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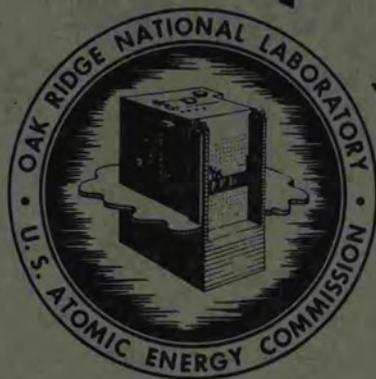
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OAK RIDGE NATIONAL LABORATORY
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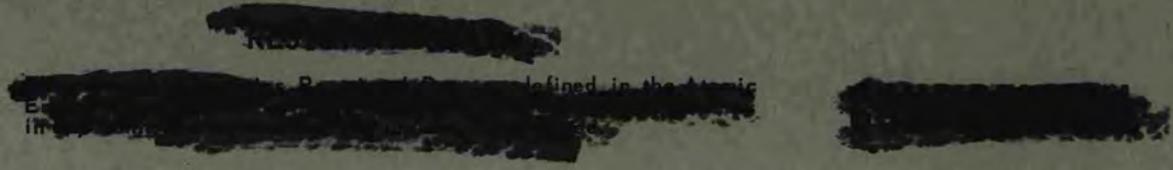
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OAK RIDGE NATIONAL LABORATORY
STATUS AND PROGRESS REPORT

March, 1956

Edited by:

F. T. Howard

and

W. H. Sullivan

Date Issued: APR 9 1956

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OAK RIDGE NATIONAL LABORATORY

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March, 1956

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OAK RIDGE NATIONAL LABORATORY
STATUS AND PROGRESS REPORT

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

March, 1956

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

PROGRAM 2000 - SPECIAL NUCLEAR MATERIALS

Metallex Process - In studies on the Metallex process for sodium amalgam reduction of ThCl_4 to metallic thorium, the reduced metal which was formed from dry, anhydrous, finely divided ThCl_4 separated into a floating semisolid phase and an underlying liquid phase (ORNL-2044). The NaCl and unreduced thorium compounds could not be separated from the reduced thorium quasi-amalgam in the floating phase by filtration, centrifugation, vacuum distillation, or reslurrying the solid product with clean mercury or sodium amalgam. Washing the amalgam product with 1-3 N HCl, followed by deaerated distilled water, produced a clean amalgam from which Th metal, containing <1% ThO_2 , could be separated by vacuum distillation.

In the present dry process flowsheet, it is necessary to recycle 15 to 30% of the thorium and 0.13 to 0.4% of the mercury fed to the reduction step from the aqueous slurries resulting from the amalgam washing step. A tentative recycle flowsheet was developed in which thorium and mercury are precipitated by 5% excess of oxalic acid or ammonia, the precipitate is gravity-settled and centrifuged, and the sludge is dried for 1 hr at 125°C in a stream of air and finally calcined at 500°C for 1 hr to separate mercury from ThO_2 . Mercury losses for this treatment were 0.006 to 0.011% of that fed to the reduction run, and thorium losses were less than 0.01%.

Preliminary cost studies indicate that thorium may be produced by reduction of dry solid ThCl_4 for ~\$2.00 per pound. If reduction is performed with ThCl_4 in propylenediamine solution, the cost is ~\$1.80 per pound. However, the problems of handling this solvent may outweigh the cost advantage. (AEC Activity 2704)

Power Reactor Fuel Processing - A new process, the ZirceX, in which the fuel is dissolved by hydrochlorination, shows promise as a method for processing all types of zirconium-containing fuels. Zirconium in Zircaloy-2 and in such alloys as 92% Zr--8% U reacted with HCl gas at 330°C to form volatile ZrCl_4 . Approximately 180 cal of heat is evolved per mole of zirconium. An auxiliary stream of cold hydrogen was used to control the temperature. As much as 99.9% of the zirconium volatilized, accompanied by only 0.008% of the uranium. The residual uranium chlorides readily dissolved in nitric acid. Prior to solvent extraction the chloride would be removed from the solution by distillation. The rate of reaction with HCl gas at 310°-320°C

PROGRAM 2000 - SPECIAL NUCLEAR MATERIALS (Continued)

varied with the alloy composition. A 15% zirconium alloy reacted rapidly, 8.8 mg/cm²-min. Reaction was slow with 2.1% molybdenum alloy (0.113 mg/cm²-min), 9.7% niobium (1.9 mg/cm²-min), and 0.49% silicon (0.057 mg/cm²-min).

In the Hermex process, both nonirradiated and irradiated uranium metal are processed by dissolving in boiling (356°) mercury and recovering the purified metal from the amalgam thus formed. The dissolution rates of uranium and of 2% Zr--98% U alloy were both 5-10 mg/cm²-min. Impurities such as calcium and aluminum were removed by factors of 5. At 650°C, Zircaloy-2 dissolved at a rate of 0.03 mg/cm²-min. With irradiated uranium that had decayed for 3.5 years, gross β and γ decontamination factors were 1100 and 700, respectively. With similar material that had decayed only 18-45 days, gross decontamination factors varied from 10-70. In the latter case the long-lived activities were preferentially removed.

The dissolution rate of niobium-uranium alloys in 8 M HNO₃ decreased from 6 mg/cm²-min for 2% niobium alloy to 0.3 mg/cm²-min for the 15% alloy. In 2 M HCl--5 M HNO₃ rates were 11 mg/cm²-min for the 2% alloy and 6.5 mg/cm²-min for the 15%. Less than 1% of the uranium remained in the insoluble solids. Zirconium-uranium alloys dissolved in 2 M HCl--5 M HNO₃ at rates of 7.6 mg/cm²-min, for 2% zirconium alloy and 6.8 mg/cm²-min for 20%. The uranium in the insoluble solids increased from 1.39% of the total with the 2% alloy to 15.3% with the 20% alloy.

An electrolyte HCl concentration of 3 M was suitable for dissolution of zirconium by anodic electrolysis. With 1.5 M HCl a large amount of metal left the anode as undissolved colloidal particles. With 6 M HCl, zirconyl chloride formed during the electrolysis and precipitated. With a current density of 0.269 amp/cm² the anode lost weight at a rate of 0.88 g/amp-hr, with 96% of the zirconium going into ionic solution. When the current density was decreased to 0.017 amp/cm², 1.53 g/amp-hr was lost from the anode but only 62% of this zirconium went into ionic solution. (AEC Activities 2924 and 5310)

PROGRAM 4000 - REACTOR DEVELOPMENT

HOMOGENEOUS REACTOR PROJECT

Homogeneous Reactor Test - The reactor installation is complete except for the installation of the pressurizers and for minor instrumentation and wiring. All process piping was finished and both high- and low-pressure systems of the core and blanket were flushed with water. In connection with the flushing operation all the process valves were removed and the machining of the master jig for the high-pressure valves was completed. With this jig it will be possible to fabricate accurate duplicates of high-pressure valve assemblies for future replacements. The high-pressure package steam boiler was tested and a hydrostatic test applied to the reactor steam system. Thermocouples were installed on all process vessels and piping, the connectors applied, water-proof seals made, and the leads pulled through into the control room. Approximately 400 thermocouples were installed. (AEC Activity 4103.1)

HR Chemical Pilot Plant - The design is estimated to be 90% complete. Fabrication of equipment is approximately 95% complete. The procurement of equipment is essentially complete except for the Westinghouse canned rotor pump. Freon and leak detector lines were installed in the shielding-wall sleeves. (AEC Activity 4103.1)

HR Physical Chemistry--Aqueous Reactor Systems - The vapor pressures of lithium nitrate and of calcium nitrate solutions (approximately 0.2 mole fraction) were measured over the temperature range from 200° to 400°C. In both cases the pressures were approximately 4/10 that of pure water at the same temperature. Neither solution showed any visual evidence of thermal instability.

Measurements of the volumes of liquid and vapor phases for stoichiometric uranyl sulfate solutions as functions of concentration and fraction filling are now complete from 25° to 400°C. Measurements were made for 0.25, 0.50, 1.0, 1.5, 1.8, 2.0, and 3.0 molal solutions and for fraction fillings in the range from 0.25 to 0.60. (AEC Activity 4103.1)

Reactor Analysis - The pressure rise within the HRT core was calculated as a function of elapsed time following an assumed stoppage of fluid flow in the core. If there were no release of solution from the high-pressure system, the pressure would reach 2800 psia in 38 seconds and continue to rise until some safety device were actuated. A letdown rate of 2 gal/min appears sufficient to prevent the pressure from reaching 2800 psia.

The pressure-time relation in the core of the HRT during a dump was calculated on the basis of various assumptions concerning heat generation, heat removal, and venting conditions. With no initial venting of the core system, the heat exchanger surface would become exposed to vapor before the initial overpressure was relieved; this would cause an extremely rapid drop in pressure, down to core saturation conditions. If vapor were initially vented from the pressurizer and the dump valve opened after the overpressure were relieved, the maximum rate of decrease in core pressure would be much slower.

PROGRAM 4000 - REACTOR DEVELOPMENT (Continued)

The fuel costs for homogeneous reactors using U^{235} as fuel were calculated for the case of batch-type fuel processing, with H_2O or D_2O as the moderator. The total fuel costs were about 4 mills/kwhr for operating cycles in excess of 2000 days; they were independent of moderator material and of size for spherical reactors ranging from 4 to 12 ft in diameter.

The Fermi age and fast diffusion coefficient for various ThO_2 -water mixtures were calculated for tabulation in a handbook of HRT nuclear constants. (AEC Activity 4103.1)

Reactor Instrumentation - A duplicate of the HRT letdown valve and operator performed very well for approximately 1200 hours in the HRT loop. No visible wearing of the integral type-347 stainless steel seating surface and only slight erosion of the Stellite No. 6 plug surface in the throttling region were observed upon inspection at the end of the test period. The valve was re-installed for further life testing.

The HRT prototype magnetically-damped pressurizer level controller operated satisfactorily for approximately 800 hours on the test loop; however, temperature shifts have as yet not been completely eliminated. - - - - The HRT emergency air control system, which utilizes a high-pressure nitrogen supply and a downstream pressure-controlled valve, was satisfactorily tested in the shops. - - - - The vendor's schematic and preliminary layout drawings for the remote area radiation monitoring system were approved. - - - - The pressurizer bleed and block valves were found to shut off tightly in tests to date on the dump test facility; control of flow with these valves was not satisfactory, however, as there was apparently a critical pressure drop occurring in a line restriction.

Instrumentation was provided for measuring the transient pressures occurring in the injection feed pump systems. For measuring very fast pressure changes, photographs of cathode ray oscillograph traces were made. For frequencies below 100 c p s, a direct-inking oscillograph was used. (AEC Activity 4103.1)

HR Design - The following items in the design of the HRT were completed: supports for high-pressure piping, fuel and blanket pressurizers, details and installation of purge pumps, high-pressure valve jig, electrical power disconnects, and space-cooler installation. Approximately 97% of the working drawings for the construction of the reactor are complete.

Final design of the sampler was completed following tests of the prototype. Tests of the revised prototype steam pressurizer, which uses a boiling condensate stream, were conducted in the HRT mockup and proved this unit to be satisfactory; the final designs for the HRT pressurizers were completed on this basis. Accordingly, the scope of the contract with the Arthur D. Little Company for study of gas pressurization was modified to include only enough work to establish the basis for a detailed design in case a need for it arises at a later date. A final report on this study, including engineering flowsheets and preliminary component designs was received from the A. D. Little Company (AEC Activity 4103.1)

PROGRAM 4000 - REACTOR DEVELOPMENT (Continued)

HR Radiation Damage - Notch-bar impact tests were conducted on subsized Izod specimens of an 8-1/2 per cent nickel steel exposed to integrated fast neutron fluxes of from 10^{19} nvt to 4×10^{20} nvt at temperatures less than 200°F. Irradiation to 4×10^{20} nvt decreased impact energy values 50 to 80% at test temperatures of 200°F and -320°F, respectively. The impact energy values at all test temperatures consistently decreased with increasing neutron dose; no saturation of this radiation effect is apparent from the data. (AEC Activity 4103.1)

HR Metallurgy - The stringers often found in Zircaloy-2, and which have been reported in the literature as being elongated voids, were shown, by cathodic etching and electropolishing, to be intermetallics of iron, nickel and chromium formed by the eutectoid decomposition of beta phase inclusions present and elongated during the fabrication. A considerable portion of an added 1000 ppm of hydrogen was retained in solution in crystal bar zirconium by rapid quenching from 1000°C. No variation in impact properties was found after aging Zircaloy-2 for periods up to 1580 hours at 250°C. This shows that the embrittlement encountered with in-pile corrosion loop samples is not a simple aging effect. (AEC Activity 4103.1)

In-Pile Autoclave Tests - Further investigations of the corrosion of titanium under irradiation were made. An all-titanium bomb containing a solution of 0.17 m UO_2SO_4 (93.2% enriched), 0.04 m H_2SO_4 , and 0.04 m $CuSO_4$ was irradiated in HB-5 of the LITR at 250°C. The estimated fission power density was about 14 w/ml. The corrosion rate was 1.6 mil/yr, nearly the same as that observed in a previous experiment (H-76) at the same temperature but at a lower power density. The accumulated measurements of titanium corrosion in the presence of fissioning solutions, from several experiments in the LITR and MTR, are as follows:

<u>Power Density</u> w/ml	<u>Temperature</u> °C	<u>Corrosion Rate</u> mil/yr
14	250	1.6
lower	250	~ 1.6
12	280	5.0
30	290(walls)	7
30	305(pins)	12

These results suggest that the corrosion rate is more strongly correlated with changes in temperature than with changes in the power density.

Two experiments in corrosion of Zircaloy-2 were performed by using 1.26 m UO_2SO_4 (14.0% U-235), 0.04 m H_2SO_4 , and 0.04 m $CuSO_4$. The rate observed at 250°C was 6 mil/yr; that at 280°C was 7.5 mil/yr. The power density was not completely established, but was probably 11-16 w/ml. The temperature influence on corrosion for these solutions is not nearly so marked as for the 0.17 m UO_2SO_4 solution. In addition, the corrosion rate is much lower than for similar power densities in solutions of the lower concentration. (AEC Activity 4103.1)

PROGRAM 4000 - REACTOR DEVELOPMENT (Continued)

In-Pile Loop Tests - The major portion of inspection and evaluation of specimens from loop experiment L-4-11 in the LITR was completed. Loop L-4-12 has been in operation in-pile for a total of 1503 hrs; the test is being continued. A total of 3,082 Mw-hrs of LITR energy has been accumulated. The installation for loop operation in beam hole HB-2 of the LITR is essentially complete. (AEC Activity 4103.1)

HR Laboratory Service Corrosion - Specimens of type-347 stainless steel, stressed at 20,000 psi, were exposed for a total of 7620 hrs in the liquid and vapor phases of a boiling (101°C) uranyl sulfate solution (0.04 m UO_2SO_4 -0.02 m H_2SO_4 -0.005 m CuSO_4). No stress-corrosion cracking was apparent during this period. The addition of 60 ppm chloride ions to the solution after 7620 hrs resulted in stress-corrosion cracking of a new type-347 stainless steel stress specimen immersed in the solution during the subsequent 500-hr period. The precorroded specimens remained free of cracks. The test is continuing.

The general undesirability of using gold plating as a means of protecting a metal against corrosion was demonstrated in the case of Iso-Elastic, a spring alloy proposed for use in the liquid level controller of the HRT. The presence of pin-holes and other defects in the gold plate permitted intensive attack of the underlying metal by the corroding solution. Flaking and peeling of the gold plate occurred as a result of the attack. In addition to the pin-hole attack a severe blistering of the gold plate was quite common.

In view of the very poor corrosion resistance of Iso-Elastic alloy, the corrosion resistance of a cobalt-base spring alloy, Elgiloy, was investigated. Short-term tests showed very low generalized corrosion rates both in dilute uranyl sulfate solutions and in the gas phase above such solutions at 300°C. However, longer testing showed that the alloy exhibited a definite susceptibility to stress-corrosion cracking both in the liquid and gas phases.

A total of 451 specimens of sensitized type-347 stainless steel for HRT use and for use by various corrosion study groups was examined in the boiling 65% HNO_3 test as required by HRP material specifications. Forty-four percent of the specimens corroded at rates in excess of the maximum penetration rate of 2.0 mils per month permitted by the HRT specifications and were, therefore, considered not acceptable for use in the HRT. (AEC Activity 4103.1)

Dynamic Loop Tests - Three 100A loops were descaled with a solution developed by the Chemical Technology Division. The solution, which consists of 0.4 m chromous sulfate and 0.5 m sulfuric acid at 85°C, dissolved the corrosion-product scale on the loop surface and did not seriously corrode the loop. However, the solution was only about 50% efficient since only about half of the chromous sulfate was utilized in the reduction of ferric oxide; the remainder of the chromous sulfate reduced hydrogen ions to form gaseous hydrogen.

PROGRAM 4000 - REACTOR DEVELOPMENT (Continued)

A series of experiments was completed in which it was shown that the critical velocity observed on type-304L stainless steel is a function of the grain size of the steel. Pin-type specimens of ASTM grain sizes 2, 4, 6 and 8 were exposed to 0.17 m uranyl sulfate solutions at 250°C and at flow rates of 15 to 20 fps. In all cases the weight losses were largest for the pins having the largest grain size and smallest for those with the smallest grain size. In other words, the smaller the grain size, the better the protective oxide adhered to the steel. At either sufficiently high or low flow rates the corrosion behavior was independent of the grain size. Similar tests with type-347 stainless gave very inconclusive results.

Three loops are in use for long-term tests with 0.04 m uranyl sulfate solutions containing 0.015 m sulfuric acid and 0.005 m copper sulfate at temperatures of 200° to 300°C. During the first one to two thousand hours of operation the solutions remained stable and corrosion rates of all alloys under test were low. (AEC Activity 4103.1)

Dynamic Slurry Tests - Dynamic slurry corrosion studies, using thorium oxide slurry circulated in the 100A pump loop, were facilitated by the addition to the loop of an improved condensate system for providing purge water to the 100A pump, and by the incorporation of a device for adding slurry to the loop while operating. One experiment was completed with slurry prepared from a lot of very pure thorium oxide which was prepared at ORNL by calcining thorium oxalate at 800°C. At 300°C the comparative corrosion rates (in mil/yr) for pin-type specimens of materials, exposed for 316 hours to the slurry at a concentration of approximately 1000 g Th/kg H₂O and a slurry velocity of 10 ft/sec, were: gold 0.1, titanium 7, platinum 0.4, Zircaloy-2 1, and type-347 stainless steel, 3. Corresponding attack at 20 ft/sec was: gold 0.1, titanium 10, platinum 0.5, Zircaloy-2 4, type-347 stainless steel 4, and at 30 ft/sec: gold 0.3, titanium 10, platinum 2, Zircaloy-2 4, and type-347 stainless steel 11. (AEC Activity 4103.1)

HR Math and Computation - An Oracle code was written for calculating the gamma-ray heating at specific positions in a 3 dimensional reactor. Another Oracle code was written for the evaluation of an integral related to the shear stress in slurries; results were obtained for a range of parameter values. (AEC Activity 4103.1)

GENERAL REACTOR RESEARCH

Basic Reactor and Shielding Research - A calculation on the effect of enriching the H₂O moderator of swimming pool-type reactors with D₂O was made with all combinations of the following parameters considered:

Fuel absorption cross section: Σ_a^F , cm⁻¹: 0.03, 0.052, and 0.07
Metal-to-water volume fraction, M/W: 0.5, 0.733, and 1.0
Buckling, B²: 0.01, 0.007, 0.004, and 0.001

The calculations are complete and a report is in progress.

PROGRAM 4000 - REACTOR DEVELOPMENT (Continued)

An attempt was made to measure directly the critical thickness of a hydrogen-reflected slab of an aqueous solution of UO_2F_2 (enriched to 93.2% in U-235) at chemical concentrations selected to give the minimum critical volume. A reactor vessel was constructed from 3/4-in. Lucite sheet reinforced by Lucite stiffening members attached to the outside. The nominal inside dimensions were 58 x 71 x 2.25 in. The slab was mounted with the 71-in. dimension vertical in such a manner that it could be filled with UO_2F_2 solution and surrounded, except for the top surface, by an effectively infinite water reflector. The thickness of the slab was altered by inserting plastic sheets adjacent to one inside surface. Critical heights of solutions of two concentrations were measured at temperatures of 72° and 75° F. It was apparent from the data that the critical dimensions were sensitive to the height of the surrounding water because of its effect as a neutron reflector above the solution and, more importantly, because of deformations of the plastic by variations in hydrostatic forces. In some instances the slab thickness was measured with gauge blocks with the liquids only slightly below the critical levels and with a neutron absorber inserted in the solution. This dimension varied by as much as + 0.01 in. over the area of the slab. Data in which there is greatest confidence were extrapolated to an infinite height which gave a value of 1.81 in. for the thickness of a corresponding infinite slab. After experimental uncertainties and assumptions in the extrapolation were allowed for, the minimum thickness for an aqueous solution of uranium was determined to be 1.66 in. with an uncertainty of +0.10 in. Nearly 50 kg of U-235 was required for criticality in this geometry.

Shielding measurements are being made for the concrete shield of the X-10 Graphite Reactor to determine whether it is adequate for higher powers and whether its structural and nuclear characteristics have changes over the 12 year since installation. (AEC Activity 4570)

Metallurgical Materials and Processing - Recent pyrometallurgical experiments have been directed toward conditioning representative fuel element materials to yield a high percentage of solid waste. Stainless steel fuel plates were made extremely sensitive to intergranular attack by the addition of 0.3% C in carburizing. Chemical attack to cause the intergranular attack and subsequent leaching to remove the uranium resulted in dissolution of only 20% of the steel present. Similar treatments on Nichrome allow it to be reduced to a porous mass, but an extended exposure to the nitric acid corroding solution is required. Iron-base alloys, containing chromium and aluminum, are reduced to a granular powder by nitriding in an ammonia atmosphere. (AEC Activity 4610)

Oak Ridge School of Reactor Technology - The deadline date for receipt of applications for the 1956-57 session was March 12. Upwards of 150 applications are being reviewed by the ORSORT staff. The Committee on Admissions will meet in April. (AEC Activity 4704)

PROGRAM 5000 - PHYSICAL RESEARCH

ORR Project - Erection of structural steel is essentially complete; the bridge for the building crane is in place and rooming and siding are being installed. Two of the reactor footings were placed and excavation for the remaining footings is nearly complete. Equipment for the reactor cooling system is arriving daily; large size aluminum pipe is scheduled for delivery at this time and installation of the cooling system will proceed as soon as delivery is made. Foundations for the air cooled heat exchangers and cooling tower were completed and further work in this area is awaiting arrival of these units. The current schedule indicates that the building and cooling system should now be 72% complete; estimates based on actual progress indicate about 34% completion. A contract was awarded to the Taylor Instrument Co. for construction of the reactor control system; this equipment is scheduled for delivery June 1, 1956.

Two series of experiments were performed with the Bulk Shielding Facility. The first series was made to obtain values for gamma-ray heating of materials near the reactor core; this work, reported in ORNL CF-56-3-72, indicates that the design values are conservative. The second series was run to observe the increase in neutron flux resulting from surrounding the ends of the six horizontal beam holes with D₂O rather than H₂O as designed. Preliminary results indicate a gain in flux of about 50%; present plans are to incorporate features necessary for the future addition of D₂O in this region of the reactor tank. (AEC Activity 5XXX)

ISOTOPE PRODUCTION

Radioisotope Production - The fission-product semi-works operations were closed down after a final run had accumulated 2800 curies. Because of the poor condition of the plant, operations will not be resumed; after a period of decontamination, the equipment will be removed and the building torn down. The tank-farm waste evaporator, formerly used, will be converted to a cesium-alum crystallizer; it will be used for cesium removal until the Fission Product Pilot Plant starts operations in 1957. Five Cs¹³⁷ sources were prepared, as follows: one teletherapy source, 2025 curies, for the University of Michigan; two 100-curie radiographic sources; and two 120-curie radiographic sources. These sources are now undergoing a 30-day storage test during which signs of deterioration, swelling, leakage, etc., are looked for. Approximately 7200 curies of Co⁶⁰ at a specific activity of 10 curies/g was received, assayed, and stored. This material will be used for gamma irradiators. (AEC Activity 5111)

Radioisotope Process Development - A procedure was developed for producing P³² by the irradiation of relatively small amounts of highly purified sulfur in high, fast flux zones of the LITR. Irradiations are made in small quartz tubes and the sulfur is quantitatively distilled, leaving pure, carrier-free P³² on the walls of the tube; the phosphorus is removed with dilute HCl. This procedure will reduce the cost of processing and will increase the availability of carrier-free material.

PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

A determination of the specific activity of fission-product Ce^{144} , separated from waste four years old, was made by the direct weighing of 20 curies of Ce^{144} in the form of ceric oxide. The value obtained was 16.4 curies Ce^{144} /gram Ce, with a probable error of $\pm 10\%$.

Stable A^{38} (1.1cc) was separated from Hanford-irradiated KCl as one step in processing the KCl to produce S^{35} and Cl^{36} . Since there appears to be a demand for A^{38} , this step will be incorporated into the regular process.

Construction of the Fission Product Pilot Plant is now proceeding quite well; phase I (cell blocks, tank farm and building) is now scheduled for completion August 3, 1956. Purchase requisitions have been issued on all important equipment to be installed by a cost-plus-fixed fee contractor in the second phase of the construction program. (AEC Activity 5112)

PHYSICS

Recoil Spectrometry - The charge spectrum following internal conversion of Xe^{133m} has re-examined in the high charge region and found to extend out to 29 instead of the previously reported 24. The final spectrum is as follows, where the intensity figures are given in terms of percentage of decays:

<u>Charge</u>	<u>Intensity</u>	<u>Charge</u>	<u>Intensity</u>
1	0.62 \pm .12	16	0.242 \pm .004
2	0.97 \pm .03	17	0.098 \pm .002
3	1.62 \pm .06	18	0.036 \pm .001
4	4.26 \pm .06	19	0.023 \pm .001
5	5.36 \pm .10	20	0.014 \pm .001
6	10.42 \pm .13	21	0.012 \pm .001
7	15.69 \pm .25	22	0.013 \pm .001
8	20.88 \pm .19	23	0.006 \pm .001
9	15.74 \pm .24	24	0.010 \pm .001
10	11.32 \pm .19	25	0.004 \pm .002
11	6.22 \pm .10	26	0.004 \pm .001
12	3.01 \pm .04	27	0.002 \pm .001
13	1.78 \pm .03	28	0.007 \pm .001
14	1.09 \pm .01	29	0.006 \pm .002
15	0.55 \pm .01	30	0.001 \pm .001

This distribution yields a mean charge of 8.04 \pm .04. (AEC Activity 5220)

Neutron Diffraction - Neutron diffraction investigations were performed on polycrystalline samples of anhydrous $FeCl_2$ and $CoCl_2$ at various temperatures from 4.2°K to room temperature to determine the existence of magnetic ordering at low temperatures. These compounds crystallize in the pseudo-hexagonal (rhombohedral) layer structure characteristic of $CdCl_2$. Previous measurements of the magnetic susceptibility and specific heat (Trapeznikow, et al., Phys.

PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

Zeits. Sowjetunion 7, 66, 1935 and 9, 237, 1936) suggested antiferromagnetic transitions at 24°K for FeCl_2 and 25°K for CoCl_2 . The neutron scattering data confirm these measurements by showing definite antiferromagnetic reflections at 4.2°K which disappear in the vicinity of the predicted Néel temperatures. For both compounds the magnetic reflections suggest an antiferromagnetic structure in which the moments are aligned parallel within each hexagonal layer with the moments of adjacent layers aligned antiparallel. However, although these compounds have crystal structures and magnetic ordering temperatures which are about the same, the direction of magnetic moment alignment in the proposed magnetic structure is different. For FeCl_2 the moments seem to be oriented parallel to the hexagonal axis, whereas the moment orientation in CoCl_2 is normal or nearly normal to that axis. (AEC Activity 5220)

Neutron Time-of-Flight Spectrometer - The high resolution time-of-flight neutron spectrometer for the ORR is now under construction. Meanwhile the old "chopper" at the LITR has been reactivated; it will be used to measure cross sections and to test neutron detectors. (AEC Activity 5220)

Physical Research, Math and Computation - A general non-linear, least-square curve-fitting code was written for use in determining the Breit-Wigner constants from xenon cross section measurements. Although the routine was written primarily for solution of the indicated problem, it will be applicable to any non-linear curve-fitting problem with the following characteristics:

Number of data points $\leq 2^{12}$

$$4 + Q + M + \frac{M^2 + M}{2} \leq 128 \text{ and } M \leq 14$$

where Q = number of independent variables

M = number of parameters to be determined.

(AEC Activity 5220)

High Voltage Program - Yield curves for the 2.31-Mev γ -ray produced in the inelastic scattering of protons from a thin N^{14} target were obtained for γ -rays observed at 0 and 90-deg to the incident proton beam. Protons from the 5.5-Mv Van de Graaff generator had energies ranging from the threshold (2.47 Mev) for the production of the 2.31-Mev γ -ray to 5 Mev, with points being taken 5 kev apart. The γ -rays were detected by means of a 3 x 3 in. $\text{NaI}(\text{Tl})$ crystal. The nitrogen target was made by bombarding a tantalum backing with nitrogen ions. Four resonances in the compound nucleus O^{15} were found with proton energies of 3.92, 4.00, 4.81, and 4.90 Mev.

Angular distributions of neutrons scattered from C^{12} were measured at neutron energies of 2.51, 2.76, 2.94, 3.04, 3.26, 3.50, 3.76, and 4.10 Mev. The angular distributions were analyzed, along with distributions previously measured at 0.66, 1.05, 1.45, and 2.15 Mev, in terms of phase shifts. The resonance at 2.07 Mev was to have a spin of $3/2$ and an even parity.

PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

For the measurement of angular distributions of neutrons above 2.5 Mev, a xylene-terphenyl liquid scintillation counter was used to detect the neutrons. Since this detector was sensitive to gamma rays, special care was exercised to see that the gamma-ray background from the ORNL 5.5 Mv Van de Graaff generator was negligible. There was no inelastic scattering in the carbon at these energies. A $H^3(p,n)He^3$ source was used to provide the neutrons and lead was used for shielding the counter from the direct neutron beam during differential cross section measurements. The carbon scattering sample was a cylinder of carbon 1 in. in diameter and 3 in. long. (AEC Activity 5220)

Mathematical Research, Math and Computation - Codes for solving a rather general class of systems of linear algebraic equations were completed and put to use on test problems, on calculating the inverse of a matrix of order 190 which originated in the Metallurgy Division, and on the solution of several smaller systems of linear equations. After the data are put on magnetic tape in a standard format, either as a result of previous computation or by using an available input code, a routine converts from packed decimal (if necessary) and scales the data to permit fixed-point operation in the main codes solving for X from the matrix equation $AX = BY + C$. An output code provides packed decimal form for the elements of X, which may in special cases be the components of a solution vector or all elements of the inverse of a matrix. For large problems the solution will be kept on magnetic tape in a binary form. (AEC Activity 5230)

CHEMISTRY

Volatility Studies - In further laboratory development work on the fused salt--fluoride volatility process, the amount of fluorine necessary for about 99% UF_6 volatilization was not affected by the method by which the contact was made between the gas and the fused salt. A simple dip tube on the end of the fluorine line was as effective as several sieve plates. The presence of impurities in the fused salt, resulting from hydrolysis or oxidation reactions, decreased the fluorine efficiency. A F_2/U mole ratio of only 1.9/1 was necessary at the 99% UF_6 volatilization point when oxide-free fused salt was used. The equation

$$\log P_{mm} = 10.88 - 5.09 \times 10^3/T$$

expressed the vapor pressure of UF_6 in equilibrium with the complex $3NaF \cdot UF_6$ over the temperature range 80-320°C. This expression was derived from data obtained by the transpiration method with dry nitrogen as the sweep gas. An enthalpy change of +23.3 kcal per mole UF_6 was calculated for the equilibrium



(AEC Activity 5310)

PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

Ion Exchange Studies - Almost complete instrument control of a Higgins continuous ion-exchange contactor was shown to be possible. With the 2-in.-dia continuous contactor used in Excer process studies, an Ohmart instrument is used to signal the difference between loaded and unloaded resin and to control the resin movement. Two conductivity probes are used, one to signal the position of an interface between sodium chloride solution and water and the other between sodium chloride and UO_2Cl_2 solutions. (AEC Activity 5310)

Feed Materials Processing - The Excer process for preparing UF_4 by ion exchange conversion of uranyl nitrate to uranyl fluoride, followed by electrolytic reduction, operated satisfactorily with unfiltered sulfuric acid-leached ore pulps. The uranyl sulfate was sorbed on a 2-in.-dia Higgins continuous cation-exchange contactor, converted on the column to uranyl chloride by 5 M NaCl, and eluted with water. The UF_4 , produced by one-stage membrane-cell electrolytic reduction followed by dehydration, contains less impurities (Fe, Cu, Mn, Ni, Cr, Mg, Hg, Pb, Ca, Na) than the maximum permitted in the UF_4 to be converted to metal for use in fabricating fuel elements. Tap densities of UF_4 products of UO_2F_2 reduction varied from 2.2 to 3.5 g/cc. The high-density product was obtained from UO_2F_2 cell feed that had been digested with UF_4 prior to the reduction.

In the Fluorox process, UF_4 is prepared from $\text{UO}_2(\text{NO}_3)_2$ by denitration to UO_3 , followed by reduction with carbon (starch) and hydrofluorination. In a 4-in.-dia moving-bed reactor, residual carbon in UF_4 , to be reduced to metal, was lowered from 0.4% to 300 ppm by oxygen at 600°C . There was no detectable loss of fluorine or uranium, and less than 2.5% of the U(IV) was oxidized. These results are considerably better than those reported previously (ORNL-2044) for batch studies. Silica was the only impurity removed from African ore concentrate pellets (crude UO_3) in a simultaneous reduction and hydrofluorination at $500\text{-}700^\circ\text{C}$. When this impure UF_4 was oxidized to UO_2F_2 and UF_6 with dry oxygen at 800°C , the bulk of the Al, Cu, Fe, and Mn remained in the UO_2F_2 residue rather than volatilizing with the UF_6 . Approximately 1 wt % platinum black doubled the rate of the oxidation reaction at 600°C . In amounts less than 1 wt % Fe_2O_3 and V_2O_5 had no detectable catalytic effect. (AEC Activity 5310)

Hot Laboratory Research - In connection with the efforts to recover neptunium-237 in large quantity for experimental purposes, some recent tank-car shipments of recovered uranium solution resulting from plutonium production operations at Chalk River were found to contain all the neptunium normally associated with that irradiation level.

By special arrangement the flow sheet for the reprocessing of this material in the ORNL Metal Recovery Plant, was altered to afford a high neptunium recovery as indicated by continuous material balance data. In effect, the small amount of residual plutonium, which normally would have been recovered, was discarded during an extraction in the presence of a reducing agent favorable for the extraction of neptunium as Np(IV).

PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

Two lots of this material, each containing approximately 15 grams of neptunium were treated in the Pilot Plant. The neptunium in an estimated yield of about 60% was adsorbed on the ion exchange columns for concentration and purification. About 10 grams of the product was isolated. An additional 10 grams is in process and 30 or more grams is anticipated in future tank car shipments. (AEC Activity 5330)

Reactor Chemistry - EMF data were obtained for the cell $\text{In}, \text{In}_2(\text{SO}_4)_3(\text{m}), \text{Ag}_2\text{SO}_4(\text{sat.}), \text{Ag}$ for $\text{In}_2(\text{SO}_4)_3$ concentrations of 0.01 to 2.3 m and temperatures of 15° to 70°C. The \log_3 of the activity of $\text{In}_2(\text{SO}_4)_3$ was approximately proportional to the molality (not log of the molality) at any given temperature. EMF, conductivity, and solubility data all strongly indicate considerable ionic association in $\text{In}_2(\text{SO}_4)_3$ solutions, at least in the range 0.1 to 2.2m.

A preliminary study of the applicability of the $\text{PbO}_2, \text{PbSO}_4$ electrode to high temperature aqueous systems was made, by using the cell $\text{Pt}, \text{PbO}_2, \text{PbSO}_4, \text{H}_2\text{SO}_4(\text{m}), \text{Ag}_2\text{SO}_4, \text{Ag}$. The electrode seemed to be satisfactorily stable when prepared by plating the PbO_2 onto platinum, while it was considerably less stable when made by inserting a platinum wire into a $\text{PbO}_2 - \text{PbSO}_4$ slurry. One advantage of this electrode over the hydrogen electrode for measuring acid activities is that the former could be used in solutions of uranyl ion without reducing it to tetravalent uranium.

The effective neutron capture cross section of U^{236} for MTR neutrons was determined from Np^{237} and Pu^{238} analyses on highly irradiated fuel rods. The value of about 35 barns obtained is consistent with a value calculated from the resonance parameters. An effective capture cross section for Pu^{240} of about 1200 barns (based on 580 b for the fission cross section of U^{235}) was calculated both from experimental Hanford plutonium isotopic ratios and from the resonance parameters by using 510 b for the thermal value. This effective value for Hanford neutrons should decrease from about 1200 b to about 500 b as the local amount of Pu^{240} increases, due to increasing self-shadowing of neutrons near the energy of the first resonance (1 ev). (AEC Activity 5330)

Chemistry of Corrosion - Measurements of the electrode potential of platinum and stainless steel electrodes were made in sulfuric acid at 85°C, in the presence of gamma radiation from Co^{60} . The data, of a preliminary nature, indicate that the radiation field leads to prompt shifts of potential to values that are intermediate between the potentials of the hydrogen and oxygen electrodes, respectively.

Further measurements of the ennobling effect of chloride and thiocyanate ions upon the electrode potential of iron in inhibitor solutions, when the additions are in quantity insufficient to cause loss of inhibition, showed that the elevation of potential varies with concentration in accordance with an adsorption isotherm. The observation is of significance in connection with the mechanism by which the potential is established.

PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

Potentiostatic measurements are in progress on the relation between the corrodibility of stainless steel and the potential at which it is maintained in dilute sulfuric acid at temperatures above 25°C. The preliminary results in aerated, 0.1 N sulfuric acid at 85°C indicate that this technique may be effective in comparing different steels undergoing the hydrogen-evolution type of corrosion. (AEC Activity 5330)

Chemistry of Technetium - Accurate chloride and rhenium analyses of the K_2ReCl_6 sample used for low-temperature heat capacity measurements gave $44.53 \pm 0.04\%$ Cl and $39.06 \pm 0.10\%$ Re as compared with the theoretical values of 44.58% and 39.04%, respectively. To ascertain that the two anomalies in the heat capacity at 103.5° and 110.5°K (in addition to the expected and observed anomaly at 76°K arising from the transition from antiferromagnetic to the paramagnetic state) are properties of the K_2ReCl_6 and not due to some impurity, the measurements will be repeated with a carefully purified sample prepared by a different method.

A preliminary value for the entropy of K_2ReCl_6 was computed from the data of sample I; at 298.16°K, $S^\circ = 87.20 \text{ cal deg}^{-1} \text{ mole}^{-1}$. This result may be compared with the entropy of the isomorphous, diamagnetic K_2PtCl_6 whose entropy at 298.16°K is $79.78 \text{ cal deg}^{-1} \text{ mole}^{-1}$. Preliminary computations of the electronic entropy of K_2ReCl_6 , comparing its total entropy with that of K_2PtCl_6 corrected by a corresponding states argument, gave a value different from the expected $RT \ln 4$. (AEC Activity 5330)

Characterization of Short-Lived Fission Products - Studies of the decay scheme of 13.5-minute Tc^{101g} were continued. An analysis of the gamma-ray scintillation spectrum in a 3 x 3 in. NaI(Tl) crystal disclosed gamma-rays of 130, 186, 238, 307, 415, 548, 630, 720, 846, and 939 keV energy. Gamma-gamma coincidence spectrometry experiments showed that: the 130-keV gamma-ray was in coincidence with the 186-keV gamma-ray; the 307-keV gamma-ray was in coincidence with gamma-rays at 125, 175, 238 keV; the 548-keV gamma-ray was in coincidence with 125, 175, 385 keV; the 720-keV gamma-ray was only in coincidence with a 125-keV gamma-ray.

Beta-ray spectra from the decay of Tc^{101} were measured on an anthracene crystal scintillation spectrometer. The most energetic beta-ray group has an energy of $1.32 \pm 0.03 \text{ Mev}$, and is in coincidence with the 307-keV gamma-ray. A second beta group of $1.07 \pm 0.05 \text{ Mev}$ energy is coincident with the 548-keV gamma-ray. Other beta-ray groups could not be resolved from the complex spectrum.

These results are consistent with a decay scheme involving levels in Ru^{101} at 130, 307, 316, 415, 548, 630, 720, 846, and 939 keV.

Preliminary scintillation spectrometry of 32-minute Cs^{138} showed that the gamma-rays of energy 0.55, 0.46, and 1.02 Mev are in coincidence with the 1.44-Mev gamma-ray, as previously proposed in the literature. Contrary to published decay schemes of this nuclide the known gamma-rays at 2.20 and 2.64 Mev are not in coincidence with the 1.44-Mev transition. A number of

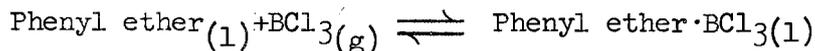
PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

low intensity gamma-rays were also disclosed in the gamma-gamma coincidence spectra; a moderately intense gamma-ray of 0.88 Mev energy was found in coincidence with the 1.44-Mev gamma-ray. It is apparent that the Cs^{138} decay is considerably more complicated than expected. (AEC Activity 5330)

Analytical Chemistry - A spectrophotometric procedure was developed for the determination of microgram quantities of gold in thorium oxide, based on absorbancy of the red-violet color of the gold-dimethylaminobenzaldehydorhodamine at 500 m μ . The coefficient of variation of the calibration factor was 4 per cent. Over the range of 3 to 10 micrograms of gold, thorium does not interfere, even when present in high concentrations.

In an investigation of the efficiency of tridecylphosphine oxide (TDPO) as an extractant for uranium, 0.1 M $Al(NO_3)_3 \cdot 9H_2O$ was shown to be a satisfactory substitute for 6 M HNO_3 as a source of nitrate ions. Since the extraction medium in this case is less acidic, $Al(NO_3)_3 \cdot 9H_2O$ would be preferred to HNO_3 when a mixed carbonate-fluoride flux is used in the fluorimetric determination of uranium. Uranium (10 μg) was proved to be extracted quantitatively with TDPO in the presence of 10 mg of each of these cations: V^{+5} , As^{+5} , Ni^{+2} , Fe^{+3} , Cu^{+2} , Pb^{+2} , Sn^{+2} , Zn^{+2} , Zr^{+4} , Mo^{+6} , Co^{+3} , and Cr^{+3} . The ions, Cr^{+6} , W^{+6} , and Th^{+4} , were extracted by TDPO and, consequently, quench the fluorescence of uranium severely. Essentially no quenching was observed, however, when 250 μg of Th^{+4} was present in the test sample. (AEC Activity 5330)

Chemical Separation of Isotopes - The separation factors for boron isotopes between BCl_3 gas and a number of BCl_3 organic complexes are listed below. Acetyl chloride, 1.003 ($-55^\circ C$), 1.014 ($2^\circ C$), 1.004 ($25^\circ C$); ethylene oxide, 1.022 ($25^\circ C$); phenyl ether, 0.999 ($-1^\circ C$), 0.998 ($28^\circ C$). The anisole- BCl_3 complex was too unstable to obtain isotopic data. Boron-10 appears to concentrate in the BCl_3 gas phase except in the phenyl-ether case. The phenyl-ether complex was of interest since BF_3 does not complex with this ether. Phenyl ether- BCl_3 was found to melt at $3-4^\circ C$. Vapor pressure-temperature data yielded a heat of reaction of -5.2 kcal/mole for the reaction:



A CS_2 - H_2O azeotrope (10 mole % H_2O , b.p. $42.5^\circ C$ at 740 mm) was distilled through a 30 bubble cap column. Assuming 15 stages in the column, the oxygen separation factor of 1.007 is approximately the H_2O^{16}/H_2O^{18} vapor pressure ratio (1.008) at this temperature. The throughput would be low because of the low water content of the azeotrope; however, such a distillation might be easier to carry out than a reduced pressure distillation of comparable throughput. (AEC Activity 5340)

OTHER PHYSICAL RESEARCH PROJECTS

The Oracle - During February, the Oracle electrostatic memory was converted from 3JPl to 6571 storage tubes. These new tubes were designed particularly for electrostatic storage and, therefore, have impurity-free storage screens;

PROGRAM 5000 - PHYSICAL RESEARCH (Continued)

thus, the redundant system which was required for 3JPl tubes could be abandoned. This effectively increases the memory capacity from 1024 to 2048 machine words.

The reliability of the memory was also increased by changing the pulse inspection scheme from that originally developed by Williams to one proposed by the University of Illinois, called the Illiac scheme. The new system takes information from more storage area for each binary digit without reducing the packing density of the digits. This is possible because in the Williams system two beam locations were required per digit, but the output signal was taken from only one; the Illiac scheme uses both locations to form a more reliable output signal.

Since these changes, the memory not only has double storage capacity, but the mean free error time has increased from about 2 hours to 10 hours. The new system stability is also improved greatly, reducing the memory maintenance time from about 6 hours to 2 hours per week.

PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Insect Cytology and Genetics - Irradiation of a population of mature sperm results in genetic changes which prevent the proper development of the zygote following fertilization (i.e. dominant lethal changes). Irradiation of a Y-bearing sperm can induce a dominant lethal in the Y and/or in an autosome; irradiation of an X-bearing sperm can induce a dominant lethal in the X and/or in an autosome. A dominant lethal in the X kills a female zygote and a dominant lethal in the Y kills a male zygote, whereas autosomal dominant lethals kill male and female zygotes equally; consequently a difference in the rate of dominant lethal production in the X and Y should result in a shift in the sex ratio.

No change in sex ratio was observed in the progeny of males given X-ray doses up to 4,000 r. These results indicate that the rate of dominant lethal production is the same in the X and the Y chromosomes, but allow no estimate of the rate. Consequently an experiment was designed which permitted an estimate of dominant lethal production in the X chromosome and in the Y chromosome. This was accomplished by comparing the effects of a given dose of radiation on the sex ratio of the progeny of males producing X-bearing and Y-bearing sperm with the sex ratio of the progeny of males which produce sperm containing X chromosomes and sperm containing neither X or Y

PROGRAM 6000 - BIOLOGY AND MEDICINE (Continued)

chromosomes (nullo-X nullo-Y sperm). From an experiment using 1500 r, it was estimated that approximately 15% of the X chromosomes and 15% of the Y chromosomes had dominant lethals associated with them. This is a dose at which 70% of the eggs hatch; consequently 20% of the chromatin (i.e. the X and the Y) is associated with approximately 50% of the dominant lethals. This may be because the sex chromosomes present a disproportionately large target, or because breaks produced in the sex chromosomes have a different average fate from breaks produced in the autosomes, possibly due to some difference in stage of chromosome replication of sex chromosomes and autosomes in mature sperm. (AEC Activity 6130)

Biochemistry - The problem of turnover of RNA in phage infected E. coli was reinvestigated under conditions thought to be more definitive than those previously employed. Thus, the RNA contribution from uninfected bacteria was maintained at an insignificant level, and furthermore, RNA phosphorus was identified unambiguously with RNA mononucleotide phosphorus. The results reveal that medium inorganic phosphate was incorporated in RNA after phage infection to an extent some 500- to 1000-fold more than could be accounted for on the basis of the few remaining uninfected cells. A marked difference was observed in the kinetics of incorporation in peptone broth as compared with glucose-synthetic medium. In peptone broth, a rapid incorporation of P^{32} into RNA phosphorus quickly ceased, whereas such incorporation in synthetic medium continued almost linearly for at least 60 minutes. In both cases, it was observed at all sample times that adenylic and uridylic acid phosphorus had specific activities some 50% greater than the other two mononucleotides, indicating that the incorporation of isotope was heterogeneous with respect to the total RNA phosphorus. Partial separation of the RNA from the infected by differential centrifugation revealed that supernatant RNA incorporated 5-10 times as much $P^{32}O_4$ as the particulate fraction RNA, although the latter contained some 60% of the total cell RNA. (AEC Activity 6130)

Pathology and Physiology - RF mice surviving acute lethality experiments in the ORNL 86-inch cyclotron have been observed throughout life in an effort to obtain information about the relative biological effectiveness (RBE) of fast neutrons for leukemia induction and other delayed effects. In approximately 500 animals exposed to lethal and sublethal doses of neutrons, the average incidence of myeloid leukemia was 22% in females and 35% in males, as compared to 17% and 20% in females and males exposed to doses of X rays equivalent in 30-day lethality, and 2-3% in controls of both sexes. The incidence of thymic lymphoma was 27% and 6% in neutron-irradiated, 48% and 17% in X-irradiated, and 16% and 4% in nonirradiated females and males, respectively. It appears that at dose levels which are equivalent in 30-day lethality, fast neutrons and X rays are of comparable leukemogenic potency. Since neutrons were observed to be about 1.5 times as effective as X rays in producing 30-day mortality, the RBE for leukemia induction would appear to be in the neighborhood of 1.5; however, the lower incidence of thymic lymphoma and greater frequency of myeloid leukemia in the neutron-exposed, as compared to the X-irradiated mice, suggests that the RBE may vary slightly with the type of leukemia induced. (AEC Activity 6130)

PROGRAM 5000 - BIOLOGY AND MEDICINE

General Physiology - The effect of temperature on the stability of the soluble fraction from rat liver (Ratlivsol - T) was examined. Fresh preparations were incubated at 28°, 37.7°, and 41.5°C and the nitrogen content of the non-precipitated supernatant material was determined. The maximum precipitation which occurred in 2 hours at 28°, 37.7° and 41.5° was 1.3, 7.8, and 15.3%, respectively. (AEC Activity 6230)

Mammalian Recovery - Preliminary immune response studies in irradiated mice treated with bone marrow indicate that the immune mechanism remains that of the host animal and is not that of the donor animal. A new finding on the effect of irradiation on the immune mechanism is the demonstration that irradiated mice temporarily lose their ability to recognize closely related antigens while retaining their ability to recognize distantly related antigens. The immune response of irradiated mice pretreated with AET is nearly complete. Preliminary evidence suggests that the homologous reaction in irradiated mice receiving foreign bone marrow cells is partially avoided by treating the mice with streptomycin. This places more emphasis on the bacterial component of the homologous reaction than was previously realized. Detailed quantitative studies of blood-forming tissue response in irradiated mice receiving foreign bone marrow and on irradiated mice pretreated with AET are nearly complete and help explain many features of these experiments. Tissue culture techniques have now shown maintenance of bone marrow effectiveness in treating irradiation injury for 1 week. Studies with white blood cell preparations (leukemoid blood) show important differences with the bone-marrow treatment method. Leukemoid blood will not work between strains of mice as is the case with bone marrow. Short-term (4 days) preservation of bone marrow at ordinary refrigerator temperatures (3-4°C) was demonstrated. (AEC Activity 6230)

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Billerbeck, C. J., Jack Farquhar III, R. C. Reid, J. C. Bresee, and A. S. Hoffman, "Performance of a Pulsed Spray Column", Industrial and Eng. Chem. 48, 183 (1956)

Cartledge, G. H., "The Mechanism of the Inhibition of Corrosion by the Pertechmetate Ion. II. The Reversibility of the Inhibiting Mechanism", J. Phys. Chem. 60, 28, (1956)

Cartledge, G. H., "The Mechanism of the Inhibition of Corrosion by the Pertechmetate Ion. III. Studies on the Perrhenate Ion", J. Phys. Chem. 60, 32 (1956)

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Holley, C. E., Jr., R. N. R. Mulford, F. H. Ellinger, W. C. Koehler, and W. A. Zachariasen, "The Crystal Structure of Some Rare Earth Hydrides", J. Phys. Chem. 59, 1226 (1956)

Lazar, N. H., E. Eichler and G. D. O'Kelley, "Nuclear Levels in Sr⁸⁸ from the Disintegration of Rb⁸⁸ and Y⁸⁸", Phys. Rev. 101, 727 (1956)

Moak, C. D. and W. B. Wisseman, "The Energy Levels of Be¹⁰", Phys. Rev. 101, 1326 (1956)

O'Kelley, G. D., N. H. Lazar and E. Eichler, "The Decay Chain Ca⁴⁹-Sc⁴⁹-Ti⁴⁹", Phys. Rev. 101, 765 (1956)

Parker, G. W., I. R. Higgins and J. T. Roberts, "Processing Radioisotopes by Ion Exchange", Ion Exchange Tech., p. 391, Academic Press, N. Y. (1956)

Rogosa, G. L. and W. F. Peed, "Tc K X-Ray Spectrum", Phys. Rev. 100, 1763 (1956)

Van Artsdalen, E. R., "Complex Ions in Molten Salts. Ionic Association and Common Ion Effect", J. Phys. Chem. 60, 172 (1956)

Vander Sluis, K. L. and J. R. McNally, Jr., "Fabry-Perot Interferometer with Finite Apertures", J. Opt. Soc. Am. 46, 39 (1956)

Willard, H. B., J. K. Bair, J. D. Kington and H. O. Cohn, "Elastic Scattering of Neutrons by Li⁶ and Li⁷", Phys. Rev. 101, 765 (1956)

STATUS OF CONSTRUCTION

Lead Shop, Building No. 7005 - The construction required for the renovation of Building No. 7005 in the Shop and Warehouse Area was completed during the month. The existing building, a sheet-metal-covered, steel-frame-structure, 40 feet by 100 feet which was originally erected for the use of the J. A. Jones Company, was altered to serve as a Lead Shop. These alterations in the main part consisted of replacing the swinging doors with roll-up doors, extending the concrete floor slab the full extent of the building, and the installation of change room facilities, utilities, heating and ventilating facilities and certain pieces of shop equipment provided by the Laboratory.

Tools and equipment from the existing Lead Shop of the main Laboratory Area will be moved to this building and it is expected that the facility will be in operation in the new location in the near future.

This is an additional step in the program of centralizing the major portion of the shop facilities in that area and the replacement of the original temporary buildings with permanent type facilities.

VISITORS

Adamson, Lt. Cdr. R. E., Jr., USN, Military Liaison Committee
Barton, Lt. Col. J. R., Military Liaison Committee
Brooks, Lt. Cdr. D. M., USN, Military Liaison Committee
Cain, Capt. G. E., Military Liaison Committee
Cochrane, Jr., Lt. Col. W. J., Military Liaison Committee
Cocoran, Maj. E. L., USAF
Coffin, Col. R. E.
Coiner, Jr., Brig. Gen. R. T., USAF, Military Liaison Committee
Daley, Brig. Gen. J. P., Military Liaison Committee
Fields, K. E. U. S. Atomic Energy Commission
Forbes, Lt. Col. M. B., Military Liaison Committee
Free, Col. R. H., Military Liaison Committee
Harman, Col. L. V., USAF
Hoy, Brig. Gen. C. E., Air Force Special Weapons Project
Johnson, T. H., U. S. Atomic Energy Commission
Loper, H. B., Chairman, Military Liaison Committee
Luedecke, Maj. Gen. A. R., Chief, Air Force Special Weapons Project
McDaniel, P. W., U. S. Atomic Energy Commission
McDonald, Rear Adm. D. L., USN, Military Liaison Committee
Orphan, Maj. R. C., Military Liaison Committee
Rodden, Maj. R. M.
Schoenfeld, Cdr. W. A., USN, Military Liaison Committee
Shands, Rear Adm. Courtney, USN, Military Liaison Committee
Stanford, Lt. Col. M. N., Military Liaison Committee
Terrell, Lt. Col. M. H.
Trexler, Lt. Col. C. E., Military Liaison Committee
Withington, Col. Kenneth, USAF, Military Liaison Committee

FOREIGN VISITORS TO ORNL:

Bjerge, Torkek, Danish Atomic Energy Commission, Copenhagen, Denmark
Dardel, G. V., Swedish Atomic Energy Commission, CERN, Geneva, Switzerland
Gelin, Ragner, Swedish Aktiebolaget Atomergi, Stockholm, Sweden
Hasegawa, Seiji, Sumitomo Trading Co., New York City (Japan)
Hirata, Y., Japanese Atomic Energy Research Institute (AERI), Japan
Hisado, T., Japanese Atomic Energy Research Institute, Japan
Holm, L. W., Nobel Institute of Physics, Stockholm, Sweden
Hormander, Olaf, Swedish Aktiebolaget Atomergi, Stockholm, Sweden
Jacobson, Jacob C., Danish Atomic Energy Commission, Copenhagen, Denmark
Julian, F. A., U.K.A.E.A., Reading, England
Nakayama, K., Tokyo Shibaura Co., Res. Engr., G.E., Schenectady, N. Y.
Omura, M., Japanese Atomic Energy Research Institute, Japan
Rynniger, R. F., Swedish Aktiebolaget Atomergi, Stockholm, Sweden
Sander, J. E., U.K.A.E.A., Harwell, England
Seligman, Henry, AERE, Harwell, England
Soto, Dr. S., Tokyo Shibaura Company, Tokyo, Japan
Svenke, Erik, Swedish Aktiebolaget Atomergi, Stockholm, Sweden
Thoraesus, R. R., Karoleniska Hospital, Stockholm, Sweden
Topsie, Haldor, Danish Atomic Energy Commission, Copenhagen, Denmark

RADIOISOTOPE SALES AND COSTS

<u>Type of Transaction</u>	<u>February 1956</u>	<u>FY 1956 to Date</u>
Domestic Sales	\$102,833	\$ 953,872
Foreign Sales	8,401	57,190
Project-Cash Sales	1,962	28,163
Project-Transfer	872	7,733
Technical Cooperation Program Credits	225	1,125
Plant Credits	2,320	13,834
AEC Credits	<u>13,864</u>	<u>114,714</u>
Total Radioisotope Income	\$130,477	\$1,176,631
Total Radioisotope Costs	\$ 90,666	\$ 685,915
Total Radioisotope Shipments	1,140	8,646
Boron and Helium		
Income	\$ 2,927	\$ 28,229
Costs	\$ 425	\$ 869
Shipments	13	65

GROSS OPERATING COSTS

	<u>Cost for February</u>	<u>FY 1956 Cost to Date</u>
Programmatic Operating Cost - Net	\$3,416,100	\$25,495,698
Plant and Equipment Cost	209,352	2,384,968
Program "H"	1,072	91,977
Work for Other Parties - Transfers	38,068	90,608
Inventory Changes	62,859*	83,251*
Reimbursable Work for Other Parties	179,827	1,630,434
Deferred Charges	<u>28,007</u>	<u>29,622</u>
Total Laboratory Cost - Net	\$3,809,567	\$29,640,056
Estimated Cost for Next Month - Neg	<u>\$4,000,000</u>	<u>\$33,640,056</u>

*Credit

PERSONNEL SUMMARY

	<u>Number of Employees</u> <u>March, 1956</u>	<u>New Hires</u> <u>March</u>	<u>Terminations</u> <u>March</u>
Administration	60	0	1
Operations*	126	2	2
Engineering, Shops, and Mechanical	796	5	4
Laboratory and Research	2027	30	35
Protection	130	0	0
Service	<u>384</u>	<u>9</u>	<u>2</u>
	3523	46	44

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

A total of 840 Laboratory personnel are located in the Y-12 Area.

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Reports in this series issued during the past year:

March 1955	ORNL-1878
April 1955	ORNL-1886
May 1955	ORNL-1905
June 1955	ORNL-1920
July 1955	ORNL-1936
August 1955	ORNL-1968
September 1955	ORNL-1980
October 1955	ORNL-1995
November 1955	ORNL-2016
December 1955	ORNL-2032
January 1956	ORNL-2044
February 1956	ORNL-2062