DECLASSIFIED

UCRL - 229

SECRET

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

TWO-WEEK LOAN COPY

This is a Library Circulating Copy which may be borrowed for two weeks. For a personal retention copy, call Tech. Info. Division, Ext. 5545

BERKELEY, CALIFORNIA

SECRET

UCRL-229 c.2

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

UNIVERSITY OF CALIFORNIA
Radiation Laboratory

Cover Sheet
Do not remove

DECLASSIFIED

INDEX NO. UCRL 229
This document contains 12 pages
and 0 plates of figures.
This is copy 15 of 17 Series A

[redacted] Issued to Safe Div.

Classification

Each person who receives this document must sign the cover sheet in the space below

Route to	Noted by	Date	Route to	Noted by	Date
[illegible]	W. P.	1/17/49			
Library	✓	"			

DECLASSIFIED

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

CLASSIFICATION CANCELLED
BY AUTHORITY OF THE DECLASSIFICATION BRANCH USAEC per TID 1113
BY B Frobett 3-31-56.
SIGNATURE OF THE PERSON MAKING THE CHANGE DATE

PROGRESS REPORT NO. 67

October 15 to November 15, 1948

Special Review of Declassified Reports
Authorized by USDOE JK Bratton
Unclassified TWX P182206Z May 79

REPORT PROPERLY DECLASSIFIED

J. B. Stuart 8-20-79
Authorized Derivative Classifier Date
L. Cohen 8-21-79
By Date

~~RESTRICTED DATA~~

~~This document contains restricted data as defined in the Atomic Energy Act of 1946.~~

CAUTION

~~This document contains information affecting the National Defense of the United States. Its transmission or the disclosure of its contents in any manner to an unauthorized person is prohibited and may result in severe criminal penalties under applicable federal laws.~~

Berkeley, California

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

October 15 to November 15, 1948

PROGRESS REPORT NO. 67

1. 184-inch Cyclotron Operation RESTRICTED

The cyclotron was used for research experiments ninety-five percent of the 497 hours that the crew was on duty.

Larger steel cones were put in the center of the cyclotron to produce stronger magnetic focussing. Since no increase in beam was observed, it was concluded that the present steel cones provided adequate focussing.

The date of November 22 has been set for the start of the proton unit installation.

2. 60-inch Cyclotron Operation UNCLASSIFIED

Under present operating conditions since reducing the frequency, alpha beams of 6 μa, proton beams of 20 μa and deuteron beams of 40 μa are readily obtained. The introduction of a probe during deuteron bombardments shows an average of 100 μa while operating at a level of 10 μa on the target. Without a target beam, internal beams of 450 μa have been realized on the probe. In general, efficiency has been at better than usual levels.

3. Synchrotron Program RESTRICTED

During the period of this report the entire effort has been devoted to further adjustments in the instrument and to the search for a betatron beam.

4. Linear Accelerator and Van de Graaff Operation RESTRICTED

There has been no operation of these machines during the month October 15 to November 15, because the Van de Graaff column was rebuilt and has not yet been worked up to full voltage.

5. Experimental Physics RESTRICTED

Film Program. Work is continuing on a measurement of meson masses by the method of bending in the magnetic field and range in photographic emulsion. Preliminary values are as follows:

Heavy negative meson:	285 m_e
Heavy positive meson:	286 m_e
Light positive meson:	216 m_e

where m_e is the mass of the electron. When this study is completed, it is hoped that the probable error of the mass determinations will be as low as ± 2 percent; however, the preliminary values given above do not have this accuracy. The ratio of masses of heavy positive to light positive mesons is 1.31. This ratio is consistent with the assumption that a light particle (e.g., a neutrino or a gamma-ray) is given off

DECLASSIFIED

RESTRICTED

when a heavy positive meson decays into a light one.

In order to check the method used for measuring meson masses in the cyclotron we have made a determination of the proton mass by a similar method. The alpha particle beam is allowed to strike a copper target, and protons are received which leave the target in a direction opposite to that of the beam. In the first run a value of the proton mass was obtained which was 1.0015 times the accepted value. This close agreement is, of course, fortuitous. In addition to the proton tracks, there were also observed tracks of deuterons, tritons, He^3 and He^4. Masses found for these particles were also in good agreement with accepted values.

Cloud Chamber. The cloud chamber group has made its first runs with the new cloud chamber and magnet. A carbon target inside the cloud chamber was bombarded in the 90 Mev neutron beam. An absorber was also placed in the chamber so that the curvatures of the particles emitted by the target could be measured on either side of the absorber In this way it was hoped to identify the fragments. Thus far very few of the tracks have been measured; we hope to work on these data while the cyclotron is shut down for the proton conversion.

Secondary Particles from Nuclei Bombarded by 90 Mev Neutrons. Analysis of the secondary charged particles from C, Cu, and Pb nuclei, bombarded by 90 Mev neutrons, has been made by determining simultaneously their $H\rho$ and range. In the forward direction both deuterons and protons with energies of 30 Mev to 100 Mev have been found in roughly equal numbers. The deuterons are apparently peaked more sharply forward than the protons.

A second method of analysis, involving simultaneous measurement of range and specific ionization, is under investigation, and will probably be ready to be used after the proton conversion.

High Energy Gamma Rays from Cyclotron Target. Considerable attention has been given to instrumentation, especially with regard to two-fold coincidence counts produced by particles originating locally in or near the counter pairs on either side. Events such as this (which can, for example, arise from secondary electrons due to capture γ radiation) yield a higher random rate of 4-fold coincidences than would obtain if all four counters operated independently.

The use of sheets of aluminum absorber between the counter pairs decreases these undesired 2-fold coincidences, but the effect of these absorbers upon the counting of low energy electron pairs is yet to be studied.

A measurement of the absorption of the radiation producing the 4-fold coincidences gave results appropriate to gamma photons of a mean energy of the order of 50-75 Mev.

Scattering of High Energy Neutrons. All experimental work on angular distribution was completed during this month. The recoil counter angular distributions for Al, Cu, Ag, and Pb were extended to 2° using large scatterers and a beam of small cross sectional area. Total cross sections of Be, C, Al, Cu, Ag and Pb nuclei were measured using the same detector. Measurements were made of the ratio of scattered to incident flux. This ratio is needed to assign absolute values to the differential cross sections.

RESTRICTED

 RESTRICTED

Fission Chambers. The differential cross section of carbon for neutrons produced in the 184-inch cyclotron has been measured for an angular range of 5 to 40 degrees. Bismuth fission chambers were employed in order to correlate the results with previous data taken with similar detectors on the total and inelastic scattering cross sections of carbon. The corrected value of the elastic scattering cross section in the direction of the neutron beam has been determined to be 124 ± 9 millibarns per steradian. The integrated elastic cross section has been computed to be .292 ± .020 barns. Previous measurements employing "good" and "poor" geometries gave the total cross section as .500 ± .004 barns and the ratio of the inelastic to total cross section of carbon as 45% ± 1.5%. The ratio of elastic to total cross section using the angular scattering data is 58% ± 4%.

Gamma Counting by Scintillations. The efficiency of our scintillation gamma ray counter has been improved by a further reduction of the extraneous counts arising from the dark current of the photo-multiplier tubes, and by improving the geometric arrangement of the photo-multiplier tubes, crystal and sample. More complete isolation and shielding of the two halves of the circuit between the photo-multiplier tubes and the coincidence circuit reduced the background counts. The greatest improvement was made by mounting a large crystal as close as possible to the light sensitive elements of the photo-multiplier tubes, and by placing the sample to be measured as close as possible to the crystal.

Rough comparisons at Donner Laboratory indicated that from a given sample the scintillation counter will count from 3 to 10 times as many gamma rays (depending on the energy) as a thick-wall Geiger tube.

RESTRICTED

6. Theoretical Physics

Good progress is being made on the n-p and p-p scattering calculations. The interpretation of the scattering and absorption cross sections of nuclei for 90 Mev neutrons looks fairly promising. The production of deuterons in nuclei by high energy neutrons is being calculated. Calculations of the meson production cross section are almost complete. The theory of resonance effects in the bevatron is being studied.

7. Isotope Separation and Analysis Programs

SECRET

Cyclorator. The name cyclorator has been suggested for the 360° isotope separator. The development of the energy modulating cyclorator was continued: receivers at 180° were used to determine the percentage of side bands and it was found that the ratio U^+/Cl^+ could be varied from 1:1 to 3:1 as the arc voltage was decreased from 150 volts to approximately 50 volts. The U^{++} side band was in all instances about 10% of U^+ and other side bands were determined to be less than 5%. For these tests an 8" J was used, and the C drain varied from 100 ma to 225 ma increasing with the arc current. U^+ could be increased to 45 ma for a C voltage of 35 kv. It is considered significant that the best operation of the arc occurred at arc voltage less than 100 volts.

Radio frequency voltages were applied to the C slit and the modulation of the beam observed at a receiver placed at 360°. On one portion of the receiver the beam was modulated from 10 ma to approximately 6 ma. On another occasion on one portion of the receiver the current was modulated from 1 ma to 0 ma. In obtaining these curves either the magnet curve or the frequency could be varied; however, a variation of the frequency is preferred. The maximum in the current given above

occurs when the beam is 180° out of phase with a voltage on the C liner and the minimum occurs when the voltage on the C liner is in phase with the beam. In connection with the RF tests, it was observed that negative current was arriving at the 360° collector. Application of appropriate voltage bias on the collector determined that approximately 30 ma of negative current was being collected, 10 ma of which had in excess of 90 volts energy. Although the negative current was not identified, it is probably associated with oscillating electrons in the vicinity of the receiver.

Development of the energy modulation principle is momentarily stopped, following Dr. Lawrence's proposal for modulating the component of beam velocity parallel to the magnetic field. Modulation is accomplished by splitting the G slit in such a way that a component of the RF voltage is parallel to the magnetic field. Preliminary results indicate that this type of modulation is feasible but that the quality of modulation will be associated with the amount of J hash. The next tests which are to be made are designed to correlate the amount of J hash present with the quality of the focus of the beam at the 360° point. The beam will be given electrostatic focusing at the G-C gap to minimize the width of the beam parallel to the magnetic field. Changes in this width with various conditions of hash in the arc are expected to give evidence of the random beam velocities parallel to the magnetic field.

Isotope Analysis. Two samples of tin, enriched respectively in Sn116 and Sn120 and samples of cadmium, enriched respectively in Cd111, 112, 114, 116 by the calutron, were analyzed. Two samples of mercury from the Bureau of Mines, reputedly enriched respectively in light and heavy isotope components, were also analyzed. No significant deviation from the normal mercury spectrum was observed.

An oven was installed in the mass spectrograph to vaporize samples under analysis. Since it is built of quartz tubing with a tungsten heating coil, it has a maximum operating temperature of 1000° C with a power consumption of 2 watts. A Foxborough Potentiometer Controller has been installed to regulate the temperature of the oven but has not been tested.

The magnetic sweep circuit was modified to reduce random fluctuations of the magnet current during the sweeping operation. Tests are being made to determine design requirements for a new sweep circuit.

New potentiometers were installed in the high voltage divider network to help stabilize the ion beam current during normal operations.

8. Chemistry

SECRET

Part A

Nuclear Reactions of High Atomic Numbers. It has been noticed in irradiations of the heavy elements with high energy charged particles that yields of spallation reactions such as d,4n or α,6n decrease sharply in the region from thorium to plutonium: e.g. with thorium, uranium and plutonium successively as target materials, it is probable that yields of comparable reactions decrease by at least one hundred-fold at each step. The implication of this finding is that the fission reaction begins to compete more and more heavily in this region.

Short-Lived α-Decay Series of Pa^{226}. The new α-decay series starting with approximately 2-minute Pa^{226} prepared with 80-Mev deuterons on thorium has been better

characterized by refining chemical separations and α-particle energy measurements. The energies of several of the α-groups fall under those from members of other decay series produced in the same bombardment making it difficult to determine the energies accurately. The decay series, as now known, is as follows:

$$Pa^{226} \xrightarrow[1.7\ \text{min.}]{6.81\ \text{Mev}} Ac^{221} \xrightarrow{6.96\ \text{Mev}} Fr^{218} \xrightarrow{7.85\ \text{Mev}} At^{214} \xrightarrow{8.7\ \text{Mev}} RaE$$

The half-lives of the intermediate members of the chain have not yet been determined but may be estimated at about 50 seconds for Ac^{222}, a few milliseconds for Fr^{218} and a few microseconds for At^{214}. It is interesting to note that At^{214} has an α-energy almost identical with that of ThC', the most energetic α-emitter known.

New α-Emitters below Bismuth. Very thin foils of gold have been irradiated with deuterons and a number of short-lived α-groups have been noted. Chemical separations were very crude and the most definite assignments that can be made are a 0.7-minute α-particle of 5.7 Mev energy to an isotope of mercury and a 4-minute, 5.2-Mev alpha to a gold isotope. The mass numbers can only be guessed and are probably less than 195 and less than 190 for the mercury and gold isotopes, respectively. These are the first examples of α-emission below the region of the heavy element natural radioactivities with the exception of the long-lived samarium α-emitter. Their discovery bears out previous observations on bismuth and higher elements that α-emission becomes prominent at sufficient high neutron deficiency.

Chemistry of the Actinide and Lanthanide Elements. It has been possible to prepare praseodymium metal on the submilligram scale using barium as a reductant for the trifluoride at 1150° C.

Praseodymium hydride has been formed at temperatures below 300° C. The hydride appeared to be stable in 1/3 atm. of hydrogen at 1000° C.

The lattice constants for a sample of pure AmF_3 have been determined. It has a hexagonal structure with lattice constants a = 4.060 ± 0.001 K_x units and c = 7.208 ± 0.002 K_x units.

A sample of PrF_3 prepared by the action of a mixture of H_2 (1/2 atm.) plus HF (1/2 atm.) on Pr_2O_3 at 700° C gave an exceptionally sharp x-ray diffraction pattern, permitting an accurate measurement of the lattice constants. The sample exhibited a hexagonal structure with lattice constants a = 4.087 ± 0.002 A and c = 7.237 ± 0.002A.

Chemistry

Part B

Synthetic and Experimental Chemistry. Preliminary work on the synthesis of phenylalanine-β-C^{14} is nearly complete. A new, simplified procedure for preparing glycine-1-C^{14} and glycine-2-C^{14} has been devloped in which a purification method is used that can also be adapted to a number of other simple amino acids. The preparation of 4,5-diiodofluorescein labeled with iodine 131 has been carried out for the investigation of its localization in brain tumors. C^{14} labeled oxalacetic acid has been prepared from ethyl acetate-1-C^{14} by condensation with ethyl oxalate. As there are apparently two competing reactions in this process, it is only by carrying out this reaction at low temperatures that satisfactory yields of the hydrolyzed product

RESTRICTED

can be obtained. Among the compounds whose preparations are being studied are diiodo^{131} tyrosine, alanine-3-C^{14}, butadiene-C^{14}, codeine-C^{14}, Demerol-C^{14}, fumaric acid-C^{14} and succinic acid-C^{14}. The yield data for the series of alanines will be reported next month.

Biological Chemistry. A series of experiments have been carried out to determine the rate of oxidation and elimination from the body as carbon dioxide of a number of simple C^{14} labeled compounds. In this group the following compounds have been studied: sodium formate-C^{14}, sodium acetate-1-C^{14}, sodium acetate-2-C^{14}, glycine-1-C^{14}, glycine-2-C^{14}, sodium propionate-1-C^{14}, potassium pyruvate-3-C^{14}, and alanine-2-C^{14}.

The studies have been made with both normal and pathological mice (mammary carcinomas and sarcomas). Ten normal and ten tumor mice were measured for each compound. The experiments are being continued with additional labeled compounds.

A preliminary survey experiment has been completed with stilbamidine (4, 4'-stilbenedicarboxamidine) labeled in the amidine ~~copper~~ carbon atoms with C^{14}. This experiment was performed primarily for the purposes of orientation. Further studies with this compound are to be continued.

A tracer study of the distribution of copper ion in the case of human malanoma has been made. If the uptake relative to the rest of the body were large enough to be selective, the possibility of radiotherapy by the administration of a radioactive copper isotope would be open. The experiment was performed on a male patient suffering from advanced melanoma with a few small pigmented surface lesions, multiple subcutaneous tumors and extensive metastasis to internal organs. Copper 64 was administered intravenously in saline, and the activity of the various regions followed with external gamma ray counters. The amount of activity was insufficient for accurate counting, but insofar as they can be interpreted, the data show no significant difference between the activity of either subcutaneous or cutaneous neoplasms and the activity of the surrounding tissues. The experiment will be repeated with more activity.

It has been felt that there are certain limitations in the use of C^{14} as a tracer in humans because of its long half-life and suggested evidence that it might deposit in the bones for long periods of time. In a series of quantitative experiments carried out to ascertain the activity of the bones after injection of glycine-2-C^{14} in mice there was found to be a uniform rise in the activity of all tissues which reached a peak in about three to four days and dropped gradually at about equal rates over a period of six weeks.

Photosynthetic Chemistry. The process of photosynthesis is being investigated using $C^{14}O_2$ and P^{32} as tracers. Several series of experiments have been conducted with the periods of photosynthesis or CO_2 fixations ranging from five seconds to five minutes. The radioactive products in alcohol extracts of algae are usually separated by paper chromatography and detected by autoradiography. The results at present verify our previous outlines of the process of photosynthesis. The role of respiration has also been investigated. A series of photosynthetic experiments is being performed at 5° Centigrade in an effort to reduce reaction rates and extend the time scale. The chromatography of P^{32} and labeled sucrose phosphates is being further investigated to substantiate preliminary experiments. The use of strong base anion exchange resins in the chloride form to separate phosphate esters is being continued.

RESTRICTED

SECRET

Chemistry

Part C. Subproject 48B

Metals and High Temperature Thermodynamics. Work is in progress on the following problems:

1. Thermodynamics of CN, N_2, and CH.
2. Absorption coefficients of CN, C_2, and CH.
3. Thermodynamics of gaseous molybdenum halides.
4. Refractory studies.
5. Thermodynamics of gaseous oxides and hydroxides.
6. Vapor pressures of metals.
7. Metal phase diagram studies.
8. Structure of solids.

Basic Chemistry. Solvent Extraction. The following problems are under investigation:

1. Lanthanum-TTA complexes in aqueous solution.
2. Polymerization of iodic acid in aqueous solution.

Engineering Development of Plutonium Separation. The following subjects are being investigated:

1. Solvent extraction using chelate process.
2. Pilot-scale synthesis of TTA.

Ore Reduction. Studies on the micro titration of uranium, based on the chromous reduction of uranyl ion, have been initiated. Preliminary investigations of the solubility of uranyl and uranous phosphates are being made.

9. Medical Physics

Part A. Project 48A -I

RESTRICTED

Radioautographic studies with strontium using the costocondral junction in rats have been initiated. Histologic analysis of the radioautographic collection are continuing.

The work with carrier-free arsenic in red blood cell metabolism is being continued. It has been shown that with in vitro studies, human red cells accumulate radio-arsenic as contrasted to in vivo studies. The metabolism of carrier-free tin which has been complexed with citrate is being continued as well as metabolic studies with radio-yttrium, radio-europium, praseodymium, and samarium.

An Oak Ridge shipment of samarium (Sm^{151}) was characterized by column separation with carrier samarium. The activity peak corresponded to the carrier peak as determined by spectrographic analysis. The radiation energy agreed with published values. About 120 microcuries of carrier-free tin were isolated from a cadmium target. The tin was retained in solution in the presence of ~ 1 mg. of citric acid per ml. of solution. Several columbrium samples, ~ 2 millicuries total, were separated from an Oak Ridge Cb-Zr mixture. An improved separation method, which is essentially a modification of electrical transference techniques,

RESTRICTED

 RESTRICTED

will be described in a separate report. The transference method shows considerable promise and has been used successfully in separating milligram amounts of copper from radio-arsenic, tungsten, from radio-tantalum, and manganese from radio-columbium.

Decontamination studies are continuing with plutonium and studying the effects of zirconium citrate treatment on this rate.

Medical Physics

Part B RESTRICTED

Activation Analysis. Considerable time is being spent on developing simple techniques for the assay of several radioactive isotopes present in the neutron irradiated tissue materials. The most promising approach appears to be in the use of ion exchange methods. Using the exchange resin dowex 50, the separation of several biologically important elements from each other has been accomplished. A recording device is being developed to give continuous recording of the radioactivity of the elution in the ion exchange columns.

Composition of Nuclear Material in Different Tissues. Using the technique of A. E. Mirsky and A. W. Pollister, the nuclear material and stroma of various tissues have been separated. Samples will be prepared for irradiation by neutrons at Hanford in order to obtain the trace element composition of cell nuclei; also the exchange of trace amounts of various elements in the nuclei of the cell being studied.

The 184" Cyclotron. No irradiations are being carried out for a number of weeks because the cyclotron is shut down for constructional purposes.

10. Health Physics and Chemistry

RESTRICTED

The previously mentioned survey of the fast neutron flux in Building 6 due to the operation of the cyclotron has been extended to three dimensions and now contains data at representative positions throughout the volume of the building below the crane level.

A derivation of the counting cross section for neutrons of an argon filled proportional counter counting recoil protons produced in a thick layer of hydrogenous material as a funtion of the distributions of the material and the neutron flux has been made for assumed mono-energetic neutrons. Experimental checks of essential parts of the result show reasonable agreements.

A two chamber counter separated by a removable septum has been completed and successful preliminary tests made on it. The minimum neutron energy for coincidences for the minimum thickness of septum available will be 1.45 Mev. It will probably not be possible to get data on the energy distribution of the fast neutron flux outside the cyclotron shielding before the proton conversion.

During the past month a complete new processing unit and dryer has been installed in our darkroom. This new equipment will make it possible to process two to three times as many film badges in the same amount of time that was previously required prior to November 3, 1948. Steps have also been taken to cover all personnel with film badges.

RESTRICTED

RESTRICTED

The projects currently in progress in the Research and Development Section of Health Chemistry Division are listed below.

1. S. G. Thompson interceptor run: the 3-day cerium trial run was successful. The interceptor was then loaded and put in the target. The run was stopped after 2 days because of a drop in the plate resistance and loss of target vacuum. The following changes were made: the air was replaced by dry helium with a drying tube in the line; increased cooling was given to the back plate; gaskets were replaced. A new run will start in a few days.

2. Specially equipped box for Dr. Gofman's yttrium and strontium processing: special stirring motors were received; gooseneck and double-ended tongs are under construction; formal drawing are being made of all equipment in this box.

3. A catalog of equipment fabricated and/or furnished by Health Chemistry is in process of preparation.

4. A new type alpha survey meter trial model has been completed; this meter has a new probe with a preamplifier. Servicing of the meters currently in use is being carried out.

5. Gloved boxes: a completely equipped box was shipped to Hanford; three new boxes were installed for S. G. Thompson; decontaminated box was installed for Dr. Huffman; a special box for W. Crane with a hallway between the new and old boxes was installed; a vacuum port dry box for L. Eyring is being readied; a special box for Dr. Conway was completed; proceeded with the assembly and fitting of six additional boxes; fourteen centrifuges are in the course of preparation for use in boxes.

On October 18 26 drums and 6 packages were dumped at sea, with the usual cement content.

RESTRICTED

LMB/11-29-48
Info. Div.

APPROXIMATE DISTRIBUTION OF EFFORT

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
1. 184-inch Cyclotron	Operation	10.32	
2. 60-inch Cyclotron	- - -	- - -	Non-Project
3. Synchrotron	R.f. System	1.60	
	General	.33	
	Injection	2.95	
	Magnet Tests and Operation	4.18	
	Vacuum Chamber	1.81	
4. Linear Accelerator	Linear Accelerator - General	6.52	
	Van de Graaf - General	6.20	
5. Experimental Physics	Cloud Chamber	6.53	
	Film Program	5.18	
	Ionization Chamber and Crystal Counter	4.38	
	Neutron-proton Scattering	.32	
	Proton-proton Scattering	2.99	
	Neutron Diffraction	1.63	
	Meson Range and Decay Measurement	1.40	
	Absolute Cross Section Measurements	1.51	
	Neutron Half Life	1.00	
	Bevatron Design Studies	2.36	
	General Physics Research	14.84	
	Magnetic Measuring Equipment	.72	
	Bevatron Magnet	1.21	
	Bevatron $\frac{1}{4}$ Scale Model	3.68	
6. Theoretical Physics	Synchrotron	- - -	
	Bevatron	2.13	
	Cyclotron	- - -	
	Linear Accelerator	- - -	
	General Physics Research	13.22	
7. Isotope Separation	Nier Spectrometer	1.34	
	Low Mass Spectrograph	1.24	
	XC Isotope Separation Program	3.48	

DECLASSIFIED

PROGRAM	SUBDIVISION	MAN MONTHS EFFORT	COMMENTS
8. Chemistry, Part A	Chemistry of Transuranic Elements	6.05	
	Nuclear Properties of Transuranium Elements	3.50	
	Transmutations with the 184" Cyclotron	7.68	
	Transmutations with the 60" Cyclotron	1.00	
	Analytical and Service	15.64	
Chemistry, Part B	Synthetic and Experimental Organic Chemistry	7.3	
	Biological Chemistry	5.4	
	Photosynthetic Chemistry	5.2	
Chemistry, Part C	Metals and High Temperature Thermodynamics	3.0	
	Basic Chemistry, including Metal Chelates	1.0	
	Engineering Development of Plutonium Separation	1.5	
	Ore Reduction	1.0	
	General	3.5	
9. Medical Physics, Part A, Div. I	Metabolism of Fission Products	10.0	
	Decontamination Studies	7.0	
	Radio-Chemistry	2.0	
	Radioautography	1.0	
Medical Physics, Part B, Div. II	Uranium Research	3.85	.95 Consultant Man-Months
	Tumor Metabolism	.97	1.25
	Special x-ray Studies, Radioactive Measurements, etc.	1.85	3.05
	Radioactive Carbon Studies	2.10	.70
	Fundamental Medical Research	.50	1.85
	Hematology	.20	1.00
	Medical Work with 184" Cyclotron	2.05	.90
	Fly Genetics	3.00	.30
	60" Cyclotron Bombardments	.30	.20
10. Health Physics and Chemistry	Monitoring and Special Problems	7.56	
	Salvage, Decontamination, Disposal, etc.	3.82	
	Research and Development	4.90	

DECLASSIFIED

DECLASSIFIED

SECRET