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- #5 J. M. West
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April 4, 1947 COPY 1 OF 1, SERIES MA

100 AREAS TECHNICAL ACTIVITIES REPORT - PHYSICS
MARCH, 1947

FILE AREAS - U. M. STAEBLER

B File

A foil test was made in tube 1363 B on March 12, 1947. The two foils irradiated gave results of 103.5 and 106.4 neutrons/cm²/sec. The average of 105 neutrons/cm²/sec. agrees within experimental error with results of last month's test. No change in reactivity is indicated for the B File. The gas purity at the time of the test was 99.15%.

D File

Summary

A power coefficient test was performed on March 7, 1947. Data obtained following the return to normal operating level at the end of the test did not agree with expected reactivity transients. A slight flattening of the A Rod calibration curve is indicated. No results are reported pending a check of the rod calibration in the region from all in to 100 inches out.

The loadings of four poison columns were changed during the month. One additional tube has been charged with bismuth and another tube outside of the permanent poison pattern was charged with special request material.

Reactivity gains averaging 0.8 inhour per day were experienced during periods of operation with the xenon poison in equilibrium. There was a net loss of one inhour in cold, clean reactivity for the month.

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HW-- 7-6032

A. B. Greninger

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April 4, 1947

Details

Coefficient Test

The power level of the D Pile was lowered by 31.4kW for a period of five hours on March 7, 1947, in an effort to determine the reactivity power coefficients and the graphite relaxation period. Interpretation of the data by means of the A Rod calibration curve currently accepted for the D Pile leads to several difficulties. First of all, the coefficients one obtains from the initial part of the test are not in good agreement with previously established trends. Secondly, the reactivity transients observed for the period of operation at normal power at the conclusion of the test do not agree with variations expected on the basis of xenon calculations. These difficulties can be corrected by assuming that the calibration curve for A Rod should be somewhat flatter in the region from all in to 100 inches out. A test has been scheduled for April 15, 1947 to check the calibration curve in this region. Coefficients from both tests will then be evaluated on the basis of this calibration curve. It should be pointed out that a similar flattening of the A Rod calibration curve has been adopted for the F Pile. Use of the F calibration curve on the data from the coefficient test at D introduces a larger correction than is needed to bring about agreement between expected and observed reactivity changes.

Special Request Material

The following table summarizes the charging and discharging of material covered by Special Requests during the month.

Date	Tube	Discharged			Charged		
		No. of Pcs.	S.R.No.	Material	No. of Pcs.	S.R.No.	Material
3/9/47	2666D	42	15-10	LIF	29	15-11	LIF
3/9/47	2682D	--	--	3L-2P	34	15-11	LIF
3/16/47	1569D	--	--	3L-2P	27	15-11	LIF
3/16/47	3268D	1	28	Fe	1	29-1	P ₂ O ₅
		1	29A	P ₂ O ₅			
		1	29C	P ₂ O ₅			

In addition to the changes listed above, tube 1582-D was charged with graphite samples as outlined in Production Test No. 106-CS-P, Supplement A, on March 23, 1947. A new column of bismuth was charged into tube 3467-D on March 9, 1947. This brings the total number of bismuth columns in the D Pile to eleven.

Reactivity Balance

The following table compares the reactivity of the D Pile at the end of this report period with that reported for the end of last month.

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April 4, 1947

	<u>2/28/47</u>	<u>3/31/47</u>
Amount held in rods	59 inhours	55 inhours
Amount held in xenon	492 inhours	492 inhours
Amount held in Special Requests		
Inside poison pattern	172 inhours	221 inhours
Outside poison pattern	5 inhours	5 inhours
Plant Assistance Irradiations	15 inhours	20 inhours
Amount held in "P" columns	113 inhours	57 inhours
Amount held in bismuth columns	44 inhours	42 inhours
Amount held in dummy columns	2 inhours	2 inhours
Due to overall power coefficient	-95 inhours	-95 inhours
Total cold, clean reactivity	807 inhours	806 inhours

F Pile

Summary

- A slight change in the physical size of the new No. 2 horizontal rod has made it operate satisfactorily. The rod withdrawal order has been changed back to 8, 5, 4, 6, 7, 2, 9, and 1.

The apparent thermal conductivity of the graphite in the F Pile has been calculated for the period from 9/3/46 to the present. Values obtained do not agree with those obtained for the D Pile for comparable exposures.

The graphite temperature readings of the gas thermometer and 14 thermocouples have been compared over the past six months. There is no definite divergence in readings as was previously reported for the D Pile. The two instruments are in satisfactory agreement.

Charges in two tubes of the regular poison pattern were changed during the month. One new tube was charged with Special Request material and one additional bismuth column was charged.

There was a net gain of five inhours in the cold, clean reactivity of the F Pile during the month.

Details

Rods

The top plates along all but the tip of the No. 2 rod were replaced with plates that had been reduced in thickness by 3/16 inch. This change in rod structure apparently gave sufficient additional flexibility to allow the rod to operate satisfactorily so it was put back into service following the shutdown of March 23, 1947. The calibration of the new rod has been checked by comparison with calculated xenon variations and found to be the same as for the replaced No. 2 rod within the accuracy of the calibration. Unexplained difficulties with No. 6 rod are still being experienced and vertical rods 35 and 36 still stick when tested.

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April 4, 1947

Apparent Thermal Conductivity

Calculations of the apparent thermal conductivity of the graphite in the vicinity of the six centrally located thermocouples have been made for the F Pile covering the period from 9/3/46 to the present. This period corresponds to an exposure range of 970 megawatt days per adjacent ton to 1260 megawatt days per adjacent ton. There are not sufficient points to establish the rate of change in the apparent thermal conductivity of the graphite but the present value is about 1/25 of the original graphite conductivity. The values over the range covered are almost 50 per cent greater than similar values calculated for the D Pile at a time of comparable exposure. Further calculations are being made to establish the rate of change in apparent thermal conductivity for the F Pile.

Graphite Temperatures

Last month it was reported that there has been a gradual divergence between graphite temperature readings of the gas thermometer and 14 G thermocouple of the D Pile. Readings from these two instruments have been compared for the past six months for the D Pile to determine if a similar disagreement has developed there. Although individual readings from the two instruments may differ by as much as 15°C, there is no evidence of a divergent trend. It may be of some interest to note that the ratio of temperature rise in the graphite over local water temperature agrees much more closely with the ratio of the power levels of the two piles if the temperature recorded by 14 G thermocouple are taken than they do if the gas thermometer readings are used.

Special Request Material

The following table summarizes the charging and discharging of material covered by Special Requests during the month.

Date	Tube	Discharged			Charged		
		No. of Pcs.	S.R.No.	Material	No. of Pcs.	S.R.No.	Material
3/9/47	2383P	--	--	U	1	27	
3/16/47	1775P	1	30	Be	--	--	U
3/16/47	2374P	29	15-10	LIF	29	15-11	LIF
3/16/47	3169F	25	15-10	LIF	25	15-11	LIF

Tube 3581-F was charged with a bismuth column for the first time on March 9, 1947, bringing the total number of bismuth columns in the F Pile to 13.

Reactivity Balance

The following table compares the reactivity of the F Pile at the end of this report period with that reported for the end of last month.

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A. P. Greeninger

April 4, 1947

	<u>2/26/47</u>	<u>3/31/47</u>
Amount held in rods	50 inhours	59 inhours
Amount held in xenon	427 inhours	426 inhours
Amount held in Special Requests		
Inside the poison pattern	134 inhours	199 inhours
Outside the poison pattern	30 inhours	30 inhours
Amount held in "P" columns	124 inhours	50 inhours
Amount held in bismuth columns	61 inhours	67 inhours
Amount held in dummy columns	5 inhours	5 inhours
Due to overall power coefficient	-78 inhours	-78 inhours
Total cold, clean reactivity	753 inhours	758 inhours

GENERAL PHYSICS - H. A. FOWLER

Production Test 106-85-P

A set of graphite samples was changed into process tube No. 1582 in the D Pile on March 23, 1947, to be exposed in an atmosphere containing 90% helium and 10% carbon dioxide by volume. The purpose of this test is to determine the effect on the mechanical properties of graphite exposed under pile conditions in this atmosphere. The type samples loaded are given in the following table:

No. Samples	MD/CT	Sample Size -inches	Type Sample
4	C	4.0 x 0.426	Transverse Cut
4	C	1.0 x 0.426	Transverse Cut
4	289	4.0 x 0.426	Transverse Cut
4	289	1.0 x 0.426	Transverse Cut
1	1155	4.0 x 0.426	Parallel Cut
2	1155	1.0 x 0.426	Parallel Cut
1	1215	4.0 x 0.426	Parallel Cut

This tube supplements the three tubes loaded with similar samples last month; these tubes contain atmospheres of helium, oxygen, and pure carbon dioxide.

Production Test 106-1-P

No samples have been removed from the Piles recently, so no new data are available. The next samples scheduled for removal are from the Test Hole at the F Pile on 4/25/47.

GENERAL PHYSICS - J. M. WEST

305 Test Pile

Egg Testing

During the month of March, 48 lots of billet eggs were tested at H.E.W. This makes a total of 71 lots which have been tested to date. Considered as a whole the results obtained at H.E.W. agree reasonably well with those reported for the same material by Argonne Laboratory. The values obtained for ΔK at H.E.W. are slightly more negative than those from Argonne. The average value of the difference in ΔK (H.E.W. minus Argonne) for the 65 most recent tests is -0.0108. The standard deviation is ± 0.0179 . The average difference is computed to be -0.0108 ± 0.0058 with 99 per cent probability.

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The slightly more negative value for ΔK which is obtained consistently at H.E.W. is not surprising, since Lot No. 1331, which had been tested only once at Argonne, was chosen as a reference standard for H.E.W. tests. The value of $-0.02\% \Delta K$ reported for this lot by Argonne is used as a correction to all H.E.W. results in referring them to the same standard as that used at Argonne. The use of $-0.009\% \Delta K$ for this lot would eliminate the consistent error. A change of this amount is believed to be within the limits of accuracy of single tests at Argonne.

Although a majority of the H.E.W. test results agree with those from Argonne, there are some exceptional cases. In cases where large discrepancies appeared, the tests were repeated at H.E.W. to determine whether anything might have caused the original result to be erroneous. The results obtained at H.E.W. and at Argonne, respectively, for these lots are shown in the following table:

Table I
Largest Discrepancies Between H.E.W. and Argonne

Lot No.	Box No.	ΔK at H.E.W.			ΔK at Argonne	
		First Test	Second	Third	First Test	Second
TX-1468	543-H	-0.121	-0.124	-0.109	-0.07	-0.08
P-1472	642-E	-0.041	-0.038	--	-0.01	--
TX-1466	540-H	-0.102	-0.104	-0.103	-0.06	-0.06
TX-1493	547-H	-0.098	-0.093	--	-0.06	--
TX-1494	548-H	-0.108	-0.102	-0.088	-0.18	--

- These results were obtained with the order of the eggs in the stringer changed deliberately. They cannot be expected to check results in first and second tests.

The discrepancy on lot TX-1494 is great enough to warrant an investigation of possible causes and corrective action. One of the most likely sources of differences in results seemed to be the fact that the test stringer at H.E.W. covers a smaller fraction of the pile length than does the one at Argonne. Since the quality of metal is known to vary widely from billet to billet, the locations of particular odd billets with respect to the center would influence the test result. For example, if a very impure egg were placed in the cell located farthest from the center of the pile, this egg would have less effect on the test result at Argonne than at H.E.W., where its more central location gives the end slug relatively more importance. To investigate whether this effect could cause the observed discrepancies, the end slugs were placed near the center of the stringer and vice versa. As will be seen in Table I, the results obtained were not greatly different from those found previously with the standard arrangement. This effect apparently does not account for the large discrepancies.

To eliminate the possibility that the large difference in results for lot TX-1494 might be due to numerical or typographical errors, Argonne was asked to search their test records for possible errors. No causes for the discrepancy were found. To clarify this situation, a series of tests on six lots of billet eggs, one of which is lot TX-1494, will be made at H.E.W., before shipping these lots back to Argonne for a similar series of tests there. From results of these tests the preciseness of tests at Argonne and at H.E.W., respectively, can be evaluated. The causes for some of the differences in results may also be uncovered.

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Test PI De Precision

In a recent statistical analysis of Test PI De results on billet egg tests during the month of March, the precision for duplicate readings (drifts) on a single sample was found to be $\pm 0.007\% \Delta K$ or ± 0.017 inhours. This value indicates improvement over the value of ± 0.032 inhours found in a similar analysis of data taken during the period January 14, 1946 to October 24, 1946. (Butler to Greninger, Document No. J-6080, November 11, 1946).

Far more important than the improvement in the reproducibility of successive drift measurements on the same sample is the greater reproducibility of the results of complete tests made at different times. A complete test is here defined as the inhour value relative to a standard lot obtained by averaging two or more successive drift measurements on a given sample. A second test result could be obtained by taking out the sample and replacing it after a lapse of time (hours or days as the case may be) for a completely new test. A series of such tests was made in December, 1946, to determine the degree of reproducibility of test results obtained in repeated tests on the same sample on the same day and on two different days. In a report of the results (Butler to Smith, Document No. J-5180, December 30, 1946) it was stated that large day-to-day and within-day differences were obtained. The average results on December 24 and December 27 were -0.240 and -0.360 inhours, respectively. The range of ΔK results for the average of duplicate readings on December 24 was -0.215 to -0.275 inhours, while on December 27, the range was -0.305 to -0.410 inhours. These very poor results are to be contrasted with the values obtained recently in duplicate tests on seven lots of billet eggs. These seven duplicate tests on billet eggs represent the only cases where tests have been repeated since the various corrective measures, including the "stripped" rod calibration, were applied to the Test PI De. Results are shown in Table II.

Table II

Results of Repeated Tests at H.S.W.

Lot No.	Box No.	First Test		Second Test	
		Date	ΔK	Date	ΔK
TX-1450	531-F	January 29	-0.110	March 14	-0.107
TX-1452	535-H	January 29	-0.106	March 14	-0.106
TX-1466	540-H	March 10	-0.102	March 10	-0.104
TX-1468	543-H	March 10	-0.121	March 11	-0.124
TX-1471	542-S	March 11	-0.041	March 11	-0.138
TX-1493	547-H	March 14	-0.098	March 14	-0.083
TX-1494	548-H	March 14	-0.100	March 14	-0.102

The improvement in reproducibility over that obtained in December 1946 is very great. Not only are the within-day differences very small, but the results obtained on different days appear to be equally good. A statistical analysis of the results in Table II showed that in 99 per cent of the cases, the result obtained from a single test can be expected to be within $\pm 0.006\% \Delta K$ of the correct value as obtained by running a large number of tests and taking the average.

Paul F. Smith

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