DUKE POWER COMPANY

OCONEE NUCLEAR STATION

OCONEE 3, CYCLE 6

STARTUP TESTING REPORT

Part I Zero Power Physics Testing

Part II Power Escalation Testing

Prepared By: M. L. Elder

OCONEE 3 CYCLE 6

Startup Testing Report

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OCONEE 3 CYCLE 6

STARTUP TESTING REPORT

PART I

ZERO POWER PHYSICS TEST

1.0 Introduction and Summary

The Oconee 3 Cycle 6 Zero Power Physics Test (ZPPT) program was conducted from 3/11/81 to 3/13/81 per Station Procedure TT/3/A/711/06 (Oconee 3 Cycle 6 Zero Power Physics Test). The purpose of this test was to verify the nuclear parameters upon which the Oconee 3 Cycle 6 safety analysis and Technical Specifications are based.

The ZPPT measurements were made at the following conditions:

(a) RC pressure ∿ 2155 PSIG

(b) RC temperature ∿ 532°F (During the temperature coefficient of reactivity measurement, temperature was varied between 527°F and 538°F)

(c) Reactor power: 2.0×10^{-10} amps < intermediate range N.I.'s < 4.3×10^{-8} amps

(d) 0.9988 < Keff < 1.0012 (Reactivity insertions < ± 1200 μP)

The following nuclear parameters were measured per the ZPPT:

(a) All rods out (ARO) Boron concentration (See Enclosure 1.0)

(b) Integral rod worth for CRA groups 5, 6, 7 (See Enclosures 2.0-2.3)

(c) Differential Boron worth (See Enclosure 1.0)

(d) Temperature and Moderator coefficients of reactivity (See Enclosure 6.0)

(e) Worst case ejected CRA worth (See Enclosure 2.0)

The plant computer was used to record RC pressure, RC temperature, intermediate range N.I. power levels, and control rod positions. Reactivity was calculated by the plant computer and output to a Leeds and Northup chart recorder.

On 3/13/81 at 1510, the ZPPT was declared complete; all acceptance criteria were met.

2.0 Approach to Critical

A verification of the subcooling monitors was performed on 2/27/81; all results were acceptable. Initial RCS heatup after refueling began on

3/2/81. On 3/7/81, at ∿ 290°F, an RCS cooldown was initiated to repair 3CF-13, which was found to be leaking excessively. Heatup was then restarted, and the unit reached hot shutdown conditions at ∿ 0200 on 3/11/81.

During the RCS heatups, Operations and Performance personnel recorded heatup count rates for 1/m (inverse multiplication) vs. RC temperature plots. Plots of 1/m vs. withdrawn rod worth were maintained by Performance personnel when rod withdrawal began for the CRD trip time test at 0830 on 3/11/81.

At 1215, the CRD trip time test was complete; all drop times were acceptable. At 1245 it was discovered that this test was performed at 2110 PSIG which is outside the required 2155 ± 30 PSIG band. At this time, the control rods were being withdrawn in preparation for deboration to criticality. Rod withdrawal was continued while station management evaluated whether a repeat of the test was necessary. Performance personnel recorded counts for 1/m vs. withdrawn rod worth (including group 8). At 1400 it was decided that the RC pressure of 2110 PSIG was acceptable and the CRD trip time test was not repeated.

At 1444, rod groups 1-8 were at 100% wd. Deboration was started at 1700 hrs. At this point, a RCS flow measurement was taken comparing both loop flows (ICS) to percent design flow. All three flow values were reasonable and consistent.

At 0510 on 3/12/81, deboration was stopped to investigate a 0.5 decade discrepancy between NI-1 and NI-2. By 0900, no apparent cause for the discrepancy had been found and based on the NI-1 and NI-2 consistent behavior (during heatup and the CRD trip time test), deboration was continued. Initial criticality was achieved at 1405 with CRA groups 1-6 at 100% wd, group 7 at 85% wd and group 8 at 37.5% wd. The RCS boron sample taken at 1400 was 1460 PPM.

3.0 Pre-Physics Measurements

After establishing steady state reactor conditions, NI overlap and sensible heat measurements were made. A power level of 4.3×10^{-8} amps on the intermediate range N.I.'s was established as the upper limit for physics measurements.

An on-line reactimeter checkout was then performed by making reactivity insertions of about ± 250, ± 750, and ± 1200 μP and measuring the associated doubling times. These doubling times were input to an offline reactivity calculation and then compared to the on-line reactivity signal. The results of this on-line test, as well as the offline test, (utilizing floppy disk reactimeter test cases) were acceptable.

4.0 Physics Testing

A. All Rods Out Boron Concentration Measurement

Due to optimum reactor conditions, the ARO Boron concentration measurement was made on 3/12/81, before the sensible heat determinations or reactimeter checkout had been performed. A RCS Boron

concentration of 1460 PPM was measured at equilibrium conditions with the following control rod positions: Groups 1-6 @ 100% wd, group 7 @ 91% wd, and group 8 @ 37.6% wd. Group 7 was withdrawn to 100% wd and the corresponding reactivity change was converted to an equivalent boron concentration which was then added to the measured concentration. The acceptance criterion was met (See Enclosure 1.0).

B. Temperature Coefficient of Reactivity Measurements

The temperature coefficient was measured at the following two control rod configurations: All rods out (Groups 1-6 @ 100% wd, group 7 @ 91% wd, and group 8 @ 37.5% wd) and all regulating rods in (Groups 1-4 @ 100%, group 5 @ 11%, group 6 and 7 @ 0%, group 8 @ 37.5%). RCS T_{av} was increased from 532°F to 538°F, reduced to 527°F and then returned to 532°F for both of the above control rod configurations. The change in RCS temperature and the resulting reactivity change were used to calculate the temperature coefficient for the ARO and ARI conditions. The moderator coefficients were calculated by subtracting the isothermal doppler coefficient (-0.1825×10^{-4} $\Delta K/K/°F$) from the temperature coefficients. All acceptance criteria were met (See Enclosure 6.0).

C. Control Rod Group Integral Worths and Differential Boron Worth Measurement

The worths of the regulating rod groups (groups 5, 6 and 7) were measured by steadily deborating the RCS and compensating for the resulting positive reactivity ramp by inserting (in discrete steps) the regulating rods from 93% wd on group 7 to 11% wd on group 5 (with no rod overlap). By making ∿ - 800 μP insertions with the control rods (starting at ∿ +400 μP on the L and N strip chart) the effective multiplication factor (Keff) was maintained within 0.9996 < Keff < 1.0004.

The group 7 worth from 93% wd to 100% wd was determined by interpolating the reactivity change from 91% wd to 100% wd, which was obtained during the ARO boron measurement. The 11% wd to 0% wd worth for group 5 was obtained by inserting group 5 over this span and recording the induced reactivity change. The reactivity changes resulting from the discrete control rod insertions were summed for each group to obtain the group integral worth (See Enclosures 2.0-2.3).

A differential boron worth was calculated by dividing the reactivity insertion from the control rods by the change in measured boron concentration from an initial critical equilibrium condition (93% wd - group 7) to a final critical equilibrium condition (11% wd - group 5). See Enclosure 1.0 for results. All results were acceptable.

D. Ejected Rod Worth Measurement

With group 5 at 0% wd, the predicted worst case ejected rod (group 7 - rod 7, location N12) worth was measured by steadily borating the RCS and concurrently withdrawing, in discrete steps, group 7 - rod 7 from 0% wd to 100% wd.

These step changes were limited to ∿ +800 μP to restrict Keff as follows: 0.9996 < Keff < 1.0004. The positive reactivity insertions from group 7 - rod 7 were then summed to obtain the "ejected rod" worth. The measured "ejected rod" worth was within the acceptance criteria (See Enclosure 2.0).

E. Core Symmetry Test

When equilibrium RCS boron conditions were obtained, the "ejected rod" was "swapped" in against the group 5 bank until the "ejected rod" was 0% wd.

Individual rods in each of the other three core quadrants were then "swapped" against group 5. The endpoints for reactivity and control rod positions were recorded. Normal core flux symmetry was indicated. See Enclosure 2.0 for results.

PART II

POWER ESCALATION TEST

1.0 Introduction and Summary

The Oconee 3 Cycle 6 Power Escalation Testing (PET) program was conducted from 3/14/81 to 4/3/81, per station procedure TT/3/A/811/06 (Oconee 3 Cycle 6 Power Escalation Test). The PET experimentally verified the nuclear parameters upon which the Oconee 3 Cycle 6 safety analysis and Technical Specifications are based. Testing was performed at approximately 15, 40, 75 and 100% F.P. The principal tests performed were:

(a) NSS Heat Balance and RC Flow Verification (15, 40, 75, and 100% F.P.)

(b) Core Symmetry Test at Power (15% F.P.)

(c) Incore Detector Checkout (40, 75, 100% F.P.)

(d) Core Power Distribution (40, 75, 100% F.P.)

(e) Power Imbalance Detector Correlation (40% F.P.)

(f) Reactivity Coefficients at Power (100% F.P.)

The acceptance criteria at each test plateau were met before power escalation was allowed to continue.

The testing at the four plateaus is summarized below.

During escalation to 15% F.P., Oconee 3 tripped at ∿ 4% F.P. (ΔT) from an anticipatory Reactor trip signal initiated by incorrectly calibrated NI power range channels. Normal trip recovery procedures were followed and the unit reached 15% F.P. at ∿ 1450 on 3/14/81. At this point, an initial Core Symmetry Test and NSS Heat Balance/RC Flow Verification were performed.

The unit reached 40% F.P. at 0153 on 3/15/81. At 0115 on 3/17/81, all 40% F.P. testing was complete and escalation to 75% F.P. was begun.

The 75% F.P. plateau was reached at 1534 on 3/17/81. The testing at 75% F.P. included a ∿ 10°F ΔT_c test to measure the effect of an unbalanced core inlet temperature on core outlet temperature distribution.

At ∿ 1400 on 3/18/81, it was discovered that 26 of the plant computer's 364 incore power indications were incorrect due to anomalous integrated incore detector current values (this affected 75% F.P. and 40% F.P. CPD). The problem was corrected and the 75% F.P. testing was completed. The affected 40% F.P. test results were adjusted slightly to reflect the corrected integrated currents. The acceptance criteria for both the 75% F.P. and 40% F.P. levels were satisfied and escalation to 100% F.P. began at 0810 on 3/19/81.

Oconee 3 reached 100% F.P. on 3/21/81 at 1704. All testing was completed by 4/3/81.

The data reduction and analyses associated with the reactivity coefficients at power measurements were performed by 5/22/81.

2.0 NSS Heat Balance/RC Flow Verification

A NSS Heat Balance/RC Flow Verification during steady state operation at power levels of 15, 40, 75 and 100% F.P. was performed. This test verified the accuracy of CTPA (the plant computer program which performs a primary and secondary heat balance) against offline calculated heat balances. A check was also made to verify that the primary flow rate was between 106.5 (value assumed in Technical Specifications) and 119% (assures against fuel assembly lift) design flow.

To check CTPA, the plant computer was used to average heat balance data (flows, temperature, pressures, etc.) for 15 minutes. This data was input into offline heat balance programs and the results were compared to CTPA averages for the same period.

RC flow was calculated (offline) based on secondary heat balance and primary loop enthalpy changes. The measurement of feedwater flow at low power levels is inaccurate, therefore, the value used for % design flow at the 15% F.P. plateau was derived from primary instrumentation (ΔP transmitters).

All acceptance criteria were met; the results of this test are listed in Enclosure 7.0.

3.0 Core Power Distribution

Core Power Distributions (CPD) were made at the 40, 75 and 100% F.P. plateaus. This test verified that reactor power imbalance, quadrant power tilt, minimum DNBR, maximum LHR (and their extrapolated values) and radial/total power peaks did not exceed their respective specified limits. Reasonable outputs from the incore detector system backup recorders were also verified.

Imbalance was plotted on the error adjusted imbalance LOCA limit curve and was verified to be within limits.

The maximum positive quadrant power tilt was verified to be less than the error adjusted LOCA limit of +3.47% (per Technical Specification 3.5.2.4).

The maximum LHR was verified to be within the LOCA limited maximum allowable heat rate (Technical Specification 3.5.2-5.)

The worst case minimum DNBR and maximum LHR, when extrapolated to the overpower trip, were verified to be within the fuel melt limits of Technical Specification 2.1.

The radial and total peaking factors were measured and compared to the B&W predicted values. The following acceptance criteria were applied:

(a) $\% \text{ Deviation} = \frac{(\text{Predicted} - \text{Measured})}{\text{Measured}} \times 100 \leq \pm 20\%$

(b) $\frac{LMP - LPP}{LMP} \times 100 \leq$

Radial	Total
8.0%	12.0% @ 40% F.P
5.0	7.5 @ 75
5.0	7.5 @ 100

Where:

LMP is the largest measured peaking factor
LPP is the largest predicted peaking factor

(c) The full core root mean square (RMS) radial peaking factor deviation for all core locations with operable incore detector strings is limited by the following equation:

$$i = \sum_{1}^{N}\left((PP - MP)^2/(N-1)\right)^{\frac{1}{2}} \leq \begin{matrix} 0.100 @ 40\% \text{ F.P.} \\ 0.075 @ 75 \\ 0.075 @ 100 \end{matrix}$$

Where:

PP = Predicted radial peaking factor
MP = Measured radial peaking factor
N = Total number of operable incore detector strings

At 75 and 100% F.P. tilt and imbalance were calculated from the backup incore recorders and then compared to full incore values.

All acceptance criteria were met. See Enclosures 3.0-3.5 and 4.0 for results.

During the performance of PT/0/B/302/6 (Incore Detector Checkout) at 75% F.P., it was discovered that the SPNDI array (integral detector current) contained incorrect values. These values slightly affected the CPD results at 40% F.P. The largest impact was on the measured total and radial peaking factors. However, correcting the SPNDI values resulted in closer agreement to the B&W predicted peaks with one exception - core location E-8, which was not limiting.

The affected core locations were determined not to be limiting (either old or revised values) relative to LHR and DNB. Therefore, the 40% F.P. CPD results remained acceptable.

4.0 Power Imbalance Detector Correlation

The Power Imbalance Detector Correlation (PIDC) test was performed at 40% F.P. The purpose of this test was:

(a) To measure the outcore to full incore power imbalance correlation slopes for NI channels 5, 6, 7 and 8 and verify these slopes are conservative with respect to the FSAR.

(b) To verify reasonable agreement for power imbalance between the backup incore detector and the full incore detector system.

(c) To verify the adequacy of the RPS flux/flow/imbalance trip envelope by demonstrating that both measured and extrapolated values of minimum DNBR and maximum LHR were within the fuel melt limits of Technical Specification 2.1.

(d) To verify the adequacy of the LOCA imbalance limit curve by demonstrating that the measured and extrapolated values of LHR are within the LOCA limit curve of Technicial Specification figure 3.5.2-5.

Each of these parameters was measured (or calculated) at imbalance levels of +6.48, +2.58, -0.60, -4.12, -7.19 and -9.65% F.P. These imbalance conditions were achieved by positioning of group 8 (APSR).

The incore/outcore imbalance correlation slope for each NI channel was determined by a least squares fitting of outcore to incore imbalance indications for the six imbalance levels.

The backup incore/full incore correlation was determined by hand calculating imbalance from the backup recorders and plotting this value versus the full incore imbalance (plant computer) value. These points were required to fall within a designated range.

Values for of the minimum DNBR and maximum LHR were obtained from the plant computer. These values, as well as their extrapolations to the maximum allowable trip* were verified to be within the fuel melt limits (< 20.15 Kw/ft and > 1.30 DNBR).

Measured values of LHR were extrapolated to the LOCA imbalance window and verified to be within the LOCA limit curve (Technical Specification figure 3.5.2-5).

All acceptance criteria were met.

At 75% F.P. when the SPNDI problem was discovered, a review of the PIDC test yielded the following results:

(a) The uncorrected outcore/full incore imbalance correlation slope was slightly conservative.

(b) The backup/incore imbalance relationship was essentially unaffected.

(c) None of the affected detector locations were limiting with regard to LHR and DNBR (the revised peaking factors, in general, were decreased); consequently, the core thermal data remained valid.

Based on the above, the 40% F.P. PIDC test results were acceptable. The test results are summarized in Enclosure 5.0.

*The maximum allowable trip being either the overpower or flux/flow/imbalance trip, whichever would be encountered first.

5.0 Reactivity Coefficients at Power

Data for calculating the doppler and temperature coefficients was taken at ~ 100% F.P. This test verified that the measured and extrapolated reactivity coefficients were conservative relative to the assumed values in the FSAR.

The reactivity coefficients were calculated in the following manner:

Controlling rod group differential rod worth measurements were made over the range of rod motion encountered in the test. The B&W "push/pull" differential rod worth measurement technique combined with the B&W "fuel power correction" calculation was used to determine the differential rod worths.

The temperature coefficient of reactivity was calculated by varying the average RC temperature (thermal power was held as steady as possible) and measuring the resulting change in control rod position. The power doppler coefficient of reactivity was calculated by varying reactor power level (average RC temperature was held as steady as possible) and measuring the resulting change in control rod position.

The measured differential rod worths were used with the temperature change and power change to calculate the temperature and the power doppler coefficients, respectively. Corrections for Xenon and temperature/power variations were also made.

All acceptance criteria were met. The results of this test are summarized in Enclosure 6.0.

ENCLOSURE 1.0

ARO AND DIFFERENTIAL BORON WORTH RESULTS

PARAMETER	CONDITIONS	MEASURED VALUE	PREDICTED VALUE	DEVIATION	ACCEPTANCE CRITERION
All Rods Out Boron Conc.	Gp 7 @ 91% wd Gp 8 at 37.6% wd	1464 ppm	1422 ppm	42 ppm	Predicted ±50 ppm
Differential Boron Worth	1300 ppm Average During Measurement	-0.97% ΔK/K per 100 ppm	-0.90% ΔK/K per 100 ppm	*-7.2%	Measured < 1.33% ΔK/K per 100 ppm <u>and</u> ±15% Deviation

$$*\%\ \text{Deviation} = \frac{\text{predicted - measured}}{\text{measured}} \times 100$$

ENCLOSURE 2.0

INTEGRAL GROUP AND WORST CASE EJECTED ROD WORTH MEASUREMENTS

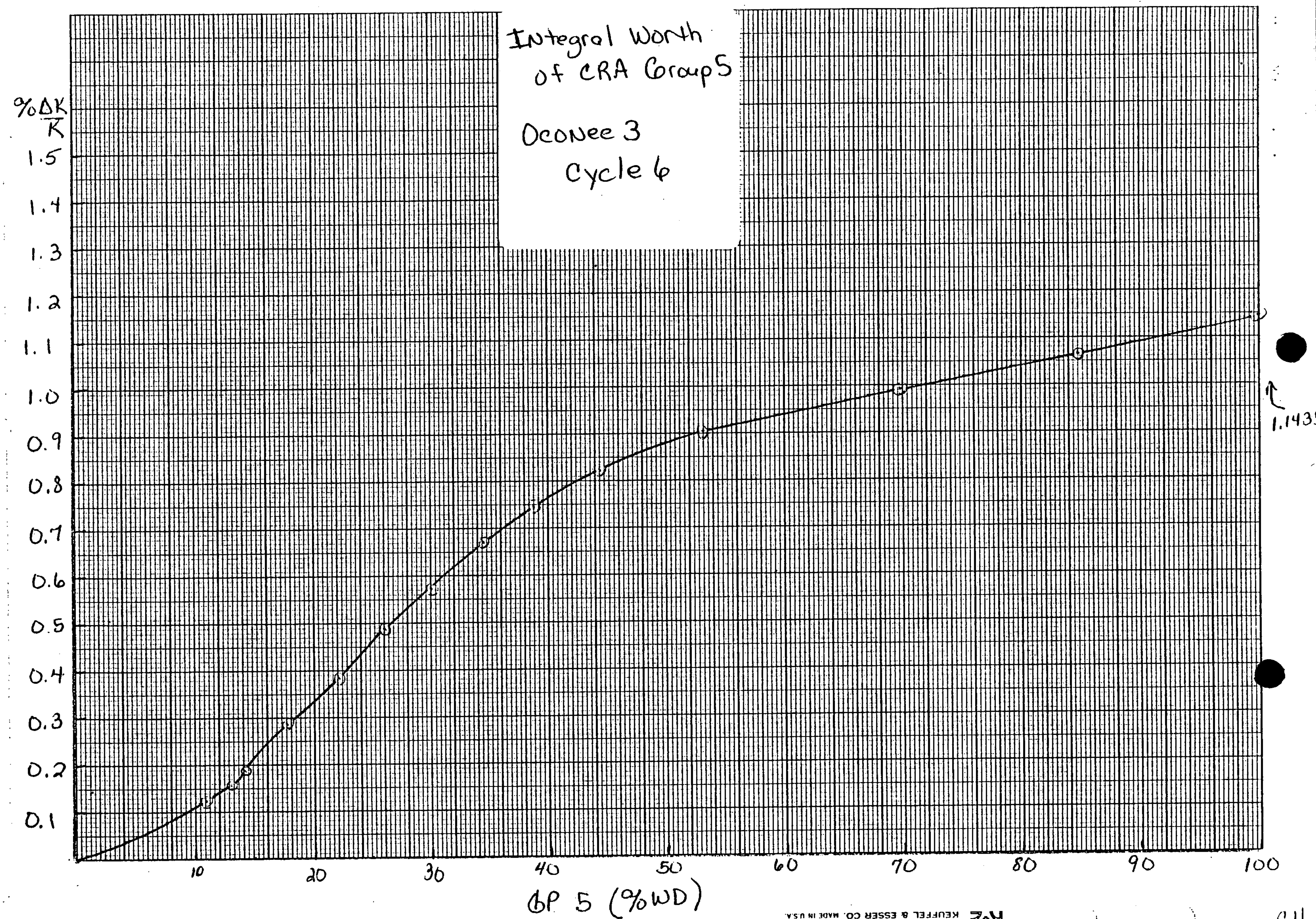
PARAMETER	CONDITIONS	MEASURED VALUE	PREDICTED VALUE	DEVIATION	ACCEPTANCE CRITERION
Gp 7 Integral Worth	N/A	-1.18% ΔK/K	-1.23% ΔK/K	+4.2%	± 15% Deviation
Gp 6 Integral Worth	N/A	-0.92	-0.88	-4.3	± 15% Deviation
Gp 5 Integral Worth	N/A	-1.14	-1.17	+2.6	± 15% Deviation
GP 5-7 Integral Worth	N/A	-3.25	-3.28	+0.9	± 10% Deviation
Worst Case Ejected Rod Worth	Gp5 at 19% wd	-0.37	-0.38	+2.7	± 20% Deviation
Error Adjusted Worst Case Ejected Rod Worth	Gp5 at 19% wd 532°F	-0.39	N/A	N/A	Measured < -1.0% ΔK/K

Symmetry Check

Location	Gp/Rod	Conditions	Measured Value	Predicted Value	Deviation	Acceptance Criterion
N-12	7-7	N/A	-0.31% ΔK/K	N/A	-4.2%	± 20% *
N-4	7-9		-0.29		+2.5	
D-4	7-12		-0.30		-0.8	
D-12	7-3		-0.29		+2.5	

$$\% \text{ Deviation} = \frac{\text{predicted} - \text{measured}}{\text{measured}} \times 100$$

$$\text{*For Symmetry Check \% Deviation} = \frac{(\text{Av. worth of symmetric rods} - \text{individual rod worth})}{\text{Av. worth of symmetric rods}} \times 100$$



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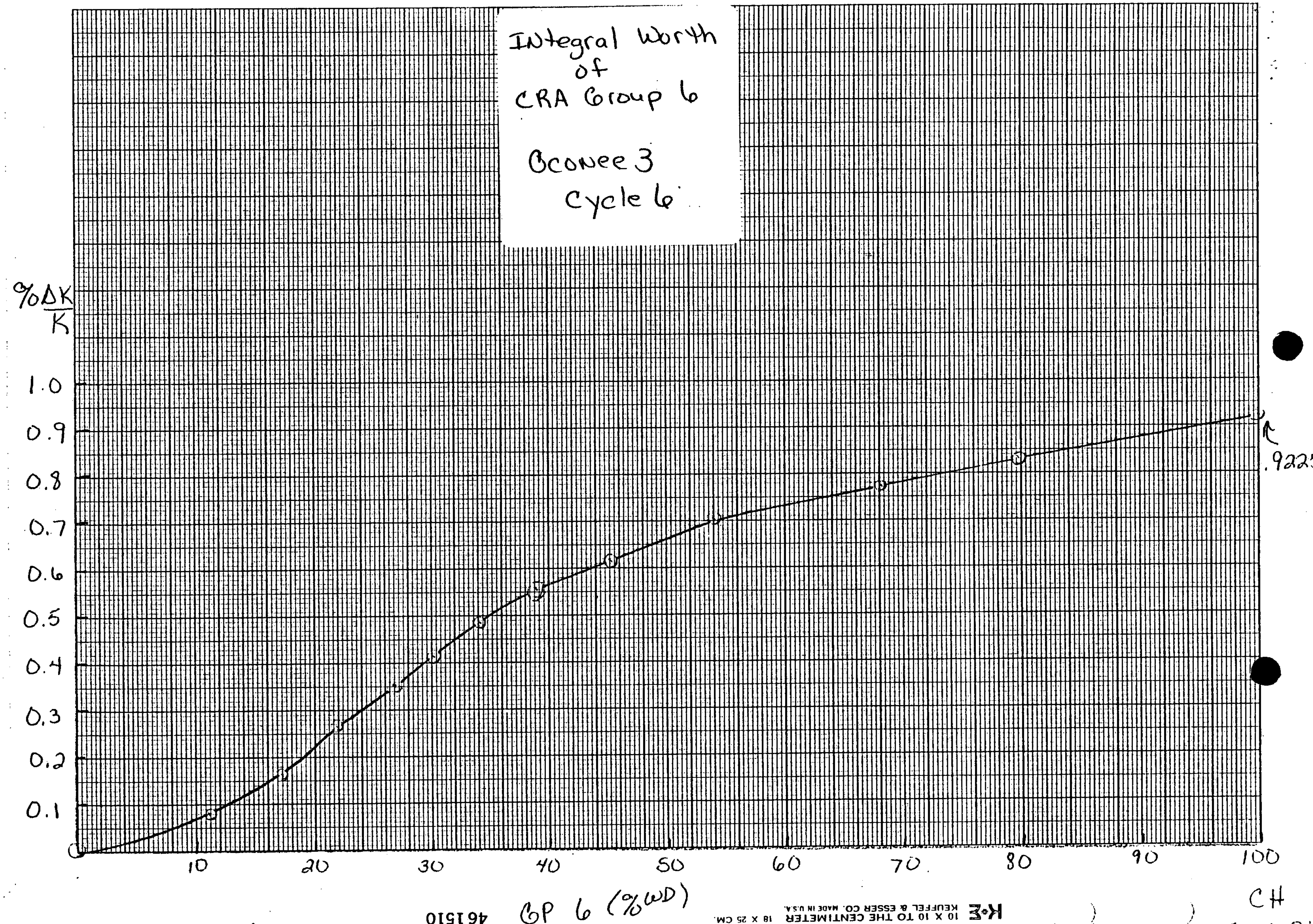
ENCLOSURE 2.2



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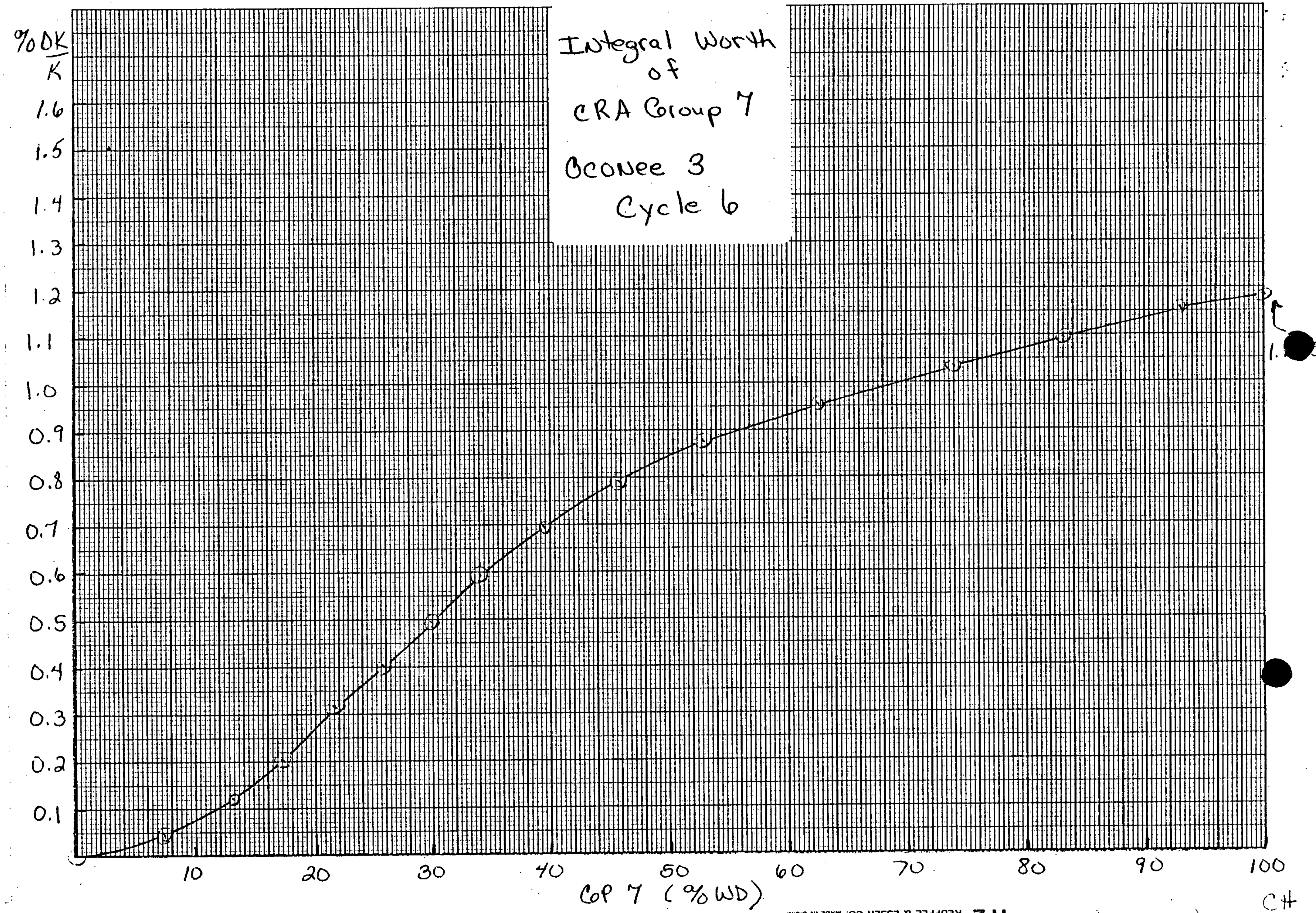
ENCLOSURE 2.3



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ENCLOSURE 3.0

Radial Peaking Factor Comparison 40 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8	5	1.036	1.02	+1.57
G-8		1.243	1.19	+4.45
F-8	6	0.910	0.91	0.00
E-8		1.312	1.22	+7.54
D-8		1.151	1.14	+0.96
C-8		1.247	1.25	-0.24
B-8	7	1.056	1.06	-0.38
A-8		0.595	0.61	-2.46
G-9		1.170	1.11	+5.41
F-9		0.946	0.94	+0.64
E-9		1.105	1.06	+4.25
D-9		1.284	1.26	+1.90
C-9	5	1.037	1.06	-2.17
B-9		1.124	1.12	+0.36
A-9		0.582	0.61	-4.59
F-10	7	1.032	1.03	+0.19
E-10		1.277	1.23	+3.82
D-10	8	1.131	1.12	+0.98
C-10		1.274	1.27	+0.31
B-10		0.969	0.93	+4.19
A-10		0.448	0.50	-10.4
E-11		1.146	1.12	+2.32
D-11		1.229	1.21	+1.57
C-11		1.015	0.95	+6.84
B-11		0.893	0.88	+1.48
D-12	6	0.932	0.86	+8.37
C-12		0.992	0.97	+2.27
B-12		0.511	0.52	-1.73
C-13		0.561	0.57	-1.58

INCORE TILT

WX: +0.21%
XY: +0.10
YZ: -0.19
ZW: -0.12

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	2.0 EFPD	0.72 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87 % wd.	85.6% wd.
GP 8	3.5% wd.	35.3 % wd.
IMB.	+0.58% imb.	-0.73% imb.
POWER	40 % FP	40 % FP
BORON		1146 ppm

KEY

Core Location	Rod Group Number (5-8 only)
Predicted Peak	Measured Peak
% Deviation ($\frac{pred.-meas.}{meas.}$) x 100	

HIGHEST % DEVIATION = -10.4% in 1/8th Core Location A-10
RMS RADIAL PEAKING FACTOR DEVIATION = 0.0367
HIGHEST MEASURED RADIAL PEAK = 1.27 in 1/8th core location C-10

$\frac{LMP - LPP}{LMP} \times 100 = -3.31\% = \frac{1.27 - 1.312}{1.27} \times 100\%$

ENCLOSURE 3.1

Total Peaking Factor Comparison 40 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8	5	1.246	1.21	+2.98
G-8		1.487	1.45	+2.55
F-8	6	1.101	1.12	-1.70
E-8		1.535	1.41	+8.87
D-8		1.331	1.37	-2.85
C-8		1.469	1.44	+2.01
B-8	7	1.301	1.29	+0.85
A-8		0.726	0.73	-0.55
G-9		1.388	1.33	+4.36
F-9		1.107	1.09	+1.56
E-9		1.272	1.18	+7.80
D-9		1.504	1.45	+3.72
C-9	5	1.203	1.19	+1.09
B-9		1.345	1.32	+1.89
A-9		0.702	0.73	-3.84
F-10	7	1.193	1.14	+4.65
E-10		1.505	1.41	+6.74
D-10	8	1.476	1.45	+1.79
C-10		1.468	1.49	-1.48
B-10		1.146	1.12	+2.32
A-10		0.537	0.58	-7.41
E-11		1.334	1.24	+7.58
D-11		1.420	1.41	+0.71
C-11		1.224	1.21	+1.16
B-11		1.072	1.05	+2.10
D-12	6	1.117	1.06	+5.38
C-12		1.196	1.18	+1.36
B-12		0.619	0.64	-3.28
C-13		0.681	0.69	-1.30

INCORE TILT

WX: +0.21%
XY: +0.10
YZ: -0.19
ZW: -0.12

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	2.0 EFPD	0.72 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87 % wd.	85.6 % wd.
GP 8	35.3 % wd.	35.3 % wd.
IMB.	+0.58% imb.	-0.73% imb.
POWER	40 % FP	40 % FP
BORON		11[illegible] ppm

KEY

Core Location	Rod Group Number (5-8 only)
Predicted Peak	Measured Peak
% Deviation (pred.-meas.)/meas. x 100	

$$\% \text{ Deviation} = \left(\frac{\text{pred.} - \text{meas.}}{\text{meas.}}\right) \times 100$$

HIGHEST % DEVIATION = +8.87 % in 1/8th Core Location E-8

HIGHEST MEASURED TOTAL PEAK = 1.49 in 1/8th core location C-10

$$\frac{LMP - LPP}{LMP} \times 100 = -3.02\ \% = \frac{1.49 - 1.535}{1.49} \times 100$$

ENCLOSURE 3.2

Radial Peaking Factor Comparison 75 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8	5	1.039	1.03	+0.90
G-8		1.237	1.21	+2.20
F-8	6	0.917	0.93	-1.40
E-8		1.296	1.24	+4.50
D-8		1.142	1.15	-0.70
C-8		1.236	1.25	-1.10
B-8	7	1.060	1.07	-0.90
A-8		0.611	0.63	-3.00
G-9		1.170	1.13	+3.50
F-9		0.952	0.96	-0.80
E-9		1.100	1.07	+2.80
D-9		1.268	1.27	0.00
C-9	5	1.035	1.06	-2.40
B-9		1.123	1.13	-0.60
A-9		0.597	0.62	-3.70
F-10	7	1.031	1.04	-0.90
E-10		1.262	1.24	+1.80
D-10	8	1.121	1.12	0.00
C-10		1.261	1.27	-0.70
B-10		0.976	0.96	+1.70
A-10		0.464	0.52	-10.80
E-11		1.137	1.12	+1.50
D-11		1.217	1.22	0.00
C-11		1.017	1.02	0.00
B-11		0.904	0.89	+1.60
D-12	6	0.937	0.92	+1.80
C-12		0.997	0.98	+1.70
B-12		0.526	0.53	0.00
C-13		0.575	0.58	0.00

INCORE TILT

WX: +0.42%
XY: +0.33
YZ: -0.09
ZW: -0.64

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	3.0 EFPD	2.35 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.0 % wd.	86.7 % wd.
GP 8	32.0 % wd.	32.1 % wd.
IMB.	-0.82% imb.	-1.25 % imb.
POWER	75.0 % FP	74.25 % FP
BORON		1050 ppm

KEY

Core Location	[box]	Rod Group Number (5-8 only)
Predicted Peak	[box]	Measured Peak
	[box]	% Deviation $\left(\frac{\text{pred.} - \text{meas.}}{\text{meas.}}\right) \times 100$

HIGHEST % DEVIATION = -10.8% in 1/8th Core Location A10
RMS RADIAL PEAKING FACTOR DEVIATION = 0.022
HIGHEST MEASURED RADIAL PEAK = 1.27 in 1/8th core location D9

$\frac{LMP - LPP}{LMP} \times 100 = 2.0\ \%$

ENCLOSURE 3.3

Total Peaking Factor Comparison 75 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8	5	1.258	1.22	+3.10
G-8		1.491	1.47	+1.40
F-8	6	1.112	1.14	-2.50
E-8		1.508	1.43	+5.50
D-8		1.324	1.30	+1.80
C-8		1.442	1.45	-0.60
B-8	7	1.284	1.30	-1.20
A-8		0.735	0.74	0.00
G-9		1.398	1.35	+3.60
F-9		1.111	1.12	-0.90
E-9		1.273	1.20	+6.10
D-9		1.471	1.43	+ 2.90
C-9	5	1.202	1.19	+1.00
B-9		1.324	1.33	-0.50
A-9		0.710	0.74	-4.10
F-10	7	1.189	1.16	+2.20
E-10		1.460	1.39	+ 5.00
D-10	8	1.401	1.39	+ 0.80
C-10		1.470	1.45	+1.40
B-10		1.147	1.11	+3.70
A-10		0.551	0.60	-8.20
E-11		1.310	1.24	+5.60
D-11		1.420	1.37	+3.60
C-11		1.240	1.27	-2.40
B-11		1.094	1.07	+2.20
D-12	6	1.126	1.13	0.00
C-12		1.212	1.18	+2.70
B-12		0.642	0.65	-1.20
C-13		0.703	0.70	0.00

INCORE TILT

WX: +0.42%
XY: +0.33
YZ: -0.09
ZW: -0.64

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	3.0 EFPD	2.35 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.0 % wd.	86.7 % wd.
GP 8	32.0 % wd.	32.1 % wd.
IMB.	-0.82% imb.	-1.25% imb.
POWER	75.0 % FP	74.25 % FP
BORON		1050 ppm

KEY

Core Location	Rod Group Number (5-8 only)
Predicted Peak	Measured Peak
% Deviation $\left(\frac{\text{pred.-meas.}}{\text{meas.}}\right) \times 100$	

HIGHEST % DEVIATION = -8.2 % in 1/8th Core Location A10
HIGHEST MEASURED TOTAL PEAK = 1.47 in 1/8th core location G8

$\frac{LMP - LPP}{LMP} \times 100 = -2.6$ %

ENCLOSURE 3.4

Radial Peaking Factor Comparison 100 % FP

Core Location	Rod Group Number (5-8 only)	Predicted Peak	Measured Peak	% Deviation
H-8	5	1.034	1.04	-0.58
G-8		1.226	1.22	+0.49
F-8	6	0.916	0.94	-2.55
E-8		1.284	1.24	+3.55
D-8		1.137	1.15	-1.13
C-8		1.230	1.25	-1.60
B-8	7	1.063	1.07	-0.65
A-8		0.622	0.64	-2.81
G-9		1.162	1.14	+1.93
F-9		0.951	0.97	-1.96
E-9		1.095	1.07	+2.34
D-9		1.258	1.26	-0.16
C-9	5	1.035	1.06	-2.36
B-9		1.124	1.13	-0.53
A-9		0.607	0.63	-3.65
F-10	7	1.028	1.05	-2.10
E-10		1.252	1.23	+1.79
D-10	8	1.118	1.09	+2.57
C-10		1.256	1.27	-1.10
B-10		0.981	0.96	+2.19
A-10		0.474	0.51	-7.06
E-11		1.132	1.12	+1.07
D-11		1.212	1.22	-0.66
C-11		1.020	1.02	+0.00
B-11		0.910	0.89	+2.25
D-12	6	0.941	0.92	+2.28
C-12		1.002	0.98	+2.24
B-12		0.537	0.53	+1.32
C-13		0.585	0.58	+0.86

INCORE TILT

WX: +0.56%
XY: +0.50
YZ: -0.24
ZW: -0.80

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	4 EFPD	6.54 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87 % wd.	88.5 % wd.
GP 8	29 % wd.	28.9 % wd.
IMB.	-0.93% imb.	+3.19% imb.
POWER	100 % FP	99.65 % FP
BORON		975 ppm

KEY

Core Location	Rod Group Number (5-8 only)
Predicted Peak	Measured Peak
% Deviation	

% Deviation $\left(\frac{\text{pred.} - \text{meas.}}{\text{meas.}}\right) \times 100$

HIGHEST % DEVIATION = -7.06 % in 1/8th Core Location A-10
RMS RADIAL PEAKING FACTOR DEVIATION = 0.028
HIGHEST MEASURED RADIAL PEAK = 1.27 in 1/8th core location C-10

$\frac{\text{LMP} - \text{LPP}}{\text{LPP}} \times 100 = -1.10$ %

Total Peaking Factor Comparison 100 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8	5	1.257	1.26	-0.24
G-8		1.483	1.53	-3.07
F-8	6	1.119	1.20	-6.75
E-8		1.511	1.50	+0.73
D-8		1.344	1.37	-1.90
C-8		1.451	1.52	-4.54
B-8	7	1.297	1.35	-3.93
A-8		0.753	0.78	-3.46
G-9		1.397	1.41	-0.92
F-9		1.125	1.18	-4.66
E-9		1.294	1.27	+1.89
D-9		1.504	1.49	+0.94
C-9	5	1.226	1.26	-2.70
B-9		1.334	1.39	-4.03
A-9		0.727	0.77	-5.58
F-10	7	1.213	1.23	-1.38
E-10		1.498	1.46	+2.60
D-10	8	1.462	1.45	+0.83
C-10		1.505	1.53	-1.63
B-10		1.168	1.17	-0.17
A-10		0.569	0.62	-8.23
E-11		1.346	1.33	+1.20
D-11		1.462	1.47	-0.54
C-11		1.265	1.28	-1.17
B-11		1.114	1.11	+0.36
D-12	6	1.157	1.19	-2.77
C-12		1.233	1.23	+0.24
B-12		0.661	0.67	-1.34
C-13		0.722	0.73	-1.10

INCORE TILT

WX: +0.56%
XY: +0.50
YZ: -0.24
ZW: -0.80

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	4 EFPD	6.54 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87 % wd.	88.5 % wd.
GP 8	29 % wd.	29 % wd.
IMB.	-0.93% imb.	+3.19% imb.
POWER	100 % FP	99.65 % FP
BORON		975 ppm

KEY

Core Location	Rod Group Number (5-8 only)
Predicted Peak	Measured Peak
% Deviation $\left(\frac{\text{pred.} - \text{meas.}}{\text{meas.}}\right) \times 100$	

HIGHEST % DEVIATION = -8.23 % in 1/8th Core Location A-10

HIGHEST MEASURED TOTAL PEAK = 1.53 in 1/8th core location G-8/C-10

$\frac{LMP - LPP}{LMP} \times 100 =$ 1.24 %

ENCLOSURE 4.0

MINIMUM DNBR AND MAXIMUM LHR CALCULATIONS AT

40%, 75%, AND 100% F.P. TEST PLATEAUS

Power Level	Burnup	Gp6/7/8 Positions	Boron CONC	Incore Imbalance	Incore Tilt WX/XY YZ/ZW	MDNBR	Extrapolated Worst Case MDNBR	MLHR	Extrapolated Worse Case MLHR
40	0.72 EFPD	100/86/35 % WD	1146 ppm	-0.73 % F.P.	+.21/+.10/ -.19/-.12%	10.80	4.9	4.27 KW/ft.	8.8 KW/ft.
75	2.4	100/87/32	1050	-1.25	+.42/+.33/ -.09/-.64	5.09	3.1	7.75	11.0
100	6.5	100/89/29	975	+3.19	+.56/+.50/ -.24/-.80	3.30	2.8	11.04	11.7

NOTE: The 40% F.P. cases were extrapolated to 85% F.P. and the 75% F.P./100% F.P. cases were extrapolated to 105.5% F.P.

ENCLOSURE 5.0

40% F.P. PIDC THERMAL CALCULATION AND CORRELATION SLOPE RESULTS

Full Incore Imbalance	MLHR	Worst Case Extrapolated MLHR	MDNBR	Extrapolated MDNBR
+6.48 % F.P.	5.10 KW/ft.	13.4 KW/ft.	8.72	3.5
+2.58	4.42	11.8	9.93	3.6
-0.60	4.27	11.0	10.86	4.3
-4.12	4.69	12.0	10.23	3.4
-7.19	5.00	12.6	9.47	3.5
-9.65	5.35	13.0	8.81	3.0

NOTE: All extrapolations are to 105.5% F.P. Except the ∿ -7% F.P. and the ∿ -10% F.P. imbalance cases (where ϕ/flow/imbalance reduces the maximum allowable trip setpoints to ∿ 103% F.P. and ∿ 99% F.P., respectively).

	NI 5	NI 6	NI 7	NI 8
Correlation Slope	1.32	1.25	1.42	1.32
Differential Amp. Gain Setting	4.80	4.80	4.80	4.80

ENCLOSURE 6.0 REACTIVITY COEFFICIENTS

PARAMETER	CONDITIONS	MEASURED VALUE	PREDICTED VALUE	ACCEPTANCE CRITERION
Hot Zero Power Temperature Coefficient (ARO)	Tav = 532°F Gp 5,6 @ 100% wd Gp 7 @ 92% wd 1460 ppm	+0.004 x 10^{-4} ΔK/K per °F	-0.083 x 10^{-4} ΔK/K per °F	Predicted ± 0.3 x 10^{-4} ΔK/K per °F
Hot Zero Power Moderator Coefficient (ARO)	Tav = 532°F Gp 5,6 @ 100% wd Gp 7 = 92% WD 1460 ppm	+0.187 x 10^{-4}	+0.099 x 10^{-4}	Predicted ± 0.3 x 10^{-4} ΔK/K per °F and Measured ≤ +0.5 x 10^{-4} ΔK/K per °F
Hot Zero Power Temperature Coefficient (Control Rods In)	Tav = 532°F Gp 6,7 @ 0% WD Gp 5 @ 10% WD 1140 ppm	-0.657 x 10^{-4}	-0.710 x 10^{-4}	Predicted ± 0.3 x 10^{-4} ΔK/K per °F
Hot Zero Power Moderator Coefficient (Control Rods In)	Tav = 532°F Gp 6,7 @ 0% WD Gp 5 @ 10% WD 1140 ppm	-0.475 x 10^{-4}	-0.525 x 10^{-4}	Predicted ± 0.3 x 10^{-4} ΔK/K per °F and Measured ≤ +0.5 x 10^{-4} ΔK/K per °F
Hot Full Power BOC Temperature Coefficient Extrapolated to 95% F.P.	Tav = 579°F 17.5 EFPD 950 ppm	-1.12 x 10^{-4}	N/A	(1) Temperature Coefficient more negative than -0.15 x 10^{-4} ΔK/K per °F at 95% F.P.
Hot Full Power BOC Temperature Coefficient Extrapolated to 100% F.P. at EOC	Tav = 579°F 386 EFPD	-2.79 x 10^{-4}	N/A	(2) Temperature Coefficient more positive than -3.15 x 10^{-4} ΔK/K per °F at 100% F.P.
Hot Full Power BOC Power Doppler Coefficient Extrapolated to 100% F.P.	Tav = 579°F 11.5 EFPD ~977 ppm	-8.95 x 10^{-5}	N/A	(3) Power Doppler Coefficient more negative than -0.55 x 10^{-4} ΔK/K per % F.P. at 100% F.P.

ENCLOSURE 7.0

NSS HEAT BALANCE/RC FLOW VERIFICATION

Test Plateau	Plant Computer On Line Primary Power Level	Plant Computer On Line Secondary Power Level	Off Line Calculated Primary Power Level	Off Line Calculated Secondary Power Level	RC Flow
15% F.P.	16.20	N/A	16.09	N/A	*115.33% Design
40% F.P.	39.74	40.13	39.53	39.99	116.95
75% F.P.	75.14	74.56	75.03	74.32	113.53
100% F.P.	100.5	99.54	100.3	98.79	112.44

*Design flow at 15% F.P. was calculated from primary flow indications.