HW-17373

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100 AREAS TECHNICAL ACTIVITIES REPORT - ENGINEERING

FEBRUARY 1950

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DISCLAIMER

Pile Engineering - Group I

Slug Corrosion Details - H. H. Greenfield .

Effect of Pressure Drop Film on Corrosion - P. T. 105-249-P

The results of this test are indicating that the presence of pressure drop film on slugs has little effect on the slug corrosion rate. The following table contains the corrosion data observed during the month under P. T. 105-249-P.

Tube No.	Exposure MD/Ton	Orifice	Avg. Outlet Water Temp.°C	Corrosion Rates, Mils/Mo Average	Maximum	Avg. Pressure Drop Film Buildup, psi
1573B-Test	398	0.240	55	0.12	0.22	35
1574B-Control	398	0.240	52	0.11	0.21	15
1870B-Test	200	0.240	53	0.14	0.23	25
1871B-Control	408	0.240	52	0.10	0.19	10
0659B-Test	200	0.140	51	0.05	0.10	75

It is to be observed that the effect of increased pressure drop film buildup on the corrosion rates of the slugs in tube 1573 and 1870 are negligible since these rates are comparable to the corrosion rates of the slugs in the control tubes 1574 and 1871. Tube 1573 was not purged for a period of seven months while the control tubes were purged on the average of once every two months. Tube 0659, with a pressure drop film buildup of about 5 times that of the control tubes, had a corrosion rate of about one half of that for the other tubes. The corrosion rate of tube 0659 is in good agreement with the average corrosion rates for 4" slugs under P.T. 105-9-P which was 0.06 mils per month at an average outlet water temperature of 50°C. From the above data, it can be tentatively concluded that the effects of abnormally large amounts of pressure drop film on the corrosion rates of slugs are negligible.

Metal Exposure Details - C. W. Botsford

P. T. 105-238-P - Forged Slugs

The enrichment level of the metal discharged under this production test has been increased to 500 MD/T. The metal shows more blistering tendency than the standard Group V metal and is blistering to a greater degree. The difference in the metal are insignificant up to the 500 MD/T.enrichment level from practical discharge difficulty considerations.

[redacted]

P. T. 105-278-P - Increased Enrichment Level

The maximum concentration of metal discharged in this production test is 575 MD/T. The changes induced in warp, length, and diameter by increasing the concentration from 400 MD/T to 575 MD/T are insignificant. The degree of blistering has increased but the effect of the blistering is inconsequental.

Final reports have been issued on production tests P. T. 105-224-P (High Nickel Uranium) and P. T. 105-235-P (The Effect of Transformation of Uranium.)

Pile Control - Thimble Removal Study - W. K. Alexander - E. C. Wood

Gas Seal

A gas seal has been designed for testing on the DR Pile. (Drawing # H-I-9096-DR). This seal is presently being constructed at the 101 Building shops. It is proposed to install this seal on one of the rods in the DR pile to determine the most suitable type of packing and lubricant. Materials to be tested include regular graphic asbestos, formed cheveron rings, Garlock Klozures, and possibly silicone seal rings. Lubricants to be tested include three different types of Dow Corning silicone greases and one high temperature grease furnished by Garlock. Both lubricants and packing must be able to withstand a wide range of temperatures. The temperature of the rod is expected to vary from 5 to 200°C. To be equally effective over this wide range the materials used must not change appreciably.

Ball Third Safety

Tests with the fluted step plug mock-up and 3/8" diameter steel balls indicate that such a 3-X system should equal or excell the present system. It appears it will be possible to completely fill an empty VSR hole in 15 seconds if the rod is completely out. If the rod is in partway the time will be increased somewhat. Preliminary calculations indicate that 1.5 seconds after tripping a ball 3-X system the control will be on the order of 75% of the full strength of the VSR system. This is equal to or better than the present system plus the advantage of having a solid neutron absorber which will not boil out.

Stuck Slug Problem - E. C. Wood

A study is in progress of the problem of reluctant tube discharges with a view toward reducing the shutdown time consumed in clearing this trouble. As a first step, it is proposed to procure a compact, protable pumping unit to be used on the elevator for washing the downstream pieces from the reluctant tube before attempting to jack the charge through. Such a unit can be applied in a very short time and will obviate the present long wait for special plumbing and starting up of the booster pumps in the 190 Bldg. Washing the downstream pieces out before beginning operations which are likely to rupture the tube will eliminate nearly every case of high readings in the discharge face due to pieces in the gunbarrel, nozzle, or on the tipoff. It will thus be possible to work in the rear face to clear the trouble with out undue delay.

In a further effort to reduce the down time, tests will be run with various equipment to determine the most practical methods of removing the stuck piece, and to develope practical devices and methods which can be applied in a minimum of time. These tests will begin as soon as facilities are available early in March.

Van Stone Flange Corrosion Details - J. F. Sullivan

Front Face Aluminum Nozzle Inspections

Three front face aluminum alloy nozzles which have been on the B Pile for four months were removed and the van stone flange was found to be in a well preserved condition. Two of the flanges were pitted from previous exposure to stanless steel nozzles but the third flange was new. Though this is rather a short exposure to make definite statements it appears aluminum nozzles will protect pitted van stones on the front face of a pile.

D-R Pile Van Stone Flange Inspections

The final inspection on the rear face van stone flanges on DR Pile was completed this month. These flange thickness inspections were performed three times over a five month period on a total of thirty three flanges in an effort to determine whether pitting type corrosion continues on flanges that are apparently dry. The measurements show no noticeable decrease in the average flange thickness and it is therefore concluded that corrosion of the dry flanges on the DR Pile has stopped.

Process Tube Corrosion Details - P. T. 105-291-P - J. F. Sullivan

Plans are in progress to remove a number of tubes from the B Pile which corrosion product deposition in the portion of the tube where there are no dummies. It is desirable to ascertain whether corrosion, when observed in this low velocity section, will continue through the tube.

Three .140 zone tubes in the lower section of D Pile were borescoped this past month for comparison with P. T. 105-291-P inspections on B Pile. Tubes 0162, 0164, and 0264 were found in good condition.

[redacted]

Flow Cup Testing Program

Corrosion weight loss tests are being conducted on zinc with high lead contents 0.5%, 1.0% and 2% to determine the effect of the high lead content. The tests will last six months.

C. W. Botsford
C. W. Botsford
Pile Technology Division

CWB/wj

[redacted]

PILE ENGINEERING - Group II

Carbon Dioxide Experiment - S. S. Jones

B Pile

The CO_2 concentration was raised from 84 to 93% during the month under Production Test 105-168-P, Supplement G. This was done by adding only CO_2 as make-up gas during all periods of level operation. The average gas consumption was 9,580 cu.ft. per week.

There was a large increase in the graphite temperature measured by the #13 couple.

The poison tube #2686 that has suppressed the temperature reading of graphite couples #10, 13 and 16 was discharged on February 7th. There resulted an increase in the graphite temperature with no significant increase in per cent carbon dioxide. By averaging the data just before and just after this change, at equilibrium conditions, one can estimate the poison effect.

TABLE I: EFFECT OF POISON TUBE ON ADJACENT GRAPHITE TEMPERATURE

POISONED COUPLE*				NORMAL COUPLE				
Water Temp. Rise Δt_w	Graphite Temp. (13G) t_g	Local Water Temp. t_L	Graphite Temp. Rise above Local water Δt_{g_p}	Water Temp. Rise Δt_w	Graphite Temp. (13G) t_g	Local Water Temp. t_L	Graphite Temp.Rise Above loc. Water Δt_{gn}	Factor $\Delta t_{gn}/\Delta t_{g_p}$
33.7	262	22	240	32.5	283	22	261	
				33.7	293	22	271	1.13

* In this case where one of the 4 tubes surrounding the couple was poisoned the Δt_w and t_L values are based upon the average of the 3 unpoisoned tubes.

From Table I it is evident that the poison tube caused about a 13% supression of the graphite temperature above local water.

Taking this into consideration the graphite temperature change with CO_2 concentration may be estimated.

[redacted]

TABLE II - EFFECT OF CO_2 ON GRAPHITE TEMPERATURE

Date	Per Cent CO_2	Water Temp. Rise tw	Graphite Temp. tg	Local Water Temp. t_L	Graphite Temp. Above Local Water Poisoned tgp	Graphite Temp. Above Local Water Unpoisoned tgn	Estimated Graphite Temp. tg
Feb. 1	84	33.0	255	21	234	264	285
4	86	33.9	267	22	245	---	---
		33.0	---	22	239	270	292
6	88	33.4	260	22	238	---	---
		33.0	---	22	235	265	287
10	86	33.0	287	22	---	265	287
13	89	31.9	279	21	---	258	---
		33.0	---	22	---	267	289
20	90.5	36.0	314	24	---	290	---
		33.0	---	23	---	266	289
24	92.5	35.8	217	24	---	293	---
		33.0	---	23	---	270	293

This indicates that the graphite temperature increase attributable to the 8% increase in CO_2 was 8°C. The estimated average maximum central graphite temperature was 345°C at level operation. The significant thermal effects were:

1. Vertical motion of the center-top of the rear face - 0.10"
2. Vertical motion of the center of the top shield - 0.22"
3. Outward motion of the far side - 0.13"

D Pile:

The CO_2 concentration averaged 60% during the month. The average central graphite temperature was 290°C for a water temperature rise of 42°C or 231,000 Watts per tube. The estimated average maximum central graphite temperature was 313°C at level operation. The total gas consumption averaged 20,150 cu. ft. per week, and the % CO_2 was 62 as added and 57% by analysis. The significant thermal motion was:

1. Vertical motion of the top-center of the rear face - 0.16"
2. Vertical motion of the center of the top shield - 0.26"
3. Shear motion across the rear face omega seal at the 44 1/2 cross header - 0.03".

F Pile

The power and % CO_2 were held constant during the month at 305 MW and 60% respectively. The central graphite temperature averaged 280°C at a water temperature rise of 41°C and a heat flux of 225,000 Watts per tube. The estimated average maximum graphite temperature was 322°C.

[redacted]

The gas consumption was 7,840 cu.ft. per week, and the amount of CO_2 was 60% as added and 52% by analysis. The important thermal effects were:

1. Vertical motion of the center-top of the rear face - 0.15"
2. Vertical motion of the center of the top - 0.21".
3. Shear across the rear face omega seal at the 44 1/2 cross header - 0.05".
4. Outward motion of the far side .07"

H Pile

The average central graphite temperature is shown in Table III.

TABLE III. CENTRAL GRAPHITE TEMPERATURE

Level	Couple No.	Graphite Temp.	Water Temp. Rise	Graphite Temp. Above Local Water
330	18	137	38.1	117
	32	205	37.5	180
	(32,48,56)	210	38.8	183
	Estimated Ave. Maximum	224°C		Based Max. 45°C Δ tw averaged for month

The CO_2 gas consumption was 1700 cu. ft. per week. There was no shut-down and therefore, no measure of thermal motion from "cold" to "hot" conditions was obtained. The far side showed a gradual outward motion of 0.13 inches. The concentration of CO in the pile gas increased during this long period of steady operation.

TABLE IV. H PILE GAS ANALYSIS

Date	Level	% CO_2	% O_2	%CO	% H_2	% H_2O	E
1-30-50		(94.5	.05	4.1	0.6	---	99.1)*
		95.2	.4	2.8	---	---	98.4
2-7-50		94.7	.4	3.1	---	---	98.2
2-10-50		(94.2	.13	4.1	0.7	---	99.1)*
		94.5	.4	4.0	---	---	98.9
2-17-50		93.5	.4	5.1	---	.03	99.0
2-21-50		92.3	.3	5.9	---	.03	98.5
2-27-50		92.1	.4	6.5	---	---	99.0

* Analysis of samples of Pile gas shipped to 300 Area and analyzed by the Control Division. All other analyses were made at the Pile by Instrument Division.

[redacted]

There has been a continued increase in the concentration of CO in the gas atmosphere. The equilibrium in the reaction.

$$H_2 + CO_2 = 2\,CO + H_2O \qquad (1)$$

would yield 10% CO at the average central graphite temperature of 210°C and the concentrations of H_2, CO_2, and H_2O reported in the latter part of table IV.

If this effect represents a graphite burn out rather than the reaction of equation (1) then the maximum burn out would be 137 lbs. per year and the per cent burn out would be:

1. Uniform burnout, per cent of total graphite - 0.004% per year.
2. Central burnout, per cent of central graphite - 0.045% per year.

Graphite Sampling - P. A. Johnson - T. P. Heckman

The operation of a cutter designed to remove a sample from a graphite filler block at the side of the A test hole was successfully demonstrated to representatives of the operationg divisions in a mock-up in the 101 building. Fabrication of the retrieving tool to be used to remove the cut sample from the pile is 75% complete.

An attempt to remove a solid core sample from the tube block over the A test hole of channel 2290-D failed when the diamond core drill in the cutter collapsed soon after the cutting operation was begun. Powder samples were successfully mined in the channels of both 2290-D and 2273-D.

A demonstration assembly of a graphite cutter that can be inserted in a process hole, operated satisfactorily in the 300 maintenance shop. Since the core obtained with this assembly was only 3/16" diameter, another assembly that will obtain a larger core will be constructed.

Special Pile Measurements - P. A. Johnson

The length of the graphite stack was measured in the channels 2273-D and 2290-D and found to be 28' - 0 27/32" and 28' - 1 6/32" respectively. These measurements show an apparent expansion of 27/32" and 1 6/32" over nominal and indicate that little further "outward warping" of the pile has occurred beyond the 3/4 to 1 inch expansion noted after 1 1/2 to 2 years of operation. Further measurements of the length of the graphite stack are planned.

Development work was continued on the mercury level manometer, and satisfactory performance was attained in measurements of vertical bowing of a process tube in the 305-A mock-up. Except for one false reading, a series of 60 readings taken at 21 locations in the tube showed a maximum deviation of 0.016 inches with 75% of the readings deviating less than 0.010 inches. The manometer will be used to traverse 4674-F to demonstrate its operation under actual pile shutdown conditions.

[redacted]

Tube 4674-D was traversed for vertical deflection using water of lowered surface tension in the routinely used water manometer equipment. The job was done under rather optimum conditions; however check readings at several points showed deviations up to 0.21 inches. The major error in using this equipment is believed due to differences resulting from the target position in the tube.

The development of a gauge to measure slope in process tubes has been virtually completed by the Instrument Development Group. In the laboratory this gauge has shown a precision in measuring slope of ± .005 in. per foot of length.

Routine Pile Measurements - H. L. Mars

The monthly pile expansion measurements are reported in doc. HW-16093.

The method and equipment used in making a horizontal traverse of a process tube were reviewed and recommendations made for improving the accuracy.

At P Division request two alternate instruments for use by the P Division in place of Micrometer depth gauges (currently used by the instrument divisions) have been sketched up. Substitution of these instruments will possibly eliminate at some points the double expense of P Division and Instrument Division men taking unit motion readings.

105 Technical Laboratories - T. P. Heckman

Preliminary information (building specifications location, facilities needed, number of labs., cost, etc.) is being assembled for the purpose of evaluating Pile Technology laboratories, situated adjacent to the 105 buildings. These laboratories would primarily be a storage, test, and rework area for contaminated equipment. Any special requests for items to be included in these prospective laboratories should be presented at this time.

Lead Glass Window

A glass window 6" diameter x 4" thick containing 50% lead was calibrated over an open vertical thimble in 105-D. The radiation beam from the thimble read 2400 mr; the window reduced this to 90 mr. which would allow direct viewing into a pile of approximately 1/2 hr. without exceeding radiation dosage tolerances.

P-10 - J. T Carleton - M. W. Carbon

An investigation of the advisability of increasing the capacity of the DR water plant in the event of the adoption of scheme R-10 has indicated that a saving of 60 KG of 25 material required in the pile would probably result if the water plant capacity were increased from 36,000 to 42,000 gallons per minute.

[redacted]

Calculations are being made to determine the effect of end cap thicknesses on the temperatures at the ends of natural uranium slugs as well as P-10 fuel slugs.

A trip was made to Schenectady by M. W. Carbon during the week of February 6 to 11 to discuss various production and heat transfer aspects of the P-10 production program.

Boiling Studies - J. T. Carleton

Continuation of pressure drop - flow rate measurements of water being boiled while flowing through a small diameter tube have resulted in two tube burnouts when attempts were made to find a point at which a fixed pressure could be applied to the tube and a flow rate maintained while boiling occurred.

W. R. Lewis
Pile Technology Division

WRL/wj

[redacted]

PHYSICAL CHEMISTRY GROUP

Pile Annealing Studies - H. H. Burton

B test hole temperatures at F Pile have risen as a result of the recent power increase to 305 megawatts. From February 4 to 21, the nominal operating temperature was approximately 350°C with a high of 363°C. No samples have been discharged since the temperature increase. Data on pile annealing of graphite to the present time have been based on a nominal temperature of 335°C.

A second group containing eleven four-inch samples was discharged on February 1, with an accumulated hot test hole exposure of 141 MD/CT. Three of the samples were loaded as virgin graphite and eight were previously irradiated in a cold test hole and thermally annealed at 375°C prior to exposure in the hot test hole.

All physical length change data obtained up to this point in the experiment are summarized in the accompanying graph. The data at 141 MD/CT represent a distinct second group of samples and are not the group discharged at 55 MD/CT with subsequent exposure. The straight lines connecting points do not indicate the actual per cent length change at any exposure but serve only to show the proper sequence of results for a particular sample.

With reference to the graph, the following is observed:

1. The amount of pile annealing accomplished is a function of exposure. Samples equally damaged at the completion of the thermal annealing treatment at 375°C continued to recover with longer exposure in the hot test facility. Note the recovery (A') at 141 MD/CT in addition to recovery (A) at 55 MD/CT.

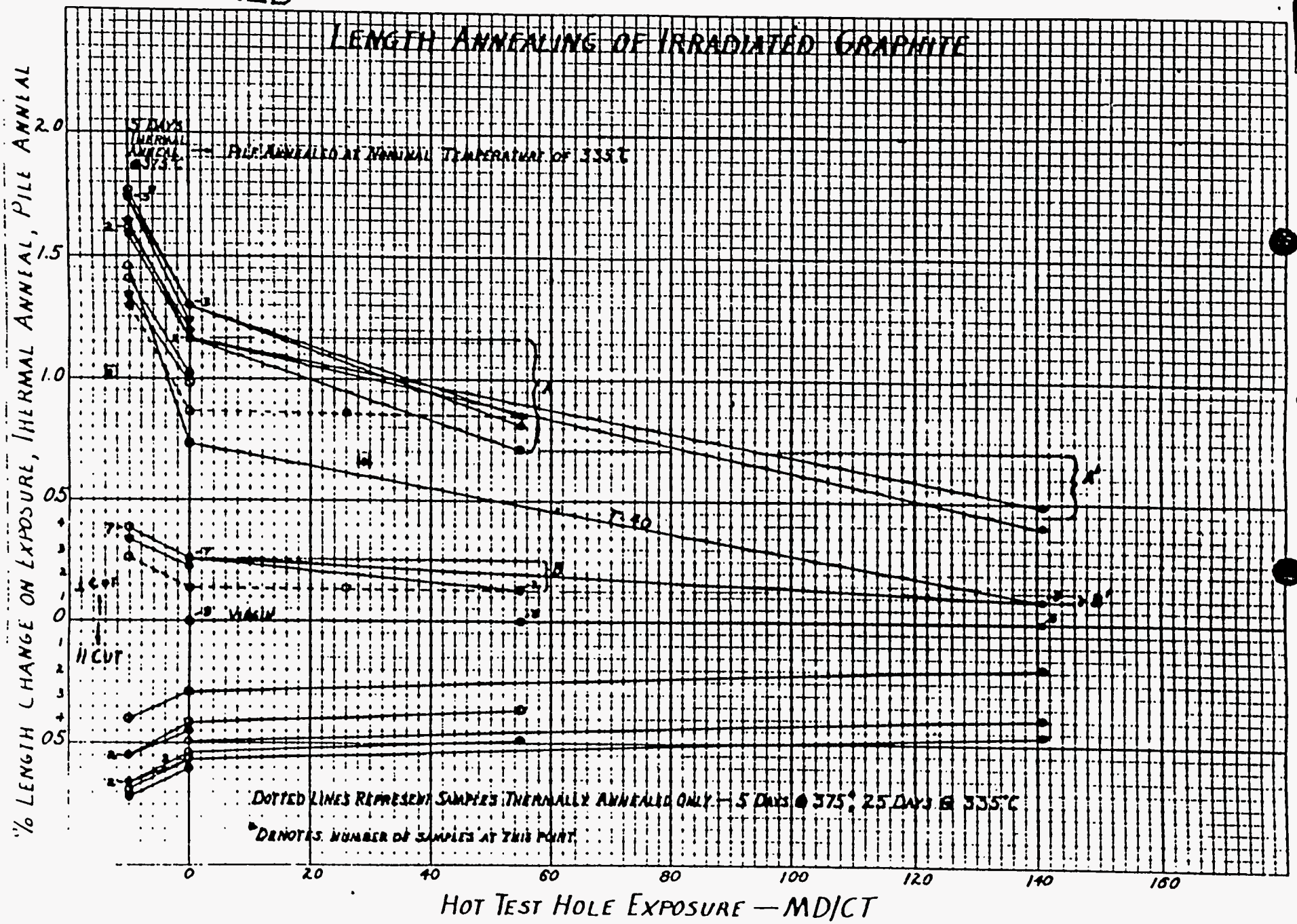
2. Annealing accomplished in the pile cannot be duplicated in the laboratory by thermal treatment alone at the same temperature. After the five-day thermal annealing, the nearly horizontal dotted lines represent samples held in a laboratory oven at 335°C for a period of 25 days.

3. The length recovery of a particular sample for a given hot test hole exposure is dependent upon the degree of damage. The recovery (A') for a sample with a cold test hole exposure of 1404 MD/CT is greater than the recovery (B') for a sample with a cold test hole exposure of 651 MD/CT. The rate of pile annealing diminishes with longer hot test hole exposure. Recovery (A) is greater than (A') and (B) is greater than (B').

4. Virgin graphite showed no detectable physical expansion in a transverse direction during the 141 MD/CT exposure at 335°C.

5. Parallel cut graphite appeared to anneal in the pile at a lower rate than transverse cut material with a similar degree of damage, although the percentage recovery in length on thermal annealing was comparable. The total recovery of the transverse samples amounted to about 75 percent during 141 MD/CT exposure while the total recovery of the parallel samples was less than 50 percent.

[redacted]



One sample, T-40, showed a wide discrepancy when plotted with all other samples in the experiment. At each step it has made recoveries which, by comparison, are too large; this virtually eliminates the possibility of errors in measurement.

Solid lines which do not extend beyond the five-day thermal anneal region represent samples in a third group which are currently in the pile and should be removed on March 22.

Gas Tube Experiment - H. H. Burton

In order to determine independently the effect of carbon dioxide and oxygen on weight losses of graphite during irradiation, an absorption train employing moist white phosphorous has been assembled to scrub all oxygen from the carbon dioxide supply. A suitable mounting for the apparatus is being fabricated by 300 Area Maintenance.

The thermocouple and graphite sample in tube 1582-D were discharged on February 24. During the same shutdown, rear face shield slugs and gas escape vents were inspected on tubes 1582 and 3574. The opening in each of the 1/4" copper tubing vents was reduced to approximately 0.11" to limit the diffusion of air into the tubes. The shield slugs will be replaced with new grooved slugs to insure easy removal and adequate provision for gas flow.

Thermal Annealing and Oxidation

Thermal annealing and oxidation studies at 335°C are continuing but no additional observations were made during February.

Thermal Conductivity and Electrical Resistivity - H. A. Baskin

The data obtained to date on the pile annealing of graphite with respect to thermal and electrical resistivity are given in the following table:

[redacted]

Sample No.	Test Hole Exposure MD/CT	Initial Values After Exposure Ko/K	R/Ro	375°C Oven Anneal Ko/K	R/Ro	55 MD/CT Hot Test Hole Exposure Ko/K	R/Ro
589	2366	45.20	4.86	40.90	4.51	33.85	5.86
547	2366	56.14	5.21	37.95	4.73	37.10	4.81
T-109	1455	36.60	4.19	26.61	3.67	24.48	3.68
T-65	1405	31.00	4.18	24.95	3.70	26.25	3.71
T-94	1405	36.62	4.17	31.30	3.71	20.34	3.64
P-27	651	17.82	3.82	11.48	3.35	7.84	3.35
P-16	651	18.22	3.78	12.60	3.33	8.74	3.34
71-98	0					1.48	1.61
71-84	0					1.50	1.60
71-113	0					1.61	1.61
						141 MD/CT Hot Test Hole Exposure	
557	2366	45.70	4.65	36.98	4.38	35.14	4.41
591	2366	59.70	4.74	42.85	4.47	38.18	4.51
621	2366	53.10	4.63	40.30	4.34	32.00	4.43
T-67	1455	33.78	4.02	19.61	3.57	22.84	3.50
T-110	1405	32.76	4.10	21.18	3.60	22.18	3.55
T-40	1405	34.19	4.36	29.10	3.91	22.30	3.87
P-28	651	17.19	3.80	12.43	3.32	6.42	3.35
P-4	651	18.36	3.90	11.56	3.45	6.39	3.43
71-134	0					1.83	1.88
71-17	0					1.63	1.89
71-47	0					1.66	1.95

The data for the thermal conductivity measurements are also plotted in the accompanying graph. These data show that pile annealing of thermal conductivity occurs, but the data are much less consistent than those obtained for length change and Co-spacing. The amount of annealing shown by these data for the 375°C thermal anneal is much greater than that obtained in previous experiments. Some systematic error may have resulted in low values of the resistance at this point, but continued exposures will verify the extent of pile annealing.

Within the limits of experimental error no pile annealing of the electrical resistivity has occurred.

The average values of Ko/K were 1.53 at 51 MD/CT and 1.71 at 141 MD/CT. R/Ro changed from an average of 1.61 at 51 MD/CT to 1.91 at 141 MD/CT.

[redacted]

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