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## Recent Work

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Special Review of Restricted Reports

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| SPECIAL REREVIEW<br>FINAL DETERMINATION<br><b>UNCLASSIFIED</b> |
| NAME: <u>J. H. Green</u>                                       |
| DATE: <u>4-29-80</u>                                           |

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MONTHLY PROGRESS REPORT  
No. 104

November 15 to December 15, 1951

January 7, 1952

Classification changed to **DECLASSIFIED**  
by authority of D. J. Flannery & J. H. Green, SR  
on April 19, 81 B. B. Skott  
Date Person making change

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

November 15 to December 15, 1951

MONTHLY PROGRESS REPORT NO. 104

January 7, 1952

1. Bevatron  
(AEC Program No. 1500)

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Magnet coil winding was almost at a standstill during the period due to the failure to receive insulating cable spacers and the use of the building cranes on other work. Construction of the magnet coil terminal structure is under way and design of the shunts and current transformers in the magnet circuit to supply signals to the frequency control equipment is proceeding.

Electrical engineering on the control room installation and in preparation for magnet generator tests is going on. Drawings have now been completed and released to procurement for the entire vacuum tank. Orders for the pole piece steel have not yet been placed.

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

UNCLASSIFIED

The cyclotron was used for research experiments approximately 98 percent of the 492 hours that the crew was on duty. The time distribution was as follows:

|                         |              |               |
|-------------------------|--------------|---------------|
| Operation for customers | 485.25 hours | 98.6 percent  |
| Electrical troubles     | 2.00         | 0.4           |
| Mechanical troubles     | 3.25         | 0.6           |
| Beam tests              | 1.75         | 0.4           |
| Total                   | 492.25 hours | 100.0 percent |

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

UNCLASSIFIED

Further work is being done on the beam envelope patterns. Efforts are being made to change the pyramidal shims to reduce the beam blow-up at 22-1/2

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inches. The general operation was about 85 percent throughout the month.

4. Synchrotron Operation  
(AEC Program No. 5731)

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Considerable interest is developing in trying to determine what part the injectors play in the ability of the synchrotron to run at high intensity levels. The beam intensity appears to be directly associated with each injector. One injector has been removed before it failed in order to make studies of it. A moderately high intensity was obtained from this injector over a two and a half week period. Injectors in use prior and after this particular one have produced maximum beam intensities down by a factor of five.

The injector under study was removed once previously while it was working well. A new injector was tried for a day in the machine with poor results. The good injector was reinstalled and a good beam intensity was attained.

Work is continuing on the new high energy injector system, slated for installation late in February.

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

As the figures below indicate, the operating efficiency of the linear accelerator was quite high for this month.

|              |            |              |
|--------------|------------|--------------|
| Running time | 273 hours  | 85.3 percent |
| Repair time  | 24.5 hours | 7.7 percent  |
| Maintenance  | 22.5 hours | 7.0 percent  |

6. Experimental Physics  
(AEC Program No. 5211)

UNCLASSIFIED

Film Program. A study has begun of background electrons, the tracks of which exist in all except newly prepared electron sensitive emulsions. The background seems to consist chiefly of quite low energy electrons, which apparently must have a very local origin. A calculation has indicated that the  $\text{Cl}^{14}$  content of the emulsion gelatin is an important source of the background electrons. The potassium content of the glass is also being studied.

Plates are being stored in the mining tunnel back of the campus to study the background effect as a function of time.

In order to test the hypothesis that the neutron and proton play symmetrical roles in the production of positive and negative mesons, we have returned to the use of the cyclotron alpha particle beam. A project has been initiated to study the  $\pi$  meson production ratio from alpha particle bombardment of alpha-particle type nuclei such as  $\text{Cl}^{12}$ .

Normal progress is continuing on a number of other items of the film program previously reported.

Cloud Chamber. The experiment on meson scattering, using a continuously sensitive cloud chamber, was run at the 184-inch cyclotron, using the meson beam. The chamber was run on a 9-second cycle for two days, during which time more than a thousand feet of film were exposed, giving possibly enough data for this low cross section event. The data is now being analysed and preliminary results will soon be tabulated.

Two new projectors are almost completed, and are already in use. A third is in the final stages of assembly. Design work in the new cloud chamber camera is complete, and the machine shop work is underway. The 10-atmosphere chamber is being assembled and prepared for a run at the 184-inch cyclotron on high-energy n-p scattering. All preliminary tests and pictures show the chamber to be functioning satisfactorily.

Elastic Deuteron-Proton Scattering using 345 Mev Protons. The methods described earlier, using reasonably thin absorbers at some angles and pulse height analysis at other angles to separate elastic from inelastic scattering have proved feasible at least in one case. No absolute cross section can be quoted as yet.

Proton-Proton Scattering at Reduced Energies (160 to 250 Mev). Construction is virtually complete. It is hoped that the test of the liquid hydrogen flask with liquid nitrogen will occur very soon. This will be followed by a trial filling with liquid hydrogen in some safe place remote from complex equipment and remote from unnecessary personnel.

Neutron-Proton Scattering at Small Angles. The feasibility of an experiment is being investigated, the purpose of which would be to measure the relative n-p scattering cross section in the region from  $0^\circ$  to  $40^\circ$  in the c.m. system, where it has not hitherto been determined. It is proposed that the new liquid hydrogen flask be used as target, and an n-p converter and scintillation crystals as neutron detector at small angles from the beam. The counting rate will be low and it will be necessary to work quite close to the neutron beam, so the experimental arrangement will have to be very carefully designed.

A preliminary run was not altogether discouraging. It revealed that a considerable neutron background from the collimator snout will have to be greatly reduced by means of collimation, shielding, and improved geometry.

Inelastic Scattering of 32 Mev Protons from Beryllium. The range spectrum of charged particles resulting from the bombardment of  $\text{Be}^9$  by 32 Mev protons from the Berkeley linear accelerator has been observed at several angles. In addition to the known levels of  $\text{Be}^9$  at 2.42 Mev and 17.2 Mev, a heretofore doubtful level at  $\approx 1.5$  Mev has been confirmed. Evidence has been found for the existence of two broad levels in  $\text{Be}^9$  at  $\approx 6.5$  Mev and  $\approx 4.5$  Mev. The spectrum includes deuteron groups representing transitions to several states of  $\text{Be}^8$ . At  $15^\circ$  a continuum of  $\alpha$ -particles with high energy cut-off at  $\approx 25$  Mev is observed. This information appears as an abstract under UCRL Report No. 1608.



Short-Lived Products of 90 Mev Neutrons on Carbon. A fourth run of the spinning disc method for determining cross sections of short-lived activities produced in a polyethylene target by 90 Mev neutrons yielded the following results:

Boron 12 cross section  $\sim 5$  millibarns ( $5 \pm 1$ )  
Lithium 8 cross section  $\sim 4$  millibarns ( $4 \pm 1$ )  
Carbon 10 cross section less than  $1/2$  millibarn ( $0 \pm 1/2$ )

Runs were made at 1200 rpm and 60 rpm with a  $1/16$  inch polyethylene disc, and at 600 rpm and 60 rpm with an  $1/8$  inch disc. The lower speeds used permitted discrimination against the  $\text{B}^{12}$  and  $\text{Li}^8$  activities. Using single and double discs permitted self-absorption coefficient estimation for  $\text{Li}^8$  and  $\text{B}^{12}$  betas (12 Mev).

Elimination of collimators at the neutron port actually improved the beam collimation produced by a 2 inch diameter pipe placed in the igloo and surrounded by lead for six feet of length. The counter backgrounds with beam on were thereby reduced 33 percent. This factor plus a 50 percent increase in beam intensity gave the best results attained thus far.

Nuclear Elastic Scattering of 300 Mev Neutrons. The triple coincidence scintillation counter wide angle neutron telescope was calibrated in the proton beam. It was found to have uniform proton counting efficiency from zero to 30 degrees, for 300 and 280 Mev protons.

The counting rate versus absorber thickness was determined at each angle and energy.

Neutral Meson Gamma Ray Spectra. Further analysis of the gamma ray spectra emitted from carbon bombarded by 345 Mev protons shows that the neutral mesons are emitted non spherically symmetrically and appear to have a  $\cos^2 \theta$  dependence in the center of mass frame of the proton-nucleon collision.

Meson Photo Production Experiment. The work this month was directed toward further analysis of data from previous runs and also toward further electronic development.

Attempt to Detect  $\text{V}^0$  Production. Energy is available in the collisions of 340 Mev protons with neutrons bombarded in nuclei in sufficient quantity to produce the  $\text{V}^0$  particles discovered by cosmic ray workers.

With the assumption that these particles may decay into a proton and positive pion, a counter experiment was attempted in search for their production by the cyclotron. Two-fold scintillation counter telescopes were arranged to detect a pion and proton in coincidence, both originating from a region of space about 12 centimeters from a carbon target. This distance was required in order to provide stopping material for other charged particles directly from the target.

In this first run the limitations of beam intensity, of solid angle, and of decay time allowed to the  $\text{V}^0$  particles prevented any conclusion more refined than to say that if  $\text{V}^0$  particles are thus produced it is with a cross section not greater than  $10^{-28}$  square centimeters for a carbon nucleus.

Attempts are in progress to devise means of increasing detection efficiency

or beam intensity so that the upper limit on the cross section may be pushed considerably lower.

Continuation of Meson Capture Gamma Ray Experiments. The experimental work on  $\pi^-$  mass measurement from capture in hydrogen has been completed. We have had one run on the measurement of n-n interaction from meson capture in deuterium. Both of these experiments are being analyzed for numerical results.

Synchrotron Studies. The operation of the synchrotron was still unsatisfactory during this period. Some experiments, however, indicated that the emission of many filaments is much lower than that expected from heating measurements made in the test tank. This is certainly not the whole explanation for the low beam; but it may be part of the reason. Further support for the view that the injectors are the main cause of trouble comes from the experience on the U.C. Hospital synchrotron, showing that the injectors made at the Radiation Laboratory gave small and rather unsteady beams, while a General Electric injector gave a large (4 times greater), steady beam.

Probably the most interesting experimental result of the month is the finding that there is an appreciable yield of photoneutrons from quanta of energy above 100 Mev. An analysis of photoneutron yields gives reason to believe that perhaps 30 percent of the yield observed at 320 Mev was due to quanta of energy above 100 or 150 Mev; which is well above the so-called dipole resonances which are in the neighborhood of 15-20 Mev for most elements. The number of neutrons was measured with a  $\text{BF}_3$  counter using 320 Mev and 160 Mev bremsstrahlung. The data was reduced to equal numbers of low energy (0-30 Mev) quanta by using the photoneutrons from deuterium and the  $\text{Cu}^{62}$  radioactivity from  $\text{Cu}^{63}(\gamma, n)\text{Cu}^{62}$ , both of which presumably have negligible cross sections above 50 Mev. All elements showed a larger yield with the 320 Mev beam, the average increase being of the order of 30 percent. Consideration of the form of the bremsstrahlung curve shows that this almost certainly is due to quanta of energy greater than 140 Mev. The two methods of monitoring the beam agreed within 6 percent. It is possible to take good measurements at half energy even though the beam cannot be spread out because the slowing down time of neutrons in the paraffin surrounding the counter is of the order of 200  $\mu\text{sec}$ , and so there is no pile-up, even with beams lasting on 20  $\mu\text{sec}$ .

More data has been obtained on experiment to measure the Compton cross section in Be and these measurements should be completed within six weeks.

One run was made for the Film Group to get plates for electron-electron and electron-positron scattering experiments. Some running time has been used for measurements of high energy protons, and for determining the photo-neutron energy distribution.

7. Theoretical Physics  
(AEC Program No. 5211)

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Many of the studies reported last month are still in progress.

The study of neutral meson production in deuterium, in the case when a deuteron is formed in the final state, has been completed. A report of this work, UCRL-1611, will soon appear in the Physical Review.

An article based on UCRL-1581, a study of photo-nuclear processes, has also been submitted to the Physical Review.

The influence of the charge distribution inside nuclei on the photoproduction of  $\pi$  mesons is being examined.

Preliminary calculations of the photodisintegration of the deuteron in the energy range of 200 - 250 Mev have yielded angular and energy dependences of the cross section which are consistent with the results of recent experiments at this laboratory. This agreement is due to the inclusion of exchange current contributions in the calculations.

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

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Mark I Tank. Further weld and strength tests have been conducted on the Mark I vacuum vessel to determine whether the welds of the vessel head are satisfactory. Of the 96 strain gauges used, only four had high readings and none of these exceeded the yield point. The welds were re-x-rayed and magnafluxed. Four cracks were found on the peripheral weld which is now being repaired. It is thought that these cracks were present originally and that they opened after magnafluxing.

The recent Q and low power tests on Mark I gave a Q of  $255,000 \pm 0.3$  percent which is 14 percent lower than the theoretically calculated value. A Q 20 percent lower than theoretical was expected upon the basis of experience with the Radiation Laboratory's 40 ft. linear accelerator. The cavity was excited by a single pre-exciter oscillator to a power level of 200 kw during the low power test. Prior to the tests it was decided that a temperature rise in the cavity walls of  $200^\circ$  C. would indicate a hot spot that would require inspection and repair. The maximum rise obtained was  $60^\circ$  C. During these tests one of the transmission lines shorted out. The cause of this failure is not known.

Mark I Drift Tubes. The delivery of completed drift tubes to Livermore is progressing according to schedule. Drift tubes nos. 0 and 9 have been sent to Livermore and no. 9 has already been installed. Vacuum leak detection tests on assembled drift tubes are being conducted in the Laboratory before shipment to Livermore. It is important that the magnet coil be leak free because of the possibility of organic vapor getting into the vacuum vessel. Assembled drift tubes nos. 1, 2, and 3 are being leak tested while no. 4 is in the first assembly stage. A series of vacuum leaks on drift tube no. 5 has made it necessary to remove the copper shell to allow the leak to be repaired. Drift tubes nos. 7 and 8 are assembled and are awaiting vacuum tests. It is expected that the final tube will be delivered in

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Livermore shortly after the first of the year. The drift tubes stems are all assembled and can be installed immediately.

Mark I Oscillators and Transmission Lines. Five oscillators have been tested and are now ready for delivery to Livermore. The oscillator transmission lines now installed at Livermore have been arcing on the air side of the insulator. It was found that the copper conductor between the rubber vacuum gasket and the insulator had rough edges extending beyond the edge of the rubber vacuum gasket. This allowed arcing to the inner conductor. The installation of a new sealing arrangement will eliminate this problem. All transmission lines will be changed but since all are not needed for starting operations, no problem exists. A classified area is being established on the second and third floors of the accelerator building in preparation for the oscillator installation. The no. 1 power supply is being tested with the remaining power supplies to be tested shortly. The pre-exciter are currently being tested at Livermore.

The 20 inch teflon gasket used as a vacuum seal on the rotating pre-exciter transmission line was found to leak. It is operated without lubricants in order to avoid contamination of the tank vacuum. It has been suggested that since it is not possible to obtain a good vacuum seal on the rotating transmission line that it might be advisable to reinvestigate the addition of metal shields around the loops and thus avoid rotating them.

Ion Injector. The construction completion date for the plant ion injector is set for the end of December. It is expected that six weeks time will be needed to achieve final operating performance. Construction on the no. 2 injector is progressing rapidly. The injector dry dock is expected to be moved to Livermore by late February.

Mercury Diffusion Pumps. The first converted mercury diffusion pump has been received from the Distillation Products, Inc. The remaining pumps are expected by the end of December. The first pump will be tested at various cooling water temperatures to confirm the results of tests conducted by DPI. Their tests showed a speed of from 5500 to 6000 liters per second at a cooling water temperature of 25° C, and a speed of from 11,000 to 17,000 liters per second at a water temperature of 5° C.

Ion Pump. A new model of the ion pump has given excellent results. The pipe is 12 ft. long and 5 in. in diameter with a solenoid magnet placed along the entire pipe. An air inlet of 1/4 in. diameter is attached at the center and a separate opening about 3 inches in diameter is made to provide for an ion gauge. With this model a vacuum of  $3.3 \times 10^{-6}$  mm of mercury, a pumping speed of 1900 liters per second, and a center to end pressure ratio of from 500 to 1000 was obtained. If a 2 ft. diameter, 20 ft. long discharge can be obtained, a pumping speed of over one million liters per second will be possible. This is a factor of a thousand greater than the pumping speed of mercury diffusion pumps for Mark I. It is thought that the discharge of the ion pump actually takes place in the region near the inlet and consequently additional inlets increase the discharge area but do not increase the pressure, which means that very high pumping speeds can be obtained from a long pump. A pressure of about one micron is required at the cathode to make the pump operate. This is attained by a constriction in the tube. The power needed for ion pumps is comparable to that required for mercury pumps; however, mercury pumps require additional power for refrigeration which is not needed on the ion pump. One possibility for the design of an ion pumping system for A-12 that has

been suggested is a series of discharges lengthwise in the bottom portion of the tank shielded from the resonant cavity by a grid structure.

A new model ion pump designed for the B-1 cavity is now being fabricated in the shop.

Mark II Target Studies. The use of deuterium oxide as a target moderator is being studied since it has been found that uranium depleted either to 0.4 percent or 0.5 percent is all that will be available, instead of materials depleting to 0.3 percent. By using the material with higher uranium 235 content and a deuterium oxide moderator the plutonium production would be increased from 5 moles per day to 8 or 10 moles per day. The need for deuterium oxide would be large (1000 tons) with the consequent high inventory cost. The cost figure of 55 dollars per pound was presumed to be reliable. The heavy water inventory would amount to one hundred million dollars. With this quantity of heavy water moderator in a uranium lattice using a 0.5 ampere beam the plutonium output would be increased by 50 percent. Before it can be decided if a deuterium oxide moderated pile is economically feasible the quantity of depleted uranium available and also the percent depletion must be known.

## 9. Chemistry

### Part A

(AEC Program No. 5311)

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Alpha-Electron Coincidences. Track counting in electron-sensitive emulsions impregnated with radioactive materials has been used to make estimates of the frequency of electron-alpha coincidences in  $\text{Cm}^{242}$ ,  $\text{Np}^{237}$ , and  $\text{Am}^{241}$ . For  $\text{Cm}^{242}$ , 23 percent of the alphas have an electron in coincidence. For  $\text{Np}^{237}$ , about 82 percent of the alphas have an electron. Several double and even triple electron coincidences were observed. About 5 percent of the coincidences in this case may be due to the daughter  $\text{Pa}^{233}$ . For  $\text{Am}^{241}$ , 56 percent of the alphas have at least one electron in coincidence.

Spontaneous Fission of  $\text{Cm}^{240}$ . The spontaneous fission of  $\text{Cm}^{240}$  was measured previously with a sample containing some  $\text{Cm}^{242}$  and  $\text{Am}^{241}$ . When corrected for the effect of these impurities, the data give a half-life of  $2.5 \times 10^6$  years for the spontaneous fission half-life of  $\text{Cm}^{240}$ .

Time-of-Flight Mass Spectrograph. The time-of-flight mass spectrograph has been modified to allow collection of isotopes and has been used in this way to verify the mass assignment of radioactive  $\text{Fr}^{212}$ .

Decay of  $\text{Tb}^{154}$ . Beta spectra have been measured for  $\text{Tb}^{154}$ , which decays by positron, negatron, and electron capture processes. The energies of two positron groups and one negatron group have been determined by Fermi plots to be:  $\beta_1^+$ , energy of 2.75 Mev and intensity of 1;  $\beta_2^+$ , energy of 1.66 and intensity of 1;  $\beta^-$ , energy of 2.34 and intensity of 1.9. Conversion electrons from several gamma rays have also been measured. The principal mode of decay is by electron capture.

Crystal Structure of  $\text{Pu}_2\text{O}_3$ . A sample of  $\text{Pu}_2\text{O}_3$  was obtained as a by-product of a metal evaporation experiment. It was identified by its x-ray diffraction pattern to be this compound with the structure of the A-form (hexagonal) rare earth

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sesquioxides. The lattice parameters are:  $a = 3.840 \pm 0.004$  Å, and  $c = 5.957 \pm 0.006$  Å. These parameters are smaller than expected for pure  $\text{Pu}_2\text{O}_3$  (for example, Zachariasen predicted  $a = 3.87$  and  $c = 6.03$ ). The composition of this sample therefore probably corresponds to an oxidation state of plutonium somewhat greater than +3.

The only previous report of  $\text{Pu}_2\text{O}_3$  was a sample identified by Zachariasen as having the C-form (cubic) structure.

Crystal Structure of NpC. A sample of NpC was prepared by heating neptunium metal in a carbon crucible. Its x-ray diffraction pattern corresponded to the sodium chloride structure with:  $a = 5.004 \pm 0.005$ . The sample contained a second phase which has not been identified.

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 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  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$ .
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. Synthesis of the following compounds has been investigated: N-butyl-1- $\text{C}^{14}$  bromide, isobutyl-1- $\text{C}^{14}$  bromide, methyl- $\text{C}^{14}$  iodide, nitromethane- $\text{C}^{14}$ , valine- $\text{C}^{14}$  (by two different methods), ring labeled toluene (by cyclodehydrogenation of heptene-1), leucine-3- $\text{C}^{14}$ , norleucine-3- $\text{C}^{14}$ , and hydroxy proline-5- $\text{C}^{14}$ .

The synthesis of cholic acid labeled with carbon-14 in the 23 position has been undertaken. This material will be used for studies of possible production

in vivo of the powerful carcinogen, methylcholanthrene. The synthesis proposed involves the degradation of cholic acid to norcholic acid followed by the reconstruction of the molecule using the Arndt-Eister synthesis with labeled diazomethane.

Studies are underway on the decomposition of formyl peroxide in alkaline solutions and on the mechanism of the Leuckart reaction. A continuation on the study of the mechanism of side product formation in the acetamidomalonate synthesis of amino acid has been made with particular emphasis on the interpretation of paper chromatograms.

Work has continued on the mechanism and products of radiation decomposition of simple organic compounds, of glycine, and of nucleic acids.

Biological Chemistry. During the past month the following projects have been active in biological chemistry:

1. Cholesterol metabolism in rats.
2. Effect of inositol on cholesterol metabolism in rabbits.
3. Cholesterol- $H^3$  metabolism in humans.
4. Degradation of glycerol from  $C^{14}$  radioactive eggs.
5. Nucleic acids in algae.
6. Metabolic rate studies in normal and hypophysectomized rats.
7. Paper chromatography of steroids and other biologically important compounds.

Photosynthesis Chemistry. The investigation of photosynthesis continues along two general lines: the study of the details of the pattern of normal photosynthesis, particularly the role and sequence of simple carbon compounds, and the effect of external variables on this pattern. The elucidation of the mechanism seems at present to depend on improved analysis of the phosphate esters of simple carbon compounds, identification of new phosphate esters and better degradation procedures.

The use of ammonium formate as a selective eluting agent in the ion exchange separation of phosphate esters is being investigated. Paper chromatography of fructose-6-phosphate and glucose-6-phosphate has shown that t-butanol-water systems containing a strong acid show most promise for the fractionation of the hexose-monophosphate area in photosynthesis experiments. The phosphate-spray technique of Axelrod has been used successfully in this work.

The benzimidazole derivatives of glyceric and gluconic acids have been made and their behavior on paper chromatograms studied.

Adaptation of a Cary recording spectrophotometer for use as a microspectrophotometer continues. A capillary cuvette of 1 mm cross sectional area is being used and compounds are transferred by direct elution from the paper chromatograms to the cuvette.

Studies of the influence of antifolic compounds on photosynthesis is continuing. Aminopterin, A-methopterin, 9-methyl pteryol glutamic acid and amino-an-fol in concentrations of 100 mg per liter have no effect on the rate of oxygen evolution by either Synechococcus or Scenedesmus.

The effect of malonate on the dark CO<sub>2</sub> fixation by Euglena is being studied. The total amount of CO<sub>2</sub> converted to alcohol soluble compounds was unaffected by the presence of malonate.

10. Medical Physics  
Part A  
(AEC Program No. 6000)

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Tracer Studies. Studies upon the ability of chelating agents such as calcium EDTA have been set up for short time periods after rats were given Pu<sup>238</sup> intravenously.

Radioautography. The algae autographs were completed. A new series on the Pu lungs has been started with investigation of some new Kodak film.

Radiochemistry. The separation of plutonium from alpha bombarded U<sup>235</sup> has been completed.

Radiation Chemistry. The radiation chemistry of C-14 labeled acetic acid in aqueous solution has been conducted. The products are being separated, using chromatographic techniques. Succinic acid has tentatively been established as the principal non-volatile radiation product.

Work has continued on the isolation and identification of the radiation synthesis products from bombardment of C-14 labeled acetic acid solution, saturated with hydrogen gas. Oxalic acid is the principal non-volatile product. Glycolic acid in low yields has been tentatively identified.

Medical Physics  
Part B  
(AEC Program No. 6000)

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Biological Effects of Radiation on the Yeast Cells. A diploid yeast *saccharomyces cerevisiae* was obtained by mating two bio-chemical labeled haploid yeast obtained from Tatum. One haploid required uracil and methionine and the other tryptophan for their growth. The diploid cell formed has three unpaired lethals if it is grown in the absence of uracil, methionine and tryptophan and possibly it might be analogous to the type of cells we have previously isolated which were pre-irradiated diploid cells with three unpaired defects. To settle this point the x-ray survival curve of the biochemical deficient diploid was obtained both on complete medium and on medium deficient in the three substances mentioned. The two survival curves do not differ significantly and they both resemble survival curves of normal diploids. The interpretation of this experiment may be one of the following:

- (a) The unpaired defects produced by preirradiation of diploid cells do not correspond to the same type of biochemical gene mutations as those of biochemical genetics.
- (b) The experiment should be repeated with other biochemical mutants before making this conclusion. In the course of the experiment it was realized



that the uracil requiring mutant is not a good specimen for our purposes because in the presence of uracil certain aspects of cell metabolism are inhibited in normal yeast cells.

The work is being extended to other biochemical mutants.

Initial tests are being carried out with a chemostat constructed for studying the steady state growth in yeast colonies. This instrument will be used for study of the growth rate and nutritional requirements of preirradiated yeast cells.

Cytological study of some aspects of the radiation effects on yeast cells was completed. An attempt was made to explain the curious observation that many yeast cells, after irradiation, appear to make one division and then they are inhibited in what is known as the two cell stage. The nuclei of the cells were stained by Delamater's technique. It was found that after a severe dose of radiation a large percentage of the cells which stopped dividing in the two cell stage showed abnormal division of their nuclei. A bud is formed on the mother cell which attains the normal size of a full grown cell. However, in a large fraction of cases the nuclei of the mother cell fails to divide and go into the daughter cell. The cytoplasmic union between mother and daughter cells never breaks. Thus it appears that inhibition of cell in the division in the two cell stage corresponds in most cases to inhibition of nuclear division in the one nucleus stage.

Instrumentation. Work is in progress to increase the sensitivity of the gamma ray pin hole camera.

The Biological Effects of Radiation with the 184-inch Cyclotron. Preliminary studies are being carried out on irradiation of the volume occupied by the hypothalamus of young Long-Evans rats. The experiments are done in collaboration with the Institute of Experimental Biology. The high energy deuteron beam is directed through a shaped aperture so that the pituitary gland does not receive appreciable amounts of radiation. At present a small scale experiment is being carried out to obtain preliminary information only. The lack of damage to the pituitary is verified by histological observations. Two months after irradiation none of the animals have shown any gross effects due to this treatment. Four months after irradiation each of the 5,000 rep irradiated animals developed abnormal obesity, weighing as much as 100 grams above the control group. This same result is known to occur after injury to the hypothalamus.

Biological Use of the Six Times Ionized Carbon Beam. Work is being continued chiefly at the level of instrumentation, while attempts are being made to increase the deflected beam intensity and obtain constant performance.

Studies with Iron 59 Attached to Globulin IV-7. Forty-seven patients have had intravenous injections of iron 59 attached to Globulin IV-7 in sufficient doses so that the concentration in plasma of the iron 59 could be studied for many days. The data was plotted on semilogarithmic paper and analyzed graphically as a function of time. The data of the normal subjects (six) and that of some of the patients was a polynomial of three exponential. The values of the individual exponential terms from the normal subjects were quite different from those of the patients. Some of the patients had data which could only be analyzed into a polynomial of

four or five exponential terms and in six of the cases there was a small amount of radioactivity constantly present in the plasma.

Studies with C<sup>14</sup> Labeled Stilbamidine. Studies are being continued on the patient with multiple myeloma who was given a tracer dose of C<sup>14</sup> labeled stilbamidine. Very small amounts of radioactivity are being excreted by urine and feces. Most of the administered activity is still in his body, presumably in the liver.

The Metabolism of C<sup>14</sup> Labeled Nor-valine. Studies of the patterns of excretion of C<sup>14</sup> labeled nor-valine in rats have been undertaken.

In four rats placed in a metabolic cage in 24 hours approximately 40 percent of the injected C<sup>14</sup> was excreted as C<sup>14</sup>O<sub>2</sub> by the lungs with smaller quantities excreted via the urine and feces.

Analysis of the tissues at intervals of 1,2,4,6 and 8 weeks, and at 3,4, 5 and 6 months after administration show that on the average the tissue decrease in C<sup>14</sup> level may be described in terms of 2 rate components having average half-time of 6 and 70 days, and representing the elimination from the body of approximately 15 and 25 percent of the C<sup>14</sup> respectively. This is very similar to what has been observed in animals and man with glycine.

Further samples at intervals greater than 6 months will be studied.

11. Health Chemistry  
(AEC Program No. 5311)

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Equipment Development Group. Work in progress is listed below:

1. Work on the new isolated water circulation system for cooling 60-inch cyclotron targets containing large quantities of alpha emitters, included rebuilding the pump system to improve its operation.
2. Equipment for processing Hanford-pile-bombarded animal ash for a January experiment has been completed.
3. A shielded Berkeley Box and auxiliary equipment for processing Hanford-pile-bombarded americium has been set up for receipt of the sample in January.
4. Equipment for metal production from heavy elements is being further tested and improved.
5. A plutonium sample which had undergone a year's bombardment in the Chalk River pile has been received and is being processed in the standard 2-inch lead boxes with remote control equipment.
6. Improved models of a safer target holder for bombarding plutonium in the internal beam of the 184-inch cyclotron have been made and tested for final selection.

7. Formal drawings completed of Health Chemistry equipment include those of the "heavy duty" and the wooden dollies for lead and gloved boxes, the hot cone bath and air heater for use in the Berkeley Boxes.
8. The Berkeley Box group completed five boxes for special chemistry runs, plus the usual reworking and reassembling of centrifuges and other allied equipment.
9. An additional source of ten 1-curie pieces of Co<sup>60</sup> were received from Oak Ridge. They have been assembled in the special "Bombardment" container built by Health Chemistry; in this last shipment some of the sources, which are approximately 1/8 inch diameter pellets, had spilled out of their open aluminum tube into the outer container during shipment from Oak Ridge, necessitating their removal by means of a special electromagnet built by the Equipment Development Group.
10. Ten special radioactive sources were prepared during this period at the request of individuals in various departments in the University; each source was prepared specially to meet the required activity and energy of the emitted material.
11. Studies are continuing on special processes for solidification and purification of liquid wastes for the sea disposal system.
12. Studies on newly developed samples of commercial laboratory surfaces with regard to their corrosion resistance and other properties were made. Their suitability for future use was catalogued.

## 12. Plant and Equipment

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Bevatron Instrument. (Program No. 1500. 5-424-9001) Winding is proceeding in Quadrant IV. Some delays have been experienced in the procurement of magnet winding spacers. Tests are proceeding on the magnet excitation equipment.

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

M.T.A. - A-12. (Program No. 1500. 5-424-1004) Development and design continuing.

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

North Gate House. Work is 95 percent complete. Final inspection is scheduled for December 20, 1951.

Paving for 184-inch Cyclotron Site. This work was complete and accepted the third week in November.

Animal House. (Program No. 1600. 6-424-9007) Animal cages are being designed for fabrication in Laboratory shops. Animal food storage bins, and cabinets for the west corridor are under construction in the Laboratory cabinet shop.

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The animal house is expected to be furnished complete for occupancy the first of the year.

Radiological Laboratory at the U.C. Medical Center. (Program No. 1600.

6-424-9008) The installation of the 70 Mev synchrotron is complete except for touch-up painting. Tests of the instrument proper are proceeding satisfactorily and it is expected that it will be accepted about the 10th of January. The sound level in the accelerator room is somewhat less than in the testing bay in Schenectady. After acceptance of the synchrotron a tile floor will be laid in the accelerator room and some acoustical treatment applied to the walls.

MAN-MONTHS EFFORT REPORT

Scientific Personnel

| PROGRAM                       | SUBDIVISION                  | MAN-MONTHS<br>EFFORT | COMMENTS |
|-------------------------------|------------------------------|----------------------|----------|
| 9200 M.T.A. - Mark I          | Design and Development       | 7.90                 |          |
| 9200 M.T.A. - Mark II         | Design and Development       | 59.27                |          |
| 9500 Bevatron                 | Miscellaneous                | .10                  |          |
| <u>Operations</u>             |                              |                      |          |
| 3000 Weapons Research         | General                      | 1.04                 |          |
| 5211 Physics Research         |                              |                      |          |
| Experimental Physics          | Cloud Chamber                | 11.75                |          |
|                               | General Physics Research     | 40.317               |          |
|                               | Instrument for General Use   | 3.94                 |          |
|                               | Special Development          | 8.99                 |          |
|                               | Magnetic Measuring Equipment | 2.60                 |          |
|                               | Charge-Exchange Accelerator  | .45                  |          |
| Theoretical Physics           | General                      | 10.45                |          |
| Photographic Film Detectors   | General                      | 12.06                |          |
| Isotope Separation            | General                      | -                    |          |
| Radioactivity Physics         | General                      | 1.24                 |          |
| 5261 Applied Physics Research |                              |                      |          |
| Thomas Cyclotron              | Electron and X-C Models      | 21.31                |          |

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| PROGRAM                                                | SUBDIVISION                                  | MAN-MONTHS.<br>EFFORT | COMMENTS |
|--------------------------------------------------------|----------------------------------------------|-----------------------|----------|
| <u>Operations (continued)</u>                          |                                              |                       |          |
| Chemistry Research                                     |                                              |                       |          |
| 5311 Basic Chemistry Research,<br>Part A               | Chemistry of Heavy Elements                  | 2.55                  |          |
|                                                        | Nuclear Properties of Heavy Element Isotopes | 9.06                  |          |
|                                                        | Transmutations with 184" and 60" Cyclotrons  | 5.76                  |          |
|                                                        | Analytical and Services                      | 18.00                 |          |
|                                                        | Special Chemistry Development                | 1.00                  |          |
|                                                        | Mass Spectroscopy, Beta Ray Spectroscopy     | 1.00                  |          |
|                                                        | Instrument Development and Services          | 4.88                  |          |
|                                                        | X-Ray Crystallographic Measurements          | 2.79                  |          |
|                                                        | Health Chemistry Research                    | 9.67                  |          |
| Basic Chemistry Research,<br>Part B                    | Metals and High Temperature Thermodynamics   | 4.0                   |          |
|                                                        | Basic Chemistry, including Metal Chelates    | 3.5                   |          |
| 5361 Applied Chemistry Research                        | Process Chemistry                            | 10.23                 |          |
| <u>Reactor and Accelerator Operation</u>               |                                              |                       |          |
| 5731 Synchrotron                                       | Operation                                    | 9.29                  |          |
| 5741 184-inch Cyclotron                                | Operation                                    | 9.52                  |          |
| 5751 Linear Accelerator and<br>Van de Graaff Generator | Operation                                    | 11.65                 |          |

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| PROGRAM                             | SUBDIVISION                                                                   | MAN-MONTHS<br>EFFORT | COMMENTS       |
|-------------------------------------|-------------------------------------------------------------------------------|----------------------|----------------|
| 6000 Biology and Medicine<br>Part A | Metabolic Properties of Various Materials                                     | 9.0                  |                |
|                                     | Radiochemistry and Radiation Chemistry                                        | 5.0                  |                |
|                                     | Radioautography                                                               | 2.0                  |                |
| 6000 Biology and Medicine<br>Part B | Instrumentation for Quantitative<br>Measurements of Radiation                 | 2.03                 | .90 Consultant |
|                                     | <sup>14</sup> C Metabolism                                                    | 2.58                 | .75 Man-Months |
|                                     | Use of Radioactive Materials in Human<br>Physiology and Experimental Medicine | 9.34                 | 5.38           |
|                                     | Trace Elements and Irradiation Studies                                        | 3.35                 | 2.40           |
|                                     | Radiation and Mutation Rate                                                   | 1.37                 | .25            |
|                                     | Physical Biochemistry                                                         | 11.65                | 3.33           |
|                                     | Biochemical Response to Irradiation                                           | 2.98                 | .50            |
|                                     | Machine Shop Expense                                                          | .91                  | -              |
|                                     | Miscellaneous                                                                 | -                    | .80            |
|                                     | Donner Animal Colony Expense                                                  | 1.98                 | 1.91           |
|                                     | Metabolism of Lipo Protein and Lipids                                         | 5.37                 | 10.82          |
|                                     | Iron Metabolism Hematopoiesis                                                 | 2.84                 | .50            |
|                                     | Internal Irradiation and Hematological<br>Response                            | 1.99                 | -              |
|                                     | Biological Effects of Cosmic Radiation                                        | 2.50                 | .25            |
|                                     | Health Medicine                                                               | 3.90                 | -              |
| 6400 Biological Research            | Synthetic and Experimental Organic<br>Chemistry                               | 5.5                  |                |
|                                     | Biological Chemistry                                                          | 6.33                 |                |
|                                     | Photosynthesis Chemistry                                                      | 5.15                 |                |
|                                     | Metabolism of Fission Products                                                | 11.28                |                |
| 6500 Biophysics Research            | General                                                                       | .95                  |                |

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