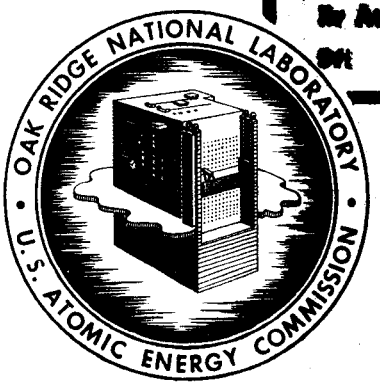
OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December 1951



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

[redacted]

ORNL-1197
This document consists of 29 pages. Copy 67 of 69. Series A.
DDC (15)

Contract No. W-7405, Eng. 26

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

J. P. Lane

Date Issued: JAN 8 1952

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]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

Distribution

Offices of Directed Operations

1-4. N. H. Woodruff — Oak Ridge, Tennessee
5. Technical Information Division — Oak Ridge, Tennessee
6. C. A. Nelson — Wilmington, Delaware

AEC Installations

7. H. A. Blair — University of Rochester
8. N. E. Bradbury — Los Alamos Scientific Laboratory
9. C. E. Center — Carbide and Carbon Chemicals Company
10. G. T. Felbeck — Carbide and Carbon Chemicals Company
11. A. B. Greninger — Hanford Works
12. L. F. Haworth — Brookhaven National Laboratory
13. A. R. Kaufman — M.I.T. Metallurgical Laboratory
14. K. H. Kingdon — Knolls Atomic Power Laboratory
15. H. D. Kinsey — Carbide and Carbon Chemicals Company
16. E. O. Lawrence — Univ. of Calif. Radiation Laboratory
17. F. L. Mohler — National Bureau of Standards
18. H. W. Russell — Battelle Memorial Institute
19. F. H. Spedding — Ames Laboratory
20. W. H. Zinn — Argonne National Laboratory

Oak Ridge National Laboratory

21. D. S. Billington
22. E. P. Blizard
23. G. E. Boyd
24. R. C. Briant
25. J. H. Buck
26. G. H. Clewett
27. W. K. Eister
28. L. B. Emlet
29. J. H. Frye, Jr.
30. A. Hollaender
31. A. S. Householder
32. J. T. Howe
33. C. P. Keim
34. M. T. Kelley
35. J. A. Lane
36. C. E. Larson
37. W. D. Lavers
38. S. C. Lind
39. R. S. Livingston
40. R. N. Lyon
41. H. J. McAlduff
42. J. R. McNally
43. Z. Morgan
44. J. Murphy
45. M. Ramsey
46. C. Secoy
47. E. D. Shipley
48. M. J. Skinner
49. A. H. Snell
50. F. L. Steely
51-52. Hezz Strickfield
53. C. D. Susano
54. J. A. Swartout
55. E. H. Taylor
56. W. E. Thompson
57. A. M. Weinberg
58. C. E. Winters
59. F. C. VonderLage
60-69. Central Files

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

TABLE OF CONTENTS

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

TABLE OF CONTENTS Continued

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

TABLE OF CONTENTS Continued

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

Purex Process (AEC Activity 2803.2)

The Purex Development Program at ORNL now has three major objectives: (1) chemical studies from the side streams from the Purex Process; (2) the final Pilot Plant development with as many of the side stream processes as is feasible coupled into the main line Purex Process; and (3) a plant design study based on the present process knowledge. Laboratory studies were continuing on the silica gel absorption step for final uranium product purification, the plutonium coupling and ion exchange step, waste concentration studies, and the recovery of plutonium from metallurgical wastes.

The modification of the Pilot Plant equipment was completed and cold runs are now in progress for the initial test of the process modification.

SCRUP Separation (AEC Activity 2344)

The equipment installation for the SCRUP Program was continued and is now scheduled to be completed during January. The processing of Chalk River material will probably start in April.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 3000 - WEAPONS

RaLa Production (AEC Activity 3630)

Three dummy runs were made to test the renovated cubicle equipment, but the results of the dummy runs were so erratic that a small test run of 150 curies was made. The hot run was successful, so the equipment is ready for a full scale run starting January 13, 1952.

MTR RaLa Development (AEC Activity 3982)

The Unit Operations and Design phases of this development program have been completed and the final reports are in progress. The laboratory development of this process will be continued until there is a firm decision by the AEC as to the future of this process.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR

LITR Operation (AEC Activity 10543)

The LITR operated at 800 KW per operating hour during December. Down time was 15.0% as compared with 17.8% in November. A new experimental facility through the top plug has been added. To date no fission products have been observed in the cooling water.

Fuel and Control Elements (AEC Activity 10543)

The first shipment of twenty-five sets of aluminum end box castings were received from the subcontractor. These castings are presently holding up completion of the initial two pile loadings requested for start-up of the reactor at Idaho.

Visual and X-ray inspection revealed the presence of serious cracks in the upper and excessively large "blow" holes in the lower adapter castings. In many cases, the casting failed to conform properly to the mold. Because of the extremely poor quality of these castings, only a few can be salvaged for use on the Idaho fuel units.

Faced with the possibility of delaying start-up of the reactor in March, an emergency order was placed with another subcontractor to supply the needed castings. Sand mold patterns and core print boxes of an old design were forwarded to this company together with new drawings requiring only a minimum of changes in an attempt to expedite delivery. It is estimated that with a directive, the castings will be available about February 1, 1952.

During the month, construction started on the shipping containers for transporting fuel and control elements to Idaho.

The accompanying eight shim control rods for the initial two pile loadings are in process of final machining in the shops. Four are essentially complete and the balance will be ready for inspection on January 15, 1952.

Shipment of the initial loadings to Idaho is tentatively scheduled for February 15, 1952. To actually meet this schedule, however, an accountability station must be established at Idaho to receive the units and good sound castings must be available prior to February 1, 1952.

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

HOMOGENEOUS REACTOR PROJECT

Building #7500 - HRE (AEC Activity 4261)

During pre-operational testing involving chemical cleaning of the fuel system and treatment with oxygenated water, several relatively minor mechanical defects were disclosed which have taken time to remedy. Included were two small leaks in the high pressure soup system, insufficient capacity of the 40 kw. boiler system used to heat the solutions, difficulty in adjusting control instruments and other minor defects. All of these have been remedied. The system has been thoroughly tested mechanically and found to be satisfactory. The chemical treatment required before addition of enriched uranyl sulfate solution is in progress.

A detailed experimental physics program for the HRE through the critical experiments stage was prepared, reviewed and approved with minor alterations.

Intermediate-Scale Homogeneous Reactor Design (AEC Activity 4261)

The preparation of a feasibility report for an intermediate-scale circulating aqueous solution homogeneous reactor is well along. This report will be completed and submitted early in 1952.

Chemistry of Homogeneous Fuel Systems (AEC Activity 4263)

Confirmation of the effectiveness of copper ion in promoting the homogeneous liquid-phase recombination of hydrogen and oxygen has been obtained in radiation experiments at neutron fluxes up to 1×10^{13}. A thorough study of the production of gas by decomposition of water (aqueous solutions of uranyl sulfate and fluoride) under pile irradiation, using various concentrations, enrichments, and temperatures, has revealed that substantially less gas is produced than was indicated by earlier workers in the field. Firm "G" values (molecules of H_2 produced per 100 e.v. energy absorbed) of 1.5 for uranyl sulfate solutions (40 gm U/l; 93.2% enrichment) have been obtained as compared with earlier values of 2.0 - 2.5 which were used for calculations of HRE gas production.

HR Fuel and Blanket Studies (AEC Activity 4263)

The uranium trioxide slurry has continued to show the most promise for a slurry type fuel to be used in a homogeneous reactor. Studies are in progress to determine the optimum procedure for preparing the most stable form of this

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

(HR Fuel and Blanket Studies)

oxide, and in addition, radiation studies are in progress. Chemical stability studies were initiated on normal uranyl phosphate to compare its characteristics with the uranium trioxide.

Experimental and Design Engineering (AEC Activity 4264)

Operation of the HRE mock-up as a corrosion test with natural uranyl sulfate was interrupted on two occasions because of the failure of the gas let-down valve and of a pulsafeeder pump head. Examination of the valve indicated construction contrary to specifications supplied by ORNL to the manufacturer in that the bellows was silver soldered instead of welded and the valve plug was made of stainless steel covered with a thin facing of stellite instead of solid stellite. As a result of corrosion of the silver solder, leakage through the bellows occured and because of cracking of the stellite facing tight closure of the valve could not be attained. This valve and the similar valve in the HRE have been replaced. With the exception of these mechanical troubles operation of the mock-up has been satisfactory. An average corrosion rate of 3 to 4 mils per year is indicated.

Installation of additional pump loops for corrosion testing progressed on schedule. The present delivery dates for 100-A pumps from Westinghouse will permit initiation of tests with two additional loops per month through April, 1952.

In static corrosion tests with high concentrations of uranyl sulfate, titanium and zirconium continued to show promise and, provided a high partial pressure of oxygen is maintained, results for 347 stainless steel were also encouraging.

HR Metallurgy (AEC Activity 4264)

The materials problems involved in extending homogeneous systems to larger scale reactors were reviewed and a detailed program was outlined for metallurgical investigation.

AIRCRAFT NUCLEAR PROPULSION PROJECT

ANP Experimental Engineering (AEC Activity 4271)

Testing of various container materials for possible use with fluoride fuel mixtures conducted in collaboration with the Metallurgy Division was accelerated

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

(ANP Experimental Engineering)

during the month of December largely due to the increased availability of fluorides. These tests were of the thermal convection loop variety, and of seven terminations, three were scheduled, three plugged, and one leaked at a weld. All failures for plugging occurred after approximately 10 hours of operation and contained (Na Li K U)Fx. These loops were fabricated from 400-variety stainless steels while on the other hand, two Inconel loops ran for 500 hours to scheduled termination while containing like material. Pitting was observed inside the one thus far examined.

Additional tests were conducted in simulated equipment to determine the feasibility of a frozen fluorides seal around a rotating shaft. The latest test ran for 122 hours which included several shutdowns to determine the difficulties involved in restarting the system. No difficulties in starting up from a cold condition were observed. Maximum pressure across the seal during the test was 60 psig with no change in the effectiveness of the seal. Termination was caused by a leak in the sump pot and post-run inspection revealed that the stellite faced shaft had been reduced in diameter by approximately 0.002" at the point where sealing occurred. Two commercial pumps were being equipped with stellite coated shafts and finned sleeve seal sections to conduct actual pumping tests with fluoride seals.

The Figure-Eight loop incorporating a NaK-to-NaK heat exchanger and utilizing an EM pump completed its 1000-hr test during the month, and the decision was made to continue testing to determine the operating life of the system. As the month ended, the loop had operated approximately 1300 hours with no observable changes in performance. Temperatures of 1510°F and 950°F were still being maintained in the hot and cold sections, respectively.

Tube burst specimens of Inconel and type 316 stainless steel were immersed in (U Li Na K)Fx at 1500°F and stressed at 1200 and 1700 psi, respectively. Total time accumulated on these tests by the end of the month was 860 hours each.

Fluorides production continued throughout the month, and improvements in transferring techniques were developed. Direct electrical resistance heating of connecting pipes during transfer operations was accomplished; however, new types of external electrical heaters were under test.

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

ANP Critical Experiments (AEC Activity 4272)

Experiments for the study of the General Electric direct cycle reactor for aircraft propulsion are in progress. The mock-up of the core of this air cooled, water moderated reactor is a pseudo-cylinder 51 inches in diameter and 36 inches long. The core consists of 1 inch thick horizontal layers of Plexiglas to simulate water, separated by 2 inch thick open arrays of stainless steel sheets. The latter represents structural materials and cooling air channels. The uranium, as thin metal discs, is placed between the stainless steel sheets. The total void fraction of the core is 0.57. This 51 inch diameter core is surrounded on the circumference by a 6 inch thick reflecting jacket of beryllium. The end reflector is a cap of 6 inch graphite which is used in lieu of available beryllium. The critical mass and dimensions have been determined, control rods have been calibrated, neutron flux measurements have been started, and some evaluation has been made of the effect of substitution of iron and water for beryllium in the reflector.

Experimental measurements have been completed on the uranium-graphite reactor which was assembled to give results for comparison with theory. The data are being evaluated and correlations are being made with calculated values of uranium investment, power distribution, neutron flux, etc.

ANP Radiation Damage (AEC Activity 4274)

Previous tests of irradiation within the LITR of KOH contained in Inconel capsules showed a slight pressure increase of about 4 psi in 16 hours. Duplicating the LITR temperatures on the capsules during bench tests resulted in pressure rises similar to those in the LITR. The conclusion from these observations is that the increased pressure was not caused by oxygen and hydrogen formed by the radiation decomposition of KOH. These preliminary tests indicate that the radiation damage aspects should not prevent the use of KOH as a reactor component, although further corrosion tests must be made to further evaluate this material.

Cyclotron and X-10 pile tests of Na-K-U fluorides showed no observable damage caused by radiation; however, testing of these materials will be continued at holes of high flux in the LITR.

Cantilever creep tests have been run on 347 stainless steel and the conclusion is that the total creep strain increases about 15% under pile irradiation after

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

(ANP Radiation Damage)

300 hours. Samples were run at 1500°F and 1500 psi stress in the X-10 pile and then compared to bench tests. Decreases in creep rate have been observed during pile shutdowns with the rate again increasing upon resumption of irradiation.

Results from the irradiation by the 86 inch cyclotron of a number of fuel pins with 20 MEV protons for one to eight hours and at a power density of approximately 400 watts/cc of fuel indicates no significant change in the chemical composition of the fuel or in the metallographic characteristics of the Inconel container.

ANP Reactor Chemistry (AEC Activity 4275)

As a result of much more severe corrosion by fused fluorides in dynamic systems than could have been anticipated on the basis of static corrosion tests, a major reorientation of effort was required. Plans were developed for a thorough investigation of the "pretreatment" of fuels and the behavior of fused fluorides in response to various conditions. Recently constructed apparatus for filtering and dispensing fused fluorides was successfully operated.

Phase studies on systems involving BeF_2 were continued, and systems involving such compounds as ZrF_4 and RbF were examined closely. Apparatus for determining the melting point of small samples was put in use in response to the need for information about possible melting point changes as a result of corrosive processes.

No alteration of melting point has been found to date.

The amount of effort toward successful handling of hydroxides at high temperatures was sharply curtailed, partly because of small progress in attempts to reach a quick solution of the corrosion problem, but mainly to allow more attention to unexpected difficulties with fuels. Of the hydroxide program, only fundamental electrochemical and solubility investigations are being continued.

Rough viscosity measurements to determine the effect of UF_4 on the viscosity of fused fluoride mixtures were extended to 30 mol percent uranium with little change in viscosity. Vapor pressures at high temperatures were measured, but the work was hampered by furnace failures.

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

ANP Metallurgy (AEC Activity 4275)

A solid fuel element can be made by loose powder sintering to produce a bond between a mixture of uranium oxide and stainless steel powders and a 347 stainless steel backing plate. This was accomplished by placing the powder mixture on the stainless steel backing plate and firing at 1325°C without a load applied to the powder layer. Additional work will be conducted on loose powder sintering and the variables of temperature and uranium oxide particle size will be studied.

In previous corrosion tests, it was found that lead was quite corrosive on most stainless steels and nickel-base alloys. It was thought that additions to lead would make it less corrosive, so an alloy of solium-lead was made and stainless steel and Inconel showed marked increase in corrosion resistance in this alloy. A special alloy, 26% Mo-74% Ni, has been made and tested in sodium, NaOH, and the fluorides. This alloy has very good corrosion resistance to these media. It is much better than the other alloys tested in NaOH and it also has creep properties equal to, if not better than Inconel at 1500°F.

An Inconel thermal convection loop containing KOH was run for 126 hours with a hot leg temperature of 705°C and a cold leg temperature of 450°C without showing mass transfer or serious corrosion. This was accomplished by dehydrating the KOH quite carefully, hydrogen firing the loop prior to testing and transferring the hydroxide to the loop using hydrogen pressure and running the loop under a hydrogen atmosphere.

ANP Central Design (AEC Activity 4275)

The search for a non-oxidative, high temperature fluid, other than sodium, which would be suitable as a reactor coolant has lead to the proposed use of uranium-bearing fluoride mixtures as a bi-functional fuel-coolant. The resulting circulating-fuel reactor has the important advantage of eliminating a heat transfer stage within the reactor core. Preliminary design studies of such a reactor indicate that a 3.5 foot diameter-core beryllium oxide-moderated, circulating-fuel reactor will produce around 350 megawatts at a maximum temperature of 1500°F.

The design point of the aircraft incorporating this circulating fuel reactor is Mach 1.5 at 45,000 feet. The aircraft would have a gross weight of $\sim$350,000 lbs., an L/D of $\sim$6.5 and a wing loading of $\sim$70 lbs. per sq. ft.

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

(ANP Central Design)

A divided shield would be incorporated in this design, and would have gamma and neutron shielding around the crew compartment and hydrogeneous neutron shielding about the reactor. Six turbojet engines each with a design point thrust of 8,200 lbs. may be arranged in the fuselage in a circle aft of the reactor-shield assembly. The circulating fuel is ducted directly from the reactor to the engine radiators.

The survey of the effects of several parametric variations on the total uranium mass, mentioned previously, has been further extended to include other fuel mixtures and beryllium oxide moderation, as well as water moderation. The minimum uranium inventory usually results in a reactor with about one-half thermal fissions.

It is known from kinetic studies of circulating fuel systems that the ratio of fuel in the reactor to that in the over-all system should be as high as practical to conserve delayed neutrons. Furthermore, since curves of total uranium inventory versus fuel-coolant volume fraction have a broad minimum, it is practical to design the reactor with a higher fuel-volume fraction - than that for minimum uranium inventory - in order to favor kinetic response. The conditions of near minimum uranium mass and of favorable kinetic behavior thus lead to a raising of the neutron spectrum and ending in a reactor just barely above intermediate. The trend of the nuclear design to one of the intermediate class is thus inescapable.

Fuel Elements (AEC Activity 4275)

Stainless steel clad metal composite plates consisting of a core of 25% uranium oxide (U_2O) and the balance stainless steel powder were used in the development work to provide a suitable fuel element for use in the proposed General Electric direct cycle aircraft reactor. These samples were 2 3/4" squares with a thickness of 0.200" (average). The final desired thickness of elements is 0.012" to 0.016" with a 0.005" clad on each side. An investigation indicated the desirability of performing as much hot rolling, with a little cold rolling, as practicable to reduce the fuel strips to final size. It was found that the clad samples could be rolled a maximum of 30% cold work without producing deleterious effects on the oxide structure. On reductions in excess of 30% it was found that U_2O particles were broken up into stringers. To get from the hot work stage to finished dimensions, two intermediate anneals are required during cold work operations.

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

Shielding Research (AEC Activity 4277)

The Laboratory has prepared a proposal for divided shield experiments on essentially full scale mock-ups. The reason for this undertaking is that calculations have been difficult and too uncertain for the ANP requirements. The ORNL proposal is to mount a reactor on a tower, to surround it with a full thickness shield, to mount above or below this a crew shield, and to install suitable instruments inside for measurement of biological dose. The crew shield should have full thicknesses for its walls, but the inside dimensions can be considerably smaller than contemplated for the airplane.

The proposal calls for an isolated site, since the radiation intensity will be high in the region of the experiment. The building to house instruments and operators will be partially recessed into the side of a hill, completely shielded, windowless, and air-conditioned. The total cost will depend somewhat on the required tower height but will probably come to less than a million dollars.

Experiments on a mock-up of the KAPL submarine shield are still in progress in the Lid Tank. It is anticipated that they will continue through February. The divided shield experiments are continuing in the Bulk Shielding Facility but are not expected to be completed before next Summer.

GENERAL REACTOR RESEARCH

Stability of Engineering Materials Under Pile Irradiation (AEC Activity 4540)

A calorimetric method has been developed and used to measure the heat dissipated by nuclear bombardment of materials placed near the axis of the LITR and adjacent to the fuel elements. This was done in order to provide data for estimating the amount of cooling required for the proper design of radiation damage experiments in the LITR and the MTR. The nuclear heat dissipated in a lead sample was $\sim$ 0.12 watts per gram with the reactor running at normal (770KW) power. Future experiments are planned using copper and hydrogeneous materials in order to determine how nuclear heat dissipation varies between different materials at various positions in the LITR. These experiments will also provide data for comparison between calorimetric determinations and those previously obtained using graphite ionization chambers. Results from the latter appear to be about three times greater than those obtained using the calorimeter.

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 4000 - REACTOR DEVELOPMENT Continued

General Reactor Radiation Damage (AEC Activity 4540)

The neutron spectrum in the pneumatic rabbit tube of the LITR is being measured using threshold detectors for the energy range above 2 MEV and resonance detectors for the range below 10 KEV. A knowledge of the neutron spectrum here will serve as a tool for the study of radiation damage effects caused by bombardment of materials with non-thermal neutrons. Future measurements will be made at positions in the LITR designated for radiation damage tests.

Idaho Chemical Plant (AEC Activity 10547)

Field engineering assistance in Idaho represents the major ORNL effort on the Idaho Chemical Process Plant at this time. In addition to following the construction work at the plant, the American Cyanamid Company is being assisted in the final preparation of the various operating manuals and in the preparation of a start-up procedure for the plant.

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF ISOTOPES

Radioisotope Production (AEC Activity 5111)

The total accumulated KWH for pile operation during December was 2,461,386, averaging 3864 KW per operating hour. Pile down time was 14.37% as compared with 8.02% during November. There were three ruptured slugs, all of which were discharged without difficulty.

Stable Isotope Production (AEC Activity 5121)

The total calutron tank time was devoted to the collection of calcium and lithium isotopes. Over-all innage for the four calutrons was 1258 hours with an integrated output of 581,656 ma-hr for the two Alpha channels and 66,708 ma-hr for the two Beta channels. Outage time was 31.0% as compared with 34.7% during November. (An estimated 99.9 grams of calcium isotopes were collected during December.)

Isotopes of vanadium, lithium and iron were chemically processed during the month. Rare earth elements are now being successfully separated in the Isotope Chemistry Laboratory by liquid-liquid (TBP-Varsol and HNO_3) extraction.

There were 28 stable isotope shipments made during the month of December.

PHYSICS

High Voltage Program (AEC Activity 5211)

The $T(p, n)He^3$ reaction has been studied from threshold to 5 MEV. The total cross section obtained by integrating the angular distribution exhibits a broad maximum at 3 MEV.

A preliminary search for levels excited by inelastic scattering of fast neutrons has been made by detection of the accompanying Gamma rays. A rapid rise in the counting rate of a NaI counter was observed at 0.8 MEV when iron was used as the scattering material. It seems probable that this rise is due to inelastic scattering in Fe^{56} by the level at 0.822 MEV previously measured only from Beta ray disintegration schemes.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 5000 - PHYSICAL RESEARCH Continued

(High Voltage Program)

Li^6 was bombarded with 320 kilovolt tritons on the Cockcroft-Walton accelerator and the mode of breakup of Be^9 into Li^8 plus a proton of a few hundred kilovolts energy was confirmed. Chalk River had earlier confirmed the other expected modes of breakup of Be^9.

Neutron Diffraction (AEC Activity 5211)

Samples of cubic manganese have been studied at a variety of low temperatures, and these studies have shown the development of an anti-ferromagnetic structure below 100°K.

The coherent scattering amplitude of C^{13} was $0.60 \pm .04 \times 10^{-12}$ cm. This value is nearly equal to 0.66×10^{-12} cm. for normal carbon; therefore, the isotopic incoherence of normal carbon caused by the 1.1% of C^{13} cannot be greater than a millibar. From total cross section measurements spin incoherence caused by C^{13} in normal carbon corresponds to a cross section of 0.03 barns or less than 0.5% of the total cross section. Carbon has been considered a zero spin-single nuclide in many scattering experiments and the direct measurement of C^{13} verifies this assumption.

Angular Correlation of Gamma Rays (AEC Activity 5211)

The angular correlation of the Gamma rays in the main cascade of Pd^{106} has been measured. A published experiment on this correlation had given a value of 1.5 for the ratio of the counting rates at 180° and 90°. The present experiment, using pulse height analyzers for Gamma ray energy discrimination, gives a ratio of 1.84. This strongly supports the suggested spin assignments in the early published work, 0-2-0, which predicts a ratio of 2.0. This experiment is of some interest because it had been suggested that a possible explanation of the published ratio was a spin assignment of 1-2-1, giving spin 1 to the ground state of an even-even nucleus.

The correlation of the Gamma ray (1.05 MEV) from the third to the first excited state with the second Gamma ray (512 Kev) of the main cascade has also been measured. The data allow the assignment of spin 2 to the third excited state in Pd^{106}.

[redacted]

PROGRAM 5000 - PHYSICAL RESEARCH Continued

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Nuclear Resonance. Nuclear resonance measurements were made on $_{43}Tc^{99}$ in a solution of $NH_4 TcO_4$ containing about 156 mg of Tc. The magnetic moment was calculated to be $+5.6805 \pm 0.0004$ n.m. using a 0.411% diamagnetic correction. The resonance of P^{31} was observed and measurements on its sign and moment are under way. The U^{235} resonance in solid UF_6 has not been located yet.

Microwave Spectroscopy. Preliminary investigation of the Cl^{35} quadrupole transitions using only wide band amplification gave cathode ray oscilloscope signals 6 times noise. Higher gains in signal strength were obtained with narrow band amplification and signal modulation.

Spectrochemical Activities. Direct spectrographic analysis of lithium hydroxide for magnesium impurities is superior to prior chemical separation of the lithium. Improvements have been made in the analysis for V, Ca, Cu impurities. Sublimation of lithium and mercury compounds is successful in samples of HgO at 400° C and Li_2SO_4 at 1000° C. Lower limits of sensitivity for several impurities have been obtained in the mercury sublimation procedure. (A total of 1575 element determinations were made this month.)

X-Rays. The following preliminary X-ray wave length values for K and L spectra of polonium have been obtained:

K Spectrum

α_2	160.5	XU
α_1	156.6	
β_1	137.9	
β_2	133.0	

L Spectrum

ℓ	1280.3	XU	γ_1	919.4	XU
α_2	1123.7		β_3	905.8	
α_1	1112.2		γ_1	784.5	
β_4	965.3		γ_2	969.9	
β_2	927.0		γ_3	762.0	

A correction curve, useful over a wide range of counting rates, has been established for the detection of uranium in solutions by homochromatic X-ray absorption at the L III edge. At 40,000 imput counts per second the inherent error of about 37% counting loss may be eliminated by use of the correction curve.

PROGRAM 5000 - PHYSICAL RESEARCH Continued

(PHYSICS)

Mass Spectrometer Laboratory (AEC Activity 5261)

A number of unsuspected ingredients were found and identified in trace quantities of impurities in ANP fuel mixtures and the individual compounds from which the fuels are made. Since the analyses are performed on solid samples without any intervening chemistry, the particular forms of the compounds are readily determined. These studies suggest that the mass spectrometer may yield assistance in determining the mechanism of corrosion.

86-Inch Cyclotron (AEC Activity 5261)

Interruption of operation for repair of a water leak within the vacuum system reduced the average innage time to 56%. Subsequently, a record innage of 88% was maintained for a seven-day period. During December the integrated beam totaled 205,000 microampere-hours.

Electronuclear Machines (AEC Activity 5261)

Recent experiments on the 22 inch cyclotron with a movable electrostatic deflector and septum system have yielded a maximum deflected proton beam of 380 μa with a deflector efficiency of approximately 35%. Tests have been made to determine the feasibility of using grid wires across the dee openings and between successive ion orbits as a system for obtaining electrostatic focusing. Attenuation curves obtained with a very narrow probe indicate that there are discreet orbital positions from the center out to approximately one-half the maximum radius.

The major components of the 63 inch cyclotron have been completed and final assembly is being made. The dees are assembled and the oscillator is undergoing preliminary tests.

CHEMISTRY

Chemical Physics (AEC Activity 5311)

The nuclear magnetic moment of Tc^{99} has been determined in a nuclear induction apparatus. The resonance frequency relative to the deuteron was found to be 1.46628 ± 0.0001 which gives the following nuclear magnet moment in units of

PROGRAM 5000 - PHYSICAL RESEARCH Continued

(Chemical Physics)

the nuclear magneton:

$$\mu(Tc^{99}) = +5.6805 \pm 0.0004.$$

A previous measurement of the nuclear magnetic moment of Tc^{99} made by optical spectroscopy by Kessler and Meggers is consistent with the more accurate value reported above.

Electrochemistry Studies (AEC Activity 5311)

The use of a diaphragm cell for adjusting the acidity of solutions was demonstrated. This technique is particularly attractive when it is necessary to reduce the acidity and yet undesirable to add chemical bases.

Ion Exchange Studies (AEC Activity 5361)

The operation of the recently developed semi-continuous ion exchange bed process has been compared under similar process conditions with a standard packed bed ion exchange system. The specific problem involved the concentration of a uranyl sulfate solution and it has been consistently demonstrated that a semi-continuous ion exchange system is significantly more effective for this type of process. A larger scale unit is now being constructed for unit operations studies.

23 Processing (AEC Activity 5361)

The equipment modification of the existing pilot plant in which the 23 Processing Program will be carried out was initiated during the past month. It is expected that equipment modification will be completed early in March and that the first hot process run will be made about April 1. It is proposed that the uranium 233 will be separated from the thorium using a tributyl phosphate type solvent extraction process.

Thorex Process Chemical Development (AEC Activity 5361)

The development of the chemistry for the Thorex Process was continued and unit operation studies have been initiated to evaluate the operability of the new proposed solvent extraction conditions. Much of this work will be directly applicable to the 23 Processing Program.

PROGRAM 5000 - PHYSICAL RESEARCH Continued

Volatility Studies (AEC Activity 5361)

A program is in progress to determine the volatilities of each of the fission product fluorides relative to uranium hexafluoride. The construction of the equipment for this experiment has been relatively difficult; however, it is expected that within the next month, significant experimental data will be obtained.

Chemistry of Uranium Raw Materials (AEC Activity 5361)

Further studies have been made of the reactions which occur when sodium hydrosulfite is added to uranium-bearing sodium carbonate solutions. In dilute sodium carbonate solutions a precipitate of uranous hydroxide is obtained. With solutions more concentrated in sodium carbonate a colorless uranium complex is obtained, and the uranium, it is believed, is in the reduced (+4) state.

Preliminary results indicate that thorium might be separated from the rare earths by solvent extraction using alkyl phosphoric or phosphinic acids as complexing agents for the thorium.

Studies of the solubility of $UO_2HPO_4.4H_2O$ in molar perchloric acid solutions containing $UO_2(ClO_4)_2$ substantiates the conclusion drawn from the previous spectral data that, in these solutions, a complex ion exists in which the mole ratio of uranium to phosphate is one.

Samples of lignite from North Dakota have been received and studies of methods for recovering uranium from this material are being started.

Recovery of uranium from low sulfate Bartow Clay leach liquors by anion exchange in batch and single column tests has been sufficiently satisfactory to warrant setting up of multicolumn tests.

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Mammalian Genetics and Development (AEC Activity 6400)

A survey of the results obtained in connection with the mutation studies in mice has been made by Dr. Sewall Wright, University of Chicago. He found the high mutation rate obtained to be highly significant and expressed his satisfaction in the way this large-scale experiment is being conducted.

Radiation Protection (AEC Activity 6400)

The recovery of bacteria after exposure to X-rays has been studied in great detail. The organisms require certain low temperature ranges to recover; in addition, they have certain nutritional requirements which are being investigated in greatest detail.

Mecholyl bromide has been found to protect mice against X irradiation to a considerable degree, and it is one of the most promising compounds in regard to radiation protection. It has been reported from England that mice are protected against X-ray damage to a certain extent by feeding them ethyl alcohol. This checks with results obtained here earlier with bacteria.

Plans are being made for biological tests to be made at the Spring weapon test in Nevada.

BIOPHYSICS

Ecological Program (AEC Activity 10999)

The Ecological Survey, a joint venture of ORNL and TVA, is a study of the various organisms in the waters of White Oak Creek and White Oak Lake, into which the dilute radioactive liquid wastes from ORNL are released. Of particular interest is the study of the accumulation of radioisotopes in the bodies of fish which live in these waters. The most abundant long-lived fission products present in the tissues are strontium, cesium, and cerium. The plankton absorbs the above mentioned radioisotopes and this is passed on to the fish as food. In the warm weather months the activity in the bodies is considerably higher than that of cold weather months. It is believed that these seasonal variations are due both to the difference in the amounts of food consumed, and since the fish is a cold blooded animal, to temperature changes.

[redacted]

PROGRAM 6000 - BIOLOGY AND MEDICINE Continued

(Ecological Program)

In the future similar studies are planned for tissues of water fowl.

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PROGRAM 9000 - RESEARCH FACILITIES

Research Laboratory Building #4500

This building is 88% complete. All exterior masonry work, built-up roofing, roof vents and concrete curbing for new roads and east parking lot are complete. Black topping has been applied to six bays of the east parking lot. Due to inclement weather conditions, very little progress has been made on grading of new roads. All outside services have been piped into the basement of building, and connections to interior services are being made. All type ceilings, terrazzo floors, and electric light fixtures are complete in Wings 1, 2, 3 and 4. Metal partitions of laboratories and offices in Wing 1 are 50% complete, in Wing 2 - 80% complete, in Wing 3 - 96% complete, and in Wing 4 - 98% complete. Air conditioning and ventilating systems of Wings 1, 2, 3 and 4 are complete. Setting of Unistrut racks with service and process piping for laboratory equipment has been started in Wing 4. No finished floor covering, touch up painting, or setting of toilet fixtures has been started in Wings 1, 2, 3 and 4 or Service Areas. In first floor of Service Area, all interior masonry partitions, ceilings and ceiling light fixtures are installed and complete. Metal partitions have just been started. In second floor of Service Area, all interior masonry partitions and framework for suspended ceilings are complete, and plastering is in process. All electric equipment and overhead wiring for Substation #20 have been installed.

Isotope Research and Unit Operations Building #4501

This building is 91% complete.

Unit Operations Section: With the exceptions of asphalt tile floor covering, touch up painting, and the setting of some laboratory equipment, this section of the building is complete.

Isotope Research Section: All interior masonry partitions and ceilings are complete. Metal partitions for laboratories and offices are being installed. Setting of pipe racks, service and process piping, installing laboratory equipment, electrical services and painting is in process and is approximately 60% complete. All exterior work of this building including outside services is complete.

High Voltage Laboratory Building #5500

This building is 40% complete. All exterior masonry walls and metal roof decking is complete. No built-up roofing has been applied to roof decks to

[redacted]

PROGRAM 9000 - RESEARCH FACILITIES Continued

(High Voltage Laboratory Building #5500)

date. Metal siding for the south side and upper portion of building is being applied. All concrete floors are poured and progress is being made on interior masonry partitions, air conditioning, electrical services, and service and process piping. Some backfilling and grading has been done on the interior building site.

Test Facilities Building #7503 (ARE)

This building is approximately 90% complete. Building is completely enclosed. Metal partitions, plumbing, heating, ventilating and electrical services and fixtures are being installed.

Chemical Isolation and Purification Laboratory Building #3508

This building is approximately 72% complete. Building is completely enclosed and plumbing, heating, ventilating and electrical services are being installed.

ORSORT Laboratory Building #3017

This building has been accepted and is being occupied by ORNL forces. Final completion form F-3 cannot be processed until exceptions shown on form F-2 have been completed.

Health Physics Waste Research Building #3504

This building has been accepted and is being occupied by ORNL forces. Final completion form F-3 has been processed and signed.

West Portal Building #2016

This building has been accepted and is being occupied by ORNL forces. Final completion form F-3 has been processed and signed.

East Portal Building #5000

This building has been accepted with exceptions as shown on completion form F-2. Final acceptance form F-3 cannot be processed and signed until electrical power for this building has been made available in this area.

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

RADIOISOTOPE SALES

Sales	October	November
Transfers within AEC	$ 714.85	$ 45,552.02
Cash Sales	18,431.43	31,915.38
Foreign	18,227.30	497.00
Cancer Program (Free)	45,776.60	52,381.77
Technical Cooperation Plan	248.27	528.27
Total Sales and Transfers to Date	1,944,060.57	2,032,586.37
Total Cancer Program (Free) to Date	1,061,703.21	1,114,084.98
Technical Cooperation Plan (Shipments to Date)	12,353.00	12,881.27

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

(a)	Actual Cost for November 1951	$ 2,596,261	
	Construction Program "H"	59,659	
	Total Operating and Construction Cost for November 1951		2,655,920
(b)	Estimated Operating Cost for December 1951		2,600,000
(c)	Actual Accumulative FY 1952 Operating Cost through November 1951	12,722,884	
	Actual Accumulative FY 1952 Construction Cost through November 1951	237,771	
	Total Actual Accumulative FY 1952 Operating and Construction Cost through November 1951		12,960,655
(d)	Estimated Operating Cost FY 1952 through December 1951		$15,560,655

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

December, 1951

PERSONNEL SUMMARY

	Number of Employees December, 1951	New Hires December	Terminations December
Administration	101	1	4
Operations*	115	0	5
Engineering, Shops and Mechanical	878	3	6
Laboratory and Research	1384	23	10
Protection	179	0	0
Service	374	4	3
Total:	3031	31	28

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

[redacted]