ROLE OF AEC LABORATORIES

Prepared by

DIVISION OF BIOLOGY AND MEDICINE

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ROLE OF AEC LABORATORIES

1. AEC basic objectives*

   b. Presidential Assignments:

The Division of Biology and Medicine identifies the following Presidential "directive" type of assignments:

(1) Establishment of long-range study of the effect of the atomic bomb on man through NAS-NRC. Copy of Document, dated November 18, 1948, attached.

(2) Presidential approval for the construction and contract operation of the Argonne Cancer Research Hospital. Copy of document, dated December 9, 1948, attached.

(3) Annual National Security Council Report. Under conditions set forth in this classified memorandum, an annual report is required on the status of certain programs for the information of the President and the National Security Council. The memorandum indicates that "the President has directed" that such reports be prepared. The Division of Biology and Medicine furnishes information on biomedical research, civil defense activities, and manpower for the consolidated report.

* This information is supplementary to data to be provided elsewhere.

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON

18 NOV 1948

The President
The White House

Dear Mr. President:

At the earliest practicable date following the capitulation of Japan, scientific groups effected a survey of damage produced by the atomic bombs on Hiroshima and Nagasaki. Medical scientists studied the effect on personnel. These observations were conducted under the auspices of the Army and Navy through the agencies of the Manhattan District and the Naval Technical Mission in Japan.

Preliminary surveys involve about 14,000 Japanese who were exposed to the radiation of atomic fission. It is considered that the group and others yet to be identified offer a unique opportunity for the study of the medical and biological effects of radiation which is of utmost importance to the United States. Such a study should continue for a span of time as yet undeterminable. However, the study is beyond the scope of military and naval affairs, involving as it does humanity in general, not only in war but in anticipated problems of peaceful industry and agriculture. In addition, demobilization and consequent loss of military scientific personnel engaged in this study prevent its continuation.

In order that the studies might be followed to their logical conclusion, a conference group of the Division of Medical Sciences, National Research Council, convened to discuss the problem. The group recommended that appropriate action be taken toward the evolution of a Presidential Directive to effect the study. The recommendation with which the Surgeon General of the Navy, the Vice Chief of Naval Operations, and the Chief of Naval Research concur is as follows:

> "That the Presidential Directive instruct the National Academy of Sciences - National Research Council - to undertake a long range, continuing study of the biological and medical effects of the atomic bomb on man. That in this directive the council be authorized to enlist the aid of governmental agencies and personnel, and such civilian agencies and personnel as may be needed. Further, that those governmental agencies whose aid is requested by the Council be authorized and requested to provide the needed cooperation."

In view of the above, it is respectfully recommended that the National Academy of Sciences - National Research Council - be so directed.

Sincerely yours,

/S/ James Forrestal

Approved

/S/ Harry S. Truman

November 26, 1946

EXECUTIVE OFFICE OF THE PRESIDENT
BUREAU OF THE BUDGET
WASHINGTON 25, D. C.

MRMORANDUM FOR THE PRESIDENT December 9, 1948

Subject: Proposed Construction of a Cancer Research Hospital at the University of Chicago by the Atomic Energy Commission

The Atomic Energy Commission has requested authorization to construct a building at the University of Chicago, in Chicago, Illinois, to be known as the Argonne Cancer Research Hospital. Although technically a hospital with a capacity of 40 beds for selected clinical cases, this will actually be a cancer research laboratory where a special program will be conducted using radioactive materials. The building is to be erected on land leased by the Atomic Energy Commission at a nominal rental for 99 years from the University of Chicago. It will therefore remain the property of the Federal Government although it will be connected to and closely integrated with the hospital of the University of Chicago and the Nathan Goldblatt Memorial Hospital and will form a part of a cancer research center. The Commission does not propose to operate the hospital and related research activities but will contract with the University of Chicago for such operation.

In its basic legislation, the Atomic Energy Commission is authorized to engage in medical, biological and health research involving the utilization of fissionable and radioactive material. The Congress has made it clear that it wishes the Commission to engage in cancer research as evidenced by specific language in the appropriation act for fiscal year 1948, making available $5,000,000 for that purpose. It is the opinion of the medical consultants of the Atomic Energy Commission that the construction of the Argonne Cancer Research Hospital is a proper part of such a program. The Surgeon General of the Public Health Service has studied the project and reports that he and members of the staff of the National Cancer Institute consider it justified.

The cost of the Argonne Hospital is estimated at not more than $3,500,000 of which $1,750,000 is available from funds appropriated for fiscal year 1948 while the remainder will be included in appropriation estimates of the Atomic Energy Commission for fiscal year 1950.

It is recommended that the Atomic Energy Commission be authorized to construct a permanent 40-bed research hospital and related laboratory facilities to be known as the Argonne Cancer Research Hospital, at the University of Chicago, Chicago, Illinois at a cost not to exceed $3,500,000.

/S/ James E. Webb

Director

A P P R O V E D:

/S/ Harry S. Truman
The President of the United States

December 9, 1948

ROLE OF ATOMIC ENERGY COMMISSION LABORATORIES

2. Respective Roles of AEC Laboratories, Industry, Research Foundations, and Universities. For the biomedical research program the relationship of industry and research foundations is not complex and can be readily treated as follows:

Industry -- It has always been the policy of the Division of Biology and Medicine, as exemplified in the Radiation Instruments development program, to stop short of getting into production in the development activities with respect to specific components. On the other hand, we have used industrial laboratories as a very important part of this program. The balance of what should be done in AEC laboratories and industrial laboratories at present is a reasonable one in view of the great reluctance on the part of industry to invest their own money into improved components and into new instruments which do not have an immediate market in the tens, hundreds of thousands, and millions. The balance here should be scrutinized carefully from time to time.

Industry represents a very small but important fraction of the total research support, and is utilized solely for applied essential activities that can be performed best or only by industry. Examples are:

(1) Development of specialized radiation detection instrumentation or components (e.g., photomultiplier tubes); or

(2) Mass quantities of specialized materials and studies, such as can be provided best by pharmaceutical companies.

There is no reasonable basis for transferring the responsibility for radiation biology, radiation protection programs or the treatment of radiation injury and the like to industry at any foreseeable time.

Research Foundations -- Research foundations seldom offer a scientific competency comparable to and not otherwise available in either the AEC-supported laboratories or to the universities. Extent of support of projects is minimal and limited to research projects of a specialized nature.

Universities -- Strictly speaking, universities have no built-in mission requiring them to provide investigators, equipment, or brains for any group, national or otherwise. Their classical purpose is to provide an atmosphere where our young people can, in a comparatively short period, acquire a grasp of the accumulated wisdom of our race. Carlyle's reference to a collection of books being the true university would stand if a man stayed young long enough to collate and understand what the words meant. Alternatively, we have certain men to select out the meat of the barious branches of knowledge, organize it and present it to our young in such a way that it can be assimilated quickly for subsequent productive use.

It is granted that research is an intrinsic part of a university's existence, one then may ask whether research is all of one color, or is there a spectrum of research activities. The answer seems to be that there is not one, but several spectra, the number being related to the field of study. To take an example, a good mathematics department will have theoretical mathemeticians as well as statisticians capable of dealing with actuarial problems on the latest IBM; similarly, in the department of mechanical engineering there may be a man working on a theory of modular stress analysis side by side with a man testing the Brinell hardness of alloys. It surely cannot be claimed that the department of mathematics carries on research and that engineering does not; nor that the man considering theories in a library is a researcher while the man using equipment larger than paper and pencil does not.

Thus, one is forced to a more inclusive definition: research is an activity which adds to man's store of knowledge, and one would say that the man testing alloys is no less a researcher than the man who knows the intricacies of an IBM. But there still remains the question: when and where does research become something else? The answer seems to be purely an expression of opinion among individuals and a matter of expediency and/or theory of education among universities as institutions.

One can imagine a university in which it is held that teaching is the important business of the school, but a definite time will be set aside for personal research which may or may not have to have outside financial assistance; every man will carry his share of the teaching load, and the laboratory space and graduate students will be divided up as evenly as possible. In another university the deliberate policy is to grow as large as possible with funds from any source, hire as many people as needed and print their names on the faculty lists, organize the university as a profit-making business organization and dominate. In this type of university the student and the faculty member becomes an unimportant, even expendable, cog in the machine, and often the faculty member responsible for attracting the funds finds he is unable to cope with an administration which orbits around the university business office.

In the former case, one would say, in general, that the investigator is doing research for the purpose of enlarging knowledge - if it will be agreed that this "for the purpose of" is admissible. In the latter case, the investigator is also doing research for the purpose of enlarging knowledge, but he is collecting data for someone else, data which he is not intrinsically interested in. To put it another way, the investigator in the latter case has become a hired brain motivated largely by a sense of professional performance.

The AEC national laboratories are especially important with respect to post-doctoral training since present-day research is so sophisticated that few universities can really train a graduate student in all of the disciplines required for him to immediately become a productive researcher. Post-doctoral training becomes increasingly important as research complexity increases, and only those universities in which the federal government is, in essence, supporting a national-laboratory-type installation (for example, Berkeley) can adequately supply this post-doctoral training. The location of such large federally-supported installations at specific universities renders them relatively inaccessible to the university community-at-large, whereas the existing national laboratories which are located in different regions of the country are available to all universities. Undoubtedly more universities will make use of the national laboratory facilities to augment their graduate training programs in the future.

The Commission's programs in Biology and Medicine complement most university research activity as they do the activity of other federal agencies. Consequently, the transfer of any portion or portions of this program to universities could not effectively be accomplished without providing the recipient institutions with the necessary physical plant and equipment to carry out the work. Fractionation of the program would also cause a dissipation of guidance of research activity pertinent to the Commission's operational problems.

It should be further understood that, with few exceptions, the AEC laboratories were conceived by and continue to be an integral part of many of the nation's major educational institutions. They have become physically separated from the main body of the parent institutions in order to facilitate and concentrate the research and development activities required by the Commission. They have not, however, become academically or intellectually isolated but continue to enjoy close liaison. This interrelationship would suffer by any subdivision of the program that would lend to the creation of artificial barriers between AEC and university laboratories.

The original concept of the national laboratory had at its very foundation the stimulation of more sophisticated research in all fields, biological as well as physical, in the universities. This mission has been most successfully pursued by the Oak Ridge National Laboratory where a very vigorous program has been carried out and where the somewhat lower level of scientific sophistication in the regional universities made the situation particularly suitable for such stimulation. As is well known, this is a many-faceted program which has done a great deal to strengthen the research activities of the southern universities. However, even though eminently successful, there are almost no universities in that particular area of the United States which could successfully take over large so-called "basic" research programs of the Oak Ridge National Laboratory. This is essentially true for all sections of the United States, the only exception being those few universities where federal agencies have, in essence, already established "national-type" laboratories on the campus. To emasculate the national laboratories of their competent staffs which would be the inevitable result of too strict a policy of programmatic applied research for the laboratories would make them totally unable to meet their responsibility of stimulating and encouraging the research development of the universities. Furthermore, to burden the universities by the transfer of such large research programs would mean that either the research programs were less efficiently pursued or else the tradiational concept of the university as a collection of independent professors working on individual programs would have to be seriously modified. Already there is evidence in the opinion of some that the emphasis upon research and the acceptance of large projects by universities has resulted in a deterioration of their primary function of good teaching at the undergraduate level.

The respective roles of AEC laboratories and universities is complex and, of necessity, an understanding of the problem involves the acceptance of certain basic premises, some of which are:

(1) That the Commission has a responsibility to conduct its operations in a manner which will safeguard and protect the health and safety of its employees and the public.

(2) That the fulfillment of this responsibility requires, among other things, the conduct of biomedical research and development activities for "the protection of health and the promotion of safety during research and production activities." (AEC Act, Sec. 31 a (5))

(3) That there is a continuing responsibility to "assist in the acquisition of an ever-expanding fund of theoretical and practical knowledge in such fields." (AEC Act, Sec. 31 a)

(4) That the needs for education and training in the nuclear energy field continue unabated.

On these bases there have been established wholly AEC-supported laboratories either physically located within AEC sites, or complete projects on university campuses, ~~usually with Departmental status,~~

An important, and expanding, adjunct to this method of operation is the "off-site" university research contract program. This program consists of separate contracts for support of research projects on an annually renewable basis. It enables the performance of research in all facets of radiation effects within a far broader spectrum of scientific disciplines and competencies than are ordinarily available to the single organization, or to few. This program, for example, includes more than 500 separate research projects conducted in approximately 150 different institutions. It might be concluded that this represents a compelling argument for university-conducted research (albeit AEC-supported) but the fact is that the two programs (i.e., AEC-supported laboratories and off-site research contracts) are not mutually exclusive. Each fulfills definitely prescribed responsibilities and each has its unique advantages.

Further discussion of the "off-site" program is thus indicated, but the content of the present document will be confined to "AEC-supported laboratories."

It is significant to note that through the years since the inception of the Commission the performance and progress of biomedical research in the AEC-supported laboratories have never been seriously limited by lack of funds. The growth of scientific facilities and staffs has been impressive, but reasonable. There have been lean years but, in general, it can truthfully be stated that an abundance of additional funds would not have resulted in anything approaching a proportionate measure of increased scientific productivity or an equivalent acceleration in reaching the resolution of scientific problems. This stems from the unavoidable fact that there is a limited number of trained scientists -- geneticists, biochemists, ecologists, medical doctors, etc. -- and fewer still of those who are interested and engaged in the nuclear energy sciences. Thus there are definite limitations as to the amount of intelligence and brain-power available to staff the AEC-supported biomedical laboratories. In addition, since the application of science to the nuclear process is a relatively new innovation, it has been necessary that the reservoir of individuals capable, scientifically trained, and interested in these fields be expanded through the educational and research processes.

Another recognized advantage and benefit of the research, as supported in our AEC laboratories, is that of the "team" approach, with particular recognition of the value of the "cross fertilization" process which makes available to the life scientist the unique advantages of discussing his problems with the chemists, physicists, engineers, metallurgists, etc., who are also concerned with the problems of nuclear energy at the same installation. But the important thing to keep in mind is that the research-team approach must not be, and is not, carried out to the exclusion of the individual scientists' efforts. As has been true through the ages, many of our most remarkable scientific discoveries have stemmed from the ideas and productivity of an individual. The operation of our AEC-supported laboratories should be so established that the imaginative individual will not be stifled by his surroundings, and indeed should benefit by virtue of being a member of a laboratory, the very existence of which is predicated on the need to delve deeper into the unknowns of the atom.

a. <u>Basic and Applied Research in the Life Sciences</u>.

In this context the title applies to biomedical research in the more fundamental radiobiological processes (necessary to the better understanding of effects), cancer research which is both basic and applied, and other research activities relating to beneficial applications, such as agricultural research projects on crop improvement, etc.

The universities can, and in fact do, perform research in these fields. They should be encouraged to do more. However, there should be no diminution of these activities as supported in the AEC laboratories. This is because these laboratories can provide the necessary research tools ordinarily too expensive for the average university (reactors, accelerators, etc.), have available short-lived radioisotopes, and more importantly, the scientific organization of the types required for such effort. These installations are in position to perform pilot studies and provide radiation facilities and radiobiological back-up for the college and university scientists.

An additional intangible, but most important consideration, is in the fact that the AEC must not permit itself to be identified solely with the production of the tools of destruction, and one important contribution is through research directed toward the beneficial uses of atomic energy for the good of humanity.

b. <u>Health and Safety</u>.

For simplicity, all biomedical research activities having a direct bearing on radiation health protection matters and the development of standards are included herein. These include irradiation effects studies, genetics, environmental research, toxicological studies, dosimetry and instrumentation, as well as activities related to civil effects and combating radiation detrimental effects.

The research programs in this group constitute approximately 80% of the total annual operating budget for biomedical activities, and the need can be classified largely as "programmatic" in fulfillment of operating requirements and in discharge of responsibilities set forth in the Atomic Energy Act. Much of the effort is more effectively and logically performed in AEC-supported laboratories, and this determination is made when one or more of the following criteria apply:

(1) The operating problems of any AEC installation require the existence of a biomedical research group at the site. (Examples are: Biology and Health Physics Divisions, Argonne National Laboratory; Health Physics Division, Oak Ridge; Health and Safety Division, Los Alamos.)

(2) The specialized nature of the problems requires the establishment of installations scientifically staffed and oriented to

treat certain aspects of the matter on a continuing basis. (Examples are: University of Rochester - toxicological problems, Health and Safety Laboratory, NYOO - radiation monitoring and analyses.)

(3) Availability of unique and costly research tools (reactors, cyclotrons, accelerators, etc.) at AEC installations may necessitate the performance of the research at these sites to the exclusion of a university operation, simply in the interests of economy.

3. <u>Review of Each Program to Determine</u>:

a. <u>Fields in which AEC support can be reduced or terminated in next ten years by</u>:

(1) <u>Completion of Work</u>.

It is unlikely that in the literal sense of the word any major field of research supported currently by the Division of Biology and Medicine would be completed in the next ten years. On the other hand, for example, should a really effective treatment for whole body injury be forthcoming one would certainly curtail the degree of effort in this direction to essentially one of developing refinements in therapy. With respect to the long-term effects of total body radiation exposure and genetic effects, it is quite possible that the currently underway and presently planned large-scale animal researches when completed in the next 10-20 years will have served the purpose for which they were intended and could be curtailed after completion provided of course that the information developed in these experiments (and this is not at all unlikely) does not raise a host of new questions which must be answered either in new long-term experiments or by the more fundamental approach in the study of mechanisms.

As to the peaceful uses of nuclear energy, it is to be hoped that the Commission will always have a sense of responsibility to spearhead the exploitation of nuclear energy, its tools and by-products in the furtherance of the biological, medical and agricultural sciences. The degree of effort in any given decade would be difficult to predict at this point.

As to the biomedical problems proper, they will be with us, I suspect, so long as atomic energy is useful. The nature of the problems will change, of course, with time. It is doubtful whether the degree of effort needed in this general area will decrease during the next 10 years. On the other hand, certain aspects of fallout from nuclear weapons tests cannot be pursued indefinitely in the absence of contaminating weapons tests for an indefinite period. The same goes for activities budgeted under civil effects. But again there is much we can do in the absence of tests, and it is unlikely that 10 years will see us with a complete body of knowledge exhausting the possibilities.

(2) Transfer of Responsibility to Industry or Universities for Private Support:

The Commission, in one sense, has transferred responsibility for the actual carrying out of biomedical research in sizeable projects to universities or groups of universities, with the exception of the ORNL program and the Hanford Atomic Products Laboratory program. To further transfer the interpretation of the Commission's and the country's needs in these fields to the universities would result in decentralization, gross duplication of effort, and in general a dissipation rather than a consolidation of the program. Money-wise, it is inconceivable that private or even wealthy state universities could pick up the financial responsibility that goes along with producing an effective program of the sort needed.

(3) Transfer of Responsibility to Another Federal Agency:

The AEC's unhappy experience with its very superior graduate fellowship program when it was transferred to the NSF is likely to be repeated if this total AEC DBM research responsibility were transferred and split between the NIH and the Department of Agriculture, which is one way to do it. It is only the Agency which is working and developing and actually creating the problems which can develop a preoccupation with solving the problem which is a prerequisite for carrying out an effective program. A classic example is the USPHS's almost total lack of interest in the radiation health problem until the past year or two, having had essentially a negative attitude toward radiation health problems whatever the source - the practice of medicine, industrial radiography, etc.

b. As to the major research programs of the Division of Biology and Medicine, the following comments are applicable:

(1) Radiobiology.

(a) Irradiation Effects - Molecular and Cellular.

The primary aim of the biomedical efforts of the AEC must be an understanding of the effects of radiation on man. Correspondingly, a great deal of our research effort has involved quantitative determinations of the biological changes produced by radiation in laboratory animals. Because of the large numbers of animals necessary to meet the statistical requirements of this type of experimentation most of this work has been and must be carried out in the national installations. The biological changes (such as mutations, tumor formation, cataract formation, death, etc.) with which we must be concerned appear hours, days, weeks, months, or even years later. To understand these "late-appearing" events it is absolutely essential that there is a prior understanding of the biophysical and biochemical (i.e., the molecular and cellular) events which precede and lead to the observed changes in the organism. Much of the research in this area can be carried out in projects of a size which can conveniently be performed in universities. Consistent with this, a large fraction of our support in this area is now placed in the universities. However, many essential research topics in this area require the specialized equipment (e.g., large accelerators) found only at the national installations. Further, it is necessary that the large-scale studies of biological effects at the organism level be carried out in close conjunction with supporting studies at the molecular and cellular levels so that effective day-to-day collaboration is possible. Much of the work on the alterations produced by radiation in isolated biochemicals is either being curtailed or reoriented. Instead, the emphasis is now being placed on (1) biophysical studies to determine the actual mechanisms which lead to the inactivation of critical cellular components, and (2) biochemical studies of the radiation effects on the large, organized structures found in cells (such as mitochondria, microsomes, chloroplasts, etc.). These programs will be expanded both in the National Laboratories and in our university off-site research.

(b) Irradiation Effects on Organ Systems.

A continuing and expanding program of research in biological response is unquestionably justified through our growing awareness of potential hazards resulting from detonation of atomic devices, from reactor operations, and from the beneficial applications of atomic energy. There is increasing need for data concerning effects on organs and organ systems resulting from continuous and intermittent low-level intake of fission products and reactor effluent radioisotopes. Facilities, personnel and experience present in the national laboratores are not duplicated elsewhere; it would, therefore, appear, economically unsound to attempt to transfer these programs to universities and industry.

(c) Irradiation Effects - Whole Body.

The program on whole body irradiation effects has been a continuing program that progressively changes emphasis to meet demands for new information pertinent to Commission operations and problems. The emphasis has in past years shifted more toward the evaluation of long-term or chronic radiation hazards and an expansion of program is underway to study the effects of very low doses. The Commission has extensive facilities for this program and has always provided the principal scientific knowledge required for the setting of radiation health standards. Since irradiation effect decreases with decreasing dose, the existing extensive facilities must be further expanded to permit studies on the scale required. No university is inherently equipped with physical facilities or staff to cope with the magnitude of the studies presently underway and proposed. The best interests of the AEC would be served by expanding this research area and also fostering further development and testing of the theoretical concepts that have arisen.

(d) Radiobiology - General.

By study of the prompt responses of cells and tissues to acute irradiation, much has been learned about damage and repair mechanisms in living systems (cell killing, loss of cellularity, neurotoxins, tissue replacements, immunity, regeneration, and restitution), including information about the interdependence of different organ systems in maintaining the conditions required for survival.

Study of the damage and repair process has led logically to consideration of tissue, organ system and organism (whole body) capabilities at different times after the prompt cycle of injury and repair, which in mammalian forms is complete in one to two months as a general rule. Basically, the question is one of residual damage apart from cell loss - the influence of sublethal irradiation effects in cells apart from the transitory biochemical imbalance or delay in mitosis.

Preliminary evidence indicates that recovered irradiated tissues age prematurely. Expressed in another way, the evidence indicates that the degenerative changes occurring normally with time are accelerated. Findings suggest that the late changes induced by radiation are similar to, if not identical with, natural aging.

To the extent that late irradiation effects and natural aging are identical, a means is available for accelerating the process of senescence not only in whole organisms, but also in organs and organ systems individually, depending on irradiation techniques. There is, thus, the strong possibility that a means is becoming available for analyzing the whole gamut of degernative diseases - those such as arteriosclerosis, cirrhosis, nephrosis, anemia, arthritis, diabetes, sterility, cataract, and loss of mental acuity -- those that involve decrease in functional ability of tissues, organs and organ systems.

Study of the functional capabilities of tissue components necessitates consideration not only of the disorganizational forces of the environment, of which radiation is one, but also of the organizational forces inherent in the life mechanism which act in the opposite direction and thus counteract deterioration. By dealing with the intensity of these forces in some quantitative terms, impressions are gained of the residual potential for life or simply the functional capability at any time - impressions that have meaning with respect to tissues, organs, and organ systems as well as organisms.

By taking into account the divergence in cell types caused by mutations, such as induced by radiation, and the emergence of differing tissue types caused by selection processes, the problems and potentials of induced anaplasia, metaplasia, and even neoplasia come in for consideration and attention.

Radiation, it is clear, is both a positive and negative force involved in the life process and it is almost a unique tool for investigating component parts of this process. It is clear also that the surface has scarcely been scratched so far as opportunity and potential for understanding in this field are concerned.

While some progress can be made by fostering small project research, the single-purpose research activity of academic interest so natural in the university environment, it is evident that coordinated effort of some magnitude is required if accomplishments of significance are to be achieved.

As expanding amounts of information and data become available, and as the complexity of biomedical problems is appreciated increasingly, there is apparent need for more "operations" type research - multiple-discipline attacks in strength on central mechanisms. Already the AEC-supported national laboratories are performing significant service in this respect. Instead of describing interesting cause and effect relationships, systematic investigations are being carried out to analyze processes and resolve problems. Moreover, indications are that the national laboratories have been more successful in this respect than other kinds of groups, due it would appear to ability to apply the magnitude of effort required to deal effectively with problems. Such effort sometimes is brought to bear in university situations (e.g., Rochester, California, Harvard, MIT, Chicago), but when this happens the project organizations, in effect, become national laboratories, since support is primarily from the Federal Government.

Actually, there appears to be little difference in research effectiveness between national laboratory and university research facilities when sizes are comparable and source of support are the same. The important feature is having available, at different locations, groups with competence that are responsive to indicated research needs and opportunities.

Central in newer developments is the research promotion role of federal agencies. With funds provided by the Congress to encourage and foster studies relative to health, atomic energy, and space exploration, not to mention commerce, industry, and defense, agency groups identify research needs and opportunities and bring them to the attention of interested groups - very often in ways that represent intellectual challenges rather than directives or financial opportunities.

Because of the complexity of present-day research, especially that of long-range character involving large research teams, the encouraging and coordinating function performed in connection with allocation of funds is a strong and influential one. Thus, in the present system it is important that two elements -

the research administration groups at the federal level and the research groups of the national laboratory type - remain sensitive to national needs and to the research requirements for general human advancement.

Radiological health and the utilization of radiant energy for biomedical purposes are matters of particular public concern at the present time. Accordingly, it appears desirable that every effort should be made to preserve the benefits now coming from the leadership and research competence existent in the Atomic Energy Commission and its national laboratories.

(2) Genetics.

The AEC genetics program is the only federally supported genetics research program specifically directed toward the analysis and interpretation of the genetic hazards of radiation exposure. While much of the program is at a stable level, that portion concerned with the direct estimation of mutation rates in animals needs to be expanded to exploit recent findings on the dose-rate dependence of mutation induction. Studies of radiation genetic effects and mechanisms must be continued since ultimately it may emerge that damage to the genetic apparatus of somatic cells is the basic radiation damage responsible for many somatic effects. New programs are anticipated on the biochemical genetics of man, a type of investigation suited to the Commission's installations where a variety of scientific disciplines are closely integrated. The research programs supported by AEC in the universities will also be expanded with emphasis in population and biometrical genetics. The major studies in the genetics program continue to serve as sources of data for the whole scientific community.

(3) Environmental Radiation.

This program is one in which the AEC Laboratories should play an expanding role in the future.

Reports of world-wide radioactive contamination from nuclear weapons tests have created a strong interest throughout the world in more detailed information on the distribution and variation of natural and artificial radioactivity in the environment, on the actual range of radiation doses received by man from these sources, and on the effects of these doses on the human population as a whole and in specific localities. As a result of the lack of clear evidence regarding the effects of low doses on the health of large populations, and also as a result of recent changes in recommended occupational exposure limits, the distribution and effects of environmental radiation at levels which were formerly thought to be insignificant have become mandatory subjects of careful study in connection with all atomic energy activities.

A minor part of the responsibility for food and milk monitoring now carried on by the Health and Safety Laboratory and the Los Alamos Scientific Laboratory may ultimately be transferred to the Department of Health, Education and Welfare. On the other hand, both the strong AEC interest in understanding the ultimate fate and consequences of environmental contamination resulting from AEC activities and the unique suitability of the AEC Laboratories should be encouraged to develop stronger scientific research programs in this area over the next few years.

Both for the AEC program and in cooperation with other agencies which will gradually be building up their own analytical facilities, it will be important that the unique talent and varied analytical facilities existing at the AEC Laboratories be more fully exploited. During an interim period support should be expanded even for such routine activities as food monitoring in order to speed up the development of an adequate national capacity for investigating local anomalies and the effects of regional climatic and dietary characteristics. Thus, both the physical and biological transport processes affecting the distribution of contaminants dispersed on a world-wide scale by high-energy sources, such as bombs or rocket propulsion systems, will require more intensive study. New projects along these lines should be initiated in some of the AEC Laboratories.

On the other hand, the part of the program dealing with the atmospheric transport of contaminants from low-altitude, low-energy sources such as land-based power plants and chemical processing facilities can continue at about the present level. However, during the next decade, attention must be shifted more toward the interactions of airborne contaminants with the earth's surface and its vegetative cover and to mechanisms by which different nuclides enter the food chain.

The terrestrial ecology, marine biology, and oceanography programs are still undergoing development, being of recent origin compared with other biological researches supported by the Commission. Continued development of the environmental aspects of these disciplines is anticipated to require 6-8 years before continuing, long-time programs can be in effective productivity.

All of the AEC on-site ecology programs are of recent origin or non-existent, with the exception of that at Oak Ridge and those operated at Savannah River by contractors from the University of Georgia and the University of South Carolina.

The Oak Ridge program should continue expansion for a year or two. The programs at Idaho and Hanford will require almost 10 years to complete development, but perhaps will not reach the dollar level of Oak Ridge.

No programs exist at Brookhaven or Argonne but some field effort should be established at both on a rather modest scale. An accident at one of these sites, with no basis for evaluation of biological damage, will leave the AEC defenseless.

(4) Radiation Protection.

(a) Combating Radiation Injury.

Studies on the means of combating radiation injury have been at a fairly steady level for several years. No major expansions are anticipated. As present studies on protection against acute effects reach completion, an increased effort should be placed on combating long-term injury and ameliorating genetic damage. Any efforts in this direction will require cooperative activity with the AEC Laboratory programs in genetics and radiation toxicity.

The development of prophylactic and therapeutic procedures to combat the deleterious effects of radiation has been recognized as a responsibility of the Division of Biology and Medicine for many years.

Although the number of workers accidentally exposed to lethal doses of ionizing radiation has been small, the need for rational procedures of evaluation and therapy is, nevertheless, important.

The blood-forming cells of the bone marrow are particularly susceptible to damage by penetrating radiation, and destruction of these cells is the underlying cause of death following both acute and chronic over-exposure.

Commission-supported laboratories have investigated many therapeutic schemes during the past decade. Some of these continue to hold promise and will receive continued support as long as the Commission retains the responsibility of insuring the health and safety of its workers.

A number of drugs and natural products have been evaluated in Commission laboratories, for example, antibiotics, flavonoids, properdin and various blood fractions. These investigations have been, in general, unproductive and the present level of effort is not high. No increase is planned unless new ideas are forthcoming.

A second method of treating actue radiation sickness may be the transplantation of new marrow in the patient to replace that destroyed by radiation.

This method was first suggested by workers at the University of Rochester. However, successful transplants of bone marrow were not achieved until several years later when a group at ORNL successfully treated mice by this technique. ORNL has continued basic experimentation in the field of bone marrow transplantation in small laboratory animals.

The application of bone marrow treatment to larger animals and to man has been carried out principally by off-site contractors, because the technique seems to work best in the hands of surgeons. It is anticipated that the clinical evaluation of the bone marrow treatment will receive increased support in those Commission-supported laboratories affiliated with university medical schools, principally the University of Rochester and ACRH, and the Medical Division of ORINS.

Pilot studies of the preservation, viability and application of frozen bone marrow are underway in several medical schools. If progress suggests that a bone marrow bank could be a sueful source for use in emergencies involving larger numbers of people, the bank should be set up and evaluated on a long-term basis at a Commission facility.

Another phase of anti-radiation research is the development of agents that will protect living organisms from the lethal or otherwise damaging effects of radiation. Perhaps the best known of these compounds is AET, developed at ORNL. This drug is, in certain dose ranges, extremely efficient in promoting the survival of mice exposed to lethal levels of radiation. However, as in the case of bone marrow, application of this technique in larger animals (dogs and monkeys) and in man has not met with immediate success. Because the national laboratories have little competence in pharmacological research, this aspect of the problem can best be carried out on an off-site basis.

In addition to injury by external sources of penetrating radiation, the possibility exists within many Commission facilities of accidents resulting in the inhalation or ingestion of dangerous amounts of radionuclides. Many of these nuclides have long half-lives and can be retained by the human body, particularly in the skeleton, for considerable periods of time. ANL has supported a study of compounds capable of decreasing the retention or increasing the excretion of many of the more hazardous radionuclides. Some progress has been made, but only slowly. No expansion of this program in the national laboratories is contemplated. Increased participation by university and industrial laboratories might provide new ideas and compounds that could become the basis for effective treatment.

In general, the national laboratories have taken the initiative in much of the preliminary work. The perfection of a useful clinical technique will continue to require the close supervision and advice of the best clinical medical help that we can obtain.

With the increased attention given to long-term effects of chronic radiation in the Commission's biomedical program, the application of the anti-irradiation drugs and other protective procedures in chronic radiation experiments will receive increased emphasis. These studies can probably best be carried out by direct Commission support in Commission-owned facilities, in conjunction with well-established programs directed toward the study of life expectancy and other long-term effects.

(b) Burns and Blast.

With particular reference to burns and blast as a program category, it appears that this subject has more direct relationship to the traumatic medical effects on man associated with actual warfare. Accordingly, studies on burns and blast are being phased out or will be transferred to the appropriate group within the Department of Defense.

(c) Radiation Detection and Measurement.

For reasons of practical necessity, much past effort has been concerned with two very critical problems in radiobiology: (1) improving the physical measurements of the dose absorbed from both external radiation sources and internally deposited radioisotopes; and (2) quantitatively determining the biological changes (such as mutations, tumor formation, cataract formation, death, etc.) which appear hours, days, weeks, months, or even years later. However, the accumulating knowledge from these studies has demonstrated that even in cases where there are good measurements of the dose neither the extent of the resulting biological change nor the exact time of its onset can be precisely predicted. This is, of course, not surprising because individual biological changes are undoubtedly initiated by different biochemical events. Many of our detection and measurement procedures are rapidly nearing the point where they are entirely adequate for our health physics needs. Thus, we need to reorient much of our effort toward utilizing the physical measurements more efficiently in predicting the radiobiological damage which will result from a given exposure. To do this requires the incorporation of many physical and biological factors into complex mathematical equations. The development of such prediction equations will require the coordinated talents of men competent in at least six disciplines. Expansion of these efforts can only logically be carried out at a national installation and is planned for the immediate future.

Radiation detection instrumentation is keyed directly to both the biomedical research and the radiation safety control programs. It is an integral part of these programs and, in fact, may be considered a prerequisite to successful quantitative research and to accurate control of radiation hazards.

0014365 These efforts are directed in two major channels: (1) basic instrumentation - the development of new detectors and components aimed toward the improvement of sensitivity, accuracy, speed and reliability of measurement; and (2) instrumentation systems - to provide complete equipment for both the experimentalist and the health physicist.

The basic instrumentation program is primarily directed toward the development of dosimetry of the interactions of radiations on tissue, using as the measured parameter: (1) the energy absorption per unit mass (rad), and (2) the linear energy transfer (LET) in terms of the energy absorbed per unit path length of the irradiating particle. The instrumentation systems development program is currently emphasizing accuracy and reliability, and data processing. The latter effort is of particular interest in order to automatically reduce large quantities of data to a significant and usable form.

In our national laboratories it is important to maintain a close working relationship between the instrument development efforts and the using experimentalists and radiation safety personnel. This close working relationship is important not only because it expedites the development of the equipment, but is of even more impotance in promoting the interchange of ideas between the instrumentalist and the user to assure the proper design of the needed equipment.

Certain specific areas of instrumentation will be reduced or terminated by the natural completion of the effort. Of interest to note here is that the production engineering and fabrication of developed instrumentation has already been turned over to industry for their own support. The only exceptions to this are found where urgency or expediency require the fabrication of a small number of instruments for the laboratories' immediate use.

The proportional level of support of radiation instrumentation as related to the biomedical research and radiation control programs is considered to be adequate. The opening of new areas of research, such as bio-energetics or low-level effects of radiation, will require intensified supporting instrumentation, but it is not anticipated that the proportionate cost should exceed the current ratio.

Because of the highly developed facilities and experienced personnel at the AEC laboratories, it is recommended that from time to time consideration be given to undertaking instrumentation research programs for the Office of Civil and Defense Mobilization and for the National Aeronautics and Space Administration.

(d) Civil Effects.

We believe that the study of the AEC laboratories' role should contain a statement on the role of the AEC laboratories conducting research and development in effects of nuclear explosions on man and his environment in support of non-military defense planning. Our dynamic and successful weapons development program has had profound effect on civil defense planning. Traditionally, AEC has been one of the principal suppliers of information on effects of nuclear explosions to the Congress and to those agencies responsible for national civil and defense mobilization planning.

We are now faced with the probability of having to discontinue critically needed field experiments on effects of nuclear explosions because of limitations on weapons tests. Increased effort on laboratory studies represents the only way we can see to supply the needed data. Weapons developments have already far out-paced our knowledge of effects and it has been recognized that special effects tests were required to up-date our information and knowledge. The test suspension has stopped most of the planning for such test series.

Despite the moratorium on tests, the weapons development program will probably continue to be vigorously pursued. Unless an equally vigorous effort is placed on effects studies, within ten years we will find that the gap between weapons effects information and weapons capability will be so great that we will not have the basic information needed for survival. This information is needed for AEC's own self-protection as well as for overall national civil defense planning.

It is anticipated that the role of the laboratories, particularly LASL, Sandia, and LRL, will include increased attention and expansion of theoretical and laboratory studies of weapons effects, phenomenology of blast, thermal, prompt radiation and fallout.

AEC cannot disassociate itself from the responsibility of seeing that the effects of nuclear reactions which will influence national survival are understood and promptly communicated to the agency responsible for non-military defense planning.

(5) Toxicological Research.

Inherently, atomic energy operations are not only faced with hazards from external radiation sources but with numerous other potentially hazardous agents which may be deposited within the body and must be regarded as either chemically toxic, radio-toxic, or both. Many of these hazards are associated with the mining, milling and concentrating operations in the procurement of raw materials and ores and in the purification, fabrication and reprocessing operations found in the manufacture of nuclear weapons and fuels. Much research effort has been spent in the past and must necessarily be expended in the future to evaluate these hazards, to set tolerance limits, and to develop protective and/or corrective methods to control or neutralize these hazards.

Because of the expanded efforts in reactor development, a concurrent effort must be expended relative to the potential hazards from fission product contamination resulting from reactor operations and possible excursions. Not only are studies necessary on the hazards of radio-toxic elements associated with reactor operations but such studies are likewise necessary to determine the toxicity of many non-radioactive elements now coming into prominence as components of reactor development and construction. The acquisition of toxicity data must parallel the development program.

Because of the expanded efforts which are now being contemplated in the above areas, it is felt that ore toxicological research efforts must necessarily expand accordingly.

Approximately half of this toxicological research is being carried out in universities under AEC contract while the balance is being performed in our national laboratories or through prime contractors. There is little reason to doubt that all such toxicological studies could be executed in qualified universities as long as the Commission is willing to wholly support the undertaking of this research.

(6) Basic and Applied Research in the Life Sciences.

(a) Cancer Research.

The major activities of the cancer research program are centered in the Argonne Cancer Research Hospital and the Brookhaven National Laboratory. In each of these installations the research programs for the most part are centered around high energy particle accelerators which have been especially adapted for use in patient treatment. In addition to the 2 Mev Van de Graaff and 2800-curie cobalt source for teletherapy, the ACRH group recently completed a linear accelerator especially adapted for patient treatment and which has a variable energy range from 5 to 50 Mev. A further refinement has been the adaptation of a magnetic deflecting and scanning unit which provides variability in beam direction and treatment area required in practical radiation therapy.

Patient treatment with the linear accelerator has been under way for a relatively short period of time, and it will be several more months before adequate experience is gained with this device to accurately assess its effectiveness in the treatment of certain malignancies.

At the Medical School in San Francisco patient treatment has been under way for some time utilizing the x-rays from the 70 Mev synchrotron. Patient studies are expected to continue for at least another two years before an evaluation can be made with respect to the effectiveness of this high energy device in the treatment of malignancies. In addition to the above-mentioned therapeutic devices covering the energy range from 2 to 70 Mev, we have two teletherapy units at ORINS, one a kilocurie source of cobalt-60 and the other a kilocurie source of cesium-137. On the latter two a substantial amount of calibration and treatment techniques have been resolved with limited patient treatment involved.

At the Lawrence Radiation Laboratory the proton beam of the 184" cyclotron has been used very effectively in irradiating the pituitary gland of breast tumor patients. Though the application of this technique has certain limitations, results to date have been sufficiently encouraging to continue research efforts in this area. In some cases, the results have been short of miraculous.

With the completion of the medical reactor at Brookhaven, we expect a marked increase in research involving the neutron beam, especially in the therapy of certain brain tumors and hemangiomas. With the calibration studies nearly completed, patient treatment should begin very soon, and within the next twelve to sixteen months the in-patient load should reach a maximum and level off. It is hoped that considerable improvement might be made in the preparation of organo-boron compounds, and with continued improvement in techniques for administering these neutron-capturing materials the medical reactor will be utilized more extensively in cancer therapy.

Interest continues in the use of various brachytherapy devices, especially in view of the limited success obtained at ACRH with the use of palladium-103 in certain advanced tumors. The use of yttrium-90 to destroy the pituitary gland in patients with metastatic carinoma of the breast has been very encouraging, for it does have a certain amount of advantages over surgical techniques for hypophysectomy. In addition, the use of iodine-131 encased in polyethylene implanted in patients with inoperable carcinomas has been receiving some attention. The group at ORINS will continue to explore the development of other brachytherapy devices, as well as the improvement of existing ones.

Although current efforts to isolate and characterize erythropoietin have not paid off as yet, the research is sufficiently encouraging to continue the biochemical fractionation with the hope of carrying out clinical trials in the near future.

Studies will continue on the effectiveness of triiodothyronine in potentiating the biological action of ionizing radiation. The use of triiodothyronine in conjunction with radiation in the control and ablation of various tumors has been found to be effective both in clinical patients and in experimental animals, although some toxicity has been noted in patients subjected to long treatment. Refinement of this technique will continue.

At the University of Rochester we have been supporting a limited amount of immunological work directed toward antibody labeling. Dr. Bale's group has been attempting through immunological means using iodine-131 to irradiate tumor masses, especially those that are metastatic, in animals. His results to date have been quite encouraging, although a great deal more must be done in increasing the efficiency of this technique.

Immunologic studies will receive continued emphasis. Extension of the recently initiated attempt to treat cancer of the thyroid by an immunologic attack on the antigen in thyroglobulin will be made. In addition, fundamental studies directed toward determining the earliest link in the chain of events leading to immunologic rejection of grafts of foreign tissue will be pursued with added vigor.

Rather extensive metabolic studies continue in both normal and cancer patients, as well as in animals, following the administration of metabolically important substances labeled with carbon-14. The excretion patterns are being followed to detect changes that occur in cancerous conditions, as well as following whole body radiation injury.

A limited amount of research is being pursued in the area of both radiation and chemical carcinogenesis at the Argonne National Laboratory. This work has been carried out at the animal level and has not revealed any new or significant information.

It is not the intention to expand the cancer research program beyond its present level, and in all probability it will require another 3 to 5 years before we will have accumulated enough information to accurately determine the effectiveness of the various radiotherapeutic devices currently in use in the program. Some flexibility is maintained in this program, especially as it relates to the studies on patients at the Argonne Cancer Research Hospital. This group is constantly on the alert to follow through and explore any promising techniques or isotopes which offer palliative or therapeutic effects in relation to various malignancies.

(b) Plant Sciences.

The Commission should maintain its present level of activity in fostering the application of radiation techniques for the improvement of economic crops. This, at present, is largely a cooperative program involving many State Agricultural Experiment Stations. The AEC installations perform pilot studies and provide radiation facilities and radiobiological back-up for the college and university scientists. The basic plant science program as related to radiation effects will be expanded, especially at the organism level, as recommended by an ad hoc committee of botanical scientists.

LABORATORY PROGRAM FORECAST

ARGONNE NATIONAL LABORATORY

Although the Argonne National Laboratory dates its official life from July 1, 1946, the Argonne program had its inception in 1942 as part of the Metallurgical Laboratory at the University of Chicago under the auspices of the Manhattan Engineering District. Early in 1942, when physicists became convinced that the nuclear chain reaction would be successful, concern arose about the radioactive hazards which would be involved. Consequently, a broad research program was initiated to determine the biological effects of radiation with the dual purposes of providing a basis for establishing permissible exposures to all forms of radiation and radioactive isotopes and the understanding of radiation sickness so as to devise preventive and therapeutic procedures. The continuing philosophy of the biological and medical research program at the Argonne Laboratory has been to study the health hazards of acute and chronic exposure to external radiation and to internally deposited radioisotopes.

As our knowledge of the acute effects of radiation has increased, greater emphasis has been placed on the chronic effects of low-level exposure to radiations, in anticipation of the increasingly important problem which will result from widespread use of nuclear reactions for power production. Consequently, a major program expansion on long-term biological effects of low-dose radiation is underway. Because of the low doses and dose rates involved, such studies require a considerable expansion of experimental animal facilities. In addition to studying the effects of fission neutrons, high-energy gamma radiation, and strontium-90 deposition, the program will undertake to evaluate the effects of a variety of mixed fission products, both short and long lived. Emphasis will be on the life shortening and carcinogenic effects.

The growing need for information concerning the chronic effects of low-level radiation exposures has already been mentioned. In addition to the large-scale laboratory animal studies with dogs and mice, a detailed epidemiological study on human populations is rapidly gaining impetus. Between 500,000 and 700,000 persons in Illinois are routinely drinking well water that contains above-average levels of radium; some waters contain levels near the maximum permissible content. Body radium burdens will be measured and correlated with estimates of the incidence of bone pathology and bone tumor mortality. These studies are integrated with the continuing follow-up of radium dial painters and other persons known to be carrying significant body burdens of radium. Basic biochemical and cell structure research programs could be shifted to universities or reduced in scope as the above programs expand. Studies on human biochemical genetics will increase. Certain projects in the plant sciences concerned with radioisotope labeling of compounds involved in biosynthesis will be brought to completion. Studies of the biochemical factors which account for differences in the radiosensitivities of individual cells within a population will be expanded as they are required by the long-range neutron and gamma ray toxicity project. A comprehensive program of the biological effects of fission neutrons at dose rates varying from about .0001 to 10,000 rad per hour will be initiated upon the completion of a special biological research reactor facility in 1960.

Based upon the above statement of research objectives at Argonne National Laboratory, the level of support for the programs in the life sciences could be expected to undergo a substantial increase in ten years over the FY 1960 operating level of $4,100,000, with an estimated 115 scientific man years of effort. On the assumption that the general economic factors in the nation will remain relatively constant, an increase in the order of 40% in operating costs is indicated by FY 1970 to provide for the expansion in the studies of chronic effects of low-level radiation, neutron toxicity, and human biochemical genetics. An allowance has been made in this estimate for the completion of certain projects as stated above.

LABORATORY PROGRAM FORECAST

BROOKHAVEN NATIONAL LABORATORY

At the end of World War II, large government laboratories for nuclear research were in operation in all sections of the country, except in the Northeastern United States where many of the country's most active and distinguished scientists are located. Recognizing the need for a nuclear research center in this region, exploratory discussions between representatives of eastern universities and the Manhattan Engineering District led to the incorporation in 1946 of Associated Universities, Inc., a non-profit educational corporation. AUI contracted with the Manhattan Engineering District, and later with the Atomic Energy Commission, to establish and operate the Brookhaven National Laboratory.

Because of its close association from the beginning with the university community, the Brookhaven National Laboratory has emphasized basic approaches to research problems of Atomic Energy Commission interest and the education and training of research, student, and technical personnel. The training activity has been especially important at the post-doctoral level, where a large number of young scientists have served as temporary research associates for periods of from one to five years before taking permanent positions in the universities. In addition, a large proportion of the total research in the laboratory is done by visiting scientists, most of whom come from the regional universities, but many from other sections of the nation as well as from abroad. Thus, in the Biology Department which constitutes about 40% of the total research effort in the life sciences at Brookhaven, there are at present about 20 staff scientists, 10 research associates, and an average of 15 visiting scientists engaged in the research program. It is currently anticipated that the research program will continue to expand until an equilibrium level of 30-35 staff scientists, 25 research associates, and an average of 30 visitors is attained.

The biology research program emphasizes research in genetics, radiation biology, molecular biology, mammalian physiology, and cellular physiology.

This Laboratory provides our principal facility for the cooperative programs in the application of radiation for crop improvement. No further expansion in this effort is anticipated. The research program in plant radiobiology will be expanded following the recommendation of an ad hoc committee of botanical scientists who recently examined critically the entire plant science research program of the Commission. Since the existing program at Brookhaven is already strong in molecular level studies, the expansion will emphasize effects on tissues, whole plants, and plant communities.

It is anticipated that the general program in genetics will remain at about its present level of toxicity. Particular emphasis will be given to the effects of radioisotopes incorporated into the genetic materials.

Strontium-90 may present a special problem in this regard since it can partially replace calcium in the molecular structure of chromosomes.

The radiation biology program has emphasized mammalian studies. Although the numbers of animals employed in radiation toxicity studies will not be greatly increased, there will be an expansion of the basic studies at the molecular and cellular levels necessary for understanding whole body radiobiological effects. Estimates of cell renewal and turnover times are important in predicting radiation effects on specific tissues of importance in maintaining the physiological levels of activity consistent with survival. Efforts in theoretical biology will be considerably expanded to aid in the prediction of radiobiological damage.

The molecular biology program will be strengthened by expansion of studies in free radical chemistry, of protein and nucleic acid biosynthesis and their interrelationships, of protein structure, and of the mechanism of enzyme action.

A program of nuclear medicine is promoted by the Medical Department. It includes application of atomic components in the treatment and diagnosis of disease and in the elucidation of fundamental biological processes. During 1959 a medical reactor (the first designed for medical use only) was brought into operation. Rapidly, the research and service activities are being oriented around this special facility.

By utilizing radiation sources designed for other than medical purposes, preliminary studies have been carried out on newly developed irradiation methods. Central among the newer procedures has been the employment of sharply localized short-range and short half-life particle radiation made possible by neutron bombardment of localized isotopes with particular characteristics. Researches inherent in this field of activity necessarily involve investigations of precise isotope localization, kinetics of distribution and redistribution, metabolism of organic compounds, functions of inorganic compounds, and the effect of excited atoms on the stability of large molecular complexes. Advantage is sought of special situations applicable to medical practice, such as neutron-capture therapy of glioblastoma multiforma. For such purposes, advantage is taken of anatomical and physiological conditions such as the blood-brain barrier situation, as well as of particle range and rate of radioactive decay.

Associated with the neutron-capture therapy developments are studies of treatment procedures employing pure neutron and pure gamma radiations - also selected mixtures of these. Such refined RBE studies enable meaningful analyses of the mechanism of radiotherapeutic action. Other associated activity areas made special by availability of the medical reactor are activation (induced radioactivity) analyses and trace element (manganese, copper, and other) investigations.

Tritium-labeling studies (largely initiated at Brookhaven) have yielded basic information about DNA synthesis, chromosome replication, tissue regeneration, durability of specialized cell types, and secretory function. The techniques (including use of carbon-14) have such remarkable possibilities that many other developments and discoveries are to be expected.

Because of interest, technical competence, and particular opportunities as well as special facilities, preliminary attention has been given to very high intensity (pulse-type) and very low intensity (environmental-type) irradiation. Within the scope of the first are unique treatment opportunities for dealing with cancer and other late effects, and within that of the latter (radioepidemiology) are opportunities to determine the influence of low-level irradiation exposure increments to population groups resulting from general atomic energy developments. Inherent are potentialities for analytical consideration and investigation of the nature of degenerative diseases of many types (arteriosclerosis, nephrosis, cirrhosis, neoplasia, sterility, anemia, and others).

Bearing in mind the unique facilities, the special competence, and the unusual associations available at the Brookhaven Laboratory, it appears necessary to take cognizance of the following:

1. That every effort will be made to discover, utilize, and test therapeutic advantages provided by a medical reactor.

2. That impressions about therapeutic advantages, based on clinical experience, will become advanced within the coming ten-year period.

3. That, despite the necessary remoteness, opportunities and advantages are provided at Brookhaven that cannot be duplicated at more than a few locations, even if unlimited funds were available.

Research in the life sciences at the Brookhaven National Laboratory is supported at an operating level of $4,715,000 in FY 1960; an estimated 103 scientific man years is devoted to projects in medicine, biology, environmental sciences and health physics. Planned expansion in plant radiobiology and in basic studies in molecular and cellular biology, along with a modest increase in a number of areas of nuclear medicine point to an overall increase approximating 30% during the next ten years.

LABORATORY PROGRAM FORECAST

OAK RIDGE NATIONAL LABORATORY

The wartime Clinton Laboratory, which ultimately gave rise to the Oak Ridge National Laboratory, was built in 1943 with two major objectives closely related to the nuclear weapons effort. First was the construction and operation of a production scale plant for the electromagnetic separation of uranium-235 from normal uranium. The second objective was the development on a pilot plant scale of methods for the production of plutonium-239 to be employed in the plutonium production plant under construction at Hanford. This involved construction of the Clinton pile and the development of methods and equipment for the chemical separation and purification of plutonium-239 from the fission products produced by neutron bombardment of uranium-238.

Following the war, the biological research effort, which previously had been concerned largely with health physics research to insure the safety of the operations, was expanded by the formation of the Biology Division. The underlying philosophy of the Biology Division is the study of the mechanisms of radiation effects in biological systems in an effort to design means of protection against radiation damage and of counteracting the damage after the radiation has been absorbed. The approach has been largely along genetical and cytological lines, with heavy emphasis on biochemistry and biophysics. Although much of the work has been concerned with cellular level effects, there is increasing emphasis on mammalian systems.

The Oak Ridge National Laboratory, in collaboration with the Oak Ridge Institute of Nuclear Studies, has emphasized education and training throughout the years. The program has had many facets, with heavy emphasis upon traveling lectureships in the southern universities, and an active research participation program whereby university staff members can work for periods from three months to several years at the Laboratory. An active program of post-doctoral training by means of temporary research associateships has been very successful, not only in training young scientists but also in recruiting scientific personnel. Since the establishment of the Laboratory, many senior personnel have left to accept university positions. This has not only strengthened the scientific programs of the regional universities but, in addition, has accomplished a transfer of certain research programs from the Laboratory to the universities, since in most cases these individuals transferred not only portions of their own research programs but also frequently some of their associated scientific personnel.

The research program of the Biology Division is organized into the following large subdivisions:

1. Cytology and Genetics.

This large project encompasses studies with a variety of organisms, including bacteriophages, bacteria, maize, Tradescantia, Vicia, Drosophila, and recently mammalian tissue culture cells. The emphasis is on basic studies of cellular structure and function, and of the action of radiation on the cell and especially on the genetic apparatus. This program will continue at the present high level.

2. Mammalian Genetics and Development.

The Oak Ridge National Laboratory is the site of the Commission's major program in mammalian genetics. Although many important results have been obtained throughout the years, the most exciting development is the recent finding that the induction of gene mutations occurs at a lower rate when the radiation exposure is protracted over a long period at a low dose rate. This is extremely significant to consideration of the genetic hazards of fallout and occupational exposures. The present level of activity will continue although new projects will be initiated as certain major studies are completed.

3. Microbial Protection and Recovery.

Bacterial and fungal cells have been employed as model systems for the study of basic mechanisms in chemical protection and recovery from radiation.

4. Mammalian Recovery.

Laboratory studies of protection by chemicals and by bone marrow transplantation in the mouse have been emphasized. The program has developed into a broader one concerned with tissue transplantation in general, with emphasis upon related immunological problems. No expansion of effort is planned.

5. Pathology-Physiology.

These studies have been concerned with the pathogenesis of early and delayed somatic radiation effects in mammals with emphasis on the induction of leukemia and neoplasia. This program will be expanded to encompass the life shortening and carcinogenic effects in mice of chronic low-level radiation.

6. Cell Physiology.

The major objective of this project is the determination of the molecular basis of cell function. The findings will provide a background to facilitate determination of the effects of radiation and other insults on cellular function. No major increase in this program is anticipated.

7. Biophysics.

The biophysics research is concerned with the understanding of the basic primary physical and chemical events which underlie and govern the action of radiation in biological systems. Significant advances have been made by the application of electron spin resonance methods to biological materials. It is anticipated that these studies will be expanded in conjunction with an overall increase in the Commission-supported effort in biophysics and bioenergetics.

8. Radiation Immunology.

These investigations are concerned with the fundamental immunological aspects of bone marrow and other tissue transplantation, and with fundamental immunological investigations. A modest expansion is planned, with emphasis on the immunogenetic aspects of the problem.

9. Biochemistry.

The biochemistry projects at the Oak Ridge National Laboratory have been concerned with three major problems: intermediary metabolism in bacteria and plants, nucleic acid biochemistry, and protein synthesis. Considerable expansion is planned with emphasis on the interrelationships and genetic control of nucleic acid and protein biosynthesis, biochemical studies of gene action, and studies of cellular differentiation at the molecular level.

While the projects in plant and mammalian genetics, which are two of the largest areas of research at Oak Ridge National Laboratory, will continue at existing levels of support, an expansion of programs in pathology-physiology, bioenergetics, radiation immunology and biochemistry indicate an increase during the next ten years of approximately 20% over the FY 1960 operating level of $5,420,000, with 166 scientific man years of effort.

LABORATORY PROGRAM FORECAST

LAWRENCE RADIATION LABORATORY - BERKELEY

The Lawrence Radiation Laboratory developed around the cyclotron devised by Ernest O. Lawrence. The basic designs and development of the instrument went forward between 1929 and 1936 to such a large extent it became necessary to establish the equivalent of a research institute to capitalize on the enormous potentialities of these instruments, for the University of California and the group working with Lawrence had become one of the three great centers of the now developing field of nuclear physics and chemistry. The 60" instrument built in the then newly organized Crocker Laboratory made available for the first time radioactive elements in amounts sufficient for medical use.

Small amounts of P^{32} had become available in 1936 from the small cyclotrons and John H. Lawrence at California and Artom and Hevesy in Europe had used P^{32} for tracer purposes in 1936. Lawrence, however, by virtue of his source of supply was the first to exploit the use of P^{32} to treat hematological diseases and this group therefore became the nucleus of the health physics-biomedical research organization formed under the Manhattan District to study the biological effects of radio-isotopes which might limit the concurrent developments in reactor technology and fissionable material production.

The position of such a biomedical group in a nuclear energy research complex was firmly established during the war years so that when the newly formed AEC undertook to support further developments in nuclear physics and chemistry at Berkeley, a biomedical group was also organized under Dr. John Lawrence and Joseph Hamilton to continue the excellent research programs of the war years. The Donner Foundation contributed to the further development of this group by providing funds for a modern biomedical research building and assisting in setting up a pavilion at the University Student Infirmary where research on patients could be carried on. An animal house with a few supporting laboratories was built with AEC funds.

At present about 60% of the personnel on the project have their laboratories in the Donner Laboratory or Donner Pavilion, the remaining being in the life sciences building, at the animal laboratories, or working in connection with one or another of the several accelerators.

In the case of the Donner Laboratory, it is anticipated that greater emphasis will be placed on the use of the particle-accelerators available at LRL to study the effects of heavy-particle radiation on cells and cell components. These studies at first will be basic but, no doubt, will have practical therapeutic applications. There is the possiblity that a particle accelerator specifically designed for depp X-ray therapy may be designed and built.

Research on the biological effects of deuterium will also be expanded.

The experiments concerned with photosynthesis and basic molecular radiation chemistry will continue to provide the major stimulus for many of the ideas responsible for the progress in understanding the effects of radiation on living tissue. It would not be improper to anticipate within the next 10 years a major breakthrough in this field on photosynthesis and energy accumulation in living tissues which would have major effects on the whole field of biochemistry.

The studies on the distribution of radioactive materials in the mammal will gradually be terminated as the animals die off. The space used for this program will be employed to develop a colony of pathogen-free animals which will be particularly useful for analyzing the role of stress from infectious diseases in the acute and chronic radiation syndrome. Other studies which may expand abruptly if a breakthrough develops are concerned with: the erythropoietic principle obtained from urine; the pinhole camera technique of scanning; the relation of fatty materials and foods to disease of the arteries and to the aging process; and the use of labeled hormones and biological compounds to study biological processes and diseases.

It is recommended that the role of the Lawrence Radiation Laboratory, as well as that of LASL and Sandia, include increased attention and expansion of theoretical and laboratory studies of weapons effects, phenomenology of blast, thermal, prompt radiation, and fallout.

The training effort at Berkeley is gaining greater reputation every year but there is a limit to the number of persons which can be accepted and adequately trained at the laboratory; in this case the limit is set by both space available and the permanent staff supported by the budget. On the whole, therefore, the Donner Research Laboratory should expand in a gradual well-controlled fashion to about 50% greater than its present size and activities. This will necessitate a rearrangement of the present facilities and quarters, but no predictions are possible until the university has decided a number of internal problems.

The FY 1960 operating level of support is $2,226,000, with an effort of 64 scientific man years.

LABORATORY PROGRAM FORECAST

LOS ALAMOS SCIENTIFIC LABORATORY

The Los Alamos Scientific Laboratory was officially established in April, 1943 for research and development concerned with nuclear weapons. Although weapons research remains one of the major objectives of the Laboratory today, the personnel and facilities make it a center of physics research and there are large programs in theoretical and experimental physics, chemistry and metallurgy in addition. Since from the outset, it was known that Los Alamos workers would be handling plutonium, a Biomedical Research Division was immediately organized to study the unique and difficult problems attendant thereto. From this beginning, the present biomedical research group of about 25 staff members and 30 supporting personnel has grown. While most of their activities have been directly related to weapons research development and testing, many of the problems encountered have necessitated basic research on radiation biology, biochemistry, biophysics, radiochemistry and instrumentation. The program of the Laboratory has been especially valuable in studying the physiology and effects of a variety of radioactive isotopes and fission products, and in the development and application of scintillation counting techniques including whole body counting methods. In addition, the Laboratory has been invaluable in radiation monitoring at weapons tests and in the fallout monitoring and surveillance project.

The total program will remain quite stable in the coming years. Continued emphasis will be placed on scintillation counting techniques for monitoring and whole body counting purposes. Attempts to recreate under laboratory conditions the exposure rates of a fresh fallout gamma field will expand slightly along with measures of changes in recovery mechanisms and resistance to stress. Smaller studies in cell injury and metabolism will provide data pertinent to the whole body effects of radiation under investigation. Some expansion in studies on the toxicity of tritium and tritiated compounds is anticipated though this will be offset by the completion of other studies of fission product metabolism and effects. The Los Alamos program on the long term effects of partial body and wole body irradiation will continue. No major expansions of program are anticipated. The close adherence of the Los Alamos Scientific Laboratory program to the programmatic needs of the Commission will continue.

Support of biomedical research may be expected to increase in the order of 15% from its FY 1960 operating level of $1,008,000, and 25 scientific man years of effort.

LABORATORY PROGRAM FORECAST

HANFORD ATOMIC PRODUCTS PLANT

The completion of the plutonium production facilities in 1944-45 necessitated a program of biological research to insure an adequate radiation protection program. This involved studies of fission product and especially plutonium metabolism and effects. In addition, since water was used to cool the reactors, investigation of possible effects on aquatic life in the Columbia River was initiated. The close association of the Hanford biological research program to a production facility has pointed the way towards many problems of importance to the Atomic Energy Commission. In recent years, the character of the research program has gradually changed towards a more basic approach to the problems being studied. In addition, a closer liaison between the northwestern universities and Hanford is developing which promises to be beneficial both to the university community and to the Commission.

Research endeavors concerning the hazard evaluation of internally deposited radioisotopes on organs and organ systems in small and large animals will be maintained and expanded where necessary, since little valid information is currently available to delineate dose-effect relationships and to permit acceptable extrapolation of effects and hazards to man. Chronic feeding experiments employing various fission products and reactor effluent radioisotopes have been emphasized. Particular attention is directed toward radiation effects on nucleic acid metabolism of the gastrointestinal tract. Projected studies over the next ten years will be expanded to include comprehensive metabolic and biologic response studies concerning Pu-239, Sr-90, Ca-45, Ra-226, Zn-65, P-32 and Ru-106.

Development of the use of miniature swine as an experimental animal will be emphasized. Studies concerning removal of internally deposited isotopes, such as plutonium, should be expanded. The addition of studies on the factors affecting the permeability and absorptive properties of cells toward radionuclides is urgently needed.

Biological and environmental sciences research at the Hanford Plant is being supported in FY 1960 at a level of $2,298,000, with 63 scientific man years of effort. On the assumption that national economic factors remain constant and that organizational relationships of the program are not altered, the current level of support could be expected to increase approximately 15%.

LABORATORY PROGRAM FORECAST

ARGONNE CANCER RESEARCH HOSPITAL

The Argonne Cancer Research Hospital, operated by the University of Chicago, was completed in early 1952 and made an integral part of the Billings Hospital, both of which are closely integrated with the Medical School. The establishment of this cancer hospital was authorized by the President for the primary purpose of exploring the therapeutic and diagnostic uses of radioisotopes in patients suffering from cancer. This facility provides an opportunity for competent medical scientists to conduct comprehensive studies in patients hospitalized with various types of malignancies. In particular, it also affords an opportunity to assess the therapeutic value of various teletherapy devices, including the cobalt-60 unit, the 2 Mev Van de Graaff, and the 50 Mev linear accelerator.

Though the program is oriented primarily toward metabolic studies and the therapeutic use of high energy particle accelerators, the group has been encouraged to pursue any promising leads, though peripheral, to the cancer problem. The encouragement of such research tends to attract better scientists into the program.

With the recently completed 50 Mev linear accelerator now in operation and being used in the treatment of patients, this cancer research facility has reached a stable operational level which should not increase to any great extent in the foreseeable future. The main mission of the Hospital will continue to be that of conducting extensive studies on hospitalized patients using radioisotopes therapeutically, diagnostically, and as tracers in metabolic experiments.

There should be little or no change in the tempo of studies directed toward detecting metabolic defects in both cancer and irradiated patients. With the available personnel interested in this phase of the research program, it is envisaged that there will be a continued interest in improvising new instrumentation, as well as the utilization of various isotopes and labeled compounds in studying metabolic defects.

The follow-up studies which have been carried out in the radium dial painters in cooperation with ANL should continue for several years, and in all probability the whole body counter at ACRH will prove useful in studying these patients and/or any other patients with similar conditions.

Both the immunological research and the research associated with recovery from radiation injury will continue at the same tempo for the ensuing three years. Also, the program directed toward an elucidation of factors which influence survival of transplanted tissues will be a continuing effort for at least a three-year period.

That portion of this program which requires some comment is the matter of erythropoietin studies. It is the expectation that in the very near future this substance will be isolated and characterized to such an extent that clinical trials will be feasible. If this becomes a reality within the next year, much of the current work in this area will terminate. Whether or not the costs involved with the clinical trials will be borne by the AEC is a matter which has not been resolved; if so, this would approximate $200,000.

It is well recognized that the decision to build and operate a cancer research hospital closely integrated with a first-class medical school has certain intangible benefits. An undertaking of this sort was not possible financially by a private institution, and in this case it has enabled a group of outstanding medical scientists to have available the facilities of the AEC to cope with most intricate and complicated problems. Though one might argue that such a facility might easily be supported by private enterprise, in reality its effectiveness would be greatly reduced under such an arrangement. The operation of this facility is costly on one hand, but it does permit careful and thorough study of cancer patients who otherwise would find it impossible to remain hospitalized for long periods of time. A considerable amount of knowledge is being accumulated in this Hospital, and it is important to note that a thorough study of selected patients yields considerable information to the research workers in contrast to the rather short-term type of study one would be forced to conduct in a private hospital where daily expenses are a concern to the patient.

It is difficult to predict results of this study during the next ten-year period, but in this particular instance it is considered that the operational level should be fairly well stabilized; and, barring any unforeseen problems, should not exceed the $2,500,000 figure, as compared to the FY 1960 level of $2,100,000, with an effort of 46 scientific man years.

The possibility of transferring funding and responsibility of this Hospital to another agency of Government was raised some time ago, and the justification for not doing so still holds.

In its basic legislation the AEC is authorized to engage in medical, biological, and health research involving the utilization of fissionable and radioactive materials. The Congress has made it clear that it wishes the Commission to engage in cancer research, as evidenced by specific language in the Appropriation Act for FY 1948 when $5,000,000 was made available for that purpose. The medical consultants to the Commission at that time considered the Argonne Cancer Research Hospital unit a proper part of the AEC cancer program. The Surgeon General of the Public Health Service carefully reviewed this project and reported that he and members of the staff of the National Cancer Institute considered it justified.

With time there has evolved some change in direction and emphasis in support of cancer research. In particular, the rapidly expanding uses of radiant energy, the increasing numbers of workers potentially exposed to radiation, the world-wide increase in radiation background secondary to atomic weapons testing, and the future problems yet to be solved in waste disposal from power and industrial uses all prompt the Commission to maintain an active supporting interest in cancer research and also in the relationship between radiation exposure and cancer induction.

The total budget for cancer research within the Division of Biology and Medicine is approximately eight per cent of the total budget, an amount which is considered minimal by our Advisory Committee for Biology and Medicine. The ACBM report of its January 1959 meeting recommends that the ACRH not be divorced from Commission responsibility.

LABORATORY PROGRAM FORECAST

UNIVERSITY OF ROCHESTER ATOMIC ENERGY PROJECT

The University of Rochester Atomic Energy Project had its beginning in 1943 under the Manhattan Engineering District. Its mission was to develop experimental data that would enable the establishment of safe levels of exposure to various chemicals and radioactive substances used in the development of the A-Bomb.

After the establishment of the Atomic Energy Commission, the biological and medical program at the University of Rochester was placed on a more permanent basis, and more closely associated with the University. The physical proximity of the AEC facilities to the Medical School has contributed to the closest association and integration with the parent university of any of the Commission-sponsored laboratories. The Project is administered by the Department of Radiation Biology, Which has full departmental status in the Medical School. Nine members of the Project staff hold the rank of full professor, and there are many more in the other faculty grades. The total scientific staff numbers about fifty.

An important educational and training program is operated by the Project. In addition to Commission-supported courses in Radiological Physics and Industrial Medicine, which supply many of the health physicists for Commission and contractor facilities, more than half of the graduate students enrolled in the life sciences in the University Graduate School are under the Department of Radiation Biology. These students may major in biophysics, radiation biology, pharmacology, or biochemistry. The graduates of these courses have filled many responsible positions in the Commission installations, both in research and in operations.

Program Forecast

Although the Rochester Project now has strong teaching and basic research programs, the Commission continues to rely on this laboratory for much of its toxicological data. The Division of Pharmacology and Toxicology has always cooperated in studying the toxicity, retention, excretion, and movement within the body of materials in the atomic energy industry suspected of chemical or radiological toxicity or other detrimental effects. Uranium, thorium, radium, radon, beryllium, polonium, thallium, indium, and mercury are examples. The alpha-inhalation laboratory is well equipped to study the relation of various particle sizes to the inhalation, retention and distribution of aerosols. The studies are expected to continue for many years and will be increased by the addition of strong programs in aerosol physics, pulmonary physiology, and instrumentation. Other programs in this division are devoted to bone metabolism and the study of the transport of ions across cellular membranes.

The Radiology and Biophysics Division is oriented primarily toward the study of biological processes by physical techniques and of certain aspects of chronic radiation damage and recovery. These programs are expected to continue for a number of years at the present level of effort. A relatively small program concerned with amino acid metabolism could be transferred to other University departments.

The Medical Division carries out metabolic studies in irradiated animals, and devises and tests various clinical procedures for promoting recovery from acute radiation damage. This program is expected to decrease in activity unless radically new anti-radiation drugs are developed. It is anticipated that the Medical Division will decrease the level of its experimental program with animals and pay increased attention to long-term effects as they may be observed in human populations occupationally exposed to radiation and radioactive materials.

A small but significant program, both basic and applied, on the production of burns by short, intense flashes of thermal radiation has supplied the Commission with most of its knowledge of the processes involved and possible methods for protection from burns caused by nuclear weapons. This work is essentially complete and will be phased out during the next two years. The basic program in physical measurements will probably be transferred to the Institute of Optics.

During the past few years the staff of the Project has paid increasing attention to the programs dealing with long-term, low-level effects of radiation in several species of laboratory animals. These studies are expected to continue for a number of years and may be further increased to meet specific needs of the Commission. However, no significant increase in the number of scientific personnel is planned, and it is expected that the level of operations will remain essentially constant during the next ten years.

The FY 1960 operating budget at the University of Rochester is $1,746,000.

LABORATORY PROGRAM FORECAST

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES

MEDICAL DIVISION

The Oak Ridge Institute of Nuclear Studies is a non-profit corporation of 37 Southern universities and colleges which have the responsibility over the four Divisions of the Institute: Special Training, University Relations, Museum and Medical.

The Medical Division was formally organized in January 1949 as a research unit, the broad interests of which are directed toward the preliminary investigation of promising possibilities in the application of radioactive substances to the study of cancer and related disease. It was located in Oak Ridge with the expressed intent of developing a medical center peculiarly appropriate to the Oak Ridge location which would exploit for the benefit of medicine as a whole the special opportunities of an A. E. C. installation. The presence and personal interest of a large staff of outstanding electronic, nuclear instrumentation and isotope production specialists of the Oak Ridge National Laboratory has contributed greatly to the successful pioneer work in radioisotope therapy, teletherapy design and patient treatment.

A primary reason for establishing a clincial research program at Oak Ridge was the availability of short-lived isotopes from the reactors. The extensive clinical evaluation of gallium-72 with a half-life of fourteen hours is an example of a study carried out at ORINS that would have been impossible to undertake at a more distant location from an isotope producing reactor. Currently the efforts in the clinical program are directed toward the internal use of new isotopes plus studies involving external irradiation followed by bone marrow transplantation. Extensive basic and pre-clinical studies are being pursued in an effort to learn more about the distribution and metabolism of man in the diseased state. Thus far 1,002 patients have been admitted for treatment. One hundred and sixty-six articles have been published in medical and scientific journals.

A corollary feature of the ORINS' Medical Division is the close working relationship which has been developed between clinical and instrumentation services. In many institutions the patient program is administratively quite separated from the physics and electronic areas, and the close cooperation and intimate working relationships ORINS now enjoys naturally are not often possible. In the case of ORINS the clinical program continually calls attention to problems requiring new instrumentation; the instruments are developed on the spot with clinical and electronic specialists working together throughout; and when developed the instruments are tried out on patients by the same team of specialists.

An accompaniment of this program is the training of physicians and scientists from the United States and foreign countries. One hundred and forty-four American physicians and twenty-seven foreign ones have spent from three months to two years in the Medical Division. This was augmented by thirty-six scientists in the life sciences.

It is contemplated that the Medical Division will continue to operate at or near its present level of support for at least another ten years. The completion of the Whole-Body Irradiation facility will undoubtedly lead to an expanded fundamental study on the effects of whole body irradiation with perhaps less emphasis on the use of new isotopes. The new facilities will permit radiation to be directed at patients from several directions with a resulting more uniform dose distribution. Efforts will be continued to develop biological tests that will help in determining doses so that persons exposed to known or unknown amounts of radiation can be properly evaluated and treated. It is expected that the leukemia and bone-marrow transplantation will separate into two paths of investigation: One will be the evaluation of the treatment of acute leukemia by whole-body irradiation without the addition of bone marrow; the second will be further efforts to transplant bone marrow. It is hoped whole-body irradiation with bone-marrow transplantation may prove to be an effective form of treatment for certain cases of acute leukemia, and whole-body irradiation without bone-marrow transplantation may be used to good effect in other types of leukemia or widespread neoplasm without abnormality of hematopoiesis. Greater emphasis will be given to questions of distribution and metabolism of isotopes. Of secondary interests will be the continued training of physicians and scientists in the medical use of radioisotopes and teletherapy methods.

While, as stated above, no major expansion is anticipated, studies in whole body irradiation and bone marrow transplantation could result in a modest increase of 10% above the FY 1960 operating level of $1,150,000, with 40 scientific man years of effort.

LABORATORY PROGRAM FORECAST

UNIVERSITY OF CALIFORNIA - LOS ANGELES

The Atomic Energy Project at the University of California at Los Angeles was established in 1947 in conjunction with the appointment of Dr. Stafford Warren as Dean of the newly created School of Medicine on the Westwood Campus. Dr. Warren who had been one of the founders of the Medical Department of the Manhattan District was thus able to carry on his ideas of the position of nuclear medicine in the general field of medical research and teaching. Experience has proved his concepts to have been remarkably accurate.

With the assistance of the then recently formed Atomic Energy Commission, a few surplus wooden barrack buildings were converted into laboratories, offices and animal quarters, and by mid-1948 the laboratory was in operation. Many of the early staff members have subsequently become faculty members of the School of Medicine, while others have gone into numerous fields of practical medicine.

Program-wise, the AEP-UCLA has been concerned with three main lines of research: environmental contamination; effects of radiation on the mammal; and instrumentation for biologic research. The program typically has dealt with a broad examination of the various facets of each of the above categories rather than a detailed penetration of an academic field in its relation to radiation. In addition, the program has had a distinctly programmatic outlook and has consistently resulted in data, techniques and equipment of special value to many aspects of the AEC as a whole.

This project is currently in the process of a major reorganization under new leadership. The next few years should see a gradual reorganization and reorientation of its program, with special reference to studies in mammalian radiobiology with a more definite programmatic tone. The exact lines of development will be defined according to the programmatic needs of the Commission and the talents of the staff.

The FY 1960 operating level is $1,600,000. A substantial portion of the anticipated increase in support is represented by the indirect costs related to the occupancy of the new building.

LABORATORY PROGRAM FORECAST

UNIVERSITY OF TENNESSEE-AEC PROJECT

The exposure of a number of cattle to radiation from prompt radioactive fallout from the historic Alamogordo nuclear detonation focused attention on the need to evaluate the effects of both external and internal radiations on animals of economic value. Accordingly, the University of Tennessee-AEC Project was established in May, 1948 to investigate these problems and others affecting agriculture. A large proportion of the effort has been directed towards research on agriculturally beneficial applications of radiation and radioactive isotopes.

Current research concerns nutrition and metabolism of fission products, methods of removal or minimizing radiocontamination in farm animals and animal products, and effects of external radiations, both acute and chronic, with special emphasis on effects on physiology of reproduction. The need for more data concerning fission product metabolism and removal of isotopes such as strontium-90 from milk and perhaps other foods is paramount. There are great voids in present information on radiation effects on fertility and sterility. It is essential that these programs be expanded at both national laboratories and universities. A major expansion in plant science radiobiological research is planned, along with coordinated expansions in plant science research in the Biology and Health Physics Divisions at the Oak Ridge National Laboratory. This Laboratory serves as a center for all Southeastern Agricultural Experiment Stations in our program on beneficial applications of radiations to economic crop breeding. A relatively steady level of this activity is planned. **Perhaps a 15% increase above the FY 1960 level of $560,000 could be anticipated.**

LABORATORY PROGRAM FORECAST
AEC HEALTH AND SAFETY LABORATORY - NEW YORK

The Health and Safety Laboratory was organized in 1947 to advise the Commission on matters relating to the identification, evaluation and control of hazards arising from the processing and fabrication of nuclear and other toxic materials in atomic energy operations. Of particular significance during the first years of operation of the Laboratory were industrial hygiene and health physics studies of the use of beryllium, uranium and thorium in feed materials plants which led to standards of control for these hazardous elements. The Laboratory staff served as consultants in the establishment of the health physics programs at Fernald, Mallinkrodt, and elsewhere.

Following the fallout of "radioactive snow" over portions of New York State resulting from test operations in Nevada in the winter of 1952, the Laboratory was requested to monitor the area for radioactivity on an emergency basis. This led to the establishment of a network of fallout monitoring stations which was first extended throughout the United States, and then throughout the world in cooperation with other agencies of the United States government and with members of the United Nations Scientific Committee on the Effects of Atomic Radiation. The Laboratory continues to perform a key role in the Commission's program to estimate the amount and distribution of fallout from weapons tests.

The expanded program of construction and operation of high energy particle accelerators also presented problems of health and safety, and the Laboratory has engaged in research, development and field investigations of radiation hazards and their control in the vicinity of these vital research installations.

In more recent years the Health and Safety Laboratory has added to its competencies a research program in the measurement of extremely low levels of radiation in the natural background and in deposits of radioactive materials in the biosphere. The Health and Safety Laboratory remains one of two Commission laboratories operated directly by its own employees. From an initial staff numbering approximately 15, the Health and Safety Laboratory has developed to a staff of 85 employees at the end of FY 1959, of whom about one-half are professional personnel and the larger portion of the remainder are technicians.

The Health and Safety Laboratory program embraces:

(1) Studies to identify and evaluate existing and potential hazards found in AEC and Contractor installations, involving: (a) mining and subsequent production processing of nuclear materials, (b) storage and handling of nuclear materials, (c) fabrication of components containing nuclear materials.

(2) Research and development on the health and safety aspects of accelerator design and operation.

(3) Development and application of methods to estimate the amount and distribution of deposited debris from weapons tests.

(4) Development and application of methods for the measurement of radiation at low dose rates, such as from natural background, in order to implement, (a) epidemiological studies of large populations, (b) accumulation of data as a basis for evaluating degree of environmental contamination in the neighborhood of reactors and other installations involving the use of atomic energy.

The above program is pursued under the guidance of the Director, Division of Biology and Medicine for the primary purpose of contributing to the maintenance of adequately safe conditions in laboratories and industrial plants owned by the AEC, as well as in privately owned installations operated under contract to the AEC. A number of the large establishments are provided with health physics or safety divisions which contribute effectively to the immediate control of radiation and general safety in the specific locations. The role of the Health and Safety Laboratory does not encroach upon the activities of local safety groups operated by and for the individual contractors. Instead, the Health and Safety Laboratory, which is the only laboratory of its type operated directly by the AEC, exerts its efforts toward developing guide lines and techniques for maintenance of health and safety in the atomic energy enterprises so that the principles and techniques developed can be utilized not only by the large and small establishments existing at present but also by the numerous industrial establishments which are expected to come into existence within the relatively near future.

The only portion of the program described above which probably should be emphasized less intensely within the next ten years is that dealing with the fallout problem (weapons test debris). On the assumption that henceforth no Nation engages in the testing of nuclear weapons under conditions which will contaminate the atmosphere, there will be a diminishing need to conduct routine sampling and analysis of fallout samples for the purpose of defining the status of fission product deposition. While it is difficult to estimate just when this effort could be reduced virtually to the disappearance point, it may be estimated that an impressive reduction in effort would be appropriate at the end of another ~~xxxxxxxx~~ five years. In this connection it should be emphasized that the techniques of collection and analysis of samples of fallout are applicable to those situations which would develop in the case of a severe reactor accident which resulted in the dissemination of fission products over a considerable portion of the landscape. As long as the Atomic Energy Commission maintains its preeminent position in the construction and operation of reactors it would appear that it will be the AEC's responsibility to maintain competence for evaluating the severity of reactor accidents.

At some time in the future other portions of the above program may become of more interest to private industry than to the Atomic Energy Commission. Just when this transition may occur is problematical, but probably industry's obligation and concern will not become preponderant with respect to that of the AEC within the next ten years.

If the assumptions stated above concerning the status of the fallout problem are correct, and a modest expansion is sustained for other HASL projects, the FY 1960 operating budget of $1,894,000 will not change materially.