715878

[redacted]

NDN-407252

THIS DOCUMENT CONSISTS OF 13 PAGES
NO. 1 OF 8 SERIES A
11/20/45

PROGRESS REPORT FOR MONTH OF OCTOBER 1945

CONTRACT #W-7405-eng-48-A.

Joseph G. Hamilton, M. D.

October 12, 1945.

[redacted]

109985b

[redacted]

Axel S.

NDN-407252

[redacted]

PART I

SUMMARY

A. Metabolic Studies of Plutonium and Allied Materials

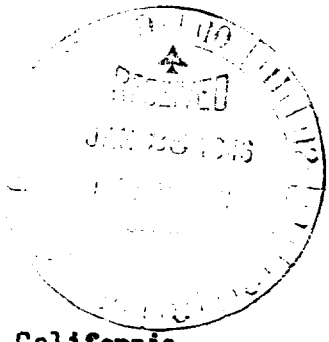
Excretory studies on the human subject who received 5.1 gms. of Plutonium containing Pu^{238}, have been completed through the 127th day, following the administration of this material by intravenous injection. The average rate of elimination has shown no significant change for the past two months, the average value being of the order of .005 percent per day with the kidneys acting as the chief channel of elimination. Preliminary inhalation studies in man, using an active smoke containing the 81 hour Zr^{89}, have been successfully completed. The purpose of this experiment was to determine the degree of retention by the lungs in man, of a very finely divided active smoke suspended in air. The results of this experiment indicate that almost 100 percent of the inhaled activity is retained within the lungs and the upper respiratory tract. Approximately two-thirds of the active material is presumed to have been entrapped in the lungs and the remaining third was deposited within the upper respiratory tract from which it was removed in three days by ciliary action. Comparable studies done with rats, using Zr^{89}, showed that the total retention by the animal was approximately eighty percent and that only one-fifth of the activity originally inhaled was deposited within the lungs, the remainder was entrapped in the upper respiratory tract and excreted by way of the digestive tract within the three day interval. The radioautographic and decontamination studies, as well as the long-term smoke and spray experiments are being continued.

B. The estimated expense for October 1945 is $6,866.00 as compared to $6,200.00 for September. Personnel decreased from 22 to 20.

[redacted]

[redacted]

PART I.



SUMMARY

B. 60" Cyclotron Activities, Berkeley, California.

The 60" cyclotron operated quite satisfactorily during October. Bombardments included the alpha particle bombardment of Pb, Th^{232}, and U^{233}; the deuteron bombardment of Pa^{231}, U^{238}, and Np^{237} for the Metallurgical Laboratory, the deuteron bombardment for Dr. J. H. Lawrence and some test runs with a D. C. ion source are for Professor E. O. Lawrence. The new Type III Backus oscillator was put into operation. The new aluminum target chamber has been completed and will be installed soon. Work is actively being continued in attempts to produce Be^{+4} and C^{+6} ions.

[redacted]

PART II

SECTION A.

TECHNICAL PROGRESS REPORT ON THE METABOLIC PROPERTIES OF PLUTONIUM AND ALLIED MATERIALS

1. Radioautographic Studies

During the past month, all of the radioautographic work has been devoted to preparation of sections and radioautographs from the samples supplied by Doctor Copp and his group in the Decontamination Section. This work will be briefly described under that section.

2. Tracer Studies

The excretory data presented below under Table I presents the information from the 100th through the 127th day, inclusive, on the human subject who received Pu^{238} several months ago. More samples are now in the process of assay together with fecal material. The feces samples for the interval included in the following table were not available. However, it will be recalled from earlier data, that the average rate of fecal elimination in man is from one-half to one-eighth of the urinary excretion rate.

TABLE I

The daily Rates of Excretion of Pu in a Human Subject following the Administration of 5γgms. by Intravenous Injection (100th to 127th Day)

Day	Activity in % of Dose	Weight in Grams	Sample Vol. in Ml.
100	.0061	10.0	500
101	.0052	12.0	1050
102	.0040	3.0	2000
103	.00695	9.0	500
104	.0051	12.0	1200
105	.0058	9.5	900
106	.0046	11.0	800
107	.00597	16.0	700
108	.0052	9.5	750
109	.00443	8.0	1100
110	.0015	11.5	1250
111	.00415	7.5	400
112	.00507	5.2	350
113	.00557	10.0	500
114	.00286	6.8	250
115	.00530	9.0	450
116	.00465	10.0	800
117	.0023	1.2	800

TABLE I (con)

	Day	Activity in % of Dose	Weight in Grams	Sample Vol. in Ml.
(con)	118	.0039	8.4	550
	119	.00362	5.4	2400
	120	.00254	6.2	650
	121	.00465	12.0	800
	122	.00388	10.0	1100
	123	.00139	4.8	750
	124	.00368	8.0	900
	125	.00355	9.5	550
	126	.00322	9.5	1650
	127	.00404	9.0	650

* Average .0052 percent per day.

It can be seen that no striking decrease in the average elimination rate has taken place during this interval as compared with the earlier periods. The average rate of elimination during the time interval indicated above was approximately .005 percent. A blood count was taken from Mr. Stevens which gave the following figures: RBC-4,100,000, WBC-14,000, 55% neutrophiles, 1% basophils, 35% lymphocytes, 9% monocytes. More complete blood studies will be undertaken in the near future.

It is of interest to compare the average rates of excretion in man with that in rats during comparable time intervals and the data obtained from three animals is shown below in Table II.

TABLE II

The Average Daily Rates of Excretion of Pu^{238} in the Rat Following Intravenous Injection.

	% Per Day Excretion of Pu^{238} in the Rat	
Time	Urine	Feces
63-78	.009	.0110
79-88	.011	.0109
89-96	.0049	.0094
97-105	.0081	.0114
106-116	.0068	.0111

1099860

The long ter[redacted]dies with rats are being continued. A single i[redacted]as done on a normal human

subject using the 81 hour Zr^{89}. This material was prepared by the 60" Cyclotron, in the carrier-free state and free from other radioactive contaminants. The material was suspended in the form of a smoke by the aid of an electrical spark in a small chamber filled with argon. The electrodes employed were gold and the spark was secured from a 15 KV transformer connected in parallel to a .01 microfarad condenser. Argon was employed instead of air due to the fact that considerable amounts of ozone would be formed from the latter gas which was felt would be of possible danger. The volume of the chamber in which the Zr^{89} smoke was produced had a volume of 600 cc. A series of preliminary runs were made so that a predetermined amount of Zr^{89} could be suspended as a smoke without the danger of volatilizing excessive amounts of this substance. The final arrangement was such that 30 seconds of the discharge of the spark produced an aerosol which contained from two to three thousand counts per second of the Zr^{89}. Before the actual experiment was undertaken, a series of determinations for the rate of settling the active material within the cylinder were made, so that the necessary correction factor could be applied for the few seconds required for the active material to be transferred from the chamber to the lungs of the subject. During the human experiment, 100 cc. of the Argon gas containing the Zr^{89} smoke was withdrawn for assay after a 30 seconds discharge of the spark between the two gold electrodes upon which the purified and carrier-free Zr^{89} had been deposited as $ZrO(NO_3)_2$. The 100 cc. sample was set aside for assay and the balance was drawn into the lungs through a short rubber tube of large diameter place in the left nostril. The inhaled gas was exhaled through the mouth into a glass wool filter, and several additional breaths of inactive air were taken which were also exhaled through this filter. The results obtained are tabulated in Table III.

TABLE III

A Human Inhalation Study with Carrier-Free Zr^{89} as a Smoke
(Total Activity Inhaled = 2,430 c/s)

		Fecal Excretion	
Time		c/s	% Excreted
1st Day	12 hrs.	171	7.1
	25 hrs.	426	17.5
	45 hrs.	134	5.5
2nd Day	49 hrs.	40	1.6
	59 hrs.	3.7	0.15
3rd Day	71 hrs.	2.3	0.10
	Total Excreted	777.0	32.00
Total Activity Exhaled		53.0	2.20
Estimated Activity Retained		1600.0	66.70

In Table IV, are presented results of parallel studies, using almost the identical set-up with 2 rats, the only difference being that the rats were attached onto the smoke chamber by means of a trap system described in an earlier report which makes it possible to accurately determine the total amount of activity inhaled as well as the fraction exhaled.

TABLE IV.

Parallel Inhalation Studies with Carrier-Free Zr^{89} in the Rat

	0 Time			3 Days		
	Animal A	Animal B	Average	Animal A	Animal B	Average
Tissue						
Lungs	28.1	21.0	24.6	11.3	26.4	18.9
Liver	<.1	<.1	<.1	.30	.62	.46
G. I. Tract	.31	<.1	.16	2.14	2.05	2.20
Skeleton	<.1	<.1	<.1	4.80	1.89	3.35
Head	39.7	42.1	40.9	2.51	2.46	2.49
Urine						
0-1 Day				.31	.23	.27
1-2 Days				.73	.54	.64
2-3 Days				.68	.50	.59
Total				1.72	1.27	1.50
Feces						
0-1 Day				9.62	7.41	8.50
1-2 Days				3.34	25.6	29.5
2-3 Days				14.2	10.9	12.6
Total				57.2	43.9	50.6
Activity Exhaled	27.0	30.5	28.8			

It can be seen from these results that in the case of the human, the amount of activity retained at the end of three days was approximately three times the amount found in rats at the same time interval. This difference would appear to be represented to a large degree by the fact that in the case of man, very little activity was exhaled and only 32% of the total of inhaled activity was excreted. The amount excreted in the human experiment was approximately three-fifths of that observed in the rats. From this very tentative preliminary human experiment, it would appear that from two to three times the pulmonary retention takes place in man as compared with the rat. This hypothesis assumes that the upper respiratory tract and bronchial tree of both animals were almost completely cleared out of activity by the end of the third day. It is known from radioautographic studies in rats that this is the case and the very rapid decrease in excretory rate in man after the third day suggests that this assumption is valid for the human. It is of interest to mention the fact that the results obtained from rats with the Zr^{89} smoke produced by the high voltage electric spark are almost

identical to the results obtained using the PuO_2 smoke which was produced by burning Plutonium metal with a carbon arc operating at 110 volts and the $PuO_2(NO_3)_2$ sprays. Future experiments using human subjects with this short-lived radioactive isotope of Zirconium are planned for the near future. It should be mentioned in passing that the total amount of activity inhaled is of the order of one-half microcurie and that no detectable amounts of long-lived activity are produced in this type of preparation of Zr^{89}. To conclude, it would appear reasonable to assume that from fifty to seventy-five percent of all active material, when inhaled as a finely divided smoke or a spray, will be deposited in the lungs in man. These figures are roughly two to three times higher than has been observed in the case of rats in large series of experiments, using different types of smokes and sprays. The amounts of Zr^{89} absorbed through the lungs and deposited in the skeleton at the three day interval in the rats was small and it is assumed a comparable effect took place in the human study.

3. Decontamination Studies

During the past month, the entire effort of the Decontamination Section, including Miss Axelrod's radioautographic work, has been devoted to securing additional information on the problem of overlayering of Plutonium in bone. It will be another month before the experiments now in progress will be carried to the point where there will be informative data available.

4. Radio-Chemical Isolation

A sample of Y^{86} (108 day) was isolated without carrier from Sr metal which had been bombarded with 22 MEV deuterons. The yield calculated to the time of bombardment was 1.1μc per micro-ampere hour.

A sample of Zr^{89} (81 hour) was prepared by a deuteron bombardment on Y_2O_3. The Zr^{89} was isolated without carrier and in an especially high state of purity since it was to be used in human inhalation experiments. The activity due to Zr^{89} was found to constitute not less than 99.8% of the total activity. The yield was 75μc per micro-ampere hour at the time of bombardment.

In both the Y^{86} and Zr^{89} preparations, the yield with 22 MEV deuterons was approximately ten times that previously obtained with 16 MEV deuterons.

The Uranium fraction was isolated from a Thorium plate which had received a bombardment of about 5,000 micro-ampere hours of 22 MEV deuterons. Due to the high activity of the target it was necessary to perform the isolation at Clinton Laboratories. The quantity of Uranium isotopes (largely U^{230} and U^{232}) recovered amounted to 1.7×10^8 alpha counts per minute.

Plant samples were collected at two locations along Whiteoak Creek which carries the wastes from Clinton Laboratories. These samples will be examined for alpha and beta activity.

5. Tracer Research with Element 95 SECRET

A sample of 95^{241} has been forwarded to us from Professor Seaborg's Group in Chicago. We received a total of approximately 105 counts per minute of this substance which will be adequate for metabolic studies in two rats. At present, Mr. Scott is devoting considerable of his energies toward analytical methods suitable for isolation of small amounts of this material from ashed tissues and excreta. It will be recalled that the chemistry of 95 follows extremely closely that of the trivalent rare earths, such as Lanthanum. This presents serious analytical problem due to the fact that the calcium in certain biological materials, notably bone, feces, and urine, tends to be carried down with the fluoride precipitate when lanthanum is used as the carrier. Attempts to employ other anions such as oxalate as well as the use of solvent extraction methods is being thoroughly investigated before the material is actually put into the animals. We would like to stretch this most limited quantity of 95 as far as possible.

6. Protoactinium Studies

The results of the 4 and 17 day intramuscular and a 7 day oral study of the metabolic properties of protoactinium are presented in Tables V and VI. Pa^{233} was prepared by the 60" Cyclotron from the d-2n reaction on Thorium and isolated free from any carriers. The Pa^{233} was administered as a solution in HNO_3 at Ph 1.9 to which enough NaCl had been added to make the solution isotonic. The I. M. data presented below has been corrected for the unabsorbed material left at the site of injection. It can be seen that all of the soft tissues accumulate this substance to a significant degree and that the concentration in the spleen, kidney, and bone were the highest. The distribution and excretory pattern of Protoactinium in the rat is quite similar to the metabolic properties of Columbium which it also resembles in its chemical properties. The oral experiments showed an apparent absorption from the G. I. tract of .25% of the administered dose.

TABLE V

The Distribution of Carrier-Free Protoactinium (Pa^{233}) Following I. M. Administration to Rats

	4 Days		17 Days	
Tissue	% per Organ	% per Gram	% per Organ	% per Gram
Lungs	0.749	0.390	0.592	0.157
Liver	3.45	0.291	5.02	0.359
Kidney	3.39	1.21	2.63	0.91
Spleen	0.518	0.769	1.10	1.17
G. I. Tract	4.48	0.165	2.52	0.076
Muscle	32.58	0.207	23.752	0.133
Skeleton	29.04	1.17	37.72	1.45
Skin	19.92	0.345	12.28	0.193
Blood	1.136	0.33	0.139	0.040

%-Daily Rate of Excretion -	Urine	Feces	Urine	Feces
1st Day	0.485	1.05	1.31	0.336
4th Da	.25	1.20	0.22	0.88
16th Da			0.22	0.392

TABLE

The Distribution of Pa^{233} 7 Days Following Oral Administration

Tissue	% Per Organ	% Per Gram
Lungs	0.0045	0.00077
Liver	0.0072	0.00054
Kidney	0.0049	0.00161
Spleen	0.0035	0.0052
G. I. Tract	0.0207	0.00050
Muscle	0.1300	0.00075
Skeleton	0.0263	0.00092
Skin	0.0466	0.00069
Blood	0.0065	0.00299
Total absorbed	0.25%	

Longer-term I. M. as well as inhalation studies are not underway and will be presented as the data becomes available.

7. Projected Studies

Tracer, smoke, radioautographic and human studies will be continued for the next two months.

PART II. [redacted]

Section B

60" CYCLOTRON ACTIVITIES, BERKELEY, CALIFORNIA, OCTOBER 1945

The 60" cyclotron operated quite satisfactorily after the initial period of baking in, adjustments, etc. were completed following the replacement of the west dee steam liners in October. It was decided to keep the oscillator plate power input below 110 KW and attempt to attain maximum efficiency at this level rather than run up to our maximum power input of 150 KW. Steady alpha particle currents of from 1 to 1.5 ua and deuteron currents up to 30 ua were obtained at the 105 to 110 KW input level. When we can obtain new dee stems and dee stem tank liners, which will carry twice the water cooling and the thickness of the liners will be 1/8 inch instead of 1/32 inch thickness of the present installation, it will be possible to use full power. In addition, the heavier liners will have considerably lower electrical losses through increasing efficiency. Their installation should permit us to obtain up to 10 ua of 44 mev alpha particles and 100 ua of 22 mev deuterons. If it appears at that time desirable to increase the energy, 1 ua of alpha particles and 10 ua of deuterons at measured energies of 53 mev and 26.5 mev respectively should be attainable. Further increases in energy can only be accomplished by replacing the present magnet motor generator set and replacing the oscillator plate power rectifier tubes and their filament transformers with larger units.

The new Type III Backus oscillator tube was put into operation at the end of the month. Minor changes in the terminating inductance of the filament transmission line were necessary. The efficiency of this tube is equal to the south unit which is a Type II Backus tube. Change over between the two oscillator units can be accomplished within thirty minutes, which will cut down lost time due to grid filament shorts, etc. The new aluminum target chamber has been assembled and set up for final testing with the electrically operated gate-closing mechanism. A few small leaks along the welds have been discovered and fixed. The entire unit will be installed soon, replacing the original bronze target chamber which leaks and has become most unpleasantly radio-active.

Work on the production of Be^{+4} and C^{+6} ions has been continuing. A fairly thorough trial of high voltage spark sources, using the 37" cyclotron magnet, indicates that this procedure does not look promising. At present, a low voltage arc in conjunction with an electron gun at high voltage is being set up. Also to be tried is P.I.G. type of source.

Bombardments for the month included the alpha particle bombardment of Thorium, U^{233}, and lead; the deuteron bombardment of Np^{237} and protoactinium for Dr. Seaborg at Chicago, the deuteron bombardment of Uranium for Dr. Stone at Chicago, the deuteron bombardment of Beryllium for Dr. J. H. Lawrence at Berkeley and some special runs with a D. C. ion source arc for Prof. E. O. Lawrence at Berkeley. Bombardments planned for the next two months include the alpha particle bombardment of Np^{237}, protoactinium, Pu^{239}, U^{233}, U^{235}, and 95^{241}, and deuteron bombardments of U^{233}, Pu^{239}, and 95^{241}. The interceptor target is in current use, so in many instances, two bombardments can be conducted at the same time.

[redacted]

[redacted]

SECTION C

Distribution of Effort for the Month of September 1945.

Problem No.	Title	Approx. No. Employees per Problem	% Effort September	% of Effort Distribution Estimate for Oct.	Nov.
1.	Writing Project Record	2	10%	10%	10%
2.	Evaluation of Metabolic Properties of Plutonium and Allied Materials, in Plants, Animals, and Man	7	50%	50%	50%
3.	Decontamination Studies	7/16	40%/100%	40%/100%	40%/100%

1099867

[redacted]

[redacted]

Berkeley Radiation Laboratory

November 6, 1945

MR. H. A. FIDLER

PART III

Re: W-7405-eng-48
Report on NDP-48A

PRIVACY ACT MATERIAL REMOVED

Expenditures of this project in October, 1945, were approximately $6,900, up about 10 per cent from the level of the preceding month.

The October estimate:

Payroll	$ 4,000.00
Overhead	[redacted]
Expense and Equipment	1,866.00
Total	$ [redacted]

Following is a two-month budget estimate for November and December 1945:

Payroll	$ 8,000.00
Overhead	[redacted]
Expense and Equipment	4,000.00
Total	[redacted]

There were 20 employees on the payroll at October 31, in the following classifications:

Executive	1
Laboratory Technicians	3
Jr. Laboratory Technicians	2
Sr. Laboratory Technicians	1
Secretary	1
Clerk	1
Physiologist, P-1	1
" P-3	1
" P-4	1
Biochemist, P-1	2
" P-3	1
" P-4	1
Biologist, P-2	1
Chemist, P-4	2
Janitor	1
Total	20

1099868

[redacted]

ESTIMATED STATUS OF NDP-48A
ON OCTOBER 31, 1945

Payroll:

Appropriation		$ 139,000.00	
Payroll to September 30	$ 101,700.00		
October payroll	4,000.00		
		105,700.00	
Balance			$ 33,300.00

Overhead:

Appropriation		34,750.00	
Overhead to September 30	[redacted]		
October overhead			
		26,425.00	
Balance			[redacted]

Expense and Equipment:

Appropriation		126,450.00	
Expense to September 30	65,030.00		
October expense	1,866.00		
		66,896.00	
Balance			59,554.00
TOTAL BALANCE			$ 101,179.00

Total Appropriation	$ 300,200.00
Total Expense	199,021.00
Total Balance	$ 101,179.00

Kenneth Priestley
Business Manager
Radiation Laboratory

KP:ml
cc: Dr. J. G. Hamilton (2)

APPROVED
M. J. BARNETT,
Major, Corps of Engineers.

[redacted]