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**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest Laboratory
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August 18, 1950

100 AREAS TECHNICAL ACTIVITIES REPORT

COPY 1 OF 1, ~~ORIGINAL~~

ENGINEERS - JULY, 1950

This document consists of
13 pages, No. 13
28 copies Serial

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MECHANICAL DEVELOPMENT GROUP

Thimble Removal Program - TP Heckman - MC Balcom

Ball Flow Tests

Tests were run in the ball 3-X mockup to determine if it will be necessary to have the balls polished rather than using them rough just as they come from the stamping machines. It was found that the flow rate for the rough balls was on the order of 20% slower than for the polished ones. This difference is sufficient to make it worthwhile to polish the boron steel balls which it is proposed to use for the Third Safety. Further flow testing in the mockup indicated that the 1/4" ledge between the 4 1/2" diameter hole in the cast iron block and the 4" hole in the graphite should be removed and the transition tapered over a six inch length to prevent retarding the flow of balls. A special tool to make this taper has been fabricated and will be tested.

Fluted Stepped Plug Fabrications.

The spirally fluted stepped plug for feeding the balls into the pile was 90% complete at month's end. It is planned to install this plug in the #20 position on D Pile during August. It will be tested for operability and gas tightness before installation.

Plug for Rod Hole Drain Slot

Mock-up tests indicate that approximately 15# lead rope when cut in short lengths and tamped in the bottom of the VSR hole will satisfactorily close the drain slot to prevent loss of balls. The lead rope and tamper are being prepared.

Ball Retriever

The design of a retriever for removing boron steel balls from cracks between the end of the vertical blocks is 90% complete. This proposed device will be attached to the borescope and will use both air jets and magnets.

Special Pile Measurements and Instruments - P. A. Johnson - J. B. Cole

Horizontal Thimble Traverse

A vertical bowing traverse was made of the number 2 horizontal thimble at D Pile using the mercury level manometer. The data are shown in the accompanying graph.

Bore Measurements

The diameter of the graphite bore was measured in tube channel 2253-B and re-measured in tube channel 2286-D. In tube 2253-B both the vertical and horizontal diameters lay in the range of 1.745" to 1.752". The data from 2286-D indicated that after running as an open channel for approximately 2 1/2 years, the horizontal diameter still ranges from 1.750" to 1.760" while the vertical diameter has remained at 1.745" ± .005". A report is being prepared summing up the current data on graphite bore diameters.

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Curvature Measurements

Curvature measurements in tube channel 2586-D indicated that the maximum curvature in the blocks was 0.013" in 16 inches in the third graphite block from the front face. The data also showed that the vertical misalignment of the blocks at their junctions was less than 0.010".

Endwise Expansion Measurements

Measurements of the length of the graphite stack continued to indicate that no significant change is presently occurring in this aspect of the pile structure. Apparent expansion of 23/32" in channel 2675-F and 29/32" in channel 2253-B were noted.

Instrument Developments

Slope gage

After successive calibration trials it was found that fresh fluid must be put in the gage before each use. If the fluid remains in the lucite gage body more than 36 hours the sensitivity of the gage falls off sharply. It is believed that the lucite material destroys the effect of the aerosol in eliminating surface tension.

An operating procedure for use of the slope gage has been prepared and affixed to the case built for the instrument. The slope gage has been modified and tested to a point where it is now ready for its production test in the pile.

Mercury Manometer

The revisions to the mercury level manometer designed to make this instrument safer and more dependable were completed, installed, and tested. Instruction was given to personnel of the area engineer group in the use of this instrument in obtaining vertical traverses of 4674-D and 4574-B. It is planned that henceforth vertical traverses will be obtained by area engineer group personnel.

Graphite Core Cutter - J. B. Cole

The technical shops, 101 Area, are preparing detail drawings on the graphite core sample cutter. This cutter is to remove graphite samples from the tube channel anywhere in the pile.

Graphite Sampling - P. A. Johnson

The 48 inch section of filler block graphite previously cut from the side of the "A" test hole in D Pile was successfully removed from the pile using a vacuum attachment on the retrieving tool. The specimen is currently being analyzed by the physical chemistry group.

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Vertical Thimble Temperatures

Design work is proceeding on a special vertical thimble which will be installed adjacent to the 13G graphite thermocouple in D Pile. This thimble will have approximately ten thermocouples located about the region nearest the 13 G couple. The temperature data to be obtained from these couples should help correlate the thimble temperature with the graphite thermocouple temperature and should also give information on the possible existence of temperature perturbations.

Ruptured Slug Problem - D. J. Foley

This project is to provide the P Division with equipment for use in removing and disposing of ruptured slugs. The recent experience at D pile indicated the need for such equipment. It is tentatively planned to provide casks for moving the good slugs from in front of and behind the ruptured one and placing them in an adjacent tube. The bad piece will be pushed out with the tube into a special cask for disposal. Preliminary sketches of the proposed equipment have been prepared and approved by P Division.

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PLANT ASSISTANCE GROUPB PILE TECHNICAL REPORT - H. L. Mars - H. G. Spencer

Power Level and Graphite Temperatures: The B pile operated at 305 MW with a goal 100% CO₂ concentration during the first portion of July. Graphite temperatures and permissible water temperature rises were sufficiently below the limits to justify an increase in power levels. A production test PT 105-337-P has been approved to increase the power level to 335 MW by 15 MW increments. The initial increase to 320 was made without incident on July 29th.

The power increase was made possible by a combination of more uniform flattening of the pile and apparent annealing of the central zone graphite. Graphite temperatures based on 13G temperature shows that a 48°C Δt can now be allowed. The hottest tubes at B Pile have been running about 42.7°C Δt so that a total of 5.3°C additional temperature rise is available. The 30 MW power rise should keep the Δt below the new 48°C limit.

The new limiting temperatures are shown below:

<u>Zone</u>	<u>t°C</u>	<u>Outlet Temp. for 20°C Inlet</u>
.240	48	68
.200	57	75*
.175	65	75*
.140	75	75*

* limited by corrosion.

Temperatures and limits at B Pile through July 25 are shown in the table below:

	<u>Observed 13G Temp.</u>	<u>Calculated Maximum Graphite Temp.</u>	<u>Observed Maximum Δt</u>	<u>Maximum Outlet Water Temp.</u>
				<u>.200 .175 .140</u>
Average	296.9	350	42.6 47	-----
Maximum	309	372	44.6 48.4	66.9 71.0 71.0
Limit	380	380	45.0 54.0	72.5* 75.0 75.0

* at 18.5°C inlet, 75° limit for corrosion.

V.S.R. Thimble Thermocouples. The thermocouples on VSR #26 were inspected by the Instrument Division on July 6th and the short circuits were determined to be about 4 to 5 feet below the flange. An apparently successful attempt was made on July 25th to repair the thermocouples. The short circuit was found in both cases to lie under a metallized part of the thermocouple where insulation was powdered. These bad sections were removed by the Instrument Division and new sections of

thermocouple wire spliced in. The splice was made by using extremely small mechanically crimped connectors. The work was done in a comparatively high radiation zone and under SWP conditions. On July 27th both thermocouples were reading satisfactorily. However, it should be pointed out that only one of approximately 20 metallized sections of each thermocouple have been repaired and it is possible that the insulation is bad at each metallized point. It is recommended that no more VSR thimbles use the metallizing method of attaching thermocouples, except possibly to attach lugs which can be mechanically bent over the thermocouple wires, after the wire is installed. The resistance of the thermocouple wires, (including short leads), after repair was 139.8 ohms for the 18' 3" wire and 150.8 ohms for the 28' 9" wire.

One thermocouple is 18' 3" from the flange on the thimble, on the front side of the thimble, and tubes 3085, 3086, 3185, 3186 surround the couple with the couple closes to row 31. The other couple is 21' 9" from the thimble flange, on the rear side of the thimble, and tubes 2585, 2586, 2685, 2686 surround the couple with the couple closes to row 25.

B Hole Graphite Samples. B Hole graphite samples, (under the Research Group Control), were removed from B Hole and stored on X level July 6th, because temperatures on the B hole threatened to exceed the 35°C limit now in force.

Production Tests. The discharge level of PG-105-277-P Exposure of Metal Transformed by Induction Heating, was increased to 350. The metal in general appears to be stable although two badly blistered slugs were found. The blister on these particular slugs were much larger than those observed on group V slugs.

D PILE TECHNICAL REPORT - J. F. Sullivan - J. M. Atwood

Power Level, Graphite Temperature and Water Flow. A nominal CO₂ concentration of 1.00% and a power level of 305 MW was maintained through the month.

TEMPERATURES OF LIMITS OF D PILE FOR JULY

	Graphite and Thimble Temperatures				Water Temp. Rise Δt			
	Observed 13G	Observed 14G	Calc. Max.	#24 VSR Thimble Temp.	.240	.200	.175	.140
Average	325	320	345	310	43.5	48	55	55
Maximum	332	338	368	317	45.0	52	70	71
Limit	330	380	380	380	45°C	54°C	75°C*	75°C*

* 75 C limit set by corrosion.

A production test was written during the month to raise the power level of the D pile to 390 MW. The pile will be operated at the maximum level based on a limiting 400°C thimble temperature. The limiting values of graphite temperature and water temperature rise controlling thimble temperatures are unchanged but the pile will operate at the established limiting value rather than at a lower value.

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Unit Motion Measurements. The unit motion data for the month indicate further lowering of the center graphite and slight annealing of the cooler front graphite. One micrometer bracket indicated a relatively large outward movement of the Top Far Front corner, but other instruments and subsequent hot readings of the same instrument show that no unusual motion has taken place.

F PILE TECHNICAL REPORT - M. W. Carbon - W. D. Gilbert

Graphite Temperature. The 105 F Pile operated at a nominal 305 MW during the month. The CO₂ concentration was constant at 80% until July 24, steps were taken to increase the concentration to a nominal 100%. At month end the concentration was 90%.

The calculated daily maximum graphite temperatures varied from 315 to 380°C although they remained at approximately 340 C on 80% of the days. The thermocouple on the #19 vertical thimble generally indicated a temperature approximately 30°C below the value calculated for this position using the 13G couple as a basis. There is some disagreement between the 13G and 14G graphite thermocouples. For a given specific local power level the 13G couple reads 35°C hotter than the 14G couple. If the 13G couple is found to be in error a higher power level can be reached. Plans are in progress to install a thermocouple thimble adjacent to the 13G couple in an effort to establish its accuracy. In the meantime the maximum graphite temperatures are being calculated from the 13G couple which indicates the highest value.

Unit Motion. Cold unit motion data gave no significant changes in most of the readings. However, the vye levels indicated that the center of the Top shield is continuing downward while the front and rear of the Top are remaining motionless. Vertical traverses will probably be made on two tubes during the next month.

A ruptured slug was suspected during the July 19th shutdown. However, later evidence indicated that high contamination in the discharge area rather than a ruptured slug was causing the high count.

H PILE TECHNICAL REPORT - E. C. Wood

Power Level, Graphite Temperature and Water Flow. Prior to the H-10 loading graphite temperatures were low and of little concern even at the present 400 MW power level. Although an increase in central graphite temperature was anticipated with the H-10 loading, the indications from the first group of tubes loaded were

that the graphite temperature rise was of the order of 12 - 15%, which still would have been well below the limit of 370°C set for the protection of the aluminum thimbles. However, after the loading of the fourth group of H-10 tubes on the tenth and eleventh of this month the readings of thermocouples 8G and 17G became high.

It was found that graphite temperatures in some parts of the pile were exceeding limits, and a limit of 49°C in a single tube within the H-10 pattern was imposed. As more data became available during the month this limit was revised downward to 48 degrees decreasing to 47 degrees for an inlet water temperature of 20 degrees. Within this limit H pile has been unable to run at its nominal power level of 400 MW during the greater part of July.

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An outline of the H-10 pattern as of July 11, 1950 is shown on the attached figure. Graphite temperature limits have been encountered only in the region of the H-10 pattern around tubes 3263 and 1563 where the H-10 is surrounded on three sides by regular metal. It is believed that this is an edge effect between the two loadings which is accentuated by the sharp horn of the pattern and may well disappear, or become much less severe when the H-10 pattern is completely loaded.

In order to check on the accuracy of the method used for calculating the maximum graphite temperatures values of the ratio

$$\frac{q}{\Delta t} = \frac{\text{heat generation in graphite per axial foot}}{\text{graphite temperature elevation above local water}}$$

were calculated from a sample of previous H pile data. The results show that the rms deviation from the mean ratio for any one thermocouple of those studied did not exceed 5%. A comparison of these factors for each plane perpendicular to the axis of the pile in which thermocouples are located shows that it is possible, within about 10% or so to calculate the temperature of one thermocouple from the readings of another consistently, unless there is a marked condition of non-equilibrium. However, it is not possible to do this for thermocouples in different planes, or possibly, since no data are available, from one in the flattened zone to one on the fringe. Since the factor $q/\Delta t_g$ is proportional to the apparent conductivity of the graphite, this effect may be a measure of the varying degrees of graphite damage in different portions of the pile.

A table of values of the factor $\frac{T_{\text{ex}}}{T_g}$ flow for four thermocouples in the central

zone before and after the H-10 loading is instructive and is included below. Pre H-10 data is based on a sample of 9 days readings from two months after startup to the end of May. The post H-10 readings are based on data taken from July 14, 1950 to July 26, 1950 in an effort to obtain adequate data on which to base a Δt limit in the H-10 zone. Figures are averages for each sample.

TC	32	33	34	48
Pro H-10 Loading	4.89	5.12	4.97	4.98
Post H-10 Loading	3.59	3.06	3.04	3.46
Ratio	1.35	1.67	1.67	1.44

It is difficult to draw a conclusion from this until a more thorough study is made, but indications are that the heat generation in the graphite packing around the H-10 loading is in excess of that around the normal loading by an amount greater than the 30% anticipated.

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FRONT FACE DIAGRAM

SHEET D-3

HW-18627

AREA: H

DATE: 7-11-50

OUTLINE OF H IS LOADING ON 7-11-50

LEGEND:

☐ REGULAR

☐ CORROSION

☐ SR. NO.

☐ "P"

☐ R.D.

☐

☐ "E"

☐ SR. NO.

☐

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CO₂ ConsumptionConsumption
Std. Cu. Ft./WeekNo. Shutdowns
In Period AveragedAvg.
% CO₂Avg.
% CO

5103

1

93.6%

4.0%

Unit Motion. Unit motion readings for July are given in Document HW-18468. There were no unusual thermal motions observed during the month. No vertical bowing measurement was taken at H pile in July.

Production Tests. Tubes 2268, 2279, 2172, and 1085 were discharged on PT 105-9-P during the month. All of these except 1085 were reloaded as H₂O corrosion tubes with only the J slugs weighed.

SPECIAL REQUEST CONTAINER SLUG - H. G. Spencer

At the request of the Physics Section, design calculations were made to determine the minimum allowable wall and end thickness for a special request slug to be used for irradiating non-rigid samples. Water pressure of 375 psi and a pushing force of 2000 pounds with a safety factor of 3 were used as a basis of calculation.

The recommended can should have a 1/8" wall thickness and a 1/4" end cap.

SUMMARY OF CALCULATIONS

For 2S aluminum, estimated tensile strength - 12000 lbs/in²; estimates shear strength - 8000 lbs/in².

Type Of Force	Type Of Stress	Part Stressed	Minimum thick- ness in inches. No safety factor	With 1/8" walls & 1/4" End caps-Factor of Safety
Pushing	Compression	Walls	.038	3.28
Pushing	As column	Walls	.038	3.28
Pushing	Bending	End caps	.0861	2.90
Pushing	Shear	End caps	.0669	3.74
-----	Transverse	Walls	.0225	3.33 for
Pressure	Compression	Walls		additive combined stress.
Pressure	Longitudinal	compression Walls	.015	

EXPOSURE OF P-10 FUEL SLUGS P. T. 105-316-P. - W. D. Gilbert

Two P-10 fuel slugs, J-9 and J-10 were discharged at D Area on July 17, 1950 after an exposure of four months. These slugs showed apparent corrosion rates of 0.64

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and 0.72 mils/month, respectively. For each slug, the diameter increased 0.008 inches, and the length increased 0.036 inches. These volumetric changes were sufficient to cause a large error in the calculated corrosion rates. For this reason, in the future corrosion rates on P-10 fuel slugs will be determined by weighing the slugs in air before and after irradiation.

The Technical Services Design Group are working on a device which will permit hot slug weighings in air. Until this can be accomplished the effect of high heat fluxes on slug corrosion rates can not be determined.

SLUG CORROSION STUDIES P. T. 105-9-P. - W. D. Gilbert

At B Area, three tubes were charged with Group V metal slugs, every fourth slug being measured for length and diameter and weighed.

At H Area, three tubes were charged as corrosion tubes containing an H-10 loading. These slugs were also weighed and measured.

CORROSION RATES AT ELEVATED TEMPERATURES P.T. 105-103-P SUPPLEMENT B. - W. D. Gilbert

An interim report on this Production Test was written which provided the basis for increasing the outlet water temperature to 75°C.

The installation of valved pigtails in the 0.140 zone on July 12, 1950 was postponed, but will be installed on August 2, 1950, at F Area.

Due to high outlet water temperature when the pigtail valve was closed, the orifices on tube 4367 were changed as follows on July 11, 1950:

	<u>Plug Orifice</u>	<u>Std Orifice</u>	<u>Water Flow - GPM</u>	
			<u>Closed</u>	<u>Open</u>
New	0.150	0.140	7.75	9.5
Old	0.144	0.175	7.4	12.5

In order to obtain more indicative temperatures from thermocouples 14G and on VSR thimble 19, and to help alleviate a hot spot on the near side, standard orifices were installed on July 19, 1950 in several tubes to replace the reduced orifices previously installed for the Van Stone corrosion program. These tubes were 0952, 0954, 1054, 1057, 2681, 2682, 2683, 2689 and 3582.

FRONT TUBE CORROSION - PT 105-291-P. TUBE 2253-B. - John F. Sullivan

Tube 2253-B was removed from the pile during this month for corrosion inspection. This completes the tubes which are to be removed under this program. The front portion of six tubes which have contained special solid front dummy charges for three months were inspected. These tubes contained significantly less corrosion products on the tube walls than they had at the start of the test. These tests are being continued.

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A production test has been written which will allow 20 more experimental dummy test to be conducted on the B and D piles.

FLOW LABORATORY EXPERIMENTS - J. M. Atwood

Work conducted in the flow laboratory indicates that front tube corrosion is not a result of the stainless nozzles. These experiments show that the stainless nozzles do not cause significant corrosion to occur more than 1/2 inch below the Van Stone flange.

Experiments show that replacement of a solid front dummy pattern would decrease the water flow about 5%; this reduction in flow would cause a 2°C rise in outlet water and graphite temperatures. The chattering of dummies placed close to a cap support piece was demonstrated to be negligible.

Slug Corrosion. A test to determine the effect of tin and uranium content on the corrosion resistance of Al-Si has been initiated. Nine slugs, prepared by the Metallurgy Group, were charged in the D flow loop mock-up process tube on July 11. Inspection of these slugs will be made periodically.

W. R. Lewis
W. R. Lewis
Pile Technology Division

WR Lewis/wjk

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