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INDIAN POINT UNIT NO. 2 CYCLE 3

STARTUP PHYSICS TEST REPORT

CONSOLIDATED EDISON COMPANY OF NEW YORK INC.

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ABSTRACT

This report summarizes the results of the Startup Physics Tests for Cycle 3 of the Indian Point Unit No. 2 Reactor performed at Hot Zero Power condition, and during reactor power level escalation. Results of these tests demonstrate adequate conservatism of the Cycle 3 design for safe operation in accordance with the Indian Point Unit No. 2 Technical Specifications.

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I. Introduction

Indian Point Unit No. 2 attained initial criticality for Cycle 3 operation on May 23, 1978. A series of physics tests described in Table 1.1 were carried out.

The objectives of these tests were: (a) to demonstrate that the core parameters during reactor operation would be within the assumptions of the accident analyses in FSAR (Reference 1) and within Technical Specification (Reference 2) limits; (b) to verify the nuclear design calculations; and (c) to provide the bases for the calibration of reactor instrumentation. Section 2 of this report gives a brief description of the reactor core and Cycle 3 core loading. Section 3 deals with measurement methods used in startup tests. In Section 4, results from Hot Zero Power (HZP) physics tests are presented and in Section 5, physics tests at different power levels up to 100% power are described. Reactor instrumentation (excore detectors, incore T/C and wide range RTDs) calibration are treated in Section 6.

The test results reported here are compared against revised Westinghouse core analysis model results (Reference 3). The revised model has improved spatial representation of water reflector across the core boundary and also contains updated control rod neutron cross sections.

Table 1.1 Indian Point Unit No. 2 Cycle 3 Startup Physics Test Program

1. Pre-criticality Measurements

Incore Thermocouple and Wide Range RTD Calibration.

2. Hot Zero Power (HZP) No Xenon Condition Tests

2.1 Initial Criticality

2.2 Isothermal Temperature Coefficient at Control rod configurations given below.

(i) All Rods Out
(ii) Control Bank D In
(iii) Control Banks, C and D In
(iv) Control Banks D, C & B at HZP Insertion Limit

2.3 End Point Boron Concentrations for Control rod configurations given below.

(i) All Rods Out
(ii) Control Bank D In
(iii) Control Banks D and C In
(iv) Control Banks D, C & B at HZP Insertion Limit

2.4 Control Rod Worth (Integral and Differential) Measurements

(i) Control Bank D
(ii) Control Bank C with Control Bank D In
(iii) Control Bank D, C and B in overlap up to HZP Insertion Limit.

3. Power Ascension Tests

3.1 Ex-core Detectors Calibration at~90% of reactor power.

3.2 Power Coefficient Measurements at~90% of reactor power.

3.3 Movable Incore Detector Flux Maps at power levels $<$5%,~40%,~90% and~100% of reactor power.

3.4 Reactor Coolant Flow Measurement.

2. Reactor Core Description

Indian Point Unit No. 2 core consists of 193 fuel assemblies of slightly enriched uranium dioxide. Each fuel assembly contains 204 fuel rods with zirconium alloy cladding, 20 stainless steel rod cluster control (RCC) guide tubes for inserting control rods, and a central stainless steel instrumentation thimble. Fourteen twice depleted burnable poison rods, coupled to the Sb-Be secondary sources were inserted in assembly locations H-3 and H-13. To ensure quarter core symmetry similar burnable poison configurations were placed in locations C-8 and N-8.

2.1 Reactor Core Control

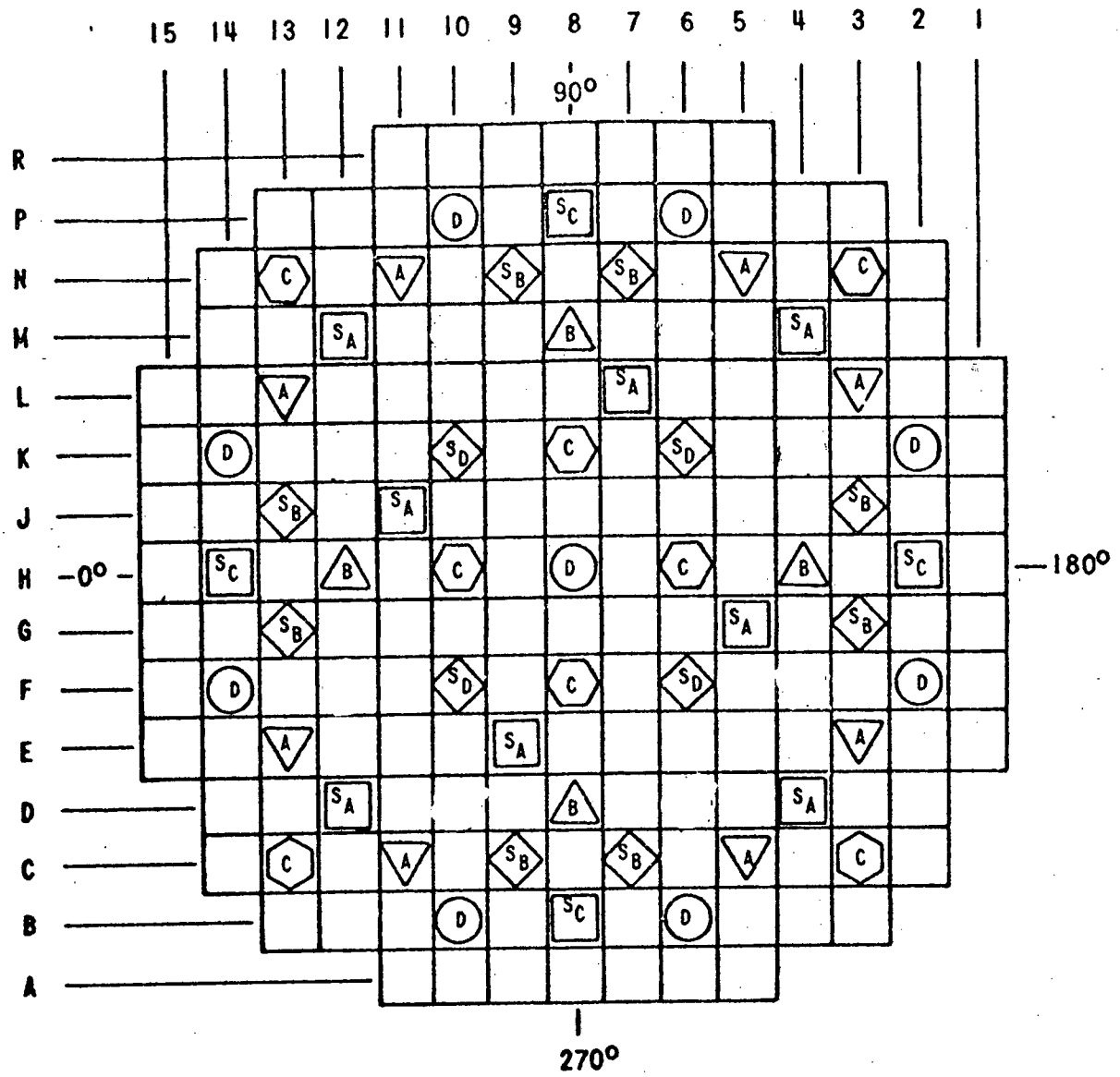
In addition to the chemical shim control by boric acid dissolved in the coolant water, control and shutdown of the reactor is accomplished by 53 full-length Rod Cluster Control Assemblies (RCCA's). The latter consist of four control and four shutdown banks. Figure 2.1 is an X-Y cross-section of the reactor core describing RCC bank positions.

2.2 Reactor Core Instrumentation

The reactor core instrumentation consists of four ex-core detectors, six moveable in-core detectors (M/D) capable of scanning up to 50 fuel assemblies through their central thimble guide tubes, 65 in-core thermocouples (T/C) to monitor exit coolant temperatures. Figure 2.2 shows the in-core instrumentation.

2.3 Cycle 3 Core Loading

The Indian Point Unit No. 2 Cycle 3 core loading as shown in Figure 2.3, was completed by April 20, 1978. The final core loading was in agreement with the core loading pattern as developed by Westinghouse and described on Westinghouse drawing #1448E88, with the exception of a switch in the core location of symmetrical fuel assemblies D-44 and D-40. During the removal of burnable poison rods from D-44 assembly a small portion of a broken burnable poison rodlet could not be removed from the assembly. This precluded its placement in core location L-7 due to the presence of a control rod at this position. D-44 was subsequently loaded into core position L-9 and D-40 into L-7. This change was reviewed and approved by Westinghouse.



BANK	SYMBOL	NUMBER OF ROD CLUSTERS
S_A	□	8
S_B	◇	8
S_C	□	4
S_D	◇	4
A	▽	8
B	△	4
C	⬡	8
D	○	9

Figure 2.1 Control Rod Locations

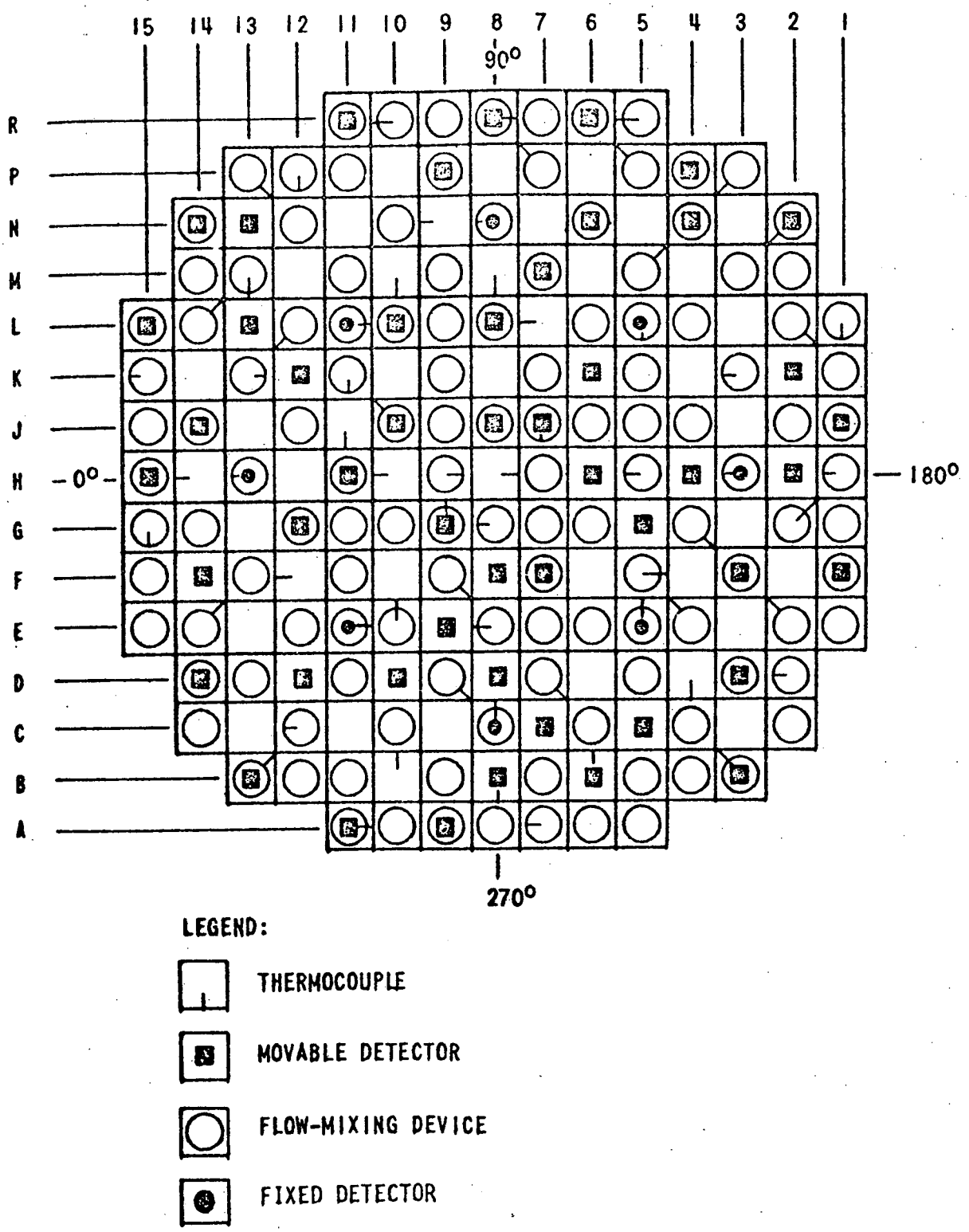


Figure 2-2 In-Core Instrumentation Thermocouples and Movable Detectors

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
R					E05 21	E25 38	E28 56	D13 36	E43 87	E45 67	E03 99				
P			E56 107	E12 109	E37 86	C40 R19	E38 211	B41 R24	E33 120	C42 R38	E35 119	E24 129	E27 106		
N		E01 110	E42 R21	C25 57	C13 R48	C47 72	C44 R51	D26 B6 P10	C48 R12	C57 77	C20 R08	C22 54	E22 R34	E14 63	
M		E50 105	C36 58	D15 R44	D06 43	D30 39	D35 40	C29 R23	D55 41	D03 42	D67 35	D56 R49	C30 49	E48 83	
L	E40 98	E60 68	C15 R26	D45 24	C19 126	D48 76	D44 * 44	D53 SS3	D40 R27	D29 108	C33 62	D63 25	C18 R13	E39 209	E36 208
K	E47 207	C60 R16	C62 130	D12 26	D57 104	C06 R01	D46 123	D65 R52	D32 31	C05 R42	D14 111	D38 27	C58 114	C54 R03	E13 206
J	E52 205	E11 204	C52 R17	D60 19	D62 R20	D72 29	D27 32	C31 51	D59 10	D49 30	D71 78	D07 20	C39 R36	E26 203	E46 202
H	D19 14	B49 R30	D02 SS2	C41 R47	D70 P2	D54 R41	C09 45	B53 R37	C37 113	D31 R05	D08 48	C46 R32	D52 SS1	B62 R53	D50 28
F	E31 201	E49 128	C49 R31	D22 22	D11 103	D10 12	D51 33	C14 55	D04 P1	D09 13	D23 R39	D37 23	C56 R10	E51 127	E59 125
E	E06 124	C59 AR48	C63 101	D36 15	D39 100	C01 R14	D69 11	D61 R09	D47 5	C23 R15	D17 96	D42 16	C61 88	C55 R43	E58 122
D	E07 121	E19 117	C16 R35	D64 17	C32 34	D66 66	D68 R46	D58 118	D25 84	D24 65	C27 64	D28 18	C24 R07	E10 116	E20 115
C		E30 210	C38 52	D16 R33	D34 7	D18 8	D05 1	C35 R04	D41 2	D35 3	D21 4	D20 AR18	C34 46	E29 97	
B		E15 94	E44 R28	C28 47	C21 R06	C50 102	C64 R29	D01 B6 P9	C53 AR11	C43 80	C17 R02	C26 50	E34 R45	E53 93	
A			E32 92	E16 91	E23 90	C51 R50	E09 89	B48 R40	E08 85	C45 R22	E17 82	E41 81	E54 79		
					E18 75	E04 74	E02 73	D43 6	E21 71	E57 70	E55 112				

EAST

WEST

NORTH

SOUTH

0°

270°

* Ass. D44 contains broken Rodlet from 12P33

ASSMLY ID
INSERT ID
BURNUP

SYMBOLS

Figure 2-3 INDIAN POINT 2 CYCLE 3 LOADING PATTERN

3. Measurement Methods

The reactor was maintained at the just critical state during the physics measurements and the reactor power was held constant via control rod/boron exchanges and/or control rod/coolant temperature exchanges. Small changes in core reactivity during the tests were indicated by a reactivity trace provided by a reactivity computer. The axial power distribution in the instrumented assemblies were obtained using the moveable in-core detectors.

3.1 Reactivity Measurement

The absolute measurement of small changes in reactivity was provided by the on-line solution of the point-reactor kinetics equations using an analog reactivity computer. The computer was checked out by comparing the reactivity obtained from the reactor period with that given directly by the reactivity computer. This comparison is shown in Table 3.1. A good agreement between reactivities obtained from two sources demonstrated the reliability of delayed neutron data, given in Table 3.2. This data was used as an input to the solution of neutron kinetics equations by the reactivity computer.

During HZP tests, an output signal from an ex-core detector, Channel N-42, as shown in Figure 3.1, was fed into the reactivity computer. During the power coefficient test, signals from the top and bottom sections of all four ex-core detectors were first summed and then fed into the reactivity computer

3.2 Core Power Distribution Measurement

The Movable Detector (M/D) Flux Mapping System was used to collect power distribtuion data during start up tests at various power levels. Data from the M/D system was input to the INCORE 2 code (Reference 4) to generate three dimensional core power profiles. The INCORE 2 code combines measured flux distributions with calculated (design) flux distributions to yield measured hot channel factors $F_{\Delta H}^{N}$ and F_Q, quadrant tilt, core average axial offset, relative assembly power distributions, etc.

3.3 Thermal Power Measurement

Core thermal power was determined by performing a heat balance across each of the steam generators. This measurement required the accurate determination of steam generator pressure, feedwater inlet temperature, feedwater flow, steam generator blowdown and other parameters.

Table 3.1

Period to Reactivity Comparison

Doubling Time (sec)	Reactor Period (sec)	Reactivity Pred.(pcm)	Reactivity Meas. (pcm)	Difference (M-P)pcm
79	114	47.8	48.3	0.5
184	266	23.2	23.5	0.3

Table 3.2

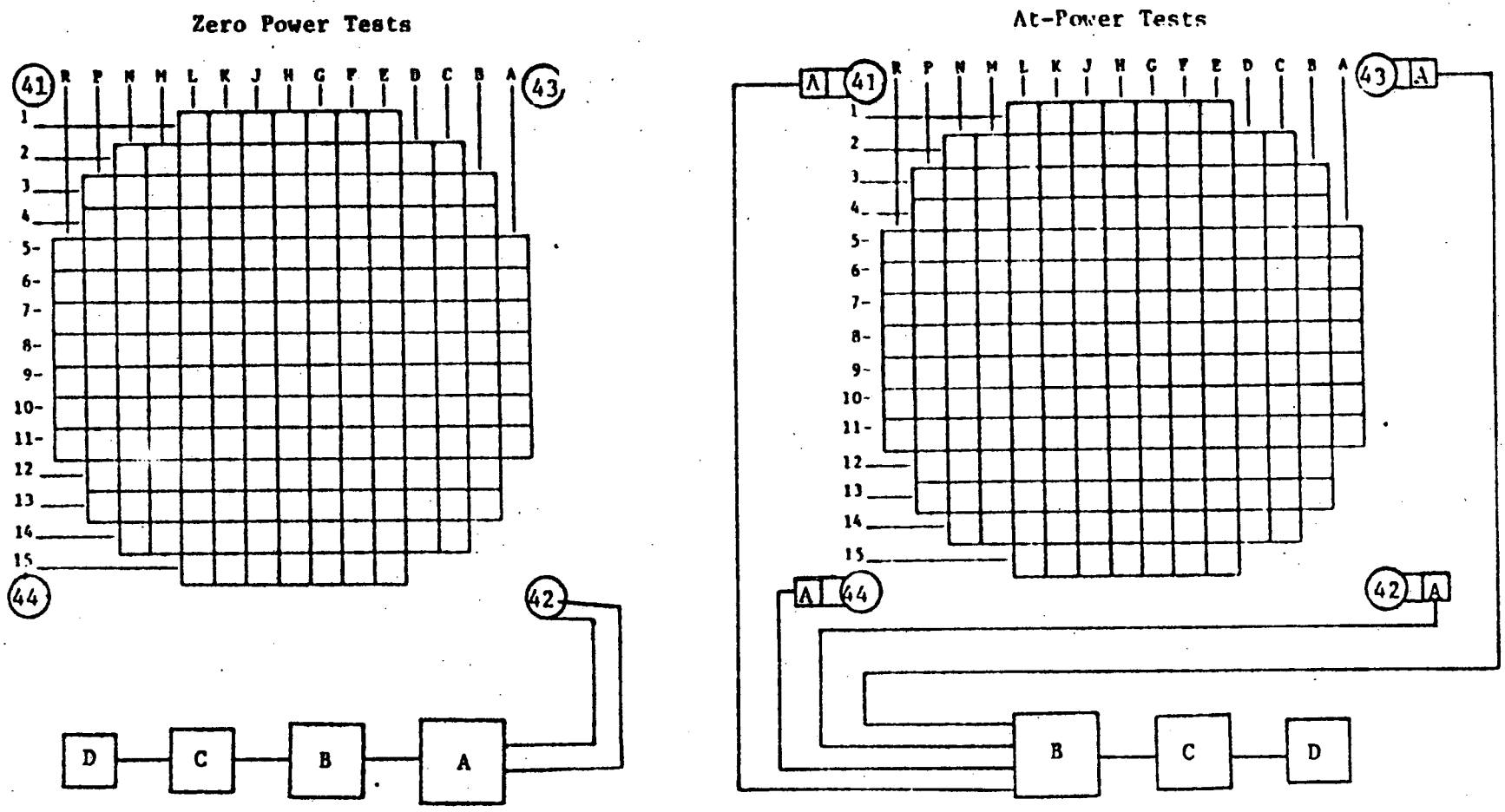
Delayed Neutron Data Bol Cycle 3

Group	$\bar{\beta}_i$	λ_i (sec^{-1})
1	0.00018	0.013
2	0.00124	0.031
3	0.00112	0.118
4	0.00230	0.315
5	0.00080	1.253
6	0.00028	3.341

$\ell^* = 17.21 \mu$sec (Prompt Neutron Life Time)

$\bar{I} = 0.970$ (Delayed Neutron Importance Factor)

$\bar{\beta}_i =$ (Delayed Neutron Fraction for ith group.)



A = Summing Junction
B = Picoammeter
C = Reactivity Computer
D = Strip Chart Recorder

A = Isolation Amplifier
B = Summing Junction
C = Reactivity Computer
D = Strip Chart Recorder

Figure 3.1 Process Instrumentation Arrangements for Reactivity Measurements

4. Hot Zero Power (HZP) Tests

4.1 Initial Criticality

The Indian Point Unit No. 2 Cycle 3 attained initial criticality on May 23, 1978. The criticality, at beginning of cycle (BOC) and HZP condition, was obtained by the sequential withdrawal of RCC shutdown and control banks and by subsequently diluting the borated reactor coolant. During the approach to criticality, ICRR (Inverse Count Rate Ratio) plots versus integrated primary water addition and control rod position (Figures 4.1 and 4.2) were maintained. Measured critical boron concentration, at no xenon, BOL, HZP and ARO (All Rods Out) core condition, was equal to 1378 ppm compared to the design prediction of 1372 ppm (Reference 3). The difference of 6 ppm between measured and design boron concentrations was well within ($\pm$ 50 ppm of design) the acceptance limit for this measurement. At the time of attainment of criticality, neutron flux level as indicated by the calibrated picoammeter (Keithley) was $3X10^{-9}$ Amps.

Neutron flux range for HZP tests was determined by the following method. The upper flux limit was determined by observing the effect of nuclear heating which decreases reactivity and increases reactor coolant temperature. The upper flux limit for testing was set below the flux value at which nuclear heating was observed. The nuclear heating was determined to be above $3X10^{-6}$ Amps, as shown in Figure 4.3. The lower limit was governed by the background noise level. In the presence of background noise, reactivity

computer underestimates changes in core reactivity. The lower limit was determined by measuring the differential worth of control bank "D" at various neutron flux levels. As shown in Figure 4.3, above the lower limit of zero power physics range(10^{-7} Amp) differential rod worth is independent of flux level. HZP Physics tests were carried out at a neutron flux level between 10^{-7} and 10^{-6} Amps. on the Keithley picammeter, as over this flux range the effects of nuclear heating and background noise are absent.

4.2 End Point Boron Concentrations

End point boron concentrations for ARO condition, control bank D in, control banks D and C in, and control banks D, C and B in HZP insertion limit bank overlap configuration cases were obtained. In Table 4.1, measured end-point boron concentration for the four control RCC bank configurations are presented. The corresponding design results are also listed. The maximum deviation, as shown in Table 4.1, is 11 ppm. Measured end-point boron concentrations met the acceptance criteria.

4.3 RCC Bank Differential and Integral Worths

Measurements of the differential and integral worths of individual RCC control banks C and D and of D, C and B in the bank overlap configuration above the HZP insertion limit were carried out via boron/RCC exchange, with the reactor critical. The reactivity computer trace provided indication of the change

in reactivity during insertion/withdrawal of a RCC bank. The differential worth of a bank, $\Delta\rho/\Delta h$, is defined as the amount of change in reactivity per unit step of bank position, about an average bank position. The integral control bank worth was obtained by summing the differential worths for the bank positions obtained during the insertion or withdrawal of the RCC bank.

In Table 4.2, the integral worths of individual control banks and overlapped banks are presented along with the design values. Measured integral worths in all cases are within $\pm 10\%$ of expected values, as shown in Table 4.2. Also, the sum of the maximum measured differential rod worth of RCC banks C and D is within the assumed value used in the safety analyses of Indian Point Unit No. 2 (Reference 1). Thus measured integral and differential rod worths met the acceptance criteria for the rod worths.

4.4 Isothermal Temperature Coefficients

Isothermal temperature coefficient measuremments were carried out for four (All Rods Out, Control bank D in, control banks D and C in, and Control banks D, C and B at HZP insertion limit) RCC bank configurations. This involved reactivity measurements during heatup and cooldown of the reactor coolant. In Table 4.3, measured as well as design values of isothermal temperature coefficients for the above four RCC bank configurations are presented. Measured values are obtained from the reactivity versus temperature curves provided by an X-Y plot recorder and

the design values are from Reference 3. Measured isothermal temperature coefficients were all negative and within the acceptance criteria of $\pm$ 3pcm/^{o}F of design value.

4.5 Differential Boron Worth

Based upon measured end-point boron concentrations and control rod worth data given in Tables 4.1 and 4.2, differential boron worth was -9.5 pcm/ppm compared to the design value of -9.5 pcm/ppm at 1300 ppm boron concentration.

Table 4.1

End-Point Boron Concentrations

Configuration	(1) Measured (ppm)	(2) Design (ppm)	(1)-(2) Deviation (ppm)
All Rods Out	1378	1372	6
D In	1312	1301	11
D and C In	1199	1194	5
B, C and D at HZP Insertion Limit	1230	1228	2

TABLE 4.2

CONTROL ROD BANK INTEGRAL WORTH SUMMARY

BANK	CONFIGURATION	(1) MEASURED Worth (pcm)	(2) EXPECTED Worth (pcm)	(1) - (2) DIFFERENCE Difference (pcm)
D	ARO	630	661±66	-31
C	D IN	1073	1002±100	+71
D In C at 80 steps B at 210 steps	HZP Insertion Limit	1436	1346±135	+90

Note: Expected Value = Design Value ±10% of Design Value

TABLE 4.3

ISOTHERMAL TEMPERATURE COEFFICIENTS

Configuration	(1) Measured (PCM/°F)	(2) Expected (PCM/°F)	(1)-(2) Difference (PCM/°F)
ARO	-0.44	-0.33±3	-0.11
D In, C Out	-1.07	-1.96±3	+0.89
D and C In	-3.57	-4.18±3	+0.61
B,C and D at HZP Insertion Limit	-3.14	-3.44±3	+0.30

Note: Expected Value ≑ Design Value ± 3pcm/°F

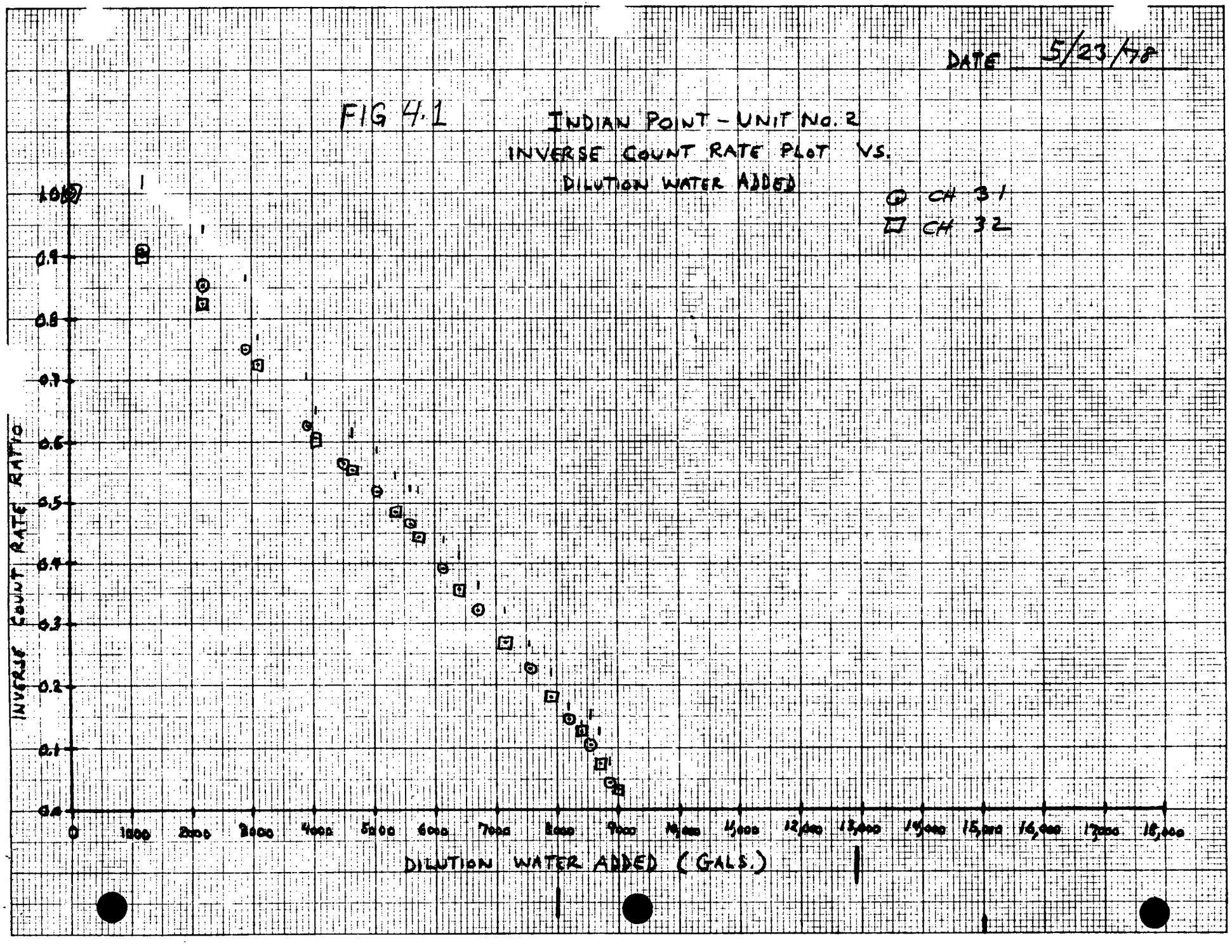

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FIG 4.1
INDIAN POINT - UNIT NO. 2
INVERSE COUNT RATE PLOT VS.
DILUTION WATER ADDED
CH 31
CH 32
INVERSE COUNT RATE RATIO
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10,000
11,000
12,000
13,000
14,000
15,000
16,000
17,000
18,000
DILUTION WATER ADDED (GALS.)

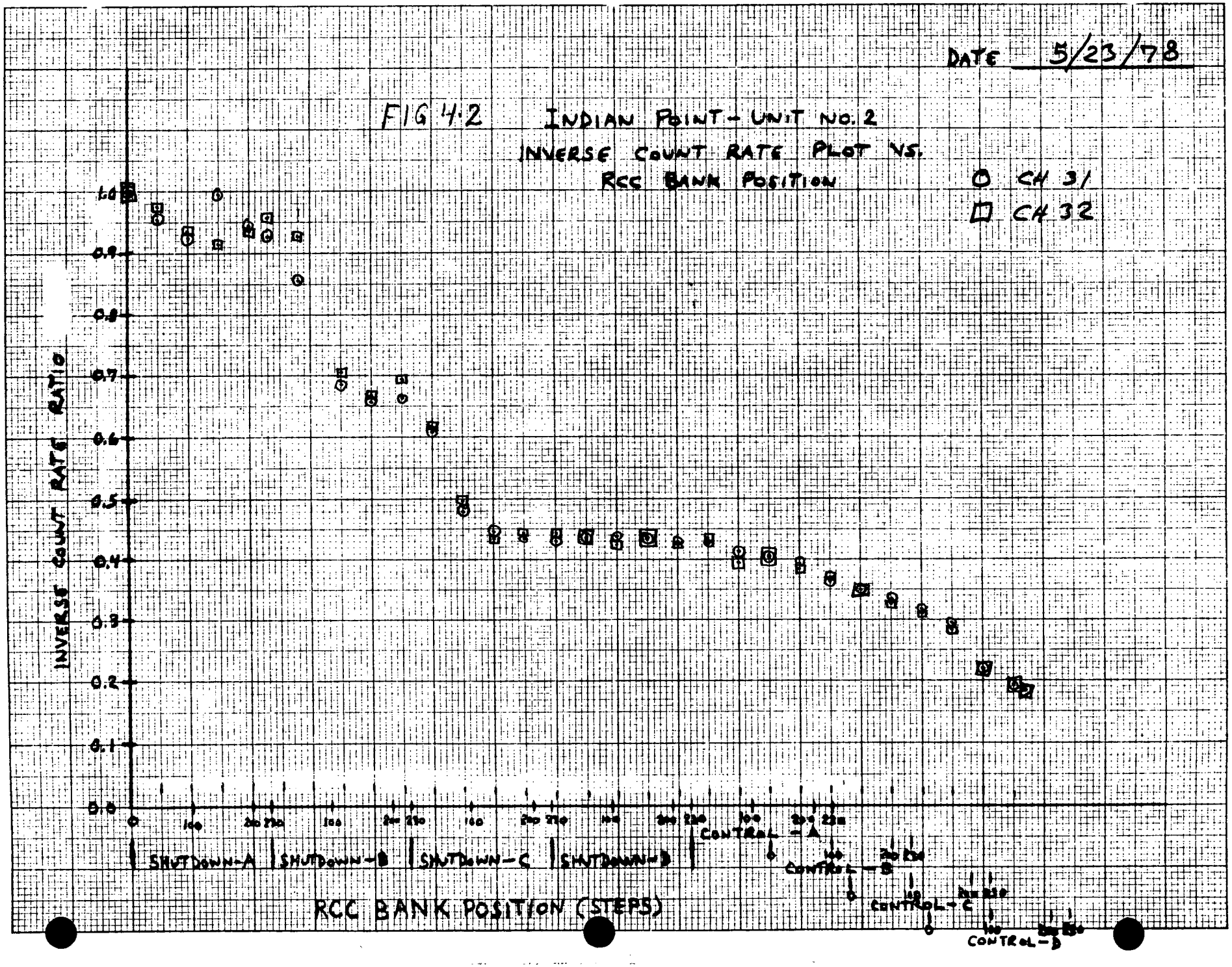
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FIG 4.2 INDIAN POINT - UNIT NO. 2
INVERSE COUNT RATE PLOT VS.
RCC BANK POSITION
CH 31
CH 32
INVERSE COUNT RATE RATIO
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
SHUTDOWN-A
SHUTDOWN-B
SHUTDOWN-C
SHUTDOWN-D
CONTROL - A
CONTROL - B
CONTROL - C
CONTROL - D
RCC BANK POSITION (STEPS)

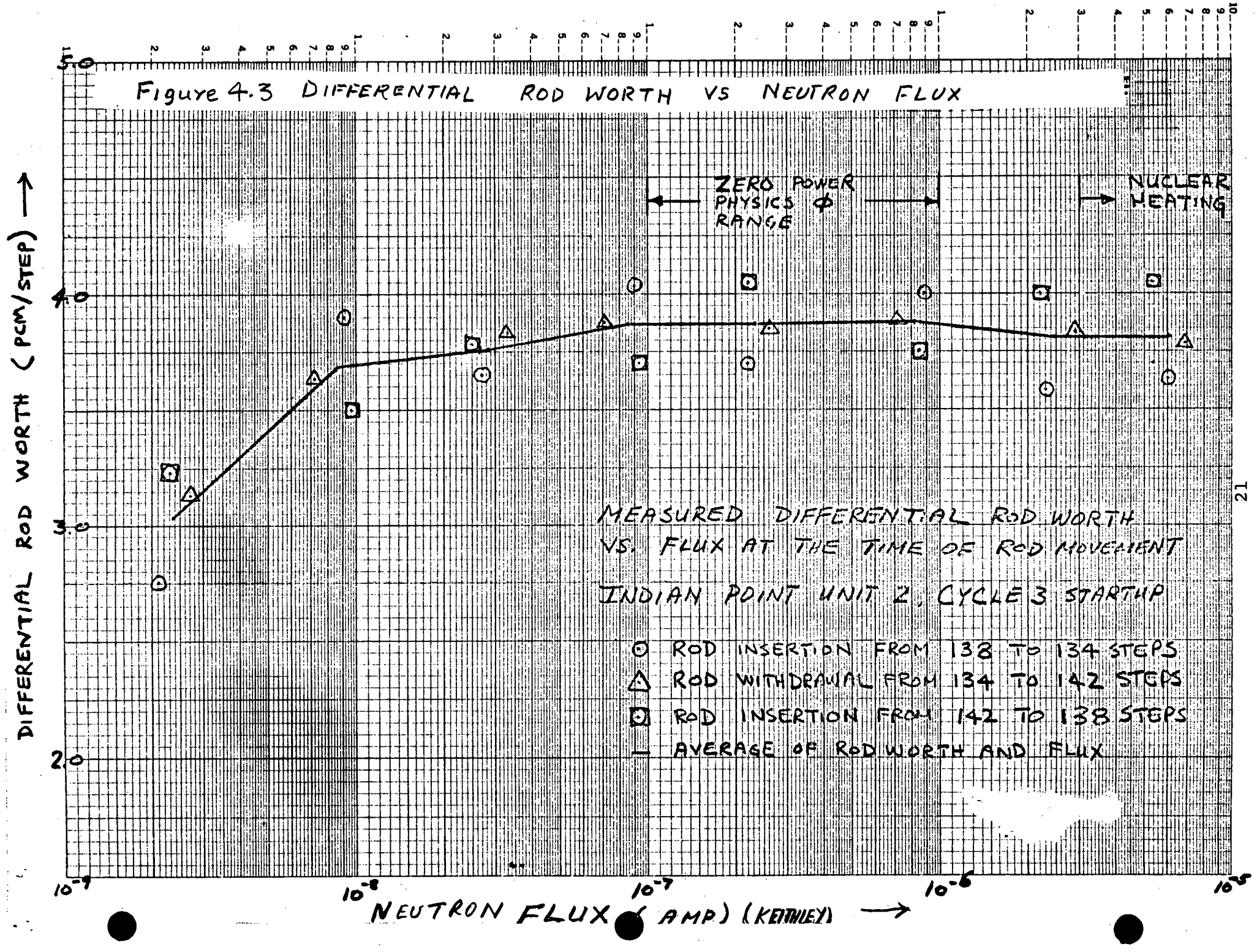


Figure 4.3 DIFFERENTIAL ROD WORTH VS NEUTRON FLUX
ZERO POWER PHYSICS Φ RANGE
NUCLEAR HEATING
MEASURED DIFFERENTIAL ROD WORTH VS. FLUX AT THE TIME OF ROD MOVEMENT
INDIAN POINT UNIT 2, CYCLE 3 STARTUP
ROD INSERTION FROM 138 TO 134 STEPS
ROD WITHDRAWAL FROM 134 TO 142 STEPS
ROD INSERTION FROM 142 TO 138 STEPS
AVERAGE OF ROD WORTH AND FLUX
DIFFERENTIAL ROD WORTH (PCM/STEP)
5.0
4.0
3.0
2.0
NEUTRON FLUX (AMP) (KEITHLEY)
10^-9
10^-8
10^-7
10^-6
10^-5

5. AT POWER TESTS

The power measurement tests consisted of: (a) relative assembly power distributions at HZP ($<5\%$), ~90% and ~100% of full power; and (b) determination of power coefficient versus reactor power. Although not part of the official startup physics test program an additional map was taken during the power escalation at ~40% of full power.

5.1 Core Power Distributions

Measurements of the core power distributions were carried out with the moveable incore detectors. The INCORE code 2 (Reference 4) was employed to analyze the in core flux maps to provide the relative assembly power, hot channel factors, quadrant tilt and axial offset. The analysis required: (i) the calculated ratio between the power and the fission reaction rate at the locations of the moveable incore detectors, and (ii) calculated (X-Y) power distributions for the All Rods Out (ARO) condition and the D bank in case. Item (ii) was employed to obtain the power distribution of the partially rodded core by the flux synthesis method. Results from the analyses of four incore full-core flux maps taken at HZP ($<5\%$), ~40%, ~90% and ~100% of full power are presented in Table 5.1. Measured values of $F^N_{\Delta H}$ and F_Q, including appropriate measurement uncertainty and engineering factors* and quadrant tilt for all four cases were within Technical Specification limits.

* (4 % measurement uncertainty for $F^N_{\Delta H}$, 5% measurement uncertainty and 3% engineering factor for F_Q).

Relative assembly power distributions derived for four incore full-core flux maps taken at HZP ($<$5%), ~40%, ~90% and ~100% of full power, are given in Figures 5-1 through 5-4, respectively. Maps taken at HZP ($<$5%), ~90% and ~100% of full power met the acceptance criteria (measured relative assembly power $P_i \pm 10\%$ of design value for $P_i > 0.9$ and $\pm$ 15% for $P_i \leq 0.9$). However, measured power distribution of four assemblies (P-12, P-11, N-11 and D-14) for the additional map taken at ~40% power differed from the design value by 10.4, 11.0, 11.0 and 10.2% (and from the acceptance criteria by 0.4, 1.0, 1.0 and 0.2%), respectively. All the other assemblies' power distribution were within the test acceptance criteria. This additional map (not part of the startup physics test program) was taken immediately after the attainment of 40% of full power when the xenon equilibrium condition had not been established. Also, during the period when this map was being taken, a 12°F change in RC temperature (Tavg) occurred. In the light of the above uncertainties the deviation of the measured power distributions from the acceptance value, for four assemblies, was found acceptable. As previously mentioned the hot channel factors and the quadrant tilt were within the Technical Specification limits (Reference 2) for this map. In addition to the four full core maps discussed above additional full core and quarter-core maps were taken at ~90% of full power during the Excore/Incore calibration test. Results of this test are presented in section 6.

5.2 Power Coefficient

The "differential" power coefficient, $\left(\frac{\Delta \rho}{\Delta Q}\right)_Q$ at a specific power level, Q, is defined as the change in reactivity, (ρ), per percent change in reactor power, Q, at that power level.

Measurement of the power coefficient involved:

(a) Determination of reactivity compensation by control bank movement during the increase and the decrease of reactor power. This was obtained from the output of the reactivity computer.

(b) Determination of reactor power level changes from the recording of primary coolant Δ T across the reactor vessel and secondary plant calorimetric data - steam pressure, feedwater temperatures, and feedwater flow rates. Steam pressure was obtained directly from the local gauges. Feedwater temperatures were obtained from a precision thermometer installed at the feedwater header, and the feedwater flow from manometers installed across the feedwater line venturi elements.

In addition to the above data, the analysis of power coefficient measurements included corrections due to xenon changes caused by power level variations, moderator temperature changes during the test, and reactor coolant boron concentration changes.

Power Coefficient is given by

$$\left(\frac{\Delta\rho}{\Delta Q}\right) = \frac{1}{\Delta Q}\left[(\Delta\rho)_{CR} + (\Delta\rho)_{Xe} + (\Delta\rho)_{B} + (\Delta\rho)_{T}\right]$$

where

$(\Delta\rho)_{CR}$ = reactivity Compensation due to Control Rod

$(\Delta\rho)_{Xe}$ = reactivity change due to Xenon Change

$(\Delta\rho)_{B}$ = reactivity change due to Boron Change

$(\Delta\rho)_{T}$ = Reactivity change due to Moderator Temperature Change

(ΔQ) = Change in Reactor Power

Table 5.2 gives the measured power coefficients from data taken during power decrease from ~90% to ~50% and increase from ~50% to ~70%, and the design power coefficients (Reference 3). The measured values are within the acceptance criteria of ± 2 pcm/%Q. A least square fit of measured power coefficient data versus reactor power was undertaken to generate coefficients of a polynomial fit. Total power defect from zero to 100% power conditions, calculated using the results of polynomial coefficients, is equal to 865 pcm compared to the design value of 980 pcm.

5.3 Reactor Coolant Flow Determination

Based on elbow tap differential pressure measurements, the total Reactor Coolant Flow Rate was verified to be greater than the design value (358,800 gpm), provided in the Indian Point Unit No. 2 Technical Specification. Table 5.3 provides the power levels and the measured coolant flow rate as a percentage of design reactor coolant flow rate. These results demonstrate compliance with Technical Specification criteria on Reactor Coolant System Total Flow Rate. Also, individual loop flow rates were found to be above the respective loop design flow rate.

Table 5.1

Summary of Results of INCORE Analysis, IP2 Cycle 3 Startup Maps

Full - core Map	1	2	3	4
Approximate Power (%)	HZP (<5%)	40	90	100
Run Number	3FC1R6	3FC2R7	3FC3R3	3FC6R2
Axial Offset (%)	26.867	22.460	4.424	3.591
Quadrant Tilt%	1.64	1.52	1.05	0.81
Measured Peak $F_{\Delta H}^{N}$	1.463	1.468	1.427	1.426
Measured Peak $F_{\Delta H}^{N}$ Location	H11DF	N13JL	N13JL	H11DF
Peak F_Q	2.340	2.233	1.905	1.873
Peak F_Q Location	N13JL	N13JL	N13JL	N13JL
Max % Diff. of Assembly $F_{\Delta H}^{N}$ between measured and predicted	9.2	11.7	8.0	7.5
Core Location of Max. Assembly $F_{\Delta H}^{N}$	D-14	B-13	B-13	B-3

TABLE 5.2

Average Power * (%Q)	Power Coefficient ($\Delta P/\Delta Q$) (1) Measured (pcm/%Q)	(2) Design (pcm/%Q)	(1)-(2) Difference (pcm/%Q)
70.2	-7.3	-9.3	2.0
56.4	-9.3	-9.7	0.4

*Average power over the test power range

Table 5.3

Total Measured Reactor Coolant Flow Rate

% Reactor Power	$\frac{(\text{Measured RC Flow Rate} \times 100)}{\text{Design RC Flow Rate}}$
0	106.4
35	106.0
51	106.2
61	105.8
72	105.8
80	105.7
90	105.7
	Avg. 105.9

1 IP2 CY-3,3FC1R6,5-26-78,HZP,ARO,LAST TRACE J-10 DEL. & CORR PDQ DECK

NORMALIZED AVERAGE AXIAL KW/FT

1.525 .....X.XX.....3.....T.....0.....P...

TRM

Figure 5.1 IP-2 Cycle 3, BOL, HZP (<5%) Condition Power Map

```
READY ? F:/MEASURED AND PERCENT. DIFF OF FDHN/
( MATCH(S) FOR :/MEASURED AND PERCENT. DIFF OF FDHN/
/READY ? SS:/MEASURED AND PERCENT. DIFF. OF FDHN/
READY ? P;200
MEASURED AND PERCENT. DIFF. OF FDHN  IP2 CY-3,3FC1R6,5-26-78,HZP,ARO,LAST TRACE J-10 DEL. & CORR PDQ DECK
      8      1      1
+                                .  .637.  .808.  .834.  .676.  .851.  .827.  .643.
R                                .   1.0.   -.5.  -2.2.  -2.2.   -.2.   1.8.   1.9.

                        .  .694.  .972. 1.132.  .871. 1.200.  .788. 1.204.  .861. 1.117.  .947.  .676.
P                       .   5.8.   3.6.   1.0.   -.6.  -2.2.  -2.2.  -1.8.  -1.7.   -.4.    .9.   3.1.

                 .  .694. 1.213. 1.018.  .883.  .961.  .915. 1.095.  .896.  .881.  .863.  .966. 1.181.  .706.
N                .   5.8.   5.9.   6.2.   1.0.  -2.2.  -2.2.  -2.7.  -4.2.  -4.3.  -1.2.    .8.   3.1.   7.6.

                 .  .975.  .983. 1.099. 1.183. 1.199. 1.183. 1.020. 1.163. 1.168. 1.172. 1.075.  .993. 1.009.
M                .   3.9.   3.0.   1.9.  -1.9.  -1.9.  -1.6.  -2.3.  -3.2.  -4.2.  -2.8.   -.4.   3.6.   7.6.

        .  .671. 1.143.  .862. 1.190. 1.028. 1.136. 1.198. 1.251. 1.193. 1.130. 1.022. 1.201.  .859. 1.102.  .620.
L       .   6.4.   2.0.  -1.4.  -1.3.  -1.0.  -1.9.  -1.6.  -2.2.  -2.1.  -2.4.  -1.6.   -.4.  -1.7.  -1.7.  -1.7.

        .  .843.  .896.  .915. 1.205. 1.157.  .947. 1.107. 1.136. 1.162.  .939. 1.139. 1.198.  .905.  .883.  .821.
K       .   3.8.   1.7.   -.5.  -1.2.   -.1.   -.1.    .3.    .4.   -.2.  -1.0.  -1.6.  -1.7.  -1.7.    .8.   1.1.

        .  .866. 1.245.  .940. 1.228. 1.243. 1.198. 1.036.  .863. 1.026. 1.172. 1.235. 1.222.  .937. 1.237.  .862.
J       .   1.6.   1.6.    .5.   2.2.   2.1.   3.0.   2.2.   1.3.   1.2.    .8.   1.4.   1.6.    .2.    .9.   1.1.

        .  .701.  .819. 1.139. 1.074. 1.313. 1.158.  .866.  .675.  .871. 1.151. 1.307. 1.056. 1.138.  .823.  .705.
H       .   1.7.   1.6.   1.2.   2.9.   2.6.   2.3.   1.7.   1.1.   2.2.   1.7.   2.2.   1.2.   1.1.   2.1.   2.3.

        .  .866. 1.246.  .946. 1.236. 1.254. 1.193. 1.022.  .851. 1.024. 1.175. 1.243. 1.196.  .929. 1.216.  .858.
G       .   1.6.   1.6.   1.2.   2.8.   2.9.   2.6.    .8.   -.1.   1.0.   1.0.   2.1.   -.5.   -.6.   -.9.   -.7.

        .  .921.  .885.  .931. 1.235. 1.174.  .935. 1.156. 1.122. 1.156.  .942. 1.165. 1.199.  .885.  .862.  .818.
F       .   1.1.   1.1.   1.2.   1.3.   1.3.  -1.4.   -.6.   -.9.   -.6.   -.8.    .6.  -1.7.  -3.9.  -1.6.    .7.

        .  .663. 1.179.  .890. 1.185. 1.012. 1.119. 1.193. 1.258. 1.205. 1.134. 1.000. 1.170.  .848. 1.101.  .635.
E       .   5.2.   5.2.   2.9.  -1.7.  -2.5.  -3.4.  -2.0.  -1.7.  -1.1.  -2.1.  -3.7.  -2.9.  -2.9.  -1.7.    .7.

                 . 1.025.  .995. 1.060. 1.176. 1.178. 1.167. 1.009. 1.100. 1.156. 1.161. 1.048.  .939.  .919.
D                .   9.2.   3.7.  -1.7.  -2.5.  -3.3.  -2.9.  -3.4.  -3.5.  -4.3.  -3.7.  -2.8.  -2.0.  -2.0.

                 .  .710. 1.202.  .984.  .852.  .891.  .914. 1.094.  .902.  .878.  .835.  .931. 1.122.  .643.
C                .   6.3.   5.0.   2.7.  -2.5.  -3.2.  -2.3.  -2.8.  -3.5.  -4.6.  -4.4.  -2.9.  -2.0.  -2.0.

                        .  .704.  .997. 1.179.  .912. 1.230.  .797. 1.179.  .835. 1.070.  .903.  .643.
B                       .   7.3.   6.3.   5.2.   4.1.    .8.  -1.1.  -3.8.  -4.7.  -4.5.  -3.7.  -2.0.

+                                .  .663.  .845.  .861.  .695.  .824.  .769.  .597.
+                                                                                          . MEAS .
A                                .   5.2.   4.1.   1.0.    .8.  -3.3.  -5.3.  -5.3.
+                                                                                          . DIFF .
```

				.704.	.862.	.877.	.725.	.902.	.872.	.688.				
				11.0.	6.5.	3.3.	3.4.	6.3.	7.6.	8.4.				
		.721.	1.024.	1.222.	.925.	1.237.	.840.	1.212.	.860.	1.129.	.985.	.706.		
		9.5.	10.4.	11.0.	6.2.	3.1.	3.3.	1.0.	-1.1.	2.6.	6.3.	7.2.		
	.721.	1.229.	1.048.	.977.	.941.	.955.	1.094.	.862.	.849.	.886.	1.011.	1.202.	.721.	
	9.5.	9.5.	9.7.	11.0.	1.6.	1.6.	-2.6.	-8.3.	-8.4.	.7.	5.8.	7.2.	9.6.	
	.980.	1.013.	1.125.	1.123.	1.135.	1.150.	1.002.	1.125.	1.112.	1.160.	1.111.	1.016.	1.017.	
	5.6.	6.0.	4.4.	-6.3.	-6.3.	-4.0.	-4.3.	-6.1.	-8.2.	-3.2.	3.1.	6.3.	9.6.	
.661.	1.118.	.864.	1.176.	.995.	1.088.	1.169.	1.222.	1.149.	1.072.	.956.	1.235.	.894.	1.116.	.643.
4.1.	1.6.	-1.8.	-1.9.	-4.6.	-6.3.	-4.0.	-4.0.	-5.6.	-7.7.	-8.4.	3.1.	1.6.	1.4.	1.4.
.854.	.900.	.935.	1.188.	1.108.	.914.	1.125.	1.100.	1.115.	.898.	1.064.	1.231.	.941.	.916.	.856.
5.4.	3.4.	.9.	-2.0.	-4.6.	-5.6.	-4.4.	=4.1.	-5.3.	-7.2.	-8.4.	1.6.	1.5.	5.3.	5.7.
.905.	1.280.	.959.	1.211.	1.208.	1.174.	.993.	.840.	.998.	1.128.	1.176.	1.155.	.922.	1.232.	.875.
6.7.	6.7.	2.1.	1.1.	-.8.	-.2.	-4.9.	-5.4.	-4.4.	-4.1.	-3.4.	-3.6.	-1.9.	2.7.	3.1.
.747.	.867.	1.137.	1.052.	1.262.	1.122.	.837.	.662.	.862.	1.124.	1.254.	1.013.	1.084.	.834.	.724.
6.6.	6.6.	1.2.	.5.	-.9.	-2.2.	-5.7.	-6.1.	-3.0.	-2.0.	-1.5.	-3.2.	-3.5.	2.6.	3.3.
.894.	1.264.	.938.	1.198.	1.223.	1.163.	.976.	.842.	1.023.	1.164.	1.197.	1.166.	.913.	1.215.	.874.
5.4.	5.3.	-.1.	.0.	.5.	-1.1.	-6.6.	-5.2.	-2.1.	-1.1.	-1.6.	-2.6.	-2.8.	1.2.	2.9.
.843.	.904.	.927.	1.159.	1.111.	.910.	1.107.	1.089.	1.130.	.943.	1.128.	1.186.	.913.	.903.	.884.
4.0.	3.9.	.1.	-4.3.	-4.3.	-6.0.	-5.9.	-5.0.	-3.9.	-2.6.	-2.8.	-2.1.	-1.5.	3.7.	9.1.
.680.	1.180.	.918.	1.180.	1.002.	1.096.	1.131.	1.195.	1.138.	1.134.	1.018.	1.191.	.874.	1.129.	.692.
7.2.	7.2.	4.3.	-1.5.	-4.0.	-5.6.	-7.0.	-6.2.	-6.5.	-2.4.	-2.5.	-.7.	-.7.	2.6.	9.1.
	1.022.	.997.	1.061.	1.150.	1.142.	1.106.	.968.	1.097.	1.164.	1.169.	1.065.	.957.	.928.	
	10.2.	4.3.	-1.5.	-4.0.	-5.7.	-7.6.	-7.5.	-8.4.	-3.9.	-2.5.	-1.2.	.1.	.1.	
	.730.	1.199.	1.003.	.845.	.866.	.887.	1.066.	.905.	.906.	.873.	.965.	1.154.	.677.	
	10.9.	6.9.	4.9.	-4.0.	-6.5.	-5.6.	-5.2.	-3.6.	-2.2.	-.8.	1.0.	2.9.	2.9.	
		.735.	1.025.	1.201.	.926.	1.230.	.813.	1.189.	.852.	1.093.	.943.	.695.		
		11.7.	10.5.	9.1.	6.4.	2.5.	-.0.	-.9.	-2.2.	-.7.	1.7.	5.6.		
				.692.	.861.	.871.	.718.	.859.	.819.	.642.				
				9.1.	6.4.	2.6.	2.5.	1.3.	1.1.	1.1.				

MEAS

DIFF

Figure 5.2 IP-2 Cycle 3, BOL~40% Power Map

P:*
1MEASURED AND PERCENT. DIFF. OF FDHN IP2 CY3,3FC3R3,91.1% POWER,D BANK=217,CORR PDQ DECKS

	R	1	1													
+					.684.	.847.	.865.	.715.	.876.	.840.	.660.					
R					6.0.	4.7.	2.1.	2.2.	3.4.	3.9.	4.2.					
P				.700.	.990.	1.187.	.907.	1.223.	.830.	1.205.	.862.	1.110.	.952.	.685.		
				6.4.	6.8.	8.0.	4.5.	2.0.	2.1.	.5.	-.7.	1.0.	2.6.	4.1.		
N			.701.	1.194.	1.009.	.950.	.938.	.952.	1.111.	.898.	.884.	.879.	.978.	1.168.	.706.	
			6.5.	6.4.	5.6.	3.0.	1.3.	1.3.	-1.2.	-4.4.	-4.5.	-.2.	2.4.	4.1.	7.3.	
M			.965.	.990.	1.099.	1.146.	1.159.	1.163.	1.021.	1.157.	1.158.	1.172.	1.086.	.994.	.996.	
			4.1.	3.6.	1.9.	-4.4.	-4.4.	-3.0.	-2.6.	-3.5.	-4.4.	-2.3.	.7.	4.0.	7.4.	
L	.664.	1.118.	.865.	1.179.	1.013.	1.111.	1.182.	1.243.	1.183.	1.120.	1.006.	1.207.	.866.	1.080.	.622.	
	5.1.	1.7.	-1.6.	-1.7.	-3.0.	-4.4.	-3.0.	-2.5.	-2.9.	-3.6.	-3.7.	.7.	-1.6.	-1.8.	-1.8.	
K	.836.	.883.	.921.	1.192.	1.136.	.943.	1.153.	1.126.	1.150.	.938.	1.120.	1.193.	.910.	.879.	.822.	
	3.5.	1.7.	-.5.	-1.6.	-2.3.	-2.7.	-2.1.	-1.9.	-2.4.	-3.2.	-3.7.	-1.5.	-1.7.	1.3.	1.7.	
J	.866.	1.224.	.941.	1.207.	1.221.	1.188.	1.031.	.870.	1.027.	1.157.	1.209.	1.205.	.938.	1.215.	.861.	
	2.1.	2.1.	.1.	.8.	.2.	.9.	-1.3.	-2.1.	-1.8.	-1.8.	-.7.	.6.	-.2.	1.3.	1.6.	
H	.715.	.830.	1.127.	1.058.	1.281.	1.152.	.877.	.690.	.879.	1.134.	1.271.	1.040.	1.130.	.834.	.720.	
	2.2.	2.1.	.3.	1.0.	.5.	.3.	-1.3.	-1.9.	-1.1.	-1.2.	-.3.	-.7.	.6.	2.7.	2.9.	
G	.873.	1.235.	.951.	1.208.	1.230.	1.189.	1.022.	.868.	1.028.	1.164.	1.213.	1.180.	.934.	1.207.	.869.	
	3.0.	3.0.	1.2.	.8.	1.0.	.9.	-2.2.	-2.3.	-1.6.	-1.2.	-.4.	-1.5.	-.6.	.7.	2.5.	
F	.835.	.895.	.938.	1.198.	1.149.	.939.	1.141.	1.114.	1.145.	.947.	1.135.	1.180.	.900.	.875.	.844.	
	3.3.	3.1.	1.3.	-1.2.	-1.2.	-3.1.	-3.2.	-3.0.	-2.8.	-2.3.	-2.3.	-2.6.	-2.8.	.8.	4.4.	
E	.662.	1.149.	.896.	1.156.	1.009.	1.116.	1.172.	1.230.	1.181.	1.136.	1.026.	1.174.	.861.	1.100.	.661.	
	4.5.	4.5.	1.9.	-3.6.	-3.4.	-4.0.	-3.8.	-3.5.	-3.0.	-2.3.	-1.8.	-2.1.	-2.1.	.1.	4.4.	
D		.978.	.964.	1.039.	1.159.	1.164.	1.152.	1.001.	1.147.	1.170.	1.177.	1.061.	.943.	.915.		
		5.5.	.9.	-3.6.	-3.4.	-3.9.	-3.8.	-4.4.	-4.3.	-3.5.	-1.8.	-1.6.	-1.3.	-1.3.		
C		.702.	1.160.	.975.	.850.	.897.	.926.	1.101.	.918.	.897.	.862.	.967.	1.154.	.677.		
		6.7.	3.3.	2.0.	-3.3.	-3.1.	-1.4.	-2.0.	-2.3.	-3.1.	-2.1.	1.2.	2.8.	2.8.		
B			.711.	.993.	1.167.	.907.	1.230.	.814.	1.178.	.840.	1.076.	.952.	.704.			
			8.0.	7.1.	6.2.	4.5.	2.6.	.2.	-1.7.	-3.2.	-2.2.	2.7.	7.0.			
+					.673.	.845.	.870.	.718.	.847.	.789.	.618.					MEAS
+ A					6.2.	4.5.	2.6.	2.6.	-.0.	-2.4.	-2.4.					DIFF
+																
+ 1																

IP2 CY3,3FC3R3,91.1% POWER,D BANK=217,CORR PDQ DECKS

Figure 5-3 IP-2 Cycle 3, BOL,~90% Power Map

**VALIDITY STATUS = 1 MEANS SYMMETRIC THIMBLE TEST FAILED

1MEASURED AND PERCENT. DIFF. OF FDHN IP2 CYCLE 3, 3FC6R2, 6-8-78, POWER=100%, D BANK=210, NEW PDQ CONSTANTS

	R	1	1													
+																
						.668.	.827.	.857.	.710.	.870.	.827.	.649.				
R						6.1.	3.2.	1.7.	1.9.	3.3.	3.2.	3.1.				
				.698.	.981.	1.162.	.882.	1.211.	.824.	1.197.	.846.	1.096.	.939.	.678.		
P				5.9.	5.8.	6.1.	3.0.	1.6.	1.7.	.4.	-1.3.	.1.	1.3.	2.8.		
		.699.	1.191.	1.009.	.934.	.925.	.939.	1.116.	.907.	.891.	.871.	.967.	1.156.	.699.		
N		6.0.	5.9.	5.4.	6.1.	.1.	.1.	-.7.	-3.4.	-3.6.	-1.0.	1.1.	2.8.	6.1.		
		.963.	.986.	1.096.	1.159.	1.172.	1.165.	1.030.	1.166.	1.174.	1.168.	1.076.	.984.	.985.		
M		3.9.	3.0.	1.4.	-3.6.	-3.6.	-3.1.	-2.0.	-3.0.	-3.4.	-2.8.	-.4.	2.9.	6.2.		
	.668.	1.112.	.864.	1.182.	1.025.	1.125.	1.186.	1.254.	1.196.	1.143.	1.020.	1.197.	.866.	1.076.	.618.	
L	6.0.	1.6.	-1.8.	-1.7.	-2.2.	-3.6.	-3.1.	-2.1.	-2.2.	-2.1.	-2.7.	-.4.	-1.5.	-1.7.	-1.8.	
	.825.	.865.	.913.	1.196.	1.149.	.954.	1.169.	1.145.	1.169.	.954.	1.136.	1.199.	.910.	.860.	.807.	
K	3.0.	.9.	-1.2.	-1.6.	-1.6.	-2.1.	-1.3.	-.7.	-1.2.	-2.0.	-2.7.	-1.4.	-1.6.	.3.	.7.	
	.850.	1.201.	.935.	1.208.	1.226.	1.189.	1.055.	.893.	1.043.	1.168.	1.221.	1.227.	.948.	1.207.	.854.	
J	.8.	.8.	-.4.	.5.	.2.	.5.	.6.	.3.	-.6.	-1.3.	-.2.	2.1.	.9.	1.2.	1.3.	
	.704.	.817.	1.115.	1.053.	1.281.	1.158.	.893.	.698.	.891.	1.141.	1.280.	1.052.	1.148.	.832.	.716.	
H	1.0.	.9.	-.7.	.2.	.1.	.4.	.3.	.0.	.1.	-1.1.	-.0.	.2.	2.2.	2.7.	2.7.	
	.868.	1.229.	.953.	1.203.	1.226.	1.193.	1.046.	.882.	1.039.	1.166.	1.221.	1.189.	.941.	1.199.	.863.	
G	3.0.	3.1.	1.5.	.1.	.2.	.8.	-.2.	-.9.	-.9.	-1.5.	-.2.	-1.1.	.3.	.5.	2.5.	
	.834.	.869.	.940.	1.199.	1.152.	.948.	1.161.	1.131.	1.167.	.952.	1.142.	1.182.	.893.	.853.	.824.	
F	4.0.	3.7.	1.6.	-1.3.	-1.3.	-2.6.	-1.9.	-1.9.	-1.4.	-2.2.	-2.2.	-2.7.	-3.3.	-.4.	2.8.	
	.654.	1.136.	.892.	1.159.	1.013.	1.119.	1.192.	1.252.	1.209.	1.141.	1.028.	1.169.	.856.	1.085.	.647.	
E	3.8.	3.8.	1.4.	-3.6.	-3.4.	-4.2.	-2.5.	-2.2.	-1.2.	-2.2.	-1.9.	-2.7.	-2.7.	-.9.	2.7.	
		.957.	.955.	1.042.	1.162.	1.166.	1.165.	1.023.	1.182.	1.188.	1.179.	1.058.	.936.	.907.		
D		3.2.	-.2.	-3.6.	-3.4.	-4.1.	-3.0.	-2.7.	-1.6.	-2.2.	-2.0.	-2.1.	-2.2.	-2.2.		
		.687.	1.143.	.964.	.850.	.896.	.932.	1.118.	.929.	.904.	.862.	.967.	1.154.	.677.		
C		4.1.	1.6.	.7.	-3.3.	-3.1.	-.7.	-.5.	-1.0.	-2.2.	-2.0.	1.1.	2.6.	2.6.		
			.694.	.979.	1.161.	.895.	1.218.	.815.	1.179.	.836.	1.071.	.954.	.709.			
B			5.2.	5.6.	6.1.	4.5.	2.2.	.7.	-1.1.	-2.5.	-2.1.	2.9.	7.5.			
+																
					.668.	.837.	.861.	.712.	.839.	.782.	.615.					
+																. MEAS .
A					6.1.	4.5.	2.2.	2.2.	-.4.	-2.4.	-2.3.					
+																. DIFF .
+																

1 IP2 CYCLE 3, 3FC6R2, 6-8-78, POWER=100%, D BANK=210, NEW PDQ CONSTANTS

CALCULATED POWER TILTS (NORMALIZED TO 1.000)

Figure 5-4 IP-2 Cycle, BOL,~100% Power Map

6. Reactor Instrumentation Calibration

The calibration of excore power range detectors, reactor coolant loop resistance temperature detectors (RTD's) and incore thermocouples are presented in this section.

6.1 Excore Detector Calibration

An excore detector calibration using movable incore detectors was performed at~90% of full power. A range of axial offsets were obtained by an axial xenon oscillation induced by rod insertion and subsequent withdrawal following xenon buildup in the upper portion of the core. Full core maps were taken at the equilibrium conditions prior to the onset of the oscillation and also at its maxima and minima. Quarter core (partial) maps were also taken at various axial offsets between the full core maps. The full power total excore detector currents were extrapolated from the currents obtained at reduced power levels. For each map, top and bottom detector currents for each detector were normalized to the extrapolated full power current. Plots of detector current versus the axial offset calculated by the INCORE 2 code are given in Figures 6.1 through 6.4. A linear least square fit using the axial offset data was performed. The results of least square fit for top and bottom detector current vs axial offset were used to calibrate the Delta Flux (ΔI) Meters and Overpower Delta T and Overtemperature Delta T setpoints.

6.2 Incore T/C and Wide Range RTD Calibration.

During the Reactor Coolant System heatup electrical resistance of RTDs (including spares), along with their

lead wire resistance, core exist thermocouple outputs and wide range RTD amplifier outputs were monitored at approximately 50°F intervals above 300°F. RTD resistances were converted into temperature using factory supplied calibration tables and plotted against the time. The RTDs with maximum correction factors less than ±0.5°F were selected for use in the protection and process circuits. Table 6.1 shows the deviation of such RTDs from the average temperature for data taken over 300°F to 547°F temperature range. Incore thermocouples provide a continuous on-line monitoring of assembly power distribution of 65 assemblies which are about evenly distributed throughout the core. This requires calibration of incore thermocouples and wide range resistance temperature detectors (RTDs). Thermocouple (PRODAC and Honeywell) and wide range RTD correction factors were obtained by comparing their temperature readings with the narrow range RTD readings taken during the heatup of the primary system.

Table 6.1

RTD Correction Factors

RTD	300°F	350°F	400°F	450°F	500°F	547°F
410A	0.2	0.0	-0.1	0.4	2.1	-0.15
411A*	0.4	0.2	-0.1	0.2	-0.1	-0.35
412A	0.3	0.1	-0.2	0.4	-0.3	-0.2
410B	-0.5	-0.5	-0.3	0.0	-0.4	-0.35
411B	-0.3	-0.4	0.0	0.1	-0.4	-0.3
412B*	0.1	0.3	-0.2	0.3	-0.5	0.25
420A**	-1.5	-1.5	-0.8	-2.0	-2.25	-2.10
421A	-1.0	-0.8	-0.4	0.7	-0.25	-0.45
422A*	-0.2	0.1	0.1	0.1	0.1	0.0
420B	-0.4	-0.2	0.1	-0.1	0.25	-0.1
421B**	-1.0	-1.5	-0.5	-2.0	-1.4	-0.75
422B*	0.0	0.0	0.0	0.0	-0.25	-0.2
430A	-1.6	-0.6	0.0	0.0	-0.75	0.10
431A	0.4	-0.5	0.25	0.3	0.0	0.25
432A*	0.1	0.0	-0.1	0.7	0.0	-0.1
430B**	1.0	1.2	0.6	1.3	+0.25	1.5
431B	0.2	0.3	0.0	0.4	0.6	0.6
432B*	0.1	0.3	0.1	-0.1	0.2	0.0
440A	0.3	0.2	0.1	1.2	0.3	0.0
441A	0.2	-0.2	0.2	0.6	0.4	0.0
442A*	0.1	-0.4	-0.2	0.2	-0.2	0.1
440B**	0.4	0.2	0.2	0.1	0.2	-0.1
441B	o/s	o/s	o/s	o/s	o/s	o/s
442B	-0.7	-0.7	0.1	-0.3	-0.45	0.6

Note: o/s Out of Service

* RTD's used in Protection Circuit

** RTD's not to be used

Correction Factor = True Temperature - Indicated Temperature

Figure 1
ONF-2-236

Detector model #WL23821
Serial # 781701
Date placed in service: 5/10/78

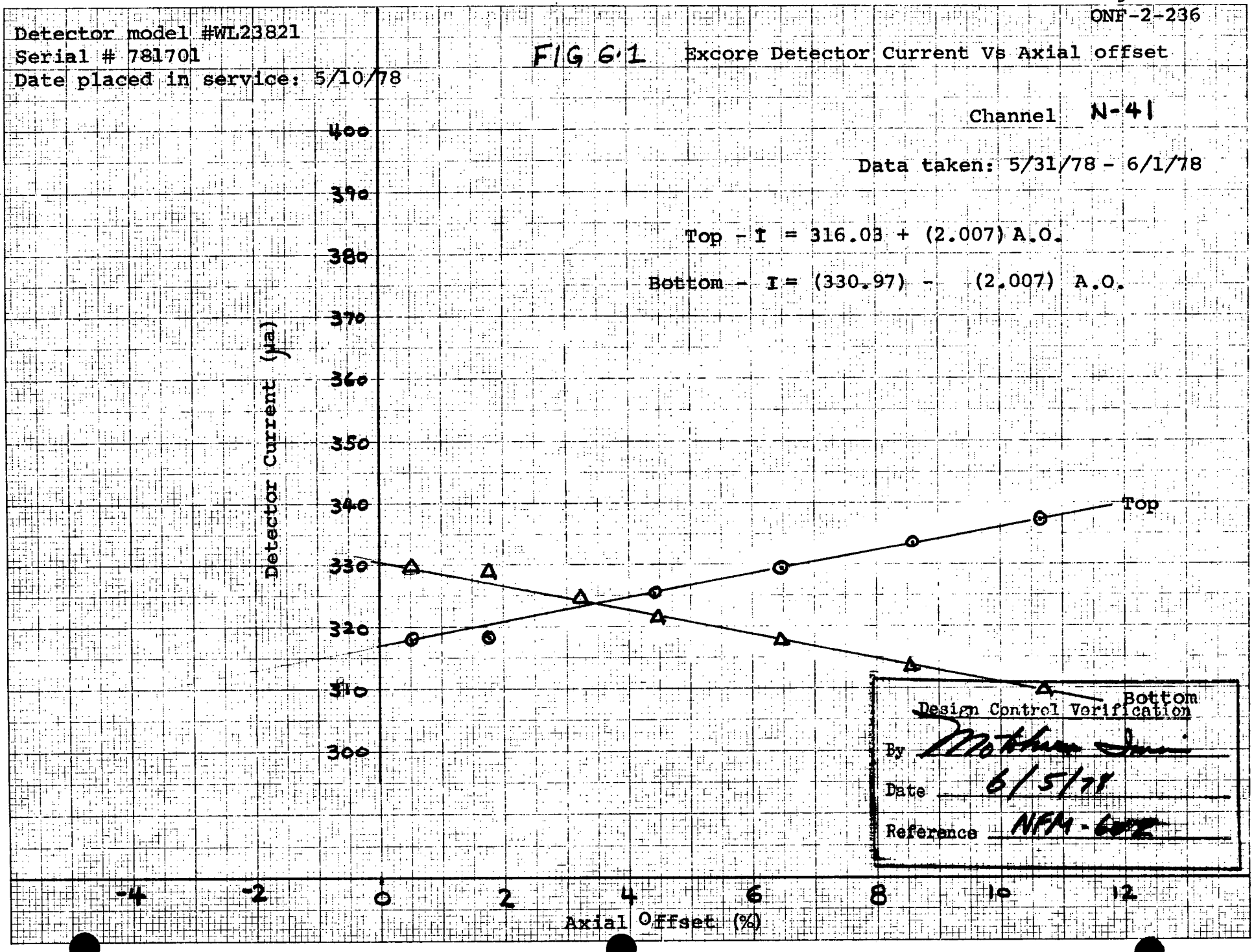
FIG 6.1 Excore Detector Current Vs Axial offset

Channel N-41

Data taken: 5/31/78 - 6/1/78

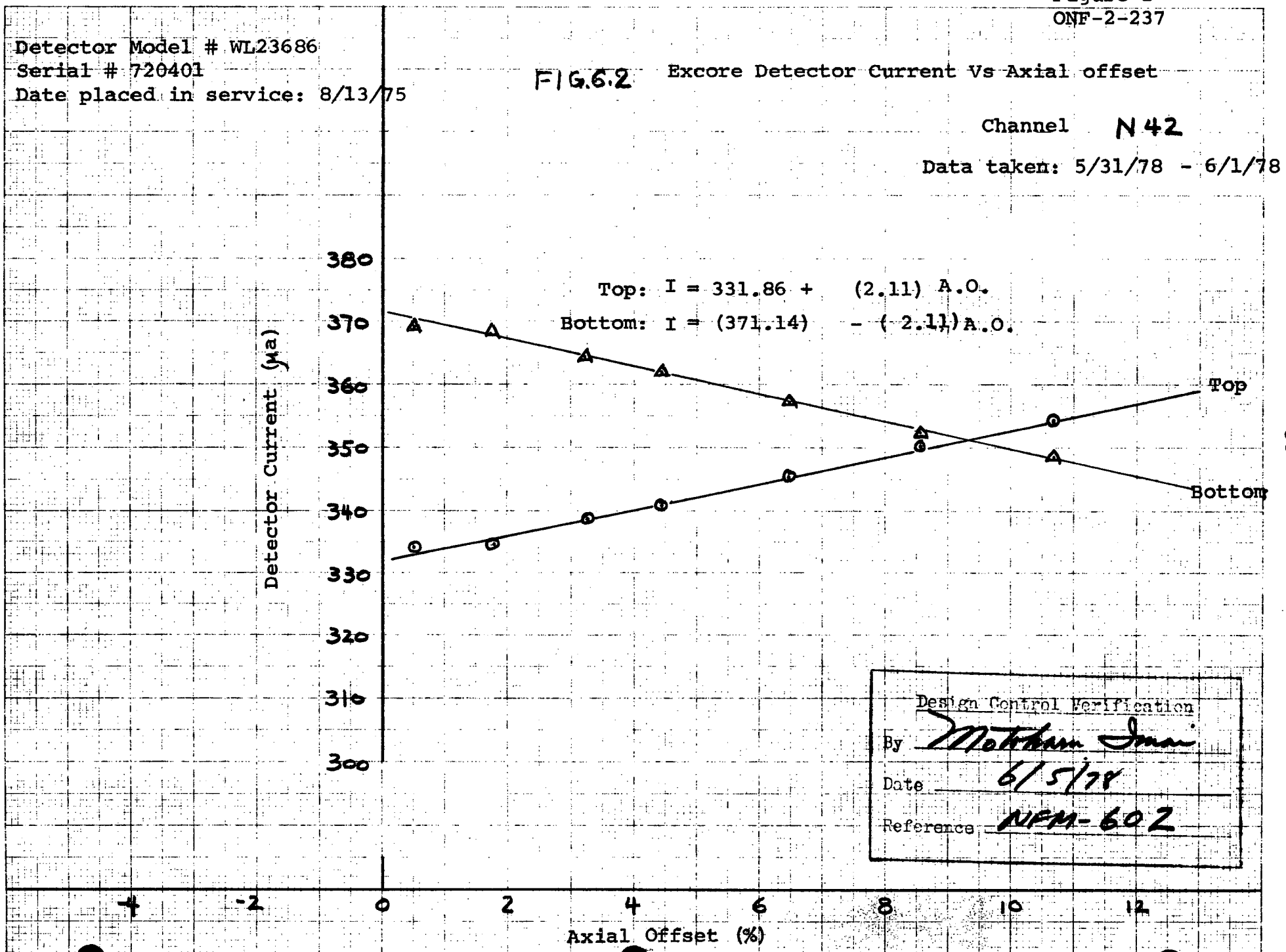
Top - I = 316.03 + (2.007) A.O.

Bottom - I = (330.97) - (2.007) A.O.



Design Control Verification
By Mathew Jose
Date 6/5/78
Reference NFM-602

Figure 2
ONF-2-237



Detector Model # WL23686
Serial # 763903
Date placed in service: 8/7/77

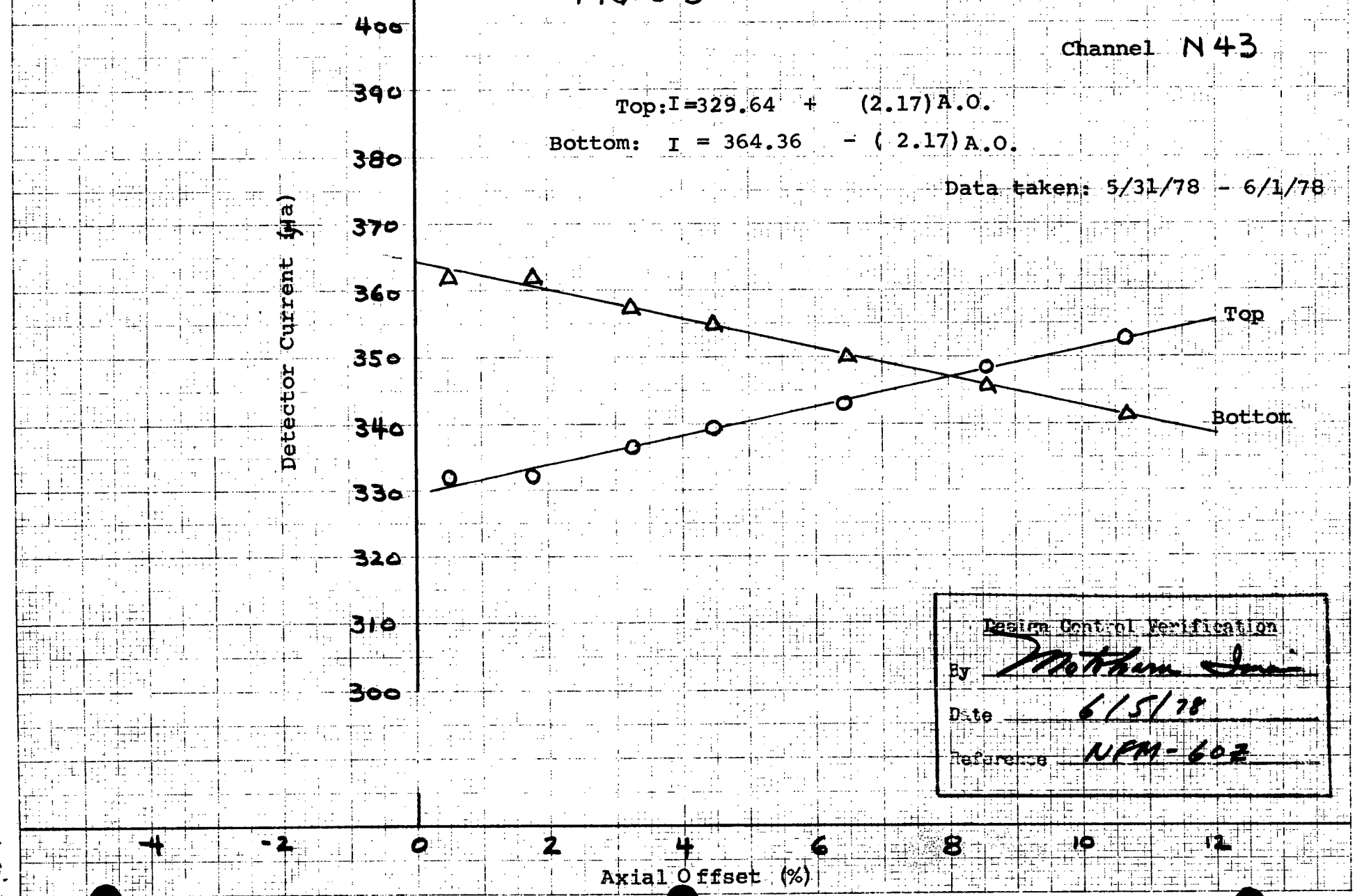
FIG. 6.3 Excore Detector Current Vs Axial offset

Channel N43

Top: I = 329.64 + (2.17) A.O.

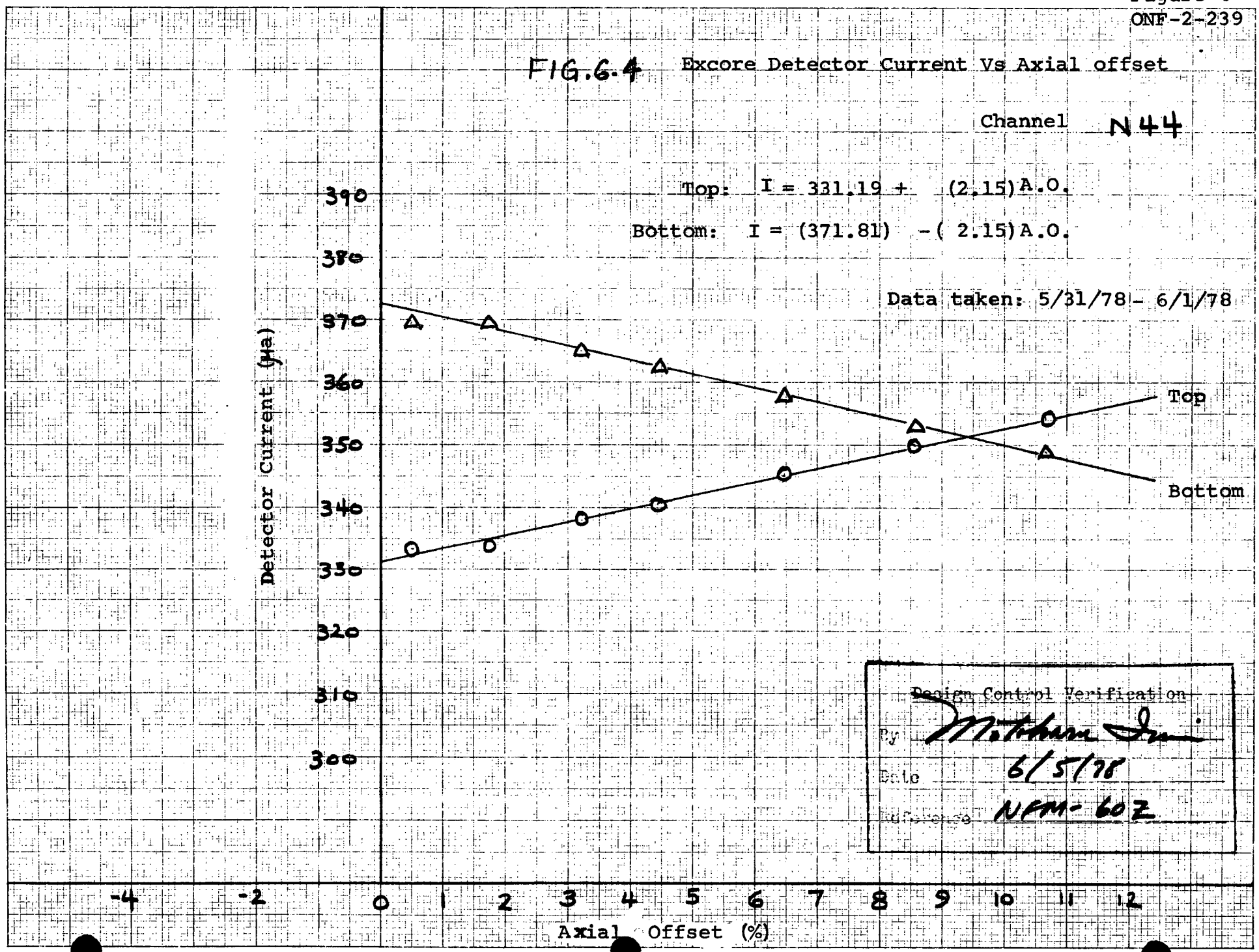
Bottom: I = 364.36 - (2.17) A.O.

Data taken: 5/31/78 - 6/1/78



Design Control Verification
By Nathan Jones
Date 6/5/78
Reference NPM-602

Figure 4
ONF-2-239



7. References

1. Docket No. 50-247 Final Facility Description and Safety Analysis Report, Consolidated Edison company of New York Inc., Indian Point Nuclear Generating Unit No. 2.

2. Docket No. 50-247 Technical Specifications as amended through Amendment No. 40 to Facility Operating License No. DPR-26 (Appendix A), COnsolidated Edison Company of New York, Inc., Indian Point Nuclear Generating Unit No. 2

3. Private Communication from Westinghouse via P. A. Loftus, J. J. Sommerville, D. N. Deardorff and R. D. Jordan (August 1978)

4. Private Communication from Westinghouse via A. J. Harris et al., (July, 1972).