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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL 1952

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OPERATED BY
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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1952

J. P. Lane

Date Issued: MAY 8 1952

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

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OAK RIDGE NATIONAL LABORATORY

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PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

Purex Process (AEC Activity 2803.2)

Laboratory scale pretreatment of second uranium cycle feed by boiling with sodium nitrite yields a five-fold increase in decontamination.

SCRUP Separation (AEC Activity 2344)

Processing of four year cooled Hanford slugs has yielded in addition to the desired Sr^{90} the separated uranium and plutonium. Some Sr^{90} will also be made available when Chalk River fuel rods are processed.

[redacted]

PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR

LITR Operations

The LITR operated at 1091 KW per operating hour during April. Down time was 11.2% as compared with 24.6% in March. On April 25, 1952, the reactor power was raised to 1500 KW and has since operated satisfactorily at that level.

MTR Project Engineering (AEC Activity 4221)

The MTR has been operated at a power level of 10 megawatts (1/3 power) with full water flow of about 18,000 gpm. The reactor appears to be functioning quite satisfactorily.

HOMOGENEOUS REACTOR PROJECT

Homogeneous Reactor Experiment (AEC Activity 4261)

Natural uranium runs, operated prior to critical experiments, established the fact that a material balance to an accuracy of $\pm$ 1% was feasible for the entire system. Then the reflector system, which previously had contained ordinary water, was leak tested, drained, dried and refilled with 1500 liters of heavy water in preparation for the critical experiment. The fuel system was also rinsed, filled with distilled water and leak tested at 1800 pounds per square inch pressure. With both the reflector and fuel system in readiness, the first fuel addition of the critical experiment was made on April 11 with the system at 30°C. Criticality was reached on April 15 at a concentration of 25.0 grams of U^{235} per kilogram of water which was exactly the value calculated for the same operating conditions. Since that time the reactor has been started up ten times and operated for a total of approximately 70 hours.

In the two weeks following criticality, the operating time was spent, for the most part, in training the operating group. However, it was possible to obtain some approximate information on the value of the control rods and reflector. These values are approximately 1.5% δk for the control rods and roughly 15% δk for the reflector. More accurate measurements of these quantities are being made. The power level of these experiments has been determined by foil measurements of the neutron flux to be about 1 milliwatt. Experiments will continue under the present operating conditions of low pressure, low or moderate temperature and low power for approximately two weeks.

HR Slurry and Blanket Studies (AEC Activity 4263.2)

Neutron irradiation experiments on slurries indicate unexplained packing of the uranium trioxide and considerable increase in uranium solubility.

Static Corrosion Studies (AEC Activity 4264)

A pretreatment method involving heating the sample at 250°C in an atmosphere of cylinder oxygen (50 psi at 25°C) for 24 hours has given encouraging results in a few preliminary tests. The most obvious effect of this type of pretreatment is to give bright surfaces essentially the same in appearance as the original machined surface. Other pretreatment methods which have been used yielded dark films.

One 347 stainless steel sample pretreated by the dry oxygen method and exposed to uranyl sulfate (40 g U/l) at 250°C for 140 hours gave a corrosion rate approximately 3 to 5 times lower than the corrosion rates observed in samples pretreated by other means and exposed to uranyl sulfate under the same conditions. The film on the oxygen pretreated sample is very thin; no indications of heavy film were observed. A second sample pretreated in the same manner has been exposed to deaerated uranyl sulfate (40 g U/l) in an evacuated bomb at 250°C for 80 hours with no measurable weight change or change in appearance. There was no reduction of uranium in the solution.

Dynamic Corrosion Studies (AEC Activity 4264)

The previously noted highly localized attack in high velocity, high turbulence regions continued in evidence. At 250°C additions of $CuSO_4$ or increases in UO_2SO_4 concentration both increased the localized attack in these regions over that encountered with 40 g U/l UO_2SO_4 solution. A loop which had operated 1000 hours on 40 g U/l plus 6 g Cu/l corroded through at a point where 1/4-inch pipe was welded to the 1-1/2-inch main line. The flow rates were 15 - 20 ft/sec in the 1-1/2-inch line and 50-60 ft/sec in the 1/4-inch line. Similar localized attack was noted in other similar flow regions. Experiments designed to attempt to evaluate the factors involved are now in progress.

Since static tests indicated that the corrosive attack of uranyl sulfate solutions on stainless steel undergoes a rather radical change, becoming much more serious, in going from 100° to 150°C and since a dynamic test operated 2840 hours at 90°C, 35 g U/l and 28 ft/sec gave very encouraging results (essentially no attack indicated); considerable effort is being shifted to studies in this temperature range.

Boiling Reactor Studies (AEC Activity 4264)

It is expected that the feasibility report for a small scale, outdoor, boiling reactor experiment will be issued during May. Current effort is being devoted to re-examining the design with a view toward decreasing the cost by simplifying the system and its equipment as much as possible, consistent with being able to obtain pertinent data.

HR Chemical Processing (AEC Activity 4268)

Studies are underway to determine the amount of plutonium that would plate out on the stainless steel walls of a full scale reactor.

Processing of short-cooled fuel was found to be complicated by contamination of the uranium and plutonium products by neptunium.

ISHR Predesign (AEC Activity 4341)

A flowsheet for an intermediate scale homogeneous reactor is now partially complete. Pressure drops and flow velocities are being calculated. Layouts for heat exchanger and pump cells of a homogeneous production reactor have been prepared and are being reviewed to determine what modifications would be needed for an ISHR.

Work has been started on a suggested design for the reactor vessel. The possibility of placing a thermal shield in contact with the fuel solution is being considered. A means for putting a neutron absorber into the core for shim control is being investigated. Calculations are being made to show what fuel concentration is required for criticality at different temperatures for a given enrichment. The results show that when the reactor is half full of 250 g U/l fuel it is not critical above 100°C, although it would be critical at 20°C.

Reactor Physics (AEC Activity 4342)

The Homogeneous Reactor Simulator has been completed. This computer simulates the Homogeneous Reactor, in so far as the equations apply, from the reactor through the heat exchanger and represents the solution of an eighth order system.

AIRCRAFT NUCLEAR PROPULSION PROJECT

ANP General Design (AEC Activity 4271)

Heat exchangers of such geometry that they can be welded to the spherical inner surface of a reactor pressure shell have been considered. This

unique location of the heat exchangers - such that they can offer some shielding to the reactor - could reduce the aircraft shield weight by about 10,000 pounds.

ANP Experimental Engineering (AEC Activity 4271)

Inconel and stainless steel thermal convection loops have been operated with (Na-K-Zr-U)Fx at 1500°F. The two Inconel loops have circulated for approximately 420 hours and the 316 loop for 370 hours with no evidence of plugging. An Inconel and a 316 stainless steel loop have been in operation for 470 hours with (Na-K-Li-U)Fx at 1650°F with no evidence of plugging. This is the longest period a 300-series stainless steel convection loop has circulated fluorides without failure. Metallographic examinations of an Inconel loop in which (Na-Be-U)Fx was circulated at 1500°F show intergranular corrosion to a depth of .014". Some pits were found in the grains but not as many as found in similar loops containing (Na-K-Li-U)Fx. Both metallic and non-metallic deposits were found in the cold portion of the loop. Metallic crystals were found in the lower portion of the cold leg of a 310-series stainless steel loop which had plugged after 368 hours of operation with (Na-K-Li-U)Fx at 1500°F. An iron loop plugged after only 25 hours of operation circulating a similar solution at 1350°F.

The Figure 8 Loop incorporating a NaK to NaK heat exchanger was terminated on schedule at 3000 hours. Preliminary examination indicates that the thin walled heat exchanger tubes are in good condition after this period of operation. More detailed metallographic examinations are underway.

The Figure 8 Loop circulating sodium with the frozen sodium seal pump continued to operate smoothly at the end of this period and had logged a total of 2563 hours.

A Durco 316 stainless steel centrifugal pump modified to incorporate a frozen seal was operated for more than 500 hours pumping (Na-K-Li)Fx at approximately 1100°F. This test definitely indicates that the frozen fluorides seal is satisfactory for centrifugal pump operation.

A sodium to air radiator core element was operated for a total of 330 hours with a sodium temperature between 1500° and 1600°F. This was a thin tube type radiator of approximately 25:1 between the air and sodium sides. Heat transfer data were obtained at sodium inlet temperatures between 700°F and 1600°F with sodium flow rates between 1 and 3.5 gpm, which resulted in maximum sodium temperature drops of 300°F. The air flow was varied between .06 to .15 lb/sec, resulting in overall transfer coefficients from 6 to 12 Btu/hr/sq.ft./°F. Maximum Reynolds number obtained was 7500. The maximum air temperature achieved was 1100°F and the maximum air pressure drop was 12 inches of water. The maximum overall heat transfer achieved was 110,000 Btu/hr.

Aircraft Reactor Experiment (AEC Activity 4271)

The direction of fuel flow through the core has been reversed to reduce the maximum wall temperature. The fuel now enters the core at the center and is discharged around the periphery. Detail drawings of the core are now complete and assembly drawings of the core and core igloo (heat shield) are well underway. The igloo is necessary to retain heat in the reactor system during preheating operation.

The secondary fill and dump tanks have been specified and a contract has been let for their construction. The primary fill and dump tanks are being fabricated in the Y-12 shops.

Primary heat exchanger details have been worked out with Griscom-Russell and the materials situation has been resolved so that these exchangers are now being manufactured. Negotitations for contracts for the secondary heat exchangers were completed during the month.

Detailed drawings of the fluid circuit layout are now well under way but not yet near completion. The fuel injection system is 75% designed. Detailing of the control rod actuators and igloo is also roughly 75% complete. The instrumentation layout is roughly 50% done and the preheating electrical circuitry has been started but will require several man months of effort to complete. Engineering of the electrical power distribution in the ARE building is 25% complete.

ANP Radiation Damage (AEC Activity 4275)

Further LITR irradiations of prospective aircraft reactor fluoride fuels contained in Inconel indicate a one mil penetration of the container by (Na-Be-U)Fx after 125 hours in a flux of 1.2×10^{13} and at a temperature of 1500°F. The penetration of (Na-K-U)Fx was 2 mils after 115 hours with the same flux and temperature. Samples of (Na-K-Zr-U)Fx are now under irradiation tests in the LITR.

Sodium has been circulated in Inconel loops within the X-10 reactor at a temperature of 1500°F and a flux of 3×10^{11}. No increased corrosion over bench tests was noted. Such work is preliminary to in-pile tests in the MTR in which fluoride fuels will be tested for radiation damage.

ANP Reactor Chemistry (AEC Activity 4275)

Ternary mixtures containing NaF, KF and about 45 mole per cent ZrF_4 give melting points in the range 400-500°C. Approximately 2 mole per cent UF_4 has been successfully added to some of the lower melting compositions; however, attempts to double the UF_4 content have resulted in the separation (on cooling to about 500°C) of uranium-rich phases. Considerable work will

be required to define the most suitable quartenary compositions in this system. Binary diagrams with ZnF_2 are nearly complete; no attractively low melting points have been found.

ANP Corrosion (AEC Activity 4275)

Filtering and sampling techniques for melts have been carefully checked, and the fate of structural metals in fused fluoride is now under investigation. Particular attention has been paid to the effect of trace sulfur contents on corrosion, and to the possible role of compounds such as K_3CrF_6 in causing the plugging behavior in thermal convection loops.

ANP Metallurgy (AEC Activity 4275)

Additional experiments have been run to study the possibility of preparing solid fuel elements by loose powder sintering. The following variables have been investigated: sintering temperature, sintering time, fuel component particle size, cold working and resintering, surface preparation, and sintering under load.

Results show that the bond between the backing sheet and powder is improved by an increase in the sintering temperature, while the effect of surface preparation is quite slight. As the uranium oxide particle size increases from 325 mesh to 100 mesh better bonding is accomplished. Gravity loading during sintering to a stress of 0.5 to 5 psi resulted in slight improvement in the density of the powder layer.

Hot pressing of mixtures of B_4C and 20% iron by volume is being studied for the preparation of slugs for use in the safety rods of the ARE. These slugs will be canned in one of the 300 series stainless steels by Nicrobrazing. The regulating rod for the ARE will be made by adding a very small amount of boron, as B_4C, to hot pressed aluminum oxide. The boron containing aluminum oxide slugs will then be canned in Inconel.

The creep testing laboratory for the study of the effect of various corrosive media on the strength properties of high temperature alloys has been completed. All these furnaces are now in test using a purified argon atmosphere over the specimen to compare the results using this equipment with the results obtained using a more conventional type creep apparatus. It is hoped that these test chambers can be filled with the fluoride mixture some time next month so the effect of the fluorides on the creep properties of these alloys can be determined.

It was found that the addition of NaK in the proportion of 20 cc of NaK to 400 cc of the fluorides is quite beneficial in stopping the corrosive action of the fluorides on the container materials. In a modified dynamic test, which is called the "seesaw" test, it has been found that addition of magnesium

and calcium are even more effective in minimizing the corrosive actions of the fluorides than NaK.

Physical Properties and Heat Transfer Research (AEC Activity 4275)

The viscosity of the zirconium bearing fluoride fuel, (Na-K-Zr-U)Fx (mole % 5-51-42-2), was measured with an efflux viscometer. The viscosity decreased essentially linearly from a value of approximately 10 cp at 550°C to 6 cp at 700°C. Preliminary values of the density of this mixture were determined to be about 3 g/cc in the above temperature region. From these data it appears probable that a fuel of this general composition will be used in the ARE.

Reactor Physics (AEC Activity 4277)

The effort was largely directed toward systematizing and assembling work previously performed regarding critical mass, power distribution, and neutron spectrum of the ARE. Preparations were also made to obtain solutions to the kinetic equations of the circulating-fuel reactor, and a literature survey was made as to the temperature coefficient of reactivity due to Doppler broadening of resonance lines.

Shielding Research (AEC Activity 4277)

Plans have been formulated and a proposal has been submitted to the AEC for full scale measurements of divided shields. The equipment will center about a 300 ft. high structure which will be capable of supporting an entire nuclear powered aircraft including reactor. A small low-power MTR type reactor will be used as a source, and standard instruments will measure the dose in the crew compartment. The tower will consist of two 300 ft high vertical members connected at their tops by a 200 ft. long bridge at the center of which is a 100 ft. long cross member which supports the main shielding components from its ends. The apparatus will be sufficiently high so that ground-scattered radiation can be made unimportant. Further, it is sufficiently flexible to permit measurements of ground scattering to simulate conditions encountered during take-off and landing. The facility will be located in the Oak Ridge area sufficiently remote so that the high radiation fields will not inconvenience other projects. The control building located near the base of the tower will be submerged and shielded with an 8 ft. overlay of earth. Completion of construction is anticipated for mid-1953 if appropriations are forthcoming.

The Bulk Shielding Facility group has completed the first measurements of the angular and spectral distributions for gamma rays in a water shield. The high energy radiation is strongly peaked in the outward direction, whereas the lower energy components are more diffuse. This information

will be of considerable help in the design of divided shields, especially when it is extended to include measurements in the transition region near the edge of a lead shadow shield.

The Lid Tank facility is being used to determine the effectiveness of an iron "neutron-piper" for use in conjunction with reactor control sensing elements. Although this work is to be applied specifically to the Westinghouse STR it is nevertheless of general interest for power reactor control.

The thermal column facility is continuing to be employed in research on air filled ducts. Effort is currently concentrated on determining the effective source area for a small duct fronting on a large source plate.

GENERAL REACTOR RESEARCH

Idaho Chemical Plant (AEC Activity 10547)

ORNL participation in the design phase of the Idaho Chemical Plant is nearing completion as construction of the plant is about 90% complete. Calibration and testing of process equipment by ORNL personnel is well underway. The design of the equipment to remove xenon and krypton from dissolver off-gases has been completed. A continuously recording waste water monitor has been fabricated at ORNL and shipped for installation.

School of Reactor Technology (AEC Activity 4590)

The Committee on Admissions has selected eighty students for the 1952-1953 session of ORSORT.

PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF ISOTOPES

Radioisotope Production (AEC Activity 5111)

The total accumulated KWH for pile operations during April were 2,203,648, averaging 3597 KW per operating hour. Pile down time was 14.9% as compared with 11.6% in March. There was one slug rupture, which was discharged without difficulty.

There were 939 radioisotope shipments during April.

Stable Isotope Production (AEC Activity 5121)

The calutron tank time was devoted to the collection of barium, tin, and boron isotopes. Overall innage for the four calutrons was 1019 hours with an integrated output of 28,575 milliampere hours for the two Alpha channels and 20,604 milliampere hours for the two Beta channels. Outage time was 46.6% as compared with 35.4% during March.

Chemical processing refinement was conducted on isotopes of lithium, strontium, calcium, lead, cerium, nickel, and tin. Chemical services were supplied to the calutrons for the separation of isotopes of cerium, barium, tin, and boron.

There were 34 stable isotope shipments during April.

PHYSICS

High Voltage Program (AEC Activity 5211)

The fission cross section of U^{236} was measured relative to U^{235} from the threshold of .7 Mev to 3.6 Mev. The (p, n) thresholds of Ne^{21} and Ne^{22} have been determined to be 3.94 Mev and 4.09 Mev respectively.

Neutron Velocity Selector (AEC Activity 5211)

Isotope assignment of some of the levels in indium has been completed. To check the resolution of the instrument, the transmission of silver was measured. Preliminary measurements on the transmission of U^{238} are in progress.

Electronuclear Machines (AEC Activity 5261)

Several accelerating slits of improved design have been tested in the 22-inch cyclotron. The best geometry increased the beam current by a factor of two. A maximum beam current of 1.5 ma was obtained at approximately 1.5 Mev with a potential of 15 Kv between dees.

Radio-frequency tests on the 63-inch cyclotron have been continued during the past month. The dee-to-dee voltage for which the machine was designed, approximately 75 kv, has been reached, and the cyclotron has oscillated for three 8-hour periods. A deflector voltage of 50 kv has been obtained over a gap varying from 1 cm to 2.8 cm.

A hollow anode type ion source has been installed in the cyclotron and has operated for periods of about 15 minutes. Source improvements to increase the stability are in progress.

The 86-Inch Cyclotron (AEC Activity 5261)

The additional water cooling added to the upper portion of the liner eliminated the low voltage sparking in this region. Further changes to increase clearances, reduce outgassing, provide more stable ion orbits, and to improve electron drain have been made which solved many of the problems associated with operation at increased power input and higher beam energy. The cyclotron has operated for several hours with 500-600 μa of beam current at 24 Mev and for short intervals at 1 ma. It is anticipated that the cyclotron will be back in continuous operation in the near future.

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Nuclear Resonance. Measurements of nuclear resonances in eleven vanadium compounds have been completed and a summary report on chemical shift phenomena in vanadium compounds is in preparation.

Spectro-Isotopy. The precision of direct reading photoelectric methods showed anomalous variation with exposure times. This has been traced to the discharging action of the transmission line capacity on the polystyrene capacitors when reversing the capacitor connections to buck out dark current. Suitable equations for correcting this error have been developed.

Spectrochemistry. The feasibility of rapid spectrochemical analysis of thorium breeder materials for rare earth impurities is under investigation. The required detection limit for the 48,000 barn gadolinium impurity is estimated at about 0.1 ppm in the thoria. A total of 4384 element determinations was made during this month.

CHEMISTRY

Chemistry of the Solid State (AEC Activity 5311)

With a view towards applying the results to the prevention of corrosion of metals by fluoride melts, solutions of alkali and alkaline earth metals in the melts of their halides are being studied. An amount of 3 mole per cent of potassium metal was found dissolved in the binary eutectic of sodium and potassium fluorides at 860°C and 1.7 mole per cent for the ternary mixtures of potassium, sodium and lithium fluorides. This amount is believed to be sufficient to offer the possibility of an effective corrosion control in molten fluoride reactor coolants and/or fuels.

Radiation Chemistry (AEC Activity 5311)

The chemical effects of ionizing radiations on aqueous benzene solutions are being studied. The yield of phenol in oxygen-saturated benzene solutions is equivalent to that of the reported hydroxyl radical. A mechanism has been proposed which satisfactorily accounts for the observed phenol and hydrogen-peroxide yields. The pH dependency of the phenol yield is being determined for comparison with pH effects in other irradiated systems.

Studies of chemical effects produced in solids by ionizing radiations have been initiated by studying decomposition of ice at various temperatures.

General Reactor Chemistry (AEC Activity 5311)

In the attempt to develop a standard cell against which a corrosion resistant film on stainless steel surfaces could be measured, the following half-cells were considered:

$$2Ag + SO_4^{--} = Ag_2SO_4 + 2e^-$$

$$2Hg + SO_4^{--} = Hg_2SO_4 + 2e^-$$

$$Pb + SO_4^{--} = PbSO_4 + 2e^-$$

$$2Tl + SO_4^{--} = Tl_2SO_4 + 2e^-$$

The e.m.f. of the cell Ag, Ag_2SO_4, $1MH_2SO_4$, Hg_2SO_4, Hg agreed with the calculated value in the ranges of 25°C to 85°C and the measurements will be extended to 250°C.

Since in preliminary studies the Ag, Ag_2SO_4 electrode appeared to be one of the best, cells were made up in stainless steel bombs to test the behavior of the e.m.f. between this electrode and a stainless steel surface by using

0.13 molar UO_2SO_4 or 0.1 molar H_2SO_4 as the electrolyte. It was observed at 100°, 200°, and 250°C that changes of a few tenths of a volt occured when the stainless steel corrosion resistant film broke down. Hence the method appears promising for possible detection of the quality of a stainless steel surface under operating conditions.

Chemistry of Uranium Raw Materials (AEC Activity 5361)

Essentially complete precipitation of thorium has been obtained from sulfuric acid solutions of monazite sand with benzene phosphonic acid, using only small quantities of reagent.

Good extraction of uranium was obtained from nitric acid leach liquor and fair extraction from reduced sulfuric acid leach liquor of Leached Zone ore with di(2-ethylhexyl) phosphinic acid in carbon tetrachloride. About two-thirds of the uranium was dissolved from Leached Zone ore in the presence of anion exchange resin with less acid than was required in direct leaching. Seventy-five per cent extraction of uranium was obtained from sulfuric acid leach liquor of Leached Zone ore with methyldioctyl amine in chloroform.

The solubility behavior of $UO_2HPO_4 \cdot 4H_2O$ in 0.02 to 1.5M H_3PO_4 solution indicates the existence in solution of the complex, $UO_2(H_2PO_4)_2^4$ and $UO_2(H_2PO_4)_2H_3PO_4$.

Direct dissolution of vanadium from carnotite ores by sodium carbonate leaching has been increased from a few per cent to more than 60% by pressure leaching (200 psi) at higher temperatures (200°C) in the presence of an oxidant ($KMnO_4$).

Thorex (AEC Activity 5361)

The acid deficient Thorex flowsheet yielded excellent U^{233}, Pa^{233} and thorium recoveries with good decontamination from fission products in laboratory scale runs. This process also provides high separation of U^{233} from beryllium impurties present in the thorium metal. Nuclear considerations necessitate the removal of the beryllium.

23 Processing (AEC Activity 5361)

Some U^{233} has been separated from a batch of thorium metal. The product, isolated by means of ion exchange methods, was within specifications.

METALLURGY

Fundamental Physico-Metallurgical Research (AEC Activity 5411)

Examination of some α-extruded uranium rods has been completed. Rods 1-1/2, 9/10, and 5/8 inches in diameter were extruded through 25° conical dies from ingots 3-1/8 inches in diameter at 500°C billet temperature (extrusion ratios - 4.3, 12.1, and 25.0, respectively). The extruded lengths were water-spray quenched as they emerged from the die to retain, insofar as possible, the as-extruded structure.

In the as-extruded condition, all samples exhibited a duplex [410]-[010] fiber texture with minor [031], [431], [001], [100] components. Increasing the extrusion ratio resulted in an increase in the strength of the [410] relative to that of the [010] component with an increase in sharpness of both. From the back to the front end of the extruded length of rod given the greatest reduction, there was an increase in the strength of [410] relative to that of the [010] component.

The degree of recrystallization increased with increase in extrusion ratio and, for the rod given the greatest reduction, increased from the back to the front end of the extruded length. From this, it would appear that the preferred orientation is related to the grain structure in that the strength of the [410] increased relative to that of the [010] component with increasing degree of recrystallization.

Upon annealing, the sample initially showing a high degree of recrystallization and a major [410] texture underwent essentially no change in texture. The sample initially exhibiting a deformed structure and a major [410]-[010] texture developed a sirgle [431] texture upon annealing. It appears than that the recrystallization texture developed in extruded uranium rod is dependent upon the manner in which recrystallization is induced.

PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Pathology and Physiology (AEC Activity 6400)

A new transmissible disease in mice characterized by anemia, leukopenia, and erythropoietic splenomegaly has been found by this Laboratory.

Biochemistry (AEC Activity 6400)

It has been possible to protect α-chymotrypsin against gamma radiation by certain substrates. This might be a useful tool in studying the biochemical effects of radiation.

Cytogenetics (AEC Activity 6400)

It has been found possible to reduce the radiation damage in sperm of *Drosophila* by reduced oxygen tension. However, this applies only to matings shortly after exposure to irradiation. This protection does not take place if the matings are done a considerable time after exposure.

BIOPHYSICS

Theoretical Physics (AEC Activity 6510)

A 30 cm slab of tissue was taken as model for the human body and was considered as irradiated by a normally directed beam of neutrons, with 1 n/cm^2 per second entering the slab. The resulting collision density is calculated for a beam of thermal neutrons, and also for beams of fast neutrons of energies 10, 5, 2.5, 0.5, and 0.005 Mev. The calculation of a dosage curve from the collision density involves the conversion to rep and this has been effected here by assuming the RBE factor to be 1 for gamma rays, 10 for protons, and 20 for any particles heavier than protons.

The calculation of the collision density has been made by the Monte Carlo method. The resulting energy losses are calculated from this collision density and yield a dosage curve, which for high energies, has its peak at or near the surface. The dosage curve for the 10 Mev beam has a fairly flat plateau extending into the slab for several centimeters. Since the Monte Carlo method is statistical in nature the dosage curve calculated by this method necessarily involves sampling errors and hence cannot be trusted in fine detail. The statistics indicate accuracy of the order of 10 - 15% for the curve. The method does enable one to obtain much detailed information. For example, collisions with elements other than hydrogen account for about 10% of the energy losses in the 10 Mev beam, and thus are not negligible. Since the neutrons are followed to thermal or near thermal energies, it is possible to get the resulting thermal distribution and to calculate its contribution to

the damage. This is quite negligible for high energy beams, but at 0.005 Mev amounts to more than half the total dose.

The maximum permissible flux based on a 40 hour week is found to be about 26, 26, 38, 82, and 1640 $n/cm^2/sec$ for beams of energies 10, 5, 2.5, 0.5, and 0.005 Mev respectively.

PROGRAM 9000 - RESEARCH FACILITIES

Research Laboratory Building #4500

All phases of contractor construction work in this building are 98% complete. Wing #4 is 99% complete. Final inspection of Wing #4 is scheduled for 5-2-52; for Wing #3 and first floor of service area 5-16-52; for Wing #2 and second floor of service area 5-30-52; and for Wing #1 together with all exterior work 6-15-52.

Isotope Research and Unit Operations Building #4501

Contractor work in this building is complete and it was accepted April 29, 1952. ORNL forces are installing equipment. Research personnel have begun moving into some areas.

Conversion of Jones Construction Camp (Central Shops)

Bids were opened on this job April 11, 1952. The V. L. Nicholson Construction Company of Knoxville, Tennessee was the apparent successful bidder.

Gas Decontamination Facilities for Buildings #4500 and #4501

Contractor work on this job is approximately 21% complete.

High Voltage Laboratory Building #5500

All phases of contractor construction work in this building are 92% complete. The 20-ton crane has arrived at the jobsite and is being installed. Final estimated completion date is 6-1-52.

Test Facilities Building #7503

The overhead crane has been received and is being installed. This is the last item of contractor work remaining to be done on this project through coordination of the job by the Austin Company architect-engineer services.

Chemical Isolation and Purification Laboratory Building #3508

ORNL forces are continuing the installation of equipment. Research personnel have moved into some of the labs.

Steam Supply Line to Building #7503 (ARE)

The 4846 foot steam line to the OCRA Area was completed when ORNL forces connected it to building #7500 (HRE) and #7503 (ARE).

Stripping and Alterations of Building #9204-1 (for HRP)

The stripped out east track area has been prepared for the installation of steel grate floors. Installation of utility service piping and electrical conduit is continuing. In the chemical laboratory lab benches, hoods, drains, and pipe racks are being installed.

Plutonium Laboratory Building #9204-3

A chemical laboratory for the preparation of calutron charge material and the purification of calutron separated plutonium isotopes has been completed by Y-12 CCC&C forces.

Ore Dressing Laboratory Building #9201-2

A laboratory for preparing uranium bearing ores for chemical analysis has been completed by Y-12 CCC&C forces.

RADIOISOTOPE SALES

Sales	February	March
Transfers within AEC	$ 5,545.95	$ 846.25
Cash Sales	25,727.20	18,096.15
Foreign	1,203.10	1,258.40
Cancer Program (Free)	41,399.45	46,950.55
Technical Cooperation Plan	450.00	53.61
Total Sales and Transfers to Date	2,170,955.98	2,227,345.41
Total Cancer Program (Free) to Date	1,241,856.83	1,288,807.38
Technical Cooperation Plan (Shipments to Date)	14,463.94	14,517.55

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

(a)	Actual Cost for March 1952	2,327,137.00	
	Actual Plant and Equipment Cost	578,040.00	
	Construction Program "H"	21,277.00	
	Total Operating and Construction Cost for March 1952		2,926,454.00
(b)	Estimated Operating Cost for April 1952		2,900,000.00
(c)	Actual Accumulative FY 1952 Operating Cost through March 1952	20,797,858.00	
	Actual Accumulative FY 1952 Plant and Equipment Cost through March 1952	3,103,006.00	
	Actual Accumulative FY 1952 Construction Program "H" Cost through March 1952	376,505.00	
	Total Accumulative FY 1952 Operating, Construction, and Plant and Equipment Cost through March 1952		24,277,369.00
(d)	Estimated Operating Cost FY 1952 through April 1952		$27,259,758.00

PERSONNEL SUMMARY

	Number of Employees April, 1952	New Hires April	Terminations April
Administration	81	1	
Operations*	124	4	
Engineering, Shops and Mechanical	898	10	27
Laboratory and Research	1458	23	5
Protection	179		4
Service	393	5	15
Total	3133	43	51

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