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100 AREAS TECHNICAL ACTIVITIES REPORT

JUN 11 1956

ENGINEERS, FEBRUARY, 1951

300 AREA
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SUMMARY

Significant increases were made in pile power levels. The table below lists, for removal purposes, the average and maximum power levels for the months of January and February.

<u>Pile</u>	<u>January</u>		<u>February</u>	
	<u>Average</u>	<u>Maximum</u>	<u>Average</u>	<u>Maximum</u>
B	365	395	387	415
D	329	370	360	385
DR	442	463	448	484
F	270	320	357	380
H	469	485	469	500

The increases are due to additional knowledge of actual graphite temperatures, improved flattening due to the efforts of the pile physicists, and improved operation of the control rods by the P Division. The DR Pile was purged during operation and power cut backs due to film build up were reduced. Some additional increases in power level can be expected until the river temperature rises above 10°C.

Two stuck slugs occurred in H Pile during the month. Neither slug was a standard uranium slug. To date, a total of seven standard production uranium slugs have ruptured. The power generation of the ruptured slugs varied from 3.03 to 8.37 KW per slug and the exposure time varied from 17 to 239 days. In general the failures have occurred at the cap end of the slug. There is not a consistent trend detectable in the exposure of ruptured slugs which will point out the cause of failure. High power levels probably aggravate slug rupturing but the low power level failures indicate that a defective slug can fail at any power level.

The addition of more graphite temperature monitoring thermocouples in the B, D and F Piles has yielded information which has resulted in significant increases in power level. The graphite in the central portion of the 240 zone has a higher thermal conductivity than in the fringe zone of this zone. With the added knowledge, it is possible to operate with several water temperature rise limits in the 240 zone.

Graphite burnout samples loaded in bare tube channels are now being exposed at temperatures of 400°C. These samples which are scheduled for removal on approximately April 1, should yield valuable information regarding current pile graphite burnout rates.

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B PILE MONTHLY REPORT FOR FEBRUARY - H. L. Mars - R. H. Purcell

Operating Levels and Temperature Data. The B Pile operated at an equilibrium power level of between 370 and 385 MW prior to February 1. On this date maximum graphite temperature rise limits were revised to include equilibrium data obtained from the C Hole thermocouples installed on January 23, 1951.

Data from the C Hole thermocouples indicated that the apparent conductivity of the graphite in the center of the pile was higher than that of the graphite at the edge of the flattened zone where 13G thermocouple is located. Maximum graphite temperature calculations and ΔT_w limits for the .240 zone tubes were therefore calculated from C Hole thermocouples, VSR thimble thermocouples, and 13 G rather than solely from the 13G thermocouple. The .240 zone was divided into three zones. At the center of the pile the .240 A zone was assigned a $59^\circ\text{C } \Delta T_w$. A ring of graphite surrounding this zone, the .240 B zone, was assigned a ΔT_w . The outer .240 zone, the C zone, which included 13G thermocouple was assigned a $56^\circ\text{C } \Delta T_w$. The method used to calculate the limits is described in a report now in preparation.

These higher limits enabled B Pile to operate at a 400 MW level prior to the shutdown of 2/8/51. Further data from the graphite couples enabled the ΔT_w limits in the .240 zone to be set at 60° , 58° , and 57° in the respective A, B, and C .240 zones. A power level of 405 MW was reached at equilibrium after the 2/8/51 shutdown, and held until the 2/19/51 shutdown.

Data for these dates follow:

Equilibrium Data - Power Levels 400 and 405 MW 2-1-51 thru 2-6-51 and 2-12-51 thru 2-19-51

	Graphite Temperature		.240 Zone					
	13G	Calculated Maximum	Water Temperature Rise					
			.240 A		.240 B		.240 C	
			1 tube	4 tubes	1 tube	4 tubes	1 tube	4 Tubes
Average	355	368*	58.3	57.6	56.6	56.0	54.7	53.9
Maximum	365	386*	59.8	59.0	58.2	57.5	56.0	55.3
Limit	380	380	59-61**		57-59**		56-58*	

* Calculated from conductivities used in the three .240 zones

** Limits varied between these figures.

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All Data - Power Levels 360-thru 405
2-1-51 thru 2-23-51

	Graphite Temperatures		Max. ΔT_w .240 zone	Outlet Water Temperatures		
	13G	Calculated Maximum*		Maximum Outlet Temperatures .200 zone	.175 zone	.140 zone
Average	348	370	57.6	60.1	65.5	67.4
Maximum	375	386	59.8	63.5	69.2	70.6
Limit	380	380	60.0	70.6**	80	80

* Calculated from conductivities used in the three .240 zones

** At 5.7°C inlet temperature

Memorandum data concerning anticipated B Pile power levels have been prepared.

File Motion and Graphite Expansion. No unusual trends were shown by regular monitoring instruments.

SR Charge and Discharge. Under Production Test 105-377-P, on February 7, 1951 Tube 0965, Westinghouse creep calibration test slug, was discharged without incident. An additional calibration slug was charged, under a supplement to the production test. Details will be reported by the Materials Testing Group.

Magnesium Dummy Installation. Under Production Test 105-407-P four tubes were loaded with magnesium front dummies. The loading in order of charging was one 3 1/4 in. dummy, fourteen 6 1/2 in. magnesium dummies. A twelve inch aluminum shielding piece was screwed onto the front cap. An additional 2 1/2°C ΔT_w above normal ΔT_w was assigned to tubes 2370 and 2963 loaded in the .240 zone to compensate for the reduced flow. Tubes 0456 and 0457 were loaded in the .140 zone.

Exit Water Monitoring Rooms. The Z and X sample rooms were revised to eliminate the top row of solenoids. An investigation is being conducted to determine operational characteristics of the various types of chambers. Data obtained during the month is reported in the following three tables.

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Table showing volume of various ion chambers in use:

Single wound 3/8" O.D. Saran Chamber	750 cc
Triple wound 3/8" O.D. Saran Chamber	700 cc
Brass shimstock chamber #1	700 cc
Brass shimstock chamber #2	380 cc

Observed water flows in the single wound 3/8" O.D. saran chamber and the 700 cc brass shimstock chamber are noted below:

Head inches of water	single wound 3/8 saran tubing Flow liters/min.	Brass shimstock chamber Flow liters/min.
5"	.26	1.26
10"	.46	1.7
15"	.61	2.5
20"	.70	2.5
25"	.80	2.5

Table showing relative header activity in B Pile as measured with a chamber constructed with three 3/8" O.D. parallel saran tubes:

	Flow rate liters/minute	Activity 10-11 amperes
A Sample room	.4 to 2.0	.50 to 1.10
B Sample room	.9 to 2.3	.99 to 1.21
C Sample room	.4 to 1.5	.33 to .80
X Sample room	.6 to 1.8	.60 to 1.2
Y Sample room	.9 to 2.6	1.61 to 2.05
Z Sample room	.6 to 1.7	.43 to .75

Flow Requirements at 375 Riser Pressure. The normal riser pressure of 350 lbs. was raised to 375 lbs. on the shutdown of 2/6/51, to determine the additional flow required.

<u>Header Pressure</u>	<u>Flow Prior to Purge</u>	<u>Flow After Purge</u>
350	32,220	32,620
375	33,120	33,570

P.T. 105-330-P - Exposure of Depleted Uranium. One tube of this production test was discharged without incident at 350 MB/f exposure. The sole remaining tube will be discharged on the March 7th shutdown.

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D PILE MONTHLY REPORT FOR FEBRUARY - H. G. Spencer - C. W. Wheelock

Power Level. The D Pile operated at power levels ranging between 365 and 385 MW throughout the month, except for non-equilibrium periods at startup. No unusual radiation or effluent water activity was evident. No limiting thermal motions were experienced.

The highest calculated graphite temperature was 399°C. This was probably not an equilibrium value. Maximum calculated graphite temperatures ranged in general from 365°C to 380°C throughout the month. The procurement of good equilibrium data for establishing and correcting water temperature rise limits is proceeding as rapidly as possible.

Boiling Consideration Startup. Boiling consideration water temperature rise limits have been put into effect from the time of startup until any graphite or thimble thermocouple rises to 360°C. This new method of startup was used during the 2-15-51 and 2-19-51 shutdowns, with favorable results. However, its quantitative utility for the entire startup period was obscured by reactivity considerations which are explained in the report by the Physics Section.

Thermocouple Installation Program. On 2-15-51, number 24 VSR thimble was replaced with a new thimble with six thermocouples spaced along it. The first equilibrium data available since the installation have shown high apparent thermal conductivity around the new thermocouples.

Flux Traverse. Tube 1385 was charged with numbered solid aluminum dummies during the 1-16-51 shutdown. They were discharged at the start of the 2-14-51 shutdown and an attempt was immediately made to determine their activities with the underwater Beckman or "weasel". The half life of the dummies was found to be too short to allow the determination of an accurate traverse, but a considerable reduction of activity was noted at a position near the location of one of the control rods used during previous operation. High storage basin background made later "weaseling" inadvisable. Further data will be obtained above water.

Shielding Test. The Development Group conducted shielding tests at VSR Number 20 concerning ball 3X design. Details are reported in their monthly report.

Pile Motion and Graphite Expansion. During the unscheduled outage of 2-19-51, vertical traverses were taken of tubes 2451, 2496, and 4674. Tubes 2451 and 2496 had been traversed before on 12-20-50 and 1-16-51, respectively. During this period, the elevation of tube 2451 increased throughout its length. Maximum increase was .19 inches at 19 feet from the front tube flange. The elevation of tube 2496 had increased .15 inches at 13 feet from the front tube flange. Data further toward the center was not obtained, because the traverse equipment failed. The data of these two traverses are quite likely in error, since the failure included the loss of mercury.

The elevation of tube 4674 toward the center of the pile has continued to decrease rapidly. The 2-19-51 traverse gave a maximum elevation of 2.61 inches at 13 feet from the front tube flange while on 10-25-50, an elevation of 2.75 inches at 14 feet was the maximum obtained.

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Shield motion instrument data taken during the month showed the general continued slow rate of graphite contraction as has been indicated during the past month. During the February 19 outage the vertical Ames gauge at the top of the pile on the near side was re-zeroed after moving the gauge to a new position. Accumulative settling of the top of the unit necessitated this adjustment. The rear face Pneumatic Electric Tightwire was repaired during the February 15 shutdown.

Effluent Water Samples. The A sample room changes, including piping rearrangement, exit water manifold addition, and bubble separator installations, which were begun during January were completed for the other sample rooms during the month. The addition of a second valve to the sample lines now makes it possible to shut off one or more lines, if necessary, without disturbing the flow adjustment of the regulating valve. The drain manifold changes did not remove the sample room air contamination problem as was hoped.

Test Facilities. One phase of the NEPA Creep test was successfully completed during the month, and the information obtained is being reported by the group involved. Priority front elevator work prevented the charging of a new sample at the completion of this test but the process tube involved, as well as a second central tube, will be charged with similar samples on the next shutdown.

A pressure test of the B test hole located leaks where three of the return tubes join the flange. An attempt will be made to repair these leaks at the first opportunity.

DR PILE MONTHLY REPORT FOR FEBRUARY - P. A. Johnson - J. E. Robb

Pile Performance. The DR Pile operated between levels of 450 to 480 MW during the month except for two unscheduled outages and a period of reduced level held while the pile was purged during operation. One short shutdown was caused by panellit instrumentation failure. The other outage was caused by a critical power condition, but the shutdown time was utilized to increase the pile flattening and water flow. No unusual behavior was noted as the power level was increased up to a maximum of 485 MW. The maximum measured graphite temperature increased to 290°C (293°C calculated). The average percentage gas analysis for the month was CO₂, 96.6%; O₂, 1.0%; CO, 0.5% with an average gas loss of 2100 standard cubic feet per day and an average daily condensate removal of 25 pints from the gas driers.

The power level has continued to be limited by the 68°C temperature rise in the .240 zone because of boiling considerations. The power level gains during the month resulted from increased water flow and improved flattening. A gain of 9 MW was possible after a successful purge during operation conducted under the provisions of Production Test 105-417-P on February 7. A further gain of approximately 20 MW resulted from increased flattening and increasing the water flow by cleaning the orifice screens in several tubes which had a consistently high outlet temperature. It is expected that a power level of 500 MW will be attainable after the shutdown of March 7 when the pile will be purged and further adjustments will be made in the poison pattern. Typical operating data for the month are summarized below:

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Power Level	Maximum Measured Graphite Temp.	Maximum Calculated Graphite Temp.	Max. Water Temp. Rise Central Tube	Maximum Outlet Water Temperature
452 MW	269°C	271°C	68°C	73°C before purge
465	279	281	68	74 after purge
465	273	274	67	71 before shutdown
481	290	293	68	72 after shutdown added poison

Calibration of Water Flow and Power Level Instrumentation. A calibration of the Bailey flow meter by Instruments and the Power Division has indicated that it is probably reading about 2% low. Further calibrations will be necessary, however, before it can be definitely stated that this is correct. If the calibration shows that the meter is reading low, approximately a 10 MW increase in measured power level would result.

Production Test 105-417-P - Purging During Pile Operation. A purge during operation was conducted under the provisions of Production Test 105-417-P on February 7. The pile power level was reduced to 250 MW during the duration of the purge and the effluent water was diverted to an empty basin and then into the crib for disposal. The pile was purged for 30 minutes with diatomaceous earth and flushed for 20 minutes. At the conclusion of the flush the nominal power level was resumed. The purge reduced the pressure drop on the eight central tubes in which this quantity is usually measured by 21 psi and increased the overall water flow by 1100 gpm. A power level rise of 9 MW can be directly attributed to the purge. A loss of 18 MW days occurred because of the reduced level during the purge but this loss was obviously regained in two days of operation at the higher level.

The radioactivity from the effluent water was not excessive. A sample of water from the inlet to the 107 Basin had an activity of 64 mrep/hr 15 minutes after sampling. This compares with an inlet activity of approximately 15 mrep/hr during normal operation and an activity of approximately 25 mrep/hr from the purged material during a normal shutdown purge. An analysis of the long-lived radioactive constituents has not as yet been received from the analytical laboratories.

Water flow to the sample rooms was shut off during the purge. Considerable flow adjustment was necessary for about a day after the purge as some of the valves were partly plugged. This, however, is often a problem after an ordinary purge. A scheduled purge on March 7 will be conducted during the shutting down period to attempt to demonstrate a way to gain additional maintenance time on a regular shutdown. A complete report on operational purging will be written after the March 7 test.

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Inspection of Metal Pieces. The 27 downstream metal pieces from the ruptured slug in tube 3188-DR and the two pieces from this tube which were dropped into the front elevator pit were visually inspected. No evidence of any unusual abnormality was found.

All the metal pieces from tube 3967-DR were inspected and found normal. This tube was discharged on the shutdown of February 18 when a radiation level of 800 mr/hr was found on the rear pigtail. No substantiating evidence of activity could be found in a water sample from the tube, but since it was also noted that the near side water sample activity on cross-header 39 1/2 had been high the previous evening for about an hour, it was decided to discharge the tube as a precautionary measure. The tube was discharged with the charging machine and reloaded with regular metal. The exact cause of the radioactivity is unknown.

An inspection of 600 slugs in the DR metal storage by P Division and Technical resulted in 36 rejects. The main defects noted were deep pits, gouges, and evidence of porosity around the weld. This high incidence of rejects is some evidence that the several slug failures which have occurred were probably due to definite faults in the cans or welds which slipped by inspection.

Unit Motion. Cold motion readings indicated no unusual motions of the pile structure have occurred. The center of the top shield of the pile has dropped approximately .10 inches and the center of the front and far side of the top has risen approximately .10 inches. The maximum graphite expansion noted by the push rods was .16 inches at a point two feet toward the front face from the pile center. This is an increase of .06 inches over that shown by a vertical traverse on 11-8-50. All outward bowing of the sides and faces of the pile is less than .05 inches. Hot motion readings taken at a level of 480 MW showed little difference from the cold readings except for the thermal expansion of the rear shield and the graphite.

F PILE MONTHLY REPORT FOR FEBRUARY - W. D. Gilbert - S. Goldsmith

Power Level and Pile Operation. The power level at the 100-F Pile was increased from 315 MW to 380 MW in successive steps over a period of 15 days with a three day waiting period between each 20 MW increment. At the end of each period hot unit motion data were taken, a temperature map was made, and temperature from all thermocouples were obtained. A limiting graphite temperature of 380°C on thermocouple 19-3 (see thermocouple locations) was reached at a power level of 380 MW. This temperature was obtained in the filler block adjacent to the bare tube channel 2682, in which the graphite burnout samples are located. A temperature of 400°C was recorded for the hottest graphite burnout sample during equilibrium operations at 380 MW and up to 410°C as rod changes were made to obtain the level of 380 MW.

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On the basis of these operating data, authorization was granted to operate 100-F Pile at a power level sufficient to maintain the hottest graphite burnout samples at 400°C. Under these conditions it is anticipated that graphite temperatures adjacent to tubes 2682 and 2777 will be in the range of 380-390°C, and maximum observed temperatures in other portions of the pile will be in the range of 360-370°C. With proper control rod configuration, it appears possible to maintain the power level at 380 MW, or perhaps slightly higher, without exceeding the 380°C graphite temperatures, except as noted above.

The schedule of power level increases, together with graphite temperatures and apparent graphite thermal conductivities ($K = Q / T_g$), is given below:

Date	Power Level		Temperatures Before Power Increase			Conductivity - K*	
	From	To	13G	14G	19-3	13G	14G
2-1-51	315 MW	335 MW	331°C	328°C	346°C	4.98	5.52
2-5-51	335	355	343	340	350	5.03	5.57
2-9-51	355	365	354	348	346	5.29	5.81
2-12-51	365	375	356	354	374	5.08	5.73
2-16-51	375	380	354	356	373	5.17	5.86
2-27-51	—	380	359	358	384	5.35	5.95

* Conductivity units are $\text{chu/hr.ft.}^\circ\text{C} = 1 / T_g$

From the above data it appears that the graphite thermal conductivity is increasing with increased power level and temperatures. Calculated average conductivities of graphite around thermocouples 13G and 14G at 380°C, and the rate of change of the conductivities are as follows:

Thermocouple No.	K at 380°C	Rate of Conductivity Change**
13G	5.27	0.0059
14G	6.10	0.0103

** Units are $\text{Chu/hr.ft.}^\circ\text{C per } ^\circ\text{C}$

An evaluation of thermal conductivities calculated from all presently working thermocouples are presented in Table I. These conductivities were calculated at the temperatures indicated at equilibrium operation.

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TABLE I

Graphite Thermal Conductivity Data
100-F Pile - February, 1951

Couple No.	C-Hole	VSR Thimble Number							
		<u>16</u>	<u>19</u>	<u>22</u>	<u>23</u>	<u>24</u>	<u>25</u>	<u>30</u>	<u>31</u>
Graphite Temperature and Conductivity									
1	308 3.604	—	312 3.924	327 4.890	345 5.628	332 5.403	327 5.136	329 5.571	318 5.489
2	340 5.667	—	321 3.804	—	350 5.541	340 5.865	307 6.197	316 6.225	314 6.080
3	327 6.270	355 5.613	384 5.233	376 5.177	357 5.748	—	338 4.447	323 6.544	332 6.181
4	332 6.184	363 5.330	—	372 5.740	356 6.166	340 6.032	340 5.994	336 6.268	314 6.047
5	340 6.055	356 5.537	358 5.365	330 5.404	350 6.344	345 6.317	358 5.757	333 5.508	333 5.686
6	338 6.237			351 5.241	327 6.383		340 5.667		350 5.978
7	360 6.034								
8	352 5.956								
		<u>10G</u>	<u>11G</u>	<u>13G</u>	<u>14G</u>	<u>16G</u>	<u>17G</u>		
		337 3.480	349 3.696	359 5.352	358 5.951	294 4.300	289 5.090		

Conductivity units are Chu/hr.ft.-°C

Thimbles 22, 23, 24 and 25 lie in a central transverse plane; thimbles 16 and 19 lie in a transverse plane 1.67 ft. in front of the central plane; thimbles 30 and 31 lie in a transverse plane 2.67 ft. behind the central plane.

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CO₂ Concentration. During the month of February, 100-F Pile operated at a nominal 100% carbon dioxide concentration, with an average of 97% and a minimum of 94%.

Unit Motion. In accordance with present operation procedure, unit motion data were taken after each 20 MW increase in power above the previous maximum level. Readings taken at 315, 335, 355, and 375 MW showed no significant changes from previously established trends.

Gas Leak. After the startup on January 26 a gas leak was detected on the front face. An attempt was made to stop the leak by spraying with the cocoon equipment in the vicinity where the leak was thought to exist. This was unsuccessful, and the pile was shutdown for an hour while "boots" were placed around the gunbarrels of tubes 0259 and 0260. This procedure also did not stop the leak. At present it is thought the leak is around tubes 0159 and 0160, and "boots" will be placed around these gunbarrels on March 7th.

Within 10 minutes after the shutdown on January 30 to repair the leak, the riser water pressure was reduced to 100 psi, and cross header 2 1/2 was valved to reduce the pressure to 20 inches. The nozzle on tube 0259 was removed and a hose, connected to a water outlet in the work area, was inserted into the tube. In a period of 74 seconds required to remove the nozzle and insert the water hose, the outlet water temperature of tube 0259 increased at a rate of 26°C per minute. After the water was supplied to the tube, the temperature decreased at a rate of 21°C per minute. For tube 0260, 55 seconds were required to remove the nozzle and insert the hose, during which the outlet temperature rose to 105°C at a rate of 70°C per minute. The outlet temperatures of remaining tubes on Row 2 increased at the rate of about 5°C per minute, and after about eight minutes the maximum temperature leveled out at 55°C.

Graphite Burnout - P.T. 105-391-P. On February 19, the first group of graphite burnout samples were removed from the bare process channel 2682, and new samples were installed. These new samples will remain in the pile for about eight weeks at a temperature of approximately 400°C. Data from the 18 samples removed will be compiled as soon as possible.

Radiation levels of 500 to 1000 Mr/hr were encountered in the removal of the graphite samples, aluminum sample carriers, and the chromel-alumel thermocouples wires.

Thimble Temperature Correlation - P.T. 105-414-P. The auxiliary thermocouples placed in the bare No. 24 VSR hole were removed on February 19, and the VSR thimble containing five chromel-alumel thermocouples was installed. Further thimble thermocouple data will be collected for comparison with the auxiliary thermocouple temperatures.

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Slug Corrosion - P. T. 105-9-P. All recent corrosion data collected under P.T. 105-9-P, Monitoring of Slug Corrosion, are tabulated in Table II. There is no apparent good correlation between outlet water temperature and slug corrosion rates. However, it was noted that corrosion rates at 100 H Pile are slightly higher than at other areas for the same outlet water temperature. Data are not yet available from the 100 DR Area. An attempt will be made to correlate these corrosion rates with corresponding slug surface temperatures.

P.T. 105-103-P. Supplement D of Production Test 105-103-P, Slug Corrosion Rates at Elevated Temperatures, has been approved. Four process tubes in the central zone with valved pigtails will be charged at 100 F Pile on March 7, 1951. Thirty-two slugs per tube will be weighed in air and water for corrosion measurements, and attempts will be made to maintain outlet water temperatures up to 95°C. Tubes previously charged are also being operated at the highest practical temperature up to 95°C.

P.T. 105-330-P. Data from P. T. 105-330-P, Irradiation of Depleted Slug, indicate that corrosion of the depleted slugs is somewhat less than for the regular metal, but to date the data are incomplete and inconclusive. In most cases it appears that deformation of the depleted slugs during irradiation was sufficient to cause large underwater-weighing weight-loss errors.

TABLE II

CORROSION DATA

Tube No.	Exposure Days	Out. Water	Corrosion Rate (Mil/mo.)		
		Temp. °C	Average	Maximum	Ave. & Highest
Production Test 105-9-P					
0990 B	492	41.2	0.084	0.136	0.127
1060 B	372	56.2	0.18	0.24	0.21
1374 B	266	56.0	0.10	0.17	0.16
1457 B	348	56.2	0.09	0.20	0.18
1467 B	283	53.6	0.12	0.21	0.19
1478 B	266	52.0	0.09	0.18	0.14
2175 B	273	41.6	0.09	0.17	0.15
2359 B	293	44	0.07	0.12	0.10
2459 B	293	44	0.06	0.09	0.09
2564 B	266	50.9	0.13	0.19	0.18
2787 B	328	44.6	0.07	0.10	0.08
3470 B	280	51.4	0.10	0.15	0.14
1387 D	313	45.5	0.11	0.24	0.18
3066 D	280	45.6	0.08	0.13	0.11
3389 D	353	43.6	0.09	0.22	0.16
0554 D	659	42.0	0.02	0.03	0.03
1173 D	288	49.9	0.13	0.22	0.19
1258 D	381	48.4	0.09	0.15	0.15

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Table II (cont)

Tube No.	Exposure Days	Out. Water Temp. °C	Corrosion Rate (Mil./mo.)		
			Average	Maximum	Av. & Highest
3684 D	292	42.3	0.11	0.20	0.18
0690 H	424	41.0	0.07	0.14	0.12
2172 H	132	39.5	0.12	0.18	0.17
3889 H	324	41.4	0.09	0.16	0.14
0687 F	523	45.0	0.08	0.14	0.12
1681 F	309	48.0	0.07	0.13	0.12
2383 F	254		0.13	0.20	0.20
3562 F	286	51.9	0.13	0.23	0.21

Production Test 105-330-P

2878 B	68	52.8	0.08	0.12	0.11
		Depleted Slug—	.007	0.013	
2366 H**	77	44.7	0.024	0.076	0.056
1565 H**	178	41.8	0.048	0.094	0.083

** Depleted slugs showed no detectable weight loss.

Air Weighing Apparatus. Testing of the apparatus to weigh corrosion test slugs in air has been discontinued until changes in the design can be incorporated in the apparatus. These changes were made by C. H. Goldthorpe of the Development Group.

Slug Charging Test. The Project Engineering Group wishes to eliminate the two-minute oiling period now used before regular metal charging. To determine if this will result in excessive wear on the process tube, a series of slugs were charged into a process tube in the 100-F flow lab.

The first part of this test has been completed and consisted of charging a process tube with regular metal equivalent to 40 charging cycles without oiling. The first two chargings were made with the tube completely dry. The remaining 38 charges were made to simulate the conditions of 20 inches of water flowing into the tube.

Measurements of the interior of the tube were taken, front and rear, after every ten charging cycles to determine to what extent the ribs on the process tube were worn. After 40 chargings the ribs were worn down approximately 0.012 inch. This is approximately the thickness of the zinc coating on the ribs. No measurements were taken after the first two chargings were made. The results, however, indicate that most of this wear may have been a result of the two dry chargings.

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The second part of the test will be run using a new process tube with all charging conducted with water flowing through the tube. At the completion of the test one-foot sections will be cut from the front, center, and rear parts of the tubes. These sections will be mounted and polished by the Metallographic Laboratory and a visual determination made of the damage done to the tube.

Extended Shutdown Work. During the shutdown for the nozzle-replacement program, thermocouples were installed on several vertical safety rod thimbles, and vertical manometer traverses were made on horizontal control rod thimbles 2, 5 and 6. Details of these will be discussed below.

a. Thimble thermocouple installation

The following are the location of the chromel-alumel thermocouples in the VSR thimbles installed in F Pile during the extended outage of January 6, 1951.

<u>Thimble No. & Location</u>	<u>Thermocouple No.</u>	<u>Location of T.C. Tube Row No.</u>
16 (Between tubes Nos 64-65)	16-1	38-39
	16-2	30-31
	16-3	24-25
	16-4	17-18
	16-5	10-11
19 (Between tubes No. 82-83)	19-1	40-41
	19-2	32-33
	19-3	25-26
	19-4	19-20
	19-5	12-13
	19-6	6-7
22 (Tubes No. 61-62)	22-1	38-39
	22-2	29-30
	22-3	26
	22-4	25-26
	22-5	17-18
	22-6	8-9
23 (Tubes No. 67-68)	23-1	37-38
	23-2	37
	23-3	26-27
	23-4	21-22
	23-5	17-18
	23-6	9-10

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<u>Thimble No. & Location</u>	<u>Thermocouple No.</u>	<u>Location of T.C. Tube Row No.</u>
24 (Tubes No. 74-75)	24-1	39-40
	24-2	31-32
	24-3	25-26
	24-4	14-15
	24-5	7-8
25 (Tubes No. 79-80)	25-1	37-38
	25-2	30-31
	25-3	25-26
	25-4	21-22
	25-5	15-16
	25-6	7-8
27 (Tubes No. 91-92)	27-1	32-33
	27-2	25-26
	27-3	18-19
30 (Tubes No. 70-71)	30-1	38-39
	30-2	31-32
	30-3	25-26
	30-4	21-22
	30-5	7-8
31 (Tubes No. 76-77)	31-1	38-39
	31-2	32-33
	31-3	25-26
	31-4	21-22
	31-5	17-18
	31-6	11-12

Thimbles No. 22, 23, 24, 25, and 27 are located on the front to rear centerline. Thimbles No. 16 and 19 are located 2.67 ft. in front of the front to rear center. Thimbles No. 30 and 31 are located 2.67 ft. in rear of the front to rear centerline.

All thermocouples were placed adjacent to the filler blocks of the tube rows as indicated, except thermocouples No. 23-3 and 23-2 which were placed adjacent to the tube block.

b. C Hole Thermocouple Installation

The chromel-alumel thermocouples which were placed in the C test hole on January 6, 1951 are located as follows:

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T.C. No.

Location Tubes No.

C-1	93-94
C-2	87-88
C-3	81-82
C-4	78-79
C-5	75-76
C-6	72-73
C-7	69-70
C-8	59-60

The C hole is located between tube rows 21 and 22 and 1.57 ft. to the rear of the front to rear centerline of the pile.

c. Traverses of HSR Thimbles

The results of the traverses made of HSR thimbles Nos. 2, 5, and 6 are plotted in Figure II. These results showed the amount of machining of the graphite tracks that was necessary for the horizontal rods to move freely in the thimbles. All horizontal rods at F Pile now move freely at any position in the pile.

H PILE MONTHLY REPORT FOR FEBRUARY - E. C. Wood - R. B. Hamilton

Power Level and Limits. H Pile attained a power level of 500 MW on February 22. Limiting conditions were temperature rises per H-10 tube of 56° and per O.285 zone regular metal tube of 58.7° . The hottest graphite thermocouple was 17G on the far side of the H-10 loading at 390° . The hottest central thermocouple was 14G at 381° . The maximum performance H-10 tubes were around 8G, 48G, and 32G all of which were below 380° . The limits on operating above 500 MW were the temperatures of 31G and 14G, both central thermocouples, although not in the maximum performance region, and the temperature rises of four regular metal tubes in the H-10 load. After a Beckman scram on February 24 the power was returned to 500 but, as equilibrium approached, could not be held because of limiting temperature on the regular metal tube. Power was cut back to 495 on February 27.

Ruptured Slugs. There were two ruptured slug incidents in H Area this month. The first occurred in 2562-H on February 2. This tube was charged with specially prepared metal under P. T. 105-330-P, Supplement A, on October 2, 1950. It was scheduled for discharge (at about 215 MWd/T) on the next shutdown. The ruptured piece was an alpha-rolled, lead-dipped piece located 21 or 22 pieces from the upstream end. It was stuck in the tube and could not be pushed normally, therefore the special discharge procedures used previously were employed. In the process of discharging the tube a uranium piece was evidently cut into by the tube cutting torch. The extent of the damage to the slug is not yet known, but the resulting near face contamination, though high, was not enormous. Considerable confusion was occasioned, however by the fact that the can containing slugs from the downstream end of the tube was inadvertently raised out of the water below the elevator. The resultant extremely high readings at the rear face labyrinths were at first feared to have been caused by the contamination spread from the slug.

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The second rupture was a P-10 target slug in 3177-H. This was discovered when operating personnel attempted to backseat the charge in this tube, in an effort to find the cause for its high outlet temperature and panellit reading, during the electrical outage of February 18-19. The piece was the first target slug from the downstream end. It was preceded by 19 regular metal pieces and one J piece. Its discharge was effected by flushing the downstream pieces out of the tube, reaming out the downstream ribs, and pushing the slug into the reamed out section with 6500# force. When examined after discharge the slug was found to be larger than normal both in length and in diameter. The end cap was partly pushed out of the can and the can itself, in addition to having been severely gouged during discharge was split through axially for about $3/4$ of its length.

Front to Rear Distribution and H-10 Production Rates. Plots of relative activities of solid aluminum pieces from two of the three tubes discharged on 2-12-51 are shown on the attached figures. These traverses are run both to check the effect of rod configuration changes and to obtain data for the more certain evaluation of graphite temperatures. The traverse of 3270-H shows that the effect of using A and 10 rods instead of 5 and 11 has been to push the maximum flux to the front of the pile in much the same manner as 5 and 11 pushed it to the rear. From the viewpoint of graphite temperature control this is superior to the previous distributions because, as shown in the figure, there are thermocouples so located that the peak can be measured.

The traverse from 1583-H is even more interesting. This tube was in a region where its axial distribution was little affected by rods. The flat-topped shape of the curve shows the extent to which depletion of the fuel slugs has gone forward since the first traverse which was reported in August. This axial self flattening also accounts for much of the power gain at H Pile since the first large rise to 470 MW in November, because the central graphite temperature becomes less and less a limiting factor as the fuel slugs deplete. At the present time the pile is limited in power as much by boiling considerations as by graphite temperature, and it is to be expected that graphite temperature will soon not be a limiting factor, even in the H-10 load.

H-10 production rates calculated from these curves and from data taken at equilibrium before shutdown show that the 1583 pattern produce about 10% more H-10 than the 3270 pattern.

Magnesium Dummies. Solid magnesium dummies were installed in H Pile on February 13 shutdown. Because these restrict the flow, panellit gauges had to be reset before startup. It is believed that the tubes chosen for this test are far enough out of the flattened cone that their higher outlet temperature will not necessitate a power reduction, but the possibility should be kept in mind as a consideration in the front dummy program.

Variable Strength Rod System. A preliminary survey of the possibility of obtaining a more symmetrical and effective control system has been prepared and will be issued early in March.

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P.T. 105-402-P. Effect of Water Vapor Concentration on Pile Gas Equilibria. The precision orsat apparatus for this equipment has arrived and been set up. The test began on February 26 and was extended by agreement between area technical and P Division representatives beyond a 24 hour period. At month's end it appeared that the moisture content of the pile gas had stabilized below the 5X normal level permitted by this production test. Results will appear in next month's report.

P.T. 105-410-P. Front To Rear Temperature Traverse of H Pile. Results from this test are not as critical as they were when the test was first written. This results from the fact that the graphite temperature maximum has been pushed to the front of the H-10 load where thermocouples are available to measure it. Therefore, by agreement with the P Division, the performance of the test will be postponed until ample elevator time is available from necessity of some other shutdown work. The test will, however, be run before removal of the H-10 load.

Pertinent Data From Standard Uranium Ruptured Slugs - C. W. Wheelock

The following table was prepared as a summary of the more important exposure conditions to which the slugs that have ruptured had been subjected.

Tube & Area	Date of Rupture	Time In Reactor (Days)	POWER GENERATION		Surface Temp. of Slug	Slug Position In Tube Numbered From Front
			KW Tube	KW Slug		
1165F	6-4-48	17	156	3.45	28°C	33
0569B	11-25-48	50	226	3.13	49	52
1572D	6-23-50	38	196	4.26	38	38
1476DR	11-29-50	29	360	7.90	37	30
3288H	12-6-50	183	301	6.67	38	34
3188DR	1-11-51	108	381	8.37	44	37
3270H	1-31-51	239	353	5.20	53	53

C. W. Wheelock
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ENGINEERING DEVELOPMENT GROUP

BALL 3-X DEVELOPMENT - T. P. Heckman and D. J. Foley

To determine the shielding afforded by the balls incorporated in the experimental step plug now installed in the No. 20 vertical control position, neutron levels were measured near three different vertical rods. The first values were taken at the deck level near No. 20, which contains the special ball 3-X step plug and a solid-tipped rod, No. 33 which has a shortened rod guide and a sectioned rod, and No. 38 which has the original design rod guide and continuous rod. These values of neutron readings indicated that No. 20, with flutes full of balls, was better than No. 33 by a factor of 4.5; and better than No. 38 by a factor of 2.

During the shutdown of February 14, 1951, the steel balls were removed from the flute that has its entrance on the "far" side. Approximately three hours after the pile's startup, the radiation readings indicated that No. 20 was still better than No. 38.

Because of power trouble, D Pile was down February 19, 1951; so the balls in the second helical flute were removed. The neutron values obtained February 21, 1951, at a power level of 370 MW indicated that No. 20 was better than No. 38 for shielding intermediate and slow neutrons by a factor of 1.16.

The intermediate neutrons were measured with a moderated BF_3 tube; the slow neutrons were measured with a BF_3 tube; the fast neutrons were measured with a methane chamber. The values for fast neutrons were so low on the scale of the instrument that the accuracy was questionable; therefore, fast neutrons were not included in the factor of shielding between different rod positions.

Because the time allowed on top of D Pile during operation was short, the values of neutron intensity were taken hastily and cannot be considered too accurate. Nevertheless, these values do indicate that a ball 3-X step plug with gates above the top of the B shield could be made to satisfy shielding requirements.

CAULKING TOOL FOR VERTICAL GRAPHITE CHANNEL - T. P. Heckman

Several means of controlling the loss of 3-X balls in the pile are under consideration. One method would be to caulk the existing spaces between vertical liner blocks with some material. A tool for installing a plastic material is in process of design.

Materials that will satisfy the physical, mechanical, and nuclear requirements are being investigated.

The mock-up of the special step plug gates with positive action features was completed. Operation of the mock-up is good. However, the linkage pivots are necessarily quite loose in fit because of the complexity of their motion, which allows some play. It is felt that ball and socket type linkage pivots would overcome this trouble and a modification of design is in progress. The mock-up shows that the operation of the gates could be made quite positive.

Preliminary design of an experimental "football" type expanding plug for use in catching balls during a Ball 3-X drop test has been completed. Sketches of each part have been submitted to the Technical Shop for fabrication of a test model.

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CORRECTION

The preceding document has been re-
photographed to assure legibility and its
image appears immediately hereafter.

The tapered flute step-plug mock-up is completed and has been installed at 189-D in the test tower. Actual tests will await the approval of a test program of experiments to be made.

3-X BALL DEVELOPMENT AND PROCUREMENT - W. K. Alexander

The Crucible Steel Company, Universal Ball Company, and the Norton Company were visited to investigate the availability of boron containing balls. Three different possibilities appear feasible and a small amount of development work should determine which will be the most economical. The carbon steel ball with 1.5% boron lacks the necessary corrosion resistance but is satisfactory otherwise. The possibility of plating or coating this type ball is being investigated. A second possibility is to use a stainless steel ball. This is also being investigated by Crucible Steel Company and the Universal Ball Company. The third possibility is the sintered nickel-boron carbide ball which has been developed by the Norton Company in conjunction with the Reactor Division. It appears advisable to develop more than one source of supply to insure delivery of the required amount of balls when needed.

WATER STUDY PROGRAM - R. M. Fryar

The water quality experimental program is proceeding along the course outlined in last month's report, but because of a series of difficulties, approximately a month of construction has been lost in the development of the experimental facilities. The AEC Directive authorizing the construction of the facilities was received in the early part of February and as per a previous decision the Maintenance Division was authorized to proceed with the construction. When work was barely underway, the Maintenance men were called off the job while the Legal Department revaluated the construction project. A new decision called for the work to be done by CPFF forces. Approximately ten days were required to line up these forces and for them to begin construction. Again work was barely underway when an administrative decision as to the division of responsibility of testing delayed the approval signatures on necessary plans for approximately one week and this in turn delayed construction. It is hoped that in the future the project will not be so plagued with time consuming difficulties.

The Water Study Group in conjunction with the Plant Assistance Group and the Power Division has undertaken a study to evaluate the possibility of increasing the pile header pressure. It appears feasible to increase the header pressure by replacing the secondary pump casings with similar casings made of a stronger alloy. This group is evaluating the effect of this change on the operation of the 105 piles. It is anticipated that a report will be issued covering the results of this study.

FILM FORMATION STUDIES - J. M. Atwood and K. J. Schneider

Installation of new tubes and steam jackets for the film formation studies in 100 F Flow Laboratory is essentially complete. The Laboratory steam facilities were redesigned to provide maximum heat flux through two mock-up process tubes and to enable automatic control of the outlet water temperatures during pile shutdown.

Canned aluminum test slugs have been received from 300 Area "P" Division and have been weighed preparatory to loading of the test tubes. Twelve of these slugs were treated with Dri-Film, a silicone compound which forms a water-repellent layer on surfaces to which it is applied. The treated slugs will be located in conjunction with the untreated test pieces to obtain information about the behavior of Dri-Filmed surfaces regarding film and corrosion inhibition. Follow up process tube tests based upon laboratory experimental data which shows Victor cans are anodic in

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process water to Scoville and Alcoa cans will be conducted to determine if this characteristic has any effect on film formation.

ANALYTICAL RESEARCH STUDIES - M. Lewis (Analytical Research Group)

Dri-Film, a silicone product for coating various metals was found to form a hydrophobic film on aluminum. Uncoated metal was attacked immediately by 0.1 N NaOH, whereas the coated metal was passive for ten minutes. Both samples were attacked immediately by 0.1 N HCl. A variety of other reagents are under tests.

Tap water at 55°C was allowed to run down both sides of an aluminum sheet, dri-filmed on one side. The coated side showed faint evidences of film formation after one week. The uncoated side had a definite brown stain after two days, and became a dark brown after one week. This test is being continued.

Twelve slugs were dri-filmed for testing in the Flow Laboratory.

METALLURGICAL AND CORROSION STUDIES - R. S. Dalrymple (Metallurgical Group)

Experimental results have definitely established that the aluminum slug cans manufactured by Victor are anodic to those manufactured by both Alcoa and Scoville in pile process water. This characteristic was not found when the potential was measured in a standard potential solution. This anodic effect could account for the fact that not all slugs in a given process tube are equally coated with film. It is planned to monitor slugs discharged to ascertain if there is any correlation between the amount of film present on the cans made by the various manufacturers.

HEAT TRANSFER GROUP - M. W. Carbon

A Heat Transfer Group was formed within the Development Section during the month. The function of the group is to handle the problem associated with heat transfer and removal in or from the piles. At present the group consists of four people.

BOILING DISEASE STUDIES - M. W. Carbon

Work has been started on three problems: (1) To determine the boiling disease limits as used at the piles; (2) to determine the feasibility of using IBM machines to make pressure drop calculations for the boiling region; and (3) to determine the practicality of increasing the permissible tube power by changing the tube outlet fittings. To date, most effort has been spent in training new personnel.

RECALIBRATION OF IRRADIATED IRON-CONSTANTAN THERMOCOUPLE WIRES - H. H. Greenfield

There is reason to believe that the original calibration of the graphite thermocouples 13 and 14 has changed appreciably due to the effects of irradiation on the physical and chemical properties of the thermocouple wires. The graphite temperatures measured by thermocouples 13 and 14 have been higher than the temperatures calculated from the readings of the newly installed C-Hole and thimble thermocouples at the B and F Piles.

The original physical condition of the wires may have changed due to the hardening effects produced by the neutron bombardment on the wires. Calculations made by G. E. Duvall, Pile Physics Section of Pile Technology, on the change in chemical composition of the wires due to neutron bombardment show that as much as 0.4% of the copper in the constantan wire could have been converted to zinc over the time

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period that D and F Piles have been operating. Both of these effects could introduce significant errors in the temperature indications. Since the graphite temperatures are currently limiting the power level at B, D, and F Piles, it is essential that the effects be evaluated.

It is planned to recalibrate up to 400°C iron-constantan thermocouples that have been exposed to pile irradiation. The calibration will be done with the aid of the Metallurgy Section at 111B.

The following thermocouples are available for testing at this time:

#5 - Horizontal Rod Track Thermocouple at F Pile

About eight feet of the 26 B&S gauge iron-constantan couple from the shielding and reflector zone of the thimble was removed in September, 1950. An additional four feet was removed in January, 1951, prior to the horizontal bowing traverse on the #5 thimble. The end of this wire was about 10 feet from the center of the pile.

B-Hole Thermocouple at D Pile

A 20 B&S gauge iron-constantan thermocouple was removed from the B-Hole thermocouple at D Pile in September. This was installed in the latter part of 1946 and the hot junction was located at the center of the pile.

B-Hole Thermocouple at F Pile

A 20 B&S gauge iron constantan thermocouple was removed from the B-Hole thermocouple at F Pile last May after only four weeks of exposure. The hot junction was located about 11 feet from the center of the pile.

MAGNESIUM SLUGS - C. H. Goldthorpe

The inlet of ten tubes of the 100-B Piles were filled with dummy magnesium slugs on February 13, 1951. The tubes (0358, 0764, 0785, 0995, 1088, 1185, 3293, 3492, 3685, 3691) were charged with one 3-1/4" magnesium slug, fourteen 6-1/2" magnesium slugs, and one 12" aluminum cap extension dummy slug which fits across the nozzle and gun barrel flanges. Tubes 3293, 3685, and 3691 were not charged with the aluminum cap extension piece since the new inlet nozzle cap plugs would not fit into the galvanized nozzles. The aluminum cap extension dummy slugs were not screwed into the original cap plugs since the original consisted of a pinned sacrificial piece and this type of connection would not hold the cap extension piece rigid within the process tube. For this reason the inlet nozzle caps were replaced with the type found on the other four piles with the exception of the three mentioned tubes. Three cap plugs have been turned down and will be placed in the three tubes on the next shutdown. The ten tubes were borescoped to determine the condition of the tubes before the magnesium slugs were charged into the pile.

Four tubes of the 100 B Pile were charged on February 19, 1951. These tubes (2963, 2370, 0457, 0456) were charged with one 3-1/4" magnesium slug, fourteen 6-1/2" magnesium slugs, and one 12" aluminum cap extension. The tubes were borescoped before they were charged. During the next shutdown five additional tubes will be brushed, borescoped, and charged with magnesium dummy slugs.

UNDERWATER CHEMICAL SLUG CLEANER - C. H. Goldthorpe

The engineering design and the drawings of the Underwater Chemical Slug Cleaner are complete. This equipment will be made by the Instrument Shop. The equipment will be used to chemically remove the film formed on slugs during exposure so that an accurate determination of its weight may be obtained and its corrosion rate while in the pile determined.

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SLUG AIR WEIGHER - C. H. Goldthorpe

Drawings have been prepared on changes which will be made to the Slug Air Weigher apparatus to obtain a water tight seal. Technical Shops will make these alterations.

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ASSISTANCE TO PILE PHYSICS GROUP, UNDERWATER MONITORING SYSTEM - C. H. Goldthorpe

Drawings on the underwater monitoring equipment have been completed during the month. The 101 Technical Shops are making this equipment with the exception of the gamma chamber which is being made in the Instrument Shop. The monitoring chamber is 50% complete.

IRRADIATED SLUG BUBBLE⁰ TESTER - C. H. Goldthorpe

The design of a periscope used to watch for the presence of leaks in slug cans has been completed and drawings have been made. This periscope will be made by the Instrument Shop.

SPECIAL LEAD SHIPPING CASK - C. H. Goldthorpe

A 2500 pound lead shipping cask to be used for shipping special requests off the plant site has been completed.

RUPTURED SLUG TRANSFER CHAMBER - D. J. Foley

Work on the production of an experimental transfer chamber is approximately 50% complete. All necessary materials have been obtained including the special Tru-Lay Push Pull operating cables.

NEW TUBE FULLER - D. J. Foley

The sketches of the tube clamp and tube cutting template have been submitted to the drafting section for finished drawings and a drawing number. An addition to the design is a ball bearing cable swivel.

W. K. Alexander
PILE TECHNOLOGY DIVISION

WK Alexander:dd

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