -1.087	1.296 1.312 -1.250	1.063 1.066 -0.319	1.096 1.097 -0.082	1.110 1.103 0.616	0.403 0.400 0.675
I		0.815 0.824 -0.996	1.268 1.268 0.008	1.183 1.183 0.008	1.019 1.028 -0.875	1.300 1.311 -0.869	1.064 1.074 -0.978	1.298 1.311 -0.976	1.016 1.028 -1.177	1.188 1.183 0.423	1.252 1.268 -1.285	0.811 0.824 -1.554	
J		0.519 0.500 3.617	1.118 1.079 3.596	1.278 1.233 3.601	1.226 1.183 3.601	1.058 1.066 -0.750	1.352 1.361 -0.691	1.059 1.066 -0.685	1.176 1.183 -0.566	1.261 1.233 2.263	1.062 1.079 -1.548	0.491 0.500 -1.859	
K			0.436 0.443 -1.559	1.064 1.079 -1.381	1.249 1.269 -1.568	1.090 1.097 -0.638	1.285 1.293 -0.603	1.084 1.097 -1.167	1.250 1.269 -1.489	1.054 1.079 -2.345	0.419 0.443 -5.333		
L				0.490 0.501 -2.018	0.809 0.824 -1.833	1.103 1.104 -0.118	1.175 1.176 -0.119	1.094 1.104 -0.897	0.804 0.824 -2.355	0.489 0.501 -2.338			
M						0.402 0.401 0.399	0.553 0.551 0.399	0.397 0.401 -0.948					

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

Standard Deviation = 2.20

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 converter alignment is checked.

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

The calibration was performed satisfactorily during the Cycle 25 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 (4) during the Cycle 25 startup. 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 25," November 2001.

(2) "Qualification of Reactor Physics Methods for Application to Kewaunee," October 1978 (submitted) and October 1979 (approved).

(3) "Reload Safety Evaluation Methods for Application to Kewaunee", WPSRSEM-NP-A, Revision 3, October 2000 (submitted) and September 2001 (approved).

(4) "Reactor Test Program, Kewaunee Nuclear Power Plant," (Revision 7, November 19, 2001).

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