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BASIC RESEARCH GROUP PAPER ON THE RESEARCH PROGRAM OF THE ATOMIC ENERGY COMMISSION

(A summary of presentation by Dr. Thomas H. Johnson, Director of the Division of Research, and Dr. John C. Bugher, Director of the Division of Biology and Medicine, AEC, to the Basic Research Group at its Second Meeting, on 9 April 1953.)

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THE RESEARCH PROGRAM OF THE ATOMIC ENERGY COMMISSION

On 9 April, 1953, Dr. Thomas H. Johnson, Director of the Division of Research, AEC, and Dr. John C. Bugher, Director of the Division of Biology and Medicine, AEC, presented to the Basic Research Group at its second meeting the character and scope of the research program of the Atomic Energy Commission. The following is a summary of the highlights of the AEC research program.

I. ORGANIZATION OF RESEARCH IN THE AEC

Research in the Atomic Energy Commission plays a relatively more important role than it does in almost any other industrial enterprise of comparable size. The whole basis of the atomic energy project is barely out of the laboratory. New materials are used under unusual conditions of high temperature and high radiation densities. Many aspects of the atomic energy program serve to demonstrate that the potential impact of research on the over-all program can be very great indeed.

In the drafting of the Atomic Energy Act of 1946 it was foreseen that research would be an important phase of the atomic energy program. The law explicitly directs the Commission to exercise its powers in such a manner as to insure the continued conduct of research and development activities in atomic energy by private or public institutions and persons, and to assist in the acquisition of an ever-expanding fund of theoretical and practical knowledge in the field. The Commission is not only directed to insure the continued conduct of research, but it is also directed to have a program of federally-conducted research at its own installations; and it is instructed to have a program for assisting and fostering independent research in these fields.

Research in the AEC makes its appearance organizationally in three ways: first, in the Division of Research, where the responsibility is vested for research not closely associated with the activities of other Divisions; second, in the Division of Biology and Medicine, where responsibilities are vested for the aspects of health and for research in uses of fissionable and radio-active materials for biological and medical studies; and third, in other Divisions where research is closely associated with developments in reactors, military applications, engineering, etc.

II. THE PHYSICAL RESEARCH PROGRAM

The physical research program of the Division of Research includes basic and applied physics, basic and applied chemistry, and basic and applied metallurgy. The research program is designed along two different lines of philosophy: (1) to look forward to the future and to provide a stronger foundation for our future potentialities; (2) to examine current effort and evolve improvements thereon.

A. The Off-Site and On-Site Components: The program is divided into "off-site" (external effort, mainly with universities) and "on-site" (internal effort, within AEC installations) with funding as follows:

	FY-52	FY-53	FY-54	Remarks
		$ Million	(Revised budget)	
Off-site	11.1	11.2	11.2	(a) 250 separate contracts with 90 Univ. and Research Institutions. (b) Largely basic, some applied (c) Includes funds transferred to ONR (2.7 for high-energy nuclear physics)
On-site	24.5	27.7	27.6	(a) Includes Rad Lab UC at Berkeley, Ames at Iowa, Oak Ridge, Argonne, Brookhaven (b) Los Alamos not included: entirely under Div. of Mil. Appl. (c) Practically no development in on-site program; emphasis at Rad Lab at Berkeley is on basic research.
TOTAL*	35.6	38.9	38.9	

* Program under cognizance of Division of Research.

There is a substantial amount of research at the Los Alamos Scientific Laboratory, in fact, a substantial amount of basic research; but administratively, it is felt that that work has to be conducted at an isolated laboratory. With respect to the other five laboratories listed (Rad Lab at Berkeley, Ames, Oak Ridge, Argonne, and Brookhaven), it should be understood that their operating budgets include funds for work other than research. For example, these laboratories do work in reactor development, weapons production and biology and medicine, etc. With respect to the classification of programs whether on-site and off-site, the distinction is made on the basis of the following criterion: If the AEC owns practically all the facilities (as Radiation Laboratory at Berkeley) and the total operation cost is paid by the Commission, then the laboratory is considered to be "on-site".

B. The Scope of the Physical Research Program: The combined off-site and on-site program has the following relative emphasis on research among three basic disciplines:

	FY-52	FY-53 $ Million	FY-54 (Revised Budget)	Remarks
Physics	17.6	18.1	18.1	Nuclear processes and forces, structure of nucleus.
Chemistry	12.2	14.7	14.7	Chemistry of special materials, ores and purification, corrosion; radiation damage, processing of nuclear fuels.
Metallurgy	4.2	4.6	4.6	Properties of new materials, molten states, solid state theory.
Other	1.6	1.5	1.5	Includes remaining portion of fellowship program; isotopes; mathematics (largely computers). Does not include fluid mechanics (considered to be closely allied to development).
	35.6	38.9	38.9	

The work in high energy nuclear physics is very extensive. There is joint support of 2.7 million effort by AEC and ONR. Some 75 accelerators in the United States are engaged in one way or another in this effort of the Commission. The nuclear properties program is also very large. The interest is in energy levels, radiation, fission, the shell structure and neutron cross sections, all kinds of particles and all kinds of energies. The one million-volt Vandegraff sees new horizons every day. The limitations are availability of funds and facilities. There is probably more non-programmatic research being done at the national laboratories than at the universities because of the exceptional facilities available.

C. Distribution of the Off-Site Program: The off-site program is administered through the medium of two types of contracts:

(1) The lump sum contract, in which the university or institution contributes substantially to the cost;

(2) The cost contract where the commission pays the full cost.

There is currently a total of 250 contracts of both types, with the cost type predominating. The average duration of a contract is one year, with one or two renewals of most contracts.

The distribution of funds invested in off-site contracts has broadly these characteristics: $7 million are invested in contracts whose annual amounts run $60,000 or over; and $5 million are invested in contracts amounting annually to $50,000 or less. The number of contracts peaks at the annual rate of $5,000 to $10,000.

D. Procedure in Selection of Contractors: The procedure involved in selection of a university contractor (or an institution) is as follows:

(1) The university formally submits a proposal.

(2) The proposal is reviewed for

(a) Competence of the scientist
(b) Commission interest in the project and its feasibility
(c) Research environment in which the scientist will work.

(Investigators are favored who have a good basic understanding in science, who have been productive, interested and enthusiastic, who have ability to supervise people if the project will involve supervision, and who show promise of providing a high quality of training to students working under the investigator.)

(3) If the Commission is interested in the proposal, the decision is made whether the research is programmatic or non-programmatic in character. If non-programmatic, it is usually treated for award on lump sum contract basis, providing for 8% overhead. If programmatic, it is usually treated for full cost re-imbursement. This, however, is not a set Commission policy; it is present operating convenience. It is also extremely difficult to distinguish between programmatic and non-programmatic research, so that generally the practicalities of the matter enter the decision.

(4) In reaching a decision of interest, there is an inclination to favor the institutions who have performed in the field previously and who have demonstrated the ability to do research. The main goal is to get good research accomplished in the fields of AEC interest. The point of view of promoting general research capabilities in the United States, including scientific manpower, although heartily endorsed by the Commission, is considered to be one of the main missions of

the National Science Foundation.

E. The Major Policy Problems: The point of view of the Commission is definitely in support of a specific mission --- atomic energy, including weapons development as related to national security and industrial power. Is the AEC, therefore, the right agency to support so much basic research? If the program were solely to produce industrial power, the program of AEC would surely be much smaller. The size and scope of the basic research program in atomic energy which is authorized is largely dependent on the weapons development aspect. Yet this work, although vital to the weapons program, should go on whether we need the weapons or not.

Is it right to concentrate so much of the research in the national laboratories, or would there be more research for the betterment of the country if more funds were put into the universities? The national laboratories are exceptionally competent in carrying out the research programs; and there has been a tremendous growth in this competence over the past six years or so. But could the current level of basic research at the national laboratories sustain itself without some practical objective, and would these exceptionally capable research teams hold together without some guiding motive?

What is the future of high energy physics? This is a field that has grown rapidly, in terms of complexity, people involved, and funds required. A large investment is in the accelerators required, and this poses additional considerations: Should the machines be at universities, at national laboratories, or at central sites?

Are research reactors devices for university campuses? These devices are relatively safe, but expensive (about $1 million): they are useful in many fields — physics, chemistry, metallurgy, geology, engineering.

III. THE PROGRAM IN BIOLOGY AND MEDICINE

Historically the program of the Division of Biology and Medicine grew from a beginning in the bio-medical and health programs of the Manhattan Engineering District to a program of sizeable extent which is now found in each of the major laboratories of the AEC, involving an appreciable effort of major consequence in a limited number of institutions engaged in the on-site program; and an extensive university and independent laboratory research activity in the off-site program. This latter program now involves over 400 projects with approximately 250 institutions; this means that this program gets into the smaller grants than those of the Division of Research. It also reflects the fact that a great deal of biological research can be conducted with a very minor outlay for equipment.

The program in biology and medicine is not sharply divided into basic and applied research. Estimates of the basic components would run from 10 to 30% of the total program; and the balance might be termed applied research.

The biology and medicine program is concerned with the effect of nuclear reactions upon living structures: the effect upon men, animals, and plants directly; and secondary effects through modification of the environment.

From the broad perspective, the program can be considered to have certain positive and certain negative aspects. The negative aspect is that of keeping people from being hurt, or insuring that the right people get hurt. This aspect involves all those problems associated with danger, damage to living things, radiation hazards, chemical hazards, or more generally the protection of health and well-being of living things almost from the time of location of a vein of ore and minerals to the time the fission reaction has been completed. The positive aspect is how, to our social betterment, to utilize our developments for long-term peacetime values --- values to be attained entirely apart from the immediate weapon and security requirements.

The funding of the over-all program in biology and medicine, by off-site and on-site components, is as follows in $ millions:

	FY-52	FY-53	FY-54	Remarks
Off-site	6.3	7.0	7.5	Univ. under contract
On-site	17.2	18.2	19.1	Facilities owned by AEC, or operated by Univ. or other as contracting agency.
TOTAL	23.5	25.2	26.6	

As an example of the biological and medical component in the program of a large national laboratory, out of a total of $11 million for all activities at Brookhaven, the medical program runs about $0.9 million and the biological about $0.6 million.

One very serious aspect of the health problem is generated by the long delay between unwitting ingestion of radioactive materials and the ultimate physiological manifestations which sometimes run an induction period of 10 to 15 years or so. A second aspect is associated with reactors, which in addition to the immediate hazard, intensifies the health problem through the fission products resulting which, besides their physiological effects, may also enter the agricultural picture of the country and food consumed by man. A third aspect is associated with weapons tests and the fall-out from experimental detonations. A fourth aspect is associated with individuals in the reproductive period who, when exposed cumulatively to radiation, have an increase in the normal mutation rate. This has

generated a very broad program in genetics: The genetics of viruses, of bacteria, of protozoa, molds, plants, lower forms of animal life, and finally man himself.

On the positive side the program is aimed at long-term values in which the atomic bomb is merely a contemporary incident. As one example, the Commission finds itself dealing with substances which are peculiarily liable to the induction of cancer, and on the other hand, having facilities of very broad application to the problem of cancer therapy. From a sense of special interest and responsibility, the Commission owns and operates four cancer research hospitals and facilities:

(1) The Argonne Cancer Hospital, operated by the University of Chicago (58 beds).

(2) The Brookhaven Hospital (20 beds) having primary interest in the application of reactor methods to cancer therapy.

(3) Oak Ridge Hospital (28 beds) having a primary interest in cancer therapy using mass accumulation of radioactive isotopes.

(4) University of California Medical School Radiological Laboratory at the University of California Medical Center, San Francisco.

These programs in cancer research are operated in close coordination with the American Cancer Society, the Public Health Service, and others.

Another aspect on the positive side is the large interest in agriculture, involving tracer techniques in the development of knowledge concerning fundamental plant physiology and fertilizer utilization. Programs in animal husbandry are also underway, involving genetics and the effects of radiation.