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AEC RESEARCH AND DEVELOPMENT REPORT



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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

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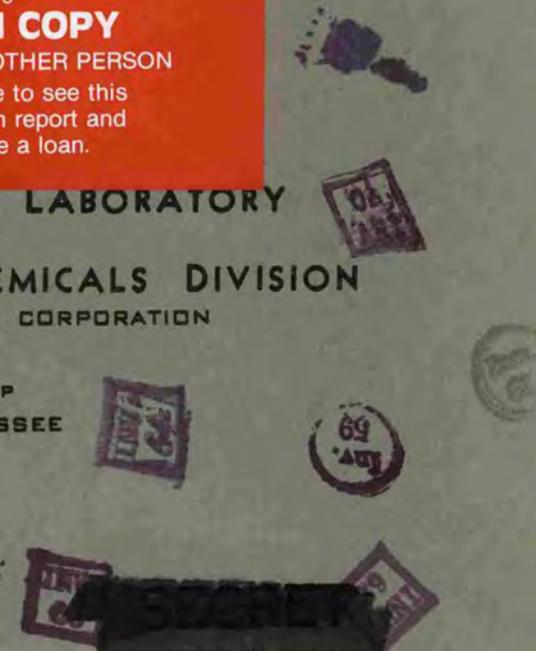
CARBIDE AND CARBON CHEMICALS DIVISION

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ORNL 700
Progress Report

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OAK RIDGE NATIONAL LABORATORY
STATUS AND PROGRESS REPORT
APRIL, 1950

W. E. Thompson

Date Issued: MAY 5 1950

Contract No. W-7405, eng 26

OAK RIDGE NATIONAL LABORATORY

Operated by

CARBIDE AND CARBON CHEMICALS DIVISION
Union Carbide and Carbon Corporation
Post Office Box P
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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

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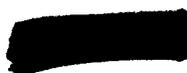
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STATUS AND PROGRESS REPORT

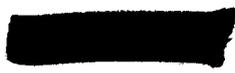
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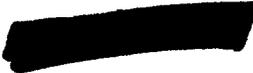
TABLE OF CONTENTS

	<u>Page</u>
PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS.....	6
TBP Process for Waste Metal Recovery.....	6
PROGRAM 3000 - WEAPONS.....	7
Chalk River Separation.....	7
RaLa Development.....	7
RaLa Production.....	7
PROGRAM 4000 - REACTOR DEVELOPMENT.....	8
MATERIALS TESTING REACTOR PROJECT (AND MODIFIED MTR).....	8
DESIGN AND EVALUATION.....	8
MTR Analysis and Engineering Design.....	8
REACTOR PHYSICS AND CRITICAL ASSEMBLY WORK.....	8
MTR Critical Experiments.....	8
FUEL ELEMENTS.....	9
Completed Fuel Assembly for Chalk River Reactor	
Irradiation.....	9
MODERATOR, STRUCTURAL MATERIALS AND REFLECTOR.....	9
Beryllium Production.....	9
INSTRUMENTATION AND CONTROL.....	9
MTR Controls.....	9
CHEMICAL PROCESSING.....	9
25 Process Design.....	9
AIRCRAFT NUCLEAR PROPULSION PROJECT.....	10
DESIGN AND EVALUATION.....	10
ANP Central Design Group; ANP Design Sub-	
contracts.....	10
COOLING, HEAT TRANSFER, AND POWER GENERATION.....	10
Liquid Metals Research.....	10
ANP Heat Transfer and Liquid Metals.....	10

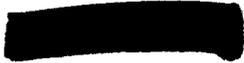


	<u>Page</u>
SHIELD DEVELOPMENT.....	11
ANP Bulk Shielding and Analysis.....	11
HOMOGENEOUS REACTOR EXPERIMENT.....	11
EXPERIMENTAL ENGINEERING.....	11
Experimental and Design Engineering for Homo- geneous Reactor.....	11
FUEL ELEMENTS.....	11
Slurry Fuel Media for Homogeneous Reactor.....	11
Chemical Control of Fuel.....	12
MODERATOR, STRUCTURAL MATERIALS AND REFLECTOR.....	12
Corrosion in Homogeneous Reactors.....	12
GENERAL REACTOR DEVELOPMENT.....	12
CHEMICAL PROCESSING.....	12
23 Process and Recovery of Thorium.....	12
Waste Processing.....	12
PROGRAM 5000 - PHYSICAL RESEARCH.....	13
PRODUCTION OF RADIOISOTOPES.....	13
Radioisotope Production, Development and Operations.....	13
PHYSICS.....	13
Neutron Diffraction.....	13
Scintillation Spectrometry.....	13
Short-Lived Isomers.....	14
Short-Period Activities.....	14
CHEMISTRY.....	14
Radiation Chemistry.....	14
Nuclear Chemistry of Elements in the Fission Product Region.....	14
Purex Process.....	14
METALLURGY.....	15
Hanford Slug Problem.....	15
Thorium Research.....	15
CP-3 Fuel Rods.....	15
PROGRAM 6000 - BIOLOGY AND MEDICINE.....	16
BIOLOGY.....	16
Pathological Effects of Radiation.....	16
Cytogenetics.....	16





	<u>Page</u>
APPLIED BIOPHYSICS.....	16
Waste Disposal Research.....	16
Instrument Development.....	17
PROGRAM 1000 - PLANT AND EQUIPMENT.....	18
PERSONNEL SUMMARY.....	20
RADIOISOTOPE SALES.....	20
GROSS OPERATING COSTS.....	21



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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

PROGRAM 2000 - SOURCE AND FISSIONABLE MATERIALS

TBP Process for Waste Metal Recovery

Sludge from the Hanford metal waste storage tank was successfully processed in two runs. The uranium product contained approximately twice the beta activity of natural uranium. A second sample of Hanford sludge is scheduled for shipment to ORNL in May.

The construction of the ORNL Metal Recovery plant now is pending approval of the project by AEC. The design of the equipment for the building and the study of chemical and engineering problems is continuing.

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

PROGRAM 3000 - WEAPONS

Chalk River Separation

The Chalk River material is now being processed through the 205 solvent extraction equipment, and the facilities for the final purification and concentration are now being tested.

RaLa Development

The laboratory and pilot plant tests are now in progress to establish optimum conditions for the ORNL production program.

RaLa Production

The product shipment on April from Run No. 41 was the largest to date and was prepared without operational difficulty, although air contamination at the time of the 6-P product sampling rose to evacuation level. An investigation of the incident showed that the trouble was caused by the A-16 (vessel ventilation) off-gas system. Present plans are to abandon this system and tie into the new off-gas lines before the next run is started.

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

PROGRAM 4000 - REACTOR DEVELOPMENT

MATERIALS TESTING REACTOR PROJECT (AND MODIFIED MTR)

Design and Evaluation

MTR Analysis and Engineering Design

Approximately 90% of the design work has been completed on that part of the MTR tank system for which ORNL is responsible.

Finished drawings for the beryllium reflector have been made and are being checked. The first of the machined rough blanks are scheduled to arrive at the Y-12 shops about June 15.

Purchase requisitions have been written for the MTR control rods. Preliminary steps have been taken to assure use of mock-up patterns for MTR aluminum castings. A survey of changes in casting design resulting from mock-up experience and of the adaptability of old patterns to the new design will be made during May.

A complete survey of the MTR graphite has been made and checked against the compilation made by Blaw-Knox.

Reactor Physics and Critical Assembly Work

MTR Critical Experiments

The first phase of neutron and gamma traverse measurements has been completed. The next phase, which is now being started, concerns measurements with a 16-square-foot section of the thermal shield in place.

Difficulties were experienced with the electromagnets as a result of shorts caused by inadequate insulation on the magnet coils. This trouble has been overcome by limiting to 1300 volts the surge which occurs at the instant of current cut-off. Coils which should withstand 10,000-volt surges are being fabricated by Westinghouse laboratories.

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STATUS AND PROGRESS REPORT

APRIL, 1950

Fuel Elements

Complete Fuel Assembly for Chalk River Reactor Irradiation

Conceptual design work on the experimental equipment for the Chalk River irradiation has been completed. Detailed design of the test assembly, thimble, and carrier will be completed during May. The MTR fuel assembly, along with two Naval Reactor assemblies, will be exposed for six months in the center of the Chalk River pile starting July 1, 1950. A dimensional check will be made upon completion of the irradiation to determine stability of the fuel assembly at burn-up rates comparable to the maximum expected during MTR operation.

Moderator, Structural Materials and Reflector

Beryllium Production

The schedule for delivery of rough machined shapes of beryllium from Brush Beryllium Company to Y-12 for machining has been established. Delivery is scheduled to start June 15 and be completed by November 15.

Instrumentation and Control

MTR Controls

A three-inch safety chamber has been built, tested, and installed in the mock-up. It will be used with the servo system, which is now undergoing final checking prior to its installation.

Design of the console has been considered further and a reasonably satisfactory compromise between available space and desirable instrumentation has been worked out.

Chemical Processing

25 Process Design

The design capacity of the Arco chemical processing plant has been increased from that required for the MTR to its maximum capacity as limited by criticality considerations. It is now proposed to process the material from the EBR and MTR through this facility.

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STATUS AND PROGRESS REPORT

APRIL, 1950

AIRCRAFT NUCLEAR PROPULSION PROJECT

Design and Evaluation

ANP Central Design Group; ANP Design Subcontracts

Preliminary design work for the Aircraft Reactor Experiment has been started. The Central Design Group has now expanded to nine, including two part-time men and three representatives of the H. K. Ferguson Company.

The H. K. Ferguson subcontract has been approved. Prime contracts between the AEC and North American Aviation and Nuclear Development Associates for ANP work are still being negotiated.

Cooling, Heat Transfer, and Power Generation

Liquid Metals Research

Additional furnace space to hold 42 samples at 1000°C, which will give a several-fold increase in the facilities for conducting sorting tests, is being obtained. This will facilitate the early completion of these tests, which have been extended to include corrosion by liquid sodium and sodium hydroxide. The evaluation of a large number of sorting tests on elements in liquid Li, Pb, and Bi is nearing completion and tests of a large number of alloys together with more exacting tests on the promising elements are being started.

A program is under way to investigate the effects of modifications in composition and structure of different alloy combinations and of impurities in the liquid metals on corrosion behavior.

ANP Heat Transfer and Liquid Metals

Equipment for the general heat transfer studies with lithium is still under construction. It is expected to be essentially completed by the end of May. Major components are now complete with the exception of a multiple plate heat exchanger in which welding difficulties have arisen.

A completely enclosed system including a canned rotor and hydraulic bearings is now in operation with water. It performs quite satisfactorily except that the current consumption of the motor with no load is somewhat higher than expected. It is believed that this is due to disruption of the magnetic circuit by the sealing can rather than due to friction in the bearings.

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STATUS AND PROGRESS REPORT

APRIL, 1950

Shield Development

ANP Bulk Shielding and Analysis

Neutron and gamma data on lead-water shields have been corrected for various instrument uncertainties and, on the basis of these data, it appears that a 27% Pb (by volume) shield demonstrates very favorable performance. The outer part of the shield should contain no lead so that essentially all of the permissible radiation tolerance is taken as gamma ionization. This accounts, in part, for the low weight of the shield, which has recently been calculated to be somewhat less than 70 tons for the unperforated shield and 4-foot spherical reactor operating at 400 MW with a crew-reactor distance of 100 ft and radiation tolerances of 1 R/hr gamma and 1/20 R (effective)/hr of neutron. The fact that it has been possible to account for all the neutrons from the source plate lends confidence to the calculations.

Recent work on the neutron attenuation theory has led to expressions for fast neutron attenuation through shields containing heavy metals plus light elements. Collisions with hydrogen and inelastic collisions in the metal are considered as absorptions, and these are combined with elastic metal collisions in such a way that the angular effects are taken into account. The theory has not yet been adequately compared with experimental results but indications are that it will be highly successful. Uncertainties in cross-sections will, however, necessitate calibration of the method against results of bulk shielding experiments.

HOMOGENEOUS REACTOR EXPERIMENT

Experimental Engineering

Experimental and Design Engineering for Homogeneous Reactor

The homogeneous reactor safeguards report was not issued in April as originally intended but will be issued in May concurrently with the feasibility report.

Fuel Elements

Slurry Fuel Media for Homogeneous Reactor

Bentonite, an aluminum silicate clay which is used by the oil industry to stabilize very heavy muds, shows promise as a stabilizer

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STATUS AND PROGRESS REPORT

APRIL, 1950

for homogeneous reactor fuel slurries. Preliminary studies have indicated that stable slurries can be made using Bentonite and further investigation is under way.

Chemical Control of Fuel

The possibility of monitoring U^{235} concentration by nuclear induction techniques appears very attractive since continuous, instantaneous, direct measurements should be possible without sampling.

Moderator, Structural Materials and Reflector

Corrosion in Homogeneous Reactors

Corrosion experiments to date have indicated that corrosion and solution stability are very closely related and that reducing conditions in the system are adverse for both. Oxidizing conditions are favorable for corrosion and solution stability.

GENERAL REACTOR DEVELOPMENT

Chemical Processing

23 Process and Recovery of Thorium

The recovery of thorium from the 23 Process waste is continuing at a low priority. It has been shown in the laboratory that its recovery is feasible by solvent extraction with tributyl phosphate.

Waste Processing

A preliminary study of a falling film type evaporator that was carried out by the MIT group has been encouraging. The principle advantage of this evaporator is the elimination of the foaming problem.

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

PROGRAM 5000 - PHYSICAL RESEARCH

PRODUCTION OF RADIOISOTOPES

Radioisotope Production, Development and Operations

The total accumulated KWH for pile operation during April was 2,236,791, averaging 3457.18 KW per operating hour. The down time was 10.1%, as compared to 7.5% during March. One ruptured slug was located by visual inspection and discharged without difficulty.

A total of 635 radioisotope shipments was made during the month of April; this represents an increase of about 50% over the 431 shipments made in April, 1949.

The California Research Corporation has made arrangements to use irradiated triphenyl stibine routinely as a tracer for marking the phase boundary between two different petroleum products as they flow through the pipeline. The strong gamma radiation from radioactive antimony makes it especially useful in this connection.

Among the carbon 14 labeled compounds synthesized recently have been two carcinogenic compounds, chrysene and benzanthracene, and numerous organic intermediates such as methyl urea, methylamine hydrochloride, malonic ester, acetonitrile and acetic acid, all methyl labeled.

PHYSICS

Neutron Diffraction

It is found that ferromagnetic scattering from unmagnetized cobalt is very appreciable, and this raises an interesting possibility relative to the production of highly polarized thermal neutrons by Bragg reflection from magnetized cobalt.

Scintillation Spectrometry

Thallium-activated sodium iodide phosphors have been found to be promising tools in the field of gamma ray spectrometry. Peaks have been observed rising from Compton scattering, photoelectric absorption, and pair production.

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STATUS AND PROGRESS REPORT

APRIL, 1950

The energy of the gamma ray of potassium 40 has been measured accurately and found to have a value of $1.462 \pm .01$ Mev. The gamma rays from Po-Be sources have been measured and only one prominent gamma ray has been found; it is approximately 4.2 Mev.

Short-Lived Isomers

An interesting regularity has been found in the occurrence of short-lived isomers. In the heavier group of isomers; namely, those with atomic numbers between 63 and 81, it turns out that those with an odd number of protons have very short half-lives (microseconds or less) whereas those in which there is an odd number of neutrons have longer half-lives (minute to days). All the short-lived isomers with odd atomic number have been found between 69 and 79. Searches outside this range have not disclosed any other short-lived isomers as yet.

Short-Period Activities

A scintillation spectrometer study of the radiation emitted by the 2.5-second erbium isomer has shown conversion peaks arising from a gamma ray of 185 Kev.

CHEMISTRY

Radiation Chemistry

A 300-curie cobalt 60 gamma source in the form of a hollow cylinder supplying 5000 R/minute inside the cylinder is being used to study the color centers produced in ionic crystals.

Nuclear Chemistry of Elements in the Fission Product Region

The rapid and complete separation of the rare gases and rare gas fission products has been demonstrated by a technique of gas chromatography using a charcoal-packed column. Rare gases adsorbed on the charcoal are separated by sweeping them off with helium at different temperatures. Argon comes off at dry ice temperatures, krypton at 0°C, and xenon at 80°C. This method will have practical applications in the preparation of rare gas radioisotopes for distribution and in preparing large quantities of radioactive xenon for cross-section measurements.

Purex Process

The laboratory development of the Purex Process for the recovery and decontamination of uranium and plutonium from Hanford production metal

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STATUS AND PROGRESS REPORT

APRIL, 1950

was continued. The work this month indicated that varsol-type diluent for the tributyl phosphate solvent was preferred over carbon tetrachloride.

METALLURGY

Hanford Slug Problem

The present cycling of gamma-extruded, alpha-rolled uranium bars under temperature conditions much more severe than those present in the Hanford reactors have shown that thermal cycling, even with a temperature gradient across the uranium bar, in the absence of radiation will not produce distortion comparable to that obtained in the Hanford reactors.

Thorium Research

The work on the modulus of elasticity and Poisson's ratio of thorium from Ames' current production has been completed. The value for modulus of elasticity for tension was found to be 10.11×10^6 and the average value for compression was 10.44×10^6 . The average value of Poisson's ratio for tension was 0.274, for compression 0.255. The shear modulus was calculated by the inter-relationship of these two and found to be 3.97×10^6 for tension and 4.16×10^6 for compression. Conventional tensile test data were taken on all specimens. From the load elongation curves, it was seen that thorium shows a yield point. Further experimental work is under way to obtain additional information on the yield point of thorium. All these tests will be checked using pure, iodide thorium.

CP-3 Fuel Rods

Of the 140 fuel rods to be fabricated from 2% enriched uranium-aluminum alloy by extrusion and machining for the Argonne CP-3, heavy water reactor, half have been extruded and sent to the Y-12 shops for final machining.

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

PROGRAM 6000 - BIOLOGY AND MEDICINE

BIOLOGY

Pathological Effects of Radiation

Mice which have been exposed to slow neutrons in a special facility in the ORNL reactor six months after radiation have shown an extremely high percentage of cataract formation. The percentage of leukemia is also considerably higher in these animals than one would expect from equivalent studies with X rays.

Cytogenetics

Studies on oxygen tension in regard to X-ray sensitivity have brought out several interesting results: 1) It has been possible, by increasing atmospheric pressure during irradiation, to increase the effect of low concentrations of oxygen in regard to the sensitivity of chromosomes in tradescantia. 2) Bacteria grown anaerobically and irradiated anaerobically are very much more resistant to X rays than bacteria grown aerobically and irradiated anaerobically. The differences between these effects are so striking that they are separated by many orders of magnitude. 3) It has been possible to protect bacteria to a certain degree against X rays by irradiating them in the presence of certain amino acids. Amino acids like alanine, glycine, etc. protect to a small degree. Glutamic acid protects very much better, and cysteine protects to a very high degree. This work shows that bacteria could be used for preliminary studies of the evaluation of different compounds in their protection against the radiation effects. The action of cysteine to protect mice to a considerable degree against X ray damage had previously been reported by the ANL group.

APPLIED BIOPHYSICS

Waste Disposal Research

On April 12 at a conference on the Joint Waste Decontamination Research Program, arrangements for the construction and operation of the Health Physics Waste Research Facility were agreed upon. Under these arrangements the U. S. Public Health Service will have an increased responsibility for technical guidance of the studies and will correspondingly increase their active participation in the program. It was agreed that the

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STATUS AND PROGRESS REPORT

APRIL, 1950

first phase of the program would be studies of the decontamination of water supplies, including the testing of water treatment equipment that is used by the armed services as field water supply units.

Design criteria for the building have been completed and turned over to the Austin Company for detail design. It is now expected that the facility which includes both laboratory and pilot plant space will be completed by the end of 1950.

An extensive ecological study of White Oak Lake was authorized by the AEC through a contract with TVA in January. Plans and organization for a cooperative program have been established and preliminary work has been started for the collection of existing data, installation of water and radioactivity measuring devices, and the completion of a silt and mud survey of the lake and marsh areas.

In connection with the AEC Geological Survey Program, 51 wells have been drilled and cased and are being surveyed for radioactivity. The wells, ranging in depth from 50 to 300 feet, were made by core drilling; the cores were examined for radioactivity and were classified by the geologist according to the underground formation. Further measurements of radioactivity in the wells include: probing with a specially developed detector and radiochemical analysis of large samples of water from selected wells.

Instrument Development

Previous calculations, reported in ORNL-589, showed that the dose received by tissue as a result of fast neutron exposure can be determined by measuring only the neutron counting rate in a proportional counter of special design. These calculations covered the energy range between about 200 Kev and 10 Mev. Experiments performed with monoenergetic sources at the Los Alamos Scientific Laboratory showed the calculations to be correct up to 2.5 Mev. No sources of neutron energies between 2.5 and 14 Mev were available, but a point at 14 Mev indicated that the response of the counters at high energies is in approximate agreement with theory.

It appears, therefore, that the counters are satisfactory as dosimeters for neutron energies at least as high as those found in the fission spectrum. Further measurements in the region of 3 to 10 Mev will be made.

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

PROGRAM 1000 - PLANT AND EQUIPMENT

RESEARCH FACILITIES

Separations Building #205

Concrete grade beams have been poured on the north, east, and west sides of the loading platform, and backfilling is in progress. The concrete floor slab has been poured. The steel window frames are being installed on the cell block penthouse. The building is 35% complete.

Research Laboratory

Bids will be opened on May 4, 1950. About twenty general contractors have indicated interest in bidding by taking out plans and specifications. Minor changes and corrections resulting from further reviews have been made available to bidders through issuance of addenda.

Physics of Solids Building

An essentially complete set of drawings covering the expanded building and Cells Nos. 1, 2, and 3 has been approved for construction. The grade beams have all been poured south of the cell walls. All foundations on the north side have been completed up to the cell floor level. Forming and pouring concrete continues. Brick work has not yet started.

Cafeteria Building

Interior partitions and glazed tile walls are nearly 100% complete; the metal lathing is 95% complete. Plasterers started work April 27, 1950. Plumbers, electricians, steam fitters, and sheet metal workers are waiting on completion of plastering to install equipment and fixtures. Major items of work remaining to be completed are: plastering, installation of equipment and furniture, painting, asphalt tile flooring, applying hardware, etc. Total completion - 65%. Laboratory furnished equipment and furniture are being re-conditioned for this building.

Instrument Laboratory

All concrete foundation piers, grade beams, platforms, and stairs are completed, all compacted stone fills under concrete floor slab are

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STATUS AND PROGRESS REPORT

APRIL, 1950

completed, twenty-five per cent of the concrete floor slab has been installed, and all structural steel has been erected, aligned, and bolted. Plumbers and fitters have installed soil, drain, and water lines in and under the floor slab. The electricians are installing conduit and grounding in and under the floor slab. Total completion - 15%.

Health Physics Calibration Building #104-A

The steel roof framing is 90% complete and the erection of interior block partition walls has been started.

Isotope Research and Semi-Works Building

The CRNL drawings on the cells have been approved and are being reproduced. Drawings and specifications covering the building, and including the cells, will be approved and reproduced during the weekend of April 29, to be available to bidders on or immediately following May 1, 1950. Corrections and clarification resulting from review the week following will be issued as an addendum about May 15, to be included in bids to be received on June 15.

Fan House #115

Construction started March 22, 1950 by J. A. Jones Company. The 2300 V electric feeders have been re-routed to permit building construction to proceed. The structural steel is complete, and the building is 25% completed. Present schedules indicate delivery of the first new compressor by the B. F. Sturtevant Company late in May. The Austin Company is preparing a work sequence program covering the installation of the compressors. This will indicate the shutdown time for each of the two compressor installations, and tie together the activities of the various agencies. This program is being delayed pending receipt of foundation drawings and shipping dates from the compressor manufacturer.

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OAK RIDGE NATIONAL LABORATORY

STATUS AND PROGRESS REPORT

APRIL, 1950

PERSONNEL SUMMARY

	<u>Number of Employees</u> <u>April 30, 1950</u>	<u>New Hires</u> <u>April</u>	<u>Terminations</u> <u>April</u>
Administration	91	2	1
Operations*	101	1	1
Engineering, Shops and Mechanical	722	31	0
Laboratory & Research	791	24	9
Protection	170	0	1
Service	<u>305</u>	<u>5</u>	<u>1</u>
TOTAL	2180	63	13

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

RADIOISOTOPE SALES

<u>Sales</u>	<u>February, 1950</u>	<u>March, 1950</u>
Transfers within AEC	\$ 8,557.40	\$18,195.09
Off Project	13,927.55	18,311.68
Foreign	2,062.20	2,251.30
Cancer Program (Free)	27,384.10	23,053.55
Technical Cooperation Plan	<u>-0-</u>	<u>2,442.90</u>
Total Sales and Transfers to Date		\$979,339.46
Total Cancer Program (free) to Date		\$431,752.96
Technical Cooperation Plan		\$ 2,842.90

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STATUS AND PROGRESS REPORT

APRIL, 1950

GROSS OPERATING COSTS

(a)	Actual ORNL operating cost for March, 1950	1,177,578	
	Construction - ORNL portion of Program "H"	<u>38,968</u>	
	Total ORNL operating & construction costs		1,216,546
(b)	Estimated ORNL operating cost for April, 1950		1,400,000
(c)	Actual accumulative FY 50 ORNL operating cost through March, 1950	9,506,778	
	Actual accumulative FY 50 ORNL construction costs (Program "H") through March, 1950	<u>235,028</u>	
	Total actual accumulative FY 50 operating and construction costs through March, 1950		9,741,806
(d)	Estimated ORNL operating cost FY 50 through April, 1950		11,141,806