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BIOLOGY AND MEDICINE PORTION OF
OAK RIDGE NATIONAL LABORATORY
RESEARCH AND DEVELOPMENT PROGRAM
FOR FISCAL YEAR 1957



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Human Studies Project

[REDACTED]

Approved for issue by: Dr. C. E. Larson
Date Issued: JUN 2 1955

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BIOLOGY AND MEDICINE PORTION OF
OAK RIDGE NATIONAL LABORATORY
RESEARCH AND DEVELOPMENT PROGRAM FOR
FISCAL YEAR 1957

CLASSIFICATION CANCELLED
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For The Atomic Energy Commission
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Chief, Declassification Branch

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PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Biology (Summary)		2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC OPNL		4. WORKING LOCATION Oak Ridge, Tennessee	
5. CONTRACT NO. W-7403-Eng-28			
6. BUDGET ACTIVITY NO.	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semiannual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Alexander Hollaender		11. STATUS (INCLUDING STARTING DATE) Active	
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)			
<p>Over-all objective of research in the Biology Division is the investigation of the effects of radiations on living materials. One of the programs, of very long-term implication, is a search for mutational changes in mice after exposure to 300, 600, and 1000 r. Studies are also carried out on developmental injuries occurring in mice irradiated during pregnancy. Physiological and pathological effects of ionizing radiation in mammals are under extensive investigation, with particular reference to radiation-induced disturbances such as leukemia, cataracts, and tumors. The following genetic problems are being investigated: fundamental genetics in chromosome mechanics and gene action; cytogenetic effects of radiation administered to viruses, microorganisms, plants, and invertebrate animals. Programs concerning radiation effects on cell division, growth, and metabolism are under way. Of great interest is the search for physical conditions or chemicals that afford protection from radiation or enhance recovery from radiation injury. In biochemistry, the following programs are in progress: plant chemistry and photosynthesis; studies on nucleic acid structure, mechanism of enzyme action, and on biological energy-transfer systems; and enzyme and isotope tracer studies on microbial intermediary metabolism. The varied biochemistry research affords basic knowledge necessary for interpretation and extension of the radiation studies mentioned above. In physical radiobiology and basic cell physiology, studies are made of physical interactions of radiations with biological materials, as well as with simple chemical systems; there are also research in basic cell physiology by advanced physical and radiobiological techniques and investigations of radiation-induced electrolyte disturbances. The scope of the work has been extended somewhat during the fiscal year 1954-55 in that the results of the basic studies of the effects of radiation on microorganisms are now being applied to mammals. As will be pointed out in the next section, some of these results are of great significance.</p>			
13. RELATED PROJECTS			
<p>We continue close cooperation with: (1) a number of Atomic Energy Laboratories, especially in a new program which is being set up with the University of Rochester, Atomic Energy Project; (2) a number of laboratories of the British Medical Research Council, i.e., Harwell, Chester Beatty Research Institute, Cambridge Radiological Laboratory, Mt. Vernon Hospital, and several others; (3) The National Bureau of Standards -- which association has turned out to be quite profitable to us; (4) Southern Universities, through research participation, traveling lectures, and recently, a program whereby we loan staff members to teach in highly specialized fields carried out at no expense to this Laboratory. Aid has been given to Duke University in establishing a radio-biology course to be taught at the Beaufort Marine Laboratory; to other</p>			

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13. RELATED PROJECTS Continued

Southern Universities on specific projects like plant physiology, etc.; (5) The U. S. Department of Agriculture -- in the use of atomic energy in controlling insects; and (6) U. S. Air Force -- the range of this cooperation is being expanded.

14. ACCOMPLISHMENTS LAST YEAR

The studies on radiation protection and recovery have given new and interesting results. It has been possible to produce in Escherichia coli a notable degree of recovery from X-ray damages by adding the following three compounds to minimal medium: glutamate, uracil, and guanine. E. coli cells which are protected by chemical means and which recover by nutritional support have a lower mutation rate than would be expected after the doses of radiation used in these experiments. This highly significant finding led us to attempt repetition of these results on mammals. The latter studies are showing that mice protected with S, β -aminoethylisothiuronium·Br·HBr (hereafter referred to as thiuronium) given before exposure, bone marrow after exposure, and a daily supplement of streptomycin, the LD₅₀ can be tripled. These findings open a new field in radiation studies, especially since it was thought impossible for animals to survive these massive irradiations.

The mammalian genetics group has now sufficient data on the effects of 300 r on mutation rates in mice to fit the results into the pattern obtained with 600 and 1000 r. Quantitative histological studies of the effect of radiations on the testis illustrate the great sensitivity of spermatogonia to X or gamma radiation. Effects of doses as low as 5 r have been readily detected.

Studies have shown that repair of radiation damage to bean root chromosomes is favored by adenosine triphosphate which is utilized as an energy source for biosynthesis of bonds to rejoin the broken chromosomes. Ehrlich mouse ascites tumors have turned out to be excellent material for studying radiation damage, providing an opportunity to correlate the data obtained from plants with those on mammalian tissues.

Studies with Habrobracon have permitted separation of the effects of X irradiation and ultraviolet on the cytoplasm and the nucleus. The effect of anoxia on the rejoinability of heterochromatic and euchromatic chromosome ends broken by irradiation is being studied in Drosophila. Interesting data have been obtained on the effect of radiation on stickiness of chromosomes. Centrifugation immediately after X irradiation will interfere with the joining of the chromosomes. In Drosophila, the relative biological effectiveness of fast neutrons as compared with X rays is much less for mutations than for recovered chromosome abnormalities. Studies have demonstrated that the so-called "inert" heterochromatic regions of chromosomes have areas with specific function with regard to the pairing and disjunction of partially homologous chromosomes.

The work on Paramecium brought out that hydrogen peroxide cannot be responsible for an appreciable part of X-ray mutagenesis. Mercaptoethanol and cysteamine protect against X-ray damage in Paramecium. Hydrogen peroxide

14. ACCOMPLISHMENTS LAST YEAR

Decreases the amount of mutation when the organisms are exposed to relatively high concentrations either immediately before or immediately after X irradiation.

The histological studies of the mice which survived "Operation Greenhouse" are continuing. Special attention is paid again to cataract production and leukemogenesis; a transmissible disease of mice characterized by anemia, leukopenia, splenomegaly, and myelosclerosis has been recognized. Activity in the cooperative project with the U. S. Air Force increased during the past year. Acute lethality studies in the 86-inch cyclotron permitted some correlation of neutron dose and energy spectrum with lethality in mice. Studies on the effect of fast neutrons on cataract induction continue.

The nucleic acid investigations have continued to give interesting information; the purine nucleotides "a" and "b" have been identified as the 2' and 3' phosphoribosides, respectively. Studies on enzyme-substrate complexes have been extended to hydrolysis of a new linkage, the carbon-carbon bond, by a proteolytic enzyme; this opens a new area, and the possibility to study the maximum bond strength that can be activated by an enzyme. Studies on bacteriophage deoxyribonucleic acid have led to the discovery of a new compound, O-glucoside of hydroxymethyl cytosine; this compound is quantitatively significant in certain bacteriophage. A large fraction of the bio-organic synthesis and testing program has been directed toward designing new compounds which will give increased radiation protection; one of these compounds, thiouronium, is of greatest promise.

The group on enzymology and photosynthesis, organized last year, discovered a new type of luminescence in fungi. The path of synthesis of nucleic acids in the chick embryo has been traced by Cl^{14} ; differences in relative rates of incorporation were observed following irradiation. The action and emission spectra for delayed light in photosynthesis have been analyzed; the emission arises from chlorophyll.

The intermediary metabolism group, in continued analysis of the sulfhydryl enzyme systems concerned with decarboxylation of alkane dioic acids have discovered an entirely new type of peroxidizing enzyme and brought it to a high state of purity. The enzyme is a flavoprotein peroxidase, and hence the first nonporphyrin peroxidase.

In plant biochemistry, a study of high levels of ionizing and ultraviolet radiation has shown severe inhibition of photosynthesis, secretion of metabolic products by algal cells, and abnormal metabolism. The biochemistry of the "greening" process in dark-grown leaves has compared the rate of chlorophyll synthesis with the rate of carbon dioxide fixation to show how the photosynthesis process is acquired by the plant. A major storage and transport of phosphorus in plants besides inorganic or metaphosphate has been discovered.

The general physiology group has developed several methods for the isolation of particulate material from cells. These new methods appear to be of great promise. The mechanism of the function of erythrocytes has been studied further by means of acetylcholine content. This group is largely responsible

14. ACCOMPLISHMENTS LAST YEAR Continued

for the evaluation of the physical aspects of the genetic effects of fast neutrons from nuclear detonations. In the comparative study of X and gamma rays and fast neutrons in the production of chromosome aberrations have been continued, the time and intensity relation has been tested. Paramagnetic resonance methods for effects of radiation on polymers has been studied. Much work has been done on the Cockcroft-Walton accelerator in an effort to obtain a maximum emission of fast neutrons. Energy measurements of fast neutrons coming from the Cockcroft-Walton have received intensive study.

The proceedings, "Genetic Recombination" of the Seventh Annual Biology Research Conference have been submitted to the publisher; the proceedings of the Sixth Annual Biology Research Conference, "Effects of Radiation and Other Deleterious Agents on Embryonic Development" has been published.

In 1954, The Biology Division published seventy-two full-length papers, 1 thirteen-chapter symposium, 2 semiannual reports (ORNL), forty-one abstracts, and seven book reviews.

In addition to its staff, the Division had working in its laboratories, nine visiting investigators, two postdoctoral fellows, two Air Force men, and several consultants.

15. EXPECTED RESULTS THIS YEAR

Special emphasis will be placed during the coming year on the development of the results obtained in this Laboratory in regard to radiation protection and recovery. Not only will the new group (Mammalian Recovery) concentrate on this work, but several other groups will conduct supporting experiments in an effort to elucidate the mechanism of protection and recovery. It is planned to conduct a major part of the work in this Laboratory, but certain portions will be farmed out to other Laboratories. Negotiations have been initiated whereby the University of Rochester, Atomic Energy Project, would assume responsibility for toxicity studies with the thicuronium compound. This has put a somewhat different pattern of development on the work of this Laboratory. Much more extensive mammalian studies will have to be conducted.

It is hoped that the Mammalian Genetics Group will complete its studies on the effect of 300 r on mutation rate, and have the 150 r test well on the way.

The work set up in cooperation with the U. S. Air Force should start to produce important results in regard to acute and chronic exposure with fast neutrons.

It might be of interest to compare the "Expected Results" which had been predicted last year -- "Closer cooperation between the radiation protection group and biochemistry investigations should give us results for designing additional methods for radiation protection. It is hoped to apply the findings obtained in bacteria to animal work." As predicted last year, the results of this investigation turned out very well. It now seems possible to give much greater protection to mammals against radiation than was ever thought

15. EXPECTED RESULTS THIS YEAR Continued

possible. This will form some of the major themes for next year's investigations.

The Cytogenetics work will continue the elucidation of the mechanism of protection of chromosomes against X-ray damage.

The individual biochemistry groups are now cooperating on the recovery project and should contribute much toward a better understanding of the mechanisms which are involved.

16. ANTICIPATED PROBLEMS NEXT YEAR

Reference is again made to our last year's Budget outline, to the section on "Anticipated Problems." Several of the predictions have been realized; but the application to mammalian work was not possible since we did not have the necessary staff to do the work. With the New Mammalian Recovery Group, this will now be possible. For example, it is hoped that the thiouronium compound may be not only the practical means of radiation protection, but also of considerable help on problems in which the Air Force is interested. It is also hoped that some of the findings which have been made in this Laboratory can be applied to man.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>1,617,000</u>	\$ <u>1,792,000</u>	\$ <u>1,892,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1. Domestic Research Associates	50,000	88,000	100,000
2. Foreign Research Associates		5,000	5,000
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ <u>50,000</u>	\$ <u>93,000</u>	\$ <u>105,000</u>
TOTAL PROGRAM COST	\$ <u>1,667,000</u>	\$ <u>1,885,000</u>	\$ <u>1,997,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>85.5</u>	<u>98.7</u>	<u>101.9</u>
B. TECHNICIANS.....			
SUBTOTAL	<u>85.5</u>	<u>98.7</u>	<u>101.9</u>
C. OTHER TECHNICAL, LOANEE: PARENT ORGANIZATION			
1. Foreign Research		5.0	5.0
2. Associates		1.5	
3. ORINS	<u>2.0</u>		
TOTAL DIRECT MANPOWER	<u>87.5</u>	<u>105.2</u>	<u>106.9</u>
19. COMMENTS			

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**PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT**

1. PROJECT TITLE Biophysics (Summary)				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-28	
6. BUDGET ACTIVITY NO.	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Karl Z. MORGAN			11. STATUS (INCLUDING STARTING DATE) Active		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>Reactor technology is advancing at a rapid pace and the time when significant amounts of power will be developed is not far off. The expansion in the application of atomic energy could at any time be seriously hampered if appropriate measures to prevent damage to people and dispersal of radioactivity in the environment are not taken. The Health Physics Research program attempts to keep ahead of the expansion in reactor technology so that as the rate of production of radioactive materials is increased, the knowledge and means with which to control the hazards are available.</p> <p>In order to provide this support more effectively, the Health Physics research effort was reorganized during FY 1955 into four general programs, radiation dosimetry, applied radiobiology, sanitary engineering and waste disposal, and education and training. These programs with their associated objectives are outlined below.</p> <p>A. <u>Radiation Dosimetry</u></p> <p>This program is concerned with experimental and theoretical investigations into the fundamental interaction of radiation and matter. The approach varies in scope from basic investigations to the development of instruments for use in radiobiology and applied health physics.</p> <p>B. <u>Applied Radiobiology</u></p> <p>The results of radiation dosimetry, radiobiology, and reactor technology hazards studies are applied and integrated in this program to provide practical data to determine maximum permissible exposure levels.</p> <p>C. <u>Sanitary Engineering and Waste Disposal</u></p> <p>An essential goal in the development of reactor technology is safe and economical means of disposal and control of radioactive wastes. This program is directed toward actual development, demonstration and testing of such means of control. It is closely associated with reactor operation, chemical technology, and applied radiobiology.</p> <p>D. <u>Education and Training</u></p> <p>The expansion in the atomic energy program requires a program for the training of health physicists to be employed in AEC facilities, industry, universities, hospitals, military services, and other governmental and private agencies.</p>					

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13. RELATED PROJECTS

- A. ORNL Applied Health Physics Department
- B. Weapons Testing Program
- C. U.S. Geological Survey
- D. ANP Project
- E. ORNL Biology Division
- F. Primate Laboratory, University of Texas
- G. Health Physics Division, Los Alamos Scientific Laboratory
- H. Subcommittee on Internal Dose of the National Committee on Radiation Protection and the International Commission on Radiological Protection
- I. Massachusetts General Hospital - Dr. William Sweet
- J. ORINS - Dr. Ralph Kniseley
- K. Ecological Society of America - Dr. Orlando Park
- L. U.S. Public Health Service
- M. Tennessee Valley Authority
- N. Engineer Research and Development Laboratories, U.S. Corps of Engineers
- O. AEC Fellowship Program in Radiological Physics, Vanderbilt University; University of Rochester, Brookhaven National Laboratory; University of Washington, Hanford Works
- P. Armed Forces Special Weapons Project

14. ACCOMPLISHMENTS LAST YEAR

A. Radiation Dosimetry

The program of basic and applied research in the field of dosimetry has been continued. The processes by which high energy electrons lose energy in penetrating matter have been studied experimentally both for thin metallic absorbers where the loss to the conduction electrons has been measured and for thick absorbers where a statistical distribution of losses is found. The

14. ACCOMPLISHMENTS- LAST YEAR continued

ionization of gases by heavy particle bombardment has been investigated as to the effects of impurities in the gases, and preliminary data on electron drift velocities and attachment coefficients have been taken. Theoretical studies have been concerned with the capture and loss of electrons by low energy heavy ions in passing through matter, the polarization of the medium by the field of the incident particle, the Cerenkov effect, and the loss of energy to the plasma of conduction electrons. Depth dose distributions have been calculated for neutrons and measured experimentally for electrons. The response of various films to neutrons and X-rays has been studied experimentally and modifications of the neutron film have been found necessary. Techniques of neutron measurement have been improved using proportional counters and threshold detectors, and extensive application has been made in the Nevada bomb tests and the Tower Shielding Facility, and in the calibration of the neutron flux from the 86-inch cyclotron and the Lady Godiva at Los Alamos for use in biological experiments. The instrumentation involved in making radiation measurements from aircraft has been improved and used during weapons tests as well as in prospecting for uranium.

B. Applied Radiobiology

The University of Tennessee spectrographic laboratory under subcontract to ORNL continued the analysis of human tissue for the distribution of trace elements. The function of procurement and preparation of tissue samples was transferred to ORNL in order to expedite the program.

Quantitative spectrographic methods for the simultaneous analysis of 21 elements were developed as well as a spectrographic method for determination of very low strontium concentrations in various biological material.

Analysis of biopsy and autopsy samples from five expired patients who had received intravenous injections of uranyl nitrate hexahydrate were completed and the data will be analyzed utilizing the ORACLE to determine the distribution and excretion of uranium as a function of time.

The experimental determination of the critical organ, effective half-life, and the per cent retention of ingested Co^{60} (as a chloride) in mice was completed.

A new and improved radiochemical procedure for analysis of radioactive strontium in urine was developed and is now in use in routine analyses.

Plans for an MPC library were formulated and its establishment is underway.

Treehole mold samples from Oak Ridge, Ohio, and Delaware were irradiated for study of effect of different dose levels on population numbers.

14. ACCOMPLISHMENTS LAST YEAR continued

C. Sanitary Engineering Research

A third chemical waste pit was constructed and put into use.

Studies were carried out to measure the effectiveness of the asphalt-tamped-clay lined pit.

Procedures were developed for determining radioactive Sr and Ba in natural waters and for recovery of the more critical radioactive materials fixed to soils.

Work continued on methods of generating and estimating size of particles in the 0.01 μ radius range.

D. Education and Training

In addition to the formal training program for the AEC Fellows in Radiological Physics, other training programs were conducted for military medical officers, personnel of outside AEC contractors, and training courses were given ORNL apprentice trainees and Applied Health Physics personnel. Special discussions on Health Physics for periods of several weeks were held with scientists from Japan and Egypt. Numerous lectures were given throughout the year at universities, hospitals, ORNL, ORINS seminars and professional meetings.

15. EXPECTED RESULTS THIS YEAR

A. Radiation Dosimetry

Theoretical studies will include a quantum mechanical treatment of the polarization effect, a calculation of stopping power for very low energy ions, a range distribution for heavy recoil atoms, and a calculation of atomic displacements in hydrocarbons exposed to fast neutrons.

Additional experimental work on electron drift velocity and attachment coefficients will be done. Depth dose studies will be continued experimentally for electrons using a new ion chamber and theoretically for fast neutrons using the principle of linear energy transfer in a Monte Carlo calculation. A new facility for measuring neutron and gamma-ray scattering will be completed and used to determine scattering from materials such as water, lead, aluminum, concrete and steel. The dosimetry work will be devoted to the solution of those problems which arise during the year. An aerial survey of the normal background of the entire United States will be considered.

15. EXPECTED RESULTS THIS YEAR continuedB. Applied Radiobiology

Approximately 100 autopsies from various geographical locations will be analyzed by the U.T. Spectrographic laboratory. Tentative figures for concentrations of about 20 elements in "standard man" should be established.

Analyses of biopsy and autopsy samples for the determination of distribution and excretion rates for uranium in man will be continued. Appropriate mathematical analyses of these data will continue.

The Oak Ridge Hospital pathologist will routinely provide autopsy tissues for analyses related to internal radiation dosimetry and the ORNL Health Program.

The experimental determination of information needed to establish MPC for Ru^{106} will be completed.

The MPC reference library will be enlarged.

Work will be done on developing a radiochemical analytical procedure for cesium and ruthenium in body fluids and on developing a general examination procedure for people exposed in radiological accidents.

Preliminary studies of the effects of external radiation on natural populations of treehole mold samples will be completed. Additional studies to determine effects of internal and external radiation on species of population numbers, total population numbers and intra- and inter-specific relationships (food web, experiments) will be initiated.

C. Sanitary Engineering Research

The efficiency of mineral and bituminous liners for waste pits will be studied.

The study of the migration of radioactive and non-radioactive materials in soils of different types and the chemical and physical processes involved will be continued.

Critical nuclides in wastes from new processes will be evaluated.

Evaluation of military water decontamination equipment for low level waste will be continued.

Work will continue on methods of generating and measuring sub-micron particles.

Preliminary evaluation of filters using particles in the 0.01μ radius range will be made.

15. EXPECTED RESULTS THIS YEAR continued

D. Education and Training

Education and Training activities in Health Physics will continue to meet the increased needs of the nuclear energy field and additional assistance will be given to foreign countries.

16. ANTICIPATED PROBLEMS NEXT YEAR

A. Radiation Dosimetry

The general program will be continued with the addition of a study of methods and techniques for estimating personnel exposure to neutrons in accidents. A more direct participation in radiobiological investigations is anticipated to enable better evaluation of dosage and to provide better facilities for irradiation of biological material. A Lady Godiva neutron source at ORNL will assist in the above endeavor.

B. Applied Radiobiology

After completion of study of trace elements in "standard man in the United States", spectrographic analyses of food, water, and soils geographically distributed will begin. Also, an investigation of trace elements in "basic man of uncivilized countries" will be initiated.

Distribution and excretion studies of intravenously injected uranium will be completed and studies will begin on distribution and excretion of inhaled uranium.

Distribution and excretion of other critical radionuclides in man may be studied.

Ecological studies will continue at a level of effort yet to be determined by the AEC. Studies at ORNL may include (1) bacteriological and mycological studies of forest floor organisms, (2) expansion of natural population studies, (3) life history studies on major and critical arthropods, and (4) comparative studies of populations from different associations within the deciduous biome.

C. Sanitary Engineering Research

Hazards associated with the operation of the high level waste disposal pits at ORNL will be evaluated.

Geological investigations for new waste disposal sites at ORNL will continue.

Cooperative sanitary engineering program with ERDL will continue.

16. ANTICIPATED PROBLEMS NEXT YEAR continued

C. Sanitary Engineering Research continued

Studies of filter penetration of particles in the 0.1 - 0.001 μ radius range will be made.

Investigations will continue in the behavior of sub-micron radioactive particles and the hazards these particles impose.

D. Education and Training

With the increase in programs for the utilization of nuclear energy for power, the need for trained Health Physicists will be increased, hence, it is expected that the activities of the Education and Training program will be expanded accordingly.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>740,000</u>	\$ <u>797,000</u>	\$ <u>797,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1. University of Tennessee			
2. (Spectrographic Laboratory)	23,000	22,000	22,000
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ <u>23,000</u>	\$ <u>22,000</u>	\$ <u>22,000</u>
LARGE AND/OR UNUSUAL COSTS:			
1. Nevada Proving Ground			
2. (Neutron Dosimetry Program)	17,500	-	-
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ <u>17,500</u>	\$ <u>-</u>	\$ <u>-</u>
TOTAL PROGRAM COST	\$ <u>780,500</u>	\$ <u>819,000</u>	\$ <u>819,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	30.5	32.5	32.5
B. TECHNICIANS.....	<u>1.4</u>	<u>1.5</u>	<u>1.5</u>
SUBTOTAL	31.9	34.0	34.0
C. OTHER TECHNICAL, LOANEEs: PARENT ORGANIZATION			
1. Research Participants	1.0	0.9	0.9
2.			
3.			
TOTAL DIRECT MANPOWER	<u>32.9</u>	<u>34.9</u>	<u>34.9</u>
19. COMMENTS			

PROGRAM 6000 - SUMMARY

AEC Activity Number	Description	FY 1955		FY 1956		FY 1957	
		Program Costs	Total M-Yrs. ORNL Personnel	Program Costs	Total M-Yrs. ORNL Personnel	Program Costs	Total M-Yrs. ORNL Personnel
6130	Radiation Effects on Biological Systems - Biological Research	1,465,000	75.5	1,645,000	81.7	1,726,000	87.9
6230	Combating Radiation Detrimental Effects - Biological Research	202,000	10.0	398,000	21.0	498,000	23.0
6440	Biomedical Problems in Atomic Energy Operations - Biophysics Research	321,000	12.0	369,000	14.6	369,000	14.6
6560	Dosimetry and Instru- mentation - Dosimetry	409,000	16.9	390,000	16.4	390,000	16.4
6680	Vocational Training Program	50,000	3.0	60,000	3.0	60,000	3.0
	Total Program 6000	2,447,500	117.4	2,862,000	136.7	3,043,000	144.9

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PROGRAM 6000 - SUMMARY

6130 - RADIATION EFFECTS ON BIOLOGICAL SYSTEMS - BIOLOGICAL RESEARCH

Page No.	ABC Activity Number	Description	FY 1955		FY 1956		FY 1957	
			Program Cost	Total M-Yrs. ORNL Personnel	Program Cost	Total M-Yrs. ORNL Personnel	Program Cost	Total M-Yrs. ORNL Personnel
21	6130	Genetic and Cytogenetic Effect of Radiations	160,000	9.0	161,000	9.0	161,000	9.0
24	6130	Effects of Radiation on Paramecium	52,000	3.0	52,000	3.0	62,000	4.0
27	6130	Insect Cytology and Genetics	127,000	8.0	127,000	8.0	127,000	8.0
31	6130	Genetic and Developmental Effects of Radiation on Mice	294,000	12.8	453,000	17.0	522,000	22.0
34	6130	Biochemistry: Nucleoproteins, Enzymes, Polysaccharides	147,000	9.0	148,000	9.0	148,000	9.0
38	6130	Mathematics and Computational Biology	40,000	2.1	40,000	2.1	40,000	2.1
40	6130	Pathology and Physiology	205,000	6.8	206,000	7.0	206,000	7.0
43	6130	Tracer Studies in Intermediary Metabolism	93,000	5.0	93,000	5.0	93,000	5.0
46	6130	Plant Biochemistry	79,000	5.0	87,000	5.8	89,000	6.0
50	6130	Enzymology and Photosynthesis	113,000	6.0	123,000	7.0	123,000	7.0
53	6130	Biophysics	103,000	5.0	103,000	5.0	103,000	5.0
56	6130	Research Participation and Travel Lecture Program	52,000	3.8	52,000	3.8	52,000	3.8
58		Total 6130	1,465,000	75.5	1,645,000	81.7	1,726,000	87.9

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6230 - COMBATING RADIATION DETRIMENTAL EFFECTS - BIOLOGICAL RESEARCH

Page No.	ABC Activity Number	Description	FY 1955		FY 1956		FY 1957	
			Program Cost	Total M-Yrs. ORNL Personnel	Program Cost	Total M-Yrs. ORNL Personnel	Program Cost	Total M-Yrs. ORNL Personnel
59	6230	Radiation Protection Living Cells	95,000	5.0	106,000	6.0	106,000	6.0
62	6230	General Physiology	82,000	4.0	92,000	5.0	92,000	5.0
65	6230	Mammalian Radiation Recovery	25,000	1.0	200,000	10.0	300,000	12.0
		Total 6230	202,000	10.0	398,000	21.0	498,000	23.0

6440 - BIOMEDICAL PROBLEMS IN ATOMIC ENERGY OPERATIONS - BIOPHYSICS RESEARCH

67	6440	Applied Radiobiology	123,000	4.0	175,000	6.0	175,000	6.0
72	6440	Mathematics and Computation - Health Physics	40,000	2.1	40,000	2.1	40,000	2.1
74	6440	Sanitary Engineering Research - Hazards with the Disposal of Radioactive Wastes from Reactors	158,000	5.9	154,000	6.5	154,000	6.5
		Total 6440	321,000	12.0	369,000	14.6	369,000	14.6

6560 - DOSIMETRY AND INSTRUMENTATION - DOSIMETRY

79	6560	Radiation Dosimetry	394,500	15.8	375,000	15.3	375,000	15.3
86	6560	Research Participation and Travel Lecture Program	15,000	1.1	15,000	1.1	15,000	1.1
		Total 6560	409,500	16.9	390,000	16.4	390,000	16.4

6680 - VOCATIONAL TRAINING PROGRAM

Page No.	AEC Activity Number	Description	FY 1955		FY 1956		FY 1957	
			Program Cost	Total M-Yrs. ORNL Personnel	Program Cost	Total M-Yrs. ORNL Personnel	Program Cost	Total M-Yrs. ORNL Personnel
89	6680	Education and Training in Health Physics	50,000	3.0	60,000	3.0	60,000	3.0
		Total Program 6000	2,147,500	117.4	2,862,000	136.7	3,043,000	144.9

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Genetic and Cytogenetic Effect of Radiations			2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC OFNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26
6. BUDGET ACTIVITY No. 6130	7. BUDGET ITEM No.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bi-monthly and Semi-Annual Reports	
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Alan D. Conner and R. F. Kimball			11. STATUS (INCLUDING STARTING DATE) Active	
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)				
<p>The efforts of the group are devoted to observation and analysis of the genetic and cytological damage caused by radiations--those mechanisms which account, in large measure, for the final consequences of irradiation of cells, namely, cellular modification and cell death. A number of genetic and cytological materials, each favorable for some biological reason, are utilized, as well as different radiational and environmental conditions which allow more thorough analysis of how radiation affects the genetic mechanism. For example, in these studies, the mold <u>Neurospora</u> allows a correlated analysis of genetic effect and cell survival, the plants <u>Tradescantia</u> and <u>Vicia</u> of chromosomal effects, the mouse ascites tumor of chromosomal effects and survival in mammalian cells, and maize of genetic and chromosomal effects as well as survival. The combination of these materials and methods furnishes an overlapping system for the examination of genic, chromosomal and lethal effects of irradiation on cells.</p>				
13. RELATED PROJECTS				
<p>Cooperation with the University of Tennessee and Duke University.</p>				
14. ACCOMPLISHMENTS LAST YEAR				
<p>Modification of the cellular environment in <u>Vicia</u> and <u>Tradescantia</u> has revealed that the ultimate expression of the primary chromosomal breakage caused by radiation is subject to some physiological control. In <u>Vicia</u>, it was shown that the repair of radiation damage to the chromosomes is dependent on oxidative metabolism producing ATP, which is utilized as an energy source for biosynthesis of bonds to rejoin the broken chromosomes. Development of a new method of chromosomal fusion analysis in <u>Tradescantia</u>, for the purpose of studying the oxygen effect, demonstrated that increase in chromosomal damage with increasing oxygen tension was due firstly to increase in the primary breakage rate, but also partly to an effect oxygen has on the rejoining of broken chromosomes. It was found that simultaneous mitotic rate-chromosomal aberration observations could be made in the <u>Ehrlich</u> mouse ascite tumor; this allows correlation of these two well-known cellular effects of radiation.</p> <p>It was shown in <u>Neurospora</u> that there is an accumulation of both spontaneous and radiation-induced recessive lethal mutations in continuously growing cultures. The general problem of genetic dominance has been studied by the use of artificially constructed nuclear ratios in <u>Neurospora</u> heterokaryons; contrary to previous statements, it was found that nuclear ratios which give optimal growth are not achieved, even in extended growing times, by cultures started initially with one or the other nucleus present as a small fraction.</p>				

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14. ACCOMPLISHMENTS LAST YEAR Continued

The association between the mutability of an unstable gene and a morphological change in a chromosomal segment was analyzed in maize. A hypothesis on the problem of gene action and protein specificity was developed.

15. EXPECTED RESULTS THIS YEAR

The successful demonstration that oxidative enzyme systems and ATP are involved in the repair of broken chromosomes will be extended to a more detailed examination of the effect that particular enzyme systems play in such repair. Magnitude of the oxygen effect has been shown to be related to the effective energy of the radiation applied, but in an ambiguous way; an attempt will be made to resolve these ambiguities by using the newly developed fusion analysis in Tradescantia. The effort to demonstrate the quantitative relation between chromosomal damage, mitotic inhibition, and cell death as a result of irradiation will be continued with the ascites tumor.

The factors limiting induction of recessive lethals and producing non-linear growth response in Neurospora will be studied, and the enumeration of genetic loci undergoing recessive lethal mutation will be continued. Further information on the behavior of unstable genes in maize is expected. Experimental support for the hypothesis of protein synthesis in relation to gene action will be sought.

16. ANTICIPATED PROBLEMS NEXT YEAR

The biological effect of radiation from the point of view of its effect on the genetic apparatus will continue to receive the major part of the attention of the group. It is becoming apparent that the final genetic consequences of radiation are quantitatively affected by the physiological conditions of the cell at or after the time it is irradiated, and more information on these physiological variables and their effects will be sought.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>150,000</u>	\$ <u>150,000</u>	\$ <u>150,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4. Foreign Research Associates		1,000	1,000
5. Domestic Research Associates	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>
TOTAL UNUSUAL COSTS	\$ <u>10,000</u>	\$ <u>11,000</u>	\$ <u>11,000</u>
TOTAL PROGRAM COST	\$ <u>160,000</u>	\$ <u>161,000</u>	\$ <u>161,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	9.0	9.0	9.0
B. TECHNICIANS.....	_____	_____	_____
SUBTOTAL	9.0	9.0	9.0
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3. Foreign Research Associates	_____	1.0	1.0
TOTAL DIRECT MANPOWER	9.0	10.0	10.0
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Effects of Radiation on Paramecium				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6130	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bi-monthly and Semi-Annual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) R. F. Kimball			11. STATUS (INCLUDING STARTING DATE) Active		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>The single-celled animal, <u>Paramecium aurelia</u>, is used as a conveniently large cell with which studies of various kinds of radiation damage, both genetic and non-genetic can be made. The purpose is to investigate both the biological nature of the damage and the mechanisms by which it is brought about and so to contribute to the understanding of the biological effects of radiation. It is hoped in this way to establish a logical basis for modifying these effects while at the same time contributing information of basic biological importance.</p>					
13. RELATED PROJECTS					
<p>Cooperation by exchange of information with Indiana University and Argonne National Laboratory.</p>					
14. ACCOMPLISHMENTS LAST YEAR					
<p>The demonstration that hydrogen peroxide is not responsible for an appreciable part of X-ray mutagenesis has been completed with additional experimental and theoretical work, the latter by J. Z. Hearon of the Mathematics Panel.</p> <p>Further studies have been made of the behavior of cell nuclei during meiosis and fertilization in <u>Paramecium</u>. The previous evidence for an autonomous effect of the nucleus' own genetic constitution on its behavior has been greatly strengthened. A partial theory of nuclear behavior has been developed, and the effects of X rays on behavior have been interpreted in terms of it.</p> <p>A number of studies on radiation-induced mutations in <u>Paramecium</u> have been made to increase the basic information about them and to attempt to modify their production. Among others may be mentioned the finding that fast neutrons are more effective than X rays in inducing mutations, the demonstration of a protective effect of mercaptoethanol and cysteamine, and the discovery that hydrogen peroxide decreases the amount of mutation when the paramecia are exposed to relatively high concentrations either immediately before or immediately after X-irradiation.</p>					
15. EXPECTED RESULTS THIS YEAR					
<p>It is planned to continue and expand the work with modifying agents in an attempt to further elucidate the events taking place in the nucleus during and shortly after irradiation. The investigations of the behavior of cell nuclei during fertilization will be continued, and it is hoped with information from this and certain other studies to achieve a better theory of mutation detection in this species.</p>					

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16. ANTICIPATED PROBLEMS NEXT YEAR

As part of the continuing program to achieve an understanding of the basis for damage to cells by radiation, studies will be carried on with modifying agents and in other ways to study the events taking place at the time of irradiation. At the same time efforts will be made to learn more of the nature of the biological damage, the way in which it expresses itself in time, and the methods by which this expression can be changed.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>52,000</u>	\$ <u>42,000</u>	\$ <u>52,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1. Domestic Research Associates		10,000	10,000
2.			
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ _____	\$ <u>10,000</u>	\$ <u>10,000</u>
TOTAL PROGRAM COST	\$ <u>52,000</u>	\$ <u>52,000</u>	\$ <u>62,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.0	3.0	4.0
B. TECHNICIANS	_____	_____	_____
SUBTOTAL	3.0	3.0	4.0
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>3.0</u>	<u>3.0</u>	<u>4.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Insect Cytology and Genetics				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6130	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semi-Annual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Mary Esther Gauden			11. STATUS (INCLUDING STARTING DATE) Active		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>The purpose of this project is to obtain fundamental information in genetics and cytology and to study the effects of radiation on cytogenetic mechanisms in organisms which have short generation times and large cells.</p> <p>New radioautographic and cytochemical methods are being used to correlate radiation-induced mitotic inhibition in the grasshopper with synthesis of nuclear material of the cell. In the wasp <u>Habrobracon</u>, where absolute distinction can be made between radiation killing by action upon cell cytoplasm or nucleus, the mechanism of cell death (nuclear and cytoplasmic) is being examined in detail. The effect of anoxia on the rejoinability of heterochromatic and euchromatic chromosome ends broken by radiation is being studied in <u>Drosophila</u>. As a final example, a project is underway in <u>Drosophila</u> to determine the relations between chromosome pairing in meiosis and the processes of recombination and disjunction of homologous chromosomes.</p> <p>Mention should be made of the fact that the <u>Drosophila</u> group has two post-doctoral Research Associates. This arrangement has been highly successful in acquainting these young geneticists with the problems in radiation genetics which confront the Atomic Energy Commission.</p>					
13. RELATED PROJECTS					
<p>Close cooperation with Biophysics, Enzymology, Physiology, Pathology and Radiation Protection groups of this laboratory and with the Biology Departments of University of Tennessee, University of Pennsylvania, University of Mississippi, Duke University, University of North Carolina, Florida State University, Princeton University, University of Maine, and Susquehanna University.</p>					
14. ACCOMPLISHMENTS LAST YEAR					
<p>Oxygen consumption is significantly reduced in grasshopper embryos <u>in vitro</u> by X-ray doses of 3500 r and above and in embryos <u>in vivo</u> by doses of 10,000 r and above (published). X-ray induced chromosome fragments which are not included in the nucleus after cell division do not undergo the changes normally occurring in chromosomes within the nucleus (published). The effects of radiation which can be observed within the first few hours after treatment on all types of cells thus far studied by radiobiologists have been reviewed (published). Low dosage alpha radiation (1 second irradiation with an average of 0.8 particle/cell) revealed that inhibition of mitosis was related to the Poisson distribution of α-particles striking prophase cells (in press). X-radiation causes chromosomes of mid-mitotic phases to become "sticky", the appearance of the effect depending on dose of radiation and mitotic phase at time of treatment (in press).</p>					

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14. ACCOMPLISHMENTS LAST YEAR Continued

High-speed centrifugation before X-irradiation reduces the percentage of broken *Tradescantia* chromosomes and centrifugation during irradiation increases the percentage of broken chromosomes (published). The genetic dominant lethal effect of nitrogen mustard resembles that of X rays whether done on *Habrobracon* sperm (published) or different stages of developing eggs (in press) and both agents probably act by blocking the synthesis of deoxyribonucleic acid, the substance which transmits hereditary information from cell to cell (in press and in manuscript). The reduced effect of X rays when administered in an oxygen-free atmosphere, is more striking on *Habrobracon* eggs than on sperm (in press).

One group of accomplishments of the *Drosophila* group centers around occasional spontaneous instability and radiation-induced breakage in ring chromosomes. These studies have led to a reinterpretation of the qualitative composition of radiation-induced lethal mutations and the inherent stability of chromosomes. The fact that fewer mutations are recovered in ring chromosomes as compared with normal rod-shaped chromosomes suggests that some lethals are formed when a chromosome is broken and the ends rejoin. This is in agreement with the findings that the relative biological effectiveness of fast neutrons as compared with X rays is much smaller for mutations than for recovered chromosome abnormalities. Spontaneously, unstable ring chromosomes may become stable but this stability is found to be irreversible. The instability is shown to be associated with heterochromatin in the centromere region of the chromosome. Evidence suggests that the instability is related to crossing over between sister chromosome strands. The importance of this sister strand crossing over in normal meiosis has been demonstrated by using attached-X chromosomes. Additional studies have demonstrated that the so-called "inert" heterochromatic regions of chromosomes have areas with specific function with regards to the pairing and disjunction of partially homologous chromosomes.

15. EXPECTED RESULTS THIS YEAR

The grasshopper and wasp studies are expected to yield information on: lethal action of radiation on genetic material in the cell, the differential effects of radiation on various parts of the cell, influence of gases on radiation-induced genetic changes, influence of cell water content on response of cell to radiation, effect of radiation on synthesis of nuclear material, the number of cytoplasmic particles inactivated when the cell is killed by irradiation of the cytoplasm.

The *Drosophila* research program is expected to yield information concerning temporary or permanent interruptions in the continuity of chromosomes arising as a result of radiation-induced breakage, breakage of chromosome bridges, and the normally occurring process of crossing over. This information will add to the knowledge of chromosome duplication. Furthermore, changes in the continuity of chromosomes result in changes in the environment of certain genes. This altered position of the gene often leads to a change in its function. These alterations will be studied in order to gain insight into the relation between gene function and chromosome continuity. Finally, the composition of populations of sex-linked recessive lethal mutations induced by radiations of different ion densities will continue to be intensively investigated.

16. ANTICIPATED PROBLEMS NEXT YEAR

The grasshopper and wasp programs will involve; chemical and physical analyses of structures in the cell and isolated from the cell and further analysis of factors involved in radiation-induced mitotic inhibition. *Drosophila* genetics will center around studies on basic genetics and cytology as revealed by radiation-induced chromosomal aberrations and the induction of genetic alterations by different types of ionizing radiation.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>107,000</u>	\$ <u>107,000</u>	\$ <u>107,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1. Domestic Research Associates	20,000	20,000	20,000
2.			
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ <u>20,000</u>	\$ <u>20,000</u>	\$ <u>20,000</u>
TOTAL PROGRAM COST	\$ <u><u>127,000</u></u>	\$ <u><u>127,000</u></u>	\$ <u><u>127,000</u></u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	8.0	8.0	8.0
B. TECHNICIANS	_____	_____	_____
SUBTOTAL	8.0	8.0	8.0
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2. ORINS	1.0	1.0	
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>9.0</u>	<u>9.0</u>	<u>8.0</u>
19. COMMENTS			

1134682

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Genetic and Developmental Effects of Radiation on Mice				2. DATE	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6130	7. BUDGET ITEM NO.	8. SECURITY CLASS	9. METHOD OF REPORTING PROGRESS		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) William L. Russell			11. STATUS (INCLUDING STARTING DATE)		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>This is an expansion of the proposal and authorization already submitted under this project title.</p> <p>The major problems under investigation, or to be investigated, are: (1) the effect of low doses of radiation on mutation rate, (2) the effect of repeated or chronic exposures on mutation rate, (3) the measurement of over-all genetic damage in populations, (4) mutation rate in females, and (5) the effect of environmental agents, for example, protective chemicals, on radiation-induced mutation rate. The purpose of the program expansion is to speed up this work.</p> <p>The need for this study is reflected by the recommendations of the National Committee on Radiation Protection in the National Bureau of Standards Handbook 59, which states: "As applications of atomic energy expand and the number of exposed individuals increases, genetic effects will become more important." Rapid advance in the development of industrial power reactors indicates that there will be a tremendous expansion in the number of reactors and, therefore, in the number of operating personnel exposed to low levels of radiation. This, and other developments of atomic energy, emphasize the seriousness of the potential genetic problems that may be encountered unless present very meager information on the extent of the genetic damage to be expected from low levels of radiation is supplemented by new data. Commissioner Strauss, on a recent visit to Oak Ridge National Laboratory, emphasized the seriousness and urgency of this problem and indicated that financial support for expansion of this project could be obtained.</p> <p>The urgency of obtaining information on the genetic effects of low levels of radiation is apparent from the data already obtained, in this project, on mutation rates in mice exposed to higher levels of radiation. These data indicate that the genetic hazard of radiation in man may be considerably higher than had been predicted from earlier studies on fruit flies. The success of the experimental methods developed and used in the mouse mutation studies already completed provides good assurance that expansion of the program would result in a significant advance in knowledge in a relatively short time.</p> <p>The doses used in the present mutation rate studies are 1,000 r, 600 r, and 300 r. It is estimated that to obtain equally reliable data, in the same length of time, a 150-r dose would require approximately twice the facilities that were devoted to the 300-r experiment. Similarly, a 75-r dose experiment would, on the same basis, require four times the 300-r facilities.</p> <p>It should be emphasized that with the experimental methods worked out in this project, the mutation rate data <u>can</u> be obtained more rapidly with an expanded program. At the level at which the project is operating, the length of a</p>					

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12. PURPOSE, NEED, AND SCOPE continued

generation in the mouse is not the limiting factor. In fact, the method used for determining mutation rates is so efficient in this respect that the rapidity with which results can be obtained is roughly proportional to the size of the facility.

It is believed that studies of the genetic effects of repeated or chronic exposures to total accumulated doses of 150 r and 75 r will make possible a realistic evaluation of this potentially serious problem. In order to accomplish this result the project should be expanded to approximately twice its current level. This will require the addition of approximately eleven scientific man-years, plus an appropriate number of animal attendants and laboratory helpers. The present number of mice in the mouse farm must be approximately doubled. This means that the physical facilities for Mouse Genetics research must also be approximately doubled.

The present mouse farm with its associated laboratories and offices is located on the first floor of Building 9210 in the ORNL Biology Area of the Y-12 plant. It is planned to duplicate the first floor facilities on the second floor, which is now vacant and completely stripped of its former process equipment. Thus, the physical facilities can be provided rapidly. The special stocks of mice developed for the mutation studies are already available in such quantity for the existing project that multiplication for the new work would cause no delay. These factors, together with the proved value of the experimental method, the freedom from diseases, and the vigorous reproductive behavior of the present mouse colony, indicate that a rapid response can be made to the urgent request for more information on the serious problem of genetic dangers of radiation to human populations.

13. RELATED PROJECTS

Same as for regular Proposal and Authorization sheets.

14. ACCOMPLISHMENTS LAST YEAR

This is a new expansion of an existing project, the accomplishments of which have been described on the regular Proposal and Authorization sheets.

15. EXPECTED RESULTS THIS YEAR

It is expected that the physical facilities will be completed, that the mouse population will have been expanded and that the experimental animals will be undergoing exposure to chronic radiation or repeated low doses of radiation.

16. ANTICIPATED PROBLEMS NEXT YEAR

Continuation of the project through this year should yield a preliminary appraisal of the genetic effects of exposure to low doses of radiation.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>284,000</u>	\$ <u>442,000</u>	\$ <u>511,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1. Foreign Research Associates		1,000	1,000
2. Domestic Research Associates		10,000	10,000
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ <u>10,000</u>	\$ <u>11,000</u>	\$ <u>11,000</u>
TOTAL PROGRAM COST	\$ <u>294,000</u>	\$ <u>453,000</u>	\$ <u>522,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	12.8	17.0	22.0
B. TECHNICIANS.....	_____	_____	_____
SUBTOTAL	12.8	17.0	22.0
C. OTHER TECHNICAL,			
LOANEES: PARENT ORGANIZATION			
1. Foreign Research			
2. Associates		1.0	1.0
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>12.8</u>	<u>18.0</u>	<u>23.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Biochemistry: Nucleoproteins, Enzymes, Polysaccharides			2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26
6. BUDGET ACTIVITY NO. 6130	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semiannual Reports	
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Waldo E. Cohn			11. STATUS (INCLUDING STARTING DATE) Active	
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)				
<p>A. Since nucleic acids are intimately connected with reproduction and growth, processes which are known to be radiosensitive, information regarding the effect of radiation upon their constitution and enzymology is desirable. This must be based on an adequate knowledge of normal composition, structure and function. New methods, developed in this laboratory, have revolutionized certain concepts of nucleic acid structure and have also led to the discovery, in living tissue, of many new nucleotides which are related structurally to the nucleic acids and functionally to the class of substances known as co-enzymes. Thus it has become possible to think of nucleic acids both as structural or template units and as sources of the co-enzymes concerned with metabolic processes. The mode of participation in either direction remains unknown and is the general object of research in this field.</p> <p>With increasing evidence of inhomogeneity among the cellular nucleic acids, attention has been turned to the viruses and bacteriophages, which contain nucleic acids and which have the advantages of biological characterization, demonstrable function and a far greater degree of chemical homogeneity than the tissue nucleic acids. The process of bacteriophage infection of bacteria serves as a model for studies on the general biological function of nucleic acid and protein and affords an opportunity physically to separate these materials and their functions. Bacteriophage thus offers a simpler approach to the study of the precursors and enzyme systems involved in nucleic acid synthesis and to the elucidation of the action of nucleic acids. These factors are presumably basic to the role of nucleic acids in multicellular organisms.</p> <p>B. Some biochemical results of radiation are probably exerted through an effect upon enzymes. The sensitivity of an enzyme depends to some extent on its degree of combination with substrates or inhibitors. Enzyme-substrate complex formation and the relationship of this to radiation sensitivity is being studied utilizing advanced techniques developed in this laboratory which have made possible a new approach to this problem. The discovery that a proteolytic enzyme can hydrolyze the carbon-carbon bond, arising from this study, offers a new approach to the study of the energetics and specificities involved.</p> <p>The experience and technique developed in working with the glyconyl peptides makes possible an approach to an effective study of the large and little understood class of biologically important substances known as mucopolysaccharides, of which heparin is an example, which are implicated in radiation damage. Using the synthetic enzymic and chromatographic techniques available in this laboratory, an investigation of the biochemistry of this class of materials, beginning with a survey of microbiological sources of pertinent enzymes, is under way.</p> <p>The synthesis and preliminary screening of substances related to the few known</p>				

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12. PURPOSE, NEED, AND SCOPE Continued

radiation protecting compounds has made available some compounds having enhanced protective powers. The study of the influence of these upon well-defined enzyme systems, to elucidate modes of action and advance our knowledge of radiation action and protection, is planned.

13. RELATED PROJECTS

- A. The synthesis and testing of organic substances related to those having radiation protection activity is a collaborative project between the Biochemistry and Radiation Protection groups. It is anticipated that this activity will continue. Consultation between Biochemistry and Enzymology groups will continue.

14. ACCOMPLISHMENTS LAST YEAR

The Hydrolysis of Carbon-Carbon Bonds by α -chymotrypsin (Doherty); The Protective Effect of a Series of β -mercaptoethylamine Derivatives (Doherty and Burnett); Identification of the Purine Nucleotides a and b as the 2'- and 3'-Phosphoribosides, Respectively (Khym and Cohn); Ribose Phosphates: Production, Ion-Exchange Separation and Characterization (Khym, Doherty and Cohn); The Linkage of Glucose in Coliphage Nucleic Acids (Volkin).

15. EXPECTED RESULTS THIS YEAR

- A. The nucleic acid moiety of bacteriophages will be further studied with respect to nucleotide sequences, the metabolic pathways of synthesis and degradation during infection, and the extent of controlled damage to parental nucleic acid as a function of its effect on specific biochemical properties of the infected cell. The protein part, which can be isolated, is to be examined with respect to its general biochemical effect on host cells and the relationship of these to the infective process.
- B. The predicted finding, that a carbon-carbon bond can be hydrolytically cleaved by the proteolytic enzyme α -chymotrypsin, will be exploited in two directions, with variations in substrate to establish the relationship of the phenomenon to bond strength and with different proteolytic enzymes (e.g., trypsin) to establish its degree of universality. The synthetic protective agents will be tested in more closely defined systems as an approach to establishing modes of action at the biochemical level. The preliminary findings on the degradation of heparin are expected to lead to the separation of crude enzyme systems and the establishment of intermediates.

16. ANTICIPATED PROBLEMS NEXT YEAR

- A. Future work will be based on the results obtained this year, towards the goals of elucidating the interrelationship of nucleic acid and protein in affecting inheritance and growth and of establishing correlations between chemical properties of nucleic acids and their biological effectiveness. With some knowledge of the relation between the chemistry and the biology of these substances, interpretable and meaningful radiation studies may be devised.

16. ANTICIPATED PROBLEMS NEXT YEAR Continued

B. The widening appreciation of the relationship between enzymes and their substrates should lead to a better understanding of biological catalysis and to its possible role in radiation damage. The participation of radiation protectors in biochemical systems should lead to a better understanding of protection mechanisms and the discovery of the systems affected by radiation. The establishment of enzymes and intermediates in the biosynthesis and degradation of heparin and other mucopolysaccharides should lead to a definition of the participation of this class of cellular substances in radiation changes.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>147,000</u>	\$ <u>147,000</u>	\$ <u>147,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5. Foreign Research Associates	_____	<u>1,000</u>	<u>1,000</u>
TOTAL UNUSUAL COSTS	\$ _____	\$ <u>1,000</u>	\$ <u>1,000</u>
TOTAL PROGRAM COST	\$ <u>147,000</u>	\$ <u>148,000</u>	\$ <u>148,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>9.0</u>	<u>9.0</u>	<u>9.0</u>
B. TECHNICIANS	_____	_____	_____
SUBTOTAL	<u>9.0</u>	<u>9.0</u>	<u>9.0</u>
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1. Foreign Research Associates	_____	<u>1.0</u>	<u>1.0</u>
2.	_____	_____	_____
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>9.0</u>	<u>10.0</u>	<u>10.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Mathematics and Computation - Biology				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6130	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) A. S. Householder			11. STATUS (INCLUDING STARTING DATE) In progress since January, 1949		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>To provide mathematical and statistical consultation and computational aid for biological and medical research workers. Mathematical consultation serves to cast current biological theory into mathematical models capable of quantitative evaluation. Statistical consultation aids in the design of useful information at minimum cost of time and effort, and evaluates experimental results. To engage in basic research in statistics and mathematical biology relevant to typical and current problems in the general biological program.</p>					
13. RELATED PROJECTS					
<p>This work frequently merges with Mathematics and Computation for Health Physics and for Physical and Chemical Research, inasmuch as the techniques are often identical.</p>					
14. ACCOMPLISHMENTS LAST YEAR					
<p>The overall level of consultations and computations did not change although there was a notable increase in requests from physical and chemical groups for assistance in curve-fitting and parameter-estimation problems. Problems of design and analysis of radiobiological experiments continued to provide the bulk of the work. Work in mathematical biology included an analysis of the diffusion-reaction problem for intact cells which allows the concentration of hydrogen peroxide to be predicted under various conditions including irradiation. This analysis was employed in an extensive study of the role of hydrogen peroxide in mutagenesis in <u>paramecium aurelia</u>.</p>					
15. EXPECTED RESULTS THIS YEAR					
<p>Final data from the Greenhouse experiment will be collected and put on punched cards this year. It is expected that the analysis of these data will add considerably to the normal work load. Extensive research on approximate solutions of the general diffusion-reaction problem will be carried out and such solutions checked against exact solutions obtained from the Oracle. This work is based on the importance of the diffusion-reaction problem in the so-called "oxygen effect" in radiation damage. An examination will be made of the mathematical basis of current methods of computing, from isotopic tagging data, the mean survival time in a cell population.</p>					
16. ANTICIPATED PROBLEMS NEXT YEAR					
<p>Dependent upon overall Biology program and upon the precise nature of the results stated in the above mentioned project.</p>					

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	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>40,000</u>	\$ <u>40,000</u>	\$ <u>40,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u>40,000</u>	\$ <u>40,000</u>	\$ <u>40,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	2.0	2.0	2.0
B. TECHNICIANS	<u>.1</u>	<u>.1</u>	<u>.1</u>
SUBTOTAL	2.1	2.1	2.1
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.			
TOTAL DIRECT MANPOWER	<u>2.1</u>	<u>2.1</u>	<u>2.1</u>
19. COMMENTS			

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PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Pathology and Physiology		2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee	
5. CONTRACT NO. W-7405-Eng-26			
6. BUDGET ACTIVITY NO. 100	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and semiannual reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Arthur C. Upton		11. STATUS (INCLUDING STARTING DATE) Active. Started July 1, 1949.	
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)			
<p>A. To determine the long term pathologic changes, such as cancer induction, cataract development, and other diseases, resulting from acute or chronic exposure to ionizing radiations and to learn the mechanisms of these effects.</p> <p>B. To explore the causes of massive irradiation death, with a view toward developing means of protection.</p> <p>C. To investigate differences in the biological effectiveness of the various types of ionizing radiations, such as neutrons and gamma rays.</p> <p>D. To study the incorporation of radioactive substances into the body and the detrimental results thereof.</p>			
13. RELATED PROJECTS			
Cooperation with the U. S. Navy, Task Force 3 ("Operation Greenhouse"), the U. S. Air Force (ANP Project), and other sections of the Biology Division.			
14. ACCOMPLISHMENTS LAST YEAR			
<p>Publications: Some Late Effects in Mice of Ionizing Radiation from an Experimental Nuclear Detonation; The Morphogenesis of Pituitary Tumors Induced by Radiothyroidectomy in the Mouse and the Effects of their Transplantation on the Pituitary Body of the Host; Physiologic and Histochemical Changes in Connective Tissue of Rat Induced by Total Body Irradiation; Late Effects of Thermal Neutron Irradiation in Mice; Leukemogenesis by Ionizing Irradiation; A Transmissible Disease of Mice Characterized by Anemia, Leukopenia, Splenomegaly, and Myelosclerosis; Platelet Life Span as Measured by Transfusion of Isotopically Labeled Platelets into Rats; Spontaneous and Radiation Induced Adenomas of the Adenohypophysis in Mice; Occular Changes in Small Animals Induced by Whole-Body Ionizing Irradiation; Radiation Hemorrhage and Spleen Homogenates; Uptake of radioactive Sulphate by Elements of the Blood and the Bone Marrow of Rats.</p> <p>Other recently completed work in some major areas of research will be presented in April before the Federated Societies and in May before the Radiation Research Society.</p>			

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15. EXPECTED RESULTS THIS YEAR

Conclusion of the investigation of the long-term effects of atomic bomb irradiation in mice ("Operation Greenhouse").

Further elucidation of some of the mechanisms of the induction of leukemia and other neoplasms by irradiation.

Additional information about the effect of irradiation on the aging process. Further knowledge of the pathogenesis of radiation-induced permeability of blood vessels and connective tissue.

Elucidation of some aspects of the effects of ionizing radiations on megakaryocytes and blood platelets.

16. ANTICIPATED PROBLEMS NEXT YEAR

Analysis of the induction of cataract, leukemia (various types including myeloid), and other neoplasms by acute and chronic fast neutron irradiation in mice, and the relative biological effectiveness of fast neutrons for these parameters.

Pathogenesis of radiation-induced cataract, leukemia, and tumors, and the factors which enhance, retard, or prevent the induction of these diseases. Continuation of studies of the behavior of hemopoietic cells after irradiation. Investigation of fundamental differences between the effects of neutron and gamma irradiation in mammals, considering all vital organs, in part to guide the development of the ANP Project.

Studies of the altered physiology of the endocrine glands and connective tissue resulting from irradiation; the possible relation of these changes to the aging process.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>195,000</u>	\$ <u>195,000</u>	\$ <u>195,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4. Foreign Research Associates		1,000	1,000
5. Domestic Research Associates	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>
TOTAL UNUSUAL COSTS	\$ <u>10,000</u>	\$ <u>11,000</u>	\$ <u>11,000</u>
TOTAL PROGRAM COST	\$ <u><u>205,000</u></u>	\$ <u><u>206,000</u></u>	\$ <u><u>206,000</u></u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	6.8	7.0	7.0
B. TECHNICIANS	<u>6.8</u>	<u>7.0</u>	<u>7.0</u>
SUBTOTAL	6.8	7.0	7.0
C. OTHER TECHNICAL, LOANEEES: PARENT ORGANIZATION			
1.			
2.			
3. Foreign Research Associates	<u> </u>	<u>1.0</u>	<u>1.0</u>
TOTAL DIRECT MANPOWER	<u>6.8</u>	<u>8.0</u>	<u>8.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Tracer Studies in Intermediary Metabolism				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6230		7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semi-Annual Reports	
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) S. F. Carson			11. STATUS (INCLUDING STARTING DATE) Active, June, 1947		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>In order to improve the understanding of basic biochemical processes which control growth, cell division and death, metabolic and enzyme studies are carried out on microbes. The detailed mechanisms of many important degradative and synthetic reactions in living systems are unknown. Various microorganisms and enzymes obtained from them, are used as simplified systems to study the details of these reactions. Such experiments are necessary to furnish a sound basis for studies concerning radiation effects on important enzyme systems. (See #15 for description of active phases of this project).</p>					
13. RELATED PROJECTS					
<p>Knowledge gained from studies on peroxidizing flavoprotein enzymes (#15) may be of value in interpreting the "oxygen effect" observed in radiation studies. The increasing importance of "thio" compounds in radiation protection studies, makes it increasingly urgent to continue our present work on reaction mechanisms associated with <u>sulfhydryl-coenzymes</u>.</p>					
14. ACCOMPLISHMENTS LAST YEAR					
<p>Published papers:</p> <p>The DPNH oxidizing enzymes of <u>Streptococcus faecalis</u>. II. The enzymes utilizing oxygen, cytochrome c, peroxide and 2,6-dichlorophenol-indophenol or ferricyanide as oxidants.</p> <p>The flavine requirements for DPNH-menadione reductase in <u>Streptococcus faecalis</u>.</p> <p>Following MSS accepted by journals (in press):</p> <p>The complete degradation of carbon-14 labelled succinic acid and succinic anhydride.</p> <p>Diacetyl oxidation by <u>Streptococcus faecalis</u>, a lipic acid system.</p> <p>Following work is also complete:</p> <p>Sulfhydryl-coenzyme reactions in decarboxylation of succinic acid by propionic acid bacteria.</p>					

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ACCOMPLISHMENTS LAST YEAR continued

An "active" one-carbon fragment produced during succinate decarboxylation.

15. EXPECTED RESULTS THIS YEAR

With the highly purified Streptococcus faecalis peroxidase it is planned to study the mechanism of flavoprotein catalysis, since the very striking discovery has been made that direct spectrophotometric determination of an "enzyme-substrate complex" is possible in this system. The mechanism will be studied in regard to (1) metal catalysis, (2) whether enzymatic catalysis is involved in the synthesis of holoenzyme from apoenzyme, and (3) whether coupled phosphorylation (or phosphate turnover) is involved in this, or any of the other oxidases of S. faecalis.

This system also makes possible an extremely sensitive quantitative micro-assay for peroxide (of the order of 1×10^{-6} millimoles).

With the succinic decarboxylase system (containing sulfhydryl-coenzymes) from Propionibacteria and Veillonella, it is expected that the mechanism of one-carbon transfer "carboxylation reactions" (CO_2 -fixation reactions) will become better understood; this system at present gives the first evidence of a labile intermediate in such reactions.

16. ANTICIPATED PROBLEMS NEXT YEAR

Continuation of work in the field of (1) sulfhydryl-coenzymes in decarboxylation reactions, (2) one-carbon transfer mechanisms involving "active" fragments, and (3) studies on flavoprotein enzyme mechanisms involving use of enzyme-substrate complexes.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>93,000</u>	\$ <u>93,000</u>	\$ <u>93,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
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4.			
5.			
TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u>93,000</u>	\$ <u>93,000</u>	\$ <u>93,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>5.0</u>	<u>5.0</u>	<u>5.0</u>
B. TECHNICIANS			
SUBTOTAL	<u>5.0</u>	<u>5.0</u>	<u>5.0</u>
C. OTHER TECHNICAL, LOANEEs: PARENT ORGANIZATION			
1.			
2.			
3. ORINS	<u>0.7</u>	<u>0.5</u>	
TOTAL DIRECT MANPOWER	<u>5.7</u>	<u>5.5</u>	<u>5.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Plant Biochemistry		2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee	
5. CONTRACT NO. W-7405-Eng-26		6. BUDGET ACTIVITY NO. 6130	
7. BUDGET ITEM NO.		8. SECURITY CLASS Unclassified	
9. METHOD OF REPORTING PROGRESS Bimonthly and Semi-Annual Reports		10. PERSON IN CHARGE (CONTRACTOR'S STAFF) N. E. Tolbert	
11. STATUS (INCLUDING STARTING DATE) Active, December 1952		12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)	
<p>This project deals with the biochemistry of plant metabolism and the effects of radiation on plant development. Certain biochemical principles common to both plants and animals are involved in growth and radiation sensitivity and some of these problems are conveniently studied with plants. Normal processes of growth, metabolism and photosynthesis are being studied by tracer techniques combined with chromatography and respiratory measurements. The effect of ultraviolet light and ionizing radiation upon these living processes of growth are being investigated by biochemical procedures. Particular emphasis is placed upon changes in enzyme activity within the cell after irradiation. These changes are reflected in the metabolic products and their utilization in the cell. Consequently, procedures are being developed for chromatographic analysis and isolation of small amounts of naturally occurring metabolic compounds labeled with radioactive carbon or phosphorus. After isolation, the identification and biological function of these compounds, as well as the enzymes catalyzing their utilization, are being sought.</p>			
<p>13. RELATED PROJECTS</p> <p>Chromatographic analyses of urine samples of mice have indicated that a great number of compounds can be detected and separated from the urine by these methods. Detailed identification of these compounds would be a major problem for a physiological group. Analysis of urine from irradiated mice has not revealed any product which consistently changed as a result of the irradiation.</p>			
<p>14. ACCOMPLISHMENTS LAST YEAR</p> <p>Isolated enzymes are themselves not particularly radiation sensitive. Biological effects of radiation may be due to damage of the chromosome and the mechanism by which they control the formation of enzymes. Control experiments on a system to test the effect of radiation on enzyme formation has been performed. Plants grown in total darkness exist without chlorophyll or the photosynthesis process. When placed in the light they have been shown to acquire over a period of one or two days the ability to photosynthesize. During this time there occurs a greening process and the adaptation or synthesis of some of the enzymes for catalyzing photosynthesis. The biochemistry of this greening process is of value to basic agricultural research by itself. Besides these experiments on the greening process, the effect of ionizing and ultraviolet radiation on the photosynthesis process in green</p>			

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ACCOMPLISHMENTS LAST YEAR continued

plants has been investigated. A rapid and convenient manometric ultraviolet actinometer has been developed for the measurements of ultraviolet light intensities used in biological radiation. Photosynthesis in the green plant is severely inhibited by high levels of both types of radiation and the cause of the destruction is being investigated.

Analyses of organic phosphate esters, several specific enzymes in plant tissues, and the effect of inhibitors on plant respiration and photosynthesis have continued. Variations in these substances and processes have been noted after radiation treatment, but interpretation of the results depend on better identification of their normal functions.

Publications listed in press from FY54 were published in FY55 and further work on the biochemistry of cell free protoplasm has continued. In FY55 papers have been given on separation of organic phosphate esters in plants; biochemical changes during greening of dark grown plants; formic acid metabolism in plants; phosphate transport in plants; and effect of carbon monoxide on photosynthesis and phosphate esters in plants.

15. EXPECTED RESULTS THIS YEAR

In FY56 the group will continue its investigation of basic plant biochemistry and the changes in the processes brought about by radiation. It is anticipated that the first phases of the work on the effect of ionizing and ultraviolet radiation on photosynthesis, phosphate metabolism, and excretion of compounds by normal green chlorella cells will be completed and published. The same tests will be repeated on plants grown in total darkness which will be irradiated during their greening period when placed in the light. A comparison will then be possible of the radiation sensitivity of the photosynthesis process in a mature green leaf with the effect of radiation on the same process during its formation. The use of radioactive C^{14} and P^{32} and chromatography will continue to be the major research tools in these investigations.

With the use of large algae cells, biochemical changes after physical injury and again are to be explored. Data collected from the unicellular systems should eventually be applicable to the more complex organization in animals. Investigation on the identity of some of the unknown organic phosphate esters in plants will continue with emphasis on the ones which show the greatest physiological variation. Variations in the phosphate esters in the plant during normal and inhibited photosynthesis is being investigated to elucidate some of the mysteries in the conversion of light energy to

EXPECTED RESULTS THIS YEAR continued

biochemical energy. This latter process occurring only in plants remains difficult, important and unsolved.

16. ANTICIPATED PROBLEMS NEXT YEAR

Studies on plant biochemistry will continue. The present type of investigations on the in vivo systems by gross analysis with radioactive tracers of all the constituents of the whole cells should have progressed so that investigation on particular enzymes and processes may be in progress. Thus there should be a trend in the group toward more work with the isolated enzyme systems involved in the physiological changes under investigation. On the other hand, our research on the effect of irradiation and on the aging or growth processes will probably continue to develop projects concerned with changes in overall metabolic patterns. These two diversifications are compatible in the long term objectives concerned with effect of radiation on biological life.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>79,000</u>	\$ <u>79,000</u>	\$ <u>79,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5. Domestic Research Associates	_____	<u>.8,000</u>	<u>10,000</u>
TOTAL UNUSUAL COSTS	\$ _____	\$ <u>.8,000</u>	\$ <u>10,000</u>
TOTAL PROGRAM COST	\$ <u>79,000</u>	\$ <u>87,000</u>	\$ <u>89,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>5.0</u>	<u>5.8</u>	<u>6.0</u>
B. TECHNICIANS	_____	_____	_____
SUBTOTAL	<u>5.0</u>	<u>5.8</u>	<u>6.0</u>
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>5.0</u>	<u>5.8</u>	<u>6.0</u>
19. COMMENTS			

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PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Enzymology and Photosynthesis				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 2507	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semiannual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) John R. Totter			11. STATUS (INCLUDING STARTING DATE) Active		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>The biosynthesis of nucleic acids is being investigated by use of tracer labelled precursors. The application of this method to the study of effects due to irradiation and to the reversal of changes induced by irradiation should provide information necessary to further advances in biochemical radiation protection as well as to improve our understanding of biochemical defects resulting from irradiation. We are undertaking an extension of this research, which is being conducted on bone marrow and on chick embryos, to the use of <u>Escherichia coli</u>. This organism is especially well adapted for use since much is known concerning its response to irradiation and to changes in nutritional requirements following irradiation. Chemiluminescence induced by ultraviolet irradiation may provide a model for studying the important phenomenon of photoreactivation. Both chemiluminescence and bioluminescence are being investigated in order to extend the application of these phenomena to basic biological problems.</p> <p>In order to increase the knowledge of how the green plants reduce carbon dioxide in the light, particular attention is given to the so-called "light reaction," i.e., on the first reaction that takes place after light absorption by chlorophyll. We have found that green plants emit light for some two minutes after they have been illuminated, and that this luminescence is closely associated with the first steps in the photosynthetic process. We believe that this new light emission will allow us to measure the amount of some of the products of the light reaction.</p>					
13. RELATED PROJECTS					
<p>Purine and pyrimidine anti-metabolites as anti-cancer agents. Development of highly sensitive enzyme and substrate assays by means of luminescent systems.</p> <p>Informal discussion is held from time to time with Drs. Emerson and Rabinowitch of the University of Illinois, and with Drs. Franck and Gaffron of the University of Chicago, who have groups interested in the problem.</p>					
14. ACCOMPLISHMENTS LAST YEAR					
<p>It has been found by means of C¹⁴ labelling experiments that adenine enters chick embryo nucleic acid to some extent by-passing the block in nucleic acid synthesis following irradiation with gamma rays. The enzyme systems responsible for bacterial luminescence has been separated and characterized. New applications of bacterial luminescence to enzyme assay have been discovered and investigated.</p> <p>(1) Both the action spectrum and the emission spectrum for the delayed light</p>					

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14. ACCOMPLISHMENTS LAST YEAR continued

from a red algae has been measured. (2) A study of the saturation of delayed light production by short flashes has been made and is being published.

15. EXPECTED RESULTS THIS YEAR

The possible exchange of free adenine with desoxyribonucleic acid adenine is being studied in hitherto unutilized biological material. Studies are being conducted on the relation of metals to flavin catalysis and their possible relation to bioluminescence.

We expect to determine the details of the decay curve for the delayed light.

16. ANTICIPATED PROBLEMS NEXT YEAR

This group anticipates continuing research on problems leading to a better understanding of the effects of radiation at the enzyme level. The cessation or modification of enzymic reactions in irradiated organisms as well as the appearance of radiation-induced reactions will be studied in this program. The possibility that aminoethylthiuronium bromide protects organisms against the effects of radiation through modification of enzyme reactions will be investigated.

It is hoped that the present studies of the delayed light emission by green plants will lead to a new method of studying the "light reaction" of photosynthesis.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>113,000</u>	\$ <u>113,000</u>	\$ <u>113,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5. Domestic Research Associates	_____	<u>10,000</u>	<u>10,000</u>
TOTAL UNUSUAL COSTS	\$ _____	\$ <u>10,000</u>	\$ <u>10,000</u>
TOTAL PROGRAM COST	\$ <u>113,000</u>	\$ <u>123,000</u>	\$ <u>123,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>6.0</u>	<u>7.0</u>	<u>7.0</u>
B. TECHNICIANS	<u>6.0</u>	<u>7.0</u>	<u>7.0</u>
SUBTOTAL	<u>6.0</u>	<u>7.0</u>	<u>7.0</u>
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.			
TOTAL DIRECT MANPOWER	<u>6.0</u>	<u>7.0</u>	<u>7.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Biophysics				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 637	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semiannual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) John S. Kirby-Smith			11. STATUS (INCLUDING STARTING DATE) July 1, 1954		
<p>12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)</p> <p>Continued investigation of the effects of ionizing and nonionizing radiations on the genetic elements of cells. Application of magnetic resonance techniques to the study of biological and biochemical systems. Achievement of a physical situation permitting precise quantitative radiobiological studies of fast neutron effects in plant and animal material. Continued study of metamorphosis and radiation effects in amphibia.</p>					
<p>13. RELATED PROJECTS</p> <p>Cooperative work on problems in radiological physics and ultraviolet applications with various groups in the Biology Division. Continued cooperation on radiation problems with the Entomology Research Branch, Agricultural Research Service, U. S. Department of Agriculture. Collaboration with Professor J. N. Dent, University of Virginia, on problems of amphibian metamorphosis.</p>					
<p>14. ACCOMPLISHMENTS LAST YEAR</p> <p>More precise determination of the relative biological effectiveness of X rays, γ rays, and fast neutrons in the production of chromosomal aberrations in <i>Tradescantia</i>. Establishment of the time/intensity relations and temperature coefficients for chromosomal aberrations in <i>Tradescantia</i> pollen. Perfection of techniques and methods for studying the effects of radiation on amphibian chromosomes. Development of an interlocking system of measurements for precise neutron dosimetry. Observation of paramagnetic resonances in radiation treated polymers. Establishment of the action spectrum for ultraviolet induced chromosome breakage in <i>Tradescantia</i> pollen.</p> <p>Publications: A Gamma-Ray Source for Sterilizing Insects; The Relative Effectiveness of Various Ionizing Radiation on Chromosome Breakage in <i>Tradescantia</i>; Effects of Fast Neutrons in <i>Tradescantia</i> Chromosomes (in Operation Upshot/Knothole Report; Genetic Effects of Fast Neutrons from Nuclear Detonations).</p>					
<p>15. EXPECTED RESULTS THIS YEAR</p> <p>Determination of precise figures for the relative biological effectiveness of monoenergetic neutrons from the D-D reaction on chromosomal aberrations in <i>Tradescantia</i>. Extension of the Cockcroft-Walton fast neutron program to</p>					

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15. EXPECTED RESULTS THIS YEAR Continued

include the production of neutrons by the Deuterium/Tritium reaction. Participation in the planning and execution of chronic fast neutron irradiation experiments and the solution of radiological physics problems encountered in these investigations. Observations of free radicals in biological systems.

16. ANTICIPATED PROBLEMS NEXT YEAR

Further investigation of the biological effects of fast neutrons. Study of molecular structure by means of fine structure in nuclear magnetic resonances. Investigations of the effects of radiation on the structure of large molecules and polymers. Radiological physics studies on heavily ionizing radiations and the investigation of the effects of such radiations on microorganisms.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>103,000</u>	\$ <u>103,000</u>	\$ <u>103,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
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TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u><u>103,000</u></u>	\$ <u><u>103,000</u></u>	\$ <u><u>103,000</u></u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>5.0</u>	<u>5.0</u>	<u>5.0</u>
B. TECHNICIANS			
SUBTOTAL	<u>5.0</u>	<u>5.0</u>	<u>5.0</u>
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.			
TOTAL DIRECT MANPOWER	<u>5.0</u>	<u>5.0</u>	<u>5.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Research Participation and Traveling Lecture Program -- Biology		2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee	
5. CONTRACT NO. W-7405-Eng-26			
6. BUDGET ACTIVITY NO. 6150	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Individual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) R. W. Johnson		11. STATUS (INCLUDING STARTING DATE) Active	
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)			
<p>The Research Participation Program provides an opportunity for university faculty members to receive advanced research experience in the field of Biology. University representatives spend from three months to one year in the Laboratory, in some instances using the unique facilities located at ORNL in connection with special problems. In fact, the facilities of the Laboratory have permitted investigators at certain universities to enter fields of investigation which would have not been possible outside this Laboratory. The impact of this experience has become obvious in a number of universities; for instance, Texas, Tulane, Emory, Tennessee, Virginia, Duke, etc.</p> <p>The Traveling Lecture Program is conducted as a part of the Commission's contribution under its program of encouraging the dissemination of scientific and technical information. Under this program, scientific and technical personnel of the Laboratory's staff deliver lectures upon request to universities throughout the Southern region. This lecture program has had considerable influence in the development and interest of certain universities and colleges. The opportunity to have personal contact with investigators who are doing extensive work in the basic radiation field has stimulated many graduate students to enter this field and has significantly expanded the scope of work which is going on in these schools.</p>			
13. RELATED PROJECTS			
<p>Research Participation and Traveling Lecture Programs in AEC Program 5000.</p> <p>A corollary benefit of the Research Participation Program is that Research Participants lend important assistance in carrying out the research program of the Laboratory. The Research Participation Program and Traveling Lecture Program have created such extensive interest in many schools in the radiation fields that a large number of applications for research funds in the Division of Biology and Medicine are now coming from these schools.</p>			
14. ACCOMPLISHMENTS LAST YEAR			
<p>Under the Research Participation Program, sixty faculty members of 34 universities spent periods of at least three months at the Laboratory. Of these, 11 were working in the field of biology. A number of research projects have been started in southern universities as a direct result of this program. The knowledge gained by the participants in the field of atomic energy is expected to promote the long-range plans of the program.</p>			

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14. ACCOMPLISHMENTS LAST YEAR Continued

Under the Traveling Lecture Program, lectures before advanced groups continued with approximately 175 lectures scheduled during FY 1955, fifty in the field of biology and biophysics. Special symposia dealing with phases of the fundamental sciences and reactor engineering were sponsored by ORNL and ORINS in cooperation with universities. Senior personnel from the Laboratory in the fields of chemistry, physics, biology and instrumentation participated in these symposia at Vanderbilt University and the University of South Carolina, and in one which was sponsored jointly by the University of North Carolina, Duke University, and North Carolina State College.

15. EXPECTED RESULTS THIS YEAR

Individuals chosen as Research Participants will contribute scientifically to the research program at ORNL. The objectives of this program are to enable universities, particularly those in the South, to expand the scope of training offered to undergraduate and graduate students, and to stimulate in universities research which is of interest to the atomic energy program. The intellectual level of the Research Participants has increased significantly. It is expected that during this year the result of the work of the Participants will make a definite impression in the scientific output of the South. A number of publications from certain schools in the Biology and Medicine field begins to show this impact.

16. ANTICIPATED PROBLEMS NEXT YEAR

This program is expected to continue in FY 1957 and to pursue the long-range objectives set forth above.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>52,000</u>	\$ <u>52,000</u>	\$ <u>52,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
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5.			
TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u>52,000</u>	\$ <u>52,000</u>	\$ <u>52,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.8	3.8	3.8
B. TECHNICIANS	_____	_____	_____
SUBTOTAL	3.8	3.8	3.8
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>3.8</u>	<u>3.8</u>	<u>3.8</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Radiation Protection, Living Cells				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6230	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semiannual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Alexander Hollaender			11. STATUS (INCLUDING STARTING DATE) Active		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT) <p>The use of microorganisms to determine the mode of action of ionizing radiations is continuing. The need for information concerning the basic mechanisms involved in postirradiation recovery of living cells has become exceedingly important. Several systems have been found which are conducive to recovery in bacteria; others which actually stimulate this process are under investigation. The real importance is in the application of the findings to higher forms of life including mammals. Some progress in this regard is already being made.</p>					
13. RELATED PROJECTS <p>The information obtained with microorganisms has been used as a basis for work on mammals. Cooperation in this field is being continued with Carnegie Institution of Washington, Cold Spring Harbor, and the University of Tennessee.</p>					
14. ACCOMPLISHMENTS LAST YEAR <p>Publications: Nutritional Requirements for Bacterial Recovery from Ionizing Radiations (Abstract); Some Nutritional Aspects of Bacterial Recovery from Ionizing Radiations; Factors Modifying the Sensitivity of Bacteria to Radiations; The Influence of Pre- and Posttreatments on Bacterial Inactivation by Ionizing Radiations; Studies on the Mechanism of Radiation Protection and Recovery with Cysteamine and β-Mercaptoethanol; The Use of Action Spectra for the Evaluation of Some Basic Biological Problems; Monochromatic Ultraviolet Action Spectra and Quantum Yields for Inactivation of T1 and T2 <u>Escherichia coli</u> Bacteriophages; The Effect of Temperature on X-ray-Induced Mutability in <u>Escherichia coli</u>.</p>					
15. EXPECTED RESULTS THIS YEAR <p>It has been found that: 1. Bacteria will recover in part from damaging effects of ionizing radiations at postirradiation incubation temperatures well below that which is optimal for growth of the cells; 2. Supplying nutritional factors to irradiated cells is stimulatory to recovery; 3. A reduction of the post-irradiation incubation temperature along with supplying known nutritional factors brings about greater recovery than either of these conditions alone; 4. Pretreatment of bacteria with cysteamine (β-mercaptoethylamine) brings about a remarkable desensitization of these cells to ionizing radiation. This desensitization is almost completely dependent on recovery of the treated cells; 5. It has been recognized in this Laboratory that bacteria either protected against radiation damage by chemical means or recovered from radiation damage by nutritional means, have a considerable lower mutation rate than one would expect for the amount of radiation to which they were exposed. On the basis of these results, extensive investigations have been initiated trying to</p>					

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15. EXPECTED RESULTS THIS YEAR continued

recognize whether or not this phenomenon would apply to mammals. The role of other stimulatory factors in promoting recovery will be studied. Tracer studies using "radioactive tagged" compounds will be made. It appears profitable to compare the rate and extent of synthesis of protein, nucleic acids, and other cell constituents under the conditions in which recovery does and does not occur.

16. ANTICIPATED PROBLEMS NEXT YEAR

Results to date suggest that some sort of biochemical chain reaction is initiated in irradiated bacterial cells, and under conditions in which recovery is not stimulated leads to a loss of synthetic ability of the cell. The research in progress should give us clues as to what metabolic systems will be most profitable to investigate in this regard.

Whereas most of the work described here has been done with bacteria exposed to X or gamma rays, it is planned to expand to the field of ultraviolet radiation. A new survey will be made of sulfhydryl compounds for their ability to protect *E. coli* against X- and ultraviolet radiation. The one compound which has been found to protect mice exceedingly well against X rays is toxic to *E. coli*. It will be attempted to modify this molecule so that its protective ability is maintained and its toxicity is reduced.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>95,000</u>	\$ <u>95,000</u>	\$ <u>95,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4. Foreign Research Associates		1,000	1,000
5. Domestic Research Associates		10,000	10,000
TOTAL UNUSUAL COSTS	\$ _____	\$ <u>11,000</u>	\$ <u>11,000</u>
TOTAL PROGRAM COST	\$ <u>95,000</u>	\$ <u>106,000</u>	\$ <u>106,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	5.0	6.0	6.0
B. TECHNICIANS	_____	_____	_____
SUBTOTAL	5.0	6.0	6.0
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2. Foreign Research Associates		1.0	1.0
3. ORINS	0.3	_____	_____
TOTAL DIRECT MANPOWER	<u>5.3</u>	<u>7.0</u>	<u>7.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE General Physiology		2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee	
5. CONTRACT NO. W-7405-Eng-26			
6. BUDGET ACTIVITY NO. 6230	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semiannual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) C. W. Sheppard		11. STATUS (INCLUDING STARTING DATE) Active	
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)			
<p>Investigation of the biophysical, biochemical and morphological alterations produced by radiation in cell nuclei and other cell components, stressing cell particulates and surface structures which relate the cell to its environment.</p>			
13. RELATED PROJECTS			
<p>Usual cooperation with other groups in the Biology Division. Cooperation with Duke University, University of Indiana, Wesleyan University and University of Maryland.</p>			
14. ACCOMPLISHMENTS LAST YEAR			
<p>Methods for perfusing and homogenizing liver have been reexamined and improved, a refrigerated centrifuge has been modified into a precision instrument for controlled centrifugation, a mechanical liquid gradient engine has been designed, built, and calibrated to produce gradients of known characteristics for gradient centrifugation, and new centrifuge tubes free of wall effects have been designed and used. Nucleoproteins from tumor cells have been found to have a marked tumor stimulating effect.</p> <p>Publications: Studies on Isolated Cell Components. VII. A Reexamination of the Preparation and Properties of Rat Liver Homogenates; A Theoretical Approach to Cell Division; A Mechanical Gradient Engine; Contamination of Nuclear Fractions of Thymus Homogenates with Whole Cells; An <u>In Vivo</u> Effect of Nucleoprotein from Ehrlich Ascites Tumor Cells; An Upper Limit for Acetylcholine Content and Synthesis on Human Erythrocytes; On the Relation Between Thyroid Depression and Pituitary Tumor Induction in Mice; Genetic Effects of Fast Neutrons from Nuclear Detonations.</p>			
15. EXPECTED RESULTS THIS YEAR			
<p>The application of centrifugal techniques developed in this laboratory and new protein fractionation methods to the quantitative analysis of alterations in the composition of liver during regeneration and after irradiation will be completed. Mechanisms of structure and fibril formation by substances isolated from tissues will be continued. Improved methods for isolation of the envelope material from hemolyzed red cells should be complete.</p>			
16. ANTICIPATED PROBLEMS NEXT YEAR			
<p>The further investigation of the intricacies of living cells requires that the major molecular components be isolated and characterized. This will be done</p>			

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16. ANTICIPATED PROBLEMS NEXT YEAR continued

with both physical methods applicable to macromolecules and with immuno-chemical techniques.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>82,000</u>	\$ <u>82,000</u>	\$ <u>82,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5. Domestic Research Associates		<u>10,000</u>	<u>10,000</u>
TOTAL UNUSUAL COSTS	\$ _____	\$ <u>10,000</u>	\$ <u>10,000</u>
TOTAL PROGRAM COST	\$ <u>82,000</u>	\$ <u>92,000</u>	\$ <u>92,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>4.0</u>	<u>5.0</u>	<u>5.0</u>
B. TECHNICIANS			
SUBTOTAL	<u>4.0</u>	<u>5.0</u>	<u>5.0</u>
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.			
TOTAL DIRECT MANPOWER	<u>4.0</u>	<u>5.0</u>	<u>5.0</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Mammalian Radiation Recovery				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6230	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Bimonthly and Semiannual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Charles G. Congdon			11. STATUS (INCLUDING STARTING DATE) February 1, 1955		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT) <p style="margin: 0;">This is a new group set up on the basic and applied aspects of spleen and bone marrow transplantation as a source of recovery in mammals and related problems. The work evolved from studies conducted with microorganisms and genetic studies where it was found that it is possible to protect against radiation damage either by hypoxia, certain chemicals before and during irradiation and by certain types of temperature treatments.</p>					
13. RELATED PROJECTS <p style="margin: 0;">This group will cooperate with different sections of the Biology Division, especially the Mammalian Physiology and Pathology Group, the Mammalian Genetics, Microbiology, and other groups. Cooperation in the human aspects will be set up with the University of Rochester, and the Jefferson Medical School.</p>					
14. ACCOMPLISHMENTS <p style="margin: 0;">In spite of the fact that the group was just set up, preliminary experiments were conducted combining chemical protection with a new compound (S₂ amino-ethylisothiuronium bromide HBr. After treatment with bone marrow and daily treatment with streptomycin, it was found that one could triple the LD₅₀ for mice if one combines these three treatments.</p>					
15. EXPECTED RESULTS THIS YEAR <p style="margin: 0;">It is planned for this group to start work with bone marrow as a means of encouraging recovery after exposure, to follow up the findings that one can triple the LD₅₀ by combining the three different types of treatment by studies of the fertility of the mice, leukemia induction, other malignant changes, longevity, etc. A special effort will be made to clarify some of the immunological aspects of the work.</p>					
16. ANTICIPATED PROBLEMS NEXT YEAR <p style="margin: 0;">It is hoped to extend this work to tissue cultures in an effort to obtain a better understanding of radiation protection and recovery. Attempts will be made to elucidate the mechanism of spleen, bone marrow, and leukocytes in their ability to encourage recovery from radiation changes.</p>					

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	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>25,000</u>	\$ <u>200,000</u>	\$ <u>300,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
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TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u>25,000</u>	\$ <u>200,000</u>	\$ <u>300,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	1.0	10.0	12.0
B. TECHNICIANS	_____	_____	_____
SUBTOTAL	1.0	10.0	12.0
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
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2.			
3.			
TOTAL DIRECT MANPOWER	<u>1.0</u>	<u>10.0</u>	<u>12.0</u>
19. COMMENTS			

**PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT**

1. PROJECT TITLE Applied Radiobiology			2. DATE March 15, 1955		
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-28	
6. BUDGET ACTIVITY NO. 6107	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) E. G. Struxness			11. STATUS (INCLUDING STARTING DATE) Active		
<p>12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)</p> <p>This project includes activities previously reported as "Radiochemical Analyses", "Internal Dose-Physics Unit", "Nuclear Power Reactors-Effects of Effluents on Environment" (Experimental Ecology Program), and "Consultation and Special Problems."</p> <p>The purpose of this project is to obtain biological, biophysical and biochemical data necessary to calculate permissible limits related to radiation dosimetry. The principle objectives include: 1) the determination of the normal distribution and concentration of trace elements in man's body, and in his food, air, water and soil; as opportunities allow, to obtain information on the internal distribution of critical radionuclides in man by cooperative research with others engaged in experimental nuclear medicine and by the analysis of human tissue (biopsy and autopsy) samples obtained through cooperation with allied medical groups; 2) the determination of the nature and extent of man's internal exposure to certain hazardous radioisotopes encountered in AEC production activities and in the nuclear power industry; 3) the experimental determination of the effect of critical fission products contained in power reactor wastes on soil fertility and soil formation in the temperate forest community due to selective or massive disturbance of soil important organisms, i.e., bacteria, fungi, and arthropods; 4) the compilation of all information available on the subject of radiation effects and dosimetry; 5) the development of suitable radiochemical procedures for the analysis of body fluids to facilitate routine monitoring of ingested and/or inhaled radioisotopes, and 6) the experimental determination of total body neutron dose from activation studies of radiological accident victims.</p>					
<p>13. RELATED PROJECTS</p> <p>This program is related to, and somewhat dependent on the work of the Subcommittee on Internal Dose of the National Committee on Radiation Protection and the International Commission on Radiological Protection. It is also related to the research of Dr. William Sweet at Massachusetts General Hospital, to the studies of Dr. Ralph Kniseley at ORINS, and to the Waste Disposal Project and Radiation Dosimetry Section of the ORNL Health Physics Division. The ecological aspect of this project is a part of the nationwide research program organized by the Ecological Society of America's Committee on the Effects of Radioactivity on Natural Populations, of which Professor Orlando Park, an ORNL Consultant, is chairman.</p>					

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13. RELATED PROJECTS continued

The ORNL Applied Health Physics Program is engaged in related activities, e.g., the development of a direct method of calculating the internal dose from data obtained from urinalysis. A graph was prepared showing the d/m/24 hr excretion, at any time 0-90 days, that gave, in this study, the maximum permissible exposure allowed for the first 90 days (3.9 reps).

14. ACCOMPLISHMENTS LAST YEAR

The spectrographic laboratory in the Physics Department of U. T. analyzed 260 samples of normal tissue from autopsies of instantaneous accidental death, 100 samples of bone and cartilage, and more than 200 other samples of tissue. Quantitative spectrographic methods for the simultaneous analysis of 21 elements were developed. A method for determination of very low strontium concentrations in various biological material was worked out. The procurement and preparation of tissue samples was revised to facilitate the handling of a larger number of samples in the coming year.

Six terminal patients of Dr. Wm. Sweet received intravenous injections of uranyl nitrate hexahydrate in amounts ranging from 4 to 50 milligrams. Five expired during the year and the analysis of all biopsy and autopsy samples was completed. Prony's method for the analysis of exponential data was programmed for the ORACLE and the limits of its application determined. Similar programming of Householder's modification of Prony's method was started. The distribution and excretion of uranium as a function of time after single injections will be determined with the aid of a mathematical model which describes its metabolism as the sum of three exponential terms.

Treehole mold samples (representative of fauna on the forrest floor) from Delaware, Ohio, and Oak Ridge were irradiated at different dose levels for evidence of immediate effect. The results of population counts before and after irradiation indicate a manifest radiation threshold between 50,000 and 200,000 r.

The experimental determination of the critical organ, the effective half life and the percent retention of Co^{60} (as the chloride) in mice after ingestion was completed and a paper submitted for publication. A similar study of Ru^{106} was started.

Plans for an MPC library were formulated and put into active practice. References, classified and unclassified, were collected and an index filing system established.

14. ACCOMPLISHMENTS LAST YEAR continued

A new and less cumbersome analytical procedure for analysis of radioactive strontium in urine was developed. Chemical recovery is good and decontamination from K^{40} , an isotope normally present in urine is excellent.

15. EXPECTED RESULTS THIS YEAR

Six terminal patients at Massachusetts General Hospital will receive intravenous administration of tetravalent uranium following which tissue samples will be collected and analyzed for evidence of distribution and excretion. In addition, 2-4 preoperative, brain tumor patients will receive minute injections of hexavalent and tetravalent uranium for evidence of differential uptake in tumor tissue. Multiple exponential equations will be fitted to the excretion data obtained in the hexavalent and tetravalent uranium experiments.

Dr. Ralph Kniseley, research pathologist at the Oak Ridge Institute of Nuclear Studies, will provide autopsy tissues routinely for purposes of spectrographic, radiochemical, and/or autoradiographic analysis for radioisotopes of interest and availability. The information will be of value not only for its application to internal radiation dosimetry but also for its interest to the Laboratory Medical Director in the accumulation of data pertinent to his program of health control.

The University of Tennessee spectrographic laboratory will analyze a large number of tissue samples (approximately 100 autopsies) from various geographical locations. It is expected that tentative figures for concentrations of about 20 elements in "standard man" can be fully established.

The experimental determinations of critical organ, effective half life and per cent retention of Ru^{106} will be completed.

Preliminary experiments to determine the immediate and delayed effects of external radiation on natural populations in tree holes will be completed. Additional studies will be initiated to determine the effects of external and internal radiation on species population numbers, total population numbers, intra and inter specific relationships (foodweb experiments).

It is expected that the number of MPC library references will be enlarged.

In cooperation with the Radiation Dosimetry Section, a program will be initiated for determining a procedure of examination for people who have been exposed in radiological accidents.

Efforts to develop radiochemical procedures for the analysis of body fluids for cesium and ruthenium will be initiated.

16. ANTICIPATED PROBLEMS NEXT YEAR

Following completion of the intravenous uranium distribution studies, efforts will be made to obtain experimental uranium inhalation data (directly, or by cooperation with other interested research groups) applicable to a complete understanding of the distribution and excretion of uranium following inhalation. This will complete the investigation of this particular problem which is of interest to the production division. It is planned to take advantage of opportunities, wherever they may exist, for further experimental evidence of distribution and excretion of critical radionuclides in man. For example, uranium may not prove to be feasible as a therapeutic agent in Dr. Sweet's thermal neutron-induced activation treatment of brain tumor. In that case, other fissionable isotopes may be investigated, thus providing another opportunity for distribution studies in man. The possible application of an analogue computer as an aid to further study of this problem will be investigated.

After completion of the trace element distribution and concentration in "standard man", spectrographic analysis of food, water and soils geographically distributed will be started, as well as sensitive analysis of tumors and pathological tissues of interest to allied medical research groups.

If the recommendations of the Ecological Society of America, Committee on the Effect of Radioactivity on Natural Populations, for nationwide ecological research are accepted by the AEC, a major problem for organizing our program with other groups can be anticipated. This potential expansion in ORNL's participation in this major program is not reflected in the accompanying cost and man power estimates for F.Y. 1957. In broad terms, the following potential experimental work at ORNL might be expected:

- (1) bacteriological and mycological studies of forest floor organisms;
- (2) expansion of natural population studies from the present restricted tree hole niche to the forest floor;
- (3) life history studies on major and critical arthropod groups (acarina, insect and chilopoda);
- (4) comparative studies of populations from different associations within the deciduous forest biome.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ 100,000	\$ 153,000	\$ 153,000
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1. Spectrographic Determination of			
2. Element Distribution in Man			
3. University of Tennessee	23,000	22,000	22,000
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ 23,000	\$ 22,000	\$ 22,000
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$	\$	\$
TOTAL PROGRAM COST	\$ 123,000 (1)	\$ 175,000	\$ 175,000
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.2	5.0	5.0
B. TECHNICIANS	0.8	1.0	1.0
SUBTOTAL	4.0	6.0	6.0
C. OTHER TECHNICAL,			
LOANEES: PARENT ORGANIZATION			
1. Research Participants	0.2	0.6	0.6
2.			
3.			
TOTAL DIRECT MANPOWER	4.2	6.6	6.6
19. COMMENTS (1) This program includes activities previously reported as "Radiochemical Analyses", "Internal Dose-Physics Unit", "Nuclear Power Reactors-Effects of Effluents on Environment" (Experimental Ecology Program), and "Consultation and Special Problems."			
<u>Program</u>	<u>FY 1955</u>	<u>FY 1956</u>	<u>FY 1957</u>
Radiochemical Analyses	7,000 0.3 M/Y	--	--
Element Distribution in Man (Internal Dose-Physics Unit)	23,000 0.0 M/Y	22,000 0.0 M/Y	22,000 0.0 M/Y
Experimental Ecology Program	96,000 1.9 M/Y	63,000 2.0 M/Y	63,000 2.0 M/Y
Internal Dose Studies	37,000 1.8 M/Y	90,000 4.0 M/Y	90,000 4.0 M/Y
Applied Radiobiology	123,000 4.0 M/Y	175,000 6.0 M/Y	175,000 6.0 M/Y

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Mathematics and Computation - Health Physics				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-28	
6. BUDGET ACTIVITY NO. 6440	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) A. S. Householder			11. STATUS (INCLUDING STARTING DATE) In progress since January, 1949		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>To provide mathematical, statistical and computational assistance for research workers in the Health Physics Division; to provide knowledge of current mathematical-biophysical theory in terms of which theoretical models may be cast and evaluated; to engage in basic studies of relevant numerical, statistical and mathematical-biophysical methods and those equations of physics and biophysics related to the objectives of the Health Physics Division.</p>					
13. RELATED PROJECTS					
<p>This work is closely related with that being done for Physical Research, Reactor Development and Biology.</p>					
14. ACCOMPLISHMENTS LAST YEAR					
<p>Monte Carlo estimates of the maximum permissible flux determinations were made for neutron beams of .1, .02, .005 and .001 mev. The model was an infinite tissue slab irradiated by monoenergetic neutron beams normally incident on one face of the slab. For each beam 10,000 neutron histories were computed and the resultant γ-source, from the $H(n, \gamma)$ reaction, was normalized to give at least 10,000 γ-ray histories. Extensive work was done on uranium excretion studies in man and small animals. Procedures for the analysis of excretion curves, with the object of computing from such information internal radiation doses, were derived. A mathematical model for uranium distribution and excretion was set up. The problem of disordering of polyatomic solids by neutrons was programmed for the Oracle.</p>					
15. EXPECTED RESULTS THIS YEAR					
<p>The permissible flux problem will be repeated following the procedure of weighting relative biological effectiveness that has been recommended by the National Committee on Radiation Protection. The uranium excretion problem is expected to demand considerable effort, in particular a model describing the distribution and excretion following inhalation of insoluble uranium dust will be set up and analyzed with the object of prescribing an internal dose control program. The problem of disordering of diatomic solids by neutrons will be coded and run when magnetic tapes are available.</p>					
16. ANTICIPATED PROBLEMS NEXT YEAR					
<p>Dependent upon the needs of the Health Physics program and upon the interpretation and use of the information in 14. and 15.</p>					

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	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>40,000</u>	\$ <u>40,000</u>	\$ <u>40,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u>40,000</u>	\$ <u>40,000</u>	\$ <u>40,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>1.8</u>	<u>1.8</u>	<u>1.8</u>
B. TECHNICIANS	<u>.3</u>	<u>.3</u>	<u>.3</u>
SUBTOTAL	<u>2.1</u>	<u>2.1</u>	<u>2.1</u>
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.			
TOTAL DIRECT MANPOWER	<u>2.1</u>	<u>2.1</u>	<u>2.1</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Sanitary Engineering Research - Hazards with the Disposal of Radioactive Wastes from Reactors		2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee	
5. CONTRACT NO. W-7405-Eng-26			
6. BUDGET ACTIVITY NO. 1000	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) E. G. Struness		11. STATUS (INCLUDING STARTING DATE) Active	
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)			
<p>The activities included in this project were previously reported as "Radioactive Liquid Waste - Environmental Problems Associated with Power Reactor Program", and "Nuclear Power Reactors - Airborne Hazards and Control."</p> <p>The purpose of this project is to evaluate the potential hazards resulting from the discharge of high level waste materials into the ground. Since ORNL is committed to a study of this method of waste disposal, it is necessary to determine whether hazards will result from the discharge of radioactive waste materials into the environment. Further, the most hazardous radioisotopes will be designated following an evaluation of hydrologic, meteorologic, pedologic and geologic parameters and on the basis of the published MPC values. Disposal into the ground is under consideration because this method appears to offer a safer and more economical solution to the waste disposal problem than does tank storage or other presently accepted methods.</p>			
13. RELATED PROJECTS			
<p>The U. S. Public Health Service is a participant in this project.</p> <p>The Tennessee Valley Authority is cooperating with the Laboratory by providing information on the time of water travel between various points in the Tennessee Valley river system. These data are of extreme importance particularly in the case of accidental discharge of radioactive materials.</p> <p>The Sanitary Engineering Branch, Engineer Research and Development Laboratories, U. S. Corps of Engineers, is cooperating with the Laboratory by assisting in studies of water decontamination and low-level waste disposal.</p> <p>The U. S. Geological Survey is determining the suitability of selected sites for waste disposal.</p> <p>The ORNL Ecological Programs will provide information regarding the effects of radioactivity on natural populations in the deciduous forest community.</p> <p>The ORNL Applied Health Physics Department is engaged in the following related activities:</p> <p>A. A proportional sampler for continuous monitoring of activity released from White Oak Lake has been developed.</p>			

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13. RELATED PROJECTS continued

- B. A soil sampling program to investigate the extent of soil contamination on the Laboratory site has been initiated. Soil contamination is one criterion for determining the background buildup of the area.
- C. A regular schedule of measurements of the activity in the Clinch and Tennessee rivers and other public waters is being conducted.
- D. Measurements of the activity in the geologic strata underlying ORNL are being made on a regular schedule to determine the subterranean seepage of activity deposited in the soil.

"Sanitary Engineering Research - Engineering Problems Associated with the Disposal of High Level Waste Materials from Nuclear Power Reactors" reported under AEC Activity

14. ACCOMPLISHMENTS LAST YEAR

- A. Because ORNL chemical waste pit No. 2 reached its capacity, a third pit was constructed and placed in operation.
- B. Pilot scale units were evaluated for the removal of radioactive materials from the large-volume low-level process wastes discharging from the Settling Basin. Three up-flow type units and ion exchange processes were investigated in this joint ERDL-PHS-ORNL endeavor. A memorandum report was prepared and submitted to the ORNL Operations Division. The ERDL group continued its study of the treatment of low-level wastes.
- C. A final report was prepared to the USFBS Advisory Board on the Decontamination of Radioactive Waters.
- D. The two experimental pits (30 ft in diameter, and 5 ft deep) were observed during the year and movement of nitrates and uranium was followed in the one case, and studies were carried out to measure the effectiveness of an asphalt-temped-clay type of liner material in the second pit.
- E. A procedure was developed for determining radioactive strontium and barium in natural waters. Concentrations of radiostrontium down to $\sim 4 \times 10^{-8}$ $\mu\text{c/ml}$ and radiobarium to $\sim 10^{-7}$ $\mu\text{c/ml}$ were found. The method has been reported in the open literature.
- F. Studies showed that cesium is removed on cellulose by ion exchange. The results of these studies have been published.
- G. Procedures were developed for the recovery of the more critical radioactive materials (Sr, Y, Zr, Nb, Cs, Ru, and Ce) fixed to soils. These findings have been reported.

14. ACCOMPLISHMENTS LAST YEAR continued

- H. Development of a cloud chamber for counting sub-micron particles was completed. The instrument was proved to be linear with respect to particle concentration by air dilution experiments. A report describing the apparatus has been prepared and published.
- I. A method of generating particles in the 0.01 μ radius range was developed.
- J. A diffusion tube and cloud chamber were used to estimate particle sizes in the 0.01 μ radius range.
- K. It was found that the diffusion battery method of aerosol particle size determination is more accurate when experimental results are extrapolated to zero air flow through the battery.

15. EXPECTED RESULTS THIS YEAR

- A. Mineral and bituminous liners will be evaluated under field conditions either in existing pits or in pilot plant facilities to be provided for this purpose.
- B. Samples of unconsolidated and consolidated materials from laboratory columns, pilot plant and field installation will be analyzed to determine the movement of radioactive materials through these soils. In addition, the migration of non-radioactive materials, such as nitrates, will be followed.
- C. Further study will be given to the chemical and physical processes involved in the removal and fixation of radioactivity by soil formations.
- D. The critical nuclides present in waste solutions, other than from the Hope Process, will be evaluated as the composition of these solutions becomes known.
- E. The evaluation of military water treatment equipment for the decontamination of low-level radioactive waste will be continued.
- F. Further studies of the method now in use for generating particles in the 0.01 μ radius range will be made so that reproducibility and uniformity of the generated aerosol may be improved.
- G. The diffusion tube - cloud chamber method will be confirmed by means of the electron microscope.
- H. Development of a method for generating reproducibly particles from 0.1 μ down to approximately 0.001 μ radius will be continued.
- I. A preliminary evaluation of filters using particles in the 0.01 μ radius range will be made.

16. ANTICIPATED PROBLEMS NEXT YEAR

- A. Continue geological investigations to determine possible additional waste disposal sites in the ORNL area of operations.
- B. Evaluate the hazards associated with the operation of the high-level waste disposal pits in the four-acre tract.
- C. Continue cooperative research program with ERDL on sanitary engineering problems.
- D. Make an exhaustive study of filter penetration of particles in the 0.1 - 0.001 μ radius range. The important variables are type of filter, particle size, and flow rate through the filter.
- E. Investigate the behavior of sub-micron particles (under 0.1 μ radius); and determine the relative hazards due to radioactive particles in this size range.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>158,000</u> ⁽¹⁾	\$ <u>154,000</u> ⁽¹⁾	\$ <u>154,000</u> ⁽¹⁾
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u>158,000</u>	\$ <u>154,000</u>	\$ <u>154,000</u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>5.1</u>	<u>6.0</u>	<u>6.0</u>
B. TECHNICIANS	<u>0.8</u>	<u>0.5</u>	<u>0.5</u>
SUBTOTAL	<u>5.9</u>	<u>6.5</u>	<u>6.5</u>
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1. Research Participants	0.2		
2.			
3.			
TOTAL DIRECT MANPOWER	<u>6.1</u>	<u>6.5</u>	<u>6.5</u>
19. COMMENTS (1) This program includes activities previously reported as "Radioactive Liquid Waste - Environmental Problems Associated with Power Reactor Program", and "Nuclear Power Reactors - Airborne Hazards and Control":			
	FY 1955	FY 1956	FY 1957
<u>Program</u>	<u>Est. Cost M/Y</u>	<u>Est. Cost M/Y</u>	<u>Est. Cost M/Y</u>
Field Investigations and Explorations	69,000 2.5	53,000 2.0	53,000 2.0
Chemistry and Soils Engineering	30,000 1.1	40,000 1.5	40,000 1.5
Airborne Radioactivity Studies	59,000 2.3	61,000 3.0	61,000 3.0
Total Sanitary Engineering Research	158,000 5.9	154,000 6.5	154,000 6.5

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Radiation Dosimetry				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6560	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) G. S. Eurst			11. STATUS (INCLUDING STARTING DATE) Active		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					

The present project of Radiation Dosimetry includes programs previously reported as "Experimental Radiation Measurements", "Physics of Nuclear Radiation", "Radiation Dose", and "Theoretical Physics". The objective of this project is to develop techniques and methods of measuring external radiation such that interpretations of possible effects of these radiations on the damage to man can be made. In order that we may have a broad understanding of the major problems involved, the program includes three main activities. The following outline shows how these activities will be broken down during the next few years:

I Physical Aspects of Dosimetry

- (a) Stopping Power Determinations
- (b) Ionization and Transport of Electricity through Gases
- (c) Selected Problems Dealing with Absorption and Scattering of Radiation in Matter

II Development of Techniques and Instruments for Dosimetry

- (a) Neutron Dosimeters and Detectors
- (b) Gamma-Ray Dosimeters and Detectors

XIII Dosimetry Applications

- (a) Aerial Surveys for Radioactivity
- (b) Nuclear Weapons
- (c) Aircraft Shielding Program
- (d) Radiobiological Research
- (e) Applied Health Physics

13. RELATED PROJECTS

ORNL Applied Health Physics Department, Weapons Testing Program, U. S. Geological Survey, ANP Project, ORNL Biology Division, Primate Laboratory at the University of Texas, Health Physics Division of Los Alamos Scientific Laboratory.

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13. RELATED PROJECTS (continued)

The ORNL Applied Health Physics Department is engaged in the following activities related to applied phases of Radiation Dosimetry.

- A. Use of Induced Radiation in the Film Badge and in Coins to determine neutrons dose is being investigated. Some work was done using activation of developed film to determine the gamma dose on film blackened beyond reading with the usual light transmission methods.
- B. Monitoring Film Packets used for personnel monitoring have been reviewed and tests performed on several types of packets. To simplify the monitoring program, the Dupont 553 packet will be replaced with the Dupont 552 packet and an Eastman 5302 film will be included in the neutron film packet.
- C. Filters to be used in the new film badge have been selected and tested. A report describing test and results has been completed.
- D. Equipment to provide, for test purposes, chemical dosimeters of a range that will be useful as a monitoring instrument at ORNL is being installed. The instruments will be produced in accord with reports from UCLA and the University of Texas.
- E. An Automatic Filter Changing Constant Air Monitor for detecting and measuring airborne radioactivity is being constructed. The instrument will provide for automatic filter changing at specific intervals of time and automatic analysis of decay rate of radioactivity collected.
- F. A low background beta counter for use with low level samples from environs surveys is being fabricated. The counter utilizes a 2" gas flow proportional counter and a liquid phosphor scintillation counter which feed into an anti-coincidence circuit.

14. ACCOMPLISHMENTS LAST YEAR

Project I (a)

Measurement of energy losses by high energy (30-115 kev) electrons making single collision in thin metal foils has been completed.

Measurements made of the energy losses by high energy electrons (330 kev) in making multiple collisions in foils are in process of completion. For this work a Solenoidal beta-ray spectrometer was developed and used.

The stopping power of a moving charged particle in a degenerate Fermi gas has been calculated.

14. ACCOMPLISHMENTS LAST YEAR continued

Project I (a) continued

The effect of the density of the medium on the charge of a moving ion has been determined.

The Aage Bohr theory of Cerenkov and density effect on charge of moving particles have been verified by rigorous methods.

Project I (b)

The effects of various impurities on the amount of ionization produced in argon mixtures were thoroughly investigated.

The apparatus and techniques for measuring the attachment coefficient of electrons and electronic drift velocity in various gases were developed. Preliminary data for the attachment coefficient of oxygen and the drift velocity of electrons in several mixtures of gases were obtained.

Project I (c)

Investigation was made of the depth distribution of ionization in aluminum produced by high energy electrons.

Depth dose curves in tissue irradiated by neutrons of energies 100 kev, 20 kev, 5 kev, and 0.1 kev have been calculated by the Monte Carlo method.

Project II (a)

Experimental determinations were made on the response of the NTA film (in a packet designed to give tissue first collision dose) with monoenergetic neutrons. The response was found to be lower than the tissue curve for neutron energy less than 1 Mev. Modifications were made to correct this.

The proportional counter method of measuring fast neutron tissue dose in the presence of gamma rays was developed further. A method of calibration with an internal alpha source was perfected, shown by comparisons with other methods of dosimetry.

The threshold detector method of measuring neutron spectra was improved to such an extent that dose interpretations could be made with accuracy of about 5%. This method consisting of activation detectors (gold and sulfur) and fission detectors (Pu^{239} surrounded with various B^{10} absorbers, Np^{237} , and U^{238}) is well suited to weapons testing and other high intensity neutron bursts.

14. ACCOMPLISHMENTS LAST YEAR continued

Project II (b)

Various aspects of scintillation counter type instruments for detection of gamma rays by aircraft surveys have been described in various publications.

The variation in sensitivity with radiation energy of Eastman type K and Blue Brand X-ray films were checked in the range from 20 kev to radium gamma rays. A summary of this and data on other types of film has been submitted for publication.

Project III (a)

Aerial surveys for gamma radiation resulting from atomic weapons test "Fall-out" were initiated and completed. The cooperative work with the U. S. Geological Survey for locating uranium deposits was extended to a survey of the states of Maine, Montana, Wyoming, Colorado and Utah.

Project III (b)

The measurements of the neutron spectrum at various distances from atomic weapons were made during the 1955 Spring Nevada test series. The measurements were made with fission and threshold detectors and gave information accurately enough to allow tissue dose to be determined.

Project III (c)

Neutron measurements were made at the Tower Shielding Facility with the standard neutron proportional counter and the threshold detectors.

Project III (d)

The proportional counter and threshold detector methods of neutron dosimetry were applied to the calibration of neutron sources used in radiobiology research. These were the ORNL 86-inch cyclotron used by the Biology Division to study the effects of neutrons on mice and other animals and the Los Alamos Lady G assembly used by the Los Alamos Health Division for studying neutron effects on animals.

Project III (e)

An electronics group was formed in this section for the purpose of following the development of various instruments that are used by the Applied Health Physics Section. Examples of their work will be to continue to make developments and improvements on instruments such as the Rudolph, a portable instrument for measuring fast neutron dose, and the alpha survey instrument.

15. EXPECTED RESULTS THIS YEAR

Project I (a)

Quantum theory of density effect on charge of particles of non-relativistic velocities.

Statistical range distribution of heavy recoil particles.

Calculation of stopping power due to nuclear collisions,

Project I (b)

The measurement of electron drift velocity and attachment coefficient will be continued to include a number of gases and gas mixtures.

Project I (c)

The distribution of ionization in aluminum for high energy (10 to 250 kev) electron bombardment will be continued with a new improved ionization chamber.

Study will be made of the amount of neutron and gamma-ray scattering from various media using a new facility under construction. The reflecting materials will include water, lead, aluminum, concrete, and steel.

Tissue dose due to a beam of fast neutrons based on linear energy transfer will be calculated by Monte Carlo method.

Calculation of displacements of atoms in hydrocarbons exposed to fast neutrons.

The dose at various points within spheres and cylinders of various diameters for both fast and thermal neutrons is programmed for calculation.

Project II (a)

Further developments will be made in neutron dosimeters and neutron detectors as the need for them in various applications arises.

Project II (b)

Research and development work will be done on a gamma-ray dosimeter which is insensitive to neutrons.

Project III (a)

An aerial survey of the normal background in the United States will be initiated in connection with the U. S. Geological Survey.

15. EXPECTED RESULTS THIS YEAR continued

Project III (b), (c), (d), and (e)

These projects will continue along the same general lines as above, depending on the need of related projects.

16. ANTICIPATED PROBLEMS NEXT YEAR

The general program, I, II, and III, will continue but with a strong emphasis in the following directions:

- (1) Accident Studies - A program will be initiated for determining a procedure of examination for people who have been accident victims such that we can assess the magnitude of neutron dosage to which they were exposed.
- (2) More direct participation in applied radiobiological investigations, especially those in which we can make contributions with our dosimeters and facilities that we have for irradiation of biological material. The success of these two programs will depend in a large part on our being able to get into operation a proposed Lady Godiva type neutron source.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>377,000⁽¹⁾</u>	\$ <u>375,000</u>	\$ <u>375,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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7.			
TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1. Nevada Tests Participation	17,500		
2.			
3.			
4.			
5.			
TOTAL UNUSUAL COSTS	\$ <u>394,500⁽¹⁾</u>	\$ <u>375,000</u>	\$ <u>375,000</u>
TOTAL PROGRAM COST	\$ _____	\$ _____	\$ _____
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	15.8	15.3	15.3
B. TECHNICIANS.....	_____	_____	_____
SUBTOTAL	15.8	15.3	15.3
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1. ORINS Graduate Fellows .6		.3	.3
2. Research Participants			
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>16.4</u>	<u>15.6</u>	<u>15.6</u>
19. COMMENTS	(1) Consolidation of Program occurred in FY 1955 into "Radiation Dosimetry" Program.		
<u>Program</u>	<u>Estimated Cost FY 1955</u>	<u>Estimated Employee M/Y FY 1955</u>	
Theoretical Physics	19,000	0.9	
Physics of Nuclear Radiation	67,000	1.9	
External Radiation Dose Studies	49,000	2.0	
Experimental Radiation Measurements	20,000	1.0	
Radiation Dosimetry	<u>224,500</u>	<u>10.0</u>	
Total Radiation Dosimetry	379,500	15.8	

**PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT**

1. PROJECT TITLE Research Participation and Traveling Lecture Programs - Biophysics				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-28	
6. BUDGET ACTIVITY NO. 6560	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Individual Reports		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) R. W. Johnson			11. STATUS (INCLUDING STARTING DATE) Active		
<p>12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)</p> <p>The Research Participation Program provides an opportunity for university faculty members to receive advanced research experience in the field of biophysics. University representatives spend from three months to one year at the Laboratory, in some instances sharing the use of unique facilities located at ORNL in connection with special problems.</p> <p>The Traveling Lecture Program is conducted as a part of the Commission's contribution under its program of encouraging the dissemination of scientific and technical information. Under this program, scientific and technical personnel of the Laboratory's staff deliver lectures upon request to universities throughout the Southern region.</p>					
<p>13. RELATED PROJECTS</p> <p>Research Participation and Traveling Lecture Programs in AEC Program 5000.</p> <p>A corollary benefit of the Research Participation Program is that Research Participants lend important assistance in carrying out the research program of the Laboratory.</p>					
<p>14. ACCOMPLISHMENTS LAST YEAR</p> <p>Under the Research Participation Program, sixty faculty members of 34 universities spent periods of at least three months at the Laboratory. Of these, two were working in the field of biophysics. A number of research projects have been started in southern universities as a direct result of this program. The knowledge gained by the participants in the field of atomic energy is expected to promote the long-range plans of the program.</p> <p>Under the Traveling Lecture Program, lectures before advanced groups continued with approximately 175 lectures scheduled during FY 1955, 50 in biology and biophysics.</p>					
<p>15. EXPECTED RESULTS THIS YEAR</p> <p>Individuals chosen as Research Participants will contribute scientifically to the research program at ORNL. The objective of this program is to enable universities, particularly those in the South, to expand the scope of training offered to undergraduate and graduate students, and to stimulate in universities research which is of interest to the atomic energy program.</p> <p>Lectures delivered by the Laboratory staff under the Traveling Lecture Program are expected to number between 200 and 250 this year.</p>					

NOTE: Financial information should be set forth on reverse side of this form.

CAUTION: This document must be classified according to the information contained herein.

16. ANTICIPATED PROBLEMS NEXT YEAR

These programs are expected to continue in FY 1957 and to pursue the long-range objectives set forth above.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>15,000</u>	\$ <u>15,000</u>	\$ <u>15,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
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TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
TOTAL PROGRAM COST	\$ <u><u>15,000</u></u>	\$ <u><u>15,000</u></u>	\$ <u><u>15,000</u></u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	1.1	1.1	1.1
B. TECHNICIANS.....	_____	_____	_____
SUBTOTAL	1.1	1.1	1.1
C. OTHER TECHNICAL, LOANEES: PARENT ORGANIZATION			
1.			
2.			
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>1.1</u>	<u>1.1</u>	<u>1.1</u>
19. COMMENTS			

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Education and Training in Health Physics				2. DATE March 15, 1955	
3. CONTRACTOR - LABORATORY C&CCD - UC&CC ORNL		4. WORKING LOCATION Oak Ridge, Tennessee		5. CONTRACT NO. W-7405-Eng-26	
6. BUDGET ACTIVITY NO. 6680	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual		
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Elda E. Anderson			11. STATUS (INCLUDING STARTING DATE) Active		
12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)					
<p>Purpose of project is to meet the need for trained health physicists in the AEC installations, industry, universities, hospitals, and other government agencies including the military. The need is met by three training programs as follows:</p> <p>A. To provide health physicists with broad training--a one-year program conducted jointly with Vanderbilt University. The AEC Fellows in this program must have an A. B. degree, and if qualified, they may earn a M. A. degree from Vanderbilt by an extension of their fellowship to a total of 18 months.</p> <p>B. For the National Military Establishment (NME) a training program of 6 weeks for medical officers.</p> <p>C. Special training for individuals for varying periods of time and for a variety of purposes.</p> <p>D. A series of courses for staff members of the Applied Health Physics Section.</p>					
13. RELATED PROJECTS					
<p>Program A (AEC Fellowship Program) is under the same administration (ORINS) as the programs at University of Rochester-Brookhaven National Laboratory and at University of Washington-Hanford Works; all three programs comprise one of the educational projects of the Division of Biology and Medicine of the AEC.</p> <p>The course for the medical officers is part of the Advanced Radiobiology for Medical Officers of the Armed Forces Special Weapons Project.</p>					
14. ACCOMPLISHMENTS LAST YEAR, 1954-55					
<p>Completed training of 21 AEC Fellows in Radiological Physics (1 year)--in connection with this program a 6 credit graduate course in Radiological Physics at Vanderbilt University is given by members of the Division. Two of the Fellows elected to do the research problems for their theses in the Health Physics Division at ORNL.</p>					

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14. ACCOMPLISHMENTS LAST YEAR continued

Began training of 21 AEC Fellows in Radiological Physics September 1954, for a period of 1 year.

Trained 9 medical officers of USAF, USN, USA and USPHS for six weeks.

Trained 1 man for Army Chemical Center, Fort McClellan, Alabama for a total of 2 weeks.

Trained 1 girl for General Electric Co., Cincinnati, Ohio for a total of 2 weeks.

Trained 1 man from the Electric Boat Company, Groton, Connecticut and 3 USN men assigned to the USS Nautilus for a period of 2 weeks.

Assisted in Egyptian training program at the request of Lt. W. B. Looney. Three (3) Egyptians were given a 6 weeks series of lectures on Health Physics during the months of March and April.

At the request of Dr. Claus, special discussions on Health Physics were held with Dr. Masami Izawa during a 2 week period. Other Japanese will be sent to Oak Ridge from time to time for similar discussions.

Lectures

One lecture on the AEC Fellowship program at a professional society meeting.

A 10-lecture series on health physics to Oak Ridge School of Reactor Technology.

Four seminars on Health Physics for ORINS.

Special Talks to plant foremen and workmen at ORNL (as requested).

Weekly orientation lecture to new laboratory employees and special groups.

Four seminars on Radiological Safety to the Military Veterinary Radiological Health Course.

Courses

Two courses in mathematics for the Apprentice Training Program at ORNL.

Two courses in Internal Dose for members of the Health Physics Division.

Miscellaneous

This project reviews reports and articles for publication written by members of the Health Physics Division and edits the Semi-Annual Reports of the Division.

14. ACCOMPLISHMENTS LAST YEAR continued

Assisted in planning program for a general Health Physics Conference to be held at Ohio State University.

15. EXPECTED RESULTS THIS YEAR

Training of medical officers as heretofore.

Completion of the training of present 21 AEC Fellows and direction of the research problems for a portion of these.

Training of another group of 25 AEC Fellows.

Training of personnel in health physics for AEC Contractors and others as requested.

Continue to assist in training of Egyptian and Japanese persons.

Discussions have been held with Dr. Claus and Dr. Morgan on the possibility of Physics Training programs in European countries as one way of implementing President Eisenhower's Atoms for Peace project.

16. ANTICIPATED PROBLEMS NEXT YEAR

Continuation of Program of previous year.

Inquiry from Dr. Herman Roth suggested the need for a course in Radiation Protection for persons not desiring to become a health physicist but who needed knowledge about radiation hazards such as insurance personnel and sanitary engineers in general.

	ESTIMATED LAST FY - 1955	ESTIMATED THIS FY - 1956	ESTIMATED NEXT FY - 1957
17. NORMAL PROGRAM COSTS	\$ <u>50,000</u>	\$ <u>60,000</u>	\$ <u>60,000</u>
R & D SUBCONTRACTS:			
<u>TYPE & NAME OF SUBCONTRACTOR</u>			
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TOTAL R & D SUBCONTRACTS	\$ _____	\$ _____	\$ _____
LARGE AND/OR UNUSUAL COSTS:			
1.			
2.			
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TOTAL UNUSUAL COSTS	\$ _____	\$ _____	\$ _____
 TOTAL PROGRAM COST	\$ <u><u>50,000</u></u>	\$ <u><u>60,000</u></u>	\$ <u><u>60,000</u></u>
18. DIRECT MANPOWER	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	<u>3.0</u>	<u>3.0</u>	<u>3.0</u>
B. TECHNICIANS	_____	_____	_____
SUBTOTAL			
C. OTHER TECHNICAL, LOANEEs: PARENT ORGANIZATION			
1.			
2.			
3.	_____	_____	_____
TOTAL DIRECT MANPOWER	<u>3.0</u>	<u>3.0</u>	<u>3.0</u>
19. COMMENTS			

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