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REPORT TO THE JOINT COMMITTEE ON ATOMIC ENERGY
CONGRESS OF THE UNITED STATES

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Management Of The Atomic Energy Commission's Controlled Thermonuclear Research Program

B-159687

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BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

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DEC. 8, 1972

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-159687

Dear Mr. Chairman:

This is our report on the management of the Atomic Energy Commission's controlled thermonuclear research program. The report was prepared in accordance with a request dated February 1, 1972, from the Vice Chairman of your Committee.

The report has been discussed with representatives of the Atomic Energy Commission, and the Commission's comments have been incorporated in the report.

Copies of this report are being sent to the Vice Chairman of your Committee; the Director, Office of Management and Budget; and the Chairman, Atomic Energy Commission.

We believe that the report will be of interest to other committees and members of the Congress. Therefore, as agreed to by the Committee, we are distributing the report to such other committees and members of the Congress.

Sincerely yours,

Elmer B. Staats

Comptroller General
of the United States

The Honorable John O. Pastore, Chairman
Joint Committee on Atomic Energy
Congress of the United States

Contents

ABBREVIATIONS

AEC	Atomic Emergy Commission
ATC	adiabatic toroidal compressor
CTR	controlled thermonuclear research
FM-1	floating multipole
GAO	General Accounting Office
IMP	injection microwave plasma
OROO	Oak Ridge Operations Office

COMPTROLLER GENERAL'S REPORT TO THE JOINT COMMITTEE ON ATOMIC ENERGY CONGRESS OF THE UNITED STATES

MANAGEMENT OF THE ATOMIC ENERGY COMMISSION'S CONTROLLED THERMONUCLEAR RESEARCH PROGRAM B-159687

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WHY THE REVIEW WAS MADE

From fiscal year 1951 through fiscal year 1972, the Atomic Energy Commission (AEC) incurred costs of about $449 million in the Controlled Thermonuclear Research program. (See p. 8.)

In November 1971 AEC told a subcommittee of the Joint Committee on Atomic Energy that this program was entering a new phase and would require greater expenditures of funds in the near future. (See p. 17.)

In view of the program's substantial costs, the General Accounting Office (GAO) decided to examine into AEC's management of the program. The Joint Committee requested a report on the results of GAO's review, including information on AEC's efforts and the role of its advisory committee--the Controlled Thermonuclear Research Standing Committee--in controlling and coordinating the efforts of contractors involved in the program. (See app. I.)

Background

AEC supports the program which is conducted under research contracts at AEC-owned, contractor-operated laboratories and at universities and other institutions. (See pp. 7 to 10.)

The overall objective of the program is to develop a major source of energy from controlled thermonuclear fusion to help solve this Nation's energy problem. (See p. 5.)

Work within the various research areas in the program generally involves fabrication and operation of major experimental devices, to find suitable solutions to scientific and technical problems. (See p. 28.)

FINDINGS AND CONCLUSIONS

AEC has established various mechanisms to control and coordinate efforts of contractors responsible for conducting the program, to insure that such efforts are consistent with program objectives. These mechanisms include:

--Reviews by the standing committee and ad hoc technical panels relating to ongoing and planned program efforts. (See p. 18.)

--Establishment of research priorities. (See pp. 21 to 23.)

--Technical evaluations of research proposals submitted by universities and other institutions. (See pp. 24 to 26.)

AEC's technical evaluations of research proposals and advice from its standing committee appear to provide AEC with useful mechanisms for controlling and coordinating the program.

In establishing research priorities, it would be useful if AEC would document and communicate to each

DEC. 8, 1972

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devices which require AEC's review and approval before fabrication.

--Require, as part of this rule, that any proposed device which is a revision or modification of a previously disapproved device, regardless of the estimated cost of the revised device, be subject to AEC's review and approval before fabrication. (See p. 42.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

AEC agreed with GAO's recommendations and said that it was taking the action necessary to insure their implementation. (See p. 42.)

CHAPTER 1

INTRODUCTION

The necessity of supplying large amounts of electrical energy for the future needs of our society has become an issue of national importance. According to Federal Power Commission projections, the demand for electrical energy will double every 10 years from 1970 to 1990. Accompanying this increasing demand is the problem of finding sources of energy which will not pollute the environment.

In a message to the Congress on June 4, 1971, the President of the United States stated:

> "A sufficient supply of clean energy is essential if we are to sustain healthy economic growth and improve the quality of our national life. I am therefore announcing today a broad range of actions to ensure an adequate supply of clean energy for the years ahead."

Part of the President's plan to facilitate the development of clean energy included increased emphasis on research in fusion power. The President stated that:

> "For nearly two decades the Government has been funding a sizeable research effort designed to harness the almost limitless energy of nuclear fusion for peaceful purposes. Recent progress suggests that the scientific feasibility of such projects may be demonstrated in the 1970s and we have therefore requested an additional $2 million to supplement the budget in this field for Fiscal Year 1972. We hope that work in this promising area will continue to be expanded as scientific progress justifies larger scale programs."

GOALS AND APPROACHES TO CONTROLLED THERMONUCLEAR RESEARCH

AEC's goal in the Controlled Thermonuclear Research (CTR) program is to develop a major source of energy from controlled thermonuclear fusion. Controlled thermonuclear fusion occurs when certain light atoms, which are heated to a high temperature in a confined region, collide and rearrange themselves to form a smaller mass with a consequent release of energy. When the atoms collide, they shed their electrons and become charged ions. The resulting mixture of electrons and charged ions is a fully ionized gas, often referred to as the fourth state of matter--the plasma state.

The essential fuel material for fusion is a form of a hydrogen atom, called heavy hydrogen or deuterium, which is present in all natural water. In theory, the amount of energy produced by the fusion of the deuterium nuclei (the small, positively charged cores of atoms) present in 1 gallon of water is equal to that obtainable from the combustion of 300 gallons of gasoline. The enormous amounts of water available on earth represent a virtually inexhaustible potential source of energy. AEC has stated that a fusion powerplant appears to have important environmental advantages.

--Combustion products are not released to the atmosphere.

--The final-reaction products are nonradioactive.

--Fusion powerplants will be inherently safe against explosive or runaway reactions.

--Increased efficiency may be possible by converting fusion power directly into electricity, which would reduce thermal pollution.

Thus fusion power represents a potential solution to this Nation's anticipated energy problems.

Some of the scientific and technical problems which are being studied by scientists in an effort to find suitable solutions to controlled thermonuclear fusion are:

1. Applying heat sufficient to achieve a sustained rate of energy production that is greater than the energy loss through radiation.

2. Developing the most suitable and stable magnetic confinement field. Confinement is essential to sustain a fusion reaction.

3. Removing plasma impurities which cause plasma to escape from its magnetic confinement.

4. Increasing plasma density.

The basic requirement for controlled fusion is the adequate confinement of plasma in the temperature range of one hundred million to a billion degrees. Because no solid material can exist at these temperature ranges, the fabrication of CTR devices using magnetic fields to confine the plasma has been emphasized.

Two basic approaches to magnetic confinement are (1) the open system and (2) the closed system. These two approaches, upon which all CTR devices are based, are illustrated in the drawings, obtained from AEC, on page 9.

The open system is one in which plasma is trapped in a roughly tubular region of space through the use of magnetic fields that are much stronger at the ends of the tube than at its center. The strong end-fields reflect plasma back into the central-field region, and therefore these systems are referred to as magnetic mirrors.

The closed, or toroidal, system is characterized by plasma confined in magnetic fields that are contained within a toroidal, or doughnut-shaped, volume.

COSTS OF CONTROLLED THERMONUCLEAR RESEARCH

AEC's efforts in CTR began in fiscal year 1951. As shown in the schedule below, AEC's accumulated costs for the CTR program through fiscal year 1972 amounted to about $449 million.

Fiscal year	Operating	Equipment	Construction	Total
	(millions)			
1951 to 1966	$241.9	$10.5	$16.3	$268.7
1967	22.4	1.5	-	23.9
1968	24.7	1.8	.1	26.6
1969	26.5	1.6	1.6	29.7
1970	27.7	2.0	4.6	34.3
1971	28.3	2.2	1.8	32.3
1972	31.0	1.5	.7	33.2
Total	$402.5	$21.1	$25.1	$448.7

The above data includes CTR costs incurred under AEC's onsite and offsite research programs. Under the onsite program, substantially all costs of the research activities are incurred at the following four AEC-owned, contractor-operated laboratories.

Lawrence Livermore Laboratory, operated by the University of California.

Princeton Plasma Physics Laboratory, operated by the Princeton University.

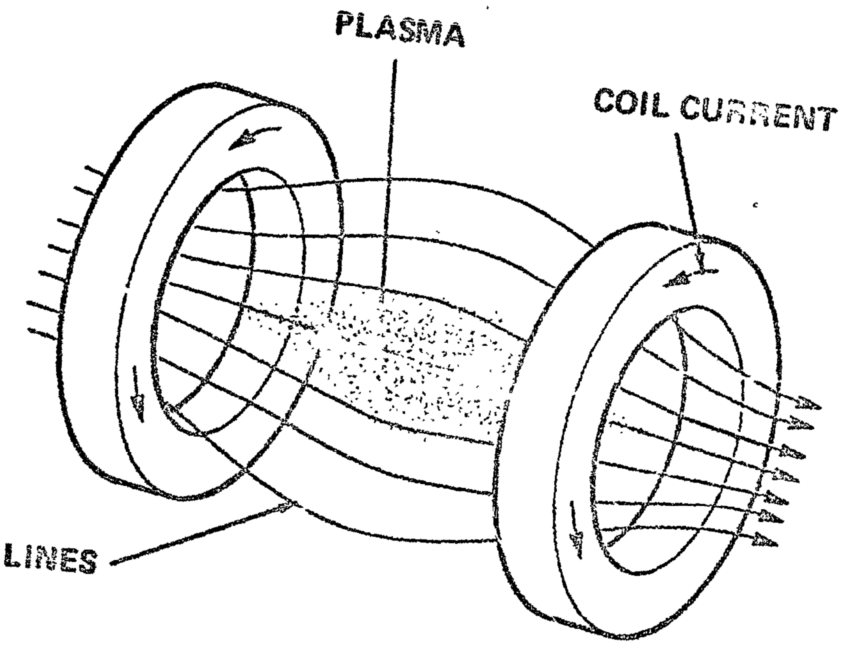
Oak Ridge National Laboratory, operated by the Union Carbide Corporation.

Los Alamos Scientific Laboratory, operated by the University of California.

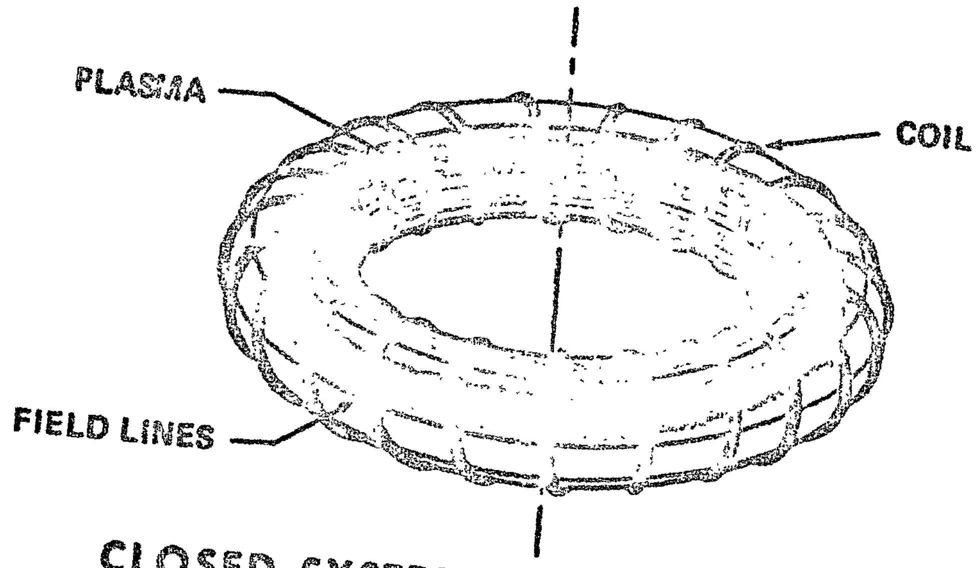
These four laboratories are referred to in this report collectively as the CTR laboratories.

AEC's offsite research program is carried out under contracts with universities or other institutions supporting individual scientists or small groups of scientists. The amount of financial support provided by AEC through contracts for the offsite research conducted by these scientists usually supplements the support provided by their respective institutions.

MAGNETIC CONTAINMENT CONFIGURATIONS



OPEN SYSTEM - SIMPLE MAGNETIC MIRROR



CLOSED SYSTEM - SIMPLE TORUS

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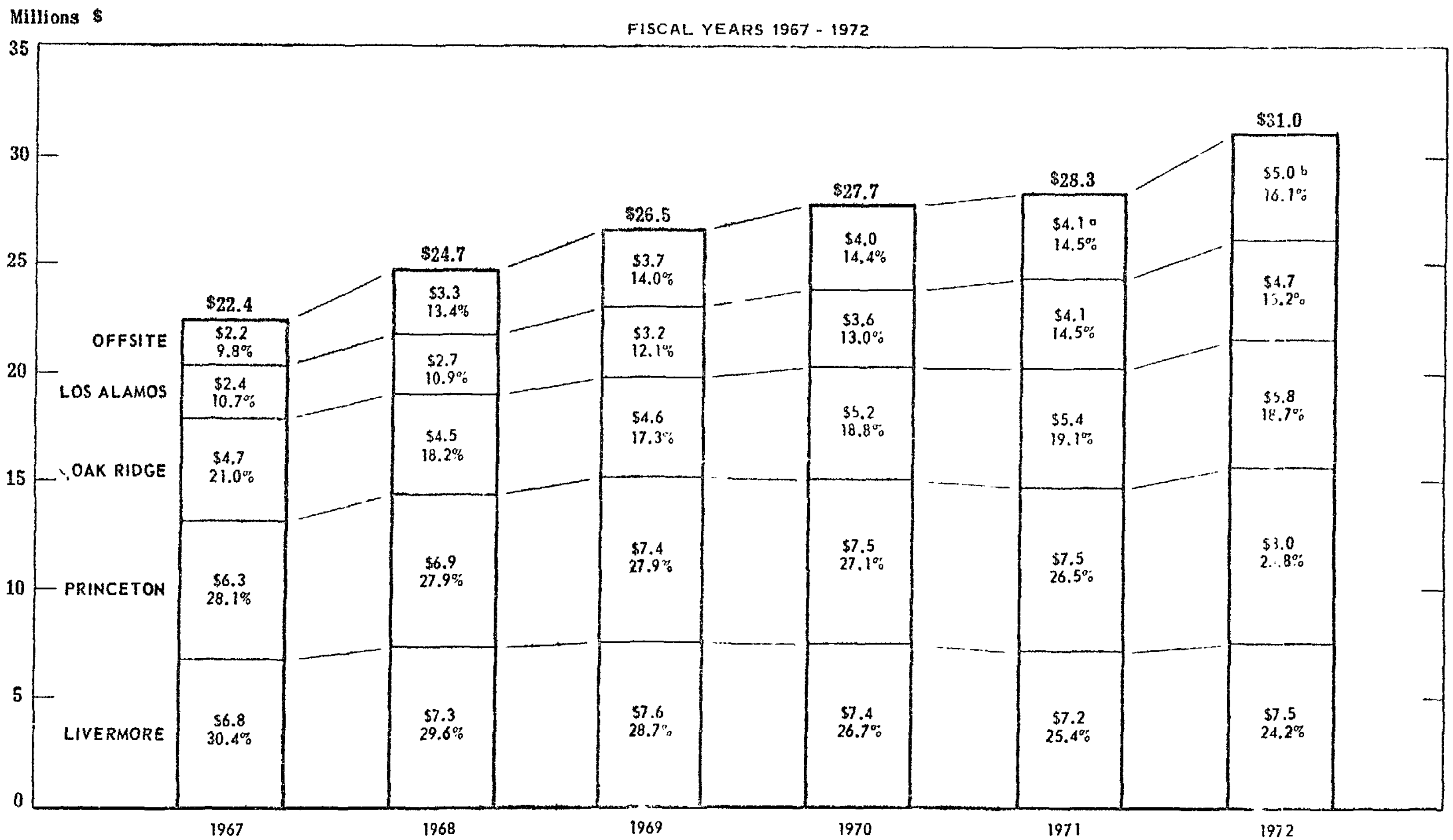
The chart on the following page shows the amount and percent of operating funds provided by AEC to the CTR laboratories and to contractors in the CTR offsite program from fiscal year 1967 through fiscal year 1972.

AEC'S CONTROLLED THERMONUCLEAR RESEARCH PROGRAM

ACTUAL OPERATING COSTS

(In Millions)



[a] Includes support of $15,000 to Brookhaven National Laboratory and $35,000 to Argonne National Laboratory.
[b] Includes support of $63,000 to Brookhaven National Laboratory and $127,000 to Argonne National Laboratory.

ORGANIZATIONAL STRUCTURE FOR ADMINISTERING CTR PROGRAM

Prior to December 7, 1971, the Assistant Director of CTR, Division of Research, had overall responsibility for the administration and management of AEC's CTR program. The Director, Division of Research, in turn, reported to the Assistant General Manager for Research and Development.

On December 7, 1971, AEC established a separate Division of CTR and transferred the functions of the Office of the Assistant Director of CTR, Division of Research, to this new division. Under the reorganization, the Director, Division of CTR,[1] reports directly to the Assistant General Manager for Research (formerly the Assistant General Manager for Research and Development).

According to AEC, the Division of CTR was established in view of the increased emphasis being placed on the development of fusion as a new source of energy. The functions of the Division of CTR include planning, development, coordination, and supervision of programs for research on, and development of, controlled thermonuclear reactions and the related fields of science and technology to achieve the goal of fusion power.

Prior to August 29, 1972, the Division of CTR consisted of a director and a staff of five professionals. The Director of CTR told us that each staff member was responsible for certain areas of CTR research or program elements.

AEC told us that, in line with the increased emphasis placed upon CTR within AEC, the Division of CTR was reorganized effective August 29, 1972. Three offices were established, each headed by an assistant director, to assume responsibility for the three major elements of the CTR program:

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[1] For ease of expression, both the Assistant Director for CTR, Division of Research, and the Director, Division of CTR, are referred to in this report as the Director of CTR.

Confinement Systems, Development and Technology, and Research. AEC said that in the near future the Division of CTR would be increased to 12 technical and professional staff members.

The Division of Physical Research (formerly the Division of Research) provides administrative support services to the Division of CTR. AEC's field operations offices provide contract administration for the CTR program.

The laboratory directors and associate directors, whom AEC considers to be experts in their respective fields, are responsible for managing the day-to-day research activities at the CTR laboratories.

The Division of CTR at AEC Headquarters is responsible for managing the CTR offsite program, including approving AEC support and reviewing and evaluating the technical progress of the research projects. AEC's operation offices negotiate and administer the nontechnical aspects of the contracts.

ACCOMPLISHMENTS OF AEC'S CTR PROGRAM

AEC provided us with the following description of the highlights of accomplishments of the CTR program, grouping them into three general areas--achievement of thermonuclear temperatures, confinement results, and technological advances.

> "Achievement of Thermonuclear Temperatures:
>
> "In the first years of the controlled-fusion research program one of the major goals was to achieve in the laboratory plasma temperatures of 60,000,000 to 80,000,000^{o}C which are necessary for fusion reactions. This goal was achieved in 1963, in a Scylla, theta pinch device, at the Los Alamos Scientific Laboratory. This test resulted in the release of fusion energy: 370 watts of fusion power during the three-millionths of a second duration of the test."

"Confinement Results:

"A major portion of the fusion research effort in the 1960's was devoted to finding means of confining plasmas in both open and closed systems. In the early 1960's both major classes of magnetic confinement systems were plagued with plasma 'instabilities' which lead to unsatisfactory confinement conditions. Substantial progress in identifying and minimizing the effect of instabilities has been made.

"By 1964, a gross type of instability (discovered in the 1950's) was found to be controllable. The cure was based on the use of specially wound and shaped magnetic coils.

"In 1969, fine grained instabilities which were believed to cause unusually rapid loss of plasma in closed systems, were controlled in a class of devices known as multipoles. Confinement very close to 'classical' or the best possible was observed in an off-site experiment at Gulf General Atomic in a large toroidal octupole device, and similar results were observed at the Princeton Plasma Physics Laboratory in the spherator shortly thereafter.

"In the ST Tokamak (closed systems) at Princeton, it has been verified that it is possible to confine a plasma of near thermonuclear temperature and density in such a way that, if similar behavior is observed in the larger plasmas necessary for fusion reactors, then the confinement time would be adequate for a practical fusion reactor."

"Technological Advances:

"Progress towards fusion has often resulted when new technological advances have permitted the production of plasmas in new ways, under cleaner conditions or in a more understandable (i.e. better diagnostics) fashion. In fact, technology as well as new physical insight has played an important role in defining where and how the experimental research program can be pursued. Some important technological developments have been:

"(a) The storage, switching and ultra-fast delivery of large blocks of electrical energy.

"(b) The generation in complex geometries of large and strong magnetic fields, both pulsed and steady-state, super-conducting and non-superconducting.

"(c) The achievement of extremely high vacuums for large chambers.

"(d) The development of intense, precisely focused beams of ions or neutral atoms for plasma production and heating.

"(e) The extension of optical, microwave, laser beam and electrical measurement techniques to the special problems of diagnosing the plasma state.

"(f) The development of advanced computational techniques and computational soft ware has made possible simulation of the plasma state on a digital computer. Computer 'experiments' performed on large digital computers have given quite accurate representations of some actual physical experiments performed in the laboratory.

"(g) The generation of intense laser and electron beams."

Although there have been accomplishments in the CTR program that, according to AEC, will assist in demonstrating the scientific feasibility of fusion power, AEC has stated that some of the more important technical questions still remain unanswered and that several steps are needed beyond the achievement of scientific feasibility to develop a fusion reactor for commercial use. During hearings before the Subcommittee on Research, Development, and Radiation of the

Joint Committee on Atomic Energy in November 1971, AEC described the major phases envisioned in the development of commercial fusion power as:

> "A basic fusion plasma research and developmental phase in which research experiments to produce, heat, contain, and study thermonuclear plasmas are conducted in parallel with the development of associated fusion technologies."
>
> "A scientific feasibility phase in which experiments are constructed and operated which attempt to reach 'break even' fusion plasma conditions (minimum values of density, temperature, and plasma confinement time) in laboratory configurations which lend themselves to development into net power producing systems. Fusion fuels need not necessarily be used in these experiments. The program is beginning to enter this phase now. It should be noted that the scientific feasibility experiments for fusion are of an entirely different nature from the zero power Stagg Field experiment of 1942 which demonstrated the scientific feasibility of fission reactors. Proof of scientific feasibility of fusion is highly technology dependent, very much more costly, but with the advantage that when it is accomplished, some of the most difficult technical problems will have been overcome."
>
> "An experimental reactor phase in which one or more experimental reactors, designed to use fusion fuels and to produce net energy in a useful form (steam or electricity) would be constructed and operated."
>
> "A prototype or demonstration reactor phase in which one or more electric power producing units, including all of the elements of a commercial power plant, would be built and operated. Successful operation of a demonstration plant would be a prelude to commercial sales."

CHAPTER 2

MECHANISMS FOR CONTROLLING AND COORDINATING EFFORTS IN CTR PROGRAM

During hearings in November 1971 before the Subcommittee on Research, Development, and Radiation of the Joint Committee on Atomic Energy on the status of the CTR program, AEC advised the Subcommittee that the program was entering into the scientific-feasibility phase in its evolution and would require greater expenditures of funds in the near future. AEC also stated that the United States, with appropriate increases in funds and no major scientific roadblocks, should be able to demonstrate the scientific feasibility of controlled fusion before 1980[1] and to pave the way for practical fusion power before the turn of the century.

In a letter dated February 1, 1972, the Vice Chairman, Joint Committee on Atomic Energy, requested a report on our review of the CTR program, including information on AEC's efforts in controlling and coordinating the various organizations responsible for conducting the program. The request was made pursuant to the Committee's continued interest in examining into the management of the CTR program in view of the large amount of funds already spent for the program and the potential for future funding levels significantly higher than present levels.

Accordingly we have placed particular emphasis on reviewing AEC's efforts and the mechanisms it uses to control and coordinate the research activities of the CTR laboratories, universities, and other organizations engaged in CTR. Our comments concerning such efforts and mechanisms are contained in the following sections.

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[1] AEC has advised us that, on the basis of a detailed study completed subsequent to the November 1971 hearings, it is now more proper to state that the demonstration of scientific feasibility of fusion can occur sometime in the next 10 years.

INDICATIONS OF PRIOR PROBLEMS IN CONTROL AND COORDINATION OF CTR PROGRAM

In June 1966 AEC issued an "AEC Policy and Action Paper on Controlled Thermonuclear Research" which was based on its evaluation of the CTR program and the findings of a review panel established by AEC to review the program. The review panel consisted of prominent scientists and engineers from universities, industry, and Government.

The policy and action paper pointed out that the entire effort in the U.S. CTR program unquestionably had been hampered by a lack of effective coordination and cooperation among the CTR laboratories. It also stated that the CTR program consisted of activities of a number of scientific and technical groups whose work was mutually interdependent and that, in view of the limited amount of total funding available, it was essential that this interdependence be recognized and that coordination and cooperation between personnel in the program be sufficient to insure that what was eventually pursued had been duly considered by others having related interests in the program.

The policy and action paper also pointed out that a number of large, new experimental devices were urgently needed and that careful consideration would have to be given to the choice of new projects to be supported and to the continued effectiveness of those in existence. AEC established a CTR Standing Committee and provided for creating subordinate ad hoc panels, to furnish guidance on these and other matters and to insure effective coordination of the efforts within the overall program.

CTR STANDING COMMITTEE AND AD HOC PANELS

The CTR Standing Committee comprises the project directors from each of the four CTR laboratories and four prominent scientists selected from the scientific community as a whole. The AEC Director of CTR is chairman of the committee. The functions of the CTR Standing Committee, which meets quarterly, usually at one of the four CTR laboratories, include:

1. Reviewing the areas of research being conducted.

2. Assessing the overall program balance as viewed in the context of the national and worldwide programs.

3. Evaluating the scientific significance and productivity of program elements.

4. Identifying major questions requiring immediate attention and research areas critical to the success of the program.

5. Advising the Division of CTR on these matters and recommending how available and projected funds can most effectively be used to carry out AEC's CTR program.

The ad hoc panels are created from time to time to review specific programs or proposals, to insure that the scientific and technical bases for such programs or proposals are as sound as possible. In their review, the panels consider similar research already performed and prepare reports which include recommendations concerning the adequacy of the programs or proposals reviewed. Thus the panels serve in the capacity of technical advisors to the CTR Standing Committee. According to the policy and action paper, each panel is to include a representative from each of the four CTR laboratories, who are appointed by the laboratory's project director, and several other representatives who are appointed by the Director of CTR.

AEC'S EFFORTS TO CONTROL AND COORDINATE FABRICATION OF MAJOR CTR DEVICES

According to Division of CTR officials, research emphasis is on exploring and testing physics questions to find suitable solutions to those scientific and technical problems which must be resolved to achieve the goal of scientific feasibility. This generally involves fabricating and operating experimental CTR devices.

The Director of CTR told us that from the spring of 1966 AEC had required the CTR laboratories to obtain its approval before starting the fabrication of major devices. He said that a major device was any new device or modification of an existing device the total cost of which was estimated by the CTR laboratories to be $500,000 or more and that generally this requirement was referred to as the $500,000 rule.

Although AEC has not stated the requirements under this rule in writing, the Director of CTR told us that the rule had been orally communicated to the CTR project directors at the CTR laboratories and that they had agreed to abide by it.

According to the Director of CTR, the CTR laboratories are responsible for initiating and submitting written proposals for major devices covered by the rule to AEC Headquarters for review and approval. Generally, in deciding whether to approve the fabrication of major CTR devices for which proposals were submitted by the CTR laboratories, AEC has followed the practice of obtaining independent scientific and technical evaluation assistance. These evaluations have been made by the CTR Standing Committee and, in some cases, by the ad hoc panels.

Since 1966 eight ad hoc panels have been formed by the Director of CTR with the advice and/or consent of the CTR Standing Committee. The Director of CTR has told us that a decision to create an ad hoc panel largely depends on whether AEC and the CTR Standing Committee feel that they need additional technical expertise on a given matter.

Each ad hoc panel which was formed to review a laboratory's proposal to fabricate a device reported on its evaluation and recommended whether the proposed device should be approved, modified, or disapproved.

In its review of a laboratory's proposal, the CTR Standing Committee considered the recommendations of each ad hoc panel, along with such other factors as the impact of the proposed device on other projects at the laboratory and on the CTR program as a whole, and made recommendations to AEC regarding the proposal. AEC told us that it had considered the recommendations of the CTR Standing Committee in making the final decision on the laboratory's proposal.

ESTABLISHMENT OF RESEARCH PRIORITIES

In its efforts to control and coordinate the CTR program, AEC's practice is to establish research priorities and to communicate them to the CTR laboratories.

According to the Director of CTR, research priorities are informally established by (1) a continual exchange of technical and programmatic information between AEC Headquarters staff and laboratory management and (2) periodic reviews of each laboratory's CTR program by the CTR Standing Committee. Although some AEC priorities have been documented and communicated to each of the CTR laboratories, the overall CTR program priorities and the bases used by AEC in determining such priorities have not been documented and communicated.

In contrast to AEC's informally establishing research priorities, the CTR Standing Committee, on two occasions after its inception in 1966, formally recommended research priorities for the overall CTR program to AEC. The Committee established these priorities on the basis of its ranking of each major research area or CTR device according to several factors, such as the potential of the research area or device for yielding results which would help accomplish CTR goals.

The Director of CTR told us that the CTR Standing Committee's ranking of research priorities was as of a fixed point in time and that, in his opinion, the existing informal system of considering priorities on a continual basis was more useful as a management tool. He explained that unexpected events occur during the year and that the existing informal system continually provides him with information which could indicate a need to shift priorities on particular areas of research or experimental devices as such events occur.

CTR officials told us that the rankings made by the CTR Standing Committee and, more importantly, the priorities identified through less formal means provided AEC with a mechanism for convincing the laboratories to reduce or eliminate their efforts on low-priority research areas or devices and/or to increase their efforts on high-priority areas or devices. AEC said that these priorities were communicated to the laboratories in written guidance accompanying the CTR laboratories' approved budgets at the beginning of each budget year.

As an example, AEC Headquarters' guidance to Oak Ridge Laboratory in a June 1971 letter accompanying the Laboratory's budget for fiscal year 1972 stated that:

> "During FY [fiscal year] 1972 the ORMAK [Oak Ridge tokamak-type device] experiment will be the most important single element of the U.S. CTR program, and therefore of the *** [Oak Ridge Laboratory] program. We expect that the highest priority will be given to conducting, as rapidly as possible, the scientific experiments for which it was designed.
>
> "We hope that in FY 1972 *** [Oak Ridge Laboratory] will begin to place a major emphasis on fusion reactor materials, technology, and engineering studies; thereby taking advantage of the unique capabilities which exist throughout the laboratory, and seizing the opportunity to become a major force in this direction."

The letter, however, did not indicate AEC's assessment of CTR priorities for the other work being performed at Oak Ridge Laboratory or for the work being performed at the other CTR laboratories. AEC's basis for assessing

Oak Ridge's tokamak as the number one priority project in the CTR program also was not indicated in the letter.

Thus the written guidance provided by AEC to a particular laboratory did not identify AEC's overall alignment of research priorities for the CTR program but rather identified only those priorities, or parts thereof, applicable to that laboratory.

MECHANISMS USED FOR CONTROL AND COORDINATION OF OFFSITE RESEARCH PROGRAM

The offsite research program is carried out under contracts primarily with educational institutions supporting individual scientists or small groups of scientists. These contracts usually are awarded for a period of 1 year and may be renewed for additional annual terms. As of June 30, 1971, the CTR offsite research program had outstanding 43 approved contracts amounting to about $4.5 million. The following table shows the number of approved contracts by the dollar level of AEC support.

Dollar level of AEC support	Number of contracts
$ 0 to $ 49,999	26
50,000 to 99,999	8
100,000 to 249,999	5
250,000 to 499,999	2
500,000 and over	2
	43

We examined into the mechanisms exercised by AEC for insuring that the work by offsite research contractors was being controlled and coordinated in a manner consistent with meeting overall program objectives.

We noted that certain aspects of the offsite research program were discussed during the quarterly meetings of the CTR Standing Committee and that the Committee occasionally advised AEC on major proposals submitted by offsite research contractors. The Director of CTR told us that the main consideration relating to the control and coordination of the offsite research program was deciding which offsite research proposals should be supported. He said that such decisions were based primarily on (1) the results of technical reviews by peers in the scientific community, (2) the evaluation of the proposal by the staff of the Division of CTR, and (3) the needs of the CTR program within the limits of available funding.

Following is a table showing the number of offsite research proposals that required evaluation by the Division of CTR during fiscal year 1971 and those which were either approved or disapproved.

	New proposals		Renewal proposals		Total	
On hand July 1, 1970	26		7		33	
Received during fiscal year	39	65	41	48	80	113
Less proposals acted upon:						
Approved	3		39		42	
Disapproved	41	44	3	42	44	86
On hand June 30, 1971		21		6		27

In deciding whether to support offsite research proposals, it is the Division of CTR's practice to submit the proposals to peers in the scientific community either at the CTR laboratories or at other offsite research contractors' locations for technical review and written comment. CTR officials told us that this practice was extremely valuable in their technical evaluation of research proposals because in many cases the written comments they received from the external reviewers often identified critical issues concerning such proposals.

According to CTR officials, the extent to which the external review practice is used depends upon whether the proposed research was a new proposal or a renewal proposal for research previously approved and funded by the Division of CTR.

CTR officials told us that, in deciding whether a new proposal should be submitted for external review, they determined whether the proposal would be seriously considered for support, assuming that it received favorable external review comments. They said that the main consideration in making such a determination was the relevance of the proposal to the CTR program and that those proposals which did not meet that test were disapproved without obtaining external review.

Also we were told that renewal proposals were reviewed each year by the staff of the Division of CTR and generally were submitted for external review about every 3 or 4 years. They stated that a renewal proposal probably would be subjected to external review if the proposed research involved a major change in scientific direction or if additional research was being proposed.

AEC said that, in determining which renewal proposals to support, it also considered information obtained during its periodic monitoring of the ongoing research of its offsite research contractors. According to the Director of CTR, this monitoring is accomplished through (1) conversing with the contractor at technical meetings, (2) reviewing technical reports and articles submitted by the contractor, (3) making site visits, and (4) reviewing progress reports which are submitted by the contractor with its renewal proposal approximately 3 months before the expiration date of the contract.

AEC provided us with examples of new and renewal proposals which had been submitted for external review. In reviewing the records relating to these examples, we noted that in many cases AEC had sent the external review comments to the proposers for information and/or comment without identifying the reviewers. AEC told us that this practice often was very useful because it afforded the proposer the opportunity to strengthen the proposed research work or to rebut those comments which might be incorrect.

CONCLUSIONS

The reviews made by the CTR Standing Committee and the ad hoc panels and the resultant advice provided to AEC appeared to have provided AEC with an additional mechanism for insuring coordination and cooperation within the CTR program.

AEC's practices and procedures relating to its review and evaluation of offsite research proposals and the overall monitoring of the CTR program by the CTR Standing Committee appear to be useful to AEC in controlling and coordinating the research efforts in the CTR offsite research program. Because of the scientific and technical factors involved, we could not evaluate the decisions made by AEC regarding its approval of offsite research proposals.

Regarding the establishment of research priorities by AEC, we believe that it would be useful to the CTR laboratories if AEC would document, and provide each laboratory with, its complete ordering of priorities as well as the bases used in arriving at such priorities. In this way the laboratories could receive the benefit of AEC's rationale and judgment underlying its ordering of priorities. Also, in conjunction with the overall ranking of priorities, the laboratories could use such knowledge to further align their ongoing, as well as planned, research programs.

In commenting on this matter on August 29, 1972, the Acting Director of CTR told us that it was his express intention to periodically review and evaluate CTR program priorities and that such reviews and evaluations, along with the resultant ordering of priorities, would be formally communicated to the CTR laboratories.

With respect to the $500,000 rule concerning AEC approval of fabrication of major devices, we believe that, conceptually, this mechanism could be highly useful to AEC in insuring that the fabrication of research devices and the related research programs which are to be conducted using such devices are consistent with CTR program objectives. We believe, however, that there is a need for improved guidance to the CTR laboratories and field offices on application of the $500,000 rule. The needed improvements and our recommendations are fully discussed in chapter 3.

CHAPTER 3

OPPORTUNITY TO IMPROVE CONTROL OVER AND COORDINATION OF FABRICATION OF MAJOR CTR DEVICES

The work within the various research areas of the CTR program generally involves fabricating and operating major experimental devices to find suitable solutions to scientific and technical problems. Because of the emphasis placed on the need to control and coordinate decisions to fabricate such devices, in 1966 AEC established the $500,000 rule requiring the CTR laboratories to obtain AEC approval of any new device or device modification estimated to have a total cost of $500,000 or more before starting its fabrication.

As discussed previously, one of AEC's objectives in establishing the CTR Standing Committee was to provide an independent evaluation of the scientific significance and productivity of research areas, to assist AEC in achieving overall program balance. In deciding whether to permit the fabrication of proposed CTR devices, AEC's practice has been to obtain the advice of the CTR Standing Committee.

Since the establishment of the $500,000 rule in 1966, the CTR laboratories have fabricated 13 major devices at an estimated total cost of about $19 million from operating funds. Each of these devices had a final estimated cost of $500,000 or more, as follows:

Laboratory	Device	Date operational	Estimated final cost (note a)
Livermore	Baseball II	June 1971	$ 2,500,000
	2X I Modification (2X II)	Jan. 1971	1,350,000
	Superconducting levitron	June 1971	800,000
	Astron Modification I	Feb. 1968	500,000
	Astron Modification II	Dec. 1968	1,250,000
	Astron Modification III	Oct. 1970	500,000
Princeton	Stellarator Modification III	July 1970	766,000
	Adiabatic toroidal compressor (ATC)	May 1972	1,350,000
	Floating multipole (FM-1)	Apr. 1971	4,940,000
	Spherator	June 1968	525,000
Oak Ridge	ORMAK	May 1971	2,189,000
	Injection microwave plasma (IMP)	July 1969	1,062,000
Los Alamos	Scyllac	Apr. 1971	1,667,000
			$19,399,000

[a]Cost data furnished by AEC.

We examined the records relating to AEC's review and approval of these 13 devices to determine whether the proposal for fabricating each device had been submitted to AEC and subjected to the review mechanisms which consisted of technical and programmatic evaluations by AEC and the CTR Standing Committee. Our review showed that:

1. Proposals for fabricating three modifications at one laboratory had not been prepared and submitted to AEC for evaluation and approval because of the laboratory's interpretation of the $500,000 rule.

2. A laboratory fabricated a modified version of a device even though AEC had disapproved a proposal for the original device. AEC had disapproved the original proposed device because it appeared to AEC and the CTR Standing Committee that the device would duplicate an approved device at another laboratory.

3. A proposal for fabricating another device had not been prepared and submitted to AEC because the laboratory's initial cost estimate was less than $500,000. The final cost of the device was $525,000.

Our review also indicated that costs had been incurred toward fabrication of two of the 13 devices before AEC had granted approval. Some pre-approval fabrication costs had been incurred on these devices because (1) for one device AEC had not adequately communicated to its cognizant field office the intent of the $500,000 rule and (2) for the second device an administrative oversight had occurred due to the circumstances under which fabrication of the device had been started.

We believe that AEC should furnish additional guidance to the CTR laboratories and cognizant field offices on the application of the $500,000 rule, to provide improved control over the fabrication of major CTR devices.

LABORATORY INTERPRETATION OF $500,000 RULE AFFECTED SUBMISSION OF PROPOSALS

The Director of CTR told us that AEC intended that the CTR laboratories prepare and submit written proposals to AEC for those new devices or modifications to existing devices which were estimated by the CTR laboratories to have a total cost of $500,000 or more. The Director also said that this intent had been communicated to the project director at each CTR laboratory and that each laboratory had agreed to abide by the rule.

In discussing the rule with officials at the Livermore, Princeton, and Oak Ridge Laboratories, however, we found that different interpretations had been placed on the meaning of the rule.

For example, Livermore Laboratory officials told us that, traditionally, AEC had expected the Laboratory to provide scientific and technical direction for its programs and that they had therefore interpreted the $500,000 rule to mean that the Laboratory had the authority to decide, among other things, which devices should be fabricated as long as such fabrication could be funded within the Laboratory's normal operating budget. They also said that they did not consider modifications to existing devices which, in their judgment, did not involve significant changes in the scientific direction of the research to come under the $500,000 rule.

Thus, according to Livermore Laboratory's interpretation of the rule, AEC approval was required only for those devices which could not be fabricated within the Laboratory's normal operating budget and for those devices which would involve significant redirection of the research.

Princeton Laboratory officials advised us that they had interpreted the $500,000 rule to include any new device or modification of an existing device which they estimated would have a total cost of $500,000 or more. In addition, Princeton Laboratory's decisions to fabricate new devices or to modify existing devices are subject to a clause in the contract between Princeton University and AEC, which provides that Princeton Laboratory not initiate fabrication or alteration of equipment or devices that probably will cost $500,000 or more without the approval of AEC. Contracts at the other two laboratories included in our review, however, did not contain similar provisions.

In discussing Oak Ridge Laboratory's interpretation of the $500,000 rule, Laboratory officials told us that, because of the local procedures at Oak Ridge Operations Office (OROO), the rule did not require their interpretation. They explained that, in accordance with OROO procedures, the Oak Ridge Laboratory was required to prepare a proposal for each CTR device which the Laboratory estimated would have a total cost exceeding $50,000. They told us that each proposal, which included a cost estimate and a narrative description and justification for the device, was submitted to OROO for its review and approval and that, once the device was approved, OROO issued a directive authorizing the Laboratory to proceed with the proposed work.

OROO officials told us that, prior to approving a CTR proposal, they generally obtained the concurrence of AEC Headquarters, if, in their judgment, the device appeared to represent a change or redirection of the Laboratory program or the estimated cost was significant (exceeded about $100,000).

Since the establishment of the $500,000 rule in 1966, three major modifications have been made to devices fabricated by Livermore Laboratory for which proposals were not submitted to AEC for its evaluation and approval. Livermore Laboratory estimated the final costs of these three modifications as follows:

	Estimated final cost
Astron Modification I	$ 500,000
Astron Modification II	1,250,000
2X II	1,350,000

With respect to the fabrication of these three modifications, Livermore Laboratory officials told us that proposals had not been prepared for review and approval by AEC because they considered such decisions to be within the Laboratory's authority inasmuch as (1) the fabrication work involved modifications to existing devices that did not represent major changes in the scientific direction of the projects and (2) the modifications were funded from the Laboratory's normal operating budget.

LABORATORY FABRICATION OF A MODIFIED VERSION OF A DEVICE DISAPPROVED BY AEC

AEC's $500,000 rule does not require that any proposed device which is a revision or modification of a previously disapproved device, regardless of the estimated cost of the device, be subject to AEC's review and approval process before fabrication. The Livermore Laboratory decided to fabricate a modified version of one device which had been disapproved by AEC. The originally proposed device had been reviewed by the CTR Standing Committee and an ad hoc panel, and the Committee had recommended that AEC disapprove the original device.

The ad hoc panel which reviewed the device, the superconducting levitron, was appointed by AEC on December 30, 1966, to provide an assessment of low-beta toroidal research and to evaluate preliminary proposals to build new devices in that area of research. Livermore Laboratory's proposal for the levitron--a low-beta toroidal device--was submitted to AEC on April 1, 1967. Livermore Laboratory estimated that the cost to fabricate the device would be $1,184,000. At about the same time, Princeton Laboratory submitted a proposal for the fabrication of another low-beta toroidal device--the FM-1.

The ad hoc panel, which issued its report in September 1967, unanimously supported Princeton Laboratory's proposal to fabricate the FM-1. Although the panel made critical comments on several technical features of the levitron design, it did not make a direct recommendation as to whether it should be fabricated.

In September 1967 the CTR Standing Committee considered the two proposals and unanimously recommended the fabrication of the FM-1 device proposed by the Princeton Laboratory. With respect to Livermore Laboratory's proposed device, the Committee stated that:

> "The Standing Committee <u>does not approve fabrication of the superconducting levitron</u> at the present time, but the Committee feels free to consider the question again at a later date." (Underscoring supplied.)

In the foreword to the published ad hoc panel report, the Director of CTR stated that, on the basis of the ad hoc panel's report and the CTR Standing Committee's recommendation, Princeton Laboratory was authorized to proceed with the fabrication of the FM-1 but that it had been decided not to initiate fabrication of the levitron.

Livermore Laboratory, however, still maintained its interest in the levitron, and by June 1968 the Laboratory had nearly completed redesigning the levitron. Laboratory officials told us that the purposes of the redesign effort were to remove the major technical feature on which the ad hoc panel had expressed criticism and to lower the estimated cost to under $500,000 so that the decision to fabricate the device would fall within the Laboratory's authority. According to an internal Laboratory study, the redesign resulted, among other things, in lower cost and in simplicity.

On September 30, 1968, the Livermore Laboratory informed AEC that the Laboratory was proceeding with an inexpensive version of the levitron and that its construction would be funded from the Laboratory's normal operating budget. Livermore did not, however, provide AEC with a cost estimate or a proposal for the redesigned version of the levitron. An internal Laboratory cost estimate dated November 8, 1968, showed that the redesigned levitron was estimated to cost about $477,000.

By letter dated December 5, 1968, the Director of CTR transmitted to the CTR Standing Committee members the agenda for the next scheduled meeting of the Committee and advised the members that a major topic of discussion would be the recent decision by Livermore Laboratory to fabricate the levitron. In his letter the Director stated that:

> "At the same time that the *** [FM-1] was recommended by the Ad-Hoc Panel and the Standing Committee for construction *** a competing proposal from *** [Livermore Laboratory] (for the fabrication of a $1.2 m superconducting levitron, filled by neutral beam injection) was considered and turned down. Since that time *** [Livermore Laboratory] has continued its studies of a superconducting levitron with the stated intention of

perhaps proceeding with a less expensive experiment (i.e., *** [less than $500,000]) which would be built out of Normal Operating Funds.

"Recently, *** [Livermore Laboratory] has taken a definitive decision to proceed with the construction of a superconducting levitron. The size of this experiment is very comparable to that originally proposed; its cost, however, is estimated by *** [Livermore Laboratory] to be less than $500K [$500,000]."

* * * * *

"*** more by happenstance than by coordinated planning, we now find ourselves engaged in a major way in the construction of *** [similar-type devices] ***. In view of our limited resources and the wide variety of experiments which we wish to pursue, it is not clear to me that we are making optimum use of the funds and manpower available to us. *** it seems to me, however, that this should be a definitive decision reached within the framework of the Standing Committee, rather than by independent laboratory actions.

"I would like to stress that, if our effort is to be effective, we must retain--and indeed enhance--the overall program coordination which we have developed together over the past two years. Each CTR laboratory must continue to feel that the work underway at the other laboratories (and in the off-site program) makes the best possible sense from the point of view of the program as a whole. In the light of recent developments, I think it both desirable and essential to have an open and free discussion of these matters, and I will seek the advice of the Committee on how best to proceed in this area of low-beta toroidal research."

Minutes of the CTR Standing Committee meeting of December 12 and 13, 1968, showed that the levitron was extensively discussed.

In a December 1968 letter to the CTR Standing Committee, the Director of CTR summarized his concern with the levitron situation as discussed during the recent Committee meeting. He stated that, except for the one member from Livermore Laboratory and the one member from Princeton Laboratory, each Committee member had expressed concern as to whether it was desirable, from the point of view of the overall program, to fabricate both the FM-1 and the levitron. The Director stated in his letter that, despite the apprehensions and extensive discussion, there appeared to be no clear solution but to request Princeton and Livermore Laboratories to jointly consider the concerns of the CTR Standing Committee and to place primary emphasis not on the Laboratories' individual desires but on the needs of the overall effort in the area of low-beta toroidal research. The Director further stated that:

> "*** if Princeton and Livermore--after joint reflection on the issues *** conclude that the plans already underway constitute, in their minds, the most appropriate course of action, I will accept their judgment in this matter."

By letter dated February 17, 1969, Livermore Laboratory advised AEC that it was proceeding with the levitron. The Laboratory stated that:

> "As indicated to you by telephone recently, we have in the end decided to proceed with construction of the superconducting levitron essentially as planned. We have discussed this decision with the *** [Princeton Laboratory] staff, and they have had the opportunity to comment on the content of this letter. Of course, we take full responsibility for the decision. Cost figures now in do confirm our estimate that the <u>project lies within the jurisdiction of the Laboratory</u>." (Underscoring supplied.)

At the March 1969 meeting of the CTR Standing Committe, background documents summarizing the outcome of the levitron decision were provided to the members of the CTR Standing Committee. The minutes of that meeting contained the following statement.

"*** [the Director of CTR] expressed his continued misgivings but stated, as promised, that he would let the matter drop. A few remarks, both pro and con, on the issue of duplication were made by various members of the committee but the issue was not re-opened for formal consideration." (Underscoring supplied.)

According to Livermore Laboratory's accounting records, the levitron, which was completed in fiscal year 1971, cost about $850,000.

PROPOSAL NOT SUBMITTED BECAUSE INITIAL COST ESTIMATE OF DEVICE WAS LESS THAN $500,000

Under AEC's $500,000 rule, CTR laboratories are required to submit proposals to AEC for those devices estimated to cost $500,000 or more. AEC's rule, however, does not cover those devices which initially are estimated to cost less than $500,000 but which, because of cost growth resulting from price escalation, design changes, and other factors, eventually cost more than $500,000. During our review we noted that substantial cost growth had occurred during the fabrication of several major devices approved by AEC.

Princeton Laboratory initiated fabrication of one major device--the spherator--without submitting a formal proposal to AEC for review and approval. Princeton Laboratory officials told us that fabrication of this device began in the fall of 1966 and that at that time the Laboratory had estimated its fabrication costs to be $278,000. The final cost of the spherator amounted to $525,000.

The Director of CTR, in commenting on such situations, told us that he was considering establishing a procedure requiring the CTR laboratories to give AEC notification, along with a cost estimate, prior to fabrication of any device planned and estimated by the CTR laboratories to cost less than $500,000. In our opinion, such a procedure could be useful to AEC in controlling and coordinating the fabrication of a device in that it would give AEC an opportunity to determine whether, because of the nature of the device or the uncertainty of the cost estimate, such a device should receive AEC review and approval before fabrication.

FABRICATION COSTS INCURRED ON TWO DEVICES PRIOR TO AEC APPROVAL

We found indications that some costs had been incurred on the fabrication of two major devices--one at Princeton Laboratory and one at Oak Ridge Laboratory--before AEC approval had been given.

It appeared that the fabrication costs incurred before approval on the Princeton Laboratory's device--the ATC--were the result of a lack of communication of the intent of the $500,000 rule from AEC Headquarters to the cognizant AEC field office. It appeared that an administrative oversight had led to incurring fabrication costs on the Oak Ridge Laboratory's device--IMP--before AEC approval had been given.

ATC

Princeton Laboratory incurred costs amounting to about $86,000 on the fabrication of the ATC prior to its approval by AEC on February 8, 1971. These costs included $38,000 for constructing a control room and $48,000 for procuring special copper bars.

The construction of the control room was approved by the New York Operations Office[1] on May 21, 1970, pursuant to AEC's construction directive system which provided for the review and approval by AEC's operations office of certain types of construction activities.

The copper-bar purchase was approved by the AEC Princeton branch office of the New York Operations Office in accordance with AEC's procurement regulations which, in the case of Princeton Laboratory, required prior AEC approval for any purchase order exceeding $10,000.

The Director of CTR told us that AEC's field offices had not been advised of the intent of the $500,000 rule. Therefore, in the case of Princeton Laboratory, neither the Princeton branch office nor the New York Operations Office was required to ascertain from the Division of CTR whether fabrication of the ATC had been approved prior to approving the Laboratory's request to spend funds for constructing the control room and purchasing the copper bars.

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[1]Effective January 1, 1972, the functions and operations of AEC's New York Operations Office and its Chicago Operations Office were consolidated at Chicago.

IMP

On June 15, 1966, the Oak Ridge Laboratory, in accordance with established OROO procedures, submitted a proposal to OROO to build a magnetic-mirror-type device--the DCX-3--at an estimated cost of $254,000. According to an internal OROO memorandum, the proposal had been discussed with the AEC Division of Research which determined that no objections existed from a program standpoint. On June 27, 1966, OROO issued a directive authorizing DCX-3.

At its meeting in September 1966, the CTR Standing Committee expressed concern that Oak Ridge Laboratory's efforts on DCX-3 paralleled the efforts of another laboratory, and at a meeting in February 1967 the Committee recommended that the Oak Ridge Laboratory discontinue its efforts on DCX-3.

Subsequently the Oak Ridge Laboratory decided that DCX-3 would not be built but would be replaced by another device--IMP. According to the Laboratory, IMP also was a magnetic-mirror-type device but it involved a shift in emphasis from the DCX-3 concept. In May 1968 the Laboratory submitted a proposal to OROO to fabricate IMP, and on July 18, 1968, OROO issued a directive authorizing the Laboratory to begin fabrication.

OROO records indicated, however, that the Oak Ridge Laboratory had started fabricating IMP prior to its approval in July 1968. The AEC Headquarters and OROO records did not show when the Laboratory decided to discontinue its efforts on DCX-3 and to begin fabrication of IMP; key personnel at these locations were no longer available for comment at the time of our review. In commenting on this matter, the Oak Ridge Laboratory stated that:

> "In fact, the parts fabricated for DCX-3, involving vacuum tanks, control room, as well as calculations relating to stress analysis, were not discarded but were used in the IMP facility. Thus *** it was not possible to determine the exact date that the fabrication was discontinued on DCX-3 and begun on the IMP facility. The Laboratory's position is that fabrication on the

IMP facility began in June 1966 when IMP evolved from the DCX-3." (Underscoring supplied.)

Thus, because of the circumstances surrounding the fabrication of IMP, which, in essence, evolved from DCX-3, we could not determine the costs incurred on IMP prior to its approval by OROO.

CONCLUSIONS

AEC has mechanisms for achieving control over and coordination among the CTR laboratories in designing and fabricating major CTR devices and for fully evaluating the scientific merit of such devices prior to starting fabrication. We believe that the CTR Standing Committee has assisted AEC in meeting these objectives.

Our review, however, indicated a need for improved guidance to the CTR laboratories and field offices on applying the $500,000 rule, to provide greater assurance that CTR devices, which AEC intends to review and approve, are subjected to AEC's review process and approved before fabrication starts.

We believe that AEC should formally define, and communicate the requirements of, the $500,000 rule to its field offices and the CTR laboratories. Particular attention should be given to clarifying whether devices funded entirely from a laboratory's normal operating budget and proposed modifications to existing devices whose costs are estimated to exceed the monetary limit prescribed by the rule are to be subjected to AEC's review and approval.

Also AEC's rule should require that any proposed device which is a revision or modification of a previously disapproved device, regardless of the estimated cost of the revised device, be subject to AEC's review and approval before fabrication. This requirement should provide greater assurance that such a device is in line with program objectives because, under the review and approval process, AEC and the CTR Standing Committee can determine whether the device would contribute significantly to the needs of the overall program and therefore should be fabricated.

As previously noted, AEC has been considering establishing a procedure requiring the CTR laboratories to give AEC notification, along with a cost estimate, prior to fabrication of any device estimated to cost less than $500,000. We believe that such a procedure, together with the implementation of the following recommendations, should provide AEC with improved control over the fabrication of CTR devices.

RECOMMENDATIONS

We recommend that AEC:

1. Formally define and communicate to CTR laboratories and AEC field offices AEC's rule pertaining to CTR devices which require AEC's review and approval before fabrication.

2. Require, as part of this rule, that any proposed device which is a revision or modification of a previously disapproved device, regardless of the estimated cost of the revised device, be subject to AEC's review and approval before fabrication.

On September 21, 1972, AEC informed us that it agreed with our recommendations and that it was taking the action necessary to insure their implementation.

CHAPTER 4

SCOPE OF REVIEW

We made our review at AEC Headquarters in Germantown, Maryland, and at three AEC-owned, contractor-operated laboratories at the following locations.

Lawrence Livermore Laboratory, Livermore, California
Oak Ridge National Laboratory, Oak Ridge, Tennessee
Princeton Plasma Physics Laboratory, Princeton, New Jersey

Our review was made also at the following AEC operations offices or branch offices having cognizance over the three laboratories.

San Francisco Operations Office, Berkeley, California
Oak Ridge Operations Office, Oak Ridge, Tennessee
Princeton branch office of the Chicago Operations Office, Princeton, New Jersey

We directed our review primarily toward obtaining information on the efforts of AEC and its CTR Standing Committee in controlling and coordinating the activities of the laboratories, universities, and other institutions involved in the CTR program. We did not evaluate the quality of the research carried on under the CTR program.

During our review we examined pertinent documents and obtained the views of various AEC and laboratory personnel knowledgeable of, and responsible for, the administration and management of the CTR program.

Congress of the United States
JOINT COMMITTEE ON ATOMIC ENERGY
WASHINGTON, D.C. 20510

February 1, 1972

The Honorable Elmer B. Staats
Comptroller General of the
United States
Washington, D. C.

Dear Mr. Staats:

As you know, the development of power from controller thermonuclear sources would be a great aid to this country in solving its energy problems, particularly for the next century. In this regard, the AEC has been conducting a sizable research program directed toward achieving a controlled thermonuclear reaction. The Joint Committee's Subcommittee on Research, Development, and Radiation of which I am chairman, conducted two days of hearings on the AEC's fusion program on November 10 and 11, 1971, to examine the past efforts in the program and its future direction.

Because of the large amount already expended on the program--about $450 million--and because of the potential for future funding commitments at significantly higher levels than the present funding level, the Joint Committee will continue to have increased interest in the improvement of the AEC's controlled thermonuclear research program.

The Joint Committee staff recently met with members of your staff at which time the Committee staff was apprised of a review of the controlled thermonuclear research program which your office has been conducting over the past several months. Preparation and submission to the Committee of a report on that review would be of great assistance in the Committee's future consideration of this important program.

Page 2
The Honorable Elmer B. Staats

The Committee desires that the General Accounting Office report include information on AEC's efforts, including the role of the controlled thermonuclear research standing committee, in controlling and coordinating the efforts of the laboratories, universities, and other organizations involved in such research, along with any suggestions for improving the management of this program.

Sincerely yours,

Melvin Price
Vice Chairman

PRINCIPAL OFFICIALS OF THE ATOMIC ENERGY COMMISSION RESPONSIBLE FOR THE ADMINISTRATION OF ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
CHAIRMAN:		
Dr. James R. Schlesinger	Aug. 1971	Present
Dr. Glenn T. Seaborg	Mar. 1961	Aug. 1971
GENERAL MANAGER:		
R. E. Hollingsworth	Aug. 1964	Present
ASSISTANT GENERAL MANAGER FOR RESEARCH (note a):		
Dr. Spofford G. English	Aug. 1961	Present
DIRECTOR OF THE DIVISION OF CONTROLLED THERMONUCLEAR RESEARCH (note b):		
Dr. Robert L. Hirsch (acting)	Aug. 1972	Present
Dr. Roy W. Gould	Feb. 1970	Aug. 1972
Dr. Amasa S. Bishop	Feb. 1966	Mar. 1970

[a] Prior to December 7, 1971, this position was entitled "Assistant General Manager for Research and Development."

[b] Prior to December 7, 1971, this position was entitled "Office of Assistant Director for Controlled Thermonuclear Research, Division of Research."