MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES
3 4456 0361282 9

CENTRAL RESEARCH LIBRARY
DOCUMENT COLLECTION

ORNL-2578
Progress

LIBRARY
REFERENCE COPY

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

JULY 1958

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
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

ORNL-2578

Copy No. 365

Contract No. W-7405-eng-26

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

July 1958

Date Issued: AUG 8 1958

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee
Operated by
UNION CARBIDE CORPORATION
for the
U. S. Atomic Energy Commission

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES

3 4456 0361282 9

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

TABLE OF CONTENTS

	Page
PROGRAM 4000 — REACTOR DEVELOPMENT	4
HOMOGENEOUS REACTOR PROJECT	4
Homogeneous Reactor Test	4
HRT Chemical Pilot Plant	5
Fuel Processing	5
Gaseous-Fission-Product Disposal	5
Thorium Oxide Slurry Development	6
Mathematics and Computation: Homogeneous Reactor Development	6
Reactor Analysis	7
Homogeneous Reactor Instrumentation	7
HRP Design	8
HRP Metallurgy	8
HRP Radiation Damage	8
Laboratory Corrosion Studies	9
Dynamic Solution Loop Corrosion Tests	9
Small-Scale Dynamic Slurry Corrosion Tests	10
Dynamic Slurry Loop Corrosion Tests	11
In-Pile Autoclave Solution Corrosion Studies	11
HRP Service Corrosion	12
CIVILIAN-POWER ADVANCED GAS-COOLED REACTOR	13
Gas-Cooled Reactor: Design Studies	13
Gas-Cooled Reactor: Radiation Effects	13
Gas-Cooled Reactor: Metallurgy	13
Gas-Cooled Reactor: Materials Compatibility Tests	14
Gas-Cooled Reactor: Physics	14
GENERAL REACTOR RESEARCH	15
Radiation Detector Development	15
Reactor Safety Studies	15
Waste Treatment	16
Long-Range Planning Studies	16
PROGRAM 5000 — PHYSICAL RESEARCH	17
Reactor Operations	17

TABLE OF CONTENTS (Continued)

Page

Program 5000 (Continued):

PHYSICS 17
Neutron Velocity Selector 17
High-Voltage Experimental Program 17
Neutron Diffraction 18

CHEMISTRY 18
Raw Materials Research and Development 18
Chemical Engineering Research 19
Chemistry of Corrosion 19
Physical Chemistry of Ion Exchangers 19
Characterization of Short-Lived Fission Products 19
Nuclear Methods of Chemical Analysis 20
Chemical Separation of Isotopes 20

METALLURGY 20
High-Temperature Reactions of Metals and Ceramics 20

PROGRAM 6000 — BIOLOGY AND MEDICINE 21

BIOLOGY 21
Cytology and Genetics: Insects 21
Pathology and Physiology 22
Microbial Protection and Recovery 22
Mammalian Recovery 22
Radiation Immunology 23

MISCELLANEOUS REPORTS 24

Open Literature Publications 24
Visitors 26

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

July 1958

This Status and Progress Report summarizes that portion of the Laboratory's work which is unclassified. Some of the topics are included every month, but the majority are reported on a bimonthly schedule.

PROGRAM 4000 — REACTOR DEVELOPMENT

HOMOGENEOUS REACTOR PROJECT

Homogeneous Reactor Test. — Run 16 was concluded with a scheduled manual shutdown on July 3 after 30 days of continuous operation at 280°C and 1750 psi. During the run 1600 Mwhr of thermal power was generated, bringing the total thermal power generation by the HRT to approximately 2000 Mwhr. In shutting down the reactor, the equipment was rinsed for 24 hr with condensate in preparation for the core-tank inspection.

The period from July 7 through July 18 was spent in attempting to make a satisfactory examination of the reactor core tank and the interior of the pressure vessel. Difficulties were experienced with lighting, with manipulation of the special periscopes which were designed to permit inspection of the entire periphery of the core tank in the region where the leak occurred, and with control of radioactive contamination. Although detailed observations were made of parts of the interior and exterior of the core tank, it was not possible to identify the region of failure. Accumulations of solids were found in the core at the junction between the diffuser screens and the wall. There was nothing unusual in the appearance of the metal surfaces or the welds that could be observed.

Maintenance activities during the shutdown included piping revisions to the steam system, replacement of the fuel sampler, installation of core corrosion samples and blanket metallurgical samples, and changes in the control circuitry to provide additional interlock protection when operating with fuel in the blanket system. The east fuel-feed-pump drive line had shown mild radioactivity (1—2 mr/hr) during the last two weeks of run 16. After shutdown, the line was tested hydrostatically at 2000 psi for 6 hr without signs of leakage. However, a gamma-ray scan of liquid withdrawn from the drive leg indicated the presence of fission-gas decay products, so it was decided to replace the pump head. This was accomplished by remotely operated tools, with the shield flooded to lower the radiation level (2000 r/hr) to working tolerance. Preparations are now being made for run 17. (AEC Activity 4103.3)

HRT Chemical Pilot Plant. — One hundred grams of corrosion-product solids was removed from the HRT in the 117-hr subcritical run reported last month. In the subsequent 300-hr power run, only 100 g, analyzing 90% stainless steel corrosion products and 10% ZrO_2, was removed. This is about 10% of the stainless steel corrosion products estimated to have been formed during the run. Analytical results from the third operating period of 340 hr, in which the total accumulated reactor power reached 1235 Mwhr, are incomplete.

The holdup of fission gases on the charcoal adsorber beds was more than adequate to allow for decay of all gases except 10.3-year Kr^{85}. The temperature rise in the beds was less than expected. (AEC Activity 4103.1)

Fuel Processing. — Samples taken from the blanket region of the HRT during the third power run contained more fission-product iodine activity than did samples from the core region. This possibly reflects the slower processing rate of the blanket as compared with the core, but quantitative statements of the amount of iodine held in solution in the reactor cannot be made until further analysis of data accumulated during the run.

Efforts to remove nickel from solutions simulating those in the outer dump tanks of the HRT (0.24 m UO_2SO_4, 0.12 m H_2SO_4, 0.18 m $NiSO_4$, 0.18 m $CuSO_4$) with organic cation exchange resins were not successful; the use of silica gel, with a surface-charge-reversal technique employed, also failed. Electrolysis of such solutions in D_2O resulted in larger amounts of nickel being removed than when H_2O was used under the same conditions of electrolysis; quantitative data are not yet available. (AEC Activity 4103.1)

Gaseous-Fission-Product Disposal. — A study to determine the effect of krypton partial pressure in an oxygen stream on the efficiency of activated charcoal for fission-gas adsorption was completed. Little effect of krypton pressure could be observed below 25 mm when the range from 0 to 760 mm was examined. At 1 atm the dynamic adsorption coefficient (k, cc/g) was 51% of that observed when the oxygen sweep gas contained only traces of krypton.

When hydrogen was used as the sweep gas carrying trace levels of Kr^{85}, the dynamic adsorption coefficient, k, was twice as large as when air, oxygen, nitrogen, or argon was used; from helium the coefficient was 50% greater than from hydrogen.

Equilibrium adsorption isotherms were determined for krypton on two varieties of Linde molecular sieves and on one variety of silica gel over the pressure range 0.04 to 0.6 mm at 28°C. At 0.1 mm krypton pressure the adsorption was 0.0062, 0.0043, and 0.0026 mg of krypton per gram of adsorbent, respectively, on Linde molecular sieve 5A, Linde molecular sieve 10X, and silica gel 35. (AEC Activity 4103.1)

Thorium Oxide Slurry Development. — A total of 1600 lb of 1600°C fired thorium oxide was classified for slurry use. Of this, 800 lb was refired at 650°C to remove the oxalic acid dispersing agent, and 420 lb was shipped to engineering test facilities.

In oxide preparation studies, the thorium oxalate precipitate was successfully dewatered and washed in a centrifuge. Uranium was completely adsorbed on a 650°C fired thoria suspended in ammonium uranyl carbonate solution by steam-distilling the suspension. From an alkaline peroxide solution of uranium and from uranyl nitrate, acetate, and formate solutions, uranium was only partially adsorbed.

The yield stresses of slurries (density = 2 g/cc) of "yeast cake" shaped thoria particles, averaging 1.8 to 4.3 μ, were nearly the same as those of similar slurries of standard pilot-plant oxide. No marked differences were noted in the infrared spectra, average particle sizes, x-ray crystallite sizes, or surface areas of undigested and 24-hr-digested samples of thorium oxalate precipitated at room temperature after drying them at either room temperature or 110°C.

Flame calcination of a methyl alcohol suspension of thoria in a zirconia-reflected oxyacetylene flame rounded the thoria particles.

In agreement with previous results, a slurry of 1000°C fired thorium-uranium oxide (U/Th = 0.05) containing no recombination catalyst showed essentially no radiolytic-gas pressure at 280°C under irradiation in the LITR. In out-of-pile studies with slurries of a similar mixed oxide containing 0.001 to 0.3 m MoO_3, treatment with hydrogen at 270°C resulted in catalytically active slurries. Some anomalies appeared, however, in that the apparent order of the reaction with respect to hydrogen pressure changed from first to one-half order with increasing temperature, and slurries of the same oxide containing no catalyst and treated with hydrogen also showed a high catalytic activity, which decreased with increasing slurry temperature and time. (AEC Activity 4103.1)

Mathematics and Computation: Homogeneous Reactor Development. — Kinetic equations pertaining to two-region reactor operation were programed; the two regions can be either separate or connected. A code was written with which the reactivity effects associated with slurry settling in finite, bare cylindrical reactors can be calculated. A two-group model is used which includes resonance capture by fuel and fertile material, and resonance fission by fuel. A general heat transfer code was prepared with which the temperature distributions in three-dimensional geometry can be calculated. Up to 999 space points can be considered. (AEC Activity 4103.1)

Reactor Analysis. — The variation of the inlet and outlet temperatures in the two-region HRT was calculated as a function of power level. The reactor was divided into regions, with the average temperature in each region varying in accordance with the fluid-flow rate and energy-generation rate in that region. Two-dimensional, two-group calculations were used. It was found that the critical temperature was nearly equal to the arithmetic average of the core-inlet and -outlet temperatures for powers up to 5 Mw.

An analysis of the stresses which were present in the HRT core vessel indicates that vessel failure could be predicted only if a defect were present which caused serious concentration of stresses.

The nuclear characteristics of the HRT having various concentrations of fuel in the blanket region were calculated. With the blanket fuel concentration about half the core fuel concentration, 50% of the power is generated in the blanket region, and the power density at the core wall is 8 kw/liter when the total power is 5 Mw. Under these circumstances, addition of corrosion samples to the core region requires an increase in the core fuel concentration of about 8.5%.

A survey was made of the nuclear characteristics of small one-region ThO_2-water reactors fueled with U^{235}. Reactor diameters up to 5 ft were considered. For the D_2O reactors, a minimum in the U^{235}/Th ratio occurred when the thorium concentration was about 200 g/liter. For H_2O reactors, this minimum occurred when the thorium concentration was greater than 600 g/liter. (AEC Activity 4103.1)

Homogeneous Reactor Instrumentation. — The gamma flux at several locations inside the HRT containment tank was measured during the initial reactor power operation by high-level gamma-sensitive ionization chambers especially designed for this purpose. This information is needed to evaluate the effectiveness of the shielding and to assess the rate of radiation damage to components.

A transistorized electropneumatic converter was developed which provides a more reliable instrument for critical control loops by the elimination of vacuum tubes. The instrument converts a low-level millivolt a-c output signal from such devices as differential transformers, inductance bridges, and strain gages to a 3- to 15-psi proportional pneumatic signal. The power requirement of the instrument is 250 ma at 48 v dc.

Three-ply prototype titanium bellows specified for 2500-psi, 300°C uranyl sulfate service were successfully formed by the manufacturer but were not satisfactory upon life-testing at ORNL. A new design with thicker plies and of double length is now being fabricated. (AEC Activity 4103.1)

HRP Design. — Major emphasis is being placed on a vessel with a concentric inlet-outlet core tank. A preliminary investigation of the heat transfer through the core wall is being made. Cooling of the core wall by use of a shroud to channel the inlet blanket flow around the core is under consideration. A study is being made of the heat generation in the existing HRT reactor-vessel wall during operation.

So that a metallurgical sample of the existing HRT reactor core can be obtained, a tool was designed for cutting a piece from the top diffuser plate.

The layout design of HRE-4, a 1- to 5-Mw single-region slurry reactor, has been initiated. A preliminary flowsheet has been prepared and is being used to determine some of the problems which will be associated with the reactor design and with installation in Building 7503 at ORNL. (AEC Activity 4103.1)

HRP Metallurgy. — The inert-gas welding procedures developed for titanium (Adamson and Leonard, Welding J. 37, No. 7, 673, 1958) have now been successfully adapted to Zircaloy-2. With only conventional welding equipment, it is possible to make Zircaloy-2 welds that have a quality equal to those made in an inert-atmosphere box. The quality of the welds has been confirmed by mechanical-property, corrosion, and microhardness tests. Although these procedures have been proved, it is not recommended that, at present, they be used on applications as critical as a Zircaloy core tank, since there is a greater opportunity for the welder to inadvertently contaminate local areas. Present inspection methods will not reveal this type of quality failure; however, work in developing nondestructive tests that will reveal weld contamination has been started and, if successful, will allow these welding procedures to be used for all Zircaloy-2 applications.

It has been shown previously that the hardening transformation in the Zr—15% Nb alloys can be delayed long enough to permit multipass welding by the addition of 2 to 5% of either molybdenum or palladium. It has now been shown that with the addition of 3% of vanadium, or an increase in the niobium content of the binary alloy to 20%, similar delays are achieved. Impact tests of binary zirconium-niobium alloys have revealed an apparent transition region near room temperature. The transition occurs at slightly higher temperatures in a 15% Nb alloy than in a 20% alloy. (AEC Activity 4103.1)

HRP Radiation Damage. — The combined effects of fast-neutron dose and irradiation temperature on the notch-impact transition temperature have been investigated in a number of pressure-vessel steels. Irradiation temperatures used were approximately 200°F and the range between 440 and 600°F. Significant

annealing during irradiation required temperatures of the order of 550°F and higher. The amount of annealing was extremely sensitive to irradiation temperature; a difference of 20°F (e.g., between 550 and 570°F) resulted in an appreciable difference in damage. The effect of a given irradiation temperature varied somewhat in different steels.

The shift in transition temperature caused by irradiation was almost linear with neutron dose up to 2×10^{19} fast neutrons/cm^2. The extreme sensitivity to neutron dose and irradiation temperature in the above studies emphasizes the need for accurate calculation of service fluxes and temperatures in reactor design if the radiation effects are to be accurately evaluated. (AEC Activity 4103.1)

Laboratory Corrosion Studies. — The pre-exposure of stress specimens of type 347 stainless steel in chloride-free uranyl sulfate solution at 100, 125, 150, 175, and 200°C has been 100% effective in preventing cracking in a similar boiling environment containing 50 ppm of chloride. In the absence of the pretreatment, 55% of the specimens cracked when tested in the chloride-containing solution.

The corrosion resistance of Nionel was found to be nearly equal to that of type 347 stainless steel in uranyl sulfate solutions at 100, 200, and 300°C. Of special interest was its immunity to stress-corrosion cracking in boiling uranyl sulfate solution containing 50 ppm of chloride.

Annealed type 202 stainless steel exhibited good corrosion resistance in a number of reactor-related environments. However, when the alloy was sensitized by heating at 1200°F, its corrosion resistance was appreciably lowered. (AEC Activity 4103.1)

Dynamic Solution Loop Corrosion Tests. — Small amounts of ruthenium added either as the nitroso sulfate or as the chloride greatly accelerated the formation of hexavalent chromium in dilute uranyl sulfate solutions at 200 to 250°C in out-of-pile stainless steel loops. Corrosion of stainless steel exposed to such solutions was markedly inhibited, presumably by the chromium(VI). At least 90% of the ruthenium precipitated within 24 hr as a mixture of the metal and the dioxide, and the deposited mixture could not be flushed from the loop. In subsequent runs without added ruthenium the effect persisted. Evidently the precipitated ruthenium was able to accelerate the formation of chromium(VI). Tests will be necessary to determine whether ruthenium can accelerate the formation of chromium(VI) to the extent that a residual concentration of chromium(VI) can be maintained in the radiation field, thereby inhibiting corrosion of stainless steel under in-pile conditions.

Additional solution stability studies have been made with 0.04 m alkali and alkaline-earth metal sulfates added to 0.04 m UO_2SO_4 containing 0.025 m D_2SO_4 and 0.03 m $CuSO_4$ in heavy water at 300°C. The solutions containing

lithium, sodium, or rubidium sulfate were unstable, the precipitate containing mostly copper. The solutions containing magnesium sulfate or beryllium sulfate were stable, but the latter caused excessive corrosion of stainless steel. Therefore magnesium sulfate was the only additive showing promise. In further tests the corrosion of stainless steel was inhibited by the magnesium-containing solution, and nickel above a concentration of about 400 ppm precipitated from the solution at 300°C. The precipitation of nickel from solution would be important from the standpoint of removing a neutron poison from the reactor fuel. (AEC Activity 4103.1)

Small-Scale Dynamic Slurry Corrosion Tests. — Effects of particle size, slurry velocity, and thoria calcination temperature on the corrosion of several metals were examined in toroid tests with slurries of thoria microspheres. The tests were made at 280°C with slurries which contained 1500 g of Th per kg of H_2O. Results, expressed as multiplicative factors relative to an attack rate of 11 mils/year (the rate for type 347 stainless steel pins with a slurry prepared from <3-μ spheres calcined at 1000°C, circulated at 26 fps), are tabulated below.

Particle size: <3 μ, 1; 3—10 μ, 2.2; 10—25 μ, 0.4; >25 μ, 0.1
Calcination temperature: 1000°C, 1; 1200°C, 1.4; 1400°C, 3; 1600°C, 6
Circulation velocity: 26 fps, 1; 10 fps, 0.14
Specimen material: 347 SS pins, 1; Zircaloy-3A pins, 0.2; Ti-75A pins, 0.3; SA-212-B steel pins, 3; 347 SS toroid (flow pattern different from that of pins), 0.3

The effect of molybdenum trioxide additive on corrosion of metals under oxygen and hydrogen atmospheres was studied in tests at 280°C in which slurries of 1.7-μ thoria, calcined at 1600°C and classified, in the concentration 1500 g of Th per kg of H_2O were circulated at 26 fps. Under oxygen atmosphere with no additive the corrosion rate of type 347 stainless steel pin specimens was 12 mils/year. Inclusion of 0.03 m MoO_3 resulted in an increase in the attack-rate average of all metals by a factor of 1.5. Operation under a hydrogen atmosphere resulted in average attack rates two times greater than those observed under oxygen atmosphere. Attack rates on pin specimens of other metals relative to the attack of type 347 stainless steel pin specimens were as follows: Zircaloy-3A, 0.01; Ti-75A, 0.3; SA-212-B mild steel, 1.0; 347 SS toroid, 0.02.

In two toroid tests for examining the corrosion-erosion characteristics of circulating aqueous slurries of thoria micropulverized after calcination at 1600°C, unclassified (1.7-μ) and classified (1.6-μ) thoria slurries were circulated at 280°C under oxygen atmospheres at 26 fps, at a concentration of 1500 g of Th per kg of H_2O. The attack rate of type 347 stainless steel pin specimens with the unclassified thoria was estimated to be 11 mils/year. Attack by classified thoria averaged one-half the attack by the unclassified thoria preparation. (AEC Activity 4103.1)

Dynamic Slurry Loop Corrosion Tests. — Six loop tests were completed at 280°C with oxygenated slurries of thoria (calcined at 1400 to 1600°C) as part of a series of tests to determine the effects of particle size and velocity on the attack on constructional materials. In one test, thoria of 1.2-μ average particle size was circulated at an average concentration of 1010 g of Th per kg of H_2O for 1550 hr. The average attack rate for the entire austenitic stainless steel circulating system was 1 mil/year. Average rates of attack on pin-type corrosion specimens exposed to slurry having velocities of 20 and 40 fps, respectively, were 2 and 19 mils/year for austenitic and martensitic stainless steels, 0.7 and 4 mils/year for titanium alloys, and 0.0 and 0.7 mil/year for Zircaloy-2. Increased attack at the higher velocity was due principally to erosion.

Approximately the same rates of attack were observed in a similar test of 1003 hr duration in which thoria having an initial mean particle size of 1.7 μ was circulated at a concentration of 1450 g of Th per kg of H_2O. The thoria was degraded to an average size of 1.4 μ during the test. When the degraded thoria was circulated at a concentration of 1210 g of Th per kg of H_2O in a subsequent 579-hr test, the average attack rates were approximately eightfold lower. A Zircaloy-2 impeller used during the run lost only 2.5 g.

Thoria with a mean particle size of 0.9 μ was circulated at concentrations of 800 to 1150 g of Th per kg of H_2O in three tests. Attack rates for austenitic stainless steels and titanium and zirconium alloys were about the same as those obtained in previous comparable tests with slurries of 1.2- to 1.7-μ thoria. Unlike preparations of larger particle size, the slurry of 0.9-μ thoria formed heavy sludges while being circulated in the test loops. (AEC Activity 4103.1)

In-Pile Autoclave Solution Corrosion Studies. — A Zircaloy-2 autoclave containing D_2O with an oxygen overpressure was exposed at 280°C for 670 hr of irradiation (1040 hr total time) in facility HB-5 of the LITR to a thermal-neutron flux which ranged (along the axis of the autoclave) from about 0.4×10^{13} to 1.2×10^{13} neutrons·cm^{-2}·sec^{-1}. Six Zircaloy-2 specimens were contained in the autoclave. The one at the highest flux position showed a weight gain which corresponds to an average corrosion rate of 0.8 mil/year, if the weight increase was assumed to be due to oxidation and retention of the oxide on the specimen. The other five specimens showed weight losses which decreased with decreasing flux and which correspond to corrosion rates of from 0.4 to 0.1 mil/year. Oxygen consumption occurred linearly with radiation time at a rate corresponding to a corrosion rate of 0.4 mil/year.

In another experiment in the same LITR facility, a Zircaloy-2 autoclave containing 0.17 m UO_2SO_4, 0.02% U^{235}, in H_2O solution with an oxygen overpressure was exposed at 280°C for 1094 hr of irradiation (1512 hr total time). As with the D_2O experiment, the change in oxygen pressure occurred linearly with time at a rate corresponding to an average corrosion rate of 0.4 mil/year.

However, all the specimens in this experiment gained weight, and the amount of weight gain for each specimen was more than expected if all Zircaloy-2 surfaces within the autoclave corroded at the average rate indicated by the oxygen data and if no transfer of oxide took place within the autoclave. There was no apparent relationship between flux and scale deposited.

In comparison with data for the out-of-pile corrosion of Zircaloy-2, the results of oxygen measurements in these two experiments indicate an increase in the rate of corrosion due to the radiation, and the same increase for the oxygenated D_2O as for the solution of depleted UO_2SO_4. The specimen results indicate that the oxide behaves differently with respect to adherence and transfer in the two different media. (AEC Activity 4103.1)

HRP Service Corrosion. — Following HRT runs 13 and 14, several metallic specimens and samples of scale accumulations were removed from the high-pressure system for examination. Although examination and analyses of these specimens are incomplete, some of the results are available and can be reported.

The type 347 stainless steel coupon from line 103 (downstream from the circulating pump), which was examined after run 13, exhibited a weight loss which corresponds to an average corrosion penetration of 0.06 mil. The weight loss for the similarly located type 309 SCb stainless steel coupon corresponds to an average penetration of 0.23 mil. In comparison, an average penetration of about 0.5 mil would be expected if uniform attack on all the steel surfaces in the high-pressure system had contributed to the buildup of nickel in the fuel solution. The only other steel surface of the high-pressure system examined after this run, that of the core access flange, showed evidence of surface roughening, which is indicative of some corrosion attack.

After run 14 the type 347 stainless steel specimen which had been attached to the core access flange was examined. Corrosion of the specimen during the run was negligible.

The results of scale weight measurements on line 103 coupons and of visual examination after run 13 showed only about 20% or less of the amount expected on these surfaces if the scale estimated to have been formed during the run was distributed uniformly over the steel surfaces in the high-pressure system.

A large amount of scale (~12 mg/cm^2) was deposited on the core access flange and specimen assembly after run 14. This evidence, together with evidence of negligible change in weight of the stainless steel specimen during the run, indicates that appreciable quantities of oxide were transported through the solution during the run. Presumably this oxide was from the extensive corrosion of stainless steel which occurred in run 13, a large, though quantitatively indeterminate, amount of which was observed in the core vessel at the conclusion of that run. (AEC Activity 4103.1)

CIVILIAN-POWER ADVANCED GAS-COOLED REACTOR

Gas-Cooled Reactor: Design Studies. — A review was made of the design study of a "pebble-bed" reactor and steam power plant prepared by the staffs of Sanderson and Porter Engineers and Alco Products, Inc., for the Division of Reactor Development of the U. S. Atomic Energy Commission. The reactor is a two-region thermal breeder in which all the core structural materials are graphite. The fuel is in the form of unclad spherical elements of graphite containing fissile and fertile material (uranium and thorium), and the blanket elements are graphite spheres containing fertile material only. The reactor coolant is helium. It was concluded that the pebble-bed reactor shows promise of being competitive with the other gas-cooled reactors in the nuclear-power market if it can be established that the fuel will have an adequate lifetime under the radiation conditions specified (Sanderson and Porter report S&P 1963) and that coolant contamination can be controlled in a manner which will permit economic maintenance of the system by either direct or remote methods. The proposed reactor can operate either as a U^{233} breeder or a U^{235} burner. The study indicated a conversion ratio of 0.863 with U^{233}, but the calculations were based on conservative estimates of some nuclear constants, and it is thought that conversion ratios exceeding unity might be achieved. (AEC Activity 4110)

Gas-Cooled Reactor: Radiation Effects. — Analyses were made of the fission-gas samples taken from the capsule in which specimens of 15% enriched UO_2 were irradiated in the LITR to a burnup of 6000 megawatt-days per metric ton. The following fission products were identified: Xe^{133}, Xe^{135}, I^{131}, I^{132}, and Kr^{85}. A preliminary estimate indicates that 0.7% of the total Xe^{133} produced was evolved.

Two additional irradiation experiments were initiated. Miniature UO_2 pellets are being irradiated in the LITR in a double capsule at a maximum surface temperature of 1930°F and a minimum surface temperature of 1630°F, and full-size UO_2 pellets are being irradiated under stress at a maximum surface temperature of 1000°F, which is to be increased to 1500°F. (AEC Activity 4110)

Gas-Cooled Reactor: Metallurgy. — A specimen of fuel capsule tubing without fuel inserts that was tested with an external pressure of 300 psi at 1300°F for 1500 hr did not collapse. Slight deformation indicated, however, that collapse was imminent. Buckling of 0.020-in.-wall tube specimens with 20- and 10-mil diametral clearances between tube wall and slugs occurred in tests at 1500°F with an external pressure of 300 psi. Uniform collapse of specimens with a diametral clearance of 5 mils was noted, however. Additional specimens with clearances of 6, 7, 8, and 9 mils were therefore tested under the same conditions. No wrinkling was observed, but only the specimen with a 6-mil diametral clearance showed uniform collapse. The other specimens were somewhat eccentric after collapse, with final diameters varying up to 12 mils.

Batch and continuous processes are being investigated for converting UF_6 to the UO_2 powder required for fabricating GCR fuel slugs. Three 2-kg batches of oxide were made that were satisfactory with respect to fabricability, sinterability, and reproducibility. The continuous process, which will be preferable from the standpoints of cost, quantity, and time, is not so far advanced as the batch process, but the development work is proceeding satisfactorily. It appears that a continuous process is feasible. (AEC Activity 4110)

Gas-Cooled Reactor: Materials Compatibility Tests. — The program of tests of the compatibility of graphite and various metals of interest for fuel element cladding in a helium atmosphere was continued. Metallographic examinations showed samples of stainless steel, columbium, and molybdenum to be virtually unaffected by exposure to static helium for 1000 hr at 1400°F in the presence of TSF or AGOT graphite. Even surfaces in contact with the graphite were unaffected. Low-alloy steels exposed in the same tests showed slight attack, and the zirconium and zirconium-alloy specimens included in these tests were grossly attacked.

Metallographic examinations of specimens from similar 1000-hr tests at 1400°F in which the helium was circulated by natural convection showed substantial differences in the effects of the two grades of graphite, TSF and AGOT. Specimens of types 410, 304, 316, and 347 stainless steels exposed near the top of the hot leg of the apparatus showed no attack. Samples of type 310 stainless steel were attacked, however, to a depth of 1.5 mils in the test system containing TSF graphite and 5 mils in the test system containing AGOT graphite, and showed considerably higher weight gains than the 18-8 stainless steel samples. Specimens of low-alloy steel were unaffected in the test system containing TSF graphite but were attacked to a depth of 2 to 3 mils in the test system containing AGOT graphite.

A static helium test system containing stainless steels, low-carbon steel, TSF graphite, and beryllium samples was shut down after approximately 12 hr of operation at 1400°F because of a leak in the gas manifold. Visual examination of the beryllium samples revealed large quantities of scale tentatively identified as beryllium carbide. (AEC Activity 4110)

Gas-Cooled Reactor: Physics. — Studies are being made of the Th-U^{233} breeding cycle. Conditions were established under which a fixed-fuel reactor system may be expected to increase the available inventory of U^{233} at a rate commensurate with increasing demand for nuclear power from thorium. Calculations of specific reactor systems are under way with the use of the General Motors GNU multigroup program. Multigroup absorption cross sections were developed for thorium at various concentrations in a graphite moderator (carbon-to-thorium atomic ratios in the range 20 to 150). These are consistent with a dilute resonance integral of thorium (including the 1/v part) that is equal to 99 barns. Multigroup cross sections were developed for U^{233}, which are based on recent measurements of $\eta(E)$, $\sigma_a(E)$, and $\sigma_f(E)$ at the MTR. The results

indicate a rather severe penalty in reduced η for reactors with an intermediate spectrum: 10 to 50% thermal, for example. An attempt was made also to develop multigroup cross sections for Pa^{233} consistent with the very limited information available on this isotope.

A few calculations were made for reactors having a fissile core, a graphite buffer region, and a fertile blanket. The results indicate a weak dependence of k on the concentration of U^{233} in the core and a considerable effect of the buffer region on the neutron leakage from the core. The results for $\bar{\eta}(U^{233})$ as a function of U^{233} concentration, which are nearly independent of the core dimensions, are given in the following table:

Ratio of Atoms of Carbon to Atoms of U^{233}	Thermal Absorptions as Percentage of Total Absorption	$\bar{\eta}(U^{233})$
500	14	2.03
1000	27	2.08
2000	46	2.14

These results indicate the need to keep the spectrum as nearly thermal as possible. (AEC Activity 4110)

GENERAL REACTOR RESEARCH

Radiation Detector Development. — The $Li^6(n,\alpha)H^3$ cross section was measured in the neutron energy interval 1.7 to 4.2 Mev. The cross section was measured relative to the known U^{238} fission cross section; the $Li^6(n,\alpha)$ events were detected in an $Li^6I(Eu)$ scintillation crystal. The data from two separate experiments, in which different geometries and different crystals were used, were in good agreement. A preliminary analysis in terms of absolute cross section indicates satisfactory agreement with previous measurements at other laboratories. (AEC Activity 4202)

Reactor Safety Studies. — Construction of the tank which will be used to study the effects of voids in reflectors was completed, and the assembly was leak-tested. Other preparations for the void experiments were essentially completed. Additional theoretical work was carried out in an attempt to calculate the effect on reactivity of voiding the entire face of a reactor. In one calculation, a zero return current at the voided boundary was assumed. In a second calculation, a finite return current calculated by use of an albedo concept was assumed. Two-group diffusion theory was used throughout. Preliminary results seem reasonable in spite of the numerous approximations made. (AEC Activity 4252)

Waste Treatment. — Methanol and formaldehyde are being studied as reagents for the destruction of nitrate in acidic wastes. In early tests with methanol, 47% of the nitric acid in a simulated Darex waste solution was destroyed in 5.5 hr at 100°C. In 7 hr at 95°C, formaldehyde destroyed >99% of the nitric acid.

In evaporation and calcination studies of simulated Sulfex coating wastes, the fission-product activity evolved during evaporation was about the same as with Darex waste except that the level of cerium in the condensate was greater by a factor of 10. The cake obtained when neutralized Sulfex waste was dried and calcined at 700°C had a bulk density of 2 g/cc and was soluble in cold water.

Three ion exchange resins — Duolite A-40, Dowex 1, and Dowex 21-K — show promise for the removal of plutonium from acidic Purex wastes. The volumetric distribution coefficients were 47, 33, and 45, respectively.

In studies on maritime reactor waste disposal, a mixed-bed ion exchange demineralizer was loaded with tracer fission and corrosion products and eluted with sea water. Elution by 130 bed volumes of sea water removed essentially all the iodine and ~40% each of the chromium and ruthenium.

Economic considerations and expected problems of remote operation and maintenance indicated that a cell for cathodic reduction of nitrate, with simultaneous plating-out of ruthenium, is a more attractive method for treating neutralized ORNL waste than either conversion of the waste to nitric acid and caustic in an electrodialysis cell or a two-step process in which electroplating of ruthenium is followed by electrodialysis. (AEC Activity 4352)

Long-Range Planning Studies. — A survey was made of the pertinent work on the transport of gases through liquid-gas mixtures, and the results were interpreted in terms of the average power density obtainable from boiling homogeneous reactors. For systems in which there is no net flow of liquid, the power density is about proportional to the ratio of vapor to liquid in the reactor and inversely proportional to the reactor height. For a reactor 5 ft in height and operating at a pressure of 500 psi, the calculated average power density is 6 kw/liter if the reactor fluid contains 30% vapor. (AEC Activity 4510)

Reactor Operations. — The ORR was turned over to the Operations Division on July 1. After a shutdown to fill the beam hole plugs with concrete and to complete piping at the large facilities and other necessary work, the reactor began routine operation on July 19. Several experiments and four isotope stringers are already in the reactor. Corrosion of aluminum pipe buried in the concrete has been observed, and a program is under way to investigate this.

The specifications for enriched fuel elements for the Graphite Reactor were completed. The stored energy annealing procedure was tested recently, and the results were promising.

PHYSICS

Neutron Velocity Selector. — The total cross section of Np^{237} was measured over the energy range from ~2 to 40 ev with the M1 chopper installed at the LITR. Transmission measurements were made on two sample thicknesses of Np^{237} (2.187×10^{21} and 12.300×10^{21} atoms/cm^2) which were prepared and filled by the Chemistry Division. Eighteen resonances were observed below 20 ev, leading to an average level spacing of ~2 ev per spin state. Parameters are being determined for these resonances. (AEC Activity 5220)

High-Voltage Experimental Program. — A program for calculating and printing tables for the transformation of angular distribution data from the laboratory system to the center-of-mass system has been written and is being run on the Oracle. The tables include values of the center-of-mass angle and its cosine, the ratio of center-of-mass to laboratory solid-angle elements, and the energy (in the laboratory system) of any of the reaction products. These quantities are tabulated in terms of two parameters: the laboratory angle and the ratio of the velocity of the center of mass to the velocity of the reaction product in the center-of-mass system. For a given reaction the latter parameter is a simple function of the masses, the bombarding energy, and the energy release of the reaction. The tables will find wide application in nuclear spectroscopy and will be especially useful at ORNL in conjunction with the new reaction-product analyzing magnet.

Excited states of Sn^{117} were studied by using 7-, 8-, 9-, and 10-Mev alpha particles to produce Coulomb excitation. The target was prepared by the electrodeposition of tin enriched in Sn^{117} to 83.8%. Gamma rays of 160, 862, and 1013 kev were observed. Further measurements showed that the 862- and 160-kev gamma rays were in coincidence. The variation in yield of the 862- and 1013-kev gamma rays with change in alpha-particle energy is consistent with the excitation of a state at 1013 kev. However, the yield of the 160-kev gamma ray increased too slowly to result solely from the cascade de-excitation of a state at 1013 kev. It is therefore concluded that two states at 1013 and 160 kev are Coulomb-excited in Sn^{117}. The B(E2)'s for excitation are $(4.3 \pm 1.0) \times 10^{-52}$ cm^4 for the 160-kev state and $(1.55 \pm 0.20) \times 10^{-49}$ cm^4 for the 1013-kev state. (AEC Activity 5220)

Neutron Diffraction. — Neutron diffraction experiments were performed on anhydrous $FeBr_2$, $CoBr_2$, $FeCl_2$, and $CoCl_2$ at temperatures from 295 to 4.2°K to investigate the existence of magnetic ordering in these haxagonal layer-type structures. All four compounds have an antiferromagnetic transition at low temperatures to structures in which the atomic magnetic moments within a metal layer form ferromagnetic sheets and the moments in adjacent layers are antiparallel. In the iron compounds the moments are oriented parallel to the hexagonal c-axis, and in the cobalt compounds the moment orientation is perpendicular to that axis. Values of the atomic magnetic moments are close to those expected for the divalent metallic ions if the orbital contribution is quenched. Small-angle scattering experiments on $FeCl_2$ and $CoCl_2$ showed that the ferromagnetic coupling between moments within a layer is much stronger than the antiferromagnetic coupling between atoms in adjacent layers, and single-crystal investigations on these two compounds indicated the method by which large net magnetization values are obtained at temperatures below T_n in moderate magnetic fields. (AEC Activity 5220)

CHEMISTRY

Raw Materials Research and Development. — The extractability of Pu(IV) by amines in hydrocarbon solution was found to depend strongly on amine class and branching, as is shown in the following table. Extraction by tertiary amines from nitric acid solution and by primary amines from sulfuric acid solution gave high values of the extraction coefficient, E_a^o.

	E_a^o Pu(IV)	
	2 M HNO_3 0.3 M amine	3 M H_2SO_4 0.1 M amine
Primene JM-T	0.02	7000
Ditridecylamine		1
Bis(1-isobutyl-3,5-trimethyl-hexyl)amine	0.4	0.03
Triisooctylamine	500	<0.001

Zirconium separation from hafnium by distribution between an aqueous nitrate solution and a hydrocarbon solution of a neutral organophosphorus compound increased with increasing zirconium-hafnium nitrate concentration up to 30 g/liter, and with increasing acid concentration to a maximum at ~5 M HNO_3. Separation factors $E_a^o(Zr)/E_a^o(Hf)$ reached ~25 with tri-n-octyl- and tri(2-ethylhexyl)-phosphine oxide and 35 with diamyl amylphosphonate.

In continued study of the fundamental chemistry of organophosphorus extractants (ORNL-2471), isopiestic measurements established that solutions of tri-n-octylphosphine oxide (R_3PO) in n-octane deviate significantly from Raoult's law even at concentrations below 0.05 M. On the continued assumption

that the triphenylmethane reference solutions obey Raoult's law, estimated activity coefficients are 0.88, 0.79, and 0.72 for 0.05, 0.10, and 0.15 M R_3PO, respectively. These activity coefficients lead to a small correction of the phosphine oxide—dialkylphosphoric acid association previously reported (ORNL-2471), and are important in the characterization of high-purity phosphine oxide through colligative properties. Although such deviations are frequently attributed to intermolecular association by dipole-dipole interaction, dielectric constant measurements showed the polarization of these solutions to be a linear function of the phosphine oxide concentrations, ruling out appreciable association. (AEC Activity 5310)

Chemical Engineering Research. — A gas-fired resonant steam pulser was operated successfully. A 2-in. sieve plate column 20 ft long was pulsed at a frequency of 50 cpm and an amplitude of 2 in. (AEC Activity 5310)

Chemistry of Corrosion. — The effect of chloride and thiocyanate ions upon the kinetics of reduction of copper(II) ions at a passive stainless steel electrode is being studied by the potentiostatic technique. The added anions increase the rate of the cathodic process significantly. With thiocyanate ions the reduction rate remains first order with respect to the copper species being reduced so long as a constant ratio of copper and thiocyanate ion concentrations is maintained. When the ratio is varied, the results give no simple kinetic order with respect to the thiocyanate ion concentration. (AEC Activity 5330)

Physical Chemistry of Ion Exchangers. — Calorimetric measurements of the heats of exchange in the bromide-fluoride system with Dowex 2 resin of nominal 1/2, 2, 4, and 10% divinylbenzene content were completed. The standard heats of exchange ranged from -2800 cal/mole with the 1/2% resin to -3500 cal/mole with the 10% resin, as compared with an average molar heat of -1350 cal for the bromide-chloride system and -2000 cal for the iodide-bromide system. The variation of the differential heat with mole fraction was also much larger in the bromide-fluoride system, ranging from -5000 cal/mole at $x_{Br} = 0$ to -1500 cal/mole at $x_{Br} = 1$ in the 4% resin. As has been the case with the other anion exchanger systems, there was no correlation between differences in the heats of dilution of the alkali bromides and fluorides and the observed heat of exchange values. (AEC Activity 5330)

Characterization of Short-Lived Fission Products. — The 8-min Ga^{74} was identified as a fission product of U^{235}. This is believed to be the first observation of mass 74 in the fission process. The gallium fraction was isolated by a combination of solvent extraction, anion exchange, and volatilization. Positive identification was based on the characteristic gamma-ray spectrum of Ga^{74} which had been observed earlier in this program from $Ge^{74}(n,p)$ and from decay studies. (AEC Activity 5330)

Nuclear Methods of Chemical Analysis. — Fast-neutron reactions have been studied for use in the determination of nickel and iron by activation analysis. The results of this study indicate that the $Ni^{58}(n,p)Co^{58}$ and the $Fe^{54}(n,p)Mn^{54}$ reactions can be used in the determination of nickel and iron in macro or micro concentrations in various types of sample material. Reactor neutron activation cross sections for these reactions were also determined. The cross sections obtained were 5.35 ± 0.32 millibarns for the $Ni^{58}(n,p)Co^{58}$ reaction and 3.55 ± 0.18 millibarns for the $Fe^{54}(n,p)Mn^{54}$ reaction.

Semiroutine analytical methods based on thermal-neutron activation have been developed for the determination of argon, xenon, and krypton in gas and liquid samples. Limits of measurement in the parts-per-billion range for each of these elements are possible by these methods. (AEC Activity 5330)

Chemical Separation of Isotopes. — A study was made of the temperature dependence of the single-stage separation factor for the Nitrox process. The N_2 samples were analyzed on the new ratio mass spectrometer. In dilute acid solutions the reaction may be represented by the following equation:

$$N^{15}O(g) + N^{14}O_3^- \rightleftharpoons N^{14}O(g) + N^{15}O_3^-$$

As the nitric acid concentration is increased, the complexity of both the gas and liquid phases increases and many equilibria are involved. The data are summarized in the following table:

Separation Factors

Molarity of HNO_3	25°C	40°C	55°C	70°C
1	1.064	1.057	1.032	1.023
3	1.063			1.013
7	1.058			1.016
10	1.048	1.032	1.018	1.010

(AEC Activity 5340)

METALLURGY

High-Temperature Reactions of Metals and Ceramics. — A study of the effect of radiation on the oxidation characteristics of niobium is in progress. Limited experimental results indicate that reactor radiation produces few changes in the early stages of the oxidation of niobium. Thus niobium specimens oxidized in purified oxygen for 2 hr at 400°C in the ORNL Graphite Reactor (neutron flux = 5×10^{11}) exhibited essentially the same surface topography (as revealed by electron optical examination) as similar specimens oxidized in the absence of radiation. No marked changes were observed in the oxidation rate of niobium as a result of this irradiation. (AEC Activity 5420)

BIOLOGY

Cytology and Genetics: Insects. -- Stern showed that in genetic mosaics the different phenotypic effects of certain mutations can be brought about by different responses of the genotypically different cells to the same unaltered general organization. This has been called the prepattern of the developing system; it was of great interest to know whether, besides genetically differing ones, tissues which differ in their developmental determination may react in the same way.

The development of a microsurgical method by which it was possible to combine different pieces of tissue in microscopic dimensions made it feasible to combine fore- and hindwing tissue of imaginal discs of *Ephestia* as well as wing tissue with that of the genital discs. The compound organs were subsequently implanted into the body cavity of a host, and their development was studied.

The first combination yielded 25 survivors out of 65 implants. In 12 of these the borderline between the fore- and hindwing tissues crossed the region of those sclerites that form a comparative-morphologic unit. In all these cases there were no intermediate structures formed, but each part developed in its gross morphology according to its situation on the implant but in its details according to the determinative state of the respective tissue.

The combination of the wing with genital-disc tissue did not lead to joint fields consisting of two types of tissues; each part of the joint implant developed morphogenetic fields of its own, exclusively on one type of tissue. However, the mounting of genital-disc tissue prevented the wing disc from regenerating another symmetric wing.

These results show that distinctly diverse structures may be brought about by an alteration of the competence of certain tissues to respond to the same prepattern. Since the failure to produce joint fields consisting of tissues as different as these from wing and genital discs may be due to incompatibilities between these tissues, it is possible that the diversity of structures all over the body is produced by the different response of tissues, which have become diversified during development, to one kind of prepattern. This type of developmental mechanism has been proved here for the more closely related organs such as fore- and hindwing.

The identical way in which mutated and differently determined tissues express their properties suggests that the determination process leads to changes in the genetic content of cells similar to some extent to those brought about by mutational events. (AEC Activity 6130)

Pathology and Physiology. -- Experiments were carried out to determine the toxicity of the radiomimetric nitrogen mustard CB 3025 in rats and to determine whether the injection of bone marrow would enable rats to recover from lethal doses of the agent. The $LD_{100}/30$ days of the drug for Sprague-Dawley rats and for rats of the C and D strains was 17.5 to 20 mg per kg of body weight. Thus far most animals injected with isologous bone marrow after administration of the drug have survived otherwise lethal doses of the compound. It would appear, therefore, that isologous bone marrow promotes recovery from the effects of this radiomimetic chemical in much the same way as it promotes recovery from radiation injury. Whether, however, homologous marrow would be similarly effective remains to be determined. (AEC Activity 6130)

Microbial Protection and Recovery. -- The catalase-negative cells of a porphyrin-requiring strain of *E. coli* H7 show two types of inactivation by ionizing irradiation. The first is a "prompt" inactivation, which can be demonstrated immediately after irradiation. The second is a delayed effect caused by radiation-produced hydrogen peroxide in the medium surrounding the cells. This postirradiation inactivation proceeds exponentially for several hours. The postirradiation effect is observed only in catalase-negative cells which have been irradiated but which have survived "prompt" inactivation. Unirradiated, catalase-negative cells are not so sensitive to hydrogen peroxide as are those which survive a dose of either ionizing or ultraviolet irradiation.

This radiation-induced sensitivity is being explored. It has been found that the sensitivity of unirradiated cells to irradiated buffer may be influenced by cultural conditions and the presence of trace amounts of contaminants present in the buffer during, but not after, irradiation. (AEC Activity 6230)

Mammalian Recovery. -- Foreign blood-forming cells taken from fetal animals proved to be superior to blood-forming cells taken from adult mice. Additional studies showed that blood-forming cells from newborn mice one day old were as effective as fetal cells. Material collected two to six days after birth was like adult tissue.

A change in the spleens of irradiated mice given rat bone marrow is thought to represent the immune reaction to the foreign tissue. After exposures of 2000 r and above, the reaction did not take place, suggesting that doses of this magnitude are required to destroy the immune mechanism.

When an animal's immune mechanism has been injured by irradiation, return of certain functions can be obtained by injecting normal compatible lymphatic tissue after exposure. Current studies suggest that any normal compatible tissue such as brain, liver, and kidney can also restore normal function after irradiation.

The rate of replacement of red blood cells after bone marrow treatment in the irradiated mouse is independent of the number of bone marrow cells injected.

With two different techniques the red blood cells of a rat were shown to have a life span of 62 days. This places their life span in the same general range as that of other species studied, including man. (AEC Activity 6230).

Radiation Immunology. -- Foreign bone marrow persists in normal non-irradiated C3H x 101 mice for one day. Following rat bone marrow treatment, alkaline phosphatase-positive staining cells were found in mouse spleen 2 days after 300 r, 3 days after 400 r, 4 days after 500 r, 5 days after 600 r, and, in the animals which survived, 10 days after 710 r. Following hamster bone marrow treatment, positive staining cells were found 5 days after 600 r, 6 days after 700 r, 8 days after 800 r, and, in animals which survived, 35 days after 950 r. Following guinea pig bone marrow treatment, positive cells were found 1 day after 950 r, 3 days after 1150 r, and 4 days after 1300 r. Following rabbit bone marrow treatment, positive cells were found 1 day after 1300 r, and 4 days after 1500 r.

Tests for rat and mouse serum proteins in the serum of heterologous (rat) chimeras were performed with specific mouse antirat serum and rat antimouse serum antisera. Interfacial tests on sera obtained at intervals of 12, 22, 34, 44, and 55 days after irradiation and rat bone marrow treatment were negative for rat proteins but positive for mouse-type proteins. Similar results were obtained in double serum-agar diffusion tests using mouse antirat globulin and rat antimouse globulin antisera on these samples. Sera obtained from heterologous chimeras immunized to sheep red blood cells were also tested for the presence of rat proteins and were found negative in both interfacial and agar diffusion tests. However, tests for rat protein were positive in sera from heterologous chimeras given a supralethal dose of x radiation. (AEC Activity 6230)

MISCELLANEOUS REPORTS

OPEN LITERATURE PUBLICATIONS

Allen, J. W., and R. B. Oliver, "Inspection of Small Diameter Tubing by Eddy Current Methods," Symposium on Nondestructive Tests in the Field of Nucl. Energy, ASTM, Spec. Tech. Pub. No. 223, 88 (1958)

Allen, J. W., R. A. Nance, and R. B. Oliver, "Eddy Current Measurement of Clad Thickness," Symposium on Nondestructive Tests in the Field of Nucl. Energy, ASTM, Spec. Tech. Pub. No. 223, 201 (1958)

Betterton, J. O., Jr., and W. K. Noyce, "The Equilibrium Diagram of Indium-Zirconium in the Region 0-26 At. Pct. In," Trans. Met. Soc. AIME, 212, 340 (1958)

Blosser, H. G., C. D. Goodman, and T. H. Handley, "Measurements of (n,α) Cross Sections at 14 Mev," Phys. Rev. 110, 531 (1958)

Boyd, G. E., "Energy Relations in Monolayer Formation: The Spreading of Long-Chain Fatty Acids on Aqueous Surfaces," J. Phys. Chem. 62, 536 (1958)

Boyd, G. E., and F. Vaslow, "Surface Viscosities of Mixed Unimolecular Films," J. Colloid Sci. 13, 275 (1958)

Busing, W. R., and H. W. Morgan, "The Infrared Spectrum of $Ca(OH)_2$," J. Chem. Phys. 28, 998 (1958)

Cohen, B. L., and C. B. Fulmer, "Fission-Fragment Mass Separator and the Nuclear Charge Distribution of Fission Fragments of a Single Mass," Nucl. Phys. 6, 547 (1958)

Congdon, C. C., "Method of Acceleration of Regeneration of Hematopoietic Tissues," in Proc. of Sixth Int'l. Cong. of Int'l. Soc. of Hematology, p. 398, W. Baker, Editor, Grune and Stratton, New York (1958)

Cumming, J. B., and N. R. Johnson, "Decay of Selenium-72," Phys. Rev. 110, 1104 (1958)

Davis, J. W., and G. D. Novelli, "The Activation of Amino Acids in Extracts of Pea Seedlings," Arch. Biochem. and Biophys. 75, 299 (1958)

Gersch, H. A., and W. C. Koehler, "Types of Magnetically Ordered Configurations on Simple Lattices," J. Phy. and Chem. of Solids 5, No. 3, 180 (1958)

Goodman, C. D., and J. L. Need, "Energy Distributions of Product Particles from Nitrogen-Induced Nuclear Reactions on Beryllium," Phys. Rev. 110, 676 (1958)

Gray, R. J., W. C. Thurber, and C. K. H. DuBose, "Preparation of Arc-Melted Uranium Carbides," Met. Prog. 74, 65 (1958)

Gude, W. D., "An Inexpensive Paraffin Knife," Am. J. Clin. Pathol. 29, 601 (1958)

Jagger, J., "Photoreactivation," Bacteriol. Revs. 22, 99 (1958)

Khym, J. X., D. G. Doherty, and R. Shapira, "Ion-Exchange Studies of Transguanylation Reactions. II. Rearrangement of 3-Aminopropylisothiourea and N-Substituted Aminoethyl- and Aminopropylisothioureas to Mercaptoalkylguanidines and 2-Aminothiazolines or Penthiazolines," J. Am. Chem. Soc. 80, 3342 (1958)

Kimball, R. F., "Experiments with Stentor coeruleus on the Nature of the Radiation-Induced Delay in Fission in the Ciliates," J. Protozool. 5, 151 (1958)

Lee, D. A., "Microdetermination of Deuterium by Effusiometry," Anal. Chem. 30, 1296 (1958)

Oliver, R. B., R. W. McClung, and J. K. White, "Production Inspection of Pipe and Tubing by the Immersed Ultrasonic Method," Symposium on Nondestructive Tests in the Field of Nucl. Energy, ASTM, Spec. Tech. Pub. No. 223, 62 (1958)

Oliver, R. B., G. M. Tolson, and A. Taboada, "The Use of Penetrants for Inspection of Small Diameter Tubing," Symposium on Nondestructive Tests in the Field of Nucl. Energy, ASTM, Spec. Tech. Pub. No. 223, 127 (1958)

Patetta-Queirolo, M. A., M. L. Randolph, and J. A. Sproul, Jr., "Intestinal Weight Loss in Mice Irradiated by Roentgen Rays, Gamma Rays, and Fast Neutrons," Acta Radiol. 49, 394 (1958)

Robinson, M. T., J. F. Krause, F. P. Green, and D. F. Weekes, "Electronic Analog Simulation of an In-Pile Circulating Fuel Loop," Nucl. Sci. and Eng. 3, 648 (1958)

Slaughter, G. M., P. Patriarca, and W. D. Manly, "Bonding of Cermet-Valve Components to Metals," Welding J. 37, No. 6, 249-s (1958)

Smith, L. H., and J. C. Toha, "Survival of Mouse-Grown Rat Erythrocytes," Proc. Soc. Exptl. Biol. Med. 98, 125 (1958)

Upton, A. C., R. F. Buffett, J. Furth, and D. G. Doherty, "Radiation-Induced 'Dental Death' in Mice," Rad. Res. 8, 475 (1958)

Urso, P., T. W. McKinley, Jr., and C. C. Congdon, "Survival of Irradiated Mice After Treatment with Repopulated Bone Marrow," Transplant. Bull. 5, 60 (1958)

von Borstel, R. C., and M. L. P. Rekemeyer, "Division of a Nucleus Lacking a Nucleolus," Nature 181, 1597 (1958)

Wollan, E. O., "Correlations Suggesting the d-Shell Configuration and a Magnetic Exchange Mechanism in Iron Group Metals," Phys. Rev. 110, 1205(L) (1958)

VISITORS

FOREIGN VISITORS:

Alami, R., French AEC
Aoki, K., Yawata Iron and Steel Co., Japan (New York City)
De Andrade, A. C., Brazilian Government
Eigen, M., Max Planck Institute, Göttingen, Germany
Eklund, S., United Nations (Citizen of Sweden)
Freeman, H. C., University of Sidney, Australia
Grenon, M., French AEC, Paris, France
Kamiya, N., Nissho Company, Tokyo, Japan
Kanai, E., Asahi Glass Co., Japan (New York City)
Kawasaki, M., Japan Atomic Energy Research Institute, Tokyo, Japan
Kotani, T., Indiana University (Citizen of Japan)
Lindholm, C. E., Royal Institute of Technology, Stockholm, Sweden
Magner, K. M. B., New York University (Citizen of Sweden)
Malamos, B., Greek AEC, Athens, Greece
Matsumoto, T., Japan Atomic Energy Research Institute, Tokyo, Japan
Mendiola, F. A., University of The Philippines
Miyakawa, T., University of Tokyo, Japan, and Rockefeller Foundation
Miyazaki, K., Mitsui Mining and Smelting Co., Japan (student of M.I.T.)
Nakazawa, G., Japanese Resources Research Institute, Japan
Nichol, J. C., University of Minnesota (Citizen of Canada)
Oel, H. J., Göttingen University, Germany
Sato, S., Atomic Fuel Corp., Japan (student of M.I.T.)
Shimokawa, J., Japanese Atomic Energy Research Institute (student of M.I.T.)
Skjoldebrand, R. H., AB Atomenergi, Sweden
Stohr, J. A., French AEC, de Chartes, France
Swenson, B. G., AB Atomenergi, Stockholm, Sweden
Taketani, K., Japan Atomic Energy Research Institute, Tokyo, Japan
Vincent, C. H., United Kingdom AEA
Wilkinson, J. H., National Physical Laboratory, Middlesex, England
Woolen, W. B., AERE, Harwell, England
Yamamoto, S., Koito Air Conditioning Co. (Citizen of Japan)

Approved by Alvin M. Weinberg, Director

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

July 1958

Distribution

U. S. Atomic Energy Commission

Oak Ridge Operations Office

1-21. Research and Development Division
22. Technical Information Service Extension

External

23.	Aeroprojects, Inc.	W. B. Tarpley
24-36.	Ames Laboratory: Iowa State College	F. H. Spedding
27-29.	Argonne National Laboratory	N. S. Hilberry
30.	Atomics International (No. Am. Aviation, Inc.)	E. E. Motta
31-32.	Battelle Memorial Institute	H. W. Russell
33-35.	Brookhaven National Laboratory	L. J. Haworth
36-41.	Hanford Atomic Products Operation	O. H. Greagor
42-43.	Idaho Chemical Processing Plant	R. L. Doan
44-45.	Knolls Atomic Power Laboratory	K. R. Van Tassell
46-47.	Los Alamos Scientific Laboratory	N. E. Bradbury
48-49.	National Bureau of Standards	F. L. Mohler
50.	National Lead Company	C. K. McArthur
51.	Nuclear Metals, Inc.	A. R. Kaufmann
52.	Union Carbide Corporation	R. W. McNamee
53.	Union Carbide Nuclear Company	C. E. Center
54.	Union Carbide Nuclear Company	J. L. Gabbard
55.	Union Carbide Nuclear Company	D. M. Lang
56.	Union Carbide Nuclear Company	J. P. Murray
57-58.	University of California Radiation Laboratory	E. O. Lawrence
59.	University of Rochester	H. A. Blair

Internal

60. E. E. Anderson
61. E. A. Bagley
62. P. S. Baker
63. C. R. Baldock
64. L. H. Barker
65. S. E. Beall
66. P. R. Bell
67. E. S. Bettis
68. D. S. Billington
69. R. E. Blanco
70. F. F. Blankenship
71. E. P. Blizard
72. A. L. Boch
73. E. G. Bohlmann
74. C. J. Borkowski
75. G. E. Boyd
76. M. A. Bredig
77. J. C. Bresee

Distribution (Continued)

78. R. B. Briggs
79. K. B. Brown
80. F. R. Bruce
81. T. H. J. Burnett
82. A. D. Callihan
83. A. E. Cameron
84. R. A. Charpie
85. C. E. Clifford
86. T. E. Cole
87. E. L. Compere
88. D. D. Cowen
89. J. A. Cox
90. J. H. Crawford
91. F. L. Culler
92. J. E. Cunningham
93. J. S. Drury
94. E. P. Epler
95. D. E. Ferguson
96. J. L. Fowler
97. J. H. Frye
98. W. F. Gauster
99. H. E. Goeller
100. J. C. Griess
101. W. R. Grimes
102. C. S. Harrill
103. J. C. Hart
104. M. R. Hill
105. C. J. Hochanadel
106. A. Hollaender
107. A. S. Householder
108. H. H. Hubbell
109. G. S. Hurst
110. G. H. Jenks
111. R. W. Johnson
112. W. H. Jordan
113. P. R. Kasten
114. G. W. Keilholtz
115. C. P. Keim
116. M. T. Kelley
117. E. M. King
118. K. A. Kraus
119. Laboratory Shift Supervisor (D. Phillips)
120. J. A. Lane
121. T. A. Lincoln
122. S. C. Lind
123. R. B. Lindauer
124. R. S. Livingston
125. R. N. Lyon
126. H. G. MacPherson
127. F. C. Maienschein
128. W. D. Manly
129. L. A. Mann
130. H. F. McDuffie
131. J. R. McNally
132. R. V. Meghreblian
133. E. C. Miller
134. K. Z. Morgan
135. E. J. Murphy
136. C. E. Normand
137. G. W. Parker
138. M. E. Ramsey
139. P. M. Reyling
140. L. P. Riordan
141. A. F. Rupp
142. H. C. Savage
143. H. W. Savage
144. A. W. Savolainen
145. H. E. Seagren
146. E. D. Shipley
147. A. Simon
148. O. Sisman
149. J. R. Sites
150. M. J. Skinner
151. A. H. Snell
152. R. W. Stoughton
153. H. Stringfield
154. E. G. Struxness
155. W. H Sullivan
156. C. D. Susano
157. J. A. Swartout
158. E. H. Taylor
159. B. S. Weaver
160. A. M. Weinberg
161. J. C. White
162. C. E. Winters
163. H. P. Yockey
164. W. Zobel
165-166. Biology Library
167-168. Central Research Library
169. Health Physics Library
170. ORNL—Y-12 Technical Library Document Reference Section
171. R.E.E.D. Library
172-479. Laboratory Records Department
480. Laboratory Records ORNL, R.C.