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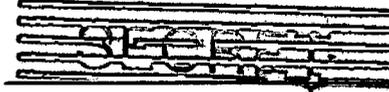
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Radiation Laboratory

Contract No. W-7405-eng-48

MONTHLY PROGRESS REPORT

No. 103

October 15, 1951 to November 15, 1951

December 3, 1951

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

October 15, to November 15, 1951

MONTHLY PROGRESS REPORT No. 103

December 3, 1951

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1. Bevatron  
(AEC Program No. 1500)

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Coil winding has proceeded slowly due to slow delivery of coil spacers caused by trouble in the fabricator's moulding press. The third quadrant was finally completed on Nov. 15.

Arrangements have been made for machining the straight section vacuum tanks at the Mare Island Navy Yard when material is received which is expected to be about next April. Drawings of the curved vacuum tank have been completed and released to procurement.

2. 184-inch Cyclotron Operation  
(AEC Program No. 5741)

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The cyclotron was used for research experiments about 97 percent of the 532 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	517.50 hours	97.3%
Electrical troubles	6.25 hours	1.1%
Mechanical troubles	6.75 hours	1.3%
New equipment	<u>1.50 hours</u>	<u>0.3%</u>
Total	532.00 hours	100.0%

3. 60-inch Cyclotron Operation  
(AEC Program No. 903)

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Operations were at the usual high level during this period, again in the order of about 80 percent. Patterns of the beam envelope for all particles (alpha, D<sub>2</sub>, p, and C<sup>+6</sup>) were taken, indicating that at 22.5 in. radius the beams blow up. This was first noted by a destruction of the dees at that point. Further plans are being made to determine the cause.

4. Synchrotron Operation  
(AEC Program No. 5731)

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During this report period, the synchrotron operation was hampered by long periods of low intensity beam. For a three day period the intensity was nearly normal. During this interval the synchrotron was operated 24 hours a day.

The filament of the injector opened and several subsequent injectors failed to reproduce a useable beam intensity. Variations in injector optics were tried with negative results. A small leak installed in front of the injector gave indications of improving the beam intensity. The leak rate and location may be exceedingly critical and conditions have not been controllable enough to give conclusive results. Work with injectors and the leak phenomenon are continuing.

It is hoped that the leak will aid injection by scattering. This could be advantageous because electrons scattered into the orbit by gas molecules are less likely to return to the injector and become lost.

5. Linear Accelerator and Van de Graaff Operation  
(AEC Program No. 5731)

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Almost half of the available time during this month was devoted to general repairs on the Van de Graaff generator.

Running time	191.75 hours	52.1%
Repair time	167.50 hours	45.5%
Maintenance	8.75 hours	2.4%

6. Experimental Physics  
(AEC Program No. 5211)

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Film Program. Electron-Electron Scattering. The work on 200 Mev electron-electron scattering was completed and prepared for publication. A similar study of 200 Mev positron-electron scattering is in progress. Another program of rapid scanning for rare events has been started. In our previous study, processes for which the mean path in emulsion is the order of a meter were observed, but too few events were found to provide satisfactory statistics.

In order to observe an increase of the electron-electron scattering cross section for high fractional energy transfers, a study has been started using 5 Mev electrons. If Møllers formula is correct, at this energy one should be able to observe the exchange effect and perhaps spin and retardation effects in the scattering cross section.

Cloud Chamber. In the work on cloud chamber poisoning impurities in the helium which is available from commercial sources have been eliminated to some degree by extensive purification processes. Passing the gas through sintered glass filters appears to remove most of the impurities causing poisoning.

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This effect is consistent with the theory that the poisoning is due to aerosols in the helium. Four or five such filters are used in series and great improvement in the behavior of the helium results.

A one day run has been made in the synchrotron to study the rectangular cloud chamber. The run was designed to test all the electronics and equipment associated with the rectangular cloud chamber (for studying the photo-disintegration of the deuteron). Final results show need for improvement in some of the techniques involved.

The diffusion cloud chamber built for study of Compton scattering on protons is now operating and making tracks in a gas heavier than air (i.e., argon).

Work on the positron spectrum from  $\mu$  meson decay is being written in final form.

Film is being read and data tabulated in the study of helium stars produced by high energy neutrons.

Inelastic Scattering Program. Further investigation of the spectrum obtained from heavy element targets is awaiting the development of a particle identifier. The scattered particle is made to pass through a proportional counter into a NaI(Tl) crystal. The pulse height from the proportional counter and that from the crystal, proportional to  $dE/dx$  and energy, respectively, serve to identify the particle.

Work is progressing on the design of a completely automatic system for carrying out extensive and systematic inelastic scattering investigations.

Study of inelastically scattered protons from helium has continued. Analysis of new data will soon enable assignment of a new, lower maximum cross section for the formation of an excited  $\text{He}^4$  nucleus.

Elastic Scattering Using 345 Mev Protons. The simple coincidence counting method that had proved satisfactory for the lower energy d-p scattering has proved inadequate in this case, because it has not been possible to obtain a clean separation of elastic from inelastic d-p scattering. Slight modifications have been devised, but not tried, which should enable a clear-cut separation. The method should differ at different angles, consisting in some cases of differentiation on the basis of different pulse heights in one counter for the two types of event. At other angles it will be necessary to use an absorber in front of one crystal. It is hoped that no absorbers greater than  $20 \text{ gm/cm}^2$  of copper will have to be used, so that corrections for nuclear collisions of particles passing through the absorber can be made with reasonable accuracy.

Proton-Proton Scattering at Reduced Energies. (160 Mev to 250 Mev) The liquid hydrogen target is still under construction. Construction of auxiliary equipment such as target supporting stand and counter supporting arm have been started.

Neutral Meson Gamma Ray Spectra. The gamma ray spectra from targets bombarded by protons have been analyzed and an estimate of the radiation from sources

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other than the decay of neutral mesons is deduced from the shape of the spectra for different proton energies and different target nuclei. The amount of the non-neutral meson radiation appears to be only a few percent. On this basis the energy distribution of the neutral mesons emitted from a carbon target bombarded by 345 Mev protons is calculated.

Development of Cerenkov Radiation Gamma Detection. Further measurements have been made of the efficiency of the detector which has a lucite rod with end area of  $0.5 \text{ cm}^2$ . At  $180^\circ$  to the direction of the proton beam with the detector about 50 feet from the target the 100 percent effective area of the counter was found to be  $0.022 \text{ cm}^2$ . This is not in disagreement with the less accurately measured  $0.03 \text{ cm}^2$  value found for the detector 10 cm from the target in the cave.

A new design of lucite Cerenkov radiator is being built. This will be 1 inch square having therefore 12 times the cross sectional area of the present design. The light collection system has also been changed.

Neutral Mesons. Carbon and calcium targets of nearly equal mass and geometry were exposed to the external proton beam of the cyclotron to investigate some of the background problems met when high energy photons are detected in the scattering detector previously mentioned. By plotting counts per unit charge in the beam as a function of beam intensity, it was possible to extrapolate to zero beam intensity where there should be no accidentals. The ratio of the calcium to carbon intercepts (in terms of unit mass in target) was in the ratio  $(A_{Ca}/A_C)^{-1/3}$  within the accuracy of the statistics about 4 percent.

Shortlived Products of 90 Mev Neutrons on Carbon. A third run of the spinning polyethylene disc method of determining the cross section for  $B^{12}$  production yielded an absolute value of  $9 \pm 2$  millibarns with much better accuracy than that found in the first two runs. However, a strong possibility exists that the above cross sections includes the  $Li^8$  cross section. Study of disc speed versus relative yield curves indicates that it may be possible to measure the  $Li^8$  cross section by using a speed of 60 rpm instead of the current 2200 rpm. Such an experiment is being planned, as well as a separate measurement of the  $Li^8$  cross section by its delayed alpha activity.

Another object of this series of experiments is to determine which reaction or reactions are responsible for about 90 millibarns worth of protons detected in 90 Mev neutron bombardment of  $C^{12}$  by Hadley and York. At present, the results account for only 10 to 20 millibarns of this value.

35 Channel Magnetic Particle Spectrometer. To improve the energy resolution of this spectrometer, which is required to seek structure in the energy spectra of protons scattered at small angles to the beam, work in the development of a bank of  $1/4$  inch diameter Geiger counters is in progress.

Synchrotron Studies. The synchrotron operation was rather poor during the past month. The chief trouble has been with the injector. One injector, during the whole month, gave an excellent beam. Careful inspection of it after it had burned out showed no apparent reason for its excellent performance. Work is going ahead with an electron linear accelerator to be used as an

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injector at an energy of 3 or more Mev so as to avoid difficulties in the beta-tron period as well as with the injection.

The only experiment for which there were good results during the month was on the photodisintegration of the deuteron. Although the run left several things to be desired, it did provide data for the cross section at 200 Mev and 250 Mev  $\gamma$ -ray energies in the center of mass system. The detailed results are reported in a doctoral thesis which will soon be finished. Suffice to say that the most interesting result is that the cross section is much larger than any possible extrapolation of the theories which should be valid up to 150 Mev would give. Presumably the increase is due to a meson interaction, not taken into account in any of the theories so far.

The cloud chamber group is doing an experiment on the photodisintegration of the deuteron also. Background runs have been made with helium in the chamber during the last month.

Other experiments have had a few runs during the month, but no final results are available.

7. Theoretical Physics  
(AEC Program No. 5211)

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A qualitative fit of experimental data on the elastic scattering cross section of  $\pi^-$  mesons on carbon has been obtained by representing the nucleus by an absorbing potential.

Work is continuing on the photomeson production in deuterium mentioned in the last monthly report. Satisfactory progress is being made.

The high energy deuteron photodisintegration cross section is being studied to seek correlation with synchrotron experiments now under way. In particular, the contribution of meson exchange currents to this process is under investigation.

The work on interpretation of experiments on the photonuclear effect, mentioned in previous reports, has been completed and a final report on this study is in preparation.

The p-p scattering cross section is being calculated for a tensor interaction of radial dependence  $e^{-r}/r^2$  cut off with a square well at short range.

Work is continuing on the Fermi-Thomas nuclear model mentioned in last month's report.

Research is continuing on the scattering of nucleons by deuterons, and by the heavier nuclei from carbon through lead.

An effort is being made to analyze the quantum mechanical corrections to the radiation from a high energy electron in a magnetic field as rigorously as possible, in order to obtain a more reliable result than that of a recently published paper in which a large quantum effect is found.

8. M.T.A. Program  
AEC Program No. 1500

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Mark I Accelerator. The installation of liner panels in Mark I was completed during this report period. The panels have been brushed and vacuum cleaned but no chemical cleaning is to be done.

The Q tests on the Mark I accelerator have just been completed and the low power tests are scheduled to begin immediately. The measured value of Q is 250,000, which is higher than expected.

The drift tube assembly is proceeding. Two drift tubes have been welded on the bottom only where they are to sit on the cradle. All the drift tubes will be so welded before final welding is done. It was decided that chromium plating will not be attempted. All cleaning of the drift tubes will be done at the Radiation Laboratory.

All the diffusion pumps have been shipped to the Distillation Products Inc. but the work of conversion to mercury has not started. However, tests on a pilot model are underway.

Tests with the B-1 Cavity. With mercury diffusion pumps having a pumping speed of 2 to 3 thousand liters per minute and one oscillator, 2.6 million volts can be obtained. The x-ray level in going from 1.6 to 2.6 Mev increases by a factor of five but the increase in electron emission is considered negligible. If a second oscillator is used with the mercury pumps it will be possible to reach 3.6 Mev, which is not as high as the Mark I gradient of 4.5 Mev but is greater than the A-12 gradient.

Ion Pump Experiments. Considerable interest has developed in the possibility of using ion pumps to evacuate large volumes. It is thought that such pumps would give better vacuum and reduce the sparking since there would be no mercury or oil vapor present.

Experiments with the ion pump are proceeding. With the present small pump the best pumping speed obtained has been 2,000 liters per second; achieving a vacuum of  $4 \times 10^{-6}$  millimeters of mercury. If both ends of the pump are utilized, the pumping speed is doubled. This pump employs a hot P I G arc discharge in an evacuated cylinder located in a solenoidal magnetic field of 1,000 gauss parallel to the axis of the cylinder. The arc power needed is about 2 kilowatts. The total power required, including that for the magnet, is less than that required by a diffusion pump of equivalent speed when the power to provide liquid nitrogen trapping is included. This type of pump on the A-12 accelerator would consist simply of a straight tube attached to one or both sides. The pipe could be made in 50 foot sections or in one piece, whichever is more convenient. The ion pump, if successful, would represent a considerable simplicity in design as well as an appreciable savings in the cost of the A-12 vacuum installation.

A-12 Accelerator Design. Three possibilities for the design of the A-12 accelerator are under consideration. (1) The use of a 1500 foot tank tapering from a diameter of 57 feet at the injector end to 45 feet at the target end with the present "fat" type drift tubes. (2) Identical with (1) except for

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the use of the thin "stove-pipe" drift tubes, possibly retapered for optimum power loss. (3) Similar to (2) without retapering, but designed for an energy of 500 Mev instead of 350 Mev. All these designs assume a frequency of 12.1 Mc. The rf power losses for the three cases are calculated to be 52 Mw, 38 Mw (36 Mw with retapering), and 200 Mw respectively. These losses include a 15 percent allowance for losses in joints. Because of the much higher rf loss, the gain in neutrons in going to an energy of 500 Mev may not be worthwhile.

In order that general design work may continue it is necessary that some of the A-12 design parameters be frozen. Because high x-ray levels and frequent sparking constitute the largest problems, it was decided that the results from tests with the Baker cavity, operating with mercury pumps and high voltage gradients, should be obtained before freezing many of the A-12 parameters. However, it was decided that the length of the tank (1500 feet), the present diameter and taper, and the approximate 12.1 megacycle operating frequency should be considered as frozen. If it is discovered that higher voltage gradients can be held, it may be desirable to reduce the tank length. The building foundation could be designed in sections so that a decrease in tank length would be possible without redesigning the building. The California Research and Development Company will proceed on this basis, but will not design the first 300 feet until trajectory calculations are complete.

A-12 Target Development. A joint target design development group composed of both UCRL and CRDC personnel has been set up. The program is to develop by March 1952 the preliminary design of an operable target. It was decided that in view of the time available, neither cost nor efficiency would be optimized in this design. The design will assume the following conditions: A 350 Mev, 500 milliamperes CW deuteron beam; the product will be  $U^{233}$ ; the primary and secondary targets will be uranium; and all targets and lattices will be water cooled.

A secondary target thickness of 6 inches will be studied to begin with. The heat loads expected are 175 Mw in the primary target, 80 to 100 Mw in the secondary target, and 80 to 100 Mw in the lattice. The lattice, which in the first design is a steel tank swimming pool filled with water, will be located outside the vacuum tank area. Primary and secondary targets will be located within a vacuum tank which is an extension of the beam tube. The target being studied has an area of 124 square feet. Studies indicate that a peak current density across the face of the target of more than five times the average current density is not to be expected.

Calculations are being made in an effort to explain the distribution of neutrons within the primary and secondary targets. The present calculations attempt to correlate the formation of neptunium in uranium at various locations in the primary and secondary targets with the current theoretical concepts of the paths the neutrons tend to follow in passing into the primary and secondary targets.

To eliminate doubts concerning the use of an ion chamber as a counter in recent experiments at the University of Chicago cyclotron, recent runs have been made using a Faraday cup with a uranium target, utilizing 190 Mev deuterons

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from the 184-inch cyclotron. This new experimental set up has given yields which are comparable to those previously obtained. Previous data shows 3 to 3-1/2 neutrons per deuteron. The latest experimental data shows about 3.25 neutrons per deuteron.

MTA Metallurgical Research. A review of the metallurgical research programs at other laboratories has led to the following conclusions. That there should be participation in the comprehensive program of thorium research being developed at ORNL; that the subsidized experiments in creep, growth and fatigue should be concentrated at one location; that the emphasis on the investigation of various uranium and thorium alloys should be increased; and that the resistance thermocycler should be moved from Oak Ridge to Livermore.

The research program at the Argonne Laboratory will be able to produce a zirconium-uranium-zirconium sandwich that may be satisfactory, and consequently the California Research and Development Company should discontinue subsidized experiments in zirconium cladding of uranium at Oak Ridge. However, zirconium cladding of thorium experiments should continue. The modified picture frame method of making zirconium-uranium-zirconium sandwiches, developed at the Argonne Laboratory, promises to be more satisfactory than the rolling to a flat shape of a zirconium clad uranium cylinder. There has been no success thus far in cladding thorium satisfactorily with zirconium. However, successful results may be achieved if higher temperatures are used.

Some experiments in creep and growth have been undertaken both at Battelle and Oak Ridge. These have shown that thorium experiences little or no growth and that creep in thorium seems to be less than has been anticipated. Both Ames and Battelle are experimenting with various alloys in thorium. Ames has tested properties of an alloy containing about 15 percent zirconium. Battelle has experimented with very small percentages of several additives such as veryllium, zirconium, titanium, tantalum, and tested some of the properties of each. Carbon also appears to be a possible hardening agent.

The resistance thermocycler constructed at Oak Ridge has been very satisfactory, primarily for producing large thermal stresses rather than for observing possible effects of instability. This small and inexpensive piece of apparatus can be made to create stresses equivalent to 1,000 pounds per square inch. It can be used for uranium and thorium and also for structural materials and bonding materials. The California Research and Development Company plans to bring the resistance thermocycler to Livermore where it can be operated at less expense and in better support of the design effort. Other experiments at Oak Ridge will be discontinued.

9. Chemistry  
Part A  
(AEC Program No. 5311)

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X-ray Spectrum of Pu<sup>239</sup>. A sample of Pu<sup>239</sup> has been studied with the bent crystal spectrograph. Three L x-ray lines were observed with energies in agreement with the accepted values for uranium. The alpha spectrum observed with the magnetic spectrograph indicates a gamma transition of 14 kev energy. No such gamma ray was observed in the x-ray spectrum; therefore, the gamma ray is probably largely converted.

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Isobars of Mass 243. The beta decay of neither Cm<sup>243</sup> nor Am<sup>243</sup> has been observed. Energy estimates place the two masses very close together, and it is not known which isobar is beta stable. Daughter milking experiments have set lower limits of  $3 \times 10^5$  years for the beta decay half-life of Am<sup>243</sup> and  $5 \times 10^4$  years for the electron capture half-life of Cm<sup>243</sup>.

Alpha Spectrograph. Apparatus has been installed in the magnet of the alpha spectrograph for measuring the magnetic field by the proton magnetic resonance method.

Geometry Factors for Low Geometry Alpha Chambers. In a low geometry alpha chamber the geometry factor depends on the shape and distribution of the sample, and for accurate work this dependence must be known. Factors for uniform circular samples located in the usual manner below the circular collimator have been calculated by an IBM machine for a considerable range of values of the ratios of sample size to collimator size and sample size to sample distance. The resulting tables will be published later.

Heavy Spallation Fragments. Experiments are being started to study the energies and abundances of heavy spallation fragments, such as lithium nuclei, by means of photographic plates placed strategically in the cyclotron.

Rare Earth Tetrafluorides. A search is being made for a suitable solvent for CeF<sub>4</sub> and TbF<sub>4</sub> to allow calorimetric determinations of thermodynamic properties.

Chemistry  
Part B  
(AEC Program No. 5311)

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

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

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<sup>2+</sup> and Fe<sup>3+</sup>.
5. Thermodynamics of indium.
6. Thermodynamics of thiosulfate.
7. Solubility of the rare earth fluorides.

Chemistry  
Part C  
(AEC Program No. 6400)

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Synthetic and Experimental Chemistry. The synthesis of several new compounds has been undertaken and the preparation of others continued. These include: Valine-4,4'-C<sup>14</sup> (18 percent yield, 6.4 mc.); Valine-2-C<sup>14</sup> (new method); glycine-2-C<sup>14</sup>; proline-5-C<sup>14</sup>; 4-hydroxyproline-5-C<sup>14</sup>; aspartic- $\gamma$ -C<sup>14</sup>; methyl-C<sup>14</sup> iodide, iso-and-n-butyl-1-C<sup>14</sup> bromide, Leucine-3-C<sup>14</sup>; norleucine-3-C<sup>14</sup>, toluene-3-C<sup>14</sup>, and phenyl-3-C<sup>14</sup>-alanine. Mechanism studies on the Leuckart reaction and on the nature of side products in the acetamidomalonate condensation reaction in the preparation of amino acids are being carried out. Radiation chemistry studies have continued. Systems under investigation include aqueous solutions of glycine-1 and -2-C<sup>14</sup>, adenine-4,6-C<sup>14</sup>, guanine-4-C<sup>14</sup>, and various mixtures of formic acid, CO<sub>2</sub>, and potassium cyanide.

Biological Chemistry. Projects of interest to animal biochemistry that have been active in the past month include: a) metabolic fate of cholesterol-C<sup>14</sup> in rats in studies related to the problem of atherosclerosis; b) the paper chromatography and spot test identification of steroids; c) the degradation of products from yolk of eggs from hens fed labeled acetate; d) the isolation and identification of labeled nucleic acids from Scenedesmus and Cana leaves fed C<sup>14</sup>O<sub>2</sub>; e) the rate of oxidation to CO<sub>2</sub> and metabolic fate of glycine-2-C<sup>14</sup> and acetate-2-C<sup>14</sup> in normal and hypophysectomized rats, and the influence of ACTH on these rats. Other biological problems are being studied jointly with the Medical Physics Group and are reported elsewhere.

Photosynthesis Chemistry. Work is in progress to adapt a Cary Recording Spectrophotometer for use as a microspectrophotometer. It could then be used in the analysis of compounds obtained in micro amounts from paper chromatograms of plant extracts.

An investigation of the carbon compounds formed during photosynthesis at various wave lengths is being started. At present a high intensity monochromator is being constructed for this investigation.

Erythronic acid and glycolaldehyde phosphate are being prepared so that their chromatographic position on paper may be determined. Benzimidazole derivatives of the aldonic acids are being prepared in order to explore their use in the detection and estimation of these acids.

The variation of carbon compounds formed during photosynthesis with age of the algae is being studied. Scenedesmus cells from one and three-day-old cultures were exposed to radioactive carbon dioxide in light for one minute. The one-day-old cells fixed more than two times the carbon dioxide fixed by the three-day-old cells. The relative activity fixed in individual compounds is now being investigated.

The effect of antifolic acid compounds on photosynthesis as measured by oxygen evolution and carbon dioxide fixation in the light is being investigated. The effect of these compounds on growth of Synechococcus is also being tested.

The Hill reaction using quinone as the hydrogen acceptor was performed with whole cells of Synechococcus cedorum. The rate of oxygen evolution for

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the Hill reaction was approximately half the rate observed for photosynthesis. The possibility of using the bacterium, Lactobacillus pentoaceticum, in the degradation of ribulose is being investigated. The fixation of carbon dioxide in the dark by Euglena as a function of time was determined. The amount of carbon fixed in both the insoluble and soluble fractions increased with time. The percent of activity in the insoluble fraction was greatest at the longest time, 68 percent insoluble at 40 minutes exposure as compared with 38 percent at 5 minutes.

10. Medical Physics

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Part A

(AEC Program No. 6000)

Tracer Studies. Metabolic studies are being conducted in rats involving the use of radio-thallium and tungsten with and without carrier.

Radioautography. Work on experimental techniques was continued. Autographs of  $I^{131}$  in rat thyroid using Carbowax and osmic acid vapor were attempted. No results have been obtained as yet. Also autographs of  $C^{14}$  in algae (spirogyra spp.) for the Photosynthesis Group are in progress.

Radiochemistry. Work was started on the separation of plutonium from alpha bombarded  $U^{235}$ . Microcurie amounts of carrier-free  $Tl^{200,201,202}$  were separated from mercury.

Radiation Chemistry. The ion pair yield data for radiation-induced oxidation of ferrous sulphate have been determined and are the same as those observed using ferrous ammonium sulphate within  $\pm 2$  percent.

The radiation synthesis program has been continued. A solution of C-14 labelled formic acid saturated with hydrogen was bombarded with 35 Mev alpha particles and the non-volatile radiation products were isolated and chromatographed, using 2-dimensional technique. A total of eight radiation products other than formic acid were observed. These are being identified.

The radiation chemistry of oxygen saturated solutions of simple organic compounds has been started. A solution of 0.25 mole acetic acid was bombarded with 35.5 Mev alpha particles to give a calculated 30 percent change, assuming an ion pair yield unity. No change was detected in the total acid content, as determined by sodium hydroxide titration. The non-volatile fraction is being separated by partition chromatography on salicylic acid gel by the method of Marvel.

Medical Physics

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Part B

(AEC Program. 6000)

Activation Analysis. The work is being continued, particularly on the distribution of zinc and cobalt in the animal body and in human blood.

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Biological Effects of Radiation on Microorganisms. Work is in progress in establishing the relationship of radiation induced unpaired genetic damage to single biochemical gene mutations.

Instrumentation. A fourfold in vivo counter is near completion. Development of a gamma ray pin hole camera with greatly increased sensitivity is in progress. A beta ray pin hole camera is under construction.

Carbon Beam. The biological effects of accelerated carbon ions, and new dose measuring and beam centering equipment has been tested. Work was begun on studying the survival of Pseudomonas bacteria to this radiation.

Iron Turnover Studies. Multicompartment iron turnover studies have now been made on a small number of active rheumatoid arthritics. (Some before and after ACTH or cortisone.) Simultaneous radioactivity measurements in plasma and cells were made as well as in vivo counter over representative marrow, spleen and liver sites. By means of this directional external gamma fluorescence computer, in vivo plots of time vs. counting rate were made.

The ferrokinetic curve pattern of the patients studied differs from the normal in several respects: (1) The depletion of  $Fe^{59}$  from plasma after a single injection ( $Fe^{59}$  in combination with Globuline IV-7) is more rapid than usual. (2) A plasma-to-tissue clearance excess is exhibited in a rising liver count with an amplitude greater than the "norm". (3) The partial re-cession of tracer from the liver maintains a high specific activity in plasma. This results in a curve with a "flattened maximum" over the marrow site. The peculiarity of the curve is believed to be caused by the presence of a liver iron "pool" in which the injected tracer iron is rapidly diluted. The "size" of the pool may be determined (in terms of a "volume" with the same iron concentration as plasma) by extrapolation of the 2nd slope to zero time. Eventually, slow incorporation of iron in hemoglobin leads to a nearly normal fraction of the tracer following the plasma-to-marrow-to-cell pathway.

The anemia of rheumatoid arthritis results from dilution by an unusually large plasma volume. This is evident from plasma volumes obtained (at the same moment, daily) within a few days of each other by the  $P^{32}$  tagged cell method and by the  $Fe^{59}$  dilution-by-plasma method. The total blood volumes found by computation with the hematocrit at the time, as well as by direct derivation of total blood volume, are also acceptable evidence. The latter method consists in plotting activity per ml of whole blood on semi-log paper as a function of minutes after injection, extrapolation to time zero. The c/m injected is then divided by the activity per ml at  $t=0$  giving a value for the whole blood volume. The total unpacked cell volume is equal to the difference between the BV and PV.

The effect of ACTH given over several weeks in one case and cortisone in several others was to restore the iron kinetics to normal or nearly normal.

In-vitro experiments, in which  $Fe^{59}$  globulin was added to plasma from rheumatoid arthritics and also to plasma of normal control patients failed to demonstrate any substance capable of changing the  $Fe^{59}$  to a dialyzable state.

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Studies with C<sup>14</sup> Stilbamidine. Normal mice were injected intraperitoneally with liver damaging amounts of carbon tetrachloride in an effort to determine the effect of liver damage on the liver concentration of stilbamidine. The concentration of activity in the livers of these carbon tetrachloride mice was markedly increased and of the same order as the increased concentration of C<sup>14</sup> activity found in the livers of tumor mice.

Tritium and Total Body Water Measurements. Studies of the total body water of 55 subjects have been completed. Of these, 24 were normal and the remainder were cardiac, liver or blood abnormalities.

The present research was undertaken to develop further the use of tritium for routine body water measurement and to extend the investigation of total body water to a variety of disease states.

Conclusions from these studies are:

- 1) Age has an apparent effect on total body water content. Younger subjects have a slightly higher total body water content, in terms of percent of body weight, than older individuals.
- 2) Tritium appears to measure the same water volume as does deuterium, averaging 2-4 percent higher than antipyrine, and undergoes a similar degree of exchange with organic molecules.
- 3) The difference between antipyrine and tritium body water volumes is accounted for quantitatively by exchange of tritium with protein-bound hydrogen.
- 4) Body water determinations vary greatly from individual to individual, the variations in proportion reflecting for the most part variation in body fat. In pathologic states where the main body mass cannot be assumed to remain constant in composition, body water determinations are of limited value without a method for quantitating fat.

Studies in Lipoprotein Metabolism. A report has been prepared of our studies on Lipoprotein Metabolism in the post irradiation state. Current studies concern (1) identification of lipoprotein-transformative material in the post irradiation state (this substance is generated by heparin) (2) further investigation of the "heparin deficient" state following severe irradiation. (3) Further investigation of possible protection of heparin given after irradiation. Doses of heparin can be achieved that will restore irradiation - deranged fat metabolism to a normal pattern of lipid transport: Preliminary results had indicated some possible benefit to the rabbit in preventing the post irradiation crises in serum lipid transport.

11. Health Chemistry

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(AEC Program No. 5311)

Equipment Development Group. Work in progress is listed below:

1. A unit for vacuum distillation of C<sup>14</sup> has been completed.

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2. Preliminary equipment for metal production from heavy elements has been completed and is being tested.
3. Equipment for electroplating an active copper anode (bombarded with alpha on the 6(-inch) to Pt disks in nitric acid with a low current is finished.
4. Formal drawings for Health Chemistry standard filter equipment have been made.
5. A target holder for plutonium to be bombarded in the internal beam of the 184-inch has been built and proved successful for use.
6. Two special cold baths for use in the yttrium preparation process in Donner were completed.
7. Preparations are being made for receiving and processing two bombardments from the Canadian pile, one in December and one in February.
8. Berkeley boxes have been completed as follows: (1) for an actinium separation; (2) for a special plutonium separation experiment; (3) for the electroplating work described in Point 3 above; (4) for an anticipated americium bombardment from the Hanford pile; (5) two boxes for the Canadian bombardments mentioned above; (6) for experiments involving the injection of rabbits with I<sup>131</sup>.
9. Studies on special processes for solidification and purification of liquid wastes are continuing.

12. Plant and Equipment

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Revatron Instrument. (Program No. 1500. 5-424-9001) Quadrant IV is being wound, and the magnet excitation equipment is being tested.

M.T.A. - Mark I. (Program No. 1500. 5-424-9004) Development and design continuing.

M.T.A. - Mark II. (Program No. 1500. 5-424-1004) Development and design continuing.

Miscellaneous Construction. (Program No. 1500. 5-424-1001)

North Gate House. This work is 65 percent complete. It will be ready for occupancy about the middle of December. Plans are being drawn for paving and realignment of security fencing.

Slope Stabilization. This work was completed and accepted on October 15.

Paving for 184-inch Cyclotron Site. Patching of edges and clean-up work is being done. This work will be completed November 16.

Animal House. (Program 1600. 6-424-9007) Work being done on purchase order is complete. Installation of laboratory furniture will be completed in about

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two weeks. Work on animal runs, run fencing and interior resilient floor covering is complete. Animal cages are yet to be installed before the building can be occupied. Animal food storage bins, racks and cupboards are being built by UCRL labor.

Radiological Laboratory at the U.C. Medical School. (Program No. 1600. 6-424-9008) The work on the building is complete and the installation and testing of the 70 Mev synchrotron is approximately 98 percent complete. A test on November 9 gave a beam of approximately 500 r. at 1 meter, operation steady.

MAN-MONTHS EFFORT REPORT

Scientific Personnel

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
9200 M.T.A. - Mark I	Design and Development	2.81	
9200 M.T.A. - Mark II	Design and Development	52.00	
9500 Bevatron	Miscellaneous	.10	
<u>Operations</u>			
3000 Weapons Research	General	1.13	
5211 Physics Research			
Experimental Physics	Cloud Chamber	12.38	
	General Physics Research	50.46	
	Instrument for General Use	3.74	
	Special Development	10.38	
	Magnetic Measuring Equipment	1.88	
	Charge-Exchange Accelerator	.20	
Theoretical Physics	General	12.69	
Photographic Film Detectors	General	13.04	
Isotope Separation	General	-	
Radioactivity Physics	General	1.75	
5261 Applied Physics Research			
Thomas Cyclotron	Electron and X-C Models	21.51	

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORTS	COMMENTS
Operations (continued)			
<u>Chemistry Research</u>			
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	2.46	
	Nuclear Properties of Heavy Element Isotopes	9.23	
	Transmutations with 184-inch and 60-inch Cyclotrons	5.25	
	Analytical and Services	17.855	
	Special Chemistry Development	1.00	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.00	
	Instrument Development and Services	4.60	
	X-Ray Crystallographic Measurements	2.77	
	Health Chemistry Research	10.95	
Basic Chemistry Research, Part B	Metals and High Temperature Thermodynamics	3.0	
	Basic Chemistry, including Metal Chelates	4.0	
5361 Applied Chemistry Research	Process Chemistry	9.915	
Reactor and Accelerator Operation			
5731 Synchrotron	Operation	9.77	
5741 184-inch Cyclotron	Operation	11.28	
5751 Linear Accelerator and Van de Graaff Generator	Operation	11.74	

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
6000 Biology and Medicine Part A	Metabolic Properties of Various Materials	8.0	
	Radiochemistry and Radiation Chemistry	5.0	
	Radioautography	2.0	
6000 Biology and Medicine Part B	Instrumentation for Quantitative Measurements of Radiation	1.74	.90 Consultant
	C <sup>14</sup> Metabolism	3.15	.73 Man-Months
	Use of Radioactive Materials in Human Physiology and Experimental Medicine	8.58	5.13
	Trace Elements and Irradiation Studies	3.64	2.26
	Radiation and Mutation Rate	1.60	.25
	Physical Biochemistry	12.03	3.80
	Biochemical Response to Irradiation	2.98	.50
	Machine Shop Expense	1.00	-
	Miscellaneous	-	.65
	Donner Animal Colony Expense	2.00	1.04
	Metabolism of Lipo Protein and Lipids	5.38	9.70
	Iron Metabolism Hematopoiesis	2.82	.50
	Internal Irradiation and Hematological Response	1.93	-
	Biological Effects of Cosmic Radiation	2.50	.25
	Health Medicine	3.82	-
	6400 Biological Research	Synthetic and Experimental Organic Chemistry	5.44
Biological Chemistry		6.41	
Photosynthesis Chemistry		5.12	
Metabolism of Fission Products		13.16	
6500 Biophysics Research	General	2.35	

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