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UNIVERSITY OF CALIFORNIA

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MONTHLY PROGRESS REPORT
No. 107

February 15, 1952 to March 15, 1952

April 2, 1952

Berkeley, California

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

February 15, 1952 to March 15, 1952

MONTHLY PROGRESS REPORT No. 107*

April 2, 1952

1. Bevatron
(AEC Program No. 9500) UNCLASSIFIED

General

The decision has been made to make the size of the aperture 1 ft. x 4 ft. rather than 2 ft. x 6 ft.

Coil Winding

One quarter (44 turns) of the fourth quadrant is now wound. Insufficient quantities of satisfactory coil spacers is at present the reason for the slow progress on the winding operation.

Magnet

The pole bases and pole tips will be fabricated by the Verson Mfg. Co. of Texas, and the promised delivery is 6 to 10 months or possibly longer contingent on the availability of materials. The possibility of enameling alternate plates instead of every plate for the pole tips is being investigated because of the possible cost saving. The pole tip stanchions will be fabricated by Mare Island Naval Shipyard, and work will start as soon as the new design necessitated by the 1 x 4 aperture decision is completed. Experiments on the 1/12 scale AC magnet model are being repeated to check a discrepancy in previous data necessary before final specification of the pole plate outline.

Vacuum System

For the curved tanks, 50 percent of the drilling jigs for the fibre parts have been fabricated by the UCRL shop; orders have been placed for all of the fibre parts and the radial bar forgings. An aluminum frame is being designed to support the vacuum tank in the area left unsupported by the smaller pole tips.

For the straight sections of the vacuum tank, material is to be delivered to Mare Island in April at which time fabrication is to start. Platforms around the straight sections are being designed.

*Previous report UCRL-1699 (No. 106)

For the transition tanks, the fabrication work is out for bids, but actual placement of the order will be postponed until the balance of the material to be furnished by UCRL is received.

Linac

The design is being modified by the addition of one drift tube (bringing the total to 44) at the low energy end where the injection energy from the ion gun will be lowered from 500 to 430 KV. The linac tank is being vacuum tested. Minor building modifications are being made for installation of the ion gun.

2. 184-INCH CYCLOTRON OPERATION (AEC Program No. 5741) UNCLASSIFIED

The cyclotron was used for research experiments approximately 97 percent of the 525 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	512.75 hours	97.6 percent
Electrical troubles	6.00	1.1
Mechanical troubles	.25	0.1
Maintenance	.50	0.2
Visitors	5.50	1.0
Totals	525.00 hours	100.0 percent

3. 60-INCH CYCLOTRON OPERATION (operated by the University of California) UNCLASSIFIED

The operating efficiency was somewhat impaired during this period by the presence of a water leak in the vacuum system. Identification, repair, and bake-in required approximately three days. Operation is again back to normal.

4. SYNCHROTRON OPERATION (AEC Program No. 5731) UNCLASSIFIED

The synchrotron has operated satisfactorily this report period. Injector changes have not been a source of trouble as in the past.

Work is continuing on the high energy injector.

Operating statistics are as follows:

Operation for customers	313.75 hours	89.13 percent
Tests with Synchrotron	8.00	2.27
Maintenance	30.25	8.60
Totals	352.00	100.0 percent

5. LINEAR ACCELERATOR AND VAN DE GRAAFF OPERATION (AEC Program No. 5751)

Work is continuing on the regulation system for the Van de Graaff. The major aim at present is to build and evaluate a 200 megacycle phase sensitive unit which will be the source of regulation signals. The primary effort is in the direction of a two-channel receiver using commercial Collins FM - IF strips. A stable converter design is in the preliminary construction stages. The receiver channels will be sensitive in the millivolt region at 200 megacycles, and the output from the second detector will be in the order of volts as a function of phase. Several phase sensitive circuits can be evaluated with the signals from the FM - IF strips and some of these are to be built.

Statistics: Running time: 74 percent; Maintenance: 18.5 percent; Repair: 7.5 percent.

6. EXPERIMENTAL PHYSICS (AEC Program No. 5211) UNCLASSIFIED

Film Program

Studies of Meson Production by Nucleon-Nucleon Collisions. The present work is concerned with determining whether or not neutrons and protons play symmetrical roles in meson production. If they do, the +/- production ratio should be unity when α-particles bombard carbon. An experiment to measure this ratio is being carried out and, parallel to it, an experiment with identical geometry in which protons bombard carbon.

Mu Meson Interaction with Matter. It was earlier established that μ^- mesons in about 5 percent of the cases cause charged particle disintegration when they are captured by nuclei of the emulsion. A few multiple-prong stars were found, and the program is now concerned with establishing by grain counting the tracks whether the multiple-prong stars arise from μ^- mesons or from π^- contamination.

Meson Masses and the Energy Balance in Meson Decay. These experiments are approaching some final results. A large amount of data with the new apparatus has been collected and it appears that reliable mass values and disintegration energies should result.

Meson Scattering. Counting of π^- mesons in nuclear track emulsion is employed to measure the ratio of the scattered meson flux to the incident flux in Al, Cu and Pb scatterers. The results can be used to estimate the large angle scattering cross section for π^- mesons.

Meson Spectrometer. The focussing of charged particles using the spiral orbit principle is being studied using a small magnet and various pole pieces. The results of these studies are to be incorporated into the design of two large spectrometer magnets under construction. The measurement of meson spectra and excitation functions is the purpose of the work.

High Energy Beta Spectra. The spiral orbit spectrometer is being developed for the study of beta ray spectra. A particular study of the resolution afforded is being made. The design of the instrument is particularly

directed to the study of short-lived, high energy beta emitters such as N^{12} and the μ^+ meson.

High Energy Electron Processes. Work on following the tracks of high energy electrons and positrons through nuclear track emulsion is continuing, and the frequency of the rarer events is particularly being studied. To supplement this program, counter and cloud chamber experiments to measure positron and electron disappearances and electron-electron scattering are being developed.

Diffraction and Coulomb Scattering of 340 Mev Protons in Lead. A highly collimated proton beam is caused to traverse a lead foil in vacuum. The angular distribution of the protons scattered at small angles is being studied using nuclear track emulsions as detectors.

Spall Analysis. This study is concerned with the analysis of the reaction products of nuclei violently disintegrated by fast protons or other projectiles. A physical analysis is made by bringing the disintegration products to 180° foci in the magnetic field of the cyclotron. The spalls are detected in nuclear track emulsion. Their identification is made from their radii of curvature, ranges and apparent charges.

Physical Measurements on Nuclear Track Emulsion. Work is continuing on the swelling of processed and unprocessed emulsion as a function of relative humidity. The effect of temperature is now being investigated.

Cloud Chamber.

The experiment on π-plus meson scattering by aluminum was run at the cyclotron March 5th and 6th in the meson beam, using the pantograph chamber and magnet. The chamber contained five plates of one-eighth inch aluminum, each separated from the one next to it by two inches. The cylinder for the chamber was made of one-eighth inch Homalite, a transparent, alcohol-resistant plastic which made possible the use of alcohol in the chamber to reduce the expansion ratio and therefore to decrease turbulence. The chamber was filled with argon .... The film is now being analyzed, and preliminary results are most encouraging.

The new stereoscopic camera is assembled, and tests and final adjustments on it are now being made. The camera runs at a speed of one frame per second, and is adaptable for almost all cloud chamber photography - especially for use with the diffusion type of chamber which is continuously sensitive.

Products of 90 Mev Neutrons on Carbon.

To supplement the cross sections measured via short-lived beta activities generated in carbon by 90 Mev neutrons (spinning disc method), a cloud chamber run has been made with 90 Mev neutrons bombarding a mixture of methane and hydrogen. The objects of the cloud chamber experiment are (1) to measure the cross section for star formation (2) to verify, and, if possible, to improve on the accuracy of York's data on the yield of protons (over 20 Mev), deuterons (over 27 Mev) and tritons (over 33 Mev). (3) to extend York's data below the energies mentioned (4) to obtain cross sections for multi-prong spallation reactions.

Normalization of the cloud chamber data is being done by counting all proton recoils over 1 Mev (i.e., out to about 84° in lab system) and equating

this number to the n-p cross section within this angle.

It is planned to identify and count about 1000 stars for statistics. To date, on the basis of 290 stars and 534 proton recoils, and ignoring temporarily the proton recoils lost beyond 84°, the data seems to check reasonably well with York's as follows: stars, 291; proton recoils, 534; protons over 20 Mev, 100; deuterons over 27 Mev, 36; tritons over 33 Mev, 3. Using σ_{np} = 83 millibarns, and the approximation mentioned, this yields the following cross sections, compared to York's. for $\sigma_{p} > 20$ Mev, 83 ± 10 mb as compared to York's 90 ± 22 mb; for $\sigma_{d} > 27$, 30 ± 6 mb as compared to York's 26 ± 6 mb; for $\sigma_{t} > 33$, 2.5 ± 1.5 mb as compared to York's 3 ± 1 mb; and σ_{star} 241 ± 17 mb.

It is to be noted that σ_{star} does not include the $\sigma_{n2n \rightarrow C^{11}}$ or $\sigma_{n3n \rightarrow C^{10}}$, which give short one-prong recoils not easily distinguishable from protons under 1 Mev. The σ_{star} value seems a bit high for this reason. However, taking into account proton recoils over 84° will lower all the cross sections shown by something under 5 percent, it is now believed.

A further run of the spinning disc method is planned to try to pin down the Li^8 and He^6 yields, as well as C^{10} and possibly Be^7.

High Energy Electrons From Nucleon Collisions.

Continuing the work reported last month on the electrons produced in nucleon collisions at high energies, another run has been made with an arrangement which allowed higher energies to be detected than heretofore. Above 100 Mev the counting arrangement employed was not ideal for separating the electrons from the relatively large number of μ mesons. However, the electron spectrum again displayed itself as a regularly decreasing yield of electrons as a function of energy up to the region of 150 Mev. Dependence upon target thickness and dependence upon target atomic number appear to rule out the conversion of π^0 photons as the origin of these electrons. It is considered that they may originate in a possible mode of decay for π^0 mesons which yields electrons directly.

Energy Spectra of Neutrons From Be and LiD.

The magnetic particle spectrometer previously described in these reports was used to obtain energy spectra of neutrons from a 2 in. Be target and a 1/2 in. LiD target bombarded with 340 Mev protons inside the 184-in. cyclotron. The neutron spectra were obtained from the recoil protons produced in a hydrogen target.

The spectrum from the 2 in. Be target was peaked at about 295 Mev and had a width of about 70 Mev. The low energy toil was roughly 20 percent as high as the peak. Using the 1/2 in. LiD target the spectrum was peaked at roughly 315 Mev and had a width of about 42 Mev. The low energy toil here was about 8 percent as high as the peak. The integrated yields above 300 Mev for the LiD target is about 65 percent of that for the Be target.

π^0 Production vs Z.

A further comparison of carbon and lead π^0 yields was made. The overall data of these two targets show a yield of π^0's per neutron from Pb to be 0.431 ± 0.022 compared to 1.000 for C. The general features of the relative yield per

neutron curve are: (1) constant yield per neutron from Li to Al, and (2) decrease in yield per neutron above Al.

The Photoproduction of Negative Pions from Deuterium.

Time of flight requirements were imposed on the detection of pion-proton coincidences so that higher beam intensities from the synchrotron could be used. These time of flight requirements are in addition to the angular and energy correlations reported previously. The results appeared very encouraging because the background counting rate from a water target did not increase as the proton counter was moved within 12 degrees of the beam. The maximum available beam intensity was used during this instrumentation run.

The Triton Reaction ($p + d \rightarrow \pi^+ + t$).

The main purpose of the second run was to increase the real counts per minute (or the CD_2 - C difference rate) by running at higher beam intensities. [At a beam channel meter reading of 0.2×10^{-8}, corresponding to approximately 10^{-11} amperes of protons, the rate is around one real count in two minutes]. The difference rate per unit of integrated beam remained constant over beam channel meter readings ranging from 0.1×10^{-8} to 0.5×10^{-8}; however, further modifications must be made before trying higher beam levels because the increasing carbon counts (the background indicator) require increasingly longer runs to get good statistics in the CD_2 - C difference.

A very preliminary cross-section for the process is $d\sigma/d\Omega = 2 \times 10^{-31}$ cm^2/steradian at a pion production angle of 130° in the center of mass coordinate system.

Magnetic Field Measurement of Pair Spectrometer Magnet.

Measurements of the magnetic field of the 200 Mev pair spectrometer with the #6 pole piece have been made in the uniform field region using the nuclear fluxmeter. These measurements were made on a 1 in. x 1 in. grid in a field of about 13,000 gauss.

Photoproduction of π^0 Mesons.

The photoproduction of π^0 mesons in hydrogen and deuterium has been observed using double γ coincidences. Preliminary data has been obtained on the energy distribution of π^0 mesons produced at 90° to the beam. Further work is in progress.

Neutron Time of Flight Experiments.

A method for determining the energy of neutrons by their time of flight is being investigated. The method consists of deflecting high energy charged particles in the 184-in. cyclotron tank onto a probe which acts both as a target for the production of neutrons, and as a pickup probe for recording the arrival of the particles, hence the origin of the neutrons. The time of flight of the neutrons to an experimental setup is then measured on a fast oscilloscope by comparing the probe pulse in time with a pulse from the counter equipment of the experimental setup. Thus, by measuring the distance from the probe to the counter and knowing the time of flight the neutron energy may be determined. The limit on the accuracy of the determination of the neutron energy is the width in time of the pulse of charged particles striking the probe, and at present appears to provide at optimum an accuracy of approximately 5 Mev in the 90 Mev neutron range. Several preliminary runs on the 184-in. cyclotron with deuterons impinging on a 1-1/8 in. copper probe have given

promising results. Investigations on the application of the method to experiments and as to refinements in the method are continuing.

π^- Meson Capture in Hydrogen and Deuterium.

Reduction of magnetic field measurements and analysis of the data from the cyclotron runs involving both reactions was continued.

Elastic Proton-Deuteron Scattering Using 345 Mev Protons.

Believing that the most reliable method of separating elastic p-d scattering from other processes should involve identification of the scattered deuteron (by estimating its mass), we are building a pair of scintillation counters designed to measure specific ionization and total energy respectively. The first counter would use a thin stilbene crystal and the second would use a one-inch thick piece of sodium iodide. The pulse heights from these two counters are to be recorded simultaneously on a photographic film.

Proton-Proton Scattering at Reduced Energies. (160 to 250 Mev).

As reported last month, target construction is still under way. Several designs have been tried, none yielding all of the proper characteristics. The design being tried at present involves 0.002 inch stainless steel walls to contain the liquid hydrogen.

Neutron-Proton Scattering at Small Angles.

Collimator construction is still in progress.

Search for V^o-Particle Production in the Synchrotron X-ray Beam.

Collimators for the x-ray beam are still under construction. It seems necessary to await these before attempting to use further synchrotron time.

Synchrotron Studies.

Except for some time out for repair of octant coils, the synchrotron operated very well during the month of February 16 to March 15.

The runs were completed on the photoneutron yields at different energies. Energies from 40 to 320 Mev in 40 Mev steps were used. In order to monitor the beam, both the photoneutrons from deuterium and the radioactivity of Cu^{62} induced in Cu^{63} by the (γ,n) process were used. Both methods gave consistent results. The $C^{12}(\gamma,n)C^{11}$ reaction was also used, which is known to have a peak at about 28 Mev, and it was found that at 40 Mev maximum energy there were definitely fewer 28 Mev quanta than 18 Mev quanta, which produce the $Cu^{63}(\gamma,n)$ reaction. The results definitely show that there are contributions above 140 Mev. Calculations on the results are now being made and they will be presented at the Washington meeting.

One long run has been completed on the π^o mesons from deuterium and hydrogen. While the run was fairly satisfactory, one more will be required to get good data on the relative yields and on the energy distribution. This other run will probably be completed in the next six weeks.

An experiment has been started to determine the cross section for annihilation of 200 and 100 Mev positrons. The energetic electrons and positrons produced are being analyzed in the pair spectrometer magnet and the number of positrons which pass into but not out of a block of Be recorded.

Some interesting results have been procured on π^--p coincidences from deuterium using a time of flight method of detecting protons, which allows the burst of electrons from one rf cycle to pass through the counter, then records the proton before the electrons from the next rf cycle arrive. Further results will be reported.

Measurements are started of the angular distribution of photoprotons. It is hoped to be able to push down to angles below 30°. The π^-/π^+ ratio work at 60° has not been completed.

7. THEORETICAL PHYSICS UNCLASSIFIED
(AEC Program No. 5211)

The interpretation of high energy deuteron photodisintegration in terms of exchange currents is continuing. The work on photoproduction of π^0 mesons from deuterium is in its concluding phase.

A calculation is being made of beam loss due to scattering by foils in a foil focused linear accelerator.

Work continues on the effect of a singular tensor potential on high energy p-p scattering, and on a statistical treatment of multiple meson production.

Additional calculations of the stripping of deuterons from high energy He^3 nuclei are under way. They will extend the energy range of calculations performed a few months ago.

Work continues on the program of fitting nuclear force parameters with ps-ps meson theoretic potentials including fourth order terms, cut off with a hard core at about 0.5×10^{-13} cm.

Continued study of the effects of meson radiation damping on the energy dependence of π-p scattering cross sections has shown that, while the inclusion of real damping processes to all orders of perturbation theory gives a good fit of π^- data, the π^+ data is about three times as large as the calculated result.

During the period of this report, eight abstracts were prepared and submitted to the American Physical Society for presentation at the Washington, D.C. meeting in May. Titles and authors are:

Phenomenological Potentials in Meson Scattering, R. LeLevier; Nuclear Forces Yielded by the Symmetrical Pseudoscalar Meson Theory with Pseudoscalar Coupling, J. Lepore; On the Fermi-Thomas Model of the Nucleus, R. Riddell; Interpretation of High Energy p-p Scattering, D. Swanson; Photoproduction of π^0 Mesons from Deuterium, W. Heckrotte, L. Henrich, J. Lepore; Multiple Meson Production, M. Ruderman; Meson Exchange Contributions to the High Energy Deuteron Photoeffect, R. Huddlestone, J. Lepore; Low Energy Properties of Pseudoscalar Interaction with Hard Core, R. Jastrow.

8. THE M.T.A. PROGRAM*
(AEC Program No. 9200)

A-12 Target Development.

Present work in the design of the A-12 target is based upon the assumption of plutonium production with a one-half ampere, 350 Mev beam. For the basic case the coolant and moderator are taken to be ordinary water. The present design for the primary target consists of two rows of bayonet tubes projecting into an evacuated extension of the accelerator with the second row of tubes spaced behind the first so that the primary target is opaque to the deuteron beam. The bayonet tubes will be filled with zirconium clad uranium plates set at right angles to the beam path and separated to permit the flow of the cooling water. The bayonet tube has the advantage that headers are at one end only. The flow will be such that the coolant will pass down the outside of the inner tube and back through the middle portion of the inner tube.

The entire target assembly would be immersed in a swimming pool which would act as a shield and a lattice moderator. The secondary target and backing lattice would be located behind the primary target and in the swimming pool but in a separate container. The lattice and reflector would surround the evacuated tube leading to the primary target and would be immersed in the water tank. The lattice and reflector would be consturcted in C shaped sub-assemblies so that any of the C sections could be removed as necessary. Each C section would be cooled by an individual pump which would pump swimming pool water through the lattice and back into the pool. Furthermore, each C section would be mounted on rails so that it could be removed separately and transferred into a handling area in such a way the section would remain submerged throughout the entire operation. The use of water shielding minimizes the extensive remote handling of equipment and the construction described would permit disassembly and replacement of the entire target or any of its components with comparative ease.

As an alternative, a gas cooled target is being studied. The gas cooling would involve the use of a large window for the deuteron beam and a design dependent on operation of a single window requires more experimental information concerning the properties of window materials under A-12 operating conditions. The Mark 0 target for the Mark I accelerator may give some of this information but the data may not be ready in time for the first A-12 machine.

Process Design Developments.

The objectives of the CRDC Process Design Group are the preparation of optimum process designs for lattice, primary and secondary target processing plants and auxiliary chemical plants. Desgin studies are under way for both plutonium and U^{233} since the U^{233} objective, especially for primary and secondary targets, has not been ruled out. The group is considering the preparation of optimum material flow sheets, equipment schematic flow sheets, preliminary equipment sizing standards, preliminary equipment layout studies, preliminary piping and instrument drawings, and general process data requirements, such as raw materials, utilities, man-power, etc. This information will be transmitted to the Process Engineering Division for detailed engineering.

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*This section reports the joint efforts of the Radiation Laboratory and the California Research and Development Company.

The first major effort will be the design of a U^{233} recovery process for lattice thorium using a hexone flow sheet. The thorium would be stored underground for eventual recovery. A study of the recovery of plutonium from lattice fuel using the purex process is also under way. This flow sheet will include necessary feed preparation, off-gas disposal, solvent, acid products and metal recovery steps. "Fumeless dissolving" design studies for both uranium and thorium are being made. The removal of radioactive gas on activated carbon is believed to be cumbersome and new approaches are under study. Also new methods of recovering the oxides from thorium and uranium nitrate are being studied, and an economic comparison of the duplex chelate-purex process with the newest purex processes is underway. Discussions with people at Oak Ridge have revealed that the purex process is feasible from a unit operations view point and that an integrated process will be demonstrated in the pilot plant shortly.

Process Research

The Process Research Group is concerned with investigations directed toward adapting existing or proposed separation processes to A-12 fuel, which contains high energy fission and spallation products. In cases where a proposed separation process is not on a firm basis, fundamental research is carried out to establish the feasibility of processing both thermal and high energy irradiated fuel. With the exception of spallation products the fission product spectrum expected in A-12 primary and secondary targets may be closely approximated by alpha particle bombardment of uranium or thorium metals in the 60-inch cyclotron. A CRDC group at Argonne National Laboratory is using 60-inch cyclotron bombarded uranium to test the feasibility of using the current purex process on A-12 target fuel. The problem of dissolving 95 percent zirconium - 5 percent uranium alloys has been investigated at the Argonne Laboratory and considerable progress has been made using fluoride ion. A uranium target which had been bombarded with 350 Mev protons provided a source containing spallation products and the analysis of this target indicated that a separation problem might arise from thorium 228. This separation is of importance because of the extremely short half-life of thorium 228 and its high energy alpha emitting daughters which contribute neutrons in the plutonium by the α,n reaction on the light element impurities.

Measurements of Energy Spectra.

Measurements are being made to determine the energy and angular distribution of the particles emitted when deuterons of a definite energy interact with uranium nuclei. This class of experiments is difficult and many measurements are required before practical, useful information is obtained. However, due to its fundamental nature it will be useful no matter what the final target design may be. In this work a one-quarter inch thick uranium target is bombarded with 190 Mev deuterons, and the energy distribution of the neutrons is measured at angles of 0°, 47° and 90° from the beam. When the energy was measured at 135 and 170 degrees from the direction of the beam, the yield was so low that it could not be distinguished from the background, which means that very few neutrons over 20 Mev were reflected in the backward direction. Since the proton and neutron in a deuteron each have about the same energy, a determination of the energy distribution of 95 Mev protons should give results similar to those obtained by measuring the neutron energy from 180 Mev deuterons. Similarly using 175 Mev protons should give results similar to the neutron measurements obtained from 350 Mev deuterons. The measurement of the energy distribution of protons is much simpler than that involving neutrons since

neutron measurements are made by causing the neutrons to pass through some material containing hydrogen and then measuring the recoil protons in the cloud chamber or with proportional counters.

Neutron measurements in the aluminum, water moderated tank mentioned in the last monthly report has continued. The stripping of helium-3 continues to be of interest and study of this method of producing high energy deuterons is continuing. Helium-3 recovery possibilities during cyclotron operation are being investigated. Without a reasonably good material balance this material cannot be used since helium-3 is a rare material. Contamination with helium-4 will not create a serious problem. The method of ray tracing to remove the 340 Mev deuterons from the cyclotron has also received some attention and at present it seems likely that this beam can be focused using a 125 to 175 ampere magnet.

9. CHEMISTRY

SECRET

Part A
(AEC Program No. 5311)

Isotopes of Curium

A new isotope of curium, Cm^{245}, has been observed by mass spectrographic analysis of curium which had been subjected to long and intense neutron irradiation in the Chalk River pile. No radiations have been observed which can be attributed to it; this fact is consistent with the expectation that it is an alpha emitter of very long half-life.

Evidence for the existence of Cm^{239} as an electron capture activity of approximately 10 hour half-life has been found in bombardments of Pu^{239} with helium ions. The mass assignment is based on the presence of 12 hour Am^{239} as a daughter; the composite curve of parent and daughter makes the estimation of the half-life of the parent rather uncertain.

Cross Sections of Plutonium for Neutrons

A new value, 420 barns, has been determined for the cross section for capture of pile neutrons by Pu^{238}. This result is based on mass spectrometric analyses of a mixture of plutonium isotopes (mostly Pu^{238} and Pu^{242}) before and after irradiation in the Chalk River pile.

X-ray Spectroscopy

The x-rays from the beta decay of U^{237} have been studied with the bent crystal x-ray spectrometer. Four L x-rays and one gamma ray were observed with energies in close agreement with those of similar radiations from the alpha decay of Am^{241}.

A Bismuth Compound for a Szilard-Chalmers Reaction

In an effort to get a sample of the long lived isomer of Bi^{210} with a higher specific activity than heretofore, an organic compound of bismuth is being sought which will undergo a Szilard-Chalmers reaction when irradiated with neutrons. For this purpose, some tri-α-naphthylbismuthine was prepared. The material is sufficiently inert with respect to mineral acids to survive the chemical separation procedure. Some will be irradiated in the Oak Ridge pile for a short time to test its behavior under irradiation.

Structures of Rare Earth Oxybromides

The oxybromides of the rare earth elements are being prepared and examined by x-ray diffraction. The examination of four has been completed, with the following results for the dimensions of the tetragonal unit cell (PbFCl-type): for LaOBr, a is 4.155 ± 0.005, c is 7.391 ± 0.010, and c/a is 1.78; for CeOBr, a is 4.11 ± 0.01, c is 7.43 ± 0.02, and c/a is 1.81; for PrOBr, a is 4.067 ± 0.005, c is 7.463 ± 0.010, and c/a is 1.84; for NdOBr, a is 4.013 ± 0.005, c is 7.595 ± 0.010, and c/a is 1.89. The values for LaOBr and NdOBr are in reasonable agreement with previous results of Zachariasen; CeOBr and PrOBr have not been reported previously.

Structure of Lanthanum Chloride Hydrate

X-ray diffraction data for single crystals of the highest hydrate of lanthanum chloride confirm that it is triclinic. Pure samples, free of excess water or lower hydrates, are being prepared by controlled desiccation to permit analysis for water content. Numerous reports in the literature give $LaCl_3 \cdot 6H_2O$ or $LaCl_3 \cdot 7H_2O$ as the formula.

CHEMISTRY UNCLASSIFIED
Part B
(AEC Program No. 5311)

Metals and High Temperature Thermodynamics.

Work is in progress on the following problems:

1. Gaseous hydroxides.
2. Thermal conductivity of gases at high temperatures.
3. Refractories.
4. Gaseous molecules.
5. Gaseous oxides.

Basic Chemistry.

The following problems are under investigation:

1. Thermodynamics of rhenium.
2. The hydrolytic polymerization of zirconium.
3. Germanium chemistry.
4. Electron exchange rate between Fe^{2+} and Fe^{3+} work has been terminated.
5. Thermodynamics of indium.
6. Thermodynamics of thiosulfate.
7. Solubility of rare earth fluorides.
8. Chemistry of ruthenium.

CHEMISTRY
Part C
(AEC Program No. 6400)

Organic Chemistry

Representative of the studies in organic chemistry are the following: (1) Synthesis of uracil-6-C^{14} and its oxidation with potassium permanganate; (2) The mechanism of the decomposition of bis (hydroxymethyl) peroxide; (3) The synthesis of cholic-23-C^{14} acid; (4) Preliminary experiments on the mechanism of the Leuckart reaction; (5) Synthesis of valeric-3-C^{14} acid; (6) The synthesis of 4-hydroxyproline-5-C^{14}; and (7) The synthesis of norleucine-3-C^{14}.

Animal Bio-Chemistry

The biological research program has continued with studies on (1) the chemical role of carbon-14 and tritium labeled cholesterol and other steroids in atherosclerosis and body metabolism; (2) the metabolism of simple organic compounds in man and other animals; (3) the conversion rate of labeled compounds to carbon dioxide as a potential assay tool of complex organic materials; and (4) the comparative metabolism of morphine in normal and addicted individuals.

Plant Bio-chemistry

The study of the path of carbon in photosynthesis using carbon-14 as a tracer element continues along three lines: (1) exposure of organisms to carbon-14 dicxide under previously untried conditions and examination of the resulting pattern of carbon reduction; (2) study and refinement of presently used experimental conditions with the aim of controlling more exactly all the variables; and (3) improvement of analytical techniques, both in the separation and identification of labeled compounds from plant extracts and in the degradation of specific compounds.

10. MEDICAL PHYSICS UNCLASSIFIED
Part A
(AEC Program No. 6000)

Tracer Studies

Studies of the chronic effects of fission products and plutonium upon monkeys are under way. The studies on the effects of Versene feeding on the excretion of plutonium in rats are being continued. Preliminary data show that the excretion rate of plutonium can be enhanced if the Versene is given prior to the administration of the plutonium.

Radioautography

The series of lung radioautographs with plutonium is almost complete. Leaf autographs for Health Chemistry were attempted with negative results.

Radiation Chemistry

Studies of the radiation induced oxidation of C-14 labelled acetic acid in oxygen saturated solutions have continued. One or perhaps two products, in addition to the previosuly reported succinic acid, have been identified.

Work has continued on the determination of the radiation products from formic acid in hydrogen saturated solutions. Data have been obtained, using calorimetric techniques, which are substantially in agreement with previously recorded values.

Radiochemistry

Approximately 8 to 10 millicuries of mixed fission products have been isolated from an uranium target, using an ether extraction technique.

MEDICAL PHYSICS UNCLASSIFIED
Part B
(AEC Program No. 6000)

Biological Effects of 190 Mev Deuterons.

Abnormal obesity developed in a small group of young, Long Evans rats, which were preirradiated by 5,000 REP in the region of the hypothalamous. Seven months after irradiation these rats averaged a six gram weight gain, or were about 20 percent heavier than the normal controls. Investigation is being directed to determine the mode of action of the radiation and the nature of the obesity.

Activation Analysis.

During analysis of the rubidium fraction of neutron activation tissue ash separated by cation exchange column, there appeared to be a samll amount of radioactive cerium mixed with the rubidium. As part of the activation analysis program work is being done to achieve quantitative separation of the cerium and rubidium fractions.

Biological Effects of Radiation on the Yeast Cells.

A difference has been established in the radiation resistance of endogenously and exogenously metabolizing cells. The former, both diploid and haploid, were found to have increased radiation sensitivity. A small fraction of diploid cells is able to survive considerably larger doses of radiation than the bulk of the cells in the colony, a similar finding to that reported for haploid cells during the preceding months.

Instrumentation.

Progress has been made on the construction of the second model of the gamma ray pin hole camera which utilizes 10 fluorescent crystals that are mounted in a line in combination with mechanical scanning. This apparatus will probably be completed in another month.

Studies with C^{14} Labeled Stilbamidine.

A patient with multiple myeloma has been given a tracer dose of C^{14} labeled stilbamidine followed 4 days later by a course of ACTH. Urine and fecal excretion of radioactivity is being followed to determine whether it will be influenced by ACTH. The results of this experiment are not yet complete.

Studies with C^{14} Labeled Formate.

Long term studies have been initiated on the metabolism of C^{14} labeled formate in rats in an attempt to determine tissue distribution and routes of excretion; these will be continued as long as nine months after administration of the C^{14}. We hope to be able to describe the pattern of C^{14} tissue distribution and excretion as a function of time as we have done for glycine and nor-valine.

This is part of a program to systematically study the various classes of compounds in an endeavor to define their potential usefulness in clinical investigation.

Nucleic Acid Turnover Studies.

Experiments using mice show that the turnover of nucleic acid is increased by the presence of growing tumors and embryos. Current work shows that saline extracts of these tissues especially of embryo tissues can induce this same phenomenon. Preliminary results indicate that de... nucleic acid turnover by radiation can be overcome by injection of the above embryo extract into the test animal after its exposure to irradiation.

11. HEALTH CHEMISTRY (AEC Program No. 5311) UNCLASSIFIED

Work in progress in the Equipment Development group includes:

1. Preparation to receive a highly active Canadian pile-bombarded sample in May.
2. Construction of equipment for "cows", or the milking of americium from plutonium.
3. Processing of Hanford-pile-bombarded americium in a two-inch lead cave and auxiliary equipment. This work was completed.
4. Completion of equipment for Brookhaven-pile-bombarded animal ash. The irradiated samples were received and processed.
5. Assembly and issuance of eight gloved boxes for specific jobs. The Berkeley Box group also performed box lining jobs, repaired and rebuilt centrifuges, reconditioned glove ports, trays, heat lamp holders, etc.

The pit of the Central Storage facilities in Bldg. 5 is being emptied and cleaned, one section at a time.

The following radioactive sources were made to order on request: two Po sources, two Ce^{144} sources, one Am, and one Na^{22}.

12. PLANT AND EQUIPMENT RESTRICTED

Bevatron Instrument. (Program No. 9500. 5-424-9001) Winding is now approximately 80 percent complete and the steel erection is approximately 60 percent complete.

Animal House. (Program No. 9600. 6-424-9007) Paving adjacent to the animal house has been delayed due to continuous rains and is now approximately 55 percent complete.

Radiological Laboratory at the U.C. Medical Center. (Program No. 9600. 6-424-9008) The synchrotron has not been accepted as yet and consequently the accelerator room has not been acoustically treated.

MAN-MONTHS EFFORT REPORT
Scientific Personnel

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
9200 M.T.A. - Mark I	Design and Development	14.12	
9200 M.T.A. - A-12	Design and Development	56.98	
9500 Bevatron	Miscellaneous	5.20	
Operations			
3000 Weapons Research	General	12.95	
5211 Physics Research			
Experimental Physics	Cloud Chamber	12.20	
	General Physics Research	41.27	
	Instrument for General Use	3.95	
	Magnetic Measuring Equipment	4.42	
Theoretical Physics	General	13.03	
Photographic Film Detectors	General	12.44	
Isotope Separation	General	-	
Radioactivity Physics	General	2.00	
5261 Applied Physics Research			
Thomas Cyclotron	Electron and X-C Models	18.04	

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
Operations (continued)			
Chemistry Research			
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	2.83	
	Nuclear Properties of Heavy Element Isotopes	9.56	
	Transmutations with 184" and 60" Cyclotrons	7.28	
	Analytical and Services	18.05	
	Special Chemistry Development	1.00	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.00	
	Instrument Development and Services	5.00	
	X-Ray Crystallographic Measurements	2.78	
	Health Chemistry Research	10.83	
Basic Chemistry Research, Part B	Metals and High Temperature Thermodynamics	5.5	
	Basic Chemistry, including Metal Chelates	3.5	
5361 Applied Chemistry Research	Process Chemistry	6.53	
Reactor and Accelerator Operation			
5731 Synchrotron	Operation	9.38	
5741 184-inch Cyclotron	Operation	11.28	
5751 Linear Accelerator and Van de Graaff Generator	Operation	8.88	

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
6000 Biology and Medicine Part A	Metabolic Properties of Various Materials	11.0	
	Radiochemistry and Radiation Chemistry	5.0	
	Radioautography	2.0	
6000 Biology and Medicine Part B	Instrumentation for Quantitative Measurements of Radiation	2.59	.90 Consultant
	C^{14} Metabolism	2.69	.75 Man-Months
	Use of Radioactive Materials in Human Physiology and Experimental Medicine	13.57	5.78
	Trace Elements and Irradiation Studies	5.98	2.42
	Radiation and Mutation Rate	1.70	.25
	Physical Biochemistry	12.64	3.90
	Biochemical Response to Irradiation	3.63	.50
	Machine Shop Expense	.97	-
	Miscellaneous	1.27	-
	Metabolism of Lipo Protein and Lipids	6.56	10.22
	Iron Metabolism Hematopoiesis	3.18	.50
	Internal Irradiation and Hematological Response	4.67	.25
	Biological Effects of Cosmic Radiation	2.60	.25
	Health Medicine	5.52	-
6400 Biological Research	Synthetic and Experimental Organic Chemistry	5.39	
	Biological Chemistry	6.69	
	Photosynthesis Chemistry	5.25	
	Metabolism of Fission Products	17.43	
6500 Biophysics Research	General	2.20	