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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

MARCH, 1952

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AEC RESEARCH AND DEVELOPMENT REPORT

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

March, 1952

J. P. Lane

Date Issued: APR 8 1952

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OAK RIDGE NATIONAL LABORATORY
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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

March, 1952

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OAK RIDGE NATIONAL LABORATORY

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PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

Purex Process (AEC Activity 2803.2)

Hanford production slugs cooled 90 days have been processed in the pilot plant with the satisfactory operability of the equipment and process demonstrated. The plutonium product met specifications. The uranium product purity was improved by alterations in the chemistry and the equipment; however the radiation contamination is still high by a factor of two and additional modifications are to be studied. The installation of equipment in the pilot plant to remove radioactive noble gases from the dissolver off-gas is continuing. Laboratory studies now in progress include flowsheet modification, uranium purification by silica gel absorption, plutonium coupling by an ion exchange method, and plutonium metallurgical waste recovery.

SCRUP Separation (AEC Activity 2344)

Cold uranium spiked with plutonium was processed in the Metal Recovery Building. Equilibrium uranium and plutonium losses were approximately 0.1%. The over-all feasibility of the plant has been demonstrated. Hot processing was started with long cooled Hanford production slugs for a special Sr^{90} program.

[redacted]

PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR

LITR Operations

The LITR operated at 1000 KW per operating hour during March. Down time was 24.6% as compared with 37.1% in February. A new vertical experimental hole has been made available through the top plug for use by General Electric personnel.

MTR Fuel and Control Elements (AEC Activity 10543)

Two complete reactor fuel loadings have been shipped to Idaho, and one additional loading is being fabricated in the ORNL shops.

HOMOGENEOUS REACTOR PROJECT

Building #7500 - HRE (AEC Activity 4261)

The planned program of mechanical, chemical and electrical testing of the HRE systems and components has been completed and all necessary repairs or alterations have been made. The HRE is now being operated under full design conditions with natural uranium fuel solution. This period of trial operation will continue until a suitable demonstration of satisfactory, trouble-free operation has been achieved. After a sufficiently long period of trouble-free operation to give confidence that the HRE will perform satisfactorily, critical experiments will be started. The critical experiment program has been established in final form and personnel assignments have been made.

Dynamic Corrosion Studies (AEC Activity 4264)

The 30-gpm loop used for reflector system corrosion studies has been shut down so the pump could be removed and substituted for the 30-gpm pump which failed in the HRE. An experimental, cast pump impeller is being installed in the loop containing 300 gU/l fuel solution. Two loops containing test bends and fittings as well as corrosion specimen sections are being fabricated for studies of dynamic effects on the test materials. Other loops are in operation for life test runs with uranyl sulfate solutions containing 5, 40 and 100 gU/l. The 40 gU/l loop also contains dissolved copper to allow its effect on corrosion to be studied.

Slurry Pumping Studies (AEC Activity 4264)

During an 80-hour test in which a 40-gram per liter slurry was pumped across a 1725-rpm stellite-stellite bearing having 0.001-inch clearance, one groove developed in the bearing surface. The groove was 24 microns deep and is believed to have been formed when slurry particles lodged in pits which were present in the bearing surface before the test was started. This view is supported by the fact that aside from the groove, the rest of the bearing surface looked good with no detectable wear after the test.

Homogeneous Reactor Fuel Reprocessing Studies (AEC Activity 4268)

The homogeneous reactor processing program has involved two major studies: (A) the definition of the feed condition after discharge of the fuel from the reactor; (B) the development of the processes for recovering the plutonium and recycling the uranium back to the reactor.

There are strong indications that the plutonium will be present in the fuel discharged from the reactor as a precipitate. Pretreatment of the reactor equipment with uranyl sulfate solution will probably retard plutonium precipitation; however, the addition of copper ions to the fuel for retarding gas production will accelerate the precipitation.

Ultimately a Purex type process will be required for plutonium decontamination. Recent studies to determine the effect of short cooling cycles on this process indicated that the separation of neptunium from plutonium was low; however, the plutonium was satisfactorily separated from the fission products. The poor separation from neptunium may not prove important.

Boiling Reactor Studies (AEC Activity 4264)

Theoretical analysis of a cylindrical boiling reactor 20 feet in diameter and 20 feet high indicates that with a power density of 2.7 KW per liter the density decrease will be about 15% while at 7 KW per liter it will be about 23%, assuming in both cases that the maximum rate of rise of bubbles in the center of the cylinder is seven feet per second.

Plans are being made for a power density study in which a small bomb containing fuel solution will be heated until steam pressure breaks a rupture disc. Temperature and pressure measurements in the bomb and in the expanded steam will give data useful in determining power density and the rate of heat removal from boiling solutions.

ISHR Predesign (AEC Activity 4341)

The following criteria have been chosen as the basis of design studies for an intermediate scale homogeneous reactor:

Core diameter: 6 feet
Operating power level: 48 megawatts
Operating temperature: 250°C
Maximum pressure: 1000 psi

Preliminary analysis of some possible flow patterns indicates that a preferred type is straight-through flow using single inlet and outlet with a baffle plate to direct the flow inside the sphere. Gas separators might be located outside the core in the outlet pipe. A generalized circulating system has been studied, although specific components have not been designed.

Studies of thermal and pressure stresses have been carried out, indicating that at a power density of 15KW per liter, a two-inch thermal shield and a three-inch pressure vessel will be required for the core. For the pressure vessel, carbon steel lined with stainless steel has been suggested.

Shielding studies indicate that some advantages may be obtained by surrounding the core and its piping with two feet of water inside the concrete shield. The over-all shield dimensions may be about 40 x 50 feet, 30 feet high, not including space for chemical processing.

AIRCRAFT NUCLEAR PROPULSION PROJECT

Aircraft Reactor Experiment (AEC Activity 4271)

The number of fuel tubes which pass through the BeO moderator in the ARE core has been reduced from 78 to 66 in order to favor uranium investment and fabricational problems. The wall thickness of these fuel tubes has been increased from 20 to 60 mils to provide better corrosion protection. Experimental and analytical investigations of the purging of bubbles from these serpentine fuel tubes indicate that bubbles will be swept out of the core. Orders for fabricated components and raw material for all core constitutents have been processed. All components, or raw materials for their fabrication, of the ARE fuel circuit are likewise on order.

The fill, flush and dump tanks in both the primary and secondary coolant circuit must be heated and insulated because of the high melting point of the fuel and secondary coolant. The hot fuel dump tank involves special problems associated with fuel after-heat and is provided with internal helium cooling tubes.

The results of an investigation of the frequency of extended power failures indicate the purchase of the auxiliary turbo-generator as originally planned is not justified since the high heat capacity of the coolant system is sufficient to permit the retention of the fluids in the circuits from four to five hours before dumping becomes necessary. However, auxiliary batteries and an AC-DC motor-generator set will be provided.

Contracts have been negotiated for the construction of 95 to 98% of the electronic and control equipment for the ARE, with their delivery expected by October 1. The control rods are being fabricated at the Laboratory. The gears and servo mechanism, which are similar to those incorporated in the MTR, have been ordered from the Modern Tooling Company. The time constant of the present ARE design is only 0.5 sec. and therefore may be sufficiently low to simplify the ARE control system.

ANP Critical Experiments (AEC Activity 4272)

The studies of the first mock-up of the General Electric direct cycle aircraft propulsion reactor previously reported have been completed and the final report submitted to General Electric. The current reactor design incorporates concentric shells of water moderator and fuel, with the cooling air flowing through the latter. In order to simulate more effectively this design the former mock-up, which had horizontal layers of Plexiglas and stainless steel, has been modified by rotating a part of the fuel element through 90°. In the resulting structure the Plexiglas and the stainless steel form nesting open ended boxes approximating the concentric cylindrical annuli of the design. A series of measurements of the kind made with the first mock-up will now be made.

It is intended to make a preliminary reactor assembly of the ARE prior to its construction. The experiments to be performed with this assembly will be at power levels of the order of one watt and at room temperature. The reflector and moderator will be made of BeO and the fuel will consist of a powder pack of those fluorides yielding the physical and chemical properties best suited to the circulating fuel-coolant. Preliminary designs of safety and control mechanisms have been completed and fabrication is now underway.

ANP Reactor Chemistry (AEC Activity 4275)

Intensive investigation of zirconium containing fuels has been continued with encouraging results; however, extensive purification of ZrF_4 has been necessary. The prospects for ZnF_2 as a fuel constituent appear to be less favorable.

Definite indications of the disproportionation of NiO in NaOH melts have been obtained; this undoubtedly plays a fundamental role in the mechanism of metal deposition in fused solvents.

The vapor pressure of BeF_2 has been measured and is now being rechecked. The viscosity of the Na-K-Li fluoride eutectic, containing 1.1 mol % UF_4, has been measured after circulation in a thermal convection loop and found to show no increase.

ANP Corrosion Studies (AEC Activity 4275)

Chromium is selectively removed from structural metals by molten fluorides. The metallic plugs which form in 400 series stainless steel convection loops are composed largely of metallic iron. A systematic quantitative study of the effect of filtering and sampling techniques is approaching completion.

ANP Radiation Damage (AEC Activity 4275)

Preliminary tests indicated that beryllium salts in the fuel eutectic are promising as far as radiation damage characteristics are concerned.

Observation of the increased creep rate of 347 stainless steel during reactor irradiation at 1500°F and 1500 psi have been previously reported. Extension of these tests now show that the sense and magnitude of the irradiation effect is dependent on the conditions of the experiment.

In-pile secondary creep rates for 347 stainless steel cantilever specimens stressed to 8000 psi were obtained at temperatures from 1200 to 1400°F during irradiation in the graphite reactor. When reciprocal absolute temperature versus creep rate was plotted, a straight line was obtained; a similar plot of bench test data also results in a straight line but of different slope. The lines intersect at a point corresponding to a temperature of about 1400°F. At 1200°F the in-pile creep rate is only about 40% of the bench test rate. These experiments indicate that either increased or decreased creep is possible under neutron bombardment, depending on the material and the test conditions.

Two creep tests on Inconel (at 1500°F and 1500 psi stress) in the graphite reactor showed a striking increase in creep rate after about one hundred hours of bombardment. Later the rate diminished and then finally settled out to a constant rate. The total strain in the in-pile test was several times that observed on the bench. A somewhat analogous point of inflection was noted in the bench tests at about 400 hours; this behavior is characteristic of Inconel annealed at temperatures in the neighborhood of 1700°F before testing. The cause of the large increase in creep is thought to be accelerated precipitation of a second phase (probably a carbide) under neutron bombardment.

ANP Metallurgy (AEC Activity 4275)

In studies of the interaction of nickel in NaOH under oxidizing conditions a new compound of nickel has tentatively been identified as $NaNiO_2$ (sodium nickelate III) which forms as a corrosion product. This material is a black crystalline substance which upon reaction with water breaks down to form a green crystal. The latter is now under study for identification.

Two new pieces of equipment have been designed and constructed for the study of the mass transfer phenomenon in liquid metal and hydroxides. One piece of equipment, the cold finger apparatus, works on the principle of heating the outside tube and cooling the inside tube of two concentric metal tubes in which the corrosive medium is held in the annulus between the tubes. The other piece of equipment, called a thermal convection pipe, consists of a single piece of tube which is divided into two compartments by placing a thin sheet of the same material down the center of the tube to leave a path for the liquid both at the top and the bottom of the tube. The liquid is heated on one side of the sheet

and cooled on the other, thus giving rise to a thermal convection. Both of these pieces of equipment have been successful in preliminary shakedown tests.

On a subcontract with ORNL, Gerity-Michigan Company has been developing a method of preparing solid fuel elements. They have successfully made fine screens and grids of stainless steel, Inconel, columbium, and molybdenum. These screens are then mounted to a suitable backing sheet and the void areas are filled with a mixture of the metallic and the uranium oxide. A cover plate is placed on top of this and the assembly is welded.closed and then hot rolled to produce bonding between the center core and the cover plates. This type of arrangement makes it possible to carefully control dispersion of the uranium oxide.

Heat Transfer and Physical Properties (AEC Activity 4275)

The heat capacity of $Ba(OH)_2$, $SR(OH)_2$, and NaF-KF-LiF-UF_4 are currently being measured; that of KOH and LiOH have been determined up to 900°C. The viscosity of NaF-KF-ZrF_4, which is of interest to the current ARE design, is being measured. The density of seven fluoride fuel mixtures, proposed for both stationary and circulating fuel type reactors, have been determined at room temperatures. The following experimental values were obtained:

KOH	Cp = 0.35	between 400°C to 900°C
LiOH	Cp = 0.80	between 500°C to 900°C

Analysis of a reactor system containing circulating fuels and moderators have resulted in the preparation of dimensionless temperature charts which indicate how much heat must be removed from the tube wall by the circulating moderator in order to maintain the desired wall temperature. It is apparent here, as with the circulating fuel reactor, that the fuel flow must be turbulent to remove the excessive quantities of heat from the tube wall.

ANP Design Physics (AEC Activity 4277)

It appears unlikely that a circulating fuel reactor will suddenly become undamped or develop increasing power oscillations. On the other hand, the initial temperature rise, following the entrance into the reactor of an excess amount of fuel, may be larger than can be tolerated. Previous calculation took into consideration the thermal expansion of fuel as the only source of negative temperature coefficient of reactivity. This thermal expansion was believed to be the reason why the excess reactivity decreased, and eventually disappeared as the temperature of the fuel was increased. Current studies are being conducted in an attempt to evaluate the nuclear effects to ascertain whether they counteract the (already marginal) negative temperature coefficient due to fuel expansion. Furthermore, these studies will determine if it is possible to use these nuclear effects to produce an additional negative temperature coefficient. Nuclear effects under investigation are: (A) the influence of the fuel temperature on the fission and absorption cross sections, and (B) the "Doppler broadening" of the resonance lines due to thermal motion of the fuel atoms.

PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF ISOTOPES

Radioisotope Production (AEC Activity 5111)

The total accumulated KWH for pile operations during March were 2,423,988, averaging 3685 KW per operating hour. Pile down time was 11.6%, as compared with 8.6% in February. There was one slug rupture, which was discharged without difficulty.

There were 1011 radioisotope shipments during March.

Stable Isotope Production (AEC Activity 5121)

The calutron tank time during the month of March was devoted to the collection of cerium, tin, and barium isotopes. Over-all innage for the four calutrons was 1126 hours with an integrated output of 12,200 milliampere hours for the two Alpha channels and 15,846 milliampere hours for the two Beta channels. Outage time was 35.4% as compared with 40.3% during February.

Approximately 100% retention was observed in a nine-hour run made to determine the effect of ion deceleration at the receiver. Assays from two additional runs in the short radius equipment showed the purity of Li^7 to be 99.9% which is equal to that produced in Alpha 2 equipment.

Chemical processing refinement was effected on isotopes of lithium, strontium, calcium, lead, molybdenum, iron, cerium and nickel.

There were 14 stable isotope shipments during March.

PHYSICS

Theoretical Physics (AEC Activity 5211)

The complete theory of angular correlation of any kind of radiations has been developed for the purpose of analysis of experiments concerning nuclear energy states. This includes the effect of magnetic fields and hyperfine structure. Methods of determining the magnetic moments in excited states have been studied. An extensive tabulation of pertinent coefficients has been made.

The problem of the photo-electric effect has been set up for computation.

The pertinent functions for describing the effect of the nuclear charge in β^- radioactivity for forbidden transitions have been developed.

Neutron Decay (AEC Activity 5211)

Considerable effort has been devoted to the possibility of determining the nature of the basic interaction n-β^- by observing the recoil protons which result from neutron decay. With the strong beams available in the LITR it

now appears that two attacks may be feasible. One is a direct measurement of the momentum spectrum of the recoil protons by means of a magnetic lens. In such an experiment the protons recoiling from a neutron beam would drift through a thin magnetic lens of large aperture and after passing the ring focus would be collected on a multiplier for counting. Only ten to twelve counts per minute would be available for the measurements; therefore the background would have to be correspondingly low. The second method consists of a coincidence experiment in which the number of events with a 180° angle between the beta particle and the recoiling proton would be compared with the number for which the angle is 125°. Again the presence of an appreciable background appears to be a major experimental difficulty.

High Voltage Program (AEC Activity 5211)

The yield of neutrons and gamma rays from the bombardment of C^{13} with protons in the region from 3 to 5 Mev has been measured. Five hitherto unobserved resonances have been located in the neutron yield and one in the gamma ray field.

Short Lived Isomers (AEC Activity 5211)

K-shell internal conversion coefficients have been measured for the following nuclei:

Nucleus	E_γ	K α Exp.	Multipole Assignment
Ta^{181}	133 K_ν	0.49	E2
Eu^{153}	70 K_ν	3.80	E2 + M1
Eu^{153}	103 K_ν	1.10	E2*
Te^{123}	159 K_ν	0.19	M1
La^{139}	165 K_ν	0.28	M1

*To be rechecked.

The directional angular correlation of the 133-481 Kev cascade of Ta^{181} has been examined and is found to be anisotropic. In this particular case the intermediate state is metastable with a half-life of 10^{-8} seconds. Preliminary results indicate that the anisotropy is at least 15%. The angular correlation of the 70-103 Kev cascade of Eu^{153} is isotropic to within ± 2%.

Electronuclear Machines (AEC Activity 5261)

Construction and assembly of the 63-inch cyclotron is now complete. The ion source assembly, probe, and an adjustable deflector septum have been installed. The magnetic field has been improved to the extent that the coefficient of the first harmonic is less than 0.03%. In preliminary radio-frequency tests of the resonant system 35 kv, dee-to-dee, has been obtained.

Both gamma and neutron survey meters have been installed for the protection of operating personnel. All components of the cyclotron will be thoroughly tested before actual operation is attempted.

86-Inch Cyclotron (AEC Activity 5261)

Relocation of the ion source during the recent shutdown has moved the apparent radial center of the beam nearer to the magnetic center of the cyclotron. At 30.5 inches from the magnetic center a beam energy of 24.4 Mev has now been measured. At this energy and radius, a beam current of one milliampere on an aluminum target has been measured. With the increase in effective radius the threshold dee-to-dee voltage has increased from ~300 Kv to ~400 Kv. This has increased the "no load" power input to the oscillator from 90 KW to 165 KW; with full beam the input has exceeded 300 KW. At these higher power inputs the liner became overheated thereby making it necessary to install additional water cooling facilities.

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Nuclear Resonance. Studies on chemical shift phenomena in nuclear magnetic resonances have been made on copper (Cu^{63} and Cu^{65}). Measurements have also been made on Ga^{69}, Ga^{71}, F^{19}, Tl^{203}, Tl^{205}, Rb^{87}, Li^{6}, and Li^{7}. Results on these will be reported in the Quarterly Report of the Stable Isotope Research and Production Division.

Optical Spectroscopy. Spectro-isotopic assay development for lithium has shown some progress. Sixty-six samples were assayed during the month; present assays are being performed to about 0.5% of the Li^{7} content. Direct reading photoelectric equipment is being tested and precision of individual measurements appears to be of the order of about 2%.

Zeeman echellograms have been obtained of copper, lead, zinc, sodium, and uranium. Uranium patterns show excellent splitting characteristics in the longer wavelength spectrum lines. The magnetic field has been calculated from the splittings of the sodium resonance lines (assuming no incipient Paschen-Back pertrubation) as 25,500 ± 400 gauss.

Mass Spectrometer Laboratory (AEC Activity 5261)

X-ray analyses show that the metallic material previously separated from a plugged test loop that contained (Na-K-Li-U)Fx is composed of at least two phases one of which is pure iron and a second phase which is a chromium iron alloy. The green salt crystal phase is now known to be a salt of chromium and has a refractive index less than 1.460.

Mass spectrometer investigations were made on UO_2F_2. Both UF_5 and UOF_4 were found to be present in UO_2F_2.

A mass spectrometer investigation has been completed on the identification of the positive ions which arise from the vapors of silicone rubber, teflon and octoil-S.

CHEMISTRY

Inorganic Solution Chemistry (AEC Activity 5311)

The activity coefficients of uranyl fluoride at moderate and high concentrations were determined at the freezing points and at 30°C. Uranyl fluoride was found to be essentially undissociated and also to dimerize to $(UO_2F_2)_2$. The heat and entropy of dimerization was determined. Since the heat of the reaction is positive, it is expected that dimerization and possible further polymerization become increasingly important with increasing temperatures.

An automatic precision method for determining freezing points of solutions has been developed using a thermistor as a temperature sensitive indicator. In view of the simplicity of the method and equipment, it is believed that the determination of freezing points might prove useful in connection with quality control of pure compounds, particularly those of soluble uranium.

Nuclear Chemistry (AEC Activity 5311)

In connection with the long term program of producing and identifying all the isotopes of technetium a new 16 second isotope of mass 100 has been detected. Only one isotope of mass 98 remains to be produced or detected; since this isotope could not be produced by prolonged intense cyclotron bombardment of highly enriched Mo^{98}, there is a possibility that the half-life may be long enough for this isotope to exist in nature.

Thermodynamic properties of technetium metal, heptoxide, dioxide, and pertechnic acid have been investigated. From measurements of vapor pressure entropies and enthalpies of fusion, of vaporization, and of sublimation and the boiling point temperature of Tc_2O_7 were determined. The entropy of fusion of the heptoxide appears to be higher than that for any other inorganic compound. The magnetic properties of technetium compounds have been previously reported. The melting point of technetium metal was found to be 2140° ± 20°C. In this respect technetium resembles manganese rather than rhenium.

Chemical Physics (AEC Activity 5311)

Neutron diffraction studies of tetragonal and high temperature cubic ND_4Br have been completed, supplementing previous work on the other two phases. Tetragonal ND_4Br contains ammonium ions in a slightly distorted CsCl arrangement in which N-D arms are directed toward four of eight surrounding bromide ions and alternate columns of ammonium ions are rotated 90° with respect to each other. The bromide ions are displaced 0.12 Angstrom along the tetragonal axis toward the plane of four near hydrogens. High temperature cubic ND_4Br contains ammonium ions rotating about an axis through one hydrogen atom, this axis being oriented at random parallel to the six cubic directions of the crystal.

23 Processing (AEC Activity 5361)

Cold thorium has been processed in the pilot plant, and operational procedures for the U^{233} production runs have been established. Approximately 2.3 tons of Hanford irradiated thorium will be processed in the near future.

Thorex (AEC Activity 5361)

An ion exchange procedure is being developed for isolation of U^{233}, and present results indicate satisfactory concentration of the product with low losses and good protactinium separation.

Alternate systems for the separation of protactinium - tributyl phosphate extraction and silica gel adsorption - were investigated. In earlier work diisopropyl carbinol was used successfully; however it had a low flash point. This work is continuing.

Chemistry of Uranium Raw Materials (AEC Activity 5361)

Moderate amounts of sulfate or fluoride ions do not decrease the extraction of U^{+6} from aqueous solution by organophosphorus acids. Thorium has been completely extracted in a single stage from a sulfuric acid solution of monazite sand using only six moles of mono-octyl phosphate per mole of thorium.

Satisfactory reduction of Leached Zone ("Bartow Clay") sulfate leach liquor has been obtained with sodium hydrosulfite, zinc amalgam, or iron metal, for precipitation of uranous phosphate. Ninety percent of the uranium has been precipitated by this method in a one percent cake.

The solubility behavior of $UO_2HPO_4.4H_2O$ in 1M $HClO_4$ solutions containing varying amounts of H_3PO_4 indicates a complex in which the ratio of phosphate to uranyl is 2.

Mineral identification of lignite shows the presence of gypsum (anhydrite), jarosite, analcite, and carbonaceous material as the main constituents. Physical concentration by heavy media separations has shown that 50% of the inorganic constituents may be discarded while losing only 2-8% of the carbon and 2-10% of the uranium.

METALLURGY

Physical Metallurgy of Reactor Materials (AEC Activity 5411)

Data have been obtained to indicate that the addition of 0.1% of carbon to thorium will approximately double the tensile strength and triple the yield strength of the metal while retaining substantial ductility. The addition of beryllium, chromium, and oxygen to both Ames and iodide thorium has been investigated; chromium significantly increases the strength and retains adequate ductility, but beryllium and oxygen show minor effects. A program

designed to investigate the effects of hydrogen on iodide titanium has been initiated. The main objective is to determine if a transition in impact strength over a temperature range is the result of hydrogen embrittlement.

Ceramics Research (AEC Activity 5411)

The physical properties of hafnia are being investigated. The melting point has been found to be about 2700°C. The thermal expansion is much less than ZrO_2, although the crystal structures of HfO_2 and ZrO_2 are almost identical. No inversion from the monoclinic to the tetragonal form was found up to 1300°C, whereas ZrO_2 inverts at about 1170°C. It is believed that the inversion will be slightly above 1300°C.

Satisfactory enamel coatings have been applied to stainless steel and copper and the coatings applied to stainless steel protected the metal from oxidation for at least 93 hours at 900°C.

A new technique has been developed in the coating of zirconium prior to rolling. This technique appears promising in preventing oxidation of the metal during hot rolling.

A major research program, designed to study the behavior of ceramic materials when subjected to radiation is being organized. Thirty-five ceramic compositions including refractories, glasses, insulators, and single crystals are being prepared for this study.

A considerable amount of time has been devoted to a petrographic study of the fluoride fuels. The optical properties of $NaBeF_3$, Na_2BeF_4, $NaUF_5$, and UF_3 have been determined as well as additional data on UF_4. The change in the mineral phases of the fuels after being circulated in the harp has likewise been investigated.

PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Mammalian Genetics and Cytogenetics (AEC Activity 6400)

The mouse embryo can be somewhat protected against radiation damage by injecting mecholyl bromide into the mother immediately before irradiation. Mecholyl bromide has a slightly damaging effect on the embryo if given in too high a concentration; however, in concentrations which appear to be safe, this chemical provides sufficient residual protection. Such treatment shows promise in protecting other types of embryos against radiation damage when it is essential to irradiate the pregnant mother.

Biochemistry (AEC Activity 6400)

It has been shown that the action of ribonuclease on ribonucleic acid is to produce short chains of purine nucleotides ending with a pyrimidine nucleotide. This has significance for the understanding of the structure of ribonucleic acid.

BIOPHYSICS

Air Prospecting for the Department of Interior (AEC Activity 10543)

In a cooperative program scintillation counters operated by ORNL personnel are flown in a Department of Interior Airplane over areas that might contain possible uranium deposits. Areas of predominant radiation background are mapped in order to be more closely investigated by ground prospectors. A uranium deposit of promising concentration was located by this method in the Powder River Basin in Wyoming.

Consultation and Special Problems (AEC Activity 6530)

Special assistance concerning potential radiation hazards from disposal of fission gases is being given for the outdoor critical experiment for boiling homogeneous reactors and for the planned operation of the HRE and the ARE.

PROGRAM 9000 - RESEARCH FACILITIES

Research Laboratory Building #4500

The contractor is 98% complete. With the exception of the grading and blacktopping of new roads adjacent to the 4500-4501 and 5500 buildings (all under the J. A. Johnson Company contract), all exterior work is complete. Interior: All phases of construction work are proceeding slowly. Due to difficulties in the testing of services to the laboratory equipment in Wing #4, the setting of laboratory equipment has been delayed. The final estimated completion date of the contractor's work in this building, May 15, 1952, remains the same.

Isotope Research and Unit Operations Building #4501

The contractor is 99% complete. Unit Operations Section: Acceptance Form F-2 for the first, second and third floors of this building was signed, and Acceptance Form F-2 for the basement, hot and cold tunnels, and room #301 will be signed later. Isotope Research Section: All phases of construction work in this section are proceeding slowly. The final estimated completion date of the contractor's work in this building remains the same (April 18, 1952).

East Portal Building #5000

Completion Form F-3 has been processed and signed. Contract is complete.

Gas Decontamination Facilities for Buildings #4500 and #4501

The design by ORNL Engineering Department is 100% complete. The contractor has started working on construction.

High Voltage Laboratory Building #5500

The contractor is 80% complete. All phases of construction work in the interior of this building are progressing 5% behind schedule. An additional contract for the setting and piping of laboratory equipment has been awarded to the prime contractor of this building, with a stipulated completion date of sixty days after all equipment is delivered on job site. The equipment has been received, and work on this phase of construction is in process. The estimated completion date with this additional work is May 23, 1952. The final estimated completion date without the crane is May 23, 1952; with the crane June 15, 1952.

Test Facilities Building #7503 (ARE)

The work on the original contract is complete. Inspection of the additional work, which was designed by ORNL Engineering Department, is being done by that Department.

Chemical Isolation and Purification Laboratory Building #3508

The exceptions noted on Acceptance Form F-2 have been completed, and Form F-3 has been signed. ORNL forces are installing laboratory equipment.

Steam Supply Line to Building #7503 (ARE)

This project is 100% complete. Acceptance Form F-3 has been submitted for signature.

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

All stripping is 85% complete. Both the west and east electromagnetic tracks have been removed as well as the track supporting concrete piers and pads. Installation of a steel grate floor and installation of piping is under way in the former west track area. The chemical laboratory is 50% complete. Floors and office partitioning is complete. The installation of laboratory benches and services is progressing as hoods and sinks are being fabricated by the shops.

Air Supply, Building #9733-1

The main air supply duct and branch ducts to laboratories on the west side of the building have been installed. New hoods are being installed where needed.

RADIOISOTOPE SALES

Sales	January	February
Transfers within AEC	$ 575.30	$ 5,545.95
Cash Sales	37,518.88	25,727.20
Foreign	637.00	1,203.10
Cancer Program (Free)	43,627.45	41,399.45
Technical Cooperation Plan	1,079.30	450.00
Total Sales and Transfers to Date	2,081,921.03	2,170,955.98
Total Cancer Program (Free) to Date	1,200,457.38	1,241,856.83
Technical Cooperation Plan (Shipments to Date)	14,013.94	14,463.94

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

(a)	Actual Cost for February 1952	$ 2,210,398.00	
	Actual Plant and Equipment Cost	378,358.00	
	Construction Program "H"	2,401.00	
	Total Operating and Construction Cost for February 1952		2,591,157.00
(b)	Estimated Operating Cost for March 1952		2,600,000.00
(c)	Actual Accumulative FY 1952 Operating Cost through February 1952	18,470,721.00	
	Actual Accumulative FY 1952 Plant and Equipment Cost through February 1952	2,524,966.00	
	Actual Accumulative FY 1952 Construction Program "H" Cost through February 1952	355,228.00	
	Total Accumulative FY 1952 Operating, Construction, and Plant and Equipment Cost through February 1952		21,350,915.00
(d)	Estimated Operating Cost FY 1952 through March 1952		$24,359,758.00