AIIM

Association for Information and Image Management

1100 Wayne Avenue, Suite 1100
Silver Spring, Maryland 20910
301/587-8202

Centimeter

Inches

MANUFACTURED TO AIIM STANDARDS
BY APPLIED IMAGE, INC.

**Cover Sheet for a Hanford
Historical Document
Released for Public Availability**

Released 1994

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute**

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This is a **historical document** that is being released for public availability. This was made from the best available copy. Neither the United States Government nor any agency thereof, nor Battelle Memorial Institute, nor any of their employees, makes any **warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights.** The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DECLASSIFIED

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION - RICHLAND, WASHINGTON

DOCUMENT NO.

HW-76509

SERIES AND COPY NO.

DATE

February 8, 1963

TITLE

FINAL REPORT PT IP-513-C
RECALIBRATION OF HORIZONTAL CONTROL
RODS AT H REACTOR

AUTHOR

A. D. Vaughn

ISSUING FILE

CIRCULATING COPY
RECEIVED 100 D AREA

ROUTE TO:

PAYROLL NO.

LOCATION [REDACTED]

FILED
DA

SIGNATURE AND DATE

AHR 121953

1.274.5

YOUTH

~~SECRET~~ JAN 31 1964

DECLASSIFIED

(Continued)

DECLASSIFIED

HW-76509

This document consists of
pages.

Distribution

1. AEC-LR00: Att'n: AT Gifford
2. AEC-LR00: Att'n: CN Zangar
3. DG Albertson
4. TW Ambrose
5. ER Astley
6. CE Bowers
7. RD Carter
8. RA Chitwood
9. EL Conner
10. DW Constable
11. JR Fredsall
12. GC Fullmer
13. SM Graves
14. OH Greager
15. AB Greninger
16. LL Grumme
17. LW Lang
18. EH Lockwood
19. AW Medcalf
20. WW McIntosh
21. R Nilson
22. GF Owsley
23. CA Priode/T Prudich
24. RW Reid
25. SM Skidmore
26. AD Vaughn
27. AP Vinther
28. 300 Files
29. Records Center

Classification Cancelled and Changed To

DECLASSIFIED

By Authority of CG-PR-2,

RM Otn, 3-21-44.

By Jerry M. Mullen, 3-30-44.

Verified By DK Hansen, 4-4-44

This document classified

by: GC Fullmer

February 8, 1963

FINAL REPORT PT IP-513-C
RECALIBRATION OF HORIZONTAL CONTROL RODS AT H REACTOR

MASTER

I. INTRODUCTION

The E-N loading at H Reactor required a remeasure of all the reactivity variables; this was desirable not only for pile safety evaluations, but also for confirmation of theoretical work performed prior to the loading. For this reason the

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DECLASSIFIED

DECLASSIFIED

reactivity calibration of the control rods was checked^{/1/} in the E-N fuel loading and compared with the measurements made in 1957 when the loading was basically natural uranium.

The large difference between the results of the two tests (approximately 25 per cent) rendered the data somewhat questionable for the exact derivation of E-N fuel parameters since it was suspected that some of the difference might be attributable to an alteration in flux distribution accompanying changes in fuel loadings which had occurred since 1957. Shadowing of rod strength by the E-N lattice in excess of that predicted theoretically was also suspected.

Therefore a second calibration test^{/2/} was performed on July 11, 1962 at H Reactor during a period when the fuel loading consisted of natural uranium fuel surrounded by a blanket of E-N. This document reports the findings from the second test and indicates the extent to which the observed differences between the earlier two calibrations were due to flux distribution effects and to what extent by shadowing of rod strength by the E-N lattice.

II. SUMMARY

The control rod calibrations in the E-N core loading and in the natural uranium core with an E-N blanket yielded results which indicate that the controls are approximately 10 per cent less effective in an E-N core due to shadowing of the rod strength by the E-N lattice; it had been expected from theoretical calculations that the E-N shadowing effect would be approximately 10 per cent.^{/3/}

The tests thus indicate that there has been approximately 25 per cent loss in effective rod calibration value since the 1957 calibration due to changes in the flux pattern associated with alterations in fuel type and geometry. The significant difference between the measurement made in 1957 when the loading was basically natural uranium, and the measurement made in November, 1961, when the pile contained E-N fuel, is thus concluded to be a combination of the blacker lattice and flux distribution effects. These effects for the total system are listed in Table 1.

Table 1

Effective HCR System Strengths at H Reactor

<u>Fuel Loading</u>	<u>Test</u>	<u>Nominal Strength (c-mk)</u>	<u>Effective Strength (c-mk)</u>	<u>Relative Strength</u>
Basic Natural Uranium	1957	3068	2562	100%
E-N Core w/E-N Blanket	Nov.-1961	1966	1686	65%
Nat. Uranium w/E-N Blanket	July-1962	2192	1880	75%

/1/ HW-72411 - Final Report - PT IP-416, Measurement of the Horizontal Rod Strength at H Reactor, 1-28-62, A.D. Vaughn

/2/ HW-73982 - Production Test IP-513-C Recalibration of Horizontal Control Rods - H Reactor, 6-13-62, A.D. Vaughn

/3/ HW-69566 - Physics of E-N Load Compared to Natural Uranium Load at H Reactor, D.I Monnie, 5-11-61

DECLASSIFIED

III. DISCUSSION

A. Modified Rising Period Calibration Test

1. Description

The rods were calibrated in a modified rising period test which consisted of a calibration of the individual rods as well as two select rod insertion orders. The first insertion order followed the configuration calibrated in the 1957 test, and the second an insertion order used during the E-N loading. Both configurations had been followed in the 1961 calibration in the E-N core.

In practice, rods were inserted to successive positions, and a pile rising period was obtained at each position. Periodically, a rod configuration previously measured was repeated; this repetition provided base points so that the pile reactivity as a function of time could be determined. Any given rod configuration was evaluated by subtracting the value of the rising period measured with the rods in that configuration from the pile reactivity derived by the summation of the reactivity increases at the tie points.

2. Instrumentation

The subcritical monitors counted the pile neutron data and plotted the results. One person determined the period from the subcritical monitor chart data using the best "by eye" measurement of the time required for the neutron current to increase by a factor of 2.718. The data was excellent and permitted constant observation of the reactivity changes taking place during the test. The variable chamber positions enabled the periods to be taken from the best available count throughout the entire transient.

3. Test Procedure

Eighty-nine different rod configurations in all were tested through a range of 0-725 c-mk; this range covers approximately 40 per cent of the complete horizontal rod systems.

The reactivity transient and strength of the rod configurations used in the test are illustrated in Figure 1 just as they were measured during the test.

4. Results and Data from the Modified Rising Period Test

The best explanation of the test results can be given by the graphs illustrated in Figures 2-9. Each graph shows the comparison of control rod strengths measured in this test to previous calibrations. The graphs illustrate that there has been some decrease in rod strength since the 1957 calibration due to alterations in the flux distribution accompanying changes in fuel loadings.

DECLASSIFIED

DECLASSIFIED

FIGURE -
ILLUSTRATION OF ROD CALI
USED DURING TEST OF 7-11

FIGURE - I

ON OF ROD CALIBRATION TECHNIQUE
G TEST OF 7-11-62 AT H REACTOR

DECLASSIFIED

FIGURE-2
ROD MEASUREMENT AT H REACTOR

FIGURE - 3
ROD MEASUREMENTS AT H REACTOR

DECLASSIFIED

HW-76509
Page 7

FIGURE - 4

REPEAT CALIBRATION OF ROD INSERTION ORDER USED IN
1957 ROD CALIBRATION TEST

DECLASSIFIED

1957 Calibration
With Natural Uranium
and Enriched Fuel
(4 & 10 at 165; 2 & 14
at 100)

7-11-62 Calibration
With E-N Blanket
Fuel

11-24-61 Calibration
With E-N Core Fuel

FIGURE - 5

CALIBRATION OF ROD INSERTION ORDER IN USE DURING
E-N CORE FUEL LOADING

DECLASSIFIED

HW-76509
Page 9

FIGURE - 6

CALIBRATION OF EQUILIBRIUM ROD CONFIGURATION AT H REACTOR
7-11-62 (TEST WITH E-N BLANKET)

DECLASSIFIED

DECLASSIFIED

HW-76509

Page 10

FIGURE -7

NOMINAL ROD STRENGTH AT H REACTOR WITH E-N BLANKET

7-11-62

DECLASSIFIED

HW-76509
Page 11

FIGURE - 8

NOMINAL ROD STRENGTH AT H REACTOR
WITH E-N BLANKET 7-11-1962

DECLASSIFIED

However the test also demonstrated that there is some loss in the effectiveness of the control rods due to shadowing by the E-N lattice. These differences are illustrated by comparing the greater HCR system strengths measured in this test to measurements made on November 21, 1961, when the pile contained an E-N fuel loading.

a. Measurement of Individual Rods and Rod Pairs

Figures 2 and 3 illustrate the difference between results of this test and measurements made on the same rods during the E-N blanket loading. The calibrations of 1957, when the loading was basically natural uranium, are also included.

b. Measurement of Rod Insertion Orders

Two different rod insertion orders were also recalibrated during the test. The first, illustrated in Figure 4, is an insertion order used in the 1957 test and tested again for comparison during the E-N core loading. The maximum rod worths from all three tests are shown on the graph. However, to eliminate confusion, the detailed calibrations of only the 1957 test and the most recent test have been plotted.

Figure 5 shows the second insertion order calibrated and follows the sequence used during operation when the E-N core was in the pile. The maximum calibrated values of all three tests are also shown on this graph for comparison purposes.

c. Measurement of the Equilibrium Rod Configuration

The equilibrium rod configuration was measured during the November 1961 calibration. The xenon decay rate and test time limit prevented this measurement from being repeated during the 1962 test. However, the rod worth at this configuration can be estimated by extrapolation of two rod evaluations which approach the equilibrium configuration. This data is illustrated in Figure 6.

5. Useful Charts and Curves

The data from this calibration test may be used to determine the nominal control rod strengths for all the individual rod locations at H Reactor. These nominal control strengths are presented in Figures 7 and 8, and may be used to determine the potential excess reactivity compensated control rods during operation with the E-N blanket.

By summing the nominal strengths at specific calibration points on the insertion order measurements, it is possible to derive a nominal to effective reactivity (shadowing) ratio for the control rods in the configuration used. Since the insertion order was only measured up

DECLASSIFIED

HW-76509
Page 14

to 725 c-mk of reactivity it is necessary to extrapolate the nominal to effective ratio beyond this measured point. For the extrapolation the same shadowing factors were assumed at the end of the curve as were measured at the lower reactivity values.

A. D. Vaughn

Process Physics Studies
Operational Physics Sub-Section
Research and Engineering Section

AD Vaughn:gs

DECLASSIFIED

HW-76509
Page 15

APPENDIX A

Test Data

<u>Period No.</u>	<u>Time</u>	<u>Rod Configuration</u>	<u>Period (c-mk)</u>
1	0826	All rods out	60.8
2	0846	8 at 300	88.6
3	0842	8 In	10.0
4	0850	All rods out	109.4
5	0852	4&10 at 300	97.3
6	0853	4 at 300	103.7
7	0859	2&14 at 300	112.6
8	0902	2&14 at 250	20.9
9	0906	8 at 300	134.2
10	0908	8 at 250	84.0
11	0912	9 at 175	81.5
12	0916	7 at 200	69.6
13	0922	4&10 at 250	67.9
14	0925	4&10 at 225	36.3
15	0927	4 at 225	101.0
16	0932	5&11 at 250	70.2
17	0934	2&14 at 250	89.6
18	0936	2&14 at 225	51.0
19	0940	8 at 250	156.9
20	0942	8 at 200	96.1
21	0948	8 at 150	81.5
22	0950	7 at 150	99.7
23	0955	4&10 at 150	20.9
24	0957	4&10 at 175	92.8
25	0959	4 at 175	136.7
26	1003	5&11 at 250	129.0
27	1004	9 at 50	150.5
28	1010	2&14 at 175	43.6
29	1013	2&14 at 150	0
30	1014	8 at 150	136.7
31	1019	7 at 150	164.0
32	1021	2&14 at 250; 8 at 275	109.4
33	1027	4&10 at 100	36.3
34	1035	4&10 at 165; 2&14 at 260	39.1
35	1039	5&11 at 175	72.1
36	1041	5 In	117.7
37	1045	2&14 at 175	114.3
38	1047	2&14 at 150	80.7
39	1048	2&14 at 230; 8 at 225	121.4
40	1053	4&10 at 100	84.9
41	1056	4&10 at 150; 2&14 at 275	79.9
42	1059	7 at 75	215.2
43	1104	4 In	215.2
44	1107	8 at 100	239.5
45	1113	5&11 at 75	0

DECLASSIFIED

HW-76509
Page 16

<u>Period No.</u>	<u>Time</u>	<u>Rod Configuration</u>	<u>Period (c-mk)</u>
46	1116	5&11 at 100	42.2
47	1118	2&14 at 150	136.7
48	1120	2&14 at 100	131.9
49	1125	4&10 at 165; 2&14 at 235, 8 at 215	42.0
50	1128	2&14 at 175; 8 at 100	54.0
51	1130	2&14 at 100; 8 at 100	10.0
52	1134	2&14 at 220; 4&10 at 150; 8 at 205	0.0
53	1136	2&14 at 220; 4&10 at 150	81.5
54	1139	5&11 at 100	89.6
55	1141	5&11 In	0.0
56	1147	2&14 at 230; 8 at 100	180.7
57	1150	2&14 at 100; 8 at 100	40.4
58	1153	2&14 at 220; 4&10 at 150	119.5
59	1159	2&14 at 220; 4&10 at 150; 8 at 205	69.0
60	1201	4&10 In	176.2
61	1204	5&11 In	61.3
62	1209	2&11 at 200; 4&10 at 150	147.5
63	1215	2&14 at 235; 4&10 at 165; 8 at 215	136.7
64	1222	2&14 at 100; 5&11 at 275; 8 at 100	38.5
65	1225	2&14 at 150; 4&10 at 150; 8 at 205	0.0
66	1228	2&14 at 150; 4&10 at 200; 8 at 205	95.0
67	1230	5&11 In	111.0
68	1235	2&14 at 170; 4&10 at 165; 8 at 215	90.7
69	1239	2&14 at 100; 8 at 100; 5&11 at 200	-20.9
70	1240	2&14 at 100; 8 at 100	131.9
71	1246	2&14 at 100; 4&10 at 150; 8 at 205	0.0
72	1247	2&14 at 200; 4&10 at 150; 8 at 205	129.0
73	1254	2&14 at 100; 4&10 at 105; 8 at 215	37.7
74	1259	2&14 at 100; 5&11 at 225; 8 at 100	40.6
75	1304	2&14 at 100; 4&10 at 150; 8 at 205	251.0
76	1305	4&10 at 165; 8 at 215; 2&14 at 170	144.6
77	1310	4&10 at 165; 8 at 215; 2&14 at 170	160.4
78	1313	2&14 at 100; 4&10 at 165; 8 at 100	10.0
79	1315	2&14 at 100; 4&10 at 165; 8 at 215	73.4
80	1317	2&14 at 100; 5&11 at 225; 8 at 100	72.1
81	1321	2&14 at 100; 5&11 at 100; 8 at 100	-56.5
82	1324	2&14 at 100; 4&10 at 150; 8 at 100	24.6
83	1329	2&14 at 100; 4&10 at 150; 8 at 200	51.0
84	1333	2&14 at 100; 4&10 at 165; 8 at 100	51.0
85	1337	2&14 at 100; 4&10 at 165; 8 at 100; 3&15 at 200	-10.0
86	1343	2,8,14 at 50; 3,6,9,12,15 at 250; 4&10 Out	142.5
87	1345	2,8,14 at 50; 3,6,9,12,15 at 250; 4&20 at 200	-47.4
88	1350	2,8,14 at 50; 3,5,11,15 at 250; 4&10 Out	114.3
89	1353	2,8,14 at 50; 3,5,11,15 at 250; 4&10 at 200	-35.8

DATE

FILMED

6 / 22 / 94

END