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7-298.4
CC: #1 - W. E. Jordan - 700
#2 - L. Squires - 300
#3 - P. F. Gast
#4 - J. Marshall
#5 - W. R. Kanne
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#7 - Yellow

THIS DOCUMENT CONSISTS OF 164 PAGES

November 29, 1945

+ *Repts. 7-2937 11-29-45*

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7-2933

TO: FILE

FROM: W. E. JORDAN

100 AREA TECHNICAL ACTIVITIES REPORT-PHYSICS
10/25/45 TO 11/25/45

100-B Area - W. R. Kanne

Two events of broad significance occurred in the 100B Area during this report period. These are the discovery of pimpled slugs in high concentration tubes discharged on 10-30-45 and the discovery of leaking VSR thimbles on 11-15-45. Although more extensive reports of these occurrences will be made elsewhere, these events have aspects of significance to physics and basic data will be given in this report for record purposes.

No pimpled slugs have been discovered in normal discharge material of 11-15-45 or 11-20-45 (circa 200 MWD/ton), but h2 have been found in at least four high concentration tubes.

No. of Pim-
pled Pieces

Tube
Number

Date
Discharged

12
5
13
12

1768,1773
2378
3273
3279

10-30-45
11-15-45
11-15-45
11-15-45

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By Authority of WA Snyder
CG-PR-2 2-2-94
By J E Sawley 2-14-94
Verified by Jerry Maly
3-4-94

Vertical thimbles 15, 28, 34, 35, 36, 37 and 38 leaked helium on 11-15-45. Thimbles 15 and 28 were sealed and the rods inactivated. The others were allowed to remain in operation but the 3XX was disconnected from all those mentioned. The physics group is represented on the committee responsible for the repair of the leaks.

Several graphite cooling periods have been determined.

Thermocouple

Date

Period

13G
16G
17G
11G

11-15-45
11-15-45
11-15-45
11-20-45

31 min.
32 min.
59 min.
61 min.

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November 29, 1945

A neptunium sample was loaded into tube 3678 on October 30. A sample of thorium was loaded into tube No. 2786 on October 30, and was discharged on November 15. The exposure of the thorium sample was calculated to be 9.8×10^{18} neutrons per cm.², assuming the flux to be equal to that in a neighboring uranium slug. This estimate is lower than the actual exposure by a considerable factor.

Survey of Ventilating Air Activity

The "Sniffer" ion chamber, Beckman amplifier, and recorder set was used to determine the gas activity in several parts of the ventilating system.

By sampling the same air as stack monitor, it was determined that the "Sniffer" has the same sensitivity as the stack monitor.

No activity was observed in the sample withdrawn by hose from the tunnel just under the 115 Building.

The reading due both to air withdrawn from the discharge area and to air from the machinery room was approximately 5×10^{-13} amp. Air sampled near the south side of the railing around the VSR thimbles showed a variation between 3.3×10^{-13} amp and 1.3×10^{-12} amp. The cycle was the same as that indicated in the bulk ventilating air, but the peak was much sharper.

It was suggested that an explanation for the variation of this air activity with the cycle of the preheaters may lie in the loss of fan efficiency with the increased temperature of the air handled by the inlet fans. Since these fans handle a smaller mass of air when it is warmed, there may be a slight decrease in pressure in the 105 Building which would let active air expand out of the thimbles.

Reactivity of the B Pile

	<u>10-25-45</u>	<u>11-25-45</u>
Xenon	469 ih	469 ih
Poison	298	298
Bismuth	8	16
Rods	<u>66</u>	<u>75</u>
Reactivity of hot pile	841 ih	858 ih
Net gain of reactivity	- 17 ih	
	<u>10-25-45</u>	<u>11-25-45</u>
Reactivity of hot pile	841 ih	858 ih
C ₀ W	<u>- 56</u>	<u>- 61</u>
Reactivity of cold pile	785 ih	797 ih

The new value of the overall coefficient is applied to the current reactivity estimate.

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Reduction To

Determination of the Reactivity Coefficients of the B Pile."
R, Doc. No. 2746, November

Reactivity determined from data 1-25-45 were found to be:

$$\begin{aligned} \rho_0 &= +0.27 \\ \rho_1 &= -0.27 \\ \rho_2 &= +0.46 \\ \tau &= 50 \text{ ms} \end{aligned}$$

is lie very close to both predicted by the observed trend
values of the recent determination.

Figuration 4e test ranged so that a previous accurate
of, obtained 095-45, could be used. No rod calibrations were
obtained this set.

As loss of reactivity observed after the 27.5 MW increase
renewal pile now operating at 225 MW. This may have been
due to slight change in present graphite theory, this
is very unlikely.

Discussion

Reactivity with irradiated Metal, Kanne, Montgomery and
McJannet, Doc. No. 7-2819. The average of four discharges
using metal reactivity indicates a pile reactivity gain of
9000 MW/ta average in each tube. This value compares
well with the best value based on the experience of all three
piles.

In addition the observed reactivity loss of the pile was
corrective fraction of the pile involved in each discharge
and change in type of metal. The observed reactivity
loss reflecting the change in rods after the xenon reached
equilibrium reactivity due to plutonium decay and extrapolating
back after the shutdown in and this extrapolated value
is due to the discharge.

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Tested, during this period, at a power level of 250
MW. Periods of planned shutdown.

Shutdown of November 6**DECLASSIFIED**

The pile was shut down between 6:35 and 7:25 AM on November 6. The average exposure of the discharge was about 200 MWD/ton.

During the shutdown several other jobs of technical interest were performed. The calibration of the gas analyzer was checked by the instrument department with a sample of gas of what was thought to be known purity. The calibration check was prompted by a continuous increase in the purity reading. The calibration sample turned out to be commercial gas with only a roughly known purity. At the present writing the instrument has not yet been adequately calibrated.

The revised cooling system for B test hole was installed during the shutdown. It includes a pressure reducing valve which is supposed to maintain the pressure automatically. This valve chattered violently when first installed, and the difficulty has not yet been eliminated. During subsequent shutdowns a pressure line was run to the control room so that the inlet pressure can be read on a penellit gauge, and thermocouple leads from the interior of the hole were run to the BGST potentiometer in the control room where the temperature is recorded by a Micromax.

The North high tank was dropped through the unchilled section of the pile during the shutdown. It was not necessary to change any screens because of this test.

Shutdown of November 13

Shutdown was between 6:35 and 7:21 AM. The average exposure of the discharged metal was 302 MWD/ton. With this discharge the last of the overexposed metal has been discharged from the pile. The pile was again at 250 megawatts at 11:32 PM.

Shutdown of November 20

The pile was shut down between 6:45 and 7:32 AM. Two bismuth bearing tubes were discharged. These had been in the pile since August 16. The average exposure of the uranium metal in the push was about 200 MWD/ton.

During this shutdown the South high tank was dropped through the chilled section of the pile.

Reactivity

In Figure 1 is shown the variation of reactivity held by the regulating and shim rods during the month. The straight line segments below the experimental points are estimates of what the reactivity would have been if Np^{239} had a short half life or if Pu^{239} were formed directly from the capture process. The discontinuities between the different segments, then, represent the effect that each push would have had on reactivity if the pushed metal had somehow been allowed to realize all its plutonium gains before the pile was shut down. Normally, of course, the formation of plutonium lags 3.3 days behind other

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effects because of the long life of its parent. After the neptunium-plutonium correction has been made to the experimental values of the reactivity, it is possible to determine more or less accurately the "between shutdowns" rate of gain of reactivity at that time. It will be seen from the graph that this rate of gain appears to be decreasing slowly at the present time.

Gains Associated With Irradiated Metal

Additional points on the metal gains curve have been obtained since the last report. They come from the shutdowns of October 25, (303 MWD/ton, 177 ih), November 6, (202 MWD/ton, 66 ih), November 13 (302 MWD/ton, 197 ih), and November 20 (202 MWD/ton, 87 ih). These points and the other available points from all three areas are plotted in Figure 2. The dashed curve is intended merely as an indication of what the true shape of the curve is thought to be.

An effort has been made to obtain points for exposure less than 200 MWD/ton. During the early operation of both the 105-B and the 105-D piles there were discharges of low exposure metal. The reactivity changes associated with most of these discharges, however, were obscured by changes in permanent poison, changes in power level, or other factors of questionable or unknown magnitude. R. L. Menegus has reviewed the poison changes of both piles on the basis of the most acceptable individual column values and shadowing corrections. Using the value of the permanent poison change as given by Menegus, and correcting also for the change in equilibrium value of the I_x poisoning, assuming ideal flattening, several evaluations were made for low exposure discharges. The results so obtained are discouragingly inconsistent and do not add materially to the experimental picture of the metal gains. Because of this the results are not given here.

Variations in Rate of Gain

In figure 3 are plotted values for the rate of reactivity gain of the D pile between shutdowns. The rate of gain is probably more significant, experimentally, than the absolute values of the gains at any time because of uncertainties in poison, xenon, etc. More points will be determined on this curve in the future. It is felt that such curves, when correlated with the exposure and discharge history of a pile, will be very useful in checking the accuracy of any theory or reactivity gains that may develop. There is no real justification for drawing a smooth curve through the points, because discontinuities are expected at discharge times.

Graphite Thermal Relaxation Periods

The following graphite periods have been determined from readings of the various thermocouples following shutdowns.

<u>Date</u>	<u>11G</u>	<u>13G</u>	<u>14G</u>	<u>17G</u>
10/18/45	66 min.	63 min.	64 min.	62 min.
10/25/45	63	63	65	62
11/6/45	62	64	70	61
11/13/45	69	67	70	64
11/20/45	—	70	73	67

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A survey of these periods over the past five months indicates that they are increasing at an average rate of about 2.5 minutes per month.

Unusual Incident of October 11

This incident was the failure of the cooling water to B Test Hole. Recalculation of the reactivity effect reported last month indicates that the agreement between the calculated and the observed effects is not as good as was reported there. The observed reactivity effect was three inhours. The calculated effect was 1.7 inhours. The difference may possibly be due to uncertainties in the cooling installation inside the hole. There appears to be no blue print that shows the finished and revised installation. A revised draft of a report on this incident was completed on November 2.

Loading and Monitoring of 105-D

A general account of the initial loading and monitoring of the 105-D pile was written. The memorandum includes the results of the various measurements made at the time.

Discharge Water Activity as a Measure of Pile Power Level

A study of this subject was completed by Staebler and a report was written. The conclusion is that the method could probably be improved by installation of more chambers in better positions, but that at present the accuracy is limited by fluctuations of the order of 10%, caused, presumably, by changes in the distribution of neutrons within the pile. There is no definite assurance that these fluctuations could be removed by improved chamber installation, but it could probably be somewhat improved.

History Chapter

A draft was written for a history chapter covering the plant assistance activities of the Physics Group of 100 Technical.

100-F Area - P. F. Gast

Summary

During the period the pile was shutdown three times for discharge of metal and experienced one scram. During the shutdown on November 8, the strength of the P-columns was reduced by 40 ih net. Efforts were made at that time and also more recently to improve the temperature distribution of the unit. The net loss of reactivity during the month was 23 ih. This was due to losses incident to the discharge of irradiated metal. A net gain of 8 ih was experienced between shutdowns during the month, partially compensating the total loss of 31 ih at discharges.

DETAILS**DECLASSIFIED**Reactivity

The reappearance of reactivity gains during the periods of steady operation between shutdowns was a noteworthy feature of the month. These gains are still not large enough to offset the losses experienced at discharges. During the month only 8 ih of gains were recorded during shutdowns whereas a total of 31 ih was lost at discharges. The reactivity change at the discharge of November 1 has been analysed in the same manner as results from other discharges which were reported in last month's report. The results of this analysis are as follows: (Complete calculation in H.E.W. - 301-L p.6)

Gross loss	14.6 ih
Net loss	20.9 ih
Concentration	298 MW/ton
Gain if all metal in unit had this concentration	258 ih

Neither of the other two discharges was suitable for analysis since the P-columns were changed during one of them and a change in rod configuration used for normal operation was made at the other.

On November 8, the strength of the P-columns was reduced by a nominal 53 ih or an actual change, after correction for shadowing, of 40 ih (Memo: Basis for P-Column Change at 100F on 11-8-45 Cast to Jordan, 11-7-45). The actual reactivity change observed was in good agreement with expectations. These results may be summarized as follows:

In rods before change	32 ih
Change in P-columns	40
Increased effectiveness of Xe in less flattened pill	- 8
Loss due to metal discharge	- 4
Expected in rods after change	60 ih
Observed in rods after change	60 ih

A comparison of the reactivity situation at the beginning and the end of the period is given in the following table:

	Beginning 10/26	End 11/25
In rods	43	53
Xenon	47 1/2	48 1/2
P-columns	276	236
Total	793	770

A net loss of 23 ih during the month is thus indicated.

Temperature Distribution

When the P-columns were changed on November 8, an attempt was made to improve the temperature distribution of the unit. For reasons to be set forth below, this

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attempt has so far not been successful. When the P-column changes were planned, it was expected that after the change rod 9 would be all in and rod A would be in the neighborhood of 125" (Basis for P-column Change at 100-P on 11-8-45 Cast to Jordan, 11-7-45). Actually a different configuration was used and A was operated nearly all in, around 15", and 9 was near 200". This of course gave a different temperature distribution than had been planned. In order to correct this, the originally planned configuration was used following the shutdown of Nov. 21. Due, however, to the losses at this discharge, rod A now operates near 180" instead of 125". For a discussion this problem, attention is centered on the vertical dipole moment which is the worst offender. On Nov. 2 this moment was 17.7%. It was originally expected that following the change this moment would be reduced to 2%. Actually on Nov. 20 it was - 7.9% and on Nov. 26, following the change in rod configuration, it had increased to 17.2%. The following table summarizes the changes which occurred and compares them with changes which would be expected from present theory (Procedure for Improving Temperature Distribution via Rods and Columns, Wheeler and Menegus to Jordan, 9-27-45).

<u>Dates and Changes</u>	<u>Measured Change</u>	<u>Predicted</u>
11-2 to 11-20, vertical moment of columns increased 330 lu. ih. Rod configuration changed.	- 25.6%	-30.0% columns - 4.8% rods -34.8% total
11-20 to 11-26, rod configuration change. No change in columns	+ 25.1%	+ 24.9%

It would appear from the above that the predictions of the results of rod changes is more successful than predictions involving P- column changes. The P-columns appear to be less effective in producing dipole changes than had been expected. If the above data is used, it appears that 16 lu.ih are required to produce a change of 1% in the temperature dipole rather than 11 lu.ih., the presently accepted value.

Production Test 105-37-P, Determination of Reactivity Coefficients of F File.

A final report has been prepared on this test and is now being typed. Briefly the results of this test are:

Graphite Coefficient	0.52 ih/lw
Metal Coefficient	-0.21 ih/lw
Overall Coefficient	0.31 ih/lw
Graphite period	46 minutes

A compilation of previous measurements of these quantities indicates that there has been no significant change in the value of the metal coefficient at F since the first measurements were made, and that the graphite coefficient and periods have shown continuing increases and will probably increase above their present values. Original data for this test are found in H. E. #. -337L, and theoretical calculations relating to it are given in H. E. W. 301L, pp 7-8.

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Current Activities

Present policy is that the recovery from any scram occurring within 16 hours after a cold start up be treated also as a cold start up. A set of curves is being prepared so that a rapid estimate of the critical condition may be made for such a cold start up.

W. E. JORDAN, CHIEF SUPERVISOR
100 - 300 AREA TECHNICAL

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DECEMBER 26, 1945

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TO: FILE

FROM: W. E. JORDAN

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100 AREA TECHNICAL ACTIVITIES REPORTPHYSICS - FOR PERIOD 11/25/45 to 12/25/45100-B AREA - W. R. KANNE

Thimble #15 was inspected by borescope on December 4, revealing that the bottom of this thimble had corroded off. An increase in permanent poison was made at this time, and temporary poison was installed because of the length of the shutdown. The pile was shut down again on December 11 for further inspection of thimble conditions and their repair. Ten vertical thimbles have been replaced. This report will discuss primarily technical aspects of these events.

Preliminary Information on Poison for Extended Shutdown

The B pile experienced a shutdown of approximately 32 hours duration on December 4-5, 1945. A modification of the program suggested by Jordan (Jordan to Worthington, Pile Control-Poison Addition during Extended Shutdown, August 2, 1945, Doc. No. 7-2155) was used successfully. The effectiveness of these poison columns was found to be considerably less than had been estimated in the document referred to above. It is suggested that a poison column at a radius of about 16 lattice units be considered to have an effectiveness of 25 ih, although the variation in effectiveness with number of rods in the pile should be taken into account if possible.

Tubes 3781 and 1081 were loaded with 45 poison slugs each during the B pile shutdown of December 4-5, 1945. It is difficult to estimate the effectiveness of these columns at the time when numerous horizontal rods are in the pile because of calibration uncertainties. The comparison of rod inhours with calculated xenon poison, making allowances for the power coefficient and the normal rod excess, indicates that the two P columns absorbed 67 ± 25 ih at the time of cold critical, $4\frac{1}{2}$ rods in the pile, and 60 ± 25 ih at the time of the reactivity peak, 7 rods in the unit.

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It is possible to obtain a better value of the P column effectiveness by comparing the difference between rod and xenon ih before and after the discharge of the columns. At these times approximately 2-1/2 rods were in the unit, and it was found that the two P columns had absorbed 44 ih. This estimate is based on the difference of two very similar rod configurations, which cannot introduce a large error, and the difference in xenon poison, which can introduce a moderate error because the distribution is abnormal. The probable error of the value of 44 ih obtained in this way is estimated to be ± 8 ih.

A weighted average of the three values that have been obtained is 50 ih for the two P columns, or 25 ih each. This figure is based most heavily upon the value for 2-1/2 rods in the pile. The effectiveness may be expected to be greater when larger numbers of rods are involved.

Temporary Poison for Shutdown of December 11

Ten full poison columns were loaded, at a radius of approximately sixteen lattice units, at the top, far and bottom sections of the pile. Data obtained on 12-6-45 indicate that these poison columns should compensate at least 220 ih and should permit the pile to resume operation with an adequate reserve in the horizontal rods. Their location was chosen so that they should be most effective when nearly all the horizontal rods are in the pile. The summation given below is the basis for the choice of 10 poison columns.

Xenon decay	464 ih
Previous rod compensation	63 ih
Neptunium decay	20 ih
Total to compensate	547 ih
Temporary poison	-220 ih
Necessary rod compensation	327 ih

The necessary rod compensation can be obtained with a reserve of nearly two horizontal rods out of the pile. This estimate is conservative since the data of December 5 indicate that the temporary poison had greater effectiveness when several rods were in the pile.

Safety Rod Margin during Shutdown of December 11

Four rods have been out of the pile at one time during the boroscopying and replacement of the vertical thimbles. This has been based on a safety margin of 0.7% k to 1.1% k estimated by Wheeler for the VSR under conditions of loss of water, a hot pile, 600 ih flattening, no xenon decay, and no horizontal rods in the pile. The following corrections were made:

+ 0.7%	conservative margin, above
+ 0.3%	because pile was cold
- 0.4%	excess of reactivity over horizontal rod control power
+ 0.6%	for temporary poison
+ 1.2%	total margin

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12-26-45

Each VSR is assumed to have an individual effectiveness of .22% k and the estimated margin is therefore 5-1/2 vertical rods.

Documents Issued

11-30-45 Montgomery to Jordan

"Changes in Graphite and Reactivity Periods for 105B"

Available periods from January 1, 1945 through November 1945 have been collected and plotted. Thermocouples 13G, 16G, 17G and 26G, as well as the reactivity effect have indicated periods which have gradually increased to approximately 60 minutes at the present time. Their present rate of increase is very nearly 2 minutes per month; six months ago the rate of increase was about 3.5 minutes per month.

It is suggested that some of the readings of 6G and 11G are not valid.

12-14-45, Kanne and Menegus to Jordan

"Poison Change in the B Pile on December 4, 1945"

The poison strength of tube 3179 was increased from 31 ih to 51 ih, and that of tube 1579 from 38 ih to 51 ih. The corrected effectiveness of this change was predicted to be 23 ih, while 26 ih was observed. Moderate improvement in the temperature distribution was obtained, but an analysis of the temperature unbalances suggests that the temperature shift due to the poison columns was considerably less than expected. It is anticipated that a more appropriate rod configuration will contribute further toward making the production correspond to the zone factor symmetry.

12-24-45, Menegus and Kanne to Jordan

"Long Term Reactivity Gains of the 105 Piles - Rate of Gain of the B Pile"

A comparison of the rate of reactivity gain of the B pile between August 26 and 29, 1945, with the gain to be expected due to metal enrichment and boron burn out. A gain of 0.86 ih per day was predicted for the metal enrichment effect by the December 14, 1945 metal gain curve of Marshall and Staebler. The gain due to boron burn out was calculated to be 0.41 ih per day. The sum of these two effects, 1.27 ih per day, is in good agreement with the observed value of 1.23 ih per day. This result may be considered a confirmation of Marshall and Staebler's metal gain curve for the 100 MW/ton to 250 MW/ton concentration range.

Reactivity of the B Pile

	<u>11-25-45</u>	<u>12-25-45</u>
Xenon	469 ih	464 ih
Bismuth	16 ih	16 ih
Poison	298 ih	321 ih
Rods	<u>75 ih</u>	<u>63 ih</u>
Reactivity (Hot)	858 ih	864 ih
Co W	<u>- 61 ih</u>	<u>- 61 ih</u>
Reactivity (Cold)	797 ih	803 ih

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100-D AREA - U. W. STAEBLER

Operation

Operation of the 105 B pile was interrupted by two planned shutdowns and two accidental scrams during the period covered by this report. The scheduled shutdowns took place on December 6, and December 13, and the scrams occurred on December 5, and December 22. The power level of the pile was raised from 250 megawatts to 275 megawatts on December 19, 1945.

Reactivity

During periods of operation between shutdowns the pile gained reactivity at an average rate of 1.1 inhours per day at a level of 250 megawatts, and 1.2 inhours at a level of 275 megawatts. In calculating the rate of gain in reactivity correction is made for the lag in the formation of plutonium. The mechanics of this correction is described in detail in a memorandum, "Long Term Reactivity Gains of the 105 Piles", from J. Marshall and U. W. Staebler to W. E. Jordan, written December 14, 1945. The rates of gain stated above represent a slight increase over the rate of about 0.9 inhour per day observed last month.

A comparison of the reactivity of the pile at the beginning of this report period with that at the end is given in the following table.

	<u>11-25-45</u>	<u>12-25-45</u>
Amount held in rods	77 inhours	74 inhours
Amount held in Xenon	518 "	545 "
Amount held in permanent poison	196 "	196 "
Amount held in B columns	16 "	16 "
Amount held in power coef.	<u>- 62 "</u>	<u>- 69 "</u>
Total cold, clean	745 "	762 "

The above figures show a net increase in reactivity of 17 inhours for the month.

It will be noted that the effective value of the poison column pattern is being taken as 196 inhours instead of the 180 inhours which has been reported in recent months. This difference is due to a change in the shadowing correction and not to any change in the strength or arrangement of the poison columns. The poison pattern has remained unchanged since the shutdown of July 5, 1945. Previously the same shadowing correction has been applied in all three areas even though the pattern at 105 D is considerably different from the pattern in effect at 105 B and 105 F for which the shadowing correction was derived. R. L. Menegus has set up the following equation for determining the effectiveness of the nine column pattern in use at 105 D.

$$\text{inhours}_{\text{eff.}} = 0.857 \left(1 - \frac{\text{ih}_{\text{total}}}{5156} \right) \text{ih}_{\text{total}}$$

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The currently stated value of 196 inhours was obtained by use of this equation. The saturated Xenon values are based on a flattening of 196 inhours, also.

There was an unexplained increase in reactivity of 6 inhours following the scram of December 22. Central graphite temperatures decreased two or three degrees following the scram but if the change in reactivity were due to some change in the properties of the graphite one would expect a loss rather than the gain which was observed. Both phenomena could be explained by assuming a reduction in power level of about two per cent but there is no basis for such an assumption from readings of the various power level instruments.

Long Term Reactivity Gains

Two additional points on the metal gains curve have been obtained from the two discharges which were made during the month. They are as follows:

<u>Date</u>	<u>Gain (lh)</u>	<u>Exposure MW/Ten</u>
12-6-45	122	205
12-13-45	189	201

Both of these points are considerably higher than the average of previous determinations which indicate a gain of about 80 inhours for a whole pile exposed the equivalent of about 200 MW/ten. The point for December 13 is especially questionable due to the small effective size of the discharge.

A memorandum has been written covering all available experimental data on long term reactivity gains up to December 14, "Long Term Reactivity Gains in the 105 Piles", from J. Marshall and U. M. Staebler to W. E. Jordan. Included in this memorandum is a summary of calculated rates of gain based on an assumed metal gains curve, and their comparison with observed rates of gain at four different points in the history of the 105 D pile. This summary is reproduced below.

<u>Date</u>	<u>Boron lh/day</u>	<u>G_e lh/day</u>	<u>Metal Gains lh/day</u>	<u>Total lh/day</u>	<u>Observed lh/day</u>
3-15-45	1.40	0.31	0.72	2.43	2.67
5-30-45	1.19	—	0.62	1.81	1.80
8-25-45	0.81	—	0.78	1.59	1.67
11-28-45	0.50	—	0.40	0.90	0.90

The agreement between observed and calculated rates of gain is well within experimental error in all cases. It is not likely that the metal gains curve can be more accurately established by means of present techniques but work will be continued on the refinement of these measurements.

Power Coefficients and Graphite Relaxation Periods

The change in operating level on December 19 made it possible to determine another set of values for the power coefficients and the graphite relaxation

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The results of this determination are shown in the following table which results obtained from previous changes in operating level.

Re Level Change	C_g	C_g	C_g	Period
5- 250 to 265	0.15	- 0.24	0.39	35 minutes
6- 265 to 280	0.17	- 0.21	0.38	38 minutes
8- 280 to 290	0.25	- 0.28	0.53	45 minutes
12- 290 to 275	0.24	- 0.24	0.48	54 minutes

Therocent values do not show the expected rise in the graphite power coefficient, C_g , and overall power coefficient, C_o , but the discontinuity is within experimental error. The graphite periods indicate a continued inch about two and one-half minutes per month, in good agreement with observations based on periods obtained from central graphite thermocouples after shutdown of the pile.

The swing periods have been obtained from graphite thermocouples during the

Date	110	130	140	170
12-6-45	—	65 min.	72 min.	68 min.
12-13-45	65 min.	65	74	65

Activity Top of Pile

The discovery of corroded VSR thimbles at 105 B has caused special attention to be given to the top of the 105 B pile in an effort to detect any signs of a possible thimble failure. During the shutdown of December 6, the Health Instrument group searched for gas leaks around eighteen of the vertical rods but found no indication of any leaks. During the shutdown of December 13, vertical thimbles 15 and 24 were borescoped and found to be in good condition. It is planned to borescope the remaining thimbles sometime next month.

The EM meter located on the east wall near the stairway to the balcony has recorded several rather sharp increases in the activity on top of the pile during the month at times when no satisfactory explanation could be offered. Several of these surges have taken the activity up by a factor of 8 or 10. Most of them decay with an argon half-life, indicating the activity may be due to gas which becomes trapped in the third safety headers. During some of these periods of high activity readings have been taken around individual rods and around the third safety headers near individual rods. Readings in excess of 200 mr/hour have been obtained near the headers around rods 12, 13, 32, 36, and 37, when most other points read 30 to 50 mr/hour. This condition is being followed very closely and an effort is being made to correlate changes in the activity with changes in the ventilating system of the building. Gas losses from the helium circulating system have shown no signs of increasing.

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7-2984Status of Production Test

105-40-P, "Experimental Hole Plugs". A special steel plug with a stainless steel tip was placed in one of the holes in the B hole assembly during the shutdown of December 6. This special plug is to be removed after a month or more of exposure and sufficient measurements made on it to determine the shielding necessary for full-length stainless plugs which are to be used in these holes in the future.

100-AREA - P. E. GASTSummary

The pile was shut down twice during the month, once for the discharge of metal and once for inspection of selected vertical and horizontal rod thimbles. The power of the unit was increased from 225 MW to 250 MW on December 20. Rod position changes carried out as a result of this change have resulted in an improved temperature pattern. Two memoranda were prepared during the month one of which has been issued in final form. The unit has shown a net permanent gain (cold) of 13 ih during the month and a gain at operating level of 25 ih.

DetailsReactivity

The single discharge, on November 29, of metal from the pile resulted in the loss of only 1 ih. This was due to the fact that the metal was discharged from a region of less than average neutron density and was a push of only average concentration. The calculated loss, using the empirical curve recently prepared by J. Marshall, was 0.8 ih for this push in good agreement with the 1 ih observed. The reactivity gains experienced during the month may be summarized as follows:

Total gains at operating level	26 ih
Loss due to metal discharge	-1
Net gains at operating level	25
Gain due to power increase on Dec. 20, overall coefficient 0.33 ih/MW	8
Gain due to increase in overall coefficient during month, 0.31 to 0.33 ih/MW	4
Net gains in cold pile	13 ih

Change of Overall Coefficient

The results of Production Test 105-37-P, reported in last month's report and also in a Final Report on that Test (Gast to File, 11-16-45 #7-3012) indicated that the F pile had a nearly constant metal coefficient and hence an increasing overall coefficient. Curves drawn thru all reliable measurements of the coefficients indicated that an overall coefficient in the neighborhood of 0.33 ih/MW could be expected on December 14. The

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observed reactivity changes between shutdown and startup on that date were adequately explained by the well known xenon changes and an overall coefficient of the above magnitude (no metal was pushed); consequently the value 0.33 $\Delta k/k$ has been adopted as the current value of the overall coefficient.

Power Increase

On December 20 the power was increased to 230 MW from its previous level of 225 MW. It was hoped that this operation could be carried out in such a way as to give information on the current values of the various reactivity coefficients and the graphite period. Unfortunately due to mechanical difficulties it was impossible to carry out the change of level by using rod A, the one for which a reliable calibration is known and which would have produced the least disturbance of the neutron density distribution in the pile. The change was carried out by using a combination of rods B and 9 which was deemed to be the next best way. Unfortunately, the shift of the neutron distribution was great enough to produce anomalous results. Rod A was subsequently returned to service and its use together with a portion of rod 9 has resulted in a satisfactory temperature distribution in the unit. The only temperature moment of any important magnitude is now a center line quadrupole moment. This moment cannot be reduced without a change in P-column strengths. In any event, all tube exit temperatures are comfortably below the set upper limits.

Transients Produced by Rod Switch

On December 21 Rod B was at 20" and rod A was nearly out, 285", while rod 9 was at 150". The return of rod A to service made it possible to withdraw B entirely and to insert A a corresponding amount. After B was withdrawn, A returned at first to the neighborhood of 100". Over the next 28 hours A gradually withdrew to around 120" out. The existence of a reliable calibration for A and the fact that the Xenon was in a steady state before the rod change enables some conclusions to be drawn about the nature of this effect.

The observations are shown in the attached figure and the existence of a graphite and xenon effect can be distinguished by the characteristic periods with which these effects take place. The graphite effect decays toward the extrapolated portion of the curve with a period of 40 minutes. The last measured value of this period for a power change of the whole pile was 46 minutes. The two values would not necessarily be identical as will be discussed below.

The following explanation for the effect is advanced. When the rod change is made the neutron flux distribution shifts rapidly to conform with the new rod position. The rapidity with which this takes place is governed by the periods of the various delayed neutron groups, the longest of which is 83 seconds. The metal temperature distribution shifts almost instantaneously with the neutron flux. When the change of rods is rapid, the graphite temperatures and the xenon concentration just after the change is completed

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remain nearly the same as they were before it took place. In the case observed here the region of high flux was shifted from the back to the front of the unit. The regions of cooler graphite temperature and of lower xenon concentration thus become the regions of high neutron flux and vice versa. This results in a quick decrease in the effectiveness of the graphite temperature and also of the xenon poison. The graphite temperatures then proceed to adjust themselves to conform to the new flux distribution with a period dependent upon the thermal conductivity in the regions involved. Since this may be different from the average effect when the power level of the whole pile is changed the two periods are not necessarily the same. In this particular case they are close enough to label the effect as belonging to the graphite. This anomalous weighting of the graphite decays in this case with a 40 minute period and when extrapolated back to an effective time for the change gives about 4 ih as the change due to the quick shift of neutron flux. This is 3% of the total graphite effect. The xenon distribution similarly changes to conform to the changed neutron distribution with a period characteristic of such changes. The magnitude of the sudden xenon shift cannot be directly determined from the present observations. The original jump may have components due to all of the following effects:

- 1) Transient Graphite Effect, -4 ih
- 2) Permanent temperature effect due to shifting of neutron flux peak toward cooler end of pile. This effect is in same direction as transient graphite effect, magnitude unknown.
- 3) Transient Xenon Effect. Since effectiveness of xenon and graphite are both proportional to square of neutron density the magnitude of this effect is also about 3% of 510 ih or, plus 15 ih.
- 4) A permanent xenon effect, magnitude and sign unknown.
- 5) A semi-permanent shift of the neutron effectiveness of the Farmer gains both in graphite and metal, magnitude and sign unknown.

The sum of all these effects, except the first, in the present case appears to be about plus 6 ih.

In the light of the net magnitude of these effects it is desirable that all experiments for the purpose of calibrating rods and measuring coefficients be planned to minimize it as much as possible. This effect undoubtedly contributed to the anomalous results mentioned above in connection with the increase in power level. Calibrations obtained from return of xenon to saturation following a shutdown are particularly suspect on this account.

Documents Issued

A set of curves has been prepared for predicting the critical position at a startup following a scram occurring when the unit is under startup conditions. This has been issued, together with explanatory material, in

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memorandum from, "Critical Position for Recovery from Scram during Startup Period", Cast to Jordan, 11-30-45, #7-3055.

A memorandum has been prepared discussing the question of how many vertical rods may safely be tied out with the piles in their present condition of power level, permanent poisoning, etc. It will be issued shortly.

Work is currently in progress on a section of the HEN history covering reactivity changes of the piles and methods for controlling them.

W. E. Jordan
W. E. JORDAN, CHIEF SUPERVISOR
100-300 TECHNICAL

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REACTIVITY TRANSIENT PRODUCED BY A ROD SWITCH
Observed at 100F on 12-21-45

P.F.G. 12-22-45

20 10 20 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

F, reactivity and power

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CC: #1 - W. E. Jordan - 700
 #2 - W. C. Kay - 300
 #3 - P. F. East
 #4 - W. H. Staehler 7-2984
 #5 - W. R. Lums
 #6 - Pink
 #7 - Yellow

THIS DOCUMENT CONSISTS OF 11 PAGES

FEBRUARY 7, 1946

THE Division

TO: FILE

FROM: W. E. JORDAN

100 AREA TECHNICAL ACTIVITIES REPORT - PENDINGFOR PERIOD 12/25/45 to 1/25/46100-B AREA - W. R. LUMSSummary

The B pile resumed operation on December 29 after a shutdown of 18-2/3 days duration. The startup provided additional information on the use and effectiveness of temporary poison columns. The effect of exposure on the reactivity of metal has been evaluated both through the pile reactivity change due to the high concentration discharge of December and through the change in the rate of gain of reactivity. A prediction test for the re-determination of rod calibrations and reactivity coefficients assisted in the interpretation of these changes.

Pile Control by Temporary Poison Columns

Information obtained from the use of temporary poison during the December 4 shutdown of the B Pile was extended and confirmed by the experience of the startup on December 29.

- 1) Five full poison columns located at a radius of 16 lattice units in the pile, supplementing the horizontal rod system, provide adequate control under present conditions for operation after a shutdown during which all the xenon has decayed.
- 2) The effectiveness of a poison column at a radius of 16 lattice units was found to increase with the number of shim rods in the pile; the columns used on December 29-30 were found to compensate 25 ih when 2-1/2 rods were in the pile and 40 ih with 7 rods.
- 3) Considerable loss of reactivity occurs during a shutdown to discharge temporary poison due to the rapid increase in xenon poison and to the cooling of the pile. This may even over-compensate the gain in reactivity due to the discharge of the poison. The pile should be shut down for the discharge while the rods held ample reserve reactivity to start the unit again. The startup is made while the pile is losing reactivity and a

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more rapid than normal withdrawal of rods to find the critical condition is indicated.

The effectiveness of the temporary poison columns was determined in all cases by comparing the expected reactivity of the pile with that actually compensated by the horizontal rods at appropriate times.

Further experience has been obtained at the D and F piles and it is expected that a joint report covering all the experience to date will be written.

Long Term Reactivity Gains in Exposed Metal

The discharge from the B Pile of 31 tons of metal having a product concentration of 335 MWd/ton has provided the largest reactivity change associated with the discharge of exposed metal observed to date. The loss of reactivity of 42.7 ih was determined with the aid of the recalibration of rod A by Production Test 105-41-P, which was carried out on January 5, and also the rate of reactivity gain of 0.26 ih/day established during unperturbed operation between January 12 and 20. The latter fact permitted the extrapolation of the excess reactivity trend from the established critical position of the morning of January 5 back to the startup on December 29.

From the observed reactivity loss must be subtracted the effect of loading tube 3671 with lead rather than uranium slugs, which is approximately 4 ih. The loss attributable to the metal exchange is therefore 38.7 ih. This discharge consisted of 21% of the effective pile and involved some reclaimed slugs of the original loading and also some 35 slug tubes which were reloaded with 32 slugs. These corrections result in a point on the "metal gain" curve at 335 MWd/ton and 168 ih gain.

A similar point for the discharge of January 8 is 83 ih gain for metal exposed 200 MWd/ton.

Rate of Reactivity Gain of the B Pile

The rate of reactivity gain of the pile after the 31 ton discharge has been compared with the Marshall-Staebler "metal gain" curve predictions by two methods. Both of these results show that the observed rate of gain is lower than the predicted.

The first comparison was made by a method similar to that described by Menegus and Kanne in a memo to Jordan ("Long Term Reactivity Gains of the 105 Piles - Rate of Gain of the B Pile", December 24, 1945) except that it was found necessary to subdivide zones into high and low concentration fractions. This analysis predicted a gain of 0.39 ih/day due to metal and 0.24 ih/day due to boron burn-out, resulting in a net predicted gain of 0.63 ih/day. This result applies to January 9 and is to be compared with the observed rate of gain of 0.26 ih/day observed the following week.

Since it was felt that the subdivision of the zones referred to above may not have been done adequately the expected change in the rate of gain due to the replacement of the high concentration material by fresh metal was determined. The expected change in rate of gain is -0.36 ih/day. Since the pile was gaining 0.9 ih/day before the shutdown of December 11, the predicted rate of gain after the discharge is 0.54 ih/day. This result is approximate.

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These predictions are in disagreement with the observed rate of gain of 0.26 ih/day and suggest that the initial loss of reactivity by the metal during exposure may be underestimated by the Marshall-Staebler curve.

Reactivity of the B Pile

	<u>12-25-45</u>	<u>1-25-46</u>
Xenon	464 ih	464 ih
Bismuth	16 ih	16 ih
Lead (tube 3671)	--	5 ih
Poison	321 ih	321 ih
Rods	88 ih	29 ih
Reactivity (hot)	884 ih	835 ih
CoW	-61 ih	-65 ih
Reactivity (cold)	803 ih	770 ih

Documents Issued

Memogus to Jordan "Poison in the Piles", January 14, 1946 -

This document gives a complete history of the permanent poison used in the B, D and F piles from the start of operation to the date of issuance. The tabulation gives both the nominal poison value and the effective poison value for the various patterns that have been used.

This is a revision of the document listed in the previous 100 area Technical Report as issued December 14, 1945.

Kanne and Memogus to Jordan "Poison Change in the B Pile on December 4, 1945", January 8, 1946 -

The effect of the poison increase on December 4, 1944 on the reactivity of the pile and on the pile temperature distribution are discussed. Assuming that the change in helium purity which occurred over this shutdown was 2% and that it accounted for a reactivity decrease of 4 ih, very good agreement is obtained between the predicted and observed effectiveness of the increase in poison. The change in temperature distribution due to the poison columns is smaller than expected but no attempt is made to determine a new factor for the dipole temperature effect of poison columns.

Status of Production Tests

Final Report, Production Test No. 105-41-P

"Determination of Reactivity Coefficients and Rod Calibration of the B Pile".

This test was carried out on January 5, 1946 and consisted in the reduction of the power level from 225 MW to 198 MW for 10 hours. The following results were obtained:

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$$\begin{aligned} C_0 &= + 0.29 \text{ ih/Mw} \\ C_1 &= + 0.53 \text{ ih/Mw} \\ C_2 &= + 0.24 \text{ ih/Mw} \end{aligned}$$

Reactivity period = 54 minutes
Rod sensitivity = 0.242 ih/inch in the linear region

100-D AREA - U. M. STANBLER

Operation

The operating level of the 105-D pile was lowered from 275 MW to 225 MW at 9:00 AM on December 30, 1945. Operation for the remainder of this report period was at 225 MW with the following exceptions. The pile was shut down on December 31, 1945 and again on January 18, 1946 for the purpose of discharging metal. The first of these shutdowns lasted about 13 hours but the second extended over a period of about 82 hours because of an extensive borosweeping program and because of work on the B. P. A. system on January 20, 1946. A third shutdown of about 4 hours duration occurred on January 22 for the discharging of 5 temporary poison columns. It was necessary to operate at 215 MW for an effective period of about 3½ hours because of excessive graphite temperatures following the startup on January 22.

Reactivity

A comparison of the reactivity of the pile at the beginning of this report period with that at the end is given in the following table:

	<u>12-25-45</u>	<u>1-25-46</u>
Amount held in rods	74 inhours	58 inhours
Amount held in xenon	545 "	467 "
Amount held in permanent poison	196 "	304 "
Amount held in B columns	16 "	16 "
Amount held in power coeff.	-69 "	-66 "
Total cold, clean	782 "	789 "

The above figures indicate a net increase of 27 inhours for the month.

The rate of gain in reactivity during periods of equilibrium operation has been about 1.3 inhours per day except for the two days just prior to the level change of December 30, and the first three days after equilibrium was reached following the shutdown of December 31. During these times the pile gained reactivity at an unexplained rate of 1.8 inhours per day.

Poison Column Changes

The permanent poison pattern of the 105 D pile was changed twice during this report period. The changes are the first since July 5, 1945, and were made necessary by accumulated reactivity gains plus the decrease in xenon poison brought about by the lowering of the operating level.

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The poison patterns in effect during various parts of the month are summarized in the following table.

Tube	Nominal Inhour Value		
	7-8-45 to 12-31-45	12-31-45 to 1-18-46	1-22-46 to present
3162	7	34*	34
3179	14	38*	38
2669	27	27	0*
2679	51	51	51
2374	46	46	46
2069	34	34	34
2079	30	30	30
1569	16	34*	34
1579	14	38*	38
1474	0	0	34*
2666	0	0	44*
Total nominal 239 inhours		332 inhours	383 inhours
Total effective			
196 "		266 "	304 "
Delta in, effective --		70 "	38 "
Delta in, observed --		67 "	41 "

Values marked with * denote a change in column strength.

Effective values of the poison patterns were calculated from the equation given by R. L. Menegus for the nine column pattern in effect until the changes of January 18, 1946. The agreement between expected and observed reactivity changes is considered quite good. Part of the discrepancy in the most recent change is probably due to the fact that this change represents an expansion of the pattern toward the eleven column pattern proposed by J. A. Wheeler, and the resulting arrangement would not be expected to have the same shadowing correction.

The poison change of December 31, 1945, is covered in detail in a memorandum "Pile Poison - Poison Column Change at 105 D" from U. M. Staebler to W. E. Jordan, written January 7, 1946. A memorandum on the poison change of January 18 is in preparation.

The effects of the poison changes on the temperature distribution of the pile are summarized below along with a comparison of the effects to be expected on the basis of the techniques set forth in Document #7-2654, "Procedure for Improving Temperature Distribution via Rods and Columns", from J. A. Wheeler and R. L. Menegus to W. E. Jordan.

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Moment	12-27-45 to 12-29-45	12-31-45		Pre- dicted	1-5-46 to 1-7-46	1-18-46		Pre- dicted	1-25-46
		Due to Poison Change	Due to Rod Change			Due to Poison Change	Due to Rod Change		
Horizontal Dipole	-1.4%	-5.1	0.5%	-4.0%	0.7%	9.6%	-15.3%	-3.0%	-3.9%
Vertical Dipole	-1.8	-1.5	4.7	1.6	0.1	14.0	-15.1	-1.0	0.3
Horizontal Quad- rupole	-6.9	6.8	0.6*	0.5	-0.9	-2.4	---	---	1.6
Diagonal Quadrupole	-1.8	0.7	2.0*	0.9	1.2	1.4	---	---	2.9

Temperature moments taken over an interval of several days as indicated were corrected to the same rod positions and averaged. The rod positions taken were as follows:

9 @ 100" and A @ 80 inches for 12-28-45 to 12-29-45

9 @ 80" and A @ 54 inches for 1-5-46 to 1-7-46; and A @ 10" for 1-25-46.

* The rod correction for the quadrupole moment was estimated by taking the inhour value of the incremental change in rod positions and using x and y values in lattice units from the center of this increment to determine the moment. The change in rod configuration over the second poison change was considered too large to be treated in this manner.

Inasmuch as the observed poison moments are not good to better than two per cent, agreements between expected and observed results are considered quite satisfactory.

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Power Coefficients and Graphite Relaxation Periods

The reduction in operating level from 275 MW to 225 MW on December 30, 1945 afforded another opportunity to determine values for the several power coefficients and the graphite relaxation period. The results are covered in detail in the "Final Report on Production Test No. 105-42-P", written January 15, 1946. They are summarized below.

Overall power coefficient, C_o	0.25 ih/MW
Metal " " C_M	-0.21 ih/MW
Graphite " " C_G	0.46 ih/MW
Graphite relaxation period	80 minutes

These values are in agreement with those obtained on December 19, 1945 and do not indicate the expected increase in the overall power coefficient over the value of 0.25 ih/MW obtained on August 25, 1945. There has been some indication that the value of this coefficient may have been as high as 0.32 ih/MW immediately after the extended shutdown of January 18 to January 21. This will be discussed later in connection with the evaluation of the temporary poison columns used during this shutdown.

The following graphite relaxation periods have been determined by means of 6 couple temperatures after shutdowns during the month.

Date	116	156	146	176
12-31-45	72 min.	67 min.	74 min.	66 min.
1-18-46	72 "	72 "	74 "	69 "

Extended Shutdown - Values of Temporary Poison Columns

As a safeguard against possible loss of water and in order to allow withdrawal of four safety rods at a time during the boroscoping operations ten temporary poison columns were added to the pile. Five of these were discharged before power operation was resumed. The tubes used for this temporary poison were as follows: 3870, 3878, 3562*, 3585*, 2489*, 1987, 1262*, 1285*, 0970 and 0978. Tubes marked with * were discharged before the pile was taken up to operating level.

The average effectiveness of these temporary columns was evaluated by comparing the excess reactivity being held in the rods at various points with the amount to be expected when allowances are made for xenon decay, power coefficients, and all other known effects except the temporary poison columns. These values were found to vary with the number of horizontal rods in the pile at the time of the measurement. This variation is to be expected because of the location of the columns outside of the horizontal rod pattern. The values ranged from 24 inhours per column with two horizontal rods in to 36 inhours per column with eight horizontal rods in.

It was also noted that average values determined from measurements on a cold pile were not in agreement with measurements on a pile at power. Since the only difference in these two types of determinations is the allowance for the overall power coefficient it was concluded that the value taken for this coefficient must be in error. By assuming an overall power coefficient of 0.32 ih/MW values obtained by the two methods can be brought into good agreement. Most recent measurements of this coefficient place it at 0.22 ih/MW to 0.25 ih/MW with a possible but unexplained trend downward. In view of the observations stated above it is planned to measure the power coefficients again in the near future.

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100-F AREA - P. F. GAST

Summary

The pile was shut down three times during the month and metal was discharged at each shutdown. On January 1 the level was dropped from 250 MW to 225 MW. The shutdown on January 20 extended over a three day period during which time 27 VSR thimbles and 8 HSR thimbles were borescoped. A production test, No. 105-45-P, was prepared and approved during the month and experimental work has been completed. The unit has shown a net gain at operating levels of 22 ih during the month and a permanent cold gain of 30 ih.

Details

Temporary Poison for Extended Shutdown

The temporary poison added during the extended shutdown had to satisfy two requirements:

- (1) With the pile in operating condition it must supplement the horizontal rod system to such an extent that the pile could be brought to operating level and controlled there when it contained no xenon.
- (2) With the pile shut down and cold the vertical and horizontal systems must be supplemented so as to leave an adequate margin of safety even when four rods were inoperative because of the borescoping operation.

To satisfy the first requirement, five temporary columns would suffice. This was based upon experience at 100-B and the following reasoning.

Reactivity in rods at shutdown	95 ih
Gained by xenon decay	481
Pu gains during shutdown	8
Lost in metal discharge	-6
Increased strength of permanent P	-55
Net to be compensated when pile is warm following startup but xenon has not yet begun to increase	523 ih
Strength of 7 horizontal rods	320
Required in temporary P-columns	203

Since, when 7 rods were in the pile, the P-columns were found at 100-B to be worth 40 ih each it appears that five columns would satisfy this requirement.

To satisfy the second requirement, however, required 10 columns. The reasoning behind this conclusion is based on conservative estimates of rod strengths as presented by J. A. Wheeler (Report for Period Ending June 28, 1945, Wheeler to Jordan, July 14, 1945, #7-2002). Since with the added P-columns the total strength in the pile will be around 500 ih, Wheeler's figures for the case of 600 ih in P-columns were used. For this case he gives for the total strength of verticals and horizontals 1,825 ih. The following table then illustrates the situation should water be lost from the pile during the borescoping operation which constitutes the worst conceivable situation.

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No.

Total rod strength	1828 ih
Ten added P-columns	220
Total restraining action	<u>2048 ih</u>
Net gains in warm pile as listed above	523 ih
Loss because pile is cold during period when rods are tied out	-74
Gains from loss of water	1040
Tying out of 4 rods	360
Total Gains	<u>1846</u>

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Net safety margin (total restraining action minus total gains) 196 ih

This is equivalent to roughly two vertical rods.

Measured Strength of Temporary Columns

By a computation similar to that described by W. R. Kanne in last month's report and also in "Temporary Poison Addition during Extended Shutdown", January 10, 1946, it was possible to obtain values for the strengths of the temporary P-columns. The following values were obtained:

<u>Conditions of Measurement</u>	<u>No. of Shims in Pile</u>	<u>ih per Column</u>
All 10 columns in, from critical measurements at startup	3	26
Columns: 3466, 3586, 2788, 1586, 1165, from critical measurements at startup	5	36
Same five columns as above, from reactivity change when pushed	3	25

These values are in good agreement with those found at 100-B.

Change in Permanent P-Columns

Since the excess reactivity held in the rods reached 95 ih just before the shutdown of January 20, the strength of the permanent P-columns was increased at that time. The changes made in the loads are summarized below.

<u>Tube No.</u>	<u>New Load</u>	<u>New Strength</u>	<u>Old Strength</u>	<u>Increase</u>
2066	4L-1P	23	16	7
2082	3L-1P-2L-1P	30	20	10
1569	3L-2P-2L-2P	41	30	11
1579	1L-3P	59	38	21
3169	2L-3P	51	46	5
3179	All P	68	51	17

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The strength of the new pattern, using the standard shadowing correction is 284 lh. This increases the net strength of the pattern by 55 lh. The actual results obtained are compared with expectations in the following table:

lh in rods at shutdown	95 lh
Increase in permanent P	-45
Decreased xenon effectiveness in more flattened pile	10
Pu gains remaining three days after startup	3
Loss from metal discharge	-4
Normal gains during 3 days after startup	3
Expected in rods	50 lh
Observed in rods	55 lh

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This is reasonably good agreement for a prediction of this type.

It is too early to tell how the more flexible arrangement of P-column moments will work out as gains or losses in reactivity appear. Up to the time of closing of this report very satisfactory temperature maps had been obtained, however. A memorandum giving in more detail the basis for the change and the results is being prepared.

Reactivity Coefficients

Up to January 1, measurements of the reactivity coefficients at 100-F had shown a constant value for the metal coefficient and an increasing value for the graphite coefficient and consequently for the overall coefficient. Graphite periods also were increasing. On January 1 the power level was dropped by 25 MW and advantage was taken of this change to obtain values for the coefficients and to check the calibration of A rod. The rod calibration was in complete agreement with the calibration which has been in use since June 1945. The value of the metal coefficient was 0.20 lh/MW in agreement with the previously established value of 0.21 lh/MW. However, the graphite coefficient was found to be 0.40 lh/MW, a surprising drop from its previous value of 0.52 lh/MW found on October 9 and confirmed on December 14. Since the graphite period was found to have experienced the expected increase since October 9 and since actual graphite temperatures and thermal periods as indicated by thermocouple measurements had shown no decreases it appeared doubtful that any curing had taken place in the graphite. However, because of the importance of so great a curing as was suggested by these results a production test, No. 105-43-P, was prepared and approved to make another determination of the coefficients. This work was carried out by dropping the power level by approximately 30 MW on January 17, holding the low level for four hours and then returning to normal operating level. The results of this test were:

Metal coefficient	- 0.23 lh/MW
Graphite coefficient	0.56 lh/MW
Overall coefficient	0.33 lh/MW
Graphite Period	51 minutes

The low value of the graphite coefficient obtained on January 1 thus appears to be an anomaly at present unexplained. A final report on the above mentioned production test is now in preparation.

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DECLASSIFIEDReactivity Changes

The following table compares the reactivity situation at the beginning and end of the report period.

	<u>Beginning</u>	<u>End</u>
In rods	801h	88 ih
Xenon	810	471
Positrons	222	284
1 Pb column	8	5
Total operating	794	818

Net gains at operating level during the month were thus 22 ih. Since 8 ih were lost from reduction of level (overall coefficient 0.33 ih/MW), the net cold gains during the month were 30 ih.

Other Activities

Data gathered by the F-department and the Instrument Department have been collected and correlated as part of a program for improving the methods of measuring the power level of the unit.

A draft of a history of "Pile Reactivity, Experience and Control" is nearing completion.

W. N. Jordan
W. N. JORDAN, CHIEF SUPERVISOR
100-800 TECHNICAL

/hp

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 #3 - P. F. Gast
 #4 - U. M. Staebler
 #5 - W. E. Rame
 #6 - C. P. Kilder
 #7 - Pink
 #8 - Yellow

March 7, 1946

TO: FILE

FROM: W. E. JORDAN

100 AREA TECHNICAL ACTIVITIESREPORT - PHYSICS - FOR PERIOD1/23/46 TO 2/23/46100-B Area - W. E. RameEffectiveness of Temporary Poison Columns

During the latter part of January temporary poison columns were used for control in connection with extended shutdowns at the B and F piles. The procedures used were similar to that used at the B pile in January and the results obtained were similar. The results obtained in the three areas are being evaluated on the basis of shim rod calibrations recently prepared by U. M. Staebler which have been supplied to us. These calibrations are based upon information from all three areas and apply to all three areas. A report on the observations of December and January is in preparation.

A computation, essentially similar to that used in determining the effectiveness of the permanent poison, has been made to determine the effectiveness of poison at a radius of 16 L.V. in the flattened pile. For computational purposes it was assumed that poison was located in 36 weak columns at this radius and it was found that 68 nominal inhours should cause an actual reduction of 34 ih. The pile was assumed to have 300 ih of permanent poison and no control rods in the pile.

Poisoning the Pile with Materials Not Black to Thermal Neutrons

The nominal inhour poisoning value for materials of various properties loaded into a 105 pile in the same form but in place of uranium slugs has been expressed in the form of a nomograph. The effectiveness may be determined according to the procedure for permanent poison columns.

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From: W. H. Jordan

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According to this nomograph a hydraulic column is found to have a nominal strength of 31 ih.

A memorandum describing these calculations is in preparation.

Document Issued

Memos to Jordan, 2-6-46, "Rod Calibrations of the B File."

The several reactivity transients (due to xenon poison, metal temperature, graphite temperature, neptunium decay and long term gains) were calculated for the pile start up on January 21. Calibrations of 54 horizontal rods were obtained by comparing the rod motions with the calculated reactivity changes. A graph showing this comparison is attached to the memorandum, along with the resulting calibration curves.

These curves were used by U. M. Staebler in determining calibration curves applicable to all three areas. The latter will be used in the B Area.

Memo to Jordan, 2-5-46, "Long Term Reactivity Gains of the 105 Piles - 335 MSD/ten Discharge of December 11 to 29, 1945 at the B File".

The large discharge of December 1945 consisted of 31.2 tons of metal having an average concentration of 335 MSD per ton. The reactivity change over this shut-down was due to: 1) the difference in reactivity of irradiated and virgin metal, 2) the decrease in total number of slugs in the pile since some 35 slug columns were replaced by 32 slug columns, 3) the insertion of slugs of slightly larger size than some of those discharged since some of the latter were recanned, and 4) lead slugs were used in the loading of one tube. The reactivity change attributable to 1) was 35.4 ih. This was caused by the discharge of 21% of the effective pile, and the effect for a complete pile of similar concentration would have been 168 ih.

The estimated pile reactivity at xenon equilibrium at the time of start up was obtained by extrapolating an observed rate of gain of reactivity and allowing for plutonium growth.

The result is in good agreement with the Marshall-Staebler metal gain curve.

General

The pile operation during this period has provided no unusual information from the point of view of physics.

Reactivity of the B File

	<u>1-25-46</u>	<u>2-25-46</u>
Xenon	464 ih	464 ih
Permanent Poison	321 ih	321 ih
Bismuth and Lead	21 ih	21 ih
Rods	29 ih	45 ih
Reactivity (Net)	835 ih	851 ih
	-65 ih	-65 ih
	<u>770 ih</u>	<u>786 ih</u>

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100-B Area - U. E. Staebler

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Summary

The B File was shut down on January 29 and again on February 12 for the purpose of discharging irradiated metal. Reactivity effects observed in connection with these discharges have been analyzed and added to the available data on reactivity gains in the metal as a function of exposure. Correction has been made for the fact that the poison Samarium is not formed directly in fission but is formed from Iridium which decays with a 47 hour half life. The effect of this transient has also been introduced into the analyses of all previous discharges from the B File used in establishing the metal gains curve.

A prediction test was performed for the purpose of determining the power coefficients of the pile. Results do not uphold previous indications of a downward trend in the overall power coefficient.

The net gain in the cold, clean reactivity of the pile for the month is three inches.

Reactivity Gains in Metal

A method for calculating metal gains from a discharge is described in Document #7-3083, "Long Term Reactivity Gains of the 105 Piles", from Marshall and Staebler to Jordan. The method described in the above document allows a correction for the transient effects in the reactivity due to the formation of Plutonium from Neptunium, but it does not recognize that the poison Samarium is not formed directly nor from a short lived parent. Since it is now rather well established that Iridium is formed as the result of fission and decays into Samarium with a 47 hour half life, an additional transient effect must be introduced into all analyses involving shutdowns or changes in power level. The revised estimates of the reactivity gains associated with various discharges from the B File are given below, along with the exposure of the metal discharged.

<u>Date</u>	<u>Gains</u> <u>in</u>	<u>Exp.</u> <u>MWD/ten</u>
7-13-45	173	247
7-26-45	109	240
8-9-45	201	244
8-16-45	211	229
8-30-45	100	210
9-6-45	79	206
9-20-45	110	197
10-9-45	144	302
10-18-45	117	199
10-25-45	178	303
11-6-45	49	202
11-13-45	182	302
11-20-45	90	202
12-6-45	122-	205

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<u>Date</u>	<u>Gains 1h</u>	<u>Exp. MBB/ton</u>
12-13-45	122	201
1-29-46	103	193
2-12-46	70	201

There is still a great deal of scattering in the distribution of the points and practically no improvement in the agreement between this method of evaluating the metal gains and results obtained by L. Marshall through analysis of the first 25,000 MBB of operation at 105 F. No suggested revision of the curve given in Document #7-3083 will be recommended until points for discharges from the other areas have been corrected for the Illinium - Samarium transient.

Power Coefficients and Graphite Relaxation Period

The power level of the B Pile was lowered from 225 MW to 200 MW on February 21. The lower level was held for four hours then the pile was returned to its normal operating level. These level changes were performed in accordance with Production Test #105-47-P for the determination of the reactivity coefficients of the pile. Results of the test are as follows.

Overall power coefficient, C_o = 0.28 1h/MW
Graphite " " , C_G = 0.50 1h/MW
Metal " " , C_M = -0.22 1h/MW
Graphite relaxation period 60 minutes

These results do not show a continuation of the slight downward trend in the overall power coefficient indicated in the determinations of December 19 and December 30, but they are in better agreement with trends expected on the basis of measurements prior to those in December.

Local graphite relaxation periods as measured by G couple temperatures after a shutdown have continued to increase. The following determinations were made during the month.

<u>Date</u>	<u>11G</u>	<u>13G</u>	<u>14G</u>	<u>17G</u>
1-29-46	79 minutes	72 minutes	79 minutes	70 minutes
2-12-46	79 "	72 "	79 "	70 "

The above values represent increases of 7 minutes for 11G and 5 minutes for 14G over values determined last month.

The normal rate of increase has been about 2 1/2 minutes per month.

Effect of Rod Movement on Temperature Distribution

In preparation for the performance of the power coefficient test a change was made in the rod configuration used for controlling the pile. The shift in the temperature distribution resulting from this change in rod configuration has been

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compared with the shift to be expected on the basis of Document #7-2654, "Procedure for Improving Temperature Distribution via Reils and Columns", from A. Wheeler and R. L. Monagan to W. E. Jordan. The comparison was made by means of temperature maps from February 19 and February 24, representing the following shift in reil positions.

<u>Date</u>	<u>A Reil</u>	<u>B Reil</u>
2-19-46	In (7")	241"
2-24-46	33.3"	160"

comparison of the observed and predicted temperature shifts in the horizontal and vertical dipole is given below.

<u>Date</u>	<u>Horiz. dipole</u>	<u>Vertical dipole</u>
2-19-46	-3.0 %	1.1 %
2-24-46	4.2	-0.2
Observed change	7.5 %	-1.3 %
Predicted change	9.9	2.5 %

better check is obtained if the effectiveness of B reil is taken as 0.6 of A reil rather than the 0.7 given in Document #7-2654. With this change the predicted shifts become 9.0 % and -1.9 %, both within the experimental error of the comparison, since the relative strength of B reil is about 0.6 of A reil and correction seems in order.

Reactivity Status

comparison of the reactivity of the pile at the beginning of this report period with that at the end is given in the following table.

	<u>1-23-46</u>	<u>2-23-46</u>
Amount held in reils	58 inhours	68 inhours
Amount held in xenon	467 "	467 "
Amount held in permanent poison	304 "	304 "
Amount held in B columns	16 "	16 "
Amount held in power coeff.	-56 "	-63 "
Total Cold, Clean	789 "	792 "

Note that the new overall power coefficient of 0.28 ih/MW was used in arriving at the figure for February 23. This represents a change of 0.03 ih/MW from the value used for January 23 and is responsible for reducing the observed gain of 3 inhours at power to one of 3 inhours when the pile is considered as cold and reactivity poison.

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From: W. E. Jordan

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Red Calibrations

Red calibrations submitted by all three areas have been compared and found to be in good agreement up to the point of having four rods in (A, 9, 2 and 7) which is as far as it was possible to make comparisons. The maximum deviation at any point over this range was less than ten inhours. The best estimate of the total value of all nine horizontal rods seems to be about 410 inhours.

Documents Issued

Staebler to Jordan "File Poisson - Poisson Column Change at 105 D on January 18, 1946", January 29, 1946. Document #7-3387.

Staebler to File "Production Test #105-47-P, Determination of Reactivity Coefficients of B File", January 29, 1946. Document #7-3401.

100-F Area - P. F. Gast

Summary

The pile was shutdown twice during the month for the discharge of metal. The level was maintained at 225 MW throughout the month and no changes were made in the P-column strengths. Drafts of five documents were completed during the month and are currently in various stages of the issuing procedure. The unit has shown a net gain during the month of 14 ih.

Samarium Poisson

The discovery that the fission product, Sm^{149} , has a parent of 47 hour half-life requires that the reactivity losses observed when metal is pushed be corrected for transient changes originating in the "trailing" of Sm^{149} .

The change in Sm induced by a shutdown is given by an equation of the form.

$$\text{Change in } \text{Sm} = 10.5 (1-f) DG \pm fX$$

in which f is the effective fraction of the metal discharged; D is a quantity depending upon the length of shutdown; G is a quantity depending upon the time elapsed after startup; X gives the growth of Sm in the newly loaded metal and is a function of time after startup. A memorandum has been prepared giving expressions for D , G and X and curves from which numerical values may be read. This memorandum, "Change in Samarium Poisson at Shutdowns", P. F. Gast to W. E. Jordan, 2-14-46; was not issued formally but is in the last stages of final typing and will be out shortly.

Reactivity Coefficients

A production test has been prepared providing for the measurement of the reactivity coefficients at all three areas at approximately two month intervals. This will be accomplished by a reduction of 25 MW in the level which will be held for four hours. If it is desirable to obtain a red calibration at any

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test, the low level will be held for ten hours. This production test will cover a six month period beginning March 1. The test is entitled "Periodic Determination of Reactivity Coefficients and Rod Calibrations of the Piles".

A final report has been prepared on Production Test 103-43-P, "Redetermination of Reactivity Coefficients of F Pile". The results of this test were given last month. The final report will issue shortly.

Other Documents

A memorandum has been prepared describing the change made in the strength of the permanent P-columns at the shutdown of 1-20 to 1-23-46. These changes were described in last month's report. The memorandum will issue shortly.

Work has been completed on a history of "Pile Reactivity, Experience and Control to August 1, 1945" and the draft has been sent to interested persons for their comments.

Reactivity Changes

The following table compares the reactivity situation at the beginning and end of the report period.

	<u>Beginning 1-23-46</u>	<u>End 2-23-46</u>
In rods	56 1h	70 1h
Xenon	471	471
P-columns	284	284
1 P column	<u>2</u>	<u>2</u>
Total operating	816 1h	830 1h
Overall effect at 223 MW	<u>-74</u>	<u>-74</u>
Net cold reactivity	742 1h	756 1h

The net gains during the month were thus 14 1h. The two pushes which occurred during the month, one on February 7, the other on February 21 contained metal of normal exposure, and because of the wealth of data in existence on gains in metal irradiated to this amount, little interest attaches to an exact computation of the losses at the pushes. The net loss observed 72 hours after startup was approximately 2 1h in each case and this was in line with expectations. Gross gains during the month are thus 18 1h. The decrease in gain as compared to the 30 1h gained last month is to be expected as the accumulated results of pushes of high neutron effectiveness since January 3, 1946.

WEJ:MM

W. E. Jordan
W. E. JORDAN, CHIEF SUPERVISOR
100 - 300 TECHNICAL

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#1 W.E. Jordan - 700 Area
 #2 W.C. Kay - 300 Area
 #3 P.F. Gant
 #4 U.M. Stasbler
 #5 W.R. Kanne
 #6 C.W.J. Wende
 #7 C.P. Kidder
 #8 Pink Copy
 #9 Yellow Copy

MARCH 23, 1946

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TO: FILE

FROM: W. E. JORDAN

100 AREA TECHNICAL ACTIVITIES REPORT - PHYSICS
FOR PERIOD FEBRUARY 23, 1946 TO MARCH 23, '46

100 B - W.R. Kanne

The B pile was shut down for an indefinite period of time at 4:00 A.M. on March 19, 1946. An extensive test for the purpose of determining xenon and samarium transient poison constants was begun at 1:30 P.M. on March 14, 1946 and concluded at the time of the shut down. The power level of the B pile was reduced to 0.5 MW at 8:30 A.M. on March 15, 1946, and production essentially ceased at this time.

Production Test No. 105-54-P"Determination of Transient Poison Constants"

The occasion of the B pile shutdown was used to follow the decay of the xenon poison and an attempt will be made to determine the several constants entering into the xenon poison equation more accurately than has been possible heretofore. These constants include the branching ratio, cross section, and direct formation fraction for Xe^{135} , and also the pile flattening correction. The pile reactivity was observed for a sufficient length of time for an attempt to determine the build-up of samarium poison due to the decay of the illinium parent.

If the pile had been shut down from its operating level of 225 MW, the loss of reactivity through the overall power coefficient and the increase of xenon poison would have been greater than the excess reactivity. In order to permit the pile to remain in the critical condition throughout the test, a preliminary power reduction to 150 MW was made 19 hours before the reduction to the low power level of 0.5 MW. After 36 hours of operation at the low power level, full poison columns were charged into tubes 3884 and 1387. This permitted control by means of the shim rods throughout the remainder of the test.

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Critical rod positions were observed throughout the test, except when pile periods were measured to provide rod calibrations. Such period measurements were made throughout the inward travel of the rods. Most of these tests were begun at definite rod configurations, chosen so that there would be an interval of at least one hour between any two such configurations. Rod withdrawals from these configurations were specified so that periods of approximately one minute would be measured. The pile was shut down for 10 minutes before each period measurement, and the power level was measured by both galvanometers and the proportional counter up to about 3 MW.

During the last 33 hours of the test a period measurement was made once each 4 hours. These runs were made with the shim rods always in the same configuration in order that the change in reactivity in each 4 hour interval could be measured. It is hoped that these data will permit a measurement of the growth of samarium poison. Altogether, a total of 31 period measurements were made.

In addition to the information on xenon and samarium poisons, useful results on rod calibrations and reactivity coefficients should be obtained from this test. Up to the close of this report period, the results have been analyzed only partially. A preliminary value of 67 ih for the effectiveness of rod A has been obtained. This is about 10 ih higher than the previously accepted calibration, which was obtained through the xenon equation. Another fact of interest is that the poison peak after the power reduction from 150 MW to 0.5 MW was about 20 ih greater than expected. It may be that the explanation of this discrepancy lies in the fact that C_0 has been underestimated due to the low A rod effectivenesses used in the coefficient determination, or there may be an increase in the effectivenesses of the xenon poison due to a $1/v$ low variation of the cross section. This preliminary analysis indicates that the present xenon equation underestimated the poison by 30 ih.

Further analyses of these data will be based upon a direct calibration of the thermocouple power measuring system made by the Instrument Department.

Documents Issued

"Pile Control - Temporary Poison Addition during Extended Shutdown", W.R.Kenne and H.L.Menegus to W.R.Jordan, March 4, 1946.

The effectivenesses of temporary poison columns used in the three 100 Areas during December 1945 and January 1946 is summarized and a chart showing the variation of effectivenesses with the number of horizontal rods in is attached. An approximate theoretical calculation of the effectiveness of a poison column at 16 lattice units radius is given in an appendix.

"Pile Poison - Procedure for Calculating Effect of Various Materials on Pile Reactivity", Menegus to Jordan, March 19, 1946.

The poisoning power of materials which are not completely black to thermal neutrons has been calculated for the 105 piles. It is assumed that this material is in the form of slugs of the same diameter as uranium slugs and that it is charged in full columns. The poisoning power depends primarily upon the thermal neutron absorption cross section. This memorandum contains a nomograph from which the poisoning power of various materials can be obtained. A myrma alloy column is found to have a strength of 47 ih. The value of 31 ih for such a column, given in the previous Technical Activities Report, was found to be in error.

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Reactivity of the B Pile

The data given below apply to the end of the operation at 225 MW, on March 14, 1946. Since the analysis of the production test discussed at the beginning of this report is incomplete, calibrations and coefficients accepted before the shutdown have been used.

	<u>2-25-46</u>	<u>2-25-46</u>
Xenon	464 ih	464 ih
Permanent poison	321 ih	321 ih
Bismuth and lead	21 ih	21 ih
Rods	<u>45 ih</u>	<u>45 ih</u>
Reactivity (Hot)	851 ih	851 ih
C ₀ W	<u>- 65 ih</u>	<u>- 65 ih</u>
Reactivity (Cold)	786 ih	786 ih

After the pile shutdown, eight additional full poison columns were added, bringing the total "temporary" poison columns to ten. Their effectiveness with all rods out is estimated to be 250 ih. Also, 271 uranium tubes were discharged and filled with solid aluminum dummies, resulting in an additional reactivity loss of approximately 900 ih.

The expected reactivity of the B pile under its present conditions may be estimated, rather uncertainly by the following summation.

Xenon poison decay	464 ih
Rods	45 ih
C ₀ W	- 65 ih
Added P tubes	-250 ih
Dummy tubes	<u>-900 ih</u>
Reactivity	-706 ih

MO D - U.M. StaeblerSummary

The D Pile had two scheduled shutdowns and two accidental scrams during the month. The shutdowns occurred on February 26 and March 12. The scrams took place on March 11, and March 18. The normal operating level of the pile was raised from 225 MW to 250 MW on March 16.

The reactivity power coefficients and graphite relaxation time were determined from data obtained as the result of the level change. Although the results of this determination are slightly lower than recent previous ones, no change in trend is indicated.

Further consideration has been given to the problem of the effect of irradiation on the reactivity of metal. More careful study of reactivity data before and after discharges indicates the possible existence of transient effects other than those now corrected for. Corrections have been applied for deviations in reactivity to be expected from the neptunium-plutonium and illinium - samarium relationships.

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Analyses of local graphite temperature trends during the past eight months have revealed that the thermal conductivity of the pile graphite is still decreasing. The rate of change in temperature rise over local water temperature appears to be linear for the period studied but differs in various locations in the pile. Central thermocouples not only record the highest temperature rise per MW but also show the greatest rate of increase in this temperature rise.

The net gain in cold, clean reactivity of the pile for the month is 11 inches.

Power Coefficients and Graphite Relaxation Period

Reactivity variations following the change in power level of pile operation on March 16 resulted in the following values for significant pile properties.

Overall power coefficient, $C_0 = 0.25$ inches/MW
Graphite power coefficient, $C_G = 0.45$ inches/MW
Metal power coefficient, $C_M = -0.20$ inches/MW
Graphite relaxation period = 54 minutes

The following local graphite relaxation periods were measured by means of G thermocouple temperatures after shutdowns during the month.

<u>Date</u>	<u>11G</u>	<u>12G</u>	<u>14G</u>	<u>17G</u>
February 26	80 minutes	75 minutes	77 minutes	75 minutes
March 12	77 minutes	77 minutes	—	—

None of the values reported above are out of line with previously reported trends in the various properties.

Rod Calibrations

An additional result determined from reactivity data following the change in pile operating level was a check on the calibration of B rod with A rod all in. B rod was calibrated from 90 inches out to 300 inches out. The calibration curve was found to be linear in the region from 90 inches out to 220 inches out with a slope of 0.136 inches per inch. This observation is in good agreement with the previously used B rod calibration based on a relative effectiveness of 0.6 of A rod.

Efforts to obtain further information on the values of rods in the standard rod withdrawal order beyond four rods in have not been very encouraging. Results of calibrations in this region by means of comparison with xenon poison calculations are not consistent. It is hoped that this problem will be solved by data obtained during the shutdown of the B pile.

Reactivity Gains in Metal

Last month it was reported that the observed reactivity of the D pile had been corrected for a transient introduced by recognition that the poison samarium is formed from illinium with a half life of 47 hours. The observed

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reactivity had previously been corrected for the transient introduced by the formation of plutonium from neptunium. If these are the only two transients affecting pile reactivity as the result of shutdowns, discharges, and level changes, it is to be expected that the corrected reactivity should result in a straight line during equilibrium operation. In the past, reactivity gains associated with various discharges have been estimated by drawing what seemed to be the best straight line through available points. More careful study of reactivity history of the D pile over the past nine months reveals that in most cases the corrected reactivity deviates considerably from a straight line in the early stages of equilibrium operation. That is to say, although the xenon concentration and graphite temperatures should be at equilibrium four days after resumption of operation, corrected reactivity points during the last part of the first week of operation do not fall on the same straight line required by points representing the second week of operation. This effect could possibly be explained by redistribution of xenon poison in local regions since the first couple of days of operation with several rods in would cause the original poison formation to be concentrated in regions other than those in which it will be concentrated during equilibrium operation with considerably fewer rods in the pile. Further work on this problem is being discontinued until data obtained during the shutdown of the B pile are analyzed for possible additional poisons or corrections in the xenon equations.

Graphite Temperatures

Graphite temperatures as measured by the G thermocouples have been studied for trends in graphite temperature rise during the past eight months. An estimate of local water temperature in the vicinity of each couple was made by assuming a cosine distribution of heat generation along the axis of a tube. This does not allow for changes in temperature distribution brought about by changes in rod configuration or poison pattern arrangement but these corrections should be small in comparison to the trends observed.

The results of the study are summarized in the following table:

<u>Couple</u>	<u>Present Temp.</u>	<u>G Temp. - Water Temp. MW</u>	<u>$\Delta T/MW/1000 MW$</u>
10 G	102	0.392	0.0021
11 G	108	0.420	0.0021
12 G	154	0.540	0.0032
14 G	159	0.563	0.0033
16 G	115	0.340	0.0020
17 G	116	0.348	0.0021

Values for present conditions are based on observations for March 25. The right hand column of the above table gives the average rate of change in local temperature rise with pile operation. The units are degrees Centigrade per MW per 1000 MW. There is some indication of variation in this slope following changes in operating level but the data are not sufficiently consistent to draw any definite conclusions.

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Locations of the six thermocouples studied are given below to aid in understanding the above results.

<u>Couple</u>	<u>Distance above bottom</u>	<u>Distance from far side</u>	<u>Distance from rear face</u>
10 C	19' - 5-11/16"	9' - 0"	21' - 1-27/32"
11 C	19' - 5-11/16"	17' - 11-21/32"	21' - 1-27/32"
13 C	19' - 5-11/16"	9' - 0"	13' - 1-17/32"
14 C	19' - 5-11/16"	17' - 11-21/32"	13' - 1-17/32"
16 C	19' - 5-11/16"	9' - 0"	6' - 10-6/32"
17 C	19' - 5-11/16"	17' - 11-21/32"	6' - 10-6/32"
Overall	35' - 11-5/16"	35' - 11-5/16"	28' - 0"

It seems significant in the interpretation of the results of this analysis that regions already showing the greatest temperature rise over local water temperatures also have been rising at the fastest rate and indicate no signs of a decrease in this rate.

Reactivity Status

A comparison of the reactivity of the pile at the beginning of this report period with that at the end is given in the following table.

	<u>2-25-46</u>	<u>3-25-46</u>
Amount held in rods	68 inhours	57 inhours
Amount held in xenon	467 inhours	436 inhours
Amount held in permanent poison	304 inhours	304 inhours
Amount held in B column	16 inhours	16 inhours
Amount held in power coef.	-63 inhours	-70 inhours
Total cold, clean	<u>792 inhours</u>	<u>803 inhours</u>

In allowing for the power coefficient in the above table, the value of 0.23 inhours/LW was used for both times. This is within experimental error of the more recently determined value of 0.25 inhours/LW.

The average rate of gain in reactivity during periods of equilibrium operation has continued at about one inhour per day.

Documents Issued

Montgomery and Staebler to Jordan, "Final Report on reduction test No. 105-47-P, Determination of Reactivity Coefficients of D Pile", February 26, 1946, Document #7-3587.

100 F - P.F.Gast

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Summary

The pile was shut down twice during the month for the discharge of metal and suffered one scram due to electrical power failure. The operating level was reduced from 225 MW to 200 MW on March 15. The discharges occurred on March 5 and March 21.

The samarium poison trailing equations have been extended to cover the deviation from a linear growth curve produced by a shutdown. The equations reported last month gave the deviation from saturation produced by the same effect.

The reactivity coefficients were measured on March 15 and show no significant changes from previous values.

An operating rule has been formed covering the amount of rod withdrawal to be made when recovering from a scram which occurs when the rods are holding a large reactivity excess.

The strength of the P-column was increased on March 21. The unit experienced not less of cold reactivity of 3 ih during the month.

Four documents were formally issued.

DetailsFurther development of Samarium Trailing Equations

In last month's report, the deviation of the samarium poison from its saturation value was discussed. The deviations arise at shutdowns and are produced by the decay of I^{149} with a 47 hour half-life. The equation given there was developed in the memorandum: "Change in Samarium Poison at Shutdowns", P.F.Gast to W.E.Jordan February 14, 1948. It has the following form.

$$\text{Change in } S_m = 10.5 (1-f) DG + \Pi$$

in which f = effective fraction of metal discharged

$$D = 1 - \exp. (-gt)$$

$$g = \text{decay constant of } \text{I}^{149}$$

$$T = \text{duration of shutdown}$$

$$G = \frac{k}{\Gamma - bW} \exp(-gt) - \frac{bW}{\Gamma - bW} \exp(-bWt)$$

$$b = \text{burnout constant of } S_m^{149}$$

$$W = \text{power level}$$

$$t = \text{time after startup}$$

$$\Pi = 220 \left(1 + \frac{bW}{\Gamma - bW} \exp(-gt) - \frac{k}{\Gamma - bW} \exp(-bWt) \right)$$

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In using the equations to correct observed reactivity changes in order to obtain the gains in the metal which has been discharged, it is desirable to know the deviation from a "linear" gain curve rather than from a saturation value. The undischarged portion of the pile makes a deviation from such a curve given approximately by the same expression as its deviation from saturation, namely: $10.5 \text{ ih } (1-f) DG$

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The growth curve of Δn in the freshly charged metal can be separated into two portions, one of which is nearly linear and the other of which approaches this linear curve. The deviation from the linear curve is given by:

$$10.8f \text{ amp } (-gt)$$

This expression represents the amount of trailing, that is there is less Δn than there would be if it were formed directly, and is combined with the expression for the rest of the pile to give:

$$\text{Deviation of } \Delta n \text{ from "linear" } = 10.8 \text{ ih } [(1-f) 10 - f \text{ amp } (-gt)]$$

The numerical value 10.8 ih holds only when the unit is operated at 225 MW; for other levels it varies proportionally.

A memorandum showing the development of the above expression is in preparation.

Reactivity Coefficients

On March 18, the power was dropped from 225 MW to 200 MW and the reactivity changes following the drop were analyzed to obtain values for the coefficients. Unfortunately for the analysis, it was necessary to carry out the change in level with 3 rods in the pile as well as portions of #9 rod and A rod. The control rod throughout the period of interest was A rod, but its calibration under these conditions is not well known. Tentative results, which may be revised when the rod calibration is known more accurately, are as follows:

Metals coefficient - 0.21 ih/LW
Graphite coefficient 0.55
Overall coefficient 0.38
Graphite period 55 minutes

These values are in close agreement with those measured on January 17 and indicate no significant change from the currently accepted values.

A production test, No. 105-50-P, has been approved providing for the measurement of reactivity coefficients at all three areas at approximately two month intervals.

Recovery from Seram - Operating Rule

In the early history of the units, they normally operated with excess reactivity held in the rods barely sufficient to insure recovery from serams. The procedure then developed was a complete withdrawal of all rods as soon as possible after the occurrence of a seram. However, under present conditions, a pile may be operating with as much as 100 ih excess at the time of seram and when the seram is of short duration a complete withdrawal of the rods is undesirable. As a result of experience at the seram which occurred on March 11, the following working rule has been adopted at 100 P. Sufficient rods are withdrawn to give the pile a net excess of 70 ih at the time when recovery from a seram is begun. Stated in another way:

Excess in rods prior to seram + change during seram - amount in rods when recovery starts = 70 ih.

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The change of reactivity during scram can be quickly read from a prepared curve and the rod settings to begin recovery rapidly determined.

A memorandum discussing this rule more fully is in preparation.

P-Column Change on March 21

Following the reduction in level on March 18, the reactivity held in the rods increased to 103 ih. At the shutdown of March 21, this excess was reduced by the addition of four columns of B material and two more P-columns. These additional columns rounded out the full 11 column pattern planned when the 9 column pattern was loaded into the pile on July 20, 1945. The addition of the two extra columns was in order at this time since one of the 9 columns had already reached full strength and several others were approaching full strength. The existence of such columns limits the flexibility of a 9-column pattern in adjusting the temperature distribution. Furthermore, the heavy metal columns discharged to make way for the two P-columns had received sufficient exposure so that they could be discharged economically.

The strength of the new columns was as follows:

<u>Tube No.</u>	<u>Load</u>	<u>Nominal Strength</u>
1474	SL-LP	20 ih
3274	LOL-LP	14 ih
Previous 2 tubes	--	<u>384 ih</u>
Total Nominal Strength		418 ih
Net strength = $418 \times 0.776(1 - 418/5208) = 308$ ih		

The reactivity balance for the change is tabulated below:

In rods before shutdown	103 ih
P-column increase	-24
B-columns	-16
Decreased xenon effectiveness	+ 5
Losses from metal discharge	- 5
Net long term gains in interval	<u>+ 4</u>
Expected in rods	67 ih
Observed in rods	56 ih

This discrepancy of 10 ih may perhaps be due to the inaccurate rod calibration in the configuration used to control the pile before shutdown. Further investigation of this discrepancy and related observations is in progress.

Reactivity Changes

The following table compares the reactivity situation at the beginning and end of the report period:

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	<u>Beginning, 2-25-46</u>	<u>End, 3-25-46</u>
In rods	70 ih	57 ih
Xenon	471	454
P-columns		
(including 1 P column)	289	315
B columns	0	16
Total operating	850 ih	825 ih
Overall effort	-74 (225 MW)	-66 (200 MW)
Net cold reactivity	756 ih	754 ih

The month thus shows a net loss of cold reactivity of 2 ih. The two shutdowns which occurred during the month both involved discharges of large amounts of metal of more than average neutron effectiveness; together they are estimated to have produced a loss of 11 ih. Gains during the month were 4 ih in the period from 2-25 to 3-5, when the first push occurred, 0 from 3-5 to the drop in power on 3-15, and 3 ih since that time.

Current Activities

Mr. J.E. Guillet joined the Physics Group at 100-F during the past month.

A history of the activities of the Area Physics Groups from 7/1/45 to 1/1/46 is in preparation.

Also currently in progress are a re-evaluation of the activity gain data at 100 F from startup to 7-20-45. This data was used by L.W. Marshall as the basis for an analysis of long term gains in irradiated metal. Data obtained from discharges is in disagreement with the results of that analysis and the present work will seek to discover whether there were any systematic errors in the original data.

Documents Issued

The following documents, although dated in the previous month, were formally issued during the period covered by this report. The contents of these documents were discussed in last month's report.

- 1) "Change in Samarium Poison at Shutdowns"
P.F.Cast to W.E.Jordan - 2-14-46, #7-3560
- 2) "Production Test 105-50-2 - 'Periodic Determination of Reactivity Coefficients and Rod Calibrations of the Piles'"
P.F.Cast to File - 2-18-46, #73558
- 3) Final Report, Production Test 105-45-P, "Redetermination of Reactivity Coefficients of P Pile"
P.F.Cast to File - 2-20-46, #7-3589
- 4) "P-Column Change at 100-F on 1-20-46"
P.F.Cast to W.E.Jordan - 2-22-46, #7-3591

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APRIL 30, 1946

TO: FILE
 FROM: W. E. JORDAN

**100 AREA TECHNICAL ACTIVITIES
 REPORT - PHYSICS - FOR PERIOD
 3/25/45 to 4/25/45**

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100-B Area - W. R. Kanne

Production Test 105-54-P, Determination of Transient Poison Constants

The calibration of eight horizontal rods was obtained by period measurements and the requirement that they provide a smooth time variation of the reactivity observed at the B Pile shutdown. Detailed calibrations are given in the following table. Rods were inserted in the order given.

	ih													
Rod	270"	250"	230"	210"	190"	170"	150"	130"	110"	90"	70"	50"	30"	10"
A	2.5	4.5	8.3	13.0	18.0	23.7	29.7	35.6	41.4	47.0	52.5	57.6	62.6	67
9	69.7	71.6	73.8	76.4	78.6	81.1	83.6	86.4	88.2	92.0	94.9	97.8	100.8	103.6
2	107.6	111.3	115.2	119.5	124.0	128.6	133.4	138.4	143.4	148.5	153.5	158.7	164.0	169.5
7	173.8	176.6	179.8	183.6	187.8	192.3	197.1	202.1	207.3	212.8	218.3	224.1	230.0	236
6	237.1	237.9	238.8	240.2	241.8	243.6	245.8	248.1	250.6	253.3	256.1	259.0	262.0	265
4	267.0	268.1	269.4	271.0	272.9	275.2	277.9	280.9	284.0	287.3	290.9	295.0	299.8	305.5
5	307.6	308.8	310.3	312.0	314.1	316.4	319.0	321.9	325.2	328.8	333.2	338.5	344.8	353
B	354.6	355.2	356.0	357.0	358.2	359.8	361.6	363.5	365.7	368.0	370.5	373.0	375.6	378

Curves have been fitted to the reactivity data which are free of temperature transients. According to the new rod calibration the excess reactivity just before the start of the test was 53.2 ih. The excess reactivity during the operation at 150 MW can be expressed as

$$ih = 163.270 - (22.864t + 137.578)e^{-It},$$

where t is time in hours after the change to 150 MW and I is the iodine disintegration constant. One of the requirements of this equation was that a true graphite period should result from the subtraction of this curve from the observed curve for the first five hours. The resulting coefficients are

$$C_G = +0.65 \text{ ih/MW}$$

$$C_M = 0.29 \text{ ih/MW}$$

$$C_0 = +0.36 \text{ ih/MW}$$

Period = 59 minutes

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It should be remarked that most of the difference between these values and similar ones previously reported is due to the fact that the calibration of rod A by periods gives an effectiveness 1.18 times greater than that given by previous calibrations based upon the xenon equation.

A similar analysis of the 0.5 MW run shows that the temperature transient free reactivity can be expressed as

$$1h = 569.8 + 2032.7 e^{-\lambda_I t} - 2022.0 e^{-\lambda_X t} - 15.3 e^{-\lambda_N t},$$

where t is hours after the drop in power and λ_I , λ_X , and λ_N are the disintegration constants of iodine, xenon, and neptunium. This equation fits the early part of the run, but not the later. The coefficients obtained were

$$\begin{aligned} C_I &= +0.77 \text{ 1h/MW} \\ C_X &= -0.37 \text{ 1h/MW} \\ C_N &= +0.40 \text{ 1h/MW} \\ \text{Period} &= 56 \text{ minutes} \end{aligned}$$

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It was found impossible to fit the whole reactivity curve of the 0.5 MW run with a combination of exponential terms having arguments involving accepted disintegration constants. The equation given approaches 569.8 1h asymptotically, while an equation which fits the tail of the reactivity curve approaches 474 1h. This situation makes difficult the evaluation of the small samarium effect. No definite evidence for an effect due to the illinium to samarium decay has been found.

A theoretical consideration of the flattening correction in the xenon equation indicates some change from current practice.

Until a consistent set of fundamental values have been obtained, this discussion must be considered tentative.

Production Test 105-58-P - B Pile Reactivity Under Shutdown Conditions

The purposes of the experimental work under this test may be considered to be:

- 1) To find, if possible, a location in the B Pile having a sufficiently high neutron flux for satisfactory measurement,
- 2) To determine the sensitivity of the flux to changes in reactivity, and
- 3) To determine the best means of measuring the flux.

The exposure of a small indium foil in the B test hole produced a saturated activity of 620 counts per minute. Difficulties with contamination of the foil were experienced. On the basis that the pile neutron flux is sufficiently high for measurement by indium foils, the lead dummies in tube 1363 were discharged in order to empty the tube for the flux measurements.

Both a small and a standard size foil were exposed in tube 1363, with all rods out, on April 11. The small foil had a saturated activity of 1700 counts per minute, showing that the flux in the center of this tube is nearly three times greater than at the location used in the B test hole. The standard size foil had a saturated activity of 2700 counts per minute.

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The proportional counter was subsequently inserted into this tube from the rear. The counting rate was 134 per minute with all rods out. The saturated activity of a foil about two feet from the proportional counter tube was 2150 counts per minute, indicating a reduction of the flux due to the neutron absorption of the tube. Since the proportional counter gives a much lower counting rate than a foil, it is planned to remove it to avoid interference with the foils. Further tests to determine the flux sensitivity to reactivity will shortly be made.

Progress has been made on a theoretical determination of neutron flux as a function of reactivity.

100-D Area - U. M. Staebler

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Summary

The D Pile was shut down four times during this report period for the purpose of discharging exposed metal.

The permanent poison pattern was modified during two of these shutdowns. On March 26 thirty-three pieces of thorium were charged into tube 1474, replacing a regular poison column of 34 inhours nominal value. Observed effects of this change were in close agreement with the nominal value of 36 inhours predicted for the column on the basis of theoretical calculations and measurements in the 305 Pile. On April 9 three poison columns were moved to positions called for in the eleven column pattern originally proposed by J. Wheeler. Tube 3274 remains to be established as a poison column to complete the transition to the desired pattern. Results of this poison change indicated that there was no change in the effect of shadowing on the effectiveness of the pattern even though the change represented an expansion away from the center of the pile.

Numerous pile motion indicators were installed during the month to aid in following changes in the pile structure resulting from future operation. They are especially designed to measure contours of shield deflections.

The vertical clearance in the thimble for number 9 horizontal rod has diminished to such an extent that jamming of the rod was encountered during start-up operations on March 26. This rod has remained inoperative throughout the remainder of the period.

The total cold, clean reactivity of the pile shows a loss of 12 inhours for the month. This apparent loss is the result of a change in the shadowing correction applied in calculating the effectiveness of the poison pattern.

Details

The D Pile was shut down for periods of from 15 to 17 hours on the following dates: March 26, April 9, April 16, and April 23.

Thirty-three pieces of thorium (Special Request #3) were charged into the center of tube 1474 on March 26. This tube was previously charged with a poison column of 34 inhours nominal strength. An estimate of the poisoning value of the new charge was obtained by comparison of reactivity conditions of the pile under equilibrium operating conditions before and after the shutdown. This comparison is given in the following table:

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Excess reactivity in rods at shutdown	38 inhours
Loss due to 9.7% effective discharge.	- 8 inhours
Change due to P _u and S _m transients.	1 inhour
Long term gains in four days.	4 inhours
Expected reactivity in rods after four days	55 inhours
Observed reactivity	52 inhours
Change in effective poisoning	3 inhours
Change in nominal poisoning	4 inhours

The above analysis indicates a nominal value of 38 hours for the column as charged. This is in good agreement with the estimate of 36 inhours based on preliminary calculations and tests in the 305 Pile.

The following changes in the poison column pattern were made on April 9.

Tubes 2069, 2079, and 2679 were discontinued as poison tubes.
Tubes 2066, 2082, and 2682 were established as poison tubes with nominal strengths of 38, 46, and 51 inhours respectively.

This change in poison represented an addition of 20 inhours to the sum of the nominal values for individual columns, but the expansion of the pattern was expected to cause some change in the effect of shadowing. Procedures for determining the shadowing correction to be used for various poison patterns are given by R.L. Monogus in a memorandum to W.E. Jordan, Document #7-2318, dated August 11, 1945. Shadowing corrections for the previous pattern have been made according to the equation

$$\text{effective inhours} = 0.857 \left(1 - \frac{\text{nominal total}}{5188} \right) \times \text{nominal total.}$$

For the expanded pattern the recommended equation becomes

$$\text{effective inhours} = 0.776 \left(1 - \frac{\text{nominal total}}{8203} \right) \times \text{nominal total.}$$

Allowing for a change in the sum of the nominal value from 385 to 405 inhours and the above change in shadowing correction, a net reduction of 6 inhours in the effective value of the pattern would be expected. Observed results on the effect of the poison change are as follows:

Excess reactivity in rods at shutdown	60 inhours
Loss due to discharge	- 5 inhours
Long term gains in four days.	4 inhours
Excess for no poison change	59 inhours
Observed excess	47 inhours
Effectiveness of poison change.	12 inhours

If no change in shadowing correction is allowed for and both nominal values are corrected for shadowing by means of the equation developed for the current, expanded pattern, an increase of 14 inhours in the poisoning effect is estimated. This figure is in satisfactory agreement with the observed effect, indicating that little or no change in the effect of shadowing was realized as a result of expanding the pattern as described. This observation is not surprising inasmuch as the central, flattened region of the pile extends beyond the radius of the poison pattern.

A comparison of observed and expected effects of the poison change on the temperature distribution of the pile is given below.

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<u>Moment</u>	<u>Observed 4-4-46</u>	<u>Due to rods A, 30"-49"</u>	<u>Due to P Change</u>	<u>Predicted</u>	<u>Observed 4-18-46</u>
Horizontal dipole	3.3%	2.3%	-12.4%	- 6.9%	-6.4%
Vertical dipole	4.7	2.4	3.8	10.6	7.5
Horizontal quadrupole	4.7	--	-11.1	- 6.4	-6.6
Diagonal quadrupole	4.9	--	- 0.2	4.7	5.9
Monopole	6.9	--	- 6.9	0	-1.3

Predicted effects in the above table are based on Document #7-2654, Procedure for Improving Temperature Distribution via Rods and Columns, from J. Wheeler and R. L. Monagus to W. E. Jordan. No changes in the procedures set forth in this document are indicated from the results of the poison change discussed above.

No new determinations of the reactivity power coefficients were made during the month but local graphite relaxation periods were measured as follows:

<u>Date</u>	<u>11 G</u>	<u>13 G</u>	<u>14 G</u>	<u>17 G</u>
March 26	83 minutes	81 minutes	82 minutes	76 minutes
April 9	83 minutes	80 minutes	82 minutes	75 minutes
April 16	80 minutes	80 minutes	77 minutes	77 minutes

No sign of any increase in the rate of change in these periods is indicated by these most recent values.

Number 9 horizontal rod jammed on several occasions during the start up on March 26. Inspection of the thimble on April 9 revealed that at about 20 feet in the vertical clearance inside the thimble was reduced to one inch or less. Measurements of the level of the rod track indicated a rise of about 3/4 inch at about 18 feet in which was the maximum travel possible with the instrument used. The shape of the rise curve pointed to possible buckling of the graphite block forming the rod track. The rod has been made inoperative pending correction of this condition. Number 8 rod has been substituted for number 9 rod in the rod withdrawal and insertion order.

The reactivity status of the pile at the beginning and the end of this report are given in the following table:

	<u>3-25-46</u>	<u>4-23-46</u>
Amount held in rods	57 inhours	50 inhours
Amount held in permanent poison	304 inhours	299 inhours
Amount held in xenon	497 inhours	497 inhours
Amount held in B columns	16 inhours	16 inhours
Amount held in power coeff.	-70 inhours	-70 inhours
Total cold, clean reactivity	803 inhours	791 inhours

The above comparison shows a net loss of 12 inhours; however, if the effectiveness of the poison pattern is calculated on the same basis in both cases, a gain of 4 inhours would be indicated.

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100-F Area - P. F. East

Summary

The pile was shut down three times during the month for the discharge of metal and suffered two scrams due to instrument troubles. The operating level was maintained at 200 MW throughout the month.

The effect on the temperature distribution of columns containing B-material has been investigated. A definite effect is found to exist but it appears to be less than the effect of ordinary P-columns.

Special request samples #15 and #8 were irradiated from April 2 to April 18. Special Request #8 was loaded on April 2 and requests #12B and #16-2 were loaded on April 18. Some data were obtained on the absorbing power of #15 samples.

Considerable time during the month was spent in assisting with the analysis of data taken at the recent shutdown of 100B. Results of this work are being reported by W. E. Kamme.

The unit showed essentially no net gain or loss during the month.

Effect of B-Columns on Temperature Distribution

On March 21, four B-columns were loaded into the unit along with two P-columns. Since the P-columns were both located in vertical row 74, they might be expected to have no effect on the horizontal dipole of the temperature distribution. All changes in this dipole are then due to rod changes and the effect of the B-columns. The following table indicates how the effect of the B columns was determined.

Observed change in Horizontal Dipole (3-19 to 3-25)	-15.3%
Change due to change of A rod position	- 0.6
Change due to change of B rod position	- 2.7
Change due to change of 9 rod position	- 6.0
Change ascribed to B columns	- 8.0%

When the horizontal dipole of the B-columns is computed in the same way as for the P-columns (i.e. nominal 1h times lattice units distant from center line) the B columns are found to have a horizontal dipole moment of 168 ihlu and their effectiveness is $168/6.0 = 28$ ihlu per %. The corresponding value for the regular P-columns is 16 ihlu per %. If the actual effective value (4 ih) of the B-columns is used instead of the nominal value (7 ih) in computing the dipole moment, then a moment of 96 ihlu is obtained and an effectiveness of 16 ihlu per % is found for the B-columns also.

Special Request Pieces - Absorbing Power of #15 Slugs

On April 2 two tubes were loaded with lead dummies with the exception that #3252 contained special request #8 and #3378 contained special request #8 and three special request #15 pieces. These two tubes absorbed 14 ih. On April 18, tube #3378 was discharged and reloaded with lead dummies and requests #12B and #16-2. The two special tubes were then considered to be identical as regards absorbing power. The discharge of the #15 samples

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produced a gain of 2 ih. This result is in essential agreement with the results of test pile measurements. These indicated that a full column of #15 pieces would be worth 80 ih as compared with 68 ih for a normal P-column. In the loading arrangement used in the F Pile the #15 pieces had a concentration equivalent to a 1P-8L column which would be worth 27 ih nominal. When this is corrected for the fact that effectively only a fraction of a column was loaded and that the pieces had reduced absorbing power as indicated by the test pile, a nominal strength of 12 ih is obtained. When this is corrected for shadowing in the usual fashion a net strength of 9 ih is expected. Since the replacement lead in #3578 has a value of 6 ih a loss of 3 ih would be expected at discharge. This compares well with the 2 ih observed.

Reactivity Changes

The following table compares the reactivity situation at the beginning and end of the report period:

	<u>4-25-46</u>	<u>3-25-46</u>
In rods	47 ih	57 ih
Isom	434	434
P-columns	313	313
B-columns	16	16
Special columns	12	0
Total operating	822 ih	820 ih
Overall effect	-66	-66
Net cold reactivity	756 ih	754 ih

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This indicates a negligible gain of 2 ih during the month. This net gain is the result of the following changes,

Gains 3-25 to 4-1	4 ih
Push of 4-2	-3
Water in B-Hole	-3
Gains 4-2 to 4-11	9
Push of 4-11	-3
Gains 4-11 to 4-18	0
Push of 4-18	-2
Gains 4-18 to 4-25	0
Net change	2 ih

Other Activities

Assistance was given in the analysis of the data gathered during the low power run following the shutdown of 105-B. The results of this work will be reported by W. R. Kame.

A draft of the history of the 100 Area Physics groups during the period from July 1, 1945 to Jan. 1, 1946 was completed.

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Drafts were prepared of the following documents which have not yet formally issued:

"Withdrawal of Beds in Serum Recovery" 4-16-48

"Change in Seminarium Poison at Shutdown: Addendum" 4-18-48

"P-Colum Increase at 100-F on March 21, 1948" 4-24-48

The contents of these documents were discussed in last month's report.

REVIEWED

W. E. Jordan C.P.V.

W. E. JORDAN, CHIEF SUPERVISOR
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MAY 27, 1946

TO: FILE

FROM: W. E. JORDAN

100 AREA TECHNICAL ACTIVITIES
REPORT - PHYSICS - FOR PERIOD
April 25, 1946 to May 25, 1946

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100-B Area - R. L. Monagan

Summary

Irradiation of indium foils in Tube No. 1563 of the B Pile indicates that the neutron birth rate is decreasing. This effect is ascribed to the gamma, neutron reaction induced by the 2.3 Mev. lanthanum gamma ray on deuterium in the water. The results thus far indicate that the primary neutrons from spontaneous fission contribute a component of about 950 counts per minute, and that the component due to the gamma excitation is falling off with the 12.5-day half life of the barium-lanthanum fission chain. By theoretical prediction, 950 counts per minute (mv is 95 neutrons/cm.²-sec.) corresponds to a sub-critical condition of 1.6% k with all rods out.

Analysis of the xenon transients obtained on the shutdown in March has advanced far enough to set the equilibrium xenon at about 505 inhours at 225 MW. The equations in use at present would give about 464 inhours under the same conditions. Correspondingly, high values were obtained for the other constants. In order to fit the equations, it was necessary to correct for the effect on the neutron distribution of inserting the shim rods. Since the xenon was built up to equilibrium with most of the rods out, insertion of the rods forces the neutron flux toward the outer regions of the pile where the xenon concentration is low. This decreases the poisoning effectiveness of the xenon. The correction used was empirical. Perhaps a theoretical form for this correction could be obtained.

Pile Reactivity Under Shutdown Conditions

It was expected that the extent of multiplication of primary neutrons from spontaneous fission would afford a means to determine the sub-critical condition of the B Pile after the shutdown, insertion of poison columns, and discharge of a large amount of metal. As a pile approaches the critical condition, the equilibrium neutron background approaches infinity. It was found, however, that the neutron flux decreased considerably with time. The shape of the decay curve from the data obtained thus far indicates that there

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is a constant component and a component which drops off with a 12.5-day half life. This observation leads one to believe that the excitation is due to the 2.3 Mev. gamma ray from the barium-lanthanum chain. This gamma is energetic enough to force a neutron out of the nuclei of deuterium and beryllium. Since a large amount of deuterium is exposed to the fission product activity, the source of the time-variant neutron activity seems to be the water in the tubes.

A foil exposure over a basket of discharged metal showed that fission product activity can produce photoneutrons in water. Since a basket of slugs is a very small pile, none of the neutron activity around it can be ascribed to multiplication of neutrons from spontaneous fission.

At present it appears that the photoneutrons greatly outnumber the neutrons from spontaneous fission at the time of shutdown.

Because of these large changes in neutron background due to changing fission product activity, any change in the reactivity of the B Pile cannot be evaluated at present. However, after the decay has proceeded sufficiently, the characteristics of the pile multiplication factor should become apparent.

Determination of the Transient Poison Constants

When the pile was shut down in March, the process was done in two steps in order to evaluate the constants in the transient poison equations. For 19 hours the power was held at 150 MW, and was then dropped to 0.5 MW until the transients died.

The first step was to determine by theoretical analysis the flattening correction on the constants A and b. This showed reasonably good agreement with Wheeler's correction factor, $1 - F/1500$, so that this was used thenceforth.

The xenon equations now in use, according to G.L. Weil, were fitted over a relatively small range of reactivity in the early part of the decay. In Weil's work, the same difficulties presented themselves as do now, namely, if the accepted values were used for the disintegration constants, it was impossible to fit the entire xenon transient with equations which are solutions of the simple differential equations. The most likely cause of the discrepancy is the change in xenon effectiveness as control rods move in to absorb the reactivity which was previously held by the xenon. Another source is the shift of neutron flux into the outer regions of the pile where the boron has not been burned out to the extent that it has in the center. The latter effect would indicate that the value of the equilibrium xenon is higher than the quoted figure of 505 inhours.

Assuming that the largest deviation is caused by control rods forcing the neutron flux away from the high concentration of xenon, one finds that the "actual" value of the xenon must be multiplied by some function of the reactivity absorbed by the control rod system at each instant during the transient. It was assumed arbitrarily that the correction factor had the form

$$1 - \text{constant } (x-x^2)$$

(1)

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where x is the ratio of the number of inhours absorbed by the control rod system at any instant to the equilibrium value of the xenon.

The run at 0.6 MW was fitted with the standard equations, corrected by this factor. Since the power was at negligible value, the only constant which could be evaluated is $\Lambda(1-\beta)$, which was found to be 4.01. The present equations give this product a value of 3.83 if a figure of 331 inhours is used as the flattening.

By means of the data on the 150-MW run, the following constants were determined:

A	6.80(1-F/1800)
b	0.00788(1-F/1800)
S	0.272
Capture cross section for xenon	5.7 megabarns
Fission Yield	4.52%
Constant in (1) above	0.21

It will be noted that these results deviate appreciably from the values now in use. The value of b is especially dependent on the shape of the reactivity curve at 150 MW, and small errors in the correction factor (1) and in the observed reactivity change this constant appreciably.

In all these calculations, it was found that a value of 0.40 ih per MW for the overall power coefficient of reactivity gave the best fit.

It is possible to fit the whole transient if one is willing to apply a correction due to the control rods. This correction is similar to that developed by Wheeler to account for the change in xenon due to changes in flattening, although the flattening correction actually changes the amount of xenon, while the proposed correction only changes the effectiveness. It may be necessary to change the form of the correction to

$$1 - \text{constant} \cdot x \quad (2)$$

in order to get a better fit on the 150 MW run.

Documents Written (not issued as yet)

Interim Report - Production Test No. 105-58-P, B Pile Reactivity Under Shutdown Conditions - by W. R. Kanne and R. L. Menegus, dated May 16, 1946.

Interim Report - Production Test No. 105-54-P, Determination of Transient Poisson Constants, by P. F. Gart, J. E. Guilloette, and W. R. Kanne, dated May 16, 1946.

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DECLASSIFIED100-D Area - U. M. StaeblerSummary

The D File was shut down four times during this report period for the purpose of discharging exposed metal.

Samples for Special Irradiations No. 13 (Be^{10}H_2) and No. 9-1 (BeO) were charged into Tube 3574 on April 30. The observed poisoning effect of ten inhours was in agreement with expectations based on Document #7-5721.

A review of reactivity gains independent of the metal indicates a realized gain of about 180 inhours up to the present time and a maximum expected gain of about 280 inhours. This is not in agreement with the gains predicted on the basis of analyses of the boron content of the graphite but it is not yet possible to determine whether the disagreement is due to errors in the boron content or to other possible effects.

Apparent thermal conductivities of the graphite have been computed by applying methods developed by W. K. Woods to the readings of six centrally located thermocouples. These calculations indicate that this property of the graphite has dropped to 1/31 of its original value as the result of an exposure of 1040 MWD per central ton and is still decreasing at a rate of about four per cent per month at the present operating level. These computed apparent thermal conductivities are only slightly greater than the absolute thermal conductivities which are determined in laboratory measurements on comparable graphite samples from water cooled test holes.

The total cold, clean reactivity of the pile shows a net loss of one inhour for the month. The absence of a net gain in reactivity is due to the fact that current metal charges consist primarily of MZ pieces replacing primarily A pieces. This change in type of metal causes a loss in reactivity which nullifies those gains which are independent of the metal.

DetailsSpecial Samples

During a shutdown on April 30, Tube 3574 was charged with eight pieces of Be^{10}H_2 and eight pieces of BeO . The irradiation of these materials in the pile is in accordance with Special Requests No's. 13 and 9-1, respectively. Using the nomograph given in Document #7-5721, "Pile Poison - Procedure for Calculating Effect of Various Materials on Pile Reactivity", from R. L. Menegus to W. E. Jordan, it was estimated that the poisoning effect of this column would be 10 inhours. Observed effects on reactivity are summarized in the following table.

Reactivity in rods at shutdown	49 inhours
Loss due to discharge	-4 inhours
Long term gains in four days	4 inhours
Loss due to difference in metal quality	-1 inhours
Expected reactivity for no poison change	48 inhours
Observed reactivity, 5-4-46	38 inhours
Effect of special samples	-10 inhours

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Reactivity Gains Independent of the Metal

According to Document #7-2733, "Final Report on Production Test 105-II-P", from L. Marshall to File, the boron content of the graphite in the D Pile accounted initially for 555 inhours with no flattening in the pile. If the present maximum flattening of 300 inhours is assumed, this document indicates that the burn up of boron in the graphite should ultimately result in a gain in reactivity of 416 inhours. This gain should be realized according to an equation of the following form:

$$\text{Gain} = K \int_0^{1.521 \times 10^{-5} \times \text{MWD}} F(y) dy$$

K is the maximum gain to be obtained by complete burn up of the boron, and values of the integral of $F(y) dy$ have been calculated by J. Marshall as follows:

<u>Limit</u>	<u>Integral</u>	<u>Limit</u>	<u>Integral</u>
0.1	0.089	0.5	0.372
0.2	0.171	1.0	0.592
0.3	0.244	2.0	0.815
0.4	0.310	3.0	0.908

In an effort to check the validity of these gains independent of the metal in the piles, the following six reactivity points were noted:

<u>Date</u>	<u>Level</u>	<u>Xenon</u>	<u>Rods</u>	<u>C₀</u>	<u>Poison Columns</u>	<u>MWD</u>	<u>Net metal gains</u>
1-10-45	190	447	30	0.05	111	3700	-18
2-15-45	250	531	27	0.05	59	11500	-20
5-15-45	268	533	57	0.22	144	32750	0
8-15-45	280	553	55	0.25	196	56900	12
2-17-46	225	472	61	0.28	299	99550	12
5-20-46	250	497	45	0.28	325	120400	12

Values listed for poison columns in the above table include the effective value of the permanent poison pattern plus the effect of special tubes such as those containing bismuth or special samples. The net metal gains were estimated using the metal gains curve of Document #7-3063, "Long Term Reactivity Gains of the 105 Piles", from J. Marshall and U. M. Staebler to W. E. Jordan.

The observed reactivity gains independent of the metal were calculated over several regions of operation and the total gains to be expected estimated from each of these calculations. These results are summarized below.

<u>From</u>	<u>To</u>	<u>Reactivity Gain</u>	<u>Fraction of Total</u>	<u>Total</u>
3700MWD	120400 MWD	187 inhours	0.735	254 inhours
11500	120400	159	0.635	250
32750	120400	107	0.425	252
56900	120400	61	0.245	249
3700	99500	181	0.677	238
11500	56900	98	0.390	251
Average				249

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So far no attempt has been made to determine the reason for the difference between expected reactivity gains resulting from boron burn up in the graphite and the observed gains reported above. It will be very difficult if not impossible to determine as yet if the smaller effect observed is due to some linear poisoning superimposed on the boron gain because operation thus far has been over a fairly linear portion of the expected gains curve. Possible contributing factors leading to a reduced gain include reactivity losses resulting from a decreased graphite density because of expansion. A loss of about 25 inhours is estimated on the basis of graphite density calibrations in the 305 Test Pile and an assumed expansion of 0.8%. Study of these gains is being continued.

Graphite Thermal Conductivities

The apparent thermal conductivity of the graphite has been calculated at various points since January, 1946, on the basis of temperatures recorded by the six centrally located graphite thermocouples. The method for making this calculation was developed by W. K. Woods, and is described in Document No. 3-1931, "Apparent Conductivity of Graphite in 105 Units", from W. K. Woods to file. There was considerable variation in local conductivities for the various thermocouples due to the fact that in figuring local power generation, no correction was made for perturbations caused by the rods. The average of all six values was taken as being representative of the condition of the central graphite. On this basis the conductivity has dropped to 1/31 of its original value after an exposure of 1040 MWD per central ton, and is still decreasing at a rate of about four per cent per month at the present operating level. Apparent conductivities appear to be about 15 per cent greater than the absolute conductivities which are determined by laboratory measurements on comparable test hole samples that have been cooled during exposure. They appear to be 60 per cent less than the conductivities of comparable test hole samples exposed at ambient pile temperatures.

The following local graphite relaxation periods have been determined during the month.

<u>Date</u>	<u>11 G</u>	<u>13 G</u>	<u>14 G</u>	<u>17 G</u>
April 30	84 minutes	71 minutes	79 minutes	79 minutes
May 7	82 minutes	76 minutes	78 minutes	79 minutes
May 14	84 minutes	78 minutes	82 minutes	79 minutes

No changes in previously reported trends in these periods is indicated.

Reactivity Status

The reactivity status of the pile at the beginning and the end of this report period are given in the following table.

	<u>4-23-46</u>	<u>5-25-46</u>
Amount held in rods	50 inhours	39 inhours
Amount held in permanent poison	299 inhours	299 inhours
Amount held in B columns	16 inhours	16 inhours
Amount held in special columns	0 inhours	10 inhours
Amount held in xenon	497 inhours	497 inhours
Amount held in power coefficient	-70 inhours	-70 inhours
Total cold, clean reactivity	792 inhours	791 inhours

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The above comparison shows a net loss of one inhour for the month. The observation that the pile reactivity is remaining essentially constant is in line with considerations of the various components which make up the net change in reactivity. If the product concentration in the pile remains constant, there should be no net gains from the metal as the result of exposure. Expected gains outside of the metal would amount to only four inhours per month on the basis of the findings discussed earlier in this report. Recent metal charges have consisted of 90 percent MZ pieces and 10 percent X pieces, replacing charges made up of about 80 percent A pieces, and 20 percent Z pieces.

Comparisons of these various types of pieces as measured in the 305 Pile average about as follows:

<u>Classification</u>	<u>ΔK_{∞}</u>
A	0
Z	-0.08
MZ	-0.08
X	-0.13

Since 17 percent of the pile (based on the square of the flux distribution) was charged during the month, the change in type of metal pieces as described above accounts for a loss of 5 inhours.

Thus:

Metal Gains-----	0 inhours
Gains independent of metal-----	4 inhours
Loss due to change in metal type--	-5 inhours
Net change in reactivity -----	-1 inhours

100-F Area - P. F. Gast

Summary

During the month, there were four scheduled shutdowns of the pile for metal discharge, one voluntary shutdown of 3 hours duration and two scrams. The operating level was maintained at 200MW throughout the month.

The possibility of obtaining values for the xenon constants from data taken at the shutdown of 100-B was examined. No consistent set of constants fitting all the data has been obtained.

An examination of the total reactivity gains from the startup period to date at 100-F reveals that gains from boron cleanup in the graphite are not as large as had been expected.

Special requests 9-3, 7, 18-1 and 10-A were loaded into the pile on May 2 and three capsule slugs were loaded at the same shutdown. No special requests were discharged.

The unit experienced a net gain of 8 ih during the month.

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Determination of Transient Poisson Constants-Interim Report Production Test 100-B-F

This report, issued under date of May 16, 1946, was prepared together with W.R.Kenne and J.E.Guillette. The section of the report prepared by the writer discusses an attempt to obtain a consistent set of xenon constants which will fit all the data obtained at the shutdown of 100-B. The chief difficulty is that the constants which best fit the run at 150MW will not fit the initial portion of the run at 0.8MW and vice versa.

This difficulty can be resolved by assuming that the cross-section of xenon varies with temperature. This leads to the following values of the various constants.

$$\begin{aligned} A_0(\text{Value of } A \text{ at } 280^\circ\text{K}) &= 4.830 \\ B_0 &= 0.003825 \\ \text{Xenon cross-section at } 280^\circ\text{K} &= 3.45 \times 10^{-18} \text{ cm.}^2 \\ \text{Fission yield of } 135 \text{ mass chain} &= 6.5\% \\ \text{Percentage of direct formation of xenon} &= 0 \end{aligned}$$

The change of cross-section, and consequently of A and B with power level is given by the expression $(1-0.0009178W)$. That is, the values of A and B for any level are given by:

$$\begin{aligned} A &= 4.830(1-0.0009178W) \\ B &= 0.003825(1-0.0009178W) \end{aligned}$$

There are two difficulties which prevent the acceptance of the above analysis. The first is that it implies a large dependence of the graphite coefficient on the amount of xenon in the unit. Such an effect has not been observed. The second difficulty is that this analysis does not explain the discrepancy between the constants obtained above and the presently accepted ones derived from the 1500 tube, 90MW run at 100-B.

J. E. Guillette carried out much of the work necessary to fit the experimental data with the empirical equations given in the report.

Reactivity Gains Due to Boron Burnup - Metal Gain Analysis

The total gains of the F pile from the startup period to 98,000 MWD exposure were 220 ih. From metal gains data gathered at discharges (Long Term Reactivity Gains of the 100-Piles, J. Marshall and U. M. Staehler, 12-14-45, Doc. No. 7-3083) the metal gains in the unit at this time were between +50 and -15 ih. The graphite gains thus lie between 170 and 235 ih, or approximately 200 ih.

The graphite gains predicted by L. W. Marshall (Final Report - Production Test 100-11-P, 10-4-45, Doc. No. 7-2733) were 380 ih. It thus appears that considerably smaller gains have been realized in the graphite than were anticipated on the basis of manufacturer's analyses.

The existence of these smaller gains explains the bulk of the discrepancy between the metal gains as indicated by data from the first 25,000 MWD of operation at 100-F and from data taken at metal discharges. An approximate calculation, based on a figure of 200 ih as the value of the graphite gains at 98,000 MWD, gives 70 ih as the gain in metal exposed to 200 MWD/ton, as compared with 80 ih obtained from the discharge of metal of the same concentration. The original analysis of the 100-F data gave -12 ih for 200 MWD/ton metal. A samarium fission yield of 0.64% is obtained as compared with 1.03% from the former analysis.

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It does not, at present, appear worthwhile to do a more exact calculation until the uncertainty with regard to xenon constants and corresponding rod calibrations is resolved.

There is at present no basis for deciding whether the reduced gains are due to inaccurate analyses of the boron content of the graphite or to production of a poison by pile operation.

Shutdown Resume

The unit was shut down for the discharge of metal on May 2, 9, 15 and 21.

At the shutdown of May 2, Special Requests No's. 9-3, 7, 16-1 and 10-A were loaded into Tube No. 1565 (Production Test No. 105-62-P, C.W.J. Wende, April 30, 1946, Document 7-4001). At this same shutdown, three capsule slugs were loaded into Tube No. 2385.

After the startup of May 21, a radiation beam was discovered coming from Tube No. 4674. Since some special grooved dummies had been removed from the charging end of this dry tube during the shutdown, a shutdown of 3 hours duration was made on May 22 to replace them. This short shutdown was made possible by the large excess reactivity available at the time.

A scram, occurring on May 17, was traced to a slipping clutch on a vertical safety rod, and a scram on May 22 was due to an electrical power surge.

Reactivity Changes

The following table compares the reactivity situations at the beginning and end of the report period:

	<u>5-25-46</u>	<u>4-25-46</u>
In rods	49 ih	47 ih
Xenon	434	434
P-columns	313	313
B-columns	18	18
Special Columns	18	12
Total operating	830 ih	822 ih
Overall effect	-66	-66
Net Cold reactivity	764 ih	756 ih

The net gain of 8 ih during the month was the result of:

gross gains 16 ih
losses at discharges 8 ih

W. E. Jordan
W. E. JORDAN, CHIEF SUPERVISOR
100 - 300 TECHNICAL

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- #1 W. E. Jordan - 700 File
- #2 W. G. Kay - 300 File
- #3 C. M. Gross - K. W. French
- #4 P. F. Gast
- #5 U. M. Staebler
- #6 C. P. Kidder
- #7 C. W. J. Wende - R. L. Monagus
- #8 Pink Copy
- #9 Yellow Copy

Division

JUNE 23, 1946

TO: FILE

FROM: C. W. J. WENDE

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100 AREA TECHNICAL ACTIVITIES REPORT - PHYSICSFOR PERIOD MAY 23, 1946 TO JUNE 23, 1946100-B Area - R. L. Monagus

Poll irradiations were made in the shutdown pile during the last month for the purpose of following the decay of the photoneutron component. In general, results were according to expectations. On 6/18/46, an irradiation was performed with the gas purity at about 42%. The impurity was air taken in during the replacement of the neoprene seal on the far side. The nv predicted by extrapolation of a least squares - fitted line of the previous data was 109.8 neutrons/cm²-sec. Actually, 101.1 neutrons/cm²-sec. were observed. The difference was said to be caused by the poisoning due to the 58% air in the gas. A change in the nv is caused by a change in the overall multiplying power of the pile, and these two quantities can be related by the following process: From work to be reported on later, the nv is related to the multiplying constant by

$$nv \approx \frac{1.575}{1-k} \quad (\text{for } 1-k = 0.015) \quad (1)$$

$$d(nv) \approx 1.575 (1-k)^{-2} dk \quad (2)$$

Since $d(nv) = 101.7 - 109.8 = -8.7$, $dk = -0.12\%$; or, a change in gas purity of 58% caused a change of 50 ih in the reactivity of the pile ($1\% k = 416$ ih).

From a consideration of the neutron absorbing power of nitrogen, one would expect a change of 116 ih for 58% air in the gas. The statistical error of the nv determinations is about 0.6% (total counts of about 29,000), so the deviation between the two determinations by different methods is unexplained at present.

Calculations on the xenon transient constants have been suspended for the present after consultation with J. A. Wheeler on a recent visit. Wheeler's determination of the constants over a limited portion of the observed reactivity curve sets the equilibrium xenon value at 543 ih for 225 MW and 320 ih of flattening, as compared with 464 ih with the present constants and the same conditions. The overall coefficient was found to be 0.38 ih/MW. It was suggested by Wheeler that another test be run by a method which would eliminate the errors due to the distortion of the neutron density by the rods.

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Documents Issued

"B Pile Shutdown - Reactivity Information for Startup", May 17, 1946,
Document 7-4229, by W. R. Kanne to File.

100-C Area - U. M. StaeblerSummary

The D Pile experienced four normal shutdowns of 17 to 21 hours duration during the month in addition to one extended shutdown of over three and one-half days and one shutdown of about two hours used to discharge temporary poison columns.

Several samples for irradiation covered by Special Requests were charged into the pile or discharged from the pile. Details of these movements are discussed below.

A test for the determination of the power coefficients and the graphite relaxation time was performed on June 10. Results of this test are not in good agreement with results or trends previously indicated. No reasons for the disagreement have been found. It is planned to repeat the test at the earliest opportunity.

Supplementary poison columns were successfully used during the extended shutdown of June 17 to June 20. Data obtained during this startup have not yet been analyzed to determine the effectiveness of the six columns but the close agreement between predicted and observed critical rod positions indicate confirmation of previous evaluations.

An analysis of effects on pile reactivity to be expected as the result of various trends in the quality of the metal has been prepared. Continuation of the present MZ and X type production of current average quality is expected to result in a net gain of only about 20 inhours during the next 80,000 MWD of operation considering both metal quality and gains independent of the metal.

The total cold, clean reactivity of the pile shows a net loss of three inhours for the month.

DetailsSpecial Samples

Movement of Special Request samples in and out of the D Pile during the month is summarized in the following table.

<u>Sample</u>	<u>Name</u>	<u>Requested Exposure</u>	<u>Tube No.</u>	<u>Date</u>	<u>Action</u>	<u>Remarks</u>
9 - 1	Beryllium Oxide	30 days	3574	5-28	Discharged	In since 4-30
13	Beryllium Nitride	30 days	3574	5/28	Discharged	In since 4-30
9 - 2	Be O and Uranium	60 days	3574	6-4	Charged	--
25 - 2	Beryllium Nitride	60 days	3574	6-4	Charged	--
3	Thorium	2-3 months	1474	6-11	Discharged	In since 3-28
15 - 1	Lithium Fluoride	50 days	1579	6-25	Charged	--
25 - 3	Beryllium Nitride	90 days	2669	6-25	Charged	--

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Coefficient Test

The power level of the pile was lowered from 250 MW to 225 MW for a period of four hours on June 10 then returned to 250 MW. Rod movements resulting from these level changes were used to evaluate the several power coefficients and the graphite relaxation period. Xenon equations and rod calibrations consistent with those used in similar previous measurements were used in arriving at the results for this test. The following values for the various properties were obtained.

	<u>Drop in Level</u>	<u>Rise in Level</u>	<u>Average</u>
Overall power coefficient, C_o	0.18 1h/MW	0.20 1h/MW	0.19 1h/MW
Graphite power coefficient, C_g	0.36 1h/MW	0.36 1h/MW	0.36 1h/MW
Metal power coefficient, C_M	-0.18 1h/MW	-0.17 1h/MW	-0.18 1h/MW
Graphite relaxation period	55 minutes	55 minutes	60 minutes

For the purpose of comparison a summary of comparable results obtained over the past year is given below.

<u>Date</u>	<u>C_o</u>	<u>C_g</u>	<u>C_M</u>	<u>Period</u>
5-8-45	0.15 1h/MW	0.39 1h/MW	-0.24 1h/MW	35 minutes
6-9-45	0.17 1h/MW	0.38 1h/MW	-0.21 1h/MW	39 minutes
8-25-45	0.25 1h/MW	0.53 1h/MW	-0.28 1h/MW	45 minutes
12-12-45	0.24 1h/MW	0.48 1h/MW	-0.24 1h/MW	54 minutes
12-30-45	0.22 1h/MW	0.43 1h/MW	-0.21 1h/MW	50 minutes
2-21-46	0.28 1h/MW	0.50 1h/MW	-0.22 1h/MW	60 minutes
3-16-46	0.25 1h/MW	0.45 1h/MW	-0.20 1h/MW	54 minutes
6-10-46	0.19 1h/MW	0.36 1h/MW	-0.18 1h/MW	60 minutes

No evidence has been found to indicate that the most recent test is any less reliable than the others reported. It is planned to check the results by means of a repeat test when operating plans allow the pile to reach a state of equilibrium again.

Temporary Poison Columns

As a safeguard against possible loss of water following the decay of the xenon poison during the extended shutdown, six temporary poison columns were charged into the pile. These poison columns were charged into Tubes 1074, 1180, 1385, 1691, 3285, and 3774. Data obtained in connection with the startup immediately after the prolonged shutdown and in connection with the startup following discharge of the temporary poison columns will be useful in adding to information relative to the effectiveness of such columns under various rod configurations. Critical rod positions observed at both of these start-ups agreed with predicted critical positions within less than ten inhours. On this basis no important change from previous observations is expected to be indicated when more detailed analysis of the data is available. Previous experience with temporary poison columns is summarized in Document #7-3687, "Pile Poison - Temporary Poison Addition During Extended Shutdown", from Kanne and Menegus to Jordan.

Metal Quality Considerations

Under the present system of metal acceptance, which is based on quality control limits established by statistical means, occasional batches of metal fall outside of the acceptance limits and need to be given special consideration before being charged into the piles. A study of the effects of various distributions of metal quality on pile reactivity was made in order to supply the background for a system of metal

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acceptance over a wide reactivity range on a routine basis. The maximum reactivity loss and the expected reactivity change for various metal acceptance limits were determined. These results are summarized below:

<u>Maximum Loss</u>	<u>Expected Change after 70,000 MWD</u>	<u>90% greater than</u>	<u>10% greater than</u>
0 inhours	10 inhours	-0.10 $\Delta K\%$	-0.20 $\Delta K\%$
10 inhours	5 inhours	-0.10 $\Delta K\%$	-0.50 $\Delta K\%$
20 inhours	5 inhours	-0.15 $\Delta K\%$	-0.25 $\Delta K\%$
*30 inhours	0 inhours	-0.15 $\Delta K\%$	-0.45 $\Delta K\%$
40 inhours	-5 inhours	-0.15 $\Delta K\%$	-0.75 $\Delta K\%$
40 inhours	0 inhours	-0.20 $\Delta K\%$	-0.30 $\Delta K\%$
50 inhours	-5 inhours	-0.20 $\Delta K\%$	-0.50 $\Delta K\%$
60 inhours	-10 inhours	-0.20 $\Delta K\%$	-0.80 $\Delta K\%$

Figures for the expected reactivity change after 70,000 MWD are based on the current distribution of production in the 90 percent group and an average $\Delta K\%$ for the 10 percent group midway between the limits of the lower group. The exposure figure was chosen because it represents 95 percent effective replacement of pile metal for the present discharge schedule and corresponds to the maximum reactivity loss in cases where losses would be expected. The maximum loss figure is based on all metal in each group having a quality equal to the lower limit of that group. The values of $\Delta K\%$ are based on comparison with the arbitrary 305 test standard.

The specifications marked with an asterisk (*) would allow for the reactivity range now being encountered in metal production.

The MZ type piece (which is slightly smaller and thus less reactive than the formerly made A type piece) has not been in process long enough to constitute the major portion of the metal in the piles. Metal now charged into the piles is estimated to have an effective $\Delta K\%$ of about -0.08 while current production has an average $\Delta K\%$ of about -0.09. The net effect of reactivity gains independent of the metal and continued charging of current metal production would be an average gain in reactivity of about 2.5 inhours per 10,000 MWD for the next 100,000 MWD of operation according to this analysis.

A memorandum "Metal Quality Considerations in Pile Operation", U. M. Staebler to C. H. Gross is being issued to cover the results of this study in greater detail.

Reactivity Status

The pile had not quite returned to equilibrium from the extended shutdown by the end of this report period but the following equilibrium conditions can be estimated as of the morning of June 25. They do not include changes in the poison and special columns made during the shutdown of June 25.

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6-28-46

Amount held in the rods	39 inhours	47 inhours
Amount held in permanent poison	299 inhours	292 inhours
Amount held in B columns	16 inhours	16 inhours
Amount held in special columns	10 inhours	6 inhours
Amount held in power coefficient	-70 inhours	-70 inhours
Total cold, clean reactivity	791 inhours	785 inhours

The above comparison shows a net loss of 3 inhours for the month. It will be noted that the same power coefficient was used for both tabulations in spite of the lower value obtained in the test on June 10. Change in the value of this coefficient is being delayed until another test can be performed.

100-F Area - P. F. Gast

Summary

There were four scheduled shutdowns of the pile during the month and no scrams. The operating level was maintained at 200 MW throughout the month.

A re-examination of the data taken at the shutdown of 100-B has revealed the source of the inconsistency reported last month. A set of xenon constants have been found which give a least squares fit to all the data.

A production test to measure the reactivity coefficients was carried out on May 27.

An unexpected and unexplained loss of 10 ih of reactivity occurred during the shutdown on May 29. This necessitated a reduction in the strength of the P-column pattern on June 5.

There was a net loss of 8 ih in reactivity during the month.

Determination of Transient Poison Constants - Production Test 105-54-P

Last month's report described some of the difficulties encountered in interpreting the reactivity data obtained from the shutdown of the 105-B Pile.

The inconsistency between the xenon constants which best fitted the run at 150 MW and those which best fitted the 0.5 MW run now appears to have been due to the type of empirical curve fitted to the run at 150 MW. The reactivity change during this run should fit a curve containing terms of the form $a \exp(-It)$ and $b \exp(-X(1+BW)t)$ in which I is the decay constant of iodine

X is the decay constant of xenon

B is the "burnout" constant of xenon

W is the power level.

Since one of the purposes of the analysis is to determine the value of B, this quantity is unknown before the fit is made. It is, unfortunately, impossible to determine B from the observed curve with any precision when it appears in the exponential function.

From a preliminary investigation of the data, it appeared that the numerical value of $X(1+BW)$ was close to I. The above two exponentials can then be combined and expanded into the form:

$$(a + bt + ct^2 + \dots) \exp(-It)$$

In the work reported last month the series was carried only to the first power term in t . This was the cause of much of the difficulty. The inclusion of the second power term brings all of the data into satisfactory agreement. The constants a , b and c are functions of the xenon constants A , B and s . The values of A , B and s determined from the above are in good agreement with the value of $A(1-s)$ determined from the initial portion of the run at 0.5 MW. A least squares fit to both sets of data gives the following values.

$$\begin{aligned} A &= 4.837 \\ B &= 0.00386 \\ s &= 0 \end{aligned}$$

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Coefficient Test - Production Test 105-50-P

On May 27 a test was run to measure the reactivity coefficients. Analysis of the data revealed a discrepancy between rod motion after the power was restored to normal and the xenon calculated by the standard constants. The observed reactivity peak was sharper and occurred 6.5 hours sooner than the calculated peak. A change of rod calibration will not resolve such a difficulty. In an attempt to solve this problem the rod calibration found at 100-B was used together with the xenon constants given in the preceding section of this report. This produced an agreement between the time of the peaks but not an agreement in their magnitudes. Further work along this line, including an application of the new calibrations and constants to previous coefficient tests, is in progress.

The values of the coefficients as measured from the 1st half of the test (i.e. the drop in power) by use of the standard xenon constants were:

$$\begin{aligned} C_m &= -0.23 \text{ ih/MW} \\ C_o &= 0.39 \\ C_g &= 0.62 \\ \text{Period: } &48 \text{ minutes} \end{aligned}$$

These values are in line with the trends indicated by previous measurements. Because of the difficulties mentioned above, no meaningful values were obtained from the second half of the test.

Sudden Reactivity Loss

During the shutdown of May 29 the unit experienced an unexpected and unexplained loss of 10 ih. Before the shutdown, rod A held 50 ih and after the xenon poison had returned to saturation following the shutdown it held 35 ih. No other rods were in the unit at either time. The known losses occurring during the shutdown are:

Loss due to metal discharge	2.3 ih
Loss due to discharging three peripheral tubes and filling one dry tube with water	2.4 ih
Total explained losses	4.7 ih

This leaves some 10 ih of unexplained reactivity loss. The following items have been checked, all with negative results, in an effort to discover the source of this loss:

- 1) Power level
- 2) Helium purity, especially moisture content
- 3) Condition of cooling system in B sample hole
- 4) Level of solution in third safety tanks
- 5) Test pile results on special cast slugs charged into three tubes during shutdown

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- 6) Test pile results on regular metal charged
- 7) Tube outlet temperatures of the entire unit and especially those tubes which were discharged during the shutdown.

Methods of determining whether the tip has fallen from one of the vertical rods have been discussed with the P-Department.

At the time of closing of this report, the 10 ih are still missing and unaccounted for.

P-Column Change on June 5

This change has been reported in a memorandum "P-Column Change at 100-F on June 5, 1946" (6-21-46, Document No. 7-4276). Briefly, the total net strength of the P-column pattern was reduced by 20 ih by decreasing the strength of tubes 3179 and 1562. The total dipole moments of rods plus P-pattern were maintained nearly constant. The reactivity and temperature results were in agreement with expectations.

Shutdown Record

The unit was shutdown for the discharge of metal on May 29, June 5 and June 20 and was shut down for maintenance work but no discharge on June 12. During the shutdown of June 12, a canvas "soft spot" was installed at the top of the downcomer. During the discharge of June 20, the graphite stringer was removed from D experimental hole. No special request slugs were loaded or discharged during the month.

Reactivity Changes

The following table compares the reactivity situation at the beginning and end of the report period:

	<u>6-23-46</u>	<u>5-23-46</u>
In rods	57 ih	49 ih
Xenom	438	424
P-columns	293	313
B-columns	16	16
Special columns	18	18
Total operating	<u>824 ih</u>	<u>830 ih</u>
Overall effect	-66	-66
Net cold reactivity	<u>758 ih</u>	<u>764 ih</u>

W. E. JORDAN, CHIEF SUPERVISOR
100 - 300 TECHNICAL

W. E. Jordan
W. E. Jordan
100 Technical

CWJW:jd

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SECRET

1. W. E. Jordan - 700
2. W. C. Day - 500
3. C. H. Gross-R. W. French
4. P. F. Gast
5. U. M. Staebler
6. C. W. J. Wende-R. L. Menegus
7. Pink
8. Yellow

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July 25, 1946

TO: FILE

FROM: C. W. J. Wende

THIS DOCUMENT CONSISTS OF [REDACTED] PAGES

100 AREA TECHNICAL ACTIVITIES REPORT
- PHYSICS -
FOR PERIOD JUNE 25 - JULY 25, 1946

D FILE - U. M. STAEBLER**DECLASSIFIED**Summary

The D File experienced four scheduled shutdowns during the month, lasting from 20 to 25 hours each.

Three Special Request samples were charged into the pile but none were discharged. All reactivity effects connected with these special samples were in satisfactory agreement with expected poisoning effectiveness.

A test for the determination of the reactivity power coefficients and the graphite relaxation period was performed on July 1. The results of this test are not in agreement with those obtained from the test of June 10 but are more in line with trends indicated by previous tests. There are sufficient uncertainties in the tests that the differences between results of June 10 and July 1 can not be taken as proof of radical changes in these pile properties. Analysis of results from coefficient tests since the start-up of the D File indicates the presence of a term linear with exposure in graphite effects.

Data from the start-up following the extended shutdown of June 17 to June 20 have been used to evaluate the effectiveness of the six temporary poison columns used during this period. These values are slightly less than, but in reasonably good agreement with, previous results from all three areas.

The apparent thermal conductivity of the central graphite of the pile has dropped to 1/33 of its original value after an exposure of 1150 megawatt days per central ton of metal. The ratio of original conductivity divided by current apparent conductivity is increasing at the rate of 0.017/MWD/central ton.

The total cold, clean reactivity of the pile shows a net loss of eight inhours for the month. Most of this apparent loss is due to a change in the value taken for the overall power coefficient.

DetailsSpecial Samples

A summary of special samples charged into the pile during the past month

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is given in the following table:

<u>Date</u>	<u>S. N. No.</u>	<u>Name</u>	<u>Prod. Test</u>	<u>Tube #</u>	<u>Requested Exposure</u>
7/2/46	19	Mercury	105-68-F	1666	90 days
7/2/46	25-2	Beryllium Nitride	105-67-F	2878	30 "
7/18/46	15-2	Lithium Fluoride	105-66-F, Sup.B	2682	50 "

Tube 2682 was formerly a poison column of 51 inhours nominal strength. The poisoning value of Special Request 15-2 as charged was estimated at 52 inhours.

The status of poison, dummy, and specially charged tubes in the D File as of the end of this report period is given below:

<u>Tube</u>	<u>Charge</u>	<u>Nominal ih</u>	<u>Effective ih</u>
3189	2L - 1P	34 inhours	
3179	2L - 2P	38 "	
2666	2L - 2P	44 "	
2682	L1P (15-2)	52 "	
2374	1L - 1P	46 "	
2066	2L - 1P	34 "	
2082	1L - 1P	46 "	
1569	2L - 1P	34 "	
1579	L1P (15-1)	27 "	
1474	2L - 1P	27 "	
		<hr/>	
3574	9-2, 25-2	7 "	283 inhours
2669	25-2	7 "	5.2 "
2878	25-1	7 "	5.2 "
1666	19	7 "	5.2 "
0174	All lead	7 "	0.6 "
2451	"	7 "	0.6 "
2496	"	7 "	0.6 "
4674	"	7 "	0.6 "
3880	Bismuth	7 "	4 "
2788	"	7 "	4 "
2088	"	7 "	4 "
0980	"	7 "	4 "

Total effective poison..... 322 "

Power Coefficients

The power level of the pile was lowered by 22.5 MW for a period of five hours on July 1 for the purpose of determining the reactivity power coefficients and the graphite relaxation period. The following results were obtained:

Overall power coefficient, CO	0.34 ih/MW
Metal " " , CM	0.26 "
Graphite " " , CG	0.60 "
Graphite relaxation period	60 minutes

These results differ considerably from those reported last month for the test

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The following equation was found to give good agreement with observed values:

$$\text{inhours} = 68 \left(\frac{\Delta T}{48} \right)^{3.4}$$

where ΔT is the temperature rise normally experienced in the tube under similar rod conditions at 250 MW operation.
 48 is the temperature rise ($^{\circ}\text{C}$) to be expected in a central tube of an unflattened pile at 250 MW.

Apparent Thermal Conductivity of Graphite

The six centrally located thermocouples in the pile graphite can be used to determine the apparent thermal conductivity of the graphite by a method developed by W. K. Woods and described in Document #3-1931. The average thermal conductivity determined by this method is 2.02 c.h.u./(hr) (ft) ($^{\circ}\text{C}$) after an exposure of 1150 megawatt days per central ton of metal. This is only 1/33 of its original value. The rate of increase in the ratio of original to current conductivities appears to have been constant since an exposure of about 500 MWD/central ton was passed. This rate is 0.017/MWD/central ton. Central graphite temperature as recorded by thermocouple 14 G is now about 180 $^{\circ}\text{C}$ during equilibrium operation at 250 MW.

Reactivity

The reactivity at the beginning and at the end of this report period is given in the following tables:

	6/25/46	7/22/46
Amount held in rods.....	47 inhours	38 inhours
Amount held in permanent poison pattern....	292 "	283 "
Amount held in special columns.....	6 "	23 "
Amount held in reason.....	497 "	497 "
Amount held in B columns.....	18 "	16 "
Amount held in power coefficient.....	-70 "	-77 "
Total cold, clean reactivity.....	788 "	780 "

The above comparison shows a net loss of 8 inhours for the month but most of this loss is due to a change in the value taken for the overall power coefficient. Best agreement with all values for this coefficient indicates a current value of 0.31 ih/MW which was used in the tabulation for 7/22/46. A value of 0.28 ih/MW was used in the tabulation for 6/25/46. A reasonable rate of change in this coefficient seems to be about 0.008 ih/MW/month at the present operating level. This would lead to an actual loss of about 3 inhours for the month.

Documents

Issued: #7-4207, "Metal Quality Considerations in Pile Operation"
 June 10, 1946 - U. M. Staebler to C. M. Gross

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Written but not yet issued:

"Interim Report on Production Test No. 105-50-P, Determination of Reactivity Coefficients and Rod Calibrations of the Piles",
U. M. Staebler to File

"Pile Control - Temporary Poison During Extended Shutdown of 105-D, June 17 to June 20",
U. M. Staebler to C. W. J. Wende

P PILE - P. P. GAST

Summary

There were five scheduled shutdowns during the month and no scrams. The operating level was maintained at 200 MW throughout the month.

On July 24 the P-columns in tubes 1474 and 3274 were replaced with special pieces for Request 13-1. The P-column in tube 2082 was replaced by special pieces for Request 3-1.

A draft of the history of the activities of the 100 Area Physics Groups from January 1 to June 25, 1948 was prepared during the month, revised drafts for several operating standards were prepared and collected material was arranged for the Standard Technical Practices Manual.

There was a net gain of 12 ih during the month.

P-Column and Special Sample Change on July 24

On July 24 the P-column in tube 1474 was discharged and replaced by 35 pieces of special request 13-1. The P-column in tube 3274 was replaced by 34 pieces of the same material, Be_3H_2 . The P-column in tube 2082 was replaced by 43 thorium slugs for special request 3-1. The total absorbing strength of the new loads was purposely greater than that of the columns which they replaced. The new and old loads and nominal absorbing strengths are summarized in the following table:

<u>Tube No.</u>	<u>New Load</u>	<u>Old Load</u>	<u>New Strength</u>	<u>Old Strength</u>
1474	10L - 35 Be_3H_2 -11L	5L-1P	20 ih	20 ih
3274	11L - 34 Be_3H_2 -11L	10L-1P	20 "	14 "
2082	7L - 43 My - 7L	3L-1P-2L-1P	45 "	30 "
Total			85 ih	64 ih

The total nominal increase was thus 21 ih; this is equivalent to a net increase, after shadowing, of 15 ih. At the time of closing of this report the pile had not yet returned to a steady state from the July 24 shutdown and no comparison with observed reactivity changes could be made.

DECLASSIFIEDDocuments Prepared

A History of the Activities of the 100 Area Physics Groups for the six months period from January 1 to June 25, 1946 was prepared in draft form under date 7/9/46.

Revised drafts were prepared of the following Operating Standards: 105-62A-X1, 105-63-A-X1, 105-64A-X1, 105-72A-X1, 105-73A-X1 and 105-74A. These revisions are contained in "Revision of Operating Standard", W. E. Jordan to C. W. Gross, 7/15/46, Document No. 7-4403.

Material for a Manual of Standard Technical Practices was collected and put into standard form. Sections of the manual on 100 Area General Physics, 100 Area Plant Assistance-File Physics, 100 Area Engineering, 300 Area Metallurgy and Report Preparation have been compiled and are in process of typing.

Shutdown Resume

The unit was shutdown on June 26, July 3, July 10, July 17 and July 24 for the discharge of metal. No special request material was removed from the pile during the month. One tube of special cast slugs was pushed at the shutdown of July 3.

Reactivity Changes

The following table compares the reactivity situation at the beginning and end of the report period. Data at the end of the period are for July 25, since the unit was not in a steady state on July 25.

	<u>6-25-46</u>	<u>7-25-46</u>
In rods	57 1h	69 1h
Xenon	438 "	438 "
P-columns	293 "	293 "
B-columns	16 "	16 "
Special columns	18 "	18 "
Total operating	<u>822 1h</u>	<u>834 1h</u>
Overall effect	-66	-66
Net cold reactivity	<u>756 1h</u>	<u>768 1h</u>

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- #1 W. E. Jordan - G. W. J. Woods
- #2 W. C. Key - 300
- #3 U. M. Staebler
- #4 E. B. Montgomery
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Division

AUGUST 31, 1946

TO: FILE

THIS DOCUMENT CONSISTS OF 6 PAGES

FROM: P. F. GAST

100 AREA TECHNICAL ACTIVITIES REPORT
- PHYSICS -
FOR PERIOD JULY 25 - AUGUST 31, 1946

B Pile - E. B. Montgomery

Reactivity of the 105-B Pile

Two indium foil irradiations have been made in the B Pile during the past month. These were made in process Tube 1363 at a distance of twenty feet from the charge end of the tube.

The first irradiation was made on August 8. Two foils were irradiated and the average result was 105.8 n/cm²/sec. The gas purity was 88%. The second irradiation was made on August 22. The average of the two foil counts was 106.1 n/cm²/sec. The gas purity on this occasion was 90%. These figures indicate 1.5% k below critical which is in agreement with results reported previously.

D Pile - E. B. Montgomery

Summary

The D unit has had five shutdowns during this report period. They vary from 18 to 22 hours in length. During this time, 288 regular metal tubes have been discharged. Four Special Request samples have been discharged and two have been charged into the unit.

Several efforts have been made to repair the leak in the "E" hole water supply system. These attempts were not successful and the graphite samples were removed.

The No. 9 shim rod thimble was examined and the graphite was removed for later examination. Because of mechanical difficulties encountered in the operation, the original positions of the central blocks could not be determined. The cause of the rod's sticking in the thimble was not apparent.

The strength of the poison pattern of the pile changed during the month due to the substitution of Special Request pieces for regular poisoning in some of the columns.

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DetailsSpecial Request Samples

A summary of Special Requests charged and discharged during the past month is given in the following table:

<u>Date</u> <u>Charged</u>	<u>S.R. No.</u>	<u>Material</u>	<u>Production Test</u>	<u>Date</u> <u>Discharged</u>	<u>Tube</u>
6-4-46	9-2	BeO	105-65-P	8-6-46	3574
6-4-46	25-2	Be ₃ H ₂	105-65-P	8-6-46	3574
7-2-46	25-1	Be ₃ H ₂	105-65-P	8-6-46	2878
8-6-46	15-2	H ₂ S	105-70-P Sup.A		3169
8-6-46	15-3	LiF	105-65-P Sup.C		2082
6-25-46	15-1	LiF	105-65-P Sup.A	8-20-46	1579

The first five of the above changes were made on August 6. They resulted in a calculated increase in the excess reactivity of 25 inhours. As this excess necessitated the use of No. 9 red in addition to A red the temperature distribution was unsymmetrical. On August 20 when Tube 1579 was discharged it was recharged with a P column of 51 nominal inhours or an increase of 25 nominal inhours.

When Tube 2878 was discharged it was recharged with regular heavy metal.

Other Special Tubes

Tube 2163 filled with cast slugs was discharged on August 6. Tube 2461, a corrosion tube was discharged August 15. On August 27 two bismuth tubes were discharged; they were No. 2088 and No. 2788.

The status of poison, dummy, "B" tubes, and Special Request tubes as of August 31 is given below.

<u>Tube</u>	<u>Charge</u>	<u>Nominal ih</u>	<u>Effective ih</u>
3169	15-2	21 inhours	
3179	3L-2P	38 "	
2668	2L-2P	44 "	
2682	15-2	52 "	
2374	1L-1P	46 "	
2066	2L-1P	34 "	
2082	15-3	41 "	
1569	2L-1P	34 "	
1579	2L-5P	51 "	
1474	3L-1P	27 "	
		388 "	
			nom. = 287 inhours effective
3574	All lead	7 "	5.2
2669	25-3	7 "	5.2
1686	19	7 "	5.2
0174	All lead	7 "	0.6
2451	" "	7 "	0.6
2496	" "	7 "	0.6

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Table Cont'd. -

<u>Tube</u>	<u>Charge</u>	<u>Nominal ih</u>	<u>Effective ih</u>
4674	All lead	7 inhours	0.6
3880	Bismuth	7 "	4
2788	"	7 "	4
2088	"	7 "	4
0960	"	7 "	4
			<u>321 inhours effective</u>

No. 9 Shim Rod Thimble

This thimble was removed to the burial ground and the graphite blocks were taken out. The blocks in the central portion of the tube were wedged too tightly to be removed without sectioning and slitting the thimble. As a result of this wedging and the manipulation necessary to remove the graphite the original positions of the blocks in the central portion of the tube were not recorded. Several of the blocks were fractured and these fractures may be used to help in reorienting the blocks.

Examination of the thimble failed to furnish the reason for the original difficulty with No. 9 rod. A more careful examination of the interior of the thimble showed no evidence of corrosion along the thimble where the CO₂ was introduced. Close observation was prevented by radiation.

Reactivity Status of the D Pile -

The reactivity at the beginning and at the end of this report period is given below.

		<u>7-22-46</u>	<u>8-26-46</u>
Amount	in rods	<u>38 inhours</u>	<u>53 inhours</u>
	in poison pattern	283 "	287 "
	in special columns	23 "	18 "
Absorbed	in "B" columns	16 "	16 "
	in xenon	497 "	497 "
	in power coefficient	-77 "	-77 "
	Total cold, clean react.	<u>780</u>	<u>794</u> "

Eighty six inhours of the above poison pattern absorption is due to Special Request samples leaving only 178 inhours-effective absorbed by the permanent poison columns.

F Pile - U. M. StaeblerSummary

During this report period, there were five scheduled shutdowns of the F Pile lasting between 14 and 18 hours. Two of these shutdowns were for maintenance work only, the other three were for the discharge of metal.

On August 7 three Special Requests were charged into the pile. Two of these displaced poison columns in the permanent poison pattern. The

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reactivity effect of these charges was in agreement with expectations. No Special Requests were discharged from the pile during this period.

A test was performed on August 28 to determine the reactivity power coefficients and the graphite relaxation period. No change from the previous trends in these properties is indicated by the results of this test.

Comparison of power coefficient data for the F Pile with equations developed from results for the D Pile leads to good correlation only in the case of the graphite relaxation period. The graphite coefficient seems to have been increasing in a more nearly linear fashion from start up for the F Pile. The early exponential term indicated by the D data is not apparent.

It has been found that apparent graphite thermal conductivities calculated from pile instrumentation agree very closely with laboratory measurements on cooled test hole samples of comparable exposure when the exposure of local graphite in the vicinity of the thermocouples is corrected for a cosine power distribution along the axis of the process tube. The ratio of original conductivity to current apparent conductivity is increasing at a rate of 0.0217/MWD/adjacent ten of metal.

There was a net gain of 17 inhours during this report period. Changing the overall power coefficient from 0.33 ih/MW to 0.38 ih/MW reduces this to an apparent gain of only 7 inhours.

Details -

Special Samples

During a shutdown on August 7 three tubes were charged with Special Request material. These charges are summarized in the following table:

<u>Tube No.</u>	<u>S.R.No.</u>	<u>Material</u>	<u>Nominal ih</u>	<u>Nominal ih Column displaced</u>
1569	15-3	Li F	41	30
2666	13-2	BegN ₂	20	27
2271	20	Tl NO ₃	7	0
Total Nominal			- 68	57

The above table indicates an increase of 11 inhours in nominal poison or an expected increase of 8 inhours in effective poison. Comparison of control rod positions before and after the shutdown indicate an observed loss in reactivity in agreement with the expected figure. Nominal poison values for the charges of LiF and BegN₂ are based on full column values of 60 inhours and 23 inhours respectively. A cosine power distribution along the tube was assumed in estimating the values for partial columns.

Power Coefficient Test

The power level of the pile was lowered from 200 MW to 176.6 MW on August 26. This power level was held for five hours at which time the power

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was returned to 200 MW. Data obtained in connection with these level changes have been used to evaluate the reactivity power coefficients and the graphite relaxation period. The results are summarized below.

<u>Coefficient</u>	<u>From Drop</u>	<u>From Rise</u>	<u>Ave.</u>
Overall power coeff., C_0	0.38 ih/MW	0.57 ih/MW	0.38 ih/MW
Graphite " " , C_G	0.64 "	0.60 "	0.62 "
Metal " " , C_M	-0.26 "	-0.23 "	-0.24 "
Graphite period	56 minutes	65 minutes	60 minutes

These results agree reasonably well with those obtained May 27, and indicate continuation of previously observed trends.

The record of power coefficients and graphite periods as a function of exposure in the F Pile has been compared with equations developed to represent changes in these properties based on all available data for the D Pile. These equations were included in last month's report, Document #7-4589, and in Document #7-4494, Interim Report on Production Test 105-50-P. Only in the case of the graphite relaxation period was there good correlation between data from the two areas. The graphite power coefficient appears to have been increasing linearly and is represented by the following equation:

$$C_G = 0.25 + 0.44 \times 10^{-5} E$$

E is the exposure in megawatt days per central ton.

The early exponential term indicated by the D data is not at all apparent in the F data. The rate of increase as given by the above equation is considerably greater than for the linear term of the equation representing the D data.

Since the value of the metal power coefficient has remained very nearly constant for both piles, the value of the overall power coefficient shows the same trend as the graphite power coefficient and is increasing more rapidly at F than at D.

Data for both piles scatter so badly that it is difficult to establish that these differences are real but further study of the results is in progress.

Apparent Thermal Conductivity of Graphite

It has previously been reported that the average apparent thermal conductivity of the graphite around the six central thermocouples is somewhat greater than indicated by laboratory measurements on cooled test hole samples with comparable exposure. This comparison assumed that graphite in the vicinity of the thermocouples received an exposure equivalent to central graphite. The use of poison columns parallel to the active tubes for flattening the pile's temperature distribution does not produce any flattening in the direction of the tubes. Since four of the six thermocouples used are over seven feet upstream or downstream from the center of the pile the average exposure of adjacent graphite would not be the same as for central graphite. Allowing for this difference in exposure by assuming a cosine distribution of neutron flux along a tube brings the two sets of measurements into good agreement.

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7-4733

8-31-46 7-2984

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Reactivity

Reactivity changes during this report period are summarized in the following table. Dates chosen are last points of equilibrium in each period.

	<u>7-22-46</u>		<u>8-28-46</u>
Amount held in rods.....	69 inhours		66 inhours
Amount held in xenon.....	438 "		435 "
Amount held in poison columns.....	293 "		198 "
Amount held in special columns.....	18 "		136 "
Amount held in B columns.....	16 "		16 "
Total at operating level.....	834 "		861 "
Overall power coefficient.....	-66 "		-76 "
Total cold, clean reactivity.....	768 "		775 "

Note that the value used for the overall power coefficient is different in the two tabulations so that although a gain of only 7 inhours is indicated for the cold, clean reactivity a gain of 17 inhours appears to have been realized under operating conditions.

Documents Issued

#7-4494, "Interim Report on Production Test #105-60-P..."
July 11, 1946, U. M. Staebler to File

#7-4560, "File Control- Temporary Poison During Extended Shutdown
of 105 D, June 17 to June 20." August 12, 1946, U. M. Staebler
to File

"Thermal Conductivity of Graphite in 105 D Unit"
August 8, 1946 W. K. Woods and U. M. Staebler to File

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W. E. JORDAN, CHIEF SUPERVISOR
100 - 300 TECHNICAL

By: Paul F. Gast
P. F. Gast

PFQ/lh

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1946

12

These were all
from 12.0 hours to
The galvan-
The Special Request
Special Request
Some difficulty
both tube exit water and
the normal operating level
for a short period of time.

The experimental hole became defective and
it was suspected that
the replacement had
been inserted further into the hole at the
time the other also gave spurious
at the next opportunity. The original
the "A" hole was first
a moist, brownish slurry was discovered.
pieces of material which looked like
aluminum metal.

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...times during ... level has been ... This condition arises ... Power Indicator ... where the ... when the refrigera- ... gradually starting ... with the charging ... month.

... of three central ... Central graphite has an average relax- ... after an exposure of 1000 megawatt days ... effort is being made to reconcile the ... for the whole pile ... changes in the power ... as measured by reactivity ... as large as the change in the period for ... measurements.

... pile vary within a range of ... during the interval following a ... must be adjusted by the horizon- ... Since the large deviations occur within a relatively short ... it is estimated that the calculated exposure of an individual ... by not more than three per cent if only equilibrium conditions are used in the calculation.

The P Pile had no net change in cold, clean reactivity during the month.

[REDACTED]

191.1 MW
191.1
194.4
188.0
191.5
189.5
189.4
192.0
188.4
190.7

There is no data available for the period immediately preceding the start of refrigeration on May 2, 1949, but available data indicate agreement to plus or minus one per cent between readings of power and the thermist instrument prior to the use of refrigeration. There appears to have been a gradual deviation after the start of refrigeration up to the minus five per cent stated above. A gradual drop would be expected inasmuch as the amount of refrigeration was increased gradually as needed.

The maximum depth of the overlying level of the pile will not affect the procedure suggested for Special Request samples, since they are obtained by means of the technique described in the water in adjacent water. A correction should be applied to graphite exposures and pro-

As a result of this, it was decided to correct for this condition, but no correction has been made because of the fact that it is planned to discontinue refrigeration early next month.

Special Requests

The charge and discharge of Special Request material during the month

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changes were in
best shadowing

have been determined

accumulated MW

100	108.108
75	109.470
50	110.804
25	115.864
75	117.067
75	112.300

observed for the
has been pointed out
increasing of a new

The graphite relaxation period, as measured by the reactivity changes associated with ionizing of the graphite temperature following a change in the power level, is about 60 minutes at present. The comparison of the relaxation period with the approximately constant control period in the reactor is not yet understood. A better understanding of the effect of graphite temperature on reactivity is needed. Thus far, it has not been possible to associate the two results satisfactorily.

Temperature measurements are taken each shift during the twenty-four hours following a shutdown and once each day thereafter. These maps have been used to determine the range of the pile's temperature moments as the horizontal rods are moved through the standard insertion and withdrawal order during this period of changing reactivity. The procedure for determining these temperature moments is described in Document #7-2854, "Procedure for Improving Temperature Distribution via Rods and

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10-30-46
 10-31-46
 10-31-46
 10-31-46
 10-31-46
 10-31-46

Other Special Notes

Three tubes were charged with 20 four-inch heavy metal plugs in each tube on 10-3-46. The tube numbers are 3869-D, 3870-D, 3871-D.

Reactivity

The reactivity status at the beginning and at the end of this report period is as follows:

	<u>9-30-46</u>	<u>10-31-46</u>
Amount in rods.	83 inhours	51 inhours
Absorbed P column of P pattern	166	0
Special Request in P pattern	128	308
Other Special Requests	10	15
Burnt	20	34
Lead Dummy	2	2
in Worth	497	497
in power coefficient	-77	-77
Total cold clean	728 inhours	515 inhours

F File - Dr. E. Stabler -

Summary

The power level of the F File has been corrected for the discrepancy noted in last month's report. Refrigeration was discontinued following the

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...temperature distribution ... of the pile as well ... for the effect of ... for improving temperature ... were obtained for ...

Overall Data For Oct.

... 15 32
... 17 14

These results are in good agreement with previously determined relationships. ... It is also possible that the effect should be ...

The P Pile gained very little or cold, clean reactivity during the month if allowance is made for xenon poison values corresponding to 190 MW for the beginning of the month and 200 MW at the end of the month.

Details

Special Requests

The following table summarizes the charging and discharging of poison and Special Request material during the month.

Date	Tube	S.R. No.	Material	lb	S.R. No.	Material	Nominal in
10-2-46	1474F	15-2	LiF	21	15-5	LiF	30
10-2-46	1562F	15-3	LiF	41	15-6	LiF	45
10-2-46	2082F	3-1	Po	45	15-8	LiF	45
10-2-46	2082F	-	Li-1F	34	15-5, 15-6	LiF	45
10-2-46	B Hole	-	-	-	11	Ba	0
10-15-46	1579F	-	11-3F	59	15-8, 15-7	LiF	48
10-16-46	3179F	-	31-5F	51	15-7	LiF	45
10-23-46	2284F	-	Po	0	-	Po	7

The temperature moments of the D pile under equilibrium operating conditions have been determined for the beginning and the end of the month according to the procedure described in Document No. 7-3320. The expected effect of the control rods in the D pile on the horizontal and vertical dipole moments has been determined from the above document, except that a further correction has been made in the horizontal dipole moment, corresponding Figure 1 of this document. The difference between the change in the horizontal dipole moment for the rod configuration is assumed to be due to the poison which remains in the pile. The horizontal and vertical poison moments have been calculated on the basis of the nominal strengths and the positions of the poison columns (all non-uranium bearing tubes). From these data the change in poison moment necessary to produce a one per cent change in the corresponding temperature moment has been calculated. The results of these calculations are summarized in the following table:

Date	Change in		Due to		Due to P		In L		In LU/%	
	ΔT	$\Delta \mu$	ΔT	$\Delta \mu$	ΔT	$\Delta \mu$	Hor.	Vert.	Δx	Δy
10-1-46	-11.9	0.8	-11.9	0.8	-23.9	13.7	914	-238.6	35	18
10-31-46	-15.7	1.8	-12.1	-14.8	-27.8	17.6	974	-292.5	35	17
Difference	-6.8	1.2	-4.9	-2.7	-1.9	3.9	60	-54	32	14

A value of 11 inhour lattice units change in poison moment for a one per cent change in the horizontal dipole as well as the vertical dipole was given in Document No. 7-3320. A study similar to the one reported above was made on the D Pile in December, 1945. Document No. 7-3320, "Poison Column Change at D on December 31, 1945", reports the result of this study as 20 inhour lattice units change in poison moment for a one per cent change in dipole temperature moment. Three of the tubes included in the procedure for determining temperature moments now contain charges other than uranium and thus cannot be used. In addition the temperature rises in several other of the tubes used in this procedure are probably affected by the close proximity of special tubes. These conditions may be partly responsible for the lack of agreement between currently reported results and those previously noted. Consideration is being given to a more advantageous selection of tubes to be used in calculating temperature moments in view of present pile conditions. Data on the effects of shifts in rod positions on temperature moments are

241
16
12
76
755

... in last month's report.
... at 180 MW which was

... in cold, clean re-
... gains for the pile
... subtracted from the
... in the
... loss of one inhour over

Special Report

Production Test 100-1-2 - Radiation Effects on Graphite

The graphite stringer removed from the "D" Test Hole of the D Pile on
... dimensional changes by
... percent recovery was
... in the "B" Test Hole indicates
... at 1000° C. On the basis of 94% re-
... the graphite in the "D" Test Hole stringer
... the "B" Test Hole, the corresponding
... 0.5%. The low value for ex-
... and agreement with the low values for stored
... reported by the Metallurgical Labora-
-tory.

P. F. Gast
P. F. Gast
100 Technical

FFG/Th

November 11, 1946

1. Title - R. E. Montgomery

Summary

The pile was down on November 1 and November 26 for regular maintenance shutdowns. At both shutdowns, the pile was down for nearly twenty-four hours (effective time down). Two scrams occurred during the month, one on November 4 and one on November 29. Both of these were of short duration. Five Special Request 16 tubes were discharged and recharged with Special Request 15. On November 1 a regular coefficient test was run for 5 hours at 221 MW. All refrigeration of processed water has been discontinued. Some 18 in hours of maintenance work has been done. Vertical rod bundles, 10 through 22, have been pressure tested. All of these were satisfactory. A monthly foil irradiation was made at 100-B. No significant changes were noted.

Details

Coefficient Test

On November 1 the level was dropped from 250 MW to 221 MW and held for 5 hours. Then the level was raised to 250. During the rise the unit was levelled at 245.5 for a few minutes before going

The temperature of the Special Request thermocouple showed the temperature of the Special Request thermocouple was that of a standard metal thermocouple. It was believed that the Special Request thermocouple was not a standard metal thermocouple. The thermocouple was not a standard metal thermocouple. The Special Request had

The two foils irradiated in Tube 1363-B gave an average η of 1.074 neutrons per cm^2 per second. This is slightly higher than last month, but is to be expected as it is within the experimental error and the new foil is slightly thicker. This gives a value of 1.42% k below critical.

Special Requests

The following is a summary of the charging and discharging of Special Requests in the D-Pile during November:

Date	Tube	Special Request No.		Special Request No.		Times Charged	Nom.
		Discharged	Placed	Charged			
11-5-46	3274-D	15-4	12	15-9	12	23	
11-5-46	1579-D	15-4	23	15-8	23	36	
11-26-46	2374-D	15-5	34	15-9 and 10	(21, 15-9 and 13, 15-10)	46	
11-26-46	2688-D	15-6	31		31	44	
11-26-46	2682-D	15-4 and 5	36 (14, 15-4)		56	48	
				(22, 15-5)			

Reactivity Status

The reactivity status at the beginning and at the end of this report period is as follows:

10-31-44 11-30-44

...this is to be expected as
the weeks, interrupted by only one shutdown.

...last month, 60 ih, the higher value
...of the value of a full column of
...A lower value of 60 ih nominal is
...method of evaluating monthly gains

...of the overall coefficient was gained
...of November 1st. It too, should be used for
...of the value of 77 ih given in the last
...monthly summary. The value of 77 ih resulted from the last previous
...coefficients test.

F. J. ... G. E. ...

A production test was performed to determine the reactivity power
coefficients of the F-11s at low power levels and with practically no
xenon poison remaining in the pile. The following results were obtained:

Coefficient	From Rise 0.2 to 36 MW	From Drop 36 to 0.4 MW	Average
Metal, ρ_m	0.32 ih/MW	0.33 ih/MW	0.33 ih/MW
Graphite, ρ_g	1.24 "	1.29 "	1.26 "
Overall, ρ_o	0.93 "	0.94 "	0.93 "
Relaxation Period	52 minutes	75 minutes	--

A rod calibration of A Rod obtained in connection with the test gives an
overall strength of 104 inches with Rods 2, 4, and 8 out, " at 134" out
and 8 temporary poison columns in the pile. The coefficient results
indicate non-linearity of the metal coefficient with power. They further
show that the graphite coefficient under the conditions of the test is
about twice that measured by means of the usual coefficient test. This
difference in the graphite coefficient is believed to be due to the de-

...the particular ... seems to depend

...the month and six ... other LIF columns. ... poisoning ... but it has ... disagreement to

...following the ... conditions just ... since October 31, ... since June 28, 1946, is in good ... No. 7-4207, "Letal ... to C. W. Gross, ... during this interval.

Known Rod Coefficient Test - Precision Test 105-78-P - Supplement A.

This test consisted of the following steps:

1. Critical rod conditions were established with A Rod at 100 ... and B to ...
2. A Rod was calibrated by means of 4 periods. These were taken with A Rod set at 140", 170", 200", and all out.
3. The power level was raised to 36 MW in less than 2 minutes and held constant at that level for five hours.
4. The power level was dropped to 0.6 MW and critical rod positions observed for 15 hours.

The time and magnitude of the turn-around point during the final critical condition measurements made it possible to reconstruct the xenon curve back to the point of the drop from 36 MW. It was then possible to

the above
figure rise
its effective-
perature rise
would be
corrected for
calculated below.

2.9
2.3
2.2
3.3
3.1

assumption that
of the tempera-
re of the
to be in error.
or the tempera-
rating at 250
data for other
der to obtain

charging of

red
material Nom. 1h

LIF	34
LIF	48
LIF	29
LIF	34
LIF	36
LIF	36

the above... a loss of one inch... It is... quality of metal charged into the piles during this int... expected graphite gains. Document No. 3-5092, "Weight... A.L. for metal tested since this has determined to be... 1 of Document No. 3-5097 predicts a net reactivity loss... for this average quality of metal being charged over th... comparison. The agreement between observed and predict... the total magnitude of... to be expected.

General Physics T. H. A. Fowler

Two sets of samples were removed from the "B" Test... 4 Pile November 4, 1944 having the following exposure:

Month

21

Month and at
following table,

11-27-46	11-30-48
17 inhours	17 inhours
31 "	260 "
16 "	15 "
41 "	41 "
2 "	2 "
76 "	--
64 "	--

for the month
of interest to
of the known
interval and the
Monthly d ih
d ih values for
average of
-0.11. Figure
of one inhour
period being
reactivity
the graphite

Hole of the
histories:

thermal conductivity ratio, 39.4, is in good
agreement with the value 40.1 in the
literature. The value 39.4 is the average of
the values for the 17 inhours samples than for the
17 inhours samples. The value 39.4 should be low
because the value varies as a function of
the temperature. The average of the values for the
17 inhours samples is in good agreement with the
value 40.1 in the literature. The value 39.4 is
in good agreement with the value 40.1 in the
literature.

The cross breaking strength is still decreasing.
The cross breaking strength ratio, B/B_0 , with expo
the following table:

Change %

0.30
2.5
2.2 0.28

showed the exposure
been partially
ole, B File.
(35°C. - 40°C.)
temperature
previously exposed,
energy will re-
piece. The
is very similar

No. 9 Thimble
spectrum
ately 150°C.

agreement with
ed from data
the D-file. Since
samples used to
er than the cal-
K₀. The ratio
agreement with
The graphite
saling of the

The variation
ure is given in

The agreement between samples exposed from the D-Test
File and the D-Test File is very close. The rate
of expansion of the samples exposed from the D-Test
File is very close to the rate of expansion of the
samples exposed from the D-Test File. The only significant
difference between the samples exposed from the D-Test
File and the D-Test File is the expansion of the
No. 9 Thimble is much lower than would be expected
and the ambient temperature of the graphite.

A visit was made to the Argonne Laboratory during
October 30 to November 2, for the purpose of obtaining
uranium reactivity testing and highest No. 15 process
the metal testing procedure are being used in getting
testing program in the D-Test File and the D-Test
used in connection with the D-Test File at Argonne was
with a view toward the eventual possibility of using
this for reactivity tests on small samples of uranium
Argonne process for preparation of lithium slugs and

exposure
section of the
table:

in good
of the D
expansion is
test hole, but
actory tests do
temperature of
erence is that
ample in the F
nits from the
the exposure

the period of
information about
Details of
p & similar
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o investigated
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traction of

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TO: FILE

FROM: W. E. JORDAN

100 AREA TECHNICAL ACTIVITIES REPORT - PILE

FOR PERIOD 12/23/45 to 1/23/46

100-B AREA - W. E. JORDAN

Summary

The B pile resumed operation on December 29 after a shutdown duration. The startup provided additional information on the effectiveness of temporary poison columns. The effect of exposure reactivity of metal has been evaluated both through the pile change due to the high concentration discharge of December change in the rate of gain of reactivity. A production test determination of rod calibrations and reactivity coefficients the interpretation of these changes.

Pile Control by Temporary Poison Columns

Information obtained from the use of temporary poison during shutdown of the B Pile was extended and confirmed by the exp-startup on December 29.

- 1) Five full poison columns located at a radius of 16 lat units in the pile, supplementing the horizontal rod array provide adequate control under present conditions for operation after a shutdown during which all the xenon has decayed.
- 2) The effectiveness of a poison column at a radius of 16 units was found to increase with the number of shim rods in the pile; the columns used on December 29-30 were found to penetrate 25 in when 2-1/2 rods were in the pile and 40 in 7 rods.
- 3) Considerable loss of reactivity occurs during a shutdown discharge temporary poison due to the rapid increase in poison and to the cooling of the pile. This may even compensate the gain in reactivity due to the discharge of poison. The pile should be shut down for the discharge of the rods hold ample reserve reactivity to start the unit. The startup is made while the pile is losing reactivity.

activity of the pile.
Exposure have been
this setup. Full
metal for de-
ity. It is also
reasons for the very
by tests on H.S.N.

W. E. Jordan
Fast
Technical

[illegible]

the same distribution coefficients and configuration. The higher value for ΔT in this case than the ΔT we measured with an identical system was due to the higher ambient temperature. The file was removed from the system and stored at

1. **Direct**
 2. **by**
 3. **25.**
 4. **25.**