

ORNL 1076
Progress Report

AEC RESEARCH AND DEVELOPMENT REPORT

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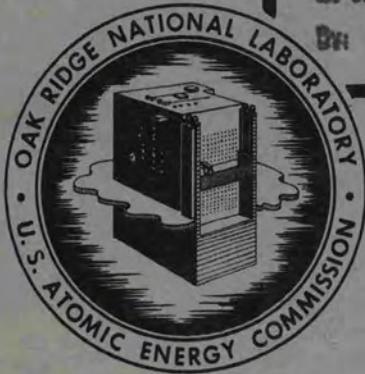
OAK RIDGE NATIONAL LABORATORY STATUS AND PROGRESS REPORT

JULY 1951

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

July, 1951

W. E. Thompson

Date Issued: AUG 8 1951

OAK RIDGE NATIONAL LABORATORY
Operated By
CARBIDE AND CARBON CHEMICALS COMPANY
A Division of Union Carbide and Carbon Corporation
Post Office Box P
Oak Ridge, Tennessee

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PROGRAM 1000 - RESEARCH FACILITIES

Research Laboratory Building #4500

Work on this building is approximately 44% complete. Concrete foundations are complete. Structural steel erection is complete. Metal roofing has been applied. Built-up roofing has been applied on Wings Nos. 3 and 4. Exterior masonry walls are 85% complete. Concrete floor slabs are 80% complete. Sheet metal duct work is 40% complete. Plumbing, heating and service piping are 50% complete. Electrical underground services are 60% complete. Electrical services in building are 50% complete.

Isotope Research and Semi-Works Building #4501

Work on this building is approximately 43% complete. Concrete foundations are complete. Concrete work on Semi-Works cell block is complete. Concrete work on Isotope Research cell block is approximately 30% complete. Structural steel erection is complete. Plumbing, heating and service lines are 30% complete. Sheet metal duct work is being installed. Concrete floor slabs are complete. Exterior masonry walls and interior partitions in Semi-Works building are approximately 95% complete. Exterior masonry walls are being erected on Isotope Research area. Electrical services in building are 35% complete.

High Voltage Laboratory Building #4503

This building is approximately 12% complete. Concrete foundations walls from 791.6 to 806. elevation are 80% complete.

Health Physics Waste Research Building #3504

This building is approximately 75% complete. Foundation walls, concrete floors and platforms are complete. Exterior metal siding and roofing are 98% complete. Structural steel and stairs are complete. Mechanical and electrical services are being installed in building.

Chemical Isolation and Purification Laboratory Building #23

This contract was awarded to the Fred E. Hicks Construction Company of Knoxville, Tennessee. Work on this building was started Wednesday, July 18, 1951. Excavation for foundations and footings has been started.

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Test Facilities Building #22

This contract was awarded to the V. L. Nicholson Company of Knoxville, Tennessee. Work on this building was started Wednesday, July 11, 1951. Excavation for foundations and footings is approximately 90% complete.

ORSORT Laboratory Building #3017

This building is being erected by the Maxon Construction Company. Work was started Monday, July 30, 1951.

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PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

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

The equipment installation in the ORNL Metal Recovery Building is now 95% complete. The process vessels have been calibrated and the leak testing of process lines is now in progress.

Purex Process (AEC Activity 2802-3)

Last month it was reported that the Purex Process had been demonstrated in the ORNL Pilot Plant at full Hanford activity level. The product losses were satisfactorily low in these runs; however, the decontamination factors were low by approximately a factor of 2. It has been demonstrated at KAPL that satisfactory decontamination factors can be obtained by the use of a head end treatment that was not used in the ORNL runs. Alternate procedures are being studied at ORNL to obtain increased decontamination. A study of conditions in the second uranium cycle indicates that by increasing the uranium feed concentration and decreasing the acid concentration that the decontamination can be significantly improved. In addition, an electrolytic decontamination step has been developed that can be used either at the head end or tail end of the process; however, its application as a tail end process has been demonstrated to give satisfactory uranium decontamination and to simplify considerably, the adjustment of chemical conditions. The TBP concentration of the solvent in the second plutonium cycle has been increased to 30% to give a uniform solvent concentration throughout the Purex Process. At this higher TBP concentration, it has been found possible to increase the plutonium concentration in the product by a factor of 10. A laboratory study aimed at the recovery of plutonium from the metallurgical wastes was initiated.

The Pilot Plant has now produced 2300 pounds of uranium from the processing of 100 to 400 g/T uranium metal. This material is to be used to evaluate its operating characteristics in the Gaseous Diffusion Plant. Since the completion of the full scale hanford activity level run, studies have been carried out at 100 g/T level to study the effect of increasing the temperature of the uranium strip column and decreasing the volume of the plutonium strip solution. Neither of these changes have had a significant effect on the process. A prototype of the final uranium products evaporator for the Savannah River Plant has been received and will be installed in the Pilot Plant for evaluation. In addition, equipment is being designed for the installation of a continuous solvent recovery system and a dissolver off-gas decontamination system for the Pilot Plant.

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SCRUP Separation (AEC Activity 2344)

The first shipment of Chalk River material has been completed and the storage and handling canal is now in operation. The storage tanks for the Chalk River waste have been installed and tested. The first hot run should be started in September.

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PROGRAM 3000 - WEAPONS

RaLa Production (AEC Activity 3982)

The RaLa production cells have been decontaminated and repairs are being made. It is expected that the equipment will be ready to start a run scheduled for August 12.

MTR RaLa Development (AEC Activity 3982)

The Chemical Flow Sheet for the MTR RaLa Process has now been revised in order to allow for the recovery of U-235. Laboratory studies are now in progress to obtain the auxiliary chemical data that will be required to establish optimum processing conditions. The design of an ORNL Pilot Plant for the demonstration of this process is under way.

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PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR

LITR Operation (AEC Activity 9543)

The calibration of shim rods and the measurement of xenon growth and decay in the LITR have been completed. About one more week of MTR instrument testing remains and following this the reactor will be shut down for maintenance in preparation for steady operation at about 750 KW.

MTR Project Engineering (AEC Activity 4221)

The MTR control instruments which were to be constructed at ORNL have been completed and are being checked out in the LITR. It is expected that they will be shipped to Idaho in August.

MTR Fuel Assemblies (AEC Activity 9543)

Six MTR fuel assemblies have been completed except for adding the end-boxes and eleven more are being fabricated. It is expected that 46 assemblies plus eight control rods (enough for two pile loadings) will be ready for use by November 1 as scheduled, and the remainder will be delivered on schedule by March 1.

Idaho Chemical Plant Design (AEC Activity 9541)

The design of the Idaho Chemical Process Plant has been essentially completed with the exception of the dissolver off-gas decontamination system, the mass isotope sampler, and the final product handling facilities. The design of the waste disposal and liquid waste evaporator facilities is now in progress and the construction work on these facilities was started during the past month. The ORNL personnel now assigned at New York are now being transferred to Idaho.

A program is being considered for the design of feed preparation facilities for STR and SIR fuel units to be incorporated in the Idaho Chemical Plant. The major part of the research and development work for this design will probably be the responsibility of ANL and KAPL.

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HOMOGENEOUS REACTOR PROJECT

Experimental and Design Engineering (AEC Activity 4264)

The full scale gas let down system has been operated under simulated operating conditions of temperature pressure and flow rates. There were no oscillations under these conditions; however, the full range of flow rates has not yet been tested.

HRE Reactor Chemistry (AEC Activity 4263)

Pit-type corrosion has been observed in the fuel circulating loop at places where there was flow constriction, sharp bends (such as tee joints), or irregularities on the inner surface. Currently, special emphasis is being placed on testing parts of the loop where one or more of these conditions may exist.

Out-of-pile corrosion tests indicate that ~ 300 ppm is the minimum concentration of trisodium phosphate required to give corrosion protection to the reflector system. With this concentration of TSP, the corrosion rate is less than one mil per year.

Building 7500 - HRE (AEC Activity 4261)

The D₂O system is essentially complete and water is being circulated through it. The components of the fuel system are being fabricated and about 75% of them are completed. The overall reactor facility is now about 75% completed.

HRE Reactor Chemistry (AEC Activity 4263)

Recombiner Pilot Plant. Additional study of the performance of the pilot plant catalytic recombiner was carried out with steam flow to the catalyst bed varying from .5 to 1.5 cfm. The introduction of 1.5 cfm of steam and the use of cooling water in the burner jacker practically eliminated the disintegration of the catalyst pellets and lowered the range of the burner nozzle to .025 cfm.

Two test runs have been completed with gas flow rates of 20 cfm and 30 cfm. Temperatures in the burner chamber indicate a need for additional cooling surface to successfully handle increased gas flows.

The completion of these tests marked the conclusion of this phase of the HRE recombiner work.

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Recombiner Fundamentals. The recombination of hydrogen and oxygen using a copper catalyst is being investigated extensively in order to evaluate the possible application of this method to a large scale reactor recombiner.

The high pressure catalytic recombination program has been hampered by failure of equipment and an inopportune explosion. However, a high pressure flashback arrestor has been constructed and the work will be continued.

HR Fuel and Blanket Studies (AEC Activity 4263)

A slurry of magnesium uranate was studied as a fuel for homogeneous type reactors. The advantage of this type slurry would be that it is stable at a higher pH than the uranium oxide slurry. At the higher pH, a wider selection of materials for construction is possible because of the reduced corrosive nature of slurry. A one liter circulating system has been set up to determine the effect of circulation on particle size. Studies are also being initiated to determine the pumping characteristics of these slurries.

HR Fuel Reprocessing Studies (AEC Activity 4263)

Laboratory studies have indicated that under the proposed reactor conditions for a uranyl sulfate solution system, plutonium will precipitate. Therefore, it should be possible to remove the plutonium by filtration from the reactor system. However, it is probable that periodic flushing of the reactor system would be required to prevent the build-up of plutonium in various components of the reactor.

The recovery of heavy water from the uranyl sulfate solution was also studied. It was found that it was very difficult to completely dehydrate the uranyl sulfate salt. To date, analytical difficulties have prevented the determination of the amount of water held up with the uranyl sulfate.

AIRCRAFT NUCLEAR PROPULSION PROJECT

ANP Central Design (AEC Activity 4271)

Core. It has been decided that all moderator and reflector beryllium oxide blocks will be hot pressed by the Norton Company, and that the original block size (3.75" across flats) will be retained. The core arrangement has been redesigned to provide for an active lattice 30" in

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diameter and 34" in length. The original coolant tube and fuel tube sizes have been retained. The current core - pressure shell assembly provides for seven control thimbles located in the core and two instrument chambers located in the reflector. Material and component orders have been revised to include the changes and features referred to above. Detail and assembly drawings for the entire core - pressure shell assembly are being prepared.

Fluid Circuit. The fluid circuit currently includes a number of loops that probably can best be discussed independently, as follows:

A. Heat disposal loops. The heat disposal systems provide for heat transfer from Na to helium to ethylene glycol to water. The Na to helium heat exchangers and the helium to glycol heat exchangers have been studied in detail by Mr. S. Manson and the configurations that appeared to be most attractive have been reviewed with two prospective suppliers, The Griscom-Russell Company and the Vulcan Copper and Supply Company. Each of these companies confirmed the basic approach and have agreed to submit formal quotations for the heat exchangers in the early part of August. As each of the prospective suppliers has agreed to quote on the basis of 1" inconel tubing in the NaK heat exchanger, tubing has been requisitioned in order to expedite the ultimate delivery. The aforementioned companies also confirmed the calculated helium flow rates and pressure drops, enabling the release of a requisition for the helium blowers. Invitations to bid have been extended to approximately six blower manufacturers and the bid closure date has been established as August 8. The glycol to water heat exchangers have been found in Y-12 surplus and their custody has been transferred to the ARE project.

B. NaK Systems. It has been decided to revise the NaK system to provide for upward flow from reactor to an expansion tank, down from the expansion tank to the heat exchangers, down from the heat exchanger to the low point immediately above the dump tank, then to the pump and to the reactor. This revision places the pump on the low temperature side of the heat exchanger and obviates the need for employing the pump as a surge chamber. It is planned to maintain pump level control by means of a forced helium flow through an orifice, the area of which is adjusted by the NaK level. It has also been decided to employ a mechanical valve in the dump tank line rather than to maintain the liquid level by gas pressure as previously contemplated.

C. Helium system for pump seal for the pressure balancing. Failure of a fuel element is expected to release xenon and crypton to the NaK circuit and in turn to the helium present at the various NaK free

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surfaces. Studies have indicated that the helium so contaminated must be held for several days before being released to the stack. After several possible scrubbing arrangements were investigated, it was decided to make this helium circuit a closed loop with a valved line to the stack, permitting release after any desired waiting time. This system will include a low pressure reservoir, a scrubber, a small compressor, a monitor and a high pressure reservoir.

D. The helium monitoring circuit, the reactor room and pump room space cooling circuits, and the control rod cooling circuits are being reanalyzed in an endeavor to obtain dual usage of some of the components.

Layouts are in process for the systems referred to above and availability of the various components from existing stock or manufacturers channels is under investigation.

Electrical Final establishment of some of the major fluid circuit features has permitted an estimate of electric power requirements. Detailed investigation of conditions to be expected following the failure of external power has indicated that the heat capacity of the system is very large compared to the post-scrum heat generation. Accordingly it is found to be unnecessary to provide for continued operation of the main heat disposal circuit. It is planned to provide instead for operation of the NaK pumps, the monitoring and control rod coolant blowers, and the space cooling systems following failure of outside power. On this basis it appears that the maximum battery power requirement will be less than 10 KW. The AC-DC motor generator set appears to be governed by the design point condition, which requires approximately 50 KW, DC power. Warm-up of the entire system from room temperature to 1500^oF, within 24 hours, appears to require 100 KW AC, and 10 KW DC. Circuit diagrams are being prepared on this basis.

Remote Handling Equipment. Conferences have been held with The Timken Bearing Company regarding bearing selection and other design features of the remote cutting machinery. On the basis of these discussions, final layouts are being made, and requisitions have been released for the larger procured components. Experimentation is in process involving welding, cutting, rescarfing, re-welding a 2" thick stainless steel plate. These tests will be repeated with a 2" thick inconel plate when the material, currently on order, is received.

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ANP Experimental Engineering (AEC Activity 4271)

A Figure-Eight loop #2 incorporating a mechanical pump for sodium circulation was put into operation during the month. The loop failed after 12 hours of operation due to external electrical arcing which burned a hole in the pipe. A more simple loop is being designed for pump testing. Oxygen content of the sodium in the Figure-Eight loop rose from 0.02% at the beginning of operations to 0.06% at the end. It has been planned to refill the system with clean sodium to test the effectiveness of sodium purging as a cleaning technique; however, premature failure of the loop prevented completion of the plan. The relatively large oxygen pickup in the comparatively short operating time indicates the need for more effective cleaning and outgassing techniques; and in this connection, perchloroethylene (C_2Cl_4) has been adopted as a degreasing and cleaning agent in place of trisodium phosphate.

Use of helium and argon with relatively high oxygen content introduced a source of liquid metals contamination which led to intensive study of methods for assuring procurement of gases with minimum oxygen content and further purification before use. Suitable techniques have been worked out to minimize air contamination of helium during its transfer from the tank car to bottles and in addition a gas purifier has been fabricated and leak tested. Purification is effected by passing helium over heated copper turnings for oxygen removal, over heated titanium turnings for moisture removal, and eventually bubbling the gas through NaK at 750°F. Helium cylinders have been assigned to the Experimental Engineering Group and these will never be permitted to go below one hundred (100) psig to minimize air contamination. A materials quality control program is being instituted to assure use of compatible materials and techniques in all liquid metals systems.

A conference was held during the month to discuss liquid metals pump development and the coolant fluid circuit as it affected pump design. It was agreed that for ARE the pump should be an upflow, single suction type incorporating concentric volutes to minimize shaft side loads. The pump will be positioned in the cold leg between the sump tank and the reactor. Plans are under way to test conventional centrifugal pumps using "frozen sodium" seals. The frozen sodium seal involves refrigerating a column of sodium around the rotating pump shaft to below the freezing point. By the end of the month, such a seal had operated successfully for more than 250 hours sealing against sodium at 1000°F at 18 psi. Drawings for the two-stage electromagnetic pump are in the shop and fabrication is under way.

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Liquid Metals Research (AEC Activity 4275)

A series of samples were prepared using various size fractions of high density UO_2 to make a 30% UO_2 in stainless steel powder mixture. The sample containing -325 mesh material was not bonded to the 316 ss fuel tube wall, while another with -200 to +325 mesh UO_2 was bonded only superficially. However, two samples using -100 to +200 mesh and -60 to +100 mesh material were well bonded.

Hot rolled plated made with Fe- UO_2 and 302 ss- UO_2 cones clad with 316 ss were held at 1000°C for 100 hours in evacuated tubes. Metallographic examination revealed a diffusion zone of less than 0.001 inch between the iron cones and the 316 ss cladding. No diffusion could be detected between the 302 ss cones and the 316 ss cladding.

Inconel tube-to-header welded pairs were fabricated and tested at room temperature. Tensile strengths were in the range of 93,000 to 96,000 psi for manual inert arc welded specimens with 100% penetration, cone arc welded specimens with 100% penetration and cone arc welded specimens with 70% penetration. Elongations were in the range from 21 to 27% in three inches. These values compare with the tensile strength of 105,000 psi and elongation of 30% in three inches for as-received inconel tubing. The tubing used had an outside diameter of 0.187-inch and an 0.025-inch wall.

Samples of inert arc and metal arc weld deposits in inconel were treated in liquid sodium at 1000°C for 100 hours and in a liquid sodium-potassium-uranium fluoride mixture at 816°C for 100 hours. There was no significant weight change. Microscopic examination indicated a weld metal immunity to attack by these media at the temperatures and times tested.

ANP Reactor Chemistry (AEC Activity 4275)

Low Melting Fluoride Systems. The binary system MgF_2-UF_4 has been investigated in some detail during the past month. While the data are still insufficient to permit complete interpretation, it is apparent that no melting points below 750°C are to be obtained. Binary diagrams for $RbF-BeF_2$ and $KF-BeF_2$ have also been essentially completed. The four component system $NaF-KF-RbF-UF_4$ has been examined in detail in the regions of low melting point.

Synthesis of UF_3 , by reduction of UF_4 with finely divided uranium metal has apparently been accomplished in 500 gram batches. X-ray

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diffraction studies indicate that the material contains at least 80% of UF_3 ; chemical studies are still incomplete.

Hydroxide Systems. Preparation of pure anhydrous barium hydroxide and strontium hydroxide has been accomplished. Pure sodium hydroxide by recrystallization of the commercial material from absolute alcohol is now prepared on a routine basis.

ANP Corrosion Studies (AEC Activity 4275)

Corrosion of Metals by Fused Salts. Stainless steel and inconel continue to resist corrosion by pretreated fluoride fuel mixtures.

Studies of corrosion of various metals by sodium and barium hydroxide have to date shown no metal whose resistance was satisfactory.

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PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF RADIOISOTOPES

Radioisotope Production, Development and Operation (AEC Activity 5111)

The total accumulated KWH for pile operation during July was 2,439,677, averaging 3656 KW per operating hour. Pile down time was 10.3% as compared with 8.9% during June. There were no ruptured slugs.

The total number of radioisotope shipments during July was 809.

PRODUCTION OF STABLE ISOTOPES

Calutron Operation and Process Development (AEC Activity 5121)

The cell for electrodeposition of lithium metal was operated for a four-hour production run which was the most successful to date. 185 mgs of Li metal were produced.

New type receiver pockets designed to give better cooling during the collection of lithium isotopes and having the cooling passages as an integral part of the design have been in operation for two weeks. Similar pockets are being fabricated for lead and iron collections.

A survey of the methods of collecting the inert gas isotopes indicates that the electromagnetic method would be most applicable to those gaseous elements with more than two isotopes. Retention at the receiver can be accomplished by impinging the ion beam on metal targets. These, in turn, may be used directly as targets in particle accelerator experiments.

Iron collections were started in the Beta channels the first of this month and are being continued. These runs have yielded an estimated 112.2 grams of isotopes. Lithium operations were in progress throughout the month in the Alpha channels. This series of collections was started in March and an estimated total of 514.1 grams of lithium isotopes have been collected thus far.

There were 25 stable isotope shipments during July.

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PHYSICS

Theoretical Physics (AEC Activity 5211)

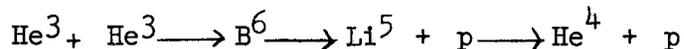
The theoretical work done on internal conversion coefficients provides results by means of which the angular correlation in cascade transitions involving conversion electrons can be obtained. This work is now nearing completion. Its great value lies in the fact that for certain nuclear transitions the emission of conversion electrons is extremely probable and in these cases, to which the present work pertains, conversion-gamma or conversion-conversion correlations would be the most advantageous experiment to carry out. In addition, such investigations determine relative aparity of nuclear states.

An effort has been made to examine in a thorough and exhaustive manner the theoretical basis for the nuclear alignment experiments. The work to date shows that there are no perturbing effects important enough to diminish appreciably the previously predicted nuclear alignment. Barring experimental difficulties, there is nothing to stand in the way of success in the nuclear alignment experiment. The following factors were considered: coupling between ions, the effect of ion-nuclear coupling on neutron absorption and the effect of neighboring resonance levels.

High Voltage Laboratory (AEC Activity 5211)

A proton source has been installed in the 2-Mev Van de Graaff accelerator and in its first test gave a beam of 26 microamperes at 1.5 Mev. It is expected that beam currents of 100 μ a can be obtained. The Cockcroft-Walton accelerator power supply has been increased to 400 KV.

The study of proton capture in nitrogen 14 has given evidence of three new levels in the oxygen 15 nucleus formed in the reaction $N^{14}(p, \gamma)O^{15}$. The He^3 - He^3 reaction has been established with reasonable certainty. Protons from the reaction have been observed and current effort is directed toward investigating possible new levels in Li^5 . The overall reaction is



Thin target yields for the He^3 -deuteron reaction are being studied; the angular distribution for this reaction at 300 KV has been studied. It was found not to be symmetrical, indicating that this is a resonance reaction, there are two levels of He^3 , or else this is a non-resonance reaction.

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Evidence has been obtained that the $\text{He}^3\text{-Li}^6$ reaction is detectable at 300 KV and it is planned to use this reaction to investigate the levels of the boron 8 which is formed.

The 5-Mev Van de Graaff accelerator has been used to study the reaction of protons with light elements, principally the neutron yield. New resonances have been found in B^{10} , C^{12} , and Be^9 .

Scintillation Spectrometry (AEC Activity 5211)

The gamma ray spectra of the uranium 234, 235 and 236 isotopes have been studied and the following gamma rays observed:

U-234	17±2Kev	53±2Kev	93±2.5Kev	118±2Kev				
U-235	17		93.5±2		143±3	184±3	289±5	386±15
U-236	17	51	93	118	143	184	289	386

The U-236 peaks at 93, 143, 184, 289 and 386 Kev were found to be of the proper energy and intensity to be caused by the U-235 content of the sample. When this contribution is subtracted from the total curve, the remainder has very nearly the same spectrum as U-234, except for the absence of the 93 Kev peak which appears with variable intensity in the U-234 spectrum. However, the concentration of U-234 in the U-236 sample would have to be about five times greater than assayed (0.15% U-234) to account for the intensity found. Thus at this point it appears that any gamma radiation from U-236 must be very weak in intensity.

Isotope Analysis Methods Laboratory (AEC Activity 5261)

Microwave Spectroscopy. Preliminary studies of dielectric materials for use in wave guide Stark equipment at temperatures up to 850°C have revealed a directional resistivity in mica at temperatures above 650°C.

Nuclear Resonance. Approximate linearity of response of the the nuclear resonance signal of lithium-7 has been obtained on pure samples with useful reproducibility (better than 5% average deviation) on samples containing 50 mg Li-7 or more. Addition of 6% HCl to pure water increased the proton signal by about 30% and indicates the importance of compound form on resonance amplitude.

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Mass Spectrometer Laboratory

In the development of a quantitative mass spectrometer method of evaluating possible radiation damage to the aircraft reactor fuel, dissociation properties of the reactor fuel, UF_4 and UF_3 have been investigated. Evidence has been found of the presence of UF_5 in the Mallinckrodt prepared UF_4 and this will be further investigated. A simplified ion source for both positive and negative ion work has been completed.

The 86-Inch Cyclotron (AEC Activity 5261)

The performance of the cyclotron has been improved by the installation of new dees and a modified insulation system. Targets operated during the month included isotope production, radiation damage, and basic physics experiments.

CHEMISTRY

Chemical Physics (AEC Activity 5311)

Neutron Diffraction. The crystal structures of deuterio-ammonium bromide at liquid nitrogen temperature and at room temperature have been determined by the neutron diffraction technique. It was found that in the low temperature phase the ammonium ions are oriented so that the deuterium atoms lie along four of the body diagonal directions in such a way as to make the arrangement about the nitrogen atom tetrahedral. In the room temperature phase the two possible tetrahedral arrangements of this sort are occupied at random so that the ammonium ion shows a two-fold orientational disorder.

Preliminary experiments relating to the use of single crystal neutron diffraction data for structural determination purposes have been encouraging in that reflections from $NaCl$ and KHF_2 specimens have given structure factor values in agreement with the known structure of these materials.

Microwave Studies. From observation of the hyperfine structure of the $J=0 \rightarrow 1$ transition of CH_3Cl^{36} , it has been confirmed that the assignment of 2 for the nuclear spin of Cl^{36} reported by others is correct. The observed quadrupole coupling was -15.87 mc, giving a somewhat more

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accurate quadrupole moment value of $-0.0168 \pm 0001 \times 10^{-24} \text{ cm}^2$. This work has been done in cooperation with members of the Physics Department of Duke University.

Instrumentation for Nuclear Chemistry (AEC Activity 5361)

A compact portable gamma scintillation counter using a thallium activated sodium iodide crystal, two inches thick and 1.5 inches in diameter, has been developed and field tested. This instrument, weighing only four pounds, includes an integral pulse height selector which allows one to detect only gamma rays above a given energy level which may be as low as 50 KV or as high as 4 Mev. The instrument has a rapid response and uses a regulated fly-back type electronic high voltage supply.

The instrument is only 3 x 3.5 x 10.5 and has a sensitivity such that where a geiger counter shows a background (cosmic rays plus natural radioactivity) of 70 counts per minute, the portable scintillation counter detects about 5000 cpm. Current effort is being devoted to the development of a differential discriminator for this instrument.

The gamma ray energy resolution of sodium iodide scintillation spectrometers has been improved by mounting the crystal directly on the photocathode of the photomultiplier after machining the crystal to give an exact fit with the tube surface. Also, Dow-Corning DC-200 oil of heavy viscosity has been found to be the best optical coupling medium. Aluminum foil reflecting surfaces completely surround the crystal.

Full width at half height for the Cs^{137} gamma ray is 9%, and the peak-to-valley ratio is 60 to 1, using an unpolished crystal which has been roughened with emory paper.

Radio-Organic Chemistry (AEC Activity 5311)

Benzoic acid labeled with carbon 14 in the carboxyl group has been irradiated under various conditions and it was found that NaBr inhibited the decomposition appreciably. Among the decomposition products other than CO_2 were found ortho, meta and para hydroxybenzoic acids. A fourth compound of similar molecular weight has been found but not yet identified.

Aqueous solutions of acetic acid labeled in carboxyl group and in the methyl group have been irradiated. Among the decomposition products, methane, malonic acid, succinic acid and glycolic acid have been identified. It has been established that the CO_2 comes from the carboxyl group.

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Chemistry of Uranium Raw Materials (AEC Activity 5361)

A report on studies of the association of carbonate and uranyl ions has been prepared and will be issued as document Y-794.

The work on development of methods for recovering uranium and vanadium from high lime carnotite ores is nearly complete. A summary report is being prepared.

Chemical Separation of Isotopes (AEC Activity 5361)

A ten-foot, one-inch column packed with 1/8-inch glass helices has been erected in order to test several possible gas-liquid exchange systems for the separation of chlorine isotopes. It is proposed to try the system HCl (gas), Cl⁻ first. In connection with the chlorine isotope work, the beta counter is being reactivated and stabilized to permit exchange experiments using Cl³⁶.

A re-evaluation of the system, LiSCN-tributyl phosphate-water, has been undertaken. This resulted because of a favorable assay obtained in the final stages of the previous run. Ten liters of tributyl phosphate approximately 1.2 molar in LiSCN has been prepared and five consecutive water washes have been made. It is planned to continue washing with water to remove approximately 50% of the LiSCN each time from the tributyl phosphate solution until at least ten passes have been made. Samples will then be submitted for the Li-7 assay.

Lithium Isotope Separation (AEC Activity 5361)

Several runs were made in the 48-foot by one-inch wide open trough apparatus. The greatest enrichment of Li⁶ achieved was from an isotopic ratio of Li⁷/Li⁶ = 12.89 (7.2% Li⁶) to a ratio of Li⁷/Li⁶ = 8.01 (11.1% Li⁶).

METALLURGY

Thorium Research (AEC Activity 5411)

Tensile tests were made on annealed samples of extruded Ames thorium. No correlation between tensile properties and extrusion conditions was found. However, the tensile properties of extruded material show definite relation to the original billets from which the extrusions were made.

Additional work has been done to determine the shear modulus of Ames thorium, and an average value of 4,260,000 psi was obtained. The average

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experimental value of shear modulus for steel was about 3% below the accepted handbook value, while the experimental value for aluminum agrees almost exactly with the handbook value, thus indicating the validity of results obtained with thorium.

Extrusions of pre-worked billets of thorium indicate that surface qualities of the extruded material are not improved by pre-working. Three-inch diameter billets which were forged from four-inch diameter cast ingots were extruded with no apparent improvement over extrusions of cast ingots. Pre-extruded billets were prepared by extruding four-inch diameter Ames-cast thorium ingots into a 2.5-inch diameter bar which was cut into approximately four-inch lengths. Three of these were extruded into 7/8-inch diameter rods which gave an overall reduction of 21 to 1. A shear die used for two of the extrusions showed no improvement in the surface quality of the extruded rod. An extrusion through a 15-degree bell die appeared to produce a slightly smoother rod.

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PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Cytogenetics (AEC Activity 6400)

Biological estimates of the ionizing radiation exposure received from atomic bombs are being made by comparing the effect of bomb radiation on the flowering plant Tradescantia with the effect caused by known doses of radiation. Tradescantia was exposed under three conditions: (1) to neutrons on the ground at varying distances from the blast center, (2) to gamma rays on the ground at varying distances from the bomb, and (3) to radiation in the cloud as experienced by drone airplanes passing through. The Tradescantia estimates of dose by biological effect (broken chromosomes) agree with the physical measurements by ionization meters and film badges within about 20% in most cases; and the biologically estimated decrease of gamma ray dose with distance agrees very closely with theory and with actual measurement by other methods.

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PERSONNEL SUMMARY

	<u>Number of Employees</u> <u>July 31, 1951</u>	<u>New Hires</u> <u>July</u>	<u>Terminations</u> <u>July</u>
Administration	94	0	7
Operations*	119	2	1
Engineering, Shops and Mechanical	916	8	11
Laboratory and Research	1359	29	20
Protection	170	2	3
Service	366	30	30
TOTAL	3024	71	72

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

RADIOISOTOPE SALES

<u>Sales</u>	<u>May</u>	<u>June</u>
Transfer within AEC	21,185.50	19,728.60
Cash Sales	25,464.73	9,170.00
Foreign	1,123.35	599.00
Cancer Program (Free)	39,347.63	37,331.05
Technical Cooperation Plan	50.00	4,020.00
Total Sales and Transfers to Date	1,705,682.52	1,768,927.87
Total Cancer Program (Free) to Date	860,007.73	897,408.78
Technical Cooperation Plan (Shipments to Date)	7,593.04	11,613.04

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

(a) Actual Cost for June, 1951 Construction - Program "H"	3,637,942 ^{1/} 47,727	
Total Operating & Constr. Cost		3,590,215 ^{1/}
(b) Estimated Operating Costs for July, 1951		2,000,000
(c) Actual Accumulative FY 1951 Operating Cost through June, 1951	26,773,041 ^{2/}	
Actual Accumulative FY 1951 Constr. Cost through June, 1951	788,528	
Total Accumulative FY 1951 Operating and Constr. Cost through June, 1951		27,561,569 ^{2/}
(d) Estimated Operating Cost FY 1951 through July, 1951		2,000,000

^{1/} Includes \$20,522 for June cost of stripping Building 9201-3 handled as deferred charge by Y-12 Production.

^{2/} Includes \$152,999 cost to date of stripping Building 9201-3 handled as deferred charge by Y-12 Production.