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METALLURGICAL LABORATORY

Report for May 1944

Part I - Summary

Probably the most outstanding event in the Physics Divisions for May was the demonstration of the chain reaction in a heterogeneous heavy-metal P-9 system. The critical condition was reached on May 15. Some alterations in the design are being made before operation at power takes place.

The usefulness of thermocouples in monitoring the neutron distribution in a pile was successfully demonstrated during the month, which introduces a new measuring instrument, probably intrinsically more reliable than the old ionization chambers and counters.

Among the many chemical researches during the month, the continued study of the W extraction process at W concentrations, and the work on problems in connection with the use of dichromate as an inhibitor in the W cooling water stand out as especially important. In connection with the former of these, the action of scavengers was intensively studied. The reduction of dichromate under the action of radiation was studied in co-operation with Site X, and rapid methods of analysis for the extent of the reduction were devised. There was continued work on the fundamental chemistry and crystallography of our product and its compounds.

The shift of the main activities in connection with Al-Si bonding of slugs to Hanford influenced the emphasis on canning in the Technical Division. During the month it was demonstrated by a semi-works run that zinc bonding is a feasible method for the production of canned heavy metal slugs.

Work on methods of stripping off the jackets and reclaiming slugs improperly bonded was initiated.

In the Health Division activities it was demonstrated that the porphyrin metabolism is affected in groups of individuals who by occupation handle heavy metal. This was shown by a study of personnel in the metal production operation at Ames, Iowa. The test is a very sensitive one and a detectable disturbance of the metabolism does not indicate physiological damage of any significance.

The total expenditures for the month of May are $811,031.40 as compared with $799,925.32 for April, an increase of $11,106.08. The net increase in the number of personnel employed on the project was 114 during the month of May.

/signed/ S. K. Allison

PHYSICS [redacted]

General Report

Experimental work is confirming the fact that the filter paper method for the extraction of product dust from air for alpha monitoring is the best. Ten sets of apparatus operating on this principal are practically finished. These sound an audible alarm when the activity reaches a predetermined level. One is in operation in the Chemistry Laboratories here and another was sent to "Y" previously.

A promising new method for filling counter tubes has been developed with 0.5 cm. of amyl acetate and 10 cm. of neon. The sensitivity of the boron coated neutron counters are proving to be about equal to the boron trifluoride filled counters. Following reports from "X" on the superior performance of the new proportional alpha counter, we have initiated activities by a reliable manufacturer to produce a considerable number of what we consider to be a really satisfactory portable survey meter.

Tests in the pile at "X" show that the boron coated thermopiles are quite satisfactory for neutron monitoring and surveying. Tests show that measurement of sound wave velocity appears practicable for continuous monitoring of Young's modulus of the graphite in the operating "W" pile. Contacts with manufacturers for the production of several instruments and the issuing of specifications for them have been carried out. The electric control developed for the argon shielded arc welding has been completed and written up. A considerable quantity of work has been done on instruments and circuits as a service to other projects' research groups.

Several problems are being attacked at the "X" pile, among them are: a cloud chamber with thin films of enriched metal, a set of photographic emulsions impregnated with uranium, and diffraction of neutrons from large crystals. The gamma ray energy of Cb^{93} was measured as 0.76 MEV. Measurements are being continued by coincidence counter methods of determining the end point of the range of Compton recoil.

A very satisfactory direct reading pocket electrometer is now being manufactured in small quantities.

The demand for cyclotron has again increased. The Chicago instrument is now being fitted with new dees and deflector plate. The half-life of Be^{10} seems now to be about 1.5×10^5 years. Beta ray spectra have been obtained for 55 day Sr^{89} and appear to be continuous but complex. A search for active chlorine in the by-products from irradiated nitrate yield negative results. Measurement of the capture cross section N^{15} shows an upper limit of 3×10^{-29} cm^2. Work with bismuth shows definite capture of fast neutrons and that the long-lived activity found in material activated at "X" is primarily associated with silver contamination.

In the mass spectrometer work emphasis has been on the light element impurity problem. Oxygen sensitivity has been found to be within the required range and the problem of reduction to quantitative values remains. Considerable progress has been made in the construction of the mass spectrometer for Y.

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Construction of the Nier type instrument for the analysis of light element impurities is progressing, as is also the magnetic analyzer to collect radioactive fission products. The further analysis of spectrograms of irradiated samarium make it more certain that mass 149 shows a decrease and mass 150 shows a large increase. A much more stronger bombarded sample will be analyzed in the coming month.

The successful extrusion of uranium tubes in the alpha region suggests compound extrusion with nickel and stainless steel. The first successful extrusion of pure beryllium was carried out, the result being a fairly respectable looking rod 1/2 inch in diameter. Improved compound aluminum tubes containing an inner layer of boron carbide were extruded at Alcoa. A series of 30 W slugs with external grooves for helium passage were successfully clad in a single aluminum jacket, all the slugs being held together with interlocking cuts. Work on the modified deflection test disclosed 15 leakers out of 1000 X slugs. When W slugs are subjected to a pressure of 2000 lbs. per sq. in., the regions where the frost test indicates pure bonding sink inward. Poorly bonded spots in the region of the thick end caps were discovered by this test, although the frost test does not detect such spots. In an experiment with an unbonded aluminum jacketed slug, fitted with long longitudinal grooves and the space between the slug and the jacket filled with 200 lbs. per sq. in. helium and 20 heating cycles, showed no change in thermal contact.

It has been found that annealing of uranium metal does start at a temperature as low as 100°C.

The Washington University Cyclotron group has completed the present phase of the study of the beta spectrum of 39. Of the 42 lines observed, the strongest are the K, L, and M conversion electrons for 3 gamma rays. Preliminary results have also been obtained on some tellurium and zirconium-columbium byproduct activities.

X-ray diffraction studies were made on a large number of plutonium preparations. Those studied included $PuCl_3.6H_2O$, $PuCl_3.H_2O$, $PuBr_3$, PuOI, PuOBr and PuOCl. It has been found that tetravalent plutonium phosphate is isomorphous with thorium phosphate and ceric phosphate. Additional experimental evidence was obtained to support the contention that LaF_3 carries trivalent and not tetravalent Pu. This was obtained from studies of precipitates which proved to be solid solutions of LaF_3 and PuF_3 prepared from a solution of Pu(IV). Indications were obtained that SrF_2 - PuF_3 solid solutions were formed in coprecipitation of these in ratios of Sr:Pu of 2:1.1 and 6:1 and showing only the SrF_2 phase. The lattice dimensions were determined for $ThS_{1.75}$ and Ce_2SO_2.

A considerable number of theoretical calculations were made on shielding problems, particularly as they concerned protection of optical instruments. This latter problem is relatively serious since the borescope with plastic lenses will be rendered useless after a few hours use unless not only the tube under examination but also the neighboring tubes are emptied of the heavy metal. Glass lenses would suffer the same fate in a few minutes.

Theoretical lattice design work is being elaborated by the use of two and three group theories. In particular, the experimentally obtained distribution of the production of thermal neutrons by a point source of fission neutrons in different moderators was analyzed, and the constants for the two and three group theories obtained. Work of importance on the diffusion theory was continued, with particular reference to the velocity distribution of thermal neutrons. Considerable attention was devoted to water uranium lattices and their temperature coefficients. It was found, as was expected, that the leveling effect plays a very important role and in some cases causes an increase in the multiplication constant of the order of 1 to 5 x 10^{-4} per degree.

Calculations show that the energy produced at the end of the slugs increases by as much as 30% compared to the energy produced in a cross section toward the middle of the slug. This is caused by the neutrons having relatively free access to the ends of the slugs. The increase in heat produced required a somewhat increased thickness of the conductor type end cap.

This is quite an important point

Theoretical consideration of the effect of radiation on materials was continued as was the construction of a pile insert for the W pile.

Personnel - There were 128 academic persons in the Division as of May 30, 1944.

CHEMISTRY

General Report

A study has been made of the variables governing the degree of carrying of Pu ("W" concentration) by the product precipitate of the $BiPO_4$ cycle, when the precipitate is formed by adding all, or nearly all, of the Bi(III) subsequent to the addition of H_3PO_4. Concentration of Fe(III) was found to be the dominant variable involved.

Preliminary tests have been made on the use of $PbSO_4$ as a scavenger in the decontamination cycle. It was found that 1 to 3 mg pb/ml are almost quantitatively removed from an oxidized solution by 0.1N H_2SO_4.

The use of $LaPO_4$ as a scavenger in the by-product step, at HNO_3 concentrations of 0.1 to 0.3N, has been tested extensively.

The Ce-Zr scavenger combination has been tested in a number of simultaneously performed process runs. There is every reason to believe that factors approaching 10^7 can be obtained for β and γ decontamination factors.

Work is continuing on a method for decontamination from rare earths.

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Study of the complete concentration-isolation process (proposed for Hanford) through the use of laboratory solutions has shown over-all yields of 97 to 98%. Preliminary experiments employing several solutions and slurries from Cell 3 and Cell 4 at Clinton have indicated that good yields may be obtained in the concentration procedure and that good PuO_4 precipitations may be obtained.

Assuming that the plutonium content of the first pile metal to be processed will be ca 30 g/T of uranium or less, experiments to determine the feasibility of recycling by-product solutions from peroxide precipitations were carried through five cycles and they indicated that the percentage yield based on the initial amount of product in each cycle increases with successive recyclings.

Work continued on evaluation of process modifications.

For purification and metal production purposes, a survey of some twelve organic solvents was made to determine Pu(IV) and Pu(VI) distributions and separation factors for light elements. Nitrobenzene showed a separation of $\sim 10^{-3}$ for those elements tested.

200 mg of $PuCl_3$ were prepared by the action of CCl_4 on $PuO_2.xH_2O$ at 750-800°C. The action of HBr on $PuO_2.xH_2O$ at 750° yields $PuBr_3$ with a crystal structure not isomorphous with that of $LaBr_3$. The preparation contains PuOBr in varying amount and also an unidentified acid-insoluble phase. $PuO_4.xH_2O$ was reacted with PCl_5 liquid at 280° in a capillary bomb. After distilling off the reagent and volatile reaction products by heating to 400° C, in vacuo, the product was well crystallized $PuCl_3$. Although X-ray studies gave no evidence of a second phase there was some water-insoluble material in the $PuCl_3$ so prepared.

Additional successful preparation of $PuCl_3$ has been made by drying HI-reduced Pu (IV) solutions in HCl and dehydrating the $PuCl_3.xH_2O$ by slow heating to 300° C. in ca 60 mm of HCl.

Wet preparations of $PuBr_3$ have been carried out by reducing aqueoug Pu(IV) bromide with HBr, evaporating to dryness in a steam of HBr at low pressure and slowing heating in HBr to 300°C. No adequate evaluation of this material is available.

It was previously reported that the reaction of Br_2 with Pu metal yielded a hexagonal $PuBr_3$, isomorphous with $LaBr_3$, $CeBr_3$, and UBr_3 (cf CK-1556). Using bromine known to be free of chlorine for the reaction with metal, a $PuBr_3$ has now been obtained which is not hexagonal but is crystallographically identical with the $PuBr_3$ made by the action of HBr on $PuO_2.xH_2O$ at 750° C.

Experiments were carried out to determine at what temperature oxygen replaces fluorine in PuF_4. Using Pt equipment and liquid oxygen traps to remove water from the O_2 gas used, it was found that conversion of PuF_4 to PuO_2 occurs at 325 - 350° but not at 275 - 300°. A series of experiments were run in which dry oxygen was passed over approximately 1-mg quantities of PuF_3 in Pt equipment for two hours. No conversion of PuF_3 to PuO_2 occurs at 225 - 250°, partial conversion (15-20%) occurs at 275 - 300° and complete conversion is effected at 325 - 350°.

For the reduction of PuF_3 in BeO crucibles, samples were prepared by both the wet and dry methods. From the standpoint of purity the wet method is most desirable because it uses readily purified reagents and low temperatures.

Vickers hardness values are greatly dependent upon the method of preparing and remelting the metal. For example, Pu remelted in BeO and in TaN-coated Ta show respective values of 124 and 292.

Plutonium metal made by barium reduction of the tetrafluoride in beryllia, with no impurities detectable spectrographically, has melted on tantalum in vacuo at 810° C. ± 25°. The plutonium metal when stripped off the tantalum contained no tantalum detectable by spectrographic examination (under 0.12%).

The compression of plutonium halide particles into pellet form has continued to show considerable advantage in reductions on a 5 to 8 mg scale. Reductions of PuF_4 is formed by treatment of dense PuO_2 with HF. Reductions of PuF_4 with calcium have been made in beryllia by vapor phase reaction, but it is almost impossible to remove the excess calcium from the interior of the crucible. Even prolonged heating at 1200° C. in vacuo does not allow the calcium to escape from the beryllia. Sodium will not reduce PuF_4 to metal by vapor phase reduction, as was previously demonstrated. Reductions of $PuCl_3$ have been successful for the sublimed crystalline halide made by the action of CCl_4 on oxide. Unpelleted $PuCl_3$ made in the "wet" way and dried in HCl has shown poor yields of metal when reduced with Ba. The crystalline $PuCl_3$ is very hygroscopic and must be handled entirely in a dry box. Pellets (5 to 7 mg) of $PuCl_3$ (CCl_4-prepared) have been successfully reduced to plutonium metal in beryllia crucibles by Ba, Ca, Na, and K in vapor phase reductions and by Na and K in liquid phase reductions. The yields in these reductions are rather low.

Work continued on basic chemistry; viz. oxidation potentials of plutonium couples, inorganic derivatives of Pu, Hydrolysis of Pu (IV) and Pu (III), rates of Pu oxidation and reduction, isolation and study of Np^{237}, Assay of "W" Pu solutions, heavy isotopes by bombardment of Pu^{239}, basic chemistry of the extraction process, carrying of Pu (III) and Pu (IV) by $BiPO_4$, direct proof that product is carried in the IV state in the process, preparation of Pu compounds for preparation of X-ray diffraction studies, instability of Pu (III) in the process, solubilities of product in process solutions, research on methods for Pu recovery, chemistry of Pu as related to its recovery and purification, and routine separation of 93^{239}.

Great emphasis has been put during the past month on the dichromate problem in "W" water. It has been established that of the 2 ppm $Na_2Cr_2O_7$ which it is planned to use in "W" cooling water, ~0.85 ppm will be reduced, based upon experiments with simulated "W" water at the N.D. generator (gamma rays) and the Berkeley cyclotron (n's). f^- for reduction of H_2O_2 has been determined for the two cases and ~1 and 0.3 respectively. Conferences at "X" have established that the 0.85 ppm result is not too far from some results which indicate that ~0.5 ppm may be reduced at "W". Attention is being addressed principally to the matter of rate of formation of Cr^{+3} ion and its rate of precipitation under radiative conditions. Although it may

seem that the direct approach in either a regular tube or capillary tube setup at "X" will give the answer, it is the unanimous opinion of the conferees at "X" that such information will be insufficient, because purely thermal effects will prevent a straightforward extrapolation from data which must of necessity be obtained in times far exceeding those at "W". For this reason, the groups at Chicago and Berkeley will continue to press actively the study of the mechanism of the processes involved in the reduction of dichromate by radiation under a variety of ambient conditions. Apparently satisfactory methods for the determination of H_2O_2 in the presence of $Cr_2O_7^-$ and Cr^{+3} have been worked out. The analysis for $Cr_2O_7^-$ in the presence of the other two substances also appears to be satisfactory, but this method will be checked. On the other hand, the determination of Cr^{+3} requires some improvement.

Work continued on the effect of radiation on water and aqueous systems, effect of neutrons on graphite, effects of neutrons on metals and alloys, and effects of radiation on solid compounds.

An intensive search has been made to determine the extent to which fission products of very low mass might be formed on fission. Two 10 day irradiated "X" slugs have been used as sources of activity. There has been found no positive evidence for low atomic weight fission products.

Radioactive arsenic has again been looked for in "X" irradiated material. If any 90d As^{77} is formed and the chemical techniques lead to adequate exchange, it must be formed in yield less than $3 \times 10^{-4}\%$. Any 17d As^{74} (β^-, β^+) must be formed in yield less than $7 \times 10^{-3}\%$. No long-lived palladium activity has been found, nor has long-lived selenium activity been found, thus casting doubt on the reported 70d selenium. No 40d rhodium has been found in Clinton material. Its fission yield must be less than $5 \times 10^{-4}\%$.

Information pertinent to the $BiPO_4$ process is being collected. A survey of phosphate literature is being carried out and preparation of the phosphates of La, Y, Zr, Ba, Sr, and Fe are being prepared for X-ray powder photographs. Solubilities of $BiPO_4$ in HNO_3 are being measured.

The amount of (n, 2n) reaction on U^{238} at Clinton was redetermined and the yield comes out to be 0.4% of the number of fissions. This is less than the yield as previously estimated, but is probably more trustworthy.

Personnel - There were 244 academic persons in the Division as of May 30, 1944.

TECHNOLOGY

General Report

Slugs bonded by the "three-dip" Al-Si process went into production at Hanford and arrangements have been made by du Pont for a Chicago manufacturer to prepare unbonded units. We are following the progress of these efforts.

An Al-Si bonding method has been demonstrated in which contamination by copper and tin is completely avoided, as has a closure which results in a weld free from braze metal contamination and which may be tested for leaks by gas flow methods. Introduction of these methods in Hanford production has been recommended. The production of 600 pieces of zinc bonded slugs has proved the feasibility of this method.

An experiment in which a leaky slug in W geometry and subjected to steam at atmospheric pressure and which swelled in three days sufficiently to break the graphite piece surrounding the ribbed tube has emphasized the necessity for rigid testing procedures and a swell detecting mechanism. Work on the single long cartridge (extending all the way through the pile and shields) with internal helium pressure (for leak detection) is being worked on very actively. Corrosion work continues to be an active study with work this month centering around the activity of dichromate at various p^H.

Although the experimental study of film formation and removal, as well as studies on internally heated slugs continues, there have been no final answers uncovered.

Approximately 150 canned slugs were processed by various methods to remove the canning and bonding in an attempt to salvage the metal for reuse.

Optical instruments ordered for the new Hot Laboratory, Clinton, have been delivered to them. There are indications that additional optical instruments will be required at Clinton and the needs are now being surveyed. Designs for the Hanford borescope are practically finished and oral approval received by du Pont. The Fly-Eye design is complete, equipment has been delivered to us and we expect assembly and testing to be finished by the end of June.

Construction of the submerged reactor for installation in the metal storage canal at Hanford now is well under way. Preliminary chemical experiments have been completed and we expect to complete this instrument during the coming month.

The continuous ether extraction system for separation and decontamination has been successfully operated. The product yield is quite low, about 30%. The batch extraction system has been successfully operated to recover decontaminated uranium from active solutions. A small "continuous-batch" solvent extraction unit has been designed and tested. It is believed that a similar unit in quartz may be used for product purification.

Personnel - There were 189 academic persons in the Division as of May 30, 1944.

HEALTH

General Report

The pocket chambers continued to take a good deal of attention. The number of off-scale readings has increased in the last 2 months and is considerably higher than that at Clinton. The pocket chambers as delivered b y Victoreen read correctly for radiations in the neighborhood of 200 kilovolts but read 18-20% low for higher energy radiations.

The film meters have not shown as close agreement with pocket meters at Chicago as at Clinton. It is believed that many members do not wear both types of meters simultaneously.

It has been found that laundrying decontaminates clothes sufficiently to remove them from the category of a health hazard. However, the possibility of instrument contamination still remains when some garments come from the laundry with counts as large as 1300/minute.

A new projection electrometer containing a Landsverk type electroscope is being tested. With it the pocket chambers can be used to read up to 0.4 r and it seems likely that the instrument will hold its characteristics better than Victoreen instruments.

Pulmonary inhalation studies with Strontium^{89} and Zirconium^{93}, using mists, showed that the lung distribution is about the same in operated animals as in normal ones. The operation consisted of cutting or ligating the oesophagus and inserting a tracheal cannula. Strontium appeared to be absorbed into the animal as quickly from the large air passages as from the alveoli.

The mid-lethal dose of Strontium^{89} for rats is 8.5×10^{-6} C/gm when given by stomach tube. Mice receiving 2×10^{-6} C/gm are gaining weight and appearing normal at 7 weeks. The mid-lethal dose of fission mixture when given by stomach tube is 15×10^{-6} C/gm.

Phosphorus^{32} in doses as low as 1.04×10^{-6} C/gm (by injection) lower the white blood counts in mice. Injections of $Ba^{140} - La^{140}$ in amounts in the same order of magnitude cause falls in white blood counts in rats.

The ovaries of "ripe" female goldfish have been found to concentrate fission mixture 10 to 15 times over that in water. This is about the same concentration as occurs in the skeleton. Strontium, on the other hand, is not concentrated in the ovaries.

The histological effects of a single dose of 100 r of X-rays on rabbits are summarized and compared with those from 800 r. It seems likely from these studies that histological changes can be detected for doses as low as 25 r but probably not below that level. Chickens respond more rapidly than mammals to doses of X-rays.

Health - Con't

At the National Cancer Institute, the chronic exposures continue to show that: the blood of mice getting 4 r or less in 8 hrs. each day are not affected while the counts of those getting 8 r in 8 hrs. each day are lowered; guinea pigs getting 4 r in 8 hrs. each day show definite blood changes and those getting 8 r show marked changes that result in death; the guinea pigs on 2 r in 8 hrs. each day show no changes in their blood; rabbits seem to respond more like mice than guinea pigs .

Since the lungs of male mice seem to show a slight increase of tumor incidence with doses above 1000 r, at the rate of 8 r in 8 hrs/day, a new experiment using a strain more susceptible to lung tumors (strain A) has been started.

The studies on tissue metabolism and enzyme inactivation after radiation are pointing the way towards an understanding of the mechanism of the action of radiations on tissues. However, the field is so technical that those of us not familiar with it have difficulty understanding the place of the individual experiments. The metabolism of slices of liver from rats who have had x-ray exposure is lower than that of normal rats and some enzymes irradiated in vitro are inhibited.

The number of pre-employment examinations continues at high level, largely due to replacements of non-academic personnel.

Dispensary service is established but is not yet in permanent quarters.

Surveys show that conditions are not all that they should be during certain operations and some individuals have recently had greater than their tolerance doses. Most of this is due to lack of planning in advance so that insufficient shielding and equipment are not on hand and operating. Some individuals have apparently received over-exposures but no blood changes that can be attributed to these have been found.

Conditions at Washington University Cyclotron require improvement since there are some over-exposures.

A resume of the abnormal laboratory findings at the Metallurgical Laboratory shows that the Work Hazards Group have the smallest percentage of such findings. This simply indicates that so-called "abnormalities" are not positive indications of damage but are simply means of discovering possible damage. The studies of the Biochemistry Group on Project members and control groups are bringing out some more evidence of their value. Porphyrin metabolism is definitely affected in the metal exposure groups. Serum sulphur appears to be more elevated in the tuballoy exposure group than in the groups exposed to other metals. The fluorescent method seems to be a satisfactory technique for detecting tuballoy in urine in very small concentrations.

Personnel - There were 62½ academic persons in the Division as of May 30th.

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ARGONNE LABORATORY

General Report

The P-9 pile has been brought to a chain reaction. The quantity of P-9 required was approximately 20% less than estimated from the results of the exponential experiments. Construction is practically complete and operations will be under way as soon as the balance of the P-9 arrives.

Long range alphas emitted by 25 under neutron irradiation have been studied in the Wilson Cloud Chamber. These studies show a cross section of about 2×10^{-24} cm^2 for the production of alpha particles with a range between 5 and 10 cm. and a cross section of 1.6×10^{-24} cm^2 for ranges between 10 and 15 cm. The total cross section corresponds to 1/200 of the absorption cross section of 25.

The average value for the diffusion length of thermal neutrons in uranium metal was found to be 1.55 cm. with a slight indication of gradual hardening with increased depth (sample thickness 5.5. cm).

The ratio of the fission cross sections for 49 and 25 was observed for neutrons of different energy; the ratio for thermal neutrons - 1.41; the ratio for pile neutrons absorbed by cadmium - 1.64; the ratio for pile neutrons filtered through pyrex - 1.89. These results are clearly due to the influence of the resonance level reported by Y. In the same series of measurements the values of the $\int_E \sigma_f \, dE$ above the cadmium cut-off were determined as 340×10^{-24} cm^2 for 25 and 450×10^{-24} cm^2 for 49. Some measurements were made of the delayed neutrons emitted by 25 and 49. The data show a half period of 55 seconds for the longest lived component, and the decay of 49 followed closely that of 25. The number of delayed neutrons emitted per fission for 49 is one-half of the corresponding number for 25.

A BF_3 chamber has been built which will detect sources emitting about one neutron per second. This will enable one to check whether the purity is adequate with a few grams of product. This chamber was used for the determination of the neutron yield for sulfur bombarded by polonium alpha particles. A yield of 0.0035×10^{-6} neutron per alpha particles was observed.

Ten additional measurements on the activation cross sections of various isotopes have been made. These cover seven isotopes of Te and one each of Os, Hg, and Tl.

A measurement showed an increase of about 40% in the neutron density in the end of a W slug when aluminum spacers of 7/8" thickness were interposed between slugs.

An experimental determination showed that up to 14 atms. pressure there was no saturation pressure for the decomposition products of water formed by fission fragments.

Personnel - There were 42 academic persons in the Laboratory as of May 30th.

PART III
Contract W-7401 Eng-37

1. Estimated cost of operating for May and Budget estimates for June and July, 1944:

	June	July
Salaries	$ 594,913.91*	$ 490,150.00**
Overhead	148,000.00	170,000.00
General Expense and Equipment	250,000.00	300,000.00
	$ 992,913.91	$ 960,150.00

2. Estimated status of Project at 31 May 1944

Salaries		
Appropriations		$3,630,000.00
Payroll to 30 April	$3,022,127.06	
May payroll	375,686.99	
Total		3,397,814.05
Balance		$ 232,185.95
Overhead		
Appropriations		$1,250,000.00
Overhead to 30 April	$1,157,430.05	
May overhead	148,989.82	
Total		1,306,419.87
Balance		(56,419.87)
General Expense and Equipment		
Appropriations		$4,670,000.00
Expense to 30 April	$2,335,356.34	
May Expense	286,354.59	
Total		2,621,710.93
Balance		$2,048,289.07
Total Balances		$2,224,055.15
Total Appropriations	$9,550,000.00	
Total Expenditures	7,325,944.35	
Balance	$2,224,055.15	

3. Personnel Employed on 31 May 1944:

	Scientific Divisions	Administrative Divisions	Total
Academic	522	11	533
Non-academic - Monthly rated	10	27	37
Non-academic - weekly rated	584	611	1,195
Total	1,116	649	1,765

* Includes $224,913.91 Billings for loaned employees which should be paid in May

** Includes $65,150.00 estimated billings for loaned employees.

(signed) W. C. Munnecke