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HW-13027 DEL

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- # 1 - AB Greeninger
- # 2 - AI Fatnode
- # 3 - CJ Wende
- # 4 - PP Gast
- # 5 - WK Woods
- # 6 - UM Staebler
- # 7 - AA Johnson
- # 8 - HA Fowler
- # 9 - MB Montgomery
- # 10 - JM West
- # 11 - 300 File
- # 12 - 700 File
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300 AREA
CLASSIFIED FILES

February 15, 1949

100 AREAS TECHNICAL ACTIVITIES REPORT - PHYSICS

JANUARY, 1949

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FILE PHYSICS GROUP - U. E. Staebler

Power Coefficient Tests - Production Test No. 105-220-P

The first test to determine the power coefficients of the F File since the addition of 25 per cent carbon dioxide to its atmosphere was performed on January 19, 1949. The power level was dropped from 275 kW to 235 kW for a period of eight hours. Mechanical difficulties with the "A" Rod prevented making a smooth recovery to the 275 kW level so the second half of the test could not be used. The results from this power coefficient test and those from the last test before the addition of carbon dioxide are summarized below.

Coefficient	Jan. 19, 1949 (25%CO ₂)	Aug. 24, 1948 (C60CO ₂)
Graphite, C _G	C.74 in/kw	0.68 in/kw
Metal, C _M	-0.30 "	-0.20 "
Overall, C _O	0.44 "	0.48 "
Graphite relaxation period	77 minutes	87 minutes

The slight reduction in the value of the overall power coefficient is consistent with results from the D File following the addition of carbon dioxide. The distribution as to metal and graphite power coefficients is not considered quite so reliable as is the value for the overall power coefficient so it cannot be said that the change in these coefficients indicated in the above comparison is a real difference.

Rod Calibration by Periods

Prior to January 4, 1949, the only current rod calibrations of the "A" control rods were those dependent upon comparison of rod motion with a calculated xenon poison transient. A direct calibration of segments of the "A" control rod of the D File by means of reactivity periods was made following a normal shutdown of the D File on January 4. Five different reactivity periods were measured in connection with this test. The values are summarized in the following table.

Minutes Elapsed	Rod Position	Beckman Period	in	F.C. Period	in
0	A = 100" others out	195s	15.9	207s	15.1
32	A = 200" " "	53.5s	43.8	53.7s	43.8
40	A out " "	29.7s	63.8	31s	62.3
54	A in " "	140.s	21.0	152s	25.7
77	A = 100" " "	66s	37.7	70s	26.1

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* From the middle of the time during which the first period was taken to the middle time during which the subsequent periods were taken. The correction for the decay of the xenon poison during the time of these measurements was made on the assumption that the decay was linear over such a short period. Values for the various positions of "A" rod measured are summarized below.

<u>Rod Position</u>	<u>Decay Periods</u>	<u>P.C. Periods</u>	<u>Average</u>
A in	49.6 in	49.1 in	49.4 in
A @ 100"	36.6	36.2	36.4
A @ 200"	17.7	16.2	17.0
A out	0.0	0.0	0.0

The total value of 49.4 inhours for "A" rod is in good agreement with the value of 50.0 inhours obtained from the most recent calibration by means of comparison of rod motion with the calculated xenon poison transient following a power coefficient test. It should be noted that these values are for the "A" rod of the D Pile with all other rods out and for a given arrangement of poison columns amounting to about 450 inhours of flattening. Similar measurements are planned in other areas as they can be scheduled conveniently. The reactivity periods discussed above are of interest aside from the fact that they yield a calibration curve for the "A" rod of the D Pile. A comparison of the inhour values of the first and last periods shows a xenon poison decay of 21.4 ± 0.5 inhours. A calculation of xenon poison for the same time interval using 450 inhours of flattening and standard xenon equations gives a decay of only 16.5 inhours. The prediction chart presently in use, which incorporates an empirical correction of the change in critical rod position vs time, gives a value of 21 inhours for the change in reactivity during the time in question. If the flattening correction to the xenon equations is taken to be in error, and is changed so that the calculated reactivity change would agree with the observed, the flattening value would fall between 300 and 360 inhours. Temperature studies of the unit at equilibrium at nominal power yield a value in close agreement with the value of 450 inhours.

Metal Quality Studies

An investigation has been carried out to determine the reactivity gains possible by zoning the pile for metal charging according to quality or by other changes in metal supply. The distribution of metal quality, as measured by the 305 test pile, was determined for the metal canned between March 1, 1948, and December 17, 1948. Calculations show that a gain of less than 6 inhours could be obtained by charging the best metal in the center of the pile and successively poorer grades in outer zones. If all metal charged could be made of the quality distribution noted for "B" type metal (metal reclaimed from scrap here) a gain of 12 inhours could be realized and an additional 6 inhours for zoning. It has been demonstrated by W. A. Kattner that poor grade slugs can be separated by visual inspection after the pickling process. A gain of 10 ± 5 inhours would be expected if poor grade slugs selected in this manner were charged in the fringe tubes of the pile; a further gain of about 5 inhours would be expected if these pieces were classed as scrap and reclaimed as "B" metal.

Polonium Production Under Emergency Conditions

In the event of a complete failure of the electrical supply system it would be necessary to meet the polonium requirements by charging additional columns of bismuth and operating at reduced powers as allowed by the limited water pumping capacity of the emergency steam system. A flow of only 12,000 gpm could be maintained at the filter plant on steam pumps alone. This is the point of minimum flow for the present steam driven equipment and would limit the power level to about 70 kW. This operating level in the present three piles would be sufficient to supply up to about 9000 curies/month with 400 columns of bismuth in the piles. This present requirements but does not allow for the temporary set-back due to time delays in changing operation.

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Process Tube Ion Chamber Failures

Three of the four $1\frac{1}{2}$ inch diameter ionization chambers installed in corner tubes of the F File in September, 1948, have failed. All three bad chambers were replaced during the month of January and the chamber which failed first was cut open for inspection to determine the cause of failure. The inside insulator ring was found to be almost completely pulverized. Tests are being undertaken to determine a more suitable insulating material for use in future chambers.

Neutron Flux - H Hole, F File

A series of measurements of the thermal neutron flux in the various pockets of the H Test Hole of the F File have been carried on during the past few months. These measurements have been made by irradiating copper wire, dissolving in nitric acid, diluting with water, and measuring the activation of the residue of a small sample evaporated to dryness. The following results are averages of from one to four measurements in each pocket.

<u>Pocket No.</u>	<u>Location</u>	<u>n</u>
		2.5×10^{12} n/cm ² /sec.
1	5.84" beyond column 96	2.2
2	4.09" " " "	8.0
3	2.34" " " "	1.7
4	0.59" " " "	1.9
5	1.16" Outside column 96	1.8
6	2.91" " " "	1.7
7	4.66" " " "	1.6
8	6.41" " " "	1.4
9	8.16" " " "	1.3
10	9.91" " " "	1.2
11	11.66" " " "	1.1
12	13.41" " " "	1.0
13	15.16" " " "	0.8
14	16.91" " " "	0.7
15	18.66" " " "	0.6
16	20.41" " " "	0.5
17	22.16" " " "	0.4
18	23.91" " " "	

Reactivity Balance

The reactivity balance of each of the operating files at the beginning and end of this report period is given in the following table.

	<u>B File</u>		<u>D File</u>		<u>F File</u>	
	<u>12-31-48</u>	<u>1-31-49</u>	<u>12-31-48</u>	<u>1-31-49</u>	<u>12-31-48</u>	<u>1-31-49</u>
In rods	62 1h	81 1h	60 1h	70 1h	38 1h	36 1h
In xenon	527	526	491	489	301	303
In Special Requests						
Inside "P" Pattern	145	145	202	268	127	186
Outside " "	20	20	10	10	31	21
In Bismuth	115	120	105	120	111	112
In "P" Columns	0	0	33	17	105	39
In Plant Assistance	0	0	40	35	0	0
In dummy tubes	0	0	3	3	28	20
Correction for SR 52	0	0	0	0	-13	-14
Correction for C ₀	-115	-130	-150	-150	-160	-160
	(10%CO ₂)	(25%CO ₂)	(40%CO ₂)	(40%CO ₂)	(25%CO ₂)	(25%CO ₂)
Cold, clean reactivity	754 1h	762 1h	344 1h	362 1h	769 1h	771 1h

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The above table shows net gains of 8 inhours for the B Pile, 18 inhours for the D Pile and 8 inhours for the F Pile.

GRAPHITE GROUP - A. A. Johnson

Thermal conductivity, electrical resistance and physical expansion measurements on three sets of KC graphite samples exposed in a cooled test hole gave the following results:

<u>Exposure (MD/CT)</u>	<u>Cut</u>	<u>K_0/K</u>	<u>R/R_0</u>	<u>% Length Change</u>
1726	⊥	31.8	3.4	--
1226	⊥	33.1	4.1	1.05
1232	⊥	31.9	4.1	1.00

The K_0/K value of 31.8 for the 1726 MD/CT samples shows that the thermal conductivity is continuing to decrease linearly and the R/R_0 value of 3.4 confirms earlier indication that the electrical resistance is increasing again but very slowly. The physical expansion data for the transverse samples show that for constant temperature test hole exposures, expansion is linear with exposure and at 25° C is equal to 0.80% per 1000 MD/AT.

A final report has been written on Production Test No. 105-172-P, "Exposure of Carbon Dioxide" and an interim report is being written on Production Test No. 105-1-P.

EXPERIMENTAL PHYSICS GROUP - J. M. West

Impurities in Graphite

(A) Rare Earths

Gadolinium was detected in a spectroscopic analysis of ash from a sample of unpurified graphite. The intensity of the gadolinium lines appeared to be about as strong as those from the ash of a sample of purified graphite to which 0.5 ppm of gadolinium had been added. This sort of comparison cannot be considered quantitatively accurate however.

Analysis for gadolinium by radiochemical methods is much more difficult than for samarium and europium, which have been identified previously. Although gadolinium has a very large absorption cross section for slow neutrons, very little induced radioactivity results from neutron capture. Thus far it has not been possible to definitely assign any of the induced activity in graphite to gadolinium.

By comparing the induced 46 hour activity in unpurified ($\Delta 4h = -0.05$) graphite with the strength of this component in a purified sample to which 0.1 ppm of samarium had been added, the concentration of samarium in the unpurified sample was calculated to be 0.18 ppm. This test was performed with care, and the figure of 0.18 ppm for samarium concentration should be reliable for that sample, at least.

(B) Nitrogen

In conversations at Argonne National Laboratory, the writer learned that Dr. Hennig has completed experiments which indicated that unpurified graphite contains enough nitrogen to account for a cross section of about 0.2 millibarn per carbon atom. If this nitrogen could be eliminated from graphite, a gain of about 140 inhours per Hanford pile would result.

A quartz furnace tube for burning large quantities of graphite is about ready for use at

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Hanford. Present plans call for burning fifty pounds of purified graphite in this furnace. The exhaust gases will be analysed for nitrogen content and other volatile impurities. Neutron absorption tests and chemical analyses will also be made on the ash from this graphite. If these tests are successful, a more reliable estimate of the absorption cross section of pure carbon should be forthcoming.

Functional Tests on Graphite

(A) Purified

The results of functional tests on purified graphite during January are summarized in Table I.

Table I

Purified Graphite

Type	Number of Heats	Average Δ ih (purity)	Effective Δ ih			Density		
			Ave.	Max.	Min.	Ave.	Max.	Min.
GBF	59	+ .916	+ .920	+ 1.00	+ .76	1.641	1.682	1.624
CSF	11	+ .938	+ .944	+ .97	+ .90	1.644	1.669	1.633

Both the GBF and CSF types were of higher average purity in January than in December. The density of GBF dropped sharply, however, and the density of CSF improved very little over last month's low average of 1.634.

Individual bars of GBF still vary over a wide range in purity. Low quality bars occur most frequently near the ends of the furnaces, but very poor bars sometimes occur in central regions.

The writer visited the Morganton N. C. plant of the National Carbon Company for the purpose of studying the "F" process and trying to eliminate the poor quality bars which have been lowering the average quality of GBF heats. Several experiments and changes in process were decided upon during this visit. These were directed toward (1) reducing the number of plugged gas feeder lines, (2) increasing the amounts of purifying gas added to all parts of the furnaces, particularly the ends, and (3) reduction of nitrogen content of graphite by substituting helium for nitrogen in the process. Detailed accounts of observations and consultations at Morganton and the decisions based on them, are described in the following documents:

HR-12276 "Visit to National Carbon Company Plant" Botsford, West
HR-12239 "Helium for 'F' Process" C. H. J. Lende
GH-13,997 "Meeting Held at Morganton" V. C. Hamister

Four experimental GBF heats on which no nitrogen flushing was used, were tested. These heats, 950-X, 951-X, 952-X and 953-X, gave Δ ih (purity) values of +.89, +.90, +.92, and +.98 respectively. These results are not significantly different from those obtained on heats with nitrogen flushing. Nitrogen flushing apparently does not improve the purity of the graphite. Several runs are to be made with helium substituted for nitrogen, not only as a flushing agent but also as a carrier of CCl_4 during the heating part of the cycle.

(B) Unpurified

The functional test results on unpurified heats tested in January are summarized in Table II.

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Table II

Unpurified Graphite

Type	Number of Heats	Average Δ in (purity)	Effective Δ in			Density		
			Ave.	Max.	Min.	Ave.	Max.	Min.
CSO	8	+ .149	+ .146	+ .22	+ .09	1.635	1.638	1.631
CSN	7	- .005	- .001	+ .06	- .06	1.644	1.666	1.634

Pile Shielding

(A) Shielding Effectiveness of Ship's Augers (P.T. #105-234-P)

Radiation measurements have been made on the inlet ends of thermal shield cooling tubes with and without the ship's augers in place. The results obtained were as follows:

Tube Number	Gamma (mr. 1 hr.)		Fast Neutrons (nrem./hr.)
	Shutdown No water	Operation With water	
19 (no auger)	5	< 1	< 1
26	3 1/2		
27	5	< 1	< 1
28	5		

The above results show that no radiation hazard will exist if the augers are omitted from new piles or are removed from the existing ones. Details of this production test are included in the final report (HRC-12289, R. L. Dickman to File, January 26, 1949).

(B) Vertical Rod Guides For D-R (PT #105-225-P)

Radiation measurements have been made on a simulated D-R rod guide and rod (with four spiral grooves in the guide) and a guide and rod of the type used in the B, D, and F, Piles, installed in turn in the A test hole of the F pile. The maximum radiation intensity along the axis of the guide, one foot from the outer end of it, and the intensity along a line parallel to and 18" away from the axis of the guide, were determined, with results as follows:

	B, D, F Guide		Simulated D-R Guide
	Gamma (mr/hr)	Fast neutrons (krem/hr)	Fast neutrons (krem/hr)
Along axis of guide	45	700	1350
18" from axis, next to pile face	0.5	13.5	10.8
" " " 10" from pile face	5.0	15.0	12.5
" " " 20" from pile face	4.0	8.0	10.8

A simulated D-R guide and rod, with two of the four grooves in the guide filled with polythene will be put in the A Test Hole and corresponding radiation measurements will be made, during February. On completion of this last series of measurements a final report will be published

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Recirculation of Pile Cooling Water

In compliance with a request by Giffels and Vallet, Inc., the strengths of radioactive isotopes expected in water with specified impurities used as a recirculating coolant for Hanford piles have been calculated. The results were reported in a separate document (H...-12275, "Water Activity", Dickman to Johnson, January 26, 1949). The main conclusion was that demineralized water would be superior to condensate water from the radioactivity standpoint because of its lower sodium content.

Paul F. Gast

P. F. Gast

PILE TECHNOLOGY DIVISION

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