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# OAK RIDGE NATIONAL LABORATORY

## STATUS AND PROGRESS REPORT

AUGUST 1952

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# OAK RIDGE NATIONAL LABORATORY

# STATUS AND PROGRESS REPORT

August, 1952

J. P. Lane

Date Issued: SEP 9 1952

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Post Office Box P
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OAK RIDGE NATIONAL LABORATORY

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August, 1952

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PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

Purex Process (AEC Activity 2803.2)

The plutonium and uranium products from the Purex pilot plant continue to meet specifications. A one ton batch of pilot plant uranium product was successfully de-nitrated at Harshaw Chemical Company; sodium and phosphorus impurities were quite low. The Purex pilot plant operation is scheduled for completion by October 1, 1952. The 3019 Pilot Plant will then be decontaminated and converted for use in Thorex pilot plant programs. Chemical studies and an economic analysis of Purex plant operation will continue.

The development of a process to recover plutonium from metallurgical wastes has been completed. The product loss is only 0.7%.

SCRUP Separation (AEC Activity 2344)

The processing of Chalk River fuel rods in the 3505 Pilot Plant was continued during the past month and this program is scheduled to be completed in September. This pilot plant will then be decontaminated and limited equipment modifications made to convert the pilot plant for the recovery of uranium from the ORNL waste storage tanks.

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PROGRAM 3000 - WEAPONS

RaLa Production (AEC Activity 3982)

Run #49 was completed August 3, 1952. This could possibly be the last run at ORNL; the future need for the product is somewhat indefinite.

## PROGRAM 4000 - REACTOR DEVELOPMENT

### HOMOGENEOUS REACTOR PROJECT

Homogeneous Reactor Experiment (AEC Activity 4103.10)

After several weeks of intensive effort, the program for recovery of enriched uranium which escaped through a leak in the HRE fuel system has been completed.

While the recovery program was under way, the reactor system was thoroughly checked and repaired or altered as needed. The system is now believed to be in the best possible condition, and hydrostatic leak tests are under way.

Radiation Studies (AEC Activity 4109.31)

Catalytic studies of peroxide decomposition have been carried out using catalysts that may be present in homogeneous reactor fuel solutions. The study is not yet complete, but the following data have been obtained by a conductance technique:

Catalytic Effects of Various Ions on Peroxide Decomposition In $UO_2SO_4$ Fuel Solutions at 100°C

| Species Added | Conc. in ppm* | Decomposition Rate Constant $\Delta k$ in $sec^{-1}$ | Peroxide Half-life in sec |
|---|---|---|---|
| $Ru^{++++}$ | 29 | 0.15 | 4.5 |
| $Fe^{++}$ | 11 | 0.081 | 8 |
| $Ni^{++}$ | 16 | 0.0031 | 96 |
| $Cr^{+++}$ | 24 | 0.0050 | 84 |
| $Rh^{+++}$ | 113 | 0.0066 | 64 |
| $I^-(I_2)$ | 154 | 0.011 | 38 |
| $Cu^{++}$ | 800 | 0.018 | 31 |
| $Ag^+$ | 3 | 0.0017 | 108 |
| $Ce^{++++}$ | 7 | 0.0012 | 108 |
| $Ti^{++++}$ | 3 | 0.0010 | 123 |
| Pd black (heterogeneous) | 290 | 0.0064 | 68 |
| Pd black, $Cr^{+++}$ } Combination | 240, 24 | 0.061 | 10 |
| $Cu^{++}$, $I^-$ } Combination | 350, ? ** (trace) | 0.027 | 17 |
| $Fe^{++}$, $Cu^{++}$ } Combination | 6, 800 ** | 0.34 | 1.9 |

* Concentration required for maximum catalytic effect.

** These concentrations are considerably above what is required for maximum catalytic effect; minimum concentrations have not yet been determined.

Dynamic Corrosion Studies (AEC Activity 4109.4)

The 347 stainless steel loop containing 5 g U/l $UO_2SO_4$ has operated over 3000 hours at 250°C with a general corrosion rate below 0.1 mils per year. Some of the uranium precipitated from the original stoichiometric $UO_2SO_4$ solution, leaving an equilibrium uranium-to-sulfate ratio of 0.88 in the solution remaining in the loop.

The loop containing titanium components is being operated with an atomosphere of hydrogen and oxygen at 250°C with 300 g U/l $UO_2SO_4$. However, the gas recombines so rapidly that the loop can only be operated about 8 hours before the gas supply (from cylinders) is exhausted. Total operation to date is about 24 hours.

HRP Metallurgy (AEC Activity 4109.4)

Tests on the possible embrittlement of titanium by hydrogen have been carried out by exposing a titanium sample as the cathode in a sulfuric acid solution and by exposing another sample in 40 g U/l $UO_2SO_4$ solution at 250°C under 900 psi pressure of hydrogen and oxygen. No embrittlement effect was observed in break and impact tests on both samples. Additional titanium samples are being exposed in the fuel circulating system of the HRE.

Slurry Pumping Studies (AEC Activity 4112.1)

The pressurizer of the 100-gpm slurry loop was replaced with one of a modified design to prevent hold-up of slurry particles in the pressurizer. The modified loop has operated 350 hours at 250°C with no further hold-up of particles in the pressurizer. However, cavitation caused by the orifice plates is still present. New orifice plates are bing installed.

The front bearing of the Westinghouse 100A pump was replaced because of wear after 1400 hours running in slurry. The wear was smooth and even, with no evidence of erosion or corrosion. In dynamic corrosion test loops the average life of bearings in non-corrosive media is about 1400 hours also.

The slurry loop was operated for one week with 200 psi oxygen pressure in the loop. No effect on corrosion or erosion was observed, based on the pump impeller weight, which has not changed measurably since the loop was started.

A glass loop has been set up to allow visual observation of the hydrodynamics of slurries at low pressure and low temperature.

The system for carrying out slurry critical experiments is being set up for testing to determine its operating characteristics. After testing, the assembly will be moved to the critical experiment facility for actual use.

Homogeneous Reactor Fuel Reprocessing (AEC Activity 4109.81)

The study of adapting the Purex Process to the Homogeneous Reactor was continued which has resulted in further improvement of uranium separation from neptunium. In addition radiation stability studies of the solvent have indicated that the expected radiation damage will not significantly increase the plutonium losses.

AIRCRAFT NUCLEAR PROPULSION PROJECT

Aircraft Reactor Experiment (AEC Activity 4401.1)

The reflector cooling circuit has been designed around the use of the $BeF_2$-NaF eutectic as a coolant. Neither NaK nor the fuel carrier NaF-KF-$ZrF_4$ are satisfactory.

The gas seal pump originally designed for ARE use has been found to be unusable for fluoride circulation without extensive modification of the seal. Since the surge tank design is intimately related to that of the pump, details on the surge tank will not be released prior to resolution of the pump problem. All other details of the fluid circuits are proceeding as rapidly as drafting manpower permits. The fuel injection system has been completely detailed and this equipment is being released for fabrication in local shops.

To completely remove the fission gases ($Br_2$, $I_2$, Kr, Xe) from the helium stream coming from the NaK vapor trap before they are released to the stack, a carbon absorber unit is being used. The unit consists of four 4" IPS stainless steel tubes - the first and second tubes are maintained at liquid nitrogen temperatures to cool the gas stream and solidify the $Br_2$ and $I_2$, the third and fourth tubes, which contain approximately 700 cu. inches of 20-28 mesh CXA carbon, to absorb Kr and Xe.

Detailed drawings have been completed for the ionization chamber liner and shield installation and for the ionization chamber gas system. Relay cabinet layout and wiring diagrams are in progress. Ionization chambers, preamplifiers, amplifier cabinets, relay cabinets, control console and recorder panels under construction by the Radiation Counter Laboratories for October delivery are on schedule.

Components for a simplified servo control have been assembled for testing with the analogue computor. The regulating rod speed has been established at 0.1% $\Delta k/k$ per second with a total of 0.4% $\Delta k/k$ in a total rod travel of twelve inches.

The pilot model of the high temperature fission chamber is ready for test. Two additional assemblies are under construction with completion expected in thirty days.

ARE Critical Experiments (AEC Activity 4401.2)

The mock-up of the fluid fuel-coolant aircraft propulsion reactor has been loaded and made critical. The critical loading was about 5.8 kg $U^{235}$, which is in good agreement with theoretical predictions. Control rods have been calibrated and changes in reactivity incurred by the introduction of structural materials and other poisons are being evaluated.

ANP Radiation Damage (AEC Activity 4401.4)

Detailed metallographic and chemical analyses of the fuel mixture 5% NaF: 50% KF: 41% $ZrF_4$: 4% $UF_4$ (mol basis) reveal that this is a satisfactory fuel so far as radiation damage is concerned. Detailed analyses are not complete on the other fuels containing zirconium.

No change in the thermal conductivity of Inconel after irradiation in the LITR at temperatures between 350°C and 830°C has been observed.

Heat Transfer and Physical Properties (AEC Activity 4401.5)

Viscosity measurements have been made for two zirconium fluoride fuel mixtures. For the fuel 46% NaF: 50% $ZrF_4$: 4% $UF_4$ (mol basis) the viscosities range from 20 centipoises at about 580°C to 7 centipoises at about 830°C, and for the fuel 50% NaF: 46% $ZrF_4$: 4% $UF_4$ (mol basis) the viscosities range from 17 centipoises at about 580°C to 6 centipoises at about 830°C.

Some preliminary thermal conductivity experiments on the fuel 10.9% NaF: 43.5% KF: 44.5% LiF; 1.1% $UF_4$ (mol basis) have yielded the conductivity values $2.2 \pm 0.2$ Btu/hr.ft$^2$ (°F/ft) over the temperature range 500°C to 750°C.

Enthalpy and heat capacity measurements have been determined for lithium hydroxide.

Experimental forced convection heat transfer data for molten sodium hydroxide flowing turbulently in circular tubes were represented by the equation

$Nu = 0.021\ Re^{0.8}\ Pr^{0.4}$ (Nusselt, Reynolds & Prandtl number respectively)

over the Reynolds number range 6,000 to 12,000. This equation is within 9% of the one which is normally used to describe convection heat transfer of the ordinary fluids. Information on thermal entry lengths was also determined.

Some experimental pool boiling data for a mercury system have been obtained for several pressure levels and two different kinds of heat transfer surface materials.

Some heat-momentum transfer analyses have been made for the ANP thermal convection harps for the purpose of predicting the liquid circulation velocities. This information is needed in the interpretation of the harp corrosion results.

ANP Metallurgy (AEC Activity 4401.5)

The technique of solid phase bonding was used in the preparation of high temperature solid fuel elements. Various combinations of stainless steel, nickel, molybdenum, and iron were run at temperatures from 2100° to 2400°F. The metallographic examination has been completed on this series of solid phase bonding tests and the results are as follows:

| Excellent | Good | Fair | Poor |
|---|---|---|---|
| Fe-Fe | Mo-Ni | Mo-Mo | Mo-Fe |
| Stainless steel-stainless steel | Mo-Ni-Mo | Mo-Inconel | Stainless steel-Mo |
| Ni-Inconel | Ni-Ni | | |
| Ni-stainless steel | Ni-Fe | | |

Alloys being studied for the preparation of spherical particles for use in fuel element cores are Ni-U, Cb-U, and Mo-U. One technique is to spray a molten alloy through a metallizing gun. As yet only about 10% of the particles formed have been in the necessary 0.008 to 0.012 inch diameter range.

The following lists of ceramic materials were tested in sodium at 816°C for 100 hours: Al 576 (porcelain), Mica, Al-192 (titanium dioxide), $SiO_2$, Al T 106 (barium titanate), $Al_2O_3$ (single crystal), lead glass, $ZrO_2$ (Hf free), $ThO_2$, Al 243 ($2MgO.SiO_2$) (fosterite), Al 202 ($2MgO.2Al_2O_3.5SiO_2$), Al A (aluminum silicate), Pyrex glass, Al 475 (zirconium silicate), $HfO_2$, soda glass, TAM $ZrO_2$, Al 228 ($MgO.SiO_2$), $Al_2O_3$, SiC, MgO, MgO (single crystal), Spinel, Al 550 ($ZrO_2$), Zircon, BeO. Results of these tests show BeO, Zircon, Spinel, MgO, SiC, $Al_2O_3$ were still intact after the tests and showed slight weight gain while the other materials completely disintegrated during the test.

The effect of small differences in test temperature on the stress-rupture life and creep rate of Inconel has been studied. The creep properties of Inconel when tested in argon and air have been studied and it was found that Inconel tested in an air atmosphere has a much longer stress-rupture life.

ANP Reactor Chemistry (AEC Activity 4401.5)

Phase equilibria in systems involving $UF_3$ are under study as possible non-corrosive fuels. $UF_3$ reacts with $ZrF_4$ to produce some $UF_4$ and a reduced zirconium phase as yet unidentified. The equilibrium constant for this reaction is as yet unknown.

$ZrF_4$ may be prepared in the presence of NaF by reaction of $ZrO_2$ with HF. This reaction requires about 12 hours to convert one kg of $ZrO_2$ in the apparatus used. It appears that by proper choice of reaction conditions it will be possible to avoid use of $ZrCl_4$ and sublimation of the $ZrF_4$ in preparation of ARE fuel mixtures.

The fuel containing 50% $ZrF_4$: 46% NaF: 4% $UF_4$ (mol basis) shows a vapor pressure corresponding to the equation:

$$\log P \text{ (mm Hg)} = -\frac{7630}{T(^{o}K)} + 7.988$$

The corresponding equation for $ZrF_4$ appears to be:

$$\log P_{(\text{mm Hg})} = -\frac{11320}{T(^{o}K)} + 12.46$$

ANP Corrosion (AEC Activity 4401.5)

An electromotive force is developed between nickel electrodes which are maintained at different temperatures in a sodium hydroxide bath containing nickel oxide. The potential is of the proper magnitude and sign to account for the observed mass transfer reaction. The potential is not established when nickel oxide is excluded and when a carefully purified hydrogen atmosphere is used.

Reactor Physics (AEC Activity 4401.7)

The theoretical investigations of the kinetics of the circulating-fuel reactor continued, still disregarding for the time being the possible coupling between "nuclear" oscillation and mechanical vibration. With this simplified concept, a large temporary disturbance was assumed to be applied to the reactor and, if the reactor survives the first short maximum of power and temperature, the following power and temperature oscillations prove to be rather moderate.

Considerable enthusiasm is felt regarding the "Fireball", a reflector-moderated circulating-fuel reactor. A number of multigroup IBM calculations have since been performed. However, this is the first time that the method has been applied to reactors with very different properties in core and reflector, and with absorptions which are fairly large and also vary within a lethargy interval. Hence, confirmation of the results by critical experiment is necessary.

ANP Experimental Engineering (AEC Activity 4401.1)

One-half of 1% zirconium hydride was added to (Na-K-Li)Fx which was circulated in an Inconel thermal convection loop. Upon examination of the loop, only .0005" corrosion attack was found. This is the least amount of corrosion experienced in any loop in which fluoride mixtures have been circulated. An unidentified precipitate was present in some of the grain boundaries in a discontinuous layer below the surface of the hot portion of the loop.

A level indicator and controller has been developed for use in connection with temperature fluid systems which will maintain the levels of two free surfaces within .1" of each other. This instrument incorporates a tapered iron core

attached to a float riding on the free surface. The iron core operates in the field of an induction coil which indicates level changes and operates appropriate solenoid valves for maintaining equal levels of the free surfaces.

Line plugging tests continued to operate for approximately 1300 hours with no evidence of line plugging. In this test high purity helium is swept across a free surface of (Na-Zr-U)Fx which is maintained at 1050°F, and exhausted through gas lines of .120" and .186" diameter. The vapor pressure of the fluorides at this temperature is approximately 80 microns. An attempt to trap out the sublimed $ZrF_4$ in a cool tube containing a large number of baffles resulted in complete plugging of the 3" diameter tube in less than 50 hours of operation. In this test high purity helium was swept across a free surface of 1500°F (Na-Zr-U)Fx and was exhausted through the cooled baffled tube.

Further tests are being conducted in an effort to trap out the sublimed $ZrF_4$ by passing the saturated exhaust gases through a bath of 1500°F (Na-K-Li)Fx. The effectiveness of this trap has not yet been determined.

A bi-fluid loop is being assembled, containing a counterflow concentric tube heat exchanger, in which measurements will be made of the overall heat transfer coefficient from (Na-Zr-U)Fx to NaK.

## PROGRAM 5000 - PHYSICAL RESEARCH

### REACTOR OPERATIONS

The total accumulated KWH for X-10 pile operations during August were 2,324,013 averaging 3476 KW per operating hour. Pile down time was 10.1% as compared with 6.4% in July. There were three slug ruptures, all discharged without difficulty.

The total accumulated KWH for LITR operations during August were 868,727 averaging 1497 KW per operating hour. Down time was 22.0% as compared with 30.2% in July. A boiling experiment was conducted during the month.

### PRODUCTION OF ISOTOPES

Radioisotope Production (AEC Activity 5111)

| Radioisotope | Millicuries Shipped |
|---|---|
| $I^{131}$ | 33,835 |
| $P^{32}$ | 8,943 |
| $Co^{60}$ | 27,780 |
| $C^{14}$ | 805 |
| $H^{3}$ | 14,720 |
| $Sr^{90}$ | 6,269 |

The total number of millicuries shipped during August was 94,048 and the number of radioisotope shipments was 796.

Stable Isotope Production (AEC Activity 5121)

The calutron tank time was devoted to the collection of germanium, lithium and titanium isotopes. Over-all production innage for the four calutrons was 1126 hours with an integrated output of 245,985 ma hours for the Alpha channels and 40,982 ma hours for the Beta channels. Outage time was 37.3% as compared with 34.0% during July. All Alpha tank time was used in new unit development work.

Chemical processing refinement was conducted on isotopes of nickel, boron, chlorine, lithium and calcium. Chemical services were supplied to the calutrons for the separation of isotopes of chlorine, germanium, titanium and lithium.

There were 21 stable isotope shipments during August.

Radioisotope Research and Development (AEC Activity 5131)

"Cold" chemical runs are in progress to test the equipment for separating relatively large amounts of fission products. The feasibility of producing kilicurie amounts of zirconium, niobium and cesium for the University of Tennessee's animal irradiation program is understudy. Equipment for the $I^{131}$ plant is being ordered.

PHYSICS

Neutron Decay (AEC Activity 5211)

Computations have been completed on the directional correlations between the beta particle and the recoil proton in neutron decay. The angular distribution functions have been integrated with respect to energy and the resulting curves show considerable dependence upon the type of beta interaction assumed. The momentum spectrum of the recoiling protons is found also to depend rather sharply upon the beta interaction.

Short Period Activities (AEC Activity 5211)

The following activities have been observed:

| Element | Half-Life | Gamma Ray Energy |
|---|---|---|
| Zirconium | $\sim$0.83 sec | $\sim$ 500 Kev |
| Germanium | $\sim$0.35 sec | $\sim$ 60 Kev |

Isotopic assignments will be made in the future.

High Voltage Program (AEC Activity 5211)

The reactions $Li^6 + He^3 \longrightarrow Li^5 + He^4$ (90%) and $Li^6 + He^3 \longrightarrow Be^8 + H^1$(10%) have been observed. The latter case consisted of two groups of protons, one a transition to ground state, the other 3.6 Mev above ground state. No other proton groups corresponding to excitation states in $Be^8$ up to 8 Mev have been detected.

Neutron Velocity Selector (AEC Activity 5261)

The time of flight spectrometer has been used to measure the transmissions of thick samples of thorium oxide and depleted uranium oxide ($U_3O_8$ with less than 7 ppm $U^{235}$). Energy levels were observed in thorium at 23.5, 35, 71, 127, 260 and 870 electron volts. Resonances were also observed in $U^{235}$ at 6.8, 21, 39, 62, 110, 200 and 1700 electron volts.

Fundamental Electromagnetic Research (AEC Activity 5261)

Studies have been aimed at controlling large arc plasmas using a lithium chloride charge. Ion outputs of 1.5 amp/in$^2$ have been obtained on a collector plate located 180° from the source. Source drain-to-output ratios varied between 1.2 and 1.5. A process efficiency of 50% was measured on one run. These units are characterized by steady operation and high enhancement.

86 Inch Cyclotron Nuclear Physics (AEC Activity 5261)

The characteristics of angular distribution targets have been investigated and methods of reducing background by various types of shielding have been tested. For elastic proton angular distribution with a tantalum target, the background

(intensity without the thin target) has now been reduced to less than 1% for angles up to 60°, and less than 10% up to 95°. The background of deuterons was found to be negligible. The angular distribution of protons elastically scattered by tantalum follows a Csc $4\theta/2$ dependence up to about 25°, and is thereafter less intense than predicted by that law, by a factor of 1.5 to 5. There is evidence for small peaks at 45° and 75°.

The chemical problems associated with deuteron detection have been solved and data are being accumulated on angular distributions of deuterons from (p,d) reactions on Be, Al, Cu, Ta and Th. Further data was obtained on the angular distribution of tritons from the (p,t) reaction on Be, and on the excitation function for $Co^{59}$ $(t,p)Co^{61}$

The 63 Inch Cyclotron Physics and Operation (AEC Activity 5261)

In continuation of the study of activities produced by the bombardment of light elements with high energy nitrogen nuclei, targets of hydrogen, deuterium and beryllium have been bombarded with the following results observed: a two-minute activity in hydrogen from the $(p,\gamma)$ reaction, a two-minute activity in deuterium from the (d,n) reaction, and a 110-minute activity in beryllium due to the reaction $Be^9$ $(N^{14},He^5)F^{18}$ .

An experiment has been designed to measure the cross section of the $N^{14}$ $(N^{14},N^{13})N^{15}$ reaction relative to the $N^{14}(p,\gamma)O^{15}$ cross section by measuring the activities, 10-minute and 2-minute respectively, induced in a compound target containing both nitrogen and hydrogen. The relative total cross sections of two or more nitrogen-induced reactions produced in a single target are also being studied.

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Preliminary work on the project to determine the spin of $U^{233}$ by hyperfine structure measurements has continued. Satisfactory Zeeman patterns in the long wavelength region of the spectrum of U and Ne have been photographed with an echelle spectrograph. Preliminary testing of a new 15,000 lines per inch plane grating and a 3.2 meter mirror has been started.

Mass Spectrometer Laboratory (AEC Activity 5261)

The recently developed high temperature (tests have been made up to 2100°C) ion sources have made possible the investigation of the ionization and dissociation properties of $UO_2$ and $U_3O_8$. It now appears possible to make quantitative analyses of uranium oxides in the proposed aircraft fuels.

Good evidence has been found that the following reaction takes place at about 800°C:

$$2\ NiO \xrightarrow{800^\circ C} 2\ Ni + O_2$$

It has been found that thermally produced positive ions of chromium are readily obtained from 347 stainless steel. Also, $UO^+$ and $UO_2^+$ thermal positive ions were produced from $UO_2$. The observation was surprising in two respects. First, the previously unreported $UO_2^+$ ions were found, and second, there was no evidence of $U^+$ ions. In preparation for the investigation of some irradiated samarium, thermal positive ions from $Sm_2O_3$ have been studied. In addition to $Sm^+$ and $SmO^+$ ions, there were also present $SmF^+$ and $SmCl^+$ ions. The latter two types, although probably resulting from fluorine and chlorine contamination in the ion source, are novel in character.

CHEMISTRY

Chemistry of Uranium Raw Materials (AEC Activity 5361)

Saturation experiments with di(2-ethylhexyl) phosphinic acid show that the extractable uranium $^{+6}$ complex has a combining ratio of two moles of phosphinic acid for each mole of uranium. A preliminary estimate of the formation constant for this complex is $K_f = 3 \times 10^3$.

Micro pH titrations have been carried out between $UO_2(ClO_4)_2$ and $H_3PO_4$ in 0.1M and 1M $HClO_4$, employing the quinhydrone electrode in the cell:

$$Pt/QH/HClO_4(C_1),\ UO_2(ClO_4)_2(C_2)//(H_3PO_4)\ .(0-C),\ (UO_2)\ (ClO_4)_2(C_2),\ HClO_4(C_1)/QH/Pt.$$

The results indicate the stability constant for the reaction

$$UO_2^{++} + H_3PO_4 = UO_2H_2PO_4^+ + H^+$$

to be about 9.0 in both acid concentrations.

In the study of the solubility behavior of uranium $^{+6}$ phosphate in 0.001 to 15M phosphoric acid, the transition point between the solid phases, $UO_2HPO_4 .4H_2O$ and $UO_2(H_2PO_4)_2.4H_2O$ was found to be at 6.1M phosphoric acid.

Isolation Processes for Plutonium and Uranium (AEC Activity 5361)

The effects of changes in feed flow rates, feed acidity, and elution flow rates upon resin beds have been studied for plutonium isolation under the expected Savannah River conditions. The operation of the beds has been found to be relatively insensitive to such changes.

23 Processing (AEC Activity 5361)

The processing of the second batch of neutron irradiated thorium metal for uranium 233 recovery was started in the 3503 Pilot Plant and is scheduled for completion in October.

Thorex (AEC Activity 5361)

The design of the pilot plant is continuing. The pulse generator system has been tested and found satisfactory for pilot plant use. The feed prepared by dissolving a small quantity of thorium metal was compared with the synthetic feeds prepared from commercial thorium nitrate; the synthetic feed appears to give comparable results. However, thorium metal is needed for evaluating the continuous dissolving procedure.

The investigation of the conditions under which $U^{233}$ can be made critical has continued. Aqueous solutions of $UO_2(NO_3)_2$, containing almost pure $U^{233}$, have been made critical under several conditions of geometry and solution concentration. The optimum conditions have not yet been reached so the minimum mass has not been measured. The lowest value thus far is about 600 grams of $U^{233}$.

METALLURGY

Physical Metallurgy of Reactor Materials (AEC Activity 5411)

The results of preliminary creep rupture tests for thorium extruded at slow and fast rates are in line with previous strength data. Material extruded at a slow rate shows considerably higher creep rupture life. This is in agreement with the more highly preferred structure associated with slowly extruded material.

Resistivity measurements on thorium show a discontinuity at $\sim$1400°C. A possible explanation is that an allotropic transformation occurs at this temperature. X-ray diffraction studies at elevated temperatures are being made to check this possible transformation.

## PROGRAM 6000 - BIOLOGY AND MEDICINE

### BIOLOGY

Pathology and Physiology (AEC Activity 6400)

The platelet transfusion on the hemorrhagic phase of radiation injury in the rat demonstrates that there is a diminished hemorrhagic tendency in animals injected with platelets after X irradiation.

An enhanced spreading of Evans blue which can be attributed to an increase of the permeability of the dermal connective tissues was observed after exposure to X radiation.

Mammalian Genetics and Development (AEC Activity 6400)

The investigation of the X-ray induced mutations in mice has been extended to dosages of 1000 r and is now being investigated at the 300 r level. It is too early to come to any conclusions in regard to these tests. Prenatal mortality, both through termination of pregnancies and through death of individuals within surviving pregnancies, is exceedingly high following irradiation of preimplantation stages. Irradiation during postimplantation stages causes little or no termination of pregnancy and considerably less death of individuals than does treatment during the preimplantation period. Furthermore, within the postimplantation period, susceptibility to prenatal killing decreases fairly rapidly with embryonic age.

The effect of irradiation at various embryonic stages on neonatal viability does not parallel that on prenatal viability. Thus, the highest rate of neonatal death follows irradiation on days 9½ and 10½ postconception, while irradiation during preimplantation stages, which has such drastic consequences prenatally, does not affect the viability of those animals which survive the normal pregnancy term.

The ORNL Biology Division is cooperating closely with the AEC Washington Office in planning for genetics tests in "Operation Knothole".

### BIOPHYSICS

Consultation and Special Problems (AEC Activity 6530)

An instrument for continuous monitoring of air borne alpha activity has been developed for use in areas where high level alpha activity is processed. The technique is to electrostatically precipitate the dust from the sampled air onto a moving tape. The alpha activity on the tape is continuously counted. Provision is made to eliminate the normal air borne alpha background. Calibration of the instrument is in progress.

## PROGRAM 9000 - RESEARCH FACILITIES

Conversion of Jones Construction Camp (Central Shops Building #7012)

The foundation is complete and the concrete floor slab is being poured.

Gas Decontamination Facilities for Buildings #4500 and #4501

All contractor work is complete. ORNL forces are installing motors and blowers.

Cooling System for the LITR

The steel superstructure has been erected and piping is being installed.

## RADIOISOTOPE SALES

| Sales | June | July |
|---|---|---|
| Transfers within AEC | $ 7,256.00 | $ 30.00 |
| Cash Sales | 8,616.17 | 5,876.72 |
| Foreign | 5,004.25 | 181.70* |
| Cancer Program (Free) | 39,899.56 | 14,767.52 |
| Technical Cooperation Plan | 200.00 | -0- |
| Total Sales and Transfers FY's '52 & '53 to Date | 1,162,738.84 | 65,378.42 |
| Total Cancer Program (Free) to Date | 1,418,715.64 | 1,433,483.16 |
| Technical Cooperation Plan (Shipment to Date) | 15,152.55 | 15,152.55 |

## GROSS OPERATING COSTS
(Including X-10 & Y-12)

| | | | |
|---|---|---|---|
| (a) | Actual Cost for July 1952 | 2,350,961.00 | |
| | Actual Plant and Equipment Cost | 354,420.00 | |
| | Construction Program "H" | 25,926.00 | |
| | Total Operating and Construction Cost for July 1952 | | 2,731,307.00 |
| (b) | Estimated Operating Cost for August 1952 | | 2,800,000.00 |
| (c) | Actual Accumulative FY 1953 Operating Cost through July 1952 | 2,350,961.00 | |
| | Actual Accumulative FY 1953 Plant and Equipment Cost through July 1952 | 354,420.00 | |
| | Actual Accumulative FY 1953 Construction Program "H" Cost through July 1952 | 25,926.00 | |
| | Total Accumulative FY 1953 Operating, Construction, and Plant and Equipment Cost through July 1952 | | 2,731,307.00 |
| (d) | Estimated Operating Cost FY 1953 through August 1952 | | 5,531,307.00 |

PERSONNEL SUMMARY

| | Number of Employees August, 1952 | New Hires August | Terminations August |
|---|---|---|---|
| Administration | 79 | 3 | 2 |
| Operations* | 120 | 1 | 0 |
| Engineering, Shops and Mechanical | 911 | 4 | 4 |
| Laboratory and Research | 1519 | 8 | 76 |
| Protection | 183 | 1 | 0 |
| Service | 393 | 1 | 4 |
| Total | 3205 | 18 | 86 |

* Includes Electrical Distribution and Steam Plant as well as the Operations Division.