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NOV 16, 1949

100 AREAS TECHNICAL ACTIVITIES REPORT - PHYSICS

NOVEMBER, 1949

FILE PHYSICS GROUP - A. B. Carson

H Area Operation

Following the completion of Technical Division tests on October 31, the power at 105-H was increased to 275 MW and maintained at this level except for two shutdowns, a five hour coefficient test, and a number of scrams, which were the result of #1 and #2 Deckman difficulties. Original poison loading was found to be too strong for equilibrium operation at 275 MW, so this was altered during the month to allow a reasonable scram recovery time for projected 325 MW operation. An additional margin was allowed for expected reactivity losses due to initial irradiation of the metal.

Octant Monitoring At H

The octant monitoring thermopile system is more nearly linear with power than the #1 Galvanometer connected to an ionization chamber in "A" test hole. However, due to its being a voltage rather than current indicating device, more manipulation is required during power changes to keep the bucking voltage in balance with the input.

Quadrant Monitoring At B

The process tube ion chambers for the quadrant monitoring system have been installed and all shielding and cabling is in place. A sensitive galvanometer has been installed at the control desk to test the chambers and to check their operational feasibility.

Test Holes At H

During the shutdown of 11-22-49, thermocouples were installed in the #4 hole of the B test facility and in the center hole of the dry D facility at H. These thermocouples, mounted in graphite and contained in regular test hole casings, were placed at the center of the pile and the leads brought out to a temporary location in the decontamination room, where a portable instrument

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can be used to read the temperatures. At 275 MW operation the B facility temperature has been 16°C with an inlet water temperature of about 10°C. The 16G thermocouple, located in the filler block near the center of tube 2080 failed on 11-28-49, and is now out of service.

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Test Hole At D

The water supply to the B test facility failed on 11-13-49. The first indication of the facility drying out was the sudden rod adjustment required to compensate for the reactivity gain. Although water flow was restored in less than 10 minutes, the indicated temperature reached 240°C, and it is thought that certain samples may have been damaged. Steps are being taken to improve the operation of the pressure regulating valves which normally control the water flow. This involves supply of the facility with process water from the 60 p.s.i. control rod cooling water lines rather than the present 350 p.s.i. source. If successful, this modification will probably be employed in all areas.

Test Hole At F

The eight ceramic insulator samples (P.T.-105-242-P) were examined after a 48 hour exposure in the E test facility. The samples show no visible effect from the exposure.

A total of 34 hours exposure in the E facility has been given 10 rubber samples (P.T.-105-252-P). About 14 hours more exposure will be given before they are examined for physical damage.

Gas Composition Changes

The Helium dilution at 105-D was raised from 40% to 60% CO₂ between 10-31 and 11-8. This resulted in an increase of observed central graphite temperature of about 28°C, corrected for flux distribution changes. The increase in reactivity observed for this period was 38 ih, 8 to 12 of which could be attributed to metal gains.

The CO₂ concentration at 105-B was changed from 60% to 80% between 11-8-49 and 11-14-49. The increase in graphite temperature was about 26°C, and the reactivity gain was tentatively set at over 40 ih, corrected for normal metal gains. A closer examination of this reactivity change will be made to see if it represents a real departure from previously observed trends. It should be noted that this CO₂ addition has brought the minimum down time to 21.8 hours for first indication, or about 22.4 hours from half-way down to half-way up, if 50 ih is assumed in the rods at equilibrium. Under the same conditions, the maximum down time is about 22.5 hours. Shutdowns are being scheduled so that start-up in the normal manner may be made.

P.T.-105-248-P, Supplement "A"

A coefficient test and rod calibration was performed at 105-B on 11-14 as reported in the semi-monthly report for that period.

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Special Request ProgramANL-141

This request concerns an in-pile experiment at ambient pile temperatures in the dry "B" test hole facility at 100-F area. The sample itself is a 347 stainless steel pressure shell, which contains about 6 cc. of water and a 347 stainless steel spring under stress. A stainless steel capillary tube and leads for two thermocouples will be brought from the samples through the pile shielding so that measurements can be made during pile operation. Mr. J. R. Humphreys and Dr. P. E. Brown from the naval reactor division of the Argonne National Laboratories are at present visiting Hanford to assist in the performance of this experiment. The instrumentation required is being installed by the instrument division at 100-F area, and is not yet complete. It is planned that the installation should be finished before December 14, the tentative charging date set for the sample. A mock-up test was run on the discharging equipment in the 100-D maintenance shop on December 1, 1949. This test showed that some revisions to the discharging equipment would be necessary, and that some special tools would be needed. No serious defects were found, however, and it was felt that the necessary changes could be made and another mock-up test run before the tentative charging date.

GECL-100

The samples for this request are non-metallic materials which are to be exposed to intensive gamma irradiation from discharged metal. A section of the flooring has been removed in the storage basin at 100-F to allow access to the bottom of the basin. Forty buckets have been fabricated to hold freshly discharged Uranium slugs in a circular array around the samples. The H.I. physics group in 300 Area has developed an instrument designed to read the high intensity radiation expected on the samples. Initial tests on the first prototype of this instrument at 100-F gave negative results. It is hoped that the instrument will be in operation within a few weeks.

Tube 1882-B

This tube, containing 1 piece of SR-63, 1 piece of ANL-114 and 2 pieces of ANL-115 was discharged on 11-1-49. Examination of the pieces following discharged showed a distinct discoloration at the ends of two of the pieces, and closer examinations were begun on the possibility that the slugs, might have become ruptured. It was found that the two slugs, which were identified as 1 piece of SR-63 and 1 piece of ANL-114, had undergone some amount of corrosion, and that apparently the welds around the end caps of the slugs were no longer water-tight. Photographs of the two slugs were taken which show clearly the effects of the corrosion. These photographs are documents GE-H-15,693 and GE-H-15,694.

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Status Of Special Requests: Summary

Number of special requests discharged from the pile 4
 Number of special requests charged into the pile 5
 Number of SR's on hand to be irradiated 21

 Number of P-10 slugs discharged during the month 172
 Number of P-10 slugs charged during the month 178

Status Of IBM Projects

P. M. Thompson reports that the IBM cards containing solutions reported in the monthly report will be kept on file for 60 days. If anyone has use for a copy of any of these results, notify Mr. Thompson on phone 7-2311.

The following solutions are reported for this month:

1. a. Table of the product $(1 - e^{-\lambda t_1})(1 - e^{-\lambda t_2})$ for values of t_1 and t_2 from 1 to 90 minutes, in one minute steps.

($\lambda = .01282$ minutes, the decay constant of Indium.)

- b. Values of $\lambda e^{-\lambda t}$ for $t = 3$ to $t = 20$ minutes.

2. a. Solution of the equilibrium Xenon term

$$\frac{\int_0^{\pi} \frac{p^3 P_d r}{1+p} dr}{\int_0^{\pi} r^2 dr} \quad \text{where } p = a f(r) \cos \frac{\pi z}{Z}$$

$$f(r) = a [J_0(ur) + kJ_0(ur)]$$

$f(r) = 1$ at maximum value, and $a = \text{maximum power density}$

for values of flattening from zero to 850 ih in 50 ih steps, and for values of power from 50 MW to 300 MW in 50 MW steps, and from 300 MW to 500 MW in 25 MW steps.

- b. The following constants related to this solution are also available:

Functions of flattening -- b, k, m, r_0 (the radius of the flattened area) and the ratio $\frac{W_{ave.}}{W_{max.}}$

Functions of flattening and power -- a , the maximum power density.

3. Sums, sums of squares, and sums of cross-products of the six terms of the reactivity curve for the old B pile shutdown, for a least squares fitting of:

$$R = a + b_{1x1} + b_{2x2} + b_{3x3} + b_{4x4} + b_{5x5}$$

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where $x_1 = e^{-\lambda_1 t}$, and $\lambda_1 = .0749$, $\lambda_2 = .1027$, $\lambda_3 = .01444$
 $\lambda_4 = .0124$, and $\lambda_5 = 3.0$

Reduction of these sums to equation constants was carried out by C. S. Bennett of the statistics group.

In addition, preliminary estimates were made of the cost, space, and time requirements for a Hanford Works centralized IBM installation.

Reactivity Balance

The reactivity status of each pile at the beginning and the end of this report period is summarized below.

	B Area		D Area		F Area		H Area	
	10-31	11-30	10-31	11-28	10-31	11-30	10-31	11-30
Rods	55	73	79	110	49	90		120
Xenon	474	469	504	499	462	466		551
SR Material	399	417	372	387	413	370		0
"P" Columns	0	0	0	0	0	0		162
"B" Columns	117	117	109	109	114	114		0
Plant Asst.	0	0	20	20	0	0		5
Dummy Coils	0	0	3	6	32	32		0
Corr. for Co	-200	-224*	-200	-228*	-235	-235		-55
Cold, Clean	845	852	887	903	835	837	825 ± 10	783

* The overall coefficient contribution at B has been adjusted to conform to the observed value for the new CO₂ concentration of 80%. The same has been done for D, for the new CO₂ concentration of 60%.

The gains of reactivity at B (7 ih) and F (2 ih) can be attributed to changing product concentration in the piles. The gain of 16 inhours at D appeared principally as daily rate of gain, not compensated for by discharge, so is also attributed to a change in product concentration in the pile. The loss of about 50 ih at H is in agreement with the expected initial metal exposure effects, where the samarium build-up and U₂₃₅ burnout over-shadow the reactivity gain due to product build-up.

EXPERIMENTAL PHYSICS GROUP - E. B. Montgomery

I. 305 Tests

A. Graphite - Non-Experimental

The 305 graphite testing program was completed November 25, 1949. The bars tested during November were odds and ends returned to 101 by the Design and Construction Divisions and 115 bars of KC graphite which had been stored in 305 since 1945.

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At the request of the P-Department no special work requests were completed during November. The P-Department made this request in order to be able to finish testing graphite before the end of November.

B. P 10-A Slugs

The variation of the lithium content of P-10-A slugs, as reported by the Analytical Section appears to be due to the method of sampling. The slugs were sampled by milling a sector through the slugs and collecting the chips. The chips were stored in paper envelopes instead of glass stoppered bottles. The lithium reacted with the moisture in the air to form the hydroxide, the extent of the reaction varying with time and the size of the chips. This factor alone is sufficient to produce a 10% error in the apparent lithium content. In order to measure the lithium content of P 10-A slugs as a function of the "blackness" in the 305 pile, a new set of slugs will be tested then submitted for chemical analysis. A second method will also be used in which lithium, as the carbonate will be added to graphite in amounts equivalent to the weight of lithium in P 10 A slugs. In this test, the percent lithium will be varied from 1% to 7% with the range 3% to 4% covered by steps of 0.2%.

II. Shielding

A. Masonite Deterioration

Investigations of the physical changes in masonite as a function of exposure is progressing satisfactorily. A series of masonite samples were irradiated in the "D" test facility at 100-F for a 19 day period. Sample positions and therefore exposure, ranged from the innermost biological shield layer to a point at the juncture of the reflector and active zone. Calculations by Wende indicate that the innermost sample dissipated a quantity of energy comparable to 40-50 years exposure in the biological shield.

Weight losses were negligible in the biological shield and were small in the thermal shield. In the reflector the losses ranged from 1.13% near the thermal shield to 8.45% at the reflector-active zone interface. These results do not differ greatly from those reported by O'Connor in Doc. 7-4097.

Analytical chemical techniques have been applied to the irradiated samples to determine carbon and hydrogen contents against an unirradiated standard. These results are

<u>Sample</u>	<u>% wt. loss</u>	<u>% C</u>	<u>% H</u>	<u>% c/% H</u>
Std.	-----	49.26	5.94	8.3
A	-----	49.95	6.59	7.5
B	0.37	50.00	6.17	8.1
C	2.09	51.2	7.12	7.2
D	6.38	50.41	6.83	7.4
E	8.45	53.05	7.73	6.9

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There appears to be no significant change in carbon to hydrogen ratio of the irradiated samples as a function of weight loss in view of the difficulties involved in making a hydrogen analysis. The decrease in oxygen content, noted by an increasing carbon and hydrogen content, is unexplained at present.

B. Tapered Gun-Barrel Assembly

A shielding-wise evaluation of the proposed taper gun-barrel assembly has been made. If design tolerances can be maintained as specified the assembly appears to be satisfactory. As a result of this conclusion it was recommended that a mock-up be tested under simulated operating conditions. Details can be found in HW-15208.

III. Exponential Pile Project (P-12)

Conversations with Meservey and Bistyga of the New York Operations Office of the A.E.C. revealed that although Ra-Be sources as presently fabricated can be made more uniform than previously was possible, nothing about the uniformity of neutron emission can be guaranteed. Since it is desirable to have four half-gram sources closely matched and a fifth that need not match too closely, it was decided to order ten quarter-gram sources. By properly pairing the quarter-gram sources, four sources matching within 2% can very probably be formed. The calibration of the sources will be carried out at Argonne. The sources are being fabricated at the present time.

The drawings for the pile assemblies are complete and are to go to 101 Bldg. in a few days so that piece details may be drawn up and machining of graphite begin.

A field release for the machining of graphite and purchasing of equipment for the project has been issued. Cost codes for purchasing equipment have been set up, and procedures for filing purchase requisitions agreed upon.

A preliminary investigation of the availability and cost of process tubes of other than standard sizes is being carried out by Bob Shier.

IV. Miscellaneous Problems

A. Fission Product Activity

1. Redox, etc. The revised report on fission product activity, referred to in the Progress Report of October 10, was completed December 1. It includes: energy level diagrams for all fission product decay chains (using best information available through September, 1949); a discussion of the equations by which the power (in watts/megawatt exposure power) may be calculated and also of the equations by which the radiation intensity in mr/hr or mrep/hr may be obtained from the power; and a repetition of the power calculation given in HW-11528 (which was published in November, 1948 using old data for fission product characteristics).

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2. The results of the theoretical calculation of slug activity, which form a part of the report on slug decay, have been reviewed in the light of new information included in the energy level diagrams referred to above. Since the slug decay report is still in rough draft form, the small correction, indicated can be made quite easily.

B. Reactivity

Pile power equations based on the theory of J. A. Wheeler, as given in a report on Pile Control, and our best inhour equation, have been developed with the aid of the Statistics Section, and will be plotted after points are calculated by an IBM method. A further study of the errors arising from approximations made by Wheeler will be made.

C. Catastrophe

A report on the validity of statements made in a report by H. M. Parker on the health hazard arising from simultaneous failure of pile cooling and control systems has been made. It was found that Parker's fission product activity data were roughly equal to results of more accurate calculation. However, a number of questions were raised as to the validity of Parker's assumptions with regard to the behavior of the pile after such a disruption. It was shown that the pile probably would not explode. However, it was also shown that most fission products would probably escape in a low cloud - the most hazardous of the possible eventualities considered by Parker.

D. Neutron Absorption Cross-Sections

A study of the available data on neutron absorption cross-sections, with a view to determining the most complete and reliable source of information, is getting under way. A memo by George Duvall, pointing out discrepancies between results given by ORNL and ANL, furnishes a starting point.

P-11 PROJECT - F. E. Kruesi

General

A schedule for the completion of physical facilities needed for the cylindrical critical mass experiments has been prepared by the Minor Construction Division of Project Engineering. The completion date for all phases of this construction work was set at March 1, 1950. It is expected, on the basis of this schedule, that it will be necessary to provide constant patrol protection starting February 1, 1950.

A detailed study of the potential hazards involved in experiments of the P-11 type has been prepared by W. J. Ozeroff, "Radiation and Explosion Hazards in a Critical Mass Experiment", Document HW-15279.

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Fabrication of the #1 Test Unit

The installation of the #1 Test Unit in the experimental building was started during this report period. The "catch tank" and steel frame have been installed. The large tamper tank and the eight inch cylindrical reactor assembly were received from Puget Sound Naval Station. All phases of the shop work are continuing on schedule. Only minor modifications in design and in material specifications have been necessary to date.

Virtually all instruments and related control equipment has been received and modified where necessary for P-11 usage.

Conversion of the #1 Test Unit

Several schemes for converting the #1 Test Unit from cylindrical to spherical and hemispherical reactor geometries have been developed. Detailed drawings are being prepared by the Project Engineering Design Division. Authorization was given to the Puget Sound Naval Station to experiment with stainless steel to develop a technique for making hemispherical reactor units. A sample unit was submitted and found to be satisfactory, thus no difficulty should be encountered in preparing reactors of this configuration.

Site Preparation Progress

The steel and sheet metal work on the experimental building was completed during the month. Work on the interior of the building is progressing rapidly with the exception of the electrical wiring which is just getting underway.

The site water system has been installed with the exception of the crocks for the hypochlorinator. All piping has been pressure tested and water samples submitted to the Medical Division for analysis.

Electrical wiring for lighting and heating purposes has been completed in the control building, heaters have been installed and are in operation.

THEORETICAL WORK - G. E. Duvall

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Pile Theory

There are some problems such as the critical buckling of a pile with an irregular shape, the effect of control rods on reactivity and neutron distribution, and the effect of an odd sized base on an exponential or sigma pile which may yield to approximate methods of calculation. As a contribution in this direction the theory of perturbed boundary conditions as applied to pile problems is discussed in the following section.

1. Solutions of the Diffusion Equation

For the analysis of sigma and exponential piles it is necessary to solve an equation of the form

$$\Delta n - n/L^2 = -S(\bar{r}), \quad (1)$$

where

n = neutron density

L = diffusion length

$S(\bar{r})$ = neutron source distribution,

subject to the condition $n = 0$ on the extrapolated boundary of the pile. In general the solutions of (1) can be obtained exactly only for boundaries with a few simple shapes, whereas it is frequently desirable to know the neutron distribution in regions which do not have these simple boundaries. If the pile boundaries differ only slightly from one of the simple shapes mentioned above, it is possible by perturbation methods to obtain an approximate solution of (1) under certain conditions. Before describing perturbation methods it is necessary to establish that the solutions of (1) can be written in terms of the solutions of the Helmholtz equation

$$\Delta \phi_n + \lambda_n \phi_n = 0, \quad (2)$$

subject to the condition ϕ_n vanish over the same boundary on which n vanishes. If the three equations (1), (2), and

$$\Delta G - G/L^2 = -\delta(\bar{r} - \bar{r}') \quad (3)$$

are considered simultaneously, then with the aid of Green's theorem it can be established from (2) and (3) that

$$G(\bar{r}, \bar{r}') = \sum_{n=0}^{\infty} \phi_n(\bar{r}') \phi_n(\bar{r}) / (\lambda_n + 1/L^2) \quad (4)$$

In (3), $\delta(\vec{r} - \vec{r}')$ is the Dirac delta-function and $G(\vec{r}, \vec{r}')$ is the Green's function for (1). G satisfies the same boundary conditions as n .

From (1) and (3), again using Green's theorem, it follows that

$$\begin{aligned} n(\vec{r}) &= \int G(\vec{r}, \vec{r}') \delta(\vec{r}') dV' \\ &= \sum_n \frac{\psi_n(\vec{r})}{\lambda_n + 1/L^2} \int \psi_n(\vec{r}') \delta(\vec{r}') dV' \end{aligned} \quad (5)$$

where the integrals are taken over the region in which (1) holds.

2. Perturbation Theory

Since it is established above that only the eigen-functions and eigen-values of the Helmholtz equation are needed to obtain n , it is sufficient to consider the effects of perturbed boundary conditions on (2) alone. Consider two solutions of (2); the unperturbed functions ϕ_n which vanish on a simple boundary S_0 and the perturbed functions ψ_m which vanish on the perturbed boundary S . The two functions belong to different eigen-values λ_n and K_m respectively so that

$$\Delta \phi_n + \lambda_n \phi_n = 0 \quad (6)$$

$$\Delta \psi_m + K_m \psi_m = 0 \quad (7)$$

We consider in addition the Green's function which is a solution of

$$\Delta G + K_m G = -\delta(\vec{r} - \vec{r}'). \quad (8)$$

and which vanishes on S_0 .

From (6) and (7)

$$\begin{aligned} K_m &= \lambda_n - \int_S \phi_n \frac{\partial \psi_m}{\partial n} dS / \int_S \phi_n \psi_m dV \\ &= \lambda_n - \int_S \phi_n \frac{\partial \phi_m}{\partial n} dS \end{aligned} \quad (9)$$

to first order in small quantities if ϕ_m is normalized.

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From (7) and (8)

$$\psi_m = \int_S G \frac{\partial \psi_m}{\partial n} dS', \quad (10)$$

and using the expansion of G in the eigen-functions ϕ_n this becomes

$$\psi_m = \int_S \frac{\phi_n(\vec{r})}{\lambda_n - K_m} \int_S \phi_n(\vec{r}') \frac{\partial \psi_m}{\partial n}(\vec{r}') dS'. \quad (11)$$

If the boundary perturbation is small and involves the introduction of no serious discontinuities, then ψ_m on the right hand side of (11) can be replaced by ϕ_m to yield a first order expression for ψ_m .

As an example of the application of this technique consider the vibrations of a membrane shaped as in the figure.

The unperturbed case is a rectangle of dimensions a and b . The perturbation consists in replacing the right boundary by the slant line as shown. The lowest unperturbed eigen-value is

$$\lambda_0 = \pi^2 (1/a^2 + 1/b^2) \quad (12)$$

and the lowest perturbed eigen-value is, by (9),

$$K_0 = \lambda_0 + (a \sin^2 \pi b/a) / \pi b (b^2 - a^2). \quad (13)$$

Vazsonyi* has calculated K_0 for $a = 4.5$, $b = 3$ by a relaxation method. His value is compared with the perturbation value in the table following

* A. Vazsonyi, Journal of Applied Physics, Vol. 15 (August, 1944) p. 606.

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unperturbed	$\lambda_0 = 1.575$	
perturbed (Vassonyi)	$K_0 = 1.527$	1st approximation
perturbed (Vassonyi)	$K_0 = 1.596$	2nd approximation
perturbed (13)	$K_0 = 1.589$	1st approximation

The use of this technique is somewhat more tedious in three-dimensions than in two, but it is clear that it offers a method of calculating the critical buckling of odd shaped piles. There is another class of problems in which this type of perturbation may be useful and that is in the effects of control rods on critical buckling and neutron distribution. The discontinuities in slope prevent the substitution of ϕ_m for ψ_m in (11), but it looks as if this difficulty can be overcome by appropriate choice of the original eigen-functions.

Sigma Piles

The question of building a thermal column on top of the 305 pile has arisen. The harmonics at 50 cm and 100 cm above a source distribution which is proportional to $\sin \theta$, $0 \leq \theta \leq \pi/2$, in the x-direction and constant in the y-direction have been calculated by methods similar to those described in the two preceding monthly reports. The results are tabulated below.

	<u>z = 100 cm</u>	<u>z = 50 cm</u>
λ_{11}	1.110	8.64
λ_{21}	-.022	-.442
λ_{31}	.00077	.0465
λ_{13}	.0030	.179
λ_{33}	.00012	.003

These numbers were computed by D. E. Davenport.

These values are for a sigma pile one-hundred-twenty-five cm square and several hundred cm high made of graphite in which the diffusion length is fifty cm. The neutron density is proportional to

$$\begin{aligned} & \lambda_{11} \sin \pi x/125 \cos \pi y/125 + \lambda_{21} \sin 2 \pi x/125 \cos \pi y/125 \\ & + \lambda_{31} \sin 3 \pi x/125 \cos \pi y/125 + \lambda_{13} \sin \pi x/125 \cos 3 \pi y/125 \\ & + \lambda_{33} \sin 3 \pi x/125 \sin 3 \pi y/125 + \dots \end{aligned}$$

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where x and y are measured from a corner of the pile. The distortion at a hundred cm is not excessive and it would seem unreasonable to rule out a thermal column on the basis of distortion alone.

Xenon

The reactivity data from the first B-shutdown has been analyzed by the method of least squares in intervals 0 to 8.8, 19 to 28, 28 to 48, and 48 to 77 hours after shutdown. The coefficients of all the transient terms vary greatly from interval to interval. If the data from the different intervals are combined, the xenon and iodine coefficients are more consistent, but the samarium and plutonium coefficients are still subject to wide variation. Because of this variation the samarium and plutonium coefficients have been calculated separately from known physical conditions and these values are being used. The reactivity after shutdown is fit by a function of the form

$$R = R_0 + b_1 (1 - e^{-\lambda_1 t}) - b_2 (1 - e^{-\lambda_2 t}) - b_3 (1 - e^{-\lambda_3 t}) \\ + b_4 (1 - e^{-\lambda_4 t}) - b_5 (1 - e^{-\lambda_5 t})$$

where subscripts 1, 2, 3, 4, 5 refer to Xe, I, Sm, Pu, graphite effects respectively and $\lambda_1 = .0749 \text{ hr}^{-1}$, $\lambda_2 = .1027$, $\lambda_3 = .0144$, $\lambda_4 = .0124$, and $\lambda_5 = 3.00 \text{ hr}^{-1}$. From examination of the coefficients in the following table it is seen that when the last part of the data is included the xenon and iodine coefficients are especially bad, that the samarium coefficient is high and the plutonium low compared to the calculated values. This may indicate that there is some other poison in the pile with a very long half-life which is contributing to the samarium coefficient and subtracting from the plutonium. When satisfactory xenon and iodine coefficients can be chosen, differences between the data and the calculated reactivity will be analyzed to see if another half-life can be identified.

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Least Squares Coefficients From First B-Shutdown
 Δt = time interval in which coefficients are determined

Δt	b_1	b_2	b_3	b_4	b_5	R_o	a
0-8.8	1736	1350	1254	1346	46.7	87.5	
8.8-19	3528	2658	1332	69			-422
19-28	129	-256	-466	-6			594
28-48	2894	3346	284	492			264
48-77	480	-1230	1129	1205			458
0-19	1768	1355	166	29	48	87.2	258
0-28	1607	1252	45	0.13	50	89.1	349
0-48	1595	1243	40	.72	50	89.6	352
0-77	1567	1222	28	2.9	52	90.7	359
0-9	1697	1333	14*	6*	47	87	396
0-19	1569	1229	14*	6*	50	90	372
0-28	1558	1219	14*	6*	51	90	370
0-77	1523	1186	14*	6*	56	92	366

* Calculated independently

a is value of R for very large t

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Paul F. Gost
 PILE TECHNOLOGY DIVISION

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