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MONTHLY PROGRESS REPORT NO. 129

December 15, 1953 to January 15, 1954

February 5, 1954

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UNIVERSITY OF CALIFORNIA, RADIATION LABORATORY

December 15, 1953 to January 15, 1954

MONTHLY PROGRESS REPORT NO. 129*

February 5, 1954

1. EXPERIMENTAL PHYSICS (A.E.C. Program No. 5211) UNCLASSIFIED

Cerenkov Radiation Counter

Two single tube Cerenkov counters were constructed. An attempt was made to use these to investigate the energy division between the pair particles in the direct decay of the neutral pion. Cosmic ray evidence indicates that this division ratio is different than that from ordinary external conversion of high energy photons.

Gamma Ray Pair Spectrometer

Evaluation of the data from past runs on the 15.2 Mev gamma ray line results in the following summary.

Beam Particle and Bombarding Energy in Lab. System	Target Material	Presence of 15.2 Mev Line	$\frac{d\sigma}{d\Omega}$ in $\frac{\text{Microbarns}}{\text{Steradian}}$ at 90° in Lab. System
30-340 Mev Protons	Be^9	Not Detectable	
110-140 Mev Protons	B^{10}	Not Detectable	
110-140 Mev Protons	B^{11}	Not Detectable	
25-30 Mev Protons	C^{12}	Present	55.7 ± 15.0
56-60 Mev Protons	C^{12}	Present	5.9 ± 1.6
250 Mev Protons	C^{12}	Present	2.0 ± 0.4
340 Mev Protons	C^{12}	Present	3.3 ± 0.7
110-140 Mev Protons	O^{16}	Not Detectable	
190 Mev Deuterons	Be^9	Doubtful**	
30-50 Mev Deuterons	B^{10}	Not Detectable	
5-18 Mev Deuterons	B^{11}	Present	27.5 ± 9.0
15-30 Mev Deuterons	B^{11}	Present	17.5 ± 5.0
40-50 Mev Deuterons	B^{11}	Present	9.4 ± 3.0
80-100 Mev Alphas	Be^9	Not Detectable	

*Previous report UCRL-2446 (No. 128).
**A broader line is seen, and data up to now indicates the probability of this line energy being somewhat lower than 15.2 Mev.

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During evaluation of the above data some interesting points were noticed with regard to the synchrocyclotron beam characteristics. Further experiments showed that beam re-circulation at most radii with thin (e.g. eight mills copper) targets could be as much as 30 or 40 times. We have observed effective internal beam currents which could rise as high as 40 micro amperes. Further experiments on general re-circulation properties should therefore be interesting.

A Comparison Study of $P + D \begin{cases} \rightarrow H^3 + \pi^+ \\ \rightarrow He^3 + \pi^o \end{cases}$ as a Test of Charge Independence

The H^3 and He^3 particles are identified by measuring E and $\frac{dE}{dx}$. The heavy particle telescope consists of three scintillators. The first scintillator is the He^3 $\frac{dE}{dx}$ counter, the second scintillator serves simultaneously as the He^3 energy and the H^3 $\frac{dE}{dx}$ counter. The third scintillator is the H^3 energy counter.

Both 1P21 phototubes and 5819 phototubes view the same scintillator. The 1P21 tubes are close to the scintillator and provide a signal which in coincidence determines when a Techtronix 517 scope is to trigger and display the pulse height signals. The 5819 phototubes view the scintillator from a distance through a light pipe and provide the pulse height signal. The $P + D \rightarrow \pi^+ + H^3$ trigger occurs whenever a triple coincidence occurs in the H^3 $\frac{dE}{dx}$, H^3E and π meson counters (this is fully explained in UCRL-2292). The $P + D \rightarrow \pi^o + He^3$ trigger occurs in the He^3 $\frac{dE}{dx}$ and He^3E counters, and when the pulses are as large as those produced by a He^3 particle of the energy expected. Thus not many fast protons and deuterons will not produce a double coincidence because their energy loss is not great enough. Thus this background will be discriminated against.

The $P + D \rightarrow \pi^+ + H^3$ and $P + D \rightarrow \pi^o + He^3$ triggers are added together and fed to the trigger input of a Techtronix 517 fast scope. The four 5819 pulse height signals are delayed and mixed and fed to the vertical amplifiers so that they occur in succession across the scope face. The trace is photographed and projected with a 35 mm microfilm viewer, and the pulse heights read off by eye. These pulse heights constitute the raw data.

Two runs have been made. The first run was conducted to determine the proper voltages and gains to use for the energy losses to be expected. The second run attempted to make a comparison of the cross sections for the two processes. The results of the second run are now being analyzed. The electronic techniques, the method of calibration, the method of data reduction, and the results will be presented in later reports.

Experiment on Polarization in P-N-P Double Scattering

Further cyclotron runs have been made on carbon and tantalum. For a first scattering angle of 17°, a bombarding energy of 190 Mev, and a second scattering angle of $25^o \pm 6^o$ the results were $e = (R - L)/(R + L) =$ zero within 3 percent for both carbon and tantalum with energy rejection up to 110 Mev. For a 35°, 35° carbon scattering, with a bombarding energy of 245 Mev, an asymmetry of about 5 percent ± 3 percent was observed. With a 45°, 45° scattering asymmetries of 5 percent to 10 percent were observed. These

could be explained by the fact that the 0° line-up is at 180 Mev while the bombarding energy is at 330 Mev or that the polarization is energy dependent. A further run is planned at a 10°, 340 Mev first scattering to examine the energy dependence.

Elastic Scattering of 3.3 Mev Gamma Rays

The experiment to detect elastic scattering of gamma rays from light elements has been resumed with a Co^{56} source of gamma rays in a new geometry. Work is in progress to eliminate the high background counting rate which is present.

Liquid Hydrogen Bubble Chamber

A recent run with the liquid hydrogen bubble chamber was made with the 184-inch cyclotron. An attempt to photograph tracks through the chamber was unsuccessful. The next run will be made with a better optical system and more control over the expansion timing.

$P + P \rightarrow D + \pi^{+}$ Cross Section at 310 Mev

An attempt to measure the $p + p \rightarrow d + \pi^{+}$ cross section at 310 Mev for 90° center of mass was frustrated when the styrafoam liquid hydrogen target developed a crack and boiled away all the available liquid hydrogen. An improved styrafoam target is being constructed.

μ^{+} Mean Life

An experiment to measure the mean life of the μ^{+} meson stopped in carbon and iron is in progress. The reported mean lives are τ_{+} (Carbon) = (2.09 ± 0.03) μ sec (Alvarez, 1948) and τ_{+} (Iron) = (2.22 ± 0.02) μ sec (Bell and Hincks, 1951) which differ by about five probable errors. The resolution of this difference (if it exists) would be significant, since a new mesonic effect would be indicated. The experiment is being performed with the deflected 340 Mev proton beam to the cave. Carbon and iron targets (remotely changed) are inserted in the beam. Most of the resulting π^{+} mesons are stopped and decay to μ^{+} mesons in less than two or three μ sec, and a pair of plastic scintillators in fast coincidence count the higher energy electrons emerging from the target at 90° to the beam. The scaler recording the coincidences is gated by a 2 μ sec gate which can be delayed from 2 μ sec up to about 30 μ sec after the beam pulse. The resultant plot of carbon counts/iron counts against gate delay should be inclined (on semi-log paper) if the difference is real, and flat if there is no difference.

Two runs have been completed. The second was relatively trouble free. The carbon/iron ratios from this are flat within the probable errors, but a slope and thus a real difference, cannot be excluded. Absolute mean life measurements are about (2.11 ± 0.06) μ sec on both elements, essentially in agreement with both previous measurements.

Improved shielding and delay circuits are being constructed to decrease the various errors due to background and gate jitter.

Proton Double Scattering

Work is continuing on double scattering of protons with the 32 Mev beam of the linear accelerator. Because of neutron background the use of counters was dropped and nuclear plates used instead.

The beam into the scattering chamber is collimated to 1/8 in. and strikes the first scatterer at the entrance to the scattering chamber. Across the chamber at an angle θ and a distance of about 20 in. a lead collimator is placed. This collimator consists of two lead blocks extending vertically to within 1/8 in. of the top of the chamber and about 3 in. square. These are placed such that the entrance width is 0.200 in. and the exit width is about one inch. The second scatterer is placed at the back of the collimator. 200 micron C-2 Nuclear plates are placed 1 1/2 in. behind the collimator and centered such that they intercept protons scattered both right and left up to about 40 degrees. The exposures are made with the scattering chamber pumped down to eliminate air scattering.

With 80 mil carbon targets runs of about 10^{-6} coulombs (through the first scatterer) were made. Runs were also made with the second scatterer out to determine the background and to determine $\frac{d\sigma}{d\Omega}$ across the slit.

The developed plates have a sharp umbra which is used to determine the center of the singly scattered beam. The region to be scanned is beyond the penumbra, which is well defined. The background is of the order of 5 percent on both sides and therefore negligible.

For carbon, carbon scattering the results to date are:

1st Angle	2nd Angle	Left Tracks	Right Tracks	Polarization $e = (R - L)/(R + L)$
18° R	20°	2252	2219	- .7 ± 1 %
18° R	28°	1057	1049	- .4 ± 1.5 %
28° R	28°	239	259	+ 4% ± 3%

Note: Errors are probable errors due to statistics only.

Runs have been made with calcium but as the right left difference is sensitive to displacements of the order of a millimeter, inclusions in the calcium have invalidated any results. Samples of pure calcium are on order.

Proton Polarization

During this month two runs were made on polarized protons. It was shown that the beam was indeed polarized and an investigation has been done of the scattering of the polarized beam by hydrogen. This is a further step of significance in the analysis of pp scattering.

N-P Scattering at Small Angles

A very successful run was made on np scattering at small angles at 90 Mev. This shows that at this energy the scattering is symmetrical around

90°, a point on which there was no direct experimental evidence, and which is of considerable theoretical interest if the interpretation often given to it (absence of p wave) should be confirmed also at other energies.

Film Program

As part of the research program on spallation reactions, exposures of C2 emulsions to spallation products from Be, Ni, Ag, Au, and U were obtained. The bombarding particles were 200 Mev protons. Particular emphasis is being placed upon the forward and backward angular distributions of the spalls. The plates are now under initial study.

Other projects under investigation are: (a) high energy two-body reactions, (b) the interaction of 380 Mev alpha particles in G5 nuclear emulsion, (c) γ-ray energy spectra from Pb and Cu under bremsstrahlung bombardment, (d) the β-ray spectrum of N^{12}, and (e) the excitation function of π^- mesons in proton-carbon collisions.

Cloud Chamber Studies

Thirty-five Atmosphere Diffusion Chamber. Testing continued with cosmic rays. A 1/16 in. Homalite ring has been installed insulating the sensitive volume from the stainless steel chamber walls. This permits a higher temperature gradient to be maintained, which improves track quality.

Four Foot by Eight Foot Diffusion Chamber. A platform has been built to support the chamber at height of the bevatron beam. Space for auxiliary equipment and supplies is provided for under the platform.

New side walls 7 inches high have been constructed of 1 1/4 in. oak. Rubber gaskets 1/4 in. by 1/4 in. seal the top and bottom edges. A thin sheet of pure gum rubber will be stretched over the inner surface of the side walls. The rubber provides a gas tight inner wall, protects the wood against the alcohol in the chamber, is easy to clean, and does not poison the chamber.

The alcohol trays have been rebuilt to fit the inside of the new chamber side walls. The old acetone system has been redesigned and is being built. The previous system cooled the bottom of the chamber to too low a temperature (below - 70° C); the new system should maintain a steady temperature of approximately - 68° C.

π-Meson Scattering in Lead. Analysis of data is continuing. To date 300 traversals of mesons through the 1/8 inch lead plate have been followed, and the following events have been observed: 78 stops, 32 with single protons emerging, 6 stops with two protons, 22 back scatters, and 5 scatters with large energy losses of the meson. Corresponding cross sections in millibarns are: 485, 200, 37, 127, 31, respectively.

N-p Scattering at 90 Mev. A total of 2143 actual tracks were obtained from the latest run. When weighted to account for the limitations imposed on the dip angles, this was equivalent to 2864 tracks. The results are not incompatible with a symmetrical distribution. These tracks were combined

with tracks from a previous n-p run and n-p measurements obtained from methane, (total of 5003 actual tracks) to obtain improved statistics. The combined total was not inconsistent with a symmetrical distribution.

Synchrotron Studies

The synchrotron returned to operation before Christmas. The intensity is not up to previous values but the operation is very steady and so quite satisfactory. The major portion of the available time, which was reduced by adjustment time and the holidays was used on experiments with the spiral orbit spectrometer. An investigation is being made of the yields of reactions $\gamma + D \rightarrow \pi^+ + 2n$, $\gamma + D \rightarrow \pi^- + 2p$, using nuclear emulsions and CD_2-C differences. In this run energies around 10 Mev are being studied.

The other run of the period was made to expose more plates to mesons from H and D. Previous results have not been completely consistent, so this short run was in the nature of a background run to investigate possible sources of background contamination.

2. THEORETICAL PHYSICS (A. E. C. Program No. 5211) UNCLASSIFIED

A paper on the first non-adiabatic approximation to the lowest order nucleon-nucleon interaction has been completed and submitted for publication to the PHYSICAL REVIEW.

The possibility of setting up a relativistic Tamm-Dancoff approximation scheme for Green's functions is being studied.

The study of the two-meson equation in the adiabatic limit, undertaken to see whether a virtual V_2^0 state exists, is being continued.

The work on the scattering problem for pseudoscaler neutral mesons in the intermediate coupling region is continuing.

The new-completely covariant approach to the calculation of probabilities for alternative processes in very high energy nucleon-nucleon encounters is still under investigation.

Studies of the Compton scattering from nucleons, and of the high energy neutron spectrum for protons on complex nuclei, are continuing.

A study was made of the model magnet measurements for the proposed conversion of the 60 in. cyclotron to see if the field shape was adequate. In particular, the radial measurements showed a wave which produces a considerable dip in the n-value, but not enough to be harmful. More questionable was the effect in azimuthal variation of two cuts in the shims at diametrically opposed points. An analysis shows that the second harmonic variation produced by the cuts should not be harmful, and a tolerance was given on the difference in the size of the local variations to prevent an excessive first harmonic component.

The conformal invariance of Maxwell's equations has been used to find the class of all non-radiative motions of a classical charged particle. This completes the previously reported work on general transformations on Maxwell's Equations and is now being written up.

3. MTA TARGET PHYSICS PROGRAM ~~CONFIDENTIAL~~
(A. E. C. Program No. 4900)

During the past month work on the large liquid scintillation counter has accelerated, in anticipation of the cyclotron conversion and possible consequent low beam intensities.

The scintillator tank, being an individual event counter, is ideally suited for measuring neutron events in low intensity beams. The Dumont 6292 photomultiplier tubes have been divided into two groups, all the tubes in each group operating at the same voltage, in preparation for being mounted around the tank in to staggered banks. The tank was coated with baked coats of Epon-base enamel supplied by Pacific Paint and Varnish Co., cleaned with reagent grade toluene, and the Pyrex windows mounted in all the portholes. The tank was then filled with technical grade toluene to check the O-ring seals and the assembly of the photomultiplier tubes is underway at present. This should be completed in a few days.

A cyclotron run was made in an attempt to measure the number of neutrons produced by 490 Mev He^3 particles incident on thin targets, and some theoretical work undertaken to see whether these results could be correlated meaningfully with deuteron data. The angular distribution of secondary neutrons from He^3 particles incident on internal stripping targets was measured by means of thin carbon foils spread around the outside of the cyclotron wall. The same experiment on neutrons from stripped deuterons correlated well with data taken in 1947, before the deflectors were installed to obstruct these experiments.

4. ACCELERATOR CONSTRUCTION AND OPERATION
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Bevatron Construction. (Program No. 9001)

Magnet. Magnet operation was stopped on December 19 and the last residual field measurements were completed a few days later. The remainder of the period was spent in installing the remaining pole face windings and their terminations at the ends of the quadrants. Some trouble was experienced from grounds to the copper tubing used for these windings due to the presence of metal chips. The magnet was cleaned as thoroughly as possible but because of the large surface areas involved there is still the possibility of grounds reoccurring. The circuits have been arranged so that in most cases such grounds can be cleared by burning without letting down to air.

In order to install the pole face winding terminations it has been necessary to remove and replace the tangential braces transmitting the magnetic forces at the ends of the quadrants and to remove and to replace the accelerating electrode and liner.

Injector. A hot cathode ion source was tried in the ion gun in place of the PIG source. Operation was unsatisfactory due to insufficient focussing and the PIG source has been replaced. The injector was moved into its approximate final operating position.

Assembly of the inflector in the extension to the east tangent tank was completed ready for installation by the end of the period.

Accelerator. During the last two nights of the magnet operation the rf system was tested and found to operate through the full frequency range under control of the magnet current. No attempt was made to shape the curve to the desired field frequency relation. Stray field from the magnet increases the load on the oscillator tube at high frequency and additional shielding is being installed.

Shielding. Work on the foundation for the shielding is proceeding. The floor has been cut out over the entire area required and about two-thirds of the concrete piles are in place. Twenty-one shielding blocks, or 56 percent of the total quantity, has been received in the building.

Schedule. It is expected that assembly of the accelerating electrode inflector and all remaining parts of the magnet and vacuum tanks will be complete ready to start pumping down during the week of January 18 with the possibility of injection experiments starting the week of January 25.

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

The cyclotron was used for research experiments approximately 92 percent of the 462 hours that the crew was on duty. The time distribution was as follows:

Operation for customers	426.00 hours	92.3 percent
Power shutdown	9.00	1.9
Electrical maintenance	4.75	1.0
Mechanical maintenance	17.00	3.7
Miscellaneous	5.25	1.1
Total	462.00 hours	100.0 percent

184-inch Cyclotron Modification. (Program No. 4900.02)

Magnet. Winding of the auxiliary coil was started last month. The speed of winding was disappointingly slow. It is hoped, however, that several changes in procedure suggested to the Westinghouse Corp. will help to speed up the operation. It is apparent that the schedule for receiving the auxiliary coil will determine the shutdown time of the cyclotron.

Rf Design. Rf design is complete insofar as calculations and experiments with the half scale model are concerned. Present design work is directed toward instrumentation of the full scale test. All major components of the rf system are on order except for the removable panels. The detail design of the latter is complete and the shop drawings are being checked prior to release.

Vibrating Condenser. The vibrating blades are in the process of being machined at Mare Island and no serious obstacles have been encountered. The first pair of blades is expected to be delivered near the end of February.

60-inch Cyclotron Operation. (Operated by the University of California)

There were 389 hours of operating time available in December, 1953. 321 hours of this time was spent on bombardment of targets requiring the use of alpha, deuteron, proton (molecular), carbon (+ 6), nitrogen (+ 7) and neon (+ 10) particles.

Twenty-four hours were spent on experimental pursuits including iron beam snouting, magnetic deflection and preparation for installation of the third harmonic stub lines. The remaining 45 hours were spent on maintenance of the equipment. An operating efficiency of 88.7 percent resulted.

Synchrotron Operation. (Program No. 5731)

At the beginning of this report period, the synchrotron was reassembled. The original resonator was reinstalled after it was repaired, and the beam was quickly found. Adjustments were made so that the synchrotron magnetic field could be compensated against the leakage flux from the spiral orbit meson magnets. The meson magnets were set up near the synchrotron for the purpose of conducing physics research.

The beam intensity continued to improve during this period and reached normal operating intensities by the end of this report period.

Following are operating statistics for the period:

Operation for customers	54.0 hours	16.9 percent
Tests	106.1	33.3
Maintenance	159.7	49.8
Totals	319.8 hours	100.0 percent

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

The linear accelerator and Van de Graaff operated routinely from December 16 to January 15. A short shutdown was made to make a change in the belt discharging needle geometry in the high voltage terminal. In this change the pulley was insulated from the shell and the needles were moved so that they discharge the belt at the rear surface of the pulley. This assures uniform spacing of belt to needles, since the pulley surface defines the belt position accurately. The needle bar has adjustable segments to permit close control of the spacing over the width of the belt. It appears that this change has materially improved the charging system stability.

Work is continuing on the pre-exciter development. The experimental variable oscillator coupling loop is finished, and awaits installation in the linear accelerator. Fabrication of more of these awaits the machine test of the first one.

A run was made in which the rf modulation of the beam at 200 Mc was searched for. Bombarding the photo cathode of an old 931-A, gave a 200 Mc signal at its output which could be detected by a radio receiver. With a better detector it may be possible to use this technique to relate the depth of rf modulation at various distances along the beam to the energy spread of the beam.

Following are the operating statistics

Operation	268 hours	88 percent
Van de Graaff maintenance	23	7
Linear Accelerator maintenance	13	5
Totals	304 hours	100 percent

5. CHEMISTRY
(A. E. C. Program No. 5311)

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The Chemistry of Neptunium

Equipment for the determination of the high temperature equilibrium and thermodynamics of $NpBr_3$ and $NpBr_4$ is being completed. A neptunium bromide sample will be mounted on a quartz fiber cantilever balance contained in an electrically heated reaction tube. Dried nitrogen passing over the sample will remove the bromine which will be collected in a 3 percent hydrogen peroxide solution. From the rate of flow of nitrogen, the loss in weight of the neptunium bromide, and the amount of bromine found in the hydrogen peroxide trap, it will be possible to calculate the equilibrium bromine vapor pressure. Such thermodynamic data is of special interest because the temperature coefficient of the vapor pressure will enable one to evaluate the entropy contribution from the change in the electronic multiplicity on changing the oxidation state of the neptunium.

Heavy Elements

In addition to element 99 recently prepared by neutron irradiation of plutonium, an isotope of the element of atomic number 100 has been prepared by bombardment of heavy californium isotopes in the Materials Testing Reactor. The method of chemical isolation was the same as used for element 99, precipitation and ion-exchange elutions. The atomic number identification depended upon the position in the elution sequence of small amounts of a new activity.

Alpha particles of 7.22 Mev and about 3 hours half-life were found in the ion exchange column fraction corresponding to the eka-erbium position immediately preceding the californium alpha activity. From the alpha systematics, the activity is assigned to the isotope 100^{254}, and a possible reaction sequence leading to its production might be:

$$Cf^{252}\ (n,\ \gamma)\ Cf^{253} \xrightarrow{\beta^-} 99^{253}\ (n,\ \gamma)\ 99^{254} \xrightarrow{\beta^-} 100^{254}\ .$$

As with element 99, there is other unpublished project information on element 100, and the question of its first preparation should not be prejudged on the basis of this announcement.

Other heavy element isotopes which have been prepared by the high neutron fluxes in the MTR are 99^{254} (36 hr., β^-); Am^{244} (26 min., β^- ~1.2 Mev, no γ); Bk^{250} (3.13 hr., 900 kev and ~2 Mev β groups, 1.1 Mev γ in coincidence with 900 kev beta particle).

Angular Correlation Studies

The angular dependence of the coincidences between a 217 kev gamma ray and its corresponding alpha group found in the decay of Th^{228} is being studied to help choose between two possible assignments of spin (1- or 2+) for the 217 level. Although some experimental difficulties prevented as good of resolution as desired, the data obtained seem to definitely indicate that the gamma transition is from a 1- level.

Electron Capture in Cs^{134}

The x-ray spectrum of Cs^{134} has been investigated by the bent crystal spectrometer as part of a program of searching for electron-capture in shielded nuclei. The expected K x-rays of barium were seen from the levels in Ba^{134} from normal β^- decay, but no xenon x-rays were seen which could have been attributed to K-capture decay. The tentative upper limit set by this experiment for the K-capture process in Cs^{134} is ~0.3 percent.

Process Chemistry

Work is in progress on the following problems: the preparation of titanium metal, film boiling from subcooled liquids, thermal diffusion in liquids, the capacity of perforated plate liquid-vapor contacting columns, gas-phase mass transfer studies, the vacuum flow through annular sections, solubility studies, the agitation of liquid-liquid system, and the thermal conductivity of gases at high temperatures.

Metals and High Temperature Thermodynamics

Work is in progress on the following problems: the heats of formation and absolute absorption coefficients of high temperature molecules, gaseous carbon species, magnesium oxide gas, the reflection coefficients of molecular beams, sodium carbonate vapor, molybdenum chloride vapor, and refractory silicides.

Basic Chemistry, Including Metal Chelates

In this field work is being done on the hydrate complexing of Cr^{+++}.

Health Chemistry

Previous progress reports have mentioned the large-scale operation which took place in Bldg. 106, Livermore, in which equipment was designed and built by Health Chemistry for processing multi-curie quantities of fission products combined with multi-curie alpha-emitting substances which had been irradiated in the Materials Testing Reactor at Idaho Falls. As noted before, this operation consumed the greater part of the effort of the Equipment Development and Airborne Activity Control groups, with assistance from personnel in the other Health Chemistry groups. The material was processed successfully and safely.

The over-all design of the setup involved a completely enclosed system at slightly negative pressure, in which all air within the system (and therefore all air in contact with any phase of the operation) could be completely entrapped within the system, being recirculated after chemical and physical treatement or stored as indicated in expandable accumulators. The system included a chemistry processing box, a materials encapsulation box, transfer boxes, and expandable accumulators, switching boxes, air treating equipment, etc. The chemistry and encapsulation boxes were shielded by straight-type lead cave walls, access and visibility being achieved through ball-socket manipulators and lead glass windows.

The equipment for chemically and physically treating the off-gases and leaks in the closed system consisted of electric furnaces to remove hydrogen in a copper oxide bed, recirculating NaOH scrubbers for acid vapor and removal, dewatering condensers, graded filter beds (glass fiber and CWS no. 6) for a particulate removal and silica gel beds for air drying. The control mechanism and electrical equipment employed involved pressure-sensitive regulators, recorders and alarms, refrigerator systems, water pumps and motorized valves, electrical blowers, continuous flow ionization chambers, scrap samplers, filter paper samplers, numerous manometers and other pressure measurement devices, thermometers, expandable accumulators. All of the above was connected together and to the processing enclosures by 1000 feet of noncorrodable polyethylene piping via more than a hundred lucite valves.

This operation afforded considerable experience in ascertaining equipment requirements for processing quantities of material of this order of magnitude. While the closed system described above was completely successful in keeping the air in the locality free of radioactive contamination, further improvements or even different methods of attack were suggested. It was concluded that for larger volume multi-curie chemistry metal boxes should receive preferred consideration.

The above-mentioned principles were tried with success in the processing of crud remaining from the Livermore work; this crud processing took place in a two-inch lead cave in Bldg. 5, Berkeley. The operation definitely showed that with the handling of large quantities of highly active alpha emitters, the employment of swiftly flowing air, recycled through scrubbers and condensers, finally to be discharged through filters, is to be looked upon with favor.

The encapsulated material from the Livermore operation, being highly active on the outside surface, was further encased, this job taking place in Health Chemistry equipment in Bldg. 4, with Health Chemists and chemists performing the task. This work was preliminary to calorimetry operation, in which the absence of contamination was mandatory.

On the termination of the program described above, an equipment disassembly and decontamination period was started. The bulk of the active equipment has been removed and prepared for sea disposal. A few items of less contaminated gear awaits removal and decontamination for possible re-use. The larger pieces of equipment, such as the chemistry and encapsulation boxes, the switching boxes and air dryers and ducting, were placed in metal boxes in Livermore and transported to Berkeley, where cement was poured into the space between the object and the metal box. These units were then dumped at sea.

The remainder of the stock material from which the above-mentioned sampled processed at Livermore were created is being processed in Bldg. 5A annex, and slugs of transuranic materials for irradiation in the Materials Testing Reactor at Idaho Falls are being made.

Research continues on other MTR irradiations and various handling and processing devices have been furnished by the Health Chemistry Equipment Development group; these include a slug cutter for opening irradiated samples encapsulated in quart capsules of less than four mm. diameter. This cutter, based on one used at the MTR, consists of pipes in a telescoping position for breaking the quartz. One irradiation from Idaho Falls was successfully repackaged at the airport in equipment set up on a Health Chemistry truck and immediately returned for further irradiation.

A special inventory and creation of a new indexing system of materials in the Pit Room in Bldg. 5 was made, with a goal of having the holders of the materials therein constantly review their holdings and make renewed decisions as to whether the material should continue in storage. It is hoped that this system will tend to eliminate the accumulation of vast numbers of odds and ends of no value.

6. BIOLOGY AND MEDICINE UNCLASSIFIED
(A. E. C. Program Nos. 6300-6500)

Physical Chemistry of Lipoproteins

Studies of the chemical composition of the various isolated lipoproteins continues both with respect to improvement in analytical methods and with respect to additional isolated lipoproteins having been processed.

The amino acid technique for analyzing the protein part of the various lipoproteins is now operating satisfactorily. Analyses of carefully isolated Sf 6 lipoproteins from two separate individuals reveals the same amino acids to be present and in the same abundance within experimental error. These determinations represent the beginning of a broad study to

determine the extent of variability in structural and analytic chemistry in lipoproteins of a particular flotation class.

The observations of the relationship of lipoprotein alterations with the prognosis for survival following total body irradiation in the median lethal range have been extended and amplified. First the observations have been extended to several additional species. Second, in the rabbit, it is now possible to determine from the lipoprotein spectrum post-irradiation whether or not death will occur with good predictability and further from the particular type of lipoprotein disturbance observed it is possible to predict whether early or late death will occur. These observations are being pursued vigorously to attempt elucidation of possible mechanisms for the observed relationships.

Radiation Studies with the 184-inch Cyclotron

Preliminary data have been secured on the acute effect of pituitary irradiation on thyroid function. After a dose of 10,000 r.e.p. to the pituitary, secretion of thyroxin is inhibited for four days and control against low temperature is also lost. Thyroid function was studied with labeled radioactive iodine. Further experiments are being carried out on this problem with lower doses of radiation to the pituitary.

Cellular Radiobiology

Biochemical changes in the yeast cell are being studied during cell division. One phase of this work concerns the separation of macromolecules, including microsomes, in the ultracentrifuge. When this is done particles of three sizes are found. One of these, the most rapidly sedimenting, is the component identified some months ago by Schachman, et al, as the S80 fraction (microsomes) of yeast cells. A second very labile component is present in the cells only when they are dividing, and absent when they are resting. The second component disappears in cold storage and also when yeast cells are allowed to respire in buffer dextrose in the absence of utilizable nitrogen. The third component disappears even more rapidly than the second when cells stop dividing.

Tracer Studies

Long and short term tracer studies using europium, thulium, cerium, actinium, terbium and lutetium in rats are continuing.

Experiments on the deposition of aerosols in the lungs of primates and long term astatine toxicity studies are progressing as are the experiments on the relative biological effects of astatine, iodine, radium and x-rays for long and short term toxicity studies on rats.

Radiation Chemistry

Studies have been made on the effect of dose rate in the radiolysis of aqueous acetic and formic acid solutions. Analytical chromatographic procedures have been developed for the determination of glycolic, glyoxylic and

oxalic acids. An automatic sampling device has been built for use in the chromatographic analysis of irradiated glycine solutions.

Histology

Further tissues from ten 65-day old control rats were run for comparison with At^{211} animals. Ten rats which received 1.8 μ/gm At^{211} were sacrificed at 6 days for tissue study of liver, spleen, lung, adrenal, mesenteric lymph node, thyroid, lacrimal gland and femur.

Bio-Organic Chemistry

The research projects that have been actively investigated during this month have involved a number of special instrumentation projects which it is hoped will permit more fundamental as well as more precise data to be obtained in our chemical, animal biochemical and plant biochemical research fields. Some of the most important of these instrumentation projects are:

1) A redesign of the algae culture apparatus to permit definitive studies of steady state growth conditions in terms of light, pH, temperature, gas composition and chemical dynamics.

2) Spectral photometric development for study of cell suspensions and colloidal solutions.

3) Instrumentation development for steady state determinations in terms of CO_2, $C^{14}O_2$, O_2, and labeled biological intermediates.

4) Development of instrumental and chemical techniques for scintillation counting of C^{14} and tritium.

5) Extension of our present animal catabolic rate apparatus to permit analysis of specific activities as well as total catabolic activities.

6) Final stage development work in a paper chromatogram radioautograph photoscanner.

The following projects are of a more strictly chemical nature:

1) Synthesis studies on thioctic acid, butyric acid disulfide, ioto-acetic acid, γ-propanol trimethylammonium chloride, cholic acid, β-choline starting with acetylene, and dipeptides.

2) Irradiation studies on quaternary amines, glycine, choline and analogues.

3) Studies on trace contaminants in opium alkaloids.

4) Preparation of enzymes from palnt tissues for the study of the primary carboxylation reaction of photosynthesis.

5) The preparation of known plant anabolic intermediates.

6) Dynamics of synthesis and break-down of the 7-carbon sugars and related intermediates.

7) Paper chromatography of hydroxypyruvic acid.

8) Further studies on the biokinetics of the primary quantum conversion step(s) of photosynthesis.

7. PLANT AND EQUIPMENT REPORT

UNCLASSIFIED

Bevatron. (Account No. 5-271-9001)

The magnet tests have been completed, and the injector assembly has been installed and is ready to operate. The vacuum tank will be pumped down on January 19, and it is expected that the trial runs will be made thereafter. The bevatron shielding foundation work is a little behind schedule, but the subcontractor has been permitted to open up the entire area from the north tangent around to and including the south tangent area. The west tangent caisson work is complete, and the reinforcing steel will be placed in this area as soon as the structural steel trench beam grillages are delivered to the job site. The modifications on the control room are proceeding.

Chemical Laboratory, Building 70. (Account No. 5-271-1002)

The second story walls have been formed, and the second story walls on the east end of the building have been poured and stripped along with the roof slab. The penthouse has been formed and is ready for pouring, and the reinforcing steel has been placed on the west portion of the roof. The plumbing and electrical work is proceeding at an even pace with the general construction work but as yet no heating or ventilating work or elevator work has been done. The entire project is approximately 36 percent complete.

Electronics Research, Building 80. (Account No. 5-271-2002)

Preliminary drawings have been submitted by the architect, but the Architect-Engineer Subcontract No. 80 which has been signed by the architect is awaiting Regents' approval. If all goes well, the final plans for this building will be ready to go to bid about May 1.

Miscellaneous Construction. (Account No. 5-271-2001)

Material for the Destructor has arrived, and construction is expected to start this month. The erection of the concrete block panels for the Gamma House is complete and the interior work on this building is scheduled for completion February 15. Alterations to Building 50 are only 85 percent complete because a guard booth in the hallway was added to this work. The east parking lot is 100 percent complete. The electricians are using the job of installing equipment wiring in the north end of 64 as fill-in work so that this project is 70 percent complete. The roof ventilators on the south end of Building 64 have been installed.

MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

Program No.	Subdivision	UCRL Man Months Effort	UCRL Vac. and Sick Leave
Operations			
3000 Weapon's Research	General	249.40	49.26
4000 Reactor Development - MTA	Design and Development	13.76	2.52
5000 Physical Research			
5200 Basic Physics Research	General Physics Research	45.03	19.55
	Theoretical Studies	10.32	5.04
	Film Detection	11.91	5.03
	Cloud Chamber	7.72	2.62
	Magnetic Measurements	3.51	2.68
	Sub-Total	78.49	34.92
5311 Basic Chemistry Research	Chemistry of Heavy Elements	4.33)	
	Nuclear Properties of Heavy Element Isotopes	9.81)	
	Transmutations with 184" and 60" Cyclotrons	4.91)	
	Analytical and Services	7.48)--	11.28
	Mass Spectroscopy, Beta Ray Spectroscopy	1.77)	
	Instrument Development and Services	4.16)	
	X-Ray Crystallographic Measurements	2.25)	
	Office and Travel	10.26)	
	High Temperature and Special Chemistry	3.99	0.69
	Health Chemistry Research	10.06	
	Sub-Total	59.02	11.97
5361 Applied Chemistry Research	Process Chemistry	3.43	
5731 Electron Synchrotron	Operations	4.88	
5741 Synchro Cyclotron (184")	Operations	7.46	
5751 Linear Accelerator	Operations	8.34	
5761 Proton Synchrotron-Bevatron	Operations	10.44	
	Sub-Total	34.55	
TOTAL PHYSICAL RESEARCH		172.06	46.89

MAN-MONTHS EFFORT REPORT

SCIENTIFIC PERSONNEL

Program No.	Subdivision	UCRL Man-Months Effort	UCRL Vac. & Sick Leave	Consultants Man-Months Effort	Consultants Vac. and Sick Leave
6000 Biology & Medicine Research					
6300 Medical Research	Health Medicine	1.29			
	Internal Irradiation	4.51		0.64	
	Sub-Total	5.80			
6400 Biological Research	Miscellaneous	3.90)		2.57)	
	Instrumentation	2.71)		-)	
	C_{14} Metabolism	2.64)		0.56)	
	Use of Radioactive Material in Human Physiology	9.77)		4.90)	
	Trace Elements	3.16)		-)	
	Physical Biochemistry	8.74)--	13.71	2.91)--	5.18
	Biochemical Response to Radiation	2.53)		1.21)	
	Metabolism of Lipo-proteins	5.95)		8.29)	
	Iron Metabolism Hematopoiesis	2.62)		-)	
	Biological Effects of Cosmic Radiation	1.93)		-)	
	Radiation and Mutation Rate	1.72)		0.42)	
	Bio-organic Chemistry	22.31	5.92		
	Metabolism of Fission Products	13.93	4.07		
	Animal Colony	2.56	0.44	3.38	
	Sub-Total	84.47	24.14	24.24	5.18
6500 Biophysics Research	Health Physics	3.66			
	Irradiation Studies	2.58		0.84	
	Sub-Total	6.24			
TOTAL BIOLOGY AND MEDICINE RESEARCH		96.51	24.14	25.72	5.18
GRAND TOTAL - OPERATIONS		531.73	122.81	25.72	5.18

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