DUKE POWER COMPANY

OCONEE NUCLEAR STATION

OCONEE 1, CYCLE 7

STARTUP TESTING REPORT

Part I Zero Power Physics Testing

Part II Power Escalation Testing

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OCONEE 1 CYCLE 7

Startup Testing Report

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OCONEE 1 CYCLE 7

STARTUP TESTING REPORT

PART I

ZERO POWER PHYSICS TEST

1.0 Introduction and Summary

The Duke Power Company Oconee 1 Cycle 7 Zero Power Physics Test (ZPPT) was conducted from 12/28/81 to 12/30/81 per Station Procedure TT/1/A/711/07 approved on 12/15/81. This test was performed to verify the nuclear parameters upon which the Oconee 1 Cycle 7 safety analysis and Technical Specifications are based.

The ZPPT measurements were obtained at the following conditions:

(a) RC pressure ∿ 2155 PSIG

(b) RC Temperature: ∿ 532°F (During the temperature coefficient reactivity measurement, temperature was varied between 526°F and 539°F)

(c) Reactor power: 1.0×10^{-10} amps < Intermediate Range N.I.'s < 6.06×10^{-8} amps

(d) 0.9988 < Keff < 1.0014 (Reactivity insertions < ± 1400 μρ)

The following nuclear parameters were measured per the ZPPT:

(a) All Rods Out (ARO) Boron Concentration (See Enclosure 1.0)

(b) Integral Rod Worths for CRA Groups 5, 6, and 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 Control Rod Worth (See Enclosure 2.0)

The on-line plant computer was used to obtain and record RC pressure, RC temperature, intermediate range NI power levels, and control rod positions. Reactivity was calculated by the on-line plant computer and output to a Leeds and Northrup two pin chart recorder.

The ZPPT was declared complete at 1000 on 12/30/81; all acceptance criteria were met.

2.0 Heatup and Approach to Critical

The operability checkout of the RCS Subcooling Monitors was satisfactorily performed on 12/11/81. Initial RCS heatup from this refueling outage began on 12/12/81. On 12/24/81 the unit was at hot shutdown,

however due to the lack of seal leakoff flow on RCP 1A1, only three reactor coolant pumps were operating. The RCS was cooled to about 200°F and 300 PSIG on 12/25/81 when RCP 1A1 was hand rotated to establish seal leakoff. (Hand rotating efforts on the initial heatup had proved unsuccessful.) Heatup resumed on 12/26/81. At 0100 on 12/27/81 the unit was approaching hot shutdown conditions (RCS at 500°F, 2180 psig) when RCP 1A2 developed high vibration readings and had to be shut down. The pump was rebalanced, returned to service, and hot shutdown conditions were reached at about 1100 on 12/27/81.

Rod withdrawal for the CRD trip time test began at 1235 on 12/27/81 and the test was completed with all drop times acceptable at 1404 on 12/27/81. Shortly after the CRD trip time test, the RC flow measurement was performed and acceptable results were obtained.

Steam chest warming and main steam pressure buildup to ~ 850 psig (conditions required for the main steam stop valve test) were completed at 2145 on 12/27/81. Two faulty valve position indicators were discovered and had to be repaired before the test was successfully completed at 0730 on 12/28/81. Because of a check valve leak in the OTSG hot blowdown line, the 1A1 RCP was shut down to allow personnel to isolate the line in the OTSG cavity. RCP 1A1 was restarted and rod withdrawal in preparation for approach to criticality began at 1050 on 12/28/81. At 1145 rod groups 1-8 were 100% WD and, using a constant feed and bleed, deboration to criticality began at 1230. Criticality was achieved at 1550 on 12/28/81 with rod groups 1-8 100% WD and the feed and bleed process was stopped. The RCS Boron concentration at 1600 was 1680 ppm.

Plots of 1/M (inverse multiplication) vs. RC temperature were obtained during the initial heatup and vs. control rod withdrawal when rods were withdrawn to perform the CRD trip time test. During deboration to criticality, 1/M plots vs. boron concentration and vs. time were maintained.

3.0 Pre-Physics Measurements

Due to leak repair work in the "A" OTSG cavity, the reactor power was initially limited to 10^{-10} amps on the Intermediate Range. During the time that the repair work was in progress, steady state reactor conditions were being established. After the work in the OTSG Cavity was stopped, and Sensible Heat measurements began at 0540 and were completed at 0630. A power level of 6.06×10^{-8} amps on the Intermediate Range was established as the upper power limit for ZPPT measurements.

The on-line reactimeter checkout was then performed by making reactivity insertions of about ± 250 μρ, ± 750 μρ, and ± 1200 μρ and measuring the associated power doubling times. These doubling times were input to an off-line reactivity calculation program and the results compared to the on-line signal. The results of this on-line reactimeter test, as well as those from the off-line test previously performed, were acceptable.

4.0 Physics Testing

A. All Rods Out (ARO) Boron Concentration Measurement

The ARO Boron concentration measurement was made during one of the large positive reactivity insertions of the on-line reactimeter checkout. The equilibrium conditions for this measurement were as follows:

RCS Boron Concentration - 1610 PPM
CR Groups 1-6 - 100% WD
CR Group 7 - 83.7% WD
CR Group 8 - 37.5% WD

CR Group 7 was then withdrawn to 100% WD and the corresponding total positive reactivity (+1000 $\mu\rho$) was converted to an equivalent boron concentration which was then added to the measured concentration. The ARO Boron concentration was determined to be 1622 PPM which was well within the acceptance criterion of 1625 ± 50 PPM. (See Enclosure 1.0).

B. Temperature Coefficient of Reactivity Measurements

The ARO and all regulating rods in (ARI) temperature coefficients were measured at the following control rod configurations and RCS T_{ave} temperatures:

ARO

CR Groups 1-6 - 100% WD
CR Group 7 - 84.6% WD
CR Group 8 - 37.5% WD

RCS T_{ave} temperature was reduced to 526.0°F, increased to 539.2°F, then returned to 532°F.

ARI

CR Groups 1-4 - 100% WD
CR Groups 6&7 - 0% WD
CR Group 5 - 6.6% WD
CR Group 8 - 37.3% WD

RCS T_{ave} temperature was reduced to 527.8°F, increased to 536.2°F, then returned to 532°F.

The ARO and ARI temperature coefficients were calculated by dividing the change in RCS temperature into the change in reactivity caused by the RCS temperature change. The moderator coefficients were calculated by subtracting the isothermal doppler coefficient ($-0.19 \times 10^{-4} \Delta K/K/°F$) 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 (CR Groups 5, 6 and 7) were measured by steadily deborating the RCS using the feed and bleed method and compensating for the resulting positive reactivity ramp by inserting the regulating rods. Starting at approximately + 400 μρ on the L and N chart recorder, the control rods were inserted in discrete steps of about -800 μρ. The measurement began with Group 7 at 85.3% WD and continued until Group 5 was at 8.0% WD. The Group 7 worth from 100% WD to 85.3% WD and the Group 5 worth from 8.0% WD to 0.0% WD were obtained by moving the rod group fully out/in while measuring the induced reactivity change. The reactivity changes resulting from the control rod insertions were summed for each group to obtain the group integral rod worth. (See Enclosures 2.0-2.3)

The differential boron worth (DBW) was calculated by dividing the total measured change in reactivity due to control rod insertion by the change in measured RCS boron concentration. (See Enclosure 1.0)

D. Ejected Rod Worth Measurement

With CR Groups 5, 6, and 7 at 0% WD, CR Groups 1-4 at 100% WD, and CR Group 8 at 37.5% WD, the predicted worst case ejected rod (CR Group 7 - rod 6, core location N-12) was measured by steadily borating the RCS. Group 7 - Rod 6 was withdrawn in discrete steps from 0% to 100% WD. The positive reactivity insertions (~ +800μρ) were summed to obtain the "ejected rod" worth. This value is then multiplied by a factor of 1.05 to obtain the "worst case" ejected rod worth.

The measured ejected rod worth of 0.41%ΔK/K deviated 34% from the predicted worth of 0.55%ΔK/K. This % deviation did not fall within the acceptable deviation of ±20% (of the measured worth from the predicted value). Therefore, to ensure core flux symmetry, the rods symmetric to Group 7 Rod 6 were swapped against Group 5. The symmetric rod worths were consistant, indicating normal core flux symmetry. B&W, Duke Power Nuclear Fuel Services, and Oconee Reactor Engineers then conferred. Because the measured ejected rod worth value was lower than the predicted value, and because core symmetry did exist, it was concluded that there was no adverse safety significance and that Oconee 1 Cycle 7 startup and power operation should continue. (See Enclosure 2.0 for results of ejected rod worth and symmetric rod swaps).

PART II

POWER ESCALATION TEST

1.0 Introduction and Summary

The Oconee 1 Cycle 7 Power Escalation Test (PET) was conducted from 12/30/81 - 4/9/82 per Station Procedure TT/1/A/811/07 approved on 12/15/81. Testing was performed at approximately 17%, 40%, 75%, and 100% F.P. to verify the nuclear parameters upon which the Oconee 1 Cycle 7 safety analysis and Technical Specifications are based. The principal tests were:

(a) NSS Heat Balance and RC Flow Verification (17, 40, 75, and 100% F.P.)

(b) Initial Core Power Distribution Check (17% F.P.)

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

(d) Core Power Distribution (40, 75, and 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.

At 1445 on 12/30/81 Unit 1 commenced power escalation. The Unit was held at ∿ 10% F.P. for scheduled Integrated Control System (ICS) adjustment. Unit 1 reached ∿ 17% F.P. at 0000 on 12/31/81. At this power level the initial Core Power Distribution check and NSS Heat Balance/RC Flow Verification were performed. The generator was placed on line at 2335 on 12/31/81. On 1/1/82, two anticipatory reactor trips occurred due to MSRH high level and MSDT high level. The reactor tripped again on 1/2/82 due to a false generator stator cooling indication.

The unit was at 40% F.P. on 1/3/82 at 2127 and power was decreased to about 28% F.P. for scheduled ICS adjustment. The unit returned to 40% F.P. at 0149 on 1/4/82. At 2200 on 1/5/82 all 40% F.P. testing was completed.

Unit 1 was shutdown on 1/6/82 at 0919 due to high vibration on one of the main turbine bearings. Feedwater heater and generator stator cooling leaks were also to be repaired before the unit was returned to service on 1/30/82. The reactor reached 75% F.P. on 2/1/82 at 0300 but had to reduce power to 55% F.P. at 0943 because of a leak on the recirculation line of the A Main Feedwater Pump. Reactor power was further decreased at 1640 and the generator taken off line due to excessive vibration on another main turbine bearing.

At 0500 on 2/4/82 the unit reached 75% F.P. On 2/5/82 at 1310 all power escalation testing at 75% F.P. was completed and power escalation to 100% F.P. was begun. Unit 1 reached 100% F.P. at ~ 1300 on 2/6/82. The NSS Heat Balance, Incore Detector Checkout, and Core Power Distribution were performed on 2/8/82.

Reactor shutdown commenced on 2/9/82 because of an OTSG tube leak. The unit was restarted on 2/26/82 and reached 100% F.P. on 2/27/82 at 2045. Because the computer equipment used to perform the reactivity coefficients testing is brought in from off-site, the test was scheduled to be performed on 3/4/82. However, on 3/4/82 the unit had to reduce power because of and EHC oil leak on a turbine intercept valve. The leak was repaired and the unit returned to 100% F.P. at 0258 on 3/5/82. On 3/6/82, before Xenon equilibrium could be achieved, the unit had to shutdown due to another OTSG tube leak. The unit was returned to service on 3/24/82 and reactor power reached 100% F.P. at 1607 on 3/25/82.

The Temperature and Doppler Coefficient measurements were taken on 3/26/82 and 3/27/82. The RC Flow constants were verified to be acceptable on 3/30/82. ΔT Power calculation constants were checked and revised on 4/5/82. Finally, the data reduction and analysis associated with the reactivity coefficients at power measurements were satisfactorily completed on 4/9/82.

2.0 NSS Heat Balance/RC Flow Verification

An NSS Heat Balance/RC Flow Verification was performed at steady state operation for power levels of 17%, 40%, 75%, and 100% F.P. These tests verified the accuracy of CTPA (the on-line plant computer program which performs a primary and secondary heat balance) when compared to heat balances calculated by off-line programs. The primary flow rate was verified to be between 106.5% (minimum value referenced in Technical Specifications) and 119% (value to assure against fuel assembly lift) of design flow by calculating primary flow rate from the secondary heat balances.

To verify CTPA accuracy, the plant computer averaged heat balance data (flows, temperatures, pressures, etc.) for 15 minutes. This data was input into the off-line heat balance programs and the results were compared to CTPA averages for the same period.

An off-line program was used to calculate RC flow based on the secondary heat balance and primary loop enthalpy changes. Because the feedwater flow measurement at low power levels is inaccurate, the value used for percent design flow at the 17% F.P. level was derived from primary ΔP instrumentation.

3.0 Core Power Distribution

Core Power Distribution (CPD) checks were conducted at 40%, 75%, and 100% F.P. power levels. These tests verified that reactor power imbalance, quadrant power tilt, minimum DNBR, maximum LHR and radial/total power peaks did not exceed their respective specified limits.

Reasonable outputs from the incore detector backup recorders were also verified. Specific checks were made as follows:

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

The maximum positive quadrant power tilt was verified to be less than the error adjusted LOCA limit of +3.71% (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) $\frac{\text{LMP} - \text{LPP}}{\text{LMP}} \times 100 \leq$

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

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:

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

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 using the backup incore recorder outputs and then compared to the full incore values.

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

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 to verify these slopes to be conservative with respect to the FSAR

b) to verify reasonable power imbalance agreement between the backup incore detector recorder system and the full incore detector system

c) to verify the adequacy of the RPS flux/flow/imbalance trip envelope by demonstrating that both the 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 were within the LOCA limit curve of Technical Specification figure 3.5-2.5.

Each of these parameters was measured (or calculated) at imbalance levels of +6.16, +2.66, -0.20, -3.68, -6.47, and -9.73% F.P. These imbalance levels were achieved by positioning of CR Group 8 (APSR's).

The incore/outcore imbalance correlation slope for each NI Channel (5-8) was determined by a least squares fit of outcore to incore imbalance indications for the six imbalance levels.

The backup incore/full incore correlation was determined by hand calculating imbalance using the backup recorder outputs and plotting this value versus the full incore imbalance value obtained from the plant computer. These points were required to be within a specified range.

Values for 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 (<20.05 Kw/ft and > 1.30 DNBR)

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

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. The test results are summarized in Enclosure 5.0.

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 specified 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.

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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 @ 100% wd Gp 8 at 37.5% wd	1622 ppm	1625 ppm	3 ppm	Predicted ±50 ppm
Differential Boron Worth	1430 ppm Average During Measurement	-0.906% ΔK/K per 100 ppm	-0.86% ΔK/K per 100 ppm	*-5.1%	Measured < 1.33% ΔK/K per 100 ppm and ±15% Deviation

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

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ENCLOSURE 2.0
INTEGRAL GROUP AND WORST CASE EJECTED ROD WORTH MEASUREMENTS

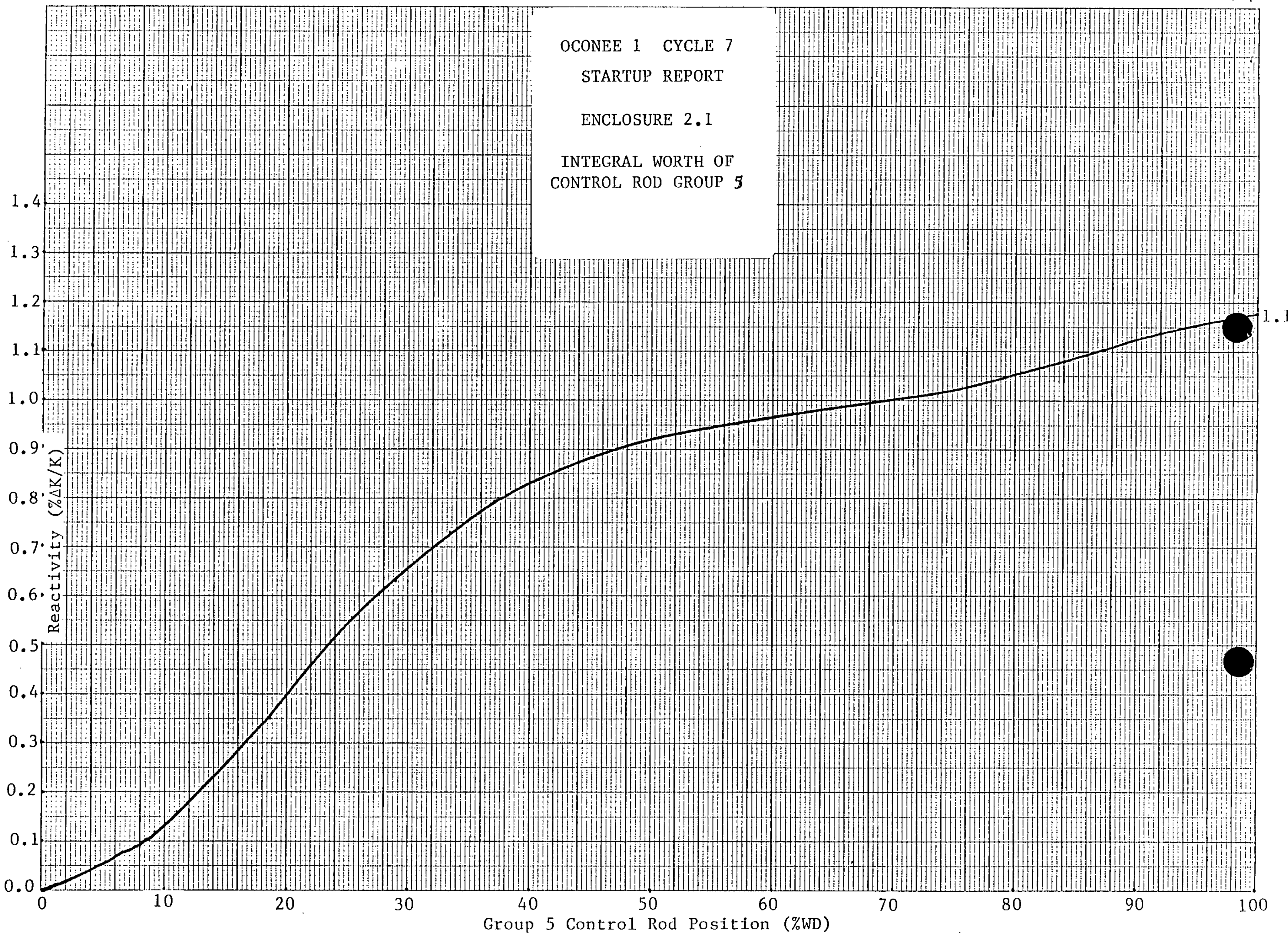
PARAMETER	CONDITIONS		MEASURED VALUE	PREDICTED VALUE	DEVIATION	ACCEPTANCE CRITERION
Gp 7 Integral Worth	N/A		-1.34% ΔK/K	-1.34% ΔK/K	-0.0%	± 15% Deviation
Gp 6 Integral Worth	N/A		-0.93	-0.86	-7.5%	± 15% Deviation
Gp 5 Integral Worth	N/A		-1.18	-1.30	+10.2%	± 15% Deviation
GP 5-7 Integral Worth	N/A		-3.44	-3.50	+1.7	± 10% Deviation
Worst Case Ejected Rod Worth	Gp5 at 0% wd	Boron Swap Rod Swap	-0.41 -0.56	 -0.55	+34.1 -1.8	± 20% Deviation
Error Adjusted Worst Case Ejected Rod Worth	Gp5 at 0% wd 532°F	Boron Swap Rod Swap	-0.43 -0.59	N/A	N/A	Measured < -1.0% ΔK/K

Symmetric Rod Swap Worths

Location	Gp/Rod	Conditions	Measured Value	Predicted Value	Deviation	Acceptance Criterion
N-12	7-6		-0.56% ΔK/K		+4.3%	± 20% *
N-4	7-9		-0.55		+6.0%	
D-4	7-12	N/A	-0.63	N/A	-7.7%	
D-12	7-3		-0.60		-2.6%	

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

$$\text{*For Symmetry Check \% Deviation} = \frac{(\text{Av. worth of symmetric rods} - \text{individual rod worth})}{\text{Av. worth of symmetric rods}} \times 100$$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STARTUP REPORT
ENCLOSURE 2.1
INTEGRAL WORTH OF
CONTROL ROD GROUP 5
Reactivity (%ΔK/K)
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
10
20
30
40
50
60
70
80
90
100
Group 5 Control Rod Position (%WD)

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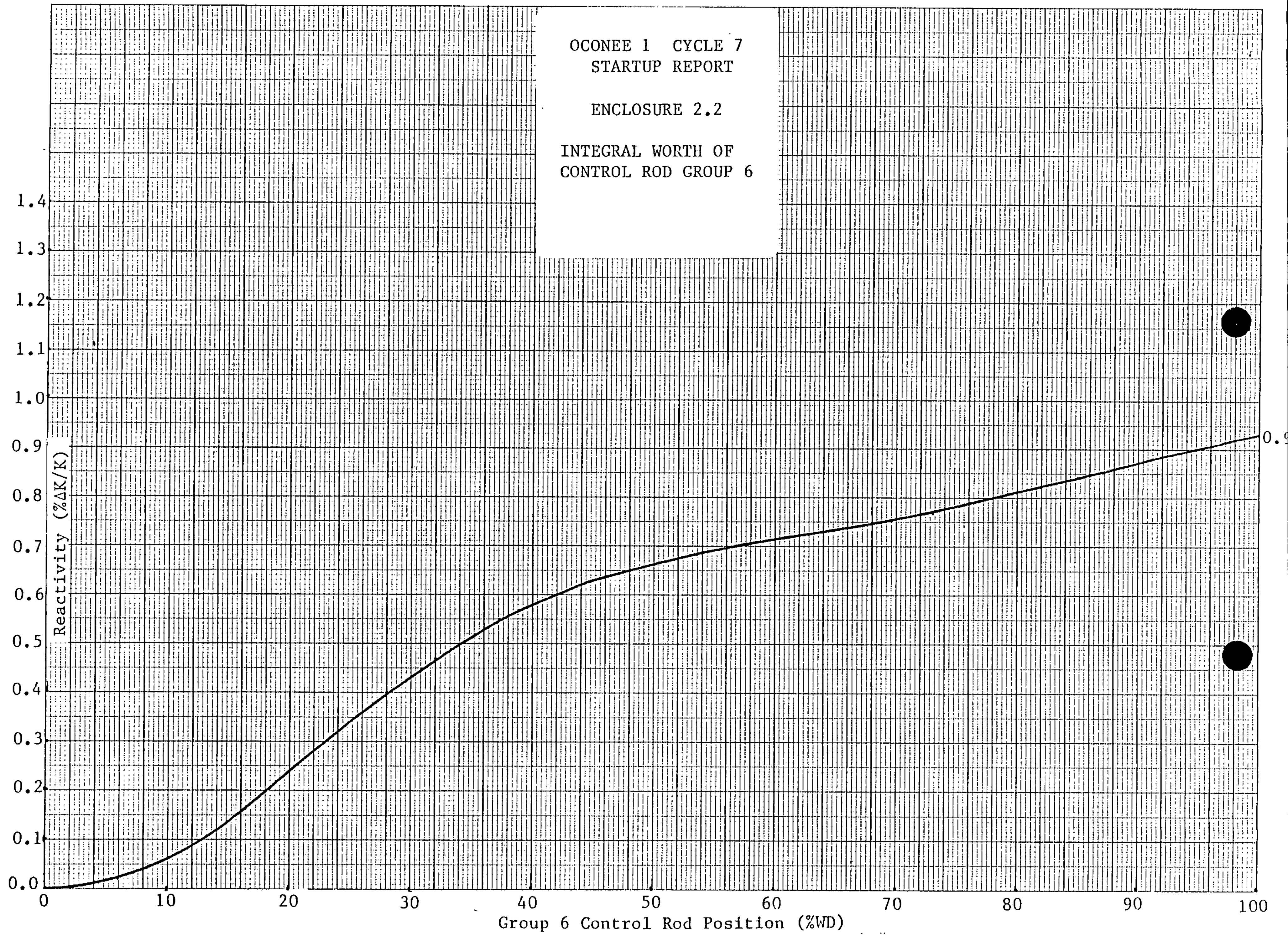
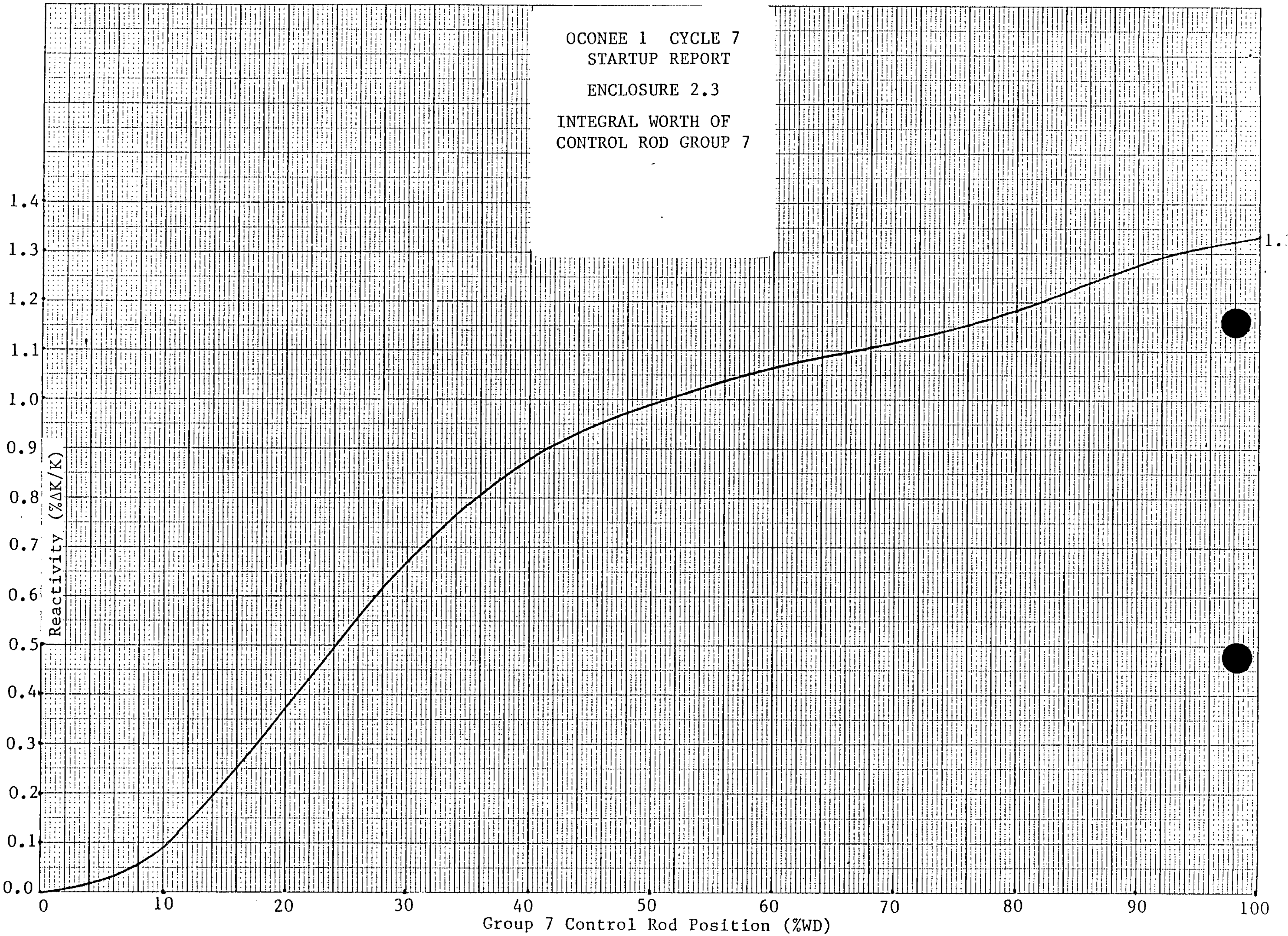
ENCLOSURE 2.2

INTEGRAL WORTH OF
CONTROL ROD GROUP 6

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ENCLOSURE 2.3
INTEGRAL WORTH OF
CONTROL ROD GROUP 7
Reactivity (%ΔK/K)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
0
10
20
30
40
50
60
70
80
90
100
Group 7 Control Rod Position (%WD)

Radial Peaking Factor Comparison 40 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8		.773	.74	4.46
G-8		1.175	1.17	0.43
F-8	5	1.081	1.04	3.94
E-8		1.358	1.37	-0.88
D-8		1.258	1.18	6.61
C-8		1.234	1.29	-4.34
B-8	7	0.92	0.92	0.00
A-8		.441	0.47	-6.17
G-9		1.078	1.04	3.65
F-9		1.094	1.04	5.19
E-9		1.173	1.16	1.12
D-9		1.312	1.35	-2.82
C-9	6	1.022	1.03	-0.78
B-9		1.073	1.13	-5.04
A-9		.442	.44	0.46
F-10	7	1.153	1.17	-1.45
E-10		1.350	1.36	-0.74
D-10	8	1.136	1.15	-1.22
C-10		1.247	1.31	-4.81
B-10		.917	0.87	+5.40
A-10		.349	0.36	-3.06
E-11	5	1.278	1.23	3.90
D-11		1.294	1.33	-2.71
C-11		1.048	1.01	3.76
B-11		.842	.87	-3.22
D-12	7	1.071	1.01	6.04
C-12		1.003	0.97	3.40
B-12		.455	0.45	1.11
C-13		.499	0.47	6.17

INCORE TILT

WX: +1.31%
XY: +0.94
YZ: -1.09
ZW: -1.14

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	2.0 EFPD	1.16 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.1 % wd.	91.9 % wd.
GP 8	35.3 % wd.	35.3 % wd.
IMB.	-0.28% imb.	+0.02 % imb.
POWER	40 % FP	40 % FP
BORON		1300 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 = 6.61 % in 1/8th Core Location D-8
RMS RADIAL PEAKING FACTOR DEVIATION = 0.042
HIGHEST MEASURED RADIAL PEAK = 1.37 in 1/8th core location E-8

$\frac{\text{LMP} - \text{LPP}}{\text{LMP}} \times 100 =$ 0.88 %

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ENCLOSURE 3.1

Total Peaking Factor Comparison 40 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8		.868	0.82	5.85
G-8		1.334	1.31	1.83
F-8	5	1.227	1.16	5.78
E-8		1.531	1.57	-2.48
D-8		1.435	1.33	7.90
C-8		1.414	1.43	-1.12
B-8	7	1.111	1.07	3.83
A-8		.528	0.54	-2.22
G-9		1.219	1.18	3.31
F-9		1.257	1.18	6.53
E-9		1.35	1.32	2.27
D-9		1.519	1.56	-2.63
C-9	6	1.165	1.17	-0.43
B-9		1.258	1.33	-5.41
A-9		.518	0.51	1.57
F-10	7	1.341	1.33	0.83
E-10		1.565	1.58	-0.95
D-10	8	1.455	1.49	-2.35
C-10		1.447	1.51	-4.17
B-10		1.065	0.98	8.67
A-10		0.41	0.41	0.00
E-11	5	1.474	1.43	3.08
D-11		1.521	1.56	-2.50
C-11		1.237	1.16	6.64
B-11		1.001	0.99	1.11
D-12	7	1.284	1.16	10.69
C-12		1.207	1.11	8.74
B-12		.542	0.50	8.40
C-13		.607	0.53	14.53

INCORE TILT

WX: +1.31%
XY: +0.94
YZ: -1.09
ZW: -1.14

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	2.0 EFPD	1.16 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.1 % wd.	91.9 % wd.
GP 8	35.3 % wd.	35.3 % wd.
IMB.	-0.28 % imb.	+0.02% imb.
POWER	40 % FP	40 % FP
BORON		1300 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 = 14.53 % in 1/8th Core Location C-13
HIGHEST MEASURED TOTAL PEAK = 1.58 in 1/8th core location E-10

$\frac{LMP - LPP}{LMP} \times 100 = 0.95\ \%$

Radial Peaking Factor Comparison 75 % FP

Core Location	H-8	G-8	F-8	E-8	D-8	C-8	B-8	A-8
Rod Group Number			5				7	
Predicted Peak	0.779	1.168	1.078	1.335	1.242	1.224	0.931	0.461
Measured Peak	0.75	1.19	1.05	1.34	1.17	1.29	0.92	0.47
% Deviation	3.87	-1.85	2.67	-0.37	6.15	-5.12	1.20	-1.91

Core Location	G-9	F-9	E-9	D-9	C-9	B-9	A-9
Rod Group Number					6		
Predicted Peak	1.077	1.092	1.162	1.291	1.023	1.080	0.462
Measured Peak	1.05	1.05	1.15	1.35	1.04	1.12	0.45
% Deviation	2.57	4.00	1.04	-4.37	-1.63	-3.57	2.67

Core Location	F-10	E-10	D-10	C-10	B-10	A-10
Rod Group Number	7		8			
Predicted Peak	1.145	1.325	1.124	1.239	0.930	0.366
Measured Peak	1.14	1.35	1.14	1.30	0.89	0.37
% Deviation	0.44	-1.85	-1.40	-4.69	4.49	-1.08

Core Location	E-11	D-11	C-11	B-11
Rod Group Number	5			
Predicted Peak	1.260	1.277	1.054	0.862
Measured Peak	1.23	1.32	1.00	0.88
% Deviation	2.44	-3.26	5.40	-2.05

Core Location	D-12	C-12	B-12
Rod Group Number	7		
Predicted Peak	1.073	1.013	0.475
Measured Peak	0.99	0.98	0.47
% Deviation	8.38	3.37	1.06

Core Location	C-13
Rod Group Number	
Predicted Peak	0.516
Measured Peak	0.48
% Deviation	7.5

INCORE TILT

WX: +0.81%
XY: +1.43
YZ: -0.72
ZW: -1.51

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	3 EFPD	4.53 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.1 % wd.	89.0 % wd.
GP 8	32.0 % wd.	32.1 % wd.
IMB.	-1.78 % imb.	+1.73% imb.
POWER	75 % FP	75 % FP
BORON		1240 ppm

KEY

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

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

HIGHEST % DEVIATION = 8.38 % in 1/8th Core Location D-12
RMS RADIAL PEAKING FACTOR DEVIATION = 0.041
HIGHEST MEASURED RADIAL PEAK = 1.35 in 1/8th core location E-10, D-9

$\frac{\text{LMP} - \text{LPP}}{\text{LMP}} \times 100 = 1.11\ \%$

Total Peaking Factor Comparison 75 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8		0.867	0.84	3.21
G-8		1.330	1.37	-2.92
F-8	5	1.215	1.20	1.25
E-8		1.511	1.56	-3.14
D-8		1.414	1.34	5.52
C-8		1.402	1.50	-6.53
B-8	7	1.116	1.13	-1.24
A-8		0.550	0.57	-3.51
G-9		1.220	1.23	-0.81
F-9		1.250	1.21	3.31
E-9		1.313	1.35	-2.74
D-9		1.511	1.60	-5.56
C-9	6	1.161	1.21	-4.05
B-9		1.267	1.35	-6.15
A-9		0.539	0.53	1.70
F-10	7	1.343	1.36	-1.25
E-10		1.573	1.61	-2.30
D-10	8	1.444	1.53	-5.62
C-10		1.476	1.53	-3.53
B-10		1.073	1.02	5.20
A-10		0.428	0.43	-0.47
E-11	5	1.475	1.47	0.34
D-11		1.537	1.55	-0.84
C-11		1.231	1.16	6.12
B-11		1.021	1.03	-0.87
D-12	7	1.293	1.17	10.51
C-12		1.212	1.16	4.48
B-12		0.562	0.53	6.04
C-13		0.624	0.57	9.47

INCORE TILT

WX: +0.81%
XY: +1.43
YZ: -0.72
ZW: -1.51

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	3 EFPD	4.53 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.1 % wd.	89.0 % wd.
GP 8	32.0 % wd.	32.1 % wd.
IMB.	-1.78 % imb.	+1.73 % imb.
POWER	75 % FP	75 % FP
BORON		1240 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 = 10.51 % in 1/8th Core Location D-12
HIGHEST MEASURED TOTAL PEAK = 1.61 in 1/8th core location E-10

$\frac{LMP - LPP}{LMP} \times 100 =$ 2.30 %

Radial Peaking Factor Comparison 100 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8		0.786	0.77	2.08
G-8		1.167	1.20	-2.75
F-8	5	1.080	1.06	1.89
E-8		1.326	1.34	-1.04
D-8		1.235	1.17	5.56
C-8		1.219	1.28	-4.77
B-8	7	0.936	0.92	1.74
A-8		0.469	0.48	-2.29
G-9		1.080	1.06	1.89
F-9		1.094	1.06	3.21
E-9		1.159	1.15	0.78
D-9		1.282	1.34	-4.33
C-9	6	1.024	1.04	-1.54
B-9		1.081	1.13	-4.34
A-9		0.471	0.46	2.39
F-10	7	1.144	1.15	-0.52
E-10		1.315	1.34	-1.87
D-10	8	1.120	1.12	0.00
C-10		1.233	1.29	-4.42
B-10		0.934	0.89	4.94
A-10		0.374	0.37	1.08
E-11	5	1.252	1.22	2.62
D-11		1.269	1.32	-3.86
C-11		1.054	1.01	4.36
B-11		0.867	0.88	-1.48
D-12	7	1.074	1.00	7.40
C-12		1.015	0.98	3.57
B-12		0.483	0.47	2.77
C-13		0.523	0.49	6.73

INCORE TILT

WX: +1.22%
XY: +1.09
YZ: -1.05
ZW: -1.25

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	4 EFPD	7.47 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.1 % wd.	88.9 % wd.
GP 8	28.8 % wd.	28.8 % wd.
IMB.	-2.52 % imb.	-0.26 % imb.
POWER	100 % FP	~99.3 % FP*
BORON		1110 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 = 7.40 % in 1/8th Core Location D-12
RMS RADIAL PEAKING FACTOR DEVIATION = 0.0395
HIGHEST MEASURED RADIAL PEAK = 1.34 in 1/8th core location E-8, D-9, E-10

$\frac{\text{LMP} - \text{LPP}}{\text{LMP}} \times 100 = 1.04\ \%$

*Power level from heat balance.

Total Peaking Factor Comparison 100 % FP

Core Location	Rod Group Number	Predicted Peak	Measured Peak	% Deviation
H-8		0.881	0.84	4.88
G-8		1.329	1.35	-1.56
F-8	5	1.227	1.19	3.11
E-8		1.511	1.54	-1.88
D-8		1.418	1.30	9.08
C-8		1.407	1.46	-3.63
B-8	7	1.127	1.12	0.63
A-8		0.558	0.57	-2.11
G-9		1.224	1.23	-0.49
F-9		1.250	1.20	4.17
E-9		1.332	1.31	1.68
D-9		1.498	1.54	-2.73
C-9	6	1.182	1.17	1.03
B-9		1.261	1.33	-5.19
A-9		0.553	0.53	4.34
F-10	7	1.359	1.36	-0.07
E-10		1.556	1.55	0.39
D-10	8	1.420	1.50	-5.33
C-10		1.467	1.48	-0.88
B-10		1.088	1.01	7.72
A-10		0.435	0.43	1.16
E-11	5	1.466	1.41	3.97
D-11		1.522	1.51	0.79
C-11		1.232	1.15	7.13
B-11		1.018	1.02	-0.20
D-12	7	1.295	1.17	10.68
C-12		1.205	1.15	4.78
B-12		0.569	0.53	7.36
C-13		0.627	0.56	11.96

INCORE TILT

WX: +1.22%
XY: +1.09
YZ: -1.05
ZW: -1.25

	ASSUMED CONDITIONS FOR PEAKING PREDICTIONS	ACTUAL MEASUREMENT CONDITIONS
BURNUP	4 EFPD	7.47 EFPD
GP 5	100 % wd.	100 % wd.
GP 6	100 % wd.	100 % wd.
GP 7	87.1 % wd.	88.9 % wd.
GP 8	28.8 % wd.	28.8 % wd.
IMB.	-2.52% imb.	-0.26% imb.
POWER	100 % FP	~99.3 % FP *
BORON		1110 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 = 11.96 % in 1/8th Core Location C-13

HIGHEST MEASURED TOTAL PEAK = 1.55 in 1/8th core location E-10

$\frac{LMP - LPP}{LMP} \times 100 =$ -0.387%

*Power level from heat balance.

OCONEE 1 CYCLE 7

STARTUP REPORT

ENCLOSURE 4.0

MINIMUM DNBR AND MAXIMUM LHR CALCULATIONS AT

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

Power Level	Burnup (EFPD)	Gp6/7/8 Positions	Boron CONC (PPM)	Incore Imbalance (% F.P)	Incore Tilt WX/XY YZ/ZW (%)	MDNBR	Extrapolated Worst Case MDNBR	MLHR (KW/FT)	Extrapolated Worse Case MLHR (KW/FT)
40	1.156	100/92/35 % WD	1300	+0.07	+1.31/+0.94 -1.09/-1.14	9.33	3.75	4.46	9.53
75	4.527	100/89/32	1240	+1.73	+0.81/+1.43 -0.72/-1.51	4.44	2.59	8.53	12.0
100	7.473	100/89/29	1110	-0.26	+1.22/+1.09 -1.05/-1.25	3.09	2.45	10.92	11.61

NOTE: The 40% F.P. cases were extrapolated to 85% F.P. and the 75% F.P./100% F.P. cases were extrapolated to 104.9% F.P.

OCONEE 1 CYCLE 7
STARTUP REPORT
ENCLOSURE 5.0
40% F.P. PIDC THERMAL CALCULATION AND CORRELATION SLOPE RESULTS

Full Incore Imbalance	MLHR	Worst Case Extrapolated MLHR	MDNBR	Extrapolated MDNBR
+6.16 % F.P.	5.43 KW/ft.	14.3 KW/ft.	7.96	2.7
+2.66	4.90	13.0	8.62	3.0
-0.20	4.49	11.9	9.39	3.3
-3.68	4.85	12.4	9.84	3.7
-6.47	5.20	12.8	9.13	3.6
-9.73	5.54	12.7	8.45	3.3

NOTE: All extrapolations are to 104.9% F.P. Except the ∿ -6.47% F.P. and the ∿ -9.73% F.P. imbalance cases (where ϕ/flow/imbalance reduces the maximum allowable trip setpoints to ∿ 100.5% F.P. and ∿ 93.9% F.P., respectively).

	NI 5	NI 6	NI 7	NI 8
Correlation Slope	1.25	1.27	1.30	1.26
Differential Amp. Gain Setting	4.80	4.80	4.80	4.80

OCONEE 1 CYCLE 7
STARTUP REPORT
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 @ 84.6% wd 1610 ppm	$+0.083 \times 10^{-4}$ ΔK/K per °F	-0.000×10^{-4} ΔK/K per °F	Predicted ± 0.3×10^{-4} ΔK/K per °F
Hot Zero Power Moderator Coefficient (ARO)	Tav = 532°F Gp 5,6 @ 100% wd Gp 7 = 84.6% WD 1610 ppm	$+0.273 \times 10^{-4}$	$+0.190 \times 10^{-4}$	Predicted ± 0.3×10^{-4} ΔK/K per °F and Measured ≤ $+0.5 \times 10^{-4}$ ΔK/K per °F
Hot Zero Power Temperature Coefficient (Control Rods In)	Tav = 532°F Gp 6,7 @ 0% WD Gp 5 @ 6.6% WD 1250 ppm	-0.600×10^{-4}	-0.71×10^{-4}	Predicted ± 0.3×10^{-4} ΔK/K per °F
Hot Zero Power Moderator Coefficient (Control Rods In)	Tav = 532°F Gp 6,7 @ 0% WD Gp 5 @ 6.6% WD 1250 ppm	-0.410×10^{-4}	-0.52×10^{-4}	Predicted ± 0.3×10^{-4} ΔK/K per °F and Measured ≤ $+0.5 \times 10^{-4}$ ΔK/K per °F
Hot Full Power BOC Temperature Coefficient Extrapolated to 95% F.P.	Tav = 579°F	-0.704×10^{-4}	N/A	(1) Temperature Coefficient more negative than -0.15×10^{-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	-2.62×10^{-4}	N/A	(2) Temperature Coefficient more positive than -3.12×10^{-4} ΔK/K per °F at 100% F.P.
Hot Full Power BOC Power Doppler Coefficient Extrapolated to 100% F.P.	Tav = 579°F	-0.809×10^{-4}	N/A	(3) Power Doppler Coefficient more negative than -0.55×10^{-4} ΔK/K per % F.P. at 100% F.P.

OCONEE 1 CYCLE 7

STARTUP REPORT

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.	16.31	N/A	16.22	N/A	*109.53% Design
40% F.P.	39.23	40.81	39.19	40.57	113.70
75% F.P.	74.0	75.93	73.95	75.74	111.75
100% F.P.	99.11	99.34	98.85	99.13	107.99

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