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BIOLOGY AND MEDICINE PORTION OF OAK RIDGE NATIONAL LABORATORY RESEARCH AND DEVELOPMENT PROGRAM FOR FISCAL YEAR 1956

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Human Studies Project

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Approved for issue by: Dr. C. E. Larson
Date of Issue: JUN 16 1954

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Report Number: CF 54-3-4

BIOLOGY AND MEDICINE PORTION OF

OAK RIDGE NATIONAL LABORATORY RESEARCH AND DEVELOPMENT PROGRAM FOR FISCAL YEAR 1956

Distribution

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United States Atomic Energy Commission
Oak Ridge, Tennessee
1-10. Attention: Mr. Kenneth Kasschau

Oak Ridge National Laboratory Central Files
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4500, ORNL
11-16. Attention: Dr. C. E. Larson

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1134551

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Biology and Medicine (Summary)			2. DATE March 15, 1954
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. 6000	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS
10. PERSON IN CHARGE (CONTRACTOR'S STAFF)		11. STATUS (INCLUDING STARTING DATE)	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The Laboratory's primary efforts in the fields of research under Biology and Medicine are directed toward determining the effects of radiation upon living things, understanding the mechanisms by which these effects are brought about, evaluating the severity of the effects with regard to ability to carry out life functions normally, and developing radiation exposure tolerances and controls and methods of protection against damaging effects. The ultimate objective is to reduce the hazards associated with radioactive materials and exposure to radiation.

The strong program of fundamental and applied research directed toward the accomplishment of this long-range objective encompasses a variety of research projects, including work in the fields of chemistry, chemical technology and physics as well as biology and applied biophysics.

13. RELATED PROJECTS

Biology research groups have continued to cooperate closely with: 1) A large number of different laboratories who were involved in "Operational Uplift" and "Knothole", and with a number of Atomic Energy Commission Laboratories; 2) A number of British Laboratories who are associated with the British Atomic Energy Projects; 3) National Bureau of Standards (U.S.); 4) Southern Universities through research participantship and traveling seminars; 5) The University of Virginia in helping to establish a radiobiology course at Mountain Lake, Virginia; 6) The U. S. Air Force in considerable extension of the study of mixed radiation, and in consultations for the ANP Project.

Health Physics research groups have engaged in cooperative programs with the following organizations: 1) AEC-TVA for an Ecological Study of White Oak Lake; 2) U. S. Public Health Service for water decontamination and radioactive waste disposal research; 3) Engineer Research and Development Laboratories of the U. S. Corps of Engineers for evaluation of water decontamination equipment and processes for military use; 4) ORNL Operations and Physics Divisions on radioactive waste disposal and shielding problems; 5) U. S. Geological Survey in the development of equipment for aerial surveys and uranium prospecting; 6) University of Pittsburgh (for U. S. Navy) on development and evaluation of sampling methods for airborne radioactivity; 7) ANP Project contributing to the shielding program; 8) U. S. Air Force in the establishment of an animal exposure program at Austin, Texas; 9) Chemical Corps in the study of airborne radioactive particles; 10) Neutron spectrum studies at atomic tests in Nevada and at Bikini; 11) Subcommittee on Internal Dose of the National Committee on Radiation Protection and of the

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13. RELATED PROJECTS Continued

International Commission on Radiological Protection; 12) AEC Fellowship Program at Vanderbilt University; 13) Health Physics seminars in southern universities; and 14) Lectures for the Educational Division of ORNL and the ORINS courses.

14. ACCOMPLISHMENTS LAST YEAR

The most important accomplishments during the year were: 1) the very successful participation in the Weapon Tests--with results which were obtained under difficult experimental conditions. It was established that good scientific data can be obtained if the work is painstakingly prepared in advance; 2) it is difficult to single out individual accomplishments since the importance of these results will not be known until considerable time has elapsed; however, the indication that radiation protection in bacteria can be accomplished by a factor which can be isolated in highest concentration from spleen appears important; 3) the discovery that "cell-free" photosynthesis can take place; 4) isolation of a number of different proteins from bacteriophage; 5) the finding that the oxygen effect operates not through chromosome breaks directly, but through "healing up" of broken chromosomes; 6) the preparation of the publication "maximum Permissible Internal Dose" to be published by the International Commission on Radiological Protection; 7) the development of a new packet for nuclear track film that measures fast neutron tissue dose from the track count; 8) the development of a new method of measuring fast neutron tissue dose with a fission and activation threshold detector; 9) the pilot scale testing of processes for removal of radioactive materials from ORNL process waste streams; 10) determination of the distribution of dose in the body from fast neutrons by the Monte Carlo method and by experimental measurements and the acceptance of these values by the International Commission in Radiological Protection; and 11) the training of personnel from universities, military organizations, AEC contractors and other Government agencies.

15. EXPECTED RESULTS THIS YEAR

It is hoped that the work on the 300-r mutation rate will be completed during the year 1955. All work has thus far been done with energy given in one single acute dose. It is now planned to give interrupted acute exposures as well as spreading the radiation over a considerable time. The first data in regard to the neutron effect on mutation production should become available. At the same time the long-term implication of neutron exposure will become recognizable. This will help to estimate the range limits for exposure to radiation from an airplane reactor--using mice as the experimental animals. Cytological work should give further information on the mechanism of radiation damage in chromosomes. Considerable information should become available in regard to the structure

15. EXPECTED RESULTS THIS YEAR Continued

of desoxyribonucleic acid. 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.

Sufficient data on the concentration of trace elements in human tissue should be accumulated to give substantial aid to the establishment of maximum permissible internal dose. Substantial progress should be made in developing techniques for analysis of cesium and ruthenium in body fluids. Calculations of the dose at various points within spheres and cylinders of various diameters for both fast and thermal neutrons will be completed. Calculations of the stopping power for slow charged particles will continue. Further development of the proportional counter neutron dosimeter will be pursued, and development of a scintillation detector for use in measuring directly the radioelement content in man and small animals will be undertaken.

Laboratory and field investigations relative to the wastes produced in the operation of nuclear power reactors will be continued with emphasis on:

Developing instrumentation for the monitoring of soil and water,
Evaluating experimental pits and barriers for the disposal of radioactive liquid waste,
Determining sites for two ORNL waste storage pits, and
Determining the critical nuclides that govern radioactive material fixation in soils.

16. ANTICIPATED PROBLEMS NEXT YEAR

Established research programs will be pursued at about the same level of effort with primary emphasis on those activities of most urgent need or of most promise. The cooperative efforts of the biochemistry and the cytogenetics groups should give considerable further information in regard to radiation mechanisms on chromosomes and genetic makeup. The first data should become available, too, on leukemia and tumor production from neutron exposures which simulate exposure to radiation in a nuclear-powered airplane. If the radiation protection work should continue to give significant results, it may be possible to recommend protective measures against radiation to men.

Progress is expected toward better evaluation of maximum permissible dose and exposure problems. Continued progress in the development and adaptation of instrumentation and techniques to meet new problems in radiation protection is anticipated. Development of a slow neutron dosimeter for general Health Physics and biological work will be initiated.

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AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 2,296,000	$ 2,304,000	$ 2,380,000
R & D SUBCONTRACTS*	22,000	23,000	23,000
LARGE OR UNUSUAL ITEMS COST*	22,000	13,000	
TOTAL PROGRAM COST	2,340,000	2,340,000	2,403,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION	20,379	180,000	
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT	65,400	49,600	51,000
TOTAL CONSTRUCTION AND EQUIPMENT	85,779	229,600	51,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	114.3	111.8	115.6
B. TECHNICIANS	1.4	2.0	2.0
SUBTOTAL	115.7	113.8	117.6
C. OTHER TECHNICAL, LOANEES, ETC.	1.0	2.0	2.0
TOTAL	116.7	115.8	119.6
20. COMMENTS			

*Detailed in comments.

1134555

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Biology (Summary)			2. DATE March 15, 1954
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. 6400	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)

The biology program largely concerns an investigation of the effects of radiations upon living material. One program of very long term implication is a study of mutational changes in mice after exposure to 300 r, 600 r and 1000 r. Studies are also carried out on developmental injuries occurring in mice irradiated during pregnancy. Physiological and pathological effect 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 the fields of chromosome mechanics and gene action; cytogenetic effects of radiation administered to viruses, microorganisms, plants and invertebrate animals. Programs are under way concerning radiation effects on cell division, growth and metabolism. Of great interest is the search for physical conditions or chemicals that afford protection from radiation or enhance recovery from prior radiation injury. In the field of plant physiology and biochemistry the following programs are under way: plant chemistry and photosynthesis; studies on nucleic acid structure, mechanism of enzyme action, and studies on biological energy-transfer systems; enzyme and isotope tracer studies on microbial intermediary metabolism. These latter groups of investigations afford basic knowledge which is necessary in order to interpret and extend radiation studies detailed above. In the fields of physical radiobiology and basic cell physiology the following subjects are under investigation: studies of physical interactions of radiations with biological materials, as well as with simple chemical systems; studies on basic cell physiology by advanced physical and radiobiological techniques; investigations of radiation-induced electrolyte disturbances.

13. RELATED PROJECTS

We continued to cooperate closely with: 1) A large number of different laboratories who were involved in "Operational Uplift" and "Knothole", and with a number of Atomic Energy Commission Laboratories; 2) A number of British Laboratories who are associated with the British Atomic Energy Projects; 3) National Bureau of Standards (U. S.); 4) Southern Universities through research participantship and traveling seminars; 5) The University of Virginia in helping to establish a radiobiology course at Mountain Lake, Virginia; 6) The U. S. Air Force in considerable extension of the study of mixed radiation, and in consultations for the ANP Project.

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14. ACCOMPLISHMENTS LAST YEAR

The determination of radiation-induced mutation rates in mice continues to give highly significant results. The work on the 600 r dosage range is completed; the 1000-r data are in the process of completion, and the 300-r data are now coming in. Indications are that a mutation rate 10 times that expected from Drosophila work is maintained over these three dosages, making the data quite reliable. Studies of the effect of fast neutrons delivered by the ORNL 86-inch cyclotron and by a nuclear detonation showed that the relatively biological efficiency is about 8 in comparison with X-rays. Further data in regard to dominant lethals have been obtained; the appearance of sterility in males produced by the different types of radiation can be accounted for by cell death rather than by inhibition of mitosis. Some data are now available on the effects of neutrons on embryonic development.

The mice obtained from "Operation Greenhouse" have continuously given highly interesting data on leukemia induction and tumor formation. In a cooperative study with the U. S. Air Force, effects of fast neutrons and X rays in different combinations are being studied. The pituitary tumors induced by feeding radioactive iodine to mice have opened an extremely interesting field of cancer research.

Studies in regard to radiation recovery in bacteria have shown that the spleen is the best source for the recovery factor. Simple organic compounds have been found to give as high as 90 per cent protection against highly lethal radiation. The work has been expanded to include studies of the effects of radiation on bone marrow, supporting the older work on radiation protection.

Photosynthesis has maintained its place as a major field; luminescence found during photosynthesis is shown to be closely associated with the photosynthetic process. It has been found that protoplasm extruded from certain algae will photosynthesize for a short time after leaving the cell, establishing that "cell-free" photosynthesis is possible. The biochemistry of certain sugars in connection with plant biosynthesis has been somewhat more clarified.

The study of the cytological effects of radiation has developed to such a degree that a more sophisticated approach to the problem is now possible. Close cooperation between cytology and biochemistry groups has been established. Sufficient information is now available on the mechanism of oxygen effect in regard to chromosome breaks to prove that this effect, in connection with X radiation is more on the "healing up" process of broken chromosomes than on the initial break. Results of Drosophila investigations have helped further to elucidate the basic genetic mechanism in flies, and have provided considerable supporting evidence for findings in mouse genetics work. The maize research has produced data which supports the work on Drosophila and Tradescantia. Fungus experiments have established the similarity of the effects of chemical compounds in regard to radiation protection in bacteria and fungi; in contrast to this, Paramecium has been found to give somewhat different results.

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14. ACCOMPLISHMENTS LAST YEAR Continued

Most interesting results have been obtained in regard to the structure of nucleic acids, which are of such great importance to biological function. The work has enabled a reconsideration of our conception of the structure of ribonucleic acid. Cooperative work with the cytology group has led to rather surprising results in investigations of the nucleic acids in bacteriophage. The elucidation of the effects of radiation on enzymes has contributed to new approaches to an understanding of enzyme function.

Tracer studies in intermediary metabolism have been extended with the aid of C^{14} and C^{13} tracers. Indications have been found for a new type of enzyme system by these methods.

Work of the biophysics group has been greatly extended with the acquisition of a Cockcroft-Walton accelerator and extensive work with weapon tests. The wavelength dependence curve for chromosome breaks in Tradescantia by monochromatic ultraviolet radiation has been worked out. Apparatus for the investigation of paramagnetic and nuclear magnetic resonance methods for the study of biological systems has been developed. Nucleic acid has been obtained in a highly polymerized form which is extremely sensitive to radiation. A technique for detection of lithium in tissues has been developed.

The proceedings, "Some Aspects of Microbial Metabolism", of the Fifth Annual Biology Research Conference was published; these symposia have been very popular; another was held in 1953 on, "Effects of Radiation and Other Deleterious Agents on Embryonic Development", the proceedings of which have been submitted for publication.

In 1953, The Biology Division published seventy-two full-length papers and thirty-two abstracts. There are in press fifty-three full-length papers and twenty-eight abstracts. The Division supplied speakers for approximately seventy traveling seminars, mostly to Southern Universities.

The cooperation with Southern Universities has been developed to such a degree that a number of cooperative projects are being conducted with staff members from these institutions.

Besides its own staff, the Division had working in its laboratories, ten visiting investigators, two postdoctoral fellows, and several consultants.

The most important accomplishments during the year were: 1) the very successful participation in the Weapon Tests -- with results which were obtained under difficult experimental conditions. It was established that good scientific data can be obtained if the work is painstakingly prepared in advance; 2) it is difficult to single out individual accomplishments since the importance of these results will not be known until considerable time has elapsed; however, the indication that radiation protection in bacteria can be accomplished by a factor which can be isolated in highest concentration from spleen appears important; 3) the discovery that "cell-free" photosynthesis can take place; 4)isolation of a number of different proteins from bacteriophage 5) the finding that the oxygen effect operates not through chromosome breaks directly, but through "healing up" of broken chromosomes.

1134558

15. EXPECTED RESULTS THIS YEAR

It is hoped that the work on the 300-r mutation rate will be completed during the year 1955. All work has thus far been done with energy given in one single acute dose. It is now planned to give interrupted acute exposures as well as spreading the radiation over a considerable time. The first data in regard to the neutron effect on mutation production should become available. At the same time the long-term implication of neutron exposure will become recognizable. This will help to estimate the range limits for exposure to radiation from an airplane reactor -- using mice as the experimental animals. Cytological work should give further information on the mechanism of radiation damage in chromosomes. Considerable information should become available in regard to the structure of desoxyribonucleic acid. 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.

16. ANTICIPATED PROBLEMS NEXT YEAR

The cooperative efforts of the biochemistry and the cytogenetics groups should give considerable further information in regard to radiation mechanisms on chromosomes and genetic makeup. The first data should become available, too, on leukemia and tumor production from neutron exposures which simulate exposure to radiation in a nuclear-powered airplane. If the radiation protection work should continue to give interesting results, it may be possible to recommend protective measures against radiation to men.

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6400 - Biology Program Summary

Page Number	Description	FY 1954 Program Cost	FY 1954 Total M-Yrs. ORNL Personnel	FY 1955 Program Cost	FY 1955 Total M-Yrs. ORNL Personnel	FY 1956 Program Cost	FY 1956 Total M-Yrs. ORNL Personnel
12	Genetic and Cytogenetic Effect of Radiations	180,000	9.5	178,000	9.0	178,000	9.0
15	Effects of Radiation on Paramecium	52,000	3.0	52,000	3.0	52,000	3.0
18	Insect Cytology and Genetics	95,000	6.0	95,000	6.0	95,000	6.0
21	Genetic and Developmental Effects of Radiation on Mice	290,000	12.5	288,000	13.0	288,000	14.0
24	Tracer Studies in Inter-Mediary Metabolism	95,000	5.0	95,000	5.0	95,000	5.0
27	Radiation Protection	143,000	7.9	85,000	5.0	85,000	5.0
30	Biochemistry, Nucleoproteins, Enzymes, Polysaccharides	170,000	9.5	161,000	9.0	161,000	9.0
34	Biophysics	147,000	9.0	156,000	8.0	156,000	8.0
37	Plant Biochemistry	60,000	3.4	75,000	4.0	75,000	4.0
40	Enzymology and Photosynthesis	38,000	2.0	95,000	6.0	95,000	6.0
43	Pathology and Physiology	230,000	7.2	220,000	7.0	220,000	7.0
46	Research Participation and Traveling Lecture Program - Biology	52,000	4.5	52,000	3.8	52,000	3.8
49	Math and Comp. - Biology	40,000	3.0	40,000	3.0	40,000	3.0
	Total 6400	1,592,000	82.5	1,592,000	81.8	1,592,000	82.8

AEC-189

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Genetic and Cytogenetic Effect of Radiations			2. DATE March 15, 1954
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. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Monthly and Semi-Annual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Alan D. Conger and R. F. Kimball		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The group is concerned with the cytological and genetic effects of radiation and, conversely, an elucidation of genetic action in biological systems by means of radiation experiments. In general, effects and actions on the cellular and subcellular level are the primary concern. The production, by all types of radiation, of mutations and chromosome breaks and the relation of these to death caused in bacteriophage virus, in Neurospora (bread mold), in the plants Zea (maize), Vicia (bean) and Tradescantia (spiderwort), and in a mouse ascites tumors are investigated. The combination of related research on such a variety of different life forms, each particularly suitable for this work for one reason or another, offers great versatility and permits generalization from the results observed in common among them.

13. RELATED PROJECTS

Cooperation with the maize group at the University of Illinois and with groups, both within and outside the AEC, concerned with the biological effects of nuclear detonations.

14. ACCOMPLISHMENTS LAST YEAR

Increasing the radiosensitivity of cells by increasing oxygen concentration has received considerable attention from this group. In the Vicia bean, it was found from oxygen experiments that both breakage and rejoining of irradiated chromosomes are independent events; in Tradescantia, that the increase of sensitivity by oxygen is not due simply to an increase in chromosome breakage, as it was first thought; in mammalian cells -- the mouse tumor -- it was proved that the oxygen effect is the same as had been found for plants and lower animals. This last may prove to be of practical use in radiotherapy. This series of studies has led to new concepts of oxygen action which are of much importance in understanding the basic mechanism of radiation action on the cell.

Maize and Drosophila studies have given rise to new concepts, of general applicability, on the mechanism of chromosome duplication and recombination. The nature and extent of indispensable gene functions, and their damage by radiation, have been explored in Neurospora using the heterokaryon technique. These studies help in understanding the nature of genes and chromosomes.

Measurements in absolute units have been made at various wavelengths of the rate constants of the light reaction involved in the photoreactivation of bacteriophage inactivated by ultraviolet radiation.

The extensive biological studies at Operation Knothole have been completed and reports published.

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15. EXPECTED RESULTS THIS YEAR

The particular advantages of the heterokaryon method in Neurospora will be used to study mutation and gene action. Attempts will be made with Vicia bean to discover at least some of the enzymatic pathways by which radiation damages the chromosomes. The relative biological efficiency of fast neutrons, and of neutrons of different energies, will be analyzed with Tradescantia. Investigation of the mechanism of chromosome recombination and of the mutagenic effect of radiation will be continued in maize. The work on the production of chromosome aberrations and cell death in the mouse ascites tumor by ionizing radiation will be continued; in addition, the production of these effects by ultraviolet light also will be studied.

16. ANTICIPATED PROBLEMS NEXT YEAR

The major emphasis will continue to be upon the mechanism by which mutation, chromosome aberrations, cell death, and related phenomena are brought about by radiation. For this purpose, a variety of radiations will be used and various ways of modifying the radiation effect will be investigated. As a necessary and integral part of this work, the biological nature of the change brought about by radiation will be studied. Different aspects of these general problems will be pursued with the organisms most suited for them.

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AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$180,000	$178,000	$ 178,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	$180,000	178,000	178,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	2,000	1,500	1,500
TOTAL EQUIPMENT	2,000	1,500	1,500
TOTAL CONSTRUCTION AND EQUIPMENT	2,000	1,500	1,500
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	9.5	9.0	9.0
B. TECHNICIANS			
SUBTOTAL	9.5	9.0	9.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	9.5	9.0	9.0

20. COMMENTS

*Detailed in comments.

1134563

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Effects of Radiation on Paramecium			2. DATE March 15, 1954
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. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS 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)

The single-celled animal, Paramecium aurelia, is used as a conveniently large cell with which to study various kinds of damage, both inherited and not inherited, produced by radiation. The work is designed to investigate the biological nature of the damage as well as the mechanism by which it is brought about, and so to contribute to the basic understanding of the effects of radiation. In this way, it is hoped to aid in establishing a logical basis for modifying these effects while at the same time contributing information of basic biological importance.

13. RELATED PROJECTS

Cooperation by exchange of information with Indiana University, Argonne National Laboratory and Agnes Scott College.

14. ACCOMPLISHMENTS LAST YEAR

Chromosome damage by X rays has been known for some time to be greater when oxygen is present than when it is absent. It has frequently been suggested that this is because hydrogen peroxide is formed in the cell when oxygen is present. This hypothesis has now been shown to be untenable for Paramecium, and presumably for other organisms, by quantitative tests of the effect of peroxide combined with theoretical and experimental determination of the amount which penetrates into the cell from outside.

The behavior of cell nuclei which take part in fertilization has been shown to be altered by X rays; and the effect has been traced, at least in part, to damage to the chromosomes. Damage to a particular nucleus may interfere with its activities even when other, undamaged nuclei are present in the same cell.

Investigations on another one-celled animal, Tillina, have shown that heavily irradiated cells may survive for a time and divide repeatedly but finally die. The cause of this delayed death is not known; but it is clear that chromosomal damage, on which similar delayed death is often blamed, is not involved.

15. EXPECTED RESULTS THIS YEAR

Investigations will be continued of the role of various modifying agents on radiation damage to Paramecium in an attempt to further elucidate the events taking place in the cell during and shortly after irradiation. In particular, it is hoped that more information can be gotten on the mechanism of the oxygen

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effect. Further analysis is planned of the nature of certain types of biological damage, especially effects on the behavior of nuclei and delayed effects which may have a non-chromosomal basis.

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 by other means 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.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$52,000	$52,000	$52,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	52,000	52,000	52,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Microscope	1,000		
Misc. Lab. Equipment		1,000	1,000
TOTAL EQUIPMENT	1,000	1,000	1,000
TOTAL CONSTRUCTION AND EQUIPMENT	1,000	1,000	1,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.0	3.0	3.0
B. TECHNICIANS			
SUBTOTAL	3.0	3.0	3.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	3.0	3.0	3.0
20. COMMENTS			

*Detailed in comments.

1134566

AEC-189

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Insect Cytology and Genetics			2. DATE March 15, 1954
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. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Monthly and Semiannual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Mary Esther Gaulden		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The grasshopper and wasp programs deal with the fundamental aspects of cytologic and genetic processes and the manner in which radiation affects them. The cells of the grasshopper embryo are large and especially amenable to in vitro study; the wasp egg has the advantage of being amenable to both cytologic and genetic analysis. Specifically, the work with these organisms is concerned with the structure and function of different parts of the cell and with effects of radiation and radiomimetic (chemical) substances on these parts. In turn, the influence of these affected parts in delaying mitosis and growth is being studied. The correlation of radiation-induced structural changes with biochemical and physiological changes in the cell is under study. The purpose of the Drosophila genetics program is two-fold: the elucidation of fundamental genetics problems as revealed by radiation and the determination of the effects of radiation on this genetic material. Such a program is vital since Drosophila is the best known genetically of any organism -- interpretations of radiation genetic experiments rest on a comparatively firm foundation in this organism and are extremely useful in unravelling problems of fundamental genetic import. The importance of this program in relation to other projects in the laboratory dealing with less well analyzed genetic material (e.g., mice, bacteria, etc.) is obvious. In addition to elucidating fundamental aspects of cytogenetic processes and effects of radiation on them, the work of this group has direct bearing on problems of abnormal growth, e.g., malignant growth.

13. RELATED PROJECTS

Close cooperation with Biophysics, Enzymology, Physiology and Plant Biochemistry groups of this laboratory and with the Zoology Departments of University of Tennessee, University of Pennsylvania, University of Mississippi, Duke University and Northwestern University.

14. ACCOMPLISHMENTS LAST YEAR

Continuous low intensity radiation (e.g., 0.8 r/hr) produces an increase in mid-mitotic index after 4- and 6-day exposure; the increase is not due to stimulation but to retardation of cells in late prophase which go into mid-mitosis on removal from radiation field. (Published) Oxygen tension at time of irradiation influences the degree of radiation-induced mitotic inhibition, the lower the tension the less the mitotic effect of X-rays. (Published) By treatment with trypsin the grasshopper embryo can be separated into its component cells, giving suspensions of cells for physiologic study. (Published) The effect of fast neutrons from nuclear detonations on the induction of specific gene mutations and recessive and dominant lethal mutations has been determined; a comparison of these results with results also obtained with fast neutrons from cyclotron irradiation and hard X rays indicate that while the detonation neutrons are no

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14. ACCOMPLISHMENTS LAST YEAR Continued

more effective than cyclotron neutrons, they are from 2 to 8 times as effective as X rays for a comparable dose. (Published and in press.) The complex relations between the stability of expression of a gene and its location with regard to particular chromosome regions (heterochromatin) have been further elucidated. (Published) X-ray-induced chromatin fragments which are not included in the nucleus after cell division do not undergo the changes normally occurring in chromosomes within the nucleus. (In press) Oxygen consumption is significantly reduced in grasshopper embryos by X-ray doses of 3500 r and above and in eggs by doses of 10,000 r and above. (In press) The frequency of X-ray-induced mutations in Habrobracon eggs is decreased by lowering oxygen tension during irradiation. (In manuscript) By irradiation of Drosophila carrying a ring chromosome, it has been found that the decrease in chromosomal aberrations recovered when the treatment is carried out in low oxygen concentrations is not due to a decreased number of breaks in the chromosome. (In manuscript) X-radiation cause chromosomes of mid-mitotic phases of grasshopper neuroblasts to become "sticky," the appearance of the effect depending on dose of radiation and stage at time of treatment. (In manuscript) Chromosome segregation, as determined by both genetic and cytological methods, in Drosophila with abnormal numbers of chromosomes, indicates that the classical concept of the relation between pairing and segregation must be modified. (In manuscript) Withdrawal of water from grasshopper neuroblasts, by increasing osmotic pressure of culture medium, induces stickiness of the chromosomes which resembles that induced by ionizing radiation. (In manuscript)

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, and effect of radiation on synthesis of nuclear material. The Drosophila investigations are expected to provide evidence on: the genetic composition of mutations as revealed by their induction with radiations of different ion density, the relation between heterochromatin and genetic stability in somatic tissue, and the behavior of broken chromosome ends in meiosis and mitosis.

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 radiation 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.

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AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 95,000	$ 95,000	$ 95,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	95,000	95,000	95,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Microscope	2,000		
Microscope		1,500	
Misc. Lab. Equipment			1,500
TOTAL EQUIPMENT	2,000	1,500	1,500
TOTAL CONSTRUCTION AND EQUIPMENT	2,000	1,500	1,500
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	6.0	6.0	6.0
B. TECHNICIANS			
SUBTOTAL	6.0	6.0	6.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	6.0	6.0	6.0
20. COMMENTS			

*Detailed in comments.

1134569

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Genetic and Developmental Effects of Radiation on Mice			2. DATE March 15, 1954
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. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Monthly and Semiannual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) William L. Russell		11. STATUS (INCLUDING STARTING DATE) Active. Started December 1, 1947	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

Determination of radiation-induced mutation rates in mice. This is a long-term project to provide data for the estimation of the genetic hazard of exposure of human beings to ionizing radiation, conducted by request of the AEC.

Determination of effects of radiation, and of radiation combined with possible protective agents, on developmental processes. This work is yielding estimates of radiation hazards to the human embryo and possible methods of protection.

13. RELATED PROJECTS

Genetic work coordinated with experiments on Drosophila at Oak Ridge, Northwestern University, Indiana University and Long Island Biological Association, and with work on mice at Institute of Animal Genetics, Edinburgh. Studies on development are coordinated with work at Pondville Hospital, Massachusetts, and College of Medicine, University of Cincinnati. Also "Operation Upshot/Knothole."

14. ACCOMPLISHMENTS LAST YEAR

The 600 r mutation rate experiment has been completed, the 1000 r experiment almost completed and the 300 r experiment continued. All these experiments agree in showing that the mutation rate in the mouse is about ten times higher than in Drosophila and indicate extra caution in drawing up human tolerance levels. The characteristics of several mutations obtained in these experiments have been studied. -- Dominant lethals induced in males by various doses of cyclotron neutrons and by a nuclear detonation have shown that the RBE for cyclotron neutrons is about 8 and that detonation neutrons have an approximately equal degree of effectiveness. The incidence of dominant lethals increases markedly with the postirradiation interval up until the time temporary sterility sets in. -- The incidence of semisterility and sterility in the offspring of males exposed to cyclotron neutrons has been measured. -- It was found that damage to the testis by exposure to X rays, gamma rays and cyclotron and detonation neutrons can be completely accounted for by cell death without recourse to the hypothesis of inhibition of mitosis. -- It was found that in X-irradiated females, preceding the onset of permanent sterility, a slight degree of superovulation is induced by 400 r-treatment, while the littersize is somewhat reduced. By examining the oviduct contents within 24 hours after copulation, it was determined that an equal proportion of ovulated eggs is fertilized in irradiated females, and that an excess of death must therefore occur among embryos resulting from irradiated oocytes. -- Abnormalities resulting from the exposure of embryos at specific stages in development to cyclotron and detonation neutrons have been studied.

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15. EXPECTED RESULTS THIS YEAR

Completion of 300 r mutation rate experiment. Continuation of study of the nature of individual mutations obtained in all experiments. Effect of neutrons on mutation rate. Initiation of an experiment measuring over-all viability and productivity of offspring of irradiated males. -- Dominant lethals induced by neutrons from a Cockroft-Walton generator. -- Final results of tests for semisterility and sterility in offspring of males exposed in a nuclear detonation. -- Study of the fate of individual cell types in the testis with various doses of gamma rays and neutrons. -- Continuation of study of radiation-induced dominant lethals in females and of radiation effects on female fertility, especially with regard to time relations, dose relations, possible protection by hypoxia. Tests for semisterility and sterility in offspring of X-irradiated females. -- More extensive study of neutron effects on embryos, using a Cockroft-Walton generator, and comparison with X-ray effects.

16. ANTICIPATED PROBLEMS NEXT YEAR

Continuation of study of the nature of individual mutations obtained in all experiments. -- Effect of neutrons on mutation rate. -- Effect of chronic gamma radiation on mutation rate. -- Tests for semisterility and sterility in offspring of mice exposed to neutrons from a Cockroft-Walton generator. -- Continuation of studies on radiation effects on individual mammalian cells in different mitotic and meiotic stages, using the testis and possibly the ovary. -- Immediate and early effects of radiation on embryos in cleavage stages and coorelation with results observed in later stages. Elucidation of the mechanism of production of certain selected abnormalities induced by radiation of embryos during major organogenesis.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 275,000	$ 275,000	$ 288,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*	15,000	13,000	
TOTAL PROGRAM COST	290,000	288,000	288,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
150 H.P. Motor	3,500		
Misc. Lab. Equipment		1,000	1,000
TOTAL EQUIPMENT	3,500	1,000	1,000
TOTAL CONSTRUCTION AND EQUIPMENT	3,500	1,000	1,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	12.5	13.0	14.0
B. TECHNICIANS			
SUBTOTAL	12.5	13.0	14.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	12.5	13.0	14.0
20. COMMENTS			
Unusual Costs			
Purchase of Plastic Mouse Cages	15,000	13,000	

*Detailed in comments.

1134572

AEC-189

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE			2. DATE
Tracer Studies in Intermediary Metabolism			March 15, 1954
3. CONTRACTOR - LABORATORY	4. WORKING LOCATION		5. CONTRACT NO.
C&CCD - UC&CC ORNL	Oak Ridge, Tennessee		W-7405-Eng-26
6. BUDGET ACTIVITY	7. BUDGET ITEM	8. SECURITY CLASS	9. METHOD OF REPORTING PROGRESS
No. 6400	NO.	Unclassified	Semi-Annual Reports and Open Lit.Pub.
10. PERSON IN CHARGE (CONTRACTOR'S STAFF)		11. STATUS (INCLUDING STARTING DATE)	
S. F. Carson		Active, June, 1947	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

A. Studies in intermediary metabolism with the aid of C^{13} and C^{14} as tracers. Purpose is to help fill in large gaps in present knowledge concerning important degradative and synthetic reactions in biological systems; when certain details of these processes are sufficiently understood, the work will help furnish sound basis for studies concerning radiation effects on important enzyme system.

B. Work includes use of various microbial systems (whole organisms and enzyme systems derived therefrom) as "models" to trace individual steps in reactions mentioned above. Chemical techniques include special C^{14} bio-organic methods for separation, organic synthesis and degradation of compounds encountered in metabolism studies. Biochemical studies include metabolism of living microorganisms as well as special methods to isolate from them certain "working" enzyme system.

C. The third O.R.I.N.S. Graduate Fellow to receive training and conduct Ph.D. research within this project has finished and will receive his Ph.D. degree.

D. Several University Research Participants receive training and take an active part in the research of this project.

13. RELATED PROJECTS

Sulfhydryl compounds have become increasingly important in studies on protection against radiation damage, and hence an intimate working knowledge of sulfhydryl-coenzymes assumes great importance. A Study of the mechanism of action of Coenzyme A (a sulfhydryl-coenzyme) in cell-free bacterial systems is being carried out in this project. Lipoic acid, a cyclic disulfide, is under investigation in connection with keto acid oxidation systems.

It is important to understand enzymatic peroxidation reactions in view of the "oxygen effect" observed in radiation protection studies. A new peroxidation enzyme system (from bacteria) has been discovered in this project, and the purification of the enzyme has progressed quite far. The mechanism of action of the peroxidizing enzyme is being studied and will be of value in interpreting and extending radiation protection studies.

14. ACCOMPLISHMENTS LAST YEAR

Following publications appeared in the open literature:

A. "A citric acid cycle in Propionibacterium pentosaceum".

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14. ACCOMPLISHMENTS LAST YEAR Continued

B. "The oxidation and peroxidation of $DPNH_2$ in extracts of Streptococcus faecalis 10C1."

C. "Significant advances in the study of carbon metabolism of microorganisms."

This project's third O.R.I.N.S. Graduate Fellow was awarded the Ph.D. degree (Virginia Polytech. Inst.).

15. EXPECTED RESULTS THIS YEAR

Following work has been completed, and manuscripts are being prepared:

A. Asymmetric enzyme conversions in the oxidative cycles of Propionibacterium pentosaceum.

B. Chemical degradation of C^{14}-labelled succinic acid.

C. Sulfhydryl-coenzyme reactions in the conversion of succinate to propionate and CO_2 by Propionic Acid Bacteria.

D. A new one-carbon fragment produced by Propionic Acid Bacteria during succinate decarboxylation.

E. Methods for degradation of C^{14}-labelled acids of the citric acid cycle (a review requested by Academic Press).

F. Mechanism of conversion of a "heterolactic" fermentation to a "homolactic" fermentation in Escherichia coli during arsenite inhibition.

16. ANTICIPATED PROBLEMS NEXT YEAR

We expect that the results of current studies on (1) sulfhydryl-coenzymes, and (2) peroxidation enzymes (see 13 above) will partially cross over into related projects being carried out in this Division on radiation protection.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 95,000	$ 95,000	$ 95,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	95,000	95,000	95,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	2,000	1,500	1,500
TOTAL EQUIPMENT	2,000	1,500	1,500
TOTAL CONSTRUCTION AND EQUIPMENT	2,000	1,500	1,500
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	5.0	5.0	5.0
B. TECHNICIANS			
SUBTOTAL	5.0	5.0	5.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	5.0	5.0	5.0
20. COMMENTS			

*Detailed in comments.

1134575

AEC-189

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Radiation Protection			2. DATE March 15, 1954
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. 6400	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) Alexander Hollaender		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The use of microorganisms in an effort to determine the sites of radiation damage is continuing. Much information has been obtained on the probable early events leading to damage of the living cells by altering the physical and chemical environment of the cells during the process of irradiation (oxygen effect, the effect of reducing compounds, sulfhydryl compounds, temperature). Several techniques have been developed in this laboratory for demonstrating the biological effects produced by the radiation on microorganisms (alterations in metabolism, loss of essential metabolic intermediates, inhibition of enzyme synthesis and inhibition of ability of irradiated cells to recover in a chemically defined synthetic medium). The mechanism of production of these effects are being investigated for their possible application to therapy against radiation damage in higher forms of life.

13. RELATED PROJECTS

Information is exchanged with Argonne National Laboratory, Argonne Cancer Hospital, Dr. J. S. Mitchell, Cambridge University, Cambridge, England, and Dr. L. H. Gray, London, England.

14. ACCOMPLISHMENTS LAST YEAR

Publications: Fundamental Aspects of Radiation Protection from a Microbiological Point of View; Adsorption of Oxygen from Buffer Solution by Cells of Escherichia coli B/r; Recovery of X-irradiated Bacteria at Sub-Optimal Incubation Temperature; The Effect of X-radiation on the Respiration of Escherichia coli; Temperature Dependence of Bacterial Inactivation by X-rays; (Abstract). Post-Irradiation Release of Adenosine-triphosphate from Escherichia coli B/r; The Effect of X-irradiation on the Macromolecular Structure of Escherichia coli; In Press: Observations on Several Changes in the Physiological and Cytological Character of Escherichia coli following X-irradiation.

15. EXPECTED RESULTS THIS YEAR

In regard to protective systems prior to or during irradiation, several new compounds, containing sulfhydryl groups have been shown to eliminate 90 per cent or more of the radiation effect if bacteria are treated with them prior to irradiation. These compounds are being tested as protective agents against lethal and mutagenic effects of X rays on bacteria and fungi. A technique has been developed for estimating the breakdown in intracellular constituents of bacteria resulting from X-irradiation, some of these

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15. EXPECTED RESULTS THIS Continued

radiation-induced-catabolic reactions may be closely related to cell death. It has been shown in this laboratory that the process of "recovery" plays an important role in the ability of bacteria to survive irradiation with X or gamma rays. If irradiated bacteria are incubated in the presence of extracts of certain mammalian tissues, notably spleen extract, recovery processes lead to a striking increase in the viability of these cells. Reduction of the incubation temperature after irradiation is especially conducive to this process. Some of the nutritives contained in the tissue extracts which are required for recovery have been determined, but much more work will be required to isolate the factors which stimulate recovery to the greatest extent. The results of these investigations with microorganisms will be examined in the light of application to post-irradiation therapy in mammals.

16. ANTICIPATED PROBLEMS NEXT YEAR

Upon completion of the isolation and identification of the nutritive factors required for recovery, it will be of utmost interest and importance to determine their biochemical function in this process. The incorporation of radioisotopes into these compounds should be an aid to determining their metabolic activity. There is some indication that bacteria do not recover from neutron irradiation. The lack of recovery after neutron irradiation may be closely related to the increased efficiency of this radiation over X or gamma rays, which is a common finding in radiobiological investigations.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 143,000	$ 85,000	$ 85,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	143,000	85,000	85,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	2,000		1,500
X-Y Recorder		2,000	
TOTAL EQUIPMENT	2,000	2,000	1,500
TOTAL CONSTRUCTION AND EQUIPMENT	2,000	2,000	1,500
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	7.9	5.0	5.0
B. TECHNICIANS			
SUBTOTAL	7.9	5.0	5.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	7.9	5.0	5.0

20. COMMENTS

*Detailed in comments.

1134578

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE			2. DATE
Biochemistry: Nucleoproteins, Enzymes, Polysaccharides			March 15, 1954
3. CONTRACTOR - LABORATORY	4. WORKING LOCATION		5. CONTRACT NO.
C&CCD - UC&CC ORNL	Oak Ridge, Tennessee		W-7405-Eng-26
6. BUDGET ACTIVITY NO. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Monthly and Semi-Annual 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)

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 already revolutionized our concepts of nucleic acid structure and composition and are currently being extended.

These methods 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 coenzymes. Thus it is becoming possible to think of nucleic acids both as structural or template units and as sources of the coenzymes concerned with metabolic processes. The mode of participation in either direction remains unknown and is the general object of research in this field.

With increasing evidence of inhomogeneity among the nucleic acids even within a given cell type, attention is now being 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. 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.

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. The study of radiation effects, particularly as they relate to this combination, is basic to any biochemical concept of radiation damage and to a rational approach to its chemotherapy. Accordingly, 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.

These studies have involved the synthesis and testing of a new class of substrates, the glyconyl peptides. The experience and technique developed in working with the latter has made possible an approach to effective study of the large and little understood class of biologically important substances known as mucopolysaccharides, of which heparin is an example, which are

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12. PURPOSE, NEED, AND SCOPE Continued

implicated in radiation damage. With the synthetic, enzymic and chromatographic techniques available in this laboratory, it is proposed to investigate the biochemistry of this class of materials as a prelude to ascertaining its role in radiation damage.

13. RELATED PROJECTS

A. It is anticipated that the findings of the Enzymology group regarding the changed pattern of labelled precursor incorporation into nucleic acids brought about by irradiation will eventually tie directly in with our studies, just as our expanding concepts must be consistent with those findings. There is a constant correlation of information, both theoretical and technical, between us so that the two projects are really quite intimately interrelated.

14. ACCOMPLISHMENTS LAST YEAR

Publications: The Separation of Sugar Phosphates by Ion-Exchange with the use of the Borate Complex (Khym and Cohn); The Identification of the Isomeric Adenylic Acids a and b (Khym, Doherty, Volkin and Cohn); On the Structure of Ribonucleic Acids: I. Degradation with Snake Venom Diesterase and the Isolation of Pyrimidine Diphosphates (Cohn and Volkin); II. The Products of Ribonuclease Action (Volkin and Cohn); Some Comparative Aspects of Cell-Free Bacterial Luminescence (Cormier and Strehler); The Identification of KCF: Requirement of Long Chain Aldehydes for Bacterial Extract Luminescence (Cormier and Strehler); Factors Affecting the Luminescence of Cell-Free Extracts of the Luminous Bacterium, A. fischeri (Strehler and Cormier); The Chemiluminescence of Riboflavin (Strehler and Shoup); Luminescence in Cell-Free Extracts of Luminous Bacteria (Strehler); Kinetic Aspects of the Bacterial Luciferin-Luciferase Reaction in vitro (Strehler and Cormier); Isolation, Identification and Function of Long Chain Fatty Aldehydes Affecting the Bacterial Luciferin-Luciferase Reaction (Strehler and Cormier); The Luminescent Oxidation of Reduced Riboflavin Phosphate in the Bacterial Luciferin-Luciferase Reaction (Strehler, Harvey, Chang, Cormier).

15. EXPECTED RESULTS THIS YEAR

A. The studies to elucidate 1) the nature of the nucleic acid-protein linkage and the nature of the protein, 2) the composition, in terms of nucleotide and polynucleotide constituents, 3) the chemical basis of participation in cell processes and 4) the biosynthetic pathways utilized (in terms of precursors and enzymes) of nucleic acids and nucleoproteins will continue utilizing bacteriophage as a source of nucleic acid. These studies will be based upon our previous studies with isolated enzyme systems and with new

15. EXPECTED RESULTS THIS YEAR Continued

chromatographic techniques, amplified by the use of labelled precursors and of other physico-chemical techniques. The possibility (indicated by current work) that bacteriophage contains more than one type of protein, and that the protein plays more than one role, will be further investigated.

B. Utilizing information obtained from previous studies of enzyme-substrate complexes, it was possible to predict and establish experimentally that a new type of linkage could be split by a proteolytic enzyme, a suitably activated carbon-carbon bond rather than the usual carbon-nitrogen or carbon-oxygen bond. This is the first recorded instance where such a linkage has been split without resorting to oxidation. Other enzymes in this class will be studied to determine the generality of this type of reaction and what possible biological function might be involved. The enzyme-substrate studies will be extended.

The procedures developed for the synthesis of glyconyl peptides and the chromatographic techniques developed for nucleotide analysis will be combined in an effort to establish the composition and structure of mucopolysaccharide material and of heparin. It is anticipated that the development of reliable analytical and degradation techniques will consume most of a year, just as was the case with the nucleic acids.

16. ANTICIPATED PROBLEMS NEXT YEAR

A. Work next year will presumably be directed according to the results of the work this year. It is felt that no meaningful studies of the effects of radiation upon nucleic acids or nucleoproteins in vivo can be accomplished until we have obtained a more clear picture of either the mode of synthesis or of the mode of action of nucleic acids or nucleoproteins. Once either of these phases of the nucleic acid problem is clarified, interpretable radiation studies can be devised.

B. It is believed that the results obtained by the study of the complexes of α-chymotrypsin with its substrates and extensions of this approach to other enzyme systems, will lead to a better understanding and perhaps an explanation of the difference between the energy required to influence enzymic reactions in vivo and in vitro and to experiments to demonstrate this difference. With regard to the mucopolysaccharides and related substances, the chemical preliminaries will be followed with investigations of the composition and structure of some representative substances of this class and of the sulfonated mucopolysaccharides, such as heparin. It is likely that improved methods of isolation of starting material must be devised to match our improved methods for isolating the breakdown products. It is certain that new enzymatic degradation methods are necessary. Following the establishment of composition, structure and breakdown products, the participation of these substances in normal and irradiation conditions will be examined.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 170,000	$ 161,000	$ 161,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	170,000	161,000	161,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Fume Hood	2,500		
Misc. Lab. Equipment		2,000	2,000
TOTAL EQUIPMENT	2,500	2,000	2,000
TOTAL CONSTRUCTION AND EQUIPMENT	2,500	2,000	2,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	9.5	9.0	9.0
B. TECHNICIANS			
SUBTOTAL	9.5	9.0	9.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	9.5	9.0	9.0
20. COMMENTS			

*Detailed in comments.

1134582

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Biophysics			2. DATE March 15, 1954
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. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Monthly and Semi-Annual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) C. W. Sheppard and J. S. Kirby-Smith		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

Investigation of the biophysical, biochemical and morophological alterations produced by radiation in cell nuclei and nuclear materials. Similar investigations on the mechanism of transport of cell electrolytes. Continuing study of the modifying effects of infrared and ultraviolet radiation singly and in combination with ionizing radiation. Applications of paramagnetic and nuclear magnetic resonance methods to the study of biological systems. Establishment of satisfactory methods for precise fast neutron exposures and precise radiobiological studies with fast neutrons.

13. RELATED PROJECTS

Work in cooperation with the University of Virginia and the Mountain Lake Biological Station summer courses. Collaboration with Operation Upshot/Knothole on problems of dosimetry and in Cytogenetics. Cooperative work on problems in radiological physics with various groups in the Biology Division, particularly Mammalian Genetics and Experimental Pathology. Participation in ultraviolet irradiation experiments with the Cytogenetics group. Supporting work for ANP project. Cooperation with U. S. Department of Agriculture, Kerrville, Texas.

14. ACCOMPLISHMENTS LAST YEAR

Demonstration that desoxyribonucleic acid is more highly polymerized than previously thought and is extremely sensitive to doses of ionizing radiation in the range injurious to man. Determination of ultraviolet induced chromosome breakage in Tradescantia pollen as a function of wavelength, intensity, and dosage. Demonstration that the effects of equal doses of fast neutrons from a cyclotron source and those produced under burst conditions in a nuclear detonation are not widely different for chromosome breakage in Tradescantia. Continuation of studies of radiation produced disturbance of selective electrolyte accumulation by cells and tissues. Observation of the iodine metabolism of the terrestrial salamander Aneides anaeus. Development of a technique for the autoradiographic detection of lithium in tissues and its preliminary application to the study of lithium disturbance in amphibian embryos. Quantitative observation of the rate and amount of penetration of lithium into amphibian embryos and its relationship to intracellular sodium potassium movements.

Publications: Studies on Isolated Cell Components VI. The Effects of Nucleases and Proteases on Rat Liver Nuclei; On the Nuclear Envelope; Degree of Polymerization of Deoxyribonucleic Acid; The Estimation of Choline Esters by Ion Exchange; A Mathematical Derivation of the Exchange of Labeled Substances between a Liquid Flowing in a Vessel and an External Compartment; Mathematical Considerations of Indicator Dilution Techniques; The Effect of Fast Neutrons from a Nuclear Detonation on Chromosome Breakage in Tradescantia; A Study of Regenerates Emanating from Limb Transplants with Reversed Proximodistal Polarity in the Adult Newt.

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15. EXPECTED RESULTS THIS YEAR

Completion of studies on methods for isolating cell nuclei. Development of techniques for extracting and characterizing nuclear proteins. Demonstration of the probable mechanism of chromosomal condensation. Determination of precise aberration frequencies in Tradescantia exposed to accurately determined fluxes of monoenergetic fast neutrons. Completion of quantitative studies on the production of chromosome aberration by ultraviolet radiation. Determination of the time/intensity relations for x-ray induced chromosomal aberration in Tradescantia pollen. Observation of free radicals in biological systems.

16. ANTICIPATED PROBLEMS NEXT YEAR

Study of free radical mechanisms and polymerization processes in simple systems of biological importance. Further studies aimed at understanding the physics of pollen germination. Study of intracellular movements of various substances using special biophysical techniques for visualizing ultraviolet and infrared absorbing substances. Investigation of the binding of electrolytes by cell constituents, and the effects of metabolic inhibitors thereon. Study of molecular structure by means of nuclear magnetic resonance experiments. Development of an integrated approach to cell division using a number of model systems. Further work on fast neutron effects.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 147,000	$ 156,000	$ 156,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	147,000	156,000	156,000
18. PLANT AND EQUIPMENT COSTS CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
Biophysics Laboratories	18,000		
TOTAL CONSTRUCTION	18,000		
B. MAJOR EQUIPMENT ITEMS			
Centrifuge	3,500		
Misc. Lab. Equipment		3,000	3,000
TOTAL EQUIPMENT	3,500	3,000	3,000
TOTAL CONSTRUCTION AND EQUIPMENT	21,500	3,000	3,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	9.0	8.0	8.0
B. TECHNICIANS			
SUBTOTAL	9.0	8.0	8.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	9.0	8.0	8.0

20. COMMENTS

*Detailed in comments.

1134585

AEC-189

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Plant Biochemistry			2. DATE March 15, 1954
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. 6400	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)

This project deals with the biochemistry of plant metabolism and the effects of radiation on plant developmental processes in coordination with similar work on animal metabolism. The same biochemical principles for plants and animals are involved in both growth and radiation sensitivity and certain problems are more conveniently studied with plants. Plant processes of growth, metabolism, and photosynthesis are being studied by tracer techniques combined with chromatography and respiratory measurements. In turn, 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.

13. RELATED PROJECTS

In cooperation with the Pathology and Physiology group: An extensive project on chromatographic analysis of urine samples of mice before and after irradiation to detect changes in its chemical composition might help explain the effect of radiation on metabolism. In cooperation with the University of Tennessee: An investigation on mineral transport in plants.

14. ACCOMPLISHMENTS LAST YEAR

In FY 1954 the group has developed a technique for obtaining cell-free photosynthesis with protoplasm extruded from very large plant cells. With this material it is possible to conduct a more direct biochemical and enzymatic investigation on the nature of this important process. At the same time, using whole plants, the group has contributed data on the metabolism of sugars through a new alternate metabolic pathway which is important in both plant and animal metabolism and in photosynthesis. Another project, concerned with methods for separating phosphate containing plant constituents, has resulted in the recognition of many previously unknown organic phosphate compounds in plants.

Studies on the physiological effects of radiation on plants have been started by exposing algae to ultraviolet light after which changes in their metabolism are detected by the products formed from substrates labeled with radioactive carbon and analyzed by paper chromatography.

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14. ACCOMPLISHMENTS LAST YEAR Continued

In press: Photosynthesis in Protoplasm Extruded from Chara and Nitella describes cell-free photosynthesis. Isolation of Carbon-14-Labelled Sedoheptulose and Other Products from Sedum Spectabile describes the isolation of labelled substrates for metabolism studies. Metabolism of Sedoheptulose in Plant Leaves contributes to the elucidation of the path of carbon in sugar metabolism and photosynthesis. The Action of Acid on 2,7-anhydro-β-D-altro-heptulose contributes basic knowledge to the chemistry of seven carbon sugars.

15. EXPECTED RESULTS THIS YEAR

In FY 1955 the group will continue its study of basic plant biochemistry and changes in these processes after irradiation. It is anticipated that with a cell-free protoplasm system, capable of photosynthesis, a detailed investigation of enzymes involved can be started. In addition, the chemistry of carbon dioxide fixation in photosynthesis is being investigated with whole plants. The path of carbon in photosynthesis, which is related to sedoheptulose metabolism, discussed in FY 54 publications, has developed so rapidly that in FY 55 effort on this project will begin to shift to the biochemistry of growth, both normal and after irradiation. With the development of chromatographic methods for analysis of organic phosphate esters in the cell, identification and function of some of the new compounds will be sought. A study of the effect of ultraviolet light on algal metabolism will be continued and enlarged to include photosynthesis. These results will be compared to those of a similar study to be done with ionizing radiation.

Chromatographic analysis of the constituents of urine before and after irradiation of mice or rats is a large project which will utilize techniques and biochemical procedures developed in the past year. At present this project is an exploratory one.

16. ANTICIPATED PROBLEMS NEXT YEAR

Studies on plant biochemistry will be continued. Investigation of the chemical steps in photosynthetic carbon dioxide fixation should progress so that the enzymes involved can be studied in greater detail. The work will be coordinated with parallel experiments on irradiated material and any leads on the biochemistry of radiation damage will be pursued. Likewise work on other fundamental biochemistry projects dealing with growth of cells will be continued at the level of enzymes and substrates involved. The radiation sensitivity and radiation effects upon these processes will be investigated. Tracer techniques used in metabolism studies will be applied to other projects in the Division, wherever possible. For example, the chromatographic analysis of urine of animals after irradiation may develop into a large project.

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AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 60,000	$ 75,000	$ 75,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	60,000	75,000	75,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	1,500	1,000	1,000
TOTAL EQUIPMENT	1,500	1,000	1,000
TOTAL CONSTRUCTION AND EQUIPMENT	1,500	1,000	1,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.4	4.0	4.0
B. TECHNICIANS			
SUBTOTAL	3.4	4.0	4.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	3.4	4.0	4.0

20. COMMENTS

*Detailed in comments.

1134588

AEC-189

PROPOSAL AND AUTHORIZATION
FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE			2. DATE
Enzymology and Photosynthesis			March 15, 1954
3. CONTRACTOR - LABORATORY	4. WORKING LOCATION		5. CONTRACT NO.
C&CCD - UC&CC ORNL	Oak Ridge, Tennessee		W-7405-Eng-26
6. BUDGET ACTIVITY NO. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Monthly 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)

The alterations in patterns of formate metabolism in bone marrow and in chick embryos brought about by radiation and by radiomimetic agents are being studied. Bone marrow has proven to be rather sensitive to radiation in vitro while chick embryo provides a material which "labels" with C^{14} formate very rapidly. In addition to the studies with surviving tissue, enzyme systems and isolated enzymes related to nucleic acid metabolism are also the subjects of investigation.

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 reactions that take place after light absorption by chlorophyll. In cooperation with Dr. Strehler, 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.

13. RELATED PROJECTS

Purine and pyrimidine anti-metabolites as anti-cancer agents. Development of highly sensitive enzyme and substrate assays by means of luminescent systems.

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.

14. ACCOMPLISHMENTS LAST YEAR

Publications: Studies on the effects of irradiation on bone marrow in vitro. The utilization of formate in thymine formation by bone marrow cell suspensions. Evidence that molybdenum is a non-dialyzable component of xanthine oxidase (in cooperation with the UT-AEC Agricultural Research Program). In press: Incorporation of isotopic formate into the thymine of bone marrow deoxyribonucleic acid. Antimetabolite studies on bone marrow in vitro. Determination of ATP and related compounds (in collaboration with B. L. Strehler, Biochemistry Group). (Above formerly in Radiation Protection Group)

(1) The determination of the emission spectrum of the delayed light from green plants has been finished and submitted for publication; (2) Both the action spectrum and the emission spectrum of the delayed light has been measured for blue-green algae and purple bacteria; (3) Measurements made on the polarization

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14. ACCOMPLISHMENTS LAST YEAR continued

of the fluorescent light from green plants show that the energy absorbed by chlorophyll is transferred from one chlorophyll molecule to another a large number of times before the process of photosynthesis takes place; (4) We have shown that the substance and state responsible for the delayed light can be "frozen in" by liquid nitrogen — the delayed light being produced hours later upon warming the plants to room temperature.

15. EXPECTED RESULTS THIS YEAR

It should be possible to separate and identify several of the compounds into which Carbon^{14} is incorporated shortly after exposure of surviving tissue to C^{14} formate. This is essential for interpretation of the differences in labelling under different conditions (irradiation, purine and pyrimidine blocking agents) which have already been visualized by means of radioautographs of paper chromatograms of extracts from the tissues being studied.

We expect to establish more clearly the connection between the delayed light and the process of photosynthesis.

16. ANTICIPATED PROBLEMS NEXT YEAR

It will be necessary to extend techniques which have been developed to the investigation of other biological material than bone marrow and chick embryos. Further, additional C^{14} compounds should be tested as possible indicators of radiation-produced alterations in enzyme reactions and metabolic patterns. It is hoped that advantage can be taken of the material which has already been extensively examined here in other groups by cytological techniques.

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.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 38,000	$ 95,000	$ 95,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	38,000	95,000	95,000
18. PLANT AND EQUIPMENT COSTS CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Centrifuge	1,000		
Misc. Lab. Equipment		1,000	1,000
TOTAL EQUIPMENT	1,000	1,000	1,000
TOTAL CONSTRUCTION AND EQUIPMENT	1,000	1,000	1,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	2.0	6.0	6.0
B. TECHNICIANS			
SUBTOTAL	2.0	6.0	6.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	2.0	6.0	6.0

20. COMMENTS

*Detailed in comments.

1134591

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Pathology and Physiology			2. DATE March 15, 1954
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. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual reports and open lit. publ.
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)

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.

B. To explore the causes of massive irradiation death, with a view toward developing means of protection.

C. To investigate differences in the biological effectiveness of the various types of ionizing radiations, such as neutrons and gamma rays.

D. To study the incorporation of radioactive substances into the body and the detrimental results thereof.

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

Publications: Quantitative Relationship between Thyroid Function and Growth of Pituitary Tumors Secreting TSH; Conditioned and Autonomous Neoplasms; Effect of Thyroid Hormone on Growth of Thyrotrophin-Secreting Pituitary Tumors; ACTH Secreting Transplantable Pituitary Tumors; Induction of Pituitary Tumors by Means of Ionizing Irradiation; The Effects of Cortisone on the Development of Spontaneous Leukemia in Mice and on its Induction by Irradiation; Depigmentation of Hair as a Biological Radiation Dosimeter; Morphologic Changes Associated with Thyrotrophin-Secreting Pituitary Tumors; Histopathologic and Carcinogenic Effects of Ionizing Irradiation; Biological Iron Storage Compounds. I. Uptake and Storage of Radioactive Iron by Mouse Liver.

Other recently completed work in some major areas of research will be presented in April before the Federated Societies.

15. EXPECTED RESULTS THIS YEAR

Completion of analysis of the long term effects of atomic bomb irradiation in mice ("Operation Greenhouse").

Completion of the study of effects of thermal neutron irradiation on the induction of various types of leukemia, tumors, cataract, other diseases, and on longevity in mice.

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15. EXPECTED RESULTS THIS YEAR Continued

Elucidation of some of the aspects of the mechanism of the induction of leukemia and other neoplasia caused by irradiation.

Knowledge of the pathogenesis of radiation-induced permeability of connective tissue and blood vessels.

Study of the role of blood platelets in the metabolism of blood vessels and connective tissue.

Data on biological effects of neutron and gamma radiation in mammals, as needed to support the ANP Project.

16. ANTICIPATED PROBLEMS NEXT YEAR

Analysis of the induction of cataract, leukemia (various types including myeloid), and other neoplasia 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.

Investigations 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.

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AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 230,000	$ 220,000	$ 220,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	230,000	220,000	220,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	1,500	1,500	1,500
TOTAL EQUIPMENT	1,500	1,500	1,500
TOTAL CONSTRUCTION AND EQUIPMENT	1,500	1,500	1,500
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	7.2	7.0	7.0
B. TECHNICIANS			
SUBTOTAL	7.2	7.0	7.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	7.2	7.0	7.0

20. COMMENTS

*Detailed in comments.

1134594

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Research Participation and Traveling Lecture Program - Biology			2. DATE March 15, 1954
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. 6400	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)

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.

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.

13. RELATED PROJECTS

Research Participation and Traveling Lecture Programs in AEC Program 5000.

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.

14. ACCOMPLISHMENTS LAST YEAR

Under the Research Participation Program, fifty faculty members of thirty universities spent periods of at least three months at the Laboratory. Of these, twelve 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.

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Under the Traveling Lecture Program, lectures before advanced groups continued with more than two hundred lectures scheduled during FY 1954, approximately fifty in the field of biology.

15. EXPECTED RESULTS THIS YEAR

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. 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 1956 and to pursue the long-range objectives set forth above.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 52,000	$ 52,000	$ 52,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	52,000	52,000	52,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	4.5	3.8	3.8
B. TECHNICIANS			
SUBTOTAL			
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	4.5	3.8	3.8
20. COMMENTS			

*Detailed in comments.

1134597

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Mathematics and Computation - Biology			2. DATE March 15, 1954
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. 6400	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual 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)

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 experimental procedures so that one ultimately realizes a maximum amount 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.

13. RELATED PROJECTS

This work frequently merges with Mathematics and Computations for Health Physics and for Physical and Chemical Research, inasmuch as the techniques are often identical.

14. ACCOMPLISHMENTS LAST YEAR

Statistical consultations and computations were maintained at the previous level although there was a marked increase in problems involving mathematical biology. Biological data from the radiation genetics groups continued to be the main source of computations. Both biological and physical data from nuclear detonation experiments required a substantial amount of analysis. Experimental studies which required the construction of mathematical models included the investigation of radiation effects on the rate of formation of erythrocytes in bone marrow, the role of hydrogen peroxide in radiation damage in *Paramecia*, and survival curves of *Paramecia* exposed to X-radiation.

15. EXPECTED RESULTS THIS YEAR

No particular change in consultations and computations is foreseen during this year.

16. ANTICIPATED PROBLEMS NEXT YEAR

Dependent on over-all biological program.

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1134598

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 40,000	$ 40,000	$ 40,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	40,000	40,000	40,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.0	3.0	3.0
B. TECHNICIANS			
SUBTOTAL			
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	3.0	3.0	3.0

20. COMMENTS

*Detailed in comments.

1134599

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Cooperative ORNL-AF Biological Research - Phase III*			2. DATE March 15, 1954
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. 4401.7	7. BUDGET ITEM NO.	8. SECURITY CLASS Secret	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	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

*While this activity is supported by Program 4000 funds, it is the program and administrative responsibility of Program 6000. Therefore, the narrative material is included here as memo information only and not to reflect a budget proposal for Program 6000.

To determine the deleterious effects on mammals of exposure to relatively low doses of neutrons and gamma rays, such as might result from operation and maintenance of a nuclear-powered aircraft, and to investigate the mechanism of these injuries.

To determine the relative effectiveness of neutron and gamma radiations for all vital parameters, taking into consideration such variables as total dose, dose rate, recovery interval between successive doses, timing of fractional doses, and mixtures of neutrons and gamma rays.

Extrapolation of data from animal studies to humans insofar as possible to help guide the ANP program.

13. RELATED PROJECTS

Correlated radiobiological studies of the Pathology-Physiology Section.

14. ACCOMPLISHMENTS LAST YEAR

Orientation experiments with cyclotron fast neutrons on acute lethality and cataract induction with tentative values for the RBE of fast neutrons for these effects.

Development of a technique for measuring radioiron uptake by mouse erythrocytes, to provide a sensitive indicator of bone marrow injury.

Studies of neutron dosimetry in the cyclotron; intercomparison of several different systems of neutron dose measurement and depth dose determinations in phantoms.

15. EXPECTED RESULTS THIS YEAR

Completion of orientation experiments and dosimetry studies.

Determination of the RBE of fast neutrons (single exposure) for erythropoietic depression in mice, as measured by erythrocyte uptake of radioiron.

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15. EXPECTED RESULTS THIS YEAR Continued

Commencement of life span studies in mice exposed to single and fractionated doses of fast neutrons and gamma rays.

Investigation of the RBE of neutrons for cataract induction in rats and guinea pigs.

16. ANTICIPATED PROBLEMS NEXT YEAR

Continuation of the investigation of delayed effects in mice (cataract, sterility, longevity, leukemia, and other neoplasia) after acute and chronic exposure to neutrons and gamma rays.

Studies of the RBE of fast neutrons as modified by dose rate, fractionation of dose, interval between successive doses, and admixture of gamma rays.

Study of the RBE of neutrons in larger mammals for selected parameters, such as cataract, acute lethality, fertility, etc.

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 30,000	$ 30,000	$ 30,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	30,000	30,000	30,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	1.0	1.0	1.0
B. TECHNICIANS			
SUBTOTAL	1.0	1.0	1.0
C. OTHER TECHNICAL, LOANEES, ETC. (U.S. Air Force)	1.0	2.0	2.0
TOTAL	2.0	3.0	3.0
20. COMMENTS			

*Detailed in comments.

1134602

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Biophysics (Summary)			2. DATE March 15, 1954
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. 6500	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) K. Z. Morgan		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The primary responsibility of the Health Physics Research Program at the ORNL is to support the protection of Laboratory personnel from radiation hazards that are or may be produced by the Laboratory.

A secondary responsibility which is growing with each year is to engage in specialized research and development at the request of the Atomic Energy Commission on problems not necessarily associated with Laboratory operations and to develop for the Commission and other Government agencies specialized technical information for application in the public interest.

The overall objectives of this program and proposed methods for obtaining them do not change materially from year to year and the major aspects of the applied research in Physics, Chemistry, Biology, and Engineering which is conducted by the Division to meet the above responsibilities are as follows:

A. Maximum Permissible Exposure and Tissue Dose Problems:

The organization and extension of information that will aid in the establishment of more reliable permissible levels of radiation exposure and of radioactive contamination.

B. Instrument Adaptation:

The development and adaptation of better instrumentation in problems of radiation measurement of special interest in health physics.

C. Waste Disposal and Water Decontamination:

The development and appraisal of procedures for the control and disposal of radioactive wastes.

D. General Physical, Chemical, Biological, and Engineering Problems:

The determination and organization of physical, chemical, biological and engineering data needed to further the objectives listed above.

E. Education and Training:

The conduct of an educational program to train health physicists to meet the increasing demand for such trained personnel and to pass on to other groups certain fundamental information about radiation protection.

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13. RELATED PROJECTS

A. AEC-TVA Ecological Study of White Oak Lake. (TVA has completed its participation and has submitted a final report.)

B. U. S. Public Health Service Program (jointly with ORNL) of research on water decontamination and radioactive liquid waste disposal.

C. Cooperative program of TVA to define conditions in Tennessee River System influenced by ORNL operations.

D. Engineer Research and Development Laboratories, U. S. Corps of Engineers - evaluation of water decontamination equipment and processes for military use.

E. Operations Division, ORNL - disposal of liquid radioactive wastes.

F. Shielding Group - Physics Division - ORNL.

G. Applied Health Physics Program, ORNL.

H. Cooperative Geological Survey Program.

I. University of Pittsburgh (for U. S. Navy) - development and evaluation of sampling methods for airborne radioactivity.

J. Subcommittees on Internal Dose of the National Committee on Radiation Protection and of the International Commission on Radiological Protection.

K. Cooperative program with the Chemical Corps in the study of radioactive particles.

L. AEC Fellowship Program - under administration of the Oak Ridge Institute of Nuclear Studies.

M. Educational Relations and Training Division, ORNL.

14. ACCOMPLISHMENTS LAST YEAR

A. Maximum Permissible Exposure and Tissue Dose Problems:

Further development of the tissue ashing methods has improved sensitivity, accuracy, and speed of handling samples. The Health Physics Division is now equipped to handle a large number of tissue samples per year.

A new method of analysis of radio-strontium in urine has been developed. It is shorter and more efficient than that previously used.

A publication for the Subcommittee on Permissible Dose for Internal Radiation of the International Commission on Radiological Protection entitled "Maximum Permissible Internal Dose" has been prepared.

14. ACCOMPLISHMENTS LAST YEAR Continued

B. Instrument Adaptation:

A new packet for Nuclear Track Film has been developed such that the track count is a measure of fast neutron tissue dose.

A new method of measuring fast neutron tissue dose with fission and activation threshold detector has been developed.

A small 250 kv accelerator has been completed and put into reliable operation. Studies will be made of the details of energy loss in matter by charged particles.

A large solenoidal beta spectrograph has been completed, installed, and operated reliably. Studies will be made of energy loss in the range from a few hundred kilovolts to 3 Mev.

C. Waste Disposal and Water Decontamination:

(a) During the past 20 months, 321,000 gallons of liquid wastes containing 9,700 curies of radioactive materials (principally Cs and Ru) were placed in a waste storage pit. Periodic examinations of test wells has disclosed that Ru was passing through at least 80 feet of soil. The USGS cooperated in obtaining data relative to ground water exploration and movement.

(b) Certain cooperative water decontamination studies by ORNL, USPHS, and ERDL including efficacy of coagulation, water softening, phosphate precipitation, clay additions, ion exchange, perm-selective membranes, distillation, portable field filtration units, and metallic dusts have been completed and reported. (Corps of Engineers, ERDL No. 1275 (24 Dec. 1952), ERDL No. 1313 (28 Aug. 1953), ERDL No. *____ (24 Feb. 1954). *No. unassigned.

(c) Three pilot scale units for removal of radioactive materials from ORNL process waste streams have been installed and operated. Results provided information on design of full scale treatment units.

(d) In cooperation with the TVA a resurvey of radioactive materials contained in bottom sediments of the Clinch and Tennessee Rivers to Chattanooga was made and reported (joint TVA-ORNL report, not released), and a detailed analysis of data on stream flows, water storage and time of water travel downstream from ORNL has been completed. (Two special reports: "Effect of Accidental Spillage of Radioactive Waste into Clinch River" (Reports Nos. 1 and 2) by Division of Water Control Planning, Hydraulic Data Branch to the Division of Health and Safety, TVA, November 10, 1952, unpublished.)

(e) Preliminary and exploratory work relative to the disposal of liquid wastes from nuclear power reactors has included:

1. Laboratory soil column studies.
2. Characterization of wastes.
3. Classification of nuclides according to hazard.

1134605

14. ACCOMPLISHMENTS LAST YEAR Continued

4. Installation of two experimental pits (28 ft. diameter x 5 ft. deep and several auger holes (3 ft. diameter x 20 ft. deep).

(f) Instrumentation included the development and/or modification of the following:

1. Underwater sediment scanner.
2. Portable probe and well-logging instruments for use with test pits or test wells.
3. Four monitoring units for use with pilot scale facilities listed under item (c).

D. General Physical, Chemical, Biological, and Engineering Problems:

The scattering of gamma rays and neutrons from concrete and other substances has been studied. This project will provide important corrections to dosimeter calculations and will provide design data for neutron facilities.

An exhaustive study of the W values in mixed gases has been made. The results are published in the April 15, 1954 Physical Review. Ionization produced in pure argon by alpha particles (April 1, 1954, Physical Review).

E. 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 to ORNL apprentice trainees and Applied Health Physics Division personnel. Numerous lectures were given throughout the year at universities, hospitals, the local Laboratory, ORINS seminars and professional meetings.

15. EXPECTED RESULTS THIS YEAR

A. Maximum Permissible Exposure and Tissue Dose Problems:

Sufficient data on the concentration of trace elements in human tissue should be accumulated to give substantial aid to the establishment of maximum permissible internal dose.

Substantial progress should be made in developing techniques for analysis of cesium and ruthenium in body fluids. Calculations of the dose at various points within spheres and cylinders of various diameters for both fast and thermal neutrons will be completed.

Calculations of the stopping power for slow charged particles will continue.

B. Instrument Adaptation:

Further development of fission and activation detector dosimetry.

15. EXPECTED RESULTS THIS YEAR Continued

Further development of the proportional counter neutron dosimeter.

Development of scintillation detector for use in measuring directly the radioelement content in man and small animals.

Development will be started on a slow neutron dosimeter.

C. Waste Disposal and Water Decontamination:

(a) Determine form of Ru passing through soil and methods for containing it in pit if possible.

(b) Continue or complete water decontamination studies in cooperation with ERDL.

(c) As required, continue pilot scale process unit experiments to confirm specific design criteria.

(d) Continue collaboration with TVA relative to movement of waters and dispersion of radioactive contamination.

(e) Continue and extend laboratory and field investigations relative to the wastes produced in the operation of nuclear power reactors.

1. Develop instrumentation for the monitoring of soil and water.
2. Evaluate experimental pits and barriers for the disposal of radioactive liquid waste.
3. Determine sites for two ORNL pits.
4. Determine the critical nuclides in soils.

D. General Physical, Chemical, Biological, and Engineering Problems:

Work on the ionization of gases by charged particles will be continued. In particular the ionization of water vapor by alpha particles will be measured.

Electron drift and attachment coefficients will be measured in particular in N_2 - A mixtures.

Calculations of the stopping power of a fast charged particle in a degenerate Fermi gas will be made.

E. Education and Training:

Activities in the field of Health Physics Education and Training will continue at the same relative level as FY 1954.

16. ANTICIPATED PROBLEMS NEXT YEAR

A. Maximum Permissible Exposure and Tissue Dose Problems:

Efforts of the Health Physics Division will be continued toward better evaluation of maximum permissible dose and exposure problems. Continued improvement in the understanding of these problems is needed in order that proper protection may be obtained without undue cost.

B. Instrument Adaptation:

The Program is expected to continue in the development and improvement of radiation detection instruments and their application to problems such as personnel dosimetry, control of radioactive wastes and research in the fundamental physics of the interaction of ionizing radiations with matter. A continuation of requests from outside the Laboratory for the development and adaptation of instrumentation and techniques to meet new problems in radiation protection is anticipated.

C. Waste Disposal and Water Decontamination:

(a) Continue collaboration with TVA relative to movement of waters and dispersion of radioactive contamination.

(b) Complete site determinations in the Oak Ridge exclusion area for the location of additional waste disposal pits.

(c) Continue the evaluation of experimental waste disposal pits.

(d) Continue the development of instrumentation required for these studies.

(e) Initiate a survey of soils in the Mississippi Valley and the Appalachian areas for possible locations of power reactor sites.

D. General Physical, Chemical, Biological, and Engineering Problems:

Gamma ray attenuation studies and investigation of properties of ion collection in gases will continue. Studies of air monitoring and particulate removal in connection with an evaluation of AEC air monitoring and sampling methods will be conducted. Additional physical, chemical, and biological data will be developed to throw more light upon the mechanisms and meaning of radiation dose and radiation damage.

E. Education and Training

Education and Training activities will be expanded to meet the increased needs of the nuclear energy field.

Page Number	Description	FY 1954 Program Cost	FY 1954 Total M-Yrs. ORNL Personnel	FY 1955 Program Cost	FY 1955 Total M-Yrs. ORNL Personnel	FY 1956 Program Cost	FY 1956 Total M-Yrs. ORNL Personnel
61	Radiation Dose	112,000	4.8	77,000	3.6	77,000	3.6
66	Radioactive Liquid Waste - Enviornmental Problems Assoc. with Power Reactor Program	124,000	5.8	113,000	4.5	113,000	4.5
71	Theoretical Physics	45,000	2.3	45,000	2.3	45,000	2.3
73	Physics of Nuclear Radiations	152,000	4.7	149,000	5.0	149,000	5.0
77	Internal Dose-Physics Unit	22,000	-	23,000	-	23,000	-
80	Radiochemical Analysis	19,000	1.0	19,000	1.0	19,000	1.0
82	Nuclear Power Reactors - Effects of Effluents on the Enviornment	15,000	.8	63,000	2.8	126,000	5.6
85	Math and Comp. - Health Physics	25,000	1.5	40,000	1.5	40,000	1.5
	Total 6510	514,000	20.9	529,000	20.7	592,000	23.5
88	Experimental Radia. Measurements	76,000	3.8	79,000	4.0	79,000	4.0
91	Nuclear Power Reactors - Air-borne Hazard and Control	71,000	3.0	75,000	3.2	75,000	3.2
	Total 6520	147,000	6.8	154,000	7.2	154,000	7.2
94	Consultation and Special Prob.	19,000	1.0				
96	Research Participation and Traveling Lecture Program - Biophysics	18,000	1.5	15,000	1.1	15,000	1.1
	Total 6530	37,000	2.5	15,000	1.1	15,000	1.1
	Total 6500	698,000	30.2	698,000	29.0	761,000	31.8

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Radiation Dose			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Reports, Memoranda
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) H. H. Hubbell		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The long range objective of this section is to study the physical processes by which ionizing radiations lose energy, and to design instruments to measure the resulting dose. In order to determine correctly the dose of radiation received by living organisms, especially man, it is essential to know how alpha, beta, gamma, neutron, and x-radiation expend their energy in materials, especially tissue, and what damage they do to the physical, chemical and biological structure of the materials. To measure the dose it is necessary to know how the radiations expend energy in physical instruments, and the relation of the readings of these instruments to tissue damage from the same radiation.

Biological and physical data are combined in the calculation of Maximum Permissible Exposures of persons to various radiations, and Maximum Permissible Concentrations of various radioisotopes in air, drinking water, and food. These values are then submitted for study to the Subcommittee on Internal Dose of the National Committee on Radiation Protection.

13. RELATED PROJECTS

Applied Health Physics, cooperation and advice to instrument manufacturers.

The Physics Department of the University of Tennessee has a contract for determination of concentrations of various elements in different organs of the human body. (See Internal Dose - Physics Unit.)

A member of the Division is a Member of the Main Commission, and Chairman of the Subcommittee II on Permissible Dose for Internal Radiation, of the International Commission on Radiological Protection.

A member of the Division is a Member of the Subcommittee V on Handling of of Radioisotopes and the Disposal of Radioactive Waste of the International Commission on Radiological Protection.

A member of the Division is a Member of the National Committee on Radiation Protection, and Chairman of the Subcommittee on Permissible Internal Dose of the National Committee on Radiation Protection.

A member of the Division represents the Laboratory on the Subcommittee on Shipment of Radioactive Substances of the National Research Council.

A member of the Division represents the Laboratory on the Subcommittee on Instruments and Techniques of the National Research Council.

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13. RELATED PROJECTS Continued

A member of the Division represents the Laboratory on the Panel for Glossary of Nuclear Energy Terms of the National Research Council.

A member of the Division represents the Laboratory on the Board of American Industrial Hygiene Association.

A member of the Division represents the Laboratory on the Subcommittee on Radium Dust, Radon Gas and Gamma Ray Exposure of the American Standards Association.

A member of the Division represents the Laboratory on the Subcommittee PH2-7 on X-Ray Film Sensitometry of the American Standards Association.

14. ACCOMPLISHMENTS LAST YEAR

A. Neutron Dosimetry:

A new packet for Nuclear Track Film was developed with the cooperation of Eastman Kodak Company, and designed and tested at ORNL. This packet makes the track count on the film a true measure of fast neutron dose within 10 percent up to 10 Mev neutrons. This work will be described in an early issue of NUCLEONICS.

B. Personnel Dosimetry:

A method of interpretation was developed from extensive calibration exposures for determining the radiation dose as measured by the new ORNL film badge. The method permits considerably higher accuracy in determinations of low voltage x- or gamma radiation doses than the old badge, and as good or better accuracy for radium or beta ray exposures.

C. Accelerator:

The accelerator operates reliably. An electrostatic analyzer was added, then several additional slits, and an entirely new electron gun system. Resolution can now be obtained with a spread of about 2 ev in 45 kev, or about 50 parts per million. This energy resolution is less than that which preliminary experiments had indicated it might give, but is still adequate for the purpose. Aluminum foils placed in the beam show a characteristic energy loss of 15.6 ev in agreement with the plasma oscillation theory of Pines and Bohm as applied to metals. Considerable data has been accumulated on this effect at various energies and foil thicknesses.

D. The method of using ionizing radiation to change directly the controlling capacitance and hence the frequency of a radio-frequency oscillator was improved and increased in sensitivity by the use of ferroelectric materials. Dosages in the range of interest in health physics can now be measured. Very high doses of thermal neutrons were detected by changes in the oscillation frequency of a boron-containing crystal.

14. ACCOMPLISHMENTS LAST YEAR Continued

E. Beta Spectrograph:

Assembly was completed on the large solenoidal beta spectrograph, and the controls were designed and installed. Successful preliminary tests showed reliable, automatic operation of the instrument with a resolution of 0.6 percent. Considerable data should have been accumulated by the end of FY 54 on the energy losses and straggling in various foils for beta particles with energies between a few hundred kev and 3 Mev.

F. Permissible Internal Dose:

A Report of the Subcommittee on Permissible Dose for Internal Radiation of the International Commission on Radiological Protection has been prepared for publication.

15. EXPECTED RESULTS THIS YEAR

A. Personnel Dosimetry:

Cooperation with the Applied Health Physics Section will be continued. Studies on the energy dependence of several health physics instruments are contemplated.

B. Accelerator:

The study will be continued of the characteristic energies lost by electrons incident on metal foils with energies up to 125 kev. Such losses to characteristic oscillation frequencies of the electron plasma in metals, and to excitation and ionization processes, may lead, it is hoped, to a better understanding of how ionizing radiations lose energy and the damage they do. Such understanding is essential in dose calculations. Similar measurements are planned with ions instead of electrons, and with both ions and electrons bombarding gaseous targets.

C. The work of Neufeld and Snyder has shown that an appreciable fraction of the energy dissipated by fast neutrons is expended in the production of atomic displacements. It is planned to study this experimentally. This work is related to radiation damage in solids. These experiments will be coordinated with the Solid State Division.

D. Beta Spectrograph:

Measurements of energy losses of electrons of the type mentioned under "Accelerator" will be extended to energies up to about 2.3 Mev with the beta spectrograph, but with lower resolution than the accelerator permits. The emphasis will be on determination of straggling and stopping power for electrons in metals, and in molecular compounds, especially materials resembling tissue in elemental composition. This study is expected to be extended to include the dependence of energy losses on angle of emergence from the absorber, and to losses in thick

15. EXPECTED RESULTS THIS YEAR Continued

absorbers. The instrument may also be used to measure atomic internal conversion coefficients, and continuous beta ray spectra in cases of especial interest to health physics.

E. Permissible Internal Dose:

Revision of Bureau of Standards Handbook 52 to include various parts of the gastro-intestinal tract as a critical tissue and lay the foundation for establishment of permissible levels for single exposure.

16. ANTICIPATED PROBLEMS NEXT YEAR

The long range problems discussed above are expected to continue, and it is anticipated that these will lead to further problems in the fundamental understanding of the action of radiation on tissue and the measurement of doses received.

1134613

AEC-189 (Back Page Revised)

	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 112,000	$ 77,000	$ 77,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	112,000	77,000	77,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Beta Spectrometer	8,000		
Misc. Lab. Equipment	2,000	6,000	6,000
TOTAL EQUIPMENT	10,000	6,000	6,000
TOTAL CONSTRUCTION AND EQUIPMENT	10,000	6,000	6,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	4.8	3.6	3.6
B. TECHNICIANS			
SUBTOTAL	4.8	3.6	3.6
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	4.8	3.6	3.6

20. COMMENTS

*Detailed in comments.

1134614

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Radioactive Liquid Waste - Environmental Problems Associated with Power Reactor Program			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Progress, Semiannual and Topical Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) Roy J. Morton and C. P. Straub (USPHS)		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The general purpose of this program is:

A. To determine the potential hazards incidental to the release or escape of radioactive materials into surface or underground waters, into water works or drainage systems, into the soil and shallow earth strata, or into deep geological formations.

B. To define the dispersion and the behavior of radioactive contaminants in the environment and the extent and significance of the resultant hazards.

C. To evaluate the hazards and define the public health criteria that are pertinent to the disposal of radioactive liquid wastes from central station power reactor installations.

D. To develop and evaluate the most economical, safe and practicable methods possible for the disposal of radioactive liquid wastes from power reactor installations.

Developmental work and evaluation studies on liquid waste disposal methods and effects are basic for a nuclear power program and other nuclear energy developments in order that suitable design criteria may be formulated and the essential measures for protection against radiation hazards may be established.

This project is augmented by direct cooperation from other agencies and by the use of data collected at Oak Ridge or elsewhere for related purposes. During FY 1954 this program has been partially reoriented to assure that the results of its research and development studies will be applicable for the evaluation and control of environmental hazards in the handling and disposal of wastes from nuclear power installations.

13. RELATED PROJECTS

A. U. S. Public Health Service - ORNL. Integrated program of research on water decontamination, radioactive liquid waste disposal and related problems.

B. U. S. Geological Survey - AEC. A cooperative program in studies of surface and ground water conditions particularly with respect to geology, hydrology, and the characteristics of various soils, and also detailed laboratory analyses of water samples and soil materials.

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13. RELATED PROJECTS Continued

C. Tennessee Valley Authority - ORNL. Cooperative program in studies to define conditions in the Clinch River and Tennessee River systems including radioactive materials in mud deposits and the effects of water flow and dilution characteristics of TVA reservoirs.

D. Sanitary Engineering Branch, Engineer Research and Development Laboratories, U. S. Corps of Engineers. Cooperation in studies on decontamination of water and on related problems.

E. Program of Operations Division, ORNL:

1. To provide more adequate and economical liquid waste storage.

2. To provide further treatment of the process waste stream before discharge to White Oak Creek.

F. Health Physics Division - ORNL - Radioactive Liquid Waste - Engineering Problems Associated with Power Reactors. This is an integral part of the Health Physics program of radioactive liquid waste research and development.

G. ORNL Power Reactor Program. This is an integral part of the Laboratory's program.

14. ACCOMPLISHMENTS LAST YEAR

A. During the past 20 months, 321,000 gallons of liquid wastes containing 9,700 curies of radioactive materials (principally Cs and Ru) were placed in a waste storage pit. Periodic examinations of test wells has disclosed that Ru was passing through at least 80 feet of soil. The USGS cooperated in obtaining data relative to ground water exploration and movement.

B. Certain cooperative water decontamination studies by ORNL, USPHS, and ERDL including efficacy of coagulation, water softening, phosphate precipitation, clay additions, ion exchange, permselective membranes, distillation, portable field filtration units, and metallic dusts have been completed and reported. (Corps of Engineers, ERDL No. 1275 (24 Dec. 1952), ERDL No. 1313 (28 Aug. 1953), ERDL No. * (24 Feb. 1954).

C. Three pilot scale units for removal of radioactive materials from ORNL process waste streams have been installed and operated. Results provided information on design of full scale treatment units.

D. In cooperation with the TVA a resurvey of radioactive materials contained in bottom sediments of the Clinch and Tennessee Rivers to Chattanooga was made and reported (joint TVA-ORNL report, not released), and a detailed analysis of data on stream flows, water storage and time of water travel downstream from ORNL has been completed. (Two special

*Number not yet assigned.

14. ACCOMPLISHMENTS LAST YEAR Continued

reports: "Effect of Accidental Spillage of Radioactive Waste into Clinch River" (Reports Nos. 1 and 2) by Division of Water Control Planning, Hydraulic Data Branch to the Division of Health and Safety, TVA, November 10, 1952, unpublished).

E. Preliminary and exploratory work relative to the disposal of liquid wastes from nuclear power reactors has included:

1. Laboratory soil column studies.
2. Characterization of wastes.
3. Classification of nuclides according to hazard.
4. Installation of two experimental pits (28 ft. diameter x 5 ft. deep) and several auger holes (3 ft. diameter x 20 ft. deep).

F. Instrumentation included the development and/or modification of the following:

1. Underwater sediment scanner.
2. Portable probe and well-logging instruments for use with test pits or test wells.
3. Four monitoring units for use with pilot scale facilities listed under item C.

15. EXPECTED RESULTS THIS YEAR

A. Continue and extend laboratory and field investigations relative to the wastes produced in the operation of nuclear power reactors.

1. Develop instrumentation for the monitoring of soil and water.
2. Evaluate experimental pits and barriers for the disposal of radioactive liquid waste.
3. Determine sites for two ORNL pits.
4. Determine the critical nuclides in soils.

B. Determine form of Ru passing through soil and methods for containing it in pit if possible.

C. Continue collaboration with TVA relative to movement of waters and dispersion of radioactive contamination.

D. Initiate an evaluation study of deep underground disposal wells and deep ocean outfall sewers in relation to waste disposal problems of a reactor power industry.

E. As required, continue pilot scale process unit experiments to confirm specific design criteria.

F. Continue or complete water decontamination studies in cooperation with ERDL.

16. ANTICIPATED PROBLEMS NEXT YEAR

A. Complete site determinations in the Oak Ridge exclusion area for the location of additional waste disposal pits.

B. Continue the evaluation of experimental waste disposal pits.

C. Continue collaboration with TVA relative to movement of waters and dispersion of radioactive contamination.

D. Continue the evaluation study of deep underground disposal wells and deep ocean outfall sewers in relation to waste disposal problems of a reactor power industry.

E. Continue the development of instrumentation required for these studies.

F. Initiate a survey of soils in the Mississippi Valley and the Appalachian areas for possible locations of power reactor sites.

	ESTIMATED LAST FY - 1954	ESTIMATED THIS FY - 1955	ESTIMATED NEXT FY - 1956
17. NORMAL PROGRAM COSTS	$ 124,000	$ 113,000	$113,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	124,000	113,000	113,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
6-24X-5039 Process Waste Disposal Plant		180,000	
TOTAL CONSTRUCTION		180,000	
B. MAJOR EQUIPMENT ITEMS			
Waste Process Test Equipment	17,700		
Count Rate Meters	2,100		
Misc. Lab. Equipment	4,200	7,500	7,500
TOTAL EQUIPMENT	24,000	7,500	7,500
TOTAL CONSTRUCTION AND EQUIPMENT	24,000	187,500	7,500
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	4.8	3.0	3.0
B. TECHNICIANS	1.0	1.5	1.5
SUBTOTAL	5.8	4.5	4.5
C. OTHER TECHNICAL, LOANEES, ETC.	1.0(1)	2.0(2)	2.0(2)
TOTAL	6.8	6.5	6.5

20. COMMENTS

(1) Loanees, FY 1954: 1.0 M/Y (U. S. Public Health Service).

(2) Loanees, FY's 1955 and 1956: 2.0 M/Y (U. S. Public Health Service. USPHS is giving consideration to the assignment of personnel in addition to these).

*Detailed in comments.

1134619

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Theoretical Physics			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Reports, Memoranda
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) J. Neufeld		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The general aim of the section is to apply fundamental physical knowledge to the study of the interaction of radiation with matter, particularly those aspects which are important in assessing biological damage. The work is concerned with applied problems in dosimetry and shielding and with more fundamental processes dealing with interaction of charged particles and matter.

The section also provides technical advice and assistance in theoretical physics for other groups in the Health Physics Division.

13. RELATED PROJECTS

Reactor Shielding, Dosimetry.

14. ACCOMPLISHMENTS LAST YEAR

A formula for determining the stopping power of heavy ions that differs from the one derived by Bohr (1948) has been derived. The number of lattice displacements in a solid irradiated by neutrons has been calculated. The neutron spectrum at various distances from atomic bomb explosion has been calculated and compared with experimental data.

15. EXPECTED RESULTS THIS YEAR

Calculations of the stopping power of a moving charged particle in a degenerate Fermi gas will be made.

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

The stopping power for slow charged particles will be evaluated.

16. ANTICIPATED PROBLEMS NEXT YEAR

We expect to undertake the problems of:

(a) The variation of dose due to neutron and gamma rays with the geometry of the irradiated object.

(b) The density effect.

(c) Cerenkov effect.

(d) Capture and loss of electrons of charged particles moving through matter.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 45,000	$ 45,000	$ 45,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	45,000	45,000	45,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	2.3	2.3	2.3
B. TECHNICIANS			
SUBTOTAL	2.3	2.3	2.3
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	2.3	2.3	2.3
20. COMMENTS			

*Detailed in comments.

1134621

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Physics of Nuclear Radiations			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Reports, Memoranda, Topical
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) George S. Hurst		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The objective of this project is to investigate some of the fundamental physical aspects of ionizing radiations of importance to the development or radiation detection instruments and their application to the Health Physics Program. Of considerable interest is the behavior of ions in gases, a study which finds immediate application in the design and proper interpretation of data obtained from ionization chambers, proportional counters, and G-M counters.

13. RELATED PROJECTS

Dosimetry problems occur in radiobiology and in reactor shielding.

14. ACCOMPLISHMENTS LAST YEAR

A. Neutron Dosimetry with Fission and Activation Detectors:

A new system of measuring the fast neutron tissue dose was devised. (The particular applications to which it applies are those involving large "bursts" of neutrons in a short time.) Recent comparisons (using the 86" cyclotron) of this method with the proportional counter method indicate that even under the conditions imposed by field operation, neutron dose can be measured to an accuracy of approximately ± 15 percent. See ORNL-1671.

B. Neutron Dosimeters Using Proportional Counters:

The development of a "standard" proportional counter for measuring fast neutron dose has been completed and a paper describing the counter has been accepted by the British Journal of Radiology. The counter is calibrated by means of a self contained alpha source and with this device it is believed that the tissue dose can be measured to ± 5 percent without the need of a known fast neutron source.

Also completed last year was the design of a very small proportional counter such that dose rates as great as 5 reps per second can be measured. This counter has been used to calibrate the fast neutron dose at the ORNL 86" cyclotron biological exposure chamber.

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14. ACCOMPLISHMENTS LAST YEAR Continued

C. Scattering of Neutrons by a Large Concrete Slab and by Air:

Data on the scattering of Po-B neutrons by large slab of concrete and by air has been obtained. Three objectives were very successfully obtained: (1) Variation of scattering from a concrete floor as a function of height of source and detector above floor and separation of source and detector; (2) Effects of air scattering on neutron dose received at a point from the neutron source; and (3) A paraffin shadow cone was developed such that placing this between source and detector so as to cut out the direct radiation permits a direct measure of scattering from the geometry. These data permit much more accurate calibration of neutron dosimeters, and can be used in the design of neutron experimental facilities. (Thesis by a Radiological Fellow.)

D. Ionization of Gases by Charged Particles:

(a) Physical Review (April 1, 1954) Ionization produced in pure argon by alpha particles.

(b) Very exhaustive study of effects of mixtures - Physical Review (April 15, 1954).

(c) Ionization in argon - Thesis by a Radiological Fellow.

(d) Ionization of methane by heavy recoil atoms.

E. Electron Drift Velocity and Attachment Coefficient:

Apparatus completed for measuring both the drift velocity and attachment coefficient for electrons. Some useful information on drift velocity in N_2 and argon - methane mixture already obtained.

15. EXPECTED RESULTS THIS YEAR

A. Fission and Activation Detector Dosimetry:

This will be continued and probably applied to future field tests.

B. Neutron Dosimetry Using Proportional Counters:

(a) Will be applied to cyclotron and other dosimetry applications.

(b) Comparison studies will be made with other total tissue dose dosimeters.

C. Ionization of Gases by Charged Particles:

(a) Work will be continued on the effects of mixtures.

(b) Ionization of water vapor by alpha particles will be studied.

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15. EXPECTED RESULTS THIS YEAR Continued

D. Electron Drift and Attachment Coefficients:

It is expected that substantial progress will be made especially with N_2 - A mixtures.

16. ANTICIPATED PROBLEMS NEXT YEAR

A. The stopping power of several gases for heavy recoil particles will be measured.

B. Slow Neutron Dosimeter:

Such an instrument is needed for health physics and radiobiological applications. Development will be initiated.

C. Electron Drift and Attachment Coefficients:

This work is expected to continue.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 145,000	$ 149,000	$ 149,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*	7,000(1)		
TOTAL PROGRAM COST	152,000	149,000	149,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	3,000	8,000	8,000
TOTAL EQUIPMENT	3,000	8,000	8,000
TOTAL CONSTRUCTION AND EQUIPMENT	3,000	8,000	8,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	4.7	5.0	5.0
B. TECHNICIANS			
SUBTOTAL	4.7	5.0	5.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	4.7	5.0	5.0

20. COMMENTS

(1) $7,000 Special Project requested by the A.E.C.

*Detailed in comments.

1134625

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Internal Dose - Physics Unit			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Progress Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) I. H. Tipton		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

In order to calculate the maximum permissible concentrations of radioisotopes in air and in water and the maximum permissible amount in the human body under equilibrium conditions, it is necessary to know, in addition to the energy and half-life of the isotopes, the normal distribution and concentration of the elements in question in the human body. Necessary information is limited for most elements and non-existent for others.

It is desirable to analyze the tissues from a large number of individuals from as many different parts of the country as possible since the variations between individuals and with geographic locations are considerable. This information is being used in the establishment of the element distribution in the "standard man" which is used in the calculation of maximum permissible exposure to external and internal sources of ionizing radiation.

13. RELATED PROJECTS

Reactor Waste Disposal. Internal Dose Standards.

14. ACCOMPLISHMENTS LAST YEAR

The spectrographic laboratory for the analysis of human tissue in the Physics Department of the University of Tennessee analyzed 192 samples of tissue from autopsies of instantaneous accidental death by the method of visual comparison.

In order to increase the sensitivity and accuracy of determinations it was decided to change the method of tissue preparation and analysis even though the number of elements that could be analyzed by the new method was somewhat less than in the old one. The tissue sample is osterized, dryed under vacuum, and wet-ashed. Devices were built to carry out these procedures on 15 samples at one time. A method of precipitation of 24 elements using organic precipitants was worked out and a stirring apparatus built for use in the method. A new spectrographic technique employing an internal standard has been perfected. The sensitivity and accuracy of determinations have been increased up to tenfold by these changes. Analyses of 300 samples were made by the new techniques.

In order to resolve a discrepancy between the values for strontium in bone from cadavers and that found in fresh bone a special program to determine strontium in normal human bone by spectrographic methods and by neutron activation (in The Activation Analysis Section of the Analytical Chemistry Division) was started.

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15. EXPECTED RESULTS THIS YEAR

The developmental phase of the program is about completed and so analysis of large numbers of samples with widely varying background can proceed. Samples from England and from Belgian Congo in addition to those from various sections of the United States will be analyzed.

The establishment of a more reliable figure for the concentration of strontium in normal bone should result from the present program.

16. ANTICIPATED PROBLEMS NEXT YEAR

Continuing spectrographic and chemical analysis of a larger number of samples with a wider geographical distribution.

Development of additional methods for determination of elements which do not lend themselves readily to present methods.

New sources of tissue samples to be sought out and maintained.

Further use of neutron activation analysis.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS R & D SUBCONTRACTS* LARGE OR UNUSUAL ITEMS COST*	$ 22,000(1)	$ 23,000(1)	$ 23,000(1)
TOTAL PROGRAM COST	22,000	23,000	23,000
18. PLANT AND EQUIPMENT COSTS CAPITAL OUTLAY DIRECTLY REQUIRED A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS) A. SCIENTISTS & ENGINEERS B. TECHNICIANS SUBTOTAL C. OTHER TECHNICAL, LOANEES, ETC.	MAN-YEARS	MAN-YEARS	MAN-YEARS
TOTAL			

20. COMMENTS

(1) C and CCC Subcontract No. 380 with University of Tennessee Research Corporation on Spectrographic Analysis of Tissue.

*Detailed in comments.

1134628

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Radiochemical Analysis			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) L. B. Farabee		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

Internal exposure to radiations from ingested radioactive isotopes can best be monitored by analysis of body fluids. Suitable radiochemical procedures for only a few of the more hazardous isotopes are now available. The intensification of reactor work at ORNL will create additional problems in monitoring for ingestion of harmful isotopes. At present there is a need for procedures for analysis of body fluids for (1) cesium, (2) ruthenium, and (3) radioactive sodium and phosphorous. The analysis of radioactive sodium and phosphorous in urine can be used to estimate the degree of exposure to slow neutrons.

13. RELATED PROJECTS

This is an application of radiochemistry to specific health physics problems.

14. ACCOMPLISHMENTS LAST YEAR

A new procedure for the analysis of radioactive strontium in urine has been developed. It is shorter and more efficient than the procedure which is presently used.

15. EXPECTED RESULTS THIS YEAR

Attempts will be made to develop radiochemical procedures for analysis of body fluids for (1) cesium, (2) ruthenium, and (3) other radioelements of interest in Health Physics in FY 55.

16. ANTICIPATED PROBLEMS NEXT YEAR

Continuation of the work on the development of new and improved analytical procedures for radiochemical analysis pertinent to the needs of the Health Physics Program.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 19,000	$ 19,000	$ 19,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	19,000	19,000	19,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	1.0	1.0	1.0
B. TECHNICIANS			
SUBTOTAL	1.0	1.0	1.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	1.0	1.0	1.0
20. COMMENTS			

*Detailed in comments.

1134630

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Nuclear Power Reactors - Effects of Effluents on the Environment			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Progress, Semiannual and Topical Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) E. G. Struxness		11. STATUS (INCLUDING STARTING DATE) Starting Date July 1, 1954	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The operation of nuclear power reactors will result in the production of large amounts of radioactive materials, which if released haphazardly, might have detrimental effects upon man and his economy. Since plants and animals may concentrate radioactive materials that may be contained in the air or deposited in soils or on plants, surveys should be made to determine to what extent and under what conditions such concentrations take place.

The purpose of this study is to determine what radioactive materials are concentrated in the environment and to what extent, so that estimates may be made of any potential hazard, and recommendations may be prepared which will influence disposal practices.

The scope will include an evaluation of the potential hazards on the basis of field observations and laboratory examination and analysis of field samples.

13. RELATED PROJECTS

The project is an integral part of the overall development of nuclear reactors for electrical power and the data obtained will be correlated with similar information available from other sites.

14. ACCOMPLISHMENTS LAST YEAR

The TVA study of the effect of the discharge of liquid wastes on the flora and fauna of White Oak Lake and environs will have been completed and will point to the various problems resulting from the discharged liquid radioactive wastes into this controlled area. The Duck Banding Program was initiated as part of the TVA-AEC Ecological Survey will have given some information on their migratory habits of waterfowl. Certain select specimens will have been examined for build up of activity.

The Waste Disposal Section completed a survey of littoral, pelagic and profundal organisms in the ORNL Settling Basin. Descriptive information of the basin (depth, retention time, flow characteristics, characterization of bottom sediment, levels of activity, chemical analysis, etc.) was obtained to evaluate selective uptake of radionuclides in the aquatic organisms.

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15. EXPECTED RESULTS THIS YEAR

1. Select a lake (or pond) and stream in the Oak Ridge Controlled Area that is not contaminated.

2. Begin measurements of environmental factors, i.e., oxygen, CO_2, pH, bicarbonates, turbidity, flow rate, light, temperature, etc.) at periodic intervals with respect to time of day and season.

3. Begin the determinations of aquatic species present in the pond and stream, population densities, life histories, food-web by direct observation and stomach contents, biomasses (weight of species population per unit area or volume) and ecological stratification.

16. ANTICIPATED PROBLEMS NEXT YEAR

1. Continue and complete the control studies initiated last year (see 15, 3, above).

2. Begin the experimental determination of the environmental effects in an aquatic community by introducing known quantities of reactor wastes to the stream and pond and following through with repeated studies listed in 15, 3, above.

3. Continue the experimental effort by successively increasing the level of radioactive wastes introduced in the stream and pond.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 15,000	$ 63,000	$ 126,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	15,000	63,000	126,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	900	4,000	5,000
TOTAL EQUIPMENT	900	4,000	5,000
TOTAL CONSTRUCTION AND EQUIPMENT	900	4,000	5,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	0.4	2.3	5.1
B. TECHNICIANS	0.4	0.5	0.5
SUBTOTAL	0.8	2.8	5.6
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	0.8	2.8	[illegible]
20. COMMENTS			

*Detailed in comments.

1134633

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Mathematics and Computation - Health Physics			2. DATE March 15, 1954
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. 6510	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual 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)

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.

13. RELATED PROJECTS

This work is closely related with that being done for Physical Research, Reactor Development and Biology.

14. ACCOMPLISHMENTS LAST YEAR

Improved estimates for radiation damage were obtained using the ORACLE. From an isotropic source of 300-kev neutrons, 2500 histories were obtained and used to compute average energy loss and thermal collision density. Confidence intervals for the maximum energy losses were obtained with IBM equipment. Preliminary, and incomplete, estimates of collision damage as a function of initial energy have been checked and extended using the ORACLE. A factorial design for the study of the uptake of radioactive cesium and strontium by Gambusia was devised and experimental data subjected to statistical analysis.

15. EXPECTED RESULTS THIS YEAR

The radiation damage from neutron distributions ranging from 1 to 300 kev will be completed using the ORACLE and tabulated as a function of penetration and the radial dimension of the cylindrical tissue phantom. The dependency of neutron flux upon the radius of spherical phantoms will be analyzed with the object of affording extrapolation from laboratory animals to man. A study will be made of the equations for the perturbed Fermi-Thomas atom with the object of extending the Bloch formula for stopping power to low velocity ranges. Additional activities dependent upon the needs of the Health Physics Program.

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16. **ANTICIPATED PROBLEMS NEXT YEAR**

Dependent upon the needs of the Health Physics program and upon the interpretation and use of the information in 14. and 15.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 25,000	$ 40,000	$40,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	25,000	40,000	40,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	1.5	1.5	1.5
B. TECHNICIANS			
SUBTOTAL	1.5	1.5	1.5
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	1.5	1.5	1.5
20. COMMENTS			

*Detailed in comments.

1134636

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Experimental Radiation Measurements			2. DATE March 15, 1954
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. 6520	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Reports, Memoranda
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) F. J. Davis		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

The program of this section includes the development of instrumentation for the measurement, both in the Laboratory and in the field, of the radioactive content, and the absorption and scattering of radiation in air, water, earth, etc., and the application of such instrumentation to studies of interest to the Division, the Laboratory, and the Commission. The scope and need of the program may be inferred from the detailed discussions of particular problems given below.

13. RELATED PROJECTS

Cooperative project with the U. S. Geological Survey.

14. ACCOMPLISHMENTS LAST YEAR

A. The section continued its present cooperative program with the U. S. Geological Survey, involving the improvement and use of airborne instrumentation for the detection of deposits of uranium. A second aircraft of the DC-3 type was equipped and calibration measurements including design data taken over various radioactive sources. Several areas were flown in search of uranium in Florida, Colorado Plateau, and Alaska.

B. A stable recording scintillation counter for gamma ray measurement or prospecting for uranium and using only storage battery power in cars or small aircraft has been developed.

C. Experimental curves of gamma ray absorption and build up due to scatter in air for several different gamma ray energies were completed.

D. A project studying the effect of scattering of gamma rays from concrete floors and various surfaces and how it affects calibration procedures has been initiated.

15. EXPECTED RESULTS THIS YEAR

A. The section will continue its cooperative program with the U. S. Geological Survey.

B. Completion of the project on the scattering of gamma rays from various surfaces will be extended to include absorption and scattering in water and other materials.

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15. EXPECTED RESULTS THIS YEAR Continued

C. Further experimentation with scintillation detectors to possible uses in measuring directly the radioelement content in man and small animals.

16. ANTICIPATED PROBLEMS NEXT YEAR

A. Design of a portable radon measuring apparatus with sensitivity sufficient to measure breath samples.

B. Design of a scintillation alpha ray spectrometer for use in identifying various radioisotopes present on electrostatic precipitator air samples.

C. Continued cooperation with the U. S. Geological Survey with studies such as soft cosmic ray intensity variation, background radiation, and contamination measurements.

D. Further studies of scintillation techniques with application to health physics problems.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 76,000	$ 79,000	$ 79,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	76,000	79,000	79,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
Stairway and Roof on Water Tank	290		
Source Manipulator	2,089		
TOTAL CONSTRUCTION	2,379		
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	3,000	6,000	6,000
TOTAL EQUIPMENT	3,000	6,000	6,000
TOTAL CONSTRUCTION AND EQUIPMENT	5,379	6,000	6,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.8	4.0	4.0
B. TECHNICIANS			
SUBTOTAL	3.8	4.0	4.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	3.8	4.0	4.0

20. COMMENTS

*Detailed in comments.

1134639

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Nuclear Power Reactors - Airborne Hazard and Control			2. DATE March 15, 1954
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. 6520	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Progress, Semiannual and Topical Reports
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) E. G. Struxness		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

A nationwide nuclear power industry will require an accurate appraisal of the hazards due to airborne radioactive effluents. A considerable effort will have to be expended to clean the air when large quantities of airborne contaminants are discharged by reactors or processing plants. It will be necessary to know the cheapest way of achieving this purification.

The purpose of this project will be to determine the cheapest way of purifying air too radioactive for direct discharge to the atmosphere.

The scope of the project includes the study of various air cleaning devices.

13. RELATED PROJECTS

At the present time all major AEC laboratories are investigating the control of radioactive airborne effluents. These projects are generally concerned with the solution of immediate local problems. The Harvard Air Cleaning Laboratory, in particular, is doing research and development on new air cleaning methods and evaluating the effectiveness of commercially available air cleaning equipment.

14. ACCOMPLISHMENTS LAST YEAR

The joint Chemical Corps-AEC project at ORNL has been concerned with the development of methods of generation and measurement of submicron aerosols, with the object in mind of testing filters against these aerosols. Generators and instruments have been developed. Preliminary filter tests have been made against particles in the range of 0.003 to 0.3 microns diameter.

Filters have been tested against the radioactive "particulate" daughters of xenon and krypton. The filter papers were found to be over 99 percent efficient against these airborne radioactive atoms or molecules. It was also determined that activated carbon will remove part of effluent xenon and krypton from the ORNL pile filter house effluent even at room temperature, and that sorption becomes much more efficient at dry ice temperature.

Some work has been done to adapt the gas flow ion chamber for use with aerosols. This instrument is normally used to determine the activity of radioactive gases in air.

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15. EXPECTED RESULTS THIS YEAR

1. Continue the investigation of the filtration of atom-sized particulates.

2. Continue evaluation of activated carbon and other materials as sorbents for multicurie quantities of xenon, krypton, bromine and iodine. Special consideration will be given to the heat evolved by multicurie quantities of sorbed gas.

3. Investigate the methods for calculating plume rise due to the momentum and heat of the stack effluent by measurements on smoke plumes from available operating stacks. This will be done by representatives of the U.S.-AEC Weather Bureau Office at Oak Ridge.

4. Determine characteristics of sand and fiber filters for open pits necessary (depth, grain size, method of filling) to produce adequate removal of particulates evolved from hot fission product mixture under different weather conditions. This will be accomplished in the study of experimental pits.

16. ANTICIPATED PROBLEMS NEXT YEAR

1. Study penetration of particles in the size range of 0.001μ to 0.1μ radius through filter paper.

2. Continue or complete items under (15).

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 71,000	$ 75,000	$ 75,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	71,000	75,000	75,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
Misc. Lab. Equipment	2,000	2,000	2,000
TOTAL EQUIPMENT	2,000	2,000	2,000
TOTAL CONSTRUCTION AND EQUIPMENT	2,000	2,000	2,000
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.0	3.2	3.2
B. TECHNICIANS			
SUBTOTAL	3.0	3.2	3.2
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	3.0	3.2	3.2
20. COMMENTS			

*Detailed in comments.

1134642

AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Consultation and Special Problems			2. DATE March 15, 1954
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. 6530	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semiannual Report
10. PERSON IN CHARGE (CONTRACTOR'S STAFF) K. Z. Morgan		11. STATUS (INCLUDING STARTING DATE) Active	

12. PURPOSE, NEED, AND SCOPE (GIVE NARRATIVE DESCRIPTION OF PROJECT)

This program which through FY 1954 employed the full effort of one technical man will now be coordinated by the Health Physics Division Director who will refer specialized phases of problems to appropriate Research and Applied Health Physics Sections for investigation and solution. These problems which are usually of a short-range nature and which may or may not develop in connection with routine consultation of the Division normally arise in connection with current ORNL operations and are in general of immediate, recurrent and lasting interest.

Costs and manpower requirements for this program will be absorbed by the supporting Research and Applied Health Physics Sections.

13. RELATED PROJECTS

Any ORNL or other group, division or project that needs consultation services concerning radiation hazards.

14. ACCOMPLISHMENTS LAST YEAR

In FY 1954 recommendations were made in problems of laboratory design, experiment planning, and reactor safety. Considerable time was spent in the development of proper values for maximum permissible contamination levels. Other activities included planning of handling methods, and diverse consultation on radiation protection.

15. EXPECTED RESULTS THIS YEAR

Studies of the relative hazards of different reactor fuel materials are in progress to provide guidance for fabrication methods. A variety of problems involving permissible levels of air contamination in specific cases will be completed during FY 1955. In addition, other consultation including assistance to other groups will be provided as requested.

16. ANTICIPATED PROBLEMS NEXT YEAR

Since this function is concerned with consultation in a wide range of health physics activities and the handling of short-range problems as they arise, it is difficult to anticipate specific problems that may be undertaken in FY 1956. However, it is expected that considerable effort may be devoted to assistance on waste disposal problems, and it is hoped that a revised radiation safety procedures manual can be prepared.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 19,000	$	$
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	19,000		
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	1.0		
B. TECHNICIANS			
SUBTOTAL	1.0		
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	1.0		

20. COMMENTS

*Detailed in comments.

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AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Research Participation and Traveling Lecture Program - Biophysics			2. DATE March 15, 1954
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. 6530	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)

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.

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.

13. RELATED PROJECTS

Research Participation and Traveling Lecture Programs in AEC Program 5000.

A corollary benefit of the Research Participation Program is that Research Participants lend important assistance in carrying out the research program of the Laboratory.

14. ACCOMPLISHMENTS LAST YEAR

Under the Research Participation Program, fifty faculty members of thirty universities spent periods of at least three months at the Laboratory. Of these, five 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.

Under the Traveling Lecture Program, lectures before advanced groups continued with more than two hundred lectures scheduled during FY 1954, approximately ten in the field of biophysics. Funds budgeted under this program are also available for honoraria and travel expenses of some of the visiting lecturers to the ORNL-ORINS sponsored symposia held regularly every summer.

15. EXPECTED RESULTS THIS YEAR

Individuals chosen as Research Participants will contribute scientifically to the research program at ORNL. The objective of this program is to enable

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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.

Lectures delivered by the Laboratory staff under the Traveling Lecture Program are expected to number between 200 and 250 this year.

16. ANTICIPATED PROBLEMS NEXT YEAR

These programs are expected to continue in FY 1956 and to pursue the long-range objectives set forth above.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 18,000	$ 15,000	$ 15,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	18,000	15,000	15,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	1.5	1.1	1.1
B. TECHNICIANS			
SUBTOTAL	1.5	1.1	1.1
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	1.5	1.1	1.1
20. COMMENTS			

*Detailed in comments.

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AEC-189

PROPOSAL AND AUTHORIZATION FOR RESEARCH OR DEVELOPMENT

1. PROJECT TITLE Education and Training in Health Physics			2. DATE February 19, 1954
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. 6720	7. BUDGET ITEM NO.	8. SECURITY CLASS Unclassified	9. METHOD OF REPORTING PROGRESS Semi-Annual Reports
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)

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:

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 an M. A. degree from Vanderbilt by an extension of their fellowship to a total of 18 months.

B. For the National Military Establishment (NME) a training program of 6 weeks for medical officers.

C. Special training for individuals for varying periods of time and for a variety of purposes.

13.. RELATED PROJECTS

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 to the Division of Biology and Medicine of the AEC.

The programs of this project are part of the training program of the Educational Division of the Oak Ridge National Laboratory.

14.. ACCOMPLISHMENTS LAST YEAR, July 1953-54

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. Three of the 21 Fellows elected to do the research problem for their thesis in the Health Physics Division at ORNL.

Began training of 21 AEC Fellows in Radiological Physics September, 1953, for period of 1 year.

Trained 6 medical officers of USAF, USN, and USA for six weeks.

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14. ACCOMPLISHMENTS LAST YEAR Continued

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

Lectures

Four or more lectures on Radiation Hazards at a corresponding number of universities and colleges, and professional society meetings.

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.

Courses

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

One course in Nuclear Physics for members of Health Physics Division.

Miscellaneous

A section on Health Physics was prepared for the textbook on Reactor Engineering.

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.

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.

16. ANTICIPATED PROBLEMS NEXT YEAR

Because of the urgent need for trained health physicists(a need which seems to be growing rather than abating) the program of this project should be expanded, both in number of persons trained and in additional courses.

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	ESTIMATED LAST FY – 1954	ESTIMATED THIS FY – 1955	ESTIMATED NEXT FY – 1956
17. NORMAL PROGRAM COSTS	$ 50,000	$ 50,000	$ 50,000
R & D SUBCONTRACTS*			
LARGE OR UNUSUAL ITEMS COST*			
TOTAL PROGRAM COST	50,000	50,000	50,000
18. PLANT AND EQUIPMENT COSTS			
CAPITAL OUTLAY DIRECTLY REQUIRED			
A. CONSTRUCTION PROJECTS			
TOTAL CONSTRUCTION			
B. MAJOR EQUIPMENT ITEMS			
TOTAL EQUIPMENT			
TOTAL CONSTRUCTION AND EQUIPMENT			
19. DIRECT MANPOWER (MAN-YEARS)	MAN-YEARS	MAN-YEARS	MAN-YEARS
A. SCIENTISTS & ENGINEERS	3.0	3.0	3.0
B. TECHNICIANS			
SUBTOTAL	3.0	3.0	3.0
C. OTHER TECHNICAL, LOANEES, ETC.			
TOTAL	3.0	3.0	3.0
20. COMMENTS			

*Detailed in comments.

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