



UCRL 560
C.2

DECLASSIFIED

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

UCRL-560
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.

DECLASSIFIED

UCRL 560

UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

CLASSIFICATION CANCELLED
 BY AUTHORITY OF THE DECLASSIFICATION
 BRANCH USAEC *REF ID: A1113*
 BY *R. Robertt* *3-31-58*
 SIGNATURE OF THE PERSON MAKING THE CHANGE DATE

MONTHLY PROGRESS REPORT

No. 80

November 15 to December 16, 1949

December 29, 1949

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

November 15 to December 16, 1949

MONTHLY PROGRESS REPORT NO. 80

1. BevatronUNCLASSIFIED

Magnet Model Tests. Radial uniformity measurements on the 1/12 scale model show a larger effect from eddy currents than expected in the top and bottom tank covers, if the covers are made of 1/16 inch stainless steel sheets running the full length of the quadrants without joints. The measurements remain to be checked but if correct, may require changes in the material and/or the thickness of the sheets. The possibilities of breaking the covers into 2-1/2 degree sections with gasket joints or of compensating the eddy currents with the bias windings provided are also being considered. Measurements have been made to determine the heating of the concrete foundation due to eddy currents in the reinforcing rods. Insulation may be required between the bars if their contact resistance is too low.

Building. The building concrete is 40 percent complete and the total building 22 percent complete at this time. Since the last report a slide occurred which damaged the form work on about 60 ft. of retaining wall. This is the only wall still incomplete. The building is expected to be delayed about two months by the steel strike, making the probable completion date the end of July. The magnet foundation drawings went to the contractor during the week of November 28.

Magnet. About 700 tons of steel arrived in the Bay Area November 29 and fabrication started immediately. Assembly of the steel into slabs will start after about 15 percent of the plates are received. Measurements of air pressure drop through a model of the magnet have been completed with results in general agreement with the design calculations.

Injector. Assembly of the ion gun with the PIG source is expected to be completed in January. It has been decided to locate the injector at the east tangent section and the accelerating electrode at the north tangent section.

2. 184-inch Cyclotron OperationUNCLASSIFIED

The cyclotron was used for research experiments approximately ninety-two percent of the 465 hours the crew was on duty. The program for improving the deflecting system has continued whenever the experimental program has allowed it.

3. 60-inch CyclotronUNCLASSIFIED

A return to bombardment scheduling was effected during this period. To date the beam intensity with alpha-particles has reached 12 μ a on the external target. Forty microamperes of deuteron were obtained on the external target with

UNCLASSIFIED

650 μ a available for internal target use. An energy determination was made that indicated an energy distribution of from 38.9 to 39.95 Mev. Approximately one-half of the available time was used in performing target bombardments.

4. High Current CyclotronSECRET

Efforts have been confined to completing design studies on the vacuum system and arc source. Final design of the oscillator is 90 percent complete with many of the components under construction. The dee "skins" are being fabricated and assembly of the dees will commence about the middle of January. The target pump is 80 percent complete with tests scheduled to begin in about two weeks. The transmission line seals are acceptable as originally designed with the exception of the quartz bushings. Failures occur because of large visible flaws in the quartz. The manufacturer is going to supply bushings without these flaws. The control room rack set-up has been completed and installation of various electronic components is under way.

None of the larger items for the cyclotron are expected to be ready for assembly before January 15.

5. Synchrotron OperationUNCLASSIFIED

Machine operation during the past month has been satisfactory but has not shown the same high peak performance of 3300 R/hr reported last month. Practically all of the beam time has been absorbed in experiments which include targets and absorbers of various kinds in addition to the collimator. No direct comparisons have been attempted in measurements of beam intensity. This would have wasted valuable machine time during the removal and replacement of experimental equipment to duplicate the conditions under which the peak intensities taken last month were measured. Use of the proper multiplying factors for adjusting to various collimator sizes and the volume of the ionization chamber with respect to beam diameter shows an average output of 1250 R/hr.

Steadiness of operation has improved with the installation of regulation on the 12 kv line. During a scheduled one day shutdown after the regulator installation the transformer taps were lowered to their normal settings and the main energizing coils were again tightened to prevent shaking during operation.

The thin window ionization chamber has been operating very well. Although no calibration has been made of it as yet, it has become a very useful and dependable instrument for integrating equal amounts of radiation.

During the past month a number of identical peaking strips for mapping the phasing of the field have been manufactured. Measurements of the rate of rise of field in each octant and variations in the time of zero field are now being taken.

6. Linear Accelerator and Van de GraaffUNCLASSIFIED

The Van de Graaff column has been sand-blasted and reassembled and is back in operating condition. This treatment of the column was surprisingly successful.

UNCLASSIFIED

Only the two days of outgassing were required to reach operating voltage. The linear accelerator is now back in routine operation with a total of 83 hours of bombardments having been made during the period covered by this report. The regular operation was not resumed until December 7th, so that only 8 days are covered by this bombardment time. Bombardments were made for chemistry isotope production, inelastic neutron production, and angular limits on anomalous scattering for heavy elements. Bombardments were also carried out on the properties of a light $1/2$ second radioactive isotope emitting heavy particles. The operating current is 5×10^{-8} amperes at a pulse length of 300 microseconds and about 10^{-7} amperes at 540 microseconds.

7. Experimental Physics

UNCLASSIFIED

Film Program. Meson Mass Measurements. Apparatus to be used for measuring meson masses in the 184-inch cyclotron is now nearly complete. Meson masses are found by comparison with the proton mass. Preliminary runs have shown that it is possible to expose photographic plates in the cyclotron in such a way that protons, π^- mesons, π^+ mesons, and μ^+ mesons, all of approximately the same velocity, strike the plate simultaneously.

Background Studies. The installation of the large air lock in the cyclotron and the adjustable block in the dee have made it possible to experiment with new arrangements for shielding photographic plates. It is now possible to place a thick shield immediately in front of the plates to protect them from stray beam particles. An adjustable vane has been placed near the ion source to limit the beam in a vertical direction. Studies are now in progress to find the arrangement which will give the best ratio of meson tracks to background tracks on the plates. Plates obtained during the past month are better than any obtained previously.

Cloud Chamber. Several runs have been made at the synchrotron in an experiment to determine the energy spectrum of the electrons at the maximum of the shower in lead. An experiment is also under way on the scattering of 90 Mev neutrons by deuterons. Measurements are now being made in both experiments.

High Energy Photons from Proton-Nuclear Collisions. The new cloud chamber with Helmholtz coils, to be used for investigating the problem of photon-photon coincidences, is nearly completed. Individual tests on each component have been successfully made.

An increased efficiency of the pair counter has been achieved by making the magnet pole gap 40 percent larger. Photon yield vs Z studies have been made with it, employing cyclotron targets whose thicknesses were adjusted to yield the same mean squared angle of proton scattering so that multiple traversal by the proton beam would be identical for each. The yield was found to increase proportionally with nuclear size ($A^{2/3}$). This result should supplant an earlier statement to the effect that the yield increased less rapidly than $A^{2/3}$.

Meson Induced Fission. Two different attempts were made to detect fissions induced by the negative π mesons which are produced by the high energy gamma rays from the synchrotron. In both cases, results were inconclusive because counting rates were too small.

UNCLASSIFIED

In the first setup, a bismuth fission counter was placed so as to accept mesons, coming off at 90° to the gamma ray beam, from a 1 in. diameter x 5 in. long carbon target. A quarter inch copper absorber was used in order to select that portion of the energy spectrum where the meson yield is a maximum. The 1 in. x 2 in. aluminum window of the fission counter was about 5 in. away from the center of the carbon target so that 4 in. of copper could be used to stop the mesons and determine a background counting rate. In approximately twenty-five minute runs with an integrated beam of about 1.8 roentgens, 13 counts were obtained when only the 1/4 in. Cu absorber was in place, and 1 count when only the 4 in. Cu absorber was in place. When a large lead brick was placed in the beam and the 1/4 in. Cu absorbers were in place, 39 counts were registered in about 17 minutes.

In the second setup, a proportional counter was placed in the meson path in coincidence with the fission counter. Because the counting rate was small, the coincidence counting rate could be explained as accidental. The design of the proportional counter and the fission counter happens to be such that an electron which stops in the proportional counter will lose nearly the same amount of energy as a π meson which stops in the surface layers of fissionable material. This coincidence method will be exploited further with counters of a new design.

Electrons for Fast Crystal Counting. Tests were completed on the first model of the preamplifier which was designed for use in the pair counter. Measured gain and bandwidth check quite well with calculated values. However, it is now thought desirable to have a preamplifier with higher gain so that it can be used with one of the commercially available distributed amplifiers. Such a preamplifier has been designed and is being constructed. Mechanical design is almost completed on a crystal light pipe photomultiplier tube preamplifier unit. It is proposed to construct two of the units for test under actual operating conditions.

Delayed Neutron Studies. A BF_3 chamber for slow neutron counting was test operated successfully with a pressure of one atmosphere of BF_3 in chamber. A signal-to-noise ratio of 5 to 1 has been attained.

To investigate possible activities with very short half-lives an interval timer has been designed and is in the shop which will have variable delays and gates, covering range from 50 microseconds to 50,000 microseconds. A test run was made on the cyclotron which has given data on efficiency of apparatus and also on size and type of targets and cyclotron beam for best results.

Nuclear Total Cross Sections. The preamplifiers of the four "long" fission chambers have been modified to accommodate the new a.c. filament linear amplifiers. The "shallow" fission chambers have cathode followers suitably altered to transmit signals to the altered preamplifiers. The chambers behaved well when electronic pulses were introduced. The long chambers performed well in a trial test utilizing the 270 Mev neutrons.

A few further measurements of nuclear cross sections of heavy elements are to be made to complete the program of these measurements.

Proton Elastic Scattering. A table with movable arm has been completed for use in this experiment. The movable arm allows the coincidence counter telescope to be

UNCLASSIFIED

placed at angles between 0° and 90° to the beam direction. At the pivot point of this arm is mounted a scatterer wheel with six positions which allows the scattering materials to be changed remotely. Work is in progress on methods to increase and more sharply define the proton beam used.

Cross Sections for π Meson Production by 345 Mev Protons. The forward-going mesons from a carbon target bombarded by the external proton beam were separated from the beam by means of a magnet and observed in nuclear emulsions. The plates are very satisfactory and it is hoped to have the absolute cross sections for this process soon.

Production of Mesons in Liquid Hydrogen. Two bombardments have been carried out in the external beam of the 184-inch cyclotron in which the liquid hydrogen target previously used at the synchrotron was used. Studies were made of the absolute cross sections of meson production at 30° and 45° . Meson yields were about as expected and counting of the photographic plates is in progress.

Production of Protons in the Synchrotron Beam. The angular distribution and energy distribution of protons produced in various targets by the synchrotron x-ray beam has been studied. It has been found that the cross sections for all elements at all energies of secondary protons varies as the two-thirds power of the atomic number, excepting for the very low energy region of the photo-protons where the Coulomb barrier reduces the yield from the heavier nuclei. The energy distribution varies approximately as the inverse $3/2$ power of the proton energy and the angular distribution corresponds to a nearly pure $\sin^2\theta$ distribution, corrected for Doppler shift of the incident radiation.

Other Studies in the 184-inch Cyclotron. Crystal counters and high resolution coincidences on the proton beam in the cave have been tested. The emission time of the cyclotron with a Th sprayer has been found to be approximately 25μ sec and the emission time with the electric deflector less than 0.2μ sec. An attempt to deflect π^+ mesons has not been successful, but will be repeated. An np calibration run with 260 Mev protons has been made.

Other Studies in the Synchrotron. In the induced activity experiments, the relative yields from several nuclear reactions with Zn have been measured using separated isotopes. Also a transition curve of x-rays causing nuclear reactions in Pb has been taken. These experiments will continue.

During the past month the work on transition curves has been completed. A summary of these experiments includes: (1) data on showers initiated in Pb, Cu, Al, and C by the 335 Mev bremsstrahlung from the synchrotron beam have been taken and a study of the resulting transition curves show that they extend to approximately 20 radiation lengths in Pb and Cu; (2) the initial rise of the showers in Pb, Cu, C, and Al has been studied and the relative values of the pair production cross sections averaged over the bremsstrahlung spectrum have been obtained; (3) a method has been developed to measure the total energy in the x-ray beam from the synchrotron.

The (γ, p) studies have yielded an energy distribution curve of protons in the (γ, p) reactions on C, Cu, and Pb. This data was taken with proportional counters. An investigation from 10-75 Mev shows that the distribution falls off rapidly with

-7-

UNCLASSIFIED

energy and seems to be the same for all elements measured except in the region where the potential barrier is effective. The cross section seems to be proportional to $A^{2/3}$ (or $Z^{2/3}$). This will be investigated further.

In the meson program no further nuclear plate bombardments have been made, and one of the meson counter experiments to detect negative mesons with crystal counters in a steering field has been discontinued. The meson experiment utilizing coincidence based on the decay electron with scintillation counters has afforded considerable data on the energy distribution and angular distribution of mesons produced from several targets.

Some preliminary work has been done on the detection of fission neutrons, cloud chamber photographs of mesons utilizing a circuit which will trigger the cloud chamber with the coincidence of a heavy particle traversing two crystals, and the measurement of the half-life of the meson.

8. Theoretical PhysicsUNCLASSIFIED

Work continues on meson production cross sections, proton-proton scattering and on shower theory. Calculations for the high current cyclotron have been completed. Considerable work has begun on linear acceleration theory. The I.B.M. method of solving the beam dynamics looks very promising.

9. ChemistryCONFIDENTIAL

Part A

Properties of Isotopes of Cerium and Lanthanum. Lanthanum oxide has been bombarded with high-energy protons in the 184-inch cyclotron. The new isotopes Ce^{133} , Ce^{134} , and La^{134} have been observed, and Ce^{135} and Ce^{137} have been reexamined.

A 6.3-hr. activity was assigned to Ce^{133} by milking the 4-hr. La^{133} daughter. Ce^{133} emits positrons of upper limit 1.4 Mev, K x-rays, and gamma-rays of 0.38 Mev and 1.4 Mev. The energetic gamma-ray was followed through 7.5 half-lives.

A 72-hr. cerium activity with a 6.5-minute lanthanum daughter has been assigned to mass 134 by elimination arguments. Ce^{134} decays by electron-capture and La^{134} 56 percent by electron-capture and 44 percent by positron-emission (2.7 Mev).

The half-life of Ce^{135} has been revised from "approximately 18 hours" to 22 hours, determined by observation of its positrons for five half-lives on the crude beta-spectrograph.

The energy of the conversion electron of 36-hr. Ce^{137} has been redetermined as 0.24 Mev.

Isotopes of Astatine. Recoil experiments have confirmed that 5.5-hr. At^{209} decays to 14-day Bi^{205} and that 1.7-hr. At^{207} decays (via Bi^{203}) to 52-hr. Pb^{203} .

CONFIDENTIAL

Beta Spectrometer. The power supply of the beta-spectrometer has been improved. The counter window is now nylon of thickness 0.4 mg/cm^2 . A number of activities have now been examined.

Am^{241} shows three electron lines which are explained as L_{II} and L_{III} , and L_{III} conversion of 50 and 63 Kev gamma-rays, respectively.

U^{231} shows lines at 30, 34, 44, and 56 Kev, which are provisionally associated with gamma-rays of 50, 64, and 76 Kev.

Cm^{242} shows five electron lines, which can be ascribed to two gamma-rays of 39 and 58 Kev.

A 90-minute positron, tentatively assigned to Zr^{87} , has been shown to have an upper limit of $2.41 \pm 0.03 \text{ Mev}$. The positrons of 80-hr. Zr^{89} have been found to have an energy limit of $1.00 \pm 0.03 \text{ Mev}$.

Spontaneous Fission Counting. A reasonably compact spontaneous fission counter has been constructed in this laboratory. The electrical circuits are contained in a single "Bud" cabinet. This equipment is now being used to study the very heavy isotopes. It is planned to investigate the energy distribution of spontaneous fission fragments.

The Vapor Phase Hydrolysis of Lanthanum Trichloride. The micro-balance method described previously has been used to measure the equilibrium constant of the reaction:



over the range 640° to 840°K . If the heat capacity differences are taken as

$$\Delta C_p = -4.11 + 0.0039T - 0.00000222T^2$$

then the data are in good agreement with the following thermodynamic constants:

$$\begin{aligned} \Delta H_{792} &= 31.83 \text{ kcal} \\ \Delta S_{792} &= 40.12 \text{ e.u.} \\ \Delta F_{792} &= 0 \\ \Delta H_{298} &= 33.2 \text{ kcal} \\ \Delta S_{298} &= 42.8 \text{ e.u.} \\ \Delta H_c &= 34.2 \text{ kcal} \end{aligned}$$

It is proposed to check ΔH by calorimetric experiments with the two solids.

Anion Exchange Separation of Zirconium and Hafnium. The separation of zirconium and hafnium by anion exchange on Amberlite IR-400 has been reported

CONFIDENTIAL

previously. Recent experiments have shown that the rate of elution with HCl-HF solutions and the sharpness of the elution peaks is markedly effected by the concentration of HCl and somewhat by the concentration of HF. A suitable solution for elution is 0.19M HCl and 0.01 M HF. Greater HCl concentrations give faster elution, but less separation.

The YF₃-type Crystal Structure. For some time x-ray powder diffraction patterns of YF₃, SmF₃, EuF₃, GdF₃, TmF₃ and YbF₃ have been prepared which showed them to be isomorphous with an unknown crystal structure. Recently single crystals of YF₃ were prepared by slow cooling from above the melting point in high vacuum. The crystal fragments were transparent and colorless, but showed no crystal faces. Oscillation and Weissenberg patterns provided information which made possible the indexing of the powder patterns. The intensities show that the cell is orthorhombic, space group D_{2h}¹⁶-Pnma, and that the structure is the same as that of Fe₃C. The lattice parameters are as follows:

	$\overset{0}{a}$ Å	$\overset{0}{b}$	$\overset{0}{c}$	ρ , g/cc calc.
YF ₃	6.33	6.86	4.39	5.20
SmF ₃	6.66	7.07	4.40	6.65
EuF ₃	6.61	7.01	4.41	6.79
GdF ₃	6.52	6.93	4.36	7.21
TmF ₃	6.29	6.79	4.39	8.02
YbF ₃	6.15	6.71	4.41	8.39

It is interesting to note that SmF₃, the first one of the rare earth fluorides to exhibit this structure, is dimorphous crystallizing also in the hexagonal LaF₃ structure.

Professor W. H. Zachariasen (private communication) has independently indexed a powder pattern of YF₃ using the values $a = 4.37$ Å, $b = 6.42$, and $c = 6.89$, in good agreement with the above values.

Properties of Plutonium, Americium, and Curium Isotopes. The isotopic composition of the americium (known locally as "51NB") which had been bombarded for 15 months in a Hanford pile has been determined to be 99 percent Am²⁴¹, 0.6 percent Am²⁴², and 0.4 percent Am²⁴³ as determined in the mass spectrograph using a thermal source. The value for Am²⁴² is still uncertain, because of incomplete resolution from Am²⁴¹. Slow neutron fissionability measurements made on this material in the Argonne heavy water pile show that the fission cross section of Am²⁴² is of the order of several thousand barns for pile neutrons. In order to explain the composition of this material, Am²⁴² must have a neutron-capture cross section of several thousand barns to form Am²⁴³.

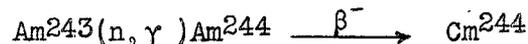
CONFIDENTIAL

Irradiation of the americium fraction from the neutron-irradiated plutonium known as "sample 12B" in the Argonne pile followed by chemical purification of the americium revealed a new beta-emitting americium activity of ~25 minute half-life. This activity is probably Am²⁴⁴ and if this is the case the capture cross section of Am²⁴³ is about 50 barns.

The milking of Np²³⁹ from the americium fraction of "sample 12B" showed that 0.3 percent of the alpha-disintegrations of this americium are due to Am²⁴³. Examination of this americium in the pulse analyzer showed an alpha of 5.21 Mev energy and in 0.3 percent abundance which is thus assigned to Am²⁴³. From milking experiments on the "51NB" americium and from the known isotopic composition, the partial alpha half-life of Am²⁴³ is estimated as about 10⁴ years. A better value will be possible when the isotopic analysis of the "12B" americium is available.

The plutonium known as "12B" has been mass analyzed with the result 58.1 ± 0.5 percent 239; 34.0 ± 0.5, 240; 6.8 ± 0.3, 241; 1.02 ± 0.11, 242 (atomic percent). Fissionability measurements on this plutonium and on some of these plutonium isotopes partially separated in the mass spectrograph show that the fission cross section of Pu²⁴¹ is between 500 and 1000 barns. The fission cross section of Pu²⁴⁰ is less than 50 barns.

Examination of the alpha-particles in the curium from sample "51NB" showed a group of 5.78 Mev in 0.3 percent abundance (after 28 months decay of the curium fraction). The curium from sample "12B" showed the same alpha-group in an abundance of 0.1 percent. This energy is the same as that of the isotope tentatively assigned as Cm²⁴⁴ produced by helium ion bombardments of Am²⁴¹. Considering the periods of irradiation and the subsequent decay of the "51NB" curium, it seems most likely that the 5.78 Mev alpha is due to Cm²⁴⁴ formed by the path:



The beta-decay half-life of Pu²⁴¹ has been determined using some of the "12B" plutonium by milking the Am²⁴¹ which grows in, and using the isotopic composition (6.8 percent Pu²⁴¹) determined with the mass spectrograph. The result is 14 ± 1 years.

Alpha-particles of a new energy (4.91 Mev) in 0.2 percent abundance have been observed in this plutonium. They are probably due to Pu²⁴¹ or Pu²⁴². The following argument based on the energy and half-life makes 241 the most likely assignment. One can calculate the partial half-life for emission of these alphas from the mass spectrographic data. If they are due to Pu²⁴¹, the result is 4 x 10⁵ years; if Pu²⁴², 6 x 10⁴ years. Pu²⁴¹ is known to have an alpha-decay half-life (from milking of U²³⁷) of about 5 x 10⁵ years. The half-life 6 x 10⁴ years from the assumption of mass 242 is too short by a factor of five or ten for an even-even nucleus of atomic number 94 emitting 4.91 Mev alpha particles. Therefore the best assignment is mass 241.

ChemistryUNCLASSIFIED

Part B

Synthetic and Experimental Chemistry. Listed below are the names, position of label and specific activity of a number of compounds whose synthesis with C¹⁴ has been completed recently. Sodium isobutyrate-1-C¹⁴, 1.72 µc/mg; sodium isovalerate-1-C¹⁴,

-11-

UNCLASSIFIED

3.35 $\mu\text{c}/\text{mg}$; sodium isocaproate-1- C^{14} , 1.79 $\mu\text{c}/\text{mg}$; leucine-1- C^{14} , 1.57 $\mu\text{c}/\text{mg}$; sodium isocaproate-2- C^{14} , 2.97 $\mu\text{c}/\text{mg}$; sodium isobutyrate-3- C^{14} , 1.50 $\mu\text{c}/\text{mg}$; alanine-3- C^{14} , 0.87 $\mu\text{c}/\text{mg}$.

Compounds whose preparation with C^{14} is currently being studied include: malic, succinic, fumaric and tartaric acids; cyclohexanone; toluene; diethyl-aminoethanol; substituted malonic acids; guanine, guanazolo and a variety of other purine and pyrimidine derivatives and isoterres; and glucose and mannose.

Biological Chemistry. Work has continued on the metabolism of sodium propionate by mouse liver slices. No detectable difference has been found in the active material produced by normal and neoplastic liver tissue. Experiments have been undertaken to determine the effect of time of incubation on the products formed.

Studies on the metabolism of fatty acids have been transferred from whole animal work to tissue slice experiments, and two new compounds, alpha-labeled isocaproic acid and methyl-labeled isobutyric acid, are now being used in these experiments.

The ability of chickens to use choline and hemocystine in place of methionine has been used in an attempt to follow the metabolism of labeled choline chloride and to determine whether the materials for the formation of the egg come via the body tissues or directly from the food. A laying and a non-laying hen have been fed choline-methyl- C^{14} chloride and the activity in the several organs and parts of the egg is being determined.

Other work in progress includes (1) biological activity of purines and nucleic acids and derivatives or isoterres; (2) rate of metabolism to C^{14}O_2 of simple labeled organic compounds; (3) metabolism of C^{14} labeled stilbamidine in mice.

Photosynthesis Chemistry. Research on the nature of the mechanism of carbon dioxide reduction in plants has been continued along several lines of approach. The identification of products of photosynthesis in C^{14}O_2 has been continued with emphasis on the nature of the phosphorylated compounds. Two separate spots in C^{14} radiograms have yielded glyceric acid upon acid hydrolysis and suggest that both 2- and 3-phosphoglycerate are formed. Oxidation of these phosphates to give phosphoglycolic acid should provide evidence for differentiation. A sample of commercial 2-phosphoglycerate is being purified by ion exchange resin separation to provide an authentic specimen for chromatography with suspected compounds. Acid hydrolysis of components of the mixture of phosphates formed in photosynthesis which have been separated by improved chromatographic technique is underway.

Ion exchange resin columns (Dowex Al) have been used to successfully separate fructose diphosphate and 3-phosphoglycerate. Complete separation and quantitative recovery have been obtained.

The analysis of products formed as a function of time has been performed for several series of photosynthesis experiments. Low temperature (5°C), high light intensity, low light intensity as well as photoreduction, oxygen-hydrogen dark carbon dioxide reduction and normal photosynthesis have been analyzed.

UNCLASSIFIED

The metabolism of the red photosynthetic bacterium, Rhodospirillum rubrum, is being investigated using the methods developed for plants in this laboratory. Preliminary results of ten minute photosynthesis experiments with $C^{14}O_2$ show little insoluble radioactive material but do show labeled aspartic acid, alanine and 90 percent of the radioactivity fixed in phosphate esters. These will be investigated further.

C^{14} labeled glyoxylic acid is being prepared from labeled glyceric acid isolated from plants. It will be used for comparison with unknown compounds.

Inhibition experiments with iodoacetamide on Chlorella show the expected diminution of photosynthesis rate and a disappearance of two compounds characteristic of normal photosynthesis. These are being identified. Even with 90 percent inhibition of rate, sucrose is formed in a one-minute $C^{14}O_2$ fixation. Apparently the inhibition is not specific.

ChemistrySECRET

Part C. Project 48B

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

1. Thermodynamics of CN and N_2 gases.
2. Gaseous aluminum oxide species.
3. Gaseous oxide species of transition metals.
4. Gaseous oxide and hydroxides species of Mo and W.
5. Reflection coefficients of gaseous molecules.
6. Liquid metal systems.
7. Refractory studies.
8. Thermal conductivity of gases.
9. Heat transfer in forced convection film boiling.

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

1. The exchange of iodine atoms between iodate ion and iodine.
2. The chelate complex of lanthanum with TTA.
3. Thermodynamic studies on rhenium.

Engineering Development of Plutonium Separation. The following subject is being investigated:

1. Solvent extraction using chelate process.

Ore Reduction. The following subjects are under investigation:

1. Micro amperometric titration of uranyl ion with chromous ion under investigation.
2. Solvent extraction using chelate process. A study of phosphate complexing.
3. A study of equilibrium in uranyl phosphate precipitation is under way.

-13-

RESTRICTED10. Medical Physics

Part A

Tracer Studies. Studies have been completed on the metabolism of Yb¹⁷⁵ in rats sacrificed at 1, 4 and 8 days following intramuscular, intravenous and stomach tube administration of this element. Still in progress are investigations on the metabolism of Lu¹⁷⁷. Proposed studies include those on rats sacrificed at 8 days following stomach tube injection of 50 microcurie and 1 millicurie levels of Lu¹⁷⁷.

Results so far demonstrate similarities in the metabolism of Yb¹⁷⁵ and Lu¹⁷⁷ to other rare earth elements so far investigated.

Decontamination and Bone Metabolism Studies. A series of rats has been injected with massive amounts of Pu(VI) in a preliminary study of the effects of internal alpha irradiation upon the levels of alkaline phosphatase in bone tissue and in serum. Histological studies of the bones from these animals have been simultaneously initiated.

Kinetic studies of the deposition and excretion of the elements columbium, yttrium, and plutonium (VI) during the first hour following intravenous injection are proceeding. The use of the 'carrier-element', zirconium, given as a massive dose with the above elements, shows marked evidence of an enhanced urinary excretion of these elements during the timeperiod studied.

The decontaminating effects of the commercial product, Versene, are being investigated in rats injected with radio-strontium.

The experimental correlation of criteria applicable to the rachitic condition in rats is proceeding.

Radioautographic Studies. Radioautographic studies of plutonium in lung are still in progress. A complete summary of the work done on rat costochondral junctions will be given in the quarterly summary.

Routine work on rat tissues injected with I¹³¹, Ho¹⁶⁶ and Yb¹⁷⁵ is continuing. A complete autopsy was made on a rat injected with 83 microcuries of astatine 211 and all tissues were taken for histological study.

Radiochemistry. Preparations for animal injection of millicurie amounts of Lu¹⁷⁷, Yb¹⁷⁵, Cb⁹⁵ and Zr⁹⁵-Cb⁹⁵ have been made. Another carrier-free procedure for isolation of Na²² from a magnesium target has been developed. At²¹¹ has been prepared twice from bismuth targets and a yield experiment for At²¹⁰ was conducted. Work is continuing on the radiochemistry of I¹³¹ in water-carbon tetrachloride systems.

Medical PhysicsUNCLASSIFIED

Part B

Studies with the 184-inch Cyclotron Beam. Experiments are currently being carried out in cooperation with members of the Hunters' Point Naval Research Laboratory,

UNCLASSIFIED

making use of the collimated deuteron beam of the 184-inch cyclotron to determine the effects of ionizing radiation on localized regions of the body in the rat. It is hoped in this way to throw some light on the relative importance of various organs and tissues in the radiation syndrome.

Bacteriology. Studies of factors determining and influencing radiation sensitivity are continuing on strains B and B/r of Escherichia coli. Survival curves have been determined for high and low energy deuterons from the 184-inch cyclotron and are being quantitatively compared to those obtained with 200 kv x-rays and with ultra violet light.

Double Nucleated Lymphocyte Problem. Additional counts on Radiation Laboratory personnel have shown a slight change in the occurrence of double nucleated lymphocytes from the figures previously reported. The most recent values being 7.4/50,000 for the "non-exposed group" and 1.7/50,000 for the "exposed group", as compared to the former figures 5.5 and 0.8 per 50,000 cells respectively. One lymphatic leukemia patient showed an incidence of 4.6 percent.

Counts have also been made on three male rats which were kept for a period of several months in the 184-inch cyclotron building in an area of highest "background". No double nucleated lymphocytes were seen in 9,000 cells counted.

Metabolism of Simple Carbon Compounds Labeled with C¹⁴. Determinations of rates of conversion of labeled compounds to CO₂ in the animal body are being continued.

Studies with Stilbamidine Labeled with C¹⁴. A patient with multiple myeloma is available for study and clinical trial with labeled stilbamidine. The experiment awaits permission for use of this material in human beings. This permission is anticipated in the near future. A year has now elapsed since the first application for permission to administer this material to patients with this fatal disease was turned down.

Assessment of Effects of Radioisotope Therapy. Studies of the effect of radioisotope therapy in certain aspects of the blood clotting mechanism are continuing. The findings are not conclusive at present.

Data gathered so far on renal blood flow in patients with polycythemia are inadequate for conclusions to be drawn. This work is continuing.

Trace Analysis. Human red blood cells from patients with polycythemia and leukemia, as well as normal individuals, are being prepared for pile bombardment and subsequent assay. Further studies are being conducted, the objective of which is the refinement of the application of ion exchange in trace element studies.

Physical Chemistry. Work is continuing in the various aspects of this program: infra red spectroscopy, light scattering photometry, the production and experimental use of radioactively labeled cholesterol, and the study of lipoproteins in arteriosclerosis.

Metabolism of Cobalt. Studies of the effects of cobalt-amino acid complexes on hemopoiesis are being continued using radioactive cobalt as a tracer.

Iron Metabolism Studies. Studies of the dynamics of iron metabolism are being continued in animals and in human beings, both normal subjects and diseased patients.

-15-

UNCLASSIFIED

The rate of disappearance of injected radioactive iron from plasma and its rate of appearance in red blood cells are being measured in patients before and during the administration of ACTH, and also in patients before and after treatment with nitrogen mustard. Data from four patients (2 in each category) are being analyzed at the present time. Some changes in the metabolism of iron appear to have followed the treatment.

Experiments carried out by feeding radio iron to normal and pathological subjects, in the form of Fe⁵⁹-tagged rabbit liver, have yielded some interesting results suggesting that in the two patients with hemochromatosis who were studied, there is an increased absorption of iron from the gut as compared to the 4 normal subjects and one patient with leukemia.

11. Health Physics and Chemistry

UNCLASSIFIED

Progress has been made on several items under development by research and development personnel. The "Junior" cave, a box for microchemical work, shielded by two inches of lead and a laminated lead glass window, has been completed and is ready for special pile samples. A container and dispenser for use in handling I¹³¹ as well as a target holder and furnace for use in determining isotopic distribution of barium are finished. Berkeley Boxes completed include a box to use in connection with Hanford dissolver solution pH determinations, and a box with a 10-step extraction unit for use in connection with dissolver solution work, plus the necessary hood attachments and modifications. Five centrifuges have been modified for use in Berkeley Boxes and 6 centrifuge controllers have been built.

12. Plant and Equipment

UNCLASSIFIED

Bevatron Building and Equipment. Pouring of building foundations is nearing completion; pouring of power equipment foundations is in progress. Excavation for magnet foundation has been made but no form work has been erected. It appears that the steel strike has delayed the structural steel for the building until the middle of February, 1950. Since this will cause an ultimate delay of approximately two months, the contractor is not working his forces during the present rainy spell. Shipments of magnet steel started in the early part of December and have since been arriving weekly. Engineering and design work have been progressing nicely on the vacuum system and injector.

Central Research Laboratory Building. This project is essentially complete.

Construction of Animal House and Cafeteria. Cafeteria bids have been received and contracts will be let in the near future. Design of the animal house is still in the preliminary stages.

Construction of Shops - plumbing, electrical, sheetmetal and salvage. The plumbing and electrical shop has been completed. The sheetmetal and salvage shop has not been started.

-16-

UNCLASSIFIED

Miscellaneous Construction. Warehouse. Major construction of this project has been completed. Some interior finishing work is still in progress. A month of concentrated moving has seen the transfer of items stored in the Oakland warehouse.

Alterations to Laboratory Buildings. The lead walls of the cave in Room 203E of the chemistry building have been installed and the fume hoods and utilities are being installed.

Power Distribution. Pulling of cable has been continuing as has the installation of the switchgear at the campus substation. Work has been progressing on additional temporary power to the Central Research Laboratory Building.

Fire Protection. Present phase of work is essentially complete; the remaining work is to be accomplished next spring.

Radiological Laboratory at the University of California Medical School. The architects are still preparing the working drawings.

Alterations to Synchrotron Building. The shop extension phase of this project is essentially completed except for final hookup of heating and some electrical outlets. Plans are now being made for extending the main synchrotron building.

Decontamination Unit. Erection of the corrugated asbestos on the sides and roof of this building is essentially completed.

Roads and Parking Areas. Bids have been received and a directive approved for the laying of the following paving: extension to the West Parking Lot, southern access to the warehouse area, paving around new Shop Building No. 53 and paving of access road east of Building No. 52.

-17-

UNCLASSIFIEDMAN MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

PROGRAM	SUBDIVISION	MAN MONTHS EFFORT	COMMENTS
184-inch Cyclotron	Operation	11.1	
	Deflector	.5	
60-inch Cyclotron	-	-	Non Project
Synchrotron	Operation	8.3	
Linear Accelerator	Linear Accelerator - General	4.5	
	Van de Graaff - General	3.9	
	Development	1.8	
Bevatron	Building	.1	
	Injector	1.8	
	Magnet	2.8	
	1/4 Scale Model Development	.3	
	Vacuum System	.2	
Experimental Physics	Cloud Chamber	5.6	
	Film Program	10.0	
	Ionization Chamber and Crystal Counter	3.4	
	Neutron-proton Scattering	.3	
	Proton-proton Scattering	3.3	
	Neutron Diffraction	.3	
	Meson Range and Decay Measurement	.5	
	Absolute Cross Section Measurements	2.6	
	General Physics Research	15.1	
	Instruments for General Use	.5	
	Meson Experiments with Synchrotron	4.8	
	Scintillation Counters - Research Experiments	.4	
	Pair Counter Experiments	2.9	
	Compton Scattering Experiments with Synchrotron	-	
	Beam Studies with XC Cyclotron	5.0	
	Particle Momentum and Energy Analysis	.4	
Proton Elastic Scattering	.8		
Magnetic Measuring Equipment	.2		
Neutron Half-Life	1.0		
Theoretical Physics	Bevatron	.9	
	General Physics Research	13.1	
Isotope Separation	Nier Spectrometer	1.3	
	Low Mass Spectrograph	-	

-18-

UNCLASSIFIEDMAN MONTHS EFFORT REPORTSCIENTIFIC PERSONNEL
(Continued)

PROGRAM	SUBDIVISION	MAN MONTHS EFFORT	COMMENTS
Chemistry, Part A	Chemistry of Transuranic Elements	3.5	
	Nuclear Properties of Transuranium Elements	5.0	
	Transmutations with the 184-inch Cyclotron	13.5	
	Analytical and Service	17.7	
	Process Chemistry	5.3	
Chemistry, Part B	Synthetic and Experimental Organic Chemistry	5.2	
	Biological Chemistry	6.5	
	Photosynthesis Chemistry	6.5	
Chemistry, Part C	Metals and High Temperature Thermodynamics	3.0	
	Basic Chemistry, including Metal Chelates	1.5	
	Engineering Development of Plutonium Separation	5.0	
	Ore Reduction	2.5	
Medical Physics, Part A	Metabolism of Plutonium and Allied Materials	9.0	
	Decontamination Studies	5.0	
	Radiochemistry	4.0	
	Radioautography	2.0	
Medical Physics, Part B	Tumor Metabolism	.7	1.4 Consultant Man Months
	Special X-Ray Studies, Radioactive Measurements, etc.	7.5	2.2
	Radioactive Carbon Studies	.6	-
	Fundamental Medical Research	5.2	2.8
	Hematology	.6	.7
	Medical Work with the 184-inch Cyclotron	2.6	.1
	Fly Genetics	3.3	-
	60-inch Cyclotron Bombardments	.3	-
	Physical Chemistry	6.4	1.0
	Specific Irradiation	2.5	-
	Donner Animal Colony Expense	1.5	1.0
Health Physics, Chemistry	Monitoring and Disposal Research and Development	5.1	
	Film Badge Program	18.3	
	Medical Examination Time	4.6	
		3.0	

SECRET

SECRET