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AEC RESEARCH AND DEVELOPMENT REPORT

LABORATORY RECORDS
1954

# OAK RIDGE NATIONAL LABORATORY
# STATUS AND PROGRESS REPORT
# OCTOBER, 1950

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# OAK RIDGE NATIONAL LABORATORY

# STATUS AND PROGRESS REPORT

October, 1950

W. E. Thompson

Date Issued: NOV 9 1950

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operated by
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## PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

### TBP Process for Waste Metal Recovery

The construction of the building and cells to house the equipment for the metal recovery process at ORNL is now scheduled for completion about November 10, 1950.



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PROGRAM 3000 - WEAPONS

RaLa Development

The preliminary evaluation of the modified ORNL RaLa plant demonstrated that the filtration of the barium sulfate precipitate was not satisfactory, and work in the Laboratory and Unit Operations Section to correct this situation was started.

The Laboratory development of the MTR-RaLa Process indicated that the sulfuric acid dissolution of the MTR fuel units followed by filtration to remove the insoluble barium sulfate gave better results than the solution of the fuel unit in either nitric acid or sodium hydroxide. The work on the sulfuric acid procedure is to be continued.

Special Separations, $U^{236}$

Assay data now available for the three $U^{236}$ calutron runs completed in September indicate the following average performance.

| | $U^{235}$ Output | $U^{236}$ Output |
|---|---|---|
| Grams of Uranium | 82 | 2.2 |
| Concentration | 99.7% | 33.5% |
| Process Efficiency | 9.3% | 6% |
| Enhancement with respect | | |
| to 234 | 27 | 55 |
| 235 | -- | 41 |
| 236 | 17 | -- |
| 238 | 86 | 58 |

The schedule of first stage runs will be completed in November. The second stage will then be initiated, following a cleanup.



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# PROGRAM 4000 - REACTOR DEVELOPMENT

## MATERIALS TESTING REACTOR

### MTR Design and Analysis

All components of the reactor proper are now either available or on order. Design work for the reactor and its components, including handling tools, has been completed. A complete set of drawings for the MTR instrumentation is now available and fabrication of the instruments in the ORNL shops has been started, although the first instruments to be built will be used in the Bulk Shielding Facility and the Homogeneous Reactor Experiment, both of which are using MTR instrumentation.

### MTR Metallurgy

All beryllium for the MTR has been delivered to the Y-12 shops where it is being machined.

### MTR Test and Development

Delivery of the MTR tank section C early in November will enable a final test to be performed in the flange mockup. Preliminary tests have indicated that the gaskets hold up satisfactorily and do not leak.

### 25 Process Design

The design of the steel and concrete for the Chemical Process Building by Foster Wheeler is now in progress. The heating and ventilation system for the building has been established and the specifications for the utilities and the stack have been completed. Construction of the SF Storage Building is in progress, and is now scheduled for completion about March, 1951. In the process design phase, the schematic flow diagram and the chemical materials flowsheet have been completed. Work on the engineering equipment flow sheet is in progress. Design sketches of the individual tanks are being prepared with sketches of representative tanks being submitted to fabricators for bids.

The development of a fumeless dissolver for use in the Idaho Plant was started and the studies on the dissolving procedures of the various types of fuels to be processed in the Idaho Plant was continued.



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## HOMOGENEOUS REACTOR EXPERIMENT

### Radiation Chemistry

A chromate pretreated stainless steel bomb was irradiated for four weeks while the ORNL reactor was operating mostly at half power. This bomb displayed excellent behavior as far as one could tell from the pressure curve. The pretreatment temperature was 290° C. and the temperature in the pile was also 290° C.

### Experimental and Design Engineering for HRE

Foundations for the HRE Building have been poured, but further work is delayed by late delivery on structural steel. Delivery of steel during the first week in November is expected. Copper wire for the power line to the building site has been obtained on a loan basis from the electrical subcontractor by promising to give him the HRE cable when it arrives. Some speed-up in the schedule for delivery of water pipe has been achieved; delivery is now expected in December instead of March.

The final flow sheet for the HRE is essentially complete, with only minor details such as sampling points remaining to be determined. Overall design has now reached the state where it appears that it can be completed by January 1, 1951.

### Long-Range Homogeneous Reactor Studies

Following the publication of a report on "Preliminary Study of The Feasibility of Large-Scale Homogeneous Reactors" (ORNL-855), a study of the feasibility of a 500-MW homogeneous reactor for submarine use to deliver 100,000 shaft horsepower has been undertaken.

### The Reaction of Hydrogen with Oxygen

Although repeated attempts to poison Product 43 in a stainless steel system by introduction of iodine had failed, this catalyst has been poisoned to 80% efficiency by iodine when an all glass system was used. In addition, dipping of the catalyst in 5% uranyl sulfate solution followed by drying before use dropped the catalyst efficiency to 60% of its former value. Analyses to indicate the iodine and uranium picked up by the catalyst mass in each case are not yet available.



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Accurate determinations of the explosion limits for hydrogen-oxygen-steam mixtures in the temperature range 90-110° C. and pressures near 1 atmosphere are under way in the new apparatus. Explosions with 21 to 22 percent electrolytic gas have been reproduced under these conditions. The effects of introduction of helium and of excess hydrogen remain to be measured.

## Pilot Tests of Primary Recombiner

The essential feasibility of the burner type primary recombiner has been sufficiently demonstrated. Modification of the pilot plant burner to simulate as closely as possible the pertinent sections of the reactor mockup is under way with the close cooperation of the design group. Plans call for testing of the recombiner in as realistic a manner as possible before incorporation on the mockup assembly.

On the basis of laboratory tests of Product 43, a secondary recombiner to follow the burner has been designed and constructed. This catalytic unit has been satisfactorily operated in the pilot plant at flow rates up to 8 liters per minute of 5% electrolytic gas.

## Chemical Processing of Homogeneous Reactor Fuel

The Laboratory evaluation of ion exchange as a procedure for processing the uranyl sulfate solution, now proposed for the homogeneous reactor fuel, was started. It was found that the stability of the proposed ion exchange resin at the expected radiation level was sufficient for only about one day's operation. The effectiveness of filtration, silica gel adsorption and electrochemical precipitation is also being evaluated.

# AIRCRAFT NUCLEAR PROPULSION PROJECT

## ANP Central Design

Preliminary design of the aircraft reactor experiment is being modified to take advantage of the recommendations of the Shielding and Control Boards, whose final reports were issued in October. Current design of the ARE is based on the decision that the ARE will be a prototype for the subsonic aircraft reactor.



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## Shielding

The Bulk Shielding Facility has been completed except for installation of the overhead crane. The building will be occupied and used without the crane until it is delivered and can be installed.

The first leg of the liquid metal duct has been tested in the thermal column water tank. Indications are that it will be just barely possible to measure radiation through three legs of the duct. In the lid tank measurements have begun on the attenuation of neutrons through pure $B_4C$. Measurements on the iron-water shield recommended by the TAB showed that the secondary gammas would be excessive if the iron were all placed next to the reactor as proposed.

## Mechanical Design and Experimental Engineering

In the dynamic corrosion testing program, 13 thermal convection harps have been placed in operation with sodium in the temperature range from 1200-1500° F. A centrifugal pump which was modified for use with liquid metals has been completed and is ready for testing; the electromagnetic pump will be ready in November.

## Liquid Fuel System for High Temperature Reactor

Low Melting Fluoride Systems. Studies of the system $UF_4$-LiF are virtually complete. The eutectic mixture (26 mole percent $UF_4$) melts at 490° C. to a dark green fluid of low viscosity. It is worthy of note that stirrers of monel have been used satisfactorily in the experimental studies. The corrosion observed is slight and may be due in part to the presence of air in small amounts. Preliminary investigation of the ternary system LiF-NaF-$UF_4$ has disclosed the existence of a eutectic melting at 430° C. The composition of this eutectic has not yet been established.

Suspensions of Uranium Compounds in NaOH. Suspensions of $UO_3$ in caustic have been prepared with particles as small as 1 micron. On long standing at 600 to 700° C., these particles seem to agglomerate; the presence of considerable silver oxide from corrosion of the container makes microscopic examination of such systems somewhat uncertain. Chemical analysis of sections of chilled melts have yielded inconclusive results to date because of difficulty in avoiding agitation during the cooling process. Better methods for ascertaining the stability of these systems are needed. X-ray diffraction techniques show that the same compound (probably sodium uranate) is produced when molten caustic reacts with $UO_3$ and $Na_2U_2O_7$.



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Lithium Separation

Most of the month was spent in the installation and test operation of three new pieces of equipment. The entire program is now concentrated on the electro-exchange process.

A preliminary estimate of the costs to produce 10 pounds per day of 25% $Li^6$ has been made at the request of Dr. Woodhouse of du Pont. This will be issued to those primarily concerned with the material.

GENERAL REACTOR DEVELOPMENT

Radioactive Waste Treatment

A Peabody scrubber has now been selected for use in removing the entrainment from the radiochemical waste evaporator. It was originally proposed to use a bubble cap column for this purpose; however, the substitution of the Peabody scrubber significantly reduced the cost.



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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 1,982,849, averaging 3038 KW per operating hour. Pile down time was 12.28% as compared with 11.8% during September. One ruptured slug was located and discharged without difficulty. One new pile cooling air fan was installed and put into operation; it was found to pull 10% more air than the other fan which had not yet been replaced.

The total number of radioisotope shipments during October was 760. Although the iodine 131 processing equipment was out of operation the last week in the month because of leaks, all I-131 commitments for October were met. The new phosphorus-32 extraction-purification equipment put into operation was found to give 90% yields on both steps.

## STABLE ISOTOPE SEPARATIONS

### Calutron Operation and Process Development

In the search for suitable target materials, neon ion beams were received on a stainless steel sheet bolted to a water-cooled copper plate. Ion bombardment of a nickel target (used in place of platinum for experimental purposes) suspended in the arc chamber yielded an average total ion current of one milliampere during a 16-hour run. A filament changer for Beta-type source units was tested and found to operate satisfactorily mechanically. Studies were being made with the low-voltage ion source unit to reveal the mechanism of arc emission.

Potassium collections yielded an estimated 40.2 grams of isotopes including 19 mg $K^{40}$. Substitution of stainless steel for graphite for ion chamber and electrode material markedly reduced the problem of high voltage sparking.



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## Isotope Chemistry

### Sample Summary

| | |
|---|---|
| Refinement Completed | 16 |
| Samples in Process, Oct. 31 | 25 |
| Samples in Backlog, Oct. 31 | 12 |
| Assay Samples Submitted | 20 |
| Assays Reported | 21 |
| Assay Sample Backlog | 47 |
| Shipments Made | 28 |

Potassium was supplied for calutron operations and chemical refinement was done on the isotopes of carbon, lithium, potassium, hafnium, sulfur, indium, chromium, and neodymium. Platinized asbestos was found to be an excellent catalyst for the chlorination of tungsten.

## PHYSICS

### High Voltage Program

In a study of angular distribution of the gamma rays from the $B^{11}(p\gamma)C^{12}$ reaction, the 16 Mev gamma ray is found to be isotropic, whereas the 12 Mev gamma ray supposedly originating from the same level in $C^{12}$ is found to be anisotropic with the distribution $1 + .22 \cos^2 \theta$. These observations are mutually inconsistent from the theoretical point of view and efforts are being made to solve the difficulty by further experiments and further consideration of the theory.

The Cockroft-Walton generator is furnishing a well-focussed, steady beam of nearly 100 $\mu a$ of magnetically analyzed protons.

### Short-Lived Isomers

The delayed coincidence scintillation spectrometer has been revised so that it can now measure half-lives as short as $2 \times 10^{-9}$ seconds. A new activity which was found in this region was the $Er^{166}$ isomer having a $1.7 \times 10^{-9}$ second half-life with the energy of transition being 80 Kev.



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## Resonance Absorption in Uranium Cylinders

Measurements have been made on the resonance absorption integral of $U^{238}$ by activating $U^{238}$ foils in cylinders of normal uranium of various sizes. A good curve representing the separation of the absorption into surface and mass effects has been obtained. Efforts are now being made to normalize the experiment so that the resonance integral can be evaluated on an absolute basis.

## Theoretical Physics

The introduction of the concept of superexchange, that is the interaction of non-neighboring magnetic ions separated by non-magnetic ions, has been successful in accounting for the magnetic anisotropy of the paramagnetic salt, copper sulfate. The hyperfine structure in this salt is also anisotropic and this phenomenon could also be explained with reasonable agreement with experimental results.

## Neutron Diffraction

By the use of improved metal crystals in the monochromator of the neutron diffraction spectrometers, a gain of a factor of five in beam intensity has been achieved. A low-temperature cryostat has been successfully operated at liquid hydrogen temperatures as a preliminary to the study of antiferromagnetic substances whose Curie points are at very low temperatures.

## Short-Period Activities

The X-ray spectra associated with more than 20 of the short-period activities have been obtained, using the photographic method of recording self-triggered oscilloscope traces. Additional studies have revealed previously unreported gamma rays in indium and ytterbium. Indium gives a 152 Kev gamma with a 2.5 seconds half-life; and Yb emits a 455 Kev gamma with a half-life of the order of 0.5 second.

## 86" Cyclotron

Modifications of the radio frequency system have been tested in an attempt to obtain its satisfactory operation under vacuum. Ion loading of the dees appears to interfere with the desired build-up of rf voltage. Insulated grids mounted from the liner and excited at dc potentials from



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one to five kilovolts, have been used with some success in flushing out the ions. Other methods of overcoming the ion-loading effect are to be investigated.

MTA Target

The proton source has been modified to permit bombarding the target with a pulsed beam for investigating effects of thermal shock and target growth. Pulsing by the application of an ac potential to the arc makes it possible to obtain an essentially square-wave beam pulse at the 90° position from the source.

Radiation Damage

A stationary target for use in the 86" cyclotron has been completed. Design work on a rotating target to operate at 70° F. is 60% complete. Preliminary design work on a rotating target to operate at 1200° F. has been started.

Isotope Physics and Spectroscopy

Isotope Displacements. Isotope displacements in spectra of thorium and samarium have been measured and preliminary reports presented at the Annual Meeting of the Optical Society of America. New wavelength data and shifts are being tabulated up to wavelengths of 9800 A in the case of samarium. This will extend the known literature data by about 1800 A further in the infra-red.

Zeeman Effects. Some preliminary studies have been made using a 3000 gauss magnet with various interferometers. Resolution of the order of 0.5 g units has been obtained with a 5 mm etalon. Hollow cathode sources and d-c arcs have been excited successfully in the field of 3000 gauss.

High Resolution Spectroscopy. A 66 mm invar spacer has been designed and set up for use in a Fabry-Perot interferometer. This will lower the free spectrum range to only 0.15 $cm^{-1}$.

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Spectrochemical Analysis. The following table summarizes the spectrochemical load for the month of October:

| Type Sample | Number Samples | Number Determinations |
|---|---|---|
| NEPA | 60 | 186 |
| General | 59 | 1,056 |
| Total | 119 | 1,242 |

Nuclear Resonance. Development work on the analysis of $Li^6$ has continued using both an autodyne circuit and a super-regenerative circuit operated at 7.5 mc.

X-Ray Absorption. Development of methods for analysis of solutions for contained uranium has continued. The concentration range 8000 ppm U in water has been investigated with results persistently lower than the expected value by several per cent. Errors as large as 25 per cent occur in concentration ranges at 100 ppm.

Source, Filament, and Vacuum Laboratory

Mass Spectrometer. Additional measurements were made on the appearance potentials of metal ions and the results were reported in a paper at the Southwide Chemical Conference in Atlanta. A bibliography is being prepared on metal carbonyls and experimental work on nickel carbonyl is in progress.

Vacuum Laboratory. Vacuum testing of gasket materials yielded data on Cenco Para Rubber tape, dental rubber sheet, and Teflon.

METALLURGY

Materials Laboratory

A 3 per cent tin, 97 per cent zirconium co-reduction was made to test the corrosion inhibiting characteristics of the alloy. Tests are under way on the resultant alloy. The density and electrical resistivity of several samples of Materials Laboratory hafnium and zirconium were determined and a report is in preparation.

A metallographic study was made of a section of stainless steel pipe brazed with silver solder in order to determine the extent of penetration



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of parent metal by the silver and its effect upon the parent metal. This work was done for the HRE program. An alundum crucible for use in the research on growth of single crystals at ORNL was fabricated.

Three corrosion tests and studies were made or are in progress:

1. Tests were run on the resistance of various coatings, coated on stainless steel, to the vapors of hexone alone and to hexone and HCl together.

2. Tests were run on the resistance of various coatings, applied on aluminum, to a combination of chemical vapors. Heresite P-403, a baked phenolic coating, showed up best in both this test and the one outlined above.

3. In connection with the ANP and ARE projects, the resistance of various metals to attack by a $NaF-UF_4$ eutectic was tested, at 700° C. for seventy hours. Several of the twenty metals tested were attacked badly or disintegrated, but some eight samples show sufficient promise to test further in both static and dynamic tests.

## CHEMISTRY

### Chemistry of Uranium Raw Materials

A report is being issued, Y-678, covering the solubility studies with sodium uranyl tricarbonate.

Important regions in the $Na_2O - UO_3 - CO_2 - H_2O$ system have been studied. A report on this work will be issued as Y-673.

A report has been issued, Y-664, covering the studies of aromatic sulfinic acids.

New projects have been started which include studies of (1) anion exchange resins in recovering uranium from Rifle and Monticello leach liquors, (2) uranium recovery from Marysvale ores and certain ligh-lime ores, and (3) certain aspects of the Mallinckrodt process.

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## Chemical Separation of Isotopes

Uranium Separation. Two additional batch separations have been made using cupferon complexing at temperatures around -30° C. No assays have been made as yet.

Molybdenum Separation. Preliminary investigation of the possibility of separation of the isotopes of molybdenum has led to a feasible exchange system involving thiocyanate complexes. The first batch pass has been started on this method.

## Radiation Chemistry

A calorimetric study of the acid ferrous sulfate actinometer gave a value of 15.7 $Fe^{+++}$ ions oxidized per 100 ev absorbed from the $Co^{60}$ gamma ray source.

## Microwave Spectroscopy

A more accurate series of measurements on methyl iodide (with $I^{129}$) allows a more accurate calculation of the quadrupole coupling of $I^{129}$ in this molecule. Similar measurements were made with $I^{127}$ to check the accuracy of the method. The new calculated value for the coupling of $I^{129}$ is -1357 megacycles per second, which is 4.5% lower than the old value of -1422 megacycles per second. This new value should be accurate to better than 1%. The measured value for $I^{127}$ agrees to within 0.4% of the accepted value. These data give a new ratio of the nuclear quadrupole moment of $I^{129}$ to $I^{127}$ of 0.705.

## Purex Process

The Purex Process has been selected for use in the du Pont program and du Pont personnel are to be assigned at this Laboratory to participate in the Laboratory, Unit Operations, and Pilot Plant phases of this development program. Until recently, the Purex Process studies in the Laboratory have been concerned with a three-cycle flowsheet. At present, the evaluation of the possibility of a one- or two-cycle flowsheet is in progress. In the Pilot Plant, calibration and testing of the equipment is now in progress and the start up of cold runs during the coming month is scheduled.



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PROGRAM 6000 - BIOLOGY AND MEDICINE

## BIOLOGY

### Cytogenetics

A special group has been organized to test the effectiveness of a large number of chemical compounds in protecting micro-organisms against radiation damage. A few promising compounds have been found.

In the irradiation of yeast, it was found that under ultraviolet radiation mutations appear before any of the organisms are killed--a rather surprising finding since, in general, a high percentage of the organisms have to be killed before mutation can be recognized after irradiation.

### Physiology and Pathology

Highly significant results have been obtained in regard to changes in the serum in animals after irradiation. This work was performed using special methods which take advantage of techniques developed by a surgeon at the Oak Ridge Hospital.

### Biophysics and Biochemistry

A new type of luminescence has been recognized during photosynthesis by special methods.

One man has been sent to Eniwetok to establish *Tradescantia* plants which will be used as test material during Operation Greenhouse.



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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

October, 1950

PROGRAM 1000 - RESEARCH FACILITIES

Pile Building #105 and Change House Addition

All work by contractor is complete, and Form 4a has been submitted for signatures. ORNL Maintenance continues work on control wiring, alterations around battery racks, and marking of service lines.

Research Laboratory Building #4500

Excavation for basement completed. Foundations under wings being formed and poured. Hot drains have been laid along south side of wings.

Isotope Research and Semi-Works Building #4501

Blasting and excavation of rock for basement and footings continues. Footings have been poured on south and southwest sides of building. Erection of grade beam forms has started.

Physics of Solids Building #3025

Completion date has been extended to November 22, 1950. Laboratory furniture and the 1-ton crane are expected to arrive in time to be installed prior to this date.

Fan House Building #115

Both new fans have been received, and the No. 3 fan has been installed and placed in service on a two-weeks trial run. Installation of the No. 2 fan is scheduled to start on November 13, 1950. The building is approximately 85% completed.

Instrument Laboratory Building #3500

Work on this building is approximately 95% complete. Vendors of laboratory equipment have changed shipping dates for some items of laboratory equipment. Completion date of November 15, 1950, will not be met.



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# OAK RIDGE NATIONAL LABORATORY

## STATUS AND PROGRESS REPORT

October, 1950

## PERSONNEL SUMMARY

| | Number of Employees October 31, 1950 | New Hires October | Terminations October |
|---|---|---|---|
| Administration | 84 | 1 | 1 |
| Operations* | 107 | 4 | 1 |
| Engineering, Shops, and Mechanical | 867 | 24 | 1 |
| Laboratory and Research | 875 | 29 | 6 |
| Y-12 Research Divisions | 282 | 2 | 0 |
| Protection | 167 | 2 | 1 |
| Service | 322 | 3 | 5 |
| TOTAL | 2704 | 65 | 15 |

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

## RADIOSOTOPE SALES

| Sales | August, 1950 | September, 1950 |
|---|---|---|
| Transfers within AEC | $ 7,643.25 | $ 77.00 |
| Off Project | 22,551.74 | 33,539.43 |
| Foreign | 1,964.90 | 1,284.20 |
| Cancer Program (Free) | 27,920.22 | 26,902.14 |
| Technical Cooperation Plan | -0- | 3,812.81 |
| Total Sales and Transfers to Date | | 1,287,454.79 |
| Total Cancer Program (Free) to Date | | 594,124.72 |
| Technical Cooperation Plan (Shipments to Date) | | 6,739.26 |



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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

October, 1950

GROSS OPERATING COSTS

(Including X-10 and Y-12)

| | | | |
|---|---|---|---|
| (a) | Actual Cost for Sept., 1950 | $1,813,899 | |
| | Construction - Program "H" | 52,402 | |
| | Total Operating & Const. Costs | | 1,866,301 |
| (b) | Estimated Operating Costs for Oct., 1950 | | 1,925,000 |
| (c) | Actual Accumulative FY 1951 Operating Cost through Sept., 1950 | 5,099,874 | |
| | Actual Accumulative FY 1951 Construction Cost through Sept., 1950 | 131,866 | |
| | Total Accumulative FY 1951 Construction and Operating Cost through Sept., 1950 | | 5,231,740 |
| (d) | Estimated Operating Cost FY 1951 through October, 1950 | | 7,156,740 |



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