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Progress Report
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AEC RESEARCH AND DEVELOPMENT REPORT

LABORATORY RECORD
1954

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

MAY, 1951

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

May, 1951

W. E. Thompson

Date Issued: JUN 8 1951

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OAK RIDGE NATIONAL LABORATORY

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PROGRAM 1000 - RESEARCH FACILITIES

Instrument Laboratory Building #3500

This building is occupied and being operated by ORNL forces. Four (4) hood fans and motors specified for this building are to be installed by ORNL when materials are received.

Sewage Treatment Plant, Building #2521

Completion Form 4-A has been processed and signed. The plant is being operated by ORNL forces. Digesters are being operated on natural gas until sufficient sewage gas is accumulated.

Research Laboratory Building #4500

Work on this building is approximately 33% complete. Concrete foundations are complete. Structural steel erection is complete. Metal roofing has been applied. Built-up roofing is being applied on Wing #4. Exterior masonry walls are 33% complete. Concrete floor slabs, 50% complete. Sheet metal duct work is being installed. Plumbing, heating and service piping is 25% complete. Electrical underground and services are 14% complete. Electrical services in building are 15% complete.

Isotope Research and Semi-Works Building #4501

This building is approximately 32% complete. Concrete foundations are complete. Concrete work on Semi-Works cell block is complete. Concrete work on Isotope Research cell block is 35% complete. Structural steel is erected complete. Plumbing, heating and service lines are 15% complete. Sheet metal duct work is being installed. Concrete floor slabs, 25% complete. Electrical services in building, 25% complete.

East Portal Building #4502

Work on this building is approximately 20% complete. Foundation walls have been erected. Exterior masonry walls are 75% complete. Compacted stone fill for floor slab has been placed. Concrete platform canopy on north side of building has been erected. Plumbers and electricians have installed underground services. Structural steel roof girders have been placed.

West Portal Building #2016

Work on this building is approximately 40% complete. Foundation walls, concrete floors, concrete platforms are complete. Structural steel has

[redacted]

been erected. Underground plumbing, heating and electrical services have been installed. Metal siding is being applied. Plumbing, heating and electrical service lines are being installed. Heating and ventilating duct work and diffusers have been installed.

High Voltage Laboratory Building #4503

This building is approximately 3.5% complete. Excavating for piers and footings. Channel of White Oak Creek south of building has been changed. Concrete has been placed for north wall footings. Erecting foundation wall forms for north wall.

Health Physics Waste Research Building #3504

This building is approximately 32% complete. Foundation walls, concrete floors and platforms are complete. Structural steel has been erected. Metal window frames have been installed. Plumbing, heating and electrical underground services have been installed. Plumbing and electrical service lines in building are being installed. Heating and ventilating duct work is being installed.

Chemical Isolation and Purification Laboratory Building #23

Phase II Engineering is complete. AEC advertising for bids that are due June 15, 1951. ORNL has placed order with vendor for structural and reinforcing steel.

Test Facilities Building #22

Phase II Engineering is complete. AEC advertising for bids that are due June 27, 1951. ORNL has placed order with vendor for structural and reinforcing steel.

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PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

TBP Process for Waste Metal Recovery (AEC Activity 2802-2)

The ORNL Metal Recovery Plant building and equipment are now about 85% complete. The Metal Recovery Program, for which this building was originally designed, has been postponed and the recovery of the metal from the ORNL metal waste will not be started until early in 1952. The building and equipment will be used initially for the recovery of plutonium from Chalk River material (see Program 3000 - SCRUP Separation).

Purex Process (AEC Activity 2802-3)

The Pilot Plant demonstration of the Purex Process was continued in pulse columns. Runs have now been made at 100 G/T level with total uranium and plutonium losses for two cycles of 0.13 and 0.16% respectively. The over-all two-cycle β decontamination factors for plutonium and uranium were 5×10^6 and 1×10^6 respectively. Full Hanford level runs (400 G/T) are now in progress.

In the initial test of the IAW first cycle aqueous waste evaporator, a 50 fold volume reduction of the aqueous waste was demonstrated with the recovery of the nitric acid as 56% nitric acid and decontamination factors of 10^6 for both the acid and water streams.

In the Laboratory, the major study has been the development of an ion exchange procedure for the isolation of plutonium. Satisfactory separation of the plutonium from the uranium has been demonstrated in this step, and further work is being carried on to evaluate its effectiveness for the separation of the plutonium from the corrosion products. By the use of this ion exchange procedure, a sufficiently concentrated solution can be obtained for the plutonium peroxide precipitation step and it is hoped that the plutonium peroxide waste can be recycled to the ion exchange step, eliminating the need to return it back into the solvent extraction cycle.

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PROGRAM 3000 - WEAPONS

RaLa Production (AEC Activity 3670)

The first full scale production run was carried nearly to completion with exceptionally low losses, giving an activity of 14,000 curies of Ba^{140} adsorbed on the resin column. However, as the product was being removed from the column, a valve failed to operate properly and the product went into the waste tanks instead of the final product evaporator. The waste in the tanks was reprocessed to recover the product, but extremely high losses were experienced because of interfering compounds present in the waste. On May 21, the reprocessing was completed and 3157 curies were shipped.

The column cubicle has been partially decontaminated and removed for repairs or replacement.

RaLa Development (AEC Activity 9541)

The chemical material balance flowsheet for the MTR RaLa Process was issued and work is now in progress on the schematic equipment flowsheet. Laboratory studies were initiated to establish the conditions required for the recovery of the Uranium-235 by the use of a modified 25 solvent extraction procedure. It was originally proposed to blend this waste in with the standard 25 Process feed solution. However, changes in the processing schedule now make it necessary to consider processing this waste solution separately.

The ion exchange step for barium purification has been satisfactorily demonstrated in the ORNL RaLa Plant. Runs with 400 curies and 14,000 curies adsorbed on the column have been completed. Unfortunately, in both runs accidents occurred which significantly reduced the amount of barium shipped in the final product.

Production work was started on the fabrication of 25 natural uranium MTR fuel units needed by the Chemical Technology Division for their dissolving and separation studies on the RaLa program. This work is estimated to be 20% complete.

SCRUP Separation (AEC Activity 3XXX)

The SCRUP Separation Program at ORNL has now been approved by the AEC for the recovery of plutonium from Chalk River irradiated uranium. The carriers

[redacted]

for the transfer of the material are now under construction and the first shipment of material is scheduled for July. The construction of a metal storage canal at the ORNL Metal Recovery Plant is now about 50% complete. The installation of two 2,500 gallon stainless steel tanks for the storage of fission product solution which will result from this process will be started in the near future. The initial operation of this equipment is scheduled for August, 1951.

Special Separations (AEC Activity 3670)

In the second stage of U236 enrichment by the electromagnetic process, starting with 23 grams of 32% U236, the first three runs have yielded one gram of 95.6% U236. For this stage the enhancement of U236 with respect to U235 is 50 at 5% process efficiency.

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PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR

LITR Operation (AEC Activity 9543)

On Monday, June 4, personnel from Phillips Petroleum Company are scheduled to start on-the-job training at the LITR. The scheduled classwork will be completed at the end of the first week in June and thereafter full time will be devoted to training for MTR operations.

Pre-Installation Assembly of MTR Components (AEC Activity 9543)

Following assembly and inspection, the MTR tank and components were dismantled for shipment to Arco as scheduled. The first shipment was on May 28; the second and final shipment is scheduled for June 11.

Idaho Chemical Plant Design (AEC Activity 9541)

The design program at ORNL has continued. A major remaining job is the preparation of the plant operation manual.

Significant progress has been made in the study of fumeless dissolving.

HOMOGENEOUS REACTOR PROJECT

Experimental and Design Engineering (AEC Activity 4264)

Two model 100A Westinghouse pumps have been operated with uranyl sulfate solutions at 250°C and 1000 psi pressure for several hundred hours without evidence of undue wear or corrosion. One pump has graphite bearings with stellite journals while the other has stellite bearings and journals; both appear satisfactory.

Recombination of Hydrogen and Oxygen (AEC Activity 4263)

The study of the catalytic recombination of hydrogen and oxygen at atmospheric pressure has been essentially completed, and interest is now in the direction of high pressure catalysis. Several experiments already completed have shown that hydrogen and oxygen react readily over platinum-on-alumina in an atmosphere of steam and helium at high pressure.

The second experiment on the use of stainless steel to remove iodine vapor from a gas stream has been terminated after 900 hours. In this time 9.4 g

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of stainless steel were completely dissolved by the action of iodine flowing through the stainless steel at the rate of 43 mg/hr.

Copper has been shown to exhibit fairly good catalytic action in experiments in which undiluted electrolytic gas was passed through 20 feet of 1/4" copper tubing. With the gas entering the tube at the rate of 120 cc/min and at a temperature of 300°C, 90 cc/min of gas were recombined.

The full scale catalytic recombiner has been installed at the pilot plant location. One run at 15 cfm and one at 0.115 cfm were conducted before a decision was made to install a 12-cell electrolytic gas generator. After calibration of the generator five runs of less than 0.35 cfm were made.

Criticality of Turbulent Systems (AEC Activity 4263)

A series of experimental runs has been made with the reactor model to determine hydraulic characteristics of the system. A heat exchanger was tested and found to maintain a constant temperature of the fluid medium in the system. Vanes were installed in the inlet and the resulting flow in the reactor was fairly uniform. Without the vanes the flow was oscillatory, indicating a need for a longer straight section of feed pipe at the inlet.

Building 7500 - HRE (AEC Activity 4261)

The reflector pressure shell and the D_2O dump tanks have been installed and piping of the D_2O system is approximately 50% complete.

HR Fuel and Blanket Studies (AEC Activity 4263)

In the initial phase of the HR fuel and blanket studies, experimentation was in progress on a 40 gram/liter uranium slurry, a 1000 gram/liter thorium slurry, and a mixed fluoride fused salt blanket of thorium. These programs have been discontinued and a new program concerned with the development of a stable uranium trioxide slurry containing approximately 300 grams of uranium per liter has been initiated. It has been indicated that this concentration of uranium in heavy water may be the optimum concentration for a slurry type homogeneous reactor. The experimental program which has been recently initiated will include the following studies: (1) preparation of UO_3 with specific particle size, (2) slurry

stability, (3) pumping characteristics of the slurry, and (4) recovery of heavy water from the slurry.

HR Fuel Reprocessing Studies (AEC Activity 4263)

The application of the Purex Process to the recovery of plutonium, uranium, and fission products from a uranyl sulphate solution fuel for a homogeneous reactor was studied in the laboratory. The laboratory data indicate that satisfactory results may be obtained with this process. The work on the continuous processing of homogeneous reactor fuel using ion exchange was also continued. The choice between these two processes will be dependent on whether the continuous processing of the homogeneous reactor fuel will be desirable.

AIRCRAFT NUCLEAR PROPULSION PROJECT

ANP Central Design (AEC Activity 4271)

The fuel system now conceived for the ARE consists of individual, sealed fuel elements. The development of a fuel manifolding system, which would permit fuel drainage and recharging, is continuing but independent of the ARE. It now appears probable that the ARE pressure shell will include only welded joints although a gasket development program is being pursued. Commercially available gas blowers and finned cross flow heat exchangers will be used in the Na to He to H_2O heat disposal system.

The ARE building drawings have been received from the Austin Company and were forwarded to the AEC on May 29, 1951, for advertisement and awarding of contract. The specifications allow 240 days for completion after notice to proceed (notification will be made about July 1) or 180 days after delivery of the steel, whichever is the greater. Delivery of the steel is expected in September.

North American Aviation, Inc., has submitted a formal report (NAA SR-110) on the results of their preliminary investigation relative to the application of a mercury vapor power plant to the propulsion of nuclear aircraft. It is concluded that the mercury vapor cycle, primarily because of the unfavorable vapor pressure characteristics of mercury, is not suitable for this application and additional work along these lines is not justified. However, a similar nuclear aircraft system using sodium vapor appears feasible and additional work is being done on this cycle.

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ANP Experimental Engineering (AEC Activity 4271)

Major emphasis has been placed on convection loop operations, liquid metal sampling procedures, Figure-Eight cleaning and loading techniques, evaluating sodium analyses, developing methods for preventing gas line stoppage, and procurement and fabrication of experimental and building equipment. 32,500 hours of liquid metal circulation have now been completed, and additional experience is now being accumulated at about 2000 hrs. per week.

Thermal convection loop operations and molten fluoride fuel capsule tests, conducted in collaboration with the Metallurgical Division, have continued throughout the month. At the beginning of the period, eight loops were in operation containing sodium at 1500°F; two nickel loops completed the 1000 hour test and were terminated leaving six in operation. Materials under test with these remaining loops included 410 and 430 stainless steels, and inconel and inconel X. During the month, control panel installation was completed furnishing facilities for operating 16 convection loops simultaneously. One 316 fuel capsule was removed after 100 hours test time, and the standpipe containing the sodium failed after an additional 50 hours of operation. The fuel tube appeared to be etched on one end. The inconel capsule tester failed and four of the five capsules removed had leaked, three at faulty welds and one at a crack in the tube.

Figure-Eight loop operations were terminated after 10 hours due to rupture of the electromagnetic pump cell. Fortunately, the loop dumped satisfactorily permitting the resulting sodium fire to be quickly extinguished. Evidence indicates that clean sodium is a prerequisite to successful operation of forced circulation loops at high temperature. Since adequate reduction of impurities has not been obtained, and because adequate cleaning techniques are essential to the ARE, one new Figure-Eight loop and a used loop will be subjected to exhaustive study to determine the techniques to be used under these two somewhat different circumstances.

Impurity analyses from liquid metal samples have been inadequate because of variations in quantity of sample, small samples being particularly ineffective. Samples of adequate size to afford maximum sensitivity are now assured; moreover, equipment has been fabricated to allow sampling from various locations in liquid metal baths thereby obtaining more representative specimens.

Water testing of an eight gpm, 45' head centrifugal pump has been virtually

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completed; and a new stainless steel impeller has been made. To prevent exposure of the pump shaft seal to hot vapors, the design includes a cooled liquid metal bath between the seal and the hot liquid metal in which the shaft runs. The final shaft seal is proposed as a double wiper seal lubricated with prestone. The Calibration Loop has been equipped with heaters, thermocouples, level controls, and venturis for determining the reliability of venturi-type flowmeters and manometers for liquid metals, to calibrate electromagnetic flowmeters, and to check performances of electromagnetic pumps. The Manometer Loop, built primarily to provide experience in operating flow nozzle manometer-type flowmeters, was prevented from starting up by burned out heaters. Parts for turbine pump tests have been received but await assembly and testing. An electrostatic precipitator on simulated harps showed promise of preventing plugged gas lines due to sodium condensation as did condensation tanks containing steel wool installed in gas lines during Figure-Eight loop operations. ARE pump design is now centered in two efforts: (1) a centrifugal sump-type similar to the small centrifugal pump described above, and (2) an electromagnetic two stage pump patterned somewhat after Mine Safety Appliance designs. A substantial increase in the rate of work on building modifications and laboratory installations has been accomplished and these are now proceeding on a schedule compatible with that of ARE.

Reactor Physics (AEC Activity 4277)

Primary emphasis has been placed upon the following activities: (1) the analysis of the U-Be critical assembly which is operated by the Critical Experiments Group and (2) the analysis of the static characteristics of the ARE core.

Critical Experiment Analysis. The critical assembly consists of a bare beryllium-uranium core in an aluminum matrix. The volume percentage of this core is, Be - 90.20%, U - 0.66%, ss - 0.08%, Al - 6.05%, Void - 3.01%.

The reflector effect of the structural aluminum has been measured experimentally to be equivalent to an additional 0.6 kg of uranium. The self shielding of 10 mil uranium foils, similar to those in this assembly, is appreciable at all energies, although it decreases in the thermal region. Refinements in the calculated critical mass have included (1) reflector savings of aluminum, (2) transport leakage due to the finite size of the reactor, (3) variable buckling due to the change in extrapolation length

with energy, and (4) age adjustment in Be p-scattering to agree with the experimental age. Calculations indicated that the 19.3 kilograms of uranium that were required for criticality should have a reactivity of only 0.90. This result has been confirmed with KAPL, Rand Corporation, and Mooneyham. It is believed that this low calculated value of k results from failing to consider the cross-section for the (n,2n) reaction of fast neutrons on beryllium, which is suspected to have an appreciably higher cross-section than that generally attributed to it.

Analysis of the ARE Core. Values for the volume fraction of a specific ARE core are given as: $NaF-UF_4$ - 1.58%, BeO - 85.04%, ss - 2.0%, Na - 11.38%. Estimates of critical mass for this reactor range from 21 to 25 pounds. The median energy of fission is in the thermal energy range: the percent thermal fissions is around 60 and may be as high as 70 in some ARE designs.

The temperature coefficient of reactivity is negative since the expanding liquid fuel will decrease the fuel concentrations in the core. In this effect lies the inherent stability of liquid fuel reactors. The uranium mass coefficient of reactivity, $(\Delta k/k)/(\Delta m/m)_U$, ranges from 0.19 to 0.23. The coefficient of reactivity associated with the sodium, $(\Delta k/k)/(\Delta \rho/\rho)_{Na}$, of -.023 is such that the assembly could go prompt critical if all the sodium were removed from the core (neglecting the effect of the resulting voids). Any design changes, however, which permit a smaller volume fraction of stainless steel will require less critical mass because of the unfavorable cross-section of the steel: $(\Delta k/k)/(\Delta \rho/\rho)_{ss} = -.165$.

The effect of a reflector has been calculated for several reflector compositions and thicknesses. These reflectors (which contain no fuel) may be compared to additional core material with the following results:

A. The greater the volume fraction of BeO in the reflector the more effective the reflector in increasing k and the greater the reflector thickness before saturation.

B. A good reflector (i.e., $\sim$97% BeO) is more effective than additional core material for small thicknesses. (This is a function of ratio of average transport mfp of core to reflector.)

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Liquid Metals Corrosion (AEC Activity 4275)

Tensile tests of inconel tube-to-header joints fabricated by manual inert arc-welding are continuing. Joint strengths of the order of 90,000 psi based on the tube dimensions of 0.188 in. (O. D.), 0.30 in. wall have been obtained consistently. Elongations of 15% in three inches in the as-welded specimens have been improved to 25% in three inches by annealing. Apparatus for fabrication of tube-to-header joints by the cone-arc technique is being installed for future work.

The argon purification and distribution system for the creep furnaces has been installed and leak tested. Twenty-five creep specimens of 16 gage, type 316 stainless steel and twenty-five 16 gage inconel creep specimens have been prepared. Three specimens of type 316 stainless steel have been placed in furnaces and will be loaded by the first of June.

A new technique called "rubber static pressing" was tried and appears to have possibilities for bonding of metal-UO_2 mixtures to the inner surfaces of tubes. In this method, a rubber core is placed inside the tube and the annulus filled with powder. Pressure is then applied to the rubber from the ends, thus pressing the powder tightly to the inside wall of the tube. In the first specimen, pressed at 40 tsi and sintered at 1250°C, fine 302 stainless steel bonded tightly to the tube while electrolytic iron pulled away during sintering. However, in a second specimen containing 30% by volume UO_2 in 302 stainless steel and carbonyl iron, neither mixture bonded significantly. This is thought to be due to too low a sintering temperature. Loose powder bonding tests have shown the temperature to be a very critical factor in sintering metal-UO_2 mixtures to a backing plate.

A number of static corrosion tests are being conducted in nonmetallic media, such as the hydroxides of sodium, barium, and strontium and mixed fluoride salt. Preliminary examination of some of these tests has verified the fact that neither inconel nor Nichrome V will contain sodium hydroxide. A very serious attack was noted. Nickel, however, showed slight attack. Inconel tube-to-header welds are also being tested in sodium and mixed fluorides. The results are not yet available.

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Liquid Fuel System for High Temperature Reactor (AEC Activity 4275)

Low Melting Fluoride Systems. Phase diagrams for the RbF-NaF, RbF-KF, and the $CsF-UF_4$ systems have been well established. In addition considerable information on the $NaF-RbF-UF_4$ and the $KF-RbF-UF_4$ systems have been obtained. Both RbF and CsF in the molten state penetrate graphite readily and must be handled in nickel crucibles.

Hydroxide Systems. Uranium trioxide is soluble to the extent of about 4% by weight in a 50-50 mixture of lithium and sodium hydroxide at 750°C. The solubility is strongly temperature dependent falling to 2% at 650°C and to very low value at 350°C.

Corrosion of Metals by Fused Salts. Recent experiments in the vacuum furnace have verified the fact that pretreatment of the molten fluoride fuels with stainless steel and inconel in the melt materially reduces subsequent attack of these materials during standard corrosion tests. By such a technique it has been established that in tests at 800°C for 100 hours virtually no corrosion can be observed on seamless tubing of stainless steel or inconel.

Radiation Damage (AEC Activity 4274)

Techniques are being developed for subjecting liquid reactor fuels and their containers to proton bombardment in the 86-inch cyclotron. Samples of liquid fuel are being sealed in flattened inconel tubing, wall thickness 0.006".

ANP Critical Experiments (AEC Activity 4272)

A critical assembly mocking up the G. E. air-water aircraft reactor has been constructed with graphite substituted for silicon carbide and plexiglass for water. The critical dimensions and critical mass have been determined and current effort is devoted to measuring neutron traverses with foils to determine the spectral distribution.

GENERAL REACTORS

Radionuclide Cross Sections (AEC Activity 4520)

The thermal neutron absorption cross sections for U234 and U236 have been measured with the pile oscillator. The values obtained were approximately 96 barns for U234 and 21.3 barns for U236.

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PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF RADIOISOTOPES

Radioisotope Production, Development and Operations (AEC Activity 5111)

The total accumulated KWH for pile operation during May was 2,402,620, averaging 3517 KW per operating hour. Pile down time was 8.2% as compared with 13.4% during April. There were no ruptured slugs.

The total number of radioisotope shipments during May was 820. Currently, difficulty is being experienced in meeting the requirements for Fe^{59} (with less than 2% Fe^{55}) for medical uses. The Shell Development Company of Emoryville, California, has expressed interest in having several hundred samples of organic vegetable extract analyzed for traces of chlorine by activation analysis.

Calutron Operation and Process Development (AEC Activity 5121)

During May, 1951, primary attention was given to electrodepositing of lithium, development of a Beta type filament changer, evaluation of lithium bromide charge material, and to collections of cerium, strontium and lithium isotopes.

An experimental cell for the electrodepositing of lithium was given seven trial runs to determine current and cell efficiencies. A solution of lithium iodide in pyridine was passed through the cell at a "drip rate" and electrolyzed for approximately four hours. The cell was then washed with anhydrous pyridine for thirty minutes. The cathode deposited material was analyzed for lithium and contaminants. Effluent and wash solution were analyzed only for lithium content. Various additives were added to the electrolyte for the purpose of chemical removal of the free iodine produced at the anode. Concurrently, work on an experimental production cell with a capacity of 5 to 10 grams of lithium metal is in the process of assembly and mechanical testing.

Better cooling of the Beta source filament changing mechanism was tested; however, after a few hours of operation, filament to source electrical shorts developed. This condition was presumably due to electrolytic action. Further study of the cooling problem is being considered. Four more sources of this type are being fabricated.

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Lithium bromide was tested in the charge evaluation laboratory to determine lithium beam resolution in a 6-7/8 inch diameter mass spectrometer. Good separation of the lithium ion beams resulted and it is evident that small quantities of the lithium isotopes may be collected in this apparatus.

Cerium collections that were started in April were completed this month; estimated total collections were 29 grams. Strontium collections were started this month and are being continued; an estimated 18 grams have been collected. The lithium series that was started in March is being continued; by the end of the month an estimated 206 grams have been collected.

Isotope Chemistry (AEC Activity 5121)

Sample Summary

Chemical Refinements Completed	18
Isotope Samples in Process, May 31	8
Samples in Backlog	9
Mass Assay Samples Submitted	35
Mass Assay Samples Reported	27
Mass Assay Sample Backlog	50
Isotope Shipments Made	18

Charge materials were supplied to the calutron for the separation of the isotopes of cerium, lithium, strontium, and chemical refinement was done on tellurium, lithium, samarium, and calcium. Mass analyses were done on samarium, sulfur, iron, tungsten, lithium, tin, and zirconium. Work is continuing on the production of lithium metal and the separation of rare earths.

PHYSICS

High Voltage Program (AEC Activity 5211)

The 5-MV electrostatic generator is now in operation. A recalibration of the voltage scale indicates that what was previously thought to be 5.7 MV was really close to 6.0 MV. The machine apparently functions satisfactorily at this voltage.

Preliminary work is now being done on p-n threshholds in several elements.

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The Cockcroft-Walton generator is being used to study the protons from the reaction $He^3 + He^3$. The observed continuous distribution of protons from the intermediate nucleus, Be^6, has the expected upper energy limit but its shape suggests some disintegration through the reactions $Be^6 \longrightarrow Li^5 + p$ and $Li^5 \longrightarrow He^4 + p$.

Scintillation Spectrometry (AEC Activity 5211)

The natural gamma rays from U234, U235, and U236 are being measured with the scintillation spectrometer. Tentative energies of the gamma rays of U234 and U235 have been measured as follows:

U234	L γ rays	17Kv
	γ rays	53Kv
		88Kv (Avg)
		118Kv
U235	γ rays	93Kv
		144Kv
		185Kv
		292Kv

The 86" Cyclotron (AEC Activity 5261)

A marked increase in operation time has been obtained since the installation of vacuum locks in the target and the ion source assemblies, and since insulation of the dees. About 25 runs have been made with targets of bismuth, copper, tantalum, and zinc. The machine has been operated steadily with 450 μa and 400 μa, at 20 and 22 Mev respectively on the target.

The 22" Test Cyclotron (AEC Activity 5261)

The deflected beam from the 22-inch test cyclotron has been used to bombard a copper crystal with 20 μa-hr of 1.4 Mev protons. The surface of the copper was protected with aluminum foil and the temperature of the target did not exceed 90°C. The crystal has been returned to the Metallurgy Division for further study.

The 63" Cyclotron (AEC Activity 5261)

Shimming of the magnetic field has reduced variations to ± 0.3%. The liner and beam deflector have been designed and the deflected beam path calculated. Circuit components of the oscillator have been fixed. The

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vacuum manifold and reaction chamber are being fabricated and the ion source is being tested.

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Nuclear Resonance. Equipment modifications have been made to permit search for low nuclear g/I ratios. Search for the Se-77 resonance has been continued with negative results to date.

Microwave Spectroscopy. Hyperfine calculations for the asymmetric top molecule vinyl iodide show good agreement with the observed frequencies. Previous intensity studies on microwave absorption lines have contributed considerably to the interpretation of this spectra.

Atomic Spectroscopy. A feasibility study of fluorometric methods for the early detection of reactor fuel leaks into a metallic sodium heat transfer medium has been made. Preliminary results on non-active material indicate that the uranium may be detected at well below 1 ppm in a metallic sodium sample in less than 10 minutes from time of receipt of the sample.

The first Zeeman spectrogram has been obtained with an echelle spectrograph and a field strength of 25,000 gauss. Magnetic resolution is approximately 0.3 Lande g units.

Spectrochemical Studies. Contributory research on reactor materials as regards corrosion effects at elevated temperatures has been carried out on heat transfer media and, more recently, on mock-up fuel media. In addition to this development work, 234 samples have been analyzed for 3190 element determinations.

X-Ray Spectroscopy. The L X-ray spectra of polonium have been re-photographed after a seven week interval and show build-up of the daughter lead lines which will be used as wavelength markers.

Mass Spectrometer and Vacuum Laboratories (AEC Activity 5261)

Mass Spectrometer. The principle effort this month has been devoted to the development of an analytical technique for evaluating possible radiation damage to the ARE fuel. Ionization and dissociation studies are being made on the fuel and on UF_4 and the method appears to be promising.

A small amount of ammonium pertechnate has been secured and prepared for investigation of the isotopes of technectium.

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Molybdenum carbonyl was prepared for further investigations of the isotopes of that element.

Vacuum Laboratory. Preliminary data was obtained of three vacuum waxes, Dennison's red, Cenco plicene, and Cenco sealstrip, using the time of pumpdown method of evaluating vapor pressure.

The vacuum balance was cleaned and rebuilt for use with the production of lithium metal.

CHEMISTRY

Chemistry of Separations Processes (AEC Activity 5311)

Anion exchange studies in chloride solutions have been further extended and a number of new separations have been developed. Of most interest is the separation of titanium and vanadium from the other members of the fourth and fifth groups as well as from iron and uranium. Systematic studies of the first, second, and third groups have shown that they are not absorbed appreciably from chloride solutions and therefore can be separated from all the elements previously found to be strongly absorved, e. g., fourth and fifth groups and transition elements.

Nuclear Chemistry (AEC Activity 5311)

To enable radiation dosage rates for Ga^{67} to be calculated, studies of the radiation spectrum of this nuclide have been initiated. Some previously unreported gamma rays have been found.

In decay scheme studies, scintillation spectrometer-thin lens spectrometer coincidences are being measured. Using this instrumentation, new low energy beta groups have been found in An^{197} and I^{131}.

Chemistry of Uranium Raw Materials (AEC Activity 5361)

Experimental tests have been made of five alternate methods for handling high lime carnotite ores. A report covering this work is being prepared.

A summary of the work thus far on the recovery of uranium from phosphate slimes is being organized. This project will be discontinued to allow greater effort on problems of more immediate importance to the Commission.

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A project on the development of methods for recovering uranium from Bartow Clay has been started. Because of its importance, this problem will hold priority over the other work carried out by this group.

Chemical Separation of Isotopes (AEC Activity 5361)

MoO_3 samples from the molybdenum thiocyanate run and assay standards have been reduced to the metal and submitted to the Assay Department.

A program to enlarge and complete the isotope reference file has been undertaken and is now practically complete. This survey is tabulated on keysort cards and is part of a master file which includes references on isotopic exchange reactions, catalysis of exchange and related subjects.

METALLURGY

Thorium Research (AEC Activity 5461)

Tensile tests were made to determine effects of rate of loading on tensile strength and yield point of annealed thorium. The values of tensile strength increased slightly with increasing rates of loading. However, none of the specimens showed evidence of a yield point. Analyses are being obtained on these specimens to see if reasons for the absence of the yield point can be defined.

Four Ames billets which had been forged from four inch to three inch diameter by Battelle Memorial Institute were extruded into rod and tube shapes. There appears to be little if any improvement in the extrusion produced from a forged billet over a cast billet.

Three Ames cast billets were extruded into 2-inch by 1-inch rectangular bar for flat rolling stock. These extrusions indicate that no particular difficulty would be experienced in extruding any desired shape.

A precision lattice parameter measurement of iodide thorium gave a value of 5.0871 $\pm$ 0.0002A at a temperature of 26.2°C. A theoretical density was calculated using this value and found to be 11.7100 gms/cc. This compares with an experimental value for arc-melted and rolled iodide thorium of 11.75 gms/cc.

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PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Cytogenetics (AEC Activity 6400)

Recent developments in the field of radiation protection show that compounds which protect only after incubation can be inhibited in their protective function by cyanide. In contrast to this the compounds which are protective against radiation damage without incubation are not interfered with by cyanide.

The pattern of protective activity of chemical compounds against radiation damage in paramecia and phage is different from that in bacteria. Alcohol has been found, in a cooperative study with the ANL, to protect mice to quite a significant degree against radiation damage.

Preliminary results from Operation Greenhouse indicate that the tests on tradescantia have been very successful.

Pathology and Physiology (AEC Activity 6400)

The mice from Operation Greenhouse have arrived in good shape and are now going through routine examinations.

Biochemistry and Biosynthesis (AEC Activity 6400)

It has been found possible to combine sugars with boron salts. This makes possible the separation of individual sugars by ion exchange methods. This finding opens a new field in sugar chemistry of great importance to laboratory work.

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PERSONNEL SUMMARY

	Number of Employees May 31, 1951	Hew Hires May	Terminations May
Administration	95	6	0
Operations*	118	1	0
Engineering, Shops, and Mechanical	923	6	0
Laboratory and Research	1256	83	24
Protection	173	2	1
Service	360	8	3
TOTAL:	2925	106	28

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

RADIOISOTOPE SALES

Sales	March	April
Transfer within AEC	17,741.20	10,717.25
Cash Sales	29,783.21	25,564.45
Foreign	3,039.80	3,702.00
Cancer Program (Free)	31,736.74	37,154.05
Technical Cooperation Plan	-0-	550.00
Total Sales and Transfers to Date	1,596,198.14	1,647,483.44
Total Cancer Program (Free) to Date	785,576.05	820,730.10
Technical Cooperation Plan (Shipments to Date)	6,993.04	7,543.04

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

(a)	Actual Cost for April, 1951	2,188,819	
	Construction - Program "H"	106,010	
	Total Operating & Const. Cost		2,294,829
(b)	Estimated Operating Costs for May, 1951		3,334,135
(c)	Actual Accumulative FY 1951 Operating Cost through April, 1951	19,992,882 1/	
	Actual Accumulative FY 1951 Const. Cost through April, 1951	733,233	
	Total Accumulative FY 1951 Operating and Const. Cost through May, 1951		20,726,115 1/
(d)	Estimated Operating Cost FY 1951 through May, 1951		24,060,250

1/ These amounts include the cost of Stripping Bldg. 9201-3 handled as a Deferred Charge.

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