ORNL 1251
Progress

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

FEBRUARY 1952

OAK RIDGE NATIONAL LABORATORY
OPERATED BY
CARBIDE AND CARBON CHEMICALS COMPANY
A DIVISION OF UNION CARBIDE AND CARBON CORPORATION
UCC
POST OFFICE BOX P
OAK RIDGE, TENNESSEE

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

February, 1952

J. P. Lane

Date Issued: MAR 10 1952

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OAK RIDGE NATIONAL LABORATORY
Operated By
CARBIDE AND CARBON CHEMICALS COMPANY
A Division of Union Carbide and Carbon Corporation
Post Office Box P
Oak Ridge, Tennessee

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

February, 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)

The Purex Pilot Plant runs were completed during the month using Hanford irradiated metal. The product losses were satisfactorily low and adequate plutonium decontamination of the plutonium product was obtained. However, the uranium product did not meet the radiation specifications.

Laboratory studies have been initiated to determine a method for improving uranium decontamination.

SCRUP Separation (AEC Activity 2344)

The first cold chemical run in the SCRUP separations equipment was satisfactorily completed with low uranium losses. The cold operation of this plant will be continued during the coming months in preparation of the hot runs.

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PROGRAM 4000 - RESEARCH DEVELOPMENT

MATERIAL TESTING REACTOR

LITR Operations

The LITR operated at 705 KW per operating hour during February. Down time was 37.1% as compared with 14.1% in January. The water circulation system has been improved such that power development of 1500 KW is now possible. A faster rate of water flow has caused higher radiation levels in the seal tank, probably because of the presence of nitrogen 16 in the exit water; consequently new shielding should be installed. Minor oscillations in power were corrected by replacing a water pump that sucked air through the packing glands into the cooling water system and by increasing the water flow rate.

MTR Fuel and Control Elements (AEC Activity 10543)

Twelve fuel assemblies have been shipped to Idaho and twelve more are available for shipping in accordance with the MTR loading schedule. The shim rod assemblies are now installed in the reactor.

HOMOGENEOUS REACTOR PROJECT

Building #7500 - HRE (AEC Activity 4261)

Toward the end of February, all leak repairs and testing had been completed, and a test run on natural uranium fuel solution was started. A total of 100 hours time on this run under full design conditions had been accumulated by the end of the month without operational difficulty.

Criticality of Turbulent Systems (AEC Activity 4263)

Plans have been made for a series of homogeneous reactor critical experiments with both solution and slurry fuels. Major emphasis will be placed upor determining the influence of various kinetic factors affecting reactivity, especially in slurry systems. Equipment is now being fabricated for the experiments.

Fuel and Blanket Studies (AEC Activity 4263)

A group has been appointed to make an evaluation of thorium blanket systems, e.g. solutions and slurries, for use in a homogeneous breeder-type reactor. From this preliminary study it is hoped to obtain suitable information for establishing the most promising blanket materials for further investigation.

Chemistry of Homogeneous Fuel Systems (AEC Activity 4263)

The yield 1.5 H_2 per 100 ev for pile irradiated 40 gU/l uranyl sulfate (93% enriched) was found to be independent of temperature from 120° to 250°C. With the U^{235} concentration constant the yield decreased with total uranium concentration to a value of 0.5 at 800 gU/l. The yield decreases as the ratio

of fission energy to total energy absorbed decreases. The yield 0.4 for gamma ray decomposition of water is less with added uraryl sulfate, reaching a value of 0.1 at 300 gU/l.

Engineering Development (AEC Activity 4264)

The HRE mock-up is being used in making studies of the operating characteristics of pulsafeeder pumps. In particular, the large pressure surges are being studied in the hope of curbing them and thus improving the life-time of the diaphragm.

Operation of the 100 gpm pumps in test loops for a total of about 14,000 hours has given confidence in the mechanical reliability of this pump under HRE operating conditions. The models tested have been modified for HRE use by substituting tantalum for the nickel seal rings, stellite 98M2 journal bushings for the titanium carbide, and by eliminating thrust loads by hydraulic balancing.

Engineering Research (AEC Activity 4264)

Allis-Chalmers has completed preliminary design studies of a 20,000 gpm pump suitable for use in large scale homogeneous reactors. The next phase of this work will cover more detailed design leading toward actual fabrication of the pump.

Dynamic Corrosion Studies (AEC Activity 4264)

Seven 100-gpm circulating loops are now in operation with uranyl sulfate ranging in concentration from 5 to 300 gU/l. Four additional loops are nearing completion. One 30-gpm loop is in operation with water for testing of the corrosion of reflector system materials and the effect of additives on the corrosion rate.

Having established that oxygen pressure in the system is essential to solution stability, the group is now trying to determine optimum oxygen concentrations. Additional studies are concerned with the corrosion effect of the presence of copper and fission products and the variation of oxygen and uranium concentrations. Plans have been made and equipment has been fabricated for studying velocity effects.

Recent examinations of failures in sections of piping in the 100-gpm test loops confirm the previous observation that localized rate of attack in high velocity regions is very much greater than the overall rate of attack.

Radiation Chemistry (AEC Activity 4264)

Studies of the recombination of hydrogen and oxygen catalyzed by copper in the fuel solution are being carried out in the higher fluxes of the LITR. New data confirm the validity of the general theory of homogeneous solution catalyst recombination and have enabled some refinements to be made so that steady state pressures under various conditions may be predicted more accurately.

Aqueous Solution Chemistry (AEC Activity 4264)

Data have been obtained for the conductivity of uranyl sulfate solutions ranging from 5×10^{-5} to 3 molar at temperatures up to 100°C. Vapor pressures of uranyl sulfate solutions are being studied as a function of concentration and temperature. The objective of these studies is to elucidate the molecular state of the uranyl sulfate solutions at high temperatures.

Further work is concerned with plutonium chemistry in homogeneous reactor fuel solutions containing fission products.

Slurry Pumping Studies (AEC Activity 4264)

In the slurry pumping studies to date, no difficulty with erosion has been encountered with UO_3 slurries ranging from 50 to 200 grams per liter. A 125 gpm slurry pumping loop is now being fabricated. This will be a 250°C loop using the modified Westinghouse Model 100A pump developed for the dynamic corrosion loops.

A program of study of thorium slurries is being planned. Actual pumping experiments are expected to get under way in March.

ISHR Predesign (AEC Activity 4341)

Layouts of an intermediate scale homogeneous reactor system including the main piping have been prepared. Shielding calculations are now in progress. The ISHR Predesign Report will be issued in the fairly near future.

Reactor Physics (AEC Activity 4342)

The design criteria for a small scale boiling reactor outdoor experiment have been established and a flowsheet has been decided upon. It is planned for a maximum power level of 250 KW to be reached in a 10 cubic foot cylindrical vessel containing about 1.5 cubic feet of fuel solution. The fuel will be uranyl sulfate solution (60 gU/l, $H/U = 400$) and the operating pressure with the solution boiling will be in the range of one to ten atmospheres.

Core drillings are being taken at the proposed site near the HRE building, since it is planned to bury the equipment in the earth using concrete shielding

only over the top. Equipment is being collected for the reactor system. The general system arrangement calls for a central reactor vessel of 10 cubic foot volume below which are the dump tanks and above which are the catalytic hydrogen-oxygen recombiner and a condenser. The core tank will also contain a cooling coil steam condenser. Solution from the dump tanks is pumped into a weigh tank and then into the core vessel during the fuel addition process. The fuel will not be circulated during operation.

The objectives of this experiment are to demonstrate the controllability of a boiling solution chain reaction at somewhat higher power levels and pressures than have been reached in the Los Alamos water boiler and to determine the maximum power density attainable under the conditions of the test.

AIRCRAFT NUCLEAR PROPULSION PROJECT

ANP Central Design (AEC Activity 4271)

A circulating-fuel aircraft-reactor system, in which the fuel circulates through the engine radiator, has already been postulated. More recent aircraft designs have attempted to evaluate the effects of an intermediate heat exchanger, various secondary coolants, use of a liquid moderator, and a more effective shield than that required by the minimum divided shield specifications. These studies have shown that the annular, or "wrap-around" type of heat exchanger arrangement gives a lower shield weight than a tandem arrangement with the heat exchanger behind the reactor. One important item turned up in these design studies was that by lacing the heat exchanger matrix with about 8% of B_4C by volume, it is possible to keep the radiation from sodium or NaK in the secondary circuit to tolerable values even with something closely approaching a unit shield. It also appears from these studies that it would be very advantageous to use a liquid moderator such as water or fused hydroxides. Not only would this greatly simplify the problem of cooling the moderator and reflector, but, by using perhaps 12 inches of reflector thickness, the problem of heating of the pressure shell by gammas, neutron captures, and inelastic scattering is greatly reduced.

The circulating-fuel ARE core design which was previously outlined, includes a secondary coolant circuit within the core to (1) maintain the pressure shell essentially isothermal at a temperature of approximately 1150°F, (2) cool the BeO reflector with a fluid other than the circulating fuel, and (3) fill the BeO moderator interstices and other internal voids with a liquid maintained at a pressure higher than fuel pressure to minimize the consequences of a fuel tube leak. At the present time it is believed that a stagnant, non-uranium-bearing fluoride - perhaps the fuel-carrier without the UF_4 - will be most satisfactory.

(ANP Central Design)

The flow diagrams for the various external fluid circuits of the ARE are essentially complete and almost all the raw materials and components have been requisitioned. Included in the latter category are the main heat disposal loop heat-exchangers, helium blowers, and helium blower hydraulic drive systems, control rod cooling blowers and heat exchangers, reflector coolant heat exchangers and helium blowers, and quite a few smaller components. The fuel filling and dump circuits have been ordered and will be located in a shielded location adjacent to reactor and heat exchanger pits.

The electrical diagram has been completed and all major components will be placed on order within the next several weeks. The electrical system includes parallel D.C. busses feeding parallel fluid circuit components, to prevent any one system failure from effecting a complete shut-down. The two D.C. busses are fed by two AC-DC motor generator sets, each with a bank of floating batteries designed to carry the load in the event of an outside power failure. A turbo-generator set is standing by for use in the event that the outside power failure is of longer duration than the battery capacity.

The basic building facility, as designed by the Austin Co., to our specifications has been completed. Additional engineering, relating to the building interior, has been completed and transmitted to our construction contractor, the Nicholson Co., via AEC. It is estimated that the Nicholson Co. will complete their portion of the work by June 1, at which time Carbide will move in for installation of process equipment.

The stability of the circulating fuel reactor was further investigated with the hope of proving that the circulation of the fuel always introduces damping of any power oscillations. The amount of this damping might of course, be zero, as in the example discussed in the last monthly report, but it turns out that these undamped cases assume idealized conditions which are not likely to occur in practice. The damping of oscillations due to fuel circulation has so far been shown to exist in the following cases: small oscillations; large, but slow oscillations; large oscillations with a period which is close to the transit time of the fuel through the reactor, or which is close to submultiple of this transit time.

Nuclear Development Associates has completed a study of the supercritical water reactor for ORNL, as first proposed in Report Wash-24, and a final report has been issued. This study has concerned itself only with the reactor and shield; it was not intended to include the power plant and airplane aspects of the Wash-24 proposal.

This supercritical water reactor consists of a structure of stainless steel plates immersed in a vessel of water which is above the critical pressure, so that it can be heated to high temperatures without phase change. The plates contain the fuel and provide surface for transfering the heat to the water. The water serves several functions: it is the coolant which carries away the heat from the plates, it is the moderator which slows down the neutrons in

(ANP Central Design)

the chain reaction, it operates (through variations in its density) to control the reactivity of the machine, it is the neutron reflector which surrounds the reactor core, and it is the innermost portion of the reactor shield.

It is NDA's conclusion that it is possible to develop a reactor of this type, but that it is an intricate machine and will present a difficult design job. NDA does not believe that this reactor represents an easy short-cut on the difficult road to supersonic flight; but that it may, however, offer one not-impossible path to that goal. It is further stated that this study is but an early step toward evolving such a reactor and definitely does not provide a preliminary design ready for detailing. The study has been able to display the potentialities of the machine, and to set forth at least some of the problems.

ANP Experimental Engineering (AEC Activity 4271)

During this month there was continued emphasis placed on thermal convection loops for dynamic corrosion studies, development of high temperature valve packings, Figure 8 loop operations for liquid metals, development of mechanical pumps for pumping high temperature fluorides, and the improvement of materials inspections techniques. New projects begun during this period were (1) a scale mock-up of a single fuel passage through the ARE core to study the evolution and dissipation of gas bubbles in the ARE; and (2) design on a fluorides to sodium heat transfer system of approximate Figure 8 size.

The following thermal convection loops operated to a scheduled termination of 500 hours without failure: An Inconel loop containing (Na Li K)Fx (Flinak) plus 20 cc of NaK; a 316 SS loop containing Flinak; a 316 loop containing Flinak plus 20 cc of NaK; an Inconel loop containing (NaF BeF_2 UF_4) (Fubena); and a nimonic (80% nickel, 20% chrome) loop containing (Na Li K U)Fx (Fulinak).

The following loops failed before scheduled termination: A 347 SS loop containing Fulinak plugged at the end of 125 hours; a 316 SS loop which had been cleaned by hydrogen firing containing Fulinak plugged at the end of 147 hours.

Loops still in operation at the end of the period were nickel containing Fulinak with 160 hours of operation; Inconel containing Fubena with 390 hours of operation; and Inconel containing Fulinak with 405 hours of operation. The temperature of the hot leg on all of the above convection loops was 1500°F.

Two stress to rupture tests had operated for 300 hours at the end of this period. They were Inconel with hoop stresses of 2200 psi and 316 SS with hoop stresses of 2300 psi.

(ANP Experimental Engineering)

The specially designed thermal convection loop designed for materials engineering studies operated for 500 hours and failed because of a leak in the system. The hot leg temperature was approximately 1600°F with approximately 500° temperature differential across the loop.

A standard SS valve of the stuffing box type which was packed with Inconel braid, nickel powder, and graphite powder operated for a period of 728 hours during this month sealing against 1500°F fluorides at 30 psig with no indication of valve failure and no increase in torque required to actuate the valve. Two additional valves are presently in operation with stems packed with Inconel braid and nickel powder. These valves are sealing against 1500° fluorides at 50 psig pressure.

The Figure 8 loop in which sodium is circulated by means of a centrifugal pump with a frozen sodium seal operated for 517 hours during this period bringing the total time for this loop to 1217 hours. The Figure 8 loop incorporating a NaK to NaK heat exchanger had logged a total of 2266 hours at the end of this period. Maximum liquid metal temperature in these loops is 1500°F.

A vertical shaft gas sealed centrifugal pump operated for 170 hours during this period pumping fluorides in an isothermal loop at a maximum temperature of 1300°F.

Specifications for materials inspection have been stiffened in order to improve the quality of equipment assemblies, thereby increasing the life expectancy of such equipment. Inspection techniques which have been added are X-ray and Dy-Chek inspection of welds, castings, etc., and boroscope for visual inspection of internal surfaces.

A scale mock-up of a single fuel passage of the proposed ARE core has been constructed and studies are being made of the evolution and dissipation of gas bubbles in the ARE core. Preliminary tests with water indicate that at design fluid flow rates any gas bubbles evolved in the stream will be swept out immediately. Even when considerable quantities of gas are introduced from an external source this condition prevails. The larger bubbles combine with and sweep out the smaller bubbles which are formed on the surfaces of the tube at bends.

Design work has started on a bi-fluid heat exchanger for the transfer of heat from fluorides to sodium. Two types of heat exchangers are being considered for this loop: (1) a concentric tube counterflow exchanger, and (2) a shell-multitube exchanger.

ANP Radiation Damage (AEC Activity 4274)

Further experiments measuring thermal conductivity changes have been run in the X-pile on Inconel. At temperatures up to and including 575°C, no change in conductivity was observed over a period of two months. However, at a temperature of approximately 800°C, a decrease was observed; further experiments are being performed to determine the possible reasons for such behavior. It is believed that heat treatment of the alloy is an important factor. Additional experiments with Inconel are in progress in the LITR; included is a specimen stabilized with respect to carbide precipitation.

A very high purity nickel specimen has been tested regarding thermal conductivity changes under irradiation in the X-pile. The tests were run at low temperatures (~ 100°C and ~300°C) over several months with no appreciable changes being observed. Similar results have so far been found over a period of two weeks at a temperature level of ~ 800°C.

An absolute thermal conductivity experiment with 316 stainless steel as the test specimen was performed at a temperature of ~ 250°C in the LITR for a one month period. No change in conductivity was observed. An approximate calculation of the nuclear heating in SS 316 in hole HB-3 of the LITR was calculated from the data to be about 0.04 cal/gm/sec.

ANP Reactor Chemistry (AEC Activity 4275)

The purification reactor for producing fuels free of oxygen compounds and higher valent uranium has been completed, but not yet operated. The existence of UO_2F_2 to the extent of 1% in the UF_4 that has been regularly used in the past was recently noted. There is little doubt that this impurity has had an extremely deleterious effect as a corrosive agent, and the preparation of fuels for thermal convection loops has been suspended until more carefully purified mixtures can be provided.

To date, the use of an HF atmosphere in conjunction with argon has not given appreciably lower viscosities as measured by a modified Brookfield viscometer. Some of the results are higher than anticipated, as well as puzzling in their erratic behavior.

ANP Corrosion (AEC Activity 4275)

Sampling and filtering techniques for following the fate of structural metals in fluoride melts are under development. Attention has been given to the construction of a rocking furnace, which provides a temperature gradient, to accomodate 20 or more capsules at one time, and to provide motion of the melt. Static tests were continued to test the effect of various additives. For example, the addition of metallic uranium causes a slight increase in corrosion, whereas addition of U_3O_8 gives a marked increase in corrosion.

ANP Metallurgy (AEC Activity 4275)

Additional experiments on the additions of zirconium, sodium, and uranium to the fluoride mixtures have shown that additions of zirconium and sodium decrease the amount of attack of the fused fluorides in Inconel and stainless steels when tested under static corrosions.

The brazing alloy evaluation program is continuing. An alloy of 60% Pd - 37% Ni - 3% Si with a melting point of 2000°F has shown excellent wet-ability and flowability properties when used as a brazing alloy for Inconel. Alloys of 64% Ag - 33% Pd - 3% Mn, and 16.5% Cr - 71% Ni - 10% Si - 2.5% Mn have been examined for melting point determination and flowability characteristics. Typical tube to header joints of these alloys are being examined for corrosion resistance in the various media: hydroxide, fluoride, sodium, lithium and lead.

The counter weight of the creep testing machines has been raised approximately one inch above the center line of the knife edges. In this position the change in effective weight of the counter weight balances the change in the spring lead of the bellows thus maintaining the constant load on the creep specimen. The creep and stress-rupture properties of Inconel have been determined in argon at 1500°F on fine and coarse grain specimens. An Inconel tube burst specimen has withstood 2,200 psi for 120 hours when filled with uranium bearing fluorides at 1500°F. A similar specimen made of 316 stainless steel tested under the same condition has withstood a stress of 2,300 psi at 1500°F.

Shielding Research (AEC Activity 4277)

The design of the Tower Shielding Facility, which will enable full scale measurements on divided shields, has progressed considerably. A configuration has been found which so far has met all requirements regarding flexibility and freedom from spuriously scattered radiation. Alternate proposals are still being considered from the standpoint of reducing costs.

Air duct research is continuing in the Thermal Column water tank, and tests on a mock-up of the KAPL submarine shield are nearing completion in the Lid Tank. At the Bulk Shielding Facility the initial phase of the gamma ray spectral measurements on the divided shield mock-up has been completed. The experiments are being continued.

GENERAL REACTOR RESEARCH

Idaho Chemical Plant (AEC Activity 10547)

The major ORNL effort in this program continued to be centered at Idaho by carrying out the field engineering for the chemical plant and the calibration of the process vessels. The cost data for this plant is being accumulated by Bechtel and a preliminary review of this was made. A more thorough analysis of this data is planned to establish a basis for cost estimation of radiochemical process plant construction.

PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF ISOTOPES

Radioisotope Production (AEC Activity 5111)

The total accumulated KWH for pile operations during February were 2,338,259, averaging 3677 KW per operating hour. Pile down time was 8.6%, as compared with 13.5% in January.

A 3,400 curie cobalt source was shipped to Knolls Atomic Power Laboratory, a 1,000 curie cobalt source to the Los Angeles Tumor Institute, and a 1,000 curie cobalt source to the Chemistry Division of ORNL.

There were 902 radioisotope shipments during February.

Stable Isotope Production (AEC Activity 5121)

The calutron tank time during the month of February was devoted to the collection of calcium, molybdenum, lead, tin, and cerium isotopes. Over-all innage for the four calutrons was 975 hours with an integrated output of 10,600 ma-hrs. for the two Beta channels. Outage time was 40.3% as compared with 36.6% during January.

Fifteen runs were made with short radius equipment to determine the feasibility of power regeneration as applied to calutron operations. A high magnetic field, low accelerating voltage, and a deceleration potential on the receiver are the major changes that were initiated.

Isotopes of lithium, strontium, lead, iron, and molybdenum were chemically processed during the month. Charge materials were supplied to the calutrons for the separation of isotopes of lithium, lead, calcium, cerium, tin, and molybdenum.

There were 34 stable isotope shipments made during February.

PHYSICS

Low Temperature Physics (AEC Activity 5211)

The magnetic susceptibility of a hafnium-zirconium alloy (about 10 atomic percent zirconium) has been investigated in the liquid helium temperature region and below 1°K. Three metal samples in the form of small chips were studied. Sample I was prepared by the chemical reduction of a mixture of the fluorides with calcium and was annealed for 50 hours at 1,000°C in a vacuum. Samples II and III were cut from a "crystal bar." Sample II was not annealed but sample III was annealed at 785°C for one and one-half hours in a vacuum. About one cubic centimeter of each of these metal samples was pressed with an approximately equal volume of chromium potassium alum and the magnetic susceptibility of each of the composites was observed by a

ballistic method. Temperatures below 1°K were obtained by adiabatic demagnetization techniques. The metal and the salt were undoubtedly in temperature equilibrium to temperatures as low as 0.1°K and probably to much lower temperatures. Susceptibility measurements on Sample I in the temperature region from 0.18°K to 4.2°K, and on sample II from 0.007°K to 4.2°K gave no evidence of a superconducting transition. The maximum superconducting volume for sample I and sample II could not have exceeded 1.0% and 0.3%, respectively, of the metal volume. Sample III, however, gave a sharp superconducting transition at 0.30° ± 0.02°K in which effectively the entire volume of the metal became superconducting. The difference of behavior of the three samples perhaps indicates in the case of hafnium an exceptionally strong dependence of the superconducting transition temperature on annealing and trace impurities. This value of the superconducting transition temperature of the alloy agrees reasonably with the value 0.35 ± 0.05°K previously given for hafnium metal by Kürti and Simon.

Three samples of the separated isotopes of neodymium were obtained from the Stable Isotopes Division of ORNL and each sample was converted to the ethyl sulphate. The specific heat of each sample was measured by the magnetic method of Benzie and Cooke in the temperature region from 0.96°K to 2.15°K. By making use of the mass analysis given by the Isotopes Division and the measured specific heats of the three samples it was possible to set up three simultaneous equations and obtain by their solution the hyperfine structure contribution to the specific heat for neodymium 143 and neodymium 145, and to obtain the contribution to the specific heat due to the electron-electron interaction. In this region of temperature the specific heat times the temperature squared is a constant. The values for this constant, b, are $b_{143} = 5.0 \times 10^{+5}$ erg degree, $b_{145} = 1.7 \times 10^{+5}$ erg degree, and $b_{el} = 0.14 \times 10^{+5}$ erg degree. In most materials the electron-electron, and other, interactions are very large compared with the hyperfine structure splitting. In this material one finds the unusual situation that the specific heat due to hyperfine structure of the separated neodymium 143 ethyl sulphate is some 36 times larger than the electron-electron interaction in this salt. The measured hyperfine structure specific heats are in agreement with those calculated from the microwave measurements of Scovil.

Nuclear Alignment (AEC Activity 5211)

Some of the most recent technical difficulties associated with the nuclear alignment experiment have been overcome sufficiently so that the collection of data can now proceed. The data which has been accumulating shows a small effect of spin dependent neutron capture in manganese. However, much more data will be needed to prove that the effect is not spurious.

Slow Neutron Spectroscopy (AEC Activity 5211)

A technique for eliminating higher orders of reflection of neutrons from crystals by the use of the total reflection properties of mirrors has been developed. It is being used for the measurement of total cross sections in the region of 2 angstron to 4.5 angstron.

Neutron Scattering Properties of Superconductors (AEC Activity 5211)

The neutron scattering properties of several superconductors are being investigated by the use of the customary neutron diffraction techniques.

Interaction of Radiation and Matter (AEC Activity 5211)

The extrapolated ionization ranges of heavy ions including H^+, He^+, Ne^+, N^+, A^+, in a variety of stopping gases including helium, nitrogen, air, and argon have been determined for each combination of incident particle and stopping gas.

The space distribution of the ionization density resulting from the entrance of a collimated beam of ions within a large volume of gas has been measured using the same ions, stopping gases, and energies as above. The ionization density was found to decrease exponentially along the axis of the beam and to follow a Gaussian curve in a direction normal to the beam.

86-Inch Cyclotron Physics (AEC Activity 5211)

The ratio of the yield of the minimum of the fission mass distribution curve to the maximum varies with the temperature of the compound nucleus as $e^{-4.9/T}$, where in computing the nuclear temperature one has to correct for the cooling effect of the distortion which leads to fission (5 Mev). This type of variation implies that compared to asymmetrical fission there is a critical energy of the order of 5 Mev required to produce symmetrical fission.

High Voltage Program (AEC Activity 5211)

The total neutron cross section of lithium 6 has been measured up to 5 million volts. An angular distribution of the neutrons from the $B^{11}(p,n)C^{11}$ reaction has been studied and reveals the presence of two levels in carbon 12. Two levels in oxygen 16 have been located by the presence of peaks in the yield of the reaction $N^{15}(p,\gamma)O^{16}$. The mechanics of the $H^3 + He^3$ reactions which can lead to either an alpha particle plus a deuteron and to an alpha particle plus a proton and a neutron are being resolved with the clear observation group corresponding to the ground state formation of helium 5.

Neutron Velocity Selector (AEC Activity 5211)

Trouble with fast neutron background has been reduced by installation of a beryllium plug against the tank of the LITR. Preliminary indications have been obtained of hitherto unknown higher resonances in the total cross section of indium. Isotopic assignment will be attempted.

Scintillation Spectrometry (AEC Activity 5211)

Absorption of gamma rays is being investigated with a scintillation spectrometer set to accept only quanta of the maximum energy emitted by the primary source. Such a detector is insensitive to the degraded radiation and promises to provide a test of gamma ray absorption theory with a vigor hitherto unattained.

Level Spacing and Shell Theory (AEC Activity 5211)

A survey by the boron absorption method of low lying resonances in a number of elements has been completed. The results have been combined with other data to show increases in nuclear level spacing at the completion of shells.

Pile Operations (AEC Activity 5211)

Recent tests have shown that the present procedure for fabricating silicon bonded slugs for the refueling of the X-10 reactor is satisfactory; the Y-12 shops can now go into full production of the slugs.

Electronuclear Machines (AEC Activity 5261)

An analysis of the ion content of the 22-inch cyclotron beam indicates that under certain ion source conditions a large percentage of H_3^+ ions may be accelerated to the maximum radius along with the H^+. The effectiveness of the accelerating electrode placed near the ion source is now being investigated.

The 63-inch cyclotron resonant system, previously tested at atmospheric pressure, has now been operated under vacuum at a frequency of 5.04 mc/sec. Leaks in the vacuum system have been found and the pressure has been reduced to 2×10^{-5} mm of Hg. Changes in the magnetic field, produced when extra windows were welded into the vacuum tank, have been corrected by reshimming. No distortion of the tank is observed when the magnetic field is measured with the tank evacuated. An externally controlled beam deflector has been mounted on the dee system to permit maximizing an external beam. Further tests of the performance of the resonant system are scheduled before actual operation is attempted.

The 86-Inch Cyclotron (AEC Activity 5261)

Since the cyclotron was shut down in mid-January a number of alterations have been completed and the vacuum testing is now under way. A mechanical refrigeration system for the vacuum pumps and an improved ion source mounting will result in greater reliability of operation. A shield door in the maze, new change house and target handling facilities, and additional semi-remote control devices have been installed for the protection of personnel. Larger targets inserted through a redesigned vacuum lock will accommodate greater proton currents. An increase in oscillator frequency and relocation of the ion sources to obtain better centering of the beam is expected to increase the maximum proton energy.

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Nuclear Resonance. The study of chemical shift phenomena in the nuclear magnetic resonances of vanadium compounds has continued with observations being made on nine vanadium chemicals. Line widths are very narrow (less than 0.15 gauss) except for metallic V 51 which gave 1.2 gauss. This latter value is considerably less than the value reported by Knight at the Berkeley American Physical Society Meeting in December, 1951.

Molecular Spectroscopy. A report on the microwave spectrum and molecular structure of C_2H_3I is in preparation. Several very weak microwave transitions were predicted and re-study of the spectrum has resulted in their measurement.

Optical Spectroscopy. The crossed echelle-Littrow spectrograph combination has been adjusted to give resolution of the order of 250,000 at a dispersion of about 0.5 A/mm. The major limitation at present appears to be the resolving power of the photographic emulsion. The 201a hyperfine component (0.1%) in the 5461 line of normal mercury has also been photographed.

Spectrochemical Activities. A procedure for analysis of monazite sand for thorium and constituent rare earths has been set up. Analysis of mercury for impurities is being carried out successfully by distillation of the mercury at 475°C and 1 mm pressure. A total of 2401 element determinations was made this month.

X-Ray. Development of the homochromatic X-ray absorption technique for uranium in solutions has continued. The effect of lead as a major impurity is to introduce an error of about 6% in the determination of the uranium concentrations.

Mass Spectrometer Laboratory (AEC Activity 5261)

Additional studies have been made on material taken from the cold leg plugged portion of a stainless steel loop undergoing tests with Na-Li-K-U

fluorides. The green crystals proved to have a refraction index less than 1.46 but the exact determination is held up by a lack of appropriate standards.

Silicon tetrafluoride was prepared and examined in the mass spectrometer. It exhibited the same metastable ion properties as the material which was found as an impurity in the metal fluorides previously studied. Mass spectrometer investigation of UF_4 showed that it had not hydrolized after three months exposure to air. Data on UF_3 and technetium have been evaluated and reports have been prepared.

CHEMISTRY

Chemical Physics (AEC Activity 5311)

As previously reported a quantitative relationship has been determined between the half life and average B^- energy of C^{14} decay by use of calorimetric methods. The results of the measurements yield a value of 1.79 x 10^{-10} Kev dis.$^{-1}$ sec.$^{-1}$ for the product of the average energy and the decay constant. This value may be used to correlate available information relating to these two quantities. The values which have been reported for the half life have ranged from less than 5,000 years to over 7,000 years; recently reported values, however, are mostly in the range from 5,400 to 5,600 years except for one of 6,400 years. No measurements of the average B^- energy as such have been reported, but evidence that the B^- spectrum of the decay has an allowed shape has been found by several investigators. Other investigators have found deviations of the Fermi plot from that for an allowed shape. If the shape of the spectrum is allowed, the average beta energy can be computed with confidence since the maximum beta energy is well known (155 Kev). If this value for average energy is assumed to be correct, the results of the present study yield a value of 6,000 years for the half life. Conversely, if the true half life is about 5,500 years, the average energy calculated from the present results is about 45 Kev.

Nuclear Chemistry (AEC Activity 5311)

A long lived argon isotope known to decay with an "α" type forbidden beta spectrum has been assigned to mass number 39. The half life has been found to be 265 ± 30 years. This half life is consistent with that of other beta transitions which have spectra of the same type.

Chemistry of Uranium Raw Materials (AEC Activity 5361)

The solubility of $UO_2HPO_4.4H_2O$ in molar perchloric acid solutions containing phosphoric acid increases with the H_3PO_4 concentration. Measurements under condition of controlled ionic strength yield the same result which implies a more extensive complex formation of uranyl with phosphate in these solutions than the 1:1 complex previously reported.

Anion exchange separations of uranium from Bartow clay leach liquors have given eluents averaging above one gram of uranium per liter. Reduction-precipitation tests from the same liquor gave 98% recovery in cakes containing about 1% uranium.

Nearly complete precipitation of uranium from sodium carbonate solutions can be obtained by reduction with only the stoichiometric quantity of sodium hydrosulfite if the total carbonate concentration in solution is low and an inert atmosphere is provided.

The extraction of, and selectivity for, uranium from aqueous solutions by branched chain phosphinic acids are greater than those shown by the corresponding normal acid. The extraction of iron and aluminum by phosphonic acids are also high. The extraction of Fe^{++} is lower than for Fe^{+++} in all cases.

Phosphonic acids show ability to complex thorium in sulfuric acid solution.

23 Processing (AEC Activity 5361)

The process equipment for the 23 processing program is now being leak tested and cold chemical runs are scheduled to be completed during the coming month.

METALLURGY

Fundamental Investigations in Radiation Damage (AEC Activity 5411)

A large magnet is being installed in conjunction with a program to investigate the effect of radiation on the magnetic properties of solids. It is an Arthur D. Little magnet of up to 25,000 gauss over a two inch gap and over a 5 3/4 inch pole diameter. The magnet will be used to investigate the effect of reactor bombardment on magnetic susceptibilities of solids, magneto resistance of semiconductors and metals, Hall (galvano magnetic) effect on metals, and investigations of ferromagnetic materials.

PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Mammalian Genetics and Cytogenetics (AEC Activity 6400)

In connection with the mutation studies in mice, it appeared essential to repeat some of the work which has been done on mutation rate in Drosophila since these data form the basis for comparison for mutation rates obtained in mice. A good part of the work has been completed and it appears now that the mutation rate in Drosophila is slightly higher than it has been reported previously; however, it is not high enough to upset the comparative studies which have been discussed in earlier reports.

Radiation Protection (AEC Activity 6400)

It has been found that bacteria which survive irradiation and are suspended in glucose do permit the leakage of a good percentage of ATP. This leakage depends on the amount of energy given and the medium in which the cells are suspended.

Pathology and Physiology (AEC Activity 6400)

The incidence of leukemia in mice surviving "Operation Greenhouse" has increased considerably. As a matter of fact, the mortality of a large part of the mice which are now being lost is caused by leukemia.

BIOPHYSICS

Waste Disposal Research (AEC Activity 6510)

A cooperative program is underway between the Corps of Engineers' Research and Development Laboratory and the ORNL Health Physics Radioactive Waste Disposal Research Section to evaluate conventional Army field methods of water purification for the removal of radioactive contaminants. Under present test is a piece of equipment (Erdlator) that in a flow process partially removes by flocculation the turbidity, bacteria, and radioactive materials. By use of alum and iron salt coagulating agents about 90% removal of mixed fission products has been experienced. Future experimentation with the "Erdlator" will incorporate the use of metallic powders and other adsorbents to remove the remaining radioactive material. It is proposed also to evaluate the Army's thermocompression distillation unit for removal of radioactive contaminants from water.

Biophysics Training (AEC Activity 6720)

A group of ten medical officers from various branches of the Armed Forces has arrived at ORNL to pursue an eight week course in health physics field training. Previously they had been stationed for nine months at Duke University to

(Biophysics Training)

participate in a special weapons program of the National Military Establishment, a program of which the ORNL training is a part. In April a similar group of five medical officers from Reed College will come to the Laboratory for the same type training. At the present time members of the Health Physics Division are teaching a course in radiological physics to the groups of AEC fellowship students now in residence at the graduate school of Vanderbilt University.

PROGRAM 9000 - RESEARCH FACILITIES

Research Laboratory Building #4500

This building is 94% complete. Exterior Building Site: Electrical sub-station #20 is complete. Cooling Tower #4504 is complete. Concrete curbing for east parking lot and new roads is complete. Due to inclement weather conditions little progress has been made on the grading, backfilling or black topping of new roads. All outside services to this building are complete. All exterior work of subject building is complete. Interior: Interior work on all phases of construction is progressing slowly, and the estimated completion dates are as follows: Wing #4 and first floor of Service Area, 4/4/52; Wing #3, 4/18/52; Wing #2, 5/1/52; Wing #1 and second floor of Service Area, 5/9/52. Final completion date of building estimated at 5/15/52.

Isotope Research and Unit Operations Building #4501

This building is 96% complete. With the exception of grading, backfilling and black topping of new roads around building site, all exterior work including outside services is complete. Unit Operations Section: All phases of construction work in this section of building are 99% complete. Punch list of items to be completed has been made, and work on this is progressing slowly. Estimated completion date of this section, 3/15/52. Isotope Research Section: All phases of construction work in this section are progressing slowly due to the removing and repouring of topping on the structural concrete floor slabs. Estimated completion date of this section, 4/15/52. Estimated final completion date of building, 4/18/52.

East Portal Building #5000

This building is 100% complete in accordance with specifications and drawings. Final completion form F-3 is being processed.

Conversion of Jones Construction Camp

Phase II drawings have received final approval, and plans and specifications are being issued to contractors with invitations to bid on contract.

High Voltage Laboratory Building #5500

This building is 75% complete. With the exception of the east side of the work area from the 851.4 elevation to the 890.8 elevation, all phases of exterior construction work are complete. Note: This section of building can not be completed until the twenty-ton three motor bridge crane is installed. Scheduled shipping date from the vendor is 6/1/52. All phases of construction work in the interior of building are lagging 5% behind schedule. No grading around building site has been done this past month. Estimated completion date without crane, 4/30/52. Final estimated completion date of building, with crane, is 6/15/52.

Test Facilities Building #7503 (ARE)

This building is 99% completed. The items of work remaining to be completed in accordance with plans and specifications are: Install P & H crane when same is received during April, 1952; light fixtures in corridor. Note: The contractor is now working on the phase of construction design by ORNL Engineering Department.

ORSORT Laboratory Building #3017

This building is complete without exceptions, and has been released to ORNL for occupancy.

Chemical Isolation and Purification Laboratory Building #3508

Final inspection was made of this building on Friday, Februay 29, and building was released to ORNL for occupancy March 1, 1952.

Steam Supply Line to Building #7503 (ARE)

This project is approximately 70% completed. The following is the status of the progress being made: Concrete piers and poles for overhead lines 95% complete; right-of-way 80% complete; installing pipe lines 65% complete; pipe insulation 15% complete.

RADIOISOTOPE SALES

Sales	December	January
Transfers within AEC	$ 42,995.17*	$ 575.30
Cash Sales	24,320.65	37,518.88
Foreign	2,239.10	637.00
Cancer Program (Free)	42,724.95	43,627.45
Technical Cooperation Plan	53.37	1,079.30
Total Sales and Transfers to Date	2,025,499.55	2,081,921.03
Total Cancer Program (Free) to Date	1,156,809.93	1,200,457.38
Technical Cooperation Plan (Shipments to Date)	12,934.64	14,013.94

(* Denotes Credit)

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

(a)	Actual Cost for January 1952	$ 2,764,919.00	
	Actual Plant and Equipment Cost	263,869.00	
	Construction Program "H"	127,204.00	
	Total Operating and Construction Cost for January 1952		3,155,992.00
(b)	Estimated Operating Cost for February 1952		3,000,000.00
(c)	Actual Accumulative FY 1952 Operating Cost through January 1952	17,206,121.00	
	Actual Accumulative FY 1952 Plant & Equipment Cost through January 1952	1,200,810.00	
	Actual Accumulative FY 1952 Construction Program "H" Cost through January 1952	352,827.00	
	Total Actual Accumulative FY 1952 Operating, Construction, and Plant & Equipment Cost through January 1952		18,759,758.00
(d)	Estimated Operating Cost FY 1952 through February 1952		$21,759,758.00

PERSONNEL SUMMARY

	Number of Employees February, 1952	New Hires February	Terminations February
Administration	98	1	3
Operations*	122	5	0
Engineering, Shops and Mechanical	892	8	5
Laboratory and Research	1414	71	56
Protection	178	2	1
Service	380	4	0
Total	3084	91	65

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