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RADIATION LABORATORY

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UNIVERSITY OF CALIFORNIA

Radiation Laboratory

Contract No. W-7405-eng-48

MONTHLY PROGRESS REPORT
No. 94

January 15 to February 15, 1951

March 6, 1951

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

January 15 to February 15, 1951

MONTHLY PROGRESS REPORT No. 94

March 6, 1951

1. Bevatron (AEC Program No. 1500)

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During the period the magnet core steel erection was completed as far as necessary for coil winding. The coil end winding supports were all erected and material for coil winding is on hand. Some changes in tooling indicated by practice winding are in progress. The start of winding is waiting on completion of these tools and the availability of electricians.

Work continued on the vacuum tank test section. Individual gaskets are tight and assembly of the complete section is proceeding.

Wiring continued in the generator room and cables from the generator room to the magnet are being pulled in.

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

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The cyclotron was used for research experiments approximately 97.5 percent of the 485 hours that the crew was on duty.

The time distribution was as follows:

Operation for customers	472.75 hours	97.5 %
Filament change	3.00	0.6
Electrical troubles	3.75	0.8
Others	5.50	1.1
	485.0	100.0

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

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A productive operational efficiency of 85 percent was achieved this month. A consistent alpha beam of greater than 10 μa was available upon demand.

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4. Synchrotron Operation (AEC Program No. 5731)

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A high intensity and reliable beam was available during this report period. Physics experiments utilized nearly all of the scheduled running time on the synchrotron. Some time was devoted to making preliminary tests of a dispenser cathode type injector. We were unable to produce a beam during these tests -- the reason is not as yet known. Further investigation and tests are planned.

The time distribution was as follows:

Operation for customers	369.0 hours	91.4 %
Tests with Synchrotron	16.0	4.0
Maintenance and installation	18.5	4.6
	403.5	100.0

5. Linear Accelerator and Van de Graaff Operation (AEC Program No. 5751)

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The linear accelerator is not yet ready for routine experiments as service tests are still being run. A beam of 3×10^{-8} amps was obtained through the 20° port. Preparations are being made to install a test buncher. Good operation has been obtained with the Van de Graaff and the reliability of the linear accelerator has increased with bake-in time.

6. Experimental Physics (AEC Program No. 5211)

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Film Program. Meson Masses. The remeasurement of the π meson masses with close attention to the reduction of systematic errors has been completed, and a communication on this subject has been sent to the Physical Review. Both π^+ and π^- masses were found to be 277 e.m. with probable errors of about 1.5 e.m. The experiment was also intended to yield the $\mu+$ mass, but contamination by μ mesons from decay in flight interfered with obtaining a precise result. A new experiment on the $\mu+$ meson mass has been started.

Meson Scattering. A study similar to the one previously made with negative mesons is now in progress in which the free path in emulsion for various nuclear processes induced by 40 Mev π^+ mesons is measured.

Another scattering experiment has been performed and the nuclear emulsion plates are now being scanned. In this experiment we attempt to measure the scattering cross-section of protons for 40 Mev π^- mesons. The elastic and inelastic scattering of carbon is being determined incidental to this experiment.

Cloud Chamber. A new continuously sensitive cloud chamber has been completed of the proper dimensions to be installed in the large iron-cored cloud chamber magnet.

The rectangular chamber for use at the synchrotron has been tested with the counter control circuits. It will be used there. Successful photographs have been taken of cosmic ray particles. The tracks in hydrogen were very narrow showing the exceptionally high speed of the new pop valve.

Successful pictures have been made of alpha particles in a very small chamber operating at a pressure of only 21 mm of water vapor. The details of the design of the windows on the high-pressure cloud chamber have been completed.

High Energy Proton Interactions with Nuclei. Energy spectra of 340 Mev protons scattered from H, C, Al, Cu, and Pb, have been obtained at scattering angles of 8-1/2°, 10-1/2°, 13°, and 17°. At angles within the first two maxima of the diffraction patterns for Al, Cu, and Pb, the spectra are peaked near the full beam energy; they are peaked at energies higher than the energies corresponding to the proton energy spectra peaks from hydrogen. At the minima of the diffraction patterns, and at large scattering angles, the peaks of the spectra from Al, Cu, and Pb, correspond in energy to those from H, indicating a preponderance of nucleon-nucleon collisions. The widths of the spectra increase monotonically with scattering angle.

Cerenkov Radiation. The energy measurements with Cerenkov radiation have reached the publication stage. Bethe and Segrè have pointed out the desirability of a new range energy experiment similar to that of Mather and Segrè (UCRL-1089) with lower velocity particles. This is being investigated. Preparation is being made for a contemplated recalculation of the range energy curves which will combine the recent work in this field.

Some efforts are being spent on the development of a particle counter using Cerenkov radiation but no conclusive results have been obtained to date.

Neutral Meson Program. The high energy photon telescopes for the coincident counting of photons from neutral mesons have been completed with their associated electronics and the taking of data has begun. These experiments will serve to determine the energy-angular-distribution of the neutral mesons produced by proton bombardment.

Meson Production. The experiment to measure the scattering cross section of π^+ mesons by carbon at 90° gives a differential scattering cross section of $(2.2 \pm 1.0)\ 10^{-26} cm^2$/steradian, on the basis of the work thus far. The method proposed by H. A. Wilcox for the detection of particles in flight by means of pulse height is now being used to count negative mesons. The experiment on the production of π^+ mesons by p-p interaction provided a method of measuring the π^+ meson mass. This mass has been determined to be (275.1 ± 2.5) electron masses.

Effect of Chemical Binding on Stopping Power. A preliminary run using 345 Mev protons from the 184-inch cyclotron has been made. An accuracy for measuring relative stopping powers of about 0.1 percent appears possible.

Proton-proton Scattering at 120 to 345 Mev. UCRL report No. 1109 on this subject is still undergoing some modifications in an attempt to bring out clear and consistent comparisons with the theoretical work.

A possible modification of the electronic apparatus is under study, with a view toward better determination of the single counting rates. This information is desirable in connection with the proposed attempt to measure the p-p scattering at small angles from the beam at reduced beam energy.

Deuteron-proton Scattering Using 190 Mev Deuterons. The inelastic d-p scattering appears to occur predominantly with the angle between the two outgoing protons within 2 degrees of 87 degrees. This is in contrast to what was expected, which was a spread of at least 10 degrees. Analysis of the energy and momentum conditions indicates, however, that this result should not be unexpected in this particular case of incident deuterons on a proton target.

π Meson Production in Helium by the 322 Mev Synchrotron Beam. The energy distribution of π^+ mesons from the 322 Mev bremsstrahlung beam has been determined using electronic methods, at 45°, 90°, and 135° to the beam. Emulsions have been exposed at the same time, which should allow determination of the π^- production. Some corrections are being evaluated and the emulsion data are being read from the plates.

Synchrotron Studies. The main run of this month was the run on H_2, D_2, and He. This was actually a completion of a run started before in which the number of π^+ mesons at 90° and 135° to the beam as a function of the meson energy was determined. The counter technique employing the delay of the π-μ decay was used. The results are being calculated, and should be important providing checks on theoretical points.

The search for the production of pairs of μ mesons by gamma rays has been abandoned. A run showed it was at most only 2-4 percent as probable as π^+ production. Calculations of the maximum possible cross section for the process still compatible with the failure to observe any are being carried out.

The reaction $Mo^{92}(\gamma,n)Mo^{91}$ has been used to determine a shower curve for the gamma rays responsible according to the technique developed by Strauch. Several other elements will be tried.

The pair spectrometer is in operation. A measurement of the absorption coefficient of Cu for 200 Mev γ-rays gave very satisfactory agreement with theory.

Several runs have been made detecting the charged particles ejected from carbon by the γ-rays and measuring their time of flight so as to identify their velocity. The particles are formed and bent in a magnetic field. The combination of velocity and $H\rho$ serves to identify the mass.

7. Theoretical Physics
(AEC Program No. 5211)

SECRET

MTA. Machines to integrate coupled equations have been made available in two places. The first is the analogue computer designed and built by Professor Nordsieck at the University of Illinois. It is a small machine with limited capacity and not too high accuracy. But it can be used for exploratory work on the coupled longitudinal and radial equations. It has been used for one machine design to study injection conditions with large initial aperture. It is being made available to the Laboratory for further work.

The REAC at the RAND Corporation was also made available. It has a greater capacity and somewhat greater accuracy. Solutions of the coupled equations on this machine showed that for the machine studied -- which had an initial inside drift radius of 0.325 feet -- it was possible to catch a range of about 90° in initial phase angle for almost the whole area of the drift tube. This amount can probably be improved considerably by using different magnetic fields than the set used in making these calculations.

Further study to improve the phase range trapped by varying the magnetic field will be done using the Illinois machine. The Illinois machine is being used since it can be brought here whereas the RAND machine cannot and the RAND machine is usually tied up with other work. Since it is now planned to reduce the strength of the accelerating field the problem of injection with a large aperture will be simplified.

Other Studies. The partial wave and energy spectrum analysis of π^+ meson production in p-p collisions has been continued, making use of the new experimental results at 60° with respect to the beam direction.

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The analysis of the transmission of fast neutron through nuclei has been completed.

Further work on range-energy relations is being done.

A study of the implications as to nuclear structure from the absorption and scattering of mesons has been initiated.

8. MTA Program
(AEC Program No. 1500)

SECRET

Drift Tube Positioning. The design of the mechanism for adjusting and observing the drift tube position in Mark I has been completed. Drift tube positioning is required because of the strong magnetic forces between adjacent drift tubes. The adjusting mechanism is to be located on the drift tube support stem and will be used to restore the drift tubes to their proper operating positions after the magnetic forces develop between adjacent drift tubes when the focusing magnets are turned on.

Analyses indicate that the use of telescopes to view the drift tubes directly is the least expensive method of determining drift tube position. It has now been decided that the position of the number zero drift tube must also be determined. Since this drift tube is thin it will probably be necessary to sight across its face rather than upon scribe marks as is planned for the remaining drift tubes.

B-1 Test Cavity. Shielding is being added to the B-1 test cavity. The shielding has now been built up to cover about two-thirds of the cavity. An examination of the sphere inside the B-1 cavity failed to show any obvious rough or contaminated areas corresponding to the approximately 30 local sources of x-ray which were detected by the x-ray photographs taken recently. The sphere will be polished with fine grade carborundum to remove a thin surface layer in an attempt to eliminate the condition responsible for the x-ray production. Arrangements will also be made to run a glow discharge in an attempt to clean up the tank.

A decision has been reached to provide heating for the sphere in the B-1 cavity in order to permit more detailed investigation of the x-ray production. The installation of the heating element may delay the oscillator test program approximately one month.

B-4 Cavity. A new x-ray cavity known as B-4 is to be constructed in Building 51. Its purpose will be to permit a determination of x-ray production as a function of such variables as drift tube material, surface contamination, drift tube temperature, geometry, and voltage gradient. The basic design involves a tank with octagonal end faces about 54 inches in diameter and between four and five feet in length. It will be designed specifically for an oil free vacuum.

1/10th Scale Model. The integration of the magnetic field required for the calculation of Q of the tenth-scale model has been more accurately performed and has lead to an improved agreement between Q measurements made on the model with and without drift tubes. Part of the remaining discrepancy of about 8 percent may be result of an error in the assumed value for the rf conductivity of copper. To check this point, a measurement of the copper conductivity will be made.

Surface Conductivity Tests. It has been found that the thickness of copper cladding on iron requires for minimum rf losses approximately 1 to 2 skin depths, or about 0.7 mils at 12 megacycles. In fact, there is a 10 percent improvement in conductivity over pure copper at a thickness of about 1-1/2 skin depths. The ability to utilize copper thicknesses of a few mils which can be achieved by plating techniques would eliminate the necessity for using copper clad steel and result in a large reduction in the cost of the cavity.

Radio Interference from Mark I. Thought is being given to the possibility of radio interference arising from the operation of Mark I. The frequency of Mark I on the basis of the most recent model tests will be 12.26 ± 0.023 megacycles. This falls in the band of frequencies assigned to fixed services. Transmitters operating in this band are located at Hong Kong, Shanghai, Pakistan, the Philippines, Alaska, and the United States. One serious source of radiation will probably be at by-pass condensers on the drift tube support stems so that these will require special shielding. Other points from which rf radiation is likely to be significant are at the power lines but it should be possible to reduce this to an acceptable level with proper filters.

Aperture Calculations. Calculations have been completed on the beam dynamics of Mark I utilizing an entrance aperture of 9.8 inches. The results show a reduction in the phase acceptance angle to about 20 to 30 degrees, which is unsatisfactory. Calculations of apertures of intermediate size are still in progress. These results favor the use of 12 megacyle frequency for Mark II, rather than 20 megacycles.

Beam Precession. The porosity of ceramic materials suitable for the fabrication of the insulated portion of the target cone within the beam precessor has proved to be excessive, and consideration is being given to two alternative designs. One of these would make use of a plastic cylinder outside of a ceramic one with provisions for evacuating the annular space between the cylinders. The other design would utilize a glass cylinder. Negotiations are underway with the Corning Glass Company with regard to fabrication of a glass section.

In connection with the precessing of the ion beam from the accelerator, consideration is being given to the use of Lissajous patterns. The presently contemplated circular sweeping reduces the ratio of peak to average intensity from its original value of about 50 to 1 down to about 5 to 1. Recent target studies indicate that the most favorable geometry are those which would require the beam to be swept over a square or rectangular area. Lissajous figures employing frequency ratios of 3/2 to 7/6 are being studied.

Mark I Vacuum Problems. A review of the vacuum system of Mark I has been undertaken to eliminate sources of organic vapors insofar as possible. Four changes

that have been suggested involve redesign of the pump gate valve to eliminate entrance of any lubricants to the vacuum, the use of special surface coating or the use of bare surfaces, the conversion of the liquid air trap to baffles of 100 percent geometry, and the control of the temperature of the tank wall. In place of the glyptal painting of the vacuum surfaces, it has been suggested that the iron be sandblasted and cleaned and left bare. Rusting would be prevented by de-humidifying the air with which the vacuum is broken. Another alternative is the use of metallic coating on the iron. Some experimentation has been done with the spray coating of iron with tin, the after-treatment comprising a vigorous rubbing of the sprayed surface with a metal bar to minimize porosity. Such samples show no evidence of rusting after allowing them to remain in water until the water has evaporated. Pending the outcome of numerous tests of coating materials and techniques the Mark I tank will be left bare. Cost estimates are now being made for the installation of a de-humidifier to supply air at 50 percent humidity at a rate sufficient to let down the tank to air in four hours. The tank will be left uncoated until the first pump down, by which time a determination will be made as to whether the coating of the tank will be necessary.

Mark I Construction. The first drift tube magnet is being assembled at the West Berkeley warehouse. All of the coils are in place on the magnet and the end plates secured. The magnet will be ready for electrical testing shortly. Fabrication of the copper drift tube shells is nearing completion and the application of the cooling tubes and resistance heaters is the next step.

All the steel is now in place for the accelerator building at Livermore with the exception of the west end. Most of the forms are ready for the decking on the 17 foot level at the north side and the east part will be poured shortly. Work is also being done on the deck at the 34 foot level on the north side. Twenty of the Chapman valves have been set in place on the vessel and five or six of the diffusion pumps have been mounted. The setting of the Kinney pump has begun and manifolding for these units is being installed. All of the steel plates on the vacuum tank are now in place and about 85 percent of them have been welded.

Most of the copper plate and tubing has been received and work is now proceeding to straighten the tubing prior to soldering it to the liner sections. It is expected that the installation of liner panels in the vacuum vessel can begin about April 1. It is expected that the deuteron drift tube will be ready on June 1.

Mark II Design. Further study has been given to the selection of the voltage gradient to be used in the Mark II accelerator. Since it appears that Mark I may have more than one megawatt dissipated in electron loading, it seems advisable to reduce the Mark II voltage gradient to one-half that used on Mark I. This will make the Mark II machine 1500 feet long. There is considerable confidence in the fact that the electron loading problem can be solved in view of the fact that in the B-1 cavity the x-ray production occurs primarily at discrete spots, thereby indicating that the surface in general is in satisfactory condition. It would seem advisable, however, to base the Mark II design on the

1500 foot tank. By doing so, the power loss would be reduced from 31 to 15 megawatts. The increase in length of the tank does not necessarily adversely affect the economics of Mark II because the saving in power equipment will allow the increased cost of a longer tank to be liquidated in a reasonable length of time. Because of the problems of mode separation, the extension of the tank to 1500 feet would definitely eliminate the possibility of operation at 20 megacycles.

Mark II Target. Investigations have been made on a target employing a graphite lattice with uranium slugs. In order to achieve a rather uniform distribution of power level, the lattice assumes the configuration of an igloo, in the center of which is placed the primary-secondary target array. The maximum value of thermal flux being considered is 3×10^{13}. A 50 percent increase in flux over the Hanford maximum is made possible by the use of the depleted material. With the use of a pulsed beam the primary-secondary target array would be approximately 9 feet square and the interior volume of the igloo would have a square cross section of about 25 feet in each dimension. The lattice thickness would be approximately 5 feet followed by a 2 foot thickness of reflector. In order to equalize cooling requirements throughout the lattice and to maximize the total production obtainable, it is necessary to equalize the thermal neutron flux insofar as possible. The thermal flux at the face of the lattice will be about 15 times higher than the incident fast flux. The fast flux incident on the lattice may have such a distribution as to render desirable a lattice of other than rectangular cross sections. Calculations have shown that with a lattice 5 feet thick one should obtain about 2-1/2 to 3 moles of plutonium per mole of incident fast neutrons. The total production would be that of about 3 Hanford piles which would make it necessary to design for about 60,000 gallons of cooling water per minute.

Electron Accelerating Cyclotron. Experimental work on the 15 inch radius electron accelerating model of the Thomas type cyclotron is progressing. The energy of the x-ray beam has been determined and indicates that the electron energy is 60 kv. Electrons of this energy have the same velocity as do deuterons of 250 Mev. It has been found that beyond a radius of 15 inches the beam is dependent upon the dee voltage. In the region from 12 to 15 inches the beam current and its variation with radius are rather well known.

The disparity between the theoretical and actual magnetic field shape is known to contribute to the requirement of high dee voltage. Until now it has not been possible to measure the magnetic field more accurately than $\pm$ 2 percent. However, a method has been developed which should allow it to be determined within 0.1 percent. It is planned to add more trimming coils to the magnetic pole faces to enable the field to be adjusted more accurately. Some work has been done on the matter of beam removal.

XC Cyclotron Tests. Attempts to improve the voltage which can be held in the XC cyclotron in the presence of a strong magnetic field are continuing. It has been found that the installation of graphite surfaces has made it possible to maintain electrode voltages of one million volts both with and without

the magnetic field. Since graphite has a poor electrical conductivity it is hoped to avoid its use as a lining material for the full scale Mark III machine. It is planned to investigate the utility of graphite copper mixtures fabricated by powder metallurgy.

9. Chemistry

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Part A
(AEC Program No. 5311)

Crystal Structure of Sodium Superoxide. X-ray diffraction patterns at low temperatures have shown that sodium superoxide exists in at least three crystal forms. At room temperature it is a sodium chloride structure, a = 5.49, with the superoxide groups oriented in a disorderly fashion. It has now been found that at -25°C it changes to the pyrite structure, a = 5.45, which is the same except with a certain order to the directions of the superoxide groups. At -75°C it changes to a third form, whose structure is not yet worked out.

Vapor Pressure Measurements. Measurements are being made of the vapor pressures of neptunium metal and of plutonium trifluoride by the effusion method, but final results are not yet at hand.

Magnetic Susceptibility of Curium Fluoride. Measurements of the magnetic susceptibility of curium fluoride had yielded a value for $\chi_M = 23{,}000 \times 10^{-6}$ c.g.s. units, which is lower than that of GdF_3. The measurements were in doubt because of uncertainty in the temperature (caused by the intense radioactivity) and because of possible effects of Heisenberg exchange interaction. Samples in which the curium was diluted ten fold with lanthanum to minimize such effects yielded the result $\chi_M = (26{,}500 \pm 700) \times 10^{-6}$ c.g.s. units at room temperature, in excellent agreement with the value for gadolinium trifluoride, thus indicating that the 5f and 4f electrons have the same configurations in these cases respectively.

Ranges of Fission Recoil Fragments. The experiments on the ranges in aluminum of fission recoil fragments are being continued. Fission induced by full energy protons in the 184-inch cyclotron results in recoil ranges the same within experimental error as those from low-energy fission. Thus the kinetic energy of the recoil fragments is mainly due to the coulomb potential effect and is nearly independent of the excitation of the nucleus.

Alpha Spectrograph. Preliminary tests on the use of the new mass-spectrograph magnet as an alpha particle spectrograph are very encouraging. The energy spectrum is observed by counting individual alpha tracks in a nuclear emulsion placed in the focal plane. The fine structure of the Cm^{242} spectrum, which is evidenced in the pulse analyzer only as an increase in peak width, has been resolved.

High Energy Fission of Uranium. An extensive study of the independent yields of individual nuclides and of the total chain yields among the products of fission of uranium by high energy protons is being pursued actively.

Chemistry SECRET

Part B
(AEC Program No. 5311)

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

1. Heat transfer in forced convection film boiling.
2. Liquid metal systems.
3. Gaseous hydroxides species of Mo and W.

Basic Chemistry, including Metal Chelates. The following problems are under investigation:

1. Germanium chemistry.
2. The polymerization of aqueous zirconium.
3. Thermodynamics of rhenium.
4. Electron exchange rate between Fe^{2+} and Fe^{3+}

Chemistry UNCLASSIFIED

Part C
(AEC Program No. 6400)

Synthetic and Experimental Chemistry. During the past month the synthesis of the following C^{14}-labeled compounds has been studied: Aspartic-γ-C^{14} acid, aspartic -β-C^{14} acid, norvaline-3-C^{14} (55 percent yield, 18 μc/mg.), norleucine-3-C^{14}, leucine-3-C^{14}, valine-4,4'-C^{14}, stilbamidine-amidine-C_2^{14}, and a series of C^{14} -labeled halides and alcohols.

Stilbamidine-amidine-C_2^{14} was prepared in a high specific activity run in yields of 30 percent from cuprous cyanide. Purification of the high specific activity preparation of vinyl acetic-1-C^{14} acid by use of silica gel chromatography columns is being attempted. Study of isotope effect in the decomposition of oxalic acid in concentrated sulfuric acid has been completed. The data are essentially consistent with those of previous experimenters (Thode and co-workers). In addition, the temperature effect has also been determined.

Studies on the isotope effects in the decomposition of malonic acid are continuing. Free naphthalenemalonic acid has been isolated and characterized and naphthylmethylmalonic ester has been prepared. Synthesis of dipeptides and tripeptides for studies in fundamental radiation chemistry has continued.

Biological Chemistry. With the completion of the high specific activity preparation of stilbamidine-amidine-C_2^{14} the biological work with this compound has been reactivated and experiments in both mice and human beings are in progress.

Metabolism studies of labeled purines in normal and neoplastic mice have continued with the injection, under varying conditions, of labeled adenine and guanine in both C57 and "A" strain mice. Separation of labeled fatty acids from eggs of a hen fed sodium acetate -1-C^{14} has continued and the glycerol isolated as the tribenzoate.

Paper chromatography of steroids has been studied on Quilon-impregnated paper. Color tests for and paper chromatography of the following steroids have been determined: Cholesterol, cholestenone; male hormones - dehydroepiandrosterone, dehydroepiandrosterone acetate, testosterone, testosterone proprionate and androsterone; female hormones - progesterone, estradiol, estradiol dipropionate.

The attempted identification of the unknown acid from propionate incubation with liver slices has continued. The benzoyl and acetyl derivatives of the unknown material have been prepared and the chromatography has been checked with similar derivatives from α-hydroxybutyric acid and it has been shown that the unknown is not this acid. It is now believed that this unknown may be β-hydroxyvaleric acid and this assumption is being checked.

Photosynthesis Chemistry. The sequence of intermediates of CO_2 reduction in photosynthesis is being reexamined with improved techniques. The relationships of two unidentified intermediates in particular are being determined. Curves for accumulation of C^{14} in the several phosphorylated intermediates of sucrose synthesis have been prepared. Of especial interest is that for phosphoglyceric acid which is found to have an inflection corresponding to rapid carboxylation followed by a delay before the rapid accumulation of two-thirds of the final activity value.

Photosynthetic products formed in both red and blue light are being examined to determine the possibility of independent action of the carotenoid pigments and chlorophyll.

The ratios of C^{14} to P^{32} in several doubly-labeled experiments have been determined. The phosphoglyceric acid reservoir was found more nearly equilibrated with C^{14} than those of other phosphated esters.

Degradation of three unidentified compounds has been performed for the purpose of structure determination.

Photosynthetic experiments have been performed with soy bean leaves and the results were found in all ways similar to those for algae, barley and sugar beet leaves.

10. Medical Physics

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Part A
(AEC Program No. 6000)

Tracer Studies. Studies are being continued on the metabolism of astatine, chromium, and radioactive lead in rats.

Chelating Experiments. The administration of CaEDTA has been found to influence the excretion of Pb in rats. Five days after a dose of Pb_2O_3 was injected intravenously into rats, the urinary excretion of the Pb was found to be 28.3 percent of the original dose. CaEDTA was administered to another group of rats under similar conditions in doses of 50 mg per day for 3 days. The urinary excretion at the end of 5 days was found to be 46.9 percent of the original dose.

Radiochemistry. Carrier-free procedures have been developed for the isolation of, (1) $Rh^{101,102}$ produced by (d,xn) reaction on ruthenium, (2) $Ir^{190,192}$ produced by (d,xn) reaction on osmium, and (3) F^{18} produced by the reaction $O^{16}(\alpha,pn)$. A method for isolating carrier-free radio-tantalum from deuteron bombarded hafnium is being developed. Previously reported procedures were used in the preparation of carrier-free Cr^{51}, At^{211}, $Mo^{93,99}$, $Re^{182,184}$ and A^{37}.

Radioautographic Studies. Double radioautographs have been made of astatine and iodine in the same thyroid tissue on NTA stripping film. Sections of animals to which had been administered 800 μc of iodine with 14 month recovery period, revealed no recognizable thyroid tissue.

Medical Physics

UNCLASSIFIED

Part B
(AEC Program No. 6000)

Biological Effects Due to High Energy Carbon Ions - $C^{(6+)}$. The partial survival curve of haploid yeast cells was obtained using six times ionized carbon ions from the 60-inch cyclotron with a specific ionization of about three times as high as that for low energy alpha particles. The shape of the survival curve appears to be exponential and the dose required for inhibition of cell division is about the same as that for low energy alpha particles. This result is preliminary, and therefore is in need of check. This work is stimulated by the Air Force interest in the possible biological effects of cosmic radiation at high altitude.

Mechanism of Radiation Effects on Unicellular Organisms. The work was continued.

Radiation Effects on Mammals (184-inch Cyclotron). Further data were secured on radiation hypophysectomy.

Induced Activity Trace Analysis. Accumulation of data on the distribution of trace elements in human blood and mouse tissues is being continued.

Double Nucleated Lymphocyte Problem. Two month old Strain A mice were given total body irradiation with 180 Mev deuterons in doses of 50 rep. The animals were irradiated unanesthetized in the direct beam of the 184-inch cyclotron. Blood samples were obtained from the tail, and blood counts made at one-half hour, one and one-half hours, four hours, twenty-four hours and seven days after irradiation. The blood samples were oxalated and centrifuged; smears

of the buffy coat were examined and counts made of double nucleated lymphocytes per thousand lymphocytes, showed an increase over the controls one-half and one and one half hours post irradiation. Subsequently at twenty-four hours and seven days they fell below the controls. Two irradiated animals were used at each time point, and six control animals were counted. Since the number of animals is small, the significance of the results is not clear-cut and will have to await multiple repetition of the experiment; however, it is of interest that these results do parallel previous experiments with total body deuteron and proton irradiation reported in the Monthly Progress Report of May 15 - June 15, 1950.

Beryllium Poisoning. Autopsy slides in the case of chronic beryllium poisoning studied here were sent to Doctor Howland at Rochester, New York, for his opinions regarding the pathology. He has since reported to us that he and Doctor Scott are in agreement that tuberculosis had so obscured the pathological picture in the lung as to make a definite diagnosis other than tuberculosis very difficult; however, they feel that the pathology in the lymph node biopsy done in 1946, the x-ray picture, and the clinical course were so typical as to make the diagnosis of beryllium poisoning almost certain.

We have not as yet heard from Doctor Vorwald at the Saranac Laboratory, to whom we also sent pathology material for evaluation.

Observations with Radioactive Hydrogen (H^3) in Experimental Atherosclerosis. Radioactive hydrogen has been used to study certain aspects of cholesterol metabolism in the normal and hypercholesterolemic rabbit.

1. Tritium labeled cholesterol when fed to normal and hypercholesterolemic rabbits appears in the serum and eventually in all tissues examined. More of the tritium label can be accounted for in the tissue and serum cholesterol in the hypercholesterolemic rabbit than in the normal animal 7 days after a single tritium labeled cholesterol feeding.

2. Exogenous cholesterol forms the bulk of the cholesterol in the atheromatous deposits found in cholesterol fed rabbits.

3. Following a single tritium cholesterol feeding the specific activity of esterified cholesterol of the serum rises to a higher level, and reaches a maximum faster than the free cholesterol. Indications are that esterified cholesterol of the serum is turning over faster than free cholesterol in the time period following cholesterol ingestion.

4. The half-time of aortic cholesterol in 4 normal rabbits has been estimated to be between 11 and 23 days. The "half-time" of the cholesterol in an atheromatous aorta has been found to be greater than 43 days.

5. Cholesterol synthesis continues in the rabbit even in the face of massive, prolonged cholesterol feeding by mouth.

Nucleic Acid Metabolism. The observation of increased desoxypentose nucleic acid turnover of tissues of tumor-bearing animals has been followed now in five additional mouse tumors and in two other strains of mice. In all of these,

effects indicating a marked stimulus of the desoxypentose nucleic acid turnover of liver and kidney were observed. These had previously been reported for "A" mice and "Curtiss-Dunning" rats.

Current studies on nucleic acid metabolism are following the line of using C 14 labeled formate to measure nucleic acid formation rate. The yield of labeled nucleic acid is approximately the same per microcurie formate as per microcurie of P 32 in the usual phosphate labeling. A direct comparison will be made between formate and phosphate as to nucleic acid turnover.

Iron Metabolism. The effects of induced polycythemia by hypertransfusion upon the iron turnover concerned with erythropoiesis were studied. Six animals were given 2 ml of blood each day for 6 days. Total red cell counts and reticulocyte counts were taken before transfusions and at intervals of a day or two throughout the transfusion and iron study period. By the 6th day the transfused rats exhibited red cell counts 9 to 12 million. A capillary hematocrit demonstrated a 31 percent mean increase over the controls. The reticulocyte counts fell progressively in the transfused animals from 4 percent to 6 percent range (which remained in the normals) to 0.05 to 1 percent.

Both hypertransfused and normal control rats, all females, were injected with Fe 59 globulin complex intravenously. The hypertransfused animals exhibited a somewhat slower disappearance of tracer from plasma. Capillary samples of blood were taken at intervals. At the end of a week these animals exhibited, in all but one of the six used, less than 3 percent of the injected tracer in red cells. One rose to about 10 percent. The 6 normals in contrast had incorporated 60 percent to 90 percent in red cells by the end of 7 days.

The failure of tracer iron to become bound temporarily in the long lived compartment (i.e. red cells) in the artificially polycythemic animals was demonstrated also in the much larger fraction of injected dose present in the livers of these animals as compared with the normals.

Similar hypertransfusion experiments with various attempts to prevent the inhibition phenomenon are planned.

Metabolism of Carbon 14 Labeled Glycine. Post mortem studies of the second patient with leukemia who has received carbon 14 labeled glycine shows that approximately 25 percent of the radioactive carbon was present in the tissues at 65 days after administration. This makes almost complete accountability for the radioactive carbon possible, since approximately 70 percent was excreted in the breath and urine.

11. Health Chemistry
(AEC Program No. 5311)

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Research and Development Group Activities. Work in progress is listed below:

1. Six Berkeley boxes were completed and installed for chemists and biochemists.

2. A modified yttrium-processing box is under construction.
3. To assist the study of pile-irradiated animal tissues, processing of bombarded slugs is being reviewed and equipment is being constructed.
4. A hydrogenation unit is under construction.
5. Modified equipment for the decontamination house is being designed.

Eighty-two drums, four large packages and one gloved box were dumped as waste in cement at sea during this period.

12. Plant and Equipment

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Measurements Project. (Program No. 1300. 3-424-1720) Development and design continuing.

Bevatron Building and Instrument. (Program 1500. 5-424-9001). Installation of the motor generator sets is 99.5 percent complete. Units are being baked out and will be tested when the bevatron power supply equipment is complete. Installation of the ladder is 89 percent complete. Bevatron paving contract is 100 percent complete. Magnet coil windings will be laid now as rapidly as the availability of electricians permits.

Cafeteria. (Program 1500. 5-424-9004) Work on the landscaping will begin when the weather permits.

M.T.A. Mark I. (Program 1500. 5-424-9004) Development and design continuing.

M.T.A. Mark II. (Program 1500. 5-424-1004) Development and design continuing.

Accelerator Design Building. (Program 1500. 5-424-1004) Contract for the general construction has been awarded and work on the building will start on February 21, 1951.

Sheetmetal and Insulator Shop. (Program 1500. 5-424-1001) The footing and walls and the slab over the insulator shop have been poured and are being stripped. The schedule for this building has been revised with the cooperation of the contractor to the end that the building may be ready for occupancy during the first week in April, 1951.

Miscellaneous Construction. (Program 1500. 5-424-1001) Hydrogenation Shelter. The hydrogenation shelter near Donner Laboratory is 10 percent complete.

Pipe Welders' Shack. This work started on January 23, 1951 and is 95 percent complete.

Animal House. (1600. 6-424-9007) The contract for the general construction for the animal house will be recorded and work initiated by February 26, 1951.

Radiological Laboratory at the University of California Medical School. (1600. 6.424-9008) The excavation is 94 percent complete; reinforcing steel

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is 88 percent complete; form work is 89 percent complete; the concrete is 89 percent complete; and the miscellaneous work is progressing, making the total building 51 percent complete. The lower floor will be poured next week. Back-filling to the south and the west is complete. The ramps on the north are about ready for pouring. The metal lathe is being installed on the top flooring. Accelerator room is ready for the installation of the hoist mechanism, parts of which have arrived from the east. The purchase order covering the installation of this equipment will be let next week.

LMM/3-7-51
Information Division

MAN-MONTHS EFFORT REPORT

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Scientific Personnel

PROGRAM	SUBDIVISION	MAN MONTHS EFFORT	COMMENTS
Plant and Equipment			
1300 Weapons	General	9.4	
1500 Bevatron	Magnet	.1	
	Miscellaneous	.9	
MTA Mark I	Design and Development	27.2	
MTA Mark II	Design and Development	18.4	
Operations			
Physics Research			
5211 Lawrence	Electron Model	12.5	
Experimental Physics	Cloud Chamber	2.4	
	General Physics Research	25.5	
	Instruments for General Use	1.5	
	Special Development	5.1	
	Magnetic Measuring Equipment	1.3	
Theoretical Physics	General	10.7	
Photographic Film Detectors	General	12.8	
Isotope Separation	Nier Spectrometer	.5	
Radioactivity Physics	General	.9	
	Crystal Program	.1	
Chemistry Research			
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	5.0	
	Nuclear Properties of Heavy Element Isotopes	8.5	
	Transmutations with the 184" and 60" Cyclotrons	8.0	
	Analytical and Services	14.3	
	Special Chemistry Development	4.0	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.5	
	Instrument Development and Services	3.5	
	X-Ray Crystallographic Measurements	1.9	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT		COMMENTS
Chemistry Research (Continued)				
Basic Chemistry Research Part B	Metals and High Temperature Thermodynamics	3.5		
	Basic Chemistry, including Metal Chelates	2.0		
	General	2.5		
5361 Applied Chemistry Research	Process Chemistry	10.3		
Reactor and Accelerator Operation				
5731 Synchrotron	Operation	6.7		
5741 184-inch Cyclotron	Operation	10.9		
5751 Linear Accelerator and Van de Graaff Generator	Operation	17.1		
6000 Biology and Medicine, Part A	Metabolism of Plutonium and Allied Materials	11.0		
	Radiochemistry	4.0		
	Radioautography	2.0		
6000 Biology and Medicine, Part B	Instrument for Quantitative Measurements of Radiation	.7	.9	Consultant
	C^{14} Metabolism	2.2	.3	Man-Months
	Use of Radioactive Materials in Human Physiology and Experimental Medicine	8.3	7.3	
	Trace Elements and Irradiation Studies	3.8	.8	
	Radiation and Mutation Rate	2.0	.3	
	Physical Biochemistry	12.5	2.1	
	Biochemical Response to Irradiation	4.9	.8	
	Miscellaneous	1.4	.2	
	Donner Animal Colony Expense	1.4	1.8	
	Metabolism of Lipo Protein and Lipids	1.6	11.8	
	Iron Metabolism Hematopoiesis	3.5	.5	
	Internal Irradiation and Hematological Response	2.4	-	
6400 Biological Research	Synthetic and Experimental Organic Chemistry	3.6		
	Biological Chemistry	7.0		
	Photosynthesis Chemistry	3.5		
	Metabolism of Fission Products	13.11		
6500 Biophysics Research	General	1.8		

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