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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

CIVIL DIVISION

B-165117

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Dear Dr. Schlesinger:

The General Accounting Office has reviewed selected aspects of the chemistry research program of the Atomic Energy Commission (AEC). The review was directed toward developing information concerning the manner in which the program was being managed and toward evaluating the administrative practices exercised by AEC and two of its contractor-operated laboratories--Lawrence Berkeley Laboratory (LBL) and Oak Ridge National Laboratory (ORNL).

During fiscal years 1970 and 1971, operating costs for the chemistry research program amounted to about $53.9 million and $51.4 million, respectively. Program operating costs applicable to LBL and ORNL are shown below.

	Fiscal year 1970	Fiscal year 1971
	(millions)	
LBL	$10.0	$10.0
ORNL	13.8	13.5

Our review showed that certain aspects of the administration and management of the chemistry research program appeared to be quite similar to aspects of the administration and management of AEC's biomedical research program which was the subject of our report to the Joint Committee on Atomic Energy on "Administration and Management of the Biology and Medicine Research Program" (B-165117, April 16, 1969).

The administration and management of both the biomedical and the chemistry programs are carried out by AEC Headquarters, although the actual research for both programs is conducted through onsite and offsite programs. The onsite biomedical and chemistry programs are carried out at AEC's national laboratories

and at other contractor-operated laboratories located at universities and other institutions.

The offsite programs are performed under research contracts awarded primarily to educational institutions, supporting individual scientists or small groups of scientists. At the national laboratories covered in our reviews, the laboratory directors had management responsibility for their programs; individual principal investigators were responsible primarily for selecting their own research projects.

Some of our observations with respect to the biomedical research program were: (1) the laboratories were not required to report cost data at the research-area level, although, with one exception, such data was accumulated by the laboratories, (2) no formal systematic method for establishing research priorities for the onsite program existed either at AEC Headquarters or at the laboratories, and (3) the potential existed for strengthening review procedures for ongoing research programs.

We made several suggestions consistent with our observations, which were designed to improve AEC's procedures for providing information concerning the direction and results of the biomedical research program. According to AEC action has been taken in accordance with those suggestions.

The following sections discuss our observations with respect to the chemistry program concerning the (1) use of cost information, (2) establishment of research priorities, and (3) reviews of chemistry research activities by AEC and the laboratories. The contents of this report have been discussed with representatives of AEC, and their comments have been incorporated into the report.

POTENTIAL FOR GREATER USE OF COST INFORMATION AT THE RESEARCH-SUBDISCIPLINE LEVEL

The Office of the Assistant Director for Chemistry Programs in the Division of Physical Research at AEC Headquarters has responsibility for the administration and management of

the chemistry research program and for the formulation of the chemistry portion of AEC's annual request to the Congress for physical research funds. During the annual budget preparation process, the Division of Physical Research obtains from the laboratories justifications for proposed chemistry research and estimates of the costs to be incurred for each research area which consists of one or more specific projects.

The information submitted by the laboratories identifies for each research project the prescribed AEC budget activity involved; the related research subdiscipline under the budget activity is specified in most instances or is readily discernible from other information contained in the narrative material describing the proposed research. Five prescribed budget activities are used for identifying the types of research conducted in the chemistry program. As shown below, three of these activities are categorized further into a total of 13 subdisciplines which are used for giving more definitive descriptions of the research included in the related activities.

1. Nuclear, Structural, and Inorganic Chemistry:

   Heavy-element chemistry
   Nuclear chemistry
   High-temperature chemistry
   Structural and theoretical chemistry
   Inorganic chemistry

2. Radiation, Isotope, and Physical Chemistry:

   Radiation chemistry, hot-atom chemistry, and photochemistry
   Physical chemistry
   Isotope-effects chemistry
   Analytical chemistry

3. Systems and Materials Chemistry:

   Nuclear-engineering chemistry
   Separations chemistry

Systems-radiation chemistry
Reactor-materials chemistry

4. Special Projects

5. Preparation and Purification of Special Isotopes for Research

Officials in the Office of Chemistry Programs have advised us that, in arriving at the amount of the Division of Physical Research budget request for the chemistry program, they (1) consider the expected overall level of financial support for the chemistry program, (2) review the budget documents provided by the laboratories, (3) assess the adequacy of the laboratories' programmatic justifications and funding estimates for the proposed research, (4) classify the funding estimates for each laboratory according to subdiscipline and budget activity, and (5) make adjustments to these estimates. Decisions concerning the amount of adjustments to the subdiscipline and budget activity allocations are arrived at by these officials on the basis of their experience, judgment, and knowledge of the research conducted at the laboratories.

The amounts approved by AEC for chemistry research are shown in the financial plans which AEC provides to the laboratories at the beginning of the budget year and at various times during the year as changes occur. The amounts are shown by budget activities and do not provide specific guidance to the laboratories concerning the level of effort or amounts which, in AEC's judgment, should be spent on each of the related subdisciplines, where applicable.

Division of Physical Research officials have advised us that the laboratories' management is responsible for determining the most appropriate level of effort and funding for each research project and, in some instances, for each subdiscipline. AEC has advised us that its financial controls require that a laboratory not exceed the total amount shown in the financial plan for chemistry research.

Both LBL and ORNL allocate the amounts shown in the approved financial plans to research projects, accumulate actual-cost and man-year data by such projects, and report these costs internally on a monthly basis. The cost information available at LBL and ORNL also identifies, where applicable, the related chemistry subdiscipline involved, or the subdiscipline usually is discernible from such information.

AEC, however, does not require that the laboratories include in the monthly cost reports submitted to AEC the actual costs incurred by subdisciplines. AEC requires, instead, that costs be reported by the five budget activities.

In our prior report on the biomedical research program, we pointed out that officials in AEC's Division of Biology and Medicine reviewed each proposed research area and made adjustments to the estimated costs shown in arriving at the Division's total budget request. In view of this fact, we suggested that the Division of Biology and Medicine also advise the laboratories of the amounts which the Division allocated to each research area and that the Division require the laboratories to report actual costs periodically at that level. In a letter to the Joint Committee on Atomic Energy dated March 2, 1971, the AEC Assistant General Manager for Research and Development, in commenting on this matter, stated that:

> "*** a number of the GAO recommendations for the management of the DBM [Division of Biology and Medicine] program are considered most timely and appropriate for the current budget year and the future outlook. For example, DBM requested that the laboratories report costs at the research area level (Forms 189) for mid-year review and end of budget year review purposes. The reporting of these costs covering the current FY 1971 mid-year review proved to be quite useful in DBM's program evaluation process and should be equally useful for the same purpose at the end of the budget year."

Therefore we suggested that AEC's Office of Chemistry Programs consider whether similar benefits could be derived

by adopting procedures for using cost data at the research-subdiscipline level, where appropriate, similar to those procedures adopted by the Division of Biology and Medicine for using cost data at the research-area level.

AEC has advised us that the Office of Chemistry Programs has agreed to explore with the laboratories the mechanisms that might be used to provide guidance at the subdiscipline level and the benefits that may be derived therefrom.

ESTABLISHMENT OF RESEARCH PRIORITIES

The AEC Office of Chemistry Programs has implemented a systematic method for establishing research priorities in awarding offsite research contracts. This method consists of rating research proposals on the basis of several factors to determine the priority of the proposals.

In regard to the onsite program, however, AEC had not implemented a systematic method for establishing research projects. According to AEC priorities are established via a continual exchange of technical and programmatic considerations between AEC Headquarters staff and laboratory management and reflect the judgment and experience of both staffs.

In commenting on a similar situation in our prior report on the biomedical research program, we stated that the potential existed for providing a more systematic method of selecting new research areas through the use of separate budget submissions by the laboratories, which would cover the requested funding for (1) projects under way and (2) proposed new projects in the order of priority determined by the laboratories.

The AEC Assistant General Manager for Research and Development, in his March 2, 1971, letter, stated:

> "*** DBM has adopted a more formal and systematic procedure for determining high priority research areas and method for approval of projects. DBM

> has not only conducted an extensive internal review of these matters, but is in the process of meeting with each laboratory director to discuss program needs and priorities."

Similarly we suggested that the Office of Chemistry Programs consider making a review of its procedures for identifying program needs and priorities with a view toward establishing a more formal method of selecting research projects for the onsite chemistry program.

In commenting on our suggestion, AEC has pointed out that, although the Division of Biology and Medicine may resemble in its operation the Division of Physical Research, certain of the biomedical programs suggest modes of operation that are directed more to specific objectives and thus lend themselves to more formal and systematic procedures for determining high-priority research areas. AEC stated:

> "The Division of Physical Research, however, in its Chemistry Programs emphasizes basic research, where the stress is on exploratory studies of fundamental phenomena and preservation of the necessary freedom to shift directions rapidly on the basis of experimental results."

We recognize that there are inherent differences between the types of research being conducted in the chemistry program and in the biomedical research program and that, on the whole, biomedical research may have more elements which are directed toward specific objectives than does the chemistry program. We note, however, that certain elements of the chemistry program similarly appear to have well-defined objectives. For example, the descriptive material contained in the President's budget for fiscal year 1971 contains the following statement regarding the chemistry program's Preparation and Purification of Special Isotopes for Research activity which in fiscal year 1971 was funded at about $7 million.

> "The objective of this activity is to produce and distribute stable isotopes, radioactive isotopes

> and high purity elements which are not produced by other Commission programs nor are available from other sources. These materials are required for the conduct of research on the chemical, physical, metallurgical and nuclear properties of the elements and isotopes. They may also be used for biological and medical research."

In addition, according to AEC's budget descriptive material, studies of the chemistry of materials and of systems of importance to the nuclear fuel cycle and thermonuclear reactors are conducted under the chemistry program's reactor-materials chemistry subdiscipline. The Office of Chemistry Programs allocated more than $2 million of its fiscal year 1971 budget to this subdiscipline.

AEC has agreed that certain elements of the chemistry program are directed toward relatively specific objectives but that the primary emphasis of the program is on basic research. AEC has pointed out that its experience has shown that the most effective management of basic chemistry research will employ a minimum of formal procedures and/or quantitative systematic evaluation.

AEC has agreed, however, that, in the event that more applied and/or developmental activities similar to those of the biomedical research program are undertaken by the Office of Chemistry Programs, AEC certainly will give further consideration to the potential administrative benefits to be derived from establishing a more formal method of selecting research projects for the onsite chemistry program in accordance with program needs and priorities.

REVIEWS OF CHEMISTRY RESEARCH ACTIVITIES BY AEC AND LABORATORIES

We noted a number of differences in the manner in which the chemistry research activities of the laboratories were being reviewed by laboratory and AEC management officials.

For example, at LBL both the Inorganic Materials Research Division and the Nuclear Chemistry Division conducted

annual reviews for AEC program officials, covering the research activities carried out in each division. With respect to the Inorganic Materials Research Division, scientists from other research laboratories, universities, and private industry attended the annual reviews, participated in audience discussions, and often raised probing questions of a critical nature. The questions raised by outside scientists and the responses to such questions given by the laboratory's scientists afforded AEC the opportunity to hear a balanced evaluation of the laboratory's program, which assisted AEC in its evaluation of the program.

The annual review of LBL's Nuclear Chemistry Division, however, did not involve participation by scientists outside LBL and was conducted more informally than the annual review of the Inorganic Materials Research Division. The review consisted primarily of AEC staff discussions with several investigators and observations of their equipment in operation during a tour of the laboratory's research facilities.

At ORNL each laboratory division performing chemistry research activities employs an external advisory committee composed of several prominent scientists who are not from AEC. Each advisory committee, together with appropriate AEC staff, attends the annual information meetings of the appropriate division for the purpose of evaluating the division's program and reporting its observations to both the division and the laboratory directors. The advisory committee members also engage in discussions with scientists concerning areas in which mutual interests exist and provide occasional advice on an informal basis.

Also at ORNL the laboratory director appointed an ad hoc committee for the purpose of evaluating the quality of chemistry research and its relevance to AEC's mission. The division directors responsible for the laboratory's chemistry programs were designated to serve on the committee which was chaired by the Associate Laboratory Director for Basic Physical Sciences. We were advised that the committee had begun

its review in April 1970 and that by July 1970 its evaluation of most of the chemistry research programs had been completed.

According to ORNL officials the ad hoc committee rated the individual research projects and investigators on the basis of the quality of work performed and mission relevance, and its August 1970 report contained recommendations relating to individual scientists and research projects. An ORNL official stated that the committee's recommendations probably would be implemented through selective reductions and increases in the level of funding for the various research projects involved.

In our prior report on the biomedical research program--and in a report to the Chairman, AEC, dated May 13, 1970, on selected aspects of the management of the high energy physics research program (B-159687)--we emphasized the desirability of AEC's giving consideration to the variety of organizational arrangements, program administration techniques, and review procedures in effect at the laboratories and of encouraging an interchange of information regarding the administrative techniques proved effective at one laboratory that could be considered for use by other laboratories. For example, we noted in our report on biomedical research that the University of Rochester had employed, on a formal, continual basis, a procedure for rating individual research projects under its AEC-sponsored program. Certain features utilized by the University of Rochester were somewhat similar to ORNL's ad hoc committee review and evaluation of chemistry research projects.

We suggested in our report on the biomedical research program that AEC encourage other laboratories to adopt formal project-rating systems to provide laboratory management with a systematic means of periodically evaluating the quality of individual research efforts. We also stated in the report that AEC could review the results of such evaluations to ensure that, in those instances in which research quality was found to be in need of improvement, appropriate corrective action was taken.

In his March 2, 1971, letter, the AEC Assistant General Manager for Research and Development stated:

> "*** DBM has recently completed an evaluation of the quality of its individual research projects both from the standpoint of scientific excellence or weakness and their relative pertinency to the program of the AEC. These findings are being made available to the laboratory directors to permit a strengthening of the DBM research program on a mutually acceptable basis."

We suggested similarly that, for the chemistry research program, AEC evaluate the various review practices used by the laboratories, particularly reviews involving participation by outside visiting scientists and ORNL's ad hoc committee review of chemistry research quality, to determine whether certain of the practices had desirable features suitable for application at other laboratories.

In response to this suggestion, AEC stated:

> "In regard to GAO's suggestion on laboratory review practices, we have been informed by the Director of LBL that the President of the University of California [contractor for the Lawrence Berkeley Laboratory] has recently established an outside scientific review committee to review and evaluate all the research programs conducted by LBL, including Chemistry. This committee will report directly to the President of the University. LBL believes that this committee review, in addition to present informal reviews, will provide more than sufficient information to evaluate the Nuclear Chemistry Research Program at LBL. Thus the review pattern of the nuclear chemistry program at LBL will be carried out in a manner similar to that at the other national laboratories, e.g., Argonne, Brookhaven, and Oak Ridge. As a result of greater attention to reviews of the programs at the

laboratories by independent review committees, the management role of Headquarters will be reinforced and the vitality of the laboratories' programs will be enhanced."

AEC has advised us that, although the above-mentioned review committee has not met, it understands that the committee will make in-depth evaluations of the chemistry research program at LBL.

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We appreciate the courtesies and cooperation extended to our representatives during the review. We would like to be advised of any additional actions planned or taken with respect to the matters discussed in this report.

Copies of this report are being sent to the Director, Office of Management and Budget, and to the Chairman, Joint Committee on Atomic Energy.

Sincerely yours,

A. T. Samuelson

Director, Civil Division

The Honorable James R. Schlesinger
Chairman, Atomic Energy Commission 743