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MONTHLY PROGRESS REPORT
No. 99

June 15 to July 15,1951

August 1, 1951

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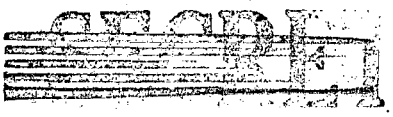

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

June 15 to July 15, 1951

MONTHLY PROGRESS REPORT No. 99

August 1, 1951

1. Bevatron (AEC Program No.1500)

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Magnet. By July 14, 300 out of the total of 704 turns had been wound on the magnet. Progress was slightly slower during the month due to several days required to install thermocouples in the coils. The magnet power supply installation is complete except for the elimination of minor mechanical troubles in the generator lubrication system and the short circuitry switches and electrical troubles in the interlock circuits. The rectifiers are being outgassed and plans are being made for subjecting them to generator voltage although current tests can not be made until the magnet winding is complete. The generators have been run for noise measurements to be used in the design of an acoustic treatment. Design of the terminal structures for the leads from the power supply to the magnet is proceeding.

Vacuum System. The tanks to occupy the straight sections have been designed and bid requests are being prepared. Design of the remainder of the vacuum system is proceeding.

Controls. Temporary occupants of the control room have now moved out in preparation for the start of the control installations. Design of the frequency control system has been proceeding steadily but slowly due to the long time before it will be required.

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

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The cyclotron was used for research experiments approximately 46 percent of the 536 hours that the crew was on duty.

The time distribution was as follows:

Operation for customers	246.5 hours	46.0 percent
Electrical troubles	1.0	0.1
Mechanical troubles	1.75	0.3
General overhaul	286.5	53.5
Miscellaneous	1.0	0.1
Total	536.75	100.0

The non-operative time was used mainly for the cleaning of the lower magnet coil tank and its associated heat exchanger. A deposit of a copper organic compound had accumulated in the coil tank and in the heat exchanger which impaired the cooling efficiency and thus necessitated frequent shutdowns to prevent the magnet from overheating. The system was cleaned by use of organic solvents.

In addition, the installation of the new 1250 kilowatt generator was completed during this shutdown period and is now in use.

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

During this period a new rf deflector assembly was installed with approximately fifteen major changes in its construction. The new assembly is now working better than expected, and another weak spot has been eliminated. The main diffusion pump gate mechanism was also replaced. A new air-operated piston unit was fabricated to replace the old motor-driven screw mechanism. A newly designed radial probe was put in use for production irradiations. Operation has continued to be well above average.

4. Synchrotron Operation (AEC Program No.5731) UNCLASSIFIED

As previously reported, the synchrotron had to be shut down early in May due to difficulties in the rf resonator quartz section. The resonator quartz was replaced and great difficulties were experienced in regaining the betatron beam. It was felt that the new resonator quartz was responsible for the troubles by introducing new and different field disturbances.

Early in June the synchrotron magnet was again disassembled and the original resonator reinstalled after it had been reworked. This did not solve the problems. The pattern of field corrections on the magnetic circuit had to be changed in order to get a betatron beam.

The latter part of June was spent in adjustments of the machine in order to increase the beam intensity. The average intensity was down by a factor of twenty from normal. Continual adjustment of the synchrotron resulted in some beam intensity improvements but these could not be maintained.

The first week in July experimenters began to do research with the synchrotron even though the beam intensity was below normal. Use of the machine for physics research limited the scope of adjustments and changes that could be made. Many of the changes reduced the beam intensity even further for a considerable length of time in the search for new peaks and conditions which would result in increased beam intensity.

At the close of this report period, the synchrotron went on a 24-hour a day schedule to allow time for major adjustment changes without further delaying the research program.

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

In the latter part of this period, the linear accelerator was shut down because of a burned out target, which let air into the column in the Van de Graaff. The automatic valve closed, but not fast enough to prevent sputtering of the insulator. A portion of the repair time was spent installing two new power supplies, an accelerator supply and a 20 kilovolt focusing supply.

Operating statistics are as follows:

Running time	191 hours	47.8 percent
Bake-in time	28.8	6.9
Repair time	181.3	45.3

6. Experimental Physics
(AEC Program No.5211)

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Film Program. π/μ Meson Mass Ratio and Energetics of Meson Decay. Further measurement of tracks has proceeded for improving statistics. All the plates have had good exposures for this experiment and it is simply a matter of reducing the data.

π Meson to Proton Mass Ratio. Improvements of the apparatus have been made to reduce the stray meson background, and further runs will be made.

Grain Density of Highly Ionizing Particle Tracks. Grain counting has continued on the tracks of C^{12} particles and on alpha particles in the same emulsion in an effort to establish the range of velocities over which pick-up of electrons occurs. Evidence for an effect has been obtained.

Meson Scattering. A number of runs have been made to obtain a beam of mesons containing no low energy particles. Any type of channel to define the meson momentum gives rise to such particles, as mesons collide with the walls and suffer loss of energy in scattering back into the beam.

For the albedo method of measuring scattering cross sections, it is much better if low energy mesons can be eliminated from the beam, although fairly good measurements can be made under present conditions.

Interaction of Negative μ Mesons with Matter. Some hundreds of μ^- mesons have been found stopping in emulsion and a prong distribution of the stars produced is being obtained. Background experiments to insure freedom from π^- contamination have been only partially completed.

Electron-Electron Scattering. New emulsion studies of electron scattering have been delayed until a stronger beam is obtainable from the synchrotron. A counter experiment has been under development which employs scintillation counters to detect the primary electron and the knock-on in coincidence.

Technical Problems. A series of measurements have been carried out on

the effect of humidity on the shrinkage factor of emulsions. The ambient humidity both before processing and at the time of observing the processed plates has been found to be important. The weight of water taken up as a function of humidity has also been determined. These measurements are important for any measurement of energy by means of the charged particle range in emulsion.

Cloud Chamber. Tracks were observed in nitrogen gas in a 10 atmosphere Wilson Cloud Chamber with thin windows. Work is being done on the controls to operate the chamber.

Five-hundred decays of the μ^+ meson were observed and their energy measured. The spectrum obtained has no unexpected features.

Several hundred two prong stars were observed on bombarding helium with 90 Mev neutrons. Probably half of these will be analyzable in detail and a complete identification of the various particles appears to be possible in the 22,000 gauss field in which the experiment was performed.

A new improved stereoscopic projector was completed and used in obtaining the μ^+ decay spectrum. This projector is much easier to use than previous designs.

Neutral Meson Program. A new type high energy photon detector, developed by this group and currently being used in experiments involving neutral meson detection, has been calibrated against the pair spectrometer in the neutral meson decay gamma ray beam of the 184-inch cyclotron. A measurement of the neutral meson yield from proton bombardment of a liquid hydrogen target will be completed next month.

Proton Elastic Scattering. The experiment is now considered completed. The last two runs were high angular resolution runs looking for some nuclear structure-dependent effect. Within the resolution of our equipment, there was no difference except that Al seemed to have a slightly sharper minimum than did Mg or Si. The final angles of maxima and minima are as follows for the elements measured ($\pm$ 1°): for C, 1st Min, 21 (?); for Mg, 1st Min, 17½, 2nd Max. 19; for Al 1st Min, 17½, 2nd Max. 19½; for Si, 1st Min 17½, 2nd Max. 19; for S, 1st Min, 15½, 2nd Max. 17; for Cu, 1st Min, 11½, 2nd Max. 14; for Ag, 1st Min, 9, 2nd Max. 12; for W, 1st Min, 8, 2nd Max. 10; for Ta, 1st Min, 8, 2nd Max. 10; for Pb, 1st Min, 7¼, 2nd Max. 10, 2nd Min, 13½, 3rd Max. 15½; for Bi, 1st Min, 7¼, 2nd Max. 9½. The angular distributions agree with those of Bratenahl, et al with 84 Mev neutrons, if the angular scales are adjusted to compensate for the difference in energy of the two experiments.

Cross Sections of Products from Carbon Bombarded by High Energy Neutrons. Method. Spin a disc of polyethylene. Irradiate with neutrons continuously at one point, beta-count the products at other points along rim after achieving product equilibrium.

Progress. 1. Lead shields containing counters have been fabricated, assembled and calibrated. The four end-window Geiger tubes have been matched to run in pairs for voltage, window thickness and count rate.

2. Absorption experiments on polyethylene indicate a 70 percent self-absorption loss for $_6C^{11}$ betas in 1/16 in. polyethylene.

3. Vibration of disc and available motor limits disc speed to 2400 r.p.m.

4. Rotating counter stand, now being fabricated, is last item needed to prepare for a run.

Inelastic Neutron-Deuteron Scattering. Work on this problem during the past month has been concentrated on measurements of the ratio of the inelastic N-D scattering cross sections at a series of angles to the N-P scattering cross sections at the same angles. The use of scintillation counters has permitted extension of the above measurements to smaller scattering angles than could be reached before.

In addition, the magnetic particle analysis was used to investigate the possible presence of elastic deuterons at a large scattering angle.

Quasi-Elastic Scattering of Protons from Light Elements. The equipment associated with the 35 channel magnetic particle spectrometer has been modified for better energy resolution. The energy channels are now defined to 12 Mev or better. The channel energies that were obtained by means of the wire method were checked during the first run using this equipment by the location of the proton energy spectrum from a hydrogen target (CH_2, C difference), at a scattering angle of 22°. Proportional counter and excessive background troubles were encountered during this run which limited the time available for gathering statistics on the energy spectra. From the counting rates obtained during the run, a proton spectrum from carbon can be obtained with 3 percent statistics at the peak in three hours. More effective shielding of the proportional counters and the G.M. tubes should enable us to double the beam and thus obtain this spectrum in one and one-half hours.

High Energy Gamma Ray Experiment. Gamma ray spectra from carbon targets bombarded by 340 Mev protons and 185 Mev protons were obtained using the multi channel coincidence circuit modified so as to reject all coincidences involving more than two signals. An inverting circuit was installed in the coincidence circuit which allows an experimental check of the pair production probability curve for unequal division of gamma ray energy between the electron positron pair and a preliminary measurement of this probability curve was made.

π^+ Meson Production. The low energy end of π^+ production by protons on protons was investigated. The preliminary results indicate the low energy peak in the region of 15 Mev, referred to by Watson and Brueckner, does not exist or is very small.

π^- Meson Production. An initial run was made on the negative production as a function of Z and π^+/π^- ratio. Equipment was calibrated on known π^+ spectrum from hydrogen.

Excitation Function for the Reaction $p + p \rightarrow d + \pi^+$. Work was continued on the excitation function for the $p + p \rightarrow d + \pi^+$ experiment. The last cyclotron

run indicated that the background was too high for sufficiently precise measurements. Additional equipment is being constructed to improve efficiency of equipment.

Elastic D-P Scattering Using 190 Mev Deuterons. Using a single counter and considerable patience good differential cross sections have been obtained at small angles, down to 5° in the laboratory coordinate system. The measurements now extend from 15° to 170° in the c.m. system. A report on the subject is in preparation, which may be available in about two months.

Inelastic D-P Scattering Using 190 Mev Deuterons. Inelastic scattering resulting from p-p collisions has been re-measured at 30° (lab.) and found to be 7.5 mb/sterad (lab.) which is still lower than would be expected theoretically.

D-P Scattering Using 345 Mev Protons. Preliminary work indicates present counter arrangements will be quite satisfactory. The electronic parts are being considerably modified to make better use of the available cyclotron time.

P-P Collisions Inside Complex Nuclei. This problem has been delayed to allow finishing some of the d-p scattering. It will probably await electronic improvements, which could allow data to be obtained considerably faster. The kinematics of the process are being extensively investigated using a perturbation method. Considerable work will be required before detailed angular distributions can be plotted from theory.

Study of Duty Cycle of 184-inch Cyclotron. The duty cycle of the cyclotron deuteron beam has been measured using equipment with a resolving time of 5 microseconds. It had been hoped that the duty cycle could be increased by a slight decrease in the cyclotron magnetic field. Thus far no change has been accomplished. The duty cycle, D, is defined as it would affect accidental coincidences in a double coincidence circuit, namely $D = (I_{ave})^2/(I^2)_{ave}$. The observed value of D is 3.3×10^{-3} (for the external (scattered) deuteron beam). Further analysis of the results will be required before a quantitative comparison between observed and calculated changes in the duty cycle can be made.

7. Theoretical Physics
(AEC Program No. 5211)

MTA. Calculations relative to various features of the cloverleaf cyclotron have continued at an accelerated rate. The fourth-order magnetic field connections required to give phase compensation and the desired orbit stability properties have been computed. An extensive study has been started relative to conditions near the ion source. This work will include the effects of three phase rf accelerating fields and magnetic "cones" and is closely tied to experimental model work along these lines. A study was made of the range of applicability of the flexible wire technique of locating particle trajectories in magnetic fields, as a part of continuing work on the problem of beam extraction and focussing. Other miscellaneous calculations are under way.

Other Studies. The study of π^+-meson production by protons bombarding carbon is nearly completed. A study of the γ-ray spectrum from protons on carbon

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is in progress. Analyses of experiments in progress of n-d and π-d scattering are being made.

8. MTA Program (AEC Program No. 1500)

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Mark I Construction. Pressure testing on the Mark I accelerator is progressing very satisfactorily. The cavity pressure has been pushed below 3×10^{-5} mm. Work still remains to be done to get the pressure down to the operating value. There is a difference of a factor of 2 between pressure readings with and without the liquid nitrogen trap, indicating that there must be some leakage in the vessel. Work on the Chapman valves is underway to get them to seat better.

If the present rate of liner panel completion of four per week can be maintained, the liner fabrication will be complete on August 15. A study will be made by both CR&D and the Radiation Laboratory on leak hunting methods to be used on the panels prior to their installation. The schedule for completion of the baffles in Mark I matches the construction schedule for the liner panels.

Injector Development. The grid of the injector is an essential part of the equipment and one of the weakest links since it is struck by the beam and becomes a source of secondary electrons. A test is being made to achieve focusing of the beam by the use of a solenoid magnet in place of the grid. It appears that the magnet focusing will be satisfactory, but at present a magnet of sufficient strength is not available for complete tests. A run has been made using a magnet of one-half the desired strength and an injector operated reasonably well.

Mark I Target Design Program. The California Research Corporation under a subcontract with California Research and Development Company has been working on Mark I target problems and has evolved primarily processing designs for two rather different modifications for polonium production targets. One target design under consideration involves solid bismuth while the other involves the use of circulating molten bismuth.

The work has proceeded on the assumption that the beam as it leaves the accelerator will be from one to three feet in diameter. The design has been based on CW operations with a 30 Mev 250 milliampere beam having a maximum precession angle of 5° 20 minutes and a precession rate of 36 ± 2 cycles per second. The present target designs do not take into account that the energy may be distributed over a fairly wide range. The design limitation in all cases is the peak metal temperature. In the molten target the bismuth will flow through stainless steel tubes having a maximum tube temperature of 900°F. In the case of solid target the maximum temperature will be the limit that can be tolerated without melting the bismuth. This has been chosen as 460°F. In the case of the solid target stresses produced by thermal cycling caused by the beam precession must be maintained below levels which would lead to the fracture of the bismuth layer and ultimate target failure. For the present design the maximum temperature swing for a 1 foot beam would be 38°F.

The bismuth inventory in the molten system is 50 tons with a circulation rate of 3250 gallons per minute. In the case of the solid target the inventory is 1.45 tons. The diameter of the molten target would be 22 feet. This target would be provided with two banks of tubes inclined at an angle 60° to the beam direction. Approximately 200 9 inch tubes would be required in this arrangement. The circulation of the bismuth would require a centrifugal pump to carry the bismuth into a heat exchanger after irradiation.

In the case of the solid target, consideration has been given to two configurations; one in which the layer of solid material would be contained in a crescent shaped annulus between concentric aluminum tubes; while in the second it would be fabricated into a series of flat plates. Attention has been concentrated on the flat plate arrangement. The individual plates would be 8 inches wide and the heavy aluminum backing plate would be provided with channels to carry the cooling water. A recess in the front face would accomodate a nominal 65 mil layer of bismuth which would be covered by a 20 mil aluminum cover plate.

The problem of pumping molten bismuth has been investigated and some information has been gathered on corrosion, erosion, and mass transfer. Experiments were also undertaken to bracket the approximate range of the diffusion coefficient of polonium through the stainless steel tubing.

The present liquid target design calls for an equilibrium of polonium concentration of 0.05 parts per million, which is well below the minimum acceptable for economical processing. Therefore an integral part of the molten system is a simple distillation process to increase the concentration of polonium. Two or three weeks of operation would be required to attain the equilibrium concentration after which the bismuth withdrawal rate would be about 2 tons per day, from which the enriched distillate would weigh about 100 pounds and contain approximately 60 curies of Po^{208}.

Investigations of the solid target fluxing techniques have been tried to bond bismuth to aluminum and a system involving mechanical abrasion of the aluminum under a layer of liquid bismuth has been found to be satisfactory. What appears to be a workable procedure for fabricating a 8 inch wide plate has now been developed. An ultrasonic technique has been used to test target sections after fabrication. From tests of the thermal conductivity of the bond it appears that it will not be less than 12,000 BTU/hr/sq.ft./degree F.

A number of metallurgical tests have been conducted on the properties of bismuth including bending stress and impact tests. They show that bismuth is an extremely fragile material at ordinary temperature but its characteristics improve markedly at elevated temperatures. The data give reason to believe that bismuth will not fracture under the temperature swings anticipated in the solid target but the properties of creep and fatigue will have to be examined.

Work has been done by the North American Aviation Company since the first of the year on radiation damage. Two small mock up targets have been exposed to the 60-inch cyclotron beam. The targets were made to simulate as closely as

possible within cyclotron limitations anticipated target conditions. Examination of the test specimens has raised no doubts over the feasibility of using the solid target. A poor bismuth-aluminum bond was observed but this has been shown to have resulted from faulty manufacturer of the samples rather than from failure during the run.

Consideration is also being given to possible hazards resulting from the failure of these targets. It is now felt that these hazards are not as great as had been originally feared. Calculations indicate that the worst possible situation would permit the escape as vapor of only about 100 microcuries of polonium.

Mark II Target Program. It is planned to conduct some neutron production measurements at Chicago with 250 Mev deuterons. Present measurements have been limited to the 190 Mev deuterons available from the 184-inch cyclotron. The Chicago experiment may be performed satisfactorily if it is possible to scatter out 10^{-6} of the circulating beam of the Chicago cyclotron. If this method does not prove satisfactory, consideration will be given to the use of a regular beam ejector.

In these experiments it is planned to use both high and low Z materials to test the neutron yield. Present indications are that if a light material such as beryllium were used for the primary target, and backed up with uranium in the secondary, the neutron yield would be about 80 percent of that obtainable with a pure uranium target. The yield from a thorium primary and a uranium secondary would be about 90 percent by comparison. With light Z targets one is more dependent upon multiplication in the secondary target. If 250 Mev is taken as the final energy of the accelerator, a beryllium target may have some merit when consideration is given to all the problems involved. At higher energies where the power distribution goes to greater depths a high Z material is more advantageous.

Information has been obtained to the effect that sintered aluminum slugs canned in either zirconium or aluminum have been developed by the Sylvania Electric Products Company. The sintered slugs are as dense as the present slugs and when subjected to thermal cycling which results in severe growth of the present type the sintered slugs have shown no detectable growth. An investigation of the use of sintered uranium in the primary target will be made.

Mark III Studies. Work is being done on a feasibility report covering the Mark III proposal (the Livermore experimental model), and also to explore as far as possible at this time the ultimate comparison between the linear accelerator and cyclotron approaches. Two of the major Mark II problems, those of holding high voltages in the tank and excessive x-ray loading are of minor consequence in Mark III. The estimate of x-ray loading on this machine is only a few kilowatts and the voltages which are required are approximately 500 kv or less, which is small in comparison with voltages required in A-12.

Tests made thus far with dee voltages in the region of one million volts have shown that sparks developed in the presence of a magnet field are particularly destructive because of the collimation of the discharge. These tests have been run in a system of relatively small energy and additional

experimental evidence is needed to determine whether it will be possible to use copper surfaces or whether it will be necessary to go to the use of graphite or refractory metal surfaces in the region of these discharges. One of the immediate experimental programs is to design a resonator with about 10 times the stored energy of the XC resonator to investigate this sparking problem. It is desired to obtain dee voltages as high as 750 kilovolts with this new system at a frequency of approximately 10 megacycles.

Work is continuing on the electron model of the cyclotron to investigate the beam removal and the variation of beam current with radius. There are also plans to modify the 20 inch injector cyclotron previously used with the quarter scale bevatron model to test three phase dee operation and to investigate ion source development and methods of capturing the beam in stable orbit in a three phase electrical field. It will also give electrical engineering experience with three phase oscillators at a higher power level than has been studied thus far.

Model magnet tests will also be made to determine the maximum energy for which the Mark III may be designed. The limit for iron core magnet is probably between 250 and 300 Mev. Tests will also be conducted on the resonator part of the system. The magnet being considered for this experimental Mark III has no return yoke for it has been discovered from magnet model measurements that the amount of copper and the number of ampere turns required without the return yoke are small enough that the saving in steel more than compensates for the increased magnet power required. This seems to be particularly desirable for the first machine which will be designed without a target and will need the maximum degree of freedom. The magnitude of the stray field for such a magnet has not as yet received detailed study. Consideration is being given to a radiation shielding with iron ore concrete so that the radiation shield will also serve to a degree as a return path for the magnet.

Estimates of the power requirements indicate that this experimental cyclotron can produce a 15 milliampere beam by using six tubes rated at 1 megawatt CW. The choice between pulsed and CW operation also remains to be decided. It is estimated that a 15 milliampere deuteron beam from the experimental Mark III, if run into heavy water, would produce a neutron flux of about 10^{15}.

The data for estimating the cost of Mark III are reasonably complete and it will be possible within a short while for CR&D and UCRL to prepare individual cost estimates of the Mark III installation.

9. Chemistry

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Part A
(AEC Program No. 5311)

X-Ray Spectrometer. The bent-crystal x-ray spectrometer is now in operation with a crystal holder of larger aperture and with a scintillation counter for its detector. Experiments are in progress to verify the energy calibration,

which was in some doubt because of mechanical imperfections. These improvements have increased the sensitivity more than a factor of ten and make possible much wider use of the instrument.

Gamma Ray Scintillation Spectrometer. A sodium iodide scintillation counter for gamma rays, combined with a 20-channel pulse analyzer is now in use as a gamma ray spectrometer. It has already proved to be of great value, and is in much demand for the investigation of radioactive species.

Francium and Emanation Isotopes. Continued work has been done on the emanation and francium radioactivities produced by high energy spallation, making use of special alpha counter chambers for the emanation, the gamma ray scintillation spectrometer, and chemical isolation of decay products. The half-life of Em^{209} is now known to be about 30 minutes and that of Fr^{210} is of the order of 2 minutes.

Recoil of Sodium from Spallation of Aluminum. The recoil of Na^{24} from aluminum irradiated with high energy particles has been studied by measurement of the loss from aluminum foils of various thicknesses and by observation of the activity caught by carbon absorbers. The recoil is all in the forward hemisphere. Its magnitude appears to be maximum at an energy of about 70 Mev for protons and about 200 Mev for helium ions.

X-Ray Diffraction. The anhydrous trichlorides of the yttrium rare earths have been prepared and examined by x-ray diffraction. Most of them exhibit a structure like that of YCl_3, which has not been worked out. The preparation of single crystals is being attempted to provide data for a serious attack on this structure.

Single crystals of sodium superoxide have been prepared by crystallization from liquid ammonia solution. They are being examined at low temperatures to determine if the transition to the low temperature form takes place without disintegration of the crystal, and if so to determine the structure of the low temperature form.

Chemistry

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Part B
(AEC Program No.5311)

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

1. Oxide phase diagrams.
2. Gaseous hydroxides of Mo and W.
3. High temperature x-ray studies.
4. Refractories.
5. Stability of gaseous CN at high temperatures.
6. Heat transfer in forced convection film boiling.
7. Thermal conductivity of gases at high temperatures.

Basic Chemistry. The following problems are under investigation:

1. Germanium chemistry.
2. Thermodynamics of rhenium.
3. Thermodynamics of indium.
4. Thermodynamics of thiosulfates.
5. The hydrolytic polymerization of zirconium.
6. Electron exchange rate between Fe^{2+} and Fe^{3+}.

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Part C
(AEC Program No.6400)

Synthetic and Experimental Chemistry. The preparation of the following compounds has been investigated: aspartic-γ-C^{14} acid and aspartic-β-C^{14} acid via sodium acetate and chloroacetic acid; sodium cyanide-C^{14} by the reduction of potassium carbonate with aqueous ammonia in presence of zinc; glucose-1-C^{14} by condensation of arabinose with sodium cyanide to give a cyanhydrin; guanine-8-C^{14} by reaction of the necessary intermediate with sodium formate; 4-isopropylidene-2-phenyloxazalone-5 (an intermediate in a possible synthesis of labeled valine); cholesterol-23-C^{14}; and a series of di- and tripeptides derived from glycine-1-C^{14} and glycine-2-C^{14}, respectively. The conversion of 200 millicuries of barium carbonate to methyl-C^{14} iodide and then to methyl-labeled acetate as intermediates in the above syntheses is in process as well as the preparation of 50 millicuries of chloroacetic acid-1-C^{14}. Cold and warm preparations of valine by condensation of labeled propyl iodide with acetamidomalonate have been carried out to give the amino acid in satisfactory purity with yields of 42-49 percent. A high specific activity preparation is now in progress.

The irradiation of diglycine in aqueous solution has been shown to produce five known volatile materials, none of which apparently give a ninhydrin-positive test. Identification is in progress. Acetylglycine and glycineamide have been prepared for such purposes.

A series of measurements on the isotope effect in the decarboxylation of phenylmalonic acid has been made. The observed values somewhat higher than the results obtained with α-naphthylmalonic acid, both for the free acid at its melting point and in aqueous dioxane at 70°C.

Biological Chemistry. A number of hypophysectomized rats have been fed a mixture of sugars labeled with C^{14} and the rate of evolution of total and radioactive carbon compared with that of normal rats. The overall metabolic rate for the normal rats is about twice that for the hypophysectomized animals, but the specific activity of the carbon dioxide from the hypophysectomized rats is enough higher so that the total sugar burned to carbon dioxide is about the same for both animals. Further experiments have been carried out with fractionation of stilbamidine in normal and tumorous mouse liver tissue by fractional centrifugation in sucrose and sodium chloride fractionation followed by ethanol precipitation. By the latter method a nucleic acid component has been isolated and shown to contain little or no activity. The

liver of a patient that came to post four days after administration of labeled stilbamidine has been fractionated by the same techniques as used for mouse livers. Similar results were obtained for the distribution of radioactivity as were previously observed for mice. In studies on the metabolism of rats and mice given labeled adenine and guanine the isolation of a nucleic acid fraction from tissues has been carried out by sodium chloride-ethanol fractionation. Other biological studies in progress include: investigation of the steroids in algae for chondrillasterol in Scenedesmus; investigation of transport of labeled C^{14} and H^3 cholesterol in rabbits; investigation of the metabolism of cholesterol-C^{14} in rats; degradation of products from labeled eggs; paper chromatography and color test identification of steroids; metabolism of C^{14} in humans; and development of ionization chamber measurements for low level C^{14} work.

Photosynthesis Chemistry. The participation of C_5 and C_7 compounds in photosynthesis by a number of organisms is being investigated in a variety of ways. Studies on the comparative biochemistry, kinetics of formation and distribution of C^{14} as a function of time of photosynthesis in $C^{14}O_2$ are in progress. The rates of appearance of labeled intermediates are being determined. Evidence for the relative rates of two carboxylation reactions is accumulating, as is that for the sequence of a number of the major intermediates. Periodate degradation of fructose, sedoheptulose and ribulose is being studied to develop accurate methods of C^{14} distribution determination. The problems of degradation of tracer quantities of compounds are different than those of macro work and such development work appears necessary. The fixation of carbon dioxide by Euglena gracilis in the presence of light and in complete darkness has been tested. The same compounds were formed under both conditions. These were compounds normally formed during photosynthesis. Euglena is the first organism out of eleven tested that formed phosphorylated compounds from carbon dioxide in the dark. Whether this fixation of carbon dioxide is a preillumination effect is now being investigated.

10. Medical Physics UNCLASSIFIED

Part A
(AEC Program No.6000)

Tracer Studies. Current tracer studies include the metabolism of the following carrier-free isotopes at 1 and 4 days following intravenous admistration to rats: W^{181}, $Tl^{200,201,202}$, and Au^{196}; and the metabolism of thulium at 256 days following intravenous administration of a dose per rat of 1.6 micrograms of inert thulium and 5 microcuries of Tm^{170}.

Radioautography. Work is in progress on the various uses of NTA stripping film. Lung tissue containing Pu^{239} is being used as an activity source.

Radiochemistry. Carrier-free procedures have been developed for the preparation and isolation of $Au^{193,194,196}$ from platinum, and $Tl^{200,201,202}$ from mercury. Previously reported procedures were used in the production of the following radioisotopes in the carrier-free state: W^{181} and F^{18}.

Preliminary data have been obtained in the radiation induced oxidation of ferrous sulphate solutions by 40 Mev helium ions.

Medical Physics UNCLASSIFIED

Part B
(AEC Program No.6000)

Biological Effects on Animals (184-inch Cyclotron). Sufficient number of rat pituitaries have now been irradiated to finish the acute phase of the study, for post irradiation effects within 2 months. A new group of animals has been irradiated with the aim to observe chronic effects produced. In order to produce significant changes in hormone secretion, the pituitary had to be irradiated with high doses (in excess of 10,000 r.e.p.). To find out the extent of stimulation on the part of the hypothalamus on pituitary hormone secretion, a new phase of this study consists of irradiation of the region of hypothalamus, with the anterior pituitary shielded.

Activation Analysis. Elution characteristics of antimony, molybdenum, niobium, tantalum, promethium, tin, hafnium, nickel, tellurium and manganese on Dowex 50 were determined.

Biological Effects of Radiations on Yeast Cells. Mutant strains of diploid saccharomyces cerevisiae, which were found to possess increased radiosensitivity are being studied. While the normal diploid and haploid strains show 100 percent survival on the two types of media which we use, on class of pre-radiated cells exhibits only 80 percent survival; when a dilute suspension of these cells is plated on nutrient agar, only 4 out of 5 develop into macroscopic colonies. The mechanism of this process is not clear. The effect might be due to a "cytoplasmic factor", missing in some cells, to the ability of each cell to produce about four buds and then die, or the effect may have some other explanation.

Biological Effects of 100 Mev C^{6+} Particles. Adaptation of the cyclotron for biological studies is being continued. Efforts to eliminate low energy multiply charged particles from the deflected carbon beam have been successful.

Radiation Hazards in High Altitude Aviation. An assay has been made of the daily dose in cosmic radiation near the top of the atmosphere. Even though a great part of the radiation is in the form of nuclei, heavier than helium, due to their high velocity the contribution to biological effects is expected to be small. Conservative estimates of dose per 24 hours at medium geomagnetic latitudes, at the top of the atmosphere have been made. It would appear that the overall daily dose is in the neighborhood of the accepted "safe" dose level. In spite of this reassuring finding, it is hard to predict the exact biological effects of the cosmic ray nuclei, particularly when certain specific effects are considered. Among the unknown factors are: possible carcinogenic effects, possible induction of leukemia, effect of radiation on nerve tissue (e.g. vision), radiation cataracts. It seems unlikely, however, that any such effects would result.

Blood Volume Studies at an Altitude of 15,000 feet. Blood volumes were done on Long-Evans rats after exposure to an environment of reduced pressure equivalent to that present at an altitude of 15,000 feet. The blood volume was shown to increase by 60 percent above that of normal controls. This was true of both animals of 45 and 100 days of age. These experiments will serve as a basis for further Blood-Endrocrine studies using the reduced pressure as an erythropoietic stimulus.

C^{14} Labeled Glycine Metabolism. The tissues from the third patient with leukemia to come to autopsy have been obtained and now are in the process of being measured for the C^{14} activity. This patient died approximately 150 days after administration of the glycine -2.C^{14}.

The life span of the rat red blood cell formed after massive hemorrhage is shorter than normal. This indicates that the cells found during this period are in some manner not qualitatively normal.

Studies with Radioactive Stilbamidine. Further studies with melanoma mice indicate that the liver concentration of activity, 4 days following injection of C^{14} labeled stilbamidine, is very little above the liver concentration found in the control mice. Why this malignancy (melanoma) behaves differently with respect to liver concentration than sarcoma is not known.

A second human with multiple myeloma in a moribund stage has been injected with C^{14} labeled stilbamidine (50 microcuries). The patient lived about 4 days after injection. The urine excretion was extremely low (same range of magnitude as was found in the first patient). Preliminary counts indicate about 70-95 percent of the amount injected concentrated in the liver at the time of autopsy.

11. Health Chemistry (AEC Program No. 5311)

UNCLASSIFIED

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

1. Progress was made on special box and equipment for demounting the soldered targets from 60-inch cyclotron.

2. The box and equipment for determination of gas adsorption on heavy elements was completed.

3. Gas tight metal box for inert atmosphere and equipment needed with the thorium diffusion experiments was 25 percent completed.

4. Experiments were continued on equipment for the Fe-Co extractor.

5. A new type case for 184-inch targets was designed and 75 percent completed.

6. A uranium target assembly was completed.

7. Major drawings for a new, improved decontamination chamber were finished.

8. A list of drawings according to subject matter for standard Health Chemistry equipment was finished.

9. Illustrative drawings for a catalog of Health Chemistry standard equipment were completed.

10. Corrections to standard drawings were brought up to date and redesign of chain drive manipulator was 75 percent completed.

11. Two standard 12 x 18 x 3 laminated lead glass windows were fabricated.

12. Plant and Equipment

Bevatron Instrument (Program No. 1500. 5-424-9001) Work is progressing on winding magnet quadrant No. 2 and is considered 40 percent complete.

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

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

Accelerator Design Building. (Program No. 1500. 5-424-1004) This building was accepted June 26, 1951 and is now about 75 percent occupied. The last groups will move into this building by July 25th. Occupancy of the building has been delayed by inability to get phones.

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

Corporation Yard Development. This was started on March 26, 1951 and is 80 percent complete.

Waste Oil Tank. This work was started on May 2, 1951 and is 98 percent complete.

Building 29 and 30 Sprinkler System. This work was started on May 1, 1951 and the sprinkler system in both buildngs is 98 percent complete.

North Gate House, Building 65. A draft of the specifications and a set of revised plans are being reviewed by the University Office of Architects and Engineers. The University plans to advertise for bids on July 31, 1951.

Slope Stabilization, Bevatron Site Area. This work commenced July 2, 1951 and is approximately 12 percent complete. It has consisted to date of dressing the slope in the vicinity of slides four and five with a drag line and placing the earth in a moist condition in six-inch layers and compacting it with a sheepsfoot roller. Under-drains are approximately 40 percent complete.

Wilson Road Repair. Work was completed and accepted on July 13, 1951.

Building 67, Compression House. Work started May 10, 1951 and is 80 percent complete.

Animal House. (Program No. 1600. 6-424-9007) Columns and roof have been poured including lightweight concrete insulation on roof slab. Little further progress can be made until shoring and forms are removed in two to three weeks. Approximately 54 percent of the building is considered complete.

Radiological Laboratory at the University of California Medical School. (Program No. 1600. 6-424-9008) Heating coils are being installed on the second floor. Light fixtures are being installed on the first floor. Cabinet

work is being installed on both floors. The 70 Mev cyclotron is scheduled for shipment from Schenectady, New York the week of July 30, 1951. Work is approximately 87 percent complete.

LMM/8-2-51
Information Division

MAN-MONTHS EFFORT REPORT

Scientific Personnel

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Plant and Equipment			
9200 M.T.A. - Mark I	Design and Development	27.1	
9200 M.T.A. - Mark II	Design and Development	34.7	
9300 Weapons	General	-	
9500 Bevatron	Miscellaneous	.2	
Operations			
Physics Research			
3000 Weapons	General	9.3	
5211 Thomas Cyclotron	Electron and XC Models	15.4	
Experimental Physics	Cloud Chamber	11.3	
	General Physics Research	39.9	
	Instrument for General Use	2.6	
	Special Development	7.2	
	Magnetic Measuring Equipment	4.3	
	Charge-Exchange Accelerator	.3	
Theoretical Physics	General	11.9	
Photographic Film Detectors	General	16.2	
Isotope Separation	General	-	
Radioactivity Physics	General	3.8	

UCRL-1423

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Operations (Continued)			
Chemistry Research			
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	5.7	
	Nuclear Properties of Heavy Element Isotopes	10.6	
	Transmutations with 184" and 60" Cyclotrons	7.7	
	Analytical and Services	14.9	
	Special Chemistry Development	1.0	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.1	
	Instrument Development and Services	3.8	
	X-Ray Crystallographic Measurements	2.7	
	Health Chemistry Research	10.0	
Basic Chemistry Research, Part B	Metals and High Temperature Thermodynamics	6.0	
	Basic Chemistry, including Metal Chelates	6.0	
5361 Applied Chemistry Research	Process Chemistry	13.0	
Reactor and Accelerator Operation			
5731 Synchrotron	Operation	8.3	
5741 184-inch Cyclotron	Operation	11.6	
5751 Linear Accelerator and Van de Graaff Generator	Operation	9.7	

UCRL-1423

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Operations (Continued)			
6000 Biology and Medicine Part A	Metabolic Properties of Various Materials	11	
	Radiochemistry	4	
	Radioautography	2	
6000 Biology and Medicine Part B	Instrumentation for Quantitative Measurements of Radiation	2.0	.7 Consultant
	C^{14} Metabolism	3.4	.7 Man-Months
	Use of Radioactive Materials in Human Physiology and Experimental Medicine	7.1	7.1
	Trace Elements and Irradiation Studies	3.3	2.0
	Radiation and Mutation Rate	2.2	.3
	Physical Biochemistry	11.8	2.9
	Biochemical Response to Irradiation	2.9	1.0
	Miscellaneous	1.0	.4
	Donner Animal Colony Expense	1.5	1.9
	Metabolism of Lipo Protein and Lipids	5.0	7.6
	Iron Metabolism Hematopoiesis	3.0	.3
	Internal Irradiation and Hematological Response	2.1	.2
	Biological Effects of Cosmic Radiation	1.5	.3
	Health Medicine	3.5	-
6400 Biophysics Research	Synthetic and Experimental Organic Chemistry	6.6	
	Biological Chemistry	6.5	
	Photosynthesis Chemistry	5.8	
	Metabolism of Fission Products	13.7	
6500 Biophysics Research	General	2.1	

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