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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

NOVEMBER 1955

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

November, 1955

F. T. Howard

and

W. H Sullivan

Date Issued: DEC 7 1955

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November, 1955

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

November, 1955

This status and progress report presents 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

Waste Metal Recovery - Since July 10, 1955, 56 tons of uranium and 5,856 g of plutonium have been dissolved and recovered from ORNL Graphite Reactor slugs at an average operating cost of $2.37 per pound of uranium processed; the Purex-type chemical flowsheet was used. Across-the-plant recoveries of uranium and plutonium were, respectively, 99% and 98%. Six days of downtime during this 130-day period reduced the on-stream efficiency of the plant to 95%. The over-all average uranium processing rate was 840 lb per day, or 905 lb per operating day. (AEC Activity 2350)

Metallex Process - In laboratory studies on the preparation of anhydrous $ThCl_4$, the temperature of initiation of thermal denitration and dehydration of hydrated thorium nitrate was lowered from 300°C to 93°C by the presence of starch and to 130°C by a graphite-type carbon. The temperature at which denitration and dehydration are complete was lowered from >500°C to 350°C by both starch and carbon. The presence of nitrate slowed the chlorination of ThO_2 in the presence of carbon at temperatures below 350°C. Hydrated ThO_2 prepared at room temperature was much more reactive to chlorine at 350°C than that prepared by thermal denitration of thorium nitrate in the presence of nitrogen at 350°C, and the latter was more reactive than ThO_2 prepared by denitration of nitrate in the presence of air and carbon at 350°C. Chlorination of ThO_2 with oxygen and chlorine simultaneously in the presence of a large excess of carbon converted 35% of the thorium to $ThCl_4$. Reaction of chlorine with ThC_2 initially at 300°C in a simple flame reactor resulted in 90% conversion of the thorium to $ThCl_4$.

In preliminary studies on dry contacting of $ThCl_4$ with 2.4 M sodium amalgam in a 1.5-gal dispersal contactor, thorium reduction was 78-98% of the 200 g charged. The filtered product residue yield was 65-77%. In laboratory studies, the percentage recovery of thorium in the residue increased with an increase in temperature from 100°C to 125°C, and decreased above 125°C. Reduction also increased with increased agitator speeds above 1500 rpm, and with agitation time above 30 min in experiments where sodium concentration, thorium/mercury ratio, and reactor design were constant. In kinetic studies at 125°C, and 1500 rpm, the percentage reduction of thorium to metal was a maximum of 95% in ~15 min agitation time. At 15 min, 41% of the total thorium and 38% of the reduced thorium metal were suspended in the bulk of the

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amalgam phase, while ~60% of the thorium metal was separated at the sides, baffles, and bottom of the reactor as a quasi amalgam.

The second and third billets prepared from Metallex thorium were extruded; one resulted in a satisfactory rod, the other gave a rod with poor surface condition. The latter was due to a surface-conditioning operation consisting of superficial melting with an inert arc which caused cracking of the billet surface. Cursory differential thermometry experiments give evidence of the existence of as many as three solid phases in the thorium-mercury system. (AEC Activity 2704)

PROGRAM 3000 - WEAPONS

RaLa Production - A run was completed during the latter part of September and 19,000 curies of product was shipped on October 2. (AEC Activity 3702)

PROGRAM 4000 - REACTOR DEVELOPMENT

HOMOGENEOUS REACTOR PROJECT

Homogeneous Reactor Test - The major construction work is now within the reactor cell itself. Equipment items installed during the month include the fuel storage tanks, blanket storage tanks, fuel and blanket feed pumps, and blanket low-pressure assembly. Prefabricated process and service pipe lines were attached to these vessels. The bottom of the thermal shield in the reactor compartment was completed. All of the work within the reactor cell is proceeding on schedule.

The assembly of the core and pressure vessel is being machined in order to accomodate the recently designed zirconium-to-stainless steel mechanical joint. The heat exchangers are in the final stages of testing at the Foster

Wheeler Corporation. The fabrication of the high-pressure piping was begun at the Crane Company shops. One of the main circulating pumps was received from Westinghouse. The main steam system was completed and pressure tested; it is presently being insulated. (AEC Activity 4103.1)

HRT Chemical Pilot Plant - The stairways into cells A and D, the roof deck of cell D, and the stainless steel floor and two intermediate concrete floors in cell A were finished. The support for the sampler assembly was installed in cell C. The office area is complete except for the heating and ventilating system. The only work still remaining for the outside contractor is the roof deck of cell A.

Zirconium oxide which had been precipitated in a circulating loop test to simulate corrosion products expected in the HRT fuel was concentrated by a factor of more than 200 upon passage through a hydroclone. A 0.04-in.-dia titanium hydroclone was eroded at a rate of 50 mils/yr in a 1300-hr test under reactor fuel processing conditions. (AEC Activity 4103.1)

HR Physical Chemistry--Aqueous Reactor Systems - Continued exploration of the metal oxide-uranium oxide-carbon dioxide-water systems at high temperatures and pressures was centered on the system containing Rb_2O. The phase relations in the Rb_2O system appear to differ from those of the corresponding Li_2O system in that there is probably a more extensive unsaturated liquid region in the Rb_2O system at 250°C. A uranium concentration of about 35 g/liter at a Rb/U mole ratio of about 14 was obtained at 250°C; higher uranium concentrations at lower (more favorable) ratios may be possible. Moreover, it appears that this system remains stable at a lower CO_2 pressure than that required for the Li_2O system.

A single experiment in the thallous oxide system at 250°C failed to reveal any appreciable uranium solubility. The solid phase obtained in the experiment was not a uranyl carbonate but probably a uranate. (AEC Activity 4103.1)

HR Analysis - The effect, upon electrical power generation costs, of adding Li_2SO_4 (99.98% Li^7) to a UO_2SO_4-D_2O plutonium-power reactor system was studied as a function of U^{238} concentration and Li_2SO_4 concentration. The addition of Li_2SO_4 to the fuel solution in the same molar concentration as uranium increased the fuel cost by about 0.8 mill/kwh near the optimum uranium concentration of 500 g/liter (reactor temperature = 280°C) when a credit of $40/g was allowed for the plutonium produced. The use of a plutonium credit of $20/g lowered the cost differential to about 0.4 mills/kwh.

Effective extrapolation distances were calculated for one-region spherical reactors which are surrounded by a thick pressure vessel. The standard two-group, two-region calculation techniques were used. The results were interpreted so as to give the effective extrapolation distance associated with a particular reactor size and pressure-vessel thickness when the reactor is treated as a bare reactor. Effective extrapolation distances were obtained for U^{235}-fueled reactors containing between 1 and 400 g of U^{238} per liter,

operating between 250°and 320°C, and ranging in size between 3 and 15 ft in diameter, with a pressure-vessel wall thickness of 3 to 20 in. The extrapolation distances which were obtained varied from 5 to 36 cm, declined with decreasing core diameter, and increased with increasing pressure-vessel wall thickness. For wall thicknesses exceeding 10 in. the extrapolation distance was near its asymptotic value. (AEC Activity 4103.1)

HR Instrumentation - The tank-weighing schemes for obtaining low-pressure system inventories were successfully demonstrated by tests conducted on the HRT low-pressure system subassembly.

Drawings covering the nuclear instrumentation system for the HRT were approved, or are now being reviewed. These include the panel interconnection, the chamber interconnection box, the power distribution, and the block diagram of the process monitoring system. A specification for the remote area monitoring system is now being reviewed.

The drawing showing the main instrument air header, the compressors, and the reducing stations was approved. All electrical panel wiring diagrams were completed. The electrical conduit schedule was completed. All reactor bellows-sealed, hand-operated valves were received and met all specifications. Fifteen of thirty low-pressure, bellows-actuated valve operators were received from the vendor. A prototype dump valve actuator was received from the vendor and is now being tested. The Instrument Index was compiled and is being reproduced for distribution. Both differential-pressure cell vendors have now received approved material and have completed machining operations. (AEC Activity 4103.1)

HR Design - HRT drawings were issued during this period for the leak detector system, refrigeration piping details, valve and equipment supports, equipment location, bulkhead penetrations, fission product adsorbers, and for the fuel and blanket storage tank installations. (AEC Activity 4103.1)

HR Metallurgy - Specimens of various zirconium alloys were heat-treated to establish their transition temperatures. For the Zircaloy-2 used in the HRT core, the $\alpha/(\alpha + \beta)$ temperature was found to be 810°C and the $\beta/(\alpha + \beta)$ temperature was 970°C. The various Zircaloy-3 materials checked had $\alpha/(\alpha + \beta)$ temperatures varying from 815°to 850°C and $\beta/(\alpha + \beta)$ temperatures between 925° and 975°C. The width of the two-phase region increases in both directions with increasing alloy content.

A preferred orientation was found in the Zircaloy-2 core tank material. The mean linear coefficient of thermal expansion over the temperature range from zero to 500°F varied from 5.0 units (10^{-6} in./in.-°C) in the longitudinal direction to 5.9 units in the transverse direction.

Half-cell measurements were made, by using calomel reference electrodes, to illustrate that stress-corrosion cracking in austenitic stainless steels may involve electrical potentials. It was shown that stainless steels which are susceptible to martensite transformation on deformation are also susceptible

to stress-corrosion cracking. Steels in the cold-worked condition (and which therefore contain martensite) were shown to be more anodic than similar ones in the annealed condition.

Stress-corrosion testing of spring-tempered Inconel-X was completed. Specimens were corroded in boiling 42 wt % $MgCl_2$ (154°C). One specimen survived a stress of 70,000 psi for 194.5 hr, while the other survived 70,000 psi for 316 hr followed by stressing at 90,000 psi for 196 hr. Both tests were terminated by equipment failures. No evidence of stress-corrosion cracks was found on either specimen. (AEC Activity 4103.1)

HR In-Pile Autoclave Tests - A series of experiments was undertaken several months ago to determine the effect of excess H_2SO_4 on the corrosion of type-347 stainless steel by uranyl sulfate solutions under irradiation. Radiation exposure in the LITR has now been completed for three of these experiments. For each experiment the bomb was of stainless steel, type 347, and the solution was 0.17 m in UO_2SO_4 and 0.01 m in $CuSO_4$. The H_2SO_4 concentrations of the solutions initially charged were 0.015 m for the first and 0.03 m for the second and third. The initial oxygen pressures at the test temperature were approximately 1100 psi, 1300 psi, and 350 psi, respectively. The exposure temperature in each case was 250°C, and the power density was about 9 w/ml. The radiation exposure times for the three experiments were approximately 310 hr, 920 hr, and 790 hr. For each experiment the corrosion rate indicated by the oxygen data was about 0.8 mpy, and there was no evidence of a marked change in rate during the course of the experiment. The pin corrosion specimens from the second experiment were examined, and the corrosion rate determined from the pin weight data is in agreement with the oxygen results.

It is clear from the above results that the irradiation effect on these three systems was much less than that observed for previous test systems which contained no added acid and were generally at an initial oxygen pressure of 250 to 350 psi, but which were otherwise similar to the present system. The present results indicate that the added acid is responsible for the improved corrosion resistance.

A determination of the effect of irradiation on the corrosion of platinum was completed. Two pin-corrosion specimens were positioned in a rack in a Zircaloy-2 bomb. The bomb was charged with a 0.17 m UO_2SO_4 solution, and exposed in hole HB-5 of the LITR for approximately 102 hr at an estimated temperature of 270°C. The power density during exposure was about 17 w/ml. The measured weight loss per specimen was 0.5 mg, which corresponds to a corrosion rate of about 0.4 mpy.

A determination of the effect of fast electrons from a van de Graaff accelerator on the corrosion of Zircaloy-2 by uranyl sulfate solutions was completed. Three foil-type specimens of Zircaloy-2 were positioned in a small thermal convection loop in such a manner that solution moved past each side of the specimens. The specimen to be irradiated was downstream from one specimen and upstream from the other. The loop was constructed of type-347 stainless steel and the solution employed was 0.17 m in UO_2SO_4 and 0.02 m in $CuSO_4$. Irradiation

was carried out intermittently for a total of 100 hr, with the test temperature at 250°C. The estimated power density during irradiation in the solution adjacent to the exposed specimen was 20 to 30 w/ml. No significant weight change for any of the specimens was observed and it is estimated that the corrosion rate during exposure was less than 1 mpy for the exposed specimen. (AEC Activity 4103.1)

HR In-Pile Loop Tests - In-pile operation of the fifth loop, designated L-4-11, is in progress. This loop contains specimens of many materials including 22 alloys of the Zircaloy-3 series. There are also specimens of Zircaloy-1, Zircaloy-2, containing varying amounts of hydrogen, and crystal bar zirconium. In addition to the zirconium alloys, there are specimens of several alloys of stainless steel and of different titanium alloys. Specimens of sintered Al_2O_3 and of synthetic sapphire are also included. As of November 25, this loop has operated with enriched fuel for a total of about 700 hr, and approximately 1500 Mw-hr of LITR energy have been accumulated during the in-pile operation. (AEC Activity 4103.1)

HR Dynamic Loop Tests - A corrosion test was completed in which a solution of 0.04 m uranly sulfate, 0.02 m sulfuric acid and 0.005 m copper sulfate was circulated at 340°C for 200 hr. Solution samples withdrawn during the run indicated that the uranium content remained essentially constant but that about 10 to 20% of the copper was lost from solution. Type-347 stainless steel specimens showed weight losses corresponding to an average corrosion rate of 3 mpy; the rate appeared independent of flow velocity in the range of 10 to 70 fps. Presumably most of the weight was lost during the period of film formation; subsequently the corrosion rate was probably considerably less than 3 mpy. Zirconium specimens showed slight weight gains and titanium showed slight weight losses; in both cases the extent of corrosion was practically nil.

Further corrosion testing with solutions containing high concentrations of uranyl sulfate and equivalent concentrations of lithium sulfate (1.3 to 4.4 m) was continued. It was demonstrated that at 300°C the flow rate at which rapid corrosion begins is between 30 and 40 fps, and that at lower flow rates the corrosion rate of stainless steel is low, probably no more than a few mils per year, after a protective coating has formed. At 250°C the flow rate at which the corrosion rate is more rapid is 20 to 25 fps; at lower flow rates the extent of corrosion is also low, once a protective coating has formed. No critical velocity was observed at 200°C; specimens showed the same weight loss regardless of flow rate (10 to 80 fps).

The following approximate values for a solution containing 4.4 m uranyl sulfate and an equimolal concentration of lithium sulfate demonstrate the substantial lowering of the vapor pressure of the solution over that of water: 350 psi at 250°C; 680 psi at 300°C; 870 psi at 325°C; and 1100 psi at 350°C. The complete phase stability of the solution was visually observed in a heated quartz tube for temperatures up to 390°C, the highest temperature to which the tube could be heated. (AEC Activity 4103.1)

HR Dynamic Slurry Tests - Corrosion studies with thorium oxide slurries were performed in a 100-gpm circulating loop at 300°C under 120 psi oxygen pressure at an average thorium concentration of 1043 g/kg H_2O; the thorium oxide had been calcined at 800°C. The following corrosion rates were observed on pin-type specimens in a 97-hr run at a velocity of 76 fps: type-347 stainless steel, 103 mpy; titanium 75A, 115 mpy; Zircaloy-2, 70 mpy; gold, 50 mpy; platinum, 90 mpy; Stellite-25, 160 mpy; and sintered aluminum oxide, 4000 mpy. Slurry corrosion appears to depend strongly on velocity and also on concentration, as well as on the nature of the material under attack. Consequently, attack rates much lower than the above would be anticipated under ordinary service conditions.

The proposed use of the HRT Core Vessel Mockup, fabricated of 54S aluminum, in the slurry blanket mockup system, suggested that tests be performed to explore the corrosion resistance of 54S aluminum to environments anticipated for this service. The material showed relatively good resistance (actually slight weight gains) to oxygenated distilled water at 200°C in the vapor and liquid phases during 1000-hr static autoclave tests. However, circulating oxygenated distilled water at 26 fps relative velocity in toroids at 200°C caused severe attack of the alloy (approximately 700 mpy) during a 56-hr exposure. The presence of ten ppm Ni(II) in solution decreased the attack by the circulating water to less than 5 mpy for the same exposure time. Oxygenated thorium oxide slurries at 1000 g Th/kg H_2O, circulating at 26 fps relative velocity in toroids at 200°C, severely attacked the 54S aluminum in 56 hr, with attack rates greater than 10,000 mpy; the presence of 400 ppm Ni(II) did not alter the attack. (AEC Activity 4103.1)

GENERAL REACTOR RESEARCH

Basic Reactor and Shielding Research - Thermocouple readings of temperature in the fuel of the third plate from the convex face of an MTR-type element in the BSR showed the following results: (1) With the convex face of the test element adjacent to the No. 2 safety rod and the reactor operating at 400 kw, movement of the safety rod from 15.1 to 21.8 in. (full out) gave rise to a temperature increase of 1.5°C in the plate. (2) After operation of the reactor at 1 Mw for 4-1/2 hr, with the test element in the center of the front face, the test element was withdrawn from the operating reactor into an air-filled can to observe afterheating; the temperature increased from an operating temperature of 78°C to a peak temperature of 102°C in 40 min.

In anticipation of a series of critical experiments to be performed with "clean" BSR-type elements of 89% enrichment with 140 g of U^{235} per element, a series of calculations of critical mass was undertaken to determine how accurately the critical loading for a reactor of this well-known type can be predicted. The calculation utilized the code for the Oracle by Bradshaw, which solves the diffusion equations in two-dimensional, cylindrical geometry for three regions which are so disposed that one region is taken as core and the other two form an effectively infinite all-around reflector. So far, 10 hr on the Oracle have yielded a curve of k vs mass which indicates k = 1 for 2100 g. Past experience indicates that this is too low a critical mass;

however, the method of constructing the equivalent cylinder for the noncylindrical actual reactor appears to be questionable and further calculations with better approximations are planned. (AEC Activity 4570)

Reactor Theory - A coding of an Oracle program for the "reflector savings method", for the two-group computation of fluxes and multiplication constant of a reflected parallelopiped, was undertaken. (AEC Activity 4570)

Metallurgical Materials and Processing - Nichrome and an alloy containing iron, chromium, and aluminum were exposed to carburizing conditions found suitable for austenitic stainless steel. The addition of carbon was accomplished with limited success. The iron-base alloy did not carburize but 2.5% carbon was found in the Nichrome after extended exposure. Preliminary dissolution experiments with the Nichrome in nitric acid indicate that the metal becomes passive regardless of the high carbon addition. (AEC Activity 4610)

PROGRAM 5000 - PHYSICAL RESEARCH

Reactor Operations - The LITR remote control panel (located in the Graphite Reactor control room) was put in operation in September and has operated very successfully. An operator is also being stationed at the old LITR control panel during the trial period.

Ninety percent of the old X-slugs in the canal have now been shipped to the Metal Recovery Plant. Many of the ruptured slugs had corroded severely during the long storage period under water, causing a difficult handling situation.

Design work was finished on a new pneumatic tube to be installed in the west regularing rod hole of the LITR beryllium reflector. Additional holes were cut also in the side of the LITR "A" tank for insertion of flexible tubes to accomodate more vertical experiments that need not be disturbed when the top lid is removed.

The LITR safety circuit on the period detector was modified so that the period scram became less sensitive above 1% full power; this has greatly reduced the number of unnecessary scrams.

ISOTOPE PRODUCTION

Radioisotope Production - The new radioisotope catalog is now being printed and will be available for distribution about January 1.

The largest irradiation device yet made at the Laboratory, containing 10,000 curies of Co^{60}, was fabricated in the new remote control cell. The irradiator consisted of 24 individual parts, each of which was sealed with solder and tested for leaks.

In the program for the scheduled production of 40 curie/gram Co^{60} in the MTR, 19,000 curies was received during the period. A total of $167,466 has been paid to the MTR operators for the Co^{60} received thus far by ORNL.

Approval was received to produce an additional 50,000 curies of 20 curie/gram Co^{60} in the MTR over a period of two years.

Approximately 120 curies of Sr^{90}, 2000 curies of Cs^{137}, and 390 curies of rare earths were produced from tank-farm waste during the last two months. (AEC Activity 5111)

Radioisotope Process Development - Loading facilities for transferring waste into a shipping container were completed and the 15-ton shielded transfer tank was shipped to Arco by rail on November 17.

Tests were made on molten cesium pyrosulfate, which might be used for casting radioactive cesium sources. The compound melts at 550°C, slowly decomposing to SO_3 and the normal sulfate. The melt was very corrosive to stainless steels and Monel metal and is probably unsuitable for source preparation.

A 2.5-yr irradiation of europium oxide in the LITR to determine the maximum point in the production curve was concluded. The maximum point was reached in 2.5 years instead of 1 year, as determined by calculation. The cross section values used in the calculation will be corrected.

About 10 mc of Xe^{131m} was obtained by milking from 20 curies of I^{131}. The Xe^{131m} was required for a Physics Division research problem.

Construction continued on Phase I of the Fission Product Pilot Plant. The excavation is completed and footings are now being poured. Phase II design work (equipment and its installation) was completed and sent out for bids, which are due on November 29. (AEC Activity 5112)

PHYSICS

Recoil Spectrometry - Internal conversion in Xe^{131m}(E_γ = 0.163 Mev, $T_{1/2}$ = 12 days) produces vacancies in the internal electronic shells of the Xe^{131} atom, and if these vacancies are not filled through "fluorescent"

x-ray emission, a cascade of Auger events may take place in which the vacancies multiply as they proceed outward through the electronic structure. The resulting distribution in charge of the product atoms was measured by using a source volume at low pressure (5×10^{-6} mm Hg), an electric collecting field, and magnetic deflection to separate the ions in various charge states. Applied voltages were made inversely proportional to the charge states, so that the electric collecting and focusing forces were uniform from charge to charge. Preliminary results for the charge spectrum of Xe^{131} are as follows:

Charge	Relative Intensity	Charge	Relative Intensity	Charge	Relative Intensity
1	*	7	76	13	9
2	*	8	100	14	5
3	7	9	72	15	3
4	20	10	54	16	1
5	35	11	28	17	0.5
6	48	12	15	18	*

*Not measured
(AEC Activity 5220)

Neutron Diffraction - The magnetic structure of Mn_2Sb was determined from neutron diffraction investigations which employed single crystals of the compound. On the basis of macroscopic magnetic measurements, Guillaud (thesis, Strasbourg, 1943) had predicted that this material was ferrimagnetic with the two manganese atoms possessing different magnetic moments, coupled in an antiparallel arrangement. Specifically, the atomic magnetic moments were thought to be 3 and -5 Bohr magnetons, and subsequent molecular field calculations by Neel (Ann. Phys. 3, 137, 1948) used these values satisfactorily to explain the unusual temperature variation of the spontaneous magnetization and inverse susceptibility. Neutron diffraction investigations on powdered samples were found to agree in general with the suggested model, but the complexity of the patterns and difficulties of analysis did not permit a straightforward determination of the magnetic scattering amplitudes and corresponding atomic magnetic moments. These values were readily determined by a study of single crystal reflectivities at room temperature with magnetized and unmagnetized samples, and investigations on specific reflectivities at 78°K allowed a direct experimental determination of the saturation atomic moments. These values were found to be 2.10 ± 0.15 and -3.95 ± 0.30 Bohr magnetons, in disagreement with the predicted values. Molecular field calculations using the experimental values were found to explain the spontaneous magnetization and susceptibility data equally as well as the earlier calculations of Neel.
(AEC Activity 5220)

High Voltage Program - Neutrons elastically scattered by Li^7 have a strong p-wave ($J = 3^+$) resonance at 256-kev incident energy. The interference with the s-wave potential scattering background should give rise to fairly large polarizations, thus making Li^7 a useful analyzer. Neutrons emitted from the

$Li^7(p,n)Be^7$ reaction at $\bar{E}_{p\ lab} = 2.2$ Mev, $\Theta_{1\ lab} = 70^\circ$ ($\varphi_{1\ cm} = 90^\circ$), and $\bar{E}_{n\ lab} = 280$ kev were scattered from a Li^7 sample, 1 in. dia by 4 in. long, through angles of $\Theta_{2\ lab} = \pm 49^\circ$ ($\varphi_{2\ cm} = \pm 55^\circ$) and $\Theta_{2\ lab} = \pm 82^\circ$ ($\varphi_{2\ cm} = \pm 90^\circ$). Energy resolution was 14 kev. The averaged values of the product polarizations obtained from measured asymmetry ratios, corrected for multiple scattering, were $P_1(90^\circ)\ P_2\ (55^\circ) = -0.20 \pm 0.04$ and $P_1\ (90^\circ) = -0.27 \pm 0.05$, respectively. Assuming that the s-wave potential scattering channel spins are statistically mixed, the calculated polarization values for elastic neutron scattering by Li^7 through CM angles of 55° and 90° at $\bar{E}_{n\ lab} = 280$ kev are $P_2\ (55^\circ) = -0.34$ and $P_2\ (90^\circ) = -0.37$. This gives an average value for $P_1\ (90^\circ) = 0.66 \pm 0.09$. If the s-wave potential scattering is all channel spin 2, the average value becomes $P_2\ (90^\circ) = 0.59 \pm 0.08$.

Neutron energies are being measured in the energy range 1 kev to 10 Mev by the time-of-flight technique. From 1 kev to 50 kev the method is employed to measure total cross sections, with the $Li(p,n)Be^7$ reaction as neutron source. In the energy range 1 kev to 10 Mev essentially the same apparatus is used to measure neutron spectra from neutron inelastic scattering and (d,n) reactions. Flight times range from 100 to 1200 millimicroseconds; they are measured with a resolution of 10 millimicroseconds by using 5×10^{-9} to 10×10^{-9} sec bursts of neutrons. These neutron bursts are produced at a repetition rate of one million/sec by ion beams which have respectively the same pulse duration and repetition rate. A fundamental advance was made in technique in that pulsing of the ion beam was achieved in the terminal of the Van de Graaff rather than beyond the analyzer magnet. This development represents a factor of at least two gain in neutron intensity available for the neutron spectrometry. At the same time, disposal at the terminal of the unused ion beam has virtually eliminated the beam itself as a source of background.

The Coulomb excitation of ruthenium isotopes was studied. Metallic powders, isotopically enriched in each of the seven stable ruthenium isotopes, were pressed into thin (~100 mg/cm^2) metallic foils which were mounted on nickel backings for support. The targets were bombarded by protons with energies 1.5 to 3.0 Mev and the resulting γ-ray spectra were studied with a 3 by 3 in. NaI scintillation spectrometer. One γ-ray was observed in each of the even-A isotopes: Ru^{104}, 358 kev; Ru^{102}, 475 kev; Ru^{100}, 540 kev; Ru^{98}, 654 kev; and Ru^{96}, 840 kev. Reduced transition probabilities for excitation were obtained from the absolute cross section measurements. The angular distribution of the 358-kev γ-ray of Ru^{104} was measured for incident proton energies of 1.5, 1.7, 1.9, 2.1, 2.4, 2.7, and 3.0 Mev. Five γ-rays with energies of 131, 187, 303, 545, and 720 kev were observed to be excited by proton bombardment of Ru^{101}. A γ-ray of 92.5 kev is observed in Ru^{99}. (AEC Activity 5220)

Theoretical Physics - The theory of the angular distribution of alpha particles emitted by aligned nuclei was worked out. The primary consideration is the evaluation of certain statistical tensors which depend on the spin Hamiltonian describing the coupling of the nucleus to the electrons in the ion. For the case of any electronic spin, including quadrupole and aniso-

tropic dipole hyperfine coupling, and with the possibility in mind that one may wish to use magnetic fields, the relevant quantities are obtained as a power series in the inverse temperature. (AEC Activity 5220)

CHEMISTRY

Volatility Studies - Two types of gas distributors were tested for use in the fluorination reactor, the sieve plate and the percolator. Agitation was more vigorous with the percolator, but entrainment was lower with the sieve plate. The percolator is being modified to decrease entrainment.

Full-scale freeze valves in process-type lines failed to seal, probably because of salt shrinkage during freezing. The design is being modified.

Laboratory studies indicated that NaF can be repeatedly reused for decontamination of the UF_6 volatilized from the fused salt. In a series of four runs with the same NaF in the two-bed absorption procedure, there was no indication of decreased decontamination resulting from buildup of activity in the material. The product UF_6 has less activity than natural uranium. The NaF/U weight ratio over all four runs was about 1/1, in contrast to a ratio of 4/1 in each single run. The uranium loss on the NaF beds under process conditions was 0.1 to 0.2%. In batch tests, with completely dry NaF, the loss was less than 0.01% when fluorine was used as a sweep gas. It was shown that refluorination is not required for desorption of the UF_6 by an experiment in which 98.6% of the absorbed UF_6 was desorbed with N_2 alone as the sweep gas. The UF_6 absorption capacity of one lot of Harshaw Chemical Co. NaF was about 0.9 g of uranium per gram of salt and was independent of temperature, pressure, or pellet size over the range 70° to 150°C, 7 to 15 psia, 1/8-in. to 40 mesh. The capacity of Baker and Adamson Analytical grade NaF was 1.9, corresponding very closely to the complex $UF_6 \cdot 3NaF$. (AEC Activity 5310)

Ion Exchange Studies - The 12-in.-dia continuous ion exchange contactor was operated at the Grand Junction Raw Materials Pilot Plant for a 5-day test period at rates of 4 to 8 gpm (5-10 tons of ore per day). The uranium loss was 1% and was not affected by flow rate; the product met uranium contamination specifications. Design was initiated for a 100-ton per day unit. (AEC Activity 5310)

Feed Materials Processing - In studies on the Florox process, 98% of the UO_3 fed to the 4-in.-dia moving-bed reactor was converted to UF_4 by carbon and HF. The product contained 0.2% carbon. The feed to the reactor was the same as that used in a 15-in.-dia reactor, in which only 87% was converted because of the inability to maintain a high temperature in the reactor. In preliminary tests, carbon was removed from UF_4-C pellets to the limit of analytical detection (0.02% of sample) by combustion in dry O_2 for 5 hr at 400°C. The reaction was accompanied by slight oxidation of the UF_4.

Free-energy-change calculations indicated that in the oxidation of UF_4 to UF_6, the reaction $2UF_4 + O_2 \longrightarrow UO_2F_2 + UF_6$ is much more likely to occur at room temperature than reactions producing undesirable by-products, for example, U_3O_8. Temperatures of 500°C or above are necessary, however, for a reasonable oxidation rate, and some by-products may be expected in this temperature range. Calculations also indicated that UO_2F_2 should not be thermally decomposed at 800°C or below.

Thermal-conductivity data on U_3O_8 indicated that it is a good insulator; the use of U_3O_8 bricks as a refractory liner for the moving-bed reactor should therefore maintain low outside wall temperatures.

In studies on the Excer process, UF_4 was prepared from simulated unfiltered ore leach pulp by ion exchange and electrolytic reduction. Calcium reduction of the UF_4 yielded a uranium metal button pure enough for fabrication of fuel elements. (AEC Activity 5310)

Hot Laboratory Research - Recovery of neptunium-237 from the ion-exchange column wastes of the Metal Recovery Plant has resulted in the isolation of nearly two grams of this isotope.

Consistent material balances were obtained which indicate that nearly 90% of the neptunium in the recovery wastes may possibly be available in the uranium strip of the plutonium ion-exchange column. One column, of two in parallel, has on occasion produced nearly three-fourths of a gram; the other column has for some reason produced only 100-200 milligrams from the same plutonium loading. It was established that the elution of neptunium along with the uranium by means of dilute sulfuric acid involves a sulfate complex of Np(IV). No difficulty is foreseen in continuing this extremely simple process nor in applying it to other Purex Plants, provided a similar distribution of neptunium is found. (AEC Activity 5330)

General Reactor Chemistry - A study was made of the effect of batch and of continuous processing on products of fluidized reactors. This effect was evaluated to give both the relative nuclide constitution and the neutron losses due to capture by any given nuclide. Several special cases were examined, including fission-product losses in a reactor core, U^{234} build-up in a Th^{232} blanket, and in particular the U^{232} content of U^{233} produced in a Th^{232} blanket. In this latter case a striking difference could be demonstrated in the U^{232} content of U^{233}. A six-fold lower U^{232} content was obtained by processing the blanket batchwise rather than continuously. This relative advantage would have been much greater but for the fast neutron leakage from the core. An average thermal flux of 5×10^{13} n/cm^2-sec and a 100-day processing period were taken in the computation which corresponds to one optimized version of this blanket.

This marked advantage factor for batch over continuous processing is inherent in the short time limit where it approaches n! ("n" refers to the "n'th" product in a sequence of nuclear transformations). Processing times encountered in practice are usually in the range of this short time limit (for "n"

neutron capture transformations) so that when one is concerned with high values of "n" large advantage factors may be realized. (AEC Activity 5330)

Chemistry of Corrosion - In the study of the effect of added electrolytes upon the electrode potential of electrolytic iron in corrosion-inhibiting solutions, it was found that chloride and thiocyanate ions produced initially a slight ennobling up to the concentration at which ultimate debasing began. Sulfate and perrhenate additions had no such effect. These observations support the previously developed hypothesis regarding the mechanism of action of the inhibitors of the pertechnetate type. The study demonstrated that it is necessary to have cooperation of an oxidative and an inhibitive process for stable passive potentials to be achieved.

The investigation of the electrochemical behavior of stainless steels is being extended to include the effect of radiation. Apparatus and instrumentation were assembled for the first studies, which will be in the gamma field of Co^{60}. (AEC Activity 5330)

Ion-Exchange Studies - Thermodynamically rigorous computations of ion-exchange selectivities are being extended to exchanges between monovalent anions on the strong-base anion exchanger, Dowex-2. Measurements of selectivities and of partial molal volumes of several resin salt forms, all of which are required for the computations, are being made.

In a continuation of isopiestic studies of resins of differing structure, osmotic coefficients have recently been obtained for the alkali and alkaline earth cation salts of a weakly cross-linked (0.5%) DVB) polymethacrylic acid resin. In general, these osmotic coefficients follow the same pattern as exists for the same salts of the acetate ion, e.g., the order of osmotic coefficients for the monovalent ions is Cs > K > Na > Li > H. This is the reverse order from that in the 0.5% DVB polystyrene sulfonate resins, and consequently the known preference of strongly cross-linked sulfonate resins for Cs^+ over Li^+ would be expected to be reversed in strongly cross-linked methacrylate resins. (AEC Activity 5330)

Instrumentation for Chemical Research - The purpose of the Multicurie Fission Products Pilot Plant (F-3 P) will be to separate usable isotopes from chemical wastes from Purex and, later, Hope chemical processing plants. It will also demonstrate the decontamination of these wastes to the extent that F-3 P plant wastes may be pumped into surrounding streams and rivers. The prime products from the F-3 P plant, in order of processing importance, will be cesium, strontium, technetium, and rare earths.

The instrumentation design for the F-3 P plant began on June 1, 1955 and was completed by October 6, 1955. The design was worked out in sufficient detail to present to a prime contractor a set of drawings and specifications for the complete procurement of all required apparatus, and to allow successful installation of all instrumentation for this plant. Thirty-nine drawings were produced which included instrument engineering flow sheets, panel-board location plans, panel-front arrangements, electrical and piping diagrams for

the rear of panel board, and piping and wiring diagrams from board to sensing element and transmitter location. Two specifications were written, entitled "Instrumentation" and "Instrument Panel-Board". The first covers the overall design, excluding the panel-board construction. Approximately 200 instrument specification sheets were written to describe the types of instruments, components, valves, etc. required. Opening of bids from contractors took place November 29, 1955. (AEC Activity 5330)

Chemistry of Technetium - Measurement of the low-temperature heat capacity of potassium hexachlororhenate (K_2ReCl_6) was completed. The three heat capacity anomalies (second-order transitions) exhibited by this compound were thoroughly characterized. The anomalies at 76° and 103°K show hysteris on cooling rapidly from just above to just below the transition region. Heat capacity measurements made immediately following this cooling were found to be approximately 1 to 2% low. Measurements made after keeping the sample overnight at a temperature just below the transition region were reproducible to within 0.1%. The third anomaly at 111°K showed no similar hysteris; the results obtained following rapid cooling agreed (to within 0.1%) with results obtained following prolonged standing at a temperature just below the transition region. Final calculations of the data are in progress. These data are of importance for comparison with the data to be obtained on the corresponding technetium compound, K_2TcCl_6.

Studies on the chemical behavior of fractional microgram quantities of technetium were continued. Less than 5% of pertechnetate ion was found to be coprecipitated with ferric hydroxide formed at pH values from 3.1 to 12. Pertechnetate ion is rapidly reduced to hexachlorotechnetate (IV) when placed in concentrated hydrochloric acid at room temperatures. In one molar acid, however, Tc (IV) appears to be oxidized rapidly by air to Tc (VII). Efficient and convenient procedures for the solvent extraction of Tc (VII) from acid, neutral and alkaline solutions were developed, based on the use of long-chain aliphatic quaternary ammonium compounds (i.e., liquid ion-exchangers) dissolved in inert solvents. With 0.3 g per 100 ml of cetyl-dimethyl-benzyl ammonium chloride in chloroform, more than 90% of pertechnetate ion could be extracted from solutions ranging from 1 M HCl to 1 M NaOH. (AEC Activity 5330)

Characterization of Short-Lived Fission Products - Preliminary measurements of the radiations from 3-m Rb^{90} disclosed a 0.87 ± 0.05 Mev gamma-ray, which probably represents the decay of the first excited state of Sr^{90}. A strong beta-ray group of energy 4.6 ± 0.2 Mev was seen, and possibly represents the beta decay to the first excited state of Rb^{90}.

Gamma-ray spectroscopy of Tc^{101} sources yielded transitions at 307 ± 3, 542 ± 5, 719 ± 8, and 840 ± 15 kev. All gamma-ray lines decayed with the 13.5-min half-life characteristic of Tc^{101}. These studies will be continued to establish the decay scheme of Tc^{101}. (AEC Activity 5330)

Chemical Separation of Isotopes - An effusiometer for determining the isotopic analysis of hydrogen-deuterium gas mixtures was constructed and tested. As the gas mixture effuses through an orifice, the change in pressure as a function of time is observed by using a thermistor as the pressure gauge. The samples are first passed over uranium metal chips heated to 500°C to remove impurities such as oxygen, nitrogen, and sulfur. The hot uranium also serves to convert water vapor samples to hydrogen gas. The device is compact, simple to operate, and gives results with uncertainties of about 2% when tested with mixtures of known isotopic composition.

A 53-fold enrichment of nitrogen-15 was achieved in a 7-ft exchange column using the Nitrox system for isotope concentration. The column operated automatically for a period of 9 days. The following isotopic separation factors between metal-ammonia complexes on Dowex-50 resin and aqueous NH_4OH were measured. Nitrogen-15 concentrated in the complexed ammonia (resin phase) in all cases. $Ni(NH_3)_4^{++}$, 1.009; $Zn(NH_3)_4^{++}$, 1.016; $Cd(NH_3)_4^{++}$, 1.007; $Ag(NH_3)_2^{+}$, 1.009. (AEC Activity 5340)

OTHER PHYSICAL RESEARCH PROJECTS

The Oracle - The cathode ray tube output unit for the Oracle was completed and placed in service. Facilities are provided for temporary visual and permanent photographic information output in the form of graphs or lettered sheets, similar to printed pages. Both of these outputs are extremely fast compared with more conventional punching and printing devices. For example, in order to plot a point on a graph it was formerly necessary to punch out two numbers for the coordinates of the point, which required about one second of machine time, then to locate this point on a piece of graph paper and to make a pencil dot. Now the entire operation is accomplished by the machine in about 200 micro-seconds. It is possible to plot a complete graph with axes and labeling in less than one second. The curve plotter camera has a film capacity of 200 exposures. Special circuitry was incorporated which provides semi-automatic letter plotting at a maximum speed of 2000 letters per second. This circuitry also makes coding for letter plotting simpler than that required for the point by point methods. The linearity of the resulting graphs is about 1%, and most of this error is caused by the nonlinearities of the plotting tube itself.

BIOLOGY

Genetic and Cytogenetic Effects of Radiations - The large protozoan, Stentor, has a surface layer of cytoplasm which is organized into a complex structure and can be regenerated after part of it is removed by cutting. This makes it possible to investigate the effects of radiation on the ability of the cell to synthesize specific structural proteins as well as increase in overall size. Irradiation with doses of about 200,000 r of X-rays causes slow decrease in size but even after this dose the animals can regenerate new surface structures. Thus, radiation can prevent the general synthesis of proteins required for increase in size without preventing the synthesis of the specific proteins required for the formation of the cell surface. A day after irradiation, however, the animals become abnormal in shape apparently as a result of an abortive spontaneous attempt to reorganize the cell surface. No abnormal animals are produced when the irradiated animals are cut within a few hours after irradiation. The cut animals regenerate normally, and this regeneration apparently prevents the later abortive reorganization. Probably some effect of the radiation, which does not inhibit the formation of new surface structure but causes it to be partially disorganized, reaches its maximum about a day after irradiation and can be avoided if the cell can be prevented from reorganizing at that time. Cutting has no effect on retardation of growth.

Dry maize seeds were irradiated with up to 500,000 r. The height of the seedlings was measured and plotted against dose. It was found that the ratio of height to dosage showed an initial decrease up to 120,000 r and then an increase to a plateau at about 400,000 r. Cytological studies showed: 1) an increase of chromosome breakage and 2) a decrease in the number of dividing cells with increased dosage. The increase in seedling height at doses above 120,000 r may be explained by postulating that the increase of chromosome breakage does not result in more cell lethality since division has ceased. (AEC Activity 6130)

Cytology and Genetics - A deficiency for the single salivary band 3C7 is responsible for the appearance of the dominant notch phenotype in Drosophila. Four recessive mutants, called facet, facet-notch, facet-notchoid, and split, have been localized in this band, and because of a reluctance to assign more than one gene to a band these mutants are often considered allelic to notch. Experiments performed here show that three of the four mutants can be separated by crossing over. Their linear order from left to right is facet, facet-notchoid, and split. The position of the fourth allele, facet-notch, has not yet been determined. (AEC Activity 6130)

Biochemistry - Ribonucleic acid-phosphorus turnover was demonstrated in T2r+ infected *E. coli* in a manner which reduces the contribution from uninfected bacteria to an insignificant level, and which unambiguously identifies such phosphorus with RNA-phosphorus. Turnover of RNA-phosphorus with medium $P^{32}O_4$ in nutrient broth takes place very shortly after infection with phage and then stops, whereas turnover of RNA-phosphorus with $P^{32}O_4$ in synthetic medium continues linearly for at least 60 min after infection. The unequal uptake of

the isotope into RNA mononucleotides isolated from alkaline hydrolysates of RNA requires a heterogeneous turnover of the phosphorus with respect to the total RNA-phosphorus. (AEC Activity 6130)

Pathology and Physiology - A single exposure of RF mice to X-rays was observed to cause a substantially greater incidence of myeloid leukemia in males than in females; following a dose of 300 r the incidence was approximately 44% in males and 11% in females, as compared to 1-3% in nonirradiated controls of both sexes. Preirradiation castration of the male inhibited the formation of this leukemia, whereas ovariectomy of the female was without effect on its incidence. Conversely, the susceptibility of the sexes to the induction of lymphoid leukemia and the effects of gonadectomy on its development were the reverse of those observed in connection with myeloid leukemia. Although endocrine factors had previously been recognized to play a significant role in the formation of lymphoid leukemia, the present studies demonstrate their importance in the pathogenesis of myeloid leukemia and indicate, furthermore, that these two types of leukemia differ fundamentally in their response to hormonal influences.

The lens of the newborn mouse was observed to be significantly more sensitive to X-irradiation than that of the adult, exhibiting rapid opacification within one month after exposure to a single dose of 300 r. The opacities noted in the newborn differ in location and configuration from those observed in the irradiated adult; these differences may be correlated with variations in the radiosensitivity of different regions of the lens occurring in the course of development and growth. (AEC Activity 6130)

Radiation Protection of Living Cells - Previous reports from this group indicated that ribonucleic acid (RNA) synthesis may be involved in bacterial recovery from damage produced by ionizing radiation. Addition to the plating medium of the purine and pyrimidine bases, guanine and uracil respectively, plus glutamic acid stimulates increased survival of X- or γ-irradiated *E. coli* B/r. Moreover, cells cultured prior to irradiation on a simple inorganic salts-glucose medium showed no such requirement for nutritional factors following irradiation. It is of interest that such cells contain 30 to 50% more RNA and no more deoxyribose nucleic acid (DNA) nor protein than cells cultured in a nitrogen-rich medium prior to irradiation. The latter cells show a striking dependence on precursors for RNA synthesis following irradiation. An RNA-polynucleotide fraction isolated from *E. coli* B/r was recently found to stimulate the recovery process. The role of this fraction in promoting recovery has not been completely elucidated at present. (AEC Activity 6230)

General Physiology - Cross reaction of antisera to rat liver homogenate supernatant and to rat plasma indicates the presence of common antigens. This is confirmed by the single and double serum-agar diffusion studies which show that there is a minimum of five different antigens in the rat liver homogenate supernatant common to rat plasma antigens. Characterization of the antisera to various ascites cell components is progressing with the use of the Ouchterlony agar diffusion technique. Various pertinent antigens are being tested as absorbants for the cross reactions previously reported.

The soluble phase of rat liver was prepared by a rapid method in which the liver is perfused, "homogenized", and the nuclei and nearly all of the mitochondria sedimented within 13-14 minutes after the death of the animal. The solution is rendered particle-free by centrifuging 60 min at 106,000 g. Rapid separation of the soluble phase is considered important since most of the catheptic activity of the liver is in the mitochondrial fraction. An average of 43% of the total liver nitrogen and 10% of the ribonucleic acid is recovered in the soluble phase. The finding that only 66% of the acid soluble nucleotides are in this phase suggests that part of the nucleotides are bound to cell structures. In phosphate buffers the soluble phase is stable between pH 1.26 and 3.5, and between 6.3 and 11. Between 3.5 and 6.3, however, marked precipitation occurs with a maximum of 24% of the soluble phase nitrogen precipitating near pH 5. Electrophoretically the precipitate is composed chiefly of one component, when observed in veronal at pH 8.6. An average of 12.3% of the soluble phase nitrogen is dialyzeable at pH 7.8. The pH stability of the soluble phase appears to be directly related to the viscosity increases which occur in living cells in acid media.

New methods are being developed to study the fate of injected proteins in the animal organism. Catalase was prepared from several species and electrophoretic studies were made. A chemical assay method was set up for catalase. Preliminary results indicate that a foreign catalase might be recovered from an injected animal by a combination of chemical and electrophoretic techniques. Catalase antibodies are being prepared as another method of recovering foreign catalase. Ring-labeled phenylalanine is being prepared with isotopic hydrogen for protein labeling with a view towards determining the rate of breakdown and the extent of reincorporation of injected proteins. Apparatus is being constructed for determining isotopic hydrogen in labeled proteins. (AEC Activity 6230)

Mammalian Radiation Recovery - A comparison of the effectiveness of isologous bone marrow (same strain of mouse) with homologous bone marrow (different strain of mouse) shows homologous bone marrow to be about one-half as effective in causing 30-day survival of irradiated mice. Changing the dose of homologous cells did not significantly improve survival. The reduced effectiveness of homologous bone marrow seems to correlate with failure of the lymphatic system of the mouse to regenerate. The food intake of irradiated mice in the homologous experiment was not significantly different from the isologous experiment. Recovered mice that received heterologous (rat) bone marrow showed no immunologic response to rat red blood cell antigens and practically no response to sheep red blood cell antigens. With massive doses of isologous bone marrow, recovery of the irradiated mice is essentially complete in four days, whereas ordinary doses show complete recovery in 10-12 days. Irradiated mice showed marked increase in bone marrow cell counts within 20 min after a massive injection of isologous bone marrow. Tissue culture of bone marrow cells for two days demonstrated effectiveness in causing survival of irradiated mice.

The 30-day LD50 for the C3H X 101F1 hybrid mouse was 692 r. In the presence of AET (S, β-aminoethylisothiuronium), the LD50 was raised to 1148 r; in the case of bone marrow treatment the LD50 was 1292 r; and with combination treatment the LD50 was 1863 r. (AEC Activity 6230)

STATUS OF CONSTRUCTION

Near the end of the month construction was started on the Process Waste Water Treatment Plant. The facility, to be located at the south side of the plant area near White Oak Creek, will remove solid particles which comprise most of the radioactive material now present in the waste water discharged from processes in the Laboratory. The plant, which is an adaption of a coagulation-sedimentation type of waste treatment plant, has a capacity of approximately 500,000 gallons per day. A small two-story structure is used to store chemicals and house the chemical feeders, mixing and agitating units, retention basins, sludge tank, and necessary pumps and piping. The system is designed so that during periods of discharge of low-activity waste water the discharge may by-pass the plant. Normally the waste water will pass through one cycle of treatment. During periods of discharge of high activity, however, the effluent may be handled batchwise and reprocessed as many times as desired. The retention basin will permit the accumulation of plant discharge, over several days, and will permit the thorough mixing of various types of discharges, prior to treatment. It is expected that the new facility will be placed in operation in October, 1956.

RADIOISOTOPE SALES AND COSTS

Type of Transaction	October 1955	FY 1956 to Date
Domestic Sales	$ 87,647	$ 397,881
Foreign Sales	3,534	28,741
Project-Cash Sales	5,579	17,502
Project-Transfer	2,567	3,688
Technical Cooperation Program Credits	0	640
Plant Credits	2,992	5,572
AEC Credits	16,075	38,935
Total Radioisotope Income	$ 118,394	$ 492,959
Total Radioisotope Costs	$ 129,320	$ 263,962
Total Radioisotope Shipments	1,161	4,101
Boron and Helium		
Income	$1,555	$13,324
Costs	$1,235	$ 3,535
Shipments	11	24

GROSS OPERATING COSTS

	Cost for October	FY 1956 Cost to Date
Programmatic Operating Cost - Net	$3,154,899	$12,250,965
Plant and Equipment Cost	132,526	1,067,651
Program "H"	49,647	82,497
Work for Other Parties - Transfers	14,861	41,755
Inventory Changes	30,722	10,902
Reimbursable Work for Other Parties	144,805	768,951
Deferred Charges	22,423	59,341*
Total Laboratory Cost - Net	$3,549,883	$14,163,380
Estimated Cost for Next Month - Net	$3,700,000	$17,863,380

*Credit

[redacted]

PERSONNEL SUMMARY

	Number of Employees November, 1955	New Hires November	Terminations November
Administration	63	0	0
Operations*	122	1	0
Engineering, Shops, and Mechanical	778	5	2
Laboratory and Research	1989	22	15
Protection	141	0	0
Service	373	8	1
	3466	36	18

*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:

November 1954	ORNL-1824
December 1954	ORNL-1838
January 1955	ORNL-1849
February 1955	ORNL-1867
March 1955	ORNL-1878
April 1955	ORNL-1886
May 1955	ORNL-1905
June 1955	ORNL-1920
July 1955	ORNL-1936
August 1955	ORNL-1968
September 1955	ORNL-1980
October 1955	ORNL-1995

[redacted]