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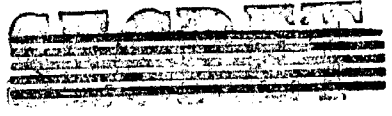
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Special Review of
Declassified Reports

UCRL-1496
Authorized by USDOE JK Bratton *1951*

Unclassified TWX P182206Z May 79

REPORT PROPERLY DECLASSIFIED

JAL Green
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Special Review of Declassified Reports

Authorized by USDOE JK Bratton
Unclassified TWX P182206Z May 79

REPORT PROPERLY DECLASSIFIED

SPECIAL REREVIEW
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MONTHLY PROGRESS REPORT
No. 101

August 15 to September 15, 1951

September 29, 1951

Classification changed to ~~SECRET~~ **DECLASSIFIED**
by authority of Dg. Faum + E.J. Thurman, L.L.
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Berkeley, California

UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

August 15 to September 15, 1951

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MONTHLY PROGRESS REPORT No. 101

September 29, 1951

1. Bevatron

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(AEC Program No. 1500)

Magnet winding stopped for three weeks beginning August 20th for vacations and to permit the production of bakelite coil spacers to get ahead of the requirements. Cracks have appeared in several of the steel bars that clamp the spacer stacks together and in one case a bar has broken across its two inch square cross section. These failures are believed to be due to hydrogen embrittlement during cadmium plating. Their cause and extent is being investigated.

A failure occurred in the bearing on the generator side of the flywheel of the west motor generator set during testing. Westinghouse is remachining the bearing shells and checking the alignment. The set has operated less than six hours.

Shop work is in progress on the magnet terminal assemblies. The sound treatment of the motor generator sets has been reviewed with Dr. Rudwick, the consultant, and the required design is now in progress. The air filters for the magnet cooling system are being installed. The vacuum tank for the injector linear accelerator is being vacuum tested.

2. 184-inch Cyclotron Operation

UNCLASSIFIED

(AEC Program No. 5741)

The cyclotron was used for research experiments approximately 77 percent of the 539 hours that the crew was on duty. The percent of operation was low because of trouble with the magnet generator bearings. The time distribution was as follows:

Operation for customers	414.5 hours	76.85 %
Electrical troubles	4.75 "	.89 %
Mechanical troubles (generator bearings)	119.00 "	22.03 %
Miscellaneous	1.25 "	.23 %
	539.50 hrs.	100.00 %

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

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Operation has continued at a level of 85 percent efficiency. No enforced shutdown of the machine has occurred for some months.

4. Synchrotron Operation
(AEC Program No. 5731)

UNCLASSIFIED

The synchrotron was operated with difficulty during the latter part of August. Physics experiments were run, even though the beam intensity was below average. Attempts to increase beam intensity during this period were not successful.

Early in September the synchrotron had to be disassembled because of a poor vacuum caused by a cracked quartz section. This section was replaced and the machine reassembled. At the close of this report period, a useable beam had not been found.

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

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Aside from a small fraction of time devoted to replacing ion source parts the linear accelerator was in constant operation during this period.

Running time	80%
Repair time	20%

6. Experimental Physics
(AEC Program No. 5211)

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Film Program. Meson Masses and Energetics of Meson Decay. Runs are now being made with the internal proton beam of the 184-inch cyclotron to determine the π^+ , π^- proton mass ratio. Special attention has been given to absolute measurement of the magnetic field employing the nuclear fluxmeter. Cycling to reproduce the field appears to be quite a lengthy procedure. Absolute measurements on successive weeks have shown as much as 1/2 percent variations for the same field current.

Electron-Electron Scattering. Over a meter of 200 Mev electron track in emulsion has been scanned and the corresponding electron-electron scattering cross-section for knock-on electrons from 30 kev to 32 Mev has been calculated and will be published. A corresponding study of 200 Mev positron track is in progress.

π^+/π^- Ratios. The π^+/π^- ratio from carbon at 90° is being measured as a function of meson energy employing the spiral orbit spectrometer. Two rather short complete μ -mesons arising from the decay of π^+ mesons in the emulsion have been seen out of 80 π - μ complete decays recorded, indicating the possibility of a different mode of decay for the π^+ meson. Further study along this line is now being made.

μ -Meson Beam. The negative μ meson beam obtained using the Heckman channel

has a nearly flat spectrum from 50-70 Mev. Approximately 40 percent of the track endings show evidence of nuclear disruption following capture.

Gap Densities of Tracks. The determination of an approximate relation between the gap densities of tracks in various emulsions enables one to measure roughly the pickup of electrons by C^{12} nuclei.

Particles Trajectories. Work on the meson trajectories has been largely completed. The orbital equations for a charged particle in an axially symmetric magnetic field have been transformed for the differential analyzer. Some particular cases have been solved for mesons of mass $275.1 m_0$ and energies 30, 50, 90, and 100 Mev, namely those which pass through an 80 inch radius point in the cyclotron at various angles. The results are being analyzed for focal points of low energy mesons inside, and high energy mesons outside the cyclotron.

Meson Scattering. The study of total scattering cross-section for 40-70 Mev π^- mesons in aluminum, copper, and lead is progressing satisfactorily. To date, approximately 15 large angle scatters ($> 90^\circ$) have been observed. Considerably more scanning must be accomplished; however, present data indicates definite results are to be expected with further analysis.

Technical Problems. Emulsion thickness variation with relative humidity, before and after processing, and the dependence of emulsion density upon relative humidity, have continued to be subjects for experiments which will yield shrinkage factor and stopping power data.

Cloud Chamber. An ionization chamber for projected experiments with He^3 and a diffusion chamber for meson scattering studies have been designed and are being built. A diffusion chamber for Compton scattering studies on protons has been constructed and is being tested.

Operational testing of a 10-atmosphere cloud chamber is being continued.

Photosensitivity has been isolated as a cause of high background in cloud chamber operation, and an intensive study of its effects is being made.

The triple-coincidence circuit on the core of showers in the four by eight foot diffusion chamber has been checked and is now functioning properly.

A data run has been made in the pantagraph cloud chamber, on high energy neutron-induced stars in oxygen. The film is being read. As a first step, a tabulation of oxygen stars according to the number of prongs in each is being made.

Reduction of Cosmic Ray Background for Low Activity Counting. The problem of counting low activity C-14 samples is increased by the cosmic ray background. A possible method of reducing this is to surround the counter containing the C-14 by a cylindrical housing filled with a scintillating liquid which is viewed by photomultiplier tubes. By eliminating the counts from the C-14 counter that occur in coincidence with pulses from the photomultiplier tubes it should be possible to reduce the effects of cosmic rays to a minimum.

As a preliminary, the electronics were tested with pulse generators to

determine the best arrangement of the counting equipment. A mixer circuit for combining the outputs of the four photomultiplier tubes was designed, built, and tested.

Nuclear Internal Momentum Distributions from the Quasi-Elastic Scattering of High Energy Protons from Nucleons in Light Nuclei. With 340 Mev protons incident on carbon, deuterium, and hydrogen, the energy spectra of protons scattered at an angle of 30° have been obtained. The peaks of the spectra can be located in an energy interval within the energy resolution of the equipment. This energy resolution is about 11 Mev.

The theoretical proton energy spectra expected, as functions of nuclear internal momentum distributions, have been calculated assuming collisions between the incident protons and nucleons in nuclei. By inserting the theoretical momentum distribution for the deuteron in Wolfe's equations, a curve is obtained which corresponds, within the accuracy of the experimental data, with the observed spectrum from deuterium scattering.

In the case of scattering from carbon, a momentum distribution inferred from the York-Hadley experiments on the pick-up process provides suitable agreement with the observed spectra.

300 Mev Neutron Elastic and Inelastic Scattering. The large stilbene crystal 5 in. in diameter by $5/8$ in. thick, which was designed for the final phosphor in the triple coincidence detecting system has been satisfactorily grown.

The arrangement of the counters dictates the use of absorbers for the recoil protons which will provide the desired stopping power in the minimum possible distance. Consequently, a set of tungsten foils and plates have been prepared.

The large steel spindle which is to shield the counters from the neutron beam has been turned and is on hand waiting for the mounting cradle. This will provide an annular region with a mean diameter of about 7 in. and a breadth of about $1-1/2$ in.

Neutral Mesons. A further attempt was made to detect γ - γ coincidences from 340 Mev proton bombardment of carbon in the cave of the 184-inch cyclotron. The two telescope arrangement for detection has been described earlier. By varying the intensity of the cyclotron beam over a sufficiently wide range it was evident that the results could be explained by accidental coincidences between neutron induced proton recoils. It is believed that this experiment may be feasible with a substitution of Cerenkov counters for the present crystals in the telescope.

Using the single scattering detector, also previously described, preliminary runs were made to determine the absolute yield of neutral mesons from liquid hydrogen and the yields relative to carbon of lithium, sodium, potassium and calcium.

High Energy Protons from Carbon at 90° to a 340 Mev Proton Beam. Protons from a carbon target with energies from 100 to 200 Mev have been detected at 90° to the incident 340 Mev cyclotron proton beam. The identification was made with a time

of flight velocity selector and by measurement of the range of the particles in copper. The experimental range agreed with the predicted range for a proton having the measured velocity.

Products of Bombardment of Carbon by 90 Mev Neutrons. A run was made to determine the cross section for production of boron 12 from carbon by the spinning disk method. The method was found to be feasible, but insufficient collimation of the neutron beam resulted in high background and consequent large errors. Design of a six-foot-long collimating system to correct this has been undertaken. This method seems to promise eventual results of accuracy of 20 percent or better.

The Inelastic Scattering Program. Work on the inelastic scattering of protons from heavy elements is continuing with most of the recent effort going to reinstrumentation. An attempt is being made to devise an apparatus to identify the various charged particles, emitted during bombardment, besides measuring the energy distribution. Preliminary results with the new apparatus are encouraging. More or less final data have been obtained for p-alpha scattering and the conclusions presented in UCRL-1423 (June 15 to July 15) have been verified. The analysis of the data is not yet complete. A program is being started to make an automatic data taking system for the inelastic scattering program. The nature of the program seems to be in the direction of developing a multi-channel pulse height analyser. It is hoped that particle identification can be included in the scheme.

Synchrotron Studies. Although it was hoped that this month would produce some good operation and some good experimental results, such was not the case. After some rather poor operation on a number of experiments, a week's run was scheduled on the photodisintegration of the deuteron and the alpha particle. The high pressure gas target was set up, and although the beam was poor, some runs were made with the target filled with deuterium. However, a leak developed which caused a complete shutdown before it was possible to get a background run in. While the data obtained are useful, another run is needed to obtain reliable data. Two quartz sections of the donut were changed in the shutdown. No operation since the shutdown has been obtained.

7. Theoretical Physics (AEC Program No. 5211)

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Many of the problems reported last month are still being studied. The optical model of the nucleus proved not to give as good a fit to experimental data on 42 Mev neutron cross-sections as had been hoped. The angular distribution of neutral photomesons from deuterium is being calculated under the two possible assumptions concerning the neutral mesonic charges of the neutron and proton, namely, that they are the same or opposite in sign, with the hope of determining which alternative is correct from the results of experiments to be carried out here.

An examination of the various possibilities for explaining the very long lifetime of pi mesons against electron-neutron decay is in progress. An effort is being made to understand the preliminary experimental angular distribution of negative pi mesons from protons on carbon.

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The discrepancy between Chew's calculations and Stern's observations on the pickup process and the elastic p-d cross section has been resolved by computing the high-frequency Fourier components of the deuteron momentum distribution from improved deuteron wave functions and comparing them with those resulting from the wave functions used by Chew. It was found that Chew's wave functions led to about twice as large a high frequency tail, thus explaining why his calculated cross sections were too large.

A rough calculation of the diffraction scattering of 340 Mev protons from nuclei with variable nucleon density has provided a qualitative explanation of the observed washing out of diffraction pattern details in light nuclei. More exact computations are to be made.

Some calculations of the properties of a non-linear spinor field are in progress. An estimate has been made of the cross section for stripping a deuteron off a high energy He³ nucleus.

The shape of the high energy end of the meson spectrum from the photo-production of negative pi mesons from deuterium yields information regarding spin flip processes. The calculated spectrum indicates that experimental detection is feasible, and experiments are now being planned. If successful, they will lead to a knowledge of the probability of spin flip in this reaction.

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

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Mark I Construction. It has been found that the quality of the head shell welds in the Mark I vessel is poor. In light of the experience during the War with weld failures in ships, there was a remote possibility that this could happen in the Mark I accelerator vessel. There was the possibility of a rip failure starting and proceeding around the end of the vessel if any of the welds should fail at the joints between the cylinder and the head plates and if the steel plate at that particular place had a low impact strength. Even though this possibility is very slight, small steel strut plates are being put in to protect against this. It is considered to be a good safety measure and the installation is not expensive. Furthermore, the work can be done simultaneously with the shot peening and thus will take very little or no extra time.

The surface finish for various parts within the Mark I vacuum vessel have been agreed upon. It is estimated that the exposed vessel and vacuum manifold box surface area inside the annular curtained region is about 40,000 sq. ft. and that the area inside the liner region is about 10,000 sq. ft. The latter figures do not include liner surface areas. The surfaces inside the annular curtained region comprise those surfaces between the liner and the vessel that are exposed to four diffusion pumps as opposed to the region inside the liner that is evacuated by the other 44 diffusion pumps.

X-ray Problem. It has been proposed that glow discharging be used as a means of reducing x-ray production. The process would involve heating the copper surfaces

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to drive off contaminating material. To create a glow discharge the vessel would probably have to be evacuated to a pressure of 1 micron. The excitation could be provided by means of a pre-exciter. However, to obtain a glow discharge in the tank at 1 microp of pressure, the annular area between the inner and outer conductors of the pre-exciter transmission line must be at even lower pressure to avoid sparking. One pre-exciter transmission line is now assembled and the other is being delayed for re-design to provide facilities for pumping separately from the vessel. Since a time possibly as long as four weeks would be needed for the necessary experimental work, it has been suggested that both pre-exciter transmission lines be constructed now with facilities for separate pumping in case it is decided to make use of them at a later date. Recent tests on drift tube conditioning to reduce the x-ray level and the amount of sparking are very encouraging. Both chemical cleaning and heating have been tried and it is found that the cleaning will reduce the x-rays to a low level. Heating, in addition, is necessary to relieve the sparking condition to any great extent. With both cleaning and heating, the x-ray level is reduced to an extremely low point. Because of the fact that the present design of drift tubes for Mark I and the contemplated A-12 will not stand the heating that was used in the tests, it appears advisable to consider now the changes that may have to be made in the A-12 design to take these developments into account.

A-12 Drift Tube Design. The encouraging results on the ability to reduce x-ray and sparking levels by drift tube treatment has led to the consideration of other drift tube designs for A-12, the geometry of which is less favorable from a sparking standpoint but more favorable from the efficiency standpoint. Such tubes would make possible higher energy beams, lower power requirement, and a shorter vacuum tank. The drift tubes would be smaller in diameter than those presently considered and would resemble long cylinders with larger diameter central sections to house the magnets. The bore diameter would be the same as that of the presently designed drift tubes. It may be possible by redesign to realize a power saving of between 30 and 50 percent. The ability to hold a higher voltage gradient would mean that the tank for the A-12 machine could be shortened in comparison with present designs. These improvements may make it advantageous to go to higher energies than the presently chosen 350 Mev, since the higher energies could be obtained with a shorter tank than the present design calls for.

Internal Finishing of Drift Tubes. Various methods of finishing internal parts of the drift tubes have been discussed, such as copper plating, phosphate treatment, and chromium plating.

Many of the internal parts of the Mark I drift tubes have been metalized with aluminum, but there is now some doubt about the value of this aluminizing. Since it is not possible to obtain good shot peening on some of these surfaces, especially those that have been machined, the conclusion has been reached that the aluminum should be removed. The copper drift tube shell is constructed of large copper sheets shaped so that the shell has a continuous surface over the outside area. However, the surface is not continuous through the bore. There is a 4 in. gap around the inner circumference of the bore through which the internal volume of the drift tube is evacuated.

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The oxidation of the steel surfaces inside the drift tubes presents a problem since the dust formed will come out into the bore of the drift tube in a place where it is least desirable and adjacent to high field areas between the drift tubes. It has been suggested that this four inch gap be closed and that the drift tube be evacuated through another aperture. A method could be devised to permit pumping through apertures around the outside perimeter of the drift tube. Alternatively, there is a 20 kv lead pipe 1-in. in diameter and 30 ft. long that is available through which the drift tube might be evacuated from the outside, although there is doubt that the drift tube could be evacuated through this 1-in. pipe to provide a pressure as slight a 1 mm inside the drift tube. If it is possible to block up the gap in the bore adequately so that only 50-100 liters per second pumping speed for evacuation of the drift tubes the outside would be needed, the perimeter pumping area need only be sufficiently large to prevent collapsing of the drift tubes during pump down.

Cyclotron Development. It will be necessary to produce approximately 700 ma of 300 Mev cyclotron beam in order to obtain the same neutron production which can be realized from a 500 ma 350 Mev linear accelerator. Cost estimates are being prepared in terms of beam current and beam energy, both for a single cyclotron to produce 700 ma of beam and also for 7 individual cyclotrons each to produce 100 ma of beam.

The reduced rf losses in the cyclotron as compared with the linear accelerator will result in a power saving of approximately three million dollars [REDACTED]. The ratio of peak to average intensity in the ion beam should be distinctly more favorable for the cyclotron than for the linear accelerator. It is also thought there may be less operating time lost in the sparking of the cyclotron. The linear accelerator, however, has the advantage of being capable of extension to higher beam energy and can, therefore, presumably be made more economical to operate. The magnitude of the target costs for the cyclotron will be determined by the fraction of the circulating beam which it proves possible to deflect, the fraction of the deflected beam it proves possible to conduct to the target, the aperture of the deflected beam, the ratio of the peak to average intensity within the beam at the primary target, and upon the neutron economy attainable within the target lattice.

Visual observations of the deflected electron beam from the electron model have shown that it proceeds beyond the external magnet pole. It has been observed that while the beam is being deflected, none of it hits the fluorescent clippers placed inside the machine. With the electron model it is not possible to obtain accurate measurements of the circulating beam; however, on the basis of visual observation it is estimated that approximately 90 percent of circulating beam can be deflected and that of this deflected beam approximately 90 percent can be focussed on the target. This latter factor of approximately 90 percent has been verified experimentally. It was possible in one experiment by the addition of iron on the pole faces to reduce the horizontal divergence of the external beam from 45 degrees to between 10 degrees and 15 degrees. It was found possible in this experiment to concentrate 50 percent of this focussed beam on an area 1/2 in. by 1-1/2 in. at a distance of one pole radius away from the cyclotron. It should be possible to improve on this with a full scale machine

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so that the target aperture of 2 ft. x 4 ft. should be adequate.

The advantage inherent in introducing the beam to the target through a small aperture could be realized either by reducing the size of the target or by increasing the production from the lattice. In any event, it is concluded that the improved focus of the cyclotron beam would result in a reduction in investment cost of about 10 percent in favor of the cyclotron. A more important consideration, however, would be the approximately 10 percent improvement in production for the cyclotron. It was concluded that the ratio of peak to average intensity for the cyclotron beam would be no greater than 2:1 as compared to 50:1 for the unprocessed and 4:1 for the processed beam of the linear accelerator. It is felt that with a cyclotron about 80 percent of the circulating beam would be available on the target and that the attainable ratio peak to average intensity in the beam would be 2:1. The figure of 80 percent is somewhat in doubt since the electron model does not allow accurate measurement of the fraction of the circulating beam which is being removed. Ten to 20 percent of the circulating beam which is lost will be collected on the tube bank near the deflector.

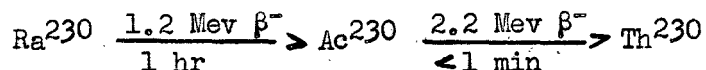
9. Chemistry

Part A

(AEC Program No. 5311)

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Ra²³⁰ and Ac²³⁰. A new beta activity of radium of half-life one hour has been produced by spallation of Th²³². The beta spectrum shows two components of end-points 2.2 and 1.2 Mev. The assignments are believed to be:



The limit on the half-life of Ac²³⁰ is set by failure to milk actinium activity in rapid separations.

The Isomeric State of RaE. Electromagnetic separation at Oak Ridge of neutron irradiated bismuth has confirmed the assignment of a long-lived activity to Bi²¹⁰, and therefore it is isomeric with RaE. This result previously was based on the milking of the Tl²⁰⁶ daughter. The enriched 210 sample had a higher specific activity than any previously available, which made possible a better measurement of the alpha energy. The new value is 4.93 ± 0.02 Mev. The energy difference of this state from RaE is therefore even less than previous estimates, and the long-lived state may even be the lower one.

Properties of Am²³⁷ and Am²³⁸. Irradiation of Pu²³⁹ with 100 Mev protons and with 17.5 Mev deuterons produced two americium activities of one or two hours half-life. A two hour electron capture associated with a 0.7 Mev gamma ray is assigned to Am²³⁸ on the basis of bombardment energetics. A 1 to 1.5 hour electron capture activity, associated with 6.01 Mev alpha particles, is believed to be Am²³⁸.

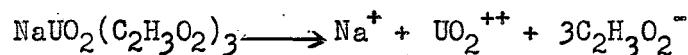
High Energy Bismuth Fission. The yields from fission of bismuth induced by 340 Mev protons are being studied for comparison with the data from 190 Mev fission of bismuth and high energy fission of other elements. Yields of 13 nuclides have been determined so far.

High Energy Zinc Spallation. The yields of 14 nuclides of gallium, zinc, copper, nickel, cobalt, and iron have been measured for the spallation of zinc with 340 Mev protons.

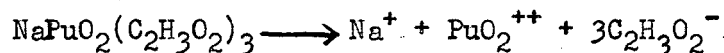
Crystal Structures of Potassium Superoxide. X-ray diffraction studies of KO_2 have shown that at elevated temperatures it has a cubic structure like the room temperature form of NaO_2 . The transition temperature is below $100^\circ C$. However, the cubic form can be quenched to room temperature, and reversible transitions have not been observed. Possibly other structures also occur, because the patterns have not been completely accounted for.

Microcalorimeter. Much work has been done with the microcalorimeter, but the precision is not as good as it is hoped to be. Attempts are being made to calibrate it by measurement of heats of dilution of sulfuric acid.

Two heats that have been measured are:



$$(0.5 \text{ N HClO}_4) \Delta H = -0.65 \pm 0.15 \text{ kcal.}$$



$$(0.5 \text{ N HClO}_4) \Delta H = -0.55 \pm 0.20 \text{ kcal.}$$

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

Basic Chemistry. The following problems are under investigation:

1. Thermodynamics of rhenium.

2. The hydrolytic polymerization of zirconium.
3. Germanium chemistry.
4. Electron exchange rate between Fe^{2+} and Fe^{3+} .
5. Thermodynamics of indium.
6. Thermodynamics of thiosulfate.
7. Solubility of the rare earth fluorides.

ChemistryUNCLASSIFIED

Part C

(AEC Program No. 6400)

Synthetic and Experimental Chemistry. The synthesis of the following compounds have been studied. These include either the development or the actual high specific activity work: Valine-4,4'- C_{14} ; methanol, ethanol and the corresponding iodides via lithium aluminum hydride reduction; vinylacetic-1- C_{14} acid; guanine-8- C_{14} ; glucose- and mannose-1- C_{14} ; aspartic- β or γ - C_{14} ; tristearin-T; leucine-3- C_{14} ; norvaline-3- C_{14} and glycine-2- C_{14} ; additional studies have continued on the general preparation of alpha labeled amino acids via the azlactone condensation. Other studies include (1) irradiation of di- and tripeptides to determine the mode of breaking in hard gamma irradiation; (2) the irradiation of simple organic compounds to study possible synthetic effects; and (3) improved procedures for the low level determination of carbon 14 samples from both chemical and biological sources.

Biological Chemistry. The following biological studies have continued active during the past month: (1) metabolism of labeled sugars and simple organic compounds in normal and hypophysectomized rats; (2) metabolism of glycine-2- C_{14} in humans; (3) products of acetate metabolism in chickens; (4) studies on carbon 14 labeled cholesterol metabolism in rats; (5) metabolism of doubly labeled (carbon 14 and tritium) cholesterol in rabbits; (6) isolation and identification of sterols from algae; and (7) paper chromatography of steroids.

Photosynthesis Chemistry. Investigation of transformations of carbon compounds by green plants and plant tissues is continuing. Further degradations of ribulose have been carried out and an improvement on the present degradation procedure is being sought. Present methods give the labeling of C_1 , C_2 , C_3 plus C_4 , and C_5 . A method of obtaining C_3 and C_4 independently is being developed.

Identification of phosphorylated compounds obtained by ion-exchange analysis from algae (*Scenedesmus*) extracts is continuing.

Feeding experiments with aspartic acid and malic acid in light and dark are continuing. Although there is good evidence that both compounds enter the cell (*Scenedesmus*) and are metabolized to some extent, no photosynthetic products are formed in the light.

A study of the fixation of $C^{14}O_2$ by barley roots under a variety of conditions is proceeding. An analysis of the products of carbon fixation by Euglena in the dark is continuing and degradation of the labeled glucose thus formed is being carried out. An investigation of the physical location of pigments in blue-green algae (Synechococcus cedorum) is in progress.

10. Medical Physics

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Part A

(AEC Program No. 6000)

Tracer Studies. Tracer studies are being continued investigating the metabolic properties of gold, scandium, tungsten and plutonium in rats.

Radioautography. Work was completed on the carrier-free gold 196 radioautographs of liver sections. Investigation into new histological techniques using carbo-wax has been initiated.

Radiochemistry. A carrier-free procedure was developed for the isolation of Mn^{54} from a vanadium target. Previously reported procedures were used in the preparation of microcurie amounts of Sc^{44} and W^{181} . The radiation chemistry studies have continued. The synthesis and degradation of C^{14} labelled organic compounds are being investigated using previously reported techniques. Calibration runs on the centrifugal pump target assembly have been made using ferrous sulphate solution as the chemical dosimeter.

Medical Physics

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Part B

(AEC Program No. 6000)

Biological Effects on Animals (184-inch cyclotron). Data are being obtained for long time studies of selected irradiation of the pituitary gland in rats. Groups now being irradiated will be studied for time periods of six months and one year. Several groups of rats were given local irradiation in the region of the hypothalamus. The rats die within a few days if more than 10,000 Rep are given, whereas when the pituitary is irradiated, as much as 30,000 Rep can be tolerated by the animals. A few hours after local irradiation of the hypothalamus with high doses above 10,000 Rep, the animals show a very abnormal excited state. They are extremely active and exhibit symptoms similar to those found by Bonet-Maury in mice after large doses of whole body neutron irradiation.

The animals which are irradiated with 5 to 10,000 Rep in the region of the hypothalamus do not show retardation of growth or of sexual development in the first two months after irradiation. This is a sign which appears to indicate that the pituitary gland lying close to the hypothalamus has not been appreciably disturbed in the process of hypothalamic irradiation and that the radiation which caused hypothalamic changes does not immediately reflect in the pituitary function.

Activation Analysis. A study of the cross contamination of iron and cobalt in the isopropyl ether separation has been completed. In a two step procedure

iron can be prepared essentially free of cobalt. Separated cobalt is still contaminated by five per cent of the iron activity.

The in vivo distribution of Rb^{86} in rats is being studied.

A cesium peak was identified in activated tissue ash which in the particular ion exchange procedure used goes along with the rubidium fraction. In the future it may be possible to analyze cesium as well as rubidium.

Biological Effects of Radiation on Yeast Cells. In a recent report by De Lamater, (J. Bact., 60, 321, 1950) a technique was described for staining the nucleus of the yeast cells. We applied this technique to yeast cells which received a dose of x-radiation sufficient to kill about 90 percent of the irradiated cells. The yeast cells are observed to have at least one division before death. The resulting doublet swells, and the two cells firmly adhere to one another. The cells were fixed at a post-irradiation time when approximately 90 percent of the irradiated cells had divided only once. Microscopic examination of the stained cells revealed that nearly all the swollen doublets had but one nucleus and this usually was centrally located in one of the cells. Some of the doublets showed the chromatinic structure stretched out in the cytoplasmic bridge between the two cells.

The inhibition of cell division is studied in *Saccharomyces cerevisiae* when the cells are grown anaerobically prior, during, and after irradiation. This anaerobic condition and results are compared to data taken when the cells are exposed to aerobic environment.

Some survival studies have been conducted with x-rays on haploid and diploid yeast cells which have known genetic biochemical deficiencies. For example, the haploid cells are biochemical mutants requiring tryptophane or uracil, while the diploids are obtained by mating the deficient haploid cells. It is hoped that a link will be established by these experiments between the mechanism of inhibition of cell division by radiation and the science of biochemical genetics.

The Use of Multiply Charged Carbon Particles. It was possible to free the external carbon beam of the 60-inch cyclotron from disturbing low energy ions. A Bragg ionization curve was obtained which gave an indication that the 120 Mev carbons are not very monoenergetic. Hence, the highest rate of energy loss that one can hope to reach at the present time in biological experiments is about 8.5×10^9 ev/cm²/g tissue. The fluctuations in the deflected beam direction during irradiation caused considerable trouble in the early biological exposures. This difficulty is being remedied by the construction of a special ionization chamber which will enable us to measure only the fraction of the beam that actually strikes the microorganisms, and at the same time gives indication of the extent of contaminating helium ions accelerated in the cyclotron when the carbon beam is slightly off resonance. The present useful dose rate for microorganisms fluctuates between 10 and 30 rep/minute, and this can be sustained only for half an hour when a filament change in the cyclotron and realignment of the slit system is necessary. This low intensity

makes it somewhat impractical to work with yeast cells so that the use of bacteria of the Pseudomonas family is being considered. This strain has much higher radiosensitivity than most other tested strains of microorganisms.

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Instrumentation. Work has been started on improvement of the sensitivity of the gamma ray pinhole camera. A progress report has been completed concerning this instrument. It was found that the pinhole camera will find usefulness not only in medical and tracer biological applications, but it might also become an important and practical tool in connection with the survey of areas highly contaminated with beta and gamma radioactivity. Exposure of contaminated areas to the pinhole camera could result in obtaining an image of the distribution of contamination. This might facilitate and accelerate the penetration of personnel into contaminated areas and might simplify decontamination procedures as well. Two approaches are being followed in increasing the sensitivity of the pinhole camera:

1. The present arrangement of fluorescent crystal and photographic plate combination for detecting the gamma rays is being replaced by a multiple Geiger counter arrangement. Each counter will initiate the flash of a neon bulb and a panel composed of neon bulbs (or a large neon bulb with many electrodes) and the flashing neon bulbs will then be photographed over a suitable time interval.

2. A television tube developed by the RCA for amplification of the intensity of images is being tested for adaptability to the pinhole camera. This is being done through the courtesy of Dr. Morton of the RCA Laboratories and Dr. L. Wouters of the Radiation Laboratory.

UNCLASSIFIED

C¹⁴ Labeled Glycine Metabolism. C¹⁴ labeled glycine metabolism, long term follow up of urinary excretion in 5 patients given 100 microcuries of glycine-2-C¹⁴, shows that the rate of urinary excretion of C¹⁴ may be described in terms of 3 rate components having average half times of 0.28, 2.5 and 53 days, respectively. Calculation of a total amount excreted indicates that approximately 12 percent of the dose is excreted in this manner: In three of the five patients, the greatest quantities were excreted with the 53 day component. In two patients, the largest quantities were excreted with the first component. With the pulmonary, renal and autopsy data, the complete accountability for C¹⁴ is now possible. This now permits description of the excretion of 98 percent of the administered dose.

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Studies with C¹⁴ Labeled Stilbamidine. It has been found that the administration of very large amounts of irradiation to the livers (with chronic phosphate) of tumor mice does not decrease the concentration of stilbamidine in these livers. Irradiation of the livers of normal mice significantly increases the concentration of subsequently administered stilbamidine in these livers. This unexpected finding in the normal mice is probably due to irradiation damage; but if so, this is the opposite of what might be expected.

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11. Health ChemistryUNCLASSIFIED

(AEC Program No. 5311)

Attached are tabulated the routine activities performed by the Monitoring and the Activity Handling groups.

Equipment Development Group Activities. Work in progress is listed below:

1. Design and drawings are finished for unit for vacuum distillation of Cl⁴.
2. Health Chemistry equipment units assembled for future production in main shops rather than within the group are the microscope front for gloved boxes and the cold bath heat exchanger.
3. The box for processing yttrium was rebuilt after a spill occurred.
4. A special ionization chamber for use in connection with radiochemical processing equipment is complete.
5. A special non-magnetic storage box is complete.
6. Gloved boxes completed include three boxes for the CR and D group, a general box for plutonium work; progress was made on the many boxes for samples coming from the Canadian pile in the near future.
7. Special problems in decontamination investigation include: (1) laboratory surfaces - eight of the new covering materials which are becoming commercially available were given the standard Health Chemistry corrosion tests for adaptability for future uses; (2) studies on special processes for solidification and purification of liquid waste are in progress.

12. Plant and Equipment~~OFFICIAL~~

Bevatron Instrument. (Program No. 1500. 5-424-9001) Magnet winding is 56 percent complete and the winding of Quadrant III is in progress.

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

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

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

Corporation Yard Development. This was started on March 26, 1951 and is 97 percent complete.

~~CONFIDENTIAL
U.S. EYE ONLY~~Miscellaneous Construction (Continued)

Building 67, Compressor House. Work started May 10, 1951 and was completed August 20, 1951.

Building 29, Alterations for Purchasing Department. Work was started on July 23, 1951. This job was completed August 20, 1951.

Building 30, Alterations for Accounting Office. This job was started August 27, 1951 and is 80 percent complete.

Building 2, Alterations to Room 101, Crocker. Benches were fabricated for this job in the shops. Installation of the benches is 98 percent complete.

North Gate House. Subcontract for the construction of the North Gate House has been awarded and work is to start Monday, September 17th. Completion schedule calls for work to be finished in 90 days.

Slope Stabilization, Bevatron Site Area. Earthwork on slides 6 and 7 is about 85 percent complete. Underdrains are in place. Concrete gutter has been finished. Excavation for the retaining wall at the toe of the slope by slides 6 and 7 is 90 percent complete. Approximately 100 feet of the wall and footing have been poured. In the outlet structure which will extend the 48 inch storm sewer at the toe of Bevatron site fill the bed has been poured, reinforcing steel for the pylons is in place and a portion of the corrugated metal arch has been installed.

Paving for 184 inch Cyclotron Site. The subcontract for construction of paving on the 184 inch hill area has been awarded and work commenced on September 12. Although the paving is being installed in a congested area and the preparation of the roadways and the pours will inconvenience hilltop traffic the work is proceeding on schedule.

Animal House. (Program Nc. 1600. 6-424-9007) The building is more than 90 percent complete and although behind schedule it should be completed within two weeks. Painting and completion of mechanical installation is in progress. The order has been placed for built-in laboratory furniture. Bids have been requested on construction of animal runs, run fencing and interior resilient floor covering.

Radiological Laboratory at the U.C. Medical School. Program Nc. 1600 (6-424-9008) The 70 Mev medical synchrotron arrived on schedule in San Francisco on August 23. It has been delivered to the site and rigged into place through an aperture left in the accelerator room wall for that purpose. Masonry has since been installed in the aperture and painted and it is expected that a notice of completion will be filed on September 18. Installation of the synchrotron and its appurtenances is approximately 25 percent complete.

MAN-MONTHS EFFORT REPORT

Scientific Personnel

PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
9200 MTA - Mark I	Design and Development	7.49	
9200 MTA - Mark II	Design and Development	53.66	
9500 Bevatron	Miscellaneous	3.47	
<u>Operations</u>			
3000 Weapons Research	General	4.85	
5211 Physics Research			
Experimental Physics	Cloud Chamber	20.03	
	General Physics Research	55.78	
	Instrument for General Use	2.34	
	Special Development	13.39	
	Magnetic Measuring Equipment	3.24	
	Charge-Exchange Accelerator	.50	
Theoretical Physics	General	10.31	
Photographic Film Detectors	General	18.79	
Isotope Separation	General	-	
Radioactivity Physics	General	6.57	
5261 Applied Physics Research			
Thomas Cyclotron	Electron and X-C Models	20.94	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS
Operations (continued)			
<u>Chemistry Research</u>			
5311 Basic Chemistry Research, Part A	Chemistry of Heavy Elements	5.32	
	Nuclear Properties of Heavy Element Isotopes	13.71	
	Transmutations with 184 inch and 60 inch Cyclotrons	11.01	
	Analytical and Services	14.05	
	Special Chemistry Development	1.00	
	Mass Spectroscopy, Beta Ray Spectroscopy	1.00	
	Instrument Development and Services	4.00	
	X-Ray Crystallographic Measurements	2.255	
	Health Chemistry Research	9.96	
Basic Chemistry Research Part B	Metals and High Temperature Thermodynamics	4.5	
	Basic Chemistry, including Metal Chelates	6.0	
5361 Applied Chemistry Research	Process Chemistry	13.49	
<u>Reactor and Accelerator Operation</u>			
5731 Synchrotron	Operation	10.06	
5741 184-inch Cyclotron	Operation	13.89	
5751 Linear Accelerator and Van de Graaff Generator	Operation	13.23	

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PROGRAM	SUBDIVISION	MAN-MONTHS EFFORT	COMMENTS	
6000	Biology and Medicine Part A	Metabolic Properties of Various Materials Radiochemistry Radioautography	11.0 4.0 2.0	
6000	Biology and Medicine Part B	Instrumentation for Quantitative Measurements of Radiation ¹⁴ C Metabolism Use of Radioactive Materials in Human Physiology and Experimental Medicine Trace Elements and Irradiation Studies Radiation and Mutation Rate Physical Biochemistry Biochemical Response to Irradiation Miscellaneous Donner Animal Colony Expense Metabolism of Lipo Protein and Lipids Iron Metabolism Hematopoiesis Internal Irradiation and Hematological Response Biological Effects of Cosmic Radiation Health Medicine	2.02 3.44 7.07 5.00 1.60 14.25 3.12 1.00 1.20 6.39 3.81 2.45 2.00 3.32	1.85 Consultant .75 Man-Months 8.82 1.81 .25 3.28 .89 - 2.00 9.21 .50 .25 .50 -
6400	Biological Research	Synthetic and Experimental Organic Chemistry Biological Chemistry Photosynthesis Chemistry Metabolism of Fission Products	6.55 5.93 6.06 11.52	
6500	Biophysics Research	General	2.03	

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