[redacted]

ORNL 1011
Progress Report

AEC RESEARCH AND DEVELOPMENT REPORT

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0360870 9

LABORATORY RECORDS
1954

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1951

DECLASSIFIED
Classification Changed To:
By Authority Of: AEC 9-21-70
By: E. Goldberg 2-4-71

OAK RIDGE NATIONAL LABORATORY
CENTRAL RESEARCH LIBRARY
CIRCULATION SECTION
4500N ROOM 175
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this report, send in name with report and the library will arrange a loan.
UCN-7969 (3 9-77)

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]

[redacted]

ORNL 1011
This document consists
of 24 pages. Copy 31
of 54. Series A.

Contract No. W-7405, eng 26

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

W. E. Thompson

Date Issued: MAY 8 1951

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]

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0360870 9

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

Distribution

Offices of Directed Operations

1-4.	N. H. Woodruff	Oak Ridge, Tennessee
5.	Technical Information Div.	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 Div.
10.	G. T. Felbeck	Carbide and Carbon Chemicals Div.
11.	A. B. Greninger	Hanford Works
12.	L. J. 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 Div.
16.	E. O. Lawrence	Univ. of Calif. Radiation Laboratory
17.	F. L. Mohler	National Bureau of Standards
18.	H. W. Russell	Batelle Memorial Institute
19.	F. H. Spedding	Ames Laboratory
20.	W. H. Zinn	Argonne National Laboratory

Oak Ridge National Laboratory

21.	E. P. Blizard	36.	M. M. Mann
22.	G. E. Boyd	37.	H. J. McAlduff
23.	R. C. Briant	38.	J. R. McNally
24.	G. H. Clewett	39.	K. Z. Morgan
25.	W. K. Eister	40.	M. E. Ramsey
26.	C. B. Ellis	41.	E. D. Shipley
27.	J. H. Frye, Jr.	42.	A. H. Snell
28.	A. Hollaender	43.	F. L. Steahly
29.	J. T. Hoff	44.	F. A. Swartout
30.	C. P. Keim	45.	E. H. Taylor
31.	J. A. Lane	46.	W. E. Thompson
32.	C. E. Larson	47.	A. M. Weinberg
33.	W. D. Lavers	48.	C. E. Winters
34.	R. S. Livingston	49.	F. C. Zonderlage
35.	J. N. Lyon	50-54.	Central Files

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

TABLE OF CONTENTS

Page

PROGRAM 1000 - RESEARCH FACILITIES..... 6
Instrument Laboratory Building #3500..... 6
Research Laboratory Building #4500..... 6
Isotope Research and Semi-Works Building #4501..... 6
High Voltage Laboratory Building #4503..... 6
Health Physics Waste Research Building #3504..... 6
Chemical Isolation Laboratory Building #23..... 6
ARE Building #22..... 6

PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS..... 7
TBP Process for Waste Metal Recovery..... 7
Purex Process..... 7

PROGRAM 3000 - WEAPONS..... 8
RaLa Production..... 8
RaLa Development..... 8
SCRUP Separation..... 8

PROGRAM 4000 - REACTOR DEVELOPMENT..... 9

MATERIALS TESTING REACTOR..... 9
LITR Operation..... 9
Pre-Installation Assembly of MTR Components..... 9
Materials Testing Reactor-Idaho Chemical Plant Design..... 9

HOMOGENEOUS REACTOR PROJECT..... 9
Radiation Stability of Fuel Media..... 9
Recombination of Hydrogen and Oxygen..... 9
HR Fuel and Blanket Studies.....10
HR Fuel Reprocessing Studies.....10
Criticality of Turbulent Systems.....10
Building 7500-HRE.....10

AIRCRAFT NUCLEAR PROPULSION PROJECT.....11
ANP Central Design.....11

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

TABLE OF CONTENTS

Page

Induced Activity in ANP Reactor Coolant.....11
ANP Radiation Damage.....12
Heat Transfer and Liquid Metals Research.....12
Liquid Metals Corrosion.....12
Liquid Fuel System for High Temperature Reactor.....14
Low Melting Fluoride Systems.....14
Alkali and Alkaline Earth Hydroxides.....14
Bulk Shielding Analysis and Lid Tank Studies.....14

PROGRAM 5000 - PHYSICAL RESEARCH.....15

PRODUCTION OF RADIOISOTOPES.....15
Radioisotope Production, Development and Operations.....15

STABLE ISOTOPE PRODUCTION.....15
Calutron Operation and Process Development.....15
Isotope Chemistry.....16

PHYSICS.....16
High Voltage Program.....16
Neutron Diffraction.....17
The 86" Cyclotron.....17
Electromagnetic Fundamentals.....17
Isotope Analysis Methods Laboratory.....17
Microwave Spectroscopy.....17
X-Ray Spectroscopy.....18
Atomic Spectroscopy.....18
Nuclear Resonance.....18
Mass Spectrometer and Vacuum Laboratories.....18
Mass Spectrometer.....18
Vacuum Laboratory.....18

CHEMISTRY.....19
Radiation Chemistry.....19
Radio-Organic Chemistry.....20
Chemical Physics.....20
Chemistry of Uranium Raw Materials.....20
Chemical Separation of Isotopes.....21
Lithium Isotope Separation.....21

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

TABLE OF CONTENTS

Page

METALLURGY.....21
Thorium Research.....21

PROGRAM 6000 - BIOLOGY AND MEDICINE.....22
Instrument Development.....22

PERSONNEL SUMMARY.....23

RADIOISOTOPE SALES.....23

GROSS OPERATING COSTS.....24

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

PROGRAM 1000 - RESEARCH FACILITIES

Instrument Laboratory Building #3500

This building has been completed in accordance with drawings and specifications. Four (4) hood fans and motors are to be installed by ORNL forces when materials are received.

Research Laboratory Building #4500

Work on this building is approximately 25% complete. Concrete foundations are completed. Structural steel erection is complete. Metal roof decking is 60% complete. Exterior brick walls are 10% complete. Concrete floors, 30% complete. Plumbing, heating and service piping, 15% complete. Electrical services, 15% complete. Compacted stone fill for concrete floor slabs, 75% complete.

Isotope Research and Semi-Works Building #4501

This building is approximately 25% complete. Concrete work on Semi-Works cell block is 90% complete. Isotope Research cell block is 30% complete. Structural Steel is 99% complete. Plumbing, heating and service piping is 15% complete. Electrical services, 15% complete. Concrete floors, 10% complete.

High Voltage Laboratory Building #4503

Piers and footings are being excavated, top soil and muck are being removed from building site, and the banks of White Oak Creek south of building are being dressed. Fabricating of concrete forms is underway. Estimated completion - 2%.

Health Physics Waste Research Building #3504

This building is approximately 30% complete. Foundation walls, platforms and concrete floors have been installed. Structural steel has been erected. Metal window frames are being installed.

Chemical Isolation Laboratory Building #23

Phase I drawings and specifications have been approved. Architect-Engineer has been authorized to proceed with Phase II engineering.

ARE Building #22

The Architect-Engineer is working on Phase I design.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

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

The installation of equipment in the ORNL Metal Recovery Plant was continued and is now about 65% complete. The transfer of the metal waste sludge from storage tank W7 to W10 was continued, and no difficulty in slurrying the metal sludge has been experienced.

Purex Process (AEC Activity 2802-3)

The Purex Process flowsheet #1 was demonstrated by the Pilot Plant at full Clinton slug activity level. Pulse columns were used for the first cycle and the second uranium cycle, while a packed column was used for the second plutonium cycle. The overall decontamination factors for uranium and plutonium were 2×10^5 and 6×10^5, respectively. The total uranium loss was about 1% with a total plutonium loss of approximately 5%. These results represent the first use of the pulse column with radioactive solutions. It is expected that the plutonium yield will be improved by altering the pulse column conditions. The decontamination obtained was the maximum that could be demonstrated with the Clinton slugs. The final uranium product of the second cycle contained fission activity that was about 15% of the activity of normal uranium.

In the Laboratory, the gas evolution during uranium dissolution was determined and work is continuing to study alternate methods for the removal of the radioactive rare gases. Laboratory countercurrent batch tests indicated that it may be possible to increase the uranium concentration in the first solvent extraction column, thereby decreasing the amount of nitric acid required and increasing the flooding rate in the scrub section. Other studies were in progress on the stability of the tributyl phosphate solvent, neutralization of the waste, and the final isolation of the plutonium.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

PROGRAM 3000 - WEAPONS

RaLa Production (AEC Activity 3670)

A special low activity run to produce 50 curies or more of Ba^{140} at the request of Los Alamos and to test the new production facilities was started on April 2. The run was successfully completed on April 6 with the shipment of 157 curies of Ba^{140} to Los Alamos. The new resin column operated satsifactorily but some difficulty was experienced in the standard fuming nitric acid precipitation because of the small amount of product. The addition of a small amount of barium carrier enabled the fuming nitric precipitation to be completed satisfactorily. The new loading cubicle and the attendant remote control equipment operated most successfully.

RaLa Development (AEC Activity 9541)

Several significant changes in the MTR RaLa Process have resulted in further laboratory work. The time cycle for the ion exchange step has been reduced from 30 to about 6 hours, thus reducing the radiation damage of the ion exchange resin. In addition, hydrochloric acid has been eliminated from the ion exchange cycle which considerably relieves the problem of materials of construction. These changes have resulted in the reduction of the total process time cycle from 59 to 27 hours. The design of the pilot plant for the demonstration of this process is now in progress.

SCRUP Separation (AEC Activity 3XXX)

The Laboratory has been requested to recover the plutonium from a limited amount of Chalk River irradiated uranium. The ORNL Metal Recovery Plant will be used for this purpose and modifications of the original plan to adapt it to this program have been made insofar as funds were available. As yet, AEC funds are not available for such facilities as carriers and a special loading and storage canal that will be required for this job.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR

LITR Operation (AEC Activity 9543)

The Low Intensity Training Reactor has been operated continuously for one five-day and one three-day period during the month. Sufficient personnel for continuous three-shift operation will be available in May and full-time operation is expected to start during the month.

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

The pre-installation assembly of the reactor tank and its components has been completed. A final inspection of all components as assembled shows the entire assembly to be satisfactory. Shipment of the reactor to Idaho will take place in the latter part of May.

Materials Testing Reactor - Idaho Chemical Plant Design (AEC Activity 9541)

The design of the Idaho Chemical Processing Plant is now 55% complete, with the effort at ORNL approximately 80% complete. Six ORNL employees and 18 Foster Wheeler employees have been returned to New York to expedite the completion of design. The purchasing group of the Bechtel Construction Company, which has been located at ORNL, will be moved to New York in May.

HOMOGENEOUS REACTOR PROJECT

Radiation Stability of Fuel Media (AEC Activity 4263)

Encouraging progress has been made in the investigation of the effect of oxygen upon fuel solution stability and corrosion. It appears that the presence of oxygen at least during start-up is definitely advantageous and there is some evidence that lowering the pH of the fuel solution by adding sulfuric acid is also helpful.

The possibility of pretreating the stainless steel surfaces with oxygen and steam instead of nitric or chromic acid is being investigated. Intensive studies are underway to elucidate the mechanism of passivation with oxygen and its effect upon the phase equilibria of the system.

Recombination of Hydrogen and Oxygen (AEC Activity 4263)

Work on the catalytic recombination of hydrogen and oxygen has continued with platinum-on-alumina catalysts, and in addition some attention

[redacted]

has been given to other catalytic agents, including massive platinum, copper, and silver. Another experiment has been started to determine the utility of stainless steel as a chemically active absorbent for iodine vapor. Alterations have been started for the attachment of the catalytic recombiner to the off-gas line of the flame recombiner.

HR Fuel and Blanket Studies (AEC Activity 4263)

Neutron irradiation for one week in the ORNL reactor of uranium oxide and thorium oxide slurries had no significant effect on stability of the slurry. The thermal stability of these slurries appears to be the most important problem, and as might be expected, is a function of the viscosity of the solution.

HR Fuel Reprocessing Studies (AEC Activity 4263)

An ion exchange process is now being studied for the extraction of plutonium and fission products from a homogeneous type plutonium producer reactor. The present tentative flowsheet involves three major steps: (1) filtration for the removal of barium and plutonium, (2) a breakthrough cation ion exchange process for the removal of plutonium, rare earths, strontium, and cesium, and finally, (3) electrolysis for the removal of iodine and tellurium. In this process, the homogeneous reactor fuel, a uranyl sulfate solution, could be returned directly to the reactor with a minimum of concentration adjustment. The plutonium and fission products held up on the cation exchanger would be eluted into a separate cycle for final purification.

Criticality of Turbulent Systems (AEC Activity 4263)

A cylindrical tank, 4 by 8 inches, and the attendant hydraulic system have been designed and constructed, and a number of experimental runs have been made. Water flow in this reactor model was excessively turbulent and friction losses at the maximum flow rate were sufficient to cause a considerable temperature rise of the liquid. Further modifications of the system have been planned.

Building 7500 - HRE (AEC Activity 4261)

Installation of the D_2O system has been started; various pieces of equipment have been mounted in their final positions and piping connections will be made during the coming months.

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

AIRCRAFT NUCLEAR PROPULSION PROJECT

ANP Central Design (AEC Activity 4271)

The Austin Company, which was contracted to complete the detailed design of the building facility for the ARE, has submitted the steel-plan for the building. The procurement of this steel has been initiated. The design of the entire building is expected to be completed by the end of May.

A modification of the pressure shell of the ARE is being considered which would permit a bolted flanged construction (instead of welded construction) to facilitate disassembly. It appears that the bolted assembly is satisfactory strengthwise, but the gasket problem is unsolved. Preliminary testing of reactor components specifically for the ARE is being undertaken in cooperation with the Experimental Engineering group. These include test of gaskets, examination of flow patterns in mocked-up liquid fuel circuits, and analyses of heat exchanger designs with various tube sizes, fin depths and flow rates.

North American Aviation's analysis of large supersonic aircraft designs has indicated that the highest L/D ratio attainable for Mach 1.5 at 45,000 feet is about 5. (The feasibility of supersonic nuclear flight had been proposed by the TAB assuming the realization of higher L/D ratios and a 1800°F operating temperature.) As a consequence of this recent finding, the attainment of supersonic nuclear flight must now depend upon the assumption either of high component efficiencies and low component weights for the power plant, or of materials which will permit higher operating temperatures and, hence, higher performance. NAA recommends that experimental and analytical work be done to determine the limitation on materials operating in a non-oxidizing atmosphere at temperatures up to 3000°F (for possible application in a compressor-jet power plant in which the turbine is completely closed).

Induced Activity in ANP Reactor Coolant (AEC Activity 4274)

A type 316 stainless steel loop for circulating lithium inside the ORNL graphite reactor has been completed and is being tested outside the reactor. After installation of panel boards, lines and a hood in the pile building, it is hoped that the test assembly can be placed in operation inside the reactor by midsummer.

Plans are now being made for a circulating sodium stress-corrosion test assembly to be installed in the LITR.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

ANP Radiation Damage (AEC Activity 4275)

Equipment and procedures have been developed to enable the measurement of the thermal conductivity of reactor structural materials as a function of temperature. An in-pile experiment is now in progress to determine the effect of irradiation upon thermal conductivity.

In cantilever creep tests with a maximum fiber stress of 1600 psi at 1500°F on 347 stainless steel in the ORNL reactor, results indicate that the primary creep extension for a given length of time is less under irradiation than in non-irradiated laboratory tests. In-pile tests at constant temperature on a microformer with a locked core show that the output voltage of the microformer changes slightly with pile power. The magnitude of this change appears to be greater than can be accounted for by leakage.

Heat Transfer and Liquid Metals Research (AEC Activity 4275)

The canned rotor liquid metals pump has been operated over 800 hours in water without operational difficulty. Inspection of the pump after 500 hours' operation showed no detectable signs of wear.

The modified apparatus for measuring thermal conductivity of liquids is now being calibrated. Correlation of values obtained with published values indicates that satisfactory accuracy can be expected. The apparatus for measuring thermal conductivity in solids has been modified to reach temperatures above 600°C and is now in operation.

The lithium heat transfer system has been filled with lithium and is now being tested. The first data should be available in May.

A report is being prepared on preliminary calculations of natural convection in fuel pins, based on work with mercury. Further work with lead-bismuth alloy is being undertaken.

Apparatus for measuring the density of liquids at temperatures up to 1000°C has been set up and calibrated. Values obtained agree with published values within 2%.

Liquid Metals Corrosion (AEC Activity 4275)

Samples of all tubular materials from which corrosion specimens are prepared have been held in vacuum at 1000°C for 100 hours to determine possible phase changes which may alter the structure and mechanical

[redacted]

properties of these metals. This will aid in distinguishing between corrosive effects and thermal effects when examining samples exposed to various corrosive environments for 100 hours at 1000°C.

Samples are now being prepared and inserted in hot and cold zones of the thermal convection loops to determine more accurately the corrosive action which occurs under such conditions.

Coolant tube to header joints have been arc welded manually in an inert atmosphere. Preliminary tensile tests at room temperature indicate that minimum strengths of 50,000 psi can be expected using a joint design in which there is incomplete penetration. Welds having complete penetration are undergoing tests and are expected to exhibit higher and more consistent strengths.

The following systems were investigated for compatability at 1000°C for 100 hours:

UO_2-Cr	No reaction
UO_2-316 SS	No reaction
UO_2-Ni	No reaction
UO_2-430 SS	No reaction
BeO-inconel	No reaction
BeO-Cr	No reaction
BeO-Ni	No reaction
BeO-Fe	No reaction
BeO-430 SS	No reaction
Cr-316 SS	Large diffusion layer
Cr-Mo	Diffusion layer
Cr-430 SS	Diffusion layer
Fe-Mo	Large diffusion layer
Fe-inconel	Large diffusion layer

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

Fe-Cb	Diffusion layer
Fe-430 SS	Diffusion layer

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

Low Melting Fluoride Systems. Phase diagrams for $KF-PbF_2$ and for $RbF-UF_4$ have been reasonably well established. In addition, considerable information on the $KF-BeF_2-UF_4$ and the $NaF-PbF_2-UF_4$ systems has been obtained. The former system unlike its sodium fluoride counterpart does not seem to have melting points sufficiently low to be of value.

Alkali and Alkaline Earth Hydroxides. The binary system $Sr(OH)_2$-$Ba(OH)_2$ shows a eutectic at about 60% $Ba(OH)_2$ melting at 360°C. Apparatus for determination of decomposition pressures in this system at high temperatures has been designed.

Bulk Shielding Analysis and Lid Tank Studies (AEC Activity 4277)

During April the lid tank was devoted to completion of a program to determine the effectiveness of boron carbide as a neutron shield. This is of particular interest to the SIR project, since hot sodium must be passed through at least the inner part of the shield in that design. The reactor facility has extended the measurements on water out to distances greater than 300 cm. It is interesting to note that beyond 180 cm the dominant source of neutrons is the photoneutron effect on deuterium in the water.

The aircraft unit shield has been assembled at the reactor building and will be tested during the next two months. Theoretical work has included setting up a method for analyzing the attenuation of a shield in which the production of secondary gamma-rays from neutrons is dominant. In addition, the work on the attenuation of neutrons through water has been extended and improved. Agreement with fast neutron measurements is satisfactory. The work is to be continued so that a direct comparison can be made with thermal neutron measurements.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF RADIOISOTOPES

Radioisotope Production, Development and Operations (AEC Activity 5111)

The total accumulated KWH for pile operation during April was 2.335,806, averaging 3747 KW per operating hour. Pile down time was 13.4% as compared with 11.2% in March. One ruptured slug was located and discharged without difficulty.

The total number of radioisotope shipments during April was 867.

STABLE ISOTOPE PRODUCTION

Calutron Operation and Process Development (AEC Activity 5121)

During April, 1951, primary attention was given to development of a Beta type filament changer, the electrodepositing of lithium, evaluation of two carbonyl charge materials, and to collections of nickel, lithium, samarium, and cerium isotopes. Copper-63 was collected during the nickel collection series.

Troublesome high frequency sparking that has accompanied operations of the filament changer type Beta source was reduced by insulation modifications and increased capacity of the by-pass condensers. Better cooling of the changing mechanism is being considered. Four more sources of this type are being fabricated.

Equipment has been designed for the electrolytic production of lithium metal in 5 to 10 gram quantities. All steps of the operations - electrolysis, drying, transfer of the metal to a container, and sealing of the container - will be carried out by remote control under an inert atmosphere. Accurate analytical chemistry is being performed to obtain more precise values for current and cell efficiencies.

Iron carbonyl, $Fe(CO)_5$, and nickel carbonyl, $Ni(CO)_5$, were tested in the charge evaluation laboratory to determine the operational characteristics of these two possible calutron charge materials. Decomposition of these compounds at temperatures below 150°C caused the metallic deposits of both iron and nickel to plug the charge inlet tube. Methods to correct this plugging action are being investigated.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

Samarium collections started in March were completed on the second day of April; estimated total collections were 13.7 grams. Estimated total nickel collections were 64.5 grams. An extra pocket to receive Cu-63 was placed in the nickel receiver; an estimated 15.5 grams was collected. The lithium series that started in March is being continued; an estimated 101.7 grams has been collected. By the end of the month an estimated 4.9 grams of cerium was collected.

Isotope Chemistry (AEC Activity 5121)

Sample Summary

Chemical Refinements Completed	19
Isotope Samples in Process, April 30	9
Samples in Backlog	12
Mass Assay Samples Submitted	28
Mass Assays Reported	21
Mass Assay Sample Backlog	62
Isotope Shipments Made	38

Chemical services and charge materials were supplied to the calutron for the separation of the isotopes of samarium, lithium, nickel, and cerium. A recycle operation was performed on samarium. Chemical refinement was done on selenium, samarium, calcium, and tellurium. Materials were prepared for mass analyses of isotopes of carbon, selenium, tin, tungsten, titanium, and iron. Quantities of rare earths were fractionated by means of double nitrate crystallization, precipitation of mandelates and extraction with tributyl phosphate. Work involving the quantitative determination of electrolytic deposits of lithium and preparation of anhydrous pyridine was started.

PHYSICS

High Voltage Program (AEC Activity 5211)

The 5-MV electrostatic generator has delivered a proton beam at nearly 6 Mev and the acceptance tests are nearly complete. Performance of the machine is very promising.

An unusually successful radiofrequency ion source has been developed for use with the Cockroft-Walton generator. The ion source delivers a beam of up to 1200 microamperes of separated protons with a gas consumption as low as 3 cc's per hour; 90% of the output ions are protons, the

[redacted]

remainder being molecular. The source is remarkably trouble-free and it is planned to adapt the design for operation in the 2-MV electrostatic generator.

Neutron Diffraction (AEC Activity 5211)

Preliminary diffraction studies have been carried out on a very pure sample of chromium metal in order to detect the possible presence of an anti-ferromagnetic lattice. Present results suggest that a very weak lattice of this type exists which breaks down at temperatures appreciably above room temperature.

The 86" Cyclotron (AEC Activity 5261)

The installation of vacuum locks in the target and the ion source assemblies now permits the cyclotron to remain under vacuum continuously, except when repairs or modifications are necessary. With the insulation of the dees and adjustments in magnetic field, improved operation has been obtained. Calculated beam power and calorimetered power are in reasonable agreement.

Energy (Mev)	Probe Current (μ a)	Power on Target (kw)	
		Calculated	Calorimetered
20	580	11.6	10.7
22	350	8.7	6.0
24	150	3.6	3.2

Two runs of five hours' duration each were made on bismuth and radiation damage targets.

Electromagnetic Fundamentals (AEC Activity 5261)

A hollow-anode type ion source has been operated in an attempt to obtain more highly ionized particles than are obtained from the hot-cathode ion source. Best yields have been about 28 ma of N^{+++}, 10.5 ma N^{++++} and traces of N^{+++++} .

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Microwave Spectroscopy. Resonance absorption frequency measurements are being made for the J = 3 to J = 4 rotational lines of asymmetric molecule C_2H_3I and give a preliminary quadrupole splitting factor, $eQI\left(\frac{\partial^2 V}{\partial^2}\right)$, of 1670 ± 170 mc. The absorption coefficient

of line 24920.8 mc has been determined as 3.13×10^{-8} cm^{-1}.

X-Ray Spectroscopy. A series of five solutions containing 3686 ppm of uranium in the presence of copper contamination ranging from 36,860 ppm to 700 ppm have been analyzed by means of the L III absorption technique with a worst error of 5 percent.

Atomic Spectroscopy. The assay of lithium by means of the isotope displacements in the 6707A resonance transition has been studied further. Sectoring of the Li-7 line down to one-seventh gives a useful ratio to the Li-6 line for densitometry (self-absorption processes presumably reduce this factor from one-twelfth and also probably account for the intensity dependency of the light source). Photoelectric monitoring of the exposures has been accomplished.

Samples of radioactive S-35 have been analyzed by both arc and spark methods. A spectrochemical method for the detection of the very volatile element, selenium, has been developed.

A total of 194 samples have been spectrographically analyzed for 2126 element determinations. A spectrographic method for rare earth analyses has been established.

An echelle spectrograph is being set up in series with a Littrow spectrograph to obtain preliminary Zeeman effects of plutonium spectra.

Nuclear Resonance. A nuclear resonance head unit covering the range 1.6 mc to 3 mc has been constructed and extends the search region to "g" factors as small as 0.13. Negative search results have been obtained so far on ^{89}Yt, ^{73}Se, and ^{103}Rh.

Mass Spectrometer and Vacuum Laboratories (AEC Activity 5261)

Mass Spectrometer. Molybdenum pentachloride and molybdenum oxychloride were prepared for studying the isotopic composition of molybdenum. From these studies there has been found a consistent variation from the values selected by Nier and Bainbridge as the best values in the literature. Further investigations will be made on these variations. A new re-entrant type of liquid nitrogen trap has been installed on the instrument.

Vacuum Laboratory. Equipment has been set up to determine vapor

pressure curves on diffusion pump oils and has been checked with mercury and several pump oils with good agreement with published results.

CHEMISTRY

Radiation Chemistry (AEC Activity 5311)

The radiation decomposition of water and the radiation-induced back reaction of the products H_2 and H_2O_2 have been studied using a cobalt gamma-ray source. Absolute yields were determined by comparison with an acid ferrous sulfate actinometer which had been calibrated calorimetrically. The measured yield for oxidation of Fe^{++} in air-saturated 0.4 M $FeSO_4$ was 15.5 ± 0.3 Fe^{++} oxidized per 100 ev. absorbed.

The decomposition of water by any ionizing radiation is treated as occurring in two separate reactions:

$$2\ H_2O \rightsquigarrow H_2O_2 + H_2 \qquad (F)$$

$$H_2O \rightsquigarrow OH + H \qquad (R)$$

The value for $k_F = 0.46$ H_2O_2 and H_2 per 100 ev. was determined from H_2O_2 yield in oxygen-free acid bromide solutions.

The value for $k_R = 2.74$ H and OH per 100 ev. was determined from the H_2O_2 yield in solutions containing H_2 and O_2. The minimum yield for decomposition of water by gamma radiation is then 3.66 H_2O per 100 ev. or 1 H_2O per 27 ev.

Infrared emission has been observed in irradiated or additively colored KCl during exposure to F-band light. This is thought to be associated with the transition from the excited F-center to the ground state of the F-center. Glow curves for infrared emission during heating of additively colored KCl following exposure to F-band light at low temperature exhibit five peaks between -196°C and + 25°C indicating five types of electron traps. Glow curves obtained simultaneously for different emission bands indicate that at least two types of processes requiring activation energy may occur, and a single type of activation step can lead to more than one spectral emission band.

NaCl and LiF irradiated at 4°K and allowed to warm give maximum emission at 66°K and 135°K respectively with little phosphorescence below these temperatures. These emission peaks are thought to arise from release of self-trapped electrons. A temperature-independent afterglow

observed in alkali halides is attributed to tunneling of trapped electrons to trapped holes.

Radio-Organic Chemistry (AEC Activity 5311)

Among the recent C^{14} labeled compounds to be synthesized have been the following: methanol, potassium cyanide, methyl labeled acetic acid, carbonyl labeled benzoic acid, phenanthrene-9-C^{14}, benzanthracene-5, 6-C^{14} and 1-methyl phenanthrene-9, 10-C^{14}.

Syntheses have been developed for glycine labeled in the -2 position, malonic-2-C^{14} acid, glycerol-1-C^{14}, glycerol-2-C^{14}, and TTA labeled in one of the carbonyl groups in the alpha position with respect to the thiophene ring.

Chemical Physics (AEC Activity 5311)

The pure quadrupole spectrum of solid chlorine at liquid nitrogen temperature has been measured; a single line was observed for Cl^{35} at 54.248 Mc and the Cl^{37} line was also seen at the expected frequency. The approximate nuclear quadrupole coupling for Cl^{35}, spin 3/2, in solid chlorine then is 108.5 Mc., twice the observed frequency. The sign of the coupling is not determined by this method, but it should be negative. The corresponding coupling for atomic chlorine, which lacks one p electron from having a closed shell, is -110.4 Mc. It has been pointed out that covalently bonded chlorine compounds should have a coupling approximately equal to that of the free atom if the chlorine bond is a pure p-type. Since molecular chlorine should have little if any ionic character, it appears that the bond in the molecule uses essentially a p orbital with no, or very little, s hybridization.

Chemistry of Uranium Raw Materials (AEC Activity 5361)

Reports on the following projects are ready for issue: (1) a process for recovering uranium from Marysvale ore, (2) spectrophotometric investigation of the uranyl fluoride complexes, and (3) spectrophotometric investigation of the carbonate uranium complexes.

A new project has been started during the month. This problem involves the recovery of uranium from wet process phosphoric acid by carrier precipitation or other techniques.

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

Chemical Separation of Isotopes (AEC Activity 5361)

Nitrogen: Work has begun on the conversion of the nitrogen in the aqueous ferrous nitroso complex to anhydrous ammonia in order to try microwave spectroscopy as a method for isotopic assay of nitrogen isotopes.

Chlorine: a literature search has been initiated to investigate the possibility of separating chlorine isotopes chemically.

Molybdenum: Samples of the eight-stage molybdenum thiocyanate-hexone run have not yet been assayed due to a lack of instrument time.

Lithium Isotope Separation (AEC Activity 5361)

Laboratory data have been collected showing (for the experimental equipment) a steady decrease in single stage processing time

$$\left(\frac{H}{\bar{V}} \text{ or } \frac{\text{holdup in grams/theoretical stage}}{\text{thruput in grams/minute}}\right)$$

with increased flowrate. The lowest value achieved in a two-inch wide baffled trough was $\frac{H}{\bar{V}} = 1.3$ minutes per stage.

METALLURGY

Thorium Research (AEC Activity 5410)

The work on extrusion of thorium tubing has been extended to investigate the cladding of this tubing with zirconium. It has been found that a uniform thickness of Zr may be produced on the inside of the tubing by extrusion. The bonding of Zr to Th is being further investigated.

Tensile tests of welded joints in thorium sheets showed them to be as strong as unwelded sheets, having a tensile strength of about 39,000 psi. Although quantitative results are not yet available, it has been observed that the welds exhibit some ductility.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

PROGRAM 6000 - BIOLOGY AND MEDICINE

APPLIED BIOPHYSICS

Instrument Development (AEC Activity 6542)

A production design has been completed and reduced to drawings numbers D-9029 to D-9035 inclusive (on file in the Engineering and Maintenance Division) describing a continuous flow water cell of 4 liters/min capacity, a 40 Kev Beta sensitive GM counter, lead shielding, and control panel. The normal background count rate is about 7 c/m and water of about 2×10^{-6} μc/cc of Sr^{90} activity is detectable by approximately a 50% increase of the background counting rate.

An operating model has been constructed and assembled. It is now monitoring the drinking water supply in room 100, and is under observation for possible faults. The present method of recording the count rate uses a scale of 2 and a traffic counter to print fifteen minute count integrations, totalizing and re-cycling every hour.

The production design is being considered (by Chemical Technology Division) for application to some waste water monitoring problems on and off area.

We have been informed by the Patent Office that a patent search discloses no similar art; an application will be made for a U. S. Patent covering the features embodied in the water cell and counter assembly.

A preliminary report is to be written, for purposes of record and discussion as to feasibility of continued effort.

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

PERSONNEL SUMMARY

	Number of Employees April 30, 1951	New Hires April	Terminations April
Administration	89	5	0
Operations*	117	2	1
Engineering, Shops, and Mechanical	917	3	9
Laboratory and Research	1197	35	3
Protection	172	1	1
Service	355	12	1
TOTAL:	2847	58	15

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

RADIOISOTOPE SALES

Sales	February	March
Transfer within AEC	-0-	17,741.20
Cash Sales	32,801.64	29,783.21
Foreign	1,096.10	3,039.80
Cancer Program (Free)	30,948.96	31,736.74
Technical Cooperation Plan	-0-	-0-
Total Sales and Transfers to Date	1,530,901.68	1,596,198.14
Total cancer Program (Free) to Date	751,839.31	785,576.05
Technical Cooperation Plan (Shipments to Date)	6,933.04	6,993.04

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

April, 1951

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

(a)	Actual Cost for March, 1951	2,330,328	
	Construction - Program "H"	103,600	
	Total Operating & Const. Cost		2,433,928
(b)	Estimated Operating Costs for April, 1951		2,650,000
(c)	Actual Accumulative FY 1951 Const. Cost through March, 1951	17,719,034	
	Actual Accumulative FY 1951 Const. Cost through March, 1951	627,223	
	Total Accumulative FY 1951 Operating and Const. Cost through March 1951		18,346,257
(d)	Estimated Operating Cost FY 1951 through April, 1951		20,996,257

[redacted]