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MONTHLY PROGRESS REPORT, No. 93 - Dec.15 to Jan. 15, 1951

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MONTHLY PROGRESS REPORT
No. 93

December 15, 1950 to January 15, 1951

January 30, 1951

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RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA

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MONTHLY PROGRESS REPORT, No. 93

December 15, 1950 to January 15, 1951

January 30, 1951

1. Bevatron
(AEC Program No. 1500)UNCLASSIFIED

Magnet. During the month the lower yoke slabs of the fourth quadrant and all the leg slabs have been erected. Final installation of the top yoke slabs will await completion of coil winding. Coil end winding supports are being erected and it is expected that the ironworkers doing the steel erection will be finished by February 1.

All necessary parts for winding the first coil are on hand and a few test turns have been wound. Start of the permanent winding is scheduled for February 1. The test winding indicates that the winding work can be completed in six months as planned.

Magnet Power Supply. All of the electrical machinery erection and most of the heavy current wiring in the generator room was completed during the month. The principal remaining work is control wiring and the cable wires from the generator room to the magnet. No effort is being made to push the electrical contractors. Completion of the power supply is expected in March.

Other Parts. The cooling tower is installed and the air filter bank design is complete. The fans are to be run on January 23.

The linear accelerator drift tube design details are completed but no plans are made for assembly.

The vacuum test section has been having trouble getting gasket joints tight. This has been proceeding slowly due to pressure of other work but the troubles are all believed to be in details.

No orders for vacuum tank or pole piece parts have yet been placed.

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

The cyclotron was used for research experiments approximately 97 percent of the 443 hours that the crew was on duty. The time distribution was as follows:

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	Hours	Percent
Operation for customers	431.50	97.5
Filament change	1.25	0.2
Electrical trouble	5.25	1.2
Mechanical trouble	2.75	0.6
Miscellaneous	2.50	0.5
Total	443.25	100.0

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

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Available operating time was limited during this period by the year-end holidays and a minor shutdown. Two days were spent installing new equipment and making necessary repairs of some of the existing parts. Operating efficiency during the available time was about 70 percent.

4. Synchrotron Operation (AEC Program No. 5731)

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Overhaul of the synchrotron was necessary due to deterioration of the vacuum seals, as reported in last month's progress report. The overhaul extended into this report period. Assembly was hampered by recurring failures of new rubber seals. These seals, made of butyl rubber were kept as spares on a shelf in the room where the machine is located. They were subject to scattered radiation during operation of the machine. These spares exhibited checks which led to tearing when they were stretched over the vacuum chamber segments. They had been shelf stored without removing the talc for a six month period.

The beam was regained on the 19th of December and was immediately employed by the physics experimentalists. During this time the beam intensity was low and somewhat erratic due to bursts of pressure in the vacuum system. The vacuum troubles were finally eliminated. By the first week in January, the beam intensity had reached 400 R/min, measured on a Victoreen thimble surrounded by 1/8 inch Pb at 1 meter from the target. Since then the beam has continued steady and reliable at high intensity levels and has been continuously used for physics research.

During the latter part of this report period, a 64 hour uninterrupted run was scheduled.

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

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Operation. The wiring on the Van de Graaff is complete, and the alignment and debugging work has begun. It was found that the Kinney pump could not be mounted directly on the Van de Graaff due to excess vibration, so a framework is being made to anchor the Kinney pump to the concrete floor in such a manner that when it is necessary to move the Van de Graaff the Kinney pump can be disconnected from the concrete floor and moved with the Van de Graaff. The linear accelerator shielding is now complete.

6. Experimental Physics
(AEC Program No. 5211)

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Film Program. High Energy Electron Processes. The first phase of a program of measuring cross sections for high energy electron-electron and positron-electron scattering has been completed. It was found that the cross section is correctly given in absolute value by the existing theories for non-relativistic recoils. However, the apparent cross section for high energy recoils is considerably below the theoretical prediction, and this is now the subject of investigation. In this second phase of the program, different observers using new plates are making the measurements. The energy of the electrons is being checked by small angle scattering observations, and a study of the large angle nuclear scattering of the electrons is also being pursued.

Meson Scattering. Definite results on the scattering of 40-60 Mev π^- mesons by aluminum were obtained. Assuming spherical symmetry of the scattering, the measurements at 90° indicate a cross section of about 0.5×10^{-24} sq. cm.

A new experiment with improved geometry is in progress to try to obtain the scattering cross section in hydrogen. Use is made of the fact that at 90° the meson loses one-quarter of its energy in an elastic collision with hydrogen, but scarcely any on collision with carbon. Thus, using a CH_2 scatterer the mesons scattered from hydrogen can be separated from those scattered elastically from carbon. We are also attempting to observe inelastic as well as elastic scattering from carbon.

Meson Masses. The observations have been completed and calculations of meson masses are in progress. The dispersion of the π^+ and π^- masses is about as calculated from the expected range straggling, but the dispersion of the μ^+ measurements is considerably higher than expected. This will require further investigation.

π - μ Decay Energetics. The range straggling of μ^+ mesons from the decay of π^+ mesons in emulsion has been measured and found slightly to exceed the classical range straggling predicted by Bohr. The distribution is essentially Gaussian with a standard deviation of about 28 microns. Ranges of π mesons of known momentum in the same emulsion are now being measured for a more exact study of the energy and momentum balance in the π meson decay process.

Cloud Chamber. A continuously sensitive diffusion chamber has been constructed to go inside the large cloud chamber magnet. It will be filled with air. A polyethylene plate beside a carbon plate will be used to obtain meson scattering off of protons. These plates will be followed by a half-inch copper absorber to distinguish between π 's and μ 's. The chamber will be placed in the π^+ meson beam from the cave and pictures taken as frequently as the lights will allow. The chamber operates very well outside of the magnet and will be tried soon in the magnet.

The rectangular chamber is operating after vigorous cleaning which stopped the poisoning from which the chamber suffered.

Pictures were taken of Cl^{32} nuclei accelerated in the 60-in. cyclotron and sent into a 22-in. diameter cloud chamber through a 1 mil thick aluminum window. The nuclei showed elastic coulomb scattering but no nuclear events in an eight hour run with argon gas in the chamber.

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Circuits have been built which will be used in obtaining the μ decay spectrum by detecting the π - μ decay in a crystal in the center of a cloud chamber at the synchrotron. These circuits are completed, and a new design of crystal holder has been made which will reduce turbulence and permit the use of a glass wall on the cloud chamber. This has the advantage of allowing alcohol and water mixtures to be used at their lower expansion ratio.

Work is progressing on a number of cloud chambers. Among these is a small exploratory chamber recently completed which will be used to study background radiation at the accelerators. Design work on a high pressure cloud chamber for operation at 10 atmospheres is nearing completion. A new cloud chamber of special design has been finished by the shop; it will be used for measuring the stars produced in helium by stopping π mesons. Work on assembling this unit will start shortly.

Detection of Coincidences between Positive Mesons and Deuterons Corresponding to the Process $p + p \rightarrow \pi + d$. Coincidences have been obtained between mesons formed in p-p collisions and deuterons. The deuterons are identified by measuring both range and magnetic rigidity; this corresponds to a mass measurement. It has been shown that such coincidences are produced essentially only for mesons formed in p-p collisions and are absent for mesons produced by proton bombardment of carbon. This confirms the early inference as to this process derived from the meson spectrum. No absolute cross sections have been obtained as yet.

P-P Scattering at High Energies. A long run on the 184-inch cyclotron has given the differential scattering cross section as close to $3.8 \times 10^{-27} \text{ cm}^2/\text{steradian}$ down to 15 degrees in the center of mass system, rising to $5.3 \times 10^{-27} \text{ cm}^2/\text{steradian}$ at 11 degrees. The rise at 11 degrees could be the result of interference between nuclear and coulomb scattering. A detailed paper on the p-p scattering to date is very nearly complete, and will appear as UCRL-1109. The report includes data taken over a wide range of angles (11° to 90°, c.m. system) at 345 Mev (lab system), as well as a limited range of angles at lower energies (about 60° to 90° at 119 Mev, 160 Mev, 249 Mev) coverage of smaller angles at the lower energies will require a different liquid hydrogen target construction, and is expected to be delayed therefore.

D-p scattering. Scattering of 180 Mev deuterons by protons is being investigated as previously reported. The elastic scattering work is fairly complete. It shows over the angular range 40° to 100° (c.m. system) good agreement with the values predicted by Chew [Phys. Rev. 74, 109 (1948)] (who used a model which might be considerably altered in light of recent scattering data). In the range 100° to 130° the experimental values of the differential cross section fall about a factor of 2 below the values given by Chew, i.e., the experiments indicate that the pickup process is somewhat less important than Chew predicted.

Inelastic scattering in the same experiment seems to show a surprisingly close correlation between the angles with which the two protons emerge. Further work is necessary to check preliminary results and to prove that the effect observed is true d-p scattering.

Quasi-Elastic Scattering of Nucleons from Light Elements. The 35-channel magnetic particle spectrometer has been used to find the energy spectra of protons, incident at 340 Mev, scattered from H, C, Al, and Cu at an angle of 40°. All of the spectra indicate a great majority of nucleon-nucleon collisions. Theoretical scattered proton spectra obtained by assuming various internal momentum distribu-

tions are being compared with the experimental results.

In the neutron beam, experiments are being continued to verify the dip in the proton yield from deuterium relative to that from hydrogen at small scattering angles. A scintillation counter telescope is being assembled to obtain data at smaller angles than is possible with the present proportional counter telescope.

High Energy Neutron Inelastic Scattering Cross Section. Measurements were made on the upper limit of the total inelastic scattering cross sections of high energy neutrons on copper. A poor geometry setup was used involving a large movable 6-in. x 4-in. x 4-in. copper attenuator near the beryllium neutron source. A triple coincidence crystal counter telescope outside the shielding was used for counting. The values obtained are

Energy	σ inelas.	Ratio $\frac{\sigma \text{ inelas.}}{\sigma \text{ total}}$
275 Mev	0.75 ± 0.06 barn	$\frac{0.75}{1.15} = 0.65$
308 Mev	0.84 ± 0.16 barn	$\frac{0.84}{1.15} = 0.73$

A total cross section of 1.15 barns was assumed from former experiments, and the indicated errors only include statistical standard deviations. An appreciable accidental counting rate was observed, hence the results obtained may be high in value. Efforts in the future will be made to eliminate these accidentals.

Production of High Energy Deuterons in Proton Bombardments. The production of high energy deuterons (and tritons) in proton bombardments is under investigation to test the "pick-up" hypothesis of G. Chew and M. L. Goldberger. The method involves the use of part of the magnetic field of the cyclotron as a spectrometer for the secondary particles. Thus for protons of energy E_p determined by placing the target at the appropriate radius R_p , deuterons of energy $E_d > \frac{1}{2}E_p$ and tritons of energy $E_t > \frac{1}{3}E_p$ that emerge from the target are analyzed in H_p by that portion of the field lying outside the radius R_p . This arrangement allows the determination of angular, and energy distribution as well as yield as a function of proton energy.

The particles are registered in a row of nuclear plates located along a radius line 150° from the target (180° focusing has not proved convenient). The plates are placed behind 45° copper wedge absorbers in such a way that a range spectrum is obtained at each radius. In order that particles may reach the plates only if they were emitted into a certain angle from the target, a brass block in which a large number of channels have been cut serving to collimate the analyzed particle flux at numerous points is placed in front of the detector array.

It is found that with this arrangement the range spectrum at each channel can be resolved into two rather sharp lines corresponding to deuterons and tritons of the appropriate energy corresponding to emission from the target at the angle determined by the channel. Background problems, including contamination from protons appears to be very slight, however the lines are broadened in the direction of lower energies. This effect is presumed to be due to small angle scattering in the channel walls, and an improved collimator is being developed.

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Synchrotron Studies. The main running time was devoted to an experiment on the production of π mesons in hydrogen and deuterium. The x-ray beam bombarded the high pressure gas target, and the mesons produced were recorded both electronically and by means of plates. Observations were made at 45° , 90° , and 135° to the incident beam, and at different energies. At 45° the radiation (electrons and quanta) scattered from the target and adjacent equipment is so intense that the counter equipment could not be used below about 100 Mev. Unfortunately this is the most interesting region since differences between H and D in the π^+ production should show up most distinctly. This data, however, will be available when the plates are scanned. The energy distributions were of the type expected, the maximum meson energy being slightly greater for D than H. In addition, a comparison of H, D, and He will be made during the coming month.

A transition curve of the type taken by Strauch has been run on Mo, using the 17-min. radioactivity of Mo^{91} . This is reported to have a high neutron threshold, and should give results between Cu and C.

An additional run for study of showers produced by gammas has been made. Data is being obtained for lower maximum energy bremsstrahlung. The possibility of detecting π^+ and π^- ratios formed in targets placed in the pair spectrometer magnet is being studied. The magnet field is used to distinguish sign and momentum of the particles, and the range is used to determine what particles are mesons.

7. Theoretical Physics (AEC Program No. 5211)

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The investigation of the γ -ray spectrum resulting from the absorption of π^- mesons in deuterium has been completed.

Analysis of photo-nuclear reactions and of the transmission of fast neutrons through nuclear matter is being continued.

The investigation of meson production by γ -rays and by protons bombarding complex nuclei is being undertaken. It is hoped to establish relationships between these experiments and those on meson absorption and scattering. A study of the angular distribution of π^+ mesons produced in proton-proton collisions is being conducted.

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

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Oscillator Development. An order has been placed with R.C.A. for 26 oscillator tubes, Type 5831. This will supply the 22 necessary to operate Mark I with six for spares. The shipments will be made from January through April at the rate of about two per month. The oscillators of the Mark II accelerator will use clusters consisting of six R.C.A. 2332 tubes. The first six of these are to be delivered by April 15. It is planned to freeze the design of the final model of the tube by July, 1951. By October R.C.A. will deliver one dozen of the final design tubes, after which they will proceed with the mass production of the number required.

To accelerate the development of the resonatron tube for Mark II or III, a

contract has been entered into with the General Electric Co., under which they will supply beam forming structures to fit into the full-scale resonatron tube for rf testing at the Laboratory.

High Voltage Sparking Problem. A study is being made of the high voltage sparking on the electrode in the XC unit, and the effect of the presence of a magnetic field upon it. Without the magnetic field the voltage which can be held is a million volts under CW operations. With a high magnetic field the ceiling voltage is reduced to about 500,000 volts by the sparking which occurs. An examination of the tank has shown that the high voltage electrode was sprinkled with numerous small particles of copper which appeared to come from localized melting and sputtering of the copper panel adjacent to the high voltage electrode. Copious cooling of the side panels of the chamber will be tried in an attempt to overcome this effect which may be serious for the operation of Mark III if high dee voltages are used.

L-2 Cavity. Engineering studies are underway on the L-2 cavity. It will make use of a copper-clad tank similar to the B-1 test cavity and will be constructed at Livermore in one of the existing buildings. It is being designed to hold four million volts, which will give a field gradient approximately equal to that expected in Mark II. This cavity will be mounted below ground to minimize shielding requirements.

Long Drift Tube Tests. Tentative requirements have been drawn up for the long drift tube tests in the Mark I cavity. It is estimated that biasing required on the full drift tube will be 40 kv rather than the previously estimated 15 kv. This means that the drift tube stem will have to be redesigned to provide the necessary additional insulation.

X-ray Measurements on B-1. In an effort to locate the sources of the x-rays from the B-1 test cavity, a pin hole camera has been constructed and employed to take x-ray photographs of the cavity under operation. The front of the camera is fabricated of 2-in. thick lead sheets and has an aperture of 1/4-in. diameter shielded by an additional 1-1/2 inches of uranium. A one hour exposure showed about 35 dots which seem to fall in the region of the hemispherical top of the test cavity, indicating that electrons giving rise to the x-rays originated on the spherical electrode and were accelerated to the dome. These spots remained in essentially the same location over considerable intervals of time. It is now planned to construct a stereoscopic camera so that photographs may be taken to enable the location of the spots to be more accurately determined. If production of the x-rays is associated with back bombardment, these spots may appear in pairs, one on the dome and one on the sphere.

Injector Development. The new injector is scheduled for initial test during early February. With the present equipment ion currents of 3 amperes have been obtained, the limit being imposed by the present power supply. Some work is being done with electrostatic lenses built at an angle with the axis of the beam such that it would be possible, if necessary, to displace the source from the axis and inject ions at an angle. This would allow the particles responsible for back bombardment of the ion source to be caught on a water-cooled target.

Mark I Electron Model. The electron accelerating model of Mark I is being moved from Bldg. 52 to Bldg. 51 because of the high x-ray background produced in the former location. It is desired to determine from this model whether the design

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values for the focusing magnet power are satisfactory. This model has been operating satisfactorily but under conditions such that the focusing magnets do not operate with magnetic fields corresponding to calculated ones. However, it has been found that some of the magnets had shorted turns so that experimental verification of the adequacy of the focusing magnet design must await rewinding of the magnets for this model. This work is now underway.

Model Cavity Measurements. Measurements have been completed on the 1/10 scale Mark I cavity. The Q has been measured with and without the pump holes and with and without skirts on the pump holes. The measurements indicated that very little energy was being lost by radiation through the pump holes. It therefore appears that essentially all of the losses are occurring in the copper. It has been concluded that although the skirts may not be required on the pump holes to reduce radiated power, it seems advantageous to use them to minimize sparking outside the liner such as has occurred on the 32 Mev linac.

Mark II Target Problems. Discussions with metallurgists at Oak Ridge, Argonne, and Ames Laboratories have confirmed the advisability of using thorium in place of uranium in the primary target of Mark II. Since thorium is ductile and can be easily extruded, drawn, or rolled, the fabrication problems could be satisfactorily solved. It appears advisable to have the thorium production and studies of fundamental metallurgy conducted by the Ames Laboratory. The facilities are available at Oak Ridge National Laboratory for the necessary fabrication.

It has been announced that the North American Aviation Company is being brought into the MTA Program to work on target problems.

Livermore Construction. In the construction at Livermore, the steel frame has been erected for three bays of the accelerator building starting from the west end. The building frame is scheduled to be completely assembled in three weeks. The 14th supporting ring of the vacuum vessel has been installed and the No. 1 ring at the opposite end of the tank is being set in place. Ninety percent of the tank plates are in place and these are 70 percent welded. The earthquake bracing of the vessel is now being installed which will allow the staging below the manifold to be removed and permit the installation of the Chapman valves and some of the booster pumps to begin. The tunnels are finished in the power supply network, and the pouring of piers for the power supply of No. 1 building is underway. Foundations have been started for the motor generator set for power supplies 2, 3, and 4. The security fence is complete except for the installation of the gates. Fourteen blocks of the shielding have been poured but the seven thus far checked are not within tolerance. They have deviations of 3/8 in. whereas the allowable tolerance is 1/8 in. The drift tube magnet coil winding is in the last phase and operations are now set up to assemble the magnet. Work will start next week. Negotiations are underway for the placement of cooling tubes on drift tube heads and the assembly of the heads on the completed magnets.

Mark II Site Selection. Recommendations of the site selection committee are due for review later this week by the Site Review Board. Three sites have been studied intensively and one of the three locations seems to be very satisfactory. The remaining problem in connection with the recommended site is the availability of power.

SECRET9. ChemistryPart A
(AEC Program No. 5311)

Berkelium and Californium Isotopes. Bombardments of natural uranium with carbon ions produced an isotope of californium which decays with 35-hour half-life by the emission of alpha-particles of 6.75 Mev energy. Recently the same isotope was produced in relatively large amounts by bombarding a mixture of Cm²⁴², Cm²⁴³, and Cm²⁴⁴ (produced in pile irradiations) with 35 Mev helium ions. The well-known isotope Cm²⁴² was observed to be produced by the decay of this new californium isotope thus establishing its mass number as 246. In the same bombardment a new isotope of berkelium was observed which decays predominantly by electron capture with a half-life of 5.0 days. Also observed was branching decay by the emission of three groups of alpha-particles with the following energies in Mev: 6.33, 6.15, and 5.9. The half-life for alpha-particle decay was estimated as roughly 25 years.

Carbon Ion Transmutations. The work with stripped carbon nuclei, accelerated in the 60-in. cyclotron, has been extended to the bombardment of copper. Two bromine activities have been observed in the targets, a 1.5-hour period which was tentatively assigned previously to Br⁷⁵, and a 0.5-hour activity which may be Br⁷³. These assignments correspond to (c,2n) and (C,4n) reactions on Cu⁶⁵.

Half-life of Rb⁸³. The previous value for the half-life of Rb⁸³ (107 days) was based on decay of weak samples which may have contained longer lived contaminants. A new value, based on much more active samples milked from Sr⁸³, is 84 ± 5 days.

Chain Yields in High Energy Fission. In continuation of the program of the measurement of independent yields of nuclides from the high energy fission of uranium, we have measured yields of three isobars at mass 166. The yield of Yb¹⁶⁶ includes all isobars of greater Z; that of Ho¹⁶⁶ is independent; that of Dy¹⁶⁶ includes isobars of lower Z. It will be possible to get the independent yield of Tm¹⁶⁶, thus for the first time (in this work) having a test of the assumption of a Gaussian distribution among isobars.

Half-life of U²³⁵. The present result of the still incomplete experiments on the specific activity and half-life of U²³⁵ corresponds to 7.2×10^8 years, with a probable error of about 2 percent. This value is close to that of Nier, 7.07×10^8 years.

Alpha Ray Spectrograph. The new large mass spectrograph which is under construction is of suitable dimensions for use as an alpha ray spectrograph. Now that the magnet, magnet supply, and vacuum chamber are complete, it has been tried out for such use with a source of Cm²⁴² of about 2×10^7 c/m. The first exposure, of 30 minutes duration, gave a plate with several thousand alpha tracks in a line of width corresponding to about 120 Kev. These alpha-particles have fine structure, but thickness of sample is suspected as the chief reason for the broadness of the line.

This work will be continued, especially until the high voltage power supply is completed.

Radiation Chemistry. The results of analyses of the products formed by irradiation of several alcohols with 38 Mev helium ions have been compared with data

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for the most probable splitting of the same alcohols in the electron bombardment source of the mass spectrometer. The data, for six simple saturated alcohols, show considerable correspondence if interpreted in terms of the bond most likely to break in the primary process. It remains to be seen how far the correspondence will hold, but this may be a means of predicting radiation effects in general.

ChemistrySECRET

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. Polymerization of aqueous zirconium.
3. Thermodynamics of rhenium.
4. Electron exchange rate between Fe^{2+} and Fe^{3+} .

ChemistryUNCLASSIFIED

Part C
(AEC Program No. 6400)

Synthetic and Experimental Chemistry. The synthesis of the following C^{14} -labeled compounds has been studied: Norvaline-3- C^{14} , norleucine-3- C^{14} , leucine-3- C^{14} , valine-4,4'- C^{14} , codeine-N-methyl- C^{14} , morphine-N-methyl- C^{14} , benadryl- C^{14} , (diphenyl-methyl- C^{14} - β -dimethylaminoethyl ether); (30 percent yield, 4.2 μ c/mg.), pyribenzamine- C^{14} [2-[benzyl- α - C^{14} (2-dimethylaminoethyl)] amino pyridine], (2 μ c/mg.), 1,1-diphenyl-4-dimethylaminobutane-1- C^{14} , ethyl bromo-acetate-1- C^{14} (also -2- C^{14}), aspartic- γ - C^{14} acid, aspartic- β - C^{14} acid, stilbamidine-amidine- C^{14} , isopropyl-methyl- C^{14} iodide (2-iodopropane-1,3- C^{14}), sodium caproate-2- C^{14} , n-butyl-1- C^{14} bromide, isobutyl-1- C^{14} iodide, methyl- C^{14} iodide, propyl-1- C^{14} iodide, propyl-2- C^{14} iodide, amyl-1- C^{14} bromide, and ethylene-1- C^{14} .

Other projects in C^{14} chemistry which have been studied include: the isotope effect in the decarboxylation of malonic acid and substituted malonic acid derivatives. The rate of hydrolysis of diethylnaphthyl acetate has been studied at two temperatures as a preliminary in the decarboxylation rate studies. Free naphthalene malonic acid has been isolated in a pure state for the first time. In study of isotope effect in the decomposition of oxalic acid, data on rate studies with oxalic acid remain to be analyzed. Improvement and modification in ionization chamber measurements for low activity C^{14} samples from human patients has continued. Studies on the irradiation of dipeptides in the cyclotron

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beam in aqueous solution have shown that this beam is so intense that the compound is destroyed after short periods of irradiation. Comparable experiments are now being tried with x-rays. The synthesis of the dipeptide aspartoglycine is being undertaken and the tripeptide will probably be prepared from this material.

Biological Chemistry. During the past month the following biological chemistry projects have been studied: the metabolism of labeled purines in normal and neoplastic mice and the fate of 8-azaguanine-4- C^{14} and guanine-4- C^{14} in mice. The isolation of the labeled components from the eggs of a hen fed sodium acetate-1- C^{14} has continued; the phospholipids, proteins and cholesterol fractions have been isolated and are being determined for radioactivity content. Work is now beginning on the methods for analysis of the saturated and unsaturated fatty acids. Studies on the application of paper chromatography of steroids have continued. Identification of the remaining major unknown component from propionate metabolism by liver slices is continuing. A cooperative project with the Division of Animal Husbandry on the Davis campus has been established in which it is hoped to evaluate the life of the red blood cells in cows and the long-term breath and urinary excretion of C^{14} from animals fed substantial amounts of labeled fatty acids.

Photosynthesis Chemistry. The chemical approaches to the processes occurring during photosynthesis have been continued during the past month. An unknown early carbohydrate intermediate in carbon dioxide assimilation has been degraded by periodate oxidation. The results indicate that it is hexose. Degradation of a conversion product of this unknown is also in progress.

The kinetics of $C^{14}O_2$ uptake into the paper chromatographically separated components by iodoacetamide-inhibited and normal Chlorella is being continued.

The kinetics of $C^{14}O_2$ uptake during the first few seconds of photosynthesis is being analyzed from the results of a 5, 10, 15, 25 and 37 second series of experiments. The prior formation of phosphoglycerate has been redemonstrated in a series of chromatograms in which the major phosphorylated components are well separated. This analysis will be extended to include enzymatic hydrolysis of the yet unseparated hexose monophosphates. The sequence of formation and identity of these phosphates is to be determined.

The fermentative action of yeast extract on photosynthetic phosphate esters is in progress. Development of more rapid enzymatic phosphatase action is in progress.

The physical nature of paper chromatography has been investigated by analysis of the solvents at different points on the chromatogram. Considerable differences are observed in contrast to the uniform properties assumed in the literature.

Malic acid-2,3- C^{14} has been fed to Scenedesmus during photosynthesis and some assimilation was observed.

Experiments to separate optical anantiomorphs by paper chromatography are in progress.

UNCLASSIFIED10. Medical PhysicsPart A
(AEC Program No. 6000)

Tracer Studies. In addition to tracer studies reported earlier, the following isotopes are being investigated as to their metabolism in the rat: tungsten (W^{181}), molybdenum (Mo^{99}), rhodium (Rh^{102}), chromium (Cr^{51}).

Chelating Studies. Experiments to determine the effect of prolonged administration of Fe-3 and Ca EDTA in the food of rats are continuing.

Radiochemistry. Carrier-free procedures have been developed for the isolation of (1) Pb^{203} from deutron bombarded thallium; (2) W^{181} from deutron bombarded tantalum; and (3) Mo from deutron bombarded zirconium. Previously reported procedures were used in the preparation of carrier-free Pd^{103} , Cr^{51} , At^{211} , and $Ta^{177,178}$.

10. Medical PhysicsUNCLASSIFIEDPart B
(AEC Program No. 6000)

Metabolism of Carbon 14 Labeled Glycine. The tissues from a second patient who has received C 14 labeled glycine for the study of the life span of the red blood cell in leukemia are now available following autopsy at approximately sixty-five days after the administration. It is of interest to note that the breath curve, while qualitatively similar to the other patients showed an excretion somewhat less than most of the previous patients. Now that the tissues are available, we will have an opportunity to determine the amount of C 14 present in a second patient, and also since we have been able to get a large number of tissue samples to compare the specific activity of the C 14 present in a sufficiently large number of tissue samples. It is interesting to note that this patient had the shortest red cell life span that has been seen so far in leukemia -- approximately 20 to 30 days.

At the present time, studies are now in progress on the separation of hemoglobin into a heme and globin. From preliminary studies the data is not yet sufficient to draw any conclusions. Studies of the urine of these patients show that instead of the 4th component of excretion being pulmonary, it is probably urinary since 30 days after activity of the urine is greater than that of the breath. This indicates that some of the glycine is getting into a metabolic pool, of which the end product is urea. This would indicate that this metabolic pool is a protein pool. Further studies are now in progress to separate out urea chemically from the urine to determine what the specific activity of the urea is and to compare this with the other carbon-containing compounds of the urine. It should be pointed out, however, that urea forms about 90 percent of the organic carbon of the urine, the other being made up of several compounds, of which the largest amount present is uric acid. Therefore, it seems unlikely that this specific activity will be present in some other compounds.

Studies of the effect of whole body radiation on glycine metabolism are planned. It probably will not prove to be as sensitive a mechanism as Fe 59 turnover, or shown previously..

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Mechanism of Radiation Effects on Unicellular Organisms. Data continue to accumulate on the distribution of pre-irradiated defective diploid yeast cells. Some of the stable defective and normal deploid strains were grown in liquid synthetic media. While the normal haploid and diploid cells have approximately the same growth rate at the same temperature, at least two of the defective pre-irradiated colonies have exhibited a slower rate of growth in the logarithmic phase. This type of measurement adds to the factors that distinguish some of the defective colonies from the normal ones. In previous experiments on micro-organisms when growth rate was studied after pre-irradiation but without preparing single cell isolates, the growth rate returned to normal after a time lag.

Iron Metabolism. The change in iron metabolism in polycythemia patients as a result of exposure to hyperoxia and irradiation is being studied. Study of the first patient of the series has been completed. This patient was exposed to 35 to 50 percent oxygen concentration at a normal barometric pressure for five days. Exposure was constant with the exception of time out for meals. There was no change in the iron turnover rate before and after the exposure. More patients will be studied, especially some secondary polycythemias, in the hope that exposure to hyperoxia and its effect on iron metabolism may serve as a diagnostic differentiation of polycythemia vera and secondary polycythemia. These studies have been stimulated by our Peruvian studies where it was found that red cell production in native Indians living at 15,000 feet, fell off to 0.1 normal -- or similar to that observed in aplastic anemia or after whole body irradiation. This latter study is also being extended.

The effect of transfusion on iron metabolism, especially with respect to red cell production is being studied in rats.

Slonaker rats have been splenectomized and will be given radio strontium in order to obliterate all sources of red cells. When the production rate of red cells is shown to be negligible, attempts will be made to transplant bone marrow from Curtis-Dunning rats with the simultaneous administration of A.C.T.H. to the recipient.

Biological Effects due to High Energy Carbon Ions - C(6+). Adaptation of the 60-in. cyclotron for studies with six times ionized carbon ions and helium ions is being continued.

The Lipoprotein Metabolism following Acute Whole Body X-Irradiation. Studies have been made on the sera of rabbits after whole body x-irradiation as to changes in several of the lipoprotein types. Tentative conclusions are along the following lines:

1. A major change in the lipoprotein pattern occurs in rabbits that have received lethal levels of irradiation. This specific change is noted in the appearance of a "Sf10" lipoprotein at 200 to 500 milligrams percent not seen in normal rabbit serum. It is probable that this fraction is largely responsible for the serum opalescence in lethally-irradiated rabbits reported by Rosenthal from this laboratory.
2. Parallel investigations of basic lipoprotein formation may give clues to the above effect. It has been noted in current studies of A.C.T.H. and Cortisone administration that lipoproteins of Sf 70-100 can be produced in large quantities after administration of 5 to 10 milligrams per day of A.C.T.H. or 20 milligrams

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of cortisone per day. These doses were in the lethal range; greater S_f 70-100 lipoproteinemia was produced by the cortisone which could be tolerated in larger dosages than A.C.T.H.

3. Alloxonized rabbits with glycosuria show a similar type of high S_f molecule when they are placed upon the cholesterol diet. Rabbits that are x-irradiated show an initial marked drop in the normal lipoprotein component, S_f 4-6; and in the cholesterol fed rabbit also in the S_f 10-30 group. This effect occurs immediately with irradiation and can be detected as rapidly as blood samples can be withdrawn following whole body x-irradiation with 800 roentgens. The effect lasts about an hour after which the concentration of these lipoproteins increases, usually exceeding the pre-irradiation level.

Administration of heparin intravenously in doses of about 1 milligram per kilo appears to have similar effect on the S_f 4-30 groups of lipoproteins.

It may be possible to study the irradiation response in man utilizing patients that are receiving whole body therapeutic doses on the order to 50-100 roentgens.

Beryllium Poisoning. Autopsy slides from the case of chronic pulmonary granulomatosis have been sent to the University of Rochester and to the Saranac Laboratory in New York for their opinions.

A report from Doctor Steadman of Rochester, New York, of his spectroscopic analysis of tissue samples for beryllium content has been received. The sample of hilar lymph nodes contained 1.12 micrograms -- a concentration of 0.075 micrograms/gram fresh tissue; the lung sample contained 3.30 micrograms -- a concentration of 0.0096 micrograms/gram fresh tissue. No beryllium was found in samples of heart, liver, thyroid, or spleen. The amounts of beryllium found in the lung and hilar nodes were many times higher than normal and fall into the range of concentrations found in the same laboratory in other cases of fatal beryllium poisoning.

Influence of Tumors on the Concentration of Carbon 14 Labeled Stilbamidine in the Liver. A new supply of C-14 labeled stilbamidine is being synthesized for continuation of the cancer studies which have been reported in previous progress reports.

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

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

11. Health Chemistry
(AEC Program No. 5311)

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

1. The processing of a bombarded sample from the Chalk River pile has been completed in the new and the modified equipment described last month.

2. A transfer system for dissolver solution processing has been revised.

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3. A new bottle capper, one for use in gloved boxes and one for hand capping, has been built.

4. Berkeley boxes: 3 new boxes have been assembled, 2 decontaminated boxes have been rebuilt and reconditioned, 5 centrifuges have been reconditioned and doors on 8 gloved boxes have been rebuilt.

During this period 81 drums of active waste in cement and 9 plywood boxes filled with active waste were disposed of at sea.

Investigations are proceeding, with favorable indications, to determine the suitability of cement for the solidification of liquid waste.

12. Plant and Equipment

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

Bevatron Building. (Project No. 1500. 5-424-9001) Installation of the motor generator sets is 99 percent complete; installation of the power excitation equipment is about 85 percent complete and the cooling tower is 99 percent complete. The paving is 99 percent complete and will be finished just as soon as the weather permits. The magnet coil test winding was started on January 10, 1951.

Cafeteria. (Project No. 1500. 5-424-9004) Paving and drainage work adjacent to the cafeteria has been completed. An order for landscaping has been placed and work is about to begin, weather permitting.

M.T.A. - Mark I. (Project No. 1500. 5-424-0001) Development and design continuing.

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

Accelerator Design Building. (Project No. 1500. 5-424-1004) Contract for the fabrication and erection of structural steel has been awarded. Shop drawings are being prepared. Bids for the general construction of the accelerator design building will be opened Tuesday, January 23, 1951.

Sheetmetal and Insulator Shop. (Project No. 1500. 5-424-1001) The foundations are being formed and the first pour will be made the week of January 22, 1951.

Miscellaneous Construction. (Project No. 1500. 5-424-1001) Alterations to Rooms 106 and 107, Building 4. These alterations are 100 percent complete.

Old Radiation Laboratory. Alterations to Rooms 208 and 209 in the Old Radiation Laboratory (for North American Aviation) were completed on December 22, 1950.

Hydrogenation Shelter. The hydrogenation shelter near Donner Laboratory is 5 percent complete.

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Animal House. (Project No. 1600. 6-424-9007) Bids have been received and preparation of contract documents is beginning.

Radiological Laboratory at the University of California Medical School. (Project No. 1600. 6-424-9008) The excavation is 90 percent complete; reinforcing steel is 86 percent complete; form work is 88 percent complete; the concrete is 84 percent complete; and the miscellaneous work is progressing, making the total building 42 percent complete. The accelerator room is being readied for the arrival of the hoist mechanism for the Medical Synchrotron which is scheduled to arrive after February 1.

Information Division
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MAN-MONTHS EFFORT REPORT

Scientific Personnel

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
<u>Plant and Equipment</u>			
1300 Weapons	General	15.1	
1500 Bevatron	Magnet	.2	
	Miscellaneous	1.7	
M.T.A. - Mark I	Design and Development	32.3	
M.T.A. - Mark II	Design and Development	11.9	
<u>Operations</u>			
<u>Physics Research</u>			
5211 Lawrence Cyclotron	Electron Model	6.7	
Experimental Physics	Cloud Chamber	7.8	
	General Physics Research	35.1	
	Instruments for General Use	1.9	
	Special Development	7.2	
	Magnetic Measuring Equipment	3.0	
Theoretical Physics	General	10.4	
Photographic Film Detectors	General	12.4	
Isotope Separation	Nier Spectrometer	.4	
Radioactivity Physics	General	1.6	
	Crystal Program	.3	
<u>Chemistry Research</u>			
5311 Basic Chemistry Research, Part A	Chemistry of Transuranic Elements	5.2	
	Nuclear Properties of Heavy Element Isotopes	8.0	
	Transmutations with the 184" and 60" Cyclotrons	6.8	
	Analytical and Services	15.0	
	Special Chemistry Development	4.0	
	Mass Spectroscopy, Beta Ray Spectro- scopy	1.4	
	Instrument Development and Services	3.5	
	X-Ray Crystallographic Measurements	2.5	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
<u>Operations (Continued)</u>			
Chemistry Research			
5311 (Continued)			
Basic Chemistry	Metals and High Temperature		
Research, Part B	Thermodynamics	2.5	
	Basic Chemistry, including Metal		
	Chelates	2.0	
	General	2.5	
5361 Applied Chemistry	Process Chemistry	11.5	
Research			
<u>Reactor and Accelerator</u>			
<u>Operation</u>			
5731 Synchrotron	Operation	6.7	
5741 184" Cyclotron	Operation	8.7	
5751 Linear Accelerator and	Operation	17.0	
Van de Graaff			
Generator			
6000 Biology and Medicine	Metabolism of Plutonium and Allied		
Part A	Materials	11.0	
	Radiochemistry	4.0	
	Radioautography	2.0	
Biology and Medicine	Tumor Metabolism	.7	1.7 Consultant
Part B	Special X-Ray Studies, Radioactive		Man-Months
	Measurements, etc.	6.0	1.8
	Radioactive Carbon Studies	2.6	.2
	Fundamental Medical Research	6.0	3.7
	Hematology	2.8	.05
	Medical Work with the 184" Cyclotron	1.1	.5
	Fly Genetics	1.2	.2
	60" Cyclotron Bombardments	.1	--
	Physical Chemistry	9.9	1.7
	Specific Irradiation	4.5	.7
	Donner Animal Colony Expense	1.4	1.9
	Large Molecule Program	1.6	12.0
	Radioactive Iron Studies	.2	.5
6400 Biological Research	Synthetic and Experimental Organic		
	Chemistry	4.4	
	Biological Chemistry	6.8	
	Photosynthesis Chemistry	3.3	
	Metabolism of Fission Products	12.0	
6500 Biophysics Research	General	1.6	