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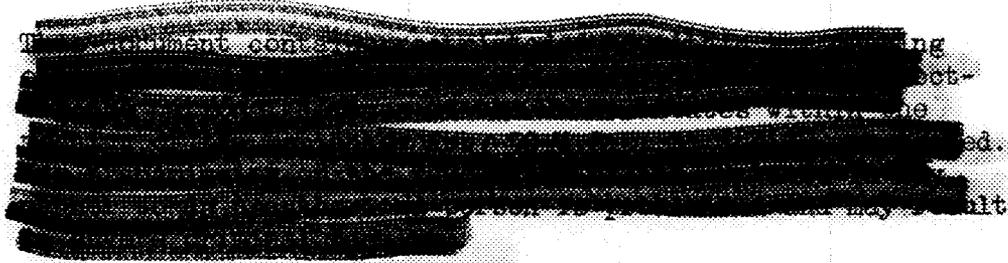
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RESEARCH AND DEVELOPMENT  
PROGRESS REPORT  
FOR THE MONTH OF APRIL 1948



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BIOLOGY DIVISION

Experiments on the mutability of neurospora of specific loci are progressing; a considerable amount of information is now available on the relation between ultraviolet dose and reversion rate at the inositolless locus utilizing microconidial stocks. Genetic analyses of colonial types appearing on minimal media in connection with reverse-mutation experiments indicate that these do not represent "partial" reversions of biochemical mutants, but are morphological mutants which segregate from wild-type as single-gene differences.

The yield of x-ray induced chromosomal aberrations in Tradescantia can be increased (for the same x-ray dose) by simultaneous treatment with ultrasonics. The yield of one-break and two-break chromosomal aberrations from treatment with 250 r of x-rays and 250 r of x-rays plus five minutes treatment with ultrasonics (about 9,000 cpm) have been compared. From an analysis of about 2,000 cells, the ratio of x-ray plus ultrasonics/x-rays alone has been found to be 1.3/1 for both one-and two-break aberrations. This increased yield is about the same as has been obtained by centrifugation in conjunction with x-rays

The occurrence of several interesting morphological mutations has prompted the pointing at the mutation study along a different line than previously anticipated. It seems necessary to study the relative frequency of the different types of mutations obtained when various radiations are used, since there is a possibility that all of the mutants are not produced as a result of the same mechanism.

The microbiology section has spent the past month in studying the effect of ultraviolet on Scenedesmus obliquus and Chlorella pyrenoidosa, with colonies picked for mutations. The specific type of mutation wanted is one effecting the mechanism of photosynthesis. Screening methods are being tried for this purpose. Two mutants of Scenedesmus have been obtained which fail to grow on mineral media with CO<sub>2</sub> and light. These mutants will grow when dextrose is added to the medium. Experiments are in progress to study these mutants thoroughly from the standpoint of their pigment and photosynthetic reaction. Dr. van Niel's cultures of purple bacteria arrived and some work has been started on them.

Two experiments on rutin are still in progress and should be finished during the course of the next thirty days. The first studies the effect of rutin upon local radiation injuries. The tail (rat) was exposed to 2400 - 3600 r and the effect of rutin upon the course of the injury is being followed. The second experiment checks the effect of rutin upon the survival of rats subjected to two sublethal exposures of x-ray at an interval of two weeks. A preliminary endocrine experiment has indicated that the rat deprived of its pituitary gland has an LD-50%, about half



[REDACTED]

that of the normal. An exposure chamber to irradiate the skin of the rat has been tested out, and as a result of these tests another improved chamber has been ordered.

During the past month apparatus has been designed and constructed for preparing and analyzing gas mixtures of variable composition and for equilibrating blood with these gases at precisely controlled known temperatures (0.05°C). Improved vessels have been designed and constructed for conducting diffusion experiments. Semi-remote control equipment has been completed and tested for converting active potassium carbonate, as obtained from the Clinton reactor, to isotonic potassium chloride. Studies are now in progress to test whether erythrocytes will maintain their normal characteristics in vitro under the conditions of the new experiments which we propose to conduct in the near future.

Multiplication of animals in the breeding colony is proceeding very well. Tabulation of the tests for Salmonella, carried out since the mouse colony was established, indicates no particular danger from this organism. Preliminary radiation experiments in the somatic mutation project have been started. The results are encouraging for the further development of this project, at least so far as the ability of irradiated pregnant females to bring their litters to term is concerned. Work on the technique of artificial insemination is now proceeding along two lines: (1) insemination of estrous mice through the vagina; (2) injection of sperm into the ovarian capsule of mice that have mated with sterile males.

#### CHEMISTRY DIVISION

During this month progress of interest has been made in the direction indicated below.

In connection with the xenon problem, the remote handling devices for the PdI<sub>2</sub> preparation have been installed and found to be workable after the usual amount of minor alterations. Final assembly of the glass portions of the equipment can now proceed.

The X-ray emission spectrum of element 61 has now been photographed at Y-12 using a sample prepared here. Excellent photographs of the four K lines were obtained. As a by-product of the large scale preparation of element 61, fairly large samples of 2 y Eu<sup>155</sup> and ca. 20 y Sm<sup>151</sup> have been prepared.

A new development in connection with radioisotope production is the recovery of Cs<sup>137</sup> from waste tank supernatant liquid by adsorption on a resin column.

The development of the lithium aluminum hydride reduction of CO<sub>2</sub> for the preparation of C<sup>14</sup> labeled methanol has progressed to the completion of a run on a tracer scale.

Further effort made to determine the conditions favoring the existence of the new, cubic phase of BeO suggests that carbon, perhaps as Be<sub>2</sub>C, stabilizes the new phase by solid solution formation.

Part of the declassifiable work of the last few months was presented at the American Chemical Society meeting in Chicago. Ten papers were read, four on the design of laboratories for radiochemistry, two on the transuranic elements, two on ion exchange as a separation method, one on gas adsorption and one on a phase rule study of the system UO<sub>2</sub>SO<sub>4</sub>-H<sub>2</sub>O.

## PHYSICS DIVISION

### High Flux Reactor

The servo system is now operating satisfactorily from signals generated by the reactor simulator. It moves a 30 pound control rod; it can hold the neutron level constant to 0.1% when  $k_{eff}$  is held constant and can correct a step change of 0.2% in about 0.3 seconds. Further work on the servo system will be directed towards developing a new tachometer, although the present system is in general satisfactory and could be used as it is.

Critical experiments using lucite in the Be reflector to simulate water have continued. It has been verified that the 3 kg reactor actually will have about 18% excess  $\frac{dk_{eff}}{k}$  and therefore the originally computed critical data for the high  $k$  flux reactor will need no major revisions.

### Nuclear Physics

In the neutron decay experiment, work continues in the direction of increasing reliability and reproducibility of the results. An experiment was made with the reactor off and a pure gamma source substituted for the beam. Characteristic foil differences and voltage differences observed in the presence of slow neutrons disappeared. This is significant because it tends to corroborate the inference that these differences are produced by decay protons.

Work on anthracene scintillation counters continues with procedures for producing large clear crystals having been worked out. The crystals have now been used in the delayed coincidence work and the apparatus refined so that delays of as little as  $10^{-7}$  seconds can be observed.

### Neutron Physics

Measurements of the coherent scattering cross section of the elements is continuing. In the case of Co a pronounced spin dependence is observed ( $\sigma_{coh} = 1.5$  b,  $\sigma_{tot} = 5$  b. Lead, on the other hand, shows only a small (if any) spin dependence,  $\sigma_{coh} = 11.9$  b,  $\sigma_{tot} = 13$  b. In this connection it should be mentioned that Fermi and Marshall gave a value  $\sigma_{coh} = 2$  b.

[REDACTED]

This bears on the neutron-electron cross section studies of Havens, Rabi and Rainwater. They assumed no spin dependence which is justified by the new measurements.

Study of order-disorder lines in the Ni-Mn system has been started.

The scattering of neutrons by liquid  $\text{CCl}_4$  has been measured. The observed peaks correspond to those obtained in X-ray and electron diffraction studies except that neutron scattering shows the characteristic slower fall off in intensity with angle.

The study of the stopping of fission fragments in helium, air and argon is now almost completed.

In the study of short life activities a number of substances have been investigated. There seems to have been found a new short lived activity in Ta, but this cannot yet be stated definitely.

#### Theoretical Physics

A study of the feasibility of aligning nuclei in solids by strong magnetic fields at low temperatures has been undertaken. A discussion group has been formed and is meeting weekly for the purpose of investigating possibilities in this field. It appears that at a field of 40,000 gauss and a temperature of  $.01^\circ\text{K}$  it will be possible to line up more than 20% of the nuclei with non-vanishing spin.

Monte Carlo calculations have been completed for slowing down of neutrons in water and for the problem of multiplications by  $n-2n$  in Be. The Monte Carlo method for calculating multiple scattering of gamma rays is being investigated and it appears to be beset with difficulties connected with the polarization of the gamma rays. In anticipation of the procurement of a large digital computer, a discussion group on coding methods and principles of computing machines has been organized.

#### Solid State Physics

Al-U Alloy. A third group of samples, exposed in the Hanford reactor for 300 days, has been investigated. Measurements of the dimensions, electrical and thermal conductivity, and hardness have been completed. No change in dimensions has been observed; the conductivities are now reduced by a factor of about .6; and the hardness has increased from an original value of  $R_p40$  to  $R_p102$ . In the sample in which 1 atom in 150 of the alloy has fissioned, evidence of brittleness has appeared, but the material still has some ductility.

Semi-conductors. Samples of Ge, Si, Se, and  $\text{Cu}_2\text{O}$  have been exposed in the Clinton reactor under various conditions of location and local shielding with Cd. Observations of the electrical resistance while in place are made by bringing leads out from the samples. The resistance changes are quite complicated in some cases, in others relatively simple and in accord with the hypothesis that displaced atoms produce new acceptor levels in the bombarded semi-conductors.

[REDACTED]

U-blistering. The appearance of the "blistered" U slugs from Hanford suggests the existence before irradiation of macroscopic regions of inhomogeneity in the slugs. Evidence of these regions is being sought for by minute changes in slug contour after thermal cycling. A simple but sensitive profilometer good to .0001" has been developed for this purpose.

## POWER FILE DIVISION

### Reactor Design

Navy Reactor Studies. Tentative requirements for the construction of the active fuel assemblies for the reactor were established for use as a guide in the development of suitable fabrication techniques. The design study of a mechanical control rod drive has been nearly completed for seven control rods. This design incorporates individual spring return drives for each shim rod under emergency shutdown conditions but with provision for re-engagement to permit resumption of operation. Attention has now been turned toward consideration of a mercury control "rod" to estimate the feasibility of applying such a system to this reactor construction. Its chief advantages are a material reduction in pressure shell height, and possibility of considerable flexibility in the number and size of control "rods" incorporated in the reactor. Work was resumed on the study of the surge tank and is aimed at a design which will answer the major problems without attempting to carry it through to a complete construction design.

Hanford Experimental Facility. A recommendation was submitted to the AEC Reactor Development Group to provide in the Hanford reactor at least one experimental test hole passing completely through the reactor with a return duct through the foundation. Such a test facility would permit future testing of power reactors on a laboratory scale. A section of the reactor under investigations would be constructed, inserted in the hole, and operated as nearly as possible under the proposed operating conditions of the nuclear power plant. The results of a preliminary analysis of the problems associated with providing such a test facility were submitted to the AEC.

### Nuclear Engineering

Navy Water-Cooled Reactor Study. Studies of six-inch and eight-inch beryllium reflectors have been made. The saving in fissionable material content of the reactor over that of the water-reflected reactor is sufficient to justify serious consideration of beryllium as a reflector material.

Analysis of a zirconium-water reactor is progressing. Results to date show that if the reactor can be constructed with a water-zirconium ratio of about 2, and can be provided with a beryllium reflector, less than 20 Kg. of U<sup>235</sup> will suffice for start-up of the reactor at the peak of the poison curve.

Calculations have been made for an array of seven three-inch control rods in the bare equivalent reactor. The results indicate that the three inch rods will control a large excess of U<sup>235</sup> above the approximately 20 Kg. contemplated for the reactor.

Reactor Simulator. An analysis was made to determine whether the network constants could be so adjusted as to make the lumped network exactly equivalent to the distributed electrical analog of the reactor at mesh terminals. The analysis showed that the correction factor required is not independent of the multiplication constant, k.

#### Engineering Analysis

Preliminary calculations were begun for a water-cooled Naval unit to operate at a pressure above the critical pressure for water, and with reactor water coolant temperatures high enough to make possible the use of superheated steam at about 700°F total temperature at the turbine throttle. Problems were investigated in connection with the design of a heat exchanger boiler and superheater to transfer the heat from the reactor coolant to steam for use in driving the turbines.

#### Material Development and Experimental Work

Static Corrosion Tests. Static corrosion tests have been run on samples of zirconium, columbium, aluminum, and titanium in the presence of distilled water. The tests run at 300°C did not show much corrosion of the sample. However, at 350° the corrosion was much more evident on all samples. Zirconium and aluminum have been tested most as interest centered on these two metals. It is planned to continue these tests with varying temperatures and perhaps the addition of H<sub>2</sub>O<sub>2</sub> to study corrosion characteristics of the metals in contact with the dissociation products of water.

Dynamic Corrosion Tests. Equipment was designed for determining the corrosion resistance of reactor materials in the presence of high temperature water under conditions as close as possible to those encountered in the water-cooled reactor study. Four test stands were designed based on equipment available on the area, and is designed to operate at 600°F and 2,000 psi pressure.

UCLA Heat Transfer Research Program. Negotiations towards setting up a research program under Dr. L. K. Boelter at the University of California at Los Angeles on heat transfer to water at high temperatures and pressures and rates of flow up to 50 ft. per second, together with the study of "film boiling" and density variations with time were continued. The method of handling the administration of the program has been established and an informal agreement reached with respect to the size and cost of the program as well as with respect to the subjects to be investigated. As a preliminary effort, an experiment will be conducted to investigate heat transfer and pressure drop for water flowing in a tube at system pressures up to about 2000 psi. As a parallel development it is proposed to set up experiments to investigate the boiling phenomena by employing a glass tube with an electrically conducting film as the heat source. A small amount of work was done preparatory to setting up an experiment on the stability of flow in parallel tubes which transfer different amounts of heat to the water flowing upward.

Creep Test Experiment. The purpose of this experiment is to measure the creep of the materials while undergoing reactor radiation. Work on the instrumentation for the experiment was started by designing a rig for testing a microformer coil in the reactor. Some bench measurements were made to check the feasibility of a pneumatic micrometer. High pressure and high temperature tests were made on the bellows which is being considered for the creep apparatus.

Miscellaneous. The thermal expansion of several BeO rods was measured and the expansion apparatus was modified to enclose the samples in an inert atmosphere.

### RADIOISOTOPES

The following table indicates the number of shipments for March and April, 1948, and a total-to-date figure since August, 1946, the start of the Isotope Distribution Program.

|                      | March<br>1948 | April<br>1948 | TOTAL<br>AUGUST, 1946, to APRIL, 1948, Inc. |
|----------------------|---------------|---------------|---|
| Separated Material   | 221           | 211           | 2,301                                       |
| Unseparated Material | 78            | 58            | 908   |
| TOTAL                | 299           | 269           | 3,209                                       |

Two hundred and eleven of the monthly shipments were to off-project customers, thirty-one to other Atomic Energy Commission installations, and twenty-seven to foreign countries.

In order to make the shipment of radioisotopes to foreign countries less expensive, it has been decided to raise the radiation limit on rail and boat shipments from 15 mr/hr to a maximum of 200 mr/hr. For the present this will be done only in special cases where an unusually large amount of activity is desired. Most rail shipments will continue to be made with less than 15 mr/hr at the surface of the container to keep, insofar as possible, the same standards for air and rail shipments. As soon as regulations permit, air shipment will be made with higher than 15 mr/hr radiation at the surface. This will effect a considerable saving in weight and, consequently, in cost of air shipments.

#### Iodine Development Work

A run with dead slugs was made in the tantalum-lined dissolver to continue tests on the efficiency of the removal of aluminum coatings with ten-percent HNO<sub>3</sub>, containing 0.05% Hg(NO<sub>3</sub>)<sub>2</sub> catalyst. There is some evidence that a slight mercury contamination of the UNH solution occurs. If necessary, a portion of the uranium will be dissolved in seventy-percent HNO<sub>3</sub> and discarded to prevent any possible Hg or Al contamination.

[REDACTED]

A series of tests were performed on dead slugs in glassware which showed that the bonding on Hanford slugs can be removed only with caustic solution, thus making it impossible to do this work in the tantalum-lined dissolver.

#### Cl<sup>14</sup> Development Work - (From Be<sub>3</sub>N<sub>2</sub>)

The installation of facilities for Cl<sup>14</sup> - Be<sub>3</sub>N<sub>2</sub> work is practically complete.

Experimental work has gone forward in testing a number of Ba(OH)<sub>2</sub> absorber-precipitators. A system is being devised whereby dry BaCl<sub>4</sub>O<sub>3</sub>, which is quite dangerous to handle, need not be scraped off filter discs. The BaCO<sub>3</sub> is being handled as a slurry, centrifuged, and dried in the final container.

#### Fission Products

UNH solution carried over from the last dissolver run was passed through the all-column equipment, mainly to secure the Zr-Cb and Y fractions.

It has been decided to decontaminate the cell and completely revise and simplify the equipment. The original equipment had been installed using stainless steel in many places, including the head tank. To prevent corrosion by the sulfuric acid used to remove uranium, one-percent HNO<sub>3</sub> had to be added. It was found that even this small amount of HNO<sub>3</sub> injures Amberlite resins over a period of time. Furthermore, HCl cannot be used, which seriously limits the flexibility of the equipment. The equipment will be re-installed, using only glass and plastic. In the revised flow-sheet, Zr-Cb will be absorbed on a small non-ion exchange pre-column and most of the remaining fission products and uranium will be passed to the large four-inch column. After the uranium is removed with sulfuric acid, all the remaining activity is removed from the column with 6-10 N HCl. Most of the HCl is distilled off this eluant, the residue is diluted with water, and it is passed through a long, thin, column; the activity concentrating in a tight band at the top of the column. The activities are then fractionated from this column with citrate solutions at various pH's. In the original system, citrate solution was used to elute material from the four-inch column, HNO<sub>3</sub> was added to destroy the complexing action of the citrate, and the activities were placed on several small columns. However, tight bands of activity are not formed at the tops of the columns by this method and the subsequent fractionation is very poor.

About 150 millicuries of yttrium was purified during the month and is ready for shipment. The limit for alpha contamination was changed from 70 c/min/mc Y to 150 c/min/mc Y because the former value is too low to be consistently counted in the presence of the large amount of beta activity.

[REDACTED]

The purification process for Zr-Cb has been worked out and extraction equipment for one-half-curie batches is being set up. The Zr-Cb is extracted in 0.5 M TTA-benzene, the Pu washed out with dilute HCl, the Cb extracted with strong HCl, and most of the TTA is removed from the organic phase with sodium hydroxide. The amount of complexing agent in the organic phase is then so small that the tightly-held Zr may be extracted with HCl-oxalic acid solution.

#### Ruthenium (Ru<sup>106</sup> -ly)

About 150 millicuries of Ru<sup>106</sup> were purified during the month. Some trouble with yields was experienced by the regular operating group in the primary separation of Ru from the Tank Farm wastes on ferrous hydroxide. A study showed that it is necessary to use the pure grade of ferrous sulfate originally used in working out the process and that the sample of supernatant used to check yield must be drawn from a point high up in the tank, well away from the settled ferrous hydroxide.

The Ru distillation equipment is being revised and more shielding added to permit safer operation.

A method is being sought to re-carry the Ru<sup>106</sup> from the accumulated ferrous hydroxide precipitates, thus avoiding distillation from large volumes of liquid. Precipitation of copper sulfide in a sulfuric acid solution of ferrous salt and Ru seems promising, an eighty percent yield being obtained in the first experiments.

### TECHNICAL DIVISION

#### Reactor Mock-Up and Engineering Development

Construction of the reactor mock-up has started by the J. A. Jones Construction Company. This will include a full scale model of the reactor tank, so set up as to test the hydraulic and mechanical features of the high-flux reactor design. The design work on the mock-up tank and its contents is not yet complete. Reactor engineering tests, including corrosion, scale formation and heat transfer, thermal stresses, heat dissipation, fluid flow, radiation stability, controls, etc., are continuing.

#### High-Flux Reactor Design

The design of the beryllium assembly is progressing. Stock-piling of vacuum cast beryllium and of beryllium oxide for the reactor proper has been authorized, and arrangements for their procurement are being made. Only minor attention has been given to other items of design of the High Flux Reactor.

Chemical Separations Processes

The 25 pilot plant operations with Clinton-irradiated metal have been completed. While the activity level was too low to demonstrate the ultimate decontamination factors obtainable, these were clearly greater than  $10^4$ , and apparently exceeded the  $10^5$  required. Uranium losses were consistently far below the 0.1% limit set. No crud formation or other serious mechanical difficulties were noted in the 1400 hours total processing time to date. Decontamination and inspection of the pilot plant is underway in preparation for the runs on Hanford-irradiated metal to be started soon. Laboratory and semi-works investigations on neptunium recovery and on increasing decontamination by the use of complexing agents and of solvents other than hexone have continued.

The current delay in starting irradiation of the 25-Al alloy slugs at Hanford is expected to result in at least a one-month idle period for the pilot plant next winter between the Hanford-metal and the Hanford-irradiated 25 alloy runs.

The new Solvent Building for the 23 semi-works is under construction. The design of the equipment to be installed therein is being pushed vigorously. Development work on the 23 process is limited until this building is ready for use, as there is no other safe facility available for work with very volatile solvents and high activity levels.