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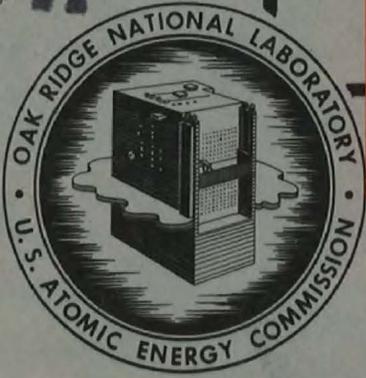
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OAK RIDGE NATIONAL LABORATORY  
STATUS AND PROGRESS REPORT  
SEPTEMBER, 1950

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of 22 pages. Copy 48  
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OAK RIDGE NATIONAL LABORATORY  
STATUS AND PROGRESS REPORT  
September, 1950

W. E. Thompson

Date Issued: OCT 6 1950

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OAK RIDGE NATIONAL LABORATORY

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PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

TBP Process for Waste Metal Recovery

Construction of the building for the ORNL Metal Recovery Plant was continued during this period, and requests for bids on the major equipment for the plant have been issued. In the laboratory, chemical conditions required for the separation of plutonium from uranium were established for the ORNL recovery program.

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PROGRAM 3000 - WEAPONS

ReLa Development

The recovery and decontamination of Ba<sup>140</sup> from MTR fuel units involves two major problems: (1) separation of the barium from the aluminum and uranium without significant loss of the uranium and (2) purification of the barium. Laboratory work is now in progress on the first phase of this program, evaluating alternate procedures for separation of the barium from aluminum and uranium.

Special Separations, U<sup>236</sup>

The five runs completed last month, for which assay data are available, yielded 3.6 grams of 33% U<sup>236</sup> and 145 grams of 99.7% U<sup>235</sup>. In the U<sup>236</sup> product the separation factor for U<sup>236</sup> with respect to U<sup>234</sup> was 40. Also, 9% of the U<sup>235</sup> and 5% of the U<sup>234</sup> vaporized was collected.

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PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR

MTR Project Engineering

Design of the shim-safety rod has been completed, but preliminary contacts with the Aluminum Company of America indicate that some dimensions may have to be modified to allow for greater tolerances on the extrusions. Westinghouse Electric Corporation has agreed to fabricate the entire magnetic clutch assembly.

Design of the handling tools is now about 50% completed.

MTR Test and Development other than Critical Experiments

The MTR flange mock-up is currently being assembled. Tank section C, the only component not yet delivered, is expected to arrive about October 10.

25 Process Design

Essentially all the material required for the design of the Chemical Process Building has been transmitted to the Foster Wheeler Corporation and the design of this building has been frozen. The process flow-sheets are 70% complete. At Arco the excavation work has been completed and the underground drain lines are now being laid. The basin for the SF storage building has been poured and the concrete for the footings and the first floor pad of the CP Building is scheduled to be poured early in December. There are now thirteen men from the Foster Wheeler Corporation assigned to ORNL and this number is to be increased to thirty. Representatives of the Bechtel Construction Corporation are to be assigned to ORNL to do the purchasing that must be closely coordinated with the design work. The metal dissolution studies were continued to establish the procedure to be used for the various fuel units to be processed in the Idaho plant.

HOMOGENEOUS REACTOR EXPERIMENT

Experimental and Design Engineering for Homogeneous Reactor

Concrete footings for the reactor building have been poured; clearing for the water and power lines has been completed. The contractor is

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experiencing difficulty in obtaining mill delivery of copper and steel products.

The heavy-wall reactor core and fuel pump have been installed in the full-scale mock-up. Tests of the fuel and dump systems will be started during October. The mock-up will be added to as HRE components are received from the shops or the vendors. This component adding and testing process will probably continue until the time when it is necessary to dismantle the mock-up for moving it to the HRE building.

Detailed design of the shim safety rods and drives has started. The recombiner program has supplied enough information to allow design work to be started. The over-all flow sheet is being revised. Shielding requirements have been established and consideration of the over-all arrangement of equipment within the shield is under way.

#### Corrosion of Reactor Materials

Re-examination of records for the in-pile tests on  $UO_2SO_4$  have indicated that extenuating circumstances existed in all cases of solution precipitation. The corrosion laboratory has been able to duplicate all cases of precipitation from various causes. It appears at this time that for the pretreatment to be effective, the temperature during pretreatment must be at least as high as that obtained in service and that pretreated surfaces should not be exposed to air for any length of time before being placed in service. On deviation from either of these principles, precipitation may be experienced.

#### Radiation Chemistry

Experimental facilities have been increased by obtaining the use of the 4 x 4 inch horizontal hole number 60 in the ORNL reactor. If it is possible to take fullest advantage of the space available, six bombs can be irradiated simultaneously in this hole, increasing by a factor of three the number of experiments which can be performed. Expansion of the analytical program is expected to expedite the compilation of data from these experiments.

#### The Reaction of Hydrogen with Oxygen

Explosion of undiluted stoichiometric mixtures of hydrogen and oxygen in the pressure range from 30 to 90 psia yields peak explosion pressures which are 10 to 15 times the initial pressure. Mixtures of this electrolytic

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gas with helium, however, appear to yield peak pressures considerably less than 10 times the initial partial pressure of the combustible gases. This is not due to incomplete explosion of the hydrogen and oxygen.

The explosion limit for mixtures of electrolytic gas with helium and steam seems to decrease slightly with increasing temperature and total pressure. The limit varies from about 21% of electrolytic gas at 25°C and 500 psia to about 14% at 160°C and 850 psia.

Low pressure recombination of hydrogen and oxygen admixed with steam at a platinum on charcoal catalyst (Product 43) has been shown to be quite rapid and complete. The recombination efficiency appears virtually independent of gas composition over the range studied. More than 99% of the gas has been recombined with the catalyst maintained at about 250°C at space velocities well above 20,000 feet per hr. The catalyst yields a negligible amount of permanent gas when treated with pure steam at low flow rates at temperatures up to 375°C.

Pilot Tests of Primary Recombiner

The primary recombiner, which consists of a multihole burner nozzle enclosed in a water-cooled chamber, has continued to perform in a satisfactory manner. In addition it has been shown that a steam generator-condenser system in the line in front of the burner serves as an excellent flashback trap. Flashbacks, produced by igniting the gas before it reached the burner, were quenched in the condenser. The burner flame, after a short interval, quietly relighted. This phenomenon can apparently be repeated indefinitely. This safety feature adds considerably to the usefulness of this burner for the recombiner circuit.

AIRCRAFT NUCLEAR PROPULSION PROJECT

ANP Central Design Group

The joint NEPA-ORNL Shielding and Control Boards have been meeting intensively during September and are scheduled to complete their projects by October 16. The Technical Advisory Board final report has been received and is being prepared for distribution by the NEPA group.

Thirteen-group reactor calculations by the General Electric method are being carried out for the ARE. Indications to date are that the ARE will be an intermediate reactor.

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Mechanical Design and Experimental Engineering for the ARE

A small core mock-up containing one fuel tube has been constructed to facilitate design studies. In investing fabricating procedures, the design group has had several small samples of fuel assemblies constructed in the shops.

Shield layouts are being made so that comparative weights can be determined. Building layouts for the ARE facility are being prepared.

A total of 25 convection loops is expected to be in operation by the middle of October.

Shielding

A new method has been developed for the optimization of a two-component shield and has been applied to the Pb-H<sub>2</sub>O system to give an indication of the minimum shield weight for these materials. The fast neutron dosimeter developed by the Health Physics Division has been used in the Lid Tank to provide a much sounder basis for specification of shield attenuation than has heretofore been possible. The 1950 ANP Shielding Board has been formed, its membership consisting of local ORNL and NEPA personnel. The purpose of the Board is to make the best estimate possible of the weights of interesting shield configurations, complete as possible in the engineering aspects. Both unit and divided shields will be investigated and the effect of employing coolants which become radioactive will be investigated. The Board convened on September 1 and will finish its report October 16.

The contractor hopes to have the new Bulk Shielding Facility completed by October 20. It is expected that it will be possible to start operation three and one-half months after completion of the building.

Liquid Metals Research

Major effort in the liquid metal corrosion test program has been directed toward the probable use of sodium as a reactor coolant. The work done to date indicates that the austenitic nickel-chromium stainless steels will, in general, withstand the corrosive effects of high-purity sodium at the temperatures being considered. The major problems in the use of the stainless steels are mechanical strength, metallurgical changes which occur during prolonged retention at elevated temperatures, and the production of sound, corrosion-resistant welds.

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Some stress-rupture machines have been received and others are being made. This equipment will be used to study the effects of stress and high temperatures on mechanical properties, metallurgical transformations, and liquid metal corrosion resistance.

Additional equipment is now arriving for the fuel element fabrication program. Some work has already been done on compatibility studies of different fuel element components, and the development of fuel elements for the ARE will shortly become a major effort of the materials program.

ANP Heat Transfer and Liquid Metals

Values for the heat capacity of lithium have been obtained and are believed to be the most accurate now available. The data will be published in the near future. Equipment for measuring the thermal conductivity of liquids is being set up.

Liquid Fuel System for High Temperature Reactor

Low Melting Fluoride Systems. The system  $UF_4$ -LiF has been shown to be considerably more complex than the analogous NaF- $UF_4$  system reported by Kraus. At present it seems certain that two compounds, ( $5LiF$ - $UF_4$  and  $LiF \cdot 3UF_4$ ) both of which show incongruent melting points, exist in this system. Almost all mixtures tested show strong tendencies to supercool. The lowest melting mixture available, the  $Li_5UF_9$  -  $LiU_3F_{13}$  eutectic, occurs at about 27 mole percent  $UF_4$  and melts at  $480^\circ C$ . The compounds have been identified by thermal analysis only; examination by x-ray diffraction has, to date, simply confirmed the fact that they are heretofore unreported materials.

Suspensions of Uranium Compounds in NaOH. Attempts to prepare stable suspensions of various uranium compounds in molten caustic have been initiated during the past month. Of the compounds tested,  $UO_3$  and uranium metal appear to yield the most promising systems when added to the molten material. Microscopic examination of the solidified melts shows the moderately uniform particles to be 1 to 5 microns in diameter. This particle size appears to be nearly independent of the particle size of the material added. These suspensions settle, when maintained at  $650$  to  $700^\circ C$ , in about 30 minutes. The suspended material appears to show little tendency to agglomerate; it is believed that moderate agitation would be sufficient to insure that the uranium oxide would remain suspended.

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PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF RADIOISOTOPES

Radioisotope Production, Development and Operations

The total accumulated KWH for pile operation during September was 2,318,760 averaging 3478 KW per operating hour. Pile down time was 11.00% as compared with 10.3% during August. There were no ruptured slugs.

Information recently received through the AEC Isotopes Division indicates that a tremendously increased demand for strontium 90 can be expected. Current estimates are that monthly production rates of the order of several hundred curies will be required to meet the demand, which arises from new uses that have recently developed.

Industrial use of cobalt 60 is increasing the demand for this radioisotope far above the predicted levels. The problem of arranging for suitable reactor space to irradiate greater amounts of cobalt 60 is becoming increasingly severe; progress to date in solving this problem has been inadequate.

STABLE ISOTOPE SEPARATIONS

Calutron Operation and Process Development

Primary attention has been given to development of lithium ion sources and receivers, to making preparations for rare gas separations, and to collections of the isotopes of rubidium and potassium.

Experiments to develop suitable sources and receivers for large-scale lithium separations have continued using both modified Alpha II and twin Beta units. Maximum total ion currents obtained were approximately 1290 and 800 ma, respectively. Experiments have been formulated to determine whether lithium isotopes are enhanced after diffusion through graphite. Pierce-type electrode studies have revealed the necessity of a flat ion emission surface; hence, a search for a suitable grid material is under way. Methods are being formulated and equipment fabricated for rare gas and vanadium collections.

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During the month, the isotopes of rubidium and lithium were collected. Experiments on Alpha II units resulted in the collection of 19 grams of lithium while rubidium operations yielded 58.9 grams of isotopes. Potassium collections were under way at the end of the month.

Isotope Chemistry

Sample Summary

Refinement Completed	7
Samples in Process, Sept. 29	21
Samples in Backlog, Sept. 29	31
Assay Samples Submitted	6
Assays Reported	8
Assay Sample Backlog	45
Shipments Made	14

Calutron charge materials prepared included rubidium iodide, vanadium (V) oxychloride, vanadium (V) oxyfluoride, vanadium (III) fluoride, potassium iodide and lithium. Neodymium and rubidium recovered from calutron operations were purified for reuse as charge materials.

Work was done on the chemical refinement of isotopes of lithium, tungsten, indium, sulfur, chromium and neodymium. Mandelic acid was found to be a selective precipitant for indium.

PHYSICS

Stable Isotope Neutron Cross Sections

The coherent scattering properties of nearly 60 elements or nuclides for slow neutrons have been determined by neutron diffraction technique and are summarized and their significance is discussed in a paper which will be submitted in October for publication in "The Physical Review." This paper covers the work performed during a period of over two years in the neutron diffraction program.

Scintillation Spectrometry and Instrument Development

Large crystals (3 x 3 inch right circular cylinders in shape) of thallium activated sodium iodide have been used to prepare a total absorption spectrometer which gives moderately good results up to the region

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of 1 Mev. Substantially all pulses from any one gamma ray falling on the crystal are of the same height. This permits the measurement of a gamma ray continuum, which cannot be measured readily by any other known method.

Low Temperature and Nuclear Alignment

Most of the engineering and development work in connection with the nuclear alignment program has been completed. This project is now entering the data-taking stage. Reliable data have not been obtained yet, but should be available soon. The following efforts are being made to increase the over-all experimental effect of nuclear alignment:

(a) The cross-sectional area of the polarized neutron beam is being increased, thus improving the rather low counting rates now available.

(b) The polarization of the neutrons is being increased by using the method of polarization by reflection from a single crystal of magnetized iron or possibly magnetite.

(c) Plans are being made to take measurements first with the neutrons and nuclei aligned parallel to each other, then antiparallel to each other, thus doubling the measured effect.

86" Cyclotron

The 86" cyclotron has been completely assembled and the resonant circuit is being tested. The circuit has been made to oscillate readily in air but with extreme difficulty under vacuum. Pressures as low as  $6 \times 10^{-6}$  mm of mercury have been obtained in the tank; this is considered very satisfactory for cyclotron operation. The amount of feedback is being increased in order to obtain more stable operation. The shielding, including walls, roof blocks, and door mazes, has also been completed.

MTA Target

For target testing, a proton source has been developed capable of producing a uniform beam with a heat flux of 1200 watts per square inch. Initial tests with a mercury-amalgam-bonded uranium target indicate that this bond is not satisfactory.

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Radiation Damage

Fabrication of a stationary target for preliminary radiation damage studies on the 86" cyclotron is 50% complete. A rotating target for measurement of creep and other tests is being designed.

Isotope Physics and Spectroscopy

Hyperfine Structure. Exposures to  $U^{233}$  using a Fabry-Perot interferometer crossed with a Littrow type prism spectrograph have shown larger structures in  $U^{233}$  than in  $U^{235}$ . Preliminary conclusions from the partially resolved hyperfine patterns which show more than four components are that the nuclear spin of  $U^{233}$  is  $5/2$  or greater (that of  $U^{235}$  was determined to be  $5/2$  earlier).

Spectrochemical Analysis. It has been found that the addition of zinc as a buffer to the desodiated sodium samples gives impurity reproducibility higher by a factor of about two; however, other elements are also under investigation. The following table summarizes the spectrochemical load for the month of September:

<u>Type Sample</u>	<u>Number of Samples</u>	<u>Number Determinations</u>
NEPA Samples	56	200
General	<u>99</u>	<u>1788</u>
Totals	155	1988

Nuclear Induction. A nuclear induction signal was found for  $Li^6$  in natural abundance saturated aqueous LiCl solution. The addition of manganous sulphate to the LiCl solution as a paramagnetic catalyst gave a signal to noise ratio  $>25:1$ .

X-ray Diffraction. In addition to the usual service work, samples of pure Zr (99.95%) metal and pure Hf (99+%) metal prepared by the Materials Laboratory were examined with the XRD-3 unit and the crystallographic constants determined. The probable values are:

	Zr	Hf
$a_0$	3.23(1)	3.20(5)
$c_0$	5.16(0)	5.09(0)

These values agree within experimental error with those previously published.

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X-ray Absorption. Because of the use of the XRD-3 instrument for diffraction work reported above, only a limited amount of absorption work was possible. One standard sample containing 500 ppm of U was analyzed with a 5 per cent error.

Source, Filament, and Vacuum Laboratory

Mass Spectrometer. A Winn-Nier design emission regulator was built and put in successful operation and the spectrometer was calibrated for appearance in potential studies. A directly heated high temperature charge material oven was also built and put in operation.

Vacuum Laboratory. Work is being continued on evaluation of gasket materials. Additional materials tested this month include Teflon, Tygon, Neoprene, Myvaseal, and rubber. The removable filament ion gauge has been completely tested and found to be very similar in characteristics to the VG-1A.

CHEMISTRY

Chemistry of Uranium Raw Materials

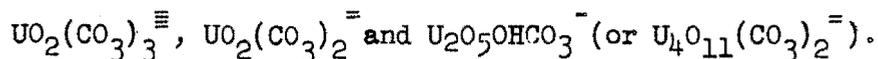
A general study of the precipitation of uranium (IV) with various arylsulfonates has been completed. The solubilities of the uranous salts of benzenesulfonic acid and p-methyl-, p-ethyl-, p-isopropyl-, and p-butyl-benzenesulfonic acids show the expected decrease in solubility with increased weight. Uranous 2, 6-dimethylbenzenesulfonate conforms to the series showing the same solubility as the para-ethyl-compound; but the mono-ortho-methyl-compound is exceptional, being much more soluble than any of the others. The solubility of uranous tetra-p-toluene sulfonate is given by:

$$\log K_{sp} = (3.2)(pH) - 10.9 \quad \text{at } 98-100^{\circ}\text{C},$$

$$\log K_{sp} = (3.2)(pH) - 11.8 \quad \text{at } 55 \pm 0.5^{\circ}\text{C}$$

in hydrochloric acid solution from a pH of 1.5 to -0.3.

Further studies in the carbonate uranium system have produced evidence for the existence of complex ions of the following compositions:



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Purex Process

The development of the Purex Process was continued in the laboratory with the Pilot Plant phase scheduled to be started about December 1, 1950. This program is now a major program in the Laboratory Section and the emphasis on this program is scheduled to be increased. During the modification of the Pilot Plant for the Purex Process, the cells are being thoroughly decontaminated and stainless steel floors and wainscots are being installed to facilitate the future cell decontamination.

METALLURGY

Materials Laboratory

Seven zirconium metal reductions were completed. Petrographic examination of the sublimed  $ZrF_4$  indicated a fair amount of impurities, causing the zirconium metal to be brittle. It was suggested that the sublimed  $ZrF_4$  be resublimed and metal from this material checked against metal from the once sublimed fluoride. The resublimed  $ZrF_4$  produced a more ductile button. A check was also made to determine if the calcium contained in the process must be used while absolutely fresh and extremely pure. Results indicated that while fresh material is desirable, it is not essential. Runs were made and results compared on once, twice, and three times sublimed  $ZrF_4$ .  $ZrF_4$  sublimed three times produced very pure and ductile zirconium. This material was cold-rolled as cast and took greater than 99 per cent reduction without cracking. Corrosion tests and chemical analyses are in process on these three reductions.

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PROGRAM 6000 - BIOLOGY AND MEDICINE

HEALTH PHYSICS

Radioactive Waste Disposal Research and Development

A program jointly carried out by ORNL and the Corps of Engineers for the testing of standard U. S. Army field water supply equipment with regard to its ability to remove radioactive contaminants from water supplies has been initiated. Preliminary tests of the standard U. S. Army 15-gpm diatomite set indicate that standard operating procedures are inadequate to remove satisfactorily high percentages of mixed fission products from the water. The next step in this program is to develop new procedures and equipment, if necessary, to give satisfactory decontamination of the water supply.

BIOLOGY

Cytogenetics

Continuous work on oxygen effect on X-ray sensitivity has given interesting results. One of them is that X-rays are more effective if given in the presence of oxygen at low temperature. In contrast to this, in a nitrogen atmosphere they are more effective in causing damage at higher temperatures. Alpha particles have been found not to be influenced in their effectiveness by the oxygen tension. Similar results have been obtained with fast neutrons in regard to chromosome breaks.

Mammalian Genetics

The mutation rate of mice irradiated with X rays is somewhat higher than was expected on the basis of results of the Drosophila studies. Effects of X rays on embryonic development in mice brought out that energy values as low as 50 and even 25 roentgens have a definite influence on the embryonic development in pregnant mice, a finding of great practical importance.

Bacteria Metabolism

It was found that crystalline cytochrome-c and vitamin B-12 have very similar effects on B-12 deficient cells.

[REDACTED]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

September, 1950

PROGRAM 1000 - RESEARCH FACILITIES

File Building #105 and Change House Addition

Completed except for portion of work by ORNL Maintenance which consists of connecting control wiring, alterations around battery racks, and identification marking of service lines.

Research Laboratory

Excavation for basement 95% complete. Forms for foundations are being erected under wings of building

Isotope Research and Semi-Works Building

Excavation approximately 90% complete; considerable rock has been encountered which requires removal by blasting. No concrete has been poured to date.

Physics of Solids Building

This building approximately 75% complete. Scheduled completion date is October 31, 1950.

Fan House, Building #115

One of the two fans for this building was shipped September 28, and the other is promised for shipment October 3. Installation date for first fan tentatively set for the week of October 9. This building is approximately 78% complete.

Separations Building #205

This work approximately 90% complete, and the contractor has set a completion date of October 25 for this building.

Instrument Laboratory

Work on this building is approximately 88% complete, and contractor expects to complete his work by scheduled completion date of November 14, 1950.

[REDACTED]

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

September, 1950

PERSONNEL SUMMARY

	<u>Number of Employees</u> <u>September 30, 1950</u>	<u>New Hires</u> <u>September</u>	<u>Terminations</u> <u>September</u>
Administration	84		1
Operations*	104	1	
Engineering, Shops, and Mechanical	844	19	2
Laboratory and Research	852	5	24
Y-12 Research Divisions	273	3	3
Protection	166		
Service	<u>324</u>	<u>6</u>	<u>1</u>
TOTAL	2647	34	31

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

RADIOISOTOPE SALES

<u>Sales</u>	<u>July, 1950</u>	<u>August, 1950</u>
Transfers within AEC	\$49,455.70	\$7,643.25
Off Project	21,725.50	22,551.74
Foreign	1,975.20	1,964.90
Cancer Program (Free)	28,478.71	27,920.22
Technical Cooperation Plan	7.15	-0-
Total Sales and Transfers to Date		2,328,740.75
Total Cancer Program (Free to date)		567,222.58
Technical Cooperation Plant (Shipments to Date)		2,926.45

OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

September, 1950

GROSS OPERATING COSTS

(Including X-10 and Y-12)

(a)	Actual Cost for Aug., 1950 Construction - Program "H"	\$1,781,097 49,681	
	Total Operating & Const. Costs		1,830,778
(b)	Estimated Operating Costs for Sept., 1950		1,800,000
(c)	Actual Accumulative FY 1951 Operating Cost through July, 1950	3,285,975	
	Actual Accumulative FY 1951 Construction Cost through August, 1950	79,464	
	Total Accumulative FY 1951 Construction and Operating Cost through August, 1950		3,365,439
(d)	Estimated Operating Cost FY 1951 through September, 1950		5,165,439