KEWAUNEE NUCLEAR POWER PLANT

CYCLE 10
STARTUP REPORT
JUNE, 1984

WISCONSIN PUBLIC SERVICE CORPORATION

WISCONSIN POWER & LIGHT COMPANY

MADISON GAS & ELECTRIC COMPANY

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KEWAUNEE NUCLEAR POWER PLANT

CYCLE 10

STARTUP REPORT

JUNE 1984

Wisconsin Public
Service Corporation
Green Bay, Wisconsin
Date 6/18/84

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1.0 INTRODUCTION, SUMMARY, AND CONCLUSION

1.1 Introduction

This report presents the results of the physics tests performed for Kewaunee Cycle 10. 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 9-10 refueling, 36 of the 121 fuel assemblies in the core were replaced with fresh assemblies of Exxon Design(5), enriched to 3.2 w/o U235. The Cycle 10 core consists of the following regions of fuel:

Region	Vendor	Initial U235 W/O	Number of Previous Duty Cycles	Number of Assemblies
1	W	2.2	1	1
7	ENC	3.2	3	12
8	ENC	3.2	2	8
9	ENC	3.2	2	8
10	ENC	3.2	2	20
11	ENC	3.4	1	36
12	ENC	3.2	0	36(Feed)

The core loading pattern, assembly identification, RCCA bank identification, instrument thimble I.D., thermo-couple I.D., and burnable poison rod configurations for Cycle 10 are presented in Figure 1.1.

On May 5, 1984 at 2121 hours, initial criticality was achieved on the Cycle 10 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 boration/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 100% 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 10.

1.3 Conclusion

The startup testing of Kewaunee's Cycle 10 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 (1).

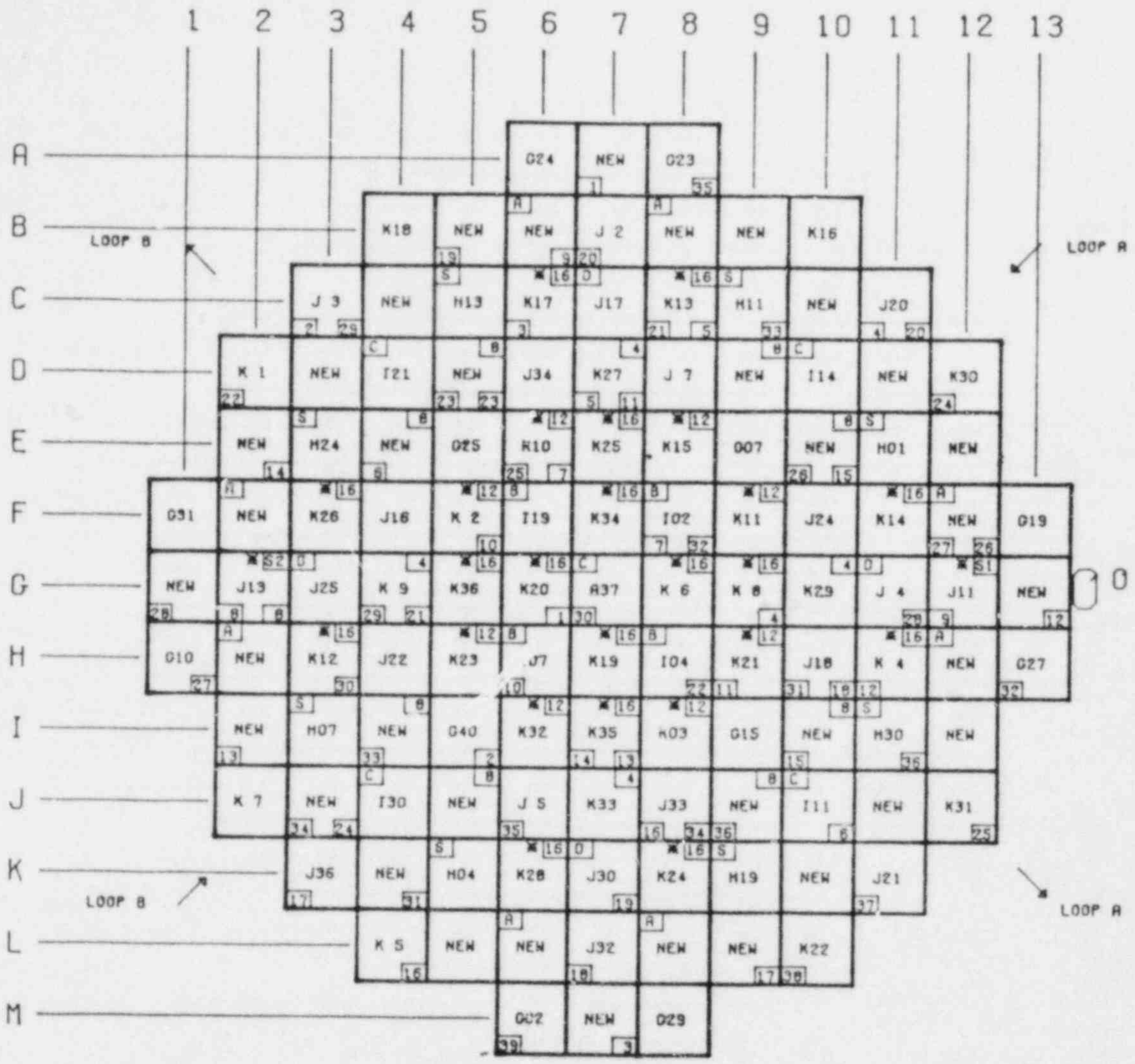
TABLE 1.1

KEWAUNEE NUCLEAR POWER PLANT

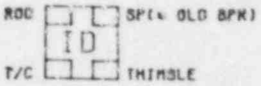
BOL CYCLE 10 PHYSICS TEST

Test	Date Completed	Time Completed	Plant Conditions
Control Rod Operability Test	5/01/84	1350	Cold SD
Hot Rod Drops	5/03/84	1530	HZP
RPI Calibrations	5/05/84	1821	HZP
Initial Criticality	5/05/84	2121	HZP
Reactivity Computer Checkout	5/05/84	2210	HZP
ARO Endpoint	5/06/84	0115	HZP
Bank C Worth (Dilution)	5/06/84	0140	HZP
Bank C In-ORO Endpoint	5/06/84	1000	HZP
Bank C Worth (Boration)	5/06/84	1000	HZP
ITC Determination	5/06/84	1112	HZP
Power Ascension Flux Map 1001	5/07/84	1914	22%
Power Ascension Flux Map 1002	5/09/84	1148	44%
Incore/Excore Calibration Flux Map 1003	5/12/84	0914	71.5%
Incore/Excore Calibration Flux Map 1004	5/12/84	1116	71.8%
Incore/Excore Calibration Flux Map 1005	5/12/84	1313	71.9%
Incore/Excore Calibration Flux Map 1006	5/12/84	1508	72.7%
Incore/Excore Calibration Flux Map 1007	5/12/84	1645	72.3%
Power Ascension Flux Map 1008	5/14/84	1428	90%
Power Ascension Flux Map 1009	5/16/84	1610	100%

FIGURE 1.1



	1	2	3	4	5	6	7	8	9	10	11	12	13
A						G24	NEW	G23					
B				K18	NEW	NEW	J 2	NEW	NEW	K16			
C			J 3	NEW	H13	K17	J17	K13	H11	NEW	J20		
D		K 1	NEW	I21	NEW	J34	K27	J 7	NEW	I14	NEW	K30	
E		NEW	H24	NEW	G25	K10	K25	K15	G07	NEW	H01	NEW	
F	G31	NEW	K26	J16	K 2	I19	K34	I02	K11	J24	K14	NEW	G19
G	NEW	J13	J25	K 9	K36	K20	A37	K 6	K 8	K29	J 4	J11	NEW
H	G10	NEW	K12	J22	K23	J7	K19	I04	K21	J18	K 4	NEW	G27
I		NEW	H07	NEW	G40	K32	K35	H03	G15	NEW	H30	NEW	
J		K 7	NEW	I30	NEW	J 5	K33	J33	NEW	I11	NEW	K31	
K			J36	NEW	H04	K28	J30	K24	H19	NEW	J21		
L				K 5	NEW	NEW	J32	NEW	NEW	K22			
M						G02	NEW	G29					



2.0 RCCA MEASUREMENTS

2.1 RCCA Drop Time Measurements

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

2.2 RCCA Bank Measurements

During Cycle 10 startup the reactivity of the reference bank (Bank C) was measured using the boration/dilution technique and 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 measured worth of the reference bank, Bank C, differed from the WPS predicted Bank C worth by -43 pcm or -4.6%, which is within the 10% review criterion. Integral and differential worth plots comparing measured to predicted reference bank worth are presented in Figures 2.1 and 2.2, respectively.

As is typical with the Kewaunee "Low Leakage" reload core configurations, Bank C and Bank A are calculated to have comparable reactivity worths. The rod swap measurements indicated that Bank A had slightly more worth than Bank C. The additional worth was measured with the reactivity computer. Rod swap results are presented in Table 2.2.

Review criteria were adequately met for all individual rod bank worths. Since the measured to predicted comparison for total rod worth was -.05%, which is within the 10% acceptance criterion, no further rod worth measurements or calculations were performed.

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% margin is allowed in the calculation of rod worth in these shutdown margin analyses. Since the measured rod worths resulted in less than a 10% difference from predicted values, the analysis in Table 2.3 is conservative and no additional evaluations were required.

TABLE 2.1

KEWAUNEE CYCLE 10

RCCA DROP TIME MEASUREMENTS

HOT ZERO POWER

	All Fuel	Westinghouse Fuel	Exxon Fuel
Average Dashpot Delta T (Sec)	1.279	1.352	1.277
Standard Deviation	0.033	0.000	0.031
Average Rod Bottom Delta T (Sec)	1.806	1.792	1.807
Standard Deviation	0.028	0.000	0.029

TABLE 2.2

KEWAUNEE CYCLE 10

RCCA BANK WORTH SUMMARY

Rod Swap Method RCCA Bank	Measured Worth (PCM)	WPS Predicted Worth (PCM)	Difference (PCM)	Percent Difference
D	741.3	756.0	-14.7	-1.9
C*	899.3	942.0	-42.7	-4.5
B	784.0	725.0	59.0	8.1
A	977.5	940.0	37.5	4.0
SA	560.2	580.0	-19.8	-3.4
SB	558.3	580.0	-21.7	-3.7
Total	4520.6	4523.0	-2.4	-.05

* Reference bank measured by boron dilution.

FIG. 2.1

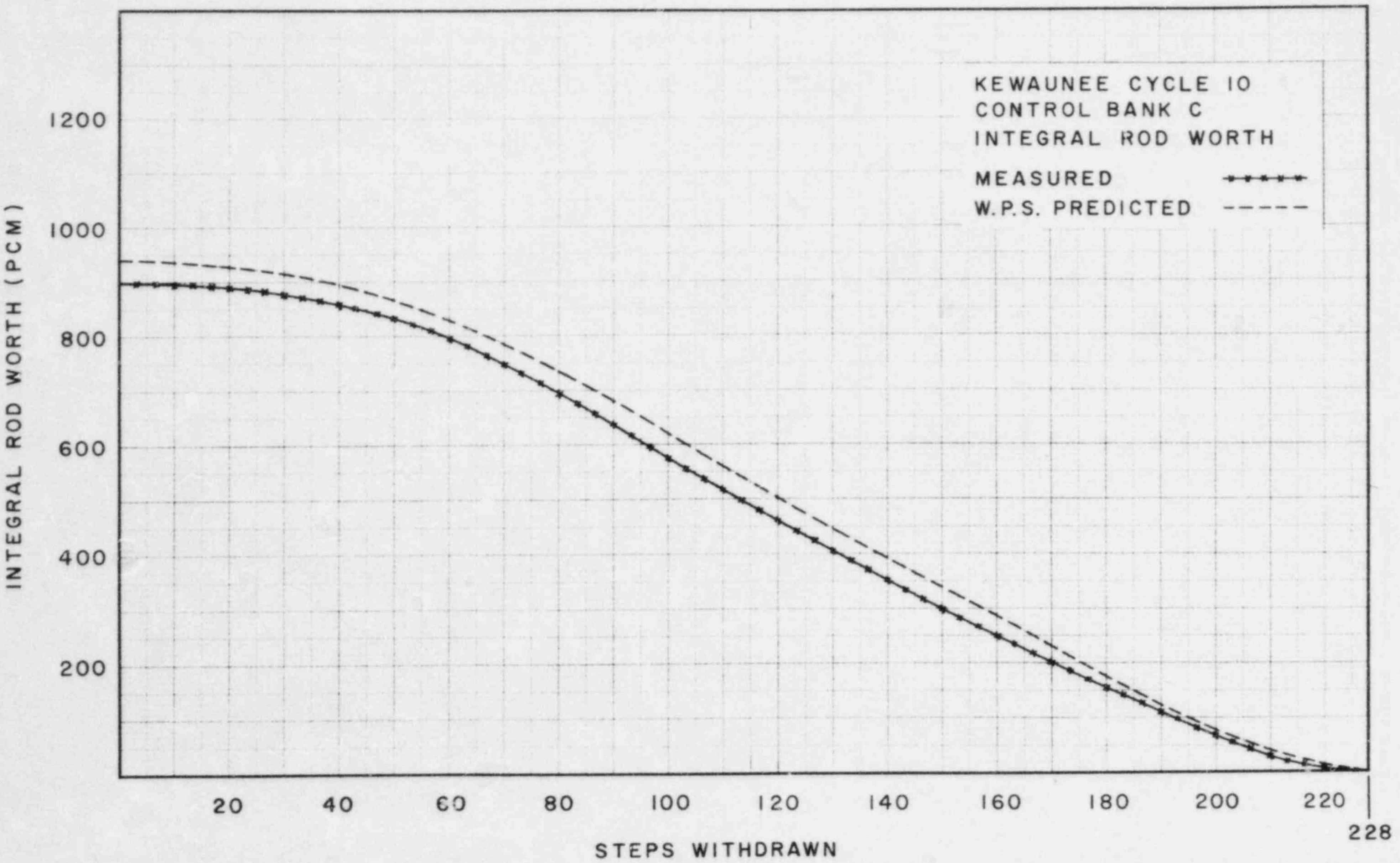

KEWAUNEE CYCLE 10
CONTROL BANK C
INTEGRAL ROD WORTH
MEASURED
W.P.S. PREDICTED
INTEGRAL ROD WORTH (PCM)
1200
1000
800
600
400
200
20
40
60
80
100
120
140
160
180
200
220
228
STEPS WITHDRAWN

FIG. 2.2

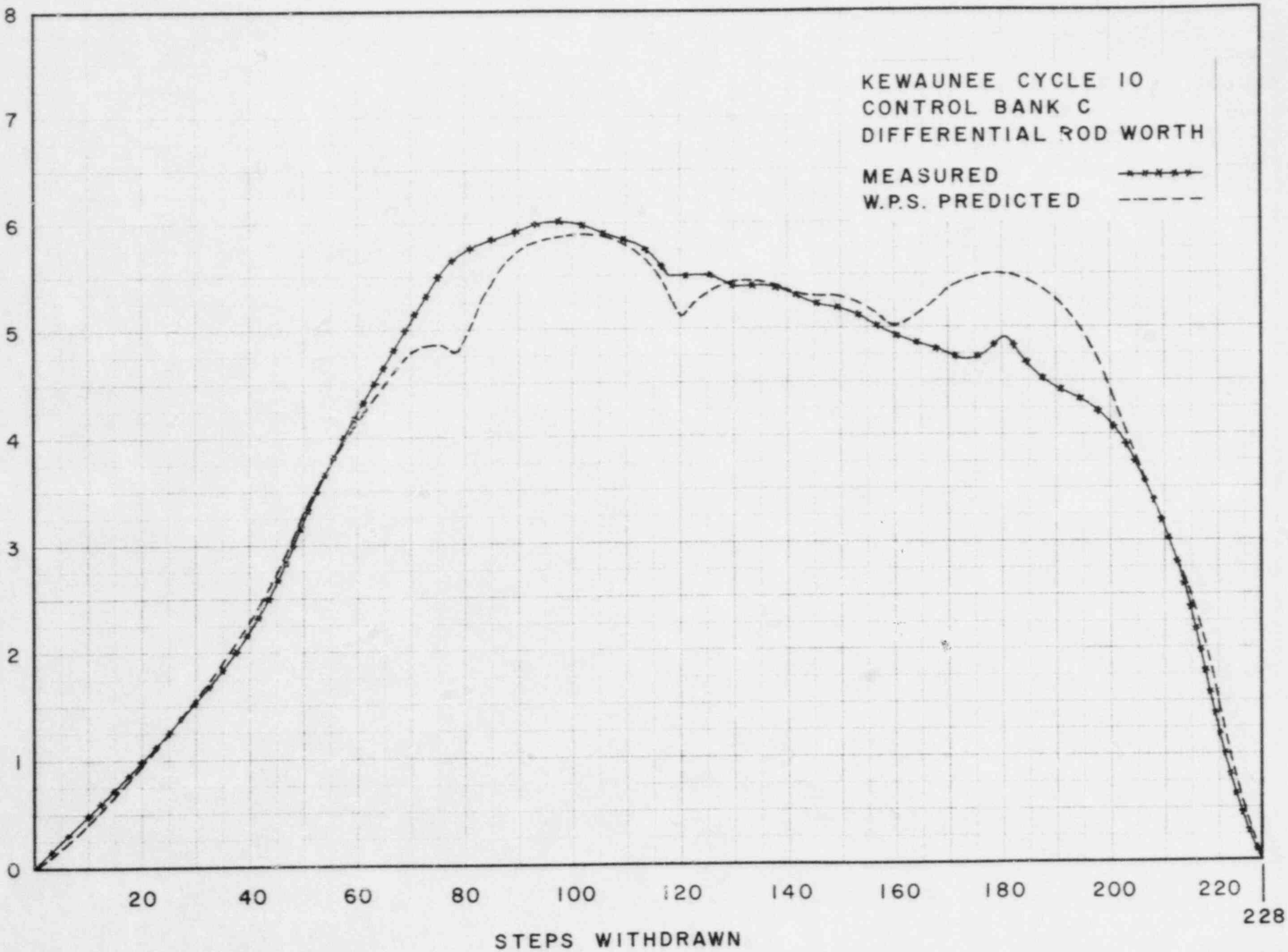

KEWAUNEE CYCLE 10
CONTROL BANK C
DIFFERENTIAL ROD WORTH
MEASURED
W.P.S. PREDICTED
DIFFERENTIAL ROD WORTH (PCM/STEP)
0
1
2
3
4
5
6
7
8
20
40
60
80
100
120
140
160
180
200
220
228
STEPS WITHDRAWN

TABLE 2.3

KEWAUNEE CYCLE 10

MINIMUM SHUTDOWN MARGIN ANALYSIS

	BOC	EOC
RCCA Bank Worths (PCM)		
N	5988	6504
N-1	5248	5724
Less 10 Percent	525	572
Sub Total	4723	5152
Total Requirements (Including Uncertainties)	2103	3090
Shutdown Margin	2620	2062
Required Shutdown Margin	1000	2000

3.0 BORON ENDPOINTS AND BORON WORTH MEASUREMENTS

3.1 Boron Endpoints

During rod movements to measure control rod worth and differential boron worth, the dilution was stopped near the fully inserted position of control Bank C to obtain a boron endpoint measurement. The boron concentration was allowed to stabilize and the just critical boron concentration was determined for the configuration desired.

Table 3.1 lists the measured and WPS predicted boron endpoints for the RCCA bank configurations shown. The results indicate a -9 PPM difference for both the ARO and "Bank C In" core configurations. 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 was calculated by dividing the worth of control Bank C by the difference in boron endpoint measurement 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. The results show good agreement. No acceptance criteria are applied to these comparisons.

3.3 Boron Letdown

The measured boron concentration data for the first few days 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 10

RCCA BANK ENDPOINT MEASUREMENTS

RCCA Bank Configuration	Measured Endpoint(PPM)	WPS Predicted Endpoint(PPM)	Difference (PPM)
All Rods Out	1308	1317	-9
Bank C In	1197	1206	-9

TABLE 3.2

KEWAUNEE CYCLE 10

DIFFERENTIAL BORON WORTH

RCCA Bank Configuration	CB Change Measured (PPM)	CB Change Predicted (PPM)	Percent Difference
ARO to C Bank In	111	111	0.0

RCCA Bank Configuration	Measured Boron Worth (PCM/PPM)	Predicted Boron Worth (PCM/PPM)	Percent Difference
ARO/C Bank In	-8.1	-8.5	-4.7

5-15-84 THROUGH 6-05-84

DEPLETION OF CHEM. SHIM
CYCLE 10
KEWAUNEE NUCLEAR POWER PLANT

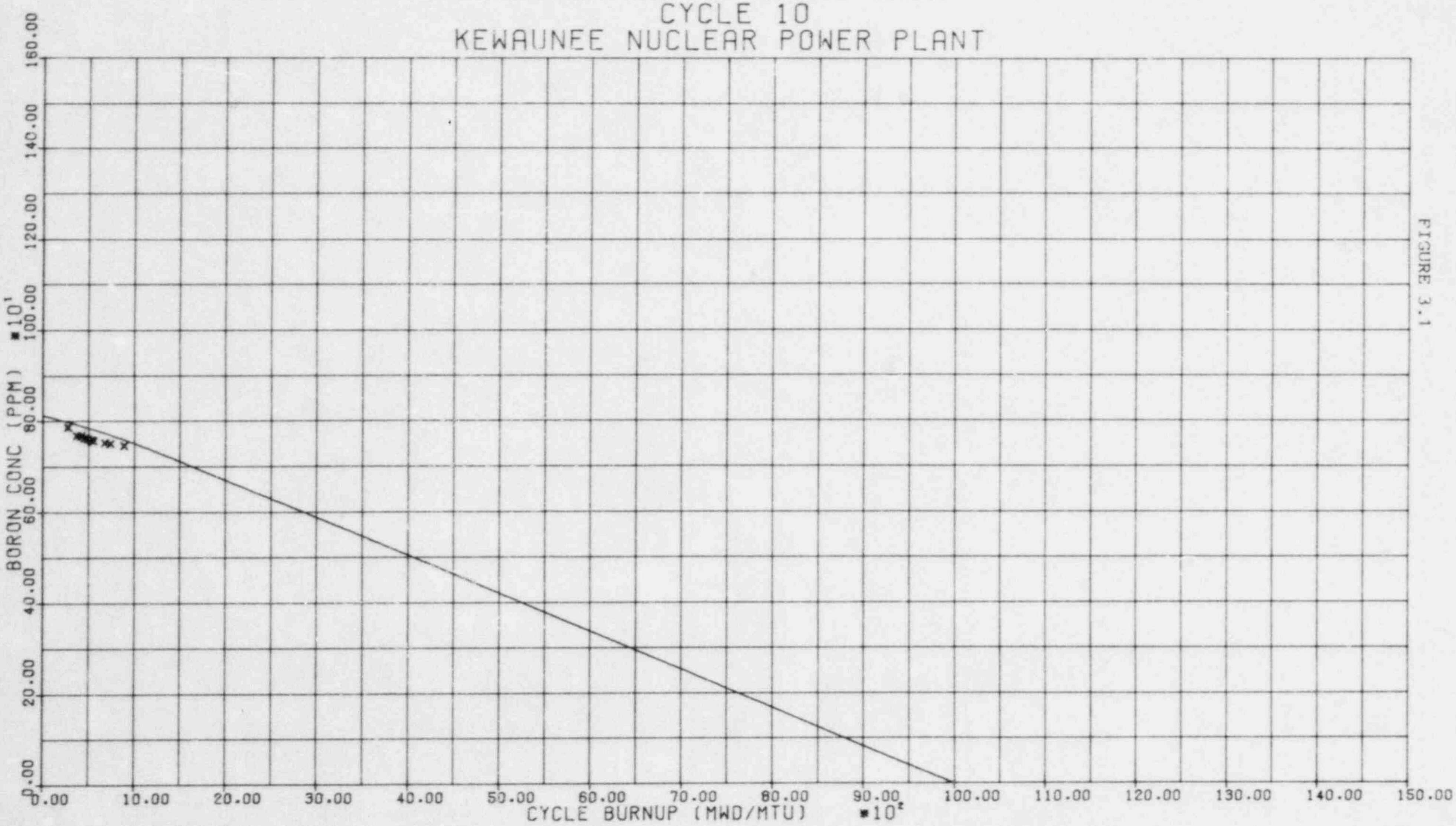


FIGURE 3.1

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 in, all other RCCA banks full out, with a boron concentration of 1300 PPM for the cooldown and 1302 PPM for the heatup. These conditions approximate the HZP, all rods out core condition which yields the least 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/Degrees F was met.

TABLE 4.1

KEWAUNEE CYCLE 10

ISOTHERMAL TEMPERATURE COEFFICIENT

Cooldown

Tave Start	546.0 Degrees F
Tave End	540.0 Degrees F
Bank D	205 Steps
Boron Concentration	1302 PPM

Measured ITC (PCM/Deg F)	WPS Predicted ITC (PCM/Deg F)	Difference (PCM/Deg F)
-4.6	-5.9	+1.3

Heat Up

Tave Start	541.0 Degrees F
Tave End	545.5 Degrees F
Bank D	205 Steps
Boron Concentration	1300 PPM

Measured ITC (PCM/Deg F)	WPS Predicted ITC (PCM/Deg F)	Difference (PCM/Deg F)
-3.6	-5.9	+2.3

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 FQN and FDHN which are limited by technical specifications. These parameters are defined as the acceptance criteria on a flux map (except for low power) (4).

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

The review criteria for the INCORE calculated quadrant power are that the quadrant tilt is less than 4% at low power physics test conditions and less than 2% 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 10. No hot zero power flux map was taken due to flux mapping equipment difficulties.

Table 5.2 identifies flux map peak FDHN and minimum margin FQN. This table addresses acceptance criteria by verifying that technical specifications limits are not exceeded. The Cycle 10 flux maps met all acceptance criteria.

Table 5.3 addresses the established review criteria for the flux maps. All review criteria were met for all the Cycle 10 flux maps.

The graphic displays of power distributions measured for representative flux maps are exhibited in Figures 5.1 through 5.4.

TABLE 5.1

FLUX MAP CHRONOLOGY AND REACTOR CHARACTERISTICS

Map	Date-Time	Percent Power	Xenon	Boron PPM	D Rods Steps	Exposure MWD/MTU
1001	5/07/84-1835	25	0	1231	202	0
1002	5/09/84-0945	44	EQ.	1098	189	0
1003	5/12/84-0815	72	EQ.	881	228	71
1004	5/12/84-1019	72	EQ.	881	207	73
1005	5/12/84-1221	72	EQ.	881	197	75
1006	5/12/84-1420	73	EQ.	881	191	77
1007	5/12/84-1552	72	EQ.	881	174	78
1008	5/14/84-1322	90	EQ.	845	209	109
1009	5/16/84-1516	100	EQ.	792	228	207

TABLE 5.2

VERIFICATION OF ACCEPTANCE CRITERIA

Flux Map	Core Location	FQN	Limit
1001	H-12 DJ,19	2.53	4.28
1002	H-12 DJ,23	2.34	4.31
1003	F-12 DE,21	2.11	2.99
1004	F-12 DE,25	2.13	3.01
1005	B-6 EK,33	2.16	3.07
1006	L-6 ED,35	2.21	3.04
1007	L-6 ED,36	2.33	3.05
1008	B-6 EK,32	2.11	2.46
1009	B-6 EK,34	2.10	2.21

Flux Map	Core Location	FDHN	Limit
1001	H-12 DJ	1.59	1.78
1002	H-12 DJ	1.60	1.72
1003	F-12 DE	1.50	1.64
1004	E-10 HH	1.51	1.64
1005	E-10 HH	1.51	1.64
1006	E-10 HH	1.51	1.63
1007	E-10 HH	1.51	1.64
1008	B-6 EK	1.50	1.58
1009	B-6 EK	1.51	1.55

FQN and FDHN include appropriate uncertainties and penalties.

Limit on FQN is a function of Core Power, Axial Location, and Fuel Rod Exposure.

Limit on FDHN is a function of Core Power and Assembly Burnup.

TABLE 5.3

VERIFICATION OF REVIEW CRITERIA

Flux Map	(a) Maximum Percent Difference	(b) Standard Deviation	(c) Maximum Quadrant Tilt
1001	7.5	2.4	0.8
1002	8.1	2.7	0.6
1003	1.8	2.0	0.6
1004	1.9	2.1	0.5
1005	1.7	2.1	0.6
1006	1.5	2.1	0.6
1007	1.3	2.1	0.6
1008	1.4	2.1	0.5
1009	2.2	2.1	0.5

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

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

(c) Percent Maximum Quadrant Tilt from normalized calculated quadrant powers. Review criteria is 4% at low power, 2% at equilibrium power.

FIGURE 5.1

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.338 0.341 -1.08	0.593 0.599 -1.08	0.338 0.341 -1.08					
B				0.540 0.541 -0.18	0.366 0.968 -0.19	1.158 1.171 -1.10	0.841 0.851 -1.10	1.158 1.171 -1.10	0.958 0.968 -1.09	0.535 0.541 -0.96			
C			0.480 0.481 -0.19	1.135 1.137 -0.18	0.986 0.988 -0.19	1.129 1.127 0.13	1.046 1.049 -0.32	1.123 1.127 -0.39	0.977 0.988 -1.10	1.126 1.137 -0.97	0.477 0.481 -0.96		
D		0.541 0.541 0.00	1.137 1.137 -0.02	1.021 1.023 -0.19	1.276 1.270 0.43	1.118 1.113 0.48	1.278 1.276 0.19	1.109 1.113 -0.32	1.266 1.270 -0.29	1.021 1.023 -0.21	1.134 1.137 -0.25	0.535 0.541 -0.96	
E		0.968 0.988 -0.02	0.988 0.988 -0.02	1.268 1.270 -0.19	1.055 1.050 0.49	1.295 1.288 0.52	1.316 1.305 0.80	1.294 1.288 0.46	1.055 1.050 0.50	1.277 1.270 0.51	0.993 0.988 0.51	0.973 0.968 0.51	
F	0.341 0.341 0.00	1.170 1.170 -0.02	1.134 1.126 0.73	1.128 1.112 1.46	1.314 1.287 2.06	1.170 1.143 2.36	1.348 1.317 2.36	1.170 1.143 2.33	1.306 1.287 1.45	1.128 1.112 1.39	1.132 1.126 0.51	1.244 1.170 6.33	0.363 0.341 6.33
G	0.599 0.599 0.00	0.863 0.850 1.45	1.064 1.049 1.46	1.295 1.276 1.46	1.338 1.305 2.51	1.364 1.317 3.55	1.109 1.079 2.74	1.345 1.317 2.12	1.333 1.305 2.14	1.306 1.276 2.33	1.116 1.049 6.33	0.904 0.850 6.33	0.637 0.599 6.35
H	0.329 0.341 -3.63	1.127 1.170 -3.64	1.142 1.126 1.46	1.112 1.112 -0.02	1.301 1.287 1.10	1.157 1.143 1.22	1.348 1.317 2.32	1.165 1.143 1.92	1.314 1.287 2.12	1.138 1.112 2.32	1.076 1.126 -4.48	1.244 1.170 6.33	0.363 0.341 6.33
I		0.933 0.968 -3.64	0.952 0.988 -3.64	1.238 1.270 -2.57	1.034 1.050 -1.55	1.288 1.288 0.01	1.328 1.305 1.72	1.310 1.288 1.73	1.036 1.050 -1.30	1.213 1.270 -4.48	0.944 0.988 -4.48	0.925 0.968 -4.48	
J		0.521 0.541 -3.63	1.096 1.137 -3.64	0.996 1.023 -2.62	1.250 1.270 -1.55	1.110 1.113 -0.28	1.281 1.276 0.34	1.117 1.113 0.35	1.213 1.270 -4.48	0.977 1.023 -4.49	1.086 1.137 -4.49	0.516 0.541 -4.48	
K			0.474 0.481 -1.48	1.121 1.137 -1.38	0.996 0.988 0.75	1.118 1.127 -0.85	1.040 1.049 -0.86	1.118 1.127 -0.85	0.944 0.988 -4.48	1.086 1.137 -4.49	0.460 0.481 -4.47		
L				0.545 0.541 0.76	0.975 0.968 0.74	1.159 1.171 -1.01	0.842 0.851 -1.01	1.159 1.171 -1.01	0.957 0.968 -1.17	0.516 0.541 -4.48			
M						0.337 0.341 -1.17	0.592 0.599 -1.15	0.337 0.341 -1.17					

LOOP B

LOOP

LOOP B

LOOP

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

FLUX MAP 1001

δ=2.51

FIGURE 5.2

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.348 0.356 -2.08	0.608 0.621 -2.09	0.352 0.356 -1.07					
B				0.545 0.556 -2.08	0.954 0.975 -2.09	1.143 1.167 -2.09	0.844 0.858 -1.60	1.154 1.167 -1.08	0.964 0.975 -1.08	0.552 0.556 -0.88			
C			0.511 0.498 2.69	1.121 1.145 -2.10	0.975 0.996 -2.09	1.116 1.118 -0.13	1.021 1.025 -0.39	1.121 1.118 0.29	0.985 0.996 -1.08	1.135 1.145 -0.87	0.494 0.498 -0.86		
D		0.571 0.556 2.70	1.176 1.145 2.70	1.040 1.033 0.63	1.272 1.264 0.63	1.122 1.108 1.27	1.265 1.258 0.57	1.113 1.108 0.42	1.267 1.264 0.27	1.037 1.033 0.40	1.149 1.145 0.34	0.552 0.556 -0.88	
E		1.001 0.975 2.70	1.023 0.996 2.70	1.266 1.264 0.19	1.056 1.052 0.41	1.284 1.273 0.90	1.300 1.284 1.27	1.297 1.273 1.91	1.069 1.052 1.61	1.284 1.264 1.61	1.005 0.996 0.84	0.975 0.975 0.05	
F	0.350 0.355 -1.52	1.149 1.167 -1.52	1.103 1.118 -1.31	1.103 1.107 -0.36	1.281 1.273 0.60	1.150 1.137 1.13	1.321 1.300 1.61	1.147 1.137 0.91	1.289 1.273 1.25	1.121 1.107 1.26	1.127 1.118 0.80	1.204 1.167 3.14	0.368 0.355 3.43
G	0.612 0.621 -1.32	0.843 0.858 -1.69	0.990 1.024 -3.29	1.252 1.257 -0.41	1.292 1.284 0.62	1.319 1.300 1.49	1.092 1.078 1.31	1.306 1.300 0.45	1.289 1.284 0.39	1.264 1.257 0.54	1.025 1.024 0.12	0.887 0.858 3.44	0.644 0.621 3.72
H	0.352 0.355 -0.96	1.152 1.167 -1.32	1.081 1.118 -3.30	1.090 1.107 -1.51	1.271 1.273 -0.19	1.142 1.137 0.47	1.314 1.300 1.11	1.143 1.137 0.55	1.278 1.273 0.35	1.113 1.107 0.51	1.120 1.118 0.18	1.246 1.167 6.80	0.380 0.355 6.81
I		0.982 0.975 0.75	0.981 0.996 -1.54	1.241 1.264 -1.84	1.030 1.052 -2.13	1.265 1.273 -0.64	1.290 1.284 0.45	1.278 1.273 0.41	1.037 1.052 -1.43	1.237 1.264 -2.13	0.975 0.996 -2.12	0.932 0.975 -4.41	
J		0.548 0.556 -1.53	1.127 1.145 -1.54	1.014 1.033 -1.82	1.237 1.264 -2.13	1.106 1.108 -0.22	1.267 1.258 0.74	1.116 1.108 0.73	1.208 1.264 -4.41	0.987 1.033 -4.41	1.094 1.145 -4.41	0.532 0.556 -4.40	
K			0.509 0.498 2.13	1.172 1.145 2.31	1.055 0.996 5.93	1.125 1.118 0.63	1.031 1.025 0.62	1.121 1.118 0.25	0.974 0.996 -2.22	1.118 1.145 -2.33	0.476 0.498 -4.42		
L				0.589 0.556 5.93	1.033 0.975 5.93	1.164 1.167 -0.29	0.856 0.858 -0.29	1.164 1.167 -0.24	0.973 0.975 -0.14	0.556 0.556 -0.14			
M						0.351 0.356 -1.21	0.613 0.621 -1.21	0.353 0.356 -0.67					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

FLUX MAP 1002

δ=2.17

FIGURE 5.3

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.370 0.369 0.27	0.649 0.642 1.14	0.376 0.369 1.95					
B				0.545 0.561 -2.87	0.977 0.974 0.28	1.174 1.171 0.27	0.894 0.888 0.68	1.166 1.171 -0.40	0.970 0.974 -0.49	0.554 0.561 -1.23			
C			0.489 0.503 -2.86	1.120 1.134 -1.19	1.004 1.000 0.41	1.131 1.130 0.06	1.088 1.090 -0.19	1.116 1.130 -1.27	0.983 1.000 -1.72	1.120 1.134 -1.23	0.506 0.503 0.62		
D		0.555 0.561 -1.10	1.120 1.134 -1.20	1.017 1.028 -1.11	1.262 1.247 1.19	1.115 1.108 0.60	1.264 1.260 0.31	1.094 1.108 -1.27	1.242 1.247 -0.37	1.028 1.028 -0.02	1.150 1.134 1.43	0.565 0.561 0.62	
E		0.980 0.974 0.55	1.005 1.000 0.55	1.263 1.247 1.28	1.061 1.045 1.50	1.262 1.249 1.01	1.266 1.256 0.76	1.252 1.249 0.20	1.062 1.045 1.66	1.275 1.247 2.27	1.015 1.000 1.50	0.981 0.974 0.69	
F	0.358 0.368 -2.71	1.138 1.170 -2.71	1.110 1.130 -1.77	1.120 1.108 1.06	1.273 1.248 1.98	1.149 1.120 2.62	1.297 1.268 2.25	1.137 1.120 1.47	1.270 1.248 1.75	1.126 1.108 1.62	1.143 1.130 1.15	1.176 1.170 0.52	0.370 0.368 0.49
G	0.632 0.642 -1.51	0.875 0.888 -1.44	1.066 1.089 -2.10	1.266 1.259 0.52	1.281 1.256 2.00	1.306 1.268 3.03	1.085 1.066 1.80	1.283 1.268 1.16	1.275 1.256 1.50	1.280 1.259 1.67	1.102 1.089 1.18	0.892 0.888 0.51	0.645 0.642 0.47
H	0.364 0.368 -1.14	1.156 1.170 -1.16	1.107 1.130 -2.01	1.103 1.108 -0.46	1.260 1.248 0.94	1.135 1.120 1.36	1.290 1.268 1.77	1.133 1.120 1.15	1.269 1.248 1.64	1.[illegible]13 1.108 0.44	1.128 1.130 -0.21	1.159 1.170 -0.92	0.369 0.368 0.27
I		0.979 0.974 0.43	0.992 1.000 -0.79	1.236 1.247 -0.87	1.034 1.045 -1.01	1.250 1.249 0.05	1.269 1.256 1.04	1.262 1.249 1.03	1.047 1.045 0.17	1.227 1.247 -1.63	0.983 1.000 -1.74	0.939 0.974 -3.58	
J		0.555 0.561 -1.12	1.123 1.134 -1.00	1.018 1.028 -1.00	1.235 1.247 -0.94	1.112 1.108 0.32	1.275 1.260 1.17	1.121 1.108 1.19	1.233 1.247 -1.10	0.990 1.028 -3.65	1.093 1.134 -3.64	0.541 0.561 -3.58	
K			0.497 0.503 -1.21	1.120 1.134 -1.21	0.988 1.000 -1.25	1.140 1.130 0.87	1.103 1.090 1.17	1.136 1.130 0.53	0.990 1.000 -1.01	1.108 1.134 -2.31	0.484 0.503 -3.70		
L				0.554 0.561 -1.28	0.962 0.974 -1.27	1.167 1.171 -0.32	0.885 0.888 -0.33	1.165 1.171 -0.51	0.966 0.974 -0.85	0.556 0.561 -0.86			
M						0.363 0.369 -1.52	0.632 0.642 -1.51	0.364 0.369 -1.19					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

FLUX MAP 1003

δ=1.48

FIGURE 5.4

	1	2	3	4	5	6	7	8	9	10	11	12	13
A						0.382 0.376 1.59	0.662 0.653 1.49	0.382 0.376 1.43					
B				0.548 0.568 -3.36	0.989 0.974 1.57	1.182 1.164 1.57	0.905 0.894 1.25	1.162 1.164 -0.21	0.971 0.974 -0.31	0.563 0.568 -0.85			
C			0.494 0.511 -3.35	1.111 1.130 -1.70	1.011 1.003 0.78	1.131 1.127 0.36	1.096 1.090 0.58	1.118 1.127 -0.85	0.991 1.003 -1.21	1.120 1.130 -0.86	0.517 0.511 1.23		
D		0.557 0.568 -1.87	1.108 1.130 -1.96	1.014 1.031 -1.62	1.261 1.242 1.51	1.118 1.108 0.91	1.266 1.253 1.05	1.098 1.108 -0.88	1.238 1.242 -0.30	1.030 1.031 -0.08	1.145 1.130 1.31	0.575 0.568 1.23	
E		0.969 0.974 -0.48	0.998 1.003 -0.48	1.262 1.242 1.63	1.071 1.048 2.17	1.263 1.243 1.57	1.262 1.249 1.06	1.243 1.243 -0.02	1.058 1.048 0.96	1.260 1.242 1.41	1.013 1.003 1.03	0.980 0.974 0.63	
F	0.365 0.376 -2.95	1.129 1.163 -2.95	1.107 1.127 -1.79	1.129 1.108 1.86	1.275 1.242 2.65	1.158 1.121 3.33	1.293 1.263 2.38	1.138 1.121 1.53	1.262 1.242 1.56	1.125 1.108 1.54	1.136 1.127 0.83	1.162 1.163 -0.08	0.375 0.376 -0.40
G	0.646 0.652 -0.98	0.881 0.894 -1.37	1.066 1.089 -2.08	1.263 1.253 0.77	1.278 1.248 2.41	1.306 1.263 3.38	1.088 1.073 1.38	1.277 1.263 1.10	1.265 1.248 1.35	1.274 1.253 1.69	1.099 1.089 0.95	0.892 0.894 -0.12	0.649 0.652 -0.51
H	0.374 0.376 -0.58	1.150 1.163 -1.11	1.104 1.127 -2.04	1.103 1.108 -0.45	1.256 1.242 1.15	1.136 1.121 1.35	1.281 1.263 1.45	1.134 1.121 1.17	1.261 1.242 1.55	1.112 1.108 0.36	1.121 1.127 -0.52	1.144 1.163 -1.62	0.371 0.376 -1.44
I		0.978 0.974 0.43	0.992 1.003 -1.06	1.231 1.242 -0.86	1.043 1.048 -0.49	1.246 1.243 0.21	1.260 1.249 0.89	1.254 1.243 0.88	1.050 1.048 0.20	1.222 1.242 -1.60	0.986 1.003 -1.73	0.936 0.974 -3.88	
J		0.563 0.568 -0.76	1.120 1.130 -0.92	1.023 1.031 -0.80	1.232 1.242 -0.79	1.111 1.108 0.26	1.266 1.253 0.99	1.120 1.108 1.03	1.235 1.242 -0.54	0.997 1.031 -3.27	1.093 1.130 -3.32	0.546 0.568 -3.87	
K			0.504 0.511 -1.27	1.116 1.130 -1.29	0.988 1.003 -1.54	1.131 1.127 0.36	1.101 1.090 0.37	1.128 1.127 0.12	0.993 1.003 -0.97	1.104 1.130 -2.28	0.497 0.511 -2.74		
L				0.559 0.568 -1.57	0.959 0.974 -1.56	1.157 1.164 -0.58	0.888 0.894 -0.59	1.153 1.164 -1.00	0.957 0.974 -1.79	0.558 0.568 -1.78			
M						0.371 0.376 -1.51	0.643 0.653 -1.55	0.370 0.376 -1.65					

LOOP B

LOOP A

LOOP B

LOOP A

MEASURED FDHN
PREDICTED FDHN
PERCENT DIFFERENCE

FLUX MAP 1009

δ=1.56

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, 200 and 228 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 10 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 10 startup (4). Several flux maps were performed over a range of axial offsets at approximately 75% power. The incore axial offset to excore axial offset ratio was generated for each detector from the data collected during the mappings. These ratios agreed well with previous results. 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 X," Wisconsin Public Service Corporation, February, 1984.

(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," Wisconsin Public Service Corporation, February, 1979.

(4) "Reactor Test Program, Kewaunee Nuclear Power Plant," Wisconsin Public Service Corporation, May, 1979. (Revised April 14, 1980)

(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.