MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0360995 9

[redacted]

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

ORNL-1936
Progress

cy. 156-A

AEC RESEARCH AND DEVELOPMENT REPORT

Inv. 66
Inv. 69
Inv. 67
Inv. 68
Inv. 65
Inv. 62

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

JULY 1955

Classification Cancelled
Or Changed To AEC 9/13/71
By Authority Of
By E. Goldberg Date 11/1/71

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this document, send in name with document and the library will arrange a loan.

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]

[redacted]

ORNL-1936

This document consists of 21 pages.
Copy 156 of 165, Series A.

Contract No. W-7405-Eng-26

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

July, 1955

F. T. Howard

and

W. H Sullivan

Date Issued: AUG 5 1955

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 0360995 9

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

July, 1955

Distribution

Offices of Directed Operations

1-10.	H. M. Roth	Oak Ridge, Tennessee
11.	Technical Information Service	Oak Ridge, Tennessee
12.	C. A. Nelson	Augusta, Georgia

AEC Installations

13.	H. A. Blair	University of Rochester
14-15.	N. E. Bradbury	Los Alamos Scientific Laboratory
16.	C. E. Center	Carbide and Carbon Chemicals Company
17-18.	A. B. Greninger	Hanford Works
19-20.	L. J. Haworth	Brookhaven National Laboratory
21.	A. R. Kaufman	M.I.T. Metallurgical Laboratory
22-23.	K. R. Van Tassel	Knolls Atomic Power Laboratory
24-25.	E. O. Lawrence	Univ. of California Radiation Laboratory
26.	R. W. McNamee	Carbide and Carbon Chemicals Company
27-28.	F. L. Mohler	National Bureau of Standards
29-30.	H. W. Russell	Battelle Memorial Institute
31-32.	F. H. Spedding	Ames Laboratory
33-34.	W. H. Zinn	Argonne National Laboratory

Oak Ridge National Laboratory

35.	E. E. Anderson	51. R. B. Briggs
36.	E. A. Bagley	52. K. B. Brown
37.	P. S. Baker	53. F. R. Bruce
38.	R. Baldock	54. T. H. J. Burnett
39.	S. E. Beall	55. A. D. Callihan
40.	S. Bernstein	56. D. W. Cardwell
41.	E. S. Bettis	57. G. H. Cartledge
42.	D. S. Billington	58. A. Charpie
43.	R. E. Blanco	59. C. H. Clewett
44.	E. P. Blizard	60. C. E. Clifford
45.	A. L. Boch	61. B. L. Cohen
46.	E. G. Bohlmann	62. T. A. Cole
47.	C. J. Borkowski	63. E. L. Compere
48.	G. E. Boyd	64. D. E. Cowen
49.	M. A. Bredig	65. J. A. Cox
50.	W. H. Bridge	66. J. H. Crawford

[redacted]

[redacted]

Distribution (Continued)

67. S. Cromer
68. F. L. Culler
69. J. E. Cunningham
70. F. J. Davis
71. J. S. Drury
72. W. K. Eister
73. E. P. Epler
74. D. E. Ferguson
75. J. L. Fowler
76. K. A. Fowler
77. J. H. Frye, Jr.
78. J. L. Gabbard
79. H. E. Goeller
80. J. C. Griess
81. W. R. Grimes
82. C. S. Harrill
83. J. C. Hart
84. C. J. Hochanadel
85. A. Hollaender
86. A. S. Householder
87. F. T. Howard
88. J. T. Howe
89. H. H. Hubbell
90. G. S. Hurse
91. H. K. Jackson
92. G. H. Jenks
93. R. W. Johnson
94. K. O. Johnsson
95. W. H. Jordan
96. G. W. Keilholtz
97. C. P. Keim
98. M. T. Kelley
99. K. A. Kraus
100. Lab. Shift Supv. (E. M. King)
101. J. A. Lane
102. C. E. Larson
103. T. A. Lincoln
104. S. C. Lind
105. R. S. Livingston
106. L. O. Love
107. R. N. Lyon
108. H. M. McLeod
109. H. F. McDuffie
110. J. R. McNally
111. F. C. Maienschein
112. W. D. Manly
113. E. C. Miller
114. K. Z. Morgan
115. R. J. Morton
116. E. J. Murphy
117. J. P. Murray - Y-12
118. C. E. Normand
119. G. W. Parker
120. R. W. Peele
121. H. F. Poppendiek
122. L. P. Riordan
123. R. H. Ritchie
124. A. F. Rupp
125. H. C. Savage
126. H. W. Savage
127. A. W. Savolainen
128. C. H. Secoy
129. E. D. Shipley
130. O. Sisman
131. M. J. Skinner
132. A. H. Snell
133. P. M. Stier
134. R. W. Stoughton
135. H. Stringfield
136. E. G. Struxness
137. W. H Sullivan
138. C. D. Susano
139. J. A. Swartout
140. E. H. Taylor
141. E. R. Van Artsdalen
142. F. C. Vonderlage
143. W. P. Walker
144. B. S. Weaver
145. A. M. Weinberg
146. T. A. Welton
147. J. C. White
148. M. K. Wilkinson
149. C. E. Winters
150. E. J. Witkowski
151. E. O. Wollan
152. [illegible] P. Yockey
153. A. Zucker
154-155. Biology Library
156-157. Central Research Library
158. Health Physics Library
159. ORNL Document Reference Library--Y-12
160. R.E.E.D. Library
161-164. Laboratory Records Department
165. Laboratory Records Dept.--ORNL-RC

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

TABLE OF CONTENTS

	Page
PROGRAM 2000 - SPECIAL NUCLEAR MATERIALS	6
Waste Metal Recovery	6
Metallex Process	6
Power Reactor Fuel Reprocessing	7
PROGRAM 3000 - WEAPONS	7
RaLa	7
PROGRAM 4000 - REACTOR DEVELOPMENT	7
HOMOGENEOUS REACTOR PROJECT	7
Homogeneous Reactor Test	7
HRT Chemical Pilot Plant	8
Homogeneous Reactor Analysis	8
HR Design	8
HR Radiation Damage	9
HR Metallurgy	9
HR Laboratory Service Corrosion	10
GENERAL REACTOR RESEARCH	10
Basic Reactor and Shielding Research	10
Reactor Theory	10
PROGRAM 5000 - PHYSICAL RESEARCH	11
Reactor Operations	11
The Oak Ridge Research Reactor (ORR)	12
ISOTOPE PRODUCTION	12
Radioisotope Production	12
Radioisotope Process Development	12

[redacted]

[redacted]

TABLE OF CONTENTS (Continued)

Program 5000 (Continued) — Page

PHYSICS 13
Recoil Spectrometry 13
Neutron Diffraction 13
Low Temperature, Nuclear and Solid State Physics 14
High Voltage Program 14

CHEMISTRY 14
Volatility Studies 14
Ion Exchange Studies 15
Chemical Engineering Research Studies 15
Feed Materials Processing 15
Neptunium Studies 16
Extraction Reagent Performance 16
Hot Laboratory Research 16
Chemistry of Corrosion 17
Chemical Separation of Isotopes 17

METALLURGY 17
Physical Metallurgy of Reactor Materials 17

OTHER PHYSICAL RESEARCH PROJECTS 17
Oracle 17

PROGRAM 6000 - BIOLOGY AND MEDICINE 18

BIOLOGY 18
Genetic and Cytogenetic Effect of Radiations 18
Insect Cytology and Genetics 18
Biochemistry 18
Pathology and Physiology 18
Enzymology and Photosynthesis 19
Biophysics 19
General Physiology 19

RADIOISOTOPE SALES AND COSTS 20

GROSS OPERATING COSTS 20

PERSONNEL SUMMARY 21

[redacted]

[redacted]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

July, 1955

This status and progress report presents material on approximately one-half the Laboratory's program, which is covered, with some exceptions, on a bimonthly schedule.

PROGRAM 2000 - SPECIAL NUCLEAR MATERIALS

Waste Metal Recovery - After 14 tons of uranium slugs from the Brookhaven National Laboratory reactor had been processed in the Metal Recovery Plant, the equipment was decontaminated and modified for processing 60 tons of ORNL Graphite Reactor slugs. Processing began July 8 at a rate of 1000 lb of uranium per day. Plant performance has been satisfactory. Recoveries of uranium and plutonium averaged 99.4 and 90%, respectively, and nitric acid recovery averaged 85%. (AEC Activity 2350)

Metallex Process - Design of a batch facility for sodium amalgam reduction of $ThCl_4$ to 5-8% thorium amalgam at a rate of 10 lb of thorium per day was begun.

In further small-scale studies, 1 lb of 98% pure anhydrous $ThCl_4$ was prepared by chlorination of pelletized thorium oxalate with a total of 1.6 moles of CCl_4 and 5 moles of Cl_2 per mole of thorium for 2 hr at 500°C, followed by 2 hr at 675°C. In further larger scale runs in the moving bed reactor, a chlorination efficiency of 90% was obtained in this reaction by using 135% of the stoichiometric chlorine requirement and 155% of the carbon required to produce CO_2, with 110% of the carbon supplied by starch and 45% by carbon monoxide. The chlorine efficiency was only 55% when 95% of the stoichiometric chlorine requirement was used and 200% of the carbon to produce CO_2, all supplied by starch. Ethanol treatment of the $ThCl_4$ and subsequent drying produced ethoxy substitution, with release of hydrogen chloride, in the dried salt.

Dry sublimed $ThCl_4$ was reduced by sodium amalgam in 97% yield on a small scale (250 ml), but large-scale dry reduction in a mildly-agitated contactor was unsuccessful. A mixer capable of handling mercury with agitator speeds above 5000 rpm was therefore designed and fabricated. In propylene diamine solution, Fernald $ThCl_4$ was reduced by sodium amalgam in 75% yield, but Bureau of Mines salt was reduced only 30%.

Dry $TiCl_4$ was reduced with sodium amalgam to a quasi-amalgam, which was washed, filtered, pressed, and sintered to a button of titanium metal. Dry $BeCl_2$ was also reduced to a quasi-amalgam, which partially oxidized in the aqueous washing process.

[redacted]

The use of an acetone or methanol wash subsequent to the aqueous HCl amalgam washing step to remove oxygen and water decreased thorium losses in the subsequent pressing and sintering steps. (AEC Activity 2704)

Power Reactor Fuel Reprocessing - In studies on dissolution of fuel elements used in power reactors, type-316L stainless steel dissolved in molten 2S aluminum up to at least 40 wt % stainless steel. Dissolution rates went through a minimum at 10 wt % stainless steel and then leveled off at a rate of 7 mg/cm^2-min. (AEC Activity 2XXX)

PROGRAM 3000 - WEAPONS

RaLa - A batch of approximately 700 curies was shipped July 22. The request was for only 500 curies, the smallest quantity in about ten years. (AEC Activity 3702)

PROGRAM 4000 - REACTOR DEVELOPMENT

HOMOGENEOUS REACTOR PROJECT

Homogeneous Reactor Test - Although strikes caused a loss of about 1/3 the working days in July, the subcontractor was able to make progress on the construction of the waste-storage pond, the cooling system, and the steam valve pit. ORNL forces completed the cooling-water and steam-condensate systems in the reactor control area. The fuel low-pressure equipment assembly which includes the dump tanks, recombiner, and cold traps was assembled. Erection of the roof beams in the reactor tank was begun. The overall work is approximately 500 man days (10 working days) behind schedule. (AEC Activity 4103)

HRT Chemical Pilot Plant - This plant is an experimental facility designed to remove the insoluble fission and corrosion products from a small (0.25 gal/min) fuel side stream by-passing the reactor heat exchanger. The separation will be accomplished by a 0.25-in.-dia hydroclone, a hydraulic adaptation of the familiar gas cyclone. The plant will operate for 48 hr each week, and will reduce the insoluble rare earth concentration from 70 to approximately 50 mg/liter. Corrosion products--iron, chromium, and zirconium--which hydrolyze and precipitate will also be removed. The plant will be located in Building 7500 in a sealed shielded cell similar to the reactor cells, designed to contain 50 psi internal pressure.

Process equipment design is 10% complete. Approximately 70% of materials and equipment has been placed on order. The cell liners have been installed and welded. Startup of the plant is currently scheduled for September, 1956. (AEC Activity 4103)

Homogeneous Reactor Analysis - The effect of slurry settling on the reactivity in large one-region thorium breeder reactors was studied; it was assumed that the reactors would remain thermal-critical assemblies. It was concluded that, for reactors of economic interest, the assemblies would become sub-critical upon slurry settling.

Neutron losses due to the use of platinum as a protective coating for a zirconium core tank were calculated. At a flux of 10^{15} neutrons/cm^2-sec, a minimum platinum cross section of 3.7 barns (2200 m/sec) would be reached in about 14 years. The average cross section over a 10-year period was calculated to be about 5 barns, representing, for a 10-mil platinum layer, a loss of 0.02 in the breeding gain for a Thorium Breeder Reactor. At 10^{15} flux about 5% of the platinum would be converted to mercury in 3 years, and in 8 years about 10% would be transformed.

An economic study of partial fuel costs for one-region plutonium-uranium reactors was completed. Where possible, the process characteristics and cost factors were the same as those used in a previous study of one-region thorium breeder reactors. The minimum partial-fuel-cost reactor was found to be about 12 ft in diameter, operating with about 225 g of uranium per liter, 2 g of fissionable fuel per liter, and giving a conversion ratio of 0.84 for a chemical processing cycle of 138 days. If $\eta(41)$ were 2.4 the partial fuel cost would be about 0.1 mill/kwhr higher than that for one-region thorium breeder reactors; if $\eta(41)$ were 1.9, the partial fuel cost would be about 0.7 mills/kwhr higher. Resonance absorptions by plutonium isotopes appear to increase the cost of power by about 0.1 mill/kwhr. (AEC Activity 4103)

HR Design - Approximately 80% of all final drawings of HRT equipment, building and services are now approved for construction. This includes fuel and blanket process piping, cooling water piping, steam and condensate piping, instrument cubicles, sampler, circulating-pump installation, feed-pump installation, and fuel and blanket line coolers.

A design study for a 440-Mw homogeneous reactor, utilizing low pressure recombination of the radiolytic gases, was completed. The cost estimate of $201/kw installed capacity and 6.2 mills/kwh assumed that maintenance and operating costs would not be different from conventional power plant experience. However, due to lack of essential engineering information, the cost conclusions represent desirable goals rather than figures achievable today. (AEC Activity 4103)

HR Radiation Damage - Tests of specimens of stainless steels and carbon steels, irradiated to integrated fast neutron fluxes of 10^{19} and 10^{20} nvt at temperatures below 100°C, proved that the mechanical properties of both types of steel are changed appreciably by such irradiation, especially by irradiation to 10^{20} nvt. Hardness and strength both were increased by irradiation, but, for the carbon steels at least, irradiation tended to embrittle the specimens. (AEC Activity 4103)

HR Metallurgy - The results of stress-corrosion tests of austenitic stainless steels in boiling 42 wt % magnesium chloride solutions showed a direct relationship between austenite stability and resistance to transgranular cracking. Threshold stresses, below which this type of failure is highly improbable, were established tentatively for types 309SCb and 310 steels.

Dynamic corrosion tests confirmed previous observations that, relative to the as-welded condition, a 1000°F heat treatment is beneficial and a full anneal at 1850°-1950°F is detrimental to the corrosion of type-347 stainless steel welds in uranyl sulfate.

Sigma phase alloys of iron and chromium and of iron, chromium, and nickel appear to have less corrosion resistance in uranyl sulfate than do ferrites of the same composition.

One hundred-hour cathodic treatments of Zircaloy-2 in 1 N sulfuric acid at 30°C and at 10 ma/cm^2 resulted in no change in hydrogen content, while similar treatments at 250°C raised the hydrogen content to 130-170 ppm.

Impact tests on Zircaloy-2 specimens from in-pile loop runs "GG" were completed. All specimens fractured completely when tested, and the impact energy values recorded at the higher testing temperatures were appreciably lower than those obtained with specimens from previous in-pile loop runs. Samples of impact specimens from run "GG" were analyzed for hydrogen content, and no evidence of hydrogen absorption was found. (AEC Activity 4103)

HR Laboratory Service Corrosion - Corrosion specimens were placed in the inner dump tank of the HRT fuel system, in both the vapor and liquid regions. Stressed specimens of type-347 stainless steel and titanium 75A, and coupons of Zircaloy-2, type-309SCb stainless steel, and 98M2 Stellite were included in each region. Type-347 stainless steel was protected effectively against stress corrosion cracking, in the liquid phase of boiling 42% $MgCl_2$ solution, when it was coupled with carbon steel.

The rate of attack by thorium oxide slurries, containing 1000 g of thorium per kilogram of water, on type-347 stainless steel, titanium 75A, and Zircaloy-2 pins in toroids, at 250°C and 26 fps, was lower with slurry prepared from an oxide fired at 1600°C but of small particle size (11% larger than 3 microns) than with slurry prepared from the regular oxide, fired at 650°C and having larger particles (41% larger than 3 microns). Furthermore, the slurry of the high-fired oxide was much less viscous after the run. (AEC Activity 4103)

GENERAL REACTOR RESEARCH

Basic Reactor and Shielding Research - A series of neutron and gamma-ray measurements were made in water beyond various thicknesses of ordinary concrete at the Lid Tank Shielding Facility (LTSF). In one configuration, twenty-two 2-in.-thick slabs were placed adjacent to each other, with the first slab being against the source plate. A preliminary analysis of the data indicates that the thermal-neutron flux was increased by a factor of ~ 50 over the flux in plain water, and it had a relaxation length of 6 cm. The gamma-ray dose rate was decreased by a factor of ~ 16. In another configuration 1/2-in. of water was interspersed between each 4 in. of the 44-in. thickness of concrete. In this case the gamma-ray dose rate was decreased by a factor of ~ 20 over that of plain water.

A preliminary design was completed for a proposed experiment to determine the spatial distribution of neutrons slowed down to indium and thorium resonances in ThO_2-D_2O slurries. The purpose of this experiment would be to provide experimental data from which calculations of the breeding ratio in an actual reactor could be made with greater accuracy than is now possible. Sources of neutrons from U^{235} and U^{233} would be used together with slurries of four different ThO_2 concentrations. The preliminary design permitted an accurate estimate of the cost of performing the experiment at the Thermal Column Facility of the ORNL Graphite Reactor. A report giving the cost estimate and the experimental techniques is now being prepared. (AEC Activity 4570)

Reactor Theory - The flux (thermal and fast) distribution in the cold clean (supercritical) Oak Ridge Research Reactor in standard configuration was computed. The uniform poison distribution necessary for criticality and the

critical mass were estimated. Two non-standard configurations, i.e., centrally reflected, were examined and a study of various possible asymmetric loadings was started. Examination of the control rod effectiveness is under way.

The status of several investigations utilizing the phenomenological theories of nuclei for reactor calculations is as follows:

(1) Numerical tables were constructed to facilitate the calculation of effective resonance integrals including the effect of Doppler broadening of nuclear resonances.

(2) An expression was set up for the calculation of the epithermal and high energy radiative capture cross sections of nuclei, based on the statistical model of the nucleus. A calculation was made for U^{238}, and excellent agreement between theory and experiment was obtained.

(3) The inelastic neutron scattering from the 850-kev level of Fe^{56} was calculated, based on the "cloudy crystal ball" model of the nucleus. Agreement between theory and experiment is good.

Group equations for the consistent P_1 approximation to the Boltzmann equation were developed for use on the Oracle. The lethargy dependent coefficients were put into a form suitable for coding. The difference equation, boundary conditions, and method of solution were developed in a fashion similar to that described in CF-55-1-76.

A program is also being prepared for the Oracle to give solutions of the neutron transport equation for one-dimensional slab and spherical geometries. The calculation is based on the S_N method of approximation. Flow sheets for the preliminary one-velocity problem were completed, and it is expected that N may take values as large or larger than ten. (AEC Activity 4570)

PROGRAM 5000 - PHYSICAL RESEARCH

Reactor Operations - There were four slug ruptures in June and two in July, making the number of slug ruptures in 1955 far ahead of 1954, when no ruptures occurred in the first half year.

The remote control equipment for the LITR is being installed and preliminary operation should begin in about a month. It is planned to operate both the Graphite Reactor and the LITR from one control room.

Processing of the slugs from the Graphite Reactor canal has begun.

Phorphorus-32 production from sulfur is being checked in the LITR in a position where the fast neutron flux is especially high.

A fuel element of the type used in the Geneva Conference Reactor (Aquarium) has been operating in the LITR since the early part of May without indication of trouble.

The Oak Ridge Research Reactor (ORR) - A contract was signed on June 16, between the AEC and Blount Brothers Construction Company of Montgomery, Alabama, for the sum of $2,283,000, for construction of the ORR Building, Reactor Structure, and Reactor Cooling System. Construction is now in progress, and should be completed by April 15, 1956.

The design of the reactor vessel and a major part of the core components, which are to be procured and installed by ORNL, was completed; these components are to be ordered on a bid basis. The development work on the mechanical controls, which in this reactor installation operate from below the core, is in the final stages and life test of the equipment are under way. The major effort at present is the design of the experimental facilities for initial operation. The reactor is scheduled to be in operation by August, 1956.

ISOTOPE PRODUCTION

Radioisotope Production - Arrangements were completed to have the Savannah River Works can cobalt for irradiation to produce teletherapy-grade (40-60 curies/g) cobalt-60. Savannah River facilities are specifically designed to produce cans which will meet their specifications.

The Argonne-type manipulator cell in Building 3029 was dismantled for refurbishing. This cell has been in continuous daily operation for three years without a major overhaul. It should be back in operation by the end of August.

Two hundred cans of Be_3N_2 were prepared to send to Hanford for irradiation. Radioisotope container designs are now being thoroughly reviewed in an attempt to reduce shipping weights and to improve safety features. Appreciable savings in shipping costs to the customers are anticipated. (AEC Activity 5111)

Radioisotope Process Development - The multikilocurie loading cell was placed in operation.

The new design for the combined cobalt-60 storage and irradiation facility increased the cost of construction to such an extent that the request for funds was resubmitted to the AEC.

The design of Phase I of the fission-product pilot plant was completed June 1, as scheduled. This phase includes the building, cell block, tank farm cells, service headers, off-gas and cell ventilation ducts, and drainage headers. The low bid for construction of Phase I was $946,000, by the Malan Construction

Company. Since the bid exceeds the funds available for this phase, awarding of the contract is delayed while awaiting approval of additional funds. Additional funds for Phase II installation (equipment, piping, instrumentation) were also requested. The design of Phase II of the fission product pilot plant is proceeding on schedule.

Arco has approved the shielded transfer tank and the proposed method of loading. Minor changes in design are being made as requested, and these changes should be completed by the end of August.

A test run was made on the separation of europium from promethium by reduction and precipitation of the europous sulfate. The results indicate that this procedure is not adequate (62% yield); therefore, plans are being made to use the resin column technique. (AEC Activity 5112)

PHYSICS

Recoil Spectrometry - Final calibration of the magnetic analyzer against internal conversion lines in Bi^{207} and Cs^{137} led to the value 9.64 ± 0.06 ev for the energy of the singly-charged neutrino recoils of A^{37}. This is to be compared with the value 9.66 ± 0.05 ev predicted from the threshold of the $Cl^{37}(p,n)A^{37}$ reaction, and the assumption of zero rest mass for the neutrino. The momentum balance within this precision sets an upper limit of about 10 kev for the rest energy of the neutrino. It is noteworthy that there is now as much inaccuracy from the (p,n) threshold measurement as there is from the recoil energy measurement in the evaluation of the momentum balance. The paper describing this work was submitted for publication in The Physical Review. (AEC Activity 5220)

Neutron Diffraction - A previous neutron diffraction investigation of iron at elevated temperatures indicated pronounced small angle scattering in the vicinity of the Curie temperature of 770°C. This scattering was presumably of magnetic origin, and additional studies were performed to obtain more information on the conditions necessary for it to occur. Experiments performed on both single crystals and polycrystalline samples of iron indicated that this type of scattering is independent of the crystalline structure. Furthermore, the small angle scattering from iron is unaffected by an external magnetic field of about 8000 oersteds. Investigations on an antiferromagnetic material, Fe_2O_3, showed no small angle scattering in the ficinity of the Néel temperature. However, experiments with a ferrimagnetic material, Fe_3O_4, did show small angle scattering near the Curie temperature, but the intensity of the scattering was much smaller than that observed from iron. The results of these experiments are consistent with recent theoretical ideas (L. Van Hove, Phys. Rev. 95, 1374, 1954). According to this theory, which is based on the pair correlation of electronic spins, the small angle scattering is produced near the Curie temperature in ferromagnetic materials by the large spontaneous fluctuations of the magnetization, and the intensity is proportional to the net magnetization of the material. Because of the striking similarity to small angle scattering from gases and liquids near critical conditions, this type of small angle scattering has been termed "critical magnetic scattering". (AEC Activity 5220)

Low Temperature, Nuclear and Solid State Physics - Np^{237} nuclei were aligned in the hexagonal crystal NpO_2 $Rb(NO_3)_3$ and the anisotropy of emission of alpha particles was observed. A 9% decrease in the emission of alpha particles takes place parallel to the c-axis of the crystal as compared with emission perpendicular to the c-axis when the temperature is lowered from 300°K to 1.1°K. Signs, such as that of the nuclear quadrupole moment, are not definite; but, assuming the Np^{237} quadrupole moment to be positive and accepting the assignment of signs in the effective spin hamiltonian given by Bleaney et al. (Phil. Mag. 45, 992, 1954) based on theoretical estimates of Eisenstein and Pryce (Proc. Roy. Soc. A229, 20, 1955) for the salt used, the results show preferred emission at the nuclear equator rather than in the polar direction, which is at variance with some theoretical discussion (D. L. Hill and J. A. Wheeler, Phys. Rev. 89, 1102, 1953) of the subject. This experiment constitutes the first demonstration of the Pound method (R. V. Pound, Phys. Rev. 76, 1410, 1949) of nuclear alignment and is the first observation of the dependence of a nuclear reaction on the non-spherical shape of the nucleus. (AEC Activity 5220)

High Voltage Program - Angular distributions of neutrons, elastically scattered from fluorine, were measured at neutron energies of 0.65, 1.05, 1.45, 2.15, and 2.94 Mev. The neutrons were produced by protons from the 5.5 Mv electrostatic generator, bombarding tritium and LiF targets. Neutrons scattered from Teflon and carbon samples were detected with a propane recoil counter. The energies of observation were between resonances in the total cross section of fluorine, and the distributions were measured as a part of an attempt to determine the potential scattering phase shifts. The distributions at the lower energies show much greater peaking in the forward direction than had been anticipated, which may indicate that interference from nearby resonances was not negligible.

The cascade generator was used for further work on the $Li^6(He^3,p)Be^8$ reaction (the Li^6 contained only 0.2 Li^7). The protons were collected in a CsI crystal on a photomultiplier and the pulses were analyzed with a 100-channel serial memory analyzer. A second excited state of Be^8 was found at approximately 12 Mev, in agreement with some α-α scattering measurements made at Illinois. No evidence was found for the 7-Mev level reported by the Indiana group. The level structure appears to be: ground state, 2.9-Mev state, and 12.5-Mev state with nothing in between, at least as far as this particular reaction is concerned. (AEC Activity 5220)

CHEMISTRY

Volatility Studies - A method of processing heterogeneous reactor fuels by dissolving the metal or alloy in a molten fluoride salt in the presence of HF, converting the UF_4 thus formed to UF_6 by means of F_2, and volatilizing the UF_6 is being investigated. When long-decayed uranium slugs were dissolved in molten NaF-ZrF_4, the volatilized UF_6 was decontaminated from fission products by a factor of 100-300. A further gross beta decontamination factor of 100-1000 was obtained by completely absorbing the UF_6 in a NaF bed at 100°C, in

which a major part of ruthenium fluoride was not absorbed, and desorbing it from the bed at 400°C, leaving niobium and the rest of the ruthenium absorbed in the NaF.

Admixture of nitrogen with the fluorine used for sparging resulted in good uranium recovery with consumption of less fluorine than when fluorine alone was used. Also, an induction period, between the time the fluorine sparging was started and the beginning of the UF_6 evolution, was eliminated by use of nitrogen. Several of the nickel vessels used for dissolution of uranium in molten salt ruptured. This behavior was attributed to embrittlement resulting possibly from sulfur contamination in the HF, since chemical analyses of the ruptured vessels showed 0.7% sulfur compared with the original of about 0.005%. (AEC Activity 5310)

Ion Exchange Studies - A 12-in.-dia Higgins continuous ion exchange column was constructed and tested. Operation of the unit was satisfactory, and it was shipped to National Lead at Grand Junction, Colorado.

In resin attrition tests, made in a circulating loop to simulate conditions in the continuous contactor, 35.7% of the resin particles were broken after 800 hr operation at 2 cycles/min.

In tests on the use of ion exchange in the decontamination of radioactive aluminum nitrate wastes, rare earths were sorbed on anion-exchange resin with a distribution coefficient (resin/aqueous) of 4 from 2.5 M aluminum nitrate solution. The $Al(NO_3)_3$ was then concentrated to colloidal $Al(OH)_2NO_3$ by destructive distillation, and the soluble fission products, such as cesium, and strontium, were recovered by sorption on cation-exchange resin. The bulk of the aluminum was non-ionic and therefore did not interfere.

Preliminary tests were carried out on the use of ion exchange to remove fluoride (3-8% dissolved, 25 wt % MgF_2 as a fine suspension) and chloride from a nitric acid solution of the diuranate cake produced in the Fernald bomb liner recycle process. The diuranate obtained from the ion exchange product contained 71% U, $<0.001\%$ Cl, and 0.03% F. (AEC Activity 5310)

Chemical Engineering Research Studies - A filter in which the filter bed is made of magnetizable material, ferrosilicon, held in place by an electromagnetic field and discharged remotely by cutting off the current responsible for the field, was designed and installed. In static batch tests, the ~3 in. dia. ferrosilicon filter was resistant to corrosion by dilute acid. The mechanical operation was satisfactory in the preliminary tests. (AEC Activity 5310)

Feed Materials Processing - In further studies on sodium amalgam reduction of UF_6 to uranium metal, the quasi-uranium amalgam was found to contain surface oxides and/or fluoride impurities which prevented its sintering to dense uranium metal. Magnesium amalgam reduced UF_6 to uranium metal, but there were no advantages over the cheaper sodium amalgam.

In further studies on the Excer process for converting uranyl nitrate to uranium tetrafluoride, $UF_4 \cdot 1/2\ H_2O$ was produced from UO_2F_2 by electrodialysis. Attempts to reduce this compound with sodium amalgam in a Rushton contactor were unsuccessful.

In studies on the Fluorox process for converting $UO_2(NO_3)_2$ to UF_4, solid UO_3-starch pellets, satisfactory for reduction in a moving bed reactor, were prepared in automatically controlled equipment. The pellets were more uniform in size and the discharge rate was more even when the feed to the pelleting machine contained recycled fines than when the feed was all fresh UO_3 and starch. (AEC Activity 5310)

Neptunium Studies - A preliminary flowsheet for recovering uranium and Np^{237} by solvent extraction from highly burned up MTR fuel elements and shim rods was designed as a result of batch studies with Np^{239}; a feed nitric acid concentration of 0.3 ± 0.1 M was determined to be optimum. Higher acidities resulted in a gradual decrease in the Np(IV) distribution coefficient, whereas lower acidities apparently promoted hydrolytic effects, causing erratic results, and, in general, very low distribution coefficients. The tributyl phosphate concentration of the solvent was set at 2%. The aluminum nitrate concentration of the scrub solution was established at 1.5 M Al^{3+}, with an acid concentration of 0.3 M and 0.01 M ferrous sulfamate as a holding reductant. The feed/scrub/extractant ratio is 1.0/0.5/2.0, to yield organic/aqueous flow ratios of 4.0 and 1.33 in the scrub and extraction sections, respectively. These conditions should give decontamination factors across the first extraction-scrubbing column as follows: Ru, 10^4 - 10^5; Zr, 2×10^3; Nb, 1.3×10^4; TRE (total rare earth) β, 10^4 - 10^5.

Neptunium losses were demonstrated as about 0.1% with a material balance of 95-100%; uranium losses were less than 0.01%. (AEC Activity 5310)

Extraction Reagent Performance - In a series of studies on degradation of organic solvents and paraffinic diluents by irradiation, ultraviolet absorption spectra are being used to follow the damage. In preliminary experiments, tributyl phosphate that had been treated with calcium hydroxide did not show any absorption bands between 360 and 220 mμ. Amsco Special Naphtha No. 1, which was pretreated with oleum at the refinery, showed strong absorption in the 280-220 mμ range. These bands disappeared when the hydrocarbon was treated several times with fuming sulfuric acid and then passed through silica gel. (AEC Activity 5310)

Hot Laboratory Research - Preliminary data were taken on melting small neutron-irradiated samples of roll-clad fuel plates of UO_2 in a stainless steel matrix. The purpose of the experiment (memorandum ORNL-CF-55-2-123) was to afford some basis for predicting the extent and nature of the radioactivity to be encountered in event of a reactor disaster.

From samples heated in air to 1720°C, in the vicinity of the melt, dispersed solids having a γ activity equal to about 5% of the total FP's were collected.

A volatile solids fraction of halogens, molybdenum, etc. of 1% was also observed. It was determined that about 50% of the total rare gases are being expelled from small samples and that this represents about 5% of the total γ activity after several hours cooling time. (AEC Activity 5330)

Chemistry of Corrosion - Further measurements of the effect of added ions upon the electrode potential of inhibited specimens of electrolytic iron were made, with sodium molybdate as the inhibitor. The results confirm the observations previously made with the pertechnetate ion in showing that the inhibited state involves a labile adsorption of inhibitor at the interface which is sensitive to the presence of competing ions. It was shown also that the electrode potential is more noble when the pertechnetate and chromate ions are simultaneously present than it is when either ion is present alone. (AEC Activity 5330)

Chemical Separation of Isotopes - Initial runs were made with laboratory semi-pilot plant equipment to study the operation of the BF_3(gas) vs BF_3·anisole (liq.) system for concentrating boron isotopes (ORNL-1760). The test unit operates in a closed cycle and simulates actual plant operations. The BF_3 (gas) is passed through a 30-plate bubble-cap column, counter-current to BF_3·anisole (liq.). An absorber at the top of the column combines BF_3 and anisole. At the base of the column BF_3 is removed from the anisole by heating. The anisole is recycled from the stripper to the absorber. Operational characteristics of the set up were found to be very satisfactory and control problems to be fewer than anticipated. Isotopic analyses show total separations as high as 1.52 $[(B^{10}/B^{11})top/(B^{10}/B^{11})bottom]$ which gives a stage efficiency of approximately 50%. Stripped anisole showed boron content in the range 0.1-0.2 mole %. Some tendency for boron buildup in the stripper was indicated which was due either to slow decomposition reactions or reaction with residual moisture. Results thus far indicate that the system will prove a feasible one for enrichment of boron isotopes. (AEC Activity 5340)

METALLURGY

Physical Metallurgy of Reactor Materials - A system of intentionally adding carbon to stainless steel, as a means of destroying its resistance to chemical dissolution, was applied in preliminary experiments to full size Army Package Power Reactor fuel elements. A maximum carbon content of 1.8% was obtained in a 4-hr exposure to a carburizing atmosphere at 950°C. The conditions of subsequent experiments will be changed to yield a carbon content of 2.5% which chemical dissolution experiments indicate is necessary for reasonable dissolution rates. (AEC Activity 5411)

OTHER PHYSICAL RESEARCH PROJECTS

Oracle - The magnetic tape auxiliary memory was made available for computational use on June 13. To date several major problems have gone into production using the auxiliary memory. The procurement of satisfactory tape remains a problem, however, an adequate supply is available for all current problems. The speed and capacity of the new unit are considerably greater than for any others now in operation.

BIOLOGY

Genetic and Cytogenetic Effect of Radiations - Four pure lines of the Ehrlich mouse ascites tumor were produced by inoculation of mice, each with a single tumor cell. Under the microscope, a tumor cell was drawn into a hand-held pipette, and the presence of but a single cell in the pipette verified. This single cell was then inoculated into the belly of a day-old mouse. Twenty percent of the inoculations were successful. This purification of tumor cultures is similar to the formation of pure cultures of bacteria from a mixed one, and is of comparable importance. Such pure lines are especially desirable for experimental purposes, since the original tumor strain was highly heterogeneous. (AEC Activity 6130)

Insect Cytology and Genetics - The newly laid egg of the wasp Habrobracon has the nucleus at the convex surface near the wide end. This makes possible the differential irradiation of the nucleus and cytoplasm with low-penetrating radiation. By appropriately arranging large numbers of eggs and exposing them to alpha particles from a polonium source, it was found that one alpha particle can kill the egg if the nucleus is irradiated. If the non-nuclear portion of the egg is irradiated, the egg fails to hatch only after being hit by approximately 4×10^7 alpha particles. (AEC Activity 6130)

Biochemistry - Controlled acid hydrolysis of DNA should theoretically liberate free purines, free deoxyribose sugars, inorganic phosphate, and, most important, intact pyrimidine polynucleotide chains. Thus an analysis for these latter products would describe the pyrimidine sequences that preexisted in the complex DNA chain. This approach was used with calf thymus DNA, and, though all products have not as yet been defined, the results are sufficiently inclusive to warrant comparison of nucleotide sequences of DNA molecules from related biological species. (AEC Activity 6130)

Pathology and Physiology - In an attempt to gain information about the factors which influence the growth of leukemia cells, the effect of the thyroid on the survival of rats bearing transplated lymphoid leukemia was investigated. Rats rendered hypothyroid by pretreatment with propylthiouracil were found to survive significantly longer after transplantation of the leukemia than pair-fed controls with normal thyroid status. This effect was nullified by administration of thyroxine. These results confirm those obtained previously in this laboratory with mice.

It was found that the blood platelets from rats injected with $Na_2S^{35}O_4$ during recovery from an $LD_{50}/30$ days of X-rays have a much higher average radioactivity count than platelets from control rats. The activity is highest 14 days postirradiation and declines to control values by about 25 days after exposure. Since the labeling of platelets occurs predominantly during their production in the bone marrow, the increased radioactivity is probably associated with the younger age composition of the platelet population during its buildup in the recovery period. (AEC Activity 6130)

Enzymology and Photosynthesis - In continuation of the studies on the enzyme systems of luminous bacteria, an investigation was made of the exchange reaction serine + C^{14} glycine $\rightarrow$ C^{14} serine + glycine in cell-free extracts. This interrelation plays a significant role in the biosynthesis of the nucleic acids. The organism used was the unnamed luminous coccobacillus obtained from Gest and previously used for production of luminescent extracts. Treatment of a water extract of the acetone-dried organism with Dowex-1 resulted in inactivation of the enzyme catalyzing the exchange. The activity was fully restored by adding a boiled extract or by adding tetrahydrofolic acid together with pyridoxal or pyridoxal phosphate. This is the first demonstration of an absolute requirement for a pyridoxal derivative in this reaction, although indirect evidence for the participation of pyridoxal was previously obtained in other laboratories. (AEC Activity 6130)

Biophysics - Spontaneous metamorphic changes were observed in a salamander, *Gynnophilus* palleucus, which is presumably a neotenous species. The specimen had been kept at 75° ± 2°F for a period of 11 months. Other specimens kept at 56° ± 1°F have not shown such changes. A second larva has been moved to 75° ± 2°F and is being kept under observation.

In a study of PAS-stained pituitary glands from surgically thyroidectomized adult *Triturus* viridescens, enlarged cells resembling the pretumor cells found in thyroidectomized mice were found to be present after 10 days and to be numerous after 30 days following thyroidectomy. A preliminary test of an hypothesis of Steinitz and Stone (1954) indicated that the ultimobronchial body of the thyroidectomized animal does not assume a thyroid function (i.e., does not take up radioiodine).

A preliminary report on the irradiation program performed with the ORNL 86-Inch Cyclotron was completed and distributed. Further calculations are being carried out on the theory of the rep/n ratio for Victoreen chambers. (AEC Activity 6130)

General Physiology - A program aiming at the complete fractionation of the liver was initiated. Initially the soluble phase was isolated by a rapid method and studied electrophoretically. A reproducible pattern is obtained in veronal (pH 8.6) and in phosphate (pH 7.8). The physical properties of the preparation were examined and found to parallel those of the cell in respect to sensitivity to freezing and thawing. A new theory of the cause of cell death by freezing and thawing was elaborated. (AEC Activity 6230)

RADIOISOTOPE SALES AND COSTS

TYPE OF TRANSACTION	JUNE 1955	FY 1955 TO DATE
Domestic Sales	$ 69,620	$1,199,233
Foreign Sales	7,422	65,905
Project-Cash Sales	10,708	65,552
Project-Transfer	0	1,743
Technical Cooperation Program Credits	137	1,647
Plant Credits	2,120	30,712
Civilian Defense Credits	184	419
Cancer Program Credits	16,718	243,647
*Miscellaneous	0	58
Total Income	$106,909	$1,608,906
**Income - No Production Costs Incurred Subtract from Total Income	10,024***	37,756
Radioisotope Income	$116,933	$1,571,150
Radioisotope Costs	$321,750	$1,221,900
Radioisotope Shipments	1,097	12,775

*Miscellaneous - Freight and Missing Parts
**Income from H^3, He^3, B^{10} and miscellaneous items in excess of handling costs.
***Credit

GROSS OPERATING COSTS

	Cost for June	FY 1955 Cost to Date
Programmatic Operating Cost - Net	$4,276,888	$32,963,292
Plant and Equipment Cost	763,901	3,698,740
Program "H"	41,726	328,998
Work for Other Parties - Transfers	61,935	472,460
Inventory Changes	204,186*	422,026*
Reimbursable Work for Other Parties	159,659	2,123,976
Deferred Charges	5,677	3,416*
Total Laboratory Cost - Net	$5,105,600	$39,162,024
Estimates Cost for Next Month - Net	$3,400,000	$ 3,400,000

*Credit

[redacted]

PERSONNEL SUMMARY

	Number of Employees July, 1955	New Hires July	Terminations July
Administration	63	0	2
Operations*	123	0	2
Engineering, Shops and Mechanical	754	15	3
Laboratory and Research	2090	37	23
Protection	140	0	2
Service	379	8	6
	3549	60	38

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

A total of 880 Laboratory personnel are located in the Y-12 Area.

-oOo-

Reports in this series issued during the past year:

July 1954	ORNL-1760
August 1954	ORNL-1781
September 1954	ORNL-1793
October 1954	ORNL-1805
November 1954	ORNL-1824
December 1954	ORNL-1838
January 1955	ORNL-1849
February 1955	ORNL-1867
March 1955	ORNL-1878
April 1955	ORNL-1886
May 1955	ORNL-1905
June 1955	ORNL-1920

[redacted]